PROPOSAL FOR PRELIMINARY EXPLORATION (G3) FOR Ni, Co, PGE and REE/ASSOCIATED MINERALS IN J C PURA MAFIC-ULTRAMAFIC SCHIST BELT NEAR RAMPURA AND GOLLARAHATTI BLOCK, HASSAN DISTRICT, KARNATAKA

PROPOSED AREA 2.00 SQ.KM

(BLOCK ID N0: SRO-15473-M2APMM-MEP/NC/SR/SU/-KG/2018/18837)

To

NATIONAL MINERAL EXPLORATION TRUST (NMET)

(Through DEPT. OF MINES & GEOLOGY,

GOVT OF KARNATAKA)

Submitted by

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(AS PER NMET FORMAT)

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Summary of the Block for Preliminary Exploration (G3 Stage)

General Information about the Block

Sl.NO	**Features**	**Details**
I	Block ID	SRO-15473-M2APMM-MEP/NC/SR/SUKG/2018/18837
II	Current Exploration Agency	GeoExpOre Private Limited
III	Previous Exploration Agency	G4 Stage by GSI
IV	G4 stage Geological Report (Previous stage Geological Report)	RECONNAISSANCE SURVEY FOR Ni-PGE AND GOLD BETWEEN RAMPURA AND GOLLARAHATTI AREAS OF J. C. PURA MAFIC-ULTRAMAFIC BELT, HASSAN DISTRICT, KARNATAKA (STAGE-G4)-***Enclosed as Annexure-1***
V	Commodity	Ni, Cobalt, PGE /REE & Associated minerals (Au, Cu etc)
VI	Mineral Belt	J. C. Pura mafic-ultramafic Schist belt, Hassan District, Karnataka
VII	Completion Period with entire Time schedule to complete the project	10 months.
VIII	Objectives	Identification of Ni, Co, PGE, Au in altered ultramafites; and REE/associated minerals in intrusive gabbro/ granite/ pegmatite and quartz veins.
IX	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	Proposed Agency and Outsourcing agencies, which are empanelled by NMET through GeoExpOre Pvt Ltd Surveying: Mr. Shri Saila, Sandur or any other component agency Drilling: GEO TECH EXPLORATION 51, Panchdeep Nagar, Wardha Road, Nagpur - 440024 Lab Tests: PSY PSN MY# Analytical & Quality Services Pvt Ltd, Vizag, or Any other competent agency Govt labs will be used whenever required (HGML, IBM, NGRI, IIMT (CSIR) & GSI
X	Name/ Number of Geoscientists	02 Geologists, 01 Surveyor 02 Geophysicist, 01 Geochemist, 01 Remote sensing Expert, 01 Hydrogeologist, 02 Sampling Assistant 08 Labours

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XI	Expected Field days (Geology) Geological Party Days	Activity wise Party days are given in Quantum of Work and Cost estimates For geological mapping and geochemical survey, Pitting/Trenching 120 days with 2 Geologist and labours Survey work for 30 days for block boundary and surface features and labours One Geological Party 90 days for geological activity and drilling programme Sampling Party days(1party) 60 days for BRS, SS, Soil sample crushing, powdering, coning quartering and packing. Sampling Party days (1 Party) 90 days for Drilling Programme -Core splitting, powdering, coning quartering and packing One Surveyor party 30 days for BH fixation, determination of Reduced Level, Coordinates & surface contouring Four labours 240-man days for geological mapping, sampling, geochemical survey Two labours 180-man days for drilling programme including sampling preparation One Geophysical party 30-day Ground geophysical survey & 2 Labours 60 man days for geophysical survey 15days for 1 Remote Sensing Expert
1	Location	Rampura and Gollarahatti villages, Hassan District, Karnataka.

	Latitude & Longitude	<table><tr><th>Block Corner points Cardinal Points</th><th>Latitude</th><th>Longitude</th></tr><tr><td>A B C D E F G</td><td>N 13° 26’ 32.39” N 13° 26’ 32.19” N 13° 25’ 50.58” N 13° 25’ 39.59” N 13° 25’ 39.59” N 13° 26’ 13.50” N 13° 26’ 13.58”</td><td>E 76° 22’ 27.96” E 76° 23’ 05.17” E 76° 23’ 29.33” E 76° 23’ 29.33” E 76° 22’ 42.58” E 76° 22’ 42.81” E 76° 22’ 27.85”</td></tr></table>
	Villages	Rampura and Gollarahatti villages
	Tehsil/ Taluk	Arsikere
	District	Hassan
	State	Karnataka
2	Area (hectares/ sq.km)	2.00 Sq.km
	Block Area	2.00 Sq.km
	Forest Area	Nil
	Government Land Area	0.80 Sq.km (40%) hilly terrain (Govt. Land)
	Private Land Area	1.2 Sq.km (60%) Cultivation land (Private Land)
3	Accessibility	Good network of motorable (non-metalled and metalled) roads
	Nearest Rail Head	Arsikere, located at the distance of 23 Km
	Road Airport	Bangalore Located at 166 Km
4	Hydrography	There is no major River in the area. The major second-order streams flow from ENE to WSW near Rampura. Streams and borewells are the main source of water for the cultivation.
	Local Surface Drainage Pattern (Channels)	The drainage system in the area is mainly controlled by lower order streams and few second-order streams (during monsoon). Few water ponds are available during summer.
	Rivers/ Streams	Major Rivers are absent in the study area. The major second-order streams flow from ENE to WSW near Rampura. Besides, several first-order streams flow westerly from the hills exposed to NE of Rampura village during the monsoon periods.
5	Climate	The climate is generally hot in summer and cold in winter. The winter temperature averages between 14°C and 26°C, summer temperature is between 19°C and 35°C. maximum temperature is in April.

	Mean Annual Rainfall	The average rainfall of the Arsikere area is 517 mm.
	Temperatures (December) (Minimum) Temperatures (June) (Maximum)	14°C 35°C.
6	Topography	The elevation varies from 780 to 860m above mean sea level and the highest peak is 871m located east of Rampura village.
	Toposheet Number	57 C/7
	Morphology of the Area	Hilly terrain
7	Availability of baseline geoscience data	--
	Geological Map (1:50K/ 25K)	Available 1:2000 Scale (GSI)
	Geochemical Map	Available -1:2000 Scale (GSI)- Partial area
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	1:15,000 Scale - (GSI report) Maps attached

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8	Justification for taking Preliminary Exploration under G3	GSI has carried out reconnaissance survey during the field Season(FS) 2018-19 covering an area of 2.00sq.km which includes geologically mapped on 1:2000 scale, along with geochemical exploration, pitting/trenching and also collected BRS, PTS, SSS & SS samples . Significant PGE content to the tune of >1.2 ppm (1230 to 1333 ppb) recorded in 1st order stream sediment samples flowing through serpentinite regions around NE of Gollarahatti village may be more favourable for PGE mineralization. The bedrock samples of serpentinite and spherulitic serpentinite yielded poor concentration of Au, i.e. < 25 ppb. While, Ni concentration in spherulitic serpentinite varies from 190 to 1020 ppm and in serpentinite varies from 60 to 335 ppm. Ni concentration in gabbro varies from 95 to 545 ppm. All the gabbro samples (n=10 nos.) shows +ve Ce and –ve Eu anomaly with its different range of REE concentration. The ΣREE (La-Lu) concentration of pegmatite (n=08) varies from 17 to 58 ppm The EPMA study reported Pt-As-Fe inclusion in association with barite in chrome-bearing magnetite in serpentinite indicating possible hydrothermal alteration of original Pt-Fe composition. GSI recommended for bedrock sampling in serpentinite especially in the highly oxidized, limonitized part has to be carried out in a closer interval to NE of Gollarahatti village. The details of surface/ subsurface (pits/old work) Geological, Geochemical, Geophysical (Ref: *GSI Field Season 2014-2015 & 2018-19)* data are given in **Annexures-1 and Plate No.4.** Based on desktop study and the recommendations of GSI, the area is considered that the geological signatures are very favourable for exploring these Ni, Co,PGE/REE,

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		Au, Cu in the area. It is planned to carry out preliminary exploration (G3 Stage). The area falls under Toposheet No. 57 C/7 ⇒ It is proposed to explore the target blocks by way of Geological mapping on 1:2000 scale. It is also carry out Geophysical and Geochemical investigation in the blocks ⇒ Based on the positive outcome of the surface Exploration techniques, delineation of the main target mineralized zone at the surface will be carried out. After the delineation of the mineralized zone it is planned to explore the depth persistence of the mineralization by way of diamond core drilling at 60m vertical depth in stage 1. If the results are encouraging, then the stage 2 will be planned to intersection the mineralized zone at a vertical depth of 120 m as infilling. In both the stages the bore holes will be placed at an interval of 200 m apart along the strike. Before taking up drilling prior approval will be obtained from NMET ⇒ The cut-off grade for PGE of 1 ppm with the width of the ore zone more than 1.50m will be considered ⇒ With successful completion of proposed exploration with a positive result for the minerals such as Ni, C ,Co, REE , Au and associated minerals the block can be recommended for auction ⇒ In this exploration programme training, capacity building & skill development will be provided to the officers & workers. Further, exploration programme will be helpful for the socio-economic development of the area. ⇒ 3D modeling will be considered for assessment

		of mineral resources, which in turn facilitate the Department of Mines & Geology, Karnataka to carve out the auctionable blocks, which will meet NMET objectives.

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1.0 BLOCK SUMMARY

1.1 Physiography:

The area belongs to J. C. Pura schist belt which is the equivalent of Sargur Group of rocks. Eastern side of the area is occupied by prominent hills, whereas thick cultivation in the western side of the study area. The elevation varies from 780 to 860m and the highest peak is 871m located east of Rampura village. Mounds / hills and ridges are made-up of mafic –ultramafic Group of rocks. Most of the larger mounds / hills are present in the eastern part of the study area.

