

**PROPOSAL FOR RECONNOISSANCE SURVEY (G-4)
FOR GRAPHITE AND MANGANESE ORE IN
RENGALI GRAPHITE BLOCK
(INCLUDING EXPIRED LEASE HOLD AREA OF
M/S. B.K. AGARWAL AND M/S T. PRADHAN)
(9.41 SQ.KM AREA)
DISTRICT- BALANGIR, ODISHA**

COMMODITY: GRAPHITE AND MANGANESE

**BY
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SEMINARY HILLS**

PLACE: NAGPUR

DATE: 12th October 2020

Summary of the Block for Reconnaissance Survey (G-4)

GENERAL INFORMATION ABOUT THE BLOCK

Features	Details
Block ID	Rengali Graphite Block
Exploration Agency	Mineral Exploration Corporation Limited (MECL)
Commodity	Graphite and Manganese
Mineral Belt	Eastern Ghats Mobile Belt, Hassan District, Karnataka
Completion period with entire Time schedule to complete the project	14 Months
Objectives	The present exploration programme (G-4) has been formulated on the basis of previous regional data available, data provided by Directorate of Geology, Govt. of Odisha and the data collected by MECL team during the field visit to graphite mines/pits to fulfil the following objectives:- i) To carry out geological mapping on 1:12,500 scale and demarcate the rock types of graphite and manganese bearing formations with the structural features i.e. strike, dip, lineation / foliations etc. ii) To demarcate concealed graphite and manganese ore bodies by carrying out surface geophysical survey (Induced Polarization (I.P), Self Potential (S.P), Resistivity, Magnetic and Gravity). iii) To drill scout boreholes to prove the existence and establish persistence of graphite and manganese ore bodies over a promising strike length deciphered by geological mapping & geophysical studies. iv) To estimate reconnaissance category (334) graphite and manganese ore resources in the block as per UNFC norms & Minerals (Evidence of Mineral Contents) Rule- 2015.
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	Two no Geoscientist (1 Field + 1 HQ)
Expected Field days (Geology, Geophysics, Surveyor)	Geologist Party days: 120 days Survey Party days: 120 days

1. Location	The block proposed for exploration lies in the parts of Survey of India Toposheet No 64 P/01 and is bounded by latitude 20°48'28" to 20°49'59" and longitude 83°08'22" to 83°10'18" (Plate No I). The Rengali Graphite block is situated North of Patanagarh Town (Tehsil) at a distance of 15 km and 55 km from Balangir (district) Town (SH-42) towards NW direction. The area is connected by all weather pucca roads from Patanagarh Tehsil, Balangir district via Baaneimunda and Ghasian. The nearest railhead is Balangir.
Latitude	A 20° 48' 27.951" N B 20° 49' 59.193" N C 20° 49' 59.193" N D 20° 48' 27.951" N
Longitude	A 83° 10' 17.835" E B 83° 10' 17.835" E C 83° 08' 22.445" E D 83° 08' 22.445" E
Villages	Rengali, Ghasian, Larasambha, Baghamunda, Bagbahal, Khursel, Bandhamal, Debhuin, Gerda, Khuntasamalai, Gandamel, hormahul, Dandel, Ghumar, Dantarimunda, Gailpita, Dalapali, Gangarchhapar, Dhormahul, Daldali, Khuntapani, Baaneimunda, Patnagarh etc.
Tehsil/Taluk	Patnagarh
District	Balangir
State	Odisha
2. Area (hectares/ square kilometres)	
Block Area	9.41 sq.km
Forest Area	Non-Forest area.
Government Land Area (Bilanam)	Data not available
Charagaha	Data not available
Private Land Area	Data not available
3. Accessibility	
Nearest Rail Head	Balangir (285 km from Raipur and 315 Km from Bhubaneswar),
Road	Rengali village is about 15 Km north of Patnagarh town and 55 km north-west-north from Balangir.
Airport	Raipur (230 km)
4. Hydrography	
Local Surface Drainage Pattern (Channels)	The general slope of the country is towards east and the drainage is collected by easterly flowing nalla ultimately draining into Suktel River. The area has got dendritic pattern of drainage. The block area is surrounded by Non-forest and Agricultural lands. Rain-fed easterly flowing Suktel River in the northern part of the block.
Rivers/ Streams	Suktel River
5. Climate	
Mean Annual Rainfall	Average annual rainfall is 100 cm
Temperatures (December) (Minimum)	Minimum temperatures 10°C (Dec-Feb),
Temperatures (June)	Maximum temperatures up to 46°C (March-June)

