PROPOSAL FOR PRELIMINARY EXPLORATION (G-3) FOR MANGANESE ORE AND GRAPHITE IN BHARATBAHAL BLOCK (2.00 SQ. KM AREA) DISTRICT- BALANGIR, ODISHA

COMMODITY: MANGANESE AND GRAPHITE

BY

MINERAL EXPLORATION AND CONSULTANCY LIMITED

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SEMINARY HILLS

PLACE: NAGPUR

DATE: 11th January 2024

Summary of the Block for Preliminary Exploration (G-3)

	Features	**Details**
	Block ID	**Bharatbahal Manganese and Graphite Block**
	Exploration Agency	Mineral Exploration and Consultancy Limited (MECL)
	Commodity	**Manganese and Graphite**
	Mineral Belt	Eastern Ghat Mobile Belt, Balangir District, Odisha
	Budget & Time schedule to complete the project	194.14 lakhs & 12 months
	Objectives	The present exploration programme (G-3) has been formulated on the outcomes of the Reconnaissance survey carried out by MECL in Larambha-Kanaital and Pudapadar-Bharatbahal block where substantial work has been carried out on a higher confidence level. The objectives of the present Preliminary Exploration are as follows: i) To prepare the detailed Topographical map of the area by means of surface contouring at 2m interval in 1:2000 scale. ii) To establish the continuity of manganese and graphite bearing ore zones at a closer interval by means of drilling in gap areas. iii) To assess the quality and quantity of the resources (333) as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2021. iv) To establish the beneficiation methods for low grade manganese and graphite ores in Eastern Ghat Mobile Belt.
	Whether the work will be carried out by the proposed agency or through outsourcing and details thereof. Components to be outsourced and name of the outsource agency	Work will be carried out by the proposed agency.
	Name/Number of Geoscientists	
	Expected Field days (Geology, Survey)	Geologist Party days: Field -120 days & HQ-50 days
		Survey Party days: 75 days (for topographic survey)
		Sampling Party days: 50 days

<table>
<tr><td>1.</td><td>Location</td><td colspan="6">The block proposed for exploration lies in the parts of Survey of India Toposheet No 64 P/01 and is bounded by latitude 20º 48' 49.32" N to 20° 47' 54.54" N and longitude 83° 13' 44.13" E to 83° 14' 26.39" E (Plate No I). The area is connected by fair weather road from the State High-Way No.-1 (Balangir-Patanagarh Road). The fair weather road crosses Suktel River through a ford north of Khuntapalli village and is open to traffic from January to June. During the peak of Monsoon, the block can be approached from Balangir via Sarmuhan by an all weather pucca road. The intermittent villages are connected by fair weather jeepable unmetalled roads. The nearest railhead is Balangir.</td></tr>
<tr><td></td><td>Latitude and Longitude</td><td colspan="6"><table>
<tr><th rowspan="3">BOUNDARY POINTS</th><th colspan="2">UTM (Zone-44N)</th><th colspan="2">DMS</th></tr>
<tr><th>EASTING</th><th>NORTHING</th><th>LONGITUDE</th><th>LATITUDE</th></tr>
<tr><th>m</th><th>m</th><th>E</th><th>N</th></tr>
<tr><td>A</td><td>732012.9290</td><td>2303133.944</td><td>83°13'45.27"</td><td>20°48"49.32"</td></tr>
<tr><td>B</td><td>733202.2557</td><td>2303133.944</td><td>83°14'26.39"</td><td>20°48"48.78"</td></tr>
<tr><td>C</td><td>733202.2557</td><td>2301448.286</td><td>83°14'25.58"</td><td>20°47"53.99"</td></tr>
<tr><td>D</td><td>732003.2437</td><td>2301448.366</td><td>83°13'44.13"</td><td>20°47"54.54"</td></tr>
<tr><td>E</td><td>732012.9290</td><td>2302110.6250</td><td>83°13'44.79"</td><td>20°48"16.06"</td></tr>
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<tr><td></td><td>Villages</td><td colspan="6">Bharatbahal</td></tr>
<tr><td></td><td>Tehsil/Taluk</td><td colspan="6">Patnagarh</td></tr>
<tr><td></td><td>District</td><td colspan="6">Balangir</td></tr>
<tr><td></td><td>State</td><td colspan="6">Odisha</td></tr>
<tr><td>2.</td><td>Area (hectares/ square kilometres)</td><td colspan="6"></td></tr>
<tr><td></td><td>Block Area</td><td colspan="6">2.00 sq.km</td></tr>
<tr><td></td><td>Forest Area</td><td colspan="6">Mostly Non-Forest area.</td></tr>
<tr><td></td><td>Government Land Area (Bilanam)</td><td colspan="6">Data not available</td></tr>
<tr><td></td><td>Charagaha</td><td colspan="6">Data not available</td></tr>
<tr><td></td><td>Private Land Area</td><td colspan="6">Data not available</td></tr>
<tr><td>3.</td><td>Accessibility</td><td colspan="6"></td></tr>
<tr><td></td><td>Nearest Rail Head</td><td colspan="6">Balangir (280 km from Raipur and 310 Km from Bhubaneswar),</td></tr>
<tr><td></td><td>Road</td><td colspan="6">The intermittent villages in the area are connected by fair weather jeepable metalled / unmetalled roads. The nearest railhead is Balangir.</td></tr>
<tr><td></td><td>Airport</td><td colspan="6">Raipur (225 km)</td></tr>
<tr><td>4.</td><td>Hydrography</td><td colspan="6"></td></tr>
<tr><td></td><td>Local Surface Drainage Pattern (Channels)</td><td colspan="6">The general slope of the country is towards southerly and the drainage is collected by southerly flowing nala ultimately draining into Suktel River. The area has got dendritic pattern of drainage. The block area is surrounded by Baraputa reserve forest on north-western part and other area mostly by Non-forest and Agricultural lands.</td></tr>
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		Rain-fed south-easterly flowing Suktel River in the southern part of the block.
	Rivers/ Streams	Suktel River
5.	**Climate**	
	Mean Annual Rainfall	Average annual rainfall is 100 cm
	Temperature:	Minimum temperatures: 10°C (Dec-Feb), Maximum temperatures: up to 46°C (March-June)
6.	**Topography**	
	Toposheet Number	64P/01
	Morphology of the Area	The area is almost flat terrain and covered with agriculture land. The average height of the area is 240m above MSL.
7.	**Availability of baseline geoscience data**	
	Geological Map (1:50K/25K)	Regional Geological map available (part of the area), Geological Survey of India (1:25,000 scale), Detailed geological map (1:12,500 scale).
	Geochemical Map	Not available.
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	Available.
8.	**Justification for taking up Reconnaissance Survey/ Regional Exploration**	i) During Reconnaissance survey in Larambha-Kanaital and Pudapadar-Bharatbahal (G-4) block five potential areas had been identified. Bharatbahal manganese and graphite block is one of them. Within the block three mineralized zones have been identified with cumulative strike length of 979m and average width is 15m. Two prominent zones trending NNE-SSW in the central part having considerable length compared to zones in other potential areas. 16 Bed rock samples collected from this area and 15 samples are more than 10% Mn where maximum value is 38.13% Mn. FC% in Graphite ranges from 4.74% to 6.56% FC. Five core boreholes have been drilled to prove the subsurface and lateral continuity of the mineralization for the two prominent zones. Subsurface drilling established the following dimension of the mineralization.

Sl No.	Mineralization	Zone	Strike length (m)	Avg. Width (m)
1	Manganese	Northern Zone	424	9.35
2	Graphite		424	4.90
3	Manganese	Southern Zone	385	9.30
4	Graphite		370	4.20

ii) Mineralization has been proved up to a vertical depth of about 20m and the following resource has been estimated:

Summary of the Manganese resources estimated in the Proposed Bharatbahal block during previous exploration

Cut-off	Total (tons)	Mn%	SiO2%	P2O5%	Fe2O3	MnO2%	Acid Insoluable
10-25% Mn	1260786.34	16.74	28.78	0.81	21.95	16.32	37.10
>25% Mn	128495.30	30.56	9.89	1.42	31.84	20.59	17.29
Total @ 10% Mn	1389281.64	**18.02**	**27.03**	**0.87**	**22.87**	**16.72**	**35.27**

Cut-off	Total (Tons.)	Moisture %	Ash%	VM%	FC%
2% FC	516817.62	1.82	84.63	9.34	4.21
Total	516817.62	1.82	84.63	9.34	4.21

iii) The present exploration programme will establish the lateral and vertical continuity of the mineralization with higher confidence level.

iv) To enhance the confidence level on the Geological axis and make the block prospective in terms of auction and resource enhancement.

v) At present graphite is a critical mineral for the nation. The previous exploration in the area has established occurrences of manganese along with graphite. Graphite is closely associated with manganese and also occurs as a separate zone with considerable thickness. Hence Preliminary Exploration (G-3) is required to establish the vertical and lateral extension of graphite in the current block which definitely will augment the graphite resource.

