PROPOSAL FOR NARINGAPANGA BLOCK, RAYAGADA DISTRICT, ODISHA STATE FOR G-3 STAGE FOR MINERAL EXPLORATION UNDER NMET

(Industrial: Graphite)

By

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Place: Bhubaneswar
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Summary of Narigapanga Graphite Block for G-3 Level Exploration

Sl. No.	Features	Details
	Block ID	Naringapanga (West & South) Graphite Block
	Current Exploration Agency	**Directorate of Geology, Odisha** for G-3
	Previous Exploration Agency	Directorate of Geology, Odisha
	Previous stage Geological Report	G-4 level GR of DG (O) attached in Annexure-I.
	Commodity	**Graphite**
	Mineral Belt	Eastern Ghats Mobile Belt, Rayagada District, Odisha
	Completion Period with entire Time schedule to complete the project	**9 months**
	Objectives	The present Preliminary exploration (G-3) in the South & West block of Narigapanga Block has been formulated on the basis of the findings of the previous General exploration (G-2) around east & north of the present block to fulfill the following objectives:- To explore the Naringapanga South & West Graphite Block in detail to bring it to G-3 level for auction by State Govt. Details are given below: i) Detailed Geological Mapping (1:2000 scale) and validation of Geological Map (1:2000) demarcate the rock types of Graphite bearing formations with the structural features i.e. strike, dip, lineation / foliation, folds, shears etc. ii) Survey (50x50m) iii) Geophysical (Self potential Survey):720 points iv) To drill boreholes in the 50 to 100 m strike/section interval and to probe depth continuity up to 60m vertical depth from the surface to examine its potentiality for further upgradation to G-2. iv) To estimate Graphite Resources (333) in the block as per UNFC norms & Minerals (Evidence of Mineral. Contents) Rules- 2015.
	Whether the work will be carried out by the proposed agency or throughout sourcing and details thereof. Components to be out sourced and name of the	Survey and Drilling work will be carried out through Outsourcing Agency. The outsourcing agency will be finalized through open tender consequent upon approval of TCC.

	outsource agency	
	Name/Number of Geoscientists	3 Geoscientists
	Expected Field days (Geology, Geophysics, Surveyor)	Geologist Party days: 150 days Geophysical Party days: 20 days Survey Party days: 25 days
1.	**Location**	**South & West of Narigapanga Block**
	Latitude	19º 43' 17.207"N to 19º 43' 34.151"N
	Longitude	83º 33' 2.146"N to 83º 33' 23.651"E
	Villages	Naringapanga
	Tehsil/Taluk	Muniguda
	District	Rayagada
	State	Odisha
2.	**Area(hectares/square kilometres)**	
	Block Area	14.316 Ha or 0.143 Sq km
	Forest Area	Land schedule data under collection.
	Government Land Area	
	Private Land Area	
3.	**Accessibility**	
	Nearest Rail Head	Muniguda on East Coast Railway is at 20 km from Naringapanga.
	Road	The distance from the district headquarter Rayagada is about 64km.
	Airport	Visakhapatnam, the nearest port is at 260 km.
4.	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	The drainage system of the area is controlled by Barha Nala flowing from the NW to SE with large meanders and it ephemeral steramlets flowing through the area.
	Rivers/Streams	Barha Nala
5.	**Climate**	
	Mean Annual Rainfall	1288 mm
	Temperatures (December) (Minimum) Temperatures (May)(Maximum)	December:7^0C to 8^0C May: 46^0C
6.	**Topography**	
	Toposheet Number	E44F10 (65M/10)
	Morphology of the Area	The area in general represents a plain country with minor undulations. The eastern and western parts of the terrain are occupied by small hillocks.
7.	**Availability of baseline geoscience data**	
	Geological Map (1:50K/25K)	Available Geological Map 1:2000 scale
	Geochemical Map	Not Available

	Litho-structural Map	Satellite Imagery interpreted Map
8.	**Justification for taking up G3 stage mineral exploration**	Amendment of MM (D & R) Act and enactment of MA Rules, thrust is given to prepare auctionable mineral blocks at different levels of exploration. Accordingly DoMG, Odisha contemplates to upgrade the known mineral occurrence to higher level. DG (O) has already proved the existence of Mineral Content i.e. Graphite in Naringapanga block through G-2 level. An indicated resource of 0.142 million tonnes of average Graphite having 4.047 % was estimated through drilling at G-2 level for 5.49 Ha and the block has been auctioned. Considering the resource and infrastructure facilities of the Auctioned Block, DoMG, Odisha proposes to take up ore resource estimation at G-3 level of exploration in West & South of Narigapanga block, which will be later upgraded to G-2 level based on the current result.

PROPOSAL FOR WEST & SOUTH OF NARIGAPANGA BLOCK, RAYAGADA DISTRICT, ODISHA STATEFOR G-3 STAGE MINERAL EXPLORATION UNDER NMET

1. Introduction

India is a major global producer of flake graphite. The country has been ranked amongst the top five graphite producers by the USGS (United States Geological Survey). Graphite occurrences are reported from different states including Jammu and Kashmir, Arunachal Pradesh, Gujarat, Jharkhand, Maharashtra, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, Chattisgarh and Rajasthan. However, the deposits of economic importance are located in Andhra Pradesh, Chattisgarh and Arunachal Pradesh, which are yet to be exploited. As far as mining and processing of graphite is concerned, Jharkhand, Odisha and Tamil Nadu are the only states where operations are being conducted.

Advent of graphene technology is a boon to the graphite industry. The worldwide as well as in the country, demand for graphite is increasing with the development of non-carbon energy applications such as batteries used in electric vehicles, electric devices and energy storage devices that use graphite. To fulfil demand and to keep a balance between demand and supply, it is essential to develop the resources of graphite in country.

In view of the auction policy of the Government and demand of graphite in the domestic industries, emphasis for assessment of graphite at G-2 level was given by the Directorate of Geology, Odisha. Directorate of Mines & Geology targeted to upscale the exploration status of the earlier reported graphite occurrences. Narigapanga Block forms a part of earlier PL area of M/s T. P. Minerals which was held under Section 10 A (2) (b) of MM (D&R) Act, 1957 which was subsequently withdrawn. After withdrawal, Narigapanga Block has been explored by Directorate of Geology, Odisha and auctioned at G-2 level. So, DoMG prepared a proposal for Preliminary exploration (G-3) in west & south of Auctioned Narigapanga Block, Rayagada District for approval of NMET funding.

1.0 Physiography & Drainage:

The area under report is a plain country with minor undulations. The eastern and western parts of the terrain are occupied by small hillocks and traversed by gullies & nalas. The minimum elevation of the area is about 328 m above msl in the extreme central west and maximum elevation has attained 352 m above msl at the northeastern corner.

The drainage of the area is controlled the perennial Barha Nala flowing from NW to SE through the area with large meanders and its ephemeral streamlets. It is more or less sub-dendritic and litho-structurally controlled. The water table in the area varies from 6.00 to 11.70 m. The area is covered by thin vegetation of sal, mango, amla and mixed bushy forests.

1.1 Climate:

The area experiences sub-tropical climate with heavy monsoon downpours, extreme cold during winter and pleasant summer. The temperature exceeds in summer up to $46^0$and falls to $7^0$to 8^0 during winter. The average annual rainfall in the area is 1288 mm.

