PROPOSAL FOR IDENTIFYING POTENTIAL MINERAL ZONES IN 65K/1 & 65K/5 IN GUDEM AND CHINTAPALLI, ALLURI SITARAMA RAJU DISTRICT, ANDHRA PRADESH STATE FOR REGIONAL MINERAL TARGETING UNDER NMET.

By

CRITICAL MINERAL TRACKERS

Place: Hyderabad
Date: 26/03/2025

GENERAL INFORMATION ABOUT THE RMT BLOCK

	Features	**Details**
	Block ID	CMT/RMT/001/2025
	Exploration Agency	Critical Mineral Trackers, Hyderabad
	Commodity	Manganese,Graphite,Tungsten,Cobalt,REE, Titanium,Vanadium,Gallium
	Mineral Belt	Eastern Ghat Mobile Belt
	Completion Period with entire Time schedule to complete the project	18 months
	Objectives	To collate the existing data pertaining to the area with respect to NGCM, NGPM, Geology Structure, Tectonics and carry out field studies and identify the potential Mineral zones.
	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 carried out by the proposed agency CRITICAL MINERAL TRACKERS Except Drone mapping, which will be out source.
	Name/ Number of Geoscientists	Senior Geologists -6 Geologists -12 (as per requirement)
	Expected Field days (Geology) Geological Party Days	180 Days
1.	**Location**	
	Latitude (DD) Northern	A) 18^0 00’ 00’, B) 18^0 00’ 00’’ C) 17^0 45’ 00’, D) 17^0 45’ 00’’
	Longitude (DD) Eastern	A) 82^0 00’ 00’, B) 82^0 30’ 00’’ C) 82^0 30’ 00’, D) 82^0 00’ 00’’
	Villages	Paderu, Gudem, Chintapalli, Mamidipalli, Tagangi
	Tehsil/ Taluk	Paderu
	District	Alluri Sitaramraju
	State	Andhra Pradesh
2.	**Area (hectares/ square kilometres)**	
	Block Area	1450 sq.km
	Forest Area	1100 sq.km
	Government Land Area	Not Known
	Private Land Area	Not Kown
3.	**Accessibility**	
	Nearest Rail Head	S. Kota

	Road	Chintapalli
	Airport	Visakhapatnam International Airport
4.	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	Dendritic
	Rivers/ Streams	Paru Gedda, Pedda Gedda, Gumma Revu, Sapara Kalva
5.	**Climate**	
	Average Annual Rainfall	1280-1290mm
	Temperatures (January) (Minimum) Temperatures (May) (Maximum)	15°C 38°C
6.	**Topography**	
	Toposheet Number	65K/01 & 65K/05
	Morphology of the Area	Highly rugged with High hills of Eastern Ghats with most of the area above 100 above MSL
7	**Availability of baseline geoscience data**	
	Geological Map (1:50K/ 25K)	Available, source GSI Bhukosh
	Geochemical Map	Not Available
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	Communication sent to RS AS For providing Aeromagnetic and Radiometric data
8.	**Justification for taking up Reconnaissance Survey / Regional Exploration**	Regional Mineral Targeting for Manganese , Graphite, Tungsten, Cobalt, Titanium, Vanadium, REE, associated Critical Minerals and Elements in Alluri Sitaramaraju district of Andhra Pradesh covering an area of 1450 sq.km in Survey of India toposheets 65K/1 and 65K/5 has been proposed. This district is bounded by Vizianagaram district to the northeast, East Godavari district on the southwest , and Odisha state to the north, Chattisgarh to northwest district to its East Paderu is the district headquarters nearest railway line is S.Kota and road

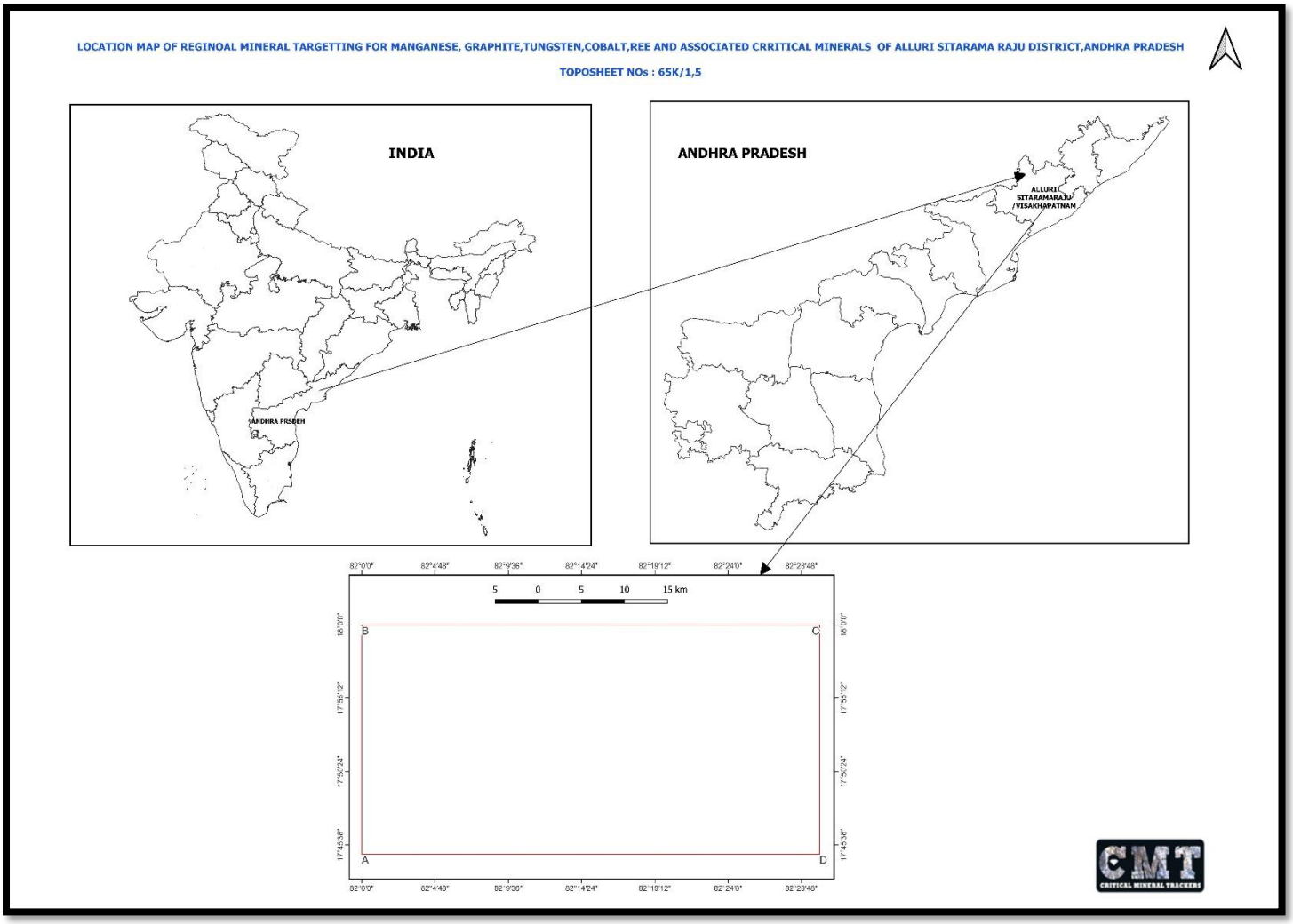
		network is Chintapalli and Paderu the nearest Airport is Visakhapatnam. The area is predominantly very rugged and hilly in nature, thickly wooded and rugged. The highest elevation in the district is 1645m and the lowest elevation is 700m above MSL. The area is drained by the tributaries of Sarada, Tandava and Gosthani rivers and their drainage network and most of stream's flow south, southeast. The drainage pattern is dendritic to sub dendritic and is controlled by structure. The area under reference forms a part of Eastern Ghat Mobile Belt exposing all the characteristic lithounits of the Eastern Ghat Supergroup such as khondalite. Charnockite and the migmatite. The khondalite group is represented by khondalite (Quartz-felspar - garnet - sillimanite - graphite gneiss which is at times Manganiferrous), calc granulite and sillimanite quartzite which occur as impersistent bands within the khondalite. The Charnockite group consists of acid, intermediate, and basic varieties. The migmatite group rock types including consists leptynite. porphyroblastic granitoid gneiss, gamet - biotite - hypersthene gneiss, quartzo felspathic mobilisates and other associated hybrid rocks. Bauxitic laterite occupies several flat topped and gently sloping hills at elevation of 1000m and above. Laterites are mostly developed on Khondalite and rarely on charnockites.

