(15)

PROPOSAL FOR G-3 LEVEL EXPLORATION FOR IRON ORE IN THE MALANGTOLI BONAI-KENDUJHAR BELT, IRON ORE DEPOSIT IN H-SUB BLOCK DISTRICT-SUNDARGARH & KENDUJHAR, ODISHA

1.0.0 Introduction

1.1.1 The Banded Iron formation (B.I.F) and associated Volcano-Sedimentary sequence of Iron ore group of Bonai-Kendujhar belt, North Odisha, received attention of geoscientists and mining agencies as early as 1930's. Geological Survey of India has been carrying Iron ore exploration work in this belt since 1960's. In addition, several Iron ore bodies also occur within the synclinal valley, which are mostly associated with the Upper Shale Formation of Koira Group of rocks. The exploration for Iron ore in Malangtoli Deposit, Sundargarh District, Odisha, has been carried out by Geological Survey of India, Eastern Region, State Unit: Odisha, Bhubaneswar.

1.1.2 The Principal Secretary, Mines Government of Odisha, has allotted the blocks of state Odisha, to MECL for taking up of exploration. MECL will take up the exploration up to G-3 level and then submit the Geological Report to DGM Odisha for auctioning of block in view of MMDR Amendment Act 2015.

1.1.3 On examination of exploration data DMG suggested twelve blocks for which detailed exploration is to be taken up. H-Sub Blocks for detailed exploration for Iron is one of them for which exploration proposal is prepared and put up for approval of Technical cum Cost Committee of NMET, for detailed exploration for iron ore.

1.2.0 Location & Accessibility

The area of investigation is 2-3 km SW of Pipokri, and falls in parts of Survey of India Toposheet Nos 73 G/5, being one of the most important iron and manganese mining centers of Odisha. It is well connected with other parts of the State as well as with the neighboring State of Jharkhand. National Highway No.215 connecting Panikoili on National Highway No.5 with Rourkela via Kendujhar, Joda, Barbil and Koira passes through the area. The other important mining centers in the vicinity are Kalta, Tensa and Barsuan. The nearest rail head Barbil is 30km on Tatanagar-Barbil section of the South-Eastern Railway. The block location is shown as Plate No-I. The block co-ordinate of H- sub-block, Malangtoli Iron Ore Deposit is given in Table No.1.2

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Table No.1.2

BLOCK COORDINATE OF MALANGTOLI IRON ORE DEPOSIT H- SUB- BLOCK DISTRICT- SUNDERGARH & KENDUJHAR, ODISHA

POINT NAME	EASTING	NORTHING	LONGITUDE	LATITUDE
H- 1	328169.878	2420658.682	85° 20' 12.703"	21° 52' 53.995"
H- 2	328047.515	2419811.990	85° 20' 8.760"	21° 52' 26.425"
H- 3	327786.241	2419853.115	85° 19' 59.644"	21° 52' 27.670"
H- 4	327779.618	2420521.174	85° 19' 59.161"	21° 52' 49.387"
H- 5	327898.692	2420615.665	85° 20' 3.273"	21° 52' 52.501"
H- 6	327878.839	2420794.281	85° 20' 2.514"	21° 52' 58.301"
H- 7	328090.504	2420794.264	85° 20' 9.887"	21° 52' 58.375"
H- 8	332097.368	2419425.930	85° 22' 29.965"	21° 52' 15.282"
H- 9	332057.664	2416482.439	85° 22' 29.665"	21° 50' 39.570"
H- 10	331786.490	2416489.057	85° 22' 20.219"	21° 50' 39.692"
H- 11	331806.317	2415278.582	85° 22' 21.355"	21° 50' 0.344"
H- 12	327723.313	2415324.156	85° 19' 59.161"	21° 50' 0.406"
H- 13	327775.642	2418999.829	85° 19' 59.597"	21° 51' 59.925"
H- 14	330868.358	2418784.769	85° 21' 47.395"	21° 51' 54.013"
H- 15	330942.461	2419327.140	85° 21' 49.775"	21° 52' 11.672"
H- 16	330463.560	2419395.943	85° 21' 33.069"	21° 52' 13.743"
H- 17	330577.339	2420324.645	85° 21' 36.687"	21° 52' 43.976"
H- 18	328714.646	2420562.766	85° 20' 31.715"	21° 52' 51.068"
H- 19	328735.817	2420800.886	85° 20' 32.363"	21° 52' 58.817"
H- 20	331140.901	2420790.290	85° 21' 56.145"	21° 52' 59.310"
H- 21	331201.736	2420253.189	85° 21' 58.463"	21° 52' 41.869"
H- 22	331111.776	2420062.706	85° 21' 55.400"	21° 52' 35.645"