1.2 Background Geology:

Regional Geology of the area:

The area under exploration forms a part of Eastern Ghats Super Group of rocks of Archaean age comprising litho units like khondalite suite of rocks, charnockite, quartzo-feldspathic gneiss and pegmatite overlain by recent soil and alluvium. The litho units form more or less banded assemblages with permeations of neosomes. The litho units exhibits foliation varying from N40º -60º W-S40º -60º E dipping at 55^0 to 75^0 southwesterly. Pegmatite occurs as intrusives within the migmatised khondalite along the folial plane. Based on the field studies and earlier works of various eminent geoscientists (Ramakrishna etal, 1998) the regional stratigraphy can be enumerated as follows:

Recent to sub recent	Soil/Alluvium
	Laterite
Intrusive	Pegmatite/vein quartz
	Porphyroblastic granite gneiss
	Garnetiferous granite gneiss
	Charnockite
	Pyroxene Granulite
Archaean	Khondalite suite: Quartzite,MigmatisedKhondalite (± Graphite)

Local Geology and Stratigraphy:

Detail geological mapping over the area revealed that area is mostly soil covered with scanty exposures of the litho units like khondalite and its variants, quartzo-feldspathic gneiss, charnockite and pegmatite which are only exposed along the Barha Nala course forming more or less banded assemblage with variable degree of alteration. Based on their mutual field relation relationships, the following stratigraphic succession is suggested in order of their increasing antiquity.

Recent to sub recent	Soil/Alluvium
Intrusive	Pegmatite
	Quartzo-feldspathic gneiss (±graphite)
Archaean	Charnockite (migmatised)
	Khondalite (migmatised/kaolinised/±graphite)

A brief note on the different litho-units of the area is given below

Khondalite:

Khondalite is the oldest rock unit occurring in the area which are migmatised and altered to variable extent. It is exposed in the Nala cuttings & wall sections only and also intercepted in boreholes. It forms a banded assemblage with the quartzo-feldspathic gneiss & often silicified. Because of close proximity to Barha Nala, the lithounits have undergone higher degree of alteration and at places kaolinised. It is reddish brown to buff in colour, medium grained, in equigranular consisting essentially of quartz, plagioclase, sillimanite, garnet and opaque minerals which are scattered throughout the rock mass. Quartz and orthoclase are abundant; plagioclase, sillimanite are common and garnet is noticed as an accessory. Secondary growth is noticed in most of the quartz grains. Under microscope plagioclases are highly saussuritised. Iron solution leached out from the garnet imparts a reddish look to the rock mass. Flakes of graphite occur as dissemination within the khondalite. The trend of foliation in khondalite varies from $N40^0$-60^0W to $S40^0$-$S60^0E$ dipping 55^0 to 70^0 southwesterly. Intense weathering and alteration of the constituent minerals rendered the litho units moderately fissile at places with kaolinisation of the plagioclage porphyroblasts.

Charnockite:

Charnockites are exposed in bouldery form in the southwestern part of the area on the Nala banks. Megascopically, it is hard, massive, mesocratic and medium grained rock showing a distinct gneissic trend and exfoliation weathering features. Gneissosity is developed due to dimensional orientation of quartz and feldspar along a definite direction. Granulated prisms of hypersthenes and flakes of biotite constitute the melanocratic bands whereas felsic bands are represented by quartz and feldspar. Mineralogically, it is composed of plagioclase, orthoclase, hypersthenes and quartz as major and biotite are found as accessory mineral. Equidimensional quartz and feldspar form a mosaic texture.

Quartzo-feldspathic gneiss:

Quartzo-feldspathic gneiss is the second most predominant unit exposed in the Nala section. It occurs in bouldery form on the surface and closely associated with migmatised khondalite exhibiting crude foliation. As observed in the adjacent auctioned block, its persistence in subsurface is ubiquitous. It is a medium grained highly altered and weathered rock showing a distinct gneissic trend. Both quartz and feldspar show dimensional orientation along the folial plane. Garnets are highly altered with leaching out of iron solution. Secondary over-growth in most of the quartz grains indicates a sedimentary parentage. It is essentially composed of quartz, orthoclase, plagioclase and graphite and garnets are found as accessory minerals. Opaque are scattered throughout the rock mass. Graphite flakes occur as

disseminations along the foliation of quartzo-feldspathic gneiss.

Pegmatite:

Small veinlets of pegmatites/pegmatoids are exposed on the Nala section both in northern and southern part of the area. These are mainly composed of megacrysts of quartz and feldspar where mica constitutes a very less percentage showing concordant relationship with the country rock. The permeations are mostly foliation guided.

Soil and alluvium:

The entire part of the area is covered with soil and alluvium with average thickness of 4m. Residual soil is formed by weathering of the in-situ country rocks. The alluvium is encountered in the narrow tracts which support vegetation and agriculture of area. The soil is grayish in look and plastic.

Structure:

Both diastrophic and non-diastrophic structures are found within the litho assemblages. The diastrophic structures include foliation, shears, folds and faults and non-diastrophic structure include joint and impersistent mineral lineation. As revealed from the surface and subsurface data in the adjacent block graphite mineralization is litho structurally controlled as it is confined to the foliation plane of quartzo-feldspathic gneiss and migmatised khondalite. The area is affected by granitic activity as a result of which meta-sediments are sheared. Drags and kinks are well marked in the migmatised khondalite. Secondary structural features are noticed in the litho units that include kinks and joints.

Study of satellite imagery revealed that the area lies in close proximity (about 12 km) to the west of Tumudibandh Shear Zone (N-S running) and a N-S sympathetic shear passes through the area of operation. Similarly asymmetric minor shears of Tel shear (ENE-WSW) also cross cuts the Tumudibandha shear in WNW-ESW direction where the intersection of lineament offered suitable avenues for emplacement of granitic melt resulting in remobilization of graphite along the structural weak planes i.e. foliation in this case.

Foliation:

Foliations are well developed in khondalite and quartzo-feldspathic gneiss. The general trend of the foliation of lithounits varies from N40ºW-S40ºE to N60º W-S60º E dipping 55^0- 70^0 southwesterly.

Joints:

Two set of joints are well developed in khondalite and quartzo-feldspathic gneiss. One set of joint trends in N45º E-S45º W dipping 74º northwesterly and other set is parallel to the folial plane.

Metamorphism:

Petrographical studies of the lithounits revealed the following mineral assemblages which signifies the metamorphic episodes the area has witnessed:

a. Quartz+ Orthoclase+Plagioclase+Sillimanite+Garnet+ graphite

b. Quartz +Plagioclase+ Orthoclase + Hypersthene+Biotite

c. Quartz+ Orthoclase+ Plagioclase+Garnet+Zircon)

The above mineralogical assemblages & their mutual textural characteristics are suggestive of high temperature– high pressure phenomena, characteristic of granulite facies of regional metamorphism. Occurrence of biotite in the fracture planes of garnet and saussuritisation of feldspar are indicative of retrogression.

Mineralisation Details:

Exposures of graphite gneisses are encountered in the Barha Nala section. During geological mapping, it was noticed from the nala wall sections that, both migmatised khondalite & quartzo feldspathic gneiss occur concomitantly & graphite mineralisation is restricted only to the contact zones (more pronounced in the hanging wall side of quartzo - feldspathic gneiss & less often in the foot wall).

Graphite mineralization is litho-structurally controlled & mineralisation has been facilitated by quartzo-feldspathic gneiss which seems to act like a scavenger and graphite is a remobilized product. Graphite being a constituent mineral of migmatised khondalite occurs as disseminations within the host rock as flakes and fibers. Size of graphite tiny flakes & fibers varies from 1 to 4mm (microphotographs) are randomly distributed exhibiting a preferred orientation in conformity to the foliation.

