PROPOSAL FOR G4 LEVEL GEOPHYSICAL AND GEOLOGICAL PROSPECTING FOR DIAMOND IN PART OF A PALAEO-CHANNEL NEAR MANGALAGIRI, GUNTUR DIST., KRISHNA BASIN, ANDHRAPRADESH

Direct

Submission To,

National Mineral Exploration Trust (NMET)
Ministry of Mines
F-114, Shastri Bhawan, New Delhi-110001

By,

Geo Marine Solutions Pvt. Ltd., Mangalore
15-17-909/9, Leslie Haven, 5th Cross, Shivabagh, Mangalore
Karnataka

September 2024

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SUMMARY OF THE BLOCK FOR G4 LEVEL GEOPHYSICAL AND GEOLOGICAL PROSPECTING FOR DIAMOND IN PART OF A PALAEO-CHANNEL NEAR MANGALAGIRI, GUNTUR DIST., KRISHNA BASIN, ANDHRAPRADESH.

	Features	Details
	Block ID	Ap-MD-1
	Exploration Agency	Geo Marine Solutions Pvt. Ltd., Mangalore for Detailed Mineral exploration
	Commodity	Alluvial diamond
	Mineral Belt	Kolluru - partiala alluvial tract known for world famous diamonds
	Completion Period with entire Time schedule to complete the project	Mobilization: Sixty days from issue of work order/LOA. Field work: 240 days Data interpretation and report: 60+60 days
	Objectives	To explore the spatial distribution, thickness and downward continuity of gravel beds within alluvium in parts of a palaeo channel near Mangalagiri, Guntur Dist, Krishna Basin, Andhra Pradesh.
	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	The entire work will be carrying out by the proposed agency(Geo Marine Solutions Pvt Ltd., Mangalore) except drilling of two boreholes.
	Name/ Number of Geoscientists	Geophysicsts-2 + Geologist - 1
	Expected Field days (Geology and Geophysics)	225-Geophysical survey 15 - Auger drill

1.	**Location**	
	Latitude	16°25'38.64"N
	Longitude	80°37'31.02"E
	Villages	Mangalagiri
	Tehsil/ Taluk	Mangalagiri
	District	Guntur
	State	Andhra Pradesh
2.	**Area (hectares/ square kilometres)**	
	Block Area	22.6 sq.km
	Forest Area	Nil
	Government Land Area	Nil
	Private Land Area	22.6 sq.km(agricultural land)
3.	**Accessibility**	
	Nearest Rail Head	Kolanukonda (640m)
	Road	Pedavadlapudi- Kolanukonda road
	Airport	Vijayawada International Airport(~20 km from block)
4.	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	Mangalagiri block situated on the right bank of Krishna river
	Rivers/ Streams	Krishna river
5.	**Climate**	
	Mean Annual Rainfall	877.12 mm in Guntur district
	Temperatures (December)(Minimum) Temperatures (June)(Maximum)	Guntur : min. temp. is 18.3°C and max. 44.4°C
6.	**Topography**	
	Toposheet Number	65D/11
	Morphology of the Area	The main fluvial landforms in the delta are the present channel of Krishna, levee, flood basin and palaeo-channel. These landforms are characterized by their forms and

		associated sediments. The lithological units consist of sand, silt, clay and their admixtures. The fluvial delta is a flat area which may be differentiated into active channel, levee, flood basin and palaeo-channels with very minor elevation difference. The Palaeo-channel between Tsunduru and Revendrapadu forms a distinct geomorphic unit characterized by thick palmyra growth. The fluvial sediments of the palaeo-channels are covered by black clay of later flood plain deposit. Levee forming slightly higher ground is developed along the western bank of the Krishna River over a width of 0.50 km to 1.50 km. It gradually merges with the flood basin
7	**Availability of baseline geoscience data**	
	Geological Map (1:50K/ 25K)	Geological inputs pertaining to the area falling in 65D/11 are available and referred while preparing the write up.
	Geochemical Map	Geochemical inputs pertaining to the area falling in 65D/11 are available
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	Not Available
8.	**Justification for taking up Reconnaissance Survey / Regional Exploration**	1. Based on the book titled "Diamond Fields of Southern India" Edited by Ravi. S. et al., 2018 Geological Survey of India, Bulletin Series A No.68, Southern Region, Hyderabad. 2. Based on the website 'www. andhra-rayalaseema-diamondmines.com' that gives more historic information about

		World famous alluvial diamonds recovered from Krishna Basin especially in the Kolluru-partiala stretch. 3. Based on the GSI report titled" Report on the study of Quaternary formations and geomorphology of the western Krishna delta between Revendrapadu and Tsunduru, Guntur district, Andhra Pradesh" by J.Nageshwara Rao, 1981. 4. Based on the GSI report titled "Preparation of profiles of Quaternary deposits in Krishna delta, east coast, Andhra Pradesh (under igcp-475)" by Shah et al.,2006. 5. Based on the paper titled" Discovery of microdiamonds in the beach placers of East Coast, Andhrapradesh" by Anil Kumar et al., 2005

Detailed description on the following titles to be made in the proposal

1. Block Summary

<u>BACKGROUND INFORMATION:</u>

Diamond itself and many famous historical diamonds were introduced to the world by India, wherein production was largely by alluvial mining that was spread over seven States (i.e. Andhra Pradesh, Chattisgarh, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh and Telangana). India introduced diamond to the world. The quaternary gravels deposited along the alluvial tracts of the Krishna and Penner Rivers in Andhra Pradesh are known to have been the major source for diamonds in the historic past. The Koh-i-noor (186 ct), the Great Moghul (787 ct), the Pitt / Regent (410 ct), the Orlof (189 ct) and the Blue Hope (45 ct) to name a few are the world famous diamonds produced from the gravels of the Krishna Valley (Fig.1). The Intensity of mining was more over a 60 km long belt, between Kolluru (Guntur district) on the right bank and Partiala (Krishna district) on the left bank. The present proposed block is lying in the middle of Kolluru- Partiala belt Ravi et al., 2018).

Fig.1: World famous diamonds from Krishna River alluvium, Guntur district, Andhra Pradesh, India (Source: www. andhra-rayalaseema-diamondmines.com)

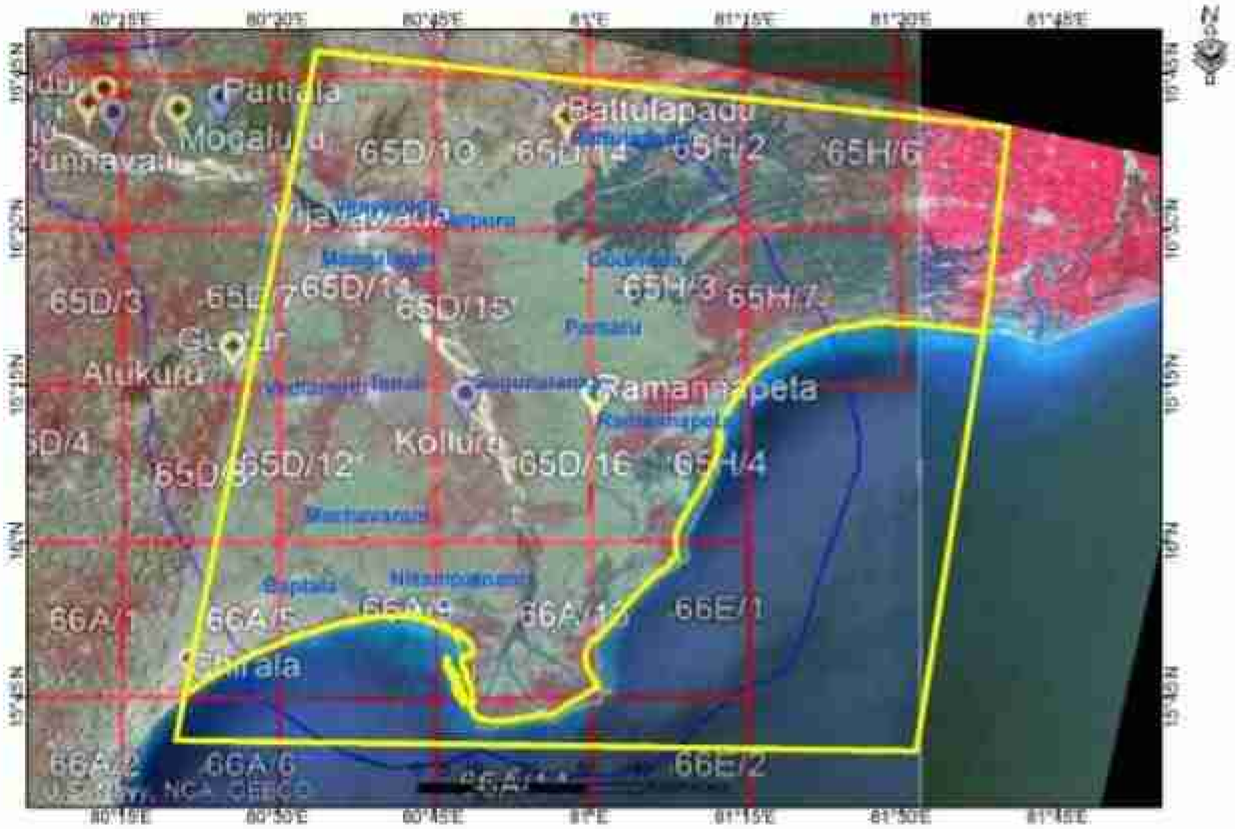


Fig.2: Imagery Showing Krishna Basin Region, the Kolluru-Partiala alluvial tract

Partiala-Kodavattikallu-Kollur area is famous for diamond occurrences for the past several centuries. The world famous diamonds "Kohinoor" and "Great Mogul" were obtained from the Kollur area and the "Pitt" from Partiala area. Even the old dumps in Partiala and Kodavattikallu areas (Fig.2) still yield occasional diamonds, as reported by villagers. Capt. Munn (1929) of the Hyderabad Geological Survey, collected all available information on these workings, and published it in the Memoir Vol.I of Hyderabad Geological Survey in 1929. According to him, Heyne had stated that the Kodavattikallu mine yielded bullock-cart loads of diamonds on first discovery (Ravi et al., 2018).