1.2 Background Geology (Regional Geology, Geology of the Block)

1.2.1 Regional Stratigraphy

The Precambrian shield of India has been divided into cratonic nuclei of Dharwar, Singhbhum and Bastar, surrounded by mobile belts of successively younger ages (Radhakrishna and Naqvi, 1986). The craton occupies a little less than half a million sq. km area. Dharwar craton, the northern block of Southern Indian shield, has a dominant suite of tonalite-trondhjemite-granodiorite (TTG) gneisses which are referred under the familiar term Peninsular Gneisses.

The Dharwar craton in south India is one of the best geologically documented terrains, divided into two distinct tectonic regions, the Western Dharwar Craton (WDC) and the Eastern Dharwar Craton (EDC), separated by the Chitradurga Shear Zone, close to the linear Closepet Granite. The contact between WDC and EDC is not sharp, and there is a transition zone between the Chitradurga Shear Zone and Closepet Granite. The Western Dharwar craton contains three suites of approximately north–south oriented schist belts: the oldest, the Sargur Group (Radhakrishna 1967; Viswanatha and Ramakrishnan 1976), the Peninsular Gneissic Complex (PGC) and the youngest, the Dharwar Supergroup (Ramakrishnan and Swaminatha 1976; Swami Nath et al. 1976; Viswanatha and Ramakrishnan 1976; Radhakrishna and Naqvi 1986). Generally, the younger schist or greenstone belts in the northern region are less metamorphosed than those in the southern part (Naqvi et al. 1988). WDC is an ancient terrain distinguished by Sargur Group involving the lithological assemblage of komatiite-tholeiite-BIF with minor quartzite-marble-pelite (Sargur Group, 3000-3300 Ma) enclosed in the TTG-type Peninsular Gneiss (3000-3400).

The schistose rocks comprising serpentinite, meta-ultramafic schists, potstone, amphibolite and subordinate quartzite occurs near Sasivala village was called as 'Sasivala belt and classified under Sargur group (Seshadri et al 1981). The J.C.Pura belt occurs mainly in an oval disposition to the east of J.C.Pura and continues southwards to Honnavalli village. The width of the belt varies from a few hundred metres to nearly 3 km, the maximum width being exposed between Holakere and

Rampura, the average width is 500 to 600 metres. The J.C. Pura schist belt is dominantly covered by ultramafic and meta-ultramafic rocks represented by serpentinised peridotite, dunite, pyroxenite, locally gabbro and schistose ultramafic rocks of talc-tremolite-chlorite-actinolite. The generalized regional stratigraphy for the Western Dharwar Craton is illustrated in Table-1 below.

Table-1 Generalized Regional Stratigraphy of Karnataka after GSI (2013)

Eon / Era / Epoch	**Suite/Assemblage Super Group**	**Group / Formation**	**Lithology**
Quaternary (<2m.y)		Coastal and fluvial	Undifferentiated fluvial sediments coastal. Sediments, transported red soil / alluvium
Neogene			Laterite
Mio-Pliocene		Warkalli Beds	Sandstone, clay, marl and limestone
Upper Cretaceous to Palaeocene (67-65 m.y)	Deccan Trap	Sahyadri Group	Continental flood basalt of tholeiitic chemistry with intertrappean beds of chert and marl
Neoproterozoic (650-540 m.y)		Bhima Group	Predominantly Mg poor carbonate sequence with shale, sandstone and conglomerate
Mesoproterozoic to Neoproterozoic (1000+200 m.y)		Chamundi Granite	Anorogenic K-rich porphyritic granite to homophanous granite
Mesoproterozoic (1800-1200 m.y)		Kaladgi Group	Two mega cycles of repeated sequence of argillite followed by chemogenic precipitates, limestone, dolomite, quartzite, conglomerate
Paleoproterozoic		Intrusive	Dolerite / Gabbro, pegmatite and quartz vein
Neoarchean (2500 m.y)	Southern Granulite Complex	Charnockite Suite	Pyroxene Granulite
Neoarchean (2530-2510 m.y)	Younger Granitoids	Closepet Granite	Granites, monzogranite / adamellite to granodiorite

		Chitra Durga Group (2700-2600 m.y)	Ranibennur Group
Neoarchean (2800-2600 m.y)	Dharwar Supergroup	Vanivilas Subgroup	Polymictic Conglomerate, cross bedded quartzites, Pelites, stromatolitic carbonates, cherts, BIF and manganese formations
		Bababudan Group (2800-2700 m.y)	BIF and carbonaceous phyllites, basalt-dacite suite with minor ultramafic/ alterations of amygdular basalts/ cross bedded quartzites, Pelites/minor BIF/ basal quartz pebble conglomerate
Neoarchean to Mesoarchean (2800-2900 m.y)		Older Granites	Granitoids and gneiss
Mesoarchean (3000-2900 m.y.)	Peninsular Gneissic Complex	Peninsular Gneissic Complex-I	Tonalite-trondhjemite-granodiorite
Mesoarchean (3200-3100 m.y.)	Ancient Supracrustal	Sargur Complex	Mafic-ultramafic intrusive complex (Holenarsipur Nuggehalli) / serpentinized komatiites, komatiitic and tholeiitic amphibolites cherts, BIF/garnet biotite schists, local marbles and calc silicates /fuchsite quartzites with chromite and barite layers
Palaeoarchaean (3400-3300 m.y)	Basement Gneiss	Gorur Gneiss	Trondjhemite, granodiorite, grey coloured banded biotite orthogneiss

1.2.2 Geology of the Block

Geological Survey of India (GSI) has carried out reconnaissance survey (G4) work in the proposed area covering Field Season (FS) 2018-19 in around 2.00 sq. km area and geologically mapped on 1:2000 scale. The proposed area of investigation falls under J. C. Pura Schist belt and surrounded by gneissic rocks which are the equivalent of Sargur Group in Western Dharwar craton. The detailed mapped area is dominantly covered by mafic-ultramafic rocks with in Peninsular Gneissic

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Complex (PGC). The mapped area exposed serpentinite, spherulitic serpentinite, talc-tremolite-chlorite schist, actinolite schist, chlorite schist, amphibolite, dolerite, foliated granite, pegmatite and quartz vein. Based on the field relationships and structural features, an attempt was made to establish a stratigraphy for the mapped area is given in Table-1 below (GSI Report 2018-2019):

Table-2 Stratigraphy of the study area

Quartz vein	Younger Intrusives Dolerite
Dolerite	
Foliated granite / Pegmatite	
Meta gabbro	J.C. Pura schist belt
Quartz sericite schist	
Actinolite schist	
Amphibolite / Garnetiferous amphibolite	
Chlorite schist	
Talc tremolite chlorite schist	
Serpentinite / Spherulitic serpentinite	

1.2.3. Structure:

Primary structural features such as polyhedral joints with pillow-like structures; pseudo-spinifex, ocelli and spherulite were reported in the proposed area. Secondary structures, such as cleavage and schistosity, fold, lineation, shear fabrics and fault zones are also recorded. The foliation in the rocks varies from N75°W-S75°E to N50°E-S50°W dipping 56° to 86° either way; mean dip amount is 68°. Early folds(F1) are rarely preserved; F2 folds are reclined to inclined in nature. Traces of F2 folds show reclined geometry with curved axis as recorded along the southern

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closure part. The F3 folds define the regional structure and are close to tight folds plunging in either direction with variable axial planes trending N20°W-S20°E to N60°E-S60°W.

1.2.4 Mineral potentiality based on geology, geophysics and geochemistry.

GSI carried out investigation for Nickel, Cobalt, Copper and PGE in J. C. Pura–Antaraghatta Belt, Hassan and Tumkur Districts, Karnataka under G4 stage (Tom and Kumar, 2015). The investigation involved mapping on 1:12,500 scale (100 Sq. Km area), detailed mapping of 0.50 Sq. Km along with pitting/ trenching (77 cu.m), collection of bedrock samples (61 nos.), stream sediment samples (50 nos.), petrochemistry (26 nos.) and petrography (29 nos.) to ascertain the PGE potentiality of the mafic- ultramafic rocks (MUM) of J. C. Pura belt. The investigation revealed the presence of nickel (20 to 3515 ppm), chromium (15 to 16,100 ppm) cobalt (between 35 and 330) and copper (from 10 to 340 ppm). The maximum Cu content is shown by schistose komatiitic variants; whereas Ni max, Co max and Cr max values are shown by SSS draining komatiitic flows in the SE range of Rampura village. This investigation has also reported PGE concentration from 9.5 to 158 ppm. The analyses results of 40 bedrock samples of serpentinite and spherulitic serpentinite and 30 trench samples of amphibolite, talc tremolite chlorite schist and pegmatite yielded poor concentration of Au, i.e. < 25 ppb (Ref- *Reconnaissance Survey For Ni-Pge and Gold Between Rampura And Gollarahatti Areas Of J. C. Pura Mafic-Ultramafic Belt, Hassan District, Karnataka (Stage-G4) Item No.: M2apmm-Mep/Nc/Sr/Su-Kg/2018/18837 -Field Season 2014-2015 & 2018-19).*

Further 1.50 sq. Km. area mapped by GSI during the Field Season 2018-19, covered by mafic - ultramafic (MUM) rocks classified as dunite-peridotite and pyroxenite are altered to serpentinite – chlorite and amphibolitic variants respectively. Besides MUM variants, gneiss (PGC), epidote – hornblende gneiss; quartz-sericite-muscovite schist (±chlorite) / quartz-talc schist; represent shear zones / mylonitic rocks. Granite(Arsikere/Banavara) batholiths traversed by younger gabbro/dolerite and pegmatite veins/units are recorded. The mapped area exposed serpentinite, spherulitic serpentinite, talc-tremolite-chlorite schist, actinolite schist, chlorite schist, amphibolite, dolerite, foliated granite, pegmatite and quartz vein. Out of these, talc-tremolite-chlorite schist and serpentinite occupies more part of the mapped area. The detailed geological map is depicted in Plate No 1.