	(Maximum)	
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 245m above MSL.	
7. Availability of baseline geoscience data		
Geological Map (1:50K/25K)	Geological map of block area from Bhukosh, Geological Survey of India (1:50,000 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	1. In order to establish the Graphite resource in Rengali area, Directorate of Geology, Odisha has requested to MECL to carry out the exploration in two lease hold areas namely (M/S BK Agarwal) and (M/S Trinath Pradhan) in Patnagarh Tahsil, Balangir district which are expired in 2016 & 2020. 2. Considering the proximity of both the graphite lease hold areas which were productive mines recently and presence of a few manganese ore bodies in the area (M/S BK Agarwal), MECL suggested to take up G-4 stage exploration for graphite as well as manganese in the area including both the pit in the lease hold area and adjoining areas. 3. Since most of the block area is covered with soil, geophysical survey (Self potential, (SP), Induced Polarization (IP), gravity, magnetic & resistivity survey) in the block will facilitate to demarcate the geophysical anomaly/mineralized zones of manganese/graphite, which will help in the formulation of G-4/G-2 level exploration programme. 4. The G-4 level exploration will be helpful in estimation of Reconnaissance (334) Resources and will help in planning G3/G2 level exploration programme which in turn will lead to estimation of indicated (332) category resources and will facilitate the State Govt. of Odisha for auctioning of blocks.	

PROPOSAL FOR RECONNOISSANCE SURVEY (G-4)
FOR GRAPHITE AND MANGANESE ORE
IN RENGALI GRAPHITE BLOCK
DISTRICT- BALANGIR, ODISHA

1.0.0 BLOCK SUMMARY:

1.1.0 Preamble:

- 1.1.1 Worldwide demand for combined natural and synthetic 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. Global demand for natural graphite has been forecasted to increase by 37% by 2020. 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. Battery demand for graphite is forecasted to double in the next six years.
- 1.1.2 Graphite, also known as plumbago or black lead or mineral carbon, is a stable form of naturally occurring carbon. Structurally, graphite is known to crystallise in hexagonal system and occurs in layered & lamellar form with grey-to-black metallic lustre and a greasy feel. Natural graphite is categorised into two commercial varieties (i) crystalline (flaky) graphite and (ii) amorphous graphite. Both flaky and amorphous varieties of graphite are produced in India. Besides natural graphite, there is synthetic or artificial graphite which is manufactured on a large-scale in electric furnaces, using anthracite or petroleum coke as raw feed.
- 1.1.3 As per NMI database, based on the UNFC system, the total reserves/resources of graphite as on 1.4.2015 have been placed at about 194.89 million tonnes, out of which 7.96 million tonnes are in the Reserves category and 186.92 million tonnes are placed under Remaining Resources category (IBM, Mineral year Book-2018). Resources containing +40% fixed carbon constitute about 2.91 million tonnes and resources analysing 10-40% fixed carbon constitute 40.65 million tonnes. The balance 151.31 million tonnes fall under 'Others', 'Unclassified' and 'Not-known' grades.
- 1.1.4 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 37% of the total resources which is

followed by Jammu & Kashmir (32%), Odisha (9.7%), Jharkhand (9%) and Tamil Nadu (4%). However, in terms of reserves, Jharkhand has the leading share of about (52%) followed by Tamil Nadu (42%) and Odisha (6%). 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.

- 1.1.5 In India the Manganese Ore deposits mainly occurs as metamorphosed bedded sedimentary deposits associated with Gondite Series (Archaean) of Madhya Pradesh (Balaghat, Chhindwara & Jabua districts), Maharashtra (Bhandara & Nagpur districts), Gujarat (Panchmahal district), Odisha (Sundargarh district) and Kodurite Series (Archaean) of Odisha (Ganjam & Koraput districts) and Andhra Pradesh (Srikakulam & Vishakhapatnam districts).
- 1.1.6 Odisha tops the total manganese reserves/resources with 44% share followed by Karnataka 22%, Madhya Pradesh 12%, Maharashtra & Goa 7% each, Andhra Pradesh 4% and Jharkhand 2%. Rajasthan, Gujarat, Telangana and West Bengal together shared the remaining about 2% resources. (IBM-Mineral Year Book-2018)
- 1.1.7 The Govt. of India enacted the MMDR Amendment Act, 2015 duly introducing the system of auction for allocation of Mineral Concessions. Bauxite, Iron Ore, Manganese and Limestone have been categorized in the Fourth Schedule which needs prospecting and exploration by the State Govt. before auctioning of Blocks
- 1.1.8 At the backdrop of enactment of the MMDR Amendment Act-2015, Minerals (Evidence of Mineral Contents) Rule 2015 and Mineral Auction Rule-2015, Ministry of Mines, Govt. of India has directed the State Governments to accelerate exploration for different mineral commodities in their respective states through NMET fund as to facilitate the State Government for auction of blocks.
- 1.1.9 In order to establish the Graphite resource in Rengali area surrounding the two expired lease areas namely 1. M/S B.K. Agarwal (Lease expired on 23.01.2019) and 2. M/S Trinath Pradhan (Lease expired on 10.04.2006) in Patanagarh Tehsil, Balangir district, Odisha state, Directorate of Geology, Govt. of Odisha has requested MECL to take up the exploration in Rengali Graphite mines of M/S B.K. Agarwal and M/S Trinath Pradhan during the meeting held on 02.08.2019 at Directorate of Mines, Bhubaneswar, Odisha. The minutes of meeting is provided by letter no. MXIII(b)25/2016/6850/DM, dated 04.09.2019.
- 1.1.10 Subsequently, MECL team visited and located both the leasehold areas/open cast pits on the basis of coordinate provided by Directorate of Geology, Govt. of Odisha. Both the graphite pits with small areas are close to each other. The area is almost soil covered with scanty exposures. Considering the closeness of these two small leasehold areas of both the existing mines/pits and lack of geological/mining

information, MECL prepared a proposal for single block for G-4 stage of exploration including both the leasehold areas/mines/pits and intervening/adjoining areas.