PROPOSAL FOR PRELIMINARY EXPLORATION (G-3) FOR MANGANESE ORE AND GRAPHITE IN BHARATBAHAL BLOCK (2.00 SQ. KM AREA) DISTRICT- BALANGIR, ODISHA

1.0.0 INTRODUCTION

1.1.0 Preamble:

1.1.1 Manganese is one of the most common elements in the Earthôs crust and is widely distributed across the planetôs surface. It is very hard, brittle, gray-white transition metal that is found in variety of minerals, but never as free element in nature; is it often found in minerals in combination with iron. Manganese ore is the basic source to provide manganese as indispensable input in making of iron and all types of steels. So far there is no technology which can substitute manganese in steel making. Manganese combines the twin benefits of relatively low price with outstanding technical usage.

1.1.2 In order to sustain the current level of production of Mn ores and to meet the future demands, the exploration of Manganese ore is the need of the hour.

1.1.3 In India the Manganese Ore deposits mainly occurs as metamorphosed bedded sedimentary deposits associated with Gondite Series (Archaeans) of Madhya Pradesh (Balaghat, Chhindwara & Jhabua districts), Maharashtra (Bhandara & Nagpur districts), Gujarat (Panchmahal district), Odisha (Sundargarh district) and Kodurite Series (Archaeans) of Odisha (Ganjam & Koraput districts) and Andhra Pradesh (Srikakulam & Vishakhapatnam districts).

1.1.4 The total reserves/resources of manganese ore in the country as on 1.04.2015 have been placed at 495.87 million tonnes as per NMI database, based on UNFC system (Mineral Year Book-2019). Out of these, 93.47 million tonnes are categorised as reserves and the balance 402.40 million tonnes are in the remaining resource category. Grade-wise, Ferromanganese grade accounts for 7%, Medium grade 11%, BF grade 28% and the remaining 54% are of Mixed, Low, Others, Unclassified, and Not-known grades including 0.17 million tonnes of battery/chemical grade. The overall grade of the

manganese ore reserve in the country is in the range of 30-35% Mn (IBM Mineral Year Book 2019).

1.1.5 The total state-wise distribution of the manganese resources in the country indicates that Odisha tops with 44% share followed by Karnataka 22%, Madhya Pradesh 12%, Maharashtra & Goa 7% each, Andhra Pradesh 4% and Jharkhand 2% each. Rajasthan, Gujarat, Telangana and West Bengal together shared the remaining about 2% resources.

1.1.6 The Govt. of India enacted the MMDR Amendment Act, 2015 duly introducing the system of auction for allocation of Mineral Concessions. Manganese has been categorized in the Fourth Schedule which needs prospecting and exploration by the State Govt. before auctioning of blocks.

1.1.7 Worldwide demand for graphite is expected to rise with the development of non-carbon energy applications such as batteries used in electric vehicles, electric devices and energy storage devices that use graphite. Such emerging & high growth applications of graphite are certainly causing noticeable impacts on the demand & consumption patterns within the country & globally as well. Demand for graphite in lithium-ion batteries for application in electric/hybrid vehicles, laptops, smart phones, home/business applications and traditional uses for expanded graphite foils, are the potential areas that are expected to be major drivers in the market. It represents 23% of global flake graphite demand.

1.1.8 The world resources of graphite are believed to exceed 800 million tonnes of recoverable graphite. However, world reserves of graphite have been placed at 320 million tonnes of which Turkey accounts for 28% followed by China (23%), Brazil (22%), Madagascar & Mozambique (8% each), Tanzania 5%, India & Uzbekisthan (2% each) and Mexico & Dem. P. R. of Korea (1% each). (IBM, Mineral Year Book-2021).

1.1.9 World graphite production has fluctuated slightly in recent years. In 2022, the total worldwide production of graphite amounted to 1.3 million metric tons, an increase from the 1.13 million metric tons produced in the previous year. In the past decade, China has consistently been the leading global graphite producer. In 2022, China produced an estimated 850,000 metric tons of graphite. Following China, was Mozambique in a distant second place, with a production volume estimated at 170,000 metric tons that year. India ranks 10th position in the top graphite producing countries.

1.1.10 Graphite occurrences are reported from various States but the deposits of economic importance are located in Arunachal Pradesh, Chhattisgarh, Jharkhand, Odisha and Tamil Nadu. Arunachal Pradesh accounts for 36% of the total resources which is followed by Jammu & Kashmir (29%), Jharkhand (9%) Madhya Pradesh (5%) Odisha (9%), and Tamil Nadu (4%). However, in terms of reserves, Tamil Nadu has the leading share of

about 36% followed by Jharkhand (30%) and Odisha (33%) of the total reserves (Mineral Year Book-2021). The graphite reserves having +40% Fixed Carbon is rather limited in the country. In view of this, detailed exploration of graphite deposits in Odisha, Jharkhand, Jammu & Kashmir and Kerala should be carried out.

1.2.0 Background:

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 along with the augmentation of reserve and resource of the country. Manganese occurrence areas in Balangir district in Odisha are among them.

1.2.2 During field execution of manganese and graphite blocks Kumiapali, Rengali, Antapali, Biarpali, Babja and Tamiya MECL assessed the nearby area and found the occurrences of manganese ore and graphite in old pits around the villages Larambha, Kanaital and Pudapadar. MECL collected few samples from the surface exposures and the manganese values are more than the threshold value (15.26 to 31.42 % Mn) stipulated by IBM for manganese. Also, the same had been reported by S. N. Behera and B. K. Acharya during the field season 1997-98. Some pits and a few trenches are available in the area; however, the analytical data of these are not available. S. N. Behera and B. K. Acharya have collected 13 bedrock samples and analysed. Eleven out of 13 samples having Mn value more than threshold i.e., 10% Mn.

1.2.3 Proposal for reconnaissance survey for manganese and graphite in Larambha-Kanaital and Pudapadar-Bharatbahal block over an extent of 135 sq km was prepared and approved in the 23rd Executive Committee (EC) meeting of NMET held on 16th March 2022 vide Office Memorandum F. No. 23/241/2022-NMET/310 dated 25th March 2023.

1.2.4 **Outcomes of reconnaissance survey in Larambha-Kanaital and Pudapadar-Bharatbahal:** During the Reconnaissance Survey for manganese and graphite in Larambha-Kanaital and Pudapadar-Bharatbahal block, five potential areas have been identified (Area-1 to 5). Bharatbahal manganese and graphite block is one of them i.e. Area-3. Bharatbahal block is located in the south eastern part of the block. Three mineralized zones have been identified with cumulative strike length of 979m and average width is 15m. Out of three zone, two prominent zones trending NNE-SSW in the central part having considerable length compared to zones in other potential areas. Bed rock samples collected from this area shows 5.76% to 33.32% Mn and 4.74% to 6.56% FC. Five core boreholes have been drilled to prove the subsurface and lateral continuity of the mineralization for the two prominent zones. Resources established in the Bharatbahal block is tabulated below:

Summary of the manganese resources estimated in Larambha- Kanaital and Pudapadar-Bharatbahal (G4) block, Balangir District, Odisha

Sectors	Resource (Tons)	Mn %	SiO_2 %	P_2O_5 %	Fe_2O_3 %	MnO_2 %	Acid Insoluble%
Area-2	53390.00	20.23	18.80	0.57	32.73	23.52	25.74
Area-1	28100.00	15.84	21.20	0.39	34.09	17.11	28.32
Area-3	1389281.64	18.02	27.03	0.87	22.87	16.72	35.27
Total resource at 10% Mn cut-off (Tons)	**1470772**	**18.06**	**26.62**	**0.85**	**23.44**	**16.97**	**34.79**
Total resource at 10% Mn cut-off (Million Tons)	**1.471**						

Summary of the graphite resources estimated in Larambha- Kanaital and Pudapadar-Bharatbahal (G4) block, Balangir District, Odisha

Sectors	Resource (Tons)	Moisture %	ASH %	VM %	FC %
Area-1	6725.00	1.06	85.33	9.72	3.89
Area-2	32280.00	2.17	86.81	8.57	2.45
Area-3	516817.62	1.82	84.63	9.34	4.21
Area-4	65890.23	6.56	82.31	7.10	4.03
Total resource in Tons	**621712.85**	**2.33**	**84.51**	**9.07**	**4.09**
Total resource in million ton	**0.622**				

1.2.5 Based on the outcome of the previous exploration and recommendations made in the geological report, the present proposal has been prepared to upgrade the block at G3 level of exploration.

1.3.0 Location & Accessibility of the Area

The block proposed for exploration lies in the parts of Survey of India Toposheet No 64 P/01 and is bounded by latitude 20º 48' 49.32" N to 20° 47' 54.54" N and longitude 83° 13' 44.13" E to 83° 14' 26.39" E (Plate No I).

The coordinate of cardinal points of block boundary are as follows:

BOUNDARY POINTS	UTM (Zone-44N)		DMS	
	EASTING	NORTHING	LONGITUDE	LATITUDE
	m	m	E	N
A	732012.929	2303133.944	83°13'45.27"	20°48"49.32"
B	733202.2557	2303133.944	83°14'26.39"	20°48"48.78"
C	733202.2557	2301448.286	83°14'25.58"	20°47"53.99"
D	732003.2437	2301448.366	83°13'44.13"	20°47"54.54"
E	732012.9290	2302110.6250	83°13'44.79"	20°48"16.06"

The area is connected by fair weather road from the State High-Way No.-1 (Balangir-Patanagarh Road). The fair weather road crosses Suktel River through a ford north of Khuntapalli village and is open to traffic from January to June. During the peak of Monsoon, Larambha-Kanaital & Pudapadar-Bharatbahal Block can be approached from Balangir via Sarmuhan by an all weather pucca road. The intermittent villages are connected by fair weather jeepable unmetalled roads. The nearest railhead is Balangir.