Massive serpentinite is exposed between Gollarahatti and Kamasamudra, whereas schistose variant is exposed west of Gollarahatti and east of Doddaghatta. The massive variant is medium to very fine grained, pistachio green with a blotchy appearance at places with weak tectonic fabrics. Two sub-groups noticed, one with carbonate viz., dolomite / magnesite and another

hosting tremolite + talc assemblages. Opaque phases comprise of magnetite, hematite and ilmenite. Inferred serperntinite body plotted over detailed geological map of the area in between Rampura-Gollarahatti (Ref. GSI-Report 2018-2019) is given in Figure 1.

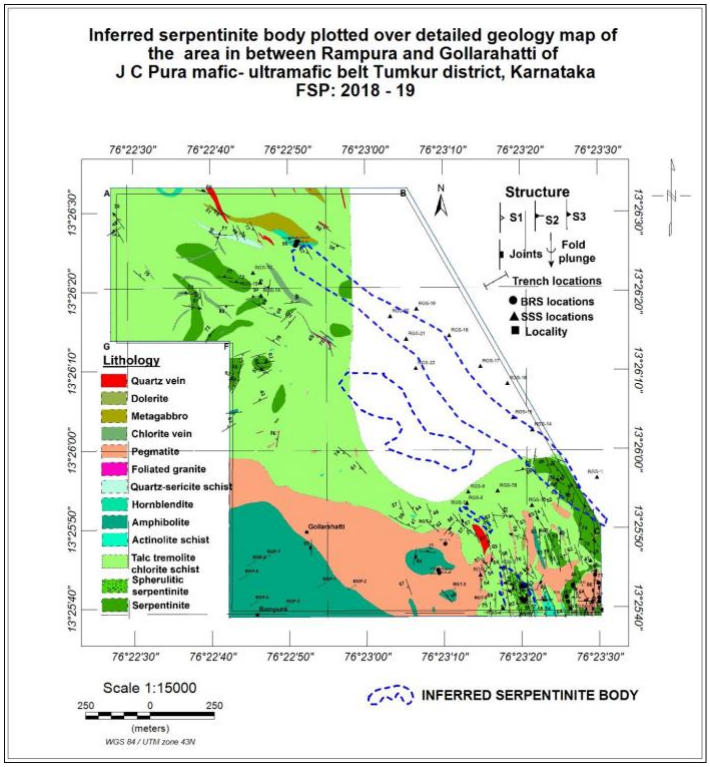

Figure 1. Inferred serpentinite body plotted over detailed geological map around Rampura – Gollarahatti area (Source GSI-2018-19)

Further, GSI has reported through EPMA studies that cobalt bearing pentlandite - pyrrhotite-chalcopyrite assemblages were identified in the study area. Two grains of palladium of bismuth – palladium (Kotulskite;1.0 micron size) were found as inclusions in pentlandite in a spherulitic serpentinite. The magnetite crystals mostly have octahedral and cubic shape in tremolite chlorite schist. Few sulfide (pyrite) disseminations were also reported near Doddaghatta.

In the study area, it was found that the ultramafic rock exhibits widespread serpentinisation, chloritization, carbonatization leading to the development of talc, tremolite, actinolite, calcite and magnetite. This mineral assemblage indicates deuteric alterations affecting the retrogression of the rocks to lower metamorphic grades. Few sulphide minerals pyrite, pyrrhotite and pentlandite are the dominant ore minerals observed in the ultramafic rocks.

The detailed geological map of Rampura-Gollarahatti is furnished in Figure 2. The significant geological features of the study area recorded during the detailed mapping by GSI are given below:

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• Demarcation of two linear bodies of spherulitic zones 150m x 50m and 50m x 20m in serpentinite to southeast of Gollarahatti village

• Demarcation of pegmatite sheets along contacts of gabbro, amphibolite and serpentinite.

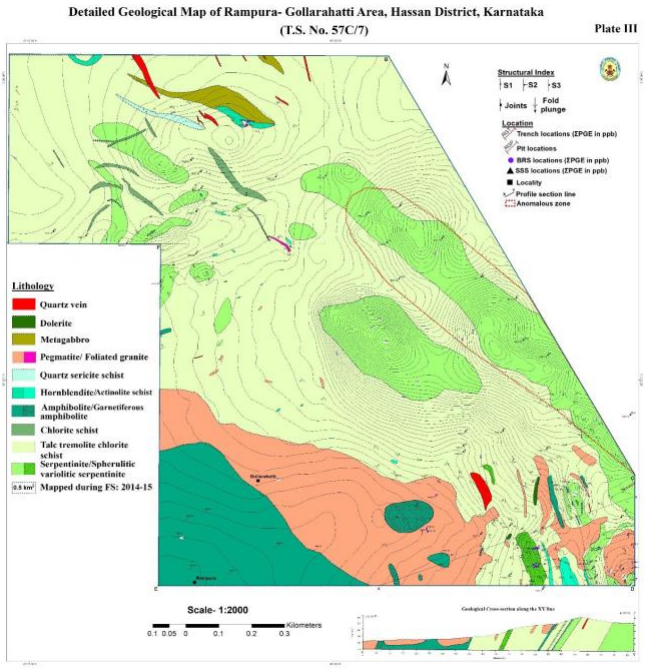

Figure 2. The detailed Geological Map of Rampura-Gollarahatti area, Hassan District. (Source GSI-2018-19)

1.3 Pitting & Trenching

A total 76 cu.m of pitting / trenching were excavated in 5 trenches namely RGT-1 (11 cu.m), RGT-2 (15 cu.m), RGT-3 (15 cu.m), RGT-4 (7 cu.m), RGT5.(7 cu.m) and 7 pits (21 cu.m) were excavated. A total of 35 nos of samples were collected from the excavated pits and 30 trench samples collected of amphibolite, talc tremolite chlorite schist and pegmatite. The results of 23 trench samples of amphibolites and 9 trench samples of talc tremolite chlorite schist show Ni concentration from 75 to 945 ppm and 65 to 430 ppm respectively. It was also reported that pegmatite body have concentrations of Au, i.e. < 25 ppb. (*Ref. GSI Reconnaissance Survey for Ni-PGE and Gold between Rampura and Gollarahatti Areas of J. C. Pura Mafic-Ultramafic belt during Field Season 2014-2015 and 2018-2019).*

1.3.1 Aerial Reconnaissance

Aerial reconnaissance study was carried out using satellite imagery, aero geophysical data and ASTER data at RSAS, Bangalore. The main objective of this study is to identify the different lithology and demarcation of lineaments present in the study area based on the tonal contrast. LISS-III (IRS-1D) satellite imagery, OLI (Operational Land Imager) data was downloaded from www.usgs.gov at Remote sensing Laboratory, RSAS, Bangalore. And the imagery was processed in ERDAS software. The lineaments were visible after made FCC for enhancing geological features. Four sets of lineaments NW-SE, WNW-ESE, NNE-SSW and ENE-WSW directions have been identified from the lineament map of toposheet no. 57C/7 over Landsat data and the same is shown in Figure 3.. In the study area, NW-SE trending lineament was identified.

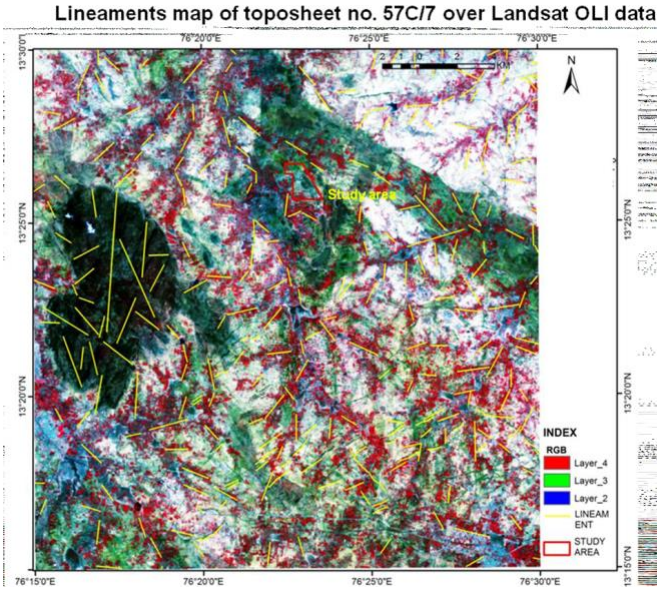

Figure 3. Lineaments map of toposheet no. 57C/7 over Landsat OLI data (Source GSI-2018-19)

1.3.2 Aero Geophysical data

The aero magnetic contour map collected from Aero Geophysical Division, RSAS, Bangalore pertaining to toposheet no. 57C/7. Aerogeophysical map of toposheet no. 57C/7 shows the lower positive magnetic anomalies over ultramafic rocks and migmatite gneiss in geological map as illustrated is in Figure 4. The aeromagnetic contour map of investigation area shows lower positive magnetic anomalies which is possibly due to the low magnetic property of the rocks