- 1.1.11 During the field visit, MECL team observed a manganese ore body in the pit of Rengali Graphite Block (M/S BK Agarwal). Hence, considering the vicinity of adjoining manganese bearing area, MECL suggest to carry out the exploration for manganese along with graphite in the block.

1.1.5 Background:

In order to establish the Graphite resource in Rengali area Directorate of Geology, Govt. of Odisha has requested MECL to carry out the exploration and provided the area details vide Memo no. 8684, dated, 01.11.2019. Subsequently, MECL team visited in the area and suggested for G-4 level of exploration due lack of geological/mining information. During the field visit, MECL team observed a manganese ore body in the pit of Rengali Graphite Block. Hence, considering the vicinity of adjoining manganese bearing area, MECL suggest to carry out the exploration for manganese along with graphite in the block.

1.1.6 Location and Accessibility:

The block proposed for exploration lies in the parts of Survey of India Toposheet No 64 P/01 and is bounded by latitude 20°48'28" to 20°49'59" and longitude 83°08'22" to 83°10'18" (Plate No I). The Rengali Graphite block is situated North of Patanagarh Town (Tehsil) at a distance of 15 km and 52 km from Balangir (district) Town (SH-42) towards NW direction. The area is connected by all weather pucca road from Patanagarh Tehsil, Balangir district via Baaneimunda and Ghasian. The nearest railhead is Balangir.

1.1.7 Physiography, Drainage and Vegetation:

The area is almost flat terrain and covered with agriculture land with scanty rock exposures. The rocks are mainly exposed in water logged graphite pits / abandoned mines. The average height of the area is 245m 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 has helped extreme cultivation in the area.

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

The areas under exploration are sparse to densely vegetated in some part of the proposed block. 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 rabbits, snakes, jackals, peacocks, wild hens and host of birds.

1.8.0 Previous Work

- 1.8.1 GSI carried out investigation for manganese in the surrounding area of the block and reported various occurrences of manganese ore as well as graphite. 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 ore 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.
- 1.8.2 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% SiO₂ and 0.12-0.48% P.
- 1.8.3 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.
- 1.8.4 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.
- 1.8.5 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 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.

- 1.8.6 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 $20^{\circ} 44'$ to $20^{\circ} 55'N$ and longitude $83^{\circ} 15'$ to $83^{\circ} 21'E$ and delineated four major ore zones.
- 1.8.7 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 (G3 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.

1.9.0 Regional Geology

- 1.9.1 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.
- 1.9.2 On the basis of contact relationship, presence of xenoliths/caught up patches of one particular unit within the other, and structural and stratigraphical relationship the tentative stratigraphic succession of the area 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		

1.9.3 Description of various rock formations in the Area:

The block area is almost entirely covered with thick alluvium accumulated due to the Suktel River. The rock types exposed in the area are graphite bearing khondalite, calc-silicate and manganiferous khondalite (Mn ore body). Description of different litho unite is given below.

Soil: The block area is mainly covered with thick alluvial soil transported by Suktel River. Soil occurs as loose cover over parent rocks with varying depth and is fine to medium grained, earthy to reddish brown, clayey at places.

Khondalite: It is schistose / gneissose rock exposed in graphite pit / abandoned mines mainly composed of quartz, feldspar, garnet, sillimanite in decreasing order of abundance with or without graphite. This is coarse grained, brownish yellow to reddish grey coloured, foliated and highly weathered rock. The rock is graphite rich and manganiferous (Mn ore body).

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.

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

Quartzite: The quartzite is medium to coarse grained, white to buff coloured, granular to faintly schistose in nature and is invariably garnetiferous. Pegmatite and quartz veins traverse the rock along foliation planes.

Calc-silicate rocks: The rock exposed in river section 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.

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.

1.9.4 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 easterly to south-easterly 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:** Altogether, two sets of joints are observed in the surrounding area. These are E-W dipping 70° to 80° to south and N 65° E-S 65° W dipping 60° - 80° to southeast.
- 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.

1.9.5 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.

1.9.6 Mineralization

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.

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. These are lateritic and have been weathered to a considerable depth along with the enclosing rocks. The manganese mineralisation is both lithologically and structurally controlled.

1.10.0 Scope of Proposed Exploration

- 1.10.1 The Reconnaissance survey at G-4 stage exploration program proposed comprises, Geological mapping(1:12,500 scale), Drilling of 5 Nos of scout boreholes involving about 800m drilling with associated survey, chemical analysis, physical analysis and geological report preparation.