1.3.0 Physiography & Drainage

The H-sub-block of Malangtoli area is a highly rugged terrain with elongated hills having general extension along NNE-SSW direction. The area is an undulating country on a plateau which rises about 400.00m to 500.00m above the surrounding plains, and has an average elevation of nearly 920.00m above mean sea level. Some of the ridges further south of the mapped area have arcuate shape with their convexity pointing towards NNE. 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 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.

1.4.0 Climate, flora and fauna:

The area experiences a humid-tropical climate. The period between December and March is very cold when the mercury drops down to sub-zero, bringing in occasional layers of frost during winter. It is very hot during summer with temperature rising to nearly 50°C during peak period. During rainy season, heavy rains bring in flash floods. Over precipitation during monsoon has resulted in development of tropical forest comprising densely packed tall trees and the thick green cover. The forests are inhabited by elephants, wild boar, bear, monkeys and occasional tiger and leopard.

2.0.0 Previous Work

2.1.1 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 estimates for the ore deposits now included in the Malangtoli block. 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 & Kurup-1962) and a reserve of about 470 m.t. of ore with average Fe of 60%. The present detailed investigation was planned on the basis of the data available from the above mentioned earlier work.

2.1.2 **Work Carried Out By GSI**

GSI carried out exploration work in the adjoining 'B'block during FS 1963-64 to1967-68 which includes geological mapping 1.06 Sq.Km. of the ore bearing and adjoining areas; 310.20m of drilling in 14 bore holes; about 10.15m of excavation in 3 shallow pits. These data of GSI has been considered for preparation of present exploration proposal presuming the continuity of occurrence of iron ore in the area as established by GSI..

3.0.0 Regional Geological setup:

3.1.1 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 & 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 of this area, as worked out by earlier workers, based on regional field studies is shown below:

Table Showing Litho-stratigraphic succession of the area

Jones (1934)		Saha(1994) Modified after Sarkar & Saha (1977)		Murthy & Acharya (1975)	
	Upper shales, epidiorite and ash bed	IRON ORE GROUP	Singhbhum Granite	KOIRA GROUP	Mixed facies formation
	B.H.Q. with iron ore bodies		Upper Shale with volcanics		Upper Shale Formation
	Shales with occasional sandstones				
	Purple sandstone with basal conglomerate		BHJ with iron ore, ferruginous quartzite		Banded Iron Formation
	----------Unconformity----------				
	Older Dharwars		Lower shale and acid, intermediate tuffs, local dolerite		Volcanic Formation

The stratigraphy of the area modified after Murty and Acharya (op. cit) is given below:	
Kolhan Group	
KOIRA GROUP	Upper Shale Formation
	Banded Iron Formation
	Volcanic Formation
	Basal Sandstone – Quartzite
Singhbhum and Bonai Granites and metamorphosed sediments	

3.1.2 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 interbanded with the greenish and black shale towards the top, the lower shale graded into the 'Banded Iron Formation'.

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.

The 'Banded Iron Formation' is overlain by the 'Upper Shale Formation' comprising of thick sequence of tuffaceous purple, white and buff coloured 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.

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.

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).

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 (65^0-75^0) whereas, the eastern limb is a normal one with moderate to low (30^0-45^0) 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.

Local Geology:

The area under investigation lies within the Upper Shale Formation of the Koira Group. The Upper Shale Formation as described by Murthy & Acharya (1975) can be subdivided in to two units' namely lower manganiferrous shale horizon and upper ferruginous shale horizon.

Local stratigraphic succession as worked out in the areas under investigation (i.e.in Malangtol Iron Ore) is as follows

Upper Shale Formation	**Ferruginous Shale Unit:** Shales of different colouration like pink, yellow, variegated with narrow inter beds of BHJ / BHQ and derived Iron ore.
	Manganiferrous Shale Unit: Manganiferous shale with associated manganese ore followed up by massive chert (brecciated at places).
Banded Iron Formation	Coarsely banded jaspellite followed up by finely banded jaspellite.