An attempt to open the Partiala mine was made in 1890 by the Hyderabad Deccan Company, who had obtained the mineral rights over this area. The actual pit, which the ancients mined, was reopened and the excavated alluvium was processed by modern machinery resulting in the extraction of 3,444 stones weighing 2085 carats. Deshpande and Sagar carried out detailed investigations during 1968 - 1973. They carried out large scale mapping, deep pitting, auger drilling and bulk treatment of the gravel material. They delineated a few subsurface gravel horizons and also recovered three diamonds, weighing 0.25, 0.625 and 3.25 carats during 1971-'72 (Ravi et al., 2018).

Krishna Basin and Delta

The Krishna River flows undivided for a distance of about 60 km from its delta apex near Vijayawada, before a relatively small distributary branches out at Puligadda village. Further downstream, the river again splits into three distributaries just within 15 km from the shoreline forming the main delta lobe. Both these adjacent rivers built their deltas on the east coast India where they join the Bay of Bengal. Swerving of the Krishna River course throughout its deltaic reaches and the clock-wise bending of the active Krishna delta lobe into the Nizampatnam offshore sub-basin appear to be associated with the Krishna Cross Trend fault (Ravi et al., 2018).

The basin which was initially formed in the Late Jurassic as a major rift graben, bounded by two major faults – the Basin Margin Fault along the landward (northwest) side, and the Matyapuri-Palakollu (MP) Fault, which marks the Eocene shelf edge (According to Raghavendra Rao, 1991, cited in Nageswara Rao et al., 2012) on its seaward margin with a landward tilt along the latter (According to Manmohan et al. 2003, cited in Nageswara Rao et al., 2012). Recurrence of tectonics in the Late Cretaceous led to en echelon faults giving rise to second order horst-graben structures within the K-G sedimentary basin. There are two cross-trend faults, namely Chintalapudi Cross Trend and Krishna Cross Trend, which divide the overall K-G sedimentary basin into three major blocks. The 8-km-wide beach ridge complex that separates the Kolleru and the southern mudflat largely coincides with the Kaja-Kaikaluru Ridge (horst) that lies in between the Gudivada and Bantumilli Sub-basins (grabens). Based on the lineaments conjectured in the Krishna delta through the interpretation of large scale aerial photographs, Nageswara Rao (1988) observed the general orientation of a majority of the lineaments is in two preferred directions of ENE-WSW and NE-SW coinciding with the basement trends indicating of neotectonic movements in the area (Ravi et al., 2018).

The deltaic area is a flat country, sloping gently eastward from the foot of the Eastern Ghats to the Bay of Bengal with isolated hills or group of hills jutting out at the western boundary of the area (with in Vijayawada city and north of Manglagiri). The delta plains exhibit two broad units – the fluvial plain in the upper part of the delta and the strand plain in the lower part. The former is a gently rolling, river-built plain sloping towards the coast characterized by landforms such as abandoned river courses and natural levees. In contrast, the lower strand plain, including the inter-delta plain, exhibits features like beach ridges, mudflats, mangrove swamps, lagoons, and spits reflecting the marine influence. The sandy beach ridges in the strand plain represent the former shoreline positions in these prograding deltas. The innermost beach ridge that lies even up to 35 km inland from the present shoreline marks the maximum Holocene transgression limit, which was tentatively dated to be around 6 ka based on about ten C-14 dates from this region (According to Nageswara Rao et al. 2005, cited in Nageswara Rao et al., 2012). The delta area upstream of this maximum Holocene transgression limit is considered as the fluvial plain as it is essentially a floodplain of either the present or abandoned distributary courses within the delta. The lower part of the delta, seaward of this limit is the strand plain. Although most part of the sediments in the delta is contributed by the river, the material is reworked and deposited by the marine processes along the shore leading to the progradation of the delta. Therefore, the strand plain that constitutes the lower part of the delta is essentially a marine-built plain. The sediments that filled the Krishna -Godavari (K-G) sedimentary basin range from the Cretaceous to the Recent (According to Biswas & Agarwal 1999, cited in Nageswara Rao et al., 2012) and vary in thickness from about 2.0 to 2.5 km over the basement highs (According to Manmohan et al. 2003 cited in Nageswara Rao et al., 2012) to as much as 5.0 to 7.0 km over the graben structures containing at least eight hiatuses (According to Govindan 2004, cited in Nageswara Rao et al., 2012).

The fluvial deposits of Quaternary/Recent age recognized in the area (from Kondavattikadu) include (1) the Quaternary gravels associated with paleo-channel terraces (2) older and younger flood plain alluvium (3) Recent alluvium and gravels of the present day river channel. A major palaeo-channel of the Krishna river, identified from the present course of the Krishna river at Ustapalli, gets forked out into two separate channels and rejoins the present course of the Krishna river at Pokkunuru (16°30' : 80° 10') and Kodavatkallu (16° 38'30": 80° 11'30") cumulative length of the palaeo-channel is about 12 km and the width varies from 1 to 2 km.

GEOLOGY OF THE AREA:

The Quaternary formations of the delta comprise clay, silt and sand and their admixtures. The fluvial sediments of the palaeochannels are covered by black clay of later flood plain deposit. The part of palaeochannel between Morampudi and Tadepalli was not subjected to later flooding. The pedi plain is covered by reddish brown/red coloured lateritic sandy soils. The flood basins around Manduru, Nelapadu, Attota, Peddapalam are covered by black clays of 9-12 m thickness underlain by sand. The black clay is slightly alkaline in nature. The braided channel of the Krishna River at Peddekonduru is covered by grey white medium-fine sand consisting of mostly quartz with minor opaques. The Quaternary sediments are further subdivided into various stratigraphic units based on landform and associated lithology (Ravi et al., 2018).

The sub-surface deltaic sedimentary sequence from five lithologs of the boreholes from western part of Krishna delta reveals that the thickness of the Quaternary deposits extends beyond 180m deep. The enormous amount of these sediments, comprising loose to semi-consolidated gravel, sand, silt and clay were laid down in the frequently changing depositional environment. The borehole lithologs suggest that, at least four sedimentary units, namely, basal sand with gravels, sticky brown silty-clay, mottled clay and dark grey silty-clay, intersected in each borehole, possess identical sedimentary characters and are correlatable. The latest and the third transgression was a major event, commenced around 10,000 yrs. B.P. The effect of this event extended much inland and beyond Ponnapalli- Inturu villages. The area remained under marine influence up to 2000 yrs. B.P, as indicated by radio carbon (14C) dates, of dark grey silty-clay unit collected from different intervals in each borehole. This was followed by stabilization of the sea-level in the area and formation of a barrier-beach ridge trending WSW-ENE, parallel to the shoreline, enclosing a lagoon. From then onwards the sea regressed and the area came under the influence of increased fluvial/sub-aerial environment (Ravi et al., 2018).

Geology of the Proposed block:

Most of the proposed area covered by black clay underlined by coarse sand of early Holocene, however in the north eastern portion a small area is occupied by black silty clay of Meghalayan age (source: Geological map of GSI, Fig.12)

GEOMORPHOLOGY OF THE AREA:

The main fluvial landforms in the delta are the present channel, levee, flood basin and palaeo-channel. These landforms are characterized by their forms and associated sediments. The lithological units consist of sand, silt, clay and their admixtures. The fluvial delta is a flat area which may be differentiated into active channel, levee, flood basin and palaeo-channels with very minor elevation difference. The Palaeo-channel between Tsunduru and Revendrapadu forms a distinct geomorphic unit characterized by thick palmyra growth. The fluvial sediments of the palaeo-channels are covered by black clay of later flood plain deposit. Levee forming slightly higher ground is developed along the western bank of the Krishna River over a width of 0.50 km to 1.50 km. It gradually merges with the flood basin (Fig.3).

