GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G-3) FOR IRON ORE (HEMATITE) IN

MALANGTOLI 'E' SUB BLOCK

BONAI-KEONJHAR IRON ORE BELT

DISTRICT: SUNDARGARH AND KEONJHAR, ODISHA

Report submitted under the Mineral (Evidence of Mineral Content) Rules-2015 (Amended up to 2021)

TEXT, ANNEXURE AND PLATES

MINERAL EXPLORATION AND CONSULTANCY LIMITED

(Formerly known as Mineral Exploration Corporation Limited)

A Government of India Enterprises

CORPORATE OFFICE, NAGPUR

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MECL

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EXECUTIVE SUMMARY

1. NAME OF THE AREA

Malangtoli 'E' Sub Block, Bonai-Keonjhar iron ore belt district: Sundargarh and Keonjhar, Odisha.

2. LOCATION

Malangtoli 'E' Sub Block is located in Koira tehsil, Sundargarh district,Odisha. A small part of the block in the southeast corner falls in Keonjhar district. It lies between longitudes 85° 17' 16" and 85° 19' 59" and latitudes 21° 52' 57" and 21° 49' 59". The block covers an area of 12.68 sq km and falls within the Survey of India toposheet No 73G/5.

3. ACCESSIBILITY

The block is well connected with National Highway (NH) 20, which connects Panikoili and Ranchi via Keonjhar and Chaibasa, passes towards the east of the block at a distance of 20 km. In addition, it is also well connected with NH 520, which connects Rimuli to Rajmunda via Joda, Koira, Kalta.

4. OBJECTIVES OF INVESTIGATION

The exploration was proposed with the following objectives:

a. Reassessment of available Mineral Resources
b. Fixation of boreholes and determination of borehole co-ordinates and RL
c. To determine Lumps and fines ratio
d. To explore broken up areas as well as virgin area
e. To demarcate mineralized and non-mineralized area
f. For quantification of associated minerals if any as per threshold values
g. To estimate the mineral resources in accordance with "Mineral (Evidence of Mineral Contents) Amendment Rules 2021".

5. DURATION OF FIELD OPERATION

Drilling and other field activities commenced on 19.08.2022 and concluded on 27.03.2023.

6. DETAILS OF NATURE AND QUANTUM OF WORK APPROVED VS ACHIEVEMENT

The quantum of exploratory work approved vis-à-vis actually performed is furnished in the following Table.

Quantum of work Approved vs Achieved

S. No	Nature of work	Unit	Approved Quantum	Achieved
1.	Topographic survey (5m Contour Interval) (1:10000)	sq km	14.70	12.68
2	Drilling (Coring)	m (No of borehole)	1000 (10)	842.50 (10)
3	Pitting (1mx1mx1m)	Cu m	15	Nil

S. No	Nature of work	Unit	Approved Quantum	Achieved
4	Sampling and Chemical Analysis			
	a) Primary+Check Sample (10% internal) for 3 radicals Fe%, SiO_2% and Al_2O_3%,	Nos.	935	726 Primary + 73 Internal Check = 799 Samples
	b) Check Sample (5% external) for 3 radicals Fe%, SiO_2% and Al_2O_3%	Nos.	40	36
	c) Composite sample 7 radicals for (Fe%, SiO_2%, Al_2O_3%, P%, Mn%, S% and V_2O_5%)	Nos.	100	37
5	Petrological Samples	Nos	15	15
6	Mineragraphic Studies	Nos	15	8
7	Specific gravity Determination	Nos.	15	8
8	Bulk Density Determination	Nos.	15	Nil
9	Report Preparation [As per Mineral (Evidence of Mineral Contents) Rule-2015] /UNFC	Nos	01	01

8. REGIONAL GEOLOGY

The geological background described here for the sake of clarity in local geology, is taken from earlier workers and from traverses made in the areas.

The present study area is a part of the Bonai-Kendujhar belt of Sundargarh and Kendujhar districts. The little metamorphosed Precambrian Volcano-Sedimentary rocks exposed in this belt between the Singhbhum Granite in the east and Bonai Granite in the west are classified as 'Iron Ore Group' (Sarkar and Saha, 1963) or 'Koira Group' (Murty and Acharya, 1975). These rocks are disposed in the form of a low northerly plunging 'Horse-Shoe' shaped Synclinorium (Jones, 1934). The litho stratigraphic succession for the belt was proposed by Murthy and Acharya (1975) is given below:

Litho-stratigraphic succession of the Malangtoli area

Kolhan Group	
K O I R A G R O U P	Upper Shale Formation
	Banded Iron Formation
	Volcanic Formation
	Basal Sandstone – Quartzite
Singhbhum and Bonai Granites and metamorphosed sediments	

9. REGIONAL STRUCTURE

In general, the Iron Ore Super Group of rocks in the Bonai-Kendujhar belt are disposed in form of an "Omega" and referred to as "Horse Shoe Synclinorium" (Jones, 1934). This belt is 60 km long and 25 km wide extending from south of Malangtoli in

Kendujhar district up to Chakradharpur in West Singhbhum district (Jharkhand). The structural fabrics in the above, little metamorphosed Volcano-Sedimentary litho-sequence indicate at least two phases of deformation and folding. The earlier phase is the most prominent and resulted in formation of two synclines intervened by an anticline trending NNE-SSW with a low north-north easterly plunge. The western limb is slightly overturned to the east and dip westerly (65°-75°) whereas, the eastern limb is a normal one with moderate to low (30°-45°) westerly dip. This phase of folding is affected by a later NW-SE to WNW-ESE trending fold resulting in broad warps and formation of structural domes and basins in the area. The western syncline known as Koira syncline, due to steep dip and overturned nature of its limb forms a deeper basin with thick sequence of younger shales in the core region. On the other hand, the eastern syncline known as Bamebari syncline is a shallower basin and exposes younger litho members within the core region as outliers. The Upper shale unit within the Koira syncline is mostly continuous whereas, in Bamebari syncline it occurs as isolated patches.

10. GEOLOGY OF THE BLOCK

The Malangtoli 'E' Sub Block and the surrounding area, comprising weakly metamorphosed volcano-sedimentary sequence of rocks, occurs in Bonai-Keonjhar Iron ore belt belonging to the Iron Ore Series of Precambrian age (Jones 1934) and forms part of the eastern limb exhibiting a westerly dip of the northerly plunging asymmetric synclinorium. The local stratigraphic succession worked at Malangtoli area is given in the below table:

Litho-stratigraphic succession of Malangtoli 'E' Sub Block

Laterites (ferruginous and occasionally Limonitic)		**Different litho units**
Iron Ore Group	Upper shale sequences	Shale, Ferruginous Shale, Cherty Shale, Chert/Quartzite
	Clay/Ferruginous Clay	
	BIF sequences	Hard Laminated Ore, Massive Heamatitic Ore
		Soft Laminated Ore, Blue Dust
		BHJ and BHQ

Mostly the plateau area within the block is occupied either by BHJ/BHQ, Hard and compact laminated ore. Flanks of the plateau are occupied by mostly BHJ/BHQ. The low lying areas in the south and southeastern part of the block sandstone and volcanics have been mapped which may be older than the BIF sequences. The plains and the nala valleys around the ore bearing areas covered with alluvium while the flanks of the hills have impersistant cover of soil, debris of banded hematite jasper and float ore. The iron ore mainly occur in the central part of the block. Common litho units found in the block are Banded Hematite Jasper, Hard laminated Ore, Massive Ore, Soft laminated Ore, Powdery Ore, Lateritic ore, Ferruginous shale, sandstone and volcanics.

Trend of the laminations in BHQ/Iron ore wherever exposed are nearly NNE-SSW to NS and dip varies from 10º to 40º at times even 70º. The direction of dip changes frequently due to folding.

11. CONTROLS OF ORE LOCALIZATION

The iron ore bodies are formed by surface alteration of BHJ/BHQ by prevailing climate; selective leaching out of silica and resultant enrichment of the iron. The later

enrichment leading to richer grade is related to structural deformation of the Iron Ore Group (IOG) host rocks of this belt. The close association of the iron ores with the banded hematite jasper which indicates a lithostratigraphic control of the mineralization. Structures like fractures, fault and joint planes pave the way for the mobilization of fluids for supergene processes. In addition, the paleoclimatic conditions might have played a role for the enrichment of mineralization. Thus, the main controls of ore localization are lithologic, stratigraphic, structure and paleoclimatic.

12. PREVIOUS EXPLORATION

The area covering parts of the Malangtoli block was geologically mapped on 1:63,360 scale by B.C.Gupta during the field season 1938-39. A preliminary survey of the various deposits of iron ore in the Malangtoli block was carried out by P.C. Mathur and P.V.S. Kurup (Mathur and Kurup-1962) and a reserve of about 470 m.t. of ore with average Fe of 60% has been established.

The detailed appraisal of the iron ore deposits in Pipokri-Sirkagutu area of Malangtoli Block, Keonjhar and Sundargarh districts, Orissa, was taken up at the instance of the Government of India for blocking out reserves of high grade iron ore for exploitation in connection with the export trade through Paradip port. Accordingly the field investigation was commenced on 17.3.1963 and concluded on 12.4.1968 over an area of 20 sq km.

The above work was aimed for certain requirement at that period. Iron ore below 55% Fe was not considered as ore for resource estimation. At that period lumpy Iron ore was given importance based on the prevailing technologies. In most cases powdery ores have not been sampled and considered not for resource estimation. Drilling meterage of 20826 m involving 296 boreholes were drilled in the area. The current block is adjacent to the above said work.

13. LIMITATIONS DURING EXECUTION OF THE EXPLORATION WORK

a) Uneven shape along with the limited scope work renders to assess the complete shape and size of the ore body. Shape of the block is like English alphabet 'U' where central portion is out of the block and the two limbs occupied by flanks of the plateaus or steep slope hills where approachability is a major constraint.
b) The block is a huge area (12.68 sq km) and approved 10 nos. of boreholes were insufficient to assess the shape and size of the ore body.
c) Geological mapping was not part of the scope work.
d) The block is totally in forest area. Getting forest clearances for the drilling of boreholes took much time to commence the work. In addition, difficulties were faced during execution due to movement of elephants in the block and surrounding areas.

14. GRADE CLASSIFICATION

The exploration efforts in 70's were mainly for lumpy ores, where, the fines were not given economic importance. This exploration was required to categorize the ore reserves / resources based on end user's grade classifications. At threshold value of 45% Fe as stipulated by IBM, zones were deciphered and delineated. Moreover, an attempt has been made to delineate the ore zones at 35-45% Fe, 45-55% Fe and >55% Fe and the same has been given in the page 29 and 30.

15. RESOURCE

The iron ore resources were assessed by geological cross section method. The resources were computed on ≥55 % Fe and ≥45% to < 55% Fe with a workable thickness of 2.00 m and above. Up to 1.00 m non-ore zones were included in zone and above 1.00 m were excluded. The bands were marked on the cross section based on the specifications and area was calculated by using AutoCAD Map. The average thickness of the ore zone is considered judiciously and, the average bulk density of 3.30 was considered to arrive tonnage. The average grade was considered for boreholes arithmetically to delineate the zones. Summary of resource at different grade and level of exploration by cross section method is provided in the table below:

G3 LEVEL (333)										
Type of Iron ore	45-55% Fe Cut off					>55% Fe Cut off				
	Gross Resource in Tonnes	Gross Resource in Million Tonnes	Fe %	SiO_2 %	Al_2O_3 %	Gross Resource in Tonnes	Gross Resource in Million Tonnes	Fe %	SiO_2 %	Al_2O_3 %
Lateritic Iron Ore	3279484.08	3.28	47.05	15.58	9.89					
Soft Laminated Ore	22254137.38	22.25	49.29	10.71	10.67	26560270.49	26.56	60.35	6.31	2.25
Total	**25533621.47**	**25.53**	**49.00**	**11.34**	**10.57**	**26560270.49**	**26.56**	**60.35**	**6.31**	**2.25**
G4 LEVEL (334)										
Lateritic Iron Ore	1704276.62	1.70	47.05	15.58	9.89					
Soft Laminated Ore	16670890.10	16.67	49.99	17.11	4.28	22590306.62	22.59	60.35	6.31	2.25
Total	**18375166.72**	**18.38**	**49.72**	**16.97**	**4.80**	**22590306.62**	**22.59**	**60.35**	**6.31**	**2.25**

SUMMARY OF RESOURCE CONSIDERED FOR THE MALANGTOLI 'E' SUB-BLOCK						
Resource Category	Gross Resource In Tonnes	Net Resource in Tonnes	Net Resource in Million Tonnes	Fe %	SiO_2 %	Al_2O_3 %
G4 level (334)	40965473.34	36868926.01	36.87	55.58	11.09	3.39
G3 level (333)	52093891.95	46884502.76	46.88	54.78	8.77	6.32
* Resources at 35-45% Fe has not been considered for the block						
* Net resources is 10% less of the Gross resources.						

16. CONCLUSIONS

Malangtoli 'E" Sub Block and its surrounding area form an undulating country occupy plateaus and intermittent valleys. The block falls in a valley surrounded by two plateaus in western and eastern side. Mainly the flanks of the plateaus are occupied the limbs of 'U' shaped block. Trend of the plateaus is NNE-SSW.

The iron ore occurs as a tabular undulating bedded deposit. The general trend of the deposit is NNE-SSW to NS and dip varies from 10º to 40º at times even 70º due west or east. The direction of dip changes frequently due to folding.

The iron ore developed up to 511.40 mRL (MNME-02) which is nothing but enrichment of iron in BHJ/BHQ by leaching of silica. The depth of enrichment varies from place to place. In all boreholes, the ore has not developed up to 511.40 mRL.

Iron ore is mostly hematitic in nature. Goethite, limonite as a minor constituents replacing hematite. Magnetite occurs as a relict.

Physical nature of the ore varies from Hard laminated ore to powdery ore based on the compactness of the mineral grains.

Resource has been estimated based on the recent boreholes of MECL.

A total of 46.88 million metric tonnes (mmt) of net resources has been estimated within the block with average 54.78 Fe%, 8.77 SiO_2% and 6.38 Al_2O_3% at G3 (333) stage at 45% Fe threshold value which includes 22.98 mmt and 23.90 mmt at 45-55% Fe and > 55%Fe respectively.

A total of 36.87 million metric tonnes of net resources has been estimated within the block with average 55.58 Fe%, 11.09 SiO_2% and 3.39 Al_2O_3% at G4 (334) stage at 45% Fe threshold value which includes 16.53 mmt and 20.33 mmt at 45-55% Fe and > 55%Fe respectively.

17. RECOMMENDATIONS

Exploration was carried out with only 10 (ten) boreholes. Boreholes are not in a grid pattern due to large area. Surface area is large and total area could not be covered up by drilling. Many mineralized area are left out where drilling was to be carried out. Most part of the area where drilling was not carried out recently, close grid boreholes may be drilled to establish the 3-dimentioal disposition of the ore body which will definitely increase the resources towards more confidence level.

Pits for bulk density and distribution of lumps and fines in the ore could not be carried out due to field difficulties. Hence, few pits may be dug for the same in the different part and type of the ore body.

In many part of the area the surface is occupied by detrital lateritic ore of rich iron ore. Resources have not been estimated due to limited scope in the present exploration. Pitting or trenching may be carried out to assess the nature of the ore and resource estimation.

Deeper boreholes may be planned in the future exploration program to establish the mineralization which have been developed and extracted in the adjacent mining pit outside the block.

Based on the quality of the ore developed in the area further exploration may be carried out to upgrade the block.

मलंगटोली 'ई' उप ब्लॉक, बोनाई-क्योंझर लौह अयस्य बेल्ट जिला : सुंदरगढ़ और क्योंझर, ओडिशा में लौह अयस्क (हेमेटाइट) के लिए प्रारंभिक गवेषण (जी3) पर

भूवैज्ञानिक रिपोर्ट

कार्यकारी सारांश

1. **क्षेत्र का नाम**

मलंगटोली 'ई' उप ब्लॉक, बोनाई-क्योंझर लौह अयस्क बेल्ट जिला: सुंदरगढ़ और क्योंझर, ओडिशा।

2. **स्थान**

मलंगटोली 'ई' उप ब्लॉक कोइरा तहसील, सुंदरगढ़ जिले, ओडिशा में स्थित है। दक्षिण पूर्व कोने में ब्लॉक का एक छोटा सा हिस्सा क्योंझर जिले में पड़ता है। यह देशांतर 85° 17' 16" और 85° 19' 59" और अक्षांश 21° 52' 57" और 21° 49' 59" के बीच स्थित है। यह ब्लॉक 14.43 वर्ग किमी के क्षेत्र को कवर करता है और भारतीय सर्वेक्षण टोपोशीट संख्या 73जी/5 के अंतर्गत आता है।

3. **ब्लॉक स्थल पर पहुचने की सुगमता**

यह ब्लॉक राष्ट्रीय राजमार्ग (एनएच) 20 से अच्छी तरह से जुड़ा हुआ है, जो क्योंझर और चाईबासा के माध्यम से पानीकोइली और रांची को जोड़ता है, जो ब्लॉक के पूर्व की ओर 20 किमी की दूरी पर गुजरता है। इसके अलावा, यह एनएच 520 से भी अच्छी तरह से जुड़ा हुआ है, जो रिमुली को जोडा, कोइरा, काल्टा के माध्यम से राजमुंडा से जोड़ता है।

4. **जांच का उद्देश्य**

गवेषण निम्नलिखित उद्देश्यों के साथ प्रस्तावित किया गया था:

क. उपलब्ध खनिज संसाधनों का पुनर्मूल्यांकन

ख. बोरहोल का निर्धारण और बोरहोल निर्देशांक और आरएल का निर्धारण

ग. पिंडक और सूक्ष्मक अनुपात निर्धारित करना

घ. टूटे हुए क्षेत्रों के साथ-साथ अछूते क्षेत्रों का पता लगाना

ङ. खनिजयुक्त एवं अखनिजीकृत क्षेत्र का सीमांकन करना

च. थ्रेसहोल्ड मूल्यों के अनुसार यदि कोई हो तो संबंधित खनिजों की मात्रा निर्धारित करने के लिए

छ. "खनिज (खनिज सामग्री के प्रमाण)संशोधन नियम 2021"के अनुसार खनिज संसाधनों का अनुमान लगाना

5. क्षेत्र परिचालन की अवधि

वेधन और अन्य फिल्ड गतिविधियाँ 19.08.2022 को शुरू हुईं और 27.03.2023 को समाप्त हुईं।

6. प्रस्तावित कार्य की मात्रा और प्रकृति का विवरण बनाम उपलब्धि

प्रस्तावित गवेषणात्मक कार्य की मात्रा की तुलना में किए गए वास्तविक कार्य को निम्नलिखित तालिका में प्रस्तुत किया गया है।