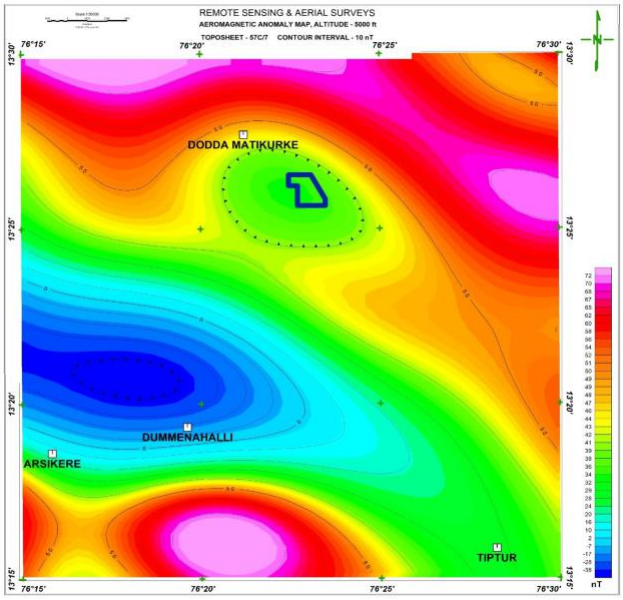

Figure 4. Location of investigation area in Aero magnetic contour map of toposheet no. 57C/7(Source GSI-2018-19)

1.3.3 ASTER data study

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data study was carried out in toposheet no. 57C/7 of an area of 720 Sq.km at Hyperspectral Division, RSAS, Bangalore. ASTER covers a wide spectral region with 14 bands from the visible to the thermal infrared region with high spatial, spectral and radiometric resolution. The ASTER Level-1B data was downloaded from ASTER reverb website and these data are stored together with metadata in one Hierarchical Data Format (HDF) file. The different FCC combinations were used in order to differentiate the lithology i.e. the spectral properties of minerals are different in electromagnetic spectrum. In the investigation area, 4 different types of alterations like hematitization, chlorite alteration, epidote alteration and illite alteration were observed. Chlorite alteration is more dominant in the western part of the block which occurs mostly over talc- temolite- chlorite schist, ASTER map showing chlorite alteration is shown in Figure 5. Epidote alteration is higher in the talc-tremolite-chlorite schist along the serpentinite body in the eastern part of the block which occurs over serpentinite and the same can be seen in Figure 6.

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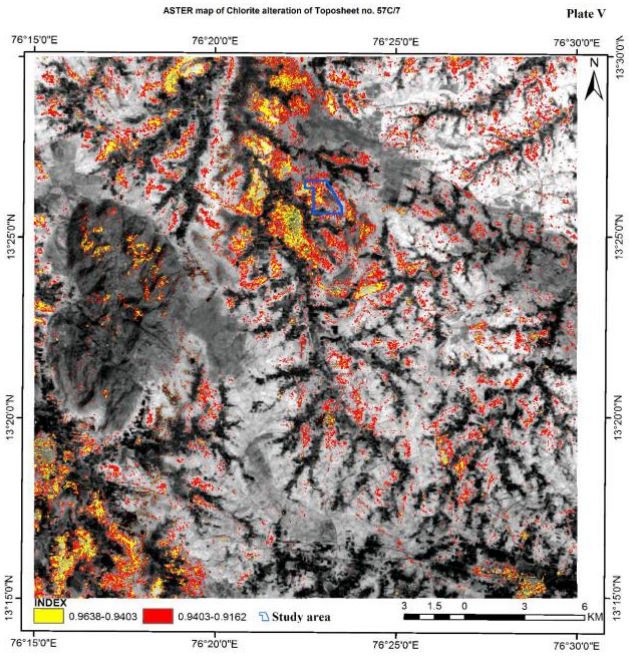

Figure 5. ASTER map showing chlorite alteration of toposheet no. 57C/7(West part of investigation area) (Source GSI-2018-19)

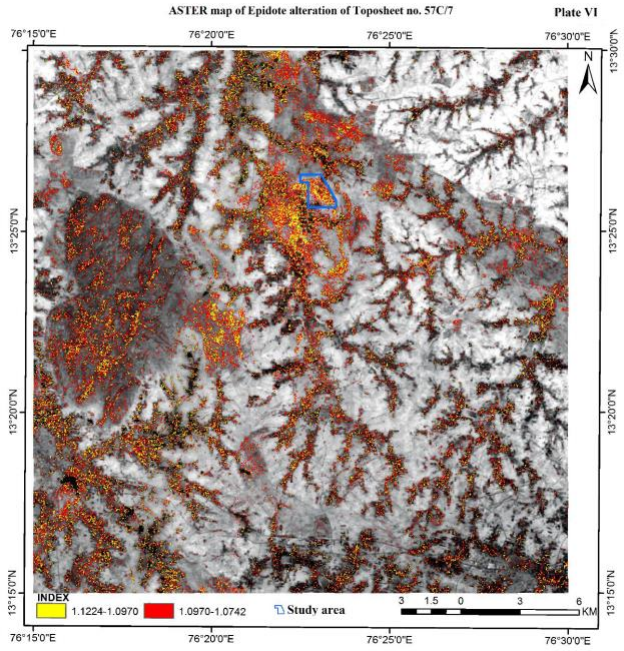

Figure 6. ASTER map of epidote alteration of toposheet no. 57C/7(Easternpart of investigation area) (Source GSI-2018-19)

1.3.4 Geophysical Exploration

The geophysical survey was carried out by GSI employing Magnetic, Induced Polarization (I. P, Time Domain) and Resistivity measuring instruments. A total of 1.5-line kilometer (L.km) of NE-SW trending baseline was laid with traverse length varying from 300 to 1300 m each, a traverse spacing of 100m and stations stacked at 10m interval. The geophysical layout map of the Rampura - Gollarahatti block overlay on geology, the base line was laid with a bearing of N50° E. The geophysical traverses layout, over detailed geological map of the proposed area is shown in Figure 7.

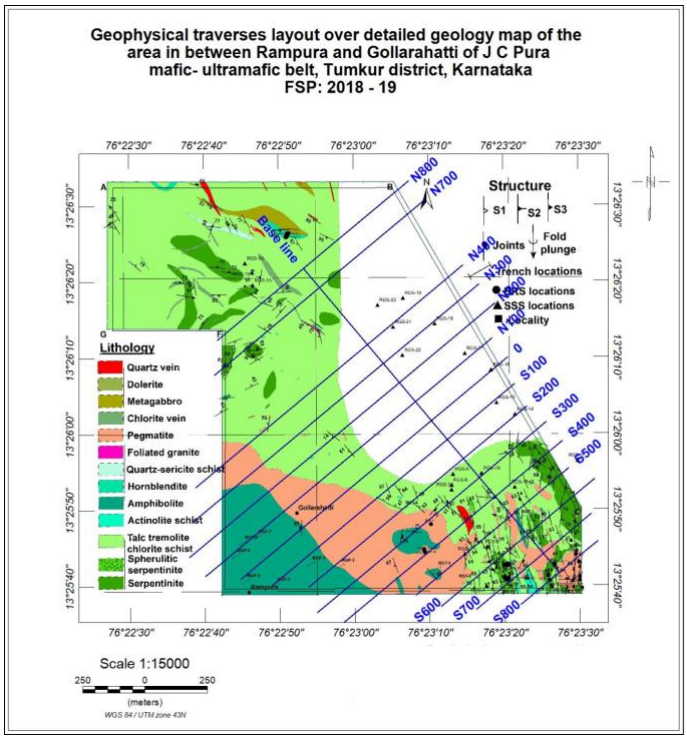

Figure 7. The geophysical traverses layout over detailed geological map (Source GSI-2018-19)

According to the magnetic intensity, the area can be divided into three magnetic zones namely high dominant magnetic anomalies of the order of +200 to +800nT have been recorded in the center part of the area over exposed talc tremolite chlorite schist (TTCS) along with pegmatite & quartz vein and linear low dominant magnetic anomalies of the order of -120nT to -1670nT observed in the eastern part, between Tr: S500 to Tr: N800 and trending NW-SE direction, which is corresponding to the exposed serpentinite. South-western part of the area is occupied with a moderate to high magnetic anomalous zone of the order of -2 nT to +150 nT which may be due

to the presence of amphibolite. In Tr. N800, the magnetic anomaly variation is 458nT to -788 nT in between station no W450 – W 300 may be due to sheared serpentinite. Station W180 to W50 and E50 toE200 shows almost similar magnetic anomaly variation of -750nT to 50nT may due to presence of amphibolites body where first one is exposed and other is concealed body.In eastern side of Tr. N700, magnetic anomaly variation is almost flat. This type of response is due to the presence of TTCS Formation. A highly varying magnetic anomaly (ranges from 1000 nT to -2000 nT) has been noticed in between W200 – W50 & E70 – E270 may be due to the presence of exposed sheared serpentinite. The magnetic (Tf) anomaly map of the area in between Rampura-Gollarahatti is shown in Figure 8.