1.4.0 Physiography, Drainage and Vegetation

1.4.1 The area comprises of wide spread plain land and folded ridges, hillocks and mounds cover the northern part. The maximum height of the ridge is 372m and minimum height of the valley is 194m above MSL. Rain-fed easterly flowing Suktel River with network of streams drains the area. The drainage is sub-parallel to sub-dendritic controlled by ridges and lineaments. Thick alluvium accumulated due to the Suktel River has helped extreme cultivation in the area.

1.4.2 The area has a sub-tropical climate with torrential rainfall between June and September. The temperature ranges between 10^0 C in winter and 46^0 C in summer season and the average annual rainfall is around 100 cm. This part of Odisha is very hot in summer with occasional extreme hotness in comparison to other parts of the state.

1.4.3 The areas under exploration are sparse to densely vegetated. The floral assemblage includes Sal (Shorea robusta), Shishu (Dalbergia latifolia), Neem (Nekua indica), Tamarind (Tamarindus indica), Jackfruit (Autocarpus intergrifolia), Kendu (Diaspyros melanxylon), Mango, Amla, Harida, Bahada, Boula, Simili, Berries and Bel etc. Wild animals are scarcely observed in this area. The faunal assemblages include bears, rabbits, snakes, wild boars, jackals, peacocks, wild hens and host of birds.

1.5.0 Previous Work

1.5.1 B.C. Roy (1940) first reported the manganese ore deposits in Balangir district. He observed that: (i) the manganese ore deposits occupy summits and plains (ii) the manganese ore bodies have definite strike and dip (iii) the manganese ore comprises mainly of pyrolusite and psilomelane as ore minerals with chert, limonite and wad, (iv) the ore bands are associated with calc-granulites and garnetiferous gneisses.

1.5.2 Later on, Jhingran (1947) investigated and Krishnaswamy (1950) estimated the ore reserve to the tune of 650 thousand tonnes up to 1.5 m depth. Later on, host of workers from Geological Survey of India have carried out field work from 1962-65 and onwards. Finally, investigation aided by drilling was taken up in 1994-95. The average grade of

ores from Balangir district range from 19-39% Mn, 10-28% Fe, 4-46% SiO_2 and 0.12-0.48% P.

1.5.3 A.G. Jhingran (1947) envisaged that the Dunguripalli manganese ore deposit (T. S. No. 64 P/5) was of considerable magnitude. Shri S. Krishnaswamy (1950) observed numerous occurrences of Mn ore mainly as lenses and pockets in calc-silicates, being parallel to regional foliation trend and assessed a reserve of 6,60,000 tonnes up to a depth of 15 m in T.S. P/1 & 5. M.W. Tak (1964-65), P. Bose (1965-66) and D. Mitra (1964-65) had mapped on 1:63,360 scale in Toposheet No. 64 P/5 & 9, 64 P/5, and 64 P/1 & 5 respectively.

1.5.4 M.W. Tak carried out mapping in the northern part of the present area and found that Mn mineralisation is associated with calc-gneiss, diopside granulite and highly weathered khondalite. P. Bose (1967) observed numerous lensoidal and pocket type deposits within khondalite and partly in calc-silicate rocks. D. Mitra observed the occurrences of Mn ore within khondalite suite of rocks. He envisaged that the presence of quartz-garnet-rhodonite association in deposits indicate probably a gonditic rock and closeness of calc-silicate within ore deposits suggest a calc-magnesian association common in sedimentary environment.

1.5.5 Patel, N.K. et al. (1983) of D.M.G., Orissa carried out systematic mapping of 60 sq. km on 1: 25,000 scale in Babja-Dumerijharam area and 2.5 sq. km detailed mapping on 1: 2000 scale in Bijapatti east of Belpali-Bhaludungri area. He computed the total probable reserve of all grades to be 95,677 tonnes up to a depth of 3m. They observed that Mn ores occurs at the contact of khondalite and calc-granulites in the form of discontinuous bands and pockets of irregular dimensions. Twelve numbers of Mn ore occurrences were reported in the area such as: near southeast of Banipali, NW of Dandapani, NW of Dumerijharam, NE of Gerdi and SE of Thakurpalli. Besides, disintegrated manganese float ores were reported near Barkani, Babja and Uchhabpalli. They had done 410 cu. m of trenching and pitting and 249 nos. of channel and grab sampling.

1.5.6 Jena, S.K. et al. (1993-94) carried out large scale mapping on 1:25,000 scale in Gadashankar-Dandapani area of Balangir district between latitude 20^0 44ô to 20^0 55ôN and longitude 83^0 15ô to 83^0 21ôE and delineated four major ore zones.

1.5.7 Patel, M.C. (1996) initiated preliminary exploration work by drilling in 1994-95 F.S. Mishra U.S. and Hussain, A. (1997) carried out E-1stage (G-3 of UNFC, Ref: letter No 2692/K-1(Vol-II)/TC/ODS/2017 dated 07/11/2017 of GSI) exploration work over four blocks, viz., Biarpalli, Khagsabahal. Tabalbanji and Dunguripalli (north) blocks aided by detailed mapping and drilling in Toposheet No. 64 P/5 & 6.

1.5.8 Behera, S.N. (1996-97) carried out large scale mapping of an area of 115 sq.km on 1:25,000 scale in Babja ($20^0$50ô00ò-$83^0$20ô36òE) - Thelkuchhapur ($20^0$50ô15òN-$83^0$46ô00òE), Dandapani, Tamiya and adjoining areas under P-II stage investigation to study manganese occurrences viz-a-viz their nature & grade and to identify potential blocks for detailed exploration.

1.5.9 During F.S.P. 1997-98, N. Behera and B. K. Acharya, carried out prospecting for manganese in Dandapani, Tamiya and adjoining areas in Balangir District, Odisha and reported manganese occurrences in and around Larambha and Kanaital villages. They have collected 13 bedrock samples and analysed. Eleven out of 13 samples having Mn value more than threshold i.e., 10% Mn.

1.5.10 MECL carried out reconnaissance survey for manganese and graphite in Larambha-Kanaital and Pudapadar-Bharatbahal block over an extent of 135 sq km and established a total resource of 1.47 million tonnes at 10% Mn cut-off having an average grade of 18.06% Mn and a total resource of 0.56 million tonnes of graphite at 2% FC cut-off having an average grade of 4.09% FC.

1.6.0 Regional Geology

1.6.1 The exploration area lies in the northern part of the Eastern Ghats Super Group of rocks belonging to the meta-sedimentary sequence of Precambrian khondalite. The sequence of para-metamorphic is made up of pelitic, psammitic and calcareous formations, which are represented by khondalite, quartzite and calc-silicate rocks. These have been intruded by granites. All the hill ranges in this area are composed of either khondalite or garnetiferous quartzite or both. Calc-silicate bands adjoining to the ore horizons form denudational hillocks or mounds and are 1 to 2m thick. Granite gneiss occupies the valleys. The whole sequence has been metamorphosed to granulite facies. Structurally the area exhibits a complex picture.

1.6.2 On the basis of contact relationship, presence of xenoliths/caught up patches of one particular unit within the other & structural and stratigraphical relationship, the tentative stratigraphic succession of the area (After GSI) may be given as follows:

Age	Formation	Lithology
Quaternary	-	Alluvium, soil and latsol
Tertiary	-	Laterite
Precambrian (Eastern Ghat Supergroup)	-	Aplite, Pegmatite and Quartz veins
	Granitoids	Equigranular, non-garnetiferous granite gneiss, garnetiferous granite gneiss and granulite, leptinitic gneiss Migmatite
	Charnockite Suite	Hypersthene bearing gneisses and granulites (mostly acid to intermediate charnockitic type)
	Khondalite Suite	Pyroxene granulite, quartzite, Khondalite with manganiferous horizons Calc-silicate rocks with manganese ore
Base Not Seen		

1.6.3 Description of various rock formations in the Area

Based on the geological mapping of the surrounding area following rock types are exposed in and around the proposed block**:** calc-silicate, quartzite (Mn bearing), granite gneiss, amphibolite and quartz and pegmatite vein. From the disposition of individual members of khondalite it is difficult to ascertain the stratigraphy, as the units have been subjected to different cycles of sedimentation as well as deformation. Description of different litho units is given below.

Calc-silicate rocks: The calc-silicate rocks occur as bands and lenses within khondalite and also with Mn-ore bearing silicate-carbonate rock in the form of denudational hillocks and mounds and are intricately folded and exhibit rib and furrow weathering structure and crude layering. Their trend generally confirms the regional foliation direction and the contact of these rocks with khondalite and granite is sharp. The calc-silicate bands are 100m to 1km in length and 20 to 50 m in width. The calc-silicate rock is usually a dark grey to greenish, fine to medium grained, hard and massive to foliated. It contains green diopside, hornblende, plagioclase (andesine), garnet (grossularite), scapolite, sphene and quartz. Accessories include zircon, calcite, apatite and epidote.