स्वीकृत कार्य की मात्रा बनाम उपलब्धि

क्र.सं.	कार्यमद	इकाई	अनुमोदित मात्रा	उपलब्धि
1.	स्थलाकृति सर्वेक्षण (5मीकंटूर . इंटरवल) (1:10000)	वर्ग.किमी .	14.70	12.68
2	वेधन (कोरिंग)	मी. (वेधछिद्रों की सं.)	1000 (10)	842.50 (10)
3	खंदक (1मी.x1 मी.x1 मी.)	घन. मी.	15	शून्य
4	नमूनाकरण और रासायनिक विश्लेषण			
	क) 3मूलकों Fe%, SiO_2% औरAl_2O_3%, के लिए प्रारंभिक + जांच नमूने (10% आंतरिक)	नग.	935	726 प्रारंभिक + 73 आंतरिक जांच = 799 नमूनें
	ख) 3 मूलकों Fe%, SiO_2% and Al_2O_3%के लिए जांच नमूने (5% बाह्य)	नग.	40	36
	ग) 7 मूलकों (Fe%, SiO_2%, Al_2O_3%, P%, Mn%, S% and V_2O_5%) के लिए समिश्र नमूने	नग.	100	37
5	शैल वैज्ञानिक नमूने	नग.	15	15
6	खनिज विज्ञान नमूने	नग.	15	8
7	विशिष्ट गुरूत्व निर्धारण	नग.	15	8
8	पुंजगतघनत्वनिर्धारण	नग.	15	शून्य
9	रिपोर्ट तैयार करना [खनिज (खनिज सामग्री का प्रमाण) नियम-2015 के अनुसार] /यूएनएफसी	नग.	01	01

7. क्षेत्रीय भूविज्ञान

स्थानीय भुविज्ञान में स्पष्टता के लिए यहां भूवैज्ञानिक पृष्ठभूमि का वर्णन किया गया है, जो पहले के भूवैज्ञानिकों और ट्रैवर्से से इसमें किए गए क्षेत्र कार्य को लिया गया है।

वर्तमान अध्ययन क्षेत्र सुंदरगढ़ और क्योंझर जिलों के बोनाई-क्योंझर बेल्ट का एक हिस्सा है। पूर्व में सिंहभूम ग्रेनाइट और पश्चिम में बोनाई ग्रेनाइट के बीच इस बेल्ट में दिखाई पडने वाली छोटी रूपांतरित प्रीकैम्ब्रियन आग्नेय-अवसादीय चट्टानों को 'लौह अयस्क समूह' (सरकार और साहा, 1963) या 'कोइरा समूह' (मूर्ति और आचार्य1975) के रूप में वर्गीकृत किया गया है। इन चट्टानों को उत्तर की ओर नीचे की ओर झुकते हुए 'हॉर्स-शू' आकार के सिनक्लिनोरियम (जोन्स, 1934) के रूप में निस्तारित किया गया है। बेल्ट के लिए लिथो-स्ट्रटिग्राफिक अनुक्रम मूर्ति और आचार्य (1975) द्वारा प्रस्तावित किया गया था, जो नीचे दिया गया है:

मलंगटोली क्षेत्र कालिथो-स्ट्रटिग्राफिक अनुक्रम

कोलहन समूह	
कोइरासमूह	ऊपरी शैल गठन
	बैंडेड लौह संरचना
	आग्नेय संरचना
	बेसल बलुआ पत्थर - क्वार्टजाइट
सिंहभूम और बोनाई ग्रेनाइट और रूपांतरित अवसाद	

8. क्षेत्रीय संरचना

सामान्य तौर पर, बोनाई-क्योंझर बेल्ट में चट्टानों के लौह अयस्क सुपर समूह को "ओमेगा" के रूप में निपटाया जाता है और इसे "हॉर्स शू सिंकलिनोरियम" (जोन्स, 1934) कहा जाता है। यह बेल्ट 60 किमी लंबी और 25 किमी चौड़ी है जो क्योंझर जिले के मलंगटोली के दक्षिण से पश्चिम सिंहभूम जिले (झारखंड) के चक्रधरपुर तक फैली हुई है। उपरोक्त संरचनात्मक फेबरिक्स, छोटे रूपांतरित आग्नेय-अवसादीय लिथो-अनुक्रम विरूपण और तह के कम से कम दो चरणों का संकेत देते हैं। पहला चरण सबसे प्रमुख है और इसके परिणामस्वरूप दो सिंकलाइनों का निर्माण हुआ, जो एक एंटीक्लाइन ट्रेंडिंग एनएनई-एसएसडब्ल्यू द्वारा कम उत्तर-उत्तर पूर्व की ओर झुकाव के साथ प्रतिच्छेद करती हैं। पश्चिमी छोर पूर्व की ओर थोड़ा उलटा हुआ है और पश्चिमी नति (65°-75°) है, जबकि, पूर्वी छोर मध्यम से कम (30°-45°) पश्चिमी नति के साथ सामान्य है। तह का यह चरण बाद में एनडब्ल्यू-एसई से डब्ल्यूएनडब्ल्यू-ईएसई ट्रेंडिंग फोल्ड से प्रभावित होता है जिसके परिणामस्वरूप क्षेत्र में व्यापक ताना-बाना और संरचनात्मक गुंबदों और बेसिनों का निर्माण होता है। पश्चिमी सिंकलाइन को कोइरा सिंकलाइन के नाम से जाना जाता है, जो अपने अंग की तीव्र ढलान और उलटी प्रकृति के कारण कोर क्षेत्र में युवा शैलों के मोटे अनुक्रम के साथ एक गहरा बेसिन बनाती है। दूसरी ओर, पूर्वी सिंकलाइन जिसे बामेबारी सिंकलाइन के नाम से जाना जाता है, एक उथला बेसिन है और कोर क्षेत्र के भीतर युवा लिथो सदस्यों को आउटलेर्स के रूप में दिखाई पडता है। कोइरा सिंकलाइन के भीतर

ऊपरी शेल इकाई अधिकतर निरंतर होती है, जबकि बामेबारी सिंकलाइन में यह पृथक पैच के रूप में होती है।

9. ब्लॉक का भूविज्ञान

मलंगटोली 'ई' उप ब्लॉक और आसपास का क्षेत्र, चट्टानों के कमजोर रूप से रूपांतरित आग्नेय-अवसादीय अनुक्रम से युक्त, प्रीकैम्ब्रियन युग (जोन्स 1934) की लौह अयस्क श्रृंखला से संबंधित बोनाई-क्योंझर लौह अयस्क बेल्ट में होता है और पूर्वी भाग का हिस्सा बनाता है जो उत्तर की ओर गिरती हुई असममित सिन्क्लिनोरियम की पश्चिमी नति को प्रदर्शित कर रहा है। मलंगटोली क्षेत्र में स्थानीय स्ट्रैटिग्राफिक अनुक्रमण संरचना को नीचे दी गई तालिका में दिया गया है:

मलंगटोली 'ई' उप ब्लॉक का लिथो स्तरकी अनक्रम

लेटराइट (फेरुजिनस और औकेजनली लिमोनाइट)		**विभिन्न लिथो इकाइयाँ**
लौह अयस्क समूह	**उपरी शेल अनुक्रम**	**शेल,फेरुजिनस शेल, चर्टि शेल, चर्ट/क्वार्टजाईट**
	क्ले/फेरुजिनसक्ले	
	बीआईएफ अनुक्रम	**कठोर लेमिनेटेड अयस्क, विशाल हेमेटिक अयस्क**
		मुलायम लेमिनेटेड में अयस्क, नीली धूल
		बीएचजे और बीएचक्यू

ब्लॉक के भीतर अधिकतर पठारी क्षेत्र पर या तो बीएचजे/बीएचक्यू, कठोर और कॉम्पैक्ट लेमिनेटेड अयस्क फैला है। पठार के किनारों पर अधिकतर बीएचजे/बीएचक्यू अच्छादित है। ब्लॉक बलुआ पत्थर और ज्वालामुखी के दक्षिण और दक्षिणपूर्वी हिस्से में निचले इलाकों का मानचित्रण किया गया है जो बीआईएफ अनुक्रमों से भी पुराना हो सकता है। अयस्क वाले क्षेत्रों के आसपास के मैदान और नाला घाटियाँ जलोढ़ से ढकी हुई हैं, जबकि पहाड़ियों के किनारे मिट्टी, बैंडेड हेमेटाइट जैस्पर के मलबे और फ्लोट अयस्क से ढके हुए हैं। लौह अयस्क मुख्यतः ब्लॉक के मध्य भाग में होता है। ब्लॉक में पाई जाने वाली सामान्य लिथो इकाइयां बैंडेड हेमेटाइट जैस्पर, हार्ड लेमिनेटेड अयस्क, विशाल अयस्क, सॉफ्ट लेमिनेटेड अयस्क, पाउडरयुक्त अयस्क, लैटेरिटिक अयस्क, फेरुजिनस शेल, बलुआ पत्थर और ज्वालामुखी हैं।

बीएचक्यू/लौह अयस्क में लेमिनेशन की प्रवृत्ति, जहां भी दिखाई देती है, लगभग एनएनई-एसएसडब्ल्यू से एनएस तक होती है और नति 10° से 40° तक होती है, कभी-कभी 70° तक भी। वलन के कारण नति की दिशा बार-बार बदलती रहती है।

10. अयस्क स्थानीयकरण का नियंत्रण

लौह अयस्क पिंडों का निर्माण प्रचलित जलवायु द्वारा बीएचजे/बीएचक्यू की सतह में परिवर्तन से होता है; सिलिका से चयनात्मक निक्षालन और परिणामस्वरूप लोहे का संवर्धन। बाद में समृद्ध ग्रेड

की ओर ले जाने वाला संवर्धन इस बेल्ट के लौह अयस्क समूह (आईओजी) मेजबान चट्टानों के संरचनात्मक विरूपण से संबंधित है। बैंडेड हेमेटाइट जैस्पर के साथ लौह अयस्कों का घनिष्ठ संबंध खनिजकरण के लिथोस्ट्रेटिग्राफिक नियंत्रण को इंगित करता है। फ्रैक्चर, भ्रंश और संयुक्त प्लेन्स पेव जैसी संरचनाएं सुपरजीन प्रक्रियाओं के लिए तरल पदार्थ जुटाने का मार्ग प्रशस्त करती हैं। इसके अलावा, पुराजलवायु परिस्थितियों ने खनिजकरण के संवर्धन में भूमिका निभाई होगी। इस प्रकार, अयस्क स्थानीयकरण के मुख्य नियंत्रण लिथोलॉजिक, स्ट्रैटिग्राफिक, संरचना और पुराजलवायु हैं।

11. पिछला गवेषण कार्य

मलंगटोली ब्लॉक के कुछ हिस्सों को कवर करने वाले क्षेत्र को फील्ड सीज़न के दौरान 39-1938 पैमाने पर भूवैज्ञानिक रूप से 1:63,360 गुप्ता द्वारा.सी.बीमानचित्रण किया गया था। मलंगटोली ब्लॉक में लौह अयस्क के विभिन्न भंडारों का प्रारंभिक सर्वेक्षण पी .एस.वी.माथुर द्वारा और पी .सी. (1962-माथुर और कुरुप) कुरुपकिया गया था और %60Fe अयस्क औसत वालेलगभग 470 मिलियन टन का रिजर्व की स्थापित हुई है।

उड़ीसा के क्योंझर और सुंदरगढ़ जिलों के मलंगटोली ब्लॉक के पिपोकरीसिरकागुटु क्षेत्र में लौह - अयस्क भंडार का विस्तृत मूल्यांकन करने हेतु, पारादीप बंदरगाह के माध्यम से निर्यात व्यापारकरने के संबंध में विदोहन के लिए उच्च ग्रेड लौह अयस्क के भंडार को ब्लॉकिंग आउट हेतु भारत सरकार के अनुरोध पर लिया गया था। तदनुसार, को शुरू हुई 17.3.1963 वर्ग किमी के क्षेत्र में क्षेत्रीय जांच 20 को समाप्त हुई। 12.4.1968 और

उपरोक्त पैराग्राफ में उल्लिखित उपरोक्त कार्य का उद्देश्य उस अवधि में कुछ आवश्यकताओं को पूरा करना था। संसाधन आकलन के लिए %55Fe से कम लौह अयस्क को अयस्क नहीं माना गया है। उस काल में प्रचलित प्रौद्योगिकियों के आधार पर ढेलेदार लौह अयस्क को महत्व दिया जाता था। अधिकांश मामलों में पाउडरयुक्त अयस्कों का नमूना नहीं लिया गया है और संसाधन आकलन के लिए उन पर विचार नहीं किया गया है। क्षेत्र में मीटर की 20826 बोरहोल सहित कुल 296वेधन की गई। वर्तमान ब्लॉक उपरोक्त कथित कार्य के समीप है।

12. गवेषण कार्य के निष्पादन के दौरान की सीमाएँ

क) सीमित दायरे के साथ असमान आकार अयस्क पिंड के पूर्ण आकृति और आकार का आकलन करने के लिए काम करता है। ब्लॉक का आकार अंग्रेजी वर्णमाला 'यू' जैसा है, जहां केंद्रीय भाग ब्लॉक से बाहर है और दोनों छोर पठारों या खड़ी ढलान वाली पहाड़ियों के किनारे पर स्थित हैं, जहां पहुंचना एक बड़ी बाधा है।

ख) ब्लॉक एक विशाल क्षेत्र (14.43 वर्ग किमी) है और 10 ब्लॉक स्वीकृत हैं। अयस्क निकाय के आकार और आकार का आकलन करने के लिए बोरहोल अपर्याप्त थे।

ग) भूवैज्ञानिक मानचित्रण कार्यक्षेत्र कार्य का हिस्सा नहीं था।

घ) ब्लॉक पूरी तरह से वन क्षेत्र में है। बोरहोल की ड्रिलिंग के लिए वन मंजूरी मिलने में काम शुरू करने में काफी समय लग गया। इसके अलावा, ब्लॉक और आसपास के क्षेत्रों में हाथियों की आवाजाही के कारण निष्पादन के दौरान कठिनाइयों का सामना करना पड़ा।

13. ग्रेड वर्गीकरण

70 के दशक में गवेषण के प्रयास मुख्य रूप से ढेलेदार अयस्कों के लिए थे, जबकि बारीक अयस्कों को आर्थिक महत्व नहीं दिया गया था। इसी प्रकार, अंतिम उपयोगकर्ता के ग्रेड वर्गीकरण के आधार पर अयस्क भंडार/संसाधनों को वर्गीकृत करने के लिए भी गवेषण की आवश्यकता होगी। आईबीएम द्वारा यथा निर्धारित 45% Fe के थ्रेशोल्ड मान पर, क्षेत्रों को समझा गया और चित्रित किया गया। इसके अलावा, अयस्क क्षेत्रों को 35-45% Fe, 45-55% Fe और >55% Fe पर चित्रित करने का प्रयास किया गया है और इसे पृष्ठ 29 और 30 में दिया गया है।

14. संसाधन

लौह अयस्क संसाधनों का मूल्यांकन भूवैज्ञानिक क्रॉस सेक्शन विधि द्वारा किया गया था। संसाधनों की गणना 2.00 मीटर और उससे अधिक की व्यावहारिक मोटाई के साथ ≥55% Fe और ≥45% से <55% Fe पर की गई थी। 1.00 मीटर तक के गैर-अयस्क क्षेत्रों को जोन में शामिल किया गया और 1.00 मीटर से ऊपर के क्षेत्रों को बाहर रखा गया। विशिष्टताओं के आधार पर बैंडों को क्रॉस सेक्शन पर चिह्नित किया गया था और ऑटोकैड मानचित्र का उपयोग करके क्षेत्र की गणना की गई थी। अयस्क क्षेत्र की औसत मोटाई को विवेकपूर्ण ढंग से माना जाता है और, 3.30 के औसत थोक घनत्व को टन भार तक पहुंचने के लिए माना जाता था।ज़ोन को चित्रित करने के लिए अंकगणितीय रूप से बोरहोल के लिए औसत ग्रेड पर विचार किया गया था। क्रॉस सेक्शन विधि द्वारा गवेषण के विभिन्न ग्रेड और स्तर पर संसाधन का सारांश नीचे दी गई तालिका में दिया गया है

G3 LEVEL (333)										
Type of Iron ore	45-55% Fe Cut off					>55% Fe Cut off				
	Gross Resource in Tonnes	Gross Resource in Million Tonnes	Fe %	SiO_2 %	Al_2O_3 %	Gross Resource in Tonnes	Gross Resource in Million Tonnes	Fe %	SiO_2 %	Al_2O_3 %
Lateritic Iron Ore	3279484.08	3.28	47.05	15.58	9.89					
Soft Laminated Ore	22254137.38	22.25	49.29	10.71	10.67	26560270.49	26.56	60.35	6.31	2.25
Total	**25533621.47**	**25.53**	**49.00**	**11.34**	**10.57**	**26560270.49**	**26.56**	**60.35**	**6.31**	**2.25**
G4 LEVEL (334)										
Lateritic Iron Ore	1704276.62	1.70	47.05	15.58	9.89					
Soft Laminated Ore	16670890.10	16.67	49.99	17.11	4.28	22590306.62	22.59	60.35	6.31	2.25
Total	**18375166.72**	**18.38**	**49.72**	**16.97**	**4.80**	**22590306.62**	**22.59**	**60.35**	**6.31**	**2.25**

SUMMARY OF RESOURCE CONSIDERED FOR THE MALANGTOLI 'E' SUB-BLOCK						
Resource Category	Gross Resource In Tonnes	Net Resource in Tonnes	Net Resource in Million Tonnes	Fe %	SiO_2 %	Al_2O_3 %
G4 level (334)	40965473.34	36868926.01	36.87	55.58	11.09	3.39
G3 level (333)	52093891.95	46884502.76	46.88	54.78	8.77	6.32
* Resources at 35-45% Fe has not been considered for the block						
* Net resources is 10% less of the Gross resources.						