		In this area there are a number of bauxite capping's which are potential units for vanadium, gallium and titanium, the Khondalite group of rocks which are graphite bearing and it places manganiferrous where tungsten and graphite are associated. The lephynites are potential lithounits with respect to REE minerals. This area is reported to have been Neotectnically active with major folds and faults/shear zones which are potential areas for Mineralisation. Therefore, this area is very significant from the Mineralisation point of view which has not been explored in detail, therefore the study of this area bears very high significance. The regional fold which is tight isoclinal in nature located near Paderu has developed a prominent axial plane fault which trends $N60^0$ E $S60^0$ W and there are a number of parallel faults/fractures and during the GSI studies as Neotectonics and sea level changes carried out between 1992-94 are concluded that the coast is fault controlled since there are evidences of a fault scarp and this block Neotectnically active which has been uplifted during the quaternary period. The faulted coast is parallel to the F-1 axial plane fault and the F-3 broad open folds seen due to interference with F-1 has developed shear zones/faults/fractures along its axis and parallel to it.All the rivers/streams are seen controlled by these structures. Previous work by GSI in this area reported occurrences on **Bauxite,**

		Manganese, Graphite, Tungsten, Apatite, Gemstones, Vermiculite, Magnetite, Phlogopite mica. Therefore, this area has been proposed to carryout Regional Mineral Targeting for delineating potential Mineral zones of the critical elements such as REE, Nickel, Cobalt, Titanium, Vanadium, Graphite, Tungsten and associated elements.