Petrological study revealed that graphite occurs as disseminated flakes and fibers along the folial plane of migmatised khondalite and quartzo feldspathic gneiss and is of erratic nature. The deleterious minerals present are quartz, plagioclase, orthoclase and opaques. Quartz grains showing secondary overgrowths occur as oval to lensoidal grains with sutured outline. Orthoclases are mostly perthitic and altered significantly to kaolin while plagioclases occur as platy crystals suffering from saussuritisation. The mineralisation is believed to be remobilized product of carbon during contact regional metamorphism facilitated during emplacement of quartzo-felspathic gneiss.

1.3 Mineral potentiality:

Based on the above discussed background exploration inputs & infrastructure facilities of the area, it is imperative that the south & west block of Narigapanga area is a potential target for Graphite mineralisation, where benicifiable grade (F.C.>2%) Graphite ore can be established and assessed, so as to prepare an auctionable block. The depth of the mineralisation may be gone up to 70 -100m by inclined borehole to identify the 2^{nd} and 3^{rd} mineralised depth levels.

1.3 Scope for proposed exploration:

The scope of the proposed exploration has been formulated on the basis of the findings of G-2 level of exploration done by the Directorate of Geology, Odisha in the adjacent block and subsequent successful auction. The scope of proposed exploration is given below:

I. Detailed Geological Mapping on 1:2000 scale: 7.56 Ha & validation of Geological Map (1:2000) of 14.316 Ha.
II. Survey (50x50m): 14.316 Ha
III. Self-Potential Survey (25m x 10m): 720 points
IV. Drilling: 10 BHs (1200 m) in 50x50m (Initial Stage)
V. Sampling: As Necessary
VI. To estimate Graphite Resources (333) in the block as per UNFC norms & Minerals (Evidence of Mineral. Contents) Rules- 2015, which will be upgraded to G-2 level based on the current findings.

1.4 Recommendations of G-2 Level Mineral Exploration Report:

In order to carve out an auctionable block, Directorate of Geology targeted to upscale the exploration status of the earlier reported graphite occurrence around Naringapanga area in Rayagada district during the F.S 2016-17. After General Exploration at G-2 level a total indicated geological resources of 0.142 million tonnes of Graphite has been estimated in the Naringapanga block with >2% of F.C. Considering the above observations and infrastructure facilities of the area, west & south of Barha Nala adjacent to the Auctioned Graphite Block may be taken up for further exploration by DoMG, Odisha to carve out an auctionable block at G-2 level.

1.5 Objectives:

The present exploration programme has been formulated in accordance with the previous work carried out by DG(O) and also as per Mineral (Evidence of Mineral Contents) (MEMC) Rule-2015 & Mineral (Auction) Rule-2015 to fulfill the following objectives:-

Objective of the proposed Exploration is to carry out G-3 level exploration work in the block to make it auction worthy:

i. To carry out detailed geological mapping & validate the Geological map on 1:2000 scale and demarcate the rock types of Graphite bearing formations with the structural features.
ii. To carry out Geophysical Survey
iii. To drill boreholes in the 50-100m section interval as per MEMC Rule 2015.
iv. To drill inclined boreholes to prove depth continuity up to 60 m depth from the ground level.

v. To estimate Graphite ore resources (333) in the block as per UNFC norms & Amendment Act 2021 of Mineral (Evidence of Mineral Contents) Rules- 2015.

2. Previous Work:

2.1 Previous Exploration in adjoining area:

1. G. Ghatak, R. C. Gathania and B. M. Faruque, (1979), carried out Systematic geological mapping (scale 1:63,360) over an area of 375 Sq km spread over toposheets No.65 M/9, M/10 and M/l4 in the Baudh-Phulbani districts and notable economic occurrence of graphite appears to be of pneumatolytic origin. Recommendations were made for pitting, trenching to prove continuation of the deposit.

2. B.C. Mohanty & P.C. Vajani (1982-83) of Directorate of Geology, Odisha first reported the graphite occurrences around Sollagudi, Narigapanga, Khallupadar, Mudra, Bongna, Berli and Sabinala villages of Rayagada District. Preliminary investigation reported graphite occurrences occur under a thick soil cover with F.C. content varying from 7 to 49%. It was observed that Graphite occurs within migmatised khondalite and are of stratiform type. The ore bodies exhibit concordant relationships with the host rocks indicating structural control of mineralization.

3. S. N. Parida & D. N. Pani (1983-84) of DG (O) carried out mapping in nearby areas of Narigapanga block and reported 7 occurrences of Graphite. Out of these the graphite deposit near Bandhamandi is of low grade with F.C. content varying from 4.56 to 21.38%. The deposit occurs in two isolated patches & is under active exploitation.

4. S. Pasayat, B. K. Jena, K.N. Adhikari of GSI carried out assessment of graphite occurrences in parts of Koraput and Phulbani districts during 1985-86 mapped around 409 sq km consituing parts of 65M/10. Graphite occurrences located at Bahali, Padampur, Salagurhi, Naringapanga, Sana Mudra appear to be promising prospects. Three other occurrences were also examined by pitting and trenching at Paik Dhakulgarh, Kalupadar and Nundurupalli. Abandoned mining activity for graphite was noted at Ghatna and Kharigurha. Anomalous zone east of - Naringapanga village, the only find in plains, was covered by 4 regional traverses of 250 metres interval and resource & grade have not been estimated for Narigapanga area. Chemical analytical results of Gotigurha and Panugurha arid visual estimate of Katikhola area indicate presence of graphite with more than 10% F.C and sampling around Khariguraha indicates graphite with FC content varying from 5 to 20%. As referred in the said report after A K Dey (1941-42), S. Chakraborty (1943-44) mapped the area and not reported Graphite in that area.

5. Later on A. K Chakraborty, N. Lal & B Sarkar (1987-88) of GSI carried out Geophysical Survey for regional assessment of graphite resources in Koraput District. Extensive S.P. and limited magnetic and electro-magnetic measurements were taken upto locate graphite mineralisation in Maligan-Gotigurha-Banganagan-Naringapanga-Salagurhi areas. 9 SP anomaly closure of net anomalous values at the center ranging from -86 mV to -371 mV with respect to background have been identified. Recommendations were made for pitting & drilling over the anomalous zone and anomalous maps are not available.

6. S.P. Nanda & B.S. Rauta (2015-16) of DG (O) carried out investigation at G-4 level around Panchubai village Rayagada Dsitrict and estimated a total reconnaissance resource of 0.032 mt for 10 graphite outcrops. Out of 10 graphite incidences, Narigapanga is a significant one.

7. D. K. Sahoo, B.S. Rauta (2016-17) of DG (O) carried out Exploration around Naringpanga of Rayagada district during the Field Season 2016-17 by DG (O) to assess the resource and grade of graphite around Naringpanga and assessed a resource of 0.142 million tonnes with avg. FC content 2.817%.

2.2 Previous Exploration details in the proposed block area:

Detailed Geological Mapping for graphite mineralisation was taken up by Directorate of Geology during F.S. 2016-17 over an area of 0.36 sq.km around northeast of Naringapanga village. However, 0.0549sq km has been targeted for General Exploration for graphite. A total of 404.45 m of drilling was achieved from 19 vertical boreholes spaced at 50m x 50m grid.

The maximum explored depth in the G-2 block was 26.15 m and the resource has been estimated up to 315 m above MSL datum line. Out of 19 boreholes, 13 boreholes encountered graphite incidences above the threshold values i.e. 2% F.C. while others were barren.