15. निष्कर्ष

मलंगटोली 'ई' उप ब्लॉक और इसके आसपास का क्षेत्र एक तरंगित प्रदेश को घेरे वाले पठारों और आंतरायिक घाटियों का निर्माण करता है। यह ब्लॉक पश्चिमी और पूर्वी तरफ दो पठारों से घिरी घाटी में पड़ता है। मुख्यतः पठारों के किनारों पर 'U' आकार के खंडों का कब्जा है। पठारों की प्रवृत्ति NNE-SSW है।

लौह अयस्क एक सारणीबद्ध तरंगितबेड्स वाले निक्षेप के रूप में होता है। निक्षेप की सामान्य प्रवृत्ति एनएनई-एसएसडब्ल्यू से एनएस है और नति 10° से 40° तक होती है, कभी-कभी पश्चिम या पूर्व में 70° तक भी होती है। वलन के कारण नति की दिशा बार-बार बदलती रहती है।

लौह अयस्क 511.40 एमआरएल (एमएनएमई-02) तक विकसित हुआ जो सिलिका की लीचिंग द्वारा बीएचजे/बीएचक्यू में लोहे के संवर्धन के अलावा और कुछ नहीं है। संवर्धन की गहराई अलग-अलग जगहों पर अलग-अलग होती है। सभी बोरहोल में 511.40 एमआरएल तक अयस्क विकसित नहीं हुआ है।

लौह अयस्क अधिकतर हेमेटिक प्रकृति का होता है। हेमेटाइट की जगह लेने वाले छोटे घटक के रूप में गोइथाइट, लिमोनाइट। मैग्नेटाइट एक अवशेष के रूप में पाया जाता है।

अयस्क की भौतिक प्रकृति खनिज कणों की सघनता के आधार पर कठोर लेमिनेटेड अयस्क से लेकर चूर्णी अयस्क तक भिन्न होती है।

एमईसीएल के हालिया बोरहोल के आधार पर संसाधन का अनुमान लगाया गया है।

ब्लॉक के भीतर कुल 46.88 मिलियन मीट्रिक टन (मिमीट) शुद्ध संसाधनों का अनुमान लगाया गया है, जिसमें औसत 54.78 Fe%, 8.77 SiO2% और 6.38 Al2O3% G3 (333) चरण पर 45% Fe सीमा मान पर है जिसमें 22.98 mmt और 23.90 शामिल हैं। एमएमटी क्रमशः 45-55% Fe और > 55% Fe पर।

ब्लॉक के भीतर कुल 36.87 मिलियन मीट्रिक टन शुद्ध संसाधनों का अनुमान लगाया गया है, जिसमें औसत 55.58 Fe%, 11.09 SiO2% और 3.39 Al2O3% G4 (334) चरण में 45% Fe सीमा मूल्य पर है, जिसमें 45 पर 16.53 mmt और 20.33 mmt शामिल है। -55% Fe और > 55% Fe क्रमशः।

16. सिफ़ारिशें

गवेषण केवल 10 (दस) बोरहोल के साथ किया गया था। बड़े क्षेत्र के कारण बोरहोल ग्रिड पैटर्न में नहीं हैं। सतह का क्षेत्रफल बड़ा है और कुल क्षेत्रफल को ड्रिलिंग द्वारा कवर नहीं किया जा सकता है। कई खनिजयुक्त क्षेत्र छूट गए हैं जहां ड्रिलिंग की जानी थी। क्षेत्र का अधिकांश भाग जहां हाल ही में ड्रिलिंग नहीं की गई थी,अयस्क पिंड के -3आयामी स्वभाव को स्थापित करने के लिए क्लोज ग्रिड बोरहोल ड्रिल किए जा सकते हैं जो निश्चित रूप से संसाधनों को अधिक आत्मविश्वास स्तर की ओर बढ़ाएगा।

क्षेत्र की कठिनाइयों के कारण अयस्क में थोक घनत्व और गांठों और बारीक पदार्थों के वितरण के लिए गड्ढे नहीं बनाए जा सके। इसलिए, अयस्क पिंड के विभिन्न भाग और प्रकार में इसके लिए कुछ गड्ढे खोदे जा सकते हैं।

क्षेत्र के कई हिस्सों में सतह पर समृद्ध लौह अयस्क के डेट्राइटल लैटेरिटिक अयस्क द्वारा घिरा है। वर्तमान गवेषण में सीमित दायरे के कारण संसाधनों का अनुमान नहीं लगाया गया है। अयस्क की प्रकृति और संसाधन अनुमान का आकलन करने के लिए पिटिंग या ट्रेंचिंग की जा सकती है। ब्लॉक के बाहर निकटवर्ती खनन गड्ढे में विकसित और निकाले गए खनिजकरण को स्थापित करने के लिए भविष्य के गवेषण कार्यक्रम में गहरे बोरहोल की योजना बनाई जा सकती है।

क्षेत्र में विकसित अयस्क की गुणवत्ता के आधार पर ब्लॉक को उन्नत करने के लिए आगे की गवेषण की जा सकती है।

PART –IV A OF SCHEDULE ANNEXED TO THE MINERALS (EVIDENCE OF MINERAL CONTENTS) RULES, 2015 AND AMENDED UPTO 2021
REPORTING OF MINERAL RESOURCES

Sl.no	Contents	Explanation
1	Details of the Qualified Person(s) / Exploration Agency	Mineral Exploration And Consultancy Limited (Formerly Known as Mineral Exploration Corporation Limited) (A PSE under Ministry of Mines, Govt. of India) Dr. Babasaheb Ambedkar Bhawan, Highland drive road, Seminary Hills,Nagpur- 440006, Maharashtra, India.
2	Title and Ownership	MALANGTOLI 'E' SUB BLOCK, GOVT. OF ODISHA
3	Details of the area under study	Malangtoli 'E' Sub Block is located in Koira tehsil, Sundargarh district,Odisha. A small part of the block in the south east corner falls in Keonjhar district. It lies between longitudes 85° 17' 16" and 85° 19' 59" and latitudes 21° 52' 57" and 21° 49' 59". The block covers an area of 12.68 sq km and falls within the Survey of India toposheet No 73G/5.
4	Physiography and environment	Malangtoli 'E' Sub Block and its surrounding area form an undulating country in between two plateaus in east and west direction. The flanks of the plateaus occupy the eastern and western part of the block. Northern part of the block occupies the valley of the plateaus and has flat topography. Recorded maximum elevation is 925 mRL towards north of the borehole MNME-03 and in the southeastern part of the block. Minimum elevation of 616.312 mRL (Survey Station EST-19) has been recorded in the northeast corner of the block. The main drainage of the area is Baitarni River which flows in a northward direction east of the Pipokri-Sirkagutu plateau and forms the eastern boundary of the Malangtoli area. The most important tributary of the Baitarni River is the Mohalda Nala which flows in a northeastern direction at the southeastern foot of the Pipokri-Sirkagutu plateau. A number of perennial streams radiate from the plateau, the notable among these are Jalpa, Nalpani, Kasijoda, Sirkagutu, Khandahar and Malangtoli Nalas; all these streams ultimately flow into Baitarni River with only exception of Malangtoli nala which flows northwards into Kundra River.
5	Infrastructure	The block is well connected with National Highway (NH) 20, which connects Panikoili and Ranchi via Keonjhar and Chaibasa, passes towards the east of the block at a distance of 20 km. In addition, it is also well connected with NH 520 which connects Rimuli to Rajmunda via Joda, Koira, Kalta. The area is well connected with district headquarter Sundargarh with metalled and unmetaled road which is located 150km in the west of the block. Koira in Sundargarh district is also well connected with the block at a distance of 30 km in northwest direction. Joda is 31 km from the block in north direction. The block is located about 280 km to the northwest of Bhubaneswar, the state capital. Nearest airport is at Bhubaneswar. The block can be approached by the nearest railhead Nayagarh located at a distance of 15 km in east of the block under Khurda road division of Eastcoast Railway. Nearest port is Paradip which is located at a distance of 280 km and connected through NH 20 and NH 53.
6	Geology	The Malangtoli 'E' Sub Block and the surrounding area, comprising weakly metamorphosed volcano-sedimentary sequence of rocks, occurs in Bonai-

Sl.no	Contents	Explanation
		Keonjhar Iron ore belt belonging to the Iron Ore Series of Precambrian age and forms part of the eastern limb exhibiting a westerly dip of the northerly plunging asymmetric synclinorium. The Iron Ore Supergroup of rocks in the Bonai-Kendujhar belt are disposed in form of an "Omega" and referred to as "Horse Shoe Synclinorium" (Jones, 1934). This belt is 60 km long and 25 km wide extending from south of Malangtoli in Kendujhar district up to Chakradharpur in West Singhbhum district (Jharkhand). The earlier phase is the most prominent and resulted in formation of two synclines intervened by an anticline trending NNE-SSW with a low north-north easterly plunge. The western limb is slightly overturned to the east and dip westerly (65°-75°) whereas, the eastern limb is a normal one with moderate to low (30°-45°) westerly dip. The western syncline known as Koira syncline, On the other hand, the eastern syncline known as Bamebari syncline is a shallower basin and exposes younger litho members within the core region as outliers. Mostly the plateau area within the block is occupied either by BHJ/BHQ, Hard and compact laminated ore. Trend of the laminations in BHQ/Iron ore wherever exposed are nearly NNE-SSW to NS and dip varies from 10º to 40º at times even 70º. The direction of dip changes frequently due to folding.
7	Previous Exploration	GSI in the adjacent areas.
8	Aerial or ground geophysical or geochemical data	NIL
9	Exploration Undertaken during current investigation	Scope of work includes topographical survey, borehole fixation, determination of coordinates and RL of boreholes, drilling sampling(Core), analyses of the sample collected and preparation of a geological report for estimation Total Drilling - 842.50m (10 BHs)
10	Location of data points	Standard methods have been adopted during DGPS and total station survey with high accuracy instruments and experienced work force were involved in the project to maintain accuracy and quality of surveys.
11	Drilling technique and drill sampling employed	Diamond Core drilling technique have been applied to expedite the exploration work.
12	Sub sampling techniques and sample preparation	Cuts/splits the core along its length in two identical halves with respect to mineral distribution as observed during logging has been applied for collection of samples in diamond core drilling. Collection of chip samples of desired quantity after coning and quartering of total chips received from the borehole for each 1m drilling in ore drilling.
13	Quality of assay data and laboratory tests	MECL- Chemical Laboratory, Nagpur, M/s Lucid Laboratories Pvt. Ltd, Hyderabad for external check analysis
14	Moisture	-
15	Bulk Density	Pitting for bulk density determination was not undertaken during this study. Iron ore wherever exposed are either Hard Laminated ore/Massive or BHJ. Pitting carried out to determine bulk density in the Malangtoli area by GSI during 1963-64 has been considered here. (Report of GSI by P.C Mathur

<table>
<tr><th>Sl.no</th><th>Contents</th><th>Explanation</th></tr>
<tr><td></td><td></td><td>1963-64). Five shallow pits each measuring about 2 x2 m were sunk to a depth 3m.To arrive bulk density for the iron ores in the block average value of the five pits has been considered here for resource estimation which is 3.30.</td></tr>
<tr><td>16</td><td>Lumps and Fines ratio</td><td>Lumps- 77.50% and 22.50% Fines (For Hard laminated ore)
Lumps- 47.14% and 52.86% Fines(For Soft laminated ore)
Lumps- 32.50% and 67.50% Fines (For Lateritic ore)
100% Fines (for Powdery ore)</td></tr>
<tr><td>17</td><td>Mineralised area</td><td>Total mineralized area is 3.84 sq km.</td></tr>
<tr><td>18</td><td>Beneficiation studies as may be required</td><td>Not carried out.</td></tr>
<tr><td>19</td><td>Reserve estimation technique</td><td>At threshold value of 45% Fe as stipulated by IBM, mineralized zone within the lease hold area, could be deciphered and demarcated both at 45% Fe and 55% Fe. Resource has been estimated by cross section method.

The rule of gradual change or law of linear function has been applied [Constantine C. Popoff, 1965] along with the rule of nearest points for application of influence of half way between successive boreholes</td></tr>
<tr><td>20</td><td>Reporting of Resources</td><td>The Resource estimated in the block for different types of iron ore with different threshold value are as follows.
<table>
<tr><th colspan="11">G3 LEVEL (333)</th></tr>
<tr><th rowspan="2">Type of Iron ore</th><th colspan="5">45-55% Fe Cut off</th><th colspan="5">>55% Fe Cut off</th></tr>
<tr><th>Gross Resource in Tonnes</th><th>Gross Resource in Million Tonnes</th><th>Fe %</th><th>SiO_2 %</th><th>Al_2O_3 %</th><th>Gross Resource in Tonnes</th><th>Gross Resource in Million Tonnes</th><th>Fe %</th><th>SiO_2 %</th><th>Al_2O_3 %</th></tr>
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<tr><th>Resource Category</th><th colspan="2">Gross Resource In Tonnes</th><th colspan="2">Net Resource in Tonnes</th><th>Net Resource in Million Tonnes</th><th>Fe %</th><th>SiO_2 %</th><th>Al_2O_3 %</th><th colspan="2"></th></tr>
<tr><td>G4 level (334)</td><td colspan="2">40965473.34</td><td colspan="2">36868926.01</td><td>36.87</td><td>55.58</td><td>11.09</td><td>3.39</td><td colspan="2"></td></tr>
<tr><td>G3 level (333)</td><td colspan="2">52093891.95</td><td colspan="2">46884502.76</td><td>46.88</td><td>54.78</td><td>8.77</td><td>6.32</td><td colspan="2"></td></tr>
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</table>
</td></tr>
<tr><td>21</td><td>Summary and recommendations</td><td>In the present scheme of exploration, Iron ore has been proved up to 511.40 mRL. However, the same has not been proved in all parts of the block. However, drilling of more boreholes at closer interval is required in the unexplored area.</td></tr>
<tr><td>22</td><td>Plates and maps</td><td>MECL reports includes all the relevant maps, sections, logs, analytical reports and fields photos.</td></tr>
<tr><td>23</td><td>Annexures or enclosures to the report</td><td>Report includes all the relevant annexure.</td></tr>
<tr><td>24</td><td>Certificate</td><td>Required certificate has been attached with this report.</td></tr>
</table>

GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G3) FOR IRON ORE (HEMATITE) IN MALANGTOLI 'E' SUB BLOCK, BONAI-KEONJHAR IRON ORE BELT DISTRICT: SUNDARGARH AND KEONJHAR, ODISHA

CHAPTER-1

1.1.0 INTRODUCTION

1.1.1 Iron is estimated to make up 32.07% of the Earth's mass and its elemental abundance varies between about 5% of the Earth's crust and as much as 80% of the planet's core (Morgan and Anders, 1980). It is therefore not surprising that there are a number of commonly occurring iron minerals and many iron ore deposits found at the surface of the Earth. Morris (1985) suggested that just one of the iron-enrichment deposit types alone, derived from iron formations, represents the largest and most concentrated accumulation of any single metalliferous element in the Earth's crust. The term "iron ore" is used here as an economic term to refer to iron-bearing deposits and products that have been, are being, or could be expected to be exploited economically for their iron content. Any uneconomic iron accumulations are simply referred to as "iron mineralization." Iron ore is the primary raw material from which metallic iron is extracted to make steel.

1.1.2 The steel industry is a very important one for the economy as a whole. It is the backbone of any industrial economy. Steel finds widespread applications in many sectors such as construction, power, infrastructure, aerospace, consumer products, industrial machinery and so on. The steel industry has strong forward and backward linkages in terms of material flows and income generation.

1.1.3 Based on the World steel Association statistics *Iron and crude steel production worldwide and in China since1980. (Source:World steel Association)*,the world's crude steel production has more than doubled since 2000 (World steel Association, 2021). It can be seen that this 129% growth in world crude steel production (850mmt to 1951mmt) between 2000 and 2021 can be attributed mainly to China's massive increase of 706% in its crude steel production over the same period.

1.1.4 To meet the growing demand for steel products, world iron ore production has increased dramatically since 2000. World's production of usable (processed) iron ore has increased from about 970 million tons in 2000 to 2600 million tonnes in 2021. With 900 million tonnes of usable iron ore mined in 2021, Australia is the largest iron ore producing country, followed by Brazil (380 million tonnes), China (360 million tonnes) and India (240 million tonnes).

1.1.5 India's share of global crude steel production in 2021 is 6.1% (118.2 million tonnes) which has been raised from 4.8% (68.3 million tonnes) in 2011(Figure 3). The Indian steel sector has grown dramatically over the few years and is the second-largest producer of steel globally, contributing to about 2% of the country's GDP. Further, The National Steel Policy which was released in 2017 aims to attain a steel production capacity in India of 300 MT by 2030. It has a long-term vision to enhance domestic consumption, produce high-quality steel and make the sector globally competitive. As a result, traditional high-grade iron ore reserves are being significantly depleted and

many new iron ore deposits of lower grade are being explored to meet the future demand.

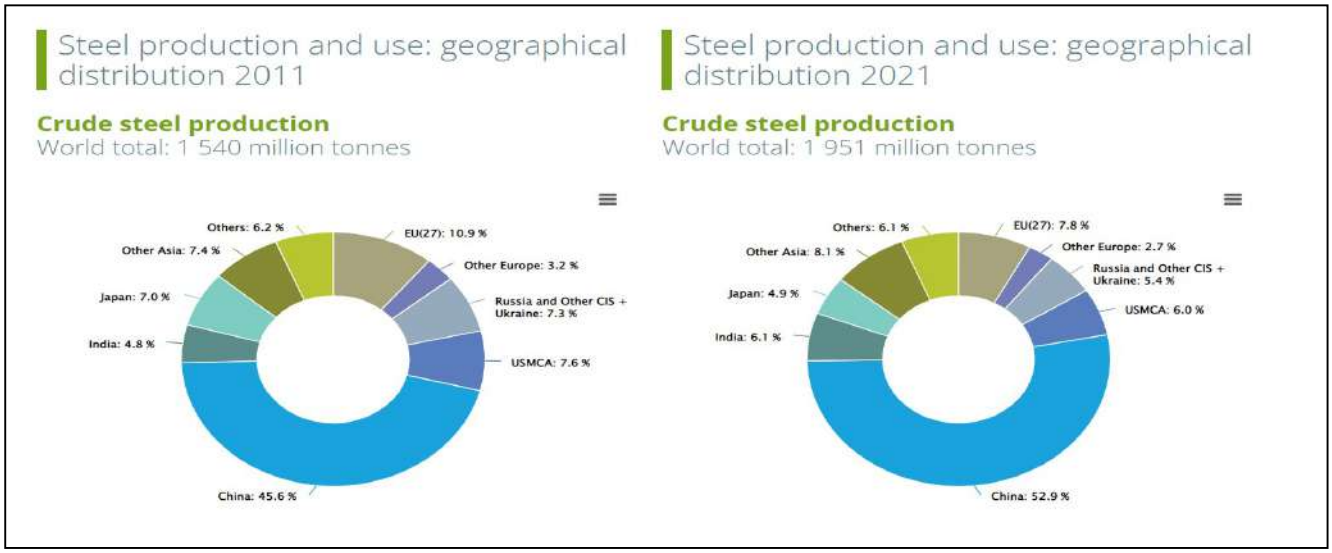

Figure 1.Iron and crude steel production worldwide (Source: World steel Association)

1.1.6 India's crude iron ore reserves are estimated to be around 5.5 Bt, containing 3.4 Bt of iron, the major economic deposits of iron ore in India are distributed across the following five broad zones:

- Zone A- Chiria, Noamundi, Kiriburu, Meghahatuburu, Thakurani, Bolani, Gua, Malangtoli, Gandhamardan, Daitari.
- Zone B- Bailadila, Dalli, Rajhara, Rowghat, Mahamaya, Aridongri, Surajgarh.
- Zone C- Donimalai, Ramgad, Kumaraswamy, NEB Range, Ettinahatti, Tumti, Belagal, Chitradurga and Tumkur Districts of Karnataka.
- Zone D- Goa, Ratnagiri in Maharastra and North Karnataka
- Zone E- Kudremukh, Bababudan, Kudachadri

1.1.7 The first four zones (A–D) account for hematite/goethite mineralization and Zone E accounting predominantly for the magnetite mineralization. The most common names used in India to describe iron ore types are Banded Hematite Quartzite (BHQ), Banded Hematite Jaspilite (BHJ), and Banded Magnetite Quartzite (BMQ). Major economic deposit of India is presented in the Figure 2.

1.1.8 Almost all the current iron ore production in India comes from hematite/goethite reserves (BHQ/BHJ). While there are also substantial magnetite resources in India, they are not exploited because they are located in the environmentally and ecologically sensitive areas of the Western Ghats, a UNESCO World Heritage Site in India and one of the eight "hottest hotspots" of biological diversity in the world. India produced about 255 Mt of usable iron ore in financial year 2022-23, primarily spread across four Indian states, that is, Odisha, Chhattisgarh, Karnataka, and Jharkhand. Unlike Australia and Brazil, the iron ore mines in India are numerous and relatively small in size. Ownership of the mining companies spans both the public and private sectors, with the state-owned National Mineral Development Corporation Limited (NMDC) being the largest iron ore producer in India. Other major iron ore producers include the state-owned Steel Authority of India Limited (SAIL), Orissa Mining Corporation (OMC) and Tata Steel, JSW, JSPL, ESL steel, Rungta and Vedanta from the private sector.