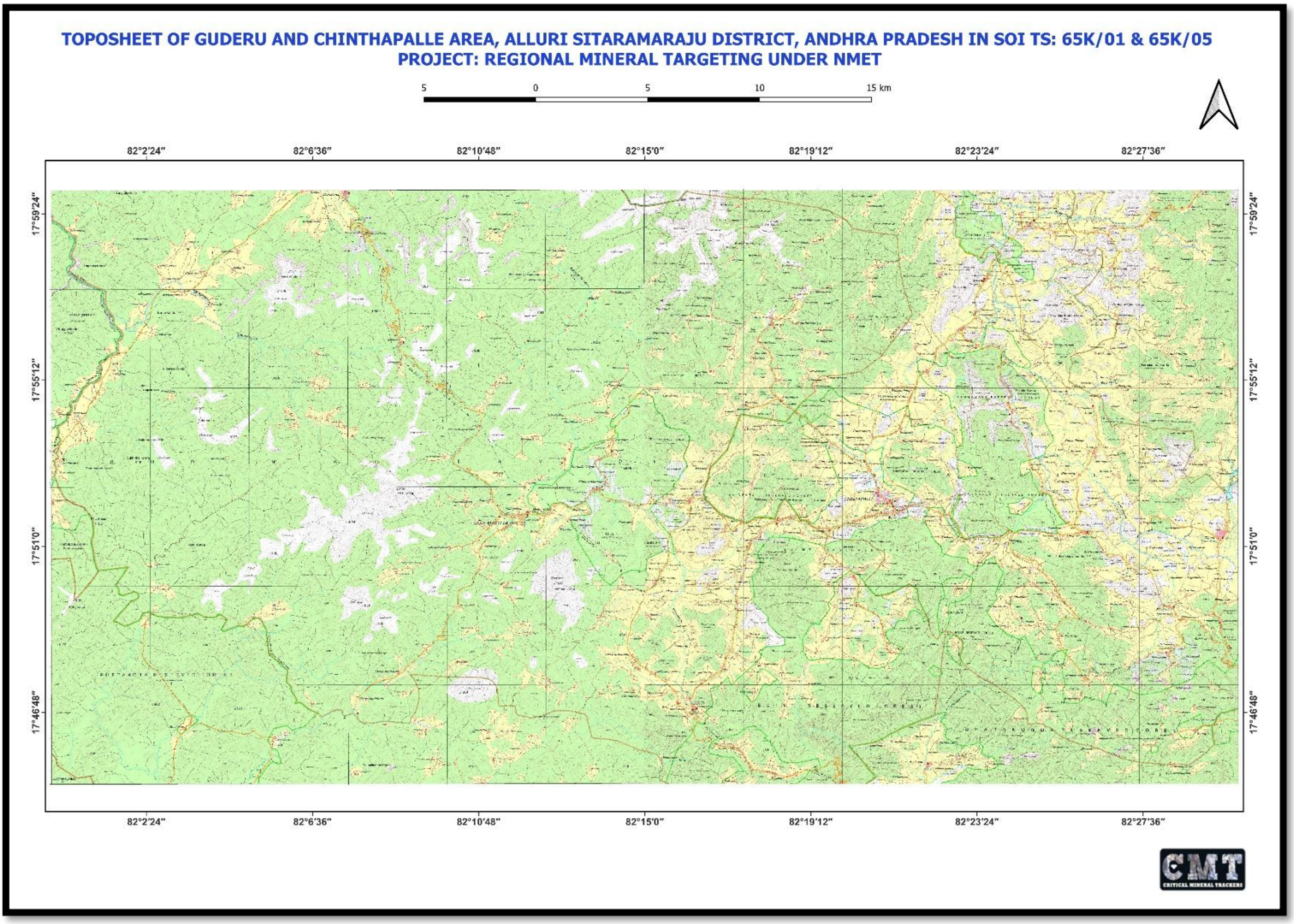
LOCATION MAP

***Figure:*1**



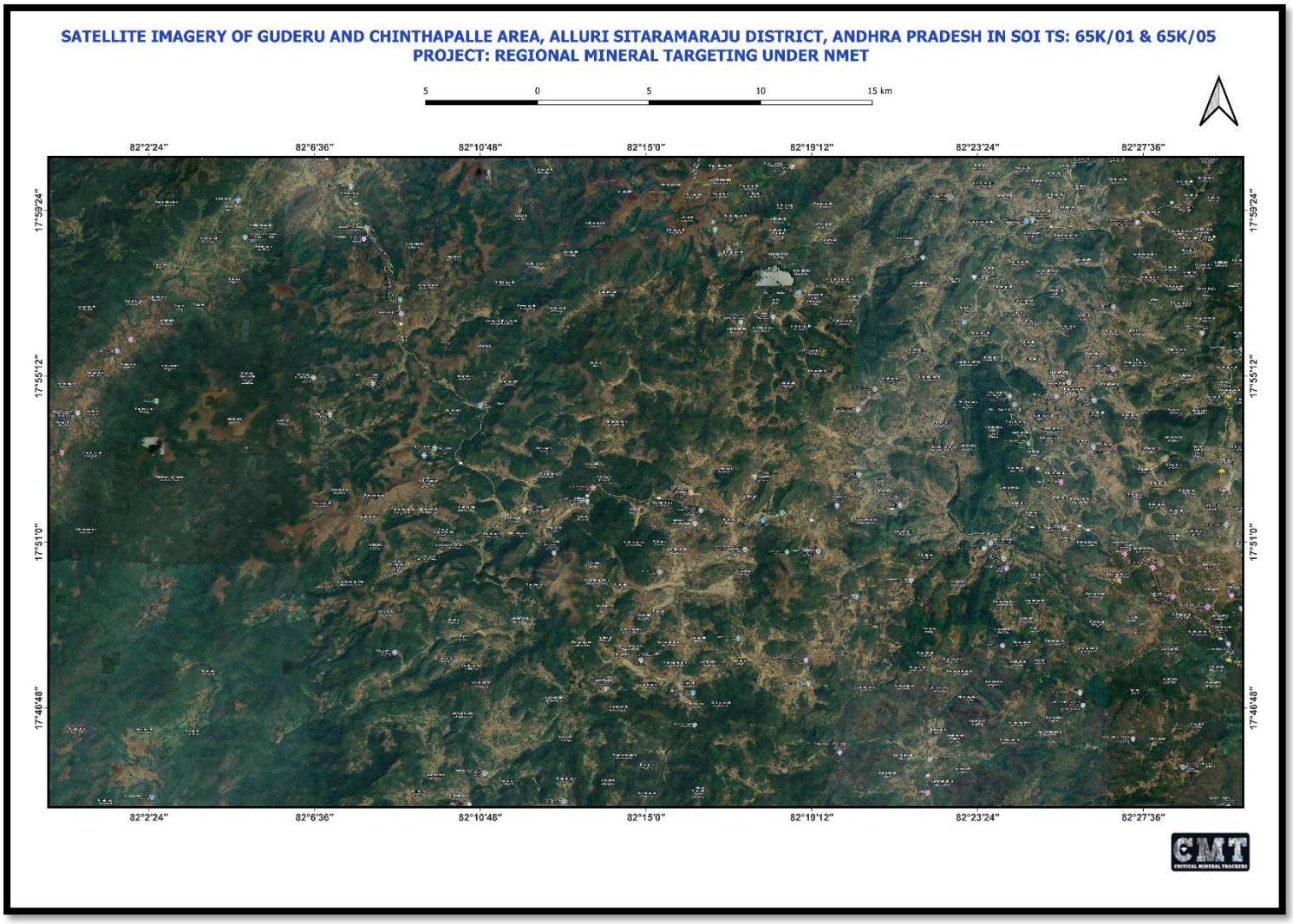
TOPOSHEET

***Figure:*2**



SATELLITE IMAGERY

Figure:3



REGIONAL MINERAL TARGETING IN ALLURI SITARAMARAJU DISTRICT IN SOI TOPOSHEETS 65K/1 AND 65K/5

REGIONAL GEOLOGY

Eastern Ghats Mobile Belt (Supergroup)

The litho-assemblage of this supergroup is located in northern Andhra Pradesh extends into Orissa are generally referred as the Eastern Ghats Mobile Belt (EGMB) and at times as the Eastern Ghat Granulite Belt, since it is predominantly a granulite terrain mainly made up of khondalite, quartzite, calc-granulite, pyroxene granulite and charnockite. The Eastern Ghat Mobile Belt (EGMB) has a trend of NE-SW and extends from Brahmini River in Odisha to Ongole in Andhra Pradesh, for over 900km. The belt skirts the eastern fringes of Dharwar and Bastar cratons and the southern fringe of Singhbhum Craton. It has a maximum width of about 300km, in Odisha which gradually tappers down to only a fewkm and terminates near Ongole in Andhra Pradesh. It stands as one of the classic examples of ultra-high temperature (UHT) metamorphic belts.

Three broad longitudinal zonations have been made in EGMB namely, (i) The Eastern Migmatite Zone (EMZ) 40km - 100km (ii) Central Khondalite Zone (CKZ) also 40km - 100km wide and (iii) Western Charnockite Zone (WCZ) which is 20km - 30km wide. The area occupied by the above suites (zones) within the EGMB is 45%, 25% and 30% respectively. The EGMB bears a tectonic 'Thrust' contact with the eastern margin of Dharwar and Bastar Cratons.

The EGMB hosts a number of minerals of econome such as manganese, graphite, tin-tungsten and apatite. Cainozoic lateritisation resulted in the well known and extensive bauxite capping’s. Besides, pegmatites in the area are known for their gemstone potential, mostly sillimanite and chrysoberyl cat's eye. Many of the charnockite varieties and leptynites are being exploited as dimension stone granites.

Radio-active Mineralisation has been reported from the central part of EGMB, north of Polavaram.

The different rock types in the EGMB are tentatively classified into Khondalite Group and Charnockite Suite (Group), which constitute the Eastern Ghats Supergroup.

As they are the most intensely deformed and metamorphosed among all the crustal rocks in the State, they have traditionally been considered oldest having Archaean ancestry. Of late, it is being realized that the prominent tectonic and metamorphic imprints in them and possibly some of the charnockites and migmatites are much younger (Meso to Neoproterozoic).

a. Khondalite Suite (Group)

The Khondalite Suite (Group) consists of quartz - feldspar - garnet - sillimanite + graphite schist/gneiss (khondalite), quartzite and calc-gneiss/cal-granulite which represent the metamorphosed equivalents of the original argillaceous, arenaceous and calcareous sediments respectively. Quartzo-feldspathic gneiss with or without garnet, biotite, sillimanite, commonly referred to as leptynite/leptite, also forms a distinct litho-unit of this Group.

The rocks of the Khondalite Suite (Group), which constitute the dominant component of the Eastern Ghats, form continuous hill ranges in the Eastern Ghats proper and as isolated ridges, hills and mounds in the midst of migmatites at lower elevations and in the adjoining coastal plains. At places, graphite-rich khondalite grades into graphite schist/gneiss which locally constitutes small but workable graphite deposits in the Districts of Khammam, East Godavari, West Godavari, Visakhapatnam, Vizianagaram and Srikakulam.