The indicated geological resource of Naringpanga graphite block is estimated to be 0.142 million tonnes which constitute 0.132 million tonnes of graphite with F.C. content ranging from 2 to < 5% and 0.01 million tonnes of graphite with more than 5% F.C. The average grade of the block with F.C. content 2 to < 5% is LOI- 9.617%, SiO_2-52.482 %, Al_2O_3-17.355 % and F.C– 2.615% and for graphite with F.C. content ≥ 5% is LOI-7.965%, SiO_2-52.107%, Al_2O_3-18.495% and F.C.– 5.551%. The graphite resource of the block can suitably be beneficiated for commercial exploitation & the block has been auctioned successfully by Govt. of Odisha in 2021.

3 Block description:

The description of the South & West of Narigapanga Block is given below in the Table No-1.

Table No-3.1

Narigapanga (S & W) Block		
Block corner points/ Cardinal Points	**Longitude**	**Latitude**
A	83° 33' 2.146" E	19° 43' 31.073" N
B	83° 33' 6.140" E	19° 43' 34.151" N
C	83° 33' 7.776" E	19° 43' 31.998" N
D	83° 33' 7.514" E	19° 43' 29.618" N
E	83° 33' 8.850" E	19° 43' 30.795" N
F	83° 33' 11.585" E	19° 43' 27.787" N
G	83° 33' 17.194" E	19° 43' 32.110" N
H	83° 33' 23.651" E	19° 43' 24.596" N
I	83° 33' 14.062" E	19° 43' 17.207" N

4 Planned Methodology:

In order to achieve the objectives, set for Preliminary Exploration (G-3) in of Narigapanga (S & W) Block, Rayagada District, Odisha, Surveying, detailed geological mapping, geophysical survey and drilling programme along sampling and analytical work is proposed in the block. The exploration shall be carried out as per Mineral (Evidence of Mineral Contents) Rule-2015 and Mineral (Auction) Rule-2015.

Accordingly, the details of different activities to be carried out are presented in subsequent paragraphs. Initially it is proposed to drill at least 10 angle BHs at an angle of 45^{o} with respect to horizontal. Based on the findings, other BHs will be drilled to establish the geometry of this ore body & assessing the resource & grade.

Topographic Surveying:

Topographical survey will be carried out in the block area. All the surface features will be picked up and marked on a map on 1:5000 scale. The prospect area would be tied up with the triangulation network. The reduced levels and co-ordinates of boreholes would be determined. The locations of the trenches and pits will be surveyed. The block boundary will be surveyed by DGPS & total station in WGS-84 Datum for demarcation of Block Boundary points.

Geological Mapping:

The detailed geological mappings on 1:2000 scale will be carried out in the small part of the block around 7.56 Ha by taking geological traverses in the block. The contacts of different formations,

identification of different rock formation, structural features, etc., will be carried out in detail. The geological map on 1:2000 scale will be generated based on the detail geological mapping of the block along with contouring at 5 m interval through Topographic Survey.

Pitting:

At least 4 pits of 3m x 3m x 4m are proposed to expose the ore body beyond nala section along the strike & dip of the ore zone involving 144 Cu.m of excavation before putting BH points.

Geophysical Survey:

Geophysical survey i.e. self-potential survey will be carried out in the entire block in 25 x 10m grid pattern around 720 points/15 line km. The geophysical map will be generated based on the SP values recorded in the block. Depth wise interpretation will be provided.

Exploratory Drilling:

Based on the known geology & mode of occurrence of the adjacent auctioned block and outcome of geological mapping & Geophysical survey, analytical results of surface, grab samples and delineation of Graphite ore body, drilling at grid interval of 50-100 m is proposed for the known mineralised area. Thus, initially a total of 10 nos. of exploratory angle boreholes for intercepting graphite lode at 30 & 60m involving 1200 m of exploratory drilling (Diamond core drilling) have been envisaged for G-3 level of exploration. The boreholes have been planned in such a manner that it is presumed to intersect the Graphite ore at deeper levels along with the strike extension of the auctioned block and at least two level of intersection have been planned in the initial stage. It is expected that the Graphite ore band will extend both laterally & vertically along dip direction & subsequent BH planning will be done after mapping. The borehole details are given in the table below and shown on the map (Plate-III).

Table No-4.1

Details of Proposed Boreholes

Sl. No.	Proposed BHs	Longitude	Latitude	Proposed Depth (m)	Approximate Thickness of expected ore zone (Cumulative)
1	PBH-1	83° 33' 5.736" E	19° 43' 30.466" N	120	30-40 m
2	PBH-2	83° 33' 7.843" E	19° 43' 27.899" N	120	30-40 m
3	PBH-3	83° 33' 8.341" E	19° 43' 26.188" N	120	30-40 m
4	PBH-4	83° 33' 12.655" E	19° 43' 27.416" N	120	30-40 m
5	PBH-5	83° 33' 14.821" E	19° 43' 24.894" N	120	30-40 m
6	PBH-6	83° 33' 16.342" E	19° 43' 23.133" N	120	30-40 m
7	PBH-7	83° 33' 13.986" E	19° 43' 28.441" N	120	30-40 m
8	PBH-8	83° 33' 18.567" E	19° 43' 25.685" N	120	30-40 m

Pit & Grab sampling:

During course of mapping, grab samples will be collected from the surface exposures & pit wall/floor sections to examine the grade of ore. The representative samples shall be prepared in field in duplicate. One shall be forwarded to NABL accredited External Laboratory for analysis. All primary, internal check and external check channel samples will be analysed for 5 radicals i.e. (Al_2O_3, SiO_2, Ash, FC and LOI). 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 has been envisaged that 4 Nos. of composite sample would be generated and will be analyzed.

Core Logging:

The borehole cores would be logged systematically. Viz. details of the litho units, colour, structural feature, texture, mineralization, core recovery and Graphite ore type would be recorded.

Core Sampling:

The mineralized part of drill core will be sampled as primary sample. The individual sample will be split into two equal halves and one part will be preserved in the core box for future reference and will be stored in core library, after completion of the project. The whole samples shall be splitted through coning and quartering in field. One part will be analysed as primary samples and second part will be preserved in the camp as duplicate sample, 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. The length of each sample will be kept 1m within the ore zone depending upon the width of particular type of Graphite ore and its physical character. The primary core samples will be analysed for 5 radicals i.e (Al_2O_3, SiO_2, Ash & Moisture, FC and LOI).

Around 400 nos of core samples might be generated from the mineralized zone intersected in the boreholes. All the primary and internal check samples would be analysed for 5 radicals i.e (Al_2O_3, SiO_2, Ash & Moisture, FC and LOI) by wet chemical analysis method. 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.

Total 10 Nos. of composite sample would be generated from drill cores in G-3 level and of exploration and be analyzed for 5 radicals i.e (Al_2O_3, SiO_2, Ash & Moisture, FC and LOI)

Around 40 nos. of primary samples will be analysed as internal check samples for graphite mineralization i.e. Al_2O_3, SiO_2, Ash & Moisture, FC and LOI.

Around 40 nos of primary samples will be sent to NABL External Labs for analysis of graphite mineralization i.e. Al_2O_3, SiO_2, Ash & Moisture, FC and LOI.

A total of 10 nos representative samples in G-3 level would be analyzed by XRD to ascertain the presence of different mineral phases and 5 nos samples will be analysed for Trace elements including "Wolframite" by ICPMS.