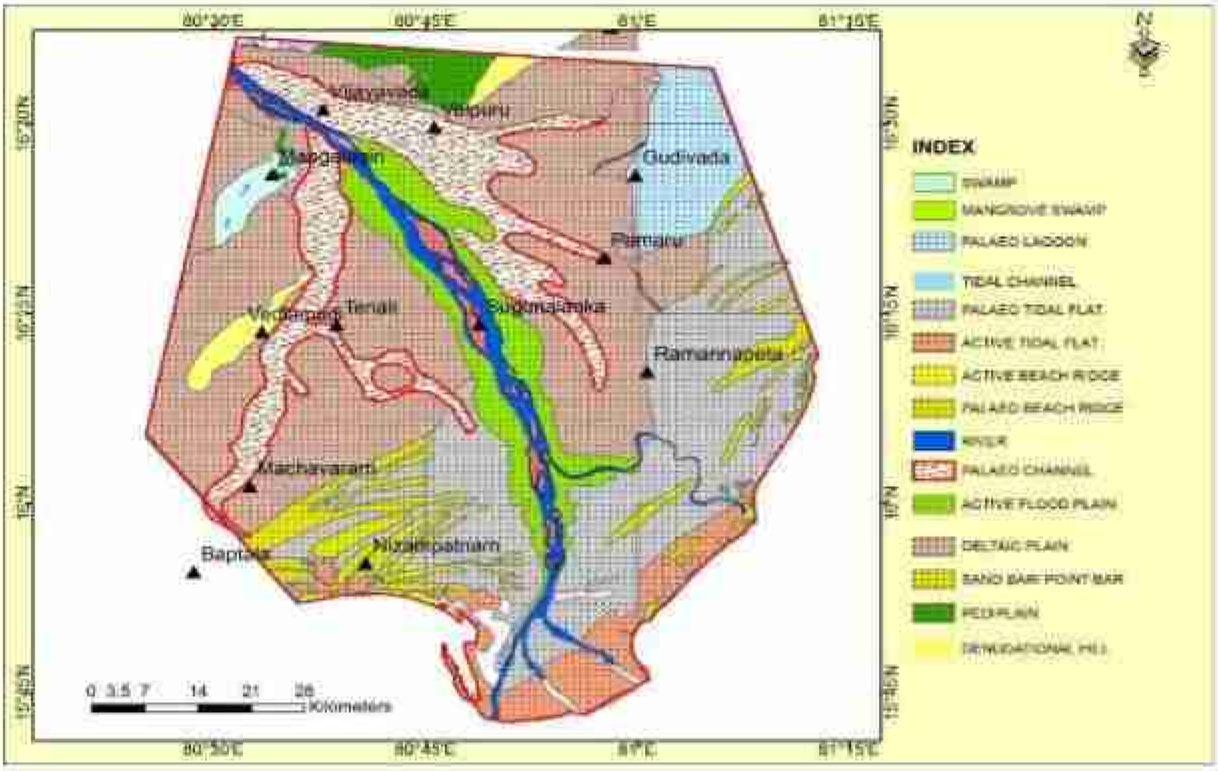


Fig.3: Geomorphology of the Krishna Basin area and Demarcated Palaeo Channels(Source: Geomorphology map is downloaded from Bhuvan Siteis crosschecked and updated with the same map from Bhukosh site)

Palaeo channels: The palaeo-channel has great significance in the exploration for placer diamonds. During the field studies it was found that the area (Kodavattikallu) in an around covered by the palaeo-channel predominantly comprises gravel made up of water worn pebbles and cobbles in a finer matrix. Some of the old workings near Kodavattikallu fall within this channel, and according to old records these workings yielded a rich bonanza of diamonds. The important river Krishna and its tributaries drain the northern part whereas in the southern and central parts there are only a number of small streams. Two major palaeo channels are identified on both sides (left and right bank) of the present day river course based on the studies on satellite imagery. The paleao channel identified on the left bank of the river runs parallel to the present day river course. One additional palaeo channel branching out from palaeo-channel on the right bank is also demarcated. Calcretes are commonly used as an indicator of Palaeo-environmental conditions prevailed during Pleistocene period. The last glacial maxima during Pleistocene period dry climatic conditions prevailed for the formation of calcretes. Calcretes described in these deltaic clays at a depth of 7m to 75m reflects a water table overprint on the stratigraphic sequences.

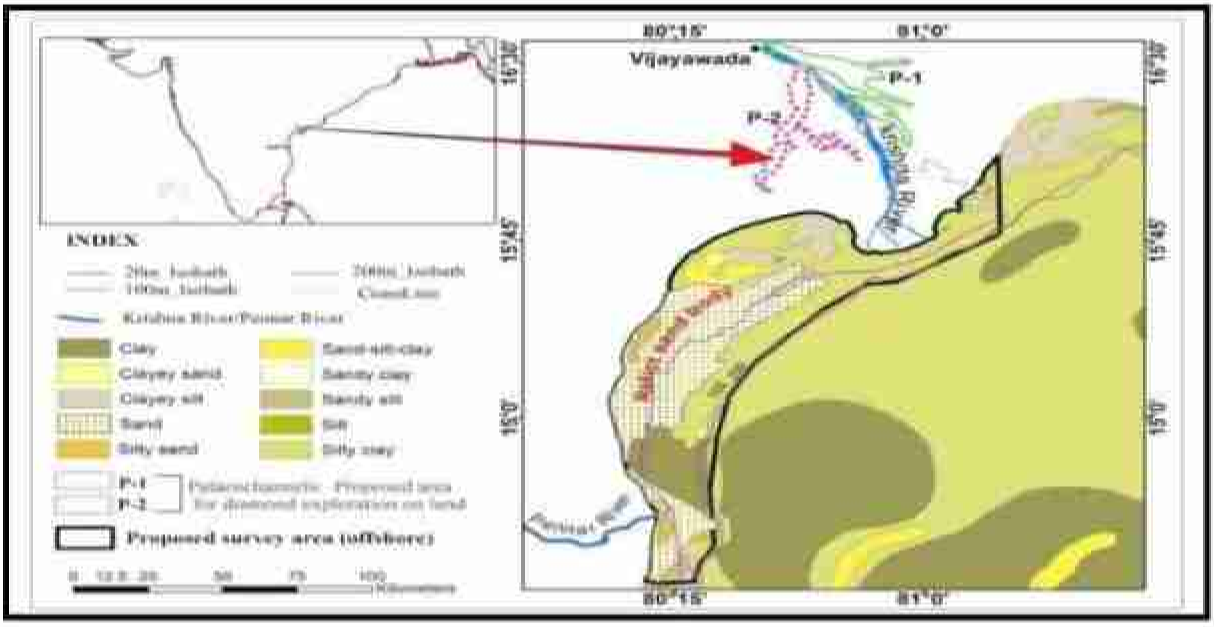


Fig.4: Probable Areas for Diamond Exploration (P1, P2 Palaeo-channels and offshore area)

Alluvial Diamonds:

Alluvial diamond occurs in five main types of deposit: fluvial, marine, wind deflation, lacustrine and glacial. Although the degree of diamond concentration varies considerably in different deposits of any one category, the most economically significant deposit type is the marine, followed by the fluvial (Ravi et al., 2018).

The importance of gaining a thorough understanding of the geomorphological history of an area to be explored for alluvial diamonds is well illustrated from various places, where active alluvial diamond mining is taking place viz., Sierra Leone, South Africa, Brazil, Ghana etc.,

Diamonds in the South Africa and Namibian Coasts

Unlike primary diamondiferous rocks, secondary diamond deposits may be found in almost any tectonic setting. Although most alluvial deposits have been found on Archaean cratons, near their primary source rocks, by far the most economically significant deposits occur off-craton, or on craton margins. The extensive marine alluvial deposits of south-western Africa are far removed from the Kaapvaal craton from whence the bulk of the diamonds were derived.

In other parts of the world, especially in South Africa off the mouth of the Orange river (Namibia), such offshore occurrences of diamonds have not only been proved but such diamonds are also mined economically. Those diamonds travelling hundreds of kilometres from the source landed off the coast of what is now Namibia, creating the world's richest marine-diamond deposit. The country's territorial waters are now estimated to hold 80 million carats, and the world's biggest diamond miner, De Beers, has quietly built up an armada off the coast to vacuum up those precious gems.

Diamonds in the offshore areas of Krishna-Pennar Coast:

Marine deposits occur both onshore and offshore as ancient strandlines that mark both eustatic and isostatic fluctuations. Economic deposits of marine alluvial result from transgressive seas. Regressive seas tend to be non-concentrating and aggradational. The latter tend often to overlie and preserve older economic transgressive beaches, making their discovery more difficult.