Khondalite (quartz- feldspar- garnet- sillimanite + graphite schist/gneiss): It occurs typically in bouldery outcrops (highly weathered) on narrow, steep hill ranges and low lying mounds and in valley interbanded with quartzite and calc-silicate rocks. This is coarse grained, brownish yellow to reddish grey coloured, foliated and highly weathered rock. Due to varying degree of weathering its colour changes to pinkish/purplish at places, when highly kaolinised, it becomes very light. It is highly sheared and

mylonitised at places. The rock is manganiferous and secondary manganese minerals occur along the foliation, fracture and joints planes. The rock is intimately associated with quartzite and both grade into each other along as well as across the foliation. They are highly migmatised and the quartzofeldspathic neosome bands that have traversed the rock along the regional foliation plane of the rocks.

Quartzite: The quartzites is medium to coarse grained, white to buff coloured, granular to faintly schistose in nature and are invariably garnetiferous. Pegmatite and quartz veins traverse the rock along foliation planes. Quartzite grades laterally to khondalite. It is predominantly made up of large xenoblastic grains of quartz with pale pink garnet and clusters of sillimanite. Quartzite is highly brecciated in a number of places such as in Dandapani block. Brecciated quartzite, in general contains ore bodies. Manganese mineralisation is noticed within brecciated and feldspathised quartzite at places. Manganiferous quartzite is exposed in Dandapani and Dunguripalli (south) blocks.

Granulite: It is coarse grained black massive rock and occurs as small lenticular inclusions parallel to foliation within granite gneiss and at places occur in boulder form along small ridges in association with khondalite and quartzite. It is mainly a plagioclase (andesine-labradorite)-pyroxene rock with subordinate amount of amphibole, biotite, garnet, perthite and quartz and accessories include sphene, ilmenite, zircon and apatite.

Migmatite: Migmatite occupy the low lying areas in the east of Bijapati and around Dunguripalli. It exhibits gneissose structure and the palaeosome includes hypersthene, diopside and biotite and the neosome comprises of K-feldspar and plagioclase.

Granite Gneiss: This is medium to coarse grained rock occupying low-lying areas with migmatite, consisting mainly of quartz, plagioclase, K-feldspar, biotite, garnet, epidote and few opaques. The whole sequence has been metamorphosed to granulite facies. The alkali-feldspar gneiss is fine to coarse grained and contains porphyroblasts of microcline and perthite within quartz-feldspar-garnet aggregates.

Pegmatite and quartz veins: Pegmatite and quartz veins traverse the rocks at a number of places close to manganese mineralisation in all the rock types both along and across the foliation. At places pegmatite contains few crystals of beryl which are of less significance.

Laterite: Laterite is developed mainly over khondalite and granite gneiss and is very common in areas close to manganese mineralised zones as in Dunguripalli (south)

Block. Extensive development of latsol over laterite has been developed in northeast of Rengali.

1.6.4 Regional Structure

The entire area covered by large scale/detailed mapping exhibits a complex structural fabric as the whole sequence has been subjected to multiple cycles of deformation. As a result, the existing structural elements are completely altered rendering it difficult to decipher the complete structural geometry. However, the secondary planar structural elements like, foliation and gneissosity and joints are well preserved in the rock types of the area. The different structural features as observed are described below:

Primary structures: The primary structures have been mostly obliterated due to granulite facies metamorphism. However, relict bedding is observed along the contact between khondalite, quartzite and calc-silicates. Interbanding of different litho units within the Khondalite Group is seen clearly in many outcrops.

Secondary structures: The secondary planar structures such as foliation, gneissosity, schistosity, joint and cleavages are well preserved in rocks. S1 is defined by compositional banding, preferred orientation of prismatic, acicular and flaky minerals in the rock.

i) **Foliations:** Foliation (S1) is most pervasive and trends in NNW-SSE to NE-SW direction with moderate to steep southerly dip. Planar arrangement of minerals like garnet, biotite, sillimanite, graphite, quartz and feldspar mark the foliation plane in khondalite, quartzite, calc-silicate rocks and granite.

ii) **Joints:** The joints in this area depicts NNW-SSE trend with 80° dip towards NE.

iii) **Lineations:** Two types of lineations are noted in the area:
(a) Slickenside lineation: This is observed in manganiferous quartzite and calc-silicate rocks.
(b) Mineral lineation: The mineral lineation is defined by minerals like sillimanite, biotite and garnet.

iv) **Folding:** The area exhibits at least three generations of folding. The first generation of folds (F1) is tight isoclinal, intrafolial, upright and reclined in nature. The F1 folds are developed conspicuously in calc-silicate rocks and to a lesser extent in quartzite. The axial planes of F1 folds have a general trend in NNW-SSE direction. The second generation of folds (F2) is moderate to steeply plunging, open and broad type on NE-SW axis and third generation fold (F3) is characterised by upright, open to broad warps with E-W trend.

v) **Faults and Shear:** Faulting and shearing are evidenced by brecciation, silicification, vug filling, slickensides and mylonitisation in quartzite and khondalite. Quartzite and khondalites are intensely silicified and brecciated resembling chert breccia in the

vicinity of manganese ore bands in a number of places such as west of Bijapali village in Dunguripalli south block. Shifting and missing of ore bands are due to local fault and pinching and swelling nature of ore bodies in the area.

1.6.5 Metamorphism

High grade metamorphism under granulite facies conditions characterise the Eastern Ghats Super Group of rocks. The mineral assemblages of khondalite (quartz-feldspar-garnet-sillimanite+graphite), granulite (plagioclase-hypersthene-diopside) and calc-silicate (diopside-plagioclase-calcite-quartz-scapolite) indicate pyroxene granulite sub-facies under granulite facies of Eskola.

1.6.6 Mineralization (Surface manifestation)

On the surface the Mn ore mineralization presents a rugged bouldery outlook. In general, oxide minerals show granoblastic to granulitic fabric. Gravity filling, stalactitic, botryoidal, box work and colloform structures are commonly observed within the ore. The ore is in general steel grey to dull grey in colour and is soft or powdery in nature. Pyrolusite, psilomelane and cryptomelane are seen replacing each other. Silica in rhodonite is seen replaced by the manganese oxides.

Manganese ore bodies occur as bands, lenses, pockets, veins, tabular bodies and disseminations within the khondalite group of rocks. The ore is more enriched at the central part. The lensoidal/discontinuous ore bodies are arranged in an en-echelon pattern. These are lateritic and have been weathered to a considerable depth along with the enclosing rocks.

The ore bodies are conformably interstratified with and enclosed in different stratigraphic levels with calc-granulite at its contact with khondalite. Detailed mapping and available subsurface data suggest that the ore is concentrated along the fold axes of minor and mesoscopic folds. Intense brecciation, shearing, fracture form the important loci for mineralisation and the granitic intrusion have influenced the depth persistence of the ore. The lensoidal discontinuous ores owe their origin to the flowage or drag folds. Hence it may be concluded that manganese ores are both lithologically and structurally controlled.

Graphite mineralisation is restricted to khondalite suite and its migmatised equivalents. The graphite is crystalline and flaky and occurs in disseminated state with varying proportion especially in quartz-feldspar-garnet-sillimanite-graphite schist. Workable concentration results through the process of remobilisation and epigenetic enrichment in migmatised khondalite. The deposits are in the form of bands, en-echelon veins and lenses usually disposed conformably to the foliation planes of the host rocks and at

places, in shear zones and hinge zones of folds suggesting both lithological and structural controls of localisation. The lensoidal bodies have limited extension both along and across the strike. The graphite deposits occur invariably at shallow depth, within 30m from the surface, just below the soil and laterite cover. The ore zone is often intercalated with grey clay partings.

1.7.0 Scope of Proposed Exploration

1.7.1 The proposed Preliminary Exploration (G-3 stage) program comprises topographical survey (1:4000 scale), Trenching and Drilling at 100m strike interval involving about 745m with associated survey, chemical analysis & physical analysis and geological report preparation.

1.8.0 Observation and Recommendations of previous work

1.8.1 During the Reconnaissance Survey for manganese and graphite in Larambha-Kanaital and Pudapadar-Bharatbahal block, five potential areas have been identified (Area-1 to 5). Bhartbahal manganese and graphite block is one of them i.e. Area-3. Area-3 is located in the south eastern part of the block. Three mineralized zones have been identified with cumulative strike length of 979m and average width is 15m. Two prominent zones, trending NNE-SSW in the central part having considerable length compared to zones in other potential areas. Bed rock samples collected from this area shows 5.76% to 33.32% Mn and 4.74% to 6.56% FC. Five core boreholes have been drilled to prove the subsurface and lateral continuity of the mineralization for the two prominent zones. Subsurface drilling established the following dimension of the mineralization:

Dimension of the Mineralized Zone in Area-3

Sl No.	Mineralization	(Area -3) Zone	Strike length (m)	Avg. Width (m)	Floor Level vertical from surface (m)
1	Manganese	Northern Zone	424	9.35	21
2	Graphite		424	4.90	35
3	Manganese	Southern Zone	385	9.30	23
4	Graphite		370	4.20	42

In the geological report submitted by MECL upgradation of the block was recommended by drilling to establish the lateral and vertical continuity of the mineralization along with the quality and quantity.