Petrological and Mineragraphic Studies:

Thin and polished section studies on drill cores as well as out-crop 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 (5 specimens from core samples and 5 specimens from outcrop samples) for petrographic and 10 specimens (5 specimens from core samples and 5 specimens from outcrop samples) for mineragraphic studies has been kept in G-3 level.

Bulk Density Determination:

A provision of 10 nos of samples of variable Graphite grade is kept for assessment of bulk density of Graphite ore.

5 Nature Quantum and Target

The quantum of work proposed by Directorate of Mines & Geology, Odisha in Narigapanga South & West Block (G-3 Level of Exploration) is given in Table 5.1. which will be achieved within a time period of 9 months.

Table - 5.1

Proposed Quantum of Work (G-3) in Narigapanga (S & W) Block, Rayagada District, Odisha			
Sl. No.	**Item of Work**	**Unit**	**QTY**
1	Detailed Geological Mapping (1:2000) & Validation of Geological Map (1:2000)	Ha	7.56
2	Geophysical Survey (Self potential Survey) (25x10m)	points	720
3	Topographic Survey	Ha	14.316
4	Drilling (10 BHs x 120 m: 12000 m)	m	960
5	Chemical Analysis	Nos	400
6	Check analysis (Internal)	Nos	40
7	Check analysis (External)	Nos	40
8	X-RD Studies of Mineral Phases	Nos	10
9	ICP -MS studies (34 trace elements including Gallium)	Nos	5

10	Composite Sample Analysis	Nos	10
11	Preparation of thin section	Nos	10
12	Petrographic studies	Nos	5
13	Mineragraphic studies	Nos	5
14	Bulk density Determination	Nos	10
15	Exploration Report	Nos	1

6 Manpower deployment:

A total of 2 geologists and 1 Geophysicist are proposed to be engaged for the exploration works at Narigapanga block. Supporting staff like 1 no of surveyor will also be posted for above work. Core drilling team selected from open bidding shall be engaged with the field team for drilling work.

7 Break-up of expenditure:

The entire drilling activity shall be outsourced and the provisional project cost is estimated at **314.901 lakhs** for the entire G-3 Level of Exploration. The details of item wise cost estimate as per the Schedule of Charges as on 01.04.2020 has been prepared and given in Table No. 7.1 and the summary is given below:

Tabel-7.1

Summary of Cost Estimate

Sl. No.	Item	Total Estimated Cost (Rs.)
1	Geological mapping & Survey	57,91,660
2	Geophysical Survey	5,29,320
3	Exploratory Drilling	1,47,24,720
4	Laboratory Studies	41,75,405
	Sub Total	25,221,105
5	Proposal Preparation	3,80,000
6	Geological Report	10,75,439
7	Peer Review	10,000
	Total	26,686,544
8	**GST (18%)**	48,03,5777.95
	Total cost including 18% GST	3,14,90,122.1
	Say, in Lakhs	**314.901**

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Nanda, S.P. & Rauta, B.S;(2015-16)	Un Published Report on investigation for Graphite around Panchubai area of Rayagada District, Directorate of Geology, Government of Odisha
Sahoo, D.K & B	Un Published Report on investigation for Graphite around Narigapanga area of Rayagada District, Directorate of Geology, Government of Odisha
Sahoo, D.K.; Rout, M.K; Behera, M. R.	GR on Geophysical Investigation for Graphite Around Kanibani-Jugapadar Block, Rayagada District, Odisha, (DGO, 2016-17)

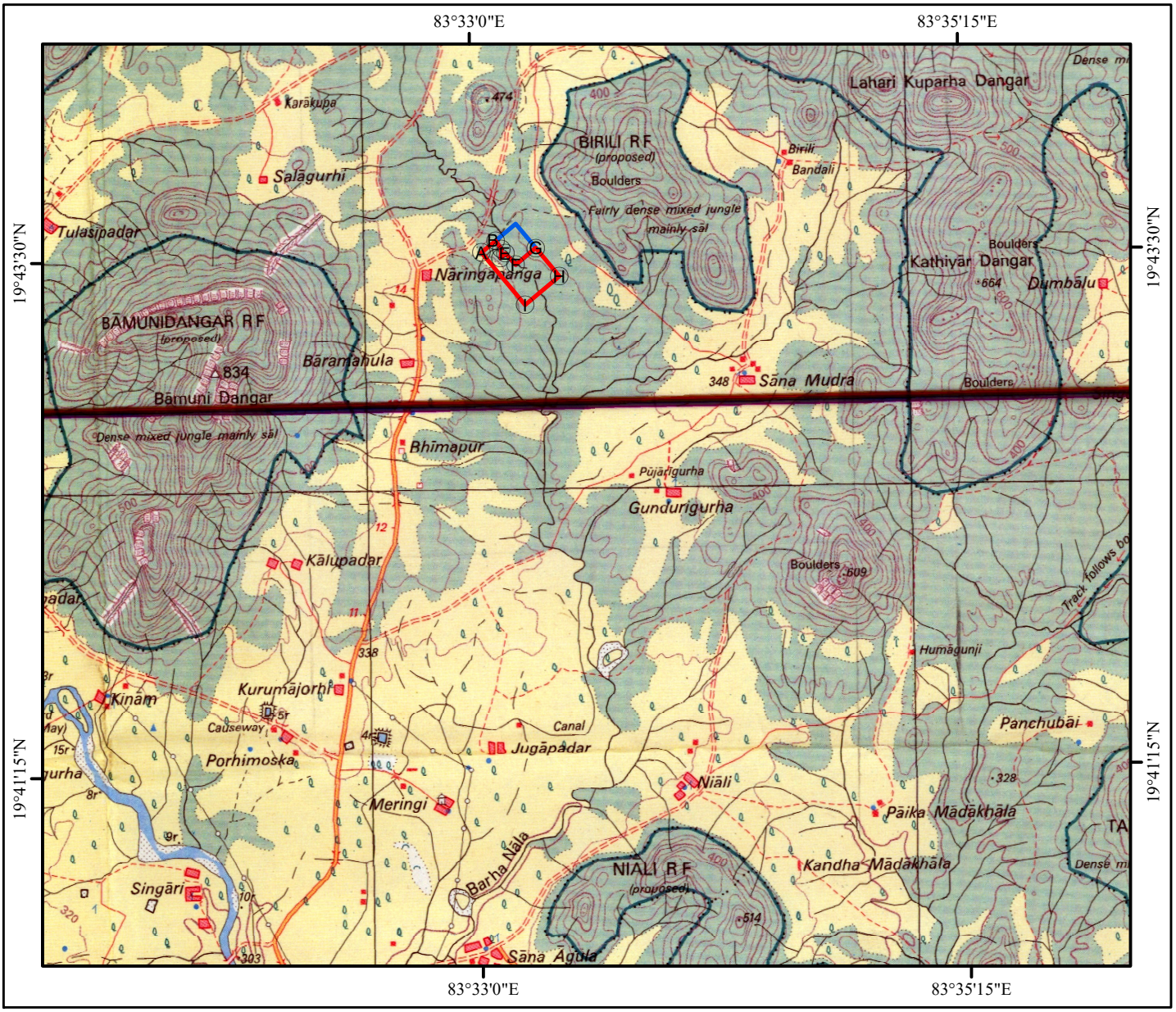
List of Plates

Sl. No.	Description	Ref. Plate No
1	Location Map of Narigapanga (South & West) Block of Rayagada District, Odisha (Scale 1:50,000)	Plate No – I
2	Geological Map with BH plan of Narigapanga (South & West) Block, Rayagada District, Odisha (Scale 1:2,000)	Plate No – II
3	Cross-Section of Narigapanga (South & West) Block, Rayagada District, Odisha (Scale 1:1000)	Plate No –III
4	Longitudinal Section of Narigapanga (South & West) Block, Rayagada District, Odisha (Scale 1:1000)	Plate No – IV
5	Interpreted Lithostructural Map of Narigapanga Area in Rayagada District, Odisha (Scale 1:25,000)	Plate No – V