The diamondiferous volcanic pipes so far identified in India may have already been eroded to deep levels. The thicker/ upperparts of these pipes normally contain more diamonds, reckoned both in size and quantity. Thus, most of the original diamonds occurring in these pipes have long been dislodged and physically been removed from the source. Quite large diamonds have been recorded from sites quite close to the sea for example, 'Koh-i-noor' had been found at Kolleru which is not far from the mouth of the Krishna. The occurrences of such tertiary nature show that these dislodged diamonds had started their journey to the sea along different rivers. The Krishna and to some extent the Pennar (and Godavari) apparently were the most important corridors of such transport to the Bay of Bengal, along the Coromondal Coast, which is the ultimate repository of the placer diamonds (Ravi et al., 2018).

The sediment distribution map along the AP coast shows a patch of sands (probably of the relict type, belonging to the Pleistocene) occurs in the offshore areas on the continental shelf between the mouths of the Krishna and the Pennar. There is a possibility that gravels may occur in this patch; earlier methods of sampling were ineffective in collecting samples when the bottom used to be gravelly. Such gravels, if present, could contain diamonds brought down by rivers in the past which might have originated from the primary source area and debouched into the Bay of Bengal.

The sediment distribution map of the seabed compiled by MCSD, GSI shows the presence of sands in an elongated patch between lat. 14°50' and 15°35' and long. 80°05' and 80°42'E. This patch occurs in between the mouths of the Krishna and the Pennar, though not near the mouths of these. Hence, an area of 7000 sq.km has been delineated in the offshore sector for prospecting diamond especially in the relict sand body (Fig.4 & Fig.6).

2. Previous Work

Presence of microdiamonds in the beach sediments of Andhra Pradesh

AMD has reported microdiamonds at the mouth of Krishna River from beach sediments in 2005 (Anil Kumar et al., 2005). The microdiamonds collected are colourless to brownish yellow and contain inclusions. Since the diamonds are not in coarser size fractions i.e. found only in 425,250,177,150 and 105 µm the identification was purely based on microscopic studies.

Confirmation of presence of palaeo channels in the proposed area

The Geological Survey of India conducted G4 level Reconnaissance to examine the quaternary formations and geomorphology of the western Krishna delta, spanning from Revendrapudu to Tsunduru in Guntur district, Andhra Pradesh. This region comprises an inner fluvial delta surrounded by a pediplain to the west. The fluvial delta exhibits active channels, levees, flood basins, and palaeochannels, each showcasing distinct lithological units. The convergence of Modukuru and Tenali palaeo-channels occurs west of Tenali, stretching northwards to Tadepalle.

Presence of alluvial sediments in the down steam of proposed Exploration block

The research topic described in the paper "Preparation of profiles of Quaternary deposits in Krishna delta, east coast Andhra Pradesh (under IGCP-475)" by Shah et al., 2006, focuses on analyzing the subsurface composition of the Quaternary delta profile from Amrutuluru towards the inland area, near the present shoreline of Nizampatnam bay. Five stratigraphic boreholes were drilled on the western side of the delta, spanning a length of 21 linear kilometers, with basement depths ranging from 110 to 180 meters having 48 to 94m thick medium to coarse gravelly-sand unit intersected at the base and it continues in all the boreholes between Amrutuluru and Nizampatnam, within the Survey of India T.S.Nos.65D/12 & 66A/9. The reported clayey sediments contains Higher lanthanides, zirconium, Co (up to 171 ppm), Y (67 ppm) and Zr (191 ppm) values. XRD data indicates the presence of small amounts of anorthite, sanidine, talc, amphibole and leucophyllite in the samples. Though the geochemistry of sediments indicate a dominant granitic province, but contributions from the ultramafic sources (anorthite, talc) or potassic ultramafic rocks (sanidine, amphiboles) are also indicated from trace chemistry and mineralogy. In view of the above, the substratum of the Mangalgiri Block has been chosen to prospect for the gravel beds. If present, such gravel beds could contain diamond bearing detritus.

Further work by ONGC indicates that the sediment deposition, consisting of a substantial volume of loose to semi-consolidated gravel, sand, silt, and clay, occurred in a frequently changing depositional environment and the basement depths were recorded between 115m to 185m in the boreholes drilled at Uppugunduru and Kanuparti (P.V.L.P.Babu, 1975 of ONGC).

Stratigraphic succession from Shah et al., 2006. Please note medium to coarse gravelly sand at the bottom.

Lithology	Environment
Upper cover of sandy/silty unit	Sub-aerial/fluvial/ aeolian
Dark grey silty clay unit	Marine / lagoonal
Brown silty clay unit with sand horizons oxidized	Fluvial /sub-aerial
Medium to coarse yellowish sand with silty clay	Tidal flat- marine with inter mittent sub-aerial exposure
Greyish clay with mottled texture	
Grey sand & silty clay with pie-sized calcrete	Fluvial
Sand-clay alternation Sticky brown silty clay with calcretes	Marine
Medium to coarse gravelly sand with calcrete and horizons of silty clay.	**Fluvial**

Note: The proposed exploration block is situated approximately 40 kilometers north of the previous study area conducted by Shah et.al., 2006, and roughly 76 kilometers from BH1 (Uppugunduru) and 87 kilometers from BH2 (Kanuparthi) of ONGC (Fig.5). Consequently, it is anticipated that the thickness of alluvial sediments in the proposed block, located upstream, will be much lesser.

The Palaeo channels P1 and P2 were delineated using Landsat Imagery as shown in Fig.6. In addition, 7000 sq.km area has been identified in the Bay of Bengal in proximity to the Krishna Delta between Krishna and Pennar River mouths based on the presence of relict sands in the shallow waters (O1 Block in Fig.6).

Palaeo-channel 1(P1) : This palaeo channel is identified on the left bank of the river and extends from the apex of the delta i.e from the Guntupalli covering Vijayawada, Velpuru and branches at south of Godavaru covering an area of about 410 sq.km. During the field studies it was found that the area (in an around covered by the palaeo-channel predominantly comprised of black clay underlain by coarse sand.

Palaeo-channel 2 (P2): This palaeo channel is identified on the right bank of the Krishna River and extends from Prathur and flowed due southerly till Tenali, where it branches. The area covering by P2 is about 300 sq.km . The main plaeo channel shows its trend southerly and the other one towards east. During the field studies it was found that the area in an around covered by the palaeo-channel predominantly comprised of black clay underlain by coarse sand.

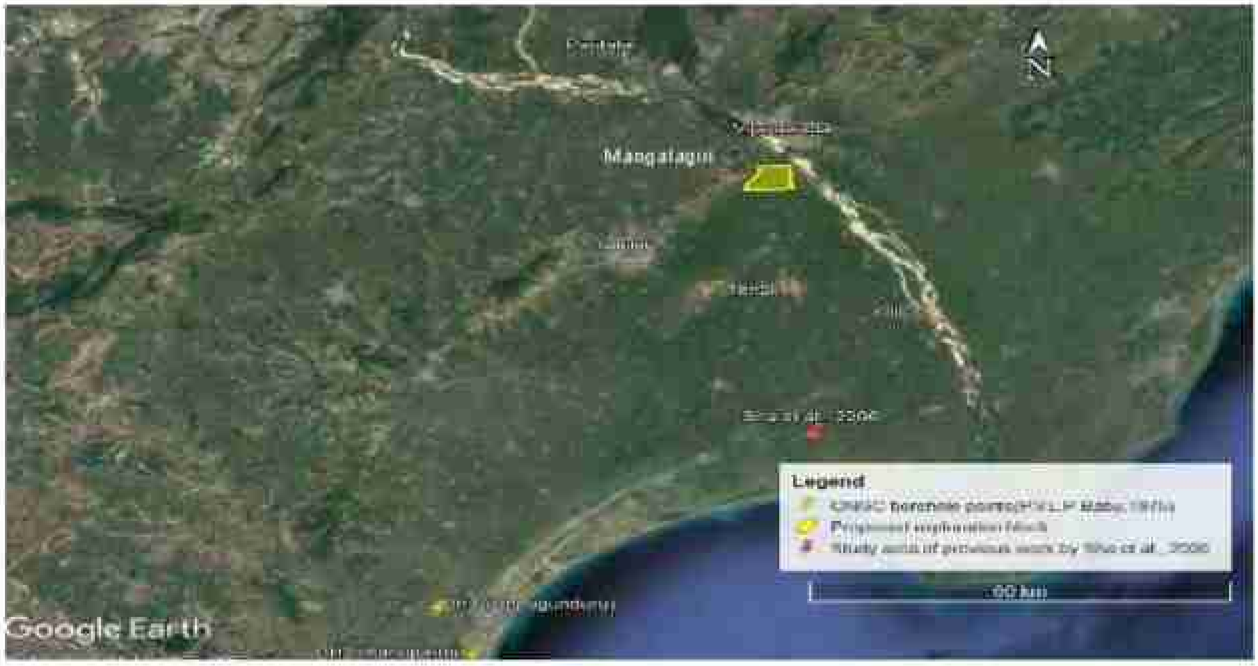


Fig.5: Google Imagery Showing Study area of previous works by B.M. Shah et.al., 2006, Borehole points of ONGC (P.V.L.P.Babu, 1975) and Proposed Mangalagiri Block