3.2.0. Description of rock types

Banded Iron Formation (BHJ & BHQ):

These rocks serve as important marker horizon. Major iron ore bodies are closely associated with these litho units. It encompasses BHJ, BHQ and ferruginous quartzite of the area. Megascopically BHJ comprises alternate bands (laminations less than 5mm thick) of haematite and dark brown to red jasper. Magnetite is rare and usually associated with hematite in minor proportion. BHQ is found to occur towards the upper part of BHJ profile or as thin layers within BHJ. Both BHJ and BHQ are sheared at various places and are traversed by fine silica and hematite veins.

They are discontinuously exposed along strike for a maximum length of 100m in a single outcrop. The BHJ bands in the valley area are affected by shearing showing unevenness of the jasper bands. The shear zones are filled with fragments of BHJ, BHQ and laminated ore. Megascopically, the individual jasper bands / laminations are seen to be much thicker as compared to that of the iron oxide rich bands / laminations within the BHJ. The Jasper contains small discrete aggregates of quartz, opaque grains and ferruginous materials. The quartz occurs as anhedral to subhedral grains and haematite forms anhedral grains and masses.

Ferruginous Shale:

It occupies the central valley and represented by a finely laminated rock having varied shades of colour ranging from white, maroon, dark gray, brownish and purple to green etc. The coloration of the shale largely depends on the mineral composition (Murthy & Acharya, 1975). It is mostly composed of clayey micaceous minerals, with lenses of chert. The upper shale contains several unmappable units such as carbonaceous shale, banded shale, sandy claystone, shales and mudstones etc. Most of the area containing this unit is lateritised extensively.

Iron ore:

The thinly laminated, hematite ore bodies exposed in the valley area are very often lateritised near the surface. However, insitu bouldery outcrops of hard and soft laminated, massive and brecciated ores are found at the identified blocks where exploration have to be carried out. 'Canga' zones occur near to the iron ore bodies within the hard lateritised duricrust and contain

mostly iron ore floats. Detrital Iron ores deposited in the saddle region adjacent to the main iron ore bodies occur at several places in the area.

Laterites:

Most part of the area is covered by laterite of various types. The laterites have been developed mostly over the shale unit of the area and depending upon the composition of the shale, different types of laterites have been developed. The shale rich in alumina has given rise to bauxitic laterite and those rich in manganese or iron have developed manganiferrous and ferruginous laterites respectively. Ferruginous laterite occupies most of the high lands in the vicinity and is wide-spread. Aluminous laterite/ bauxite occur in form of small patches and narrow bands, spread over the area. The yellowish black laterite covering major part of the area has been the host for pockets of manganese concentration.

Alluvial soil: The low lying areas, river banks etc. are filled up with alluvial soil

3.6.0. Mineralisation Details

Mode of Occurrence and Controls of Ore Localisation:

Iron ore in the Malangtoli Iron Ore Deposit, H-Sub-Block area occurs as continuous bodies associated with variegated shale and ferruginous shale. The ore bodies are capped by ferruginous laterite on surface. Though the ore types show outcrops of hard ore, lateritic ore and float ore on the surface but soft laminated and powdery ore constitutes the bulk thickness of the ore zone as evidenced from pit sections and drill cores.

Nature of Ore and Mineralogy:

The ore is mostly powdery to soft laminated varieties with partings of ferruginous shale. Thin layers of Hard Laminated ore are present on the surface, followed by powdery and soft laminated at depth, which are inseparable. The mineralization of iron ore is mainly bedded type associated with ferruginous shale of Upper shale Formation of Iron Ore Super Group.

4.0.0 Objective of the proposed exploration programme

4.1.1. The present exploration programme has been formulated to fulfil the following objectives:-

i) To prove the existence/ occurrence of iron ore in strike and dip continuity in the block by drilling bore holes at 400m x 400m grid interval
ii) To find out the quality and grade of iron ore
iii) To estimate resources of iron ore at G-3 Level of UNFC
iv) To carry out Preliminary exploration as per Minerals (Evidence of Mineral Contents) Rules 2015, Mineral Auction Rule 2015 & MMDR Amendment Act 2015.