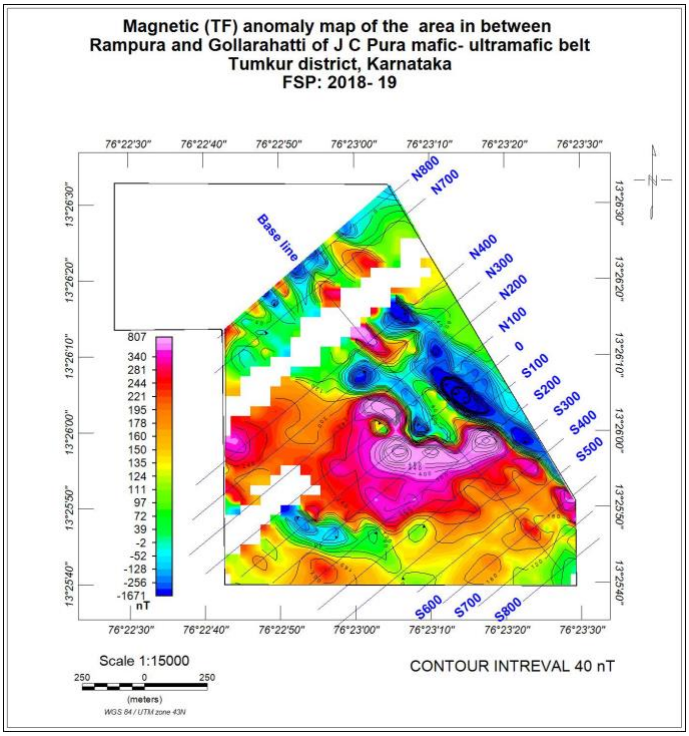

Figure 8. The magnetic (TF) anomaly map of the area in between Rampura-Gollarahatti (Source GSI-2018-19)

Two high resistivity (1000 – 2000 Ohm-m) zones with moderate to low chargeability have been noticed at W350 – W300 & W250 – W300. It may correspond to the presence of a concealed pegmatite/quartz vein. A moderate to high resistivity (700 – 1500 Ohm-m) variation with moderate to low chargeability values has been noticed in between W400 - W100 which may be the possible zone for REE/ gold mineralization within pegmatite/quartz vein. Traverse S300 magnetic anomaly is highly fluctuating (500nT to -1250nT) in between station E50 – E250 which is corresponding to exposed serpentinite. Moderate to high resistive zones of 1000 – 2000 ohm-m have been recorded along with moderate to high chargeability (4 – 6 mV/V) in between

station W400 – W100. This zone may be favourable for PGE mineralization. A small magnetic variation has been observed in between W150 to W100 with low resistivity and high chargeability which may corresponding to concealed sphrelutic serpentinite body covered by TTCS (Ref. *GSI Reconnaissance Survey for Ni-PGE and Gold between Rampura and Gollarahatti Areas of J. C. Pura Mafic-Ultramafic belt during Field Season 2014-2015 and 2018-2019).*

Geophysical surveys have identified the following aspect in respect of positive PGE mineralization.

- ◊ Geophysical IP, dipole dipole, magnetic and resistivity surveys have identified few moderate to high resistivity and chargeability zones associated with moderate magnetic signatures in the central part of this block, between the stations W400 and W150 along the traverses from Tr: S100 to Tr: S300.

- ◊ NW – SE trending linear serpentinite body with highly fluctuating magnetic (TF)anomaly recorded in Geophysical survey. This body may be probable host of PGE and warrants ground follow up studies

- ◊ Pseudo-depth section reveals that, moderate chargeability anomalies corroborating well with moderate resistivity in traverses Tr: S400 between stations from E110 toE130 at a vertical depth of 10 - 20m, needs ground follow up to expose the causative source

1.3.5 Geochemical Exploration

GSI carried out Geochemical exploration studies in the proposed area and collected bedrock samples, stream sediment samples and pitting / trenching samples around Gollarahatti and Rampura village in the course of mapping.

Out of 58 nos of chip and grab Bed Rock Samples (BRS) from spherulitic serpentinite, serpentinite and pegmatite were subjected to chemical analysis, the results of 50 bedrock samples show ΣPGE concentration varies from 12 to 46 ppb. Higher concentration of ∑PGE (Pt+Pd+Ir+Ru+Rh) 46.28 ppb recorded in spherulitic serpentinite to ENE of Rampura village, in which Pt concentration is 31 ppb. Ni concentration in spherulitic serpentinite varies from 190 to 1020 ppm and in serpentinite varies from 60 to 335 ppm. Ni concentration in gabbro varies from 95 to 545 ppm.

Further a total of 32 stream sediments samples (SSS) were collected by GSI from 1st order streams were subjected to chemical analyses, out of which 29 stream sediment samples show

PGE concentration from 9.5 to 300 ppb (<300ppb). While 03 samples analysed PGE content from 1230 to 1333 ppb.-By considering these higher values, a PGE concentration zone (1Km x 250m) demarcated to NE of Gollarahatti. The Ni concentration in stream sediment samples varies from 185 to 945 ppm. The maximum Ni concentration of 945 ppm and ΣPGE of 299 ppb is obtained from RGS-20 draining over serpentinite. The higher Ni concentration correlates positively with higher PGE concentration suggesting sulfide-associated PGE. Chemical Analyses results of BSR, Geochemical survey are given separately **Annexure-1** (*Ref. GSI Field Season 2018-2019 reports).*

1.3.6 Scope for proposed exploration.

Based on the results of GSI reconnaissance survey and its recommendations, the block was taken up for a detailed study on the results achieved in the reconnaissance survey. Based on the results achieved, an area of 2 sq.. It is proposed to explore the areas at preliminary exploration G-3 stage with the combination of surface exploration in-pus such as Geological mapping, Geochemical sampling followed by Geophysical techniques followed by collection of BRS, pits and tranche etc., Based on the results of these techniques the surface signature of the mineralized zone will be established. If the result achieved is encouraging, sub-surface exploration by way of diamond core drilling is planned in 2 stages.

1.4 Recommendations of G4 Stage Mineral Exploration Report

GSI reported that occurrence of nickel content of the samples ranges from 20 to 3515 ppm; chromium ranges from 15 to 16,100 ppm; Cobalt between 35 and 330 and copper ranging from 10 to 340 ppm. Ni concentration in spherulitic serpentinite varies from 190 to 1020 ppm and in serpentinite varies from 60 to 335 ppm and Ni concentration in gabbro varies from 95 to 545 ppm. The maximum Cu content is shown by schistose komatiitic variants; whereas Ni max, Co max and Cr max values are shown by SSS draining komatiitic flows in the SE range of Rampura village. The higher PGE concentrations of 1230 ppb, 1333 ppb recorded in 1st order streams flowing through serpentinite warranted to take up propose this new work. By Considering these higher values (>1000 ppb) a potential area for PGE mineralization (1Km x 250m) has been demarcated to NE of Gollarahatti village. EPMA identified sperrylite (PtAs2 or Pt-As-Fe) inclusion in Cr-bearing magnetite associated with Fe-chromite in serpentinite. Hence, bedrock sampling in serpentinite especially in the highly oxidized, limonitized study has to be carried out at closer interval to NE of Gollarahatti village. Geophysical studies indicated that NW – SE trending linear serpentinite body, highly fluctuating magnetic (TF) anomaly. This body may be a probable host of PGE, and warrants ground follow up studies.

Further, the bedrock samples of serpentinite and spherulitic serpentinite yielded poor

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concentration of Au, i.e. < 25 ppb. All the gabbro samples (n=10 nos.) shows +ve Ce and –ve Eu anomaly with its different range of REE concentration. The ΣREE (La-Lu) concentration of pegmatite (n=08) varies from 17 to 58 ppm

The EPMA study reported Pt-As-Fe inclusion in association with barite in chrome-bearing magnetite in serpentinite indicating possible hydrothermal alteration of original Pt-Fe composition.

1.5 Objective of Exploration

1. To carry out detailed geological and structural mapping on 1: 2000 scale in GSI unmapped area of 0.85.Sq.Km for demarcation of Ni, Co, PGE/Au, Cu and REE/rare minerals bearing formations (host rock) with the structural features to identify the surface manifestations and lateral dispositions of the mineralized zones.

2. To collect samples from the bedrock/ soil/ stream sediments, pits, trenches and analyse for Ni, Co, PGE, Cu, Au , & REE/ rare minerals and decipher further course of exploration programme other than the area studied by GSI. Few surface / trench samples will also be collected in the GSI studied area to confirm the chemical analysis results.

3. Bedrock sampling will be collected for Ni, Co, PGE, Au, Cu & REE/ rare minerals concentration by chip samples and through pits/trenches. Stream sediment samples from 1st order streams shall be collected to verify the occurrence of PGE and REE etc concentration levels. Trenching will be carried out in the contacts of different litho units exposed in the mapped area.

4. Based on the positive outcome by the above Exploration in-puts, the delineation of the main target mineralized zone at the surface will be carried. After the delineation of the mineralized zone it is planned to explore the depth persistence of the mineralization at 60 m vertical depth in 1st stage. If the results are encouraging then the 2nd stage will be planned to intersection the mineralized zone at a vertical depth of 130 m. In both the stages the bore holes will be placed at an interval of 200 m apart along the strike.

5. Few samples will be studied for Petrology, Mineralogy, Ore-microscopy, Geochemistry.

6. Few samples will be studied for gold by the Fire Assay method at HGML or GSI Laboratory.

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7. In case surface study sample indicate positive results sub-surface exploration by way of diamond core drilling will be carried out to establish depth continuation of the ore body by way of exploratory diamond core drilling as per NMET guidelines.

8. To estimate resources as per UNFC norms and Minerals (Evidence of Mineral Content) Rule- 2015 at G-3 level and meet the NMET objectives.

2.0 PREVIOUS WORK

2.1 Attach Complete Previous Geological Report G4 Stage (Attached)

Previously, 0.50 Sq.km area was covered by Tom and Kumar (GSI-2015), reported 183 ppb & 345 ppb in stream sediment sample and 1810 ppm Ni in bed rock samples in around Gollarahatti and Holalkere villages and evidence of Ni-Co mineralization in the form of greenish tinge in talc serpentinite near Gollarahatti village.

Further, 1.5 Sq.km was investigated during Field Season (FS)2018-19. Detailed geological mapping in 0.65 Sq. Km (out of 1.50 Sq.km) area was carried out and mapped peridotite, dunite, pyroxenite, gabbro and schistose ultramafic rocks and classified as talc tremolite-chlorite-actinolite schists closely associated with thin and discontinuous bands of cherty quartzite, carbonate rock, hornblende schist/ amphibolite, banded magnetite quartzite and are intruded by the gneisses and granite. Delineated two linear bodies of spherulitic zones 150m x 50m and 50m x 20m in serpentinite to southeast of Gollarahatti village and Demarcated pegmatite sheets along contacts of gabbro, amphibolite and serpentinite. The maximum Cu content is shown by schistose komatiitic variants; whereas Ni max, Co max and Cr max values are shown by SSS draining komatiitic flows in the SE range of Rampura village.