3. Block description

Table-1. Boundary coordinates of Proposed Mangalagiri Block, Andhra Pradesh

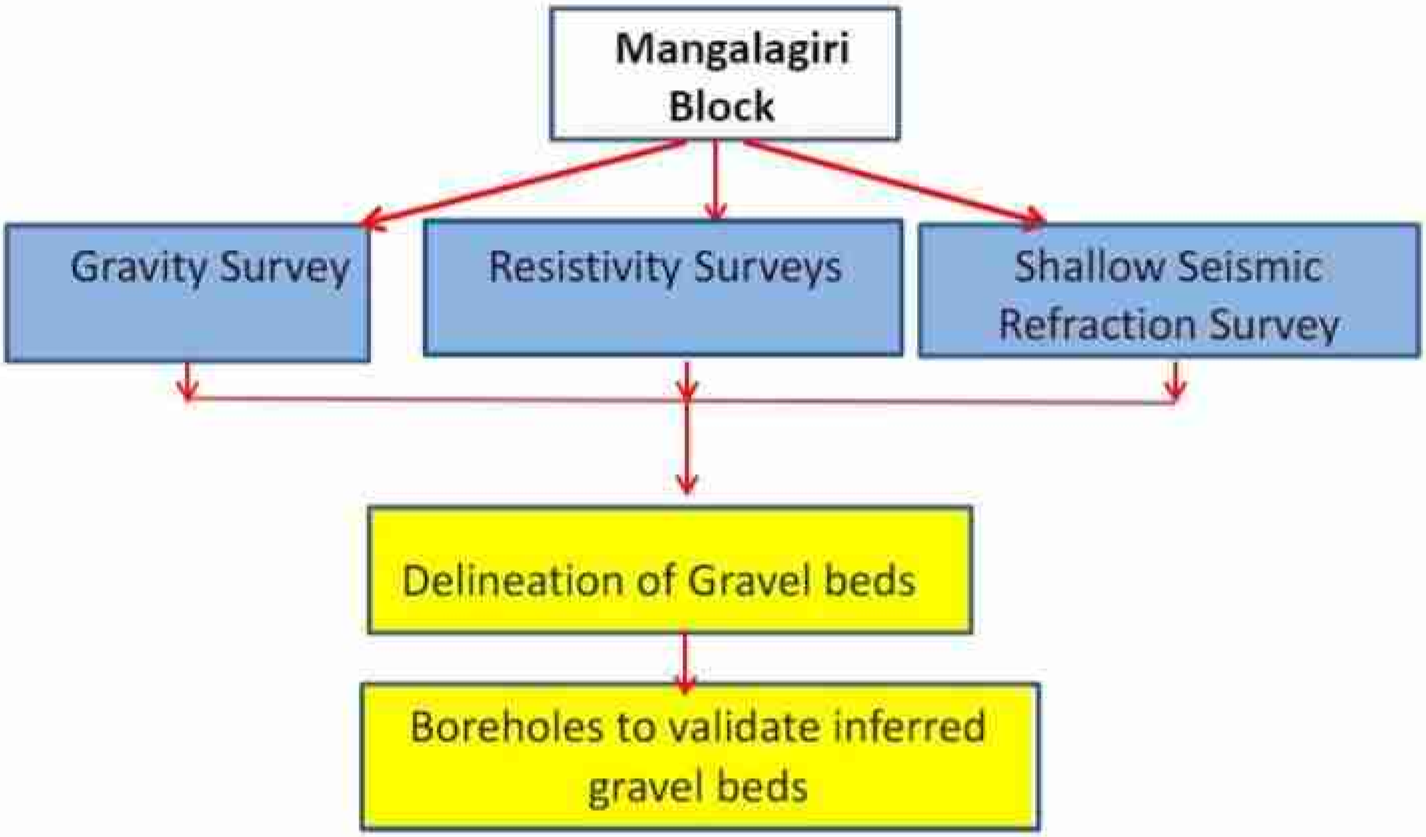
Sl.no	Longitude (dd)	Latitude (dd)
1	80.61026	16.44944
2	80.61113	16.44656
3	80.60914	16.43721
4	80.60601	16.43198
5	80.59557	16.42019
6	80.59152	16.41079
7	80.65509	16.41103
8	80.65192	16.41953

9	80.65177	16.4248
10	80.65282	16.42972
11	80.65139	16.44235
12	80.65062	16.45017
13	80.61026	16.44944
14	80.61026	16.44944
15	80.61113	16.44656

4. Planned Methodology

Scope of Work: All these factors presented above suggest the entire area delineated as P1, P2, and O1 (Palaeochannels-1, 2 and offshore area) may be subjected to G4 level prospecting for diamond. The total area demarcated is large and covers approx. 8000 sq.km.

Hence to start with, as a test case, a small area of 22.6 sq.km comprising part of palaeo-channel-2 (P2) is being proposed for G4 level prospecting for alluvial diamonds by geophysical surveys followed by two test drilling (Auger core drilling up to 50 m depth) to encounter the interpreted gravel beds if any for validation purpose (Fig 6,9 &10)).



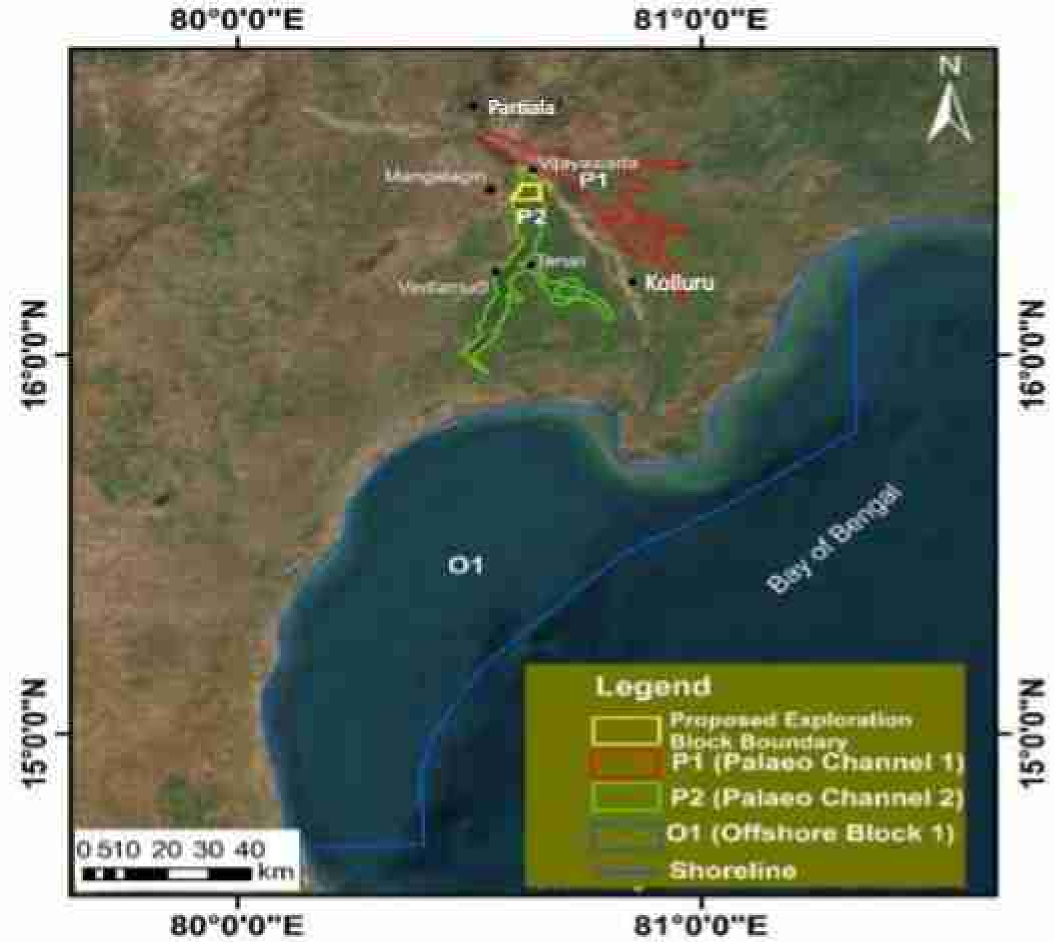


Fig.6: Google Image Showing Probable Locations (P1, P2 and O1 Blocks) for Alluvial Diamond Exploration vis-à-vis Proposed Exploration Block (Mangalagiri) within P2.

Proposed Geophysical Surveys for Exploring Gravel beds

Geophysical exploration can be carried out by gravity survey followed by resistivity and seismic refraction surveys to identify gravel zones embedded within the alluvium in the demarcated block within the Paleo river channel (P2).

Gravity survey

Gravity survey can be carried out by CG-5 gravimeter, which gives a resolution of 0.001mGal. An anomaly ranging from micro to miiliGal may be expected by the gravel bed from gravity anomaly map. To achieve the goal, 50m x 250m grid may be preferable to undertake the gravity survey i.e., every 50m there should be a gravity observation, measured in micro to milli Gal range. As such about 23 sq. km. area may contain 1901 observations. Using suitable bench mark in the nearby survey area, the elevation will be transferred to calculate the elevation of the observation points w.r.to MSL at all Gravity observation points. As such 1901elevations should be recorded by DGPS survey with respect to MSL. After applying necessary corrections Gravity map can be prepared by Surfer software. From the gravity map, anomaly zones can be traced out to conduct seismic refraction survey. A photograph of CG-5 Gravimeter is shown in Fig.7.