In addition to the mineral assemblages named above, some sillimanite-bearing rocks with unusual mineral assemblages containing sapphirine, kornerupine, spinel, cordierite, corundum and hypersthene have been recorded in Sungavarapukota, Paderu, Chintapalli and Anakapalli areas of Visakhapatnam District and Rampachodavaram-Maredumili-Gurtedu area of East Godavari District. Quartzite occasionally contains minor feldspar with or without sillimanite or garnet. A rare presence of diopside-quartzite is also reported between Borra (Visakhapatnam District) and Pachipenta (Vizianagaram District. The calc-granulite's are mainly composed of diopside, plagioclase feldspar, calcite, quartz, and garnet with or without scapolite and graphite.

They form small hillocks and mounds in the coastal part of the Eastern Ghats in Visakhapatnam and Vizianagaram Districts and also at places within the Ghats, as at Borra. In Garividi area of Visakhapatnam District, these rocks are associated with manganese Mineralisation constituting workable deposits. Calc-

granulite's locally show segregation of carbonate or diopside resulting in the formation of marbles (crystalline limestone) and diopsidite respectively.

Charnockite Suite (Group)

The Charnockite Suite (Group) includes; i) pyroxene- granulite (basic charnockite) and ii) hypersthene bearing rocks of tonalite, granodiorite and granite composition (intermediate to acid charnockite). They are interbanded and co-folded with the khondalite and migmatite rocks on a regional scale.

The pyroxene granulite occurs as small lenticular bodies or linear bands parallel to the regional foliation within the intermediate and acid charnockites. Many of the pyroxene granulite bands are distinctly gabbro/ noritic in composition. The intermediate and acid charnockites form large bodies associated with the khondalites. They can be classified into enderbite, mangerite, and charnockite based on the proportion of quartz, plagioclase feldspar and K-feldspar. Some charnockites contain feldspar megacrysts, which show crude orientation parallel to regional foliation. They appear to be syntectonic intrusives. Beginning from Singarayakonda, south of Ongole, the charnockites extendtowards northeast into the Kondavidu, Kondapalli and Yerrapalem hill ranges on either side of Krishna River. After a short gap, marked by the block-faulted Gondwana basin south of the Godavari River, the charnockites further extend from Kannegiri and Aspaka hill ranges across the Godavari into the hills along the western and central parts of the Eastern Ghats.

The Kondapalli layered anorthosite complex located in Krishna District, was emplaced in the Charnockite Suite (Group) of rocks of the Eastern Ghats Mobile Belt along a NNE-SSW trending shear zone developed parallel to the axial plane of a tight antiform. Pyroxenite, dunite, serpentinite and gabbro-gabbroic anorthosite with chromite constitute the different members of the layered complex. The charnockite gneisses were highly deformed whereas the layered sequence was relatively less deformed although it locally exhibits minor slips.

c. Migmatite group

Migmatisation of the khondalite, charnockite and pyroxene granulite gave rise to a variety of rock types. These include: 1) banded gneiss with alternating bands of khondalite and quartzo-feldspathic rock, 2) khondalite with feldspar porphyroblasts, 3) garnetiferous quartzo-feldspathic gneiss with pyroxene and/or sillimanite, 4) garnetiferous quartzo-feldspathic gneiss with relict patches of charnockite/pyroxene granulite. The migmatites, predominantly occurring along the foothills and coastal plains, are associated with intrusive granitic rocks.

Geochronology of the area: The Late Archaean and Early Proterozoic (2500 Ma -1800 Ma) precisely, which represents a time of rigorous crustal growth and reworking of older Archaean lithosphere under conditions of high grade metamorphism, witnessed the development of the Eastern Ghats Granulite Belt (Eastern Ghats Mobile Belt). This granulite belt girdling the eastern margins of the Dharwar-Bastar-Singbhum Cratons is constituted of a sequence of repetitively deformed high grade rocks referred to as charnockites and khondalites and their granitised equivalents. These rocks are of Archaean ancestry, at least in part, butaffected and

modified by younger tectono-thermal events including granitoid-charnockite intrusions and the granite melts generated from two cycles of high grade metamorphism, one around 2600 Ma and other 1000 Ma. The contact between the cratonic gneisses and the EGMB is a major tectonic feature which alomost is located at Telangana and Andhra Pradesh state boundary is borne out by many geological evidences. It is at places marked by gabbro-anorthosite and alkaline plutons of Middle Proterozoic age (1600 Ma - 1000 Ma). This testifies that plate tectonics, normally considered to be in operation only during the last 200 Ma was operative in some primitive form even during the Proterozoic. Contemporary ideas on granulite belts indicate that the EGMB most probably represents the lower crust of about 30km depth that is exhumed to its present level by some form of thrusts tectonics associated with continent-continent collision or underplating of an oceanic plate.

U, Th total Pb data from Regali province and northern and northwestern parts of Easternghats from the para gneissic rocks show a metamorphic age of 2775 ± Ma. Zircon, U-Pb data from the northern part of the Easternghats show 1230± Ma and 1220 ± 9 Ma. These ages suggest a major phase of high-grade metamorphism of basement. Para gneissic rocks from the northwestern margin of the Easternghats yielded monazite ages of 966 ± 21 Ma and 555 ± 12 Ma respectively from the core and rim parts of the monazite grains. (Sankar Bose et al, 2021)