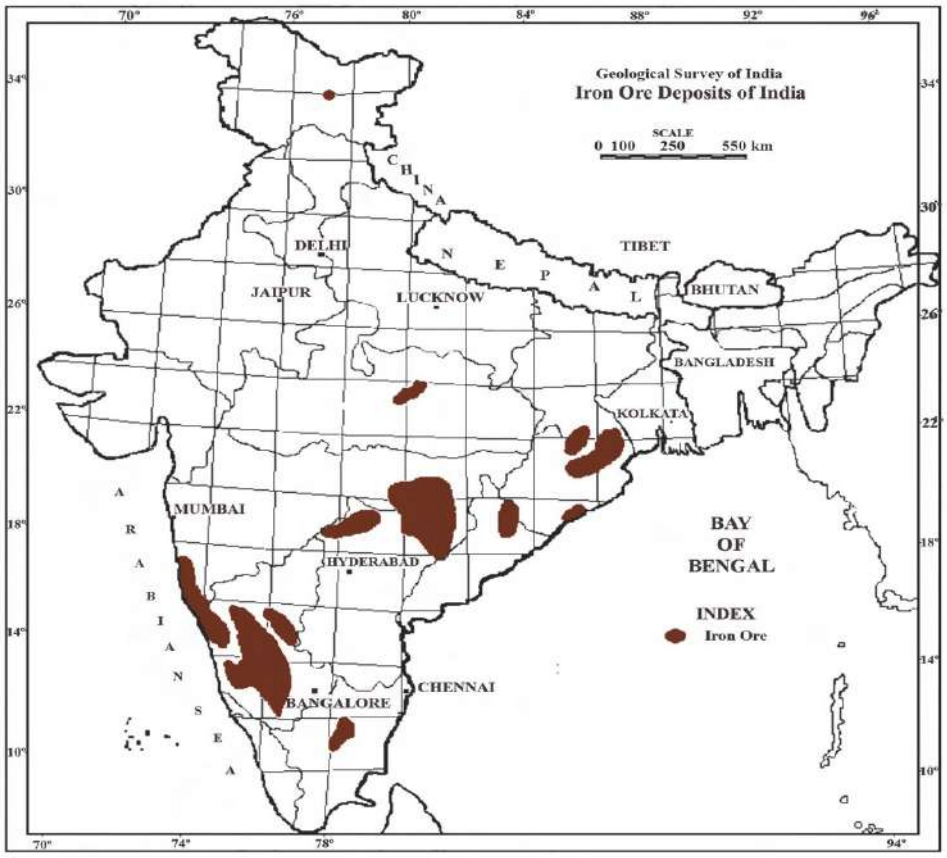

Figure 2. Major economic deposits of iron ore in India

1.1.9 India is close to self-sufficient with respect to iron ore, but the current reserves have a limited life of 15–20 years at the present rate of steel production. Hence, despite revision of the threshold value for iron ore reserves to 35–45% Fe depending on the ore type, with their high-grade reserves under threat of depletion it is now obligatory for the mining industry to look at exploitation of the huge resources/reserves of low/lean-grade iron ores in India, which in the past have been left undeveloped. Furthermore, a 30% export duty has been imposed on iron ore >58% Fe, aimed at preserving India's high-grade iron ore resources for domestic use. This export duty, together with a royalty rate of 15%, mining bans, mine closures, and expiry of leases, has had a major impact on India's iron ore production and exports.

1.1.10 Access and allocation of capital is often cited as one of the biggest challenges facing the mining industry, especially for the junior miners. Rocketing exploration and production costs as well as falling commodity prices have adversely impacted profit margins and left investors reticent to engage in new projects, especially with smaller companies. Junior miners, who lack the financial resources of the major companies, face the challenge of raising the necessary capital to invest in increasingly expensive mining practices or in large-scale equipment. Nervous investors and a lack of access to capital has meant numerous high-profile projects have been scrapped, shelved or sent back to the drawing board. Flexible finance has therefore become an increasingly popular solution and it enables junior miners to continue to push the barriers of exploration and project development.

1.2.0 DETAILS OF THE PROJECT

1.2.1 In view of the enactment of the MMDR Amendment Act, 2015 and Mineral Auction Rule, 2015 by the Govt. of India, the State administration of Odisha desired that some mineral prospects of the State be explored on priority basis through National Mineral Exploration Trust (NMET) fund so that those could be auctioned and thereby earn revenue for the state. Malangtoli area in Bonai-Keonjhar Iron Ore belt, Sundargarh and Keonjhar district, Odisha is one of them.

1.2.2 The Principal Secretary, Ministry of Mines, Government of Odisha, has allotted the iron ore blocks in Malangtoli area, to MECL for taking up of exploration. MECL has taken up the exploration up to G-3 level for auctioning of block in view of MMDR Amendment Act 2015.

1.2.3 On examination of earlier exploration data, Directorate of Geology, State Govt. of Odisha suggested twelve blocks in the Malangtoli area for which exploration for iron ore have to be taken up; Malangtoli 'E' Sub Block over an extent of 14.70 sq km in Sundargarh and Keonjhar district is one of them.

1.2.4 Proposal for preliminary exploration for Iron ore at G3 level was discussed in the Technical cum Cost Committee (TCC) of NMET in its 15th meeting and approved by the 9th Executive Committee (EC) meeting of NMET held on 08th August 2018 vide Office Memorandum F. No. 6/25/2015-NMET dated 16th August 2018.

1.2.5 The block under discussion is falling wholly within the forestland. As per the prevailing guidelines to accord forest clearance (FC), MECL submitted online application (FP/OR/OTHERS/27/2019) on 11.12.2019 seeking FC for drilling and other activities after completing the necessary prerequisite field and other activities. FC proposal was in process meanwhile guidelines for prospecting in the forest land was amended on 17.11.2020. As per the new amendments, online application was no longer required for the quantum of work to be carried out. Hence, online application withdrawn on 22.12.2020 and offline application submitted to the concern authority on 24.12.2020. FC was granted to carry out drilling and other activities vide FC order No. 10976/6F-(Mg.), dated 27.12.2021 where number of boreholes to be drilled is 10 (Ten).

1.2.6 After getting the FC, MECL took the action for drilling through outsourcing as approved by the NMET. The same was not successful due to various reasons.

1.2.7 Later, MECL appraised TCC, NMET about the progress of the project during the 38th TCC, held on 24th and 25th January 2022 where it was decided to complete the exploration as per the already approved cost without any escalation with in-house resources and 14 months time extension i.e. up to 31st May 2023 including report submission. The same had been approved by the EC, NMET in its 23rd meeting held on 11.03.2022 vide Office Memorandum F. No. 6/2/2015-NMET/320, dated 25.03.2022. The same has been attached as Annexure-XI

1.2.8 Drilling and other field activities commenced on 19.08.2022 and concluded on 27.03.2023.

1.2.9 Draft geological report of the block had been prepared as per the time schedule and reviewed in 53rd meeting of TCC, NMET held on 25th May where it was decided to incorporate earlier exploration data of GSI carried out during 1963-68 and 03 months time extension was given for the report submission after dove tailing of earlier

exploration data of GSI i.e. up to 31st August 2023. In the meeting it was appraised that earlier exploration data of GSI which was carried out more than 55 years ago is obsolete because of various reasons such as all data points don't have co-ordinates and collar levels, no co-ordinate references area available in the maps, selective sampling as per the requirement at that time.

1.2.10 An attempt had been made to collect the earlier exploration data carried out by GSI in Malangtoli area. It has been found that most of the work (drilling, pitting and others) carried out in the adjacent areas like in Malangtoli 'G' and 'H' Sub Blocks. No drilling and other data is available with this block.

1.2.11 Draft geological report had been prepared for peer review based on the activities carried out in the block and information available in the earlier exploration of GSI related to the block. After attending the comments of the peer reviewer final geological report has been prepared. The same has been discussed in the 57th meeting of the TCC, NMET and peer reviewer comments and reply to that has been provided in the Annexure-XII.

1.2.12 At the time of proposal approval the extent of the block was 14.70 sq km as per the co-ordinates provided by DMG, Odisha. In the eastern part, the block is overlapping with the lease of M/s NINL (Kadalia Block). Hence, final block boundary has been considered after excluding the M/s NINL area which is 12.68 sq km.

1.3.0 DETAILS OF NATURE AND QUANTUM OF WORK PROPOSED VS ACHIEVEMENT

1.3.1 The quantum of exploratory work proposed vis-à-vis actually performed are furnished in the following Table-1.

Table-1: Quantum of work Approved Vs Achieved

S. No	Nature of work	Unit	Approved Quantum	Achieved
1.	Topographic survey (5m Contour Interval) (1:10000)	sq km	14.70	12.68
2	Drilling (Coring)	m (No of borehole)	1000 (10)	842.50 (10)
3	Pitting (1mx1mx1m)	Cu m	15	Nil
4	Sampling and Chemical Analysis			
	a) Primary+Check Sample (10% internal) for 3 radicals Fe%, SiO_2% and Al_2O_3%,	Nos.	935	726 Primary + 73 Internal Check = 799 Samples
	b) Check Sample (5% external) for 3 radicals Fe%, SiO_2% and Al_2O_3%	Nos.	40	36
	c) Composite sample 7 radicals for (Fe%, SiO_2%, Al_2O_3%, P%, Mn%, S% and V_2O_5%)	Nos.	100	37
5	Petrological Samples	Nos	15	15

S. No	Nature of work	Unit	Approved Quantum	Achieved
6	Mineragraphic Studies	Nos	15	8
7	Specific gravity Determination	Nos.	15	8
8	Bulk Density Determination	Nos.	15	Nil
9	Report Preparation [As per Mineral (Evidence of Mineral Contents) Rule-2015] /UNFC	Nos	01	01

1.4.0 INVESTIGATING AGENCY

1.4.1 The block was explored by Mineral Exploration And Consultancy Limited (Formerly Mineral Exploration Corporation Limited)-MECL during 2022-23 and the exploration programme was funded by NMET. MECL was established as an autonomous Public Sector Company in October 1972, under the administrative control of Ministry of Mines, Government of India for systematic exploration of minerals, to bridge the gap between the initial discovery of a prospect and its eventual exploitation.

1.4.2 MECL has completed over 1619 projects/reports and established 199.40 billion metric tonnes of mineral reserves/resources of minerals like Coal, Lignite, Bauxite, Copper, Gold, Lead-Zinc, Iron Ore, Limestone, Manganese, Magnesite, Chromite, Fluorspar and several other Industrial Minerals since inception (As on March 2023).

1.4.3 MECL's registered address is:

Mineral Exploration And Consultancy Limited
(Formerly Known as Mineral Exploration Corporation Limited)
(A PSE under Ministry of Mines, Govt. of India)
Dr. Babasaheb Ambedkar Bhawan, Highland drive road, Seminary Hills, Nagpur- 440006, Maharashtra, India.

1.5.0 OBJECTIVES OF INVESTIGATION

The exploration was proposed with the following objectives:

1. Reassessment of available Mineral Resources
2. Fixation of boreholes and determination of borehole co-ordinates and RL
3. To determine Lumps and fines ratio
4. To explore broken up areas as well as virgin area
5. To demarcate mineralized and non-mineralized area
6. For quantification of associated minerals if any as per threshold values
7. To estimate the mineral resources in accordance with "Mineral (Evidence of Mineral Contents) Amendment Rules 2021".

1.6.0 ASSOCIATED PERSONNEL

Table-2: List of personnels associated in the project

1	General Supervision and Guidance	Shri P.Ravindran, GM(Exploration)
		Shri P.P. Kulkarni, DGM (Exploration)
2	Field Operation	Shri Rishabh Kumar, Project Manager, Malangtoli Project
		Shri Motish Kumar, Project Manager, Malangtoli Project
		Shri Sujit Kumar Jena. Asst. Manager(Geology)
		Shri. Ripan Pal Sr.T.A. (S and D)
		Shri. Santanu Dey Technician (D)
3	Documentation	Shri S.K.Satapathy, Manager (Geology)
		Ms. Saumya Anand, Sr. Geologist
4	Survey and Drawing	Shri Jagadish Thakral, Survey and Map Officer
		Shri. Punit Khandale, Sr. Tech (S & D)
5	Chemical Division	Shri. Rohit Sharma, Asst. Manager (Chemical)
6	Non-Coal Geological Report Cell	Shri. Uday Patil, Sr.Computer Operator
		Shri. Shivanada, Sr. Computer Operator

1.7.0 WORK COMPONENTS AND ASSOCIATED AGENCIES

1.7.1 The List of work components and agency fulfilled is given in the table below:

Table-3: List of recent work components and fulfilling agencies

SL.	WORK COMPONENT	AGENCIES ASSOCIATED
1.	Topographic Survey	MECL
2.	Geological mapping	GSI and MECL
3.	Exploratory drilling	MECL
4.	Sampling	MECL
5.	Chemical Analysis	MECL, Chemical Laboratory, Nagpur, Lucid Laboratories Private Limited, Hyderabad
6.	Report preparation	MECL

CHAPTER-02

2.1.0 LOCATION OF THE BLOCK

2.1.1 Malangtoli 'E' Sub Block is located in Koira tehsil, Sundargarh district, Odisha. A small part of the block in the southeast corner falls in Keonjhar district. It lies between longitudes 85° 17' 16" and 85° 19' 59" and latitudes 21° 52' 57" and 21° 49' 59". The block covers an area of 12.68 sq km and falls within the Survey of India toposheet No 73G/5. Location map of the block is given in the Plate-I.

2.1.2 Except near the block boundary corner point 'E2' in the south west direction, all part of the block falls in the Koira tehsil of Sundargarh district.

2.1.3 The block is part of the Malangtoli iron ore deposit of well known NNE-SSW trending horse-shoe shaped Bonai-Keonjhar Iron ore belt and lies in the central part of the eastern limb of the belt. Bonai-Keonjhar belt has most important mining centers of Odisha and in India. The area is famous for the rich iron and manganese deposits. Kalta, Joda, Barbil, Jajang and Barsuan are few mining centers in the vicinity of the block. Hence, the block is well connected with other parts of the State as well as with the neighboring State of Jharkhand.

2.1.4 GPS co-ordinates (WGS-84) of the boundary corner points of the block are given in the Annexure I and in the following Table 4:

Table 4. GPS co-ordinates in WGS-84 datum of the boundary corner points of Malangtoli 'E' Sub Block.

GPS Co-ordinates of Boundary Corner points in WGS-84							
Sl No.	Latitude	Longitude	Description of Corner Points	Sl No.	Latitude	Longitude	Description of Corner Points
1	21° 50' 00.406" N	85° 19' 59.161" E	E-1	**19**	21° 52' 06.983" N	85° 18' 49.820" E	E-19
2	21° 49' 59.145" N	85° 17' 28.781" E	E-2	**20**	21° 52' 08.754" N	85° 18' 11.201" E	E-20
3	21° 52' 06.115" N	85° 17' 29.640" E	E-3	**21**	21° 51' 24.662" N	85° 18' 02.599" E	E-21
4	21° 52' 08.805" N	85° 17' 55.865" E	E-4	**22**	21° 51' 25.058" N	85° 18' 16.003" E	E-22
5	21° 52' 31.687" N	85° 17' 53.635" E	E-5	**23**	21° 50' 38.151" N	85° 17' 57.205" E	E-23
6	21° 52' 30.434" N	85° 17' 46.853" E	E-6	**24**	21° 50' 42.133" N	85° 19' 23.548" E	E-24
7	21° 52' 55.059" N	85° 17' 26.052" E	E-7	**25**	21° 51' 13.567" N	85° 19' 26.867" E	E-25
8	21° 52' 53.964" N	85° 17' 16.418" E	E-8	**26**	21° 51' 51.090" N	85° 19' 15.600" E	E-26
9	21° 52' 56.820" N	85° 17' 16.384" E	E-9	**27**	21° 52' 03.954" N	85° 19' 32.731" E	E-27
10	21° 52' 57.373" N	85° 18' 55.597" E	E-10	**28**	21° 52' 27.843" N	85° 19' 34.295" E	E-28
11	21° 52' 54.288" N	85° 18' 56.740" E	E-11	**29**	21° 52' 48.712" N	85° 19' 58.381" E	E-29
12	21° 52' 48.876" N	85° 18' 57.522" E	E-12	**30**	21° 52' 27.670" N	85° 19' 59.644" E	E-30
13	21° 52' 46.313" N	85° 18' 59.211" E	E-13	**31**	21° 52' 29.428" N	85° 19' 42.111" E	E-31
14	21° 52' 26.120" N	85° 19' 08.296" E	E-14	**32**	21° 52' 14.357" N	85° 19' 41.091" E	E-32
15	21° 52' 22.755" N	85° 19' 02.253" E	E-15	**33**	21° 52' 14.392" N	85° 19' 35.697" E	E-33
16	21° 52' 36.662" N	85° 18' 54.725" E	E-16	**34**	21° 50' 30.783" N	85° 19' 40.093" E	E-34
17	21° 52' 34.904" N	85° 18' 49.437" E	E-17	**35**	21° 50' 31.057" N	85° 19' 59.273" E	E-35
18	21° 52' 28.535" N	85° 18' 52.498" E	E-18				

2.1.5 Malangtoli 'E' Sub Block is in the districts of Sundargarh and Keonjhar, Odisha. Administratively the block falls in Koira tehsil of Sundargarh District and The block falls in the villages of Baldih, Sanua, Badpaturi, Patmunda, Khajurdih, San Rusibenua and Kadamdih in Sundargarh District.

2.1.6 The block totally falls in forest area under Khajurdih Reserved Forest and Protected Reserve Forest.

2.2.0 PHYSIOGRAPHY AND ENVIRONMENT

2.2.1 Malangtoli 'E' Sub Block and its surrounding area form an undulating country in between two plateaus in east and west direction. The flanks of the plateaus occupy the eastern and western part of the block. Northern part of the block occupies the valley of the plateaus and has flat topography.

2.2.2 Recorded maximum elevation is 925 mRL towards north of the borehole MNME-03 and in the southeastern part of the block. Minimum elevation of 616.312 mRL (Survey Station EST-19) has been recorded in the northeast corner of the block.

2.2.3 The main drainage of the area is Baitarni River which flows in a northward direction east of the Pipokri-Sirkagutu plateau and forms the eastern boundary of the Malangtoli area. The most important tributary of the Baitarni River is the Mohalda Nala which flows in a northeastern direction at the southeastern foot of the Pipokri-Sirkagutu plateau. A number of perennial streams radiate from the plateau, the notable among these are Jalpa, Nalpani, Kasijoda, Sirkagutu, Khandahar and Malangtoli Nalas; all these streams ultimately flow into Baitarni River with only exception of Malangtoli nala which flows northwards into Kundra River.

2.2.4 No Major roads, railway track, electric transmission lines etc. pass through the block.

2.3.0 POPULATION AND SOCIO-DEMOGRAPHY

2.3.1 Major part of the area falls in Sundargarh district. Hence, information has been provided for the district and source is Census 2011.