INDEX MAP SHOWING THE PROPOSED AREA FOR GRAPHITE EXPLORATION AROUND NARINGPANGA DIST-RAYAGADA

SCALE- 1:50,000

TOPOSHEET NO: E44F10



LEGEND

PROPOSED AREA FOR EXPLORATION

AUCTION BLOCK

PROPOSED AREA CORNER POINT

CP	Longitude	Latitude
A	83° 33' 2.146" E	19° 43' 31.073" N
B	83° 33' 6.140" E	19° 43' 34.151" N
C	83° 33' 7.776" E	19° 43' 31.998" N
D	83° 33' 7.514" E	19° 43' 29.618" N
E	83° 33' 8.850" E	19° 43' 30.795" N
F	83° 33' 11.585" E	19° 43' 27.787" N
G	83° 33' 17.194" E	19° 43' 32.110" N
H	83° 33' 23.651" E	19° 43' 24.596" N
I	83° 33' 14.062" E	19° 43' 17.207" N

0 0.5 1 2 3 4

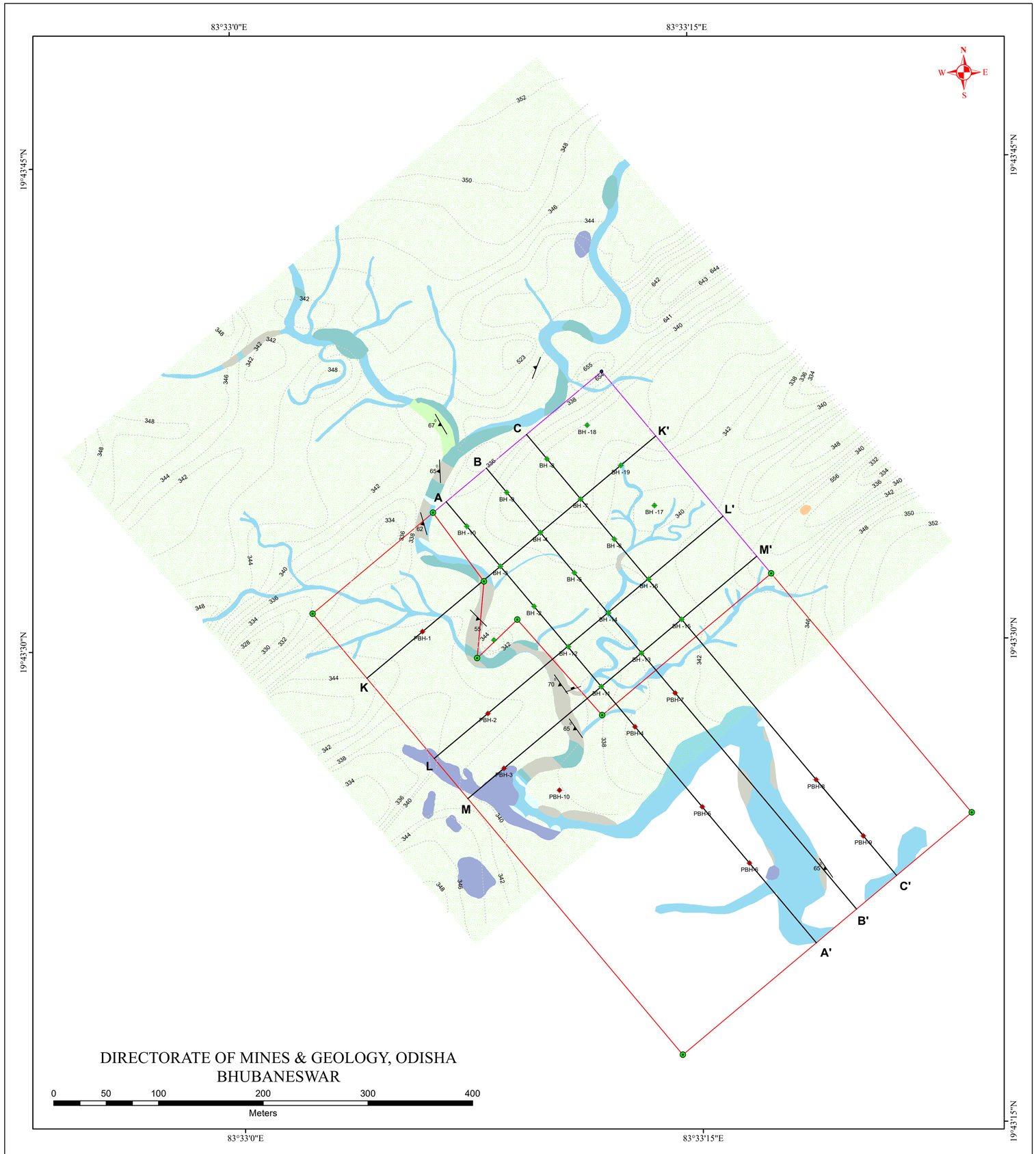
Kilometers

DIRECTORATE OF GEOLOGY, ODISHA
BHUBANESWAR

GEOLOGICAL MAP ALONG WITH PROPOSED BOREHOLES AROUND NARINGPANGA, DIST-RAYAGADA

SCALE- 1:2,000

TOPOSHEET NO: E44F10



LEGEND

Lithology

- Soil
- Pegmatite
- Quartzofeldspathic rock
- Migmatised Charnockite
- Disseminated graphitic khondalite
- Kaolinised khondalite
- Khondalite

- ATTITUDE (55°)
- PROPOSED BH
- EXISTING BH
- CONTOUR (340)
- SECTION LINE (L — B')
- PROPOSED AREA WITH CORNER POINT
- EXPLORED AREA DURING FS:2016-17

BH	Longitude	Latitude
PBH-1	83° 33' 5.736" E	19° 43' 30.466" N
PBH-2	83° 33' 7.843" E	19° 43' 27.899" N
PBH-3	83° 33' 8.341" E	19° 43' 26.188" N
PBH-4	83° 33' 12.655" E	19° 43' 27.416" N
PBH-5	83° 33' 14.821" E	19° 43' 24.894" N
PBH-6	83° 33' 16.342" E	19° 43' 23.133" N
PBH-7	83° 33' 13.986" E	19° 43' 28.441" N
PBH-8	83° 33' 18.567" E	19° 43' 25.685" N
PBH-9	83° 33' 20.086" E	19° 43' 23.922" N
PBH-10	83° 33' 10.147" E	19° 43' 25.484" N

INTERPRETED LITHO-STRUCTURAL MAP OF NARINGAPANGA AREA, RAYAGADA DISTRICT

(Based on Interpretation of LISS - III & Sentinel 2 B Satellite Image)

T. S No - F45 T2

N

83°30'0"E 83°31'0"E 83°32'0"E 83°33'0"E 83°34'0"E 83°35'0"E 83°36'0"E

19°46'0"N 19°45'0"N 19°44'0"N 19°43'0"N 19°42'0"N 19°41'0"N 19°40'0"N

Bengei Nadi

Banganagan

Salagurhi

Tulasipadar

Naringapanga

Dumbalu

F O L D ?