TABLE-1: STRATIGRAPHIC SUCESSION

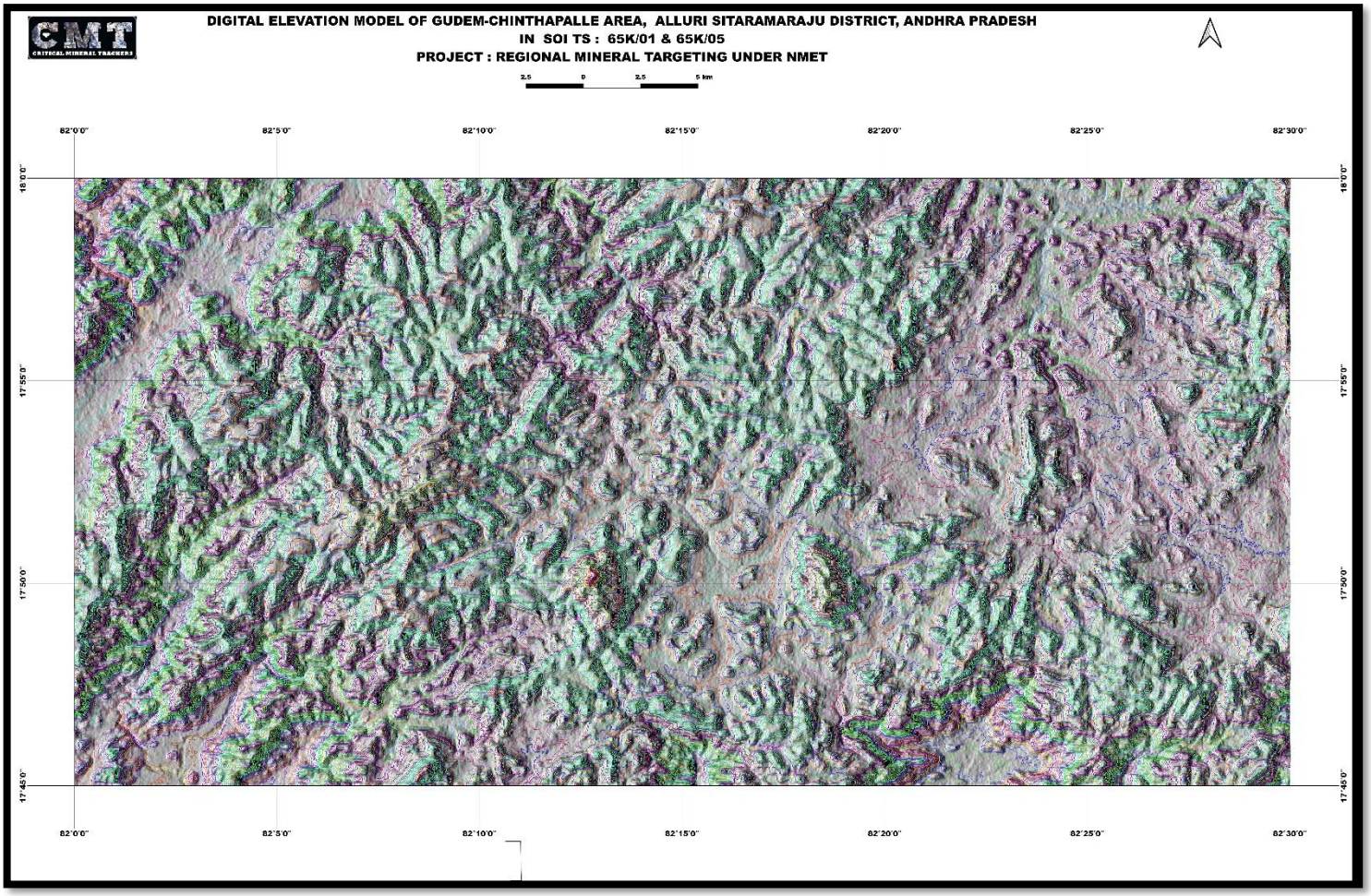
LITHOLOGY	GROUP	SUPER GROUP	AGE
LATERITE			CENOZOIC
GRANITOID	MIGMATITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC
GARNET GNEISS	MIGMATITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC
LEPTYNITE	MIGMATITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC
MIGMATITE GNEISS	MIGMATITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC
META-GABBRO	CHARNOCKITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC
ACID TO INTERMEDIATE CHARNOCKITE	CHARNOCKITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC
PYROXENE GRANULITE	CHARNOCKITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC
GARNET-SILLIMANITE-GNEISS +GRAPHITE+ CORDIERITE	KHONDALITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC
CALC GRANULITE	KHONDALITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC
QUARTZITE	KHONDALITE	EASTERN GHAT	ARCHAEAN-PROTEROZOIC

Physiography and Drainage:

The area exhibits highly rugged terrain with high hill ranges covered with reserve forest, which are further dissected by deep valleys. Physiography is mostly controlled by lithology and drainage by structural elements. Apart from these small patchy hills, open scrub can be seen in some part. General elevation of high relief domain (uplands and hills) ranges from about 1645m to 700m. The terrain shows dendritic drainage pattern. The digital elevation model map of Gudem-Chintapalli area, is given as **Figure** – 4:

DIGITAL ELEVATION MODEL MAP

Figure - 4:



Climate and rainfall:

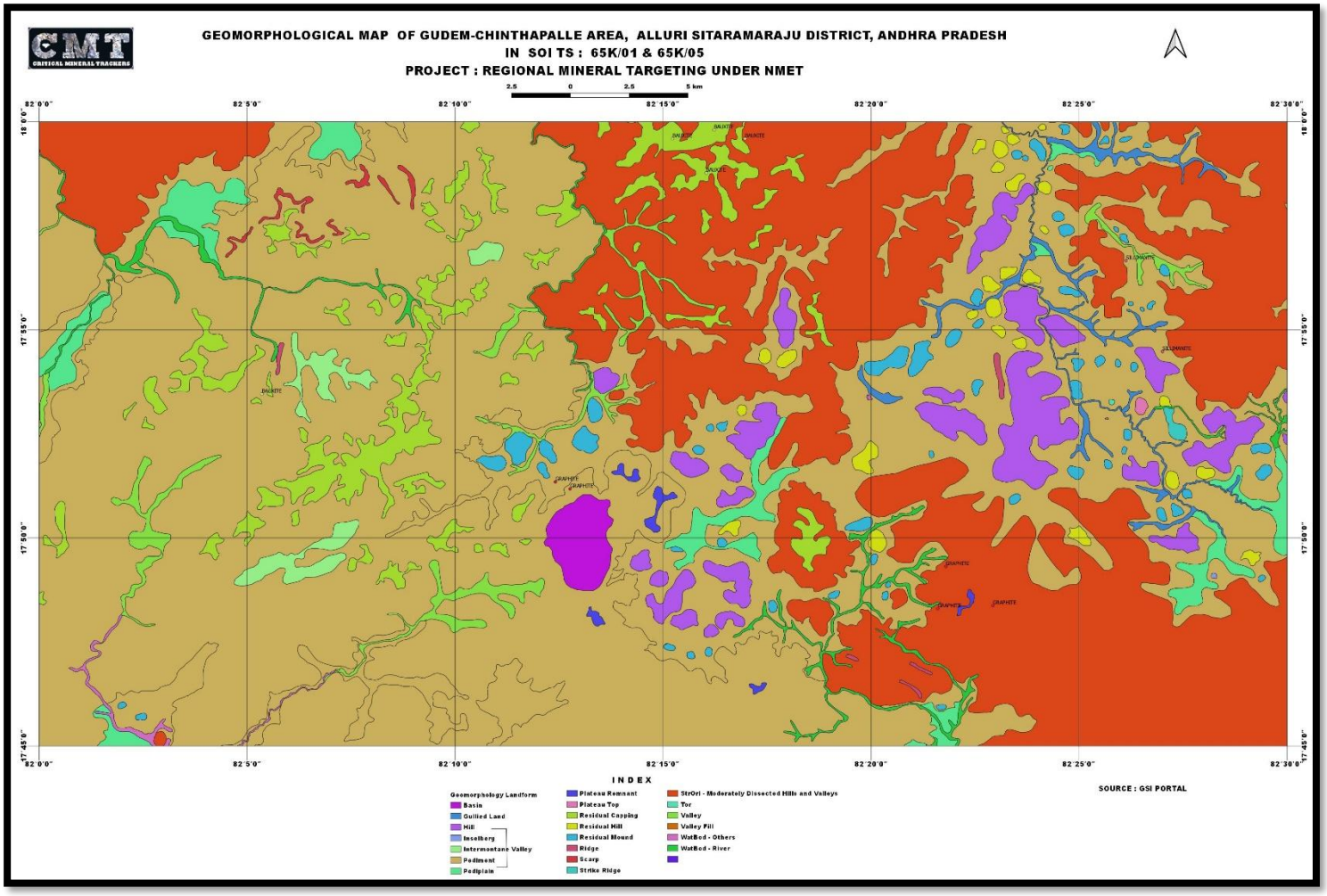
The climate of the area is tropical and sub-tropical with cold climate and pleasant summer. With an average elevation of 1100m above mean sea level, the area is cooler than the surrounding plains and is covered with moist deciduous forest. There are several coffees, pineapple, and eucalyptus plantations around the area and in some area near Lambasingi strawberry plantation. The temperature in winter season often falls around 8˚C. The temperature in summer season varies between 22˚C and 38˚C.