5.0.0 Proposed Scheme of Exploration

5.1.0 In accordance with the objectives set for detailed exploration in Malangtoli, H-Sub-Block, the drilling program is proposed to fill the data gap of earlier exploration of GSI at 200m strike interval. The exploration shall be carried out as per Mineral (Evidence & Mineral Contents) Rule -2015 and Mineral Auction Rule-2015.

Therefore, the following scheme of exploration was formulated in order to achieve the objectives. The details of different activities to be carried out are presented in subsequent paragraphs.

5.2.0 Topographic Surveying

The deposit area would be tied up with the triangulation network of GSI & earlier MECL work. The reduced levels and co-ordinates of boreholes would be determined, keeping GSI co-ordinates and benchmarks intact. The contouring would be done at 5 m interval on 1:10,000 scale to prepare a detailed topographic map of the deposit. The block boundary will be surveyed by DGPS & total station in WGS -84 Datum for demarcation of Block Boundary points and ancillary area to facilitate the State Governments for Auctioning of Blocks.

5.3.0 Geological Mapping

The area of the block is 14.70 sq.km calculated by auto cad software which is almost equal to the area supplied by DGM, Govt. of Odisha.

The earlier geological map of the area prepared by GSI will be updated with the present exploration data by few rapid geological traverses and also with reference to the new subsurface data which will be generated through this exploration program and would be used as a base map for the purpose of exploration work.

5. 4.0 **EXPLORATORY DRILLING-** The drilling work is proposed at rectangular grid of 400mX 400m and the grid has been maintained to bring the deposit to G-3 Level which will help the State Govt. of Odisha to facilitate auctioning.

However, the average depth of the boreholes has been considered 30.00m on the basis of drilling information gathered from adjoining B sub-block of GSI and the information gathered by MECL from the nearby area of the block during field visit. The bore hole closure depth will be judiciously taken care of by field geologist during the course of exploration.

The bore hole location plan at 400mX 400m grid is shown as plate No. II. A total of **111 nos.** of coring bore holes will be drilled on above proposed grid to establish the deposit of G-3 level which involves **3330.00m** of drilling in the block.

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Table No. 5.1		
Details of Proposed Boreholes		
SL. NO	CORING BOREHOLE	PROPOSED DEPTH TO BE DRILLED (m)
1	PBH 1	30.00
2	PBH 2	30.00
3	PBH 3	30.00
4	PBH 4	30.00
5	PBH 5	30.00
6	PBH 6	30.00
7	PBH 7	30.00
8	PBH 8	30.00
9	PBH 9	30.00
10	PBH 10	30.00
11	PBH 11	30.00
12	PBH 12	30.00
13	PBH 13	30.00
14	PBH 14	30.00
15	PBH 15	30.00
16	PBH 16	30.00
17	PBH 17	30.00
18	PBH 18	30.00
19	PBH 19	30.00
20	PBH 20	30.00
21	PBH 21	30.00
22	PBH 22	30.00
23	PBH 23	30.00
24	PBH 24	30.00
25	PBH 25	30.00
26	PBH 26	30.00
27	PBH 27	30.00
28	PBH 28	30.00
29	PBH 29	30.00
30	PBH 30	30.00
31	PBH 31	30.00
32	PBH 32	30.00
33	PBH 33	30.00
34	PBH 34	30.00
35	PBH 35	30.00
36	PBH 36	30.00
37	PBH 37	30.00

38	PBH 38	30.00
39	PBH 39	30.00
40	PBH 40	30.00
41	PBH 41	30.00
42	PBH 42	30.00
43	PBH 43	30.00
44	PBH 44	30.00
45	PBH 45	30.00
46	PBH 46	30.00
47	PBH 47	30.00
48	PBH 48	30.00
49	PBH 49	30.00
50	PBH 50	30.00
51	PBH 51	30.00
52	PBH 52	30.00
53	PBH 53	30.00
54	PBH 54	30.00
55	PBH 55	30.00
56	PBH 56	30.00
57	PBH 57	30.00
58	PBH 58	30.00
59	PBH 59	30.00
60	PBH 60	30.00
61	PBH 61	30.00
62	PBH 62	30.00
63	PBH 63	30.00
64	PBH 64	30.00
65	PBH 65	30.00
66	PBH 66	30.00
67	PBH 67	30.00
68	PBH 68	30.00
69	PBH 69	30.00
70	PBH 70	30.00
71	PBH 71	30.00
72	PBH 72	30.00
73	PBH 73	30.00
74	PBH 74	30.00
75	PBH 75	30.00
76	PBH 76	30.00
77	PBH 77	30.00
78	PBH 78	30.00