2.3.2 Sundargarh district of Odisha has a total population of 20,93,437 as per the Census 2011. Out of which 10,61,147 are males while 10,32,290 are females. The Average Sex Ratio of Sundargarh district is 973.

2.3.3 Out of the total population for 2011 census, 35.26 percent lives in urban regions of district. In total 738,097 people lives in urban areas of which males are 385,079 and females are 353,018. Sex Ratio in urban region of Sundargarh district is 917 as per 2011 census data.

2.3.4 Similarly child sex ratio in Sundargarh district was 903 in 2011 census. Child population (0-6) in urban region was 81,678 of which males and females were 42,912 and 38,766. This child population figure of Sundargarh district is 11.14 % of total urban population.

2.3.5 Average literacy rate in Sundargarh district as per census 2011 is 85.34 % of which males and females are 90.21 % and 80.04 % literates respectively. In actual number 560,175 people are literate in urban region of which males and females are 308,654 and 251,521 respectively.

2.3.6 As per 2011 census, 64.74 % population of Sundargarh districts lives in rural areas of villages. The total Sundargarh district population living in rural areas is 1,355,340 of which males and females are 676,068 and 679,272 respectively.

2.3.7 Schedule Caste (SC) constitutes 9.16% while Schedule Tribe (ST) was 50.75% of total population in the district.

2.3.8 The total area of Sundargarh district is 9712 km^2. Thus the density of the district is 216 people per square kilometer.

2.3.9 The District has wide range of languages. Being located in the western part of the State, the principal language is Kosali-Sambalpuri. In total 36 languages including tribal languages are spoken in the District. Next to Odia other important languages are Mundari, Kurukh / Oraon, Hindi, Kharia, Kisan, Laria, Bengali, Urdu, Ho, Kol,Telugu, Kui, Bhumij, Malayalam, Punjabi and Tamil. The number of speakers of other languages like Bengali, Telugu, Malayalam, Punjabi and Tamil is insignificant. Among the non-tribal languages, the popularity of Hindi is only next to Odia. In terms of number of speakers tribal languages, namely, Mundari and Kurukh / Oraon occupy the second and third position respectively.

2.3.10 In Keonjhar district out of total population, 5,35,112 were engaged in work activities. 25.56% of workers describe their work as Main Work (Employment or Earning more than 6 Months) while 16.15% were involved in Marginal activity providing livelihood for less than 6 months. Of 5,35,112 workers engaged in Main Work, 1,84,273 were cultivators (owner or co-owner) while 2,53,327 were Agricultural labourers.

2.3.11 To facilitate the administration, Sundargarh district is further divided into 17 Blocks (Taluka/Tehsil/Tahsil) which are administrative divisions denoting sub-districts. Blocks consists of multiple villages and a few towns.

2.3.12 Within the block many small settlements exist. Baldih, Sanua, Badpaturi, Patmunda, Khajurdih, San Rusibenua and Kadamdih are among them.

2.4.0 IMPORTANT PLACES

2.4.1 No Historical sites and archaeological monuments, public utilities are within the block. However, few small scale waterfalls in the southern side of the plateau are located in the flanks of plateau. Some of them have tourist attraction. Khandadhar water fall is one of them located 06 km away from the block in the southeastern direction.

2.4.2 There are no national parks, wild life sanctuary, eco sensitive areas, within block. However, the block is part of the Khajurdih Reserved Forest in Koira Range of Bonai Forest Division.

2.5.0 FLORA

2.5.1 The district falls under peninsular sal type and dry deciduous mixed forest as per Champion's classification of flora of India. The sal is the principal timber tree throughout the area. The surface of the plateau land between the valleys, where level, is often bare and rocky, but where undulating is usually clothed with many climbers. Sal (Shorea robusta) is gregarious and among other noteworthy trees are Asan (Terminalia), Kurum (Adina), Bija or Piasal (Pterocarpus), Gambhari (Gmelina), Kusum (Schleichera), Aonla (Phyllonthus), Mahua (Bassia), Sunari (Casia), Kendu (Diospyros), Khair (Acacia), Sisoo(Dalbergia), Bandhan (Ougeinia). Mango is

commonly found in all forests. A large number of edible and indigenous drug trees are also found. The conspicuous shrubs are Dhatuki(Woodfordia), Telai (Wendlandia), Harssinghar (Nyctonthes), Kurdu (Gardenia). The principal grass sabai or Panasi is used for paper pulp, rope-making and also used as fodder in young stage

2.6.0 FAUNA

2.6.1 The district is the abode of numerous big game and rich varieties of animal lives in keeping with the extensive and splendid forests. Wild life is more abundant in Bonai division. The elephant is fairly numerous and are mostly seen in Bonai. They usually move in herds. The wild buffaloes are found in Sundargarh and Panposh sub-divisions. The bison (Gayal), a very retiring animal is generally seen in the denser forest. Among the principal Carnivore, may be mentioned, are the Tiger, Panther, Hyena, Wild-dog, Jackal and Fox. In the past, Bonai forests had an unenviable reputation for man-eating tigers. The Panther (Kalara-Pathria) is found in great numbers in almost all the forests. It is mostly seen in small hills adjoining to cultivated area. Black panthers are more dangerous than man-eating tigers and they are available in Hemgir area. The jungle cats, common gray mongoose, jackal, common fox are chiefly found in most of the area. The giant squirrel, common stripped squirrel (Gunduchi), giant flying squirrel, porcupine (Jhinka), the hare, pangolin(Bajrakapta) are mostly found in the district. The hyenas is very common whereas the wild dog is very rare. The common Indian bear is found all over the forests generally in caves in the hot and wet weathers and in heavy grass and bushes during the cold. It feeds chiefly on the mahua flowers, barriers and white ants. They are a menace to sugarcane and maize. The honey badger is entirely nocturnal in habits and is seldom seen. It lives chiefly in rocky caves in the hills and feeds on lizards, insects and honey. The Sambar is found in all the fairly forests and is nocturnal in habits. The barking deer, Nilgai, Hanuman and Bandar are mostly found. The fair numbers of game birds are met within the district. Mayura, the National Bird of India, is numerous. The whistling teals and the little cotton teals are common. The common or painted sandgrouse is also met with. The district is quite rich in other common birds, both terrestrial and aquatic. Both the snub-nosed crocodile and the long-nosed Gharial are found in the rivers. The monitor lizard is commonly seen. Various species of snakes occur in the district. Among the principal poisonous snakes Tampa, Naga or Gokhara, Chandra Boda and the common Krait are usually seen in the district. In the large deep pools of the rivers, water reservoirs and tanks the species of fish like Rohi, Mirikali, Bhakur, Sala, Balia, Ilishi are available.

2.7.0 CLIMATE

2.7.1 The climate of this district is characterized by hot dry summer and well distributed rainfall in southwest monsoon season. The cold season commences in November and lasts till the end of February. The hot season follows thereafter and continues till about the end of June. The south-west monsoon starts from mid-June and continues to the end of September. October and November constitute the post monsoon season.

2.7.2 The average normal rainfall of the district is 274.5mm and maximum normal rainfall is 480.2mm in the month of July About 86 per cent of the annual rainfall is received during the monsoon months extending over June to September, July being the month with heaviest rainfall.

2.7.3 The hot season commences by about the beginning of March when temperatures begin to rise. May is the hottest month with the mean daily maximum temperatures at about 41 C (105.3 F) and the mean daily minimum at about 27 C (80.60 F). However, the maximum temperature may reach 47 C (116.6 F) during mayor early June.

2.8.0 INFRASTRUCTURE

2.8.1 The block is well connected with National Highway (NH) 20, which connects Panikoili and Ranchi via Keonjhar and Chaibasa, passes towards the east of the block at a distance of 20 km. In addition, it is also well connected with NH 520 which connects Rimuli to Rajmunda via Joda, Koira, Kalta.

2.8.2 The area is well connected with district headquarter Sundargarh with metalled and unmetaled road which is located 150km in the west of the block. Koira in Sundargarh district is also well connected with the block at a distance of 30 km in northwest direction. Joda is 31 km from the block in north direction.

2.8.3 The block is located about 280 km to the northwest of Bhubaneswar, the state capital. Nearest airport is at Bhubaneswar. The block can be approached by the nearest railhead Nayagarh located at a distance of 15 km in east of the block under Khurda road division of Eastcoast Railway. Nearest port is Paradip which is located at a distance of 280 km and connected through NH 20 and NH 53.

2.9.0 CONSUMER INDUSTRIES

2.9.1 It is a matter of great concern that with rapid expansion in the steel manufacturing capacity, there will be unprecedented demand for iron ore for domestic consumption, since it is estimated that by the year 2030 India is likely to produce 300 m.t. of steel to meet the ever-growing domestic demand. Besides, India is likely to continue its iron ore export to keep the structural balance in the international market.

2.9.2 The rapid industrialization in Odisha is leading to the construction of buildings, rail tracts, industrial plants, bridges, etc. All these are increasing the demand for iron and steel in the state.

2.9.3 Iron ore is mainly used for manufacturing pig iron, sponge iron and steel. It is also used in Cement, Coal Washeries, Ferroalloys, Foundry, and Glass Industries. Industries in local and in the adjacent districts may use the minerals for different uses.

2.9.4 There are a number of steel plants along with sponge iron plants in Keonjhar and adjacent districts. Industries in neighbor state Jharkhand may consume the raw materials. In addition, few projects are in pipe line. They are the main consumers of the iron ore mined in Bonai-Keonjhar Iron ore belt.

2.10.0 ACKNOWLEDGEMENT

2.10.1 Mineral Exploration and Consultancy Limited (MECL) expresses its sincere gratitude to the Executive Committee (EC), Technical-Cost Committee of National Mineral Exploration Trust (NMET), Ministry of Mines, Govt. of India at whose behest the exploration work in Malangtoli ‘E’ Sub Block has been executed.

2.10.2 MECL places on record its profuse thanks to the Director, Directorate of Mines and Geology, Odisha for assigning the responsibility of exploration in Malangtoli ‘E’ Sub Block, Keonjhar and Sundargarh district, Odisha.

2.10.3 MECL also gratefully acknowledges the co-operation in execution of exploration activity at Malangtoli ‘E’ Sub Block by the local administration/authorities in Keonjhar and Sundargarh district.

CHAPTER-03

3.1.0 REGIONAL GEOLOGY

3.1.1 The geological background described here for the sake of clarity in local geology, is taken from earlier workers and from traverses made in the areas.

3.1.2 The present study area is a part of the Bonai-Kendujhar belt of Sundargarh and Keonjhar districts. The little metamorphosed Precambrian Volcano-Sedimentary rocks exposed in this belt between the Singhbhum Granite in the east and Bonai Granite in the west are classified as 'Iron Ore Group' (Sarkar and Saha, 1963) or 'Koira Group' (Murty and Acharya, 1975). These rocks are disposed in the form of a low northerly plunging 'Horse-Shoe' shaped Synclinorium (Jones, 1934). Geological map of the Bonai-Keonjhar belt is provided in the Text figure-3

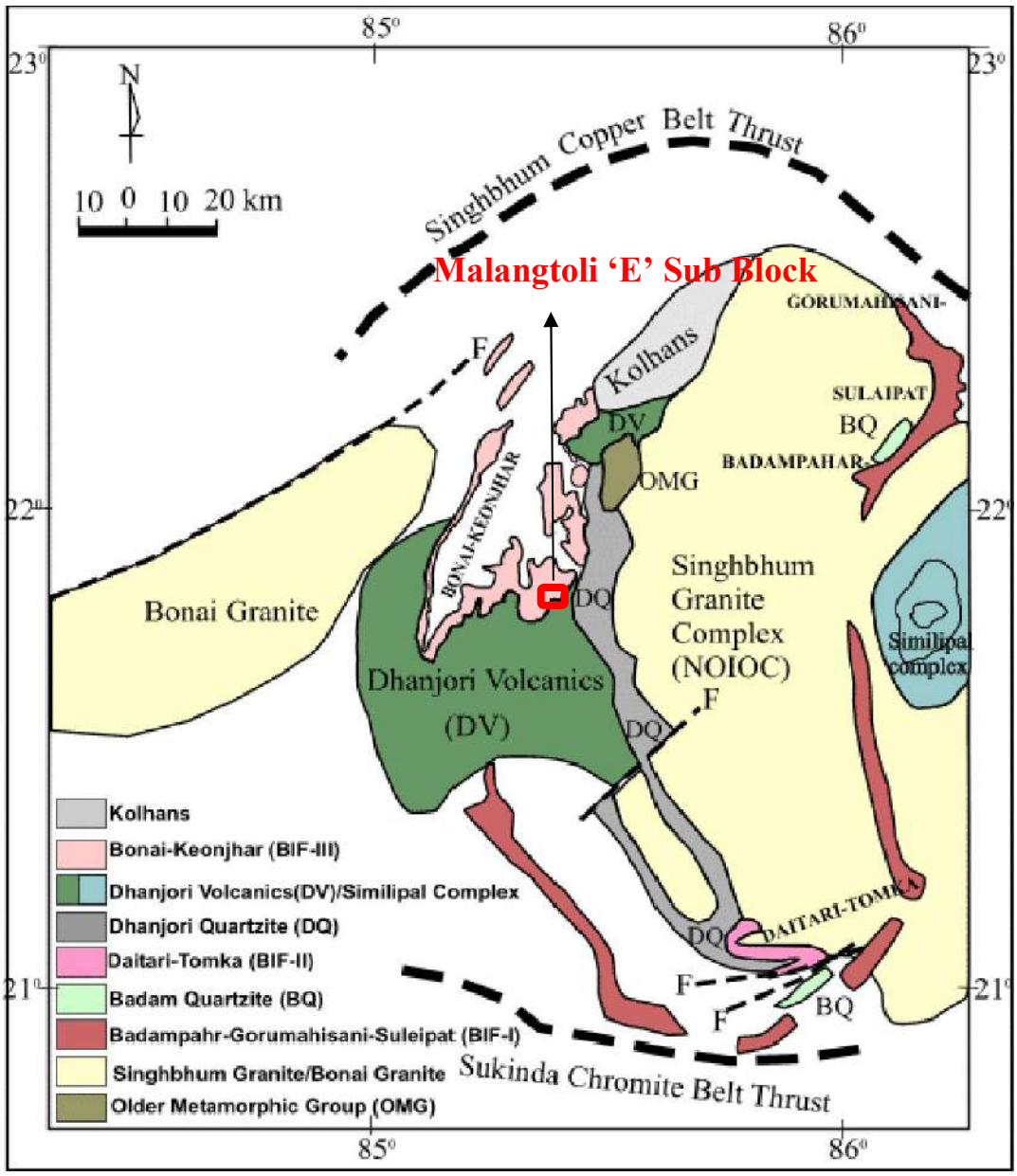

Figure 3: Generalised regional geological map of North Odisha Iron Ore Craton (Modified after Jones, 1934; Beura, 2014)

3.1.3 The base of the Koira Group is marked by a pronounced unconformity over the Singhbhum Granite in the eastern side and has a sheared inter-fingering contact relationship with Bonai Granite on the western side. The Basal Formation comprises of gritty sandstone, which ranges from ortho-quartzite on one hand to pebbly sandstone and conglomerate on the other. This arenaceous unit is followed by mafic volcanics which is found all along the outer periphery of the Horse-Shoe Synclinorium. The volcanic formation comprises predominantly of Lower volcanic flows dominantly of mafic composition and an upper tuffaceous zone. The lava is pillowed at the bottom part and amygdaloidal at the top indicating its sub-aqueous and subsequent sub-aerial character. The lava grades into purple colour tuffaceous shale conformably towards the upper part and described as 'Lower Shale Formation' (Murty and Acharya, op. cit.). By the appearance of jasper and banded jasper inter-banded with the greenish and black shale towards the top, the lower shale graded into the 'Banded Iron Formation'.

3.1.4 The litho stratigraphic succession for the belt was proposed by Murthy and Acharya (1975) is given below:

Table 5: Litho-stratigraphic succession of the Malangtoli area

<table>
<tr><td colspan="2">Kolhan Group</td></tr>
<tr><td rowspan="4">K O I R A G R O U P</td><td>Upper Shale Formation</td></tr>
<tr><td>Banded Iron Formation</td></tr>
<tr><td>Volcanic Formation</td></tr>
<tr><td>Basal Sandstone – Quartzite</td></tr>
<tr><td colspan="2">Singhbhum and Bonai Granites and metamorphosed sediments</td></tr>
</table>

3.1.5 The 'Banded Iron Formation' is represented by BHJ / BHQ, inter-bedded with black or green shale and banded ferruginous chert. Due to high resistance of erosion, these litho-units form high ridges conspicuously mark the outline of the 'Horse-Shoe' Synclinorium and depict the major structural pattern of the belt.

3.1.6 The 'Banded Iron Formation' is overlain by the 'Upper Shale Formation' comprising of thick sequence of tuffaceous purple, white and buff colored shale, black shale, banded ferruginous shale with inter-bedded chert and BHJ / BHQ bands which spread over the entire core of the synclinorium. The 'Upper Shale Formation' can be divided into two horizons / zones (Patel, et.al, 2005) namely, lower manganiferrous shale horizon / zone and upper ferruginous shale horizon / zone. These two horizons / zones exhibit conformable relationship and are characterised by their typical litho-assemblages. The manganiferrous horizon / zone comprising predominantly of manganiferrous grayish green shale, carbonaceous black shale with inter-beds of chert locally grading to dolomite hosts almost all the major manganese ore deposits of the area, whereas, ferruginous shale horizon / zone comprising of banded ferruginous shale with inter-beds of BHJ / BHQ and BFC gives rise to isolated iron ore deposits within the core of the synclinorium. The regional geological map of the Bonai – Kendujhar Iron ore belt (After GSI) is shown in the Text Figure No. 3.

3.1.7 A younger sequence of conglomerate and sandstone, exposed on the northern and north eastern part of the belt are unconformably overlying the Koira Group of rocks, is arenaceous rock sequence which have been described as Kolhan Series (Dunn, 1940) or Kolhan Group (Murty and Acharya, 1975). It is differentiated from the basal

sandstones and conglomerate by the presence of jasper pebbles, iron ore pebbles and fragments of BHJ.

3.1.8 The iron ore bodies associated with the 'Upper Shale Formation', occur at much lower topographic elevations (450-650 m) within the core of the synclinorium compared to the major iron ore deposits belonging to the 'Banded Iron Formation' and occurring at the ridge tops (750-950 m).

3.2.0 REGIONAL STRUCTURE

3.2.1 In general, the Iron Ore Super Group of rocks in the Bonai-Kendujhar belt are disposed in form of an "Omega" and referred to as "Horse Shoe Synclinorium" (Jones, 1934). This belt is 60 km long and 25 km wide extending from south of Malangtoli in Kendujhar district up to Chakradharpur in West Singhbhum district (Jharkhand). The structural fabrics in the above little metamorphosed Volcano-Sedimentary litho-sequence indicate at least two phases of deformation and folding. The earlier phase is the most prominent and resulted in formation of two synclines intervened by an anticline trending NNE-SSW with a low north-north easterly plunge. The western limb is slightly overturned to the east and dip westerly (65°-75°) whereas, the eastern limb is a normal one with moderate to low (30°-45°) westerly dip. This phase of folding is affected by a later NW-SE to WNW-ESE trending fold resulting in broad warps and formation of structural domes and basins in the area. The western syncline known as Koira syncline, due to steep dip and overturned nature of its limb forms a deeper basin with thick sequence of younger shales in the core region. On the other hand, the eastern syncline known as Bamebari syncline is a shallower basin and exposes younger litho members within the core region as outliers. The Upper shale unit within the Koira syncline is mostly continuous whereas, in Bamebari syncline it occurs as isolated patches.