Land use and land cover:

The study area is mostly covered with steep hills. The central part of the study area covered by Ebulam Reserve Forest. Remaining part also dense with barren at places, makes it inaccessible in major part of the study area. Typic argiustolls are the predominant soil type in the study area falls entirely in Toposheet No. 65K/1. These are soils with relatively high organic matter. Next to typic argiustolls are typic ustropepts. These are fine, loamy, mixed isohyperthermic i.e., mean annual soil temperatures of 23 °C or more. The geomorphological map of Gudem-Chintapalli area shown as **Figure** – 5:

GEOMORPHOLOGICAL MAP OF THE BLOCK

Figure – 5:



GEOLOGY OF THE BLOCK

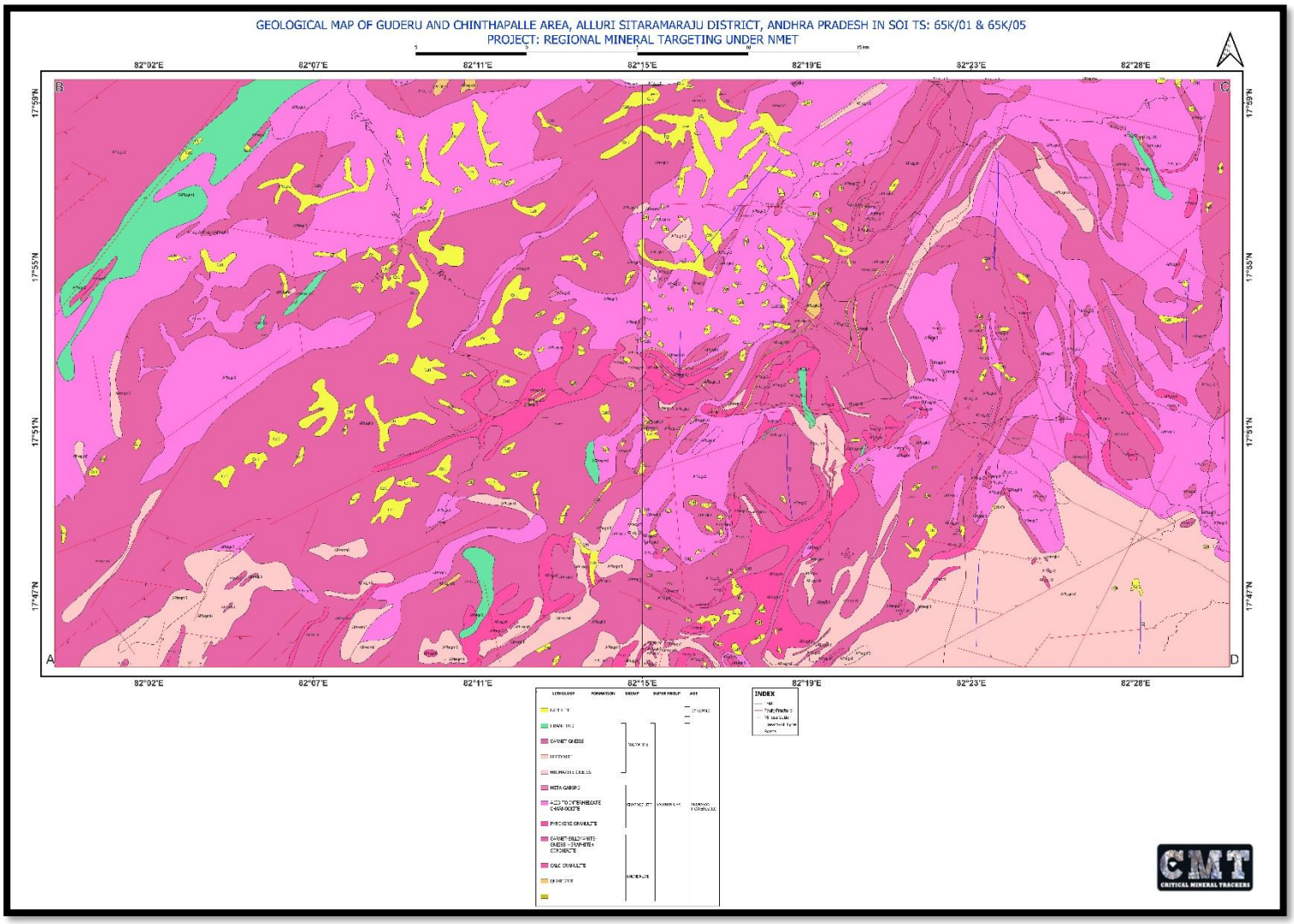
The RMT block forms a part of the Eastern Ghat Mobile Belt composed of lithounits of Charnokite, Khondalite suites and the migmatites derived from these suites . The lithounits are mostly Garnet-Sillimanite Gneiss $^{+-}$ graphite^{+-}, sillimanite quartzites acid, intermediate ,basic charnokites Leptinites Magmatic gneiss with laterite and bauxite capping's.