2.0.0 Previous Work / Background information

2.0.1 The background information and previous works have been described in para 1.2.0 and 1.5.0 respectively.

3.0.0 Block description

3.0.1 The proposed block details are given in para 1.3.0.

4.0.0 Objective of the proposed Preliminary Exploration (G-3):

The present exploration programme (G-3) has been formulated on the outcomes of the Reconnaissance survey carried out by MECL in Larambha-Kanaital and Pudapadar-Bharatbahal block where substantial work has been carried out on a higher confidence level.
The objectives of the present Preliminary Exploration are as follows:

i) To prepare the detailed Topographical map of the area (02 sq km) by means of surface contouring at 2m interval in 1:2000 scale.
ii) To prepare a detailed geological map in 1:2000 scale over an area of 02 sq km.
iii) To establish the continuity of manganese and graphite bearing ore zones at a closer interval by means of trenching and drilling in gap areas.
iv) To assess the quality and quantity of the resources (333) as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2021.
v)

5.0.0 Planned Methodology

5.0.1 In accordance to the objective set for Preliminary Exploration (G-3) of the block, the exploration programme is proposed. The Exploration shall be carried out as per Minerals (Evidence of Mineral Contents) Rule-2015. Accordingly, the following scheme of exploration is formulated in order to achieve the objectives. The details of different activities to be carried out are presented in subsequent paragraphs.

5.2.0 Surveying:

5.2.1 The prospect area would be tied up with the triangulation network and the surface features will be picked up and marked on a map on 1:2000 scale. The reduced levels and co-ordinates of boreholes and boundary coordinates would be determined with the help of DGPS. A total of 02 sq km area will be surveyed to record the elevation at a closer internal for generation of contours at 2m interval.

5.3.0 Trenching

5.3.1 Five trenches (150 cu. m) have been proposed in the area to ascertain the continuity of ore body identified during the previous level of exploration. A total of 100 Nos of

primary & 15 check (5% internal+10% External) samples are kept for analysis of manganese and graphite samples.

5.4.0 Exploratory Drilling:

5.4.1 Approximately **745.00 m** of drilling in 12 inclined boreholes will be carried out for intersection of mineralised zones in the block. Out of 12 boreholes, three boreholes are for deeper level where mineralized has already being proved in the previous exploration up to nearly 20m vertical depth. Another four boreholes have been proposed to establish the continuity of mineralization at closer grid (100m strike interval) followed by five conditional boreholes based on the outcomes of the said five trenches and four boreholes.

Sr. No.	Section no.	Borehole no.	Azimuth °	Inclination °	Proposed Depth	No. of samples for Mn	No. of samples for Graphite	Total samples	Remarks	Phase
1	A0-A0'	PBH-1	125	50	70.00	15	10	25	FIRST LEVEL	I
2	A1-A1'	PBH-2	95	50	50.00	15	10	25	FIRST LEVEL	I
3	B-B'	PBH-3	95	50	90.00	15	10	25	SECOND LEVEL	I
4	B1-B1'	PBH-4	95	50	50.00	15	10	25	FIRST LEVEL	I
5	D-D'	PBH-7	135	50	85.00	15	10	25	SECOND LEVEL	I
6	D1-D1'	PBH-8	135	50	50.00	15	10	25	FIRST LEVEL	I
7	E-E'	PBH-9	135	50	100.00	15	10	25	SECOND LEVEL	I
TOTAL (m)					**495.00**	**105.00**	**70.00**	**175.00**		
Conditional Boreholes										
8	C1-C1'	PBH-5	95	50	50.00	15	10	25	FIRST LEVEL	I
9	C2-C2'	PBH-12	95	50	50.00	15	10	25	FIRST LEVEL	II
10	C3-C3'	PBH-6	135	50	50.00	15	10	25	FIRST LEVEL	I
11	E1-E1'	PBH-10	135	50	50.00	15	10	25	FIRST LEVEL	I
12	F1-F1'	PBH-11	135	50	50.00	15	10	25	FIRST LEVEL	I

Sr. No.	Section no.	Borehole no.	Azimuth °	Inclination °	Proposed Depth	No. of samples for Mn	No. of samples for Graphite	Total samples	Remarks	Phase
TOTAL (m)					**250.00**	**75.00**	**50.00**	**125.00**		
Total meterage (m)					**745.00**	**180.00**	**120.00**	**300.00**		

5.5.0 Core Logging

5.5.1 The borehole cores would be logged systematically. Viz. details of the litho units, colour, structural feature, texture, mineralization, besides the recovery, rock quality designation (RQD) and graphite and manganese ore type would be recorded.

5.6.0 Core Sampling

5.6.1 The mineralized (graphite & manganese) part of drill core will be sampled as Primary sample. The length of each sample will be kept 1.00 m within the ore zone depending upon the thickness of particular type of manganese ore & graphite and its physical character. The primary core samples for manganese mineralisation will be analysed for 6 radicalsô i.e. Mn, SiO_2, P_2O_5 Fe_2O_3, MnO_2 and Acid insolubles. The primary core samples for graphite mineralisation will be analysed for Fixed Carbon (FC: Non-carbonate), Ash, Moisture and Volatile Matter (VM) (Proximate Analysis for 4 parameters). The cores of rocks 3 m immediate on footwall and 3 m immediate on hanging wall of mineralized zones would be sampled at 1.0 m interval, as far as possible, depending upon the intensity of mineralization, change in lithology and core recovery etc.

a) A total of 180 no of primary core samples for manganese mineralization (Mn, SiO_2, P_2O_5 Fe_2O_3, MnO_2 and Acid Insolubles) and 120 no of primary core samples will be analyzed for graphite mineralization (FC: Non-carbonate, Ash, Moisture and VM). 10 composite samples for Mn and 10 composite samples for Graphite are also proposed. Another 10 samples for Total Sulphur will be analysed.

b) Around 5% (13 no samples for Manganese and 7 no samples for Graphite) samples will be analyzed in Chemical Laboratory of MECL as Internal check samples and 10% of Primary samples (26 no samples for Manganese and 15 no samples for Graphite) will be sent to NABL External Labs for analysis of manganese mineralization (Mn, SiO_2, P_2O_5 Fe_2O_3, MnO_2 and Acid Insolubles) and/or for graphite mineralization (FC: Non-carbonate, Ash, Moisture and VM) as external check samples.

c) A provision of 26 samples for Cobalt analysis and 15 samples for Vanadium analysis is also proposed for manganese and graphite zones respectively.

d) 5 samples for Carbon isotope analysis by Mass Spectrometer are also proposed to assess the source of carbon in the host rock.

e) 5 samples are kept for Raman Spectroscopy is proposed to assess the physical properties of graphite.

5.8.0 Petrological and Mineragraphic Studies

5.8.1 Thin and polished section studies on drill cores samples would be done for ascertaining the petrographic and mineragraphic characteristics. These samples would be drawn from ore zones and host rocks. A provision of 5 specimens for petrographic and 5 specimens for mineragraphic studies has been proposed in the block.

5.9.0 Specific gravity study

5.9.1 Specific gravity study is proposed for 05 samples to be collected from borehole core in the mineralized area.

5.10.0 Quantum of work:

5.10.1 The quantum of work proposed by MECL in Bharatbahal Manganese and Graphite Block (G-3 Stage of Exploration) is given in Table 5.1.

Table: 5.1 Proposed Quantum of Exploratory Work in Bharatbahal Manganese and Graphite Block, District-Balangir, Odisha

Sl. No.	Item of Work	Unit	Proposed Quantum of work
1	Topographical survey (1:2000)	sq. km.	2.00
2	Geological Mapping (1:2000)	sq. km.	2.00
3	DGPS survey (BH+block boundary points)	Nos.	16
4	Trenching (1m x 2m x15m) x 5 trenches	cu. m	150
5	Core Drilling	m.	745
6	Sample Preparation & Chemical Analysis		
A.	Primary samples for Manganese (Borehole)		
	i) Primary samples for 6 radicals i.e. Mn, SiO_2, P_2O_5, Fe_2O_3, MnO_2 and Insolubles	Nos.	255
	ii) Internal Check samples (5% of Primary samples) for 6 radicals	Nos.	13
	iii) External Check sample (10% of Primary samples) for 6 radicals	Nos.	26
	iv) Primary sample analysis for Cobalt	Nos.	26
	v) Composite samples	Nos.	10

Sl. No.	Item of Work	Unit	Proposed Quantum of work
B.	Primary samples for Graphite (Borehole)		
	i) Proximate Analysis of Primary samples for Graphite for 4 parameters i.e. Fixed Carbon (FC), Ash (A), Moisture (M) and Volatile Matter (VM)	Nos.	145
	ii) Internal Check samples (5% of Primary samples) for Graphite for 4 parameters	Nos.	7
	iii) External Check sample (10 % of Primary samples) for Graphite for 4 parameters	Nos.	15
	iv) Primary sample analysis for Vanadium	Nos.	15
	v) Composite samples	Nos.	10
	vi) Total Sulphur (S)	Nos.	10
	vii) Carbon isotope analysis by Mass Spectrometer	Nos.	5
7	Petrographic Studies	Nos	5
8	Mineragraphic Studies	Nos	5
9	Specific gravity studies	Nos	5
10	Raman Spectroscopy	Nos	5
11	Report Preparation (Digital format)	Nos.	1

6.0.0 Manpower Deployment

6.0.1 Manpower deployment List may be provided later.

7.0.0 Break-up of Expenditure

7.1.0 The proposed exploration programme is planned for Preliminary Exploration (G-3). The work activities like camp setting, geological work, survey work, drilling & laboratory work, report writing will be completed within 12 monthsô time. The bar chart showing activities wise time schedule is placed at **Table-7.1.**