1.11.0 Observation and Recommendations of previous work

- 1.11.1 There are two lease hold areas namely (M/S BK Agarwal) and (M/S Trinath Pradhan) in Patanagarh Tahsil, Balangir district which are expired in 2020. Considering the proximity of both the graphite lease hold areas which were productive mines recently and presence of a few manganese ore bodies in the area (M/S BK Agarwal), MECL suggested to take up G-4 stage exploration for graphite as well as manganese in the area including both the pit in the lease hold area and adjoining areas.

2.0.0 Previous Work / Background information

- 2.0.1 The background information and previous works have been described in para 1.1.5 and 1.8.0 respectively. On the basis of presence of abandoned mining pit and a very few geological information, the block has been proposed for G-4 level of exploration.

3.0.0 Block description

- 3.0.1 The block proposed for exploration lies in the parts of Survey of India Toposheet No 64 P/01 and is bounded by latitude 20°48'28" to 20°49'59" and longitude 83°08'22" to 83°10'18" (Plate No I). The coordinate of cardinal points of block boundary are as follows:

CARDINAL POINT	WGS 84		UTM	
	longitude	latitude	Easting	Northing
A	83° 10' 17.835" E	20° 48' 27.951" N	722685.190	2305201.160
B	83° 10' 17.835" E	20° 49' 59.193" N	725984.590	2305201.160
C	83° 08' 22.445" E	20° 49' 59.193" N	725984.590	2302350.060
D	83° 08' 22.445" E	20° 48' 27.951" N	722685.190	2302350.060

3.0.0. Proposed programme for Exploration (G-4 Stage)

- 3.0.1 The present exploration programme (G-4) has been formulated on the basis of previous regional data available and the data collected by MECL team during the field visit to graphite mines/pits to fulfil the following objectives:-

3.1.0 Objective of the proposed Reconnaissance Survey (G4):

- i) To carry out geological mapping on 1:12,500 scale and demarcate the rock types of graphite and manganese bearing formations with the structural features i.e. strike, dip, lineation / foliations etc.
- ii) To carry out surface geophysical survey (Induced Polarization (I.P), Self Potential (S.P), Resistivity, Magnetic and Gravity) to demarcate concealed graphite and manganese ore bodies.
- iii) To drill scout boreholes to prove the existence and establish persistence of graphite and manganese ore bodies over a promising strike length deciphered by geophysical studies.
- iv) To estimate reconnaissance category (334) graphite and manganese ore resources in the block as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2015.

5.0.0 Planned Methodology

5.1.0 In accordance to the objective set for reconnaissance survey (G-4) 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 1:12,500 scale. The reduced levels and co-ordinates of boreholes, pits and trenches would be determined.

5.3.0 Geological Mapping

5.3.1 Large scale geological mapping on 1:12,500 scale will be carried out in the entire block by taking geological traverses. The contacts of different formations, identification of different lithological units, structural features, etc., will be carried out in detail. The geophysical survey data could help in updating of map. The geological map on 1:12,500 scale will be generated based on the detail geological mapping of the block and interpretation of exploration data.

4.4.0 Channel Sampling:

4.4.1 During the exploration, approximate trenching work will be carried out by cutting trenches of 1m width and 2 m depth directly on the fresh outcrop/rock exposures across the Mn ore body involving 200 cubic meter excavation. The channel of 5cm x 2cm dimension will be cut on the floor of the trenches to collect the channel

samples. The length of each channel sample will be kept as 0.50m uniformly in the same type of lithology, whereas, the length of the sample may be adjusted with variation/change in lithology. The length of channel sample may not exceed 1.00 m in any case. The representative powdered samples of (-) 200 # size will be obtained by stage wise grinding of the chips collected from the channels and by reducing the weight of sample by repeated coning and quartering. A final finished sample of 500 gram (- 200 mesh) will thus be prepared. One part around 100gm sample will be sent to chemical laboratory for analysis, second part will be preserved in the camp as duplicate sample, the third part will be utilized for preparing composite sample for individual ore band and the fourth part will be kept as either check sample or sample to be used for any other specific purpose. Thus total 200 no of primary channel samples will be generated. 5% of Primary channel samples (10 no samples) will be analyzed as internal check samples. Around 10% of primary samples (20 no samples) will be analyzed as external check samples from any NABL accredited External Laboratory. A total of 100 no of primary, 5 no of internal check and 10 no of external check channel samples will be analyzed for graphite mineralization i.e. Fixed Carbon (FC: Non-carbonate), Ash (A), Moisture (M) and Volatile Matter (VM). Similarly, 100 no of primary, 5 no of internal check and 10 no of external check channel samples will be analyzed for manganese mineralization i.e. Mn, SiO₂, P₂O₅, Fe₂O₃, MnO₂ and Acid Insolubles.

- 4.4.2 Mineralized zones will be delineated at cut off grade based on the chemical results of primary channel samples. Composite samples would be prepared from the mineralized zones of primary channel samples for each channel. It is expected that 20 Nos. of composite sample would be generated. Out of which 10 will be analyzed for graphite mineralization (FC: Non-carbonate, Ash, Moisture and VM) and 10 for manganese mineralization (Mn, SiO₂, P₂O₅, Fe₂O₃, MnO₂ and Acid Insolubles).