Resistivity profiling

Resistivity profiling with twin separation will ensure the lateral variation of resistivity enabling to identify the gravel bed along the traverse.Total 20 lkm of profiling along 5 traverses with 4Lkm on each is proposed with AB/2 10m, 30m etc at various depths and station interval 10m to understand the lateral variation of resistivity pertaining to different depth. This will provide cumulative resistance of various strata from which resistivity high in the profiles indicate the gravel beds.

Vertical electrical sounding survey

Vertical electrical sounding (VES) enables to understand the nature of strata at depth and the extend of gravel bed based on apparent resistivity estimation. On an average 5 VES survey are proposed based on the outcome of resistivity profile with maximum AB/2 200m along each 5km traverse. By conducting 5 VES surveys on each traverses amounting to 1 lkm, a total of 5Lkm resistivity data will be collected on all 5 traverses. On analysis of the sounding data the apparent resistivity of different strata can be obtained. This information distinguishes the gravel zones, with a characteristic resistivity high with respect to the adjacent strata, in the subsurface. VES survey will be limited to the anomaly zone identified by profiling.

Seismic Refraction Survey

This will be carried out by a portable seismic refraction instrument, which can be deployed across the anomaly zone depending on the length and width of the anomaly. Refraction can be conducted in mutually perpendicular directions. A seismic signal generator which generates 4000 to 4500 joules of impact energy on the Earth's surface will be deployed. Geophones can be judiciously aligned 120m to 200m depending on the requirement. The area is expected to have a bedrock depth of the order of 50m, above which, soil, sand, alluvium embedded with gravel beds are present. Refraction survey depends on the acoustic impedance (velocity x density) contrast. The available information as per the literature for litho units can be considered as follows:

	Litho units	Velocity
1.	Soil	400 – 800 m/s
2.	Sand (wet)	800 – 1200 m/s
3.	Gravel zone filled with dry alluvium and sand	500 – 900 m/s
4.	Gravels zone filled with wet alluvium and sand	1100 – 1600 m/s
5.	Fractured rock (if any)	1800 – 3000 m/s
6.	Hard rock	4000 – 5500 m/s

Seismic refraction survey will be limited to the anomaly zone, identified by the gravity and resistivity surveys. Seismic refraction survey are planned at VES sounding locations having traverse length 240m with forward and reverse shots amounting to 0. 480 Lkm at each station. On an average 5 such stations on a 1 km traverse provide 2.4Lkm. On all 5 traverse 12 Lkm of seismic refraction survey can be conducted. Photograph of seismic signal generator is shown in the Fig.8.

Fig.7: CG-5 Gravimeter

Fig.8: Seismic Signal Generator

Combination of gravity, Resistivity (profiling and VES) and seismic refraction surveys:

The residual gravity identifies the variation of density/mass distribution in the subsurface which may highlight the presence of gravel bed and resistivity profiling enables to confirm the lateral variation of resistivity to trace the gravel bed along the traverse. VES at the probable locations may enable to distinguish gravels associated with alluvium at depth.

Seismic refraction survey analyses thickness of different strata and its velocities viz; sand, wet soil, gravels associated with alluvium, fractured rock, hard rock/ basement etc., where by the depth of different strata can be estimated.

The combination of gravity, resistivity profiling, VES and seismic survey gives the distribution of gravel beds at depths and its lateral extension.

Resistivity investigation may be affected by under laid strata due to possible occurrence of water at places, which can be sorted out by gravity survey.

Why magnetic and GPR surveys are not preferred?

i) Magnetic survey:

The expected magnetic anomaly of the gravel bed from the prevailing geological environment may be of the order of 20 – 30nT. (?). To achieve this accuracy the following factors may be a hindrance:

1. Diurnal variation of the magnetic anomaly may be of the order of 30 – 40 nT
2. Drift in the instrument may vary according to temperature
3. Buried and unnotified pipelines, ferromagnetic materials near the observation points

4. Adjacent power lines (if any)
5. Concrete buildings nearby (if any)

From the above noises filtering is not practical to get an anomaly of the order of 20 – 30 nT

ii) Electromagnetic – GPR survey

In wet conditions within paleochannels, electromagnetic waves will be absorbed, limiting the depth of investigation. Also, the depth probe of GPR survey is limited from 5 to 15m in ideal conditions such as dry soil and di-electric contrast between different materials. Since the depth probe is of the order of 50m GPR survey may not be dependable.

5. Nature Quantum and Target

Table 2: Nature, Quantum and Targets

Sl. No.	Description of Work	Quantum (Sq.km / Number)	Time required
1	Geophysical Survey	22.6 Sq. km	
1.1	Gravity Method- Regional/Detailed (at 50m x 250m grid interval over 22.6 Sq.km)	1901stations	120 days
1.2	High resolution Seismic Survey - A Source: Hammer/Weight drop &Equipment: 24 Channel r ecording Group Interval: 5m (12 foldage) & within 300 m	12 km	30 days
1.3	Electrical Resistivity Sounding	5Nos	20 days
1.4	Resistivity profiling	20 km	60 days
2	Diamond drilling upto 50m BGL	2 no.s	15 days
3	Report writing	1	60 days

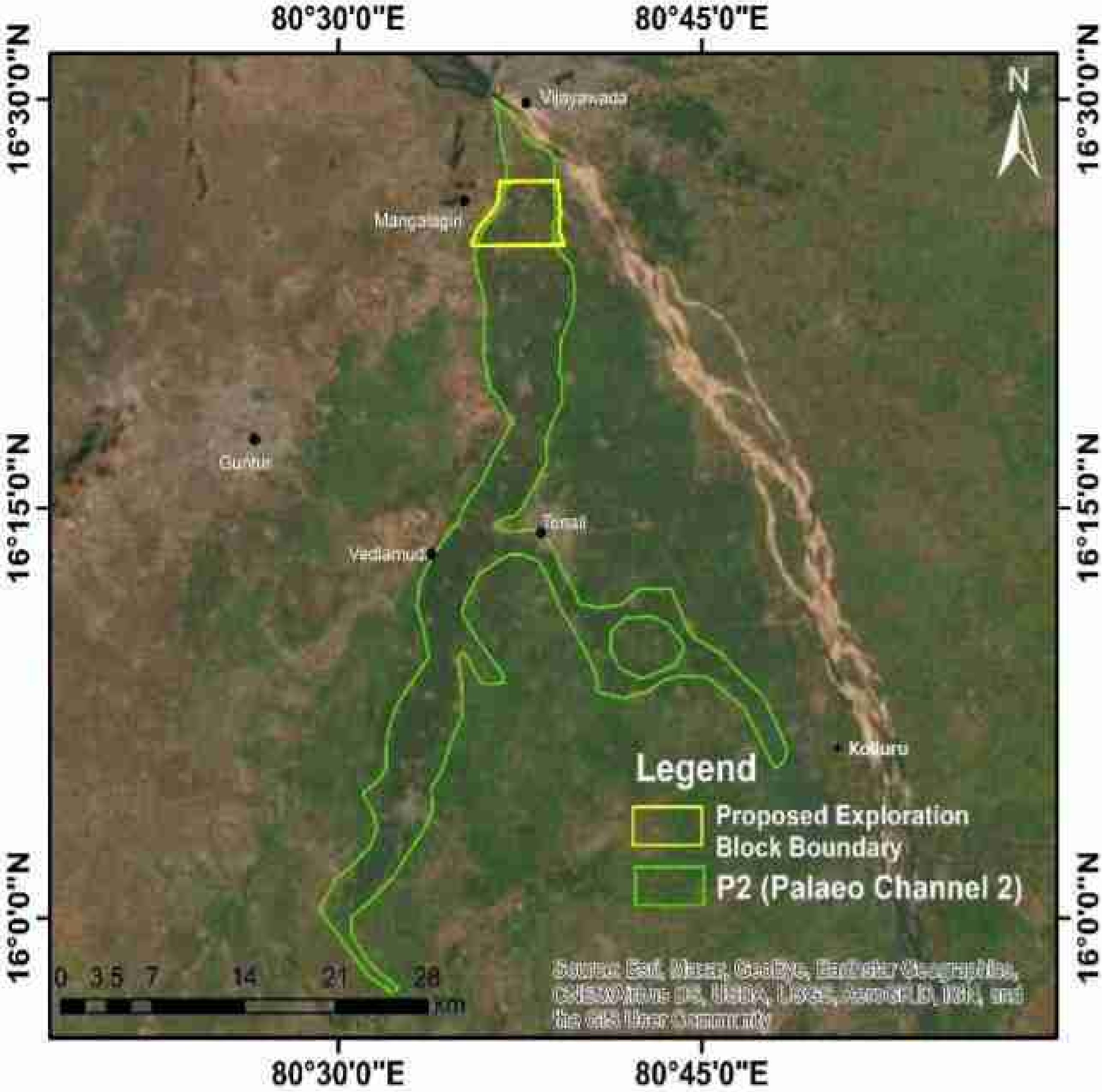


Fig.9: Enlarged view of Proposed Mangalagiri Block within P2.