Geophysical studies indicated NW – SE trending linear serpentinite body with highly fluctuating magnetic (TF) anomaly recorded in geophysical survey, which may be probable host of PGE, and warranted for further ground follow up studies

Geochemical exploration in the area has indicated higher PGE concentrations of 1252 ppb, 1331 ppb recorded in 1st order streams flowing through serpentinite, based on which higher values (>1000 ppb) a potential area for PGE mineralization (1Km x 250m) demarcated to NE of Gollarahatti village. The Complete Previous Geological Report G4 Stage is enclosed in Annexure-1 for G3 stage exploration.

2.2 Previous Exploration details in the proposed block area

There are currently scanty sulfide nickel deposits in India, a single lateritic nickel deposit is known in Orissa. There are several operating / abandoned chromite mines in India, chromite being a good indicator of nickel mineralization since it is hosted in ultramafic – mafic rocks. India is totally dependent on imports of nickel metal. Ni-Cu-PGE sulfide deposits hosted by mafic/ultramafic intrusions associated with Continental Flood Basalts (CFB) are gaining importance as future targets for large ore bodies. Some common features of these deposits are: Olivine-rich magma, proximity to a major crustal fault, sulfide bearing country rocks and optimum assimilation, chalcophile element depletion in related intrusive and overlying extrusive rocks, and the successive flow of magma and preservation of flow channel and field and/or geochemical evidence of interaction between the magma and the country rock (Naldrett, 1999).

Bushveld Igneous complex in South Africa is a world class deposit containing PGE associated with chromites, as well as some Cu, Ni and PGE associated with sulphides. There are several other PGE deposits in the world which produce the precious metal in economic quantities.

In India, Sittampundi ultramafic complex in Namakkal district, Tamil Nadu has been recently explored by GSI and delineated several zones of PGE mineralization (Shesha Sai et al., 2013; Dhanendran et al., 2014; Balaram., 2019; and several subsequent reports of various authors; Nathan, 2009; Dhanendran PGE resources of Tamil Nadu,2016; A brief on Exploration for Platinum Group of Elements (PGE) in India – 2020, Govt. of India, Ministry of Mines, Geological Survey of India).

In Karnataka, Hanumalapura area belonging to Channagiri ultramafic-mafic complex has been explored in detail by GSI and subsequently by DMG, Karnataka and resources have been delineated based on sub-surface drilling activity. All the mafic - ultramafic units of the Hanumalapura area have yielded PGE values to economic significance. However, metapyroxenite, talc-tremolite schist and chlorite schist ± magnetite are the most favourable host rock units. The base metal sulphides associated with the PGE minerals consist of pyrrhotite, chalcopyrite, pentlandite, sphalerite and pyrite. Magnetite (at places chrome - magnetite) and ilmenite are the associated oxides; (Sougata Bhattacharjee et al., 2009).

Apart from the above-mentioned areas, many other ultramafic- mafic complexes are present in India. Some of them have received only academic interest and have not been explored in detail by any agency.

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GSI reconnaissance survey during Field Season 2018-19 carried out in the area has not covered the entire area due to some local issues. Now it is proposed to carry out the Preliminary Exploration needed to cover the entire area of 2.00 Sq. Km area for possible delineating the PGE, Ni-Co and associated mineralisation in the area with geological mapping followed by geophysical and geochemical activities and exploration drilling to delineate subsurface mineralization up to 200 m depth.

Previous Exploration activity by GSI was a reconnaissance survey involving Geological mapping, geophysical survey, geochemical survey. All the sample (bedrock/trench/ stream/soil) locations are plotted on the geological map as given in Plate No-4.

2.2.1 Geological Mapping

The significant geological features of the study area recorded during the detailed mapping are:

- *Demarcation of two linear bodies of spherulitic zones 150m x 50m and 50m x 20m in serpentinite to southeast of Gollarahatti village.*
- *Demarcation of pegmatite sheets along contacts of gabbro, amphibolite and serpentinite. Massive serpentinite is exposed between Gollarahatti and Kamasamudra.*

2.2.2 Electron Probe Microanalysis (EPMA) Study

Eleven samples were studied by GSI through EPMA to find out the mineral chemistry of representative spherulitic serpentinite, serpentinite and amphibolite. Sulphide minerals observed in pentlandite, chalcopyrite, antimony and galena in serpentinite during the EPMA study. EPMA study reveals a platino-arsenide; Sperrylite (PtAs2: 1µm) in relict massive (relatively un-deformed) serpentinite. Spherules are associated with baryte, chrome magnetite and magnetite. Besides, several pentlandite, few chalcopyrite, galena and chalcocite are identified.

2.2.3 Geophysical surveys

The geophysical survey carried out (GSI) by employing Magnetic, Induced Polarization (I.P,Time Domain) and Resistivity measuring instruments. A total of 1.5 L.km of baseline was laid with a different traverse varying from 300 to 1300 m each in NE-SW direction with a traverse spacing of 100m and stations were stacked at 10m intervals. Geophysical surveys brought out few important positive factors in respect of PGE mineralization.

- ◊ *Geophysical IP, dipole dipole, magnetic and resistivity surveys have identified few moderate to high resistivity and chargeability zones associated with moderate magnetic signatures in the central part of this block, between the stations W400 and W150 along the traverses from Tr: S100 to Tr: S300.*

- ◊ *NW – SE trending linear serpentinite body with highly fluctuating magnetic (TF) anomaly recorded in Geophysical survey and this body may be probable host of PGE, warrants ground follow up studies*

- ◊ *Pseudo-depth section reveals that, moderate chargeability anomalies corroborating well with moderate resistivity in traverses Tr: S400 between stations from E110 toE130 at a vertical depth of 10 - 20m, needs ground follow up to expose the causative sourc*

2.2.4 Pitting / Trenching:

A total of 5 trenches namely RGT-1 (11 cu.m), RGT-2 (15 cu.m), RGT-3 (15 cu.m), RGT-4 (7 cu.m), RGT5.(7 cu.m) and 7 pits (21 cu.m) were excavated by GSI . Collected 35 nos of pitting / trenching samples and 30 trench samples collected of amphibolite, talc tremolite chlorite schist and pegmatite. 40 bedrock samples of serpentinite and spherulitic serpentinite yielded poor concentration of Au, i.e. < 25 ppb. While Ni concentration in spherulitic serpentinite varies from 190 to 1020 ppm and in serpentinite varies from 60 to 335 ppm. Ni concentration in gabbro varies from 95 to 545 ppm

2.2.5 Geochemical identification of anomalous zones with strike length and width

The higher PGE concentrations of 1230, 1252, 1331 ppb recorded in 1st order streams flowing through serpentinite. The Ni concentration in stream sediment samples varies from 185 to 945 ppm. The maximum Ni concentration of 945 ppm and ΣPGE of 299 ppb is obtained from RGS-20 draining over serpentinite. By considering these higher values, a potential area (1Km x250m) for possible PGE mineralization is being delineated based on anomalous PGE in stream sediment samples to NE of Gollarahatti and Rampura Area.

3. BLOCK DESCRIPTION

The details of block corner points and cardinal points along with latitude and longitude are given below Table -3 and the same is shown in Figure. 9

Table 3- Block corner points and cardinal points along with latitude and longitude

Block Corner points Cardinal Points	Latitude	Longitude
A	N 13° 26’ 32.39”	E 76° 22’ 27.96”
B	N 13° 26’ 32.19”	E 76° 23’ 05.17”
C	N 13° 25’ 50.58”	E 76° 23’ 29.33”
D	N 13° 25’ 39.59”	E 76° 23’ 29.33”
E	N 13° 25’ 39.59”	E 76° 22’ 42.58”
F	N 13° 26’ 13.50”	E 76° 22’ 42.81”
G	N 13° 26’ 13.58”	E 76° 22’ 27.85”

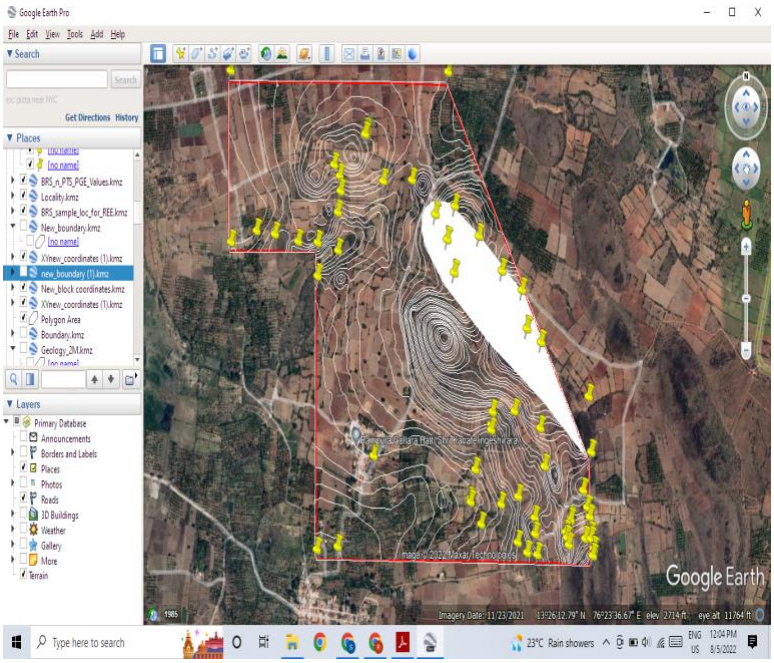

Figure 9. Rampura-Gollarahatti area with contour and sample locations (Source GSI-2018-19)

4. PLANNED METHODOLOGY:

Based on the previous work done by GSI, it is proposed to carry out geological, geochemical and geophysical exploration activities in the area to identify and delineate the Ni, Co, PGE, Cu, Gold (Au), REE and rare metal occurrence zones in the area to bring the area of mineral investigation under G3 category .Exploratory core drilling is proposed after delineating the mineralized zone and it is planned to execute in the proposed area To achieve these objectives, the following methodology will be adopted.