5.5.0 Geophysical Survey

- 5.5.1 The proposed area consists of a sequence of para-metamorphics made up of pelitic, psammitic and calcareous formation, which were represented by khondalite, quartzite and calc-Silicate rocks. The rock types in the area are khondalite, granite gneiss, granulite, quartzite, calc-silicate, quartz vein. Graphite as well as manganese mineralisation is restricted to Khondalite Suite and its migmatized equivalents.

- 5.5.2 The Physical properties of Graphite are given in table:

S.No	Property	Value
1	Bulk Density (g/cm ³)	1.3-1.95
2	Porosity (%)	0.7-53
3	Modulus of Elasticity (GPa)	8-15
4	Compressive strength (MPa)	20-200
5	Thermal conductivity (W/m.K)	25-470
6	Electrical resistivity (Ω.m)	5x10 ⁻⁶ -30x10 ⁻⁶

5.5.3 Physical properties of Manganese ore and expected host rocks are given in table below.

Ore/ rock	Chemical composition	Mn content	Density (g/cc)	Magnetic Susceptibility. 0-CGS
Pyrolusite	MnO ₂	63%	4.70-5.00	Paramagnetic
Psilomelane	MnOMn ₂ OH ₂ O		3.70-4.70	
Braunite	Mn ₂ O ₃ Mn ₆ O ₂	64.3%	4.75-4.82	
Rhodonite	MnSiO ₃	41.8%	3.40-3.6	Paramagnetic
Rhodochrosite	MnCO ₃	47.8%	3.40-3.60	100
Jacobsite	MnFe ₂ O ₄		4.95	200-300
Quartz	SiO ₂		2.6-2.8	.00063
Mica	K(Mg,Fe) ₃ AlSi ₃ O ₁₀ (F,OH) ₂ / KAl ₂ (F,OH) ₂		2.15	

5.5.4 Based on the above physical properties of the graphite in typical geological settings the variation in Resistivity, Conductivity and Self potential are very high. Density of the Graphite deposit varies significantly in order of magnitude.

5.5.5 In addition to above the resistivity contrast between Manganese ore and host rocks is also remarkable, based on the above physical properties of the manganese ores and its host rocks in typical geological settings.

5.5.6 On the basis of above properties, Integrated Geophysical Surveys i.e., Induced Polarization (I.P), Self Potential (S.P), Resistivity, Magnetic and Gravity have been planned to carry out in proposed area. The survey has been planned in a grid pattern of 25mx 200m for Gravity Survey and that of 20m x 100m with 90.00 Lkm for I.P, S.P, Resistivity and Magnetic Surveys. The profiles will be laid along East West direction which is almost perpendicular to the strike direction. A total of 1900 stations of Gravity and 90.00 Lkm of I.P, S.P, Resistivity and Magnetic Surveys each will be covered in the block. The Approximate time period to conduct the survey will be around 4 months.

5.6.0 Exploratory Drilling:

5.6.1 Based on the outcome of geological mapping, analytical results of surface channel samples and delineation of graphite and manganese ore zones on the basis of surface geophysical survey by using Induced Polarization (I.P), Self Potential (S.P), Resistivity, Magnetic and Gravity methods, approximately 500.00 m of drilling in 5 scout boreholes will be carried out for intersection of mineralised zones in the block covering the lease hold area of M/S B.K. Agarwal) and M/S Trinath Pradhan.

5.7.0 Core Logging

- 5.7.1 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.

5.8.0 Core Sampling

- 5.8.1 The mineralized (graphite & manganese) part of drill core will be sampled as Primary sample. The length of each sample will be kept 0.50m within the ore zone depending upon the thickness of particular type of manganese ore & graphite and its physical character. 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 radicals). The primary core samples for manganese mineralisation will be analysed for 6 radicals' i.e. Mn, SiO₂, P₂O₅, Fe₂O₃, MnO₂ and Insolubles. 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) Around 230 no of core samples (200 No **Primary** & 30 No **Check samples**) shall be generated from the mineralized zones to be intersected in the boreholes of **Rengali Graphite Block**. A total of 100 no of primary core samples will be analyzed for graphite mineralization (FC: Non-carbonate, Ash, Moisture and VM) and 100 no of primary core samples for manganese mineralization (Mn, SiO₂, P₂O₅, Fe₂O₃, MnO₂ and Acid Insolubles).
 - b) Around 5% (5 no samples each for Graphite and Manganese)samples will be analyzed in Chemical Laboratory of MECL as Internal check samples and 10% of Primary samples (10 no samples each for Graphite and Manganese) will be sent to NABL External Labs for analysis of graphite mineralization graphite mineralization (FC: Non-carbonate, Ash, Moisture and VM) and/or for manganese mineralization (Mn, SiO₂, P₂O₅, Fe₂O₃, MnO₂ and Acid Insolubles) as external check samples.
 - c) Composite samples would be prepared from the mineralized zones of primary drill core samples of each borehole as well as from the mineralized zones demarcated in the channels. A total of 10 nos. of composite samples each for Graphite and Manganese would be generated from drill cores and be analyzed for graphite mineralization (FC: Non-carbonate, Ash, Moisture and VM) and/or for manganese mineralization (Mn, SiO₂, P₂O₅, Fe₂O₃, MnO₂ and Acid Insolubles).
 - d) A total of 10 nos composite samples would be analyzed by X-ray diffraction to ascertain the presence of different mineral phases.
 - e) A total of 10 nos composite samples would be analyzed by ICP-MS method to ascertain the presence of 34 no trace elements associated with the Manganese deposit i.e. Cu, Pb, Zn, Cd, Sn, W, Sb, Ce, Nb, Ba, La, Bi, Co, Ni, Sr, Mo, V, Ta, Ag, Zr, Ga etc.