79	PBH 79	30.00
80	PBH 80	30.00
81	PBH 81	30.00
82	PBH 82	30.00
83	PBH 83	30.00
84	PBH 84	30.00
85	PBH 85	30.00
86	PBH 86	30.00
87	PBH 87	30.00
88	PBH 88	30.00
89	PBH 89	30.00
90	PBH 90	30.00
91	PBH 91	30.00
92	PBH 92	30.00
93	PBH 93	30.00
94	PBH 94	30.00
95	PBH 95	30.00
96	PBH 96	30.00
97	PBH 97	30.00
98	PBH 98	30.00
99	PBH 99	30.00
100	PBH 100	30.00
101	PBH 101	30.00
102	PBH 102	30.00
103	PBH 103	30.00
104	PBH 104	30.00
105	PBH 105	30.00
106	PBH 106	30.00
107	PBH 107	30.00
108	PBH 108	30.00
109	PBH 109	30.00
110	PBH 110	30.00
111	PBH 111	30.00
GRAND TOTAL		**3330.00m**

5.5.0 Core Logging

The borehole cores would be logged systematically. Details of the lithounit viz. colour, structural feature, texture, mineralisation, besides the recovery and rock quality designation (RQD) would be recorded. The details of nature of ore as Massive, Laminated, Lateritic, Limonitic ore and Fine/Blue Dust ore will be recorded in detail.

5.6.0 Sampling: The drill core will be splitted into two equal halves and one part would be preserved in the core box. The other half will be powdered to - 100 # size and the same would be divided into four parts by thorough coning and quartering. One part of 100gm sample will be sent to chemical laboratory for analysis, second part to be preserved in the camp as duplicate sample, third part to be utilized for preparing composite sample for individual ore band and the fourth part would kept as either check sample or sample to be used for any other specific purpose. The length of each sample will be kept 0.50 m - 1.0m depending upon the width of particular type of iron ore and its physical character (like lumpy, powdery, friable massive etc.). The primary core samples will be analysed for various radicals such as Fe, SiO_2, and Al_2O_3.

The mineralized zone including the cores of immediate footwall and hanging wall rocks (5 m length each) would be sampled at 1.0 m interval, as far as possible, depending upon the intensity of mineralisation, change in lithology and core recovery etc. It is envisaged that:

a) Around **2830 nos.** of primary samples including check samples would be generated from the mineralized zone intersection, so obtained from the drill holes of Malangtoli iron ore deposit, H-Sub-Block. All the primary and check samples would be analysed for 3 radicals i.e. Fe%, SiO_2% & Al_2O_3% (3110 Nos Core Samp. + Check Samp.)

b) Around 5% of Primary samples (**140 nos.**) will be sent to NABL accredited external labs for analysis of 3 radicals i.e. Fe%, SiO_2% & Al_2O_3% as Check Samples.

c) Composite samples would be prepared from mineralized zones of primary drill core samples from each borehole. It has been envisaged that **110 nos.** of composite sample would be generated and will be analysed for 7 radicals i.e. Fe, SiO_2, Al_2O_3, P, Mn, Ti & LOI. A total of **30 nos.** of composite samples will be sent for trace and minor elements study by ICP-MS method (15 elements).

d) A total of **30 nos.** of composite samples would be analysed by X-ray diffraction to ascertain the presence of any uncommon minerals.

5.7.0 Petrological and Mineragraphic Studies: Thin and polished section studies on drill cores as well as out-crop samples would be studied for detailed petrographic and mineragraphic characteristics. These samples would be drawn from ore zones and host rocks. A provision of 30 specimens for petrographic and 30 specimens for mineragraphic studies has been kept for the purpose.