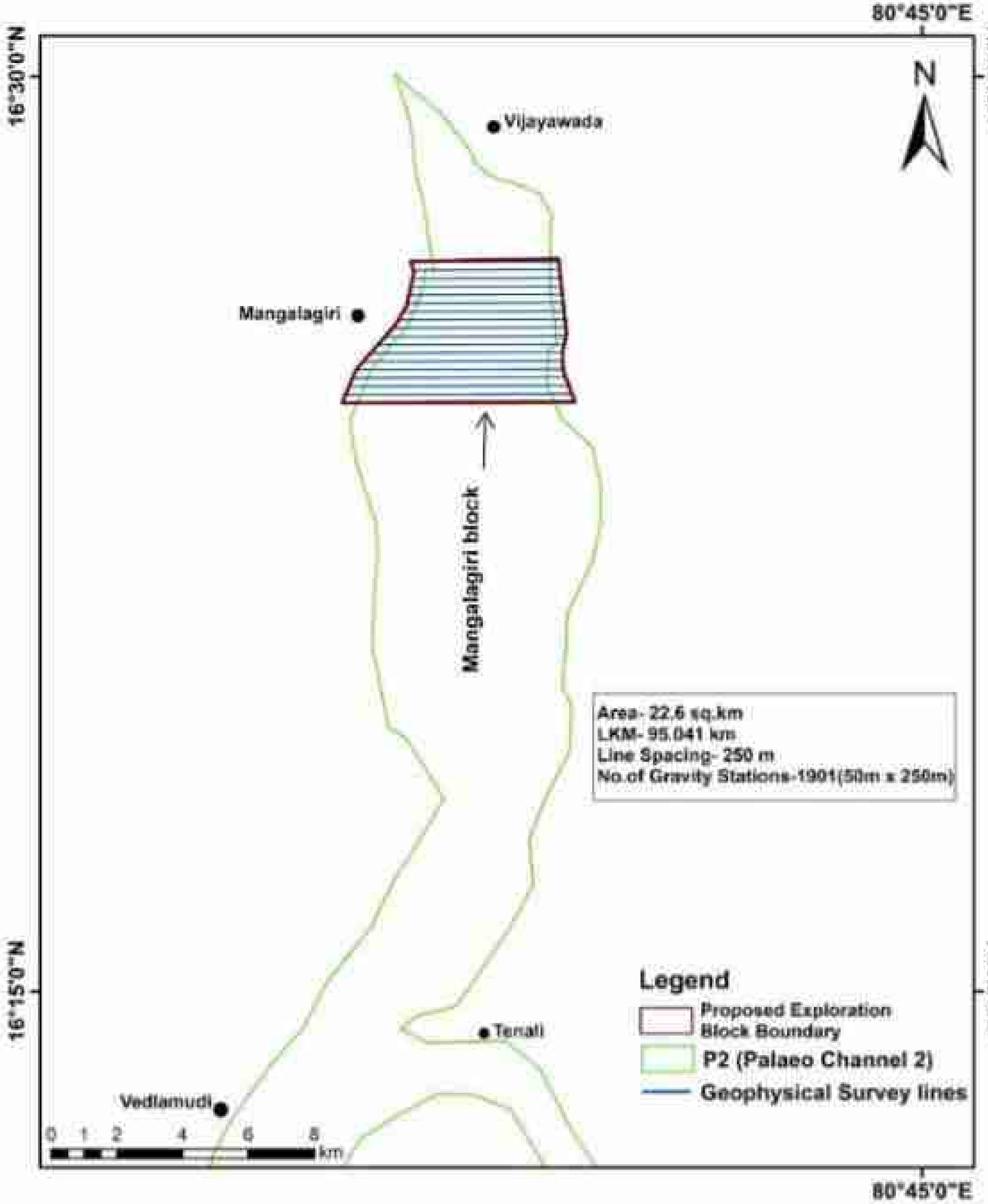


Fig. 10: Proposed Mangalagiri Block with Geophysical survey tracks for G4 Level Prospecting for Diamond. (Note that the 1901Gravity measurements @50m x 250m interval will be caried out within the proposed block)