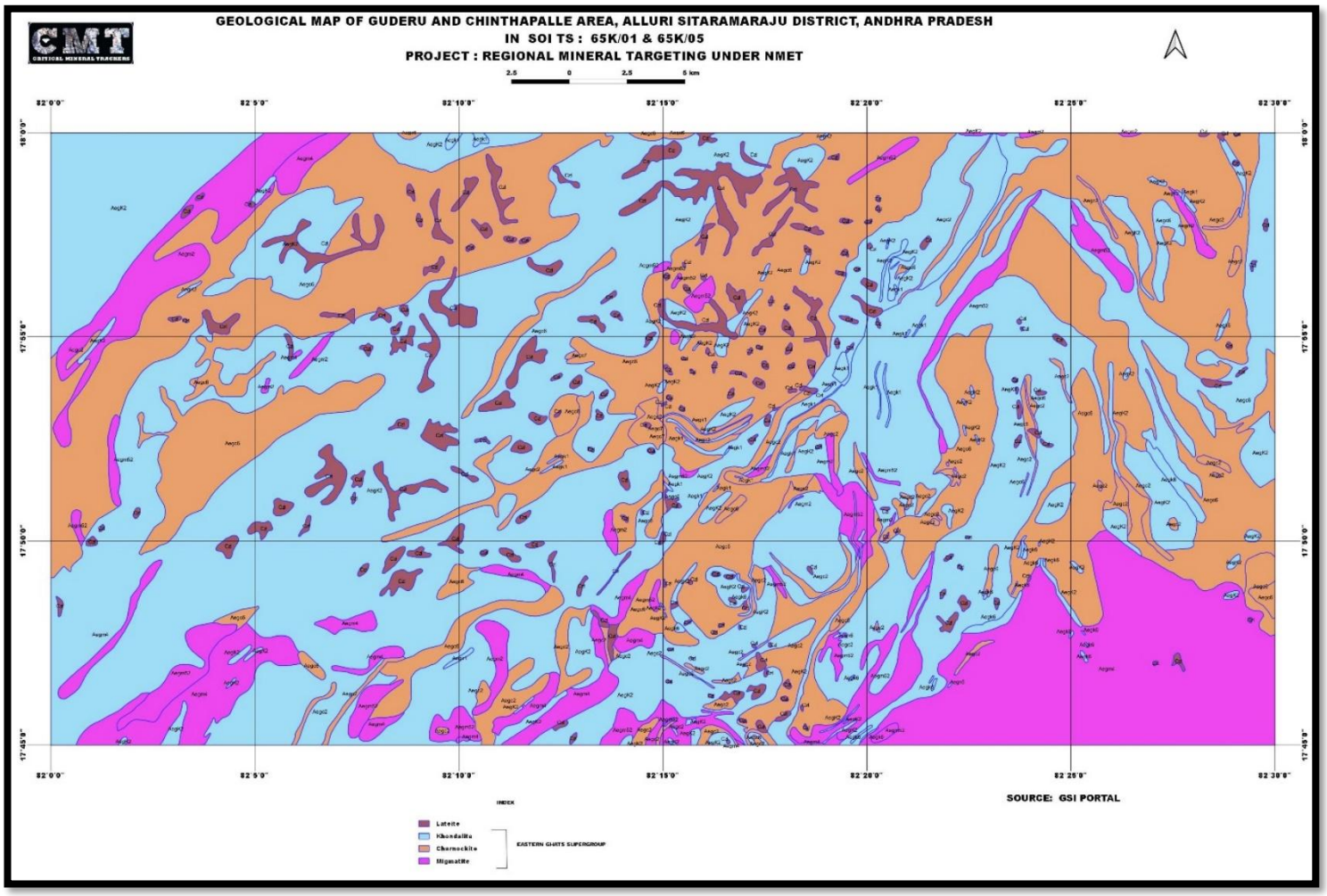
Regional Mineral Targeting for Manganese , Graphite, Tungsten, Cobalt, Titanium, Vanadium, REE, associated Critical Minerals and Elements in Alluri Sitaramaraju district of Andhra Pradesh. The proposed block is bounded by latitudes 17^0 45' 00'' - 18^0 00' 00" and longitudes 82^0 00' 00" – 82^0 30' 00" (**Figure** – **1)** and covers an area of 1450 sq.km in Survey of India toposheets 65K/1 and 65K/5 has been proposed (**Figure – 2).** Satellite Imagery of the is given as **Figure – 3.**This district is bounded by Vizianagaram district to the northeast, East Godavari district on the southwest , and Odisha state to the north, Chattisgarh to northwest district to its East Paderu is the district headquarters nearest railway line is S.Kota and road network is Chintapalli and Paderu the nearest Airport is Visakhapatnam.

The area is predominantly very rugged and hilly in nature, thickly wooded and rugged. The highest elevation in the district is 1645m and the lowest elevation is 700m above MSL.The Digital elevation map of the proposed block is shown as **Figure - 4** The area is drained by the tributaries of Sarada, Tandava and Gosthani rivers and their drainage network and most of stream's flow south, southeast. The drainage pattern is dendritic to sub dendritic and is controlled by structure. The Geomorphological map of Gudem-Chintapalli area shown as **Figure – 5** and Geological map along with lineaments of the block as **Figure – 6**.