Table- 7.1

Estimated time schedule for Preliminary Exploration (G-3) for Manganese and Graphite in Bharatbahal Block, Districts: Balangir State: Odisha
[Block area- 2.00 sq. km; Schedule timeline- 12 months]

S. No.	Particulars	Months	1	2	3	4	5	6		7	8	9	10	11	12
1	Camp Setting/ mobilization	Months							Review						
2	Survey days	days													
3	Trenching	days													
4	Drilling (1 rig)	m													
5	Geologist days	days													
6	Sampling days	days													
7	Camp winding	Months													
8	Laboratory Studies	days													
9	Geologist days, HQ	days													

10	Report Writing with Peer Review	**days**													

7.2.0 Tentative cost has been estimated based on Schedule of Charges (SoC) of projects funded by National Mineral Exploration Trust (NMET) w.e.f. 01/04/2020 and the total estimated cost is **Rs. 194.15 Lakh.** The summary of tentative cost estimates for Reconnaissance Survey is given in **Table No.-7.2** and details of tentative cost estimates are given as **Annexure-I.**

Table No-7.2
Summary of Tentative Cost Estimates for Preliminary Exploration (G-3)

Sl. No.	Item	Total
1	Geological Work	33,27,660
2	Laboratory Studies	17,48,838
3	Drilling	1,02,89,560
	Sub total	**1,53,66,058**
4	Report	7,50,000
5	Peer Review	30,000
6	Proposal Prepration	3,07,321.17
	Total	**1,64,53,379**
7	GST (18%)	29,61,608.29
Total cost including 18% GST		**1,94,14,988**
SAY, in Lakhs		**194.15**

8. 0.0 Justification:

i) During Reconnaissance survey in Larambha-Kanaital and Pudapadar-Bharatbahal (G-4) block five potential areas had been identified. Bharatbahal manganese and graphite block is one of them. Within the block three mineralized zones have been identified with cumulative strike length of 979m and average width is 15m for manganese and 400m average strike length for graphite. Two prominent zones, out of three zones trending NNE-SSW in the central part having considerable length compared to zones in other potential areas. 16 Bed rock samples collected from this area and 15 samples are more than 10% Mn where maximum value is 38.13% Mn. FC% in Graphite ranges from 4.74% to 6.56% FC.

Five core boreholes have been drilled to prove the subsurface and lateral continuity of the mineralization for the two prominent zones based on the anomalous values of geochemical samples and geophysical survey. Subsurface drilling established the following dimension of the mineralization.

Sl No.	Mineralization	(Area -3) Zone	Strike length (m)	Avg. Width (m)
1	Manganese	Northern Zone	424	9.35
2	Graphite		424	4.90
3	Manganese	Southern Zone	385	9.30
4	Graphite		370	4.20

ii) Mineralization has been proved up to a vertical depth of about 20m and the following resource has been estimated:

Summary of the Manganese resources estimated in the Proposed Bharatbahal block during previous exploration

Cut-off	Total (tons)	Mn%	SiO2%	P2O5%	Fe2O3	MnO2%	Acid Insoluable
10-25% Mn	1260786.34	16.74	28.78	0.81	21.95	16.32	37.10
>25% Mn	128495.30	30.56	9.89	1.42	31.84	20.59	17.29
Total @ 10% Mn	1389281.64	**18.02**	**27.03**	**0.87**	**22.87**	**16.72**	**35.27**

Cut-off	Total (Tons.)	Moisture %	Ash%	VM%	FC%
2% FC	516817.62	1.82	84.63	9.34	4.21
Total	516817.62	1.82	84.63	9.34	4.21

iii) The present exploration programme will establish the lateral and vertical continuity of the mineralization with higher confidence level.

iv) To enhance the confidence level on the Geological axis and make the block prospective in terms of auction and resource enhancement.

v) At present graphite is a critical mineral for the nation. The previous exploration in the area has established occurrences of manganese along with graphite. Graphite is closely associated with manganese and also occurs as a separate zone with considerable thickness. Hence Preliminary Exploration (G-3) is required to establish the vertical and lateral extension of graphite in the current block which definitely will augment the graphite resource.

9. 0.0 References:

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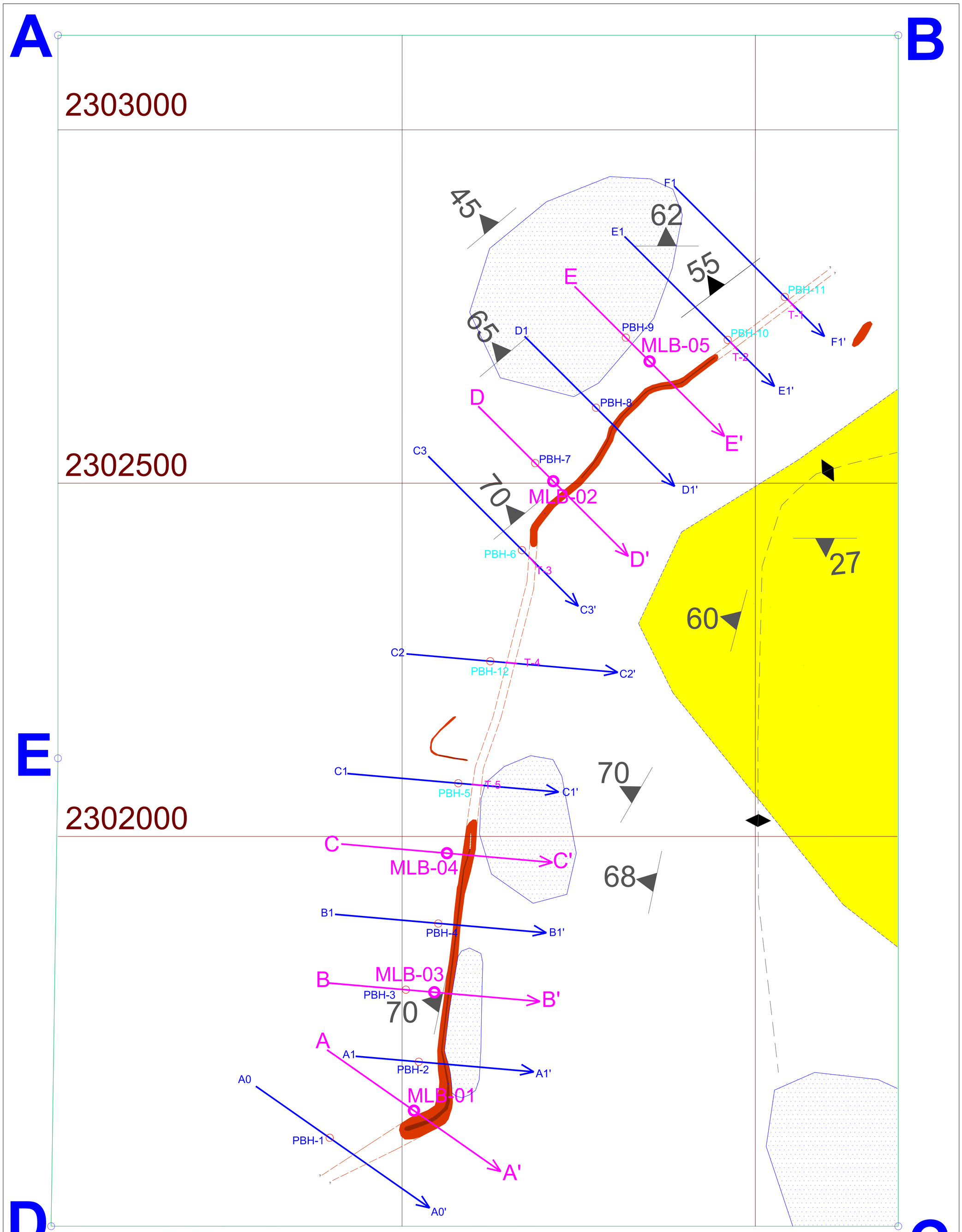
List of Plates:

1. Plate-I: Block Location Map of Bharatbahal Manganese and Graphite Block in Toposheet no. 64P/01, Balangir District, Odisha State.
2. Plate-II: Regional Geological Map of the area (Scale 1: 1,00,000).
3. Plate-III: Geological map of Bharatbahal block (Scale 1:2000).
4. Plate-IV: Geological Cross-sections (Scale 1:2000).

List of Annexures:

Annexure-I: Details of the total cost estimated for the Preliminary Exploration (G-3) in Bharatbahal manganese and graphite block, District: Balangir, Odisha.