Sana Mudra

Bhimapur

Kuruma

Gundurigurha

Tebhapadar

Bengei Nadi

Jugapadar

Niali

Meringi

0 1 2 4 KM

Area Recommended for Ground Verification
Area Around Lithocontact
Structurally Weak Planes

Lithology

- Soil
- Lateritic Upland
- Migmatite
- Charnockite
- Khondalite

Structure

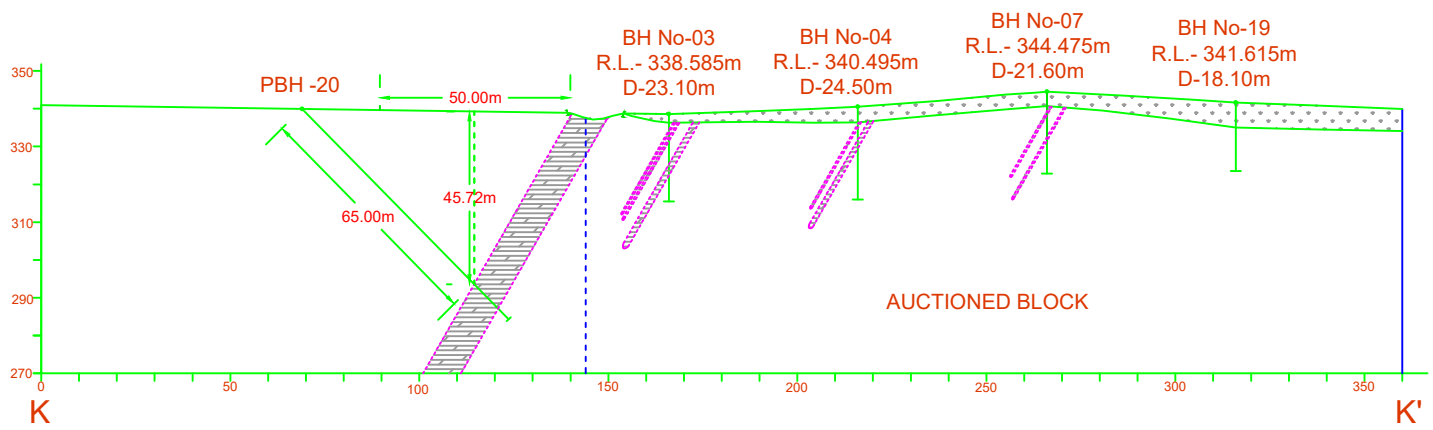
- Bedding trace
- Fault
- Joint
- Lineament
- Thrust

- Area of Exploration

PLATE - III

CROSS SECTION ALONG K-K' FOR PROPOSED GRAPHITE EXPLORATION PROJECT AROUND NARINGPANGA WEST IN RAYAGADA DISTRICT

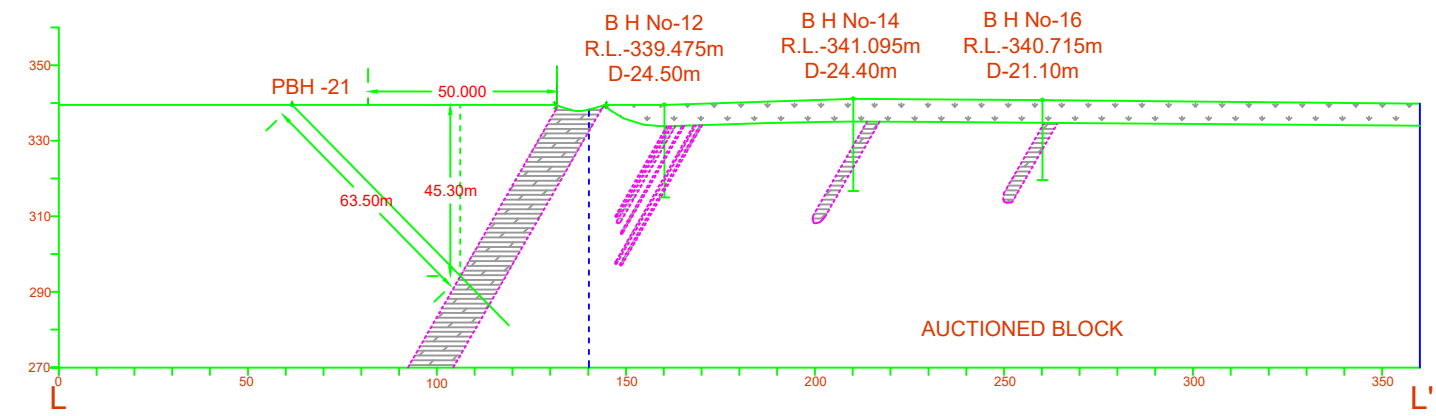
SCALE - 1cm=20m (1:2,000)



INDEX	
SOIL	
GRAPHITE BEARING MIGMATISED KHONDALITE (F.C.- 2 - 5%).	
DRILLED VERTICAL BOREHOLE	BH-07
PROPOSED INCLINED BOREHOLE	PBH -21
RIVER	
Auction Block Boundary	

CROSS SECTION ALONG L-L' FOR PROPOSED GRAPHITE EXPLORATION PROJECT AROUND NARINGPANGA WEST IN RAYAGADA DISTRICT

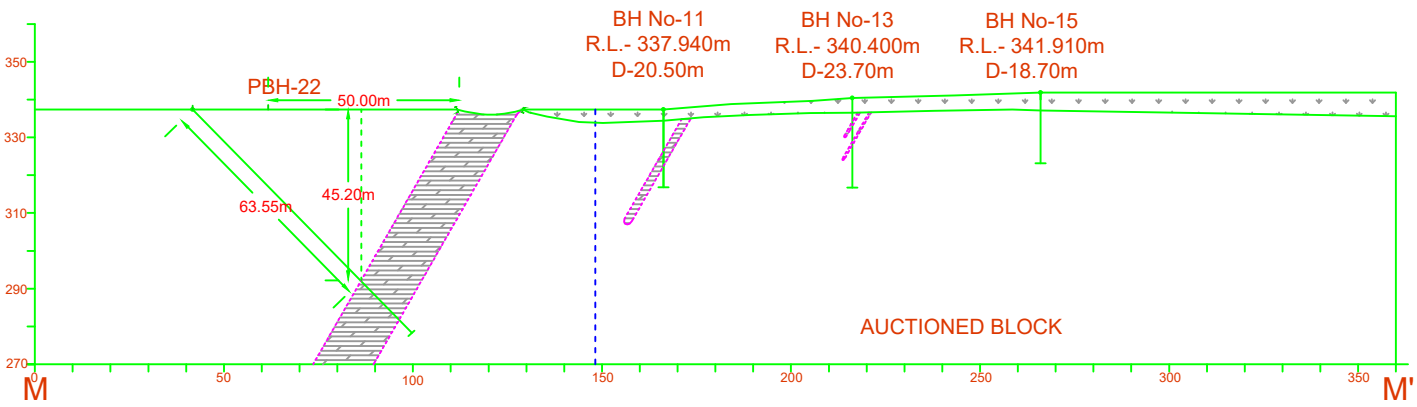
SCALE - 1cm=20m (1:2,000)



INDEX	
SOIL	
GRAPHITE BEARING MIGMATISED KHONDALITE (F.C.- 2 - 5%).	
DRILLED VERTICAL BOREHOLE	BH-07
PROPOSED INCLINED BOREHOLE	PBH -21
RIVER	
Auction Block Boundary	