5.8.0 Specific Gravity Determination: To derive the tonnage factors, **50 nos.** of samples are proposed to be subjected for specific gravity determination. The sample to be drawn from ore zones/ mineralised zones.

5.9.0 Bulk Density & lumps and fines Ratio Determination: In addition to specific gravity determination, **50 nos.** of bulk density determination study will be carried out. Lumps and Fines ratio has also to be determined for 15 nos. of samples.

5.10.0 Quantum of work

The quantum of work proposed by MECL in H-Sub- Block is given in Table 5.2.

Table: 5.2 Proposed Quantum of work in H-Sub- Block

SL NO	Item of work	Unit (m)	TOTAL
1	**Survey (1:10000)** a) B.H. fixation (Hilly Terrain)	Nos.	111
	b) R.L. & coordinate determination	Nos.	111
	c) Traverse	Line km	22
	d) Contouring (5m Contour Interval)	Sq. Km	18.06
	e) DGPS Survey (Demarcation of Block Boundary points)	Sq. Km	18.06
2	Drilling (coring)	m	3330 m(111Bhs.) at 400mx400m grid
3	Geological work a) Geological Core Logging	m	3330m (111Bhs.)
	b) Sampling (Primary+ Check) for 3 radicals Fe%, SiO_2% & Al_2O_3%,	Nos.	3110
	c) Composite sample for 7 radicals (Fe%, SiO_2%, Al_2O_3%, P%, Mn%, S% & V_2O_5%)	Nos.	1110
4	**Chemical Analysis** Borehole core sample	Nos.	
	a)Primary+Check Sample (10% internal)	Nos.	3110
	Check Sample (5% external)	Nos.	140
	b) Composite sample 7 radicals (Fe%, SiO_2%, Al_2O_3%, P%, Mn%, S% & V_2O_5%)	Nos.	1110
5	XRD – Studies	Nos.	30
	Trace Element Study ICP-MS Method (15 elements)	Nos.	30
6	Petrological Samples	N0s	30
7	Mineragraphic Studies	N0s	30
8	Specific gravity Determination	Nos.	50
9	Bulk Density Determination	Nos.	50
10	Lumps and Fines Ratio Determination	Nos.	50
11	**Report Preparation**[As per Mineral (Evidence of Mineral Contents) Rule-2015] /UNFC	N0s	1

6.0.0 Time schedule and Cost estimates

6.1.0 Time schedule:

The proposed exploration programme is planned in such a way that all the activities like, camp setting, winding, drilling, survey and associated geological work and laboratory work will be completed within 7 months' time. Report writing will take another 6 months time over lapping three month of Laboratory studies. Thus the total duration of the project shall be completed in 12 months from the date of commencement of the project.

The bar chart showing activities wise time schedule is placed at Table-6.1.

6.2.0 Cost estimates:

The Project cost with provisional escalation is estimated at **Say. Rs. 1027.64 lakhs.** The details of item wise cost estimate with inbuilt actual escalation as per RBI indices as on 31-03-17 and same has been for the subsequent years, is given in Table No. 6.2 and the summary is given below :

Summary of Cost estimates

Sl. No.	Item	Estimated Cost (Rs.)
1	Drilling	70022310/-
2	Geology	6209460/-
3	Laboratory	8234695/-
4	Preservation of Core	1749600/-
5	Total (1+2+3+4)	86216065/-
6	Report	862161/-
7	Peer Review	10000/-
8	Total (5+6+7+8)	87088226/-
9	GST (18% of Sl. No. 9)	15675881/-
10	Total cost including 18% GST.	102764106/-

Or Say, Rs. 1027.64 lakhs (Rs 10.28 Crore approx.)

7.0.0 Justification

i) In view of MMDR Amendment Act and Mineral Auction Rule 2015 DMG Odisha requested MECL to take up the detailed exploration in this block. Accordingly MECL prepared the detailed exploration as proposed for approval of NMET.

ii) The mineralized zones intersected in GSI boreholes drilled in adjacent B block are continuous both in strike and dip direction. Hence the continuity of the zones requires further proving.

Iii The present exploration will establish the resources and grade of the iron ore at G3 Level thereby decision would be feasible for taking up G2 level exploration in the block and will eventually lead to enable the state government of Odisha for Auctioning of the block.