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 10 specimens for petrographic and 10 specimens for mineragraphic studies has been kept in the block.

5.9.0 Specific Gravity Determination

5.9.1 To derive the tonnage factors, 20 nos. of samples are proposed to be subjected for specific gravity determination. The samples are to be drawn from ore zones/mineralised zones of both graphite and manganese.

5.10.0 Quantum of work:

5.10.1 The quantum of work proposed by MECL in Rengali Graphite Block (G-4 Stage of Exploration) is given in Table 5.1.

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

Sl. No.	Item of Work	Unit	Proposed Quantum of work
1	Geological Mapping (on 1:4000 Scale).	Sq. Km.	9.41
2	Geophysical Work		
	i) Gravity Survey	No of Station	1900
	ii) Induced Polarization (I.P), Self Potential (S.P), Resistivity Survey and Magnetic Survey	Line Km	90.00
3	Trenching (1m x 2m x100m)	Cu. m	200
4	Core Drilling (5 to 6 Scout Boreholes)	m.	500.00
5	Sample Preparation & Chemical Analysis		
A.	Primary samples for Graphite (Core + Channel Samples)		
	A) Proximate Analysis of Primary samples for Graphite i) for 4 radicals i.e. Fixed Carbon (FC), Ash (A), Moisture (M) and Volatile Matter (VM)	Nos.	(100+100)=200
	B) Internal Check samples (5% of Primary samples) for Graphite i) for 4 radicals i.e. Fixed Carbon (FC), Ash (A), Moisture (M) and Volatile Matter (VM)	Nos.	(5+5)=10
	C) External Check sample (10 % of Primary samples) for Graphite ii) for 4 radicals i.e. Fixed Carbon (FC), Ash (A), Moisture (M) and Volatile Matter (VM)	Nos.	(10+10)=20

Sl. No.	Item of Work	Unit	Proposed Quantum of work
B.	Primary samples for Manganese (Core + Channel Samples)		
	i) Primary samples for 6 radicals i.e. Mn, SiO ₂ , P ₂ O ₅ , Fe ₂ O ₃ , MnO ₂ and Insolubles	Nos.	(100+100)=200
	iii) Internal Check samples (5% of Primary samples) for 6 radicals i.e. Mn, SiO ₂ , P ₂ O ₅ , Fe ₂ O ₃ , MnO ₂ and Insolubles	Nos.	(5+5)=10
	iv) External Check sample (10 % of Primary samples) for 6 radicals i.e. Mn, SiO ₂ , P ₂ O ₅ , Fe ₂ O ₃ , MnO ₂ and Insolubles	Nos.	(10+10)=20
C.	Composite samples for Graphite (Core + Channel Samples)	Nos.	(10+10)=20
	i) for 4 radicals i.e. Fixed Carbon (FC), Ash (A), Moisture (M) and Volatile Matter (VM)		
	ii) Total Sulphur	Nos.	(10+10)=20
D.	Composite samples for Manganese (Core + Channel Samples)	Nos.	(10+10)=20
	i) for 6 radicals i.e. Mn, SiO ₂ , P ₂ O ₅ , Fe ₂ O ₃ , MnO ₂ and Acid Insolubles		
6	Trace Element Study by ICP-MS Method (34 Elements)	Nos	10
7	XRD study	Nos	10
8	Petrographic Studies	Nos	10
9	Mineragraphic Studies	Nos	10
10	Specific Gravity Determinations	Nos	20
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 reconnaissance survey (G-4). The work activities like camp setting, survey and associated geological work, geophysical studies, drilling & laboratory work will be completed within 10 months' time. Report writing (including peer review) will take another 4 months' time with overlapping of two month's laboratory studies. Thus the total duration of the project shall be 12 months from the date of commencement of the project. The bar chart showing activities wise time schedule is placed at Table-7.1.