3.3.0 GEOLOGY OF THE BLOCK

3.3.1 The Malangtoli 'E' Sub Block and the surrounding area, comprising weakly metamorphosed volcano-sedimentary sequence of rocks, occurs in Bonai-Keonjhar Iron ore belt belonging to the Iron Ore Series of Precambrian age (Jones 1934) and forms part of the eastern limb exhibiting a westerly dip of the northerly plunging asymmetric synclinorium.

3.3.2 The local stratigraphic succession worked at Malangtoli area is given in the below table:

Table 6: Litho-stratigraphic succession of Malangtoli Iron Ore block

<table>
<tr><td colspan="2">Laterites (ferruginous and occasionally Limonitic)</td><td>Different litho units</td></tr>
<tr><td rowspan="5">Iron Ore Group</td><td>Upper shale sequences</td><td>Shale, Ferruginous Shale, Cherty Shale, Chert/Quartzite</td></tr>
<tr><td colspan="2">Clay/Ferruginous Clay</td></tr>
<tr><td rowspan="3">BIF sequences</td><td>Laminated Ore, Massive Hematitic Ore</td></tr>
<tr><td>Soft Laminated Ore, Blue Dust</td></tr>
<tr><td>BHJ and BHQ</td></tr>
</table>

Mostly the plateau area within the block is occupied either by BHJ/BHQ, Hard and compact laminated ore. Flanks of the plateau are occupied by mostly BHJ/BHQ. The low lying areas in the northern part of the block occupied by alluvium. Common litho units found in the block are described in the following paragraphs:

3.3.3 **Banded Hematite Jasper/Quartzite:**The most striking feature is their striped and banded character with layers of chert/ferruginous chert alternating with pure hematite. Clastic grains are absent. The rock is predominantly jaspery passing only occasionally into quartzite. It is conspicuously well developed in the area particularly along the steep flanks plateau and is also met with in some of the hillocks. As the name indicates the banded hematite jasper is composed of alternating bands and laminae formed mainly of hematite and jasper/quartzite. Band thicknesses vary from about a milimetre to several centimeters.

3.3.4 A close scrutiny of the constituent bands of the rock indicates that even these are not homogeneous. The hematite bands usually contain small lenticels, streaks and partings of jasper. Likewise the jaspery bands bear streaks, lenses and occasionally partings of hematite besides a fair sprinkling of hematite grains all over. The intensity of the sprinkling of the hematite grains varies so much so that sometimes parts of the jasper band or lenticels becomes very rich in hematite. Often these jasper bands, lenses and nodules have incipient fractures filled with hematite.

3.3.5 Under the microscope, the rock is found to be composed essentially of cherty silica and hematite as alternate bands. The cherty material often contains grains of hematite. Sometimes streaks and lenses of interlocking quartz grains are also observed. Quartz is seen present as very fine criss-cross fillings in areas. Few borehole samples have been subjected to petrographic studies and the results are provided in the Annexure-XI.

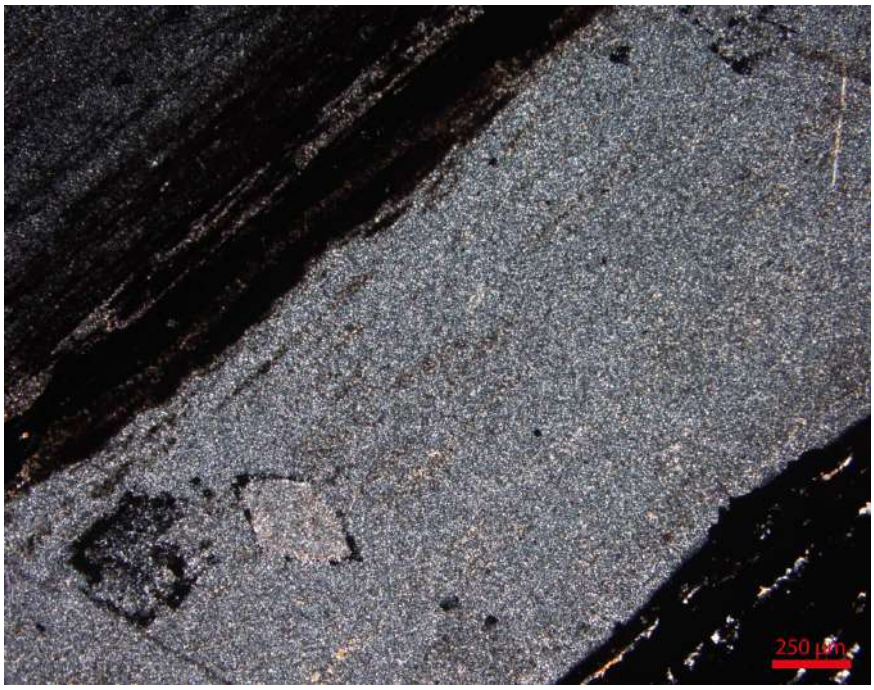

Figure 4: Photomicrograph showing thin to moderately thick sub-parallel bands of chert/ jasper and opaque as seen under crossed nicols. **Specimen No. : MNMEP-10** BH No. **MNME-06/ 50.40m – 50.50m) (Magnification :40X)**

The banded hematite jasper generally forms the floor of the iron ore deposits in the area which has been observed from the intersections in the all boreholes.

3.3.6 **Lateritic iron ore/Laterite**: It is seen on the top and slopes of the hillocks. The color of the lithounit varies from yellowish to earthy brown depending on the rock type underlained. In most cases, the laterite is underlained by BHJ/BHQ. The fragments of hematite (iron ore) are randomly oriented and size varies from pebble to silt size. At places it also shows massive character.

3.3.7 **Laminated Ore:** Different types of iron ores have been encountered in surface and sub-surface exploration, of which laminated iron ore is dominant one. Hard laminated ores are steel grey in color and are relatively of high grade. They consist of massive hematite with bands of specular hematite which exhibit similar pattern as of BHJ. In soft laminated type of ore, individual lamellae measure from a few millimeters to centimeters in thickness and the ore is porous and fragile. The texture of soft laminated ore is almost similar to hard laminated ore but there are many voids between the lamellae, which are filled with secondary goethite and clay. Microscopically, it is a metallic steel grey coloured thinly laminated ore type showing pores, fractures and reddish stains. Under microscope, opaques occur as segregated sub-parallel bands disrupted by fractures at places and showing pores in-between. Ferruginous matter is present as fine mass, patches and stains. Pores and fractures are filled up by fine clay minerals and gibbsite, at places. Otherwise, it is called as soft laminated or hard laminated.

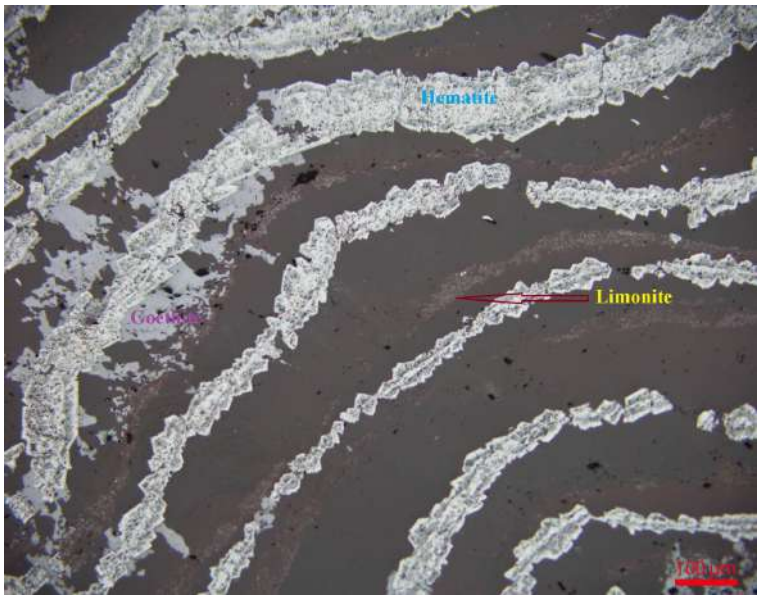

Figure 5: Photomicrograph showing thin sub-parallel micro-folded bands of hematite being replaced by goethite patches and also showing reddish amorphous limonitic aggregates segregating into thin sub-parallel bands as seen under reflected light. Specimen No. : MNMEM-04 (BH No. MNME-06/ 25.00 – 25.10m) Magnification :100X

3.3.8 **Float Ore**: Loose rolled fragments of the ore mixed with soil in varying proportion, are frequently met with along the slopes and plains around the ore bearing hills in the area and also on the flattish grounds on top of the hills. These fragments invariably have a thin greyish black coating over them due to atmospheric oxidation. These are well known as float ore.

3.3.9 **Detrital lateritic Iron Ore:** In certain areas the float ore fragments are found cemented together in a lateritic matrix, the degree of cementation varying from place to place. In those cases where the proportion of the matrix is high, the overall grade of the ore is lowered as the fragments are not easily separable from the matrix.

3.3.10 **Ferruginous shale:** It is of fine grained compact clay without any fissility and with or without Fe content. It might be the alteration of the BHQ and iron content rocks.

3.4.0 STRUCTURES

Trend of the laminations in BHQ/Iron ore wherever exposed are nearly NNE-SSW to NS and dip varies from 10º to 40º at times even 70º towards west and east. The direction of dip changes frequently due to folding.

3.4.1 Among the primary sedimentary structures recognized in the area are made of the laminations and bedding in the banded hematite jasper and iron ores The secondary structures met with in the area include folds both regional as well as local, faults and joints.

Bedding: It is the smallest internal division of the formation. The bedding planes of BIF are sharp, linear and may be traced over a considerable lateral extent. The BIF consists of numerous bands of iron oxide and silica of both meso and micro scale and these bands together form thicker composite beds of 80-100 cm thickness.

Brecciation: It is occasionally observed in BHJ/BHQ formation where angular fragments of brittle silica (jasper or quartzite) are embedded in iron oxide matrix, observed in drill core. The zone of brecciation, about 1.0m thick, confines within undisturbed sequence of BHJ/BHQ.

Intraformational Folds: These folds are small scale and are confined within few successive layers of BHJ/BHQ. These are localized in nature and the folded zones are confined within undisturbed sequence of BHJ/BHQ on either side. It indicates that these were formed when interlayer gliding and slumping occur in the volcano-sediments. Such types of folds vary in geometry from place to place and bear no relationship with the regional fold pattern.

3.5.0 CONTROLS OF ORE LOCALIZATION

3.5.1 The iron ore bodies are formed by surface alteration of BHJ/BHQ by prevailing climate; selective leaching out of silica and resultant enrichment of the iron. The later enrichment leading to richer grade is related to structural deformation of the Iron Ore Group (IOG) host rocks of this belt. The close association of the iron ores with the banded hematite jasper which indicates a litho and stratigraphic control of the mineralization . Structures like fractures, fault and joint planes pave the way for the mobilization of fluids for supergene processes. In addition, the paleoclimatic conditions might have played a role for the enrichment of mineralization. Thus, the main controls of ore localization are lithologic, stratigraphic, structure and paleoclimatic.

3.6.0 MODE OF OCCURRENCE

Iron ore body in the block occurs as tabular and bedded form occupies the valley in between two plateaus in the east and west direction with undulating in nature. Top surface has undergone low degree of laterisation as evidenced from the intersections in all boreholes. Below the laterisation hard to soft laminated ore occur underlain by BHJ/BHQ. The banded hematite jasper generally forms the floor of the iron ore deposits in the area which has been observed from the intersections in the all boreholes.

3.6.1 The laminated iron ore occurs as capping over BHJ and BHQ. It is finely laminated and exhibits similar fold patterns like that of BHJ and BHQ. It is often cross cut by fracture and joints, which are later mineralised with secondary iron oxide minerals. At places,

near hinge of folds, small lensoidal bodies of lateritic and massive iron ore are developed. Limonite pockets are also found along joint and fractures. The laminated ore body is seen underlain by blue dust/powdery zone, followed by BHJ and BHQ.

CHAPTER-4

4.1.0 PREVIOUS EXPLORATION

4.1.1 H.C.Jones (Hayden-1920; Pascoe-1921, 1923, 1924, 1925, 1927; Fermor-1923; and Jones-1922 and 1934) and M.S.Krishnan (Pascoe-1927, 1928; and Jones-1934) carried out traverses in parts of the area under report, while covering the entire Singhbhum-Keonjhar-Bonai iron ore region between 1919 and 1927, for delineating the geological set up and rapid assessment of the potentialities of the various iron ore deposits in the region. They estimated a reserve of about 2970 m.t. for the entire area. Out of this, about 200 m.t. was their estimate for the ore deposits now included in the Malangtoli block.

4.1.2 The area covering parts of the Malangtoli block was geologically mapped on 1:63,360 scale by B.C.Gupta during the field season 1938-39. A preliminary survey of the various deposits of iron ore in the Malangtoli block was carried out by P.C. Mathur and P.V.S. Kurup (Mathur and Kurup-1962) and a reserve of about 470 m.t. of ore with average Fe of 60% has been established.

4.1.3 The detailed appraisal of the iron ore deposits in Pipokri-Sirkagutu area of Malangtoli Block, Keonjhar and Sundargarh districts, Orissa, was taken up at the instance of the Government of India for blocking out reserves of high grade iron ore for exploitation in connection with the export trade through Paradip port. Accordingly the field investigation was commenced on 17.3.1963 and concluded on 12.4.1968 over an area of 20 sq km.

4.1.4 The above work was aimed for certain requirement at that period. Iron ore below 55% Fe was not considered as ore for resource estimation. At that period lumpy Iron ore was given importance based on the prevailing technologies. In most cases powdery ores were not sampled and considered for resource estimation. Drilling of 20826m involving 296 boreholes were drilled in the area. The current block is adjacent to the above said work.

4.2.0 LIMITATIONS DURING EXECUTION OF THE EXPLORATION WORK

a. Uneven shape along with the limited scope work renders to assess the complete shape and size of the ore body. Shape of the block is like English alphabet ‘U’ where central portion is out of the block and the two limbs occupied by flanks of the plateaus or steep slope hills where approachability is a major constraint.

b. The block is a huge area (12.68 sq km) and approved 10 nos. of boreholes were insufficient to assess the shape and size of the ore body.

c. Geological mapping was not part of the scope work.

d. The block is totally in forest area. Getting forest clearances for the drilling of boreholes took much time to commence the work. In addition, difficulties were faced during execution due to movement of elephants in the block and surrounding areas.

4.3.0 PRESENT SCOPE OF WORK

4.3.1 Scope of work includes topographical survey, drilling, sampling, analysis and geological report submission.

4.4.0 OBJECTIVE

4.4.1 The main objective of exploration by MECL was to estimate iron ore resources in the Malangtoli Sub Block-E.

4.4.2 The following objectives were set for this purpose:

- To assess the level of topography through topographical survey.
- Borehole fixation, determination of co-ordinates and RL of boreholes.
- To assess the strike and depth continuity of iron ore in the area.
- Determination of Lumps and fines ratio
- Determination of Broken up area / virgin area
- Determination of Mineralized / Non-mineralized area
- Associated minerals if any with quantification as per threshold values.
- To carryout exploration accordance with "Mineral (Evidence of Mineral Contents) Rules 2015".
- Estimation of iron ore resources as per UNFC classification.

However, few of the above objectives are not achieved due to limitations in the field.

4.4.3 The whole field activities commenced on 19.08.2022 and completed on 27.03.2023.

4.5.0 SURFACE SURVEY

4.5.1 The survey work has been carried out by using Differential Global Positioning System (DGPS) and total stations of Tremble make having accuracy of 0.10m and with WGS 1984 datum. In the absence of survey of India reference point, within the vicinity of the area, base station 'Base Point-2' was fixed to commence the survey work. Base was made on the ground and its reduced level and coordinates were recorded with DGPS in WGS-84 datum and later on converted to UTM Zone-45N

4.5.2 In the initial part network of stations were established all around the block for contouring and borehole fixation with the help of DGPS. List of major stations established in the area has been provided in Annexure-II

4.5.3 The contouring was done over an extent of 12.68 sq km at 5.00 m. interval with the help of total station and DGPS. The detailed Topographical Map of the block was prepared on 1:10000 scale. However, for easy viewing in large area the Surface Map has been provided in Plate-II in 1:5000 scale.

4.5.4 Boreholes were fixed on the ground with the help of base and triangulation stations and the same had been surveyed again after drilling for the final location by DGPS instrument. Co-ordinate and RL details of the drilled boreholes have been provided in the Annexure-III.

4.5.5 GPS co-ordinates provided during proposal making has been considered for the extent of the block area which was 14.70 sq km. However, after plotting in Autocad software the total area comes 12.68 sq km and the same has been considered for this report.

4.6.0 GEOLOGICAL MAPPING

4.6.1 Geological mapping in the block was not part of the scope of work. However, few traverses were made to confirm the already prepared geological map of GSI on regional scale and assess the different litho units/ iron ore and its nature. Revised geological map has been provided in the Plate- III in 1: 5000 scale.

4.7.0 BULK DENSITY DETERMINATIONS

4.7.1 Pitting for bulk density determination was not undertaken during this study. Also, it is not a part of the scope of work. In addition Bulk density determination in the block with limited scope and time was not possible due to iron ore wherever exposed are either Hard Laminated ore/Massive or BHJ. Pitting in this area was difficult and requires small scale blasting. Blasting and associated activities in the forest was not a part of the scope of work and time taken activities with many clearances.

4.7.2 Pitting carried out to determine bulk density in the adjacent area by GSI during 1963-64 has been considered here. (***REPORT ON THE DETAILED INVESTIGATION OF IRON ORE DEPOSITS IN PIPOKRI-SIRKAGUTU AREA, MALANG-TOLI BLOCK, KEONJHAR and SUNDARGARH DISTRICTS, ORISSA*** By P.C. Mathur Geologist (Sr.) and F.N. Mitra, Rafi Ahmed, S. C. Kanungo, P.K. Pradhan, S. N. Mishra Assistant Geologists, Geological Survey of India), Accession No. UE1353. Bulk density/tonnage factor determined by GSI is summarized in the below paragraphs.

4.7.3 Five shallow pits each measuring about 2 x 2 m. on the surface, were sunk to a depth of about 3 m using small explosives. These pits were located on outcrops of typical common varieties of ore. The ore excavated from these pits was weighed and its in situ volume computed by filling the pits with measured quantity of water. In order to avoid seepage of water in course of the work, the walls and floor of the pit were covered by polythene cloth. The volume per unit of weight (tonnage factor) and weight per unit volume (multiplication factor) for the common varieties of ore computed from the total weight and volume of the ore excavated from these pits,

Table 7: Estimation of Bulk Density for different types of ore (GSI)

Variety of ore	Deposit No.	Pit No	Tonnage factor (cu m/tonne)	Multiplication factor (T/cu m)	Present classification
Steel grey Laminated ore	F	TF-1	0.202	4.95	Massive ore/ Thickly Hard laminated ore
Laminated somewhat compact	F	TF-2	0.33	3.08	Hard laminated ore
Laminated with voids	L	TL-2	0.34	2.97	Soft laminated ore
Laminated (biscuity type)	G	TG-1	0.39	2.56	Soft laminated ore
Lateritic	L	TL-1	0.49	2.04	Lateritic iron ore/ Detrital Lateritic iron ore

4.7.4 MECL could not carry out the bulk density determination study in the block, the bulk density (Tonnage factor and Multiplication factor) determined by GSI for different types of iron ore of different deposits in Malangtoli area has been considered for computing resource estimation of iron ore in the Malangtoli 'E' Sub Block thus making allowance for the possible fissures, joints, voids etc. in the ore.