(1) A

Table-6.2 Cost Estimate for Iron Ore Exploration Malangtoli H Sub - Block District- Sundargarh, Odisha								
SL. N0.	Item of Work	Unit	Base Rate	Escalated rates (2018-19)			Grand Total	
				Esc. Rate	Qty.	Amount	Qty.	Amount
			1.4.90					(Rs)
A	DRILLING							
1	Surface Drilling (4 rigs)	m	19716	19716	3330	65654280	3330	65654280
2	Pitting (1m x 1m x 1m)	Cu.m.	395	1673	50	83650	50	83650
2	Transportation	Km	8.8	31	3000	93000	3000	93000
3	Accomodation (One time/ Drill)		185925	663715	4	2654860	4	2654860
4	Camp Setting / Winding	- do-	68606	244910	4	979640	4	979640
5	Road Making (Hilly Terrain)	Km	7800	27844	20	556880	20	556880
	Sub Total A					70022310		70022310
B	GEOLOGICAL WORK							
1	Survey Party days (2 party)	day	1180	5840	300	1752000	300	1752000
2	Geologist Party days (2 party)	day	1541	7802	360	2808720	360	2808720
3	Bulk Sampling Party days (1 party)	day	2566	13434	60	806040	60	806040
4	Core Sampling Party days (2 party)	day	525	2809	300	842700	300	842700
5	SUB TOTAL B					6209460		6209460
C	LABORATORY STUDIES							
1	Chemical Analysis							
	i) Primary & Check samples							
	a. For 3 radicals Fe, SiO_2 & Al_2O_3 [core samp + Internal Check Samp	Nos	262(110 +76x2)	1374	3110	4273140	3110	4273140
	d) External Check Samples from NABL Labs for 3 radical (Fe, SiO2 & Al2O3)	Nos	262(110 +76x2)	1374	140	192360	140	192360
	II) Composite Samples							
	a) Composite Samples for 7 radicals (Fe%, SiO2%, Al2O3%, P%, Mn%, S% & V2O5%)	Nos	268	2982	1110	3310020	1110	3310020
2	Physical Analysis							
i)	a) X-RD Studies on composite	Nos	1137	5605	30	168150	30	168150
ii)	b) Trace Element Study By ICPMS Method (15 elements- Cd,Sn,W,Sb,Mi,Ce,Nb,Ba,La,Bi,Co & Ni	Nos	-	4620	30	138600	30	138600
iii)	Preparation of thin section	Nos	100	538	30	16140	30	16140
iv)	Petrographic Studies	Nos	228	1436	30	43080	30	43080
v)	Preparation of polished section	Nos	100	538	30	16140	30	16140
vi)	Mineragraphic Studies	Nos	364	2023	30	60690	30	60690
vii)	Density Determination	Nos	24	139	50	6950	50	6950
viii)	Specific Gravity determination	Nos	32	188.5	50	9425	50	9425
	Sub-Total C					8234695		8234695
D	Preservation of Core							
i)	GI Core boxes	Nos.		2000	850	1700000	850	1700000
ii)	Transportation of Core Boxes	Km	8.8	31.0	1600	49600	1600	49600
	Sub-Total D					1749600		1749600
	Total A+B+C+D							86216065
E	EXPLORATION REPORT - 1% of (A+B+C+D)					1		862161
F	PEER REVIEW OF DGR (Lump Sum)	Nos		10000	1	10000	1	10000
	Grand Total : A to F							87088226
G	GST @ 18%							15675881
H	GRAND TOTAL							102764106
Notes:								
1	Revised Rates of Promotional Work done by MECL on behalf of Govt. of India Vide letter No. 37(I) /2006-M.I. dated- 02/07/2014 and based on actual escalation as per RBI indices as on 31-03-2017 and the same has been considered for subsequent year.							
2	**Nityanad Committee Rates with actual escalation as per RBI index as on 31.3.2017 and the same for subsequent year.							
3	*** As approved in the 12th meeting of Technical Committee & th meeting of Executive Committe of NMET							
4	**** Rate has taken from Schedule of Charges of differen activities of GSI as on 2014-15 and 40% escalation on the same has been considered for							

Mineral Exploration and evaluation 18%(SAC Code: 998343)