7.2.0 The Project cost with provisional escalation is estimated at **Rs. 411.30 (Say)**. The details of item wise cost estimate with inbuilt actual escalation as on 31.3.17 and same

has been considered for subsequent years for geological and laboratory studies and is given in Table No. 7.2 and the summary is given below:

Summary of Cost Estimates

Sl. No.	Item	Total Estimated Cost (Rs.) G-4 Level
1	Geological Work	28,33,000
2	Geophysical Work	2,14,22,237
3	Pitting and Trenching	6,60,000
3	Drilling	69,85,500
4	Laboratory studies	17,71,320
5	Drill Core Preservation	1,59,000
6	Report Preparation	10,14,932
7	Peer Review	10,000
8	Subtotal (1-5)	3,48,55,989
9	GST-18%	62,74,078
	Total	4,11,30,067
	Say	411.30 Lakhs

8.0.0 Justification:

- 8.0.1 In order to establish the Graphite resource in Rengali area, Directorate of Geology, Odisha has requested to MECL to carry out the exploration in two lease hold areas namely (M/S BK Agarwal) and (M/S Trinath Pradhan) in Patanagarh Tehsil, Balangir district which are expired in 1016/2020.
- 8.0.2 Considering the proximity of both the graphite lease hold areas which were productive mines recently and presence of a few manganese ore bodies in the area (M/S BK Agarwal), MECL suggested to take up G-4 stage exploration for graphite as well as manganese in the area including both the pit in the lease hold area and adjoining areas.
- 8.0.3 Since most of the block area is covered with soil, geophysical survey (Self potential, (SP), Induced Polarization (IP), gravity, magnetic & resistivity survey) in the block will facilitate to demarcate the geophysical anomaly/mineralized zones of manganese/graphite, which will help in the formulation of G-3/G-2 level exploration programme.
- 8.0.4 The G-4 level exploration will be helpful in estimation of Reconnaissance (334) Resources and will help in planning G3/G2 level exploration programme which in turn will lead to estimation of indicated (332) category resources and will facilitate the State Govt. of Odisha for auctioning of blocks.

9.0.0 References:

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List of Plates:

1. Plate-I: Block Location Map of Rengali Graphite Block in Toposheet no. 64P/01, Balangir District, Odisha State.
2. Plate-II: Regional Geological Map of the area (Scale 1: 25,000).
3. Plate-III: Geological Map of the block (Scale 1: 5,000).

Cost Estimate for Reconnaissance Survey (G4) of Graphite and Manganese Ore in Rengali Graphite Block, Distt. Balangir Odisha
 Total Area - 9.41 sq km; Nos. of Borehole - 5; Borehole depth range - 100m avg; Completion Time - 12 Months

S.N	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	Year 2020-2021		Year 2021-2022		Total		
					Qty.	Amount (Rs)	Qty.	Amount (Rs)	Qty.	Amount (Rs)	
A GEOLOGICAL WORK											
1	Bore Hole Fixation and determination of co-ordinates & Reduced Level of the boreholes by DGPS	Nos	1.6.2	19,200	-	-	5	96,000	5	96,000	
2a	Geologist Party days (1 party)-Field	day	1.2	11,000	-	-	130	1,430,000	130	1,430,000	
2b	Geologist Party days (1 party)-HQ	day	1.2	9,000	-	-	60	540,000	60	540,000	
2c	4 labours/ party (Rs 350/day/labour) (As per rates of Central Labour Commissioner)	day	5.7	1,400	-	-	130	182,000	130	182,000	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
3a	Core Sampling -1 Samplers Labour charge not included	day	1.5.2	5,100	-	-	90	459,000	90	459,000	
3b	4 labours/ party (Rs 350/day/labour) (As per rates of Central Labour Commissioner)	day	5.7	1,400	-	-	90	126,000	90	126,000	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
Sub-Total A							2,833,000		2,833,000		
B GEOPHYSICAL SURVEY											
1	Gravity Survey	Nos	3.1a	3,800	900	3,420,000	1,000	3,800,000	1,900	7,220,000	
2	IP, SP, Resistivity and Magnetic Survey	Line Km	3.4b	144,869	40	5,794,772	50	7,243,465	90	13,038,237	
3	Surveyor Work	days	1.6.1a	8,300	60	498,000	60	498,000	120	996,000	
4	4 labours/ party (Rs 350/day/labour) (As per rates of Central Labour Commissioner)	day	5.7	1,400	60	84,000	60	84,000	120	168,000	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
Sub-Total B					9,796,772		11,625,465		21,422,237		
C FITTING AND TRENCHING											
1	Trenching (1m x 2mx 150 m)	Cu m	2.1.1	3300	-	-	200	660,000	200	660000	
Sub-Total C							660,000		660,000		
D DRILLING											
1	Drilling (1 rigs)	m	2.2.1.4a	11,500	-	-	500	5,750,000	500	5,750,000	
2	Borehole deviation Survey	m	2.2.6	330	-	-	500	165,000	500	165,000	
3	Land / Crop Compansation	per BH	5.6	20,000	-	-	5	100,000	5	100,000	Amount will be reimburse as per actuals or max. Rs. 20000 per BH with certification from local authorities
4	Construction of concrete Pillar (12"x12"x30")	per borehole	2.2.7a	2,000	-	-	5	10,000	5	10,000	
5	Transportation of Drill Rig & Truck associated per drill	Km	2.2.8	36	-	-	1,400	50,400	1,400	50,400	
6	Monthly Accomodation Charges for drilling Camp (up to 2 Rigs)	month	2.2.9	50,000	-	-	6	300,000	6	300,000	
8	Drilling Camp Setting Cost	Nos	2.2.9a	250,000	-	-	1	250,000	1	250,000	
9	Drilling Camp Winding up Cost	Nos	2.2.9b	250,000	-	-	1	250,000	1	250,000	
10	Road Making (Flat Terrain)	Km	2.2.10a	22,020	-	-	5	110,100	5	110,100	Road Making will be considered as per the requirement and Road Making Charges will be reimbursed accordingly.
Sub Total D							6,985,500		6,985,500		
E LABORATORY STUDIES											
1 Chemical Analysis											
i) 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	-	-	200	600,000	200	600,000	
b	Proximate Analysis for Graphite (Ash, Moisture, V.M. and F.C.) for Internal (5%) and External (10%) Check Samples NABL Lab	Nos	4.1.16	3,000	-	-	30	90,000	30	90,000	
ii) 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	-	-	200	568,200	200	568,200	
b.	Internal (5%) and External(10%) Check samples from NABL Lab for 6 radical (Mn, SiO2, P2O5, Fe2O3, MnO2 and Insolubles)	Nos	4.1.7a + 7b	2,841	-	-	30	85,230	30	85,230	
iii) Composite Samples											
a.	Proximate Analysis for Graphite (Ash, Moisture, V.M. and F.C.)	Nos	4.1.16	3,000	-	-	20	60,000	20	60,000	
b.	Total Sulphur (S)	Nos	4.1.14	1,900	-	-	20	38,000	20	38,000	
c.	6 radical (Mn, SiO2, P2O5, Fe2O3, MnO2 and Insolubles)	Nos	4.1.7a + 7b	2,841	-	-	20	56,820	20	56,820	
2 Physical & Petrological Studies											
i)	X-RD Studies on composite	Nos	4.5.1	4,000	-	-	10	40,000	10	40,000	
ii)	ICP-MS studies (21 Trace elements- Cu, Pb, Zn, Cd, Sn, W, Sb, Ce, Nb, Ba, La, Bi, Co, Ni, Sr, Mo, V, Ta, Ag, Zr & Ga)	Nos	4.1.14	7,731	-	-	10	77,310	10	77,310	
iii)	Preparation of thin section	Nos	4.3.1	2,353	-	-	10	23,530	10	23,530	
iv)	Complete petrographic study report	Nos	4.3.4	4,232	-	-	10	42,320	10	42,320	
v)	Preparation of polished section	Nos	4.3.2	1,549	-	-	10	15,490	10	15,490	