CROSS SECTION ALONG M-M' FOR PROPOSED GRAPHITE EXPLORATION PROJECT AROUND NARINGPANGA WEST IN RAYAGADA DISTRICT

SCALE - 1cm=20m (1:2,000)

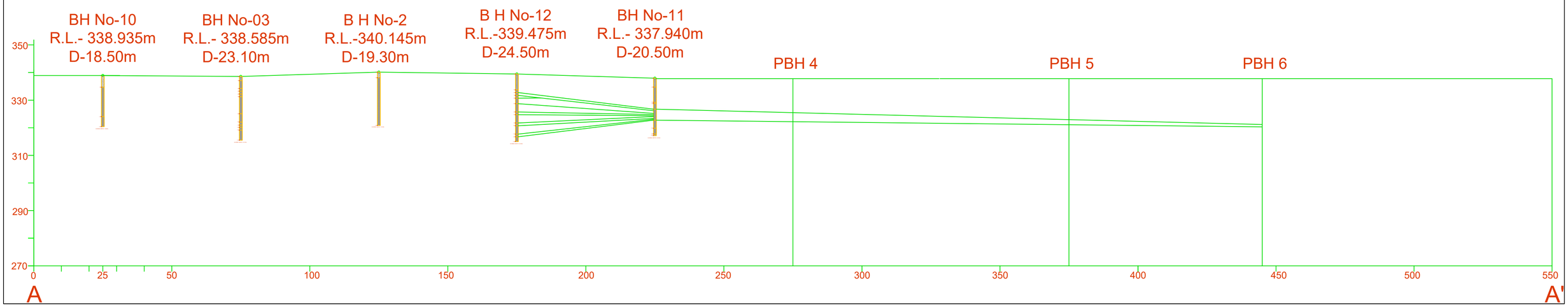


INDEX	
SOIL	
GRAPHITE BEARING MIGMATISED KHONDALITE (F.C.- 2 - 5%).	
DRILLED VERTICAL BOREHOLE	BH-07
PROPOSED INCLINED BOREHOLE	PBH -21
RIVER	
Auction Block Boundary	

LONGITUDINAL SECTION ALONG A-A' FOR PROPOSED GRAPHITE EXPLORATION PROJECT AROUND NARINGPANGA WEST & SOUTH BLOCK IN RAYAGADA DISTRICT

PLATE- IV

SCALE - 1cm=10m (1:1,000)



Cost Estimate for Graphite in Naringapanga(S & W) Block (G3)						
Rayagada District, Odisha						
Sl. No.	**Item of Work**	**Unit**	**Rates as per NMET SoC (2020-21)**		**Estimated cost of the Proposal**	
			Soc-Item-Sl.No.	**ESC Rate**	**QTY**	**Amount**
				Rs		*Rs*
A	**DRILLING**					
1	Drilling (10 BHs) outsourcing	m	2.2.1.4a	11,500	1200	1,38,00,000
2	Drill Core Preservation	per m	5	1,590	400	6,36,000
						1,44,36,000
	Tender Processing Cost	2% of the above Project or 5 lakh whichever is lower will be paid.				2,88,720
	Reimbursement of cost in case of outsourced coponents of project work.	Cost				10,82,700
	Sub Total A					**1,47,24,720**
B	**GEOLOGICAL WORK**					
1	Bore Hole Fixation and determination of co-ordinates & Reduced Level of the boreholes by DGPS	Per Point of observation	1.6.2	19,200	10	1,92,000
2	Survey Party days (One Surveyor Charges)	day	1.6.1a	8,300	25	2,07,500
3	Labours (4 Nos) Base rate - Rs. 326*4=1304/-	day	5.7	1,304	25	32,600
4	Charges for one Geologist per day at HQ	day	1.2	9,000	90	8,10,000
5	Geological Mapping, Core Logging (Charges for one Geologist per day at field)	day	1.2	22,000	150	33,00,000
6	Labours (4 Nos) Base rate - Rs. 326*2=652/-	day	5.7	652	150	97,800
7	Sampler	day	1.5.2	5,100	60	3,06,000
8	Labours (4 Nos) Base rate - Rs. 326*4=1304/-	day	5.7	1,304	60	78,240
9	Pitting	Cu.m	2.1.3	5,330	144	7,67,520
	Sub total B					**57,91,660**
C	**GEOPHYSICAL WORK**					
1	Charges for one Geophysicist per day at field	day	3.18	11,000	20	2,20,000
2	Charges for one Geophysicist per day at HQ	day	1.2	9,000	7	63,000
3	Selfpotential Survey (25x10m)	Line Km	3.3a	29,600	7	2,07,200
4	Labours (6 Nos) Base rate - Rs. 326*6=1956/-	day	5.7	1,956	20	39,120
	Sub total C					**5,29,320**
D	**LABORATORY STUDIES**					
1	**Chemical Analysis**					
i)	**Primary check samples**					
	Primary samples for 5 radicals (Al_2O_3, SiO_2, FC, Ash and LOI)	Nos	4.1.1	8,157	400	32,62,800
	X-RD Studies	Nos	4.5.1	4,000	10	40,000
	ICPMS/ICP-AES (34 elelments Analysis)	Nos	4.1.14	7,731	5	38,655
ii)	**Check samples Internal**					
	Check samples for 5 radicals (Al_2O_3, SiO_2, FC, Ash and LOI)	Nos		8,157	40	3,26,280
ii)	**Check samples External**					
	Check samples for 5 radicals (Al_2O3, SiO_2, FC, Ash and LOI)	Nos		8,157	40	3,26,280
iii)	**Composite Samples**					
	Check samples for 5 radicals (Al_2O_3, SiO_2, FC, Ash and LOI)	Nos		8,157	10	81,570
2	**Physical Analysis**					
i)	Preparation of thin section	Nos		2,353	10	23,530
ii)	Petrographic studies	Nos		4,232	5	21,160
iii)	Preparation of polished section	Nos		1,549	10	15,490
iv)	Mineragraphic studies	Nos		4,232	5	21,160
v)	Digital Photographs	Nos		280	10	2,800
vii)	Bulk density	Nos		1,568	10	15,680
	Sub- total D					**41,75,405**
	Total A+B+C+D					**2,52,21,105**
E	Preparation of Exploration Proposal	One number (5 Hard copies with a soft copy)		2% of the approved project cost or 3.8 lakh whichever is		3,80,000
F	Geological Report Preparation	5 Hard copies with a soft copy		For the projects having cost more than Rs. 300 lakh, A		10,75,439
G	Peer review Charges	As per EC decision				10,000
H	**Total Estimated Cost without GST**					**2,66,86,544**
I	GST @18%	%				48,03,577.95
J	**Total Estimated Cost with GST**					**3,14,90,122.10**
				or Say Rs. , In Lakhs:		**314.901**

Time Schedule of Naringapanga (S & W) Graphite Project, Rayagada District: 9 months												
Sl. No.	**Work Components**	**Units**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Time period**
1	Camp Setting	Days										7 Days
2	Survey Work units (Total Station survey)	Days										40 Days
3	Detailed Geological Mapping (1:2000) (7.56 Ha) & Validation of Geological map	Days										30 Days
4	Self-Potential Survey (25x10m)	Days										20 Days
5	Pitting (4 Pits)											15 Days
6	Drilling (10 BHs)	Months										4 months
7	BH core Logging & Sampling	Months										3 months
8	Sample processing & Analysis	Month										3 months
9	Camp Winding	Days										7 days
10	Data Analysis (DA) & Report Writing with Peer Review	Month										2 months