1. Proposed to carry out Geophysical investigations (Gravity Magnetic survey, Magnetic survey, IP / SP surveys and Electrical Resistivity survey) in GSI left out areas such as NE portion of 0.50 Sq.Km; unmapped area of 0.85 Sq. Km (serpentinite anomaly zone). Also remote sensing works will be initiated simultaneously.

2. To carry out geological and structural mapping on 1: 2000 scale for unmapped area of 0.85 Sq.km for demarcation of Ni, Co, Cu, PGE, Au and REE/rare minerals bearing formations (host rock) with the structural features to identify the surface manifestations and lateral dispositions of the mineralized zones. Integration of the data in GIS platform.

3. To collect surface bedrock/ soil/ stream sediments, pit, trench samples and analyse for Ni, Co, PGE, Au , Cu & REE/ Associated minerals and decipher further course of exploration programme other than the area studied by GSI. Few surface / trench samples will also be collected in the GSI studied area to confirm the chemical analysis results. All samples will be sent to NABL accredited laboratories and QA / QC samples will be inserted appropriately.

4. Bedrock sampling will be collected for Ni, Co, PGE & REE / associated minerals (Au, Cu etc) concentration by chip samples and through pits / surface outcrops. All samples will be sent to NABL accredited laboratories and QA / QC samples will be inserted appropriately.

5. Geochemical survey covering the probable zones of mineralization, will be carried out simultaneously, to delineate the Ni, Co, PGE & REE/ Au, Cu mineralization. All samples will be sent to NABL accredited laboratories and QA / QC samples will be inserted appropriately.

9. Based on the positive outcome by the above Exploration in-puts, the delineation of the main target mineralized zone at the surface will be carried. After the delineation of the mineralized zone it is planned to explore the depth persistence of the mineralization at 60 m vertical depth in 1st stage. If the results are encouraging then the 2nd stage will be planned to intersection the mineralized zone at a vertical depth of 130 m. In both the stages the bore holes will be placed at an interval of 200 m apart along the strike. Exploratory boreholes shall be drilled as per NMET guidelines to decide the further course of exploration programme.

10. It is proposed to collect samples and subject for the studies such as Petrology, Mineralogy, Ore-microscopy, Geochemistry. Few samples will be subjected for fire assay to ascertain the gold content.

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11. To estimate resources as per UNFC norms and Minerals (Evidence of Mineral Content) Rule- 2015 at G-3 level and meet the NMET objectives.

12. Submission of reports and recommendations compliant with G3 level as per MEMC 2021 and suggestions for follow up work to upgrade the project, if deemed necessary.

5. NATURE QUANTUM AND TARGET

TIME SCHEDULE IN (Months) QUANTUM OF WORK

PRELIMINARY EXPLORATION (G3) FOR Ni, Co, PGE and REE/ASSOCIATED MINERALS (in J C PURA MAFIC-ULTRAMAFIC SCHIST BELT NEAR RAMPURA AND GOLLARAHATTI BLOCK, HASSAN DISTRICT, KARNATAKA

Item of Work	1	2	3	4	5	6	7	8	9	10
Camp Setting					REVIEW / APPROVAL					
Remote Sensing Studies, & Ground Geophysical studies										
Geol. Mapping (0.85 Sq.Km.)										
Geochemical exploration (BRS,Stream sediments & Soil sampling)										
Pitting/Tecnching (4 Pits + 4 Trences)										
Sample Collection & Preparation- includes crushing, powdering, packing & Labeling										
Survey work- boundary survey & surface features										
Geologist Party days for Mapping, Geochemical. Pitting/Trenching and sampling										
Loboratory Studies										
Review of Surface exploration activities										
Surface Drilling (1300 Mtrs.)- 2 Drills										
Sampling Preparation including core splitting, crussing, powdering, coning and quartering										
Geologist Party days for drilling, Core logging and core sample										
Survey work-Contouring, BH fixation, determination of coordinates and Reduced level										
Camp Winding										
Geological Report Preparation and submission										

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5.1 Nature and Quantum of work proposed

Components	G3 Stage
Aerial reconnaissance	Not proposed
Geological Survey	i) 1:2000 Scale mapping ii) Assessment of lithology, structure, surface mineralisation
Geochemical Survey	Proposed to carry out (Chip/Channel/Pit/Trench/Core/Soil)
Geophysical Survey	Proposed ground geophysical work and borehole geophysical logging
Pitting/ Trenching	4 pits and 4 trenches to expose mineralised zones. The location of Pitting and trenching shall be judiciously planned based on geological traverses to cover the entire mineralised body, to delineate the strike & depth extension and also for planning scout boreholes.
Scout drilling / Systematic drilling	10 boreholes for delineation of sub-surface mineralization along the positive profiles delineated by surface sampling/pitting trenching and systematic Core logging
Grab and Chip sampling	Systematic sampling of few representative samples to be subjected to Davis tube recovery test in case of BMQ
Petrographic and miner graphic studies	It is proposed to collect samples from rocks of the deposit (host rock for mineralisation), alterations connected with mineralisation, target mineral phases (ore and gangue metal/mineral), paragenesis, primary secondary zones
Synthesis of all available data	i) Integration of regional/detailed geophysical, geological and geochemical data (e-mailed shape files) ii) Synthesis of all available data and Report writing- will do done as per NMET guidelines.

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5.2 Borehole spacing (As per MEMC, 2015)

Type of deposit	Bedded Stratiform and Tabular deposit of regular habit (Minerals to be identified)	Bedded stratiform and tabular deposits of irregular habit (Minerals to be identified)	Lenticular bodies occurring en echelon Lenses, pockets. (Different minerals)
G3 Stage	–	–	Based on Geophysical, Geological mapping, Geochemical investigations, ore body will be delineated and diamond core drilling activity will be planned with prior approval NMET. Tentatively, 10 Boreholes will be proposed in an area of 2.00 Sq.km with the spacing of 200 meters apart along the strike.
(Vertical depth of intersection of mineralised zone for different level boreholes should be specified, number of boreholes (first, second, third), borehole spacing, approximate length of different level of boreholes may also be specified)			

5.3 Geophysical Studies

General specifications of geophysical studies for various commodities is practiced by GSI are as below, however, the parameters likely to vary depending on the local geological set-up and nature and behavior of ore body.

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Commodity	Parameters	Technique	G3 stage (Preliminary Exploration)
REE & RM	Method	Gravity	200 m-1 km grid, Semi Regional 500-200 m
	Spacing		
	Method	Resistivity	200 m-1 km grid, Semi Regional 500-200 m
	Spacing		
	Method	Radiometric	200 m-1 km grid, Semi Regional 500-200 m
	Spacing		
Gold/ PGE & Ni/ Base Metals	Method	IP / Resistivity	Traversing, 100 m-200 m (50-25 m) traverse interval, 10-20 m (3-5 m) station interval
	Spacing		
	Method	Magnetic	Traversing, 100 m-200 m traverse interval, 10-20 m station interval
	Spacing		
	Method 3	SP	Traversing, 100 m-200 m traverse interval, 10-20 m station interval
	Spacing		

6. EXPLORATORY DRILLING

The Rules governing the NMET have been notified vide gazette notification No. G.S.R. 632 (E) dated 14.08.2015. As per the Rules the funds accrued to NMET will be utilized primarily for the purpose of regional and detailed mineral exploration. In line with the notification, TCC, NMET developed Exploratory Drilling Guidelines for NMET Funded Projects. The exploratory drilling methodology for the investigation area will be in accordance with Mineral (Evidence and Contents) Rules, 2015 and is given below.

6.1 Diamond Core Drilling:

It is proposed to carry out diamond core drilling, as drilling is an important and integral procedural component in mineral exploration (i) to ascertain the subsurface configuration of the orebody (ii) to bring out a three-dimensional model of the ore deposit and (iii) to arrive at the size and grade of the deposit. As per G4 Exploration by GSI, the mineralization is vein type with foliations dipping

moderate to steeply. The proposed exploratory drilling is to demarcate Ni/Co/PGE/REE , Au, Cu, etc by vertical and inclined (angle) boreholes are planned at 200m x 200 grid to intersect the ore body at 60 mt vertical intersection and also planned for infilling boreholes in between the grid at 120 mt vertical intersection.

6.2 Survey:

The BH collars shall be surveyed very accurately either with a Differential Geographic Positioning System (DGPS) or Total Station with respect to any established and recognized Benchmark (BM) in the area.

6.3 Drill Core sampling:

Drill core collected in core barrels of 3m to 6m length is dried and preserved in a core box made of GI sheet or casted PVC box as per run with proper numbering using a wooden /metal or PVC block. After logging and determining the RQD of cores, the core obtained in the mineralized zone is vertically split into two equal halves, by core splitter and one-half of the cores are retained in the core box for future reference and the other half is reduced to a size of about 10mm, coned and quartered for chemical analyses. One half of representative sample (two opposite quarters) is stored properly as per G3 stage requirement and the same will be used for the ore beneficiation studies during G2 stage of the same block). Half of the drill core will be subjected to pulverization requisite fine mesh size (#120 or #200 mesh size) and the same will be subjected to coning and quartering to bring it to 100 of sample which will be packed and sent for lab for analysis. The remaining portion of the pulverized will be retained as duplicate samples for further studies if required.