S.N	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	Year 2020-2021		Year 2021-2022		Total		
					Qty.	Amount (Rs)	Qty.	Amount (Rs)	Qty.	Amount (Rs)	
vi)	Complete mineragraphic study report	Nos	4.3.4	4,232	-	-	10	42,320	10	42,320	
vii)	Specific Gravity determination	Nos	4.8.1	1,605	-	-	20	32,100	20	32,100	
	Sub-Total -E					-		1,771,320		1,771,320	
F	Drill Core Preservation										
	One complete borehole plus mineralised cores of all the remaining Bhs	m	5.3	1,590	-	-	100	159,000	100	159,000	
	Sub-Total - F					-		159,000		159,000	
G	Total - A to F					9,796,772		24,034,285		33,831,057	
H	Geological Report Preparation		5.2	For the projects having cost more than Rs. 300 lakhs - A minimum of Rs. 9 lakhs or 3% of the value of work		-		1,014,932		1,014,932	
I	Peer review Charges		As per EC decision			-		10,000		10,000	
J	Total Estimated Cost without GST					9,796,772		25,059,217		34,855,989	
K	Provision for GST (18% of J)	%				1,763,419		4,510,659		6,274,078	GST will be reimburse as per actual and as per notified prescribed rate
L	Total Estimated Cost with GST					11,560,191		29,569,876		41,130,067	
or Say Rs. 411.30 Lakhs											
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 execution of the project by NEA on its own, a Certificate regarding non outsourcing of any component/project is required.											
2. Rates are calculated as per NMET SOC issued on 31st March 2020 without escalation. Although billing for subsequent financial years will be done as per the actual escalations as per RBI Indices											

TABLE- 7.1 TIME SCHEDULE / ACTION PLAN FOR EXPLORATION PROPOSAL FOR GRAPHITE & MANGANESE ORE IN RENGALI (G-4) BLOCK, DISTRICT - BALANGIR, ODISHA													
		1	2	3	4	5	6	7	8	9	10	11	12
1	Camp Setting	Month											1 month
2	Geophysical Work	Month											
	a. Gravity Survey	Stn											1900 Stations
	b. IP, SP, Resistivity and Magnetic Survey	L.Km											90 L.km
3	Survey Party days (1 Party)	Party days											120 Days
4	Geophysical Report	Month											2 month
5	Pitting Trenching (5 Pit & 7 Trenches)	Cu.m											300 Cu m
6	Surface Drilling (1 rig)	m.											400m In 5 Bhs
7	Geologist Party days (1Party)	Party days											120 Days
8	Core Sampling	Party days											90 Days
9	Camp Winding	Months											1 month
10	Laboratory Studies	Months											310 Nos
11	Geologist Party days, HQ (1Party)	Party days											60 Days
12	Report Writing with Peer Review	Months											4 months