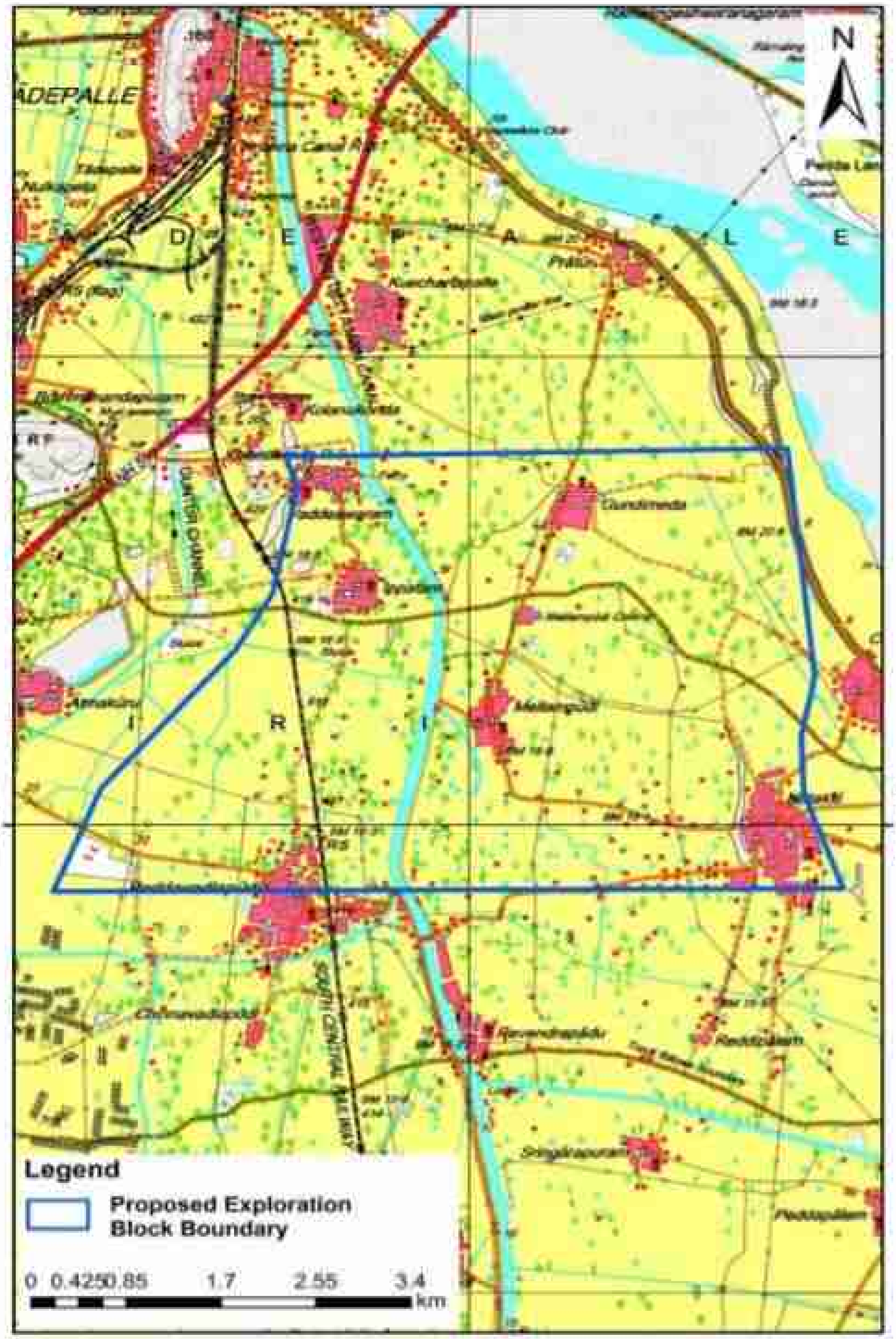


Fig.11: Proposed Mangalagiri Block on Toposheet NO. 65D/11

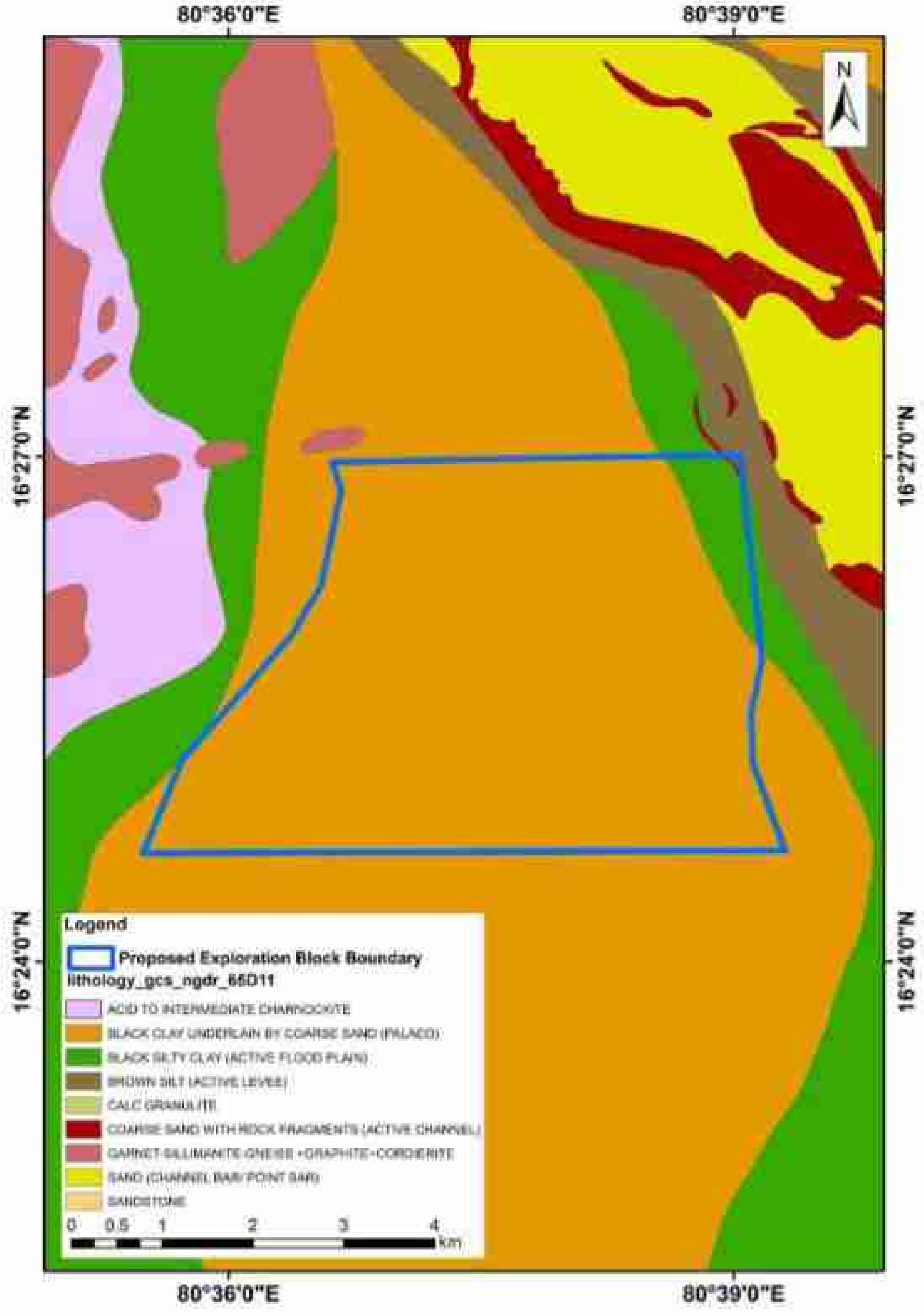


Fig 12. Proposed Mangalagiri Block on 50 K Geological map

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Table 3: Mangalagiri block Exploration (G4) timeline

S. No.	ACTIVITIES	DAYS	MONTHS													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Camp Setting	60														
2	Geophysical survey	225														
3	Geophyscist party days (HQ) for data interpretation & Report	60														
4	Surface Drilling (2 rigs)	15														
5	Geologist Man days	15														
6	Camp Winding	15														
7	Report Writing with Peer Review	60														

Table 4: Cost table for G4 level Geophysical and Geological Prospecting for Diamond in part of a palaeo-channel near Mangalagiri, Guntur District, Krishna basin, Andhra Pradesh.

Cost table for G4 level Geophysical and Geological Prospecting for Diamond in part of a palaeo-channel near Mangalagiri, untur District, Krishna basin, Andhra Pradesh.							
S. No.	Item of Work *	Unit *	Rates as per NMET SoC 2020-21		Estimated Cost of the Proposal		Remarks
			SoC-Item No. *	Rates as per SoC * (a)	Qty. (b)	Total Amount (Rs) (a*b)	
A	**Geophysical Mapping Other Geological and Geophysical Work & Surveying**						
	Geophysical mapping, & drilling work	**22.6 sq.km**					
i	a. Charges for Geophysicist (120*1-gravity, 30*2-seismic, 15*2-sounding, 60*2-profiling)	day	**3.18**	11,000	330	3630000	

ii	b. Labours Charges; Base rate-2 labourer per day (5 labourer*30-seismic; 6 labourer *60-electrical profiling.; 5 labourer *15 -elec.sounding; 2 labourer*120 -gravity)	day		504	825	415800	
iii.	c. Charges for Geophysicist per day (HQ)(15-gravity) & 15-seismic, 30-elctrical sounding & profiling)	day	**3.18**	9,000	60	5,40,000	
i	a. Charges for Geologist per day (Field) for **drilling work**	day	1.2	11,000	15	1,65,000	
ii	b. Labours Charges; Base rate (2 labourers)	day		504	30	15,120	Amount will be reimbursed as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher.
	Sub Total- A					**47,65,920**	
B	**Ground Geophysical Survey**						
1.a	Gravity Method-Regional/Detailed (22.6 sq.km depending on the objective)250 m line spacing, 50 m station spacing	**per station**	**3.1a**	**3800**	1901	72,23,800	

1.b	High resolution Seismic Survey- A. Source: Hammer Weight drop &Equip: 24 Channel- 2. Group Interval: 5m (12 Foldage) & within 300 m	Per Line km	**3.13b**	3,03,437	12	36,41,244.00	
	Elec Resistivity (sounding)	stn	**3.5. a**	70,650	5	10,59,750.00	
	Resistivity profiling	I km	**3.6.c**	3,00,000	20	60,00,000.00	
	Sub Total- B					**1,79,24,794**	
C	**Survey work**						
a	**DGPS Survey for BH -RL fixing**	day	**1.6.1a**	8,300	3	24900	
b	Labours Charges for DGPS survey;2 labourers	day		504	6	3024	
Sub-Total C						**27924**	
E	**DRILLING (after review)**						
1	Drilling in unconsolidated sediments for boreholes up to 50m	Per m	**2.2.2**	4,760	50 m*2	**4,76,000**	
5	Transportation of Drill Rig & Truck associated per drill	Km	**2.2.8**	36	994 km	35784	
6	Monthly Accomodation Charges for drilling Camp	month	**2.2.9**	50,000	15 days	25,000	
7	Drilling Camp Setting Cost	Nos	**2.2.9a**	2,50,000	1	250000	

8	Drilling Camp Winding up Cost	Nos	**2.2.9b**	2,50,000	1	250000	
10	Drill Core Preservation	per m	**5.3**	1,590	50 m*2	1,59,000	
Sub-Total E						**11,95,784**	
H	**Total A to E**					**2,39,14,422**	
I	**Geophysical Report Preparation**	**5 Hard copies with a soft copy**	**5.2**	Exploration cost of work exceeding 150 lakhs but less than 300 lakhs: A Minimum of ₹ 7.5 lakh or 3% of the work whichever is more		7,17,432.66	Reimbursement will be made after submission of the final Geological Report in Hard Copies (5 Nos) and the soft copy to NMET.
						2,46,31,854.66	
J	**Peer review Charges**		**As per EC decision**				
K	**Preparation of Exploration Proposal (5 Hard copies with a soft copy)**	**5 Hard copies with a soft copy**	**5.1**	2% of the Cost or Rs. 3.8 Lakhs whichever is less		3,80,000.00	EA will be reimbursed after submission of the Hard Copies and the soft copy of the final proposal along with Maps and Plan as suggested by the TCC-NMET in its meeting while clearing the proposal.
L	**Total Estimated Cost without GST**					**2,50,11,854.66**	
M	**Provision for GST (18% of J)**					**45,02,133.84**	

N	Total Estimated Cost with GST	2,95,13,988.50	
		or Say Rs. In Lakhs	295.139 Lakhs
Note:			
1	Strict adherence to the Ministry of Finance's and GFR guidelines is mandatory. Every transaction must adhere to GFR rule 21.		
2	In case of delay/non- performance, the appropriate action will be taken by competent authority against delinquent agency as per prevailing govt. of India rules/guidelines on procurement.		
3	If any part of the project is outsourced, the amount will be reimbursed as per the Paragraph 3 of NMET SoC and Item no. 6 of NMET SoC. In case of execusion of the project by NEA on its own, a Certifiate regarding non outsourcing of any component/project is required.		
4	Necessary efforts should be made to minimize any adverse impact on the environment during exploration activities.		
5	Any item of work not mentioned above shall be added as per SoC.		
*	SoC Item No, Unit and Rate for each item of work must be as mentioned in the SoC.		