4.7.5 To arrive bulk density for the iron ores in the block average value of the five pits has been considered here for resource estimation which is **3.30.** This is considered uniformly for all types of ores in the block.

4.8.0 SPECIFIC GRAVITY

Specific gravity determinations were carried out on 08 no. of borehole core samples by walker steel yard balance in MECL Laboratory, Nagpur. The succinct detail of specific gravity determined by MECL is as follows:

Table 8: Specific Gravity Determination results

Sl.No.	Sample No	Specific Gravity	Location	Description of the ore
1	MNMEM-01	3.73	(MNMG-02/ 7.50-7.60m)	Hard laminated Ore
2	MNMEM-02	4.44	(MNMG-0339.80-39.90m)	Massive Ore
3	MNMEM-03	5.00	(MNMG-03/ 50.80-50.90m)	Massive Ore
4	MNMEM-04	3.38	(MNMG-06/ 25.00-25.10m)	Hematite (Soft laminated Ore
5	MNMEM-05	3.63	(MNMG-06/ 42.80-42.90m)	Hematite (Soft laminated Ore
6	MNMEM-06	3.40	(MNMG-06/ 88.20-88.30m)	Hematite (Soft laminated Ore
7	MNMEM-07	3.08	(MNMG-09/ 13.40-13.50m)	Hard laminated Ore
8	MNMEM-08	3.02	(MNMG-09/ 14.80-14.90m)	Hard laminated Ore
Average Specific Gravity		**3.71**		

4.9.0 LUMPS AND FINES

4.9.1 Pits could not be made for bulk density/lumps and fines ratio determination due to the reasons as mentioned in the above paragraph 4.7.1. However, activities carried out by GSI in the adjacent area have been considered here due to similar nature of mineralization for lumps and fines distribution in the varities of ores and summarized in the following paragraphs.

4.9.2 The lump recovery factors for the commonly occurring varieties of iron ore have been computed from the data collected from the deep pits sunk in the major deposits and from the five shallow pits excavated for determining the tonnage factor of the in situ ores.

Variety of ore	Range of lump recovery factors in %
Steel grey laminated	67.8 - 92.8
Laminated (rather compact)	63.4 - 79.0
Laminated with voids and cavities	55.8 - 76.3
Laminated (biscuity type)	68.00 - 75.01 (anticipated recovery in mining about 30%)
Laterite ore and laterite	67.5 - 83.0

4.9.3 The variations in the lump recovery factor of a single variety of ore even within the same deposit, may be attributed mainly to the difference in coherence of the constituent laminae of the ore; thickness, proportion and frequency of the partings and pockets of powdery ore and ferruginous shale, if any, size and frequency of the voids and cavities; degree and spacing of joints, cleavage partings etc.; and also the extent of lateritisation. It is presumed that these variables besides mechanical factors, also influenced to a great extent the proportion of core recovered in course of drilling. Therefore, it may be assumed that the Lump recovery in a particular ore zone may vary within the above

limits with the proportion of the core recovered in the course of drilling through the zone. Hence, an attempt were made to estimate the distribution of lumps and fines in the ore by using drill core recovery. The values of lump recovery factors assumed for the different varieties of iron ore vis a vis their core recovery are given in the following table. However for the present classification the average value of the particular type of ore has been considered for the block.

Variety of ore	Core recovery in	Estimated Lump Recovery %	Present classification ore	Avg. Lump and Fines Recovery %
A-Hard ores.				
1. Steel grey laminated	70 and over	90.00	Hard Laminated Ore	77.50% Lumps and 22.50% Fines
	50.00 to 69.99	80.00		
2. Steel grey massive	30.00 to 40.99	70.00		
3. Greyish brown laminated	15.00 to 29.99	50.00		
4. Greyish brown massive	5.00 to 14.99	20.00		
	less than 5	Nil		
B. Moderately Hard Ores				
Laminated	60.00 and over	80.00	Soft Laminated Ore	47.14% lumps and 52.86% Fines
	50.00 to 59.99	70.00		
	30.00 to 49.99	60.00		
	15.00 to 29.99	50.00		
	5.00 to 14.99	20.00		
	Less than 5	Nil		
Biscuity variety	5 and over	30.00		
C. Soft Ore				
Flaky and friable	Only such bands as are intercalated within hard ore	20.00		
D. Powdery Ore		Nil	Powdery Ore including blue dust	100% Fines
Powdery including blue dust				
E. Lateritic Ore				
Lateritic	40.00 and over	60.00	Lateritic Ore	32.50% Lumps and 67.50% Fines
	15.00 to 39.99	50.00		
	5.00 to 14.99	20.00		
	less than 5.00	Nil		

4.10.0 EXPLORATORY DRILLING

Total 10 no of boreholes with 1000.00m drilling was approved by NMET for G-3 level exploration in the Malangtoli Sub Block–E, Out of the approved meterage, 842.50m with ten (10) boreholes has been achieved. The quality of drilling was ensured during the operation. The base, BHJ/shale formation was considered for closure of the borehole, as it forms the lesser mineralized rock formation. Details of the boreholes drilled in the block is provided in the Annexure-III

4.10.1 The block under study is of greater extent (12.68 sq km) and approved ten boreholes were planned to cover the mineralized area. However, most part of the area is left out where drilling is required.

4.11.0 CORE LOGGING

4.11.1 The core materials recovered from the drilling were logged systematically to demarcate various litho-units. The logging of run wise cores and the powdery materials as well as the cuttings from boreholes have helped in discerning the physical characters like colour, shape, size and nature of mineralisation. Besides, the qualitative analytical data helped in delineating the ore types and non-ore.

4.11.2 The logging was carried out run-wise for the exploratory borehole. Since the numbers of litho units were more, the consolidated litho logs were prepared to show the litho units as graphic representation and were plotted for every borehole on each cross section. The grouping of litho units was done as soil, laterite, float ore, soft laminated ore, hard laminated ore, shale, ferruginous shale, BHQ/BHJ. Lithological details along with the chemical analyses of the individual boreholes are given as Annexure-IV and V.

4.12.0 PRIMARY SAMPLING

4.12.1 The borehole cores recovered by drilling were divided into two longitudinal equal halves. The first (one) half was taken for sampling, whereas the second (other) half was kept for future reference. The first half was subjected to uniform size reduction of 1mm size. It is thoroughly mixed, pounded and powdered to (-) 100 mesh size by jaw crusher and pulveriser and then coned and quartered. 3 sample packets of 100 grams each have been prepared; out of the three one packet has been labeled and sent to MECL laboratory for Fe, SiO_2 and Al_2O_3 analysis, whereas other two packets have been preserved for future reference. Generally, one meter length of the core has been considered as a sampling unit, provided there is no change in lithology or else, the length corresponds to a particular lithology has been taken into consideration for sampling purposes. In the non mineralized area samples have been made more than one meter. The analytical details of the samples are given in Annexure-V

4.12.2 All the primary samples were analyzed for Fe, SiO_2 Al_2O_3 on the basis of the characteristics and association of other minerals at MECL laboratory by XRF method.

4.13.0 PETROGRAPHIC STUDIES

4.13.1 Petrological studies have been carried out on 15 no of borehole samples in MECL Petrological Laboratory and the results are given in Annexure– X. Some of the rock/ore samples identified during petrological studies has been described briefly as under.

4.13.2 **Shale** (MNME-07/ 40.80 – 40.90m): It is a dark grey colored massive rock and made up of very fine flaky aggregates of clay minerals. Opaques occur as very fine euhedral to anhedral grains segregating into thin sub-parallel lamellae. Quartz is present as very fine disseminated silt sized grains. Very fine hair line chert fillings have seen intruded in areas.

4.13.3 Banded Hematite Jasper (MNME-06/ 50.40 – 50.50m): It is a very fine grained rock showing alternate whitish grey/ reddish grey and dark metallic grey coloured bands.Chert/ jasper occur as moderately thick sub-parallel bands comprising very fine micro-crystalline aggregates and often associating reddish amorphous ferruginous matter with it. Opaques (hematite) occur as thin to moderately thick sub-parallel bands

comprising fine to very fine subhedral to anhedral grains. Opaques are also seen present as fine to medium subhedral grains in dissemination. Reddish ferruginous fillings have intruded in areas and also reddish ferruginous patches are seen oozing out around opaques, at places. Quartz is seen developing after recrystallization of chert/ jasper in areas, especially in contact with opaque bands.

4.13.4 Chlorite rich rock/ chloritised mafic volcanic rock (MNME-07/ 36.80 – 36.90m): It is a dark greenish grey colored massive rock. The specimen is made up of lensoidal patches of chlorite comprising very fine micro-crystalline to finely crystalline flaky aggregates showing crude alignment. Opaques are seen present as very fine anhedral to subhedral and bladed disseminations. Plagioclase occurs as sericitised turbid patches in pockets. Biotite is present as fine flakes being replaced by chlorite. Carbonates are seen present as fine to medium anhedral to subhedral grains and patches in areas. Quartz occurs as very fine grains in accessories.

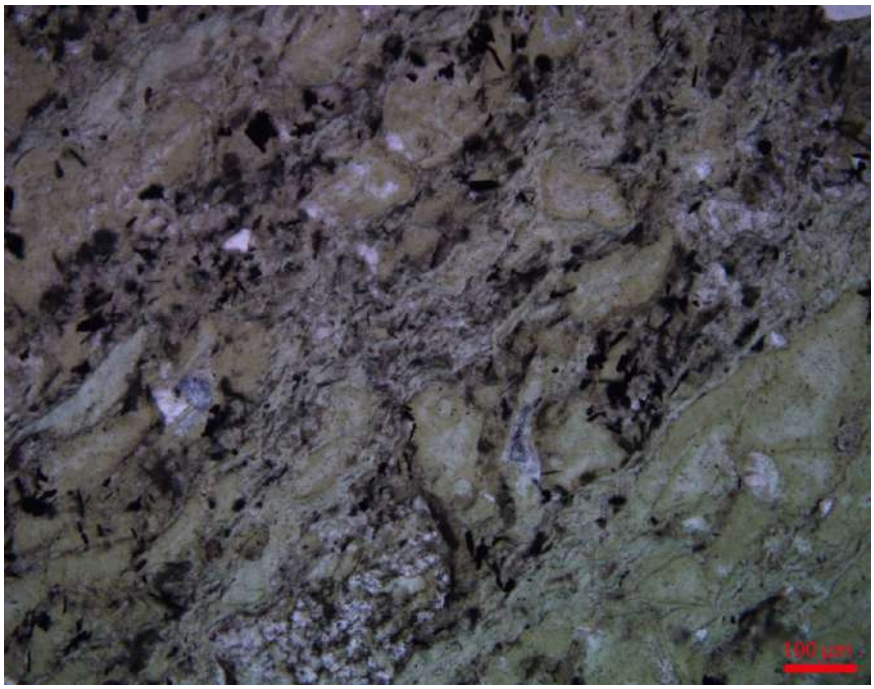

Figure 6: Photomicrograph showing lensoidal patches and fine to very fine micro-crystalline aggregates of chlorite as seen under crossed nicols. **Specimen No. : MNMEP-07 (Magnification :100X)**

4.14.0 MINERAGRAPHIC STUDIES

4.14.1 Minerographic studies have been carried out on 08 (Eight) borehole samples in the block in MECL Petrological Laboratory and the results have been presented in Annexure –IX.

4.14.2 In General the iron ore is of hematitic in nature. Hematite is present as very fine anhedral and bladed aggregates, segregating into massive patches throughout the specimen leaving pores and gangues in-between. Goethite and hematite together also occur as isolated and as well as intermixed fillings showing colloform texture. Limonite is present as reddish amorphous aggregates along pores and cavities. Magnetite is noted as very fine relicts within hematite. Limonite occurs as very fine reddish amorphous aggregates in pockets.

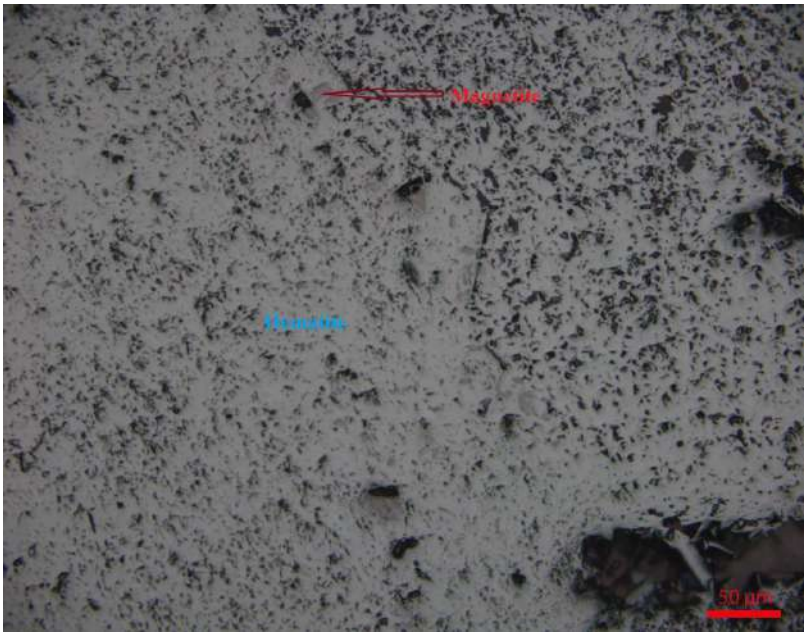

Figure 7: Photomicrograph showing very fine relicts of magnetite within hematite as seen under reflected light.
Specimen No. : MNMEM-03 (MNME-03/ 50.80 – 50.90m) Magnification :200X

4.15.0 OLD WORKINGS

Malangtoli 'E' Sub Block is a virgin area and no old workings have been found within the block.

4.16.0 PRIMARY VS CHECK ANALYSIS

4.16.1 A total of 73 primary samples were subjected to check sample analysis. Results and comparison of the primary and check samples are provided in the Annexure-VI.

4.16.2 A total of 36 primary samples were subjected to external check sample analysis. Results and comparison of the primary and check samples are provided in the Annexure-XIII.

4.17.0 COMPOSITE SAMPLE ANALYSIS

A total of 37 nos. of samples were subjected to composite analysis of the radicals Fe, SiO_2, Al_2O_3, P, Mn, S and V_2O_5. Samples have been prepared from the iron ore zones intersected in the boreholes at different cut off and physical characteristics of the ore. Results and other details of the composite samples have been provided in the Annexure-VII.

CHAPTER-5

5.0.0 MINERALISATION AND CHARACTERISTICS OF IRON ORE

5.1.0 MINERALISATION

5.1.1 BHJ/BHQ was the proto-ore for the iron ores. The enrichment of iron is primarily through the process of leaching of silica from the BHQ. Subsequently there was enrichment of Fe by the circulating solutions. The cavities got sealed to different degrees in different ores. Depending upon the degree of enrichment, different types of ores have resulted. The Massive ore, hard laminated ore and soft laminated ores belong to this category. In majority the iron ore contains hematite.

5.1.2 The samples with more than 45% and above have been considered as the iron ore, However, an attempt has been made to estimate the resources where samples are ≥35% to <45% Fe for enriched BHJ/ soft laminated ore which can be beneficiated. The ore exhibits wide variations in the physical properties ranging from compactness, hardness and massive ore to soft, granular, laminated and powdery ore in the block.

5.1.3 However, categorization/classification of the ore, based on quantitative data, such as hard, soft, laminated, powdery etc., have been possible based on the surface and sub surface data. It is also based on physical properties like colour, presence or absence of weakness, cohesiveness of the grains etc. This lithological classification helped in revealing a stratigraphical picture of the relative preponderance of different ore types.

5.1.4 The iron ore in nature is not homogeneous, but consists of a mixture of many ore types. Hence, practical approach of demarcating the ore zones based on predominant nature of the lithology/ore substantiated with analytical data have been applied.

5.2.0 TYPES OF ORES

5.2.1 Various types of iron ores are derived from hematite viz. float ore, massive ore, laminated ore, and. The diagnostic characters of various types observed are as follows;

Table 9: Types of Ore encountered in the block

Type of Ore	Characteristic Features
Lateritic ore	Brecciated, soil bounded , pebbly in nature-reconsolidated in ferruginous matrix
Hard Laminated Ore (Steel Grey Laminated Ore)	Closely spaced compact laminations
Soft laminated ore Powdery ore/ Biscuity Ore	Laminated and friable in nature mixed with powdery ore or clay
Powdery Ore/ Blue dust	The powdery ores consist almost entirely of unconsolidated grains

5.3.0 GRADE CLASSIFICATION

5.3.1 The exploration efforts in 70's were mainly for lumpy ores, while, the fines were not given economic importance. Similarly, exploration will also be required to categorize the ore reserves / resources based on end user's grade classifications. At threshold value of 45% Fe as stipulated by IBM, zones deciphered and delineated with the present level of exploration and presented in the following Table 10, Table 11 and Table 12 at 45-55% Fe, more than 55%Fe and 35-45% Fe respectively.