Bharatbahal Block (G-3) BH Plan of Proposed										
Sr. No.	**Section no.**	**Borehole no.**	**Azimuth °**	**Inclination °**	**Proposed Depth**	**No. of samples for Mn**	**No. of samples for Graphite**	**Total samples**	**Remarks**	**Phase**
1	A0-A0'	PBH-1	125	50	70.00	15	10	25	FIRST LEVEL	I
2	A1-A1'	PBH-2	95	50	50.00	15	10	25	FIRST LEVEL	I
3	B-B'	PBH-3	95	50	90.00	15	10	25	SECOND LEVEL	I
4	B1-B1'	PBH-4	95	50	50.00	15	10	25	FIRST LEVEL	I
5	D-D'	PBH-7	135	50	85.00	15	10	25	SECOND LEVEL	I
6	D1-D1'	PBH-8	135	50	50.00	15	10	25	FIRST LEVEL	I
7	E-E'	PBH-9	135	50	100.00	15	10	25	SECOND LEVEL	I
TOTAL (m)					**495.00**	**105.00**	**70.00**	**175.00**		
Conditional Boreholes										
Sr. No.	**Section no.**	**Borehole no.**	**Azimuth**	**Inclination °**	**Proposed Depth**	**No. of samples for Mn**	**No. of samples for Graphite**	**Total samples**	**Remarks**	**Phase**
8	C1-C1'	PBH-5	95	50	50.00	15	10	25	FIRST LEVEL	I
9	C2-C2'	PBH-12	95	50	50.00	15	10	25	FIRST LEVEL	II
10	C3-C3'	PBH-6	135	50	50.00	15	10	25	FIRST LEVEL	I
11	E1-E1'	PBH-10	135	50	50.00	15	10	25	FIRST LEVEL	I
12	F1-F1'	PBH-11	135	50	50.00	15	10	25	FIRST LEVEL	I
TOTAL (m)					**250.00**	**75.00**	**50.00**	**125.00**		
Total meterage (m)					**745.00**	**180.00**	**120.00**	**300.00**		



INDEX

- Block Boundary
- Mn Ore Body / Float Ore
- Mn Ore at 10% Mn cut-off with average grade
- Calc-silicate
- Quartzite/Quartz vein
- Graphite Zones at 2% FC cut-off with average grade
- Strike & Dip of foliation
- Drilled Boreholes
- Joints
- Fold Axis
- Interpreted Mn ore body
- Soil
- Proposed Trench
- Proposed Boreholes with number
- Proposed Conditional Boreholes with number

0 100 200

Meters

MINERAL EXPLORATION AND CONSULTANCY LIMITED
(Formerly Mineral Exploration Corporation Limited)

GEOLOGICAL MAP

PROPOSED BHARATBAHAL (G-2) BLOCK, (EXTENT-2.00 sq km)

DISTRICT: BALANGIR & BARGARH — STATE: ODISHA

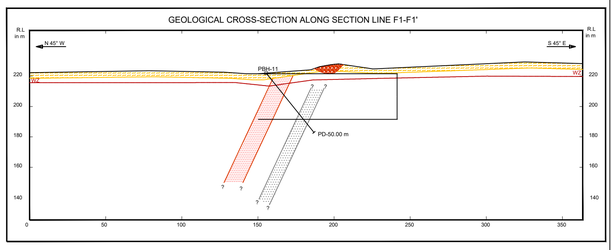
RF. 1:2,000

PROCESSED AT : NON-COAL GR CELL, EXPLORATION DIV., MECL, NAGPUR.

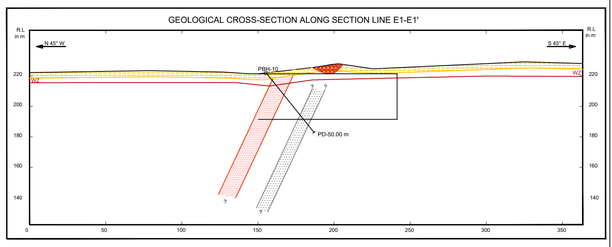
Prepared by : Moumita Ghosh, (Sr. Geologist)
Checked by : S. K. Satapathy, Manager (Geology)
P.P. Kulkarni, DGM (Exploration)
Approved by : P.Ravindran, GM (Expl / NEM)

MECL/EXPL./SEP-2023 — PLATE NO.- III — 03

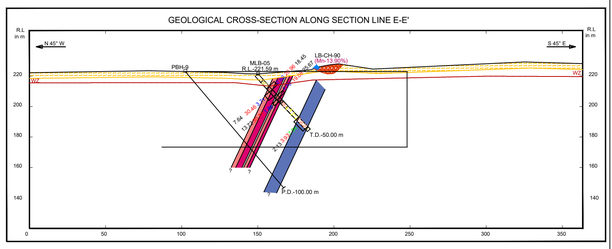
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE F1-F1'



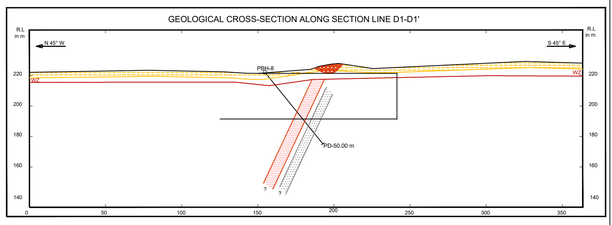
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE E1-E1'



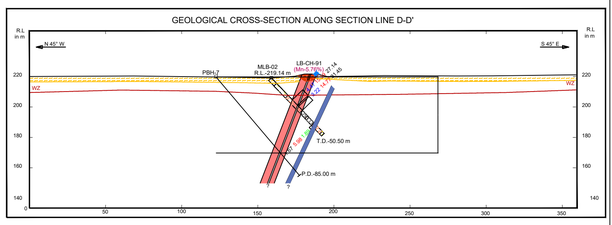
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE E-E'



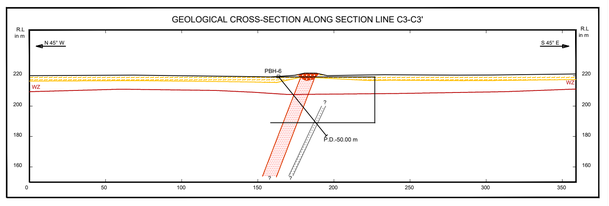
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE D1-D1'



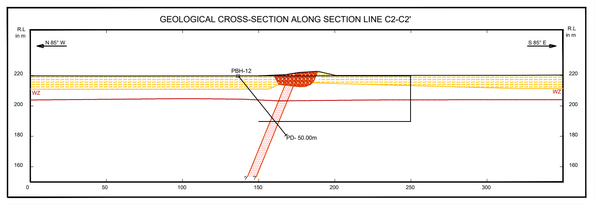
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE D-D'



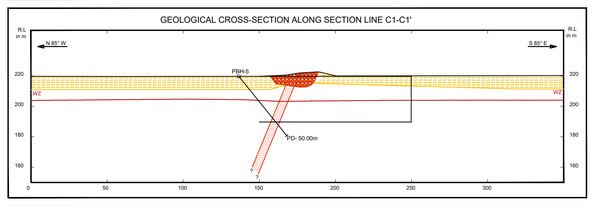
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE C3-C3'



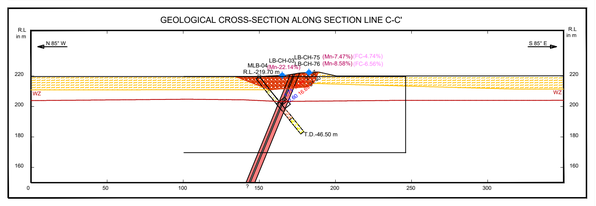
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE C2-C2'



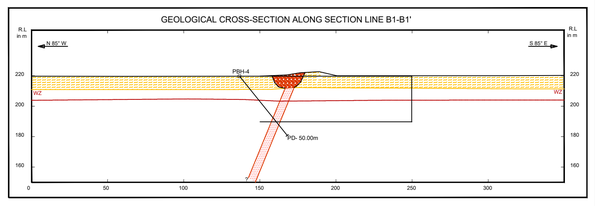
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE C1-C1'



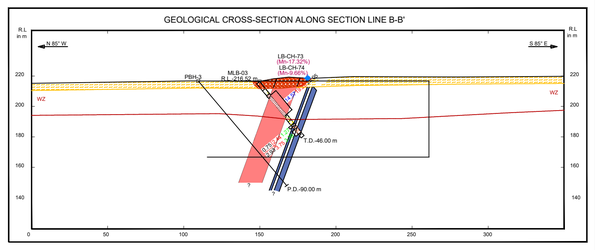
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE C-C'



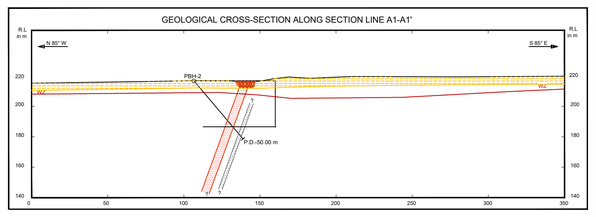
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE B1-B1'



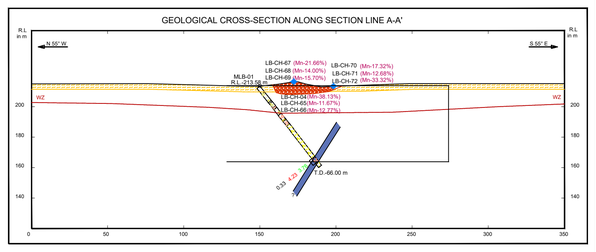
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE B-B'



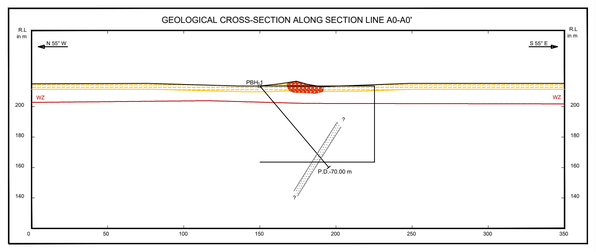
GEOLOGICAL CROSS-SECTION ALONG SECTION LINE A1-A1'