Core Boxes of galvanized iron sheet (about 22-gauge thickness) having 90cm length, 30 cm width and 10 cm height with three adjustable partitions dividing the box longitudinally in four compartments shall be utilized as per guideline and ore boxes painted with red oxide periodically in order to avoid rusting of the boxes. The core boxes will be labelled with borehole numbers, project code etc. The excel file attached to the skeletonised core table shall be created for core boxes stored.

6.4 Bulk Density:

The bulk density determination is crucial for understanding the tonnages of ore and metal in a resource. The collection of bulk densities outside of the ore horizon is also needed as this will

have impact on waste handling and mining. The bulk density can be determined by measuring the length of the core or half - split core. Weigh the measured core to determine the bulk density by DB=M/V, where DB is the bulk density and M is the mass of the measured core & V is volume of the core. To take weight in water, the core piece can be hung by a thread and made to immerse in a beaker full of water and then take the reading. This can be easily measured by Walker's Steelyard balance by computing weight in air and weight in water.

6.5 Core Recovery and Grade Computing:

It is planned to carry out drilling of boreholes to obtain NX core to maintain 90-95% recovery of core from boreholes

6.6 Preservation of Drill Cores.

Provision shall be made in the core library documentation for retrieving the cores belonging to a particular tectonic setting based on their genetic aspects and the drill cores shall be submitted along with Annexures II to IV of Guideline. Further, 5-10% of drill cores shall be made available for drill core archive. GSI being a nodal agency for maintaining the National Drill Core Library will be responsible for fixing selection parameters to assign the priority.

6.7 Drilling Logs Documentation:

Project geologist shall maintain borehole wise logbook depicting all the Geological inputs such as the core recovery, core loss, RQD, lithology, structure features and the mineralization details. The project geologist shall also have a photo record of the cores, the presentation of the core shall be as consistent as possible.

- Borehole No;
- Project name;
- Site location;
- Dates and times that drilling was started and completed;
- Drilling company;
- E & E geologist's name;
- Drill rig type used to drill the borehole;
- Drilling method(s) used to drill the borehole;
- Bit and auger size(s);
- Lithology/Lithologs

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- Depth of auger/split barrel sampler refusal;
- Total depth of borehole;
- Water level at time of completion measured from top of inside casing (TOIC); and
- A well location sketch.

7. MANPOWER DEPLOYMENT

Manpower requirement for initial Geological activity shall be 8 Nos. which includes Geologist, Surveyor, sampling technicians and labours. Geophysical survey will be outsourced. Followed by ground Geophysical & Geochemical Exploration and Diamond Core Drilling Activities

8.BREAK-UP OF EXPENDITURE

ESTIMATED COST FOR PRELIMINARY EXPLORATION (G3) FOR Ni, Co, PGE and REE/ASSOCIATED MINERALS (in J C PURA MAFIC-ULTRAMAFIC SCHIST BELT NEAR RAMPURA AND GOLLARAHATTI BLOCK, HASSAN DISTRICT, KARNATAK, Proposed Area : 2.0 Sq.Km , Number of Boreholes: 10, Borehole Depth: 130 meters: Time: 10 Months

Sl.No	Item of work	Unit	NMET SoC-Item - Sl No.	NMET Rates (2020)	Quantity	Amount
A	**A.GEOLOGICAL WORK**					
1	**Mapping (on 1: 2000 Scale), Borehole Logging & Sampling & Report Writing**					
a	Geologist Party days (2parties) for Geological mapping, Pit/Trench, Geochemical work	days	1.2	11000	210	2310000
b	Geologist Party Days (1 Party) for Report Work	days	1.2	9000	60	540000
c	Labours (Rs 350/day/labour) for Mapping, Survey,, Pit/Trench & Sampling collection (4 Nos)	days	5.7	350	240	84000
d	Sampling Party days(1party)- BRS,SS, Soil sample crushing, powdering, coning quartering and packing	days	1.5.2	5100	60	306000
e	Sampling Party days(1 Party) for Drilling Programme -Core splitting, powdering, coning quartering and packing	days	1.5.2	5100	90	459000
2	**SURVEY (on 1:2000 scale)**					

a	Survey Party Days (1 party) includes boundary survey, surface features	days	1.6.1a	8300	30	249000
b	DGPS Survey - boundary survey	Per Point	1.6.2	19200	5	96000
c	Labourers (Rs 350/day/labour) for Survey Party (4 Nos)	days	5.7	350	30	10500
d	Survey Party Days (1 party) (DGPS)-Drilling Programme- includes BH Fixation, determination of ReducedLevel, Coordinates &surface contouring	days	1.6.1a	8300	30	249000
e	DGPs Survey- Fixation of BHS.Determination of Coordinates & Reduced Levels	Per Point	1.6.3	19200	10	192000
f	Labours (Rs 350/day/labour) BHS.Determination of Coordinates & Reduced Levels 2Nos)	days	5.7	350	180	63000
	Sub·Total A					4558500
B	**B.GEOPHYSICAL SURVEY**	line km			2	
a	Gravity Method-Regional/Detailed (0.5 to200 Sq.km depending on the objective	per station	3.1b	4500	80	360000
b	Magnetic Survey (10-30 LineKm)	per station	3.2a	1800	500	900000
c	Self-Potential (8-20 Line Km)	Line Km	3.3a	29600	3	88800
d	S.P & Shallow electrical Resitivity (10-20Line Km)	Line Km	3.3c	60000	3	180000
e	Induced Polarization (Dipole-Dipole)(10-20 Line Km)	Line Km	3.4a	69950	2	139900
f	Electrical Resitivity (AB/2=1 km)	per station	3.5a	70650	5	353250
g	Labours (Rs 350/day/labour) Geophysical Survey(2Nos)	days	5.7	350	60	21000
h	Expert Charges for Geophysicist (HQ)	per day	3.18	9000	7	63000
i	Expert Charges for Geophysicist (Field)	per day	3.18	11000	8	88000
j	Outsourcing cost to NPE	per project	6(iii)			219395
	SubTotal B					**2413345**
C	**C. PITITNG AND TRENCHING**					
a	Pitting -(1m x 1mx 2 m) -4 Pit s	Per Cu.M	2.1.2	3800	8	30400
b	Trenching(1m x 2mx 25 m) (4 Nos)	Per Cu.M	2.1.1	3330	200	666000
	SubTotal D					**696400**
D	**D. DRILLING**					
a	Surface Drilling (2 Rigs) (130 m depth)	mts.	2.2.1.4a	11500	1300	14950000

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c	Drillcore preservation charges- "One complete borehole plus mineralised cores of all the BHs of the Block, all cost included "150m for one borehole, 50m mineralised zone for remaining 9 Bhs, "	per Mts.	5.3	1590	700	1113000
d	Approach Road making for Rugged-Hilly terrain	per Km.	2.2.10b	32200	5	161000
e	Land Compensation	Per Borehole	5.6	20000	10	200000
f	Construction of concrete Pillar (12'' x12''x30'')	Per Borehole	2.2.7a	2000	10	20000
g	Drilling Outsourced Cost for NPE (8.75+ 3.5506 Lakhs)	per project	6.(iii)			957220
	Sub Total E					**17401220**
E	**E. LABORATORY STUDIES**					
	a.Chemical analyses					
a	Analyses of BRS, Trench/Pit & Stream samples for, PGE, REE,Au,Ni	Per sample	4.1.1	8157	200	1631400
b	*Primary + Check Sample*					
c	(i)Primary Samples for Elemental Analyses-PGE, REE,Au,Ni core samples (50 sample *10BHs)	Per sample	4.1.1	8157	565	4608705
d	(ii)Check Samples- PGE, REE,Au,Ni (15%)	Per sample	4.1.1	8157	75	611775
e	(iii) Fire Assay for PGE(ICP-MS Ni-S) (5%)	Per sample	4.1.5d	11800	10	118000
f	(vI) Fire Assay for Gold	Per sample	4.1.5a	2380	10	23800
g	**b.Physical & Petrological Stusies**					
h	(ii) Preparation of thin sections	Per sample	4.3.1	2353	10	23530
i	(iii)Complete petrographic /ore microscopic study/Mineragraphic studies & study report	Per sample	4.3.4	4232	10	42320
j	(iv)Preparation of Polished Sections	Per sample	4.3.2	1549	10	15490
	c.EPMA/SEM Lab.					
	EPMA Studies (15 samples)	per hour	4.4.1	8540	40	341600

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	d.Estimation of Major Oxides by XRF technique (Whole Rock analysis)	per samples	4.1.15a	4200	10	42000
	e. Water Sample analyses					
a	Complete analyses for 14 determinations (pH, Conductivity, Total Hardness, alkalinity, TDS,Suphides, Nitrate, Chloride Iron,Silica, Phosphorous, Manganese, Sodium & Potassium)	Per sample	4.1.8a	3680	10	36800
b	(i) ICP-MS studies (14 REE elements/ Radials	Per sample	4.1.13	5380	10	53800
	Chemicals Analysis outsource cost for NPE	Per Project	6.(iii)			691192
	Sub Total E					**8240412**
F	**F. GEOTECHNICAL STUDIES**					
a	Specific Gravity determination	Per sample	4.8.1	1605	4	6420
b	Bulk Density Dermination	Per sample	4.10	3540	4	14160
	Sub Total G					**20580**
G	**Preparation of Exploration Proposal (5+1 softcopy)**	Per Project	5.1		1	**380000**
	Sub Total (A to G)					**33710457**
H	**Geological Report Preparation (3%)- 5Nos Hardcopies + 1 Softcopy**	Per Project	5.2 (iv)		1	**1011314**
	TOTAL A to H					**34721770**
	GST 18%					**6249919**
	Grand Total: with GST 18%	Say : 4.09 Cr				**40971689**

Note
a) Separate Geological Report for Block-A and Block-B will be prepared for the project
b) Proposed Boreholes will be taken up after getting prior approval from NMET/DMG
c) Above rates are as per SoC of NMET

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