Table 10:
DETAILS OF IRON ORE ZONE INTERSECTED IN THE BOREHOLES
(At 45-55% Fe cut off)

Sl. No.	BH Name	BH RL	Cross Section	Depth (m)		Thick-ness (m)	Level of Intersection (mRL)		Avg. Value		
				From	To		From	To	Fe %	SiO_2 %	Al_2O_3 %
1	MNME-1	830.42	S1-S1'	6.00	8.00	2.00	824.42	822.42	49.06	9.25	8.52
2	MNME-1	830.42	S1-S1'	26.00	27.00	1.00	804.42	803.42	47.81	10.68	7.75
3	MNME-2	668.90	S5-S5'	8.00	11.00	3.00	660.90	657.90	47.97	11.78	8.27
4	MNME-2	668.90	S5-S5'	40.00	42.00	2.00	628.90	626.90	54.22	6.13	3.35
5	MNME-2	668.90	S5-S5'	99.50	118.50	19.00	569.40	550.40	52.45	14.48	2.71
6	MNME-2	668.90	S5-S5'	121.50	136.50	15.00	547.40	532.40	49.62	17.30	2.42
7	MNME-2	668.90	S5-S5'	152.50	157.50	5.00	516.40	511.40	46.21	30.60	2.16
8	MNME-3	832.50	S1-S1'	0.00	3.50	3.50	832.50	829.00	47.21	19.37	11.24
9	MNME-3	832.50	S1-S1'	13.00	24.00	11.00	819.50	808.50	50.55	14.29	9.67
10	MNME-3	832.50	S1-S1'	38.00	48.00	10.00	794.50	784.50	51.91	15.93	3.51
11	MNME-3	832.50	S1-S1'	70.00	71.50	1.50	762.50	761.00	51.13	20.16	2.39
12	MNME-8	636.24	S8-S8'	0.00	8.90	8.90	636.24	627.34	46.54	15.52	9.67
13	MNME-8	636.24	S8-S8'	14.00	18.00	4.00	622.24	618.24	48.08	25.51	2.28
14	MNME-8	636.24	S8-S8'	20.00	30.00	10.00	616.24	606.24	47.61	26.52	2.68
15	MNME-9	837.05	S2-S2'	6.90	15.00	8.10	830.15	822.05	46.70	4.60	11.17
16	MNME-6	713.12	S7-S7'	15.00	19.00	4.00	698.12	694.12	45.47	30.61	1.71
17	MNME-6	713.12	S7-S7'	79.00	89.00	10.00	634.12	624.12	50.11	5.63	8.06

Table 11:
DETAILS OF IRON ORE ZONE INTERSECTED IN THE BOREHOLES
(At >55% Fe cut off)

Sl. No.	BH Name	BH RL	Cross Section	Depth (m)		Thick-ness (m)	Level of Intersection (mRL)		Avg. Value		
				From	To		From	To	Fe %	SiO_2 %	Al_2O_3 %
1	MNME-2	668.90	S5-S5'	5.00	8.00	3.00	663.90	660.90	58.03	4.21	2.61
2	MNME-2	668.90	S5-S5'	31.00	40.00	9.00	637.90	628.90	61.51	2.36	1.94
3	MNME-2	668.90	S5-S5'	42.10	99.50	57.40	626.80	569.40	62.77	3.97	1.91
5	MNME-2	668.90	S5-S5'	118.50	121.50	3.00	550.40	547.40	56.01	8.25	2.72
6	MNME-3	832.50	S1-S1'	24.00	30.00	6.00	808.50	802.50	56.76	9.03	3.78
7	MNME-3	832.50	S1-S1'	35.00	38.00	3.00	797.50	794.50	58.74	8.24	2.81

Sl. No.	BH Name	BH RL	Cross Section	Depth (m)		Thick-ness (m)	Level of Intersection (mRL)		Avg. Value		
				From	To		From	To	Fe %	SiO_2 %	Al_2O_3 %
8	MNME-3	832.50	S1-S1'	48.00	50.00	2.00	784.50	782.50	56.64	11.42	3.06
9	MNME-3	832.50	S1-S1'	51.00	54.00	3.00	781.50	778.50	56.23	12.56	2.34
10	MNME-3	832.50	S1-S1'	55.00	59.00	4.00	777.50	773.50	57.12	11.34	2.12
11	MNME-3	832.50	S1-S1'	60.00	70.00	10.00	772.50	762.50	57.82	10.49	2.48
12	MNME-8	636.24	S8-S8'	8.90	14.00	5.10	627.34	622.24	59.40	6.71	2.95
13	MNME-8	636.24	S8-S8'	18.00	20.00	2.00	618.24	616.24	58.22	8.06	2.71

Table 12:
DETAILS OF IRON ORE ZONE INTERSECTED IN THE BOREHOLES
(At 35-45% Fe cut off)

Sl. No.	BH Name	BH RL	Cross Section	Depth (m)		Thickness (m)	Level of Intersection (mRL)		Avg. Value		
				From	To		From	To	Fe %	SiO_2 %	Al_2O_3 %
1	MNME-1	830.424	S1-S1'	27.00	37.00	10.00	803.42	793.42	41.75	13.62	5.95
2	MNME-2	668.903	S5-S5'	136.50	152.50	16.00	532.40	516.40	43.96	32.94	2.46
3	MNME-3	832.496	S1-S1'	34.00	35.00	1.00	798.50	797.50	38.99	39.56	3.32
4	MNME-8	636.236	S8-S8'	0.00	1.00	1.00	636.24	635.24	43.44	19.96	9.00
5	MNME-8	636.236	S8-S8'	30.00	32.00	2.00	606.24	604.24	42.91	31.86	5.02
6	MNME-9	837.054	S2-S2'	15.00	25.00	10.00	822.05	812.05	41.64	9.28	13.84
7	MNME-6	713.118	S7-S7'	0.00	15.00	15.00	713.12	698.12	40.18	35.93	3.70
8	MNME-6	713.118	S7-S7'	19.00	40.00	21.00	694.12	673.12	38.32	40.33	2.15
9	MNME-6	713.118	S7-S7'	59.90	68.10	8.20	653.22	645.02	37.59	41.92	1.91
10	MNME-6	713.118	S7-S7'	69.20	79.00	9.80	643.92	634.12	38.34	40.71	1.81

5.4.0 DEPTH PERSISTANCE

5.4.1 The iron ore developed up to 511.40 mRL (MNME-02) which is nothing but enrichment of iron in BHJ/BHQ by leaching of silica. The depth of enrichment varies from place to place. In all boreholes, the ore has not developed up to 511.40mRL and also not proved in all parts of the block. Only 10 boreholes have been drilled in a larger area in a scattered manner where mineralization at deeper level is to be proved. More close spaced boreholes in block are required to establish the 3-dimensional disposition of the ore body, which could not be achieved due to limitations. The area which is outside the block but surrounded by the block has old mining pits (100-150m deep) where ore has been extracted and now filled with water. Within the block boreholes are not drilled up to the bottom level of the existing pits in the surrounding area. Hence, deeper boreholes are required to prove the bottom most development of the mineralization. The mineralized zone intersection details with the level of intersection are given in the Table 10, 11 and 12.

5.5.0 MINERALISATION FACTOR

5.5.1 Mineralogy of an iron deposit has a great influence in the ore treatment characteristics and economics. Mineralisation factor is the ratio of net ore bearing area to gross area. It is referred as the co-efficient of impurities. Out of the total area of 12.68 sq km, the mineralized area is 5.14 based on the surface geological data. Total surface area of different types of iron one exposed on the surface have been considered as the total mineralized area. Hence, the mineralization factor for Malangtoli 'E' Sub Block is 0.25.

5.6.0 PHYSICAL CHARACTERISTICS OF ORE

5.6.1 The types of ore present in this block are Hard laminated, soft laminated, along with powdery ore.

5.6.2 Principal ore mineral is hematite. In addition, goethite and limonite occur as minor constituent replacing hematite.

5.6.3 The physical characteristics of the hematite ore is its natural size as lumps and fines. Further mechanical crushing of ore for feeding into the blast furnace also creates fines and super fines.

5.6.4 The core samples with more than 45% Fe and above have been considered as the iron ore. The ore exhibits wide variations of physical properties ranging from compact, hard and massive ore to soft, granular, laminated, reddish-brown powdery ore.

5.6.5 The iron ore in nature is not homogeneous but consists of a mixture of many ore types. Hence, practical approach of demarcating the ore zones based on predominant nature is considered.

5.6.6 An attempt has been made to estimate the ore whose Fe% ranges from 35-45% Fe and falls under soft laminated ore/ enriched BHJ which can be beneficiated.

5.7.0 CHEMICAL CHARACTERISTICS OF THE IRON ORE

5.7.1 At 45-55% Fe cut off, Fe% in the samples ranges between 45.47 to 54.22 with an average value of 49.07 whereas SiO_2 is in between 4.60 to 30.61 with an average value of 16.50 and Al_2O_3 is in between 1.71 to 11.24 with average value of 5.82.

5.7.2 At >55% Fe cut off, Fe% in the samples ranges between 56.01 to 62.77 with average value of 58.43 whereas SiO2 is in between 2.36 to 12.56 with an average value of 7.97 and Al_2O_3 is in between 1.91 to 3.78 with average value of 2.65. In the entire deposit, the high grade ore is almost free from lateritisation.

CHAPTER-6

6.1.0 METHOD OF RESOURCE ESTIMATION

6.1.1 RESOURCE ESTIMATION BY GEOLOGICAL CROSS-SECTION

6.1.2 Following methodology has been adopted while computation of ore resource estimation by cross section method;

6.1.3 A total of 08 cross sections serially numbered S1-S1' to S8-S8' along W-E have been prepared (Plate-IV-A to IV-D), based on the interpretation of sub-surface borehole qualitative data drilled by MECL along with surface geological data, which is nearly perpendicular to general strike of the ore body.

6.1.4 Ore resources has been estimated based on the ore zones deciphered and demarcated at 35-45%, 45 -55%Fe and +55%Fe cut-off along with the physical characteristics of ores.

6.1.5 In Cross Section Method' the cross-sections were prepared by marking surface geology on the profile and the borehole data (lithology, ore zones etc.) plotted on vertical section for each borehole. Boreholes not falling on the cross sections have been projected to the nearest cross section.

6.1.6 Zones are used for resource calculation in Conventional Cross section methods with varied sectional influence as per each section lines drawn (refer Geological map). The non-ore portions below the cut-off are excluded.

6.1.7 After limiting both down hole and lateral extents of the ore body, zones of same cut-off/ ore type have been joined in each section, best possibly following the roof.

6.1.8 Efforts were made to pass these sections through drilled borehole locations wherever possible. The boreholes which were not falling on section lines have been projected on the nearest section line.

6.1.9 Sectional influence (strike influence) of a particular borehole is limited to half way to the boreholes on either side along strike where sections are continuous at a certain interval. In other cases strike influence 200m on each side along the strike have been considered as the exploration is at G3 level.

6.1.10 The banded hematite jasper generally forms the floor of the iron ore. Hence, continuity of ore has been restricted up to the proved level of the ore body or roof of the BHQ/BHJ.

6.1.11 Lateral continuity (along dip direction) of 200.00m on each side of the iron ore intersection of the borehole has been placed under (G3) category. Beyond G3 area another 200m on both sides has been considered for G4 category.

6.1.12 The isolated ore pockets if any, without substantial sub-surface data, was completely excluded from the computation.

6.1.15 The area of influence was summed up to arrive at the total area for the cross-section.

6.1.16 The area measurements were made with the help of computer by using Auto Cad Map software (which is nothing but True width x Average dip length).

6.1.17 Thus, the area obtained was multiplied by cross sectional influence (strike influence) to obtain the sectional volume.

6.1.18 Thus, the sum of cross-sectional resource is the total geological gross in situ resources.

6.1.19 The thickness of the ore zones were considered separately (ore type / band-wise) based on geological cross sections, for the physical intersection in the boreholes and in the influence area.

6.1.20 A 10% of deduction to the total geological gross in-situ resources tonnage is considered in order to arrive net geological in-situ resources.

6.1.21 An intervening parting (non-ore zone) up to 1.00m was included in the ore zone till diluted grade of the zone did not come below the cut-off grades 45% or 55% while delineation of the ore zone.

6.1.22 Within the block, type of ore varies according to the physical characteristics. In resource estimation ore types of nearly same physical characteristics have been grouped. The major types considered here are Soft laminated ore/soft laminated ore with powdery ore or clay as Soft Laminated Ore, Powdery ore/Blue dust, lateritic iron ore, detrital lateritic iron ore and float ore as Float ores

6.2.0 ASSUMPTIONS

6.2.1 Resource was computed by "Geological cross-sectional method" at varing sectional spacing. Certain axiomatic assumptions are inherently involved in estimating overall grade and resource of a deposit, they are:

6.2.2 The rule of gradual change or law of linear function has been applied (Constantine C. Popoff, 1965) along with the rule of nearest points for application of influence of half way between successive boreholes.

6.2.3 A total of 08 cross sections along W-E have been prepared (Plate-IV-A to IV-D), based on the interpretation of sub-surface borehole qualitative data along with surface geological data, which is perpendicular to general strike of the ore body.

6.2.4 The shape of the mineralized zone on the cross section line has been obtained by interpretation and correlation of the borehole data. Each borehole gives a point for the location in space of the ore bottom which, in general is BHQ/ BHJ.

6.2.5 The possibility of the mineralized zone being in the nature of folded sedimentary bed, behaving as a stratigraphic unit was considered. The alternative hypothesis of the ore body, being a leached and replaced portion of some pre-existing rock, in this case the

BHQ/BHJ, appeared to be more realistic and adopted for determination of the ore bottom configuration. The mineralized zone bottom has been thus delineated by joining intersection on adjacent boreholes through smooth lines, though these lines may cut across the general dip of the formation.

6.3.0 GEOMETRY OF THE ORE BODY

6.3.1 Over the entire area, from west to east, the iron ore zone occurs as an undulating bedded sequence of Iron ore. Sub surface continuity varies from place to place depending on the leaching process of BHQ/BHJ. Only 10 boreholes have been drilled in a huge area which is insufficient to assess the geometry of the ore body and maximum depth continuity of the mineralization.

6.4.0 ESTIMATION OF RESERVE / RESOURCES AND GRADE

6.4.1 After delineating the limit of the mineralized zone between 35-45%, 45-55% and >55% Fe and boundaries of different litho-units, geometry of the ore zone has been deciphered and demarcated. The same has been plotted on to the respective cross sections (Plate-IV-A to IV-D). The sectional area of the ore zone based on the cut off and type of ore has been computed by using AutoCAD map software. Volume of the each category has been arrived after multiplying with sectional influence for each section.

6.4.2 All calculations for grade are by weighted averages method. In each borehole, average grades of ore zones and for the total ore column in borehole are calculated from the primary analysis. The weightage is given to the length, in other words the average obtained is “thickness-weighted average”. For the calculation of average grade per section thickness-weighted average of the borehole is taken as an unit and weighted against its respective tonnage. In other words, the average obtained in cross section is “tonnage-weighted average”.

6.4.2 Ore resource tonnage has been estimated by multiplying the volume with the tonnage factor of 3.30. This is considered uniformly in all types of ores for ore resource estimation. Thus the product has been considered as geological in-situ resources.

6.4.3 Summarized in-situ resources estimated are provided in the following Table-13 and the net in-situ resources have been considered for the block. Details of ore resource estimation are given in Annexure VIII-A, VIII- B, VIII-C and VIII-D

6.4.4 The behavior of ore bands has been studied along E-W and N-S direction, which reveals that the mineralized zone has good persistence over the strike length.

Table 13: Summarized in-situ resources estimated in the Malangtoli 'E' Sub Block

G3 LEVEL (333)										
Type of Iron ore	45-55% Fe Cut off					>55% Fe Cut off				
	Gross Resource in Tonnes	Gross Resource in Million Tonnes	Fe %	SiO_2 %	Al_2O_3 %	Gross Resource in Tonnes	Gross Resource in Million Tonnes	Fe %	SiO_2 %	Al_2O_3 %
Lateritic Iron Ore	3279484.08	3.28	47.05	15.58	9.89					
Soft Laminated Ore	22254137.38	22.25	49.29	10.71	10.67	26560270.49	26.56	60.35	6.31	2.25
Total	**25533621.47**	**25.53**	**49.00**	**11.34**	**10.57**	**26560270.49**	**26.56**	**60.35**	**6.31**	**2.25**
G4 LEVEL (334)										
Lateritic Iron Ore	1704276.62	1.70	47.05	15.58	9.89					
Soft Laminated Ore	16670890.10	16.67	49.99	17.11	4.28	22590306.62	22.59	60.35	6.31	2.25
Total	**18375166.72**	**18.38**	**49.72**	**16.97**	**4.80**	**22590306.62**	**22.59**	**60.35**	**6.31**	**2.25**

SUMMARY OF RESOURCE CONSIDERED FOR THE MALANGTOLI 'E' SUB-BLOCK						
Resource Category	Gross Resource In Tonnes	Net Resource in Tonnes	Net Resource in Million Tonnes	Fe %	SiO_2 %	Al_2O_3 %
G4 level (334)	40965473.34	36868926.01	36.87	55.58	11.09	3.39
G3 level (333)	52093891.95	46884502.76	46.88	54.78	8.77	6.32
* Resources at 35-45% Fe has not been considered for the block						
* Net resources is 10% less of the Gross resources.						

CHAPTER-7

7.1.0 CONCLUSIONS

7.1.1 Malangtoli 'E' Sub Block is located in Koira tehsil, Sundargarh district,Odisha. A small part of the block in the south east corner falls in Keonjhar district. It lies between longitudes 85° 17' 16" and 85° 19' 59" and latitudes 21° 52' 57" and 21° 49' 59". The block covers an area of 12.68 sq km and falls within the Survey of India toposheet No 73G/5. Location map of the block is given in the Plate-I. The area is totally a virgin area in mining point of view.

7.1.2 Malangtoli 'E" Sub Block and its surrounding area form an undulating country occupying plateaus and intermittent valleys. The block falls in a valley surrounded by two plateaus in western and eastern side. Mainly the flanks of the plateaus are occupied the limbs of 'U' shaped block. Trend of the plateaus is NNE-SSW.

7.1.3 The iron ore occurs as a tabular undulating bedded deposit. The general trend of the deposit is NNE-SSW to NS and dip varies from 10º to 40º at times even 70º due west or east. The direction of dip changes frequently due to folding.

7.1.4 The iron ore developed up to 511.40 mRL (MNME-02) which is nothing but enrichment of iron in BHJ/BHQ by leaching of silica. The depth of enrichment varies from place to place. In all boreholes, the ore has not developed up to 511.40 mRL.

7.1.5 Iron ore is mostly hematitic in nature. Goethite, limonite as a minor constituents replacing hematite. Magnetite occurs as a relict.

7.1.6 Physical nature of the ore varies from Hard laminated ore to powdery ore based on the compactness of the mineral grains.

7.1.7 A total of 46.88 million metric tonnes (mmt) of net resources has been estimated within the block with average 54.78 Fe%, 8.77 SiO_2% and 6.38 Al_2O_3% at G3 (333) stage at 45% Fe threshold value which includes 22.98 mmt and 23.90 mmt at 45-55% Fe and > 55%Fe respectively.

7.1.8 A total of 36.87 million metric tonnes of net resources has been estimated within the block with average 55.58 Fe%, 11.09 SiO_2% and 3.39 Al_2O_3% at G4 (334) stage at 45% Fe threshold value which includes 16.53 mmt and 20.33 mmt at 45-55% Fe and > 55%Fe respectively.

8.2.0 RECOMMENDATIONS

8.2.1 Exploration was carried out with only 10 (ten) boreholes. Boreholes are not in a grid pattern due to large area. Surface area is large and total area could not be covered up by drilling. Many mineralized area are left out where drilling was to be carried out. Most part of the area where drilling was not carried out recently, close grid boreholes may be drilled to establish the 3-dimentioal disposition of the ore body which will definitely increase the resources towards more confidence level.

8.2.2 Pits for bulk density and distribution of lumps and fines in the ore could not be carried out due to field difficulties. Hence, few pits may be dug for the same in the different part and type of the ore body.

8.2.3 In many part of the area the surface is occupied by detrital lateritic ore of rich iron ore. Resources have not been estimated due to limited scope in the present exploration. Pitting or trenching may be carried out to assess the nature of the ore and resource estimation.

8.2.4 Deeper boreholes may be planned in the future exploration program to establish the mineralization which have been developed and extracted in the adjacent mining pit outside the block.

8.2.5 Based on the quality of the ore developed in the area further exploration may be carried out to upgrade the block.

CERTIFICATE FROM THE QUALIFIED PERSON

This is to certify that geological report has been prepared in respect of Preliminary Exploration (G-3) for Iron ore in Malangtoli 'E' Sub Block, Sundargarh and Keonjhar districts, Odisha by Mineral Exploration and Consultancy Limited (MECL) on behalf of National Mineral Exploration Trust. 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.

DATE: 30-09-2023

GENERAL MANAGER (EXPLORATION)

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