GEOLOGICAL CROSS-SECTION ALONG SECTION LINE A-A'



GEOLOGICAL CROSS-SECTION ALONG SECTION LINE A0-A0'



INDEX

Khondalite

Weathered Khondalite

Manganese Ore

Quartzite

Calc-silicate

Phyllite

Weathered zone

Float Ore

Soil/Top soil/Manganiferous soil/ Sandy soil

Charnockite

Graphite ore zone at 2% FC

Mn ore zone at 10-25%

Mn ore zone at >25%

LB-CH-90 (Mn-13.90%) Bedrock sample location with grade

PBH-9 PD-50.00 m Proposed Boreholes for G-3 exploration

Interpretred Manganese orebody

Interpretred Graphite orebody

MLB-05 (Borehole id.)
R.L.-221.59 m (RL of Borehole collar)
3.66 20.96 18.45 TRUE THICKNESS Mn% &SiO2%
7.79 19.08 25.67 (Mn at 10-25% cut-off)
(Graphite at 2% FC)
2.13 3.93 6.06
Moisture%,FC%, DUP
THICKNESS (m)
2.13 3.93 7.59
(Mn at >25% cut-off)
T.D.-50.00 m (Termination depth of Borehole)

FORMULATED FROM LABORATORY ANALYSIS DATA

SCALE
0 20 40 60 80 100

MINERAL EXPLORATION AND CONSULTANCY LIMITED
(Formerly Mineral Exploration Corporation Limited)

GEOLOGICAL CROSS SECTION OF PROPOSED BHARATBAHAL BLOCK (G-3)
BALANGIR DISTRICT, ODISHA.

RF. 1:2000

Estimated cost for Preliminary Exploration (G-3) for manganese ore and graphite in Bharatbahal blocks, District: Balangir, Odisha. [Block area- 2.00 sq. km; Nos. of Borehole- 12; Borehole depth range- 50-100m; Schedule timeline- 12 months]							
S. No.	Item of Work	Unit	Rates as per NMET SoC 2020-21		Estimated Cost of the Proposal		Remarks
			SoC-Item -Sl No.	Rates as per SoC	Qty.	Amount (Rs)	
A	**GEOLOGICAL WORK**						
1	**Geological Mapping (1:2000), Borehole logging, sampling & Report writing**						
i	Charges for one Geologist- Field	day	1.2	11,000	120	1,320,000	
ii	Charges for one Geologist - HQ	day	1.2	9,000	50	450,000	
iii	2 labours/ party (Rs 504/day/labour) (As per rates of Central Labour Commissioner)	day	5.7	504	240	120,960	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
iv	Core Sampling -1 Samplers Labour charge not included	day	1.5.2	5,100	50	255,000	
v	4 labours/ party (Rs 504/day/labour) (As per rates of Central Labour Commissioner)	day	5.7	504	200	100,800	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
2	**Survey (on 1:2000 Scale)**						
i	Bore Hole Fixation and determination of co-ordinates & Reduced Level of the boreholes by DGPS and boundary coordinates	Per Point of observation	1.6.2	19,200	16	307,200	12 BHs and 4 boundary coordinates
ii	Charges of Surveyor	one surveyor per day	1.6.1a	8,300	75	622,500	Contouring and Mapping
iii	Labours Charges for survey work; Base rate - Rs.504	day	5.7	504	300	151,200	Amount will be reimburse as per the notified rates for unskilled labor by the Central Labour Commissioner or respective State Govt. whichever is higher
					Sub Total- A	**3,327,660**	
B	**DRILLING**						
i	Drilling upto 300m (Hard Rock) (1 rig)	m	2.2.1.4a	11,500	745	8,567,500	
ii	Borehole deviation Survey	m	2.2.6	330	-	-	
iii	Land / Crop Compansation	per BH	5.6	20,000	12	240,000	Amount will be reimburse as per actuals or max. Rs. 20000 per BH with certification from local authorities
iv	Construction of concrete Pillar (12"x12"x30")	per borehole	2.2.7a	2,000	12	24,000	
v	Transportation of Drill Rig & Truck associated per drill	Km	2.2.8	36	1,050	37,800	Certification in this regard is required to be provided
vi	Monthly Accomodation Charges for drilling Camp (up to 2 Rigs)	month	2.2.9	50,000	5	250,000	
vii	Drilling Camp Setting Cost	Nos	2.2.9a	250,000	1	250,000	
viii	Drilling Camp Winding up Cost	Nos	2.2.9b	250,000	1	250,000	
ix	Approach Road Making (Flat Terrain)	Km	2.2.10a	22,020	3	66,060	Road Making will be considered as per the requirement and Road Making Charges will be reimbursed later
x	Core Preservation: One complete borehole plus mineralised cores of all the remaining Bhs	m	5.3	1,590	380	604,200	This amount will be reimbursed after successful delivery of the cores to concerned libraries/authorities
					Sub Total- B	**10,289,560**	
C	**LABORATORY STUDIES**						
1	**Chemical Analysis**						
i	**Primary & Check samples for Maganese**						
	a. Primary Samples for 6 radical (Mn, SiO2, P2O5, Fe2O3, MnO2 and Insolubles)	Nos	4.1.7a + 7b	2,841	255	724,455	BH-180, Trench-75
	b-Internal (5%) Check samples for 6 radical (Mn, SiO2, P2O5, Fe2O3, MnO2 and Insolubles)	Nos	4.1.7a + 7b	2,841	13	36,223	
	c-External(10%) Check samples from NABL Lab for 6 radical (Mn, SiO2, P2O5, Fe2O3, MnO2 and Insolubles)	Nos	4.1.7a + 7b	2,841	26	72,446	
ii	**Primary & Check samples for Graphite**						
	a. Proximate Analysis for Graphite (Ash, Moisture, V.M. and F.C.) for Primary Samples	Nos	4.1.16	3,000	145	435,000	BH-120, Trench-25
	b Proximate Analysis for Graphite (Ash, Moisture, V.M. and F.C.) for Internal (5%) Check Samples	Nos	4.1.16	3,000	7	21,750	
	c Proximate Analysis for Graphite (Ash, Moisture, V.M. and F.C.) for External (10%) Check Samples NABL Lab	Nos	4.1.16	3,000	15	43,500	
iii	**Composite samples for Manganese**	Nos	4.1.7a + 7b	2,841	10	28,410	
iv	**Primary sample analysis for Cobalt**	Nos	4.1.7b	335	26	8,543	
v	**Composite samples for Graphite**	Nos	4.1.16	3,000	10	30,000	
vi	**Total Sulphur (S)**	Nos	4.2.14	1,900	10	19,000	
vii	**Primary sample analysis for Vanadium**	Nos	4.1.7b	335	15	4,858	
viii	**Carbon isotope analysis by Mass Spectrometer**	Nos	4.6.1	25,340	5	126,700	
ix	**Raman Spectroscopy**	Nos		25,340	5	126,700	Price not available in SoC, NMET. Will be reimbursed as per actual cost through outsourcing.
2	**Physical & Petrological Stusies**						
i	Preparation of thin section	Nos	4.3.1	2,353	5	11,765	
ii	Complete petrographic study report	Nos	4.3.4	4,232	5	21,160	
iii	Preparation of polished section	Nos	4.3.2	1,549	5	7,745	
iv	Complete mineragraphic study report	Nos	4.3.4	4,232	5	21,160	
v	Digital Photographs	Nos	4.3.7	280	5	1,400	
vii	Specific gravity studies	Nos	4.8.1	1,605	5	8,025	

S. No.	Item of Work	Unit	Rates as per NMET SoC 2020-21		Estimated Cost of the Proposal		Remarks
			SoC-Item -Sl No.	Rates as per SoC	Qty.	Amount (Rs)	
					Sub Total- C	**1,748,838**	
D					**Total A to C**	**15,366,058**	
E	**Geological Report Preparation**		**5.2**	For the projects having cost exceeding Rs. 150 lakhs and less than Rs. 300 lakhs - A minimum of Rs. 7.5 lakhs or 3% of the value of work whichever is more		**750,000**	Reimbursement will be made after submission of the final Geological Report in Hard Copies (5 Nos) and the soft copy to NMET.
F	**Peer review Charges**		**As per EC decision**			**30,000**	
G	**Preparation of Exploration Proposal (5 Hard copies with a soft copy)**	**5 Hard copies with a soft copy**	**5.1**	2% of the Cost or Rs. 5 Lakhs whichever is lower		**307,321**	EA has to submit the Hard Copies and the soft copy of the final proposal along with Maps and Plan as suggested by the TCC-NMET in its meeting while clearing the proposal.
H	**Total Estimated Cost without GST**					**16,453,379**	
I	**Provision for GST (18% of I)**					**2,961,608**	GST will be reimburse as per actual and as per notified prescribed rate
J	**Total Estimated Cost with GST**					**19,414,988**	***or Say Rs. 194.15 Lakh***
Note:							
1	If any part of the project is outsourced, the amount will be reimbursed as per the Paragraph 3 of NMET SoC and Item no. 6 of NMET SoC. In case of execusion of the project by NEA on its own, a Certifiate regarding non outsourcing of any component/project is required.						