GEOLOGICAL MAP

Figure - 6

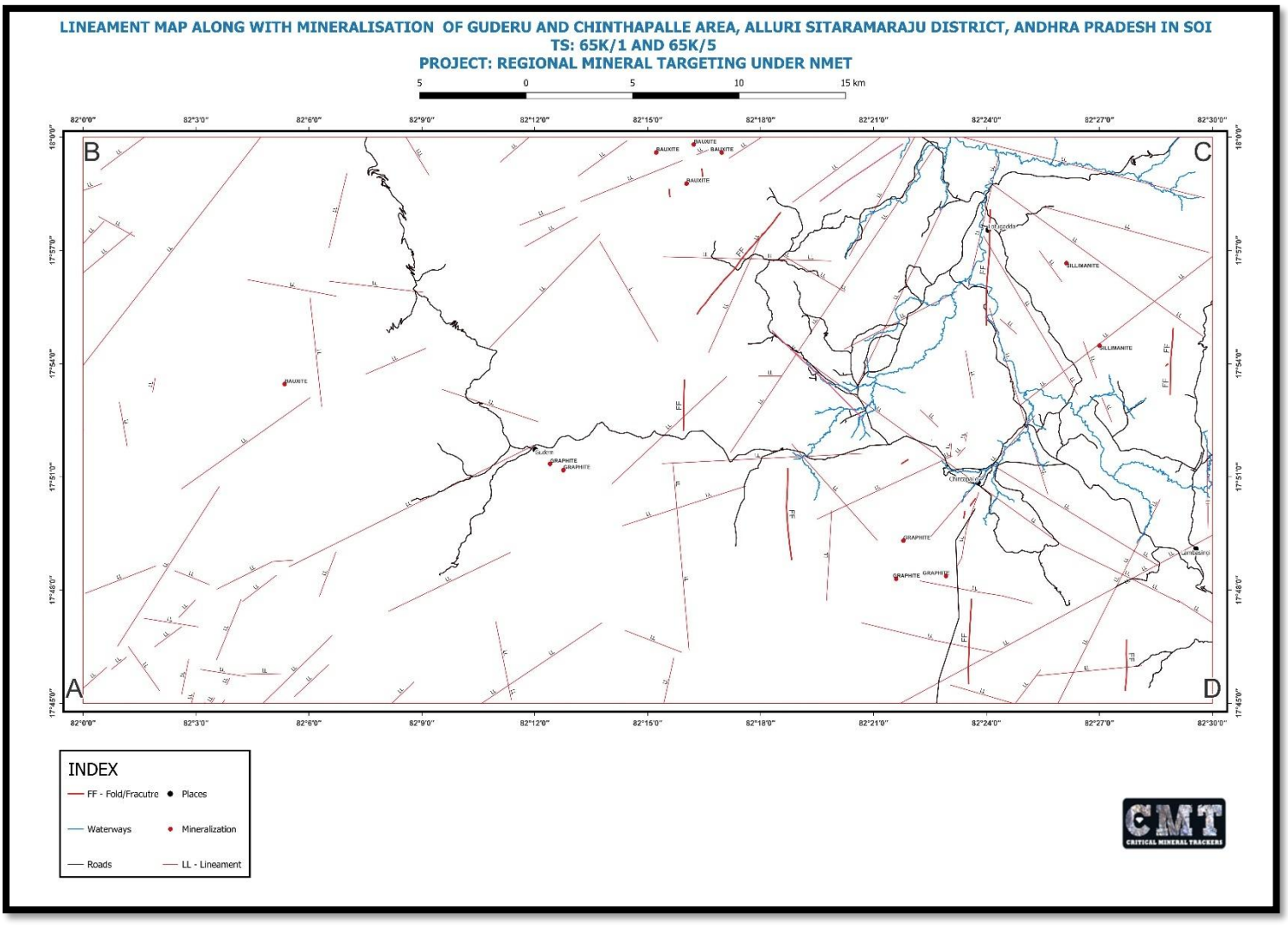



GEOLOGICAL MAP OF GUDERU AND CHINTHAPALLE AREA, ALLURI SITARAMARAJU DISTRICT, ANDHRA PRADESH
IN SOI TS : 65K/01 & 65K/05
PROJECT : REGIONAL MINERAL TARGETING UNDER NMET
2.5 0 2.5 5 km
82°0'0"
82°5'0"
82°10'0"
82°15'0"
82°20'0"
82°25'0"
82°30'0"
18°0'0"
17°55'0"
17°50'0"
17°45'0"
INDEX
Laterite
Khondalite
Charnockite
Migmatite
EASTERN GHATS SUPERGROUP
SOURCE: GSI PORTAL

The lineament map of the proposed exploration block indicates four structural trends viz. **NE-SW, NW-SE, N-S,** and **E-W.** Already report mineralization (bauxite, graphite, sillimanite) in the block is also marked in the map (**Figure - 7**).

LINEAMENT MAP

Figure -7



PREVIOUS WORK CARRIED OUT BY GSI

Gemstone: Gem variety of sillimanite is reported from the khondalite and migmatites in Araku and Paderu area. In Araku it is occurring within the khondalite near Korai, Turaiguda and Panirangani where as in Paderu area it occurs within the migmatised khondalite near Nittimaidi and Kontil

Bauxite: Bauxite capping's of variable extent and thickness occur on several hill tops. The important Bauxite deposits Chittamgondi the are Galikonda in Araku area and at Gudem and Sapparia, in Chintapalle area. The alumina in the ore ranges from 45 to over 51%. Some more cappings are also reported in Minimuluru areas. and Anantagiri areas.

Graphite: Graphite is present in the khondalite suite of rocks as specks, streaks, veins and lenses. It occurs at Kuppumetta Peddalapalem Lankalapalem Marupalem, Sivalingapuram, and Padikonda. Graphite is used in manufacture of crucibles, as lubricant in machinery working at high temperature, in the manufacturing of dry battery cells and in electrical

Apatite: Apatite occurs in Kasipatnam area as veins. It is largely used in the manufacturing of fertilisers. Reserves are estimated upto a depth of 100m.

Vermiculite: Vermiculite occurs along the margins of apatite vein zones in Kasipatnam area, and is used in cement concrete and gypsum plasters for acoustical, air conditioning and fire proof. Sizeable reserves are estimated.

Magnetite: It is seen associated with apatite in Kasipatnam area and the reserves are estimated to a depth of 30m.

Marble / Crystalline limestone : Magnesian marble/crystalline limestone occur as bands at Borra. It is used as filler, mild abrasive and for making magnesian lime.

Phlogophite mica: Occur in narrow zones in granitic rocks at Borra and useful as heat resistants.

Ochre: Ochre deposits occur at Sarangi and Araku along Nalla section at foothills. Ochre is used in distemper and paints.

MINERAL POTENTIALITY

1	Gemstone
2	Bauxite
3	Graphite
4	Apatite
5	Vermiculite
6	Magnetite
7	Marble / Crystalline limestone
8	Phlogophite mica
9	Ochre

Mineral exploration details

Geological Survey of India carried out investigation of bauxite deposits in the area under East Coast Bauxite Project (1975-77). Gurtedu, Chintapalli and Anantagiri were three Bauxite Group of deposits in Andhra Pradesh identified by GSI under this project. Krishnaswamy (1950-51), carried out mineral survey of agency tracts of Srikakulam, Visakhapatnam and East Godavari districts. Imam Ali Khan et al., (1975) carried out investigation for bauxite in Galikonda block in Toposheet No. 65K/01. Area around Chintapalle was mapped by Augustine et al (1980-81). The author presumes Supracrustals for the geological setup of khondalites and pyroxene granulites rest over acid charnockite granito gneissic complex. The authors also reported the sapphirine + quartz association for the first time in Eastern Ghat Mobile Belt.

Sarolkar et al (1982-83) mapped the area around Gudem and Darakonda. They mapped a pre-tectonic intrusive rock which is coarse grained and melanocratic comprising of both the ortho and clino pyroxenes, plagioclase. It was identified as meta-gabbro, which is not reported from this area earlier. The garnet-sillimanite-sapphirine-spinel-quartz assemblage and sillimanite pyroxene assemblage represents high temperature and high pressure conditions of metamorphism i.e., Granulite facies metamorphism. Retrograde metamorphism also evident from the development of amphibole at the expense of orthophyroxene.

Sarolkar et al (1989) mapped Chintapalli taluk and Tekkali taluk areas and revealed that the terrain is represented by Archean rocks that subjected to polymetamorphism and polydeformation. Prominent litho-units are classified as (a) khondalite group consisting of meta-sediments viz- quartzite, sillimanite gneiss and calc-granulite and (b) Charnockite group consisting of pyroxene granulite, hypersthene granulite and sub-group comprising variety of products of migmatisation. Porphyroblastic gneiss and granitic gneiss represent later phase of acidic injections. Laterite and laterite bauxite cappings are developed on khondalite and charnockite also reported. Structurally, foliation is the predominant planar structure developed in all the lithounits trending NE-SW direction. Four generations of folds are reported by the authors. The metasedimentaries of EGMB near Paderu, Visakhapatnam district is intruded by a peraluminous megacrystic granitoid. It comprises of K-feldspar (perthitic), plagioclase, quartz as major and biotite, sillimanite, spinel and rutile are accessory minerals. The chemical characteristics of the Paderu megacrystic granitoid suite are comparable with S-type granite and formed during Syn to post- collision regime (Narayana et al., 1999). Maddi Karthik Reddy et al., (2015) carried out work on mode of occurrence and distribution of Bauxite deposits in Andhra Pradesh and Feasibility of Aluminium Industry. According to them, bauxite forms four groups of capping in high hills of the Eastern Ghat from SW to NE the Gurtedu group, Chintapalli group, Paderu

group and Araku (or Anantagiri) group in a belt of 130 km long and 20km wide. Yadav et al., (2020-21) carried out gravity and magnetic surveys during National Geophysical Mapping (NGPM) on 1: 50,000 in parts of Toposheet Nos. 65K/1, 2, 5, 6 & 9 in Vishakhapatnam and East Godavari Districts of Andhra Pradesh. A NE-SW trending linear high gravity anomalous zone over charnockites and pyroxene granulites has been demarcated between Pidugurai-GK Veedhi-Mondigedda in toposheet nos. 65K/1 and 2. The PiduguraiGK Veedhi-Mondigedda area is reflected with moderate magnetic anomaly of +200 to +250 nT.

In view of encouraging results and significant identification of anomalous zone in GK Veedhi area, a STM project for the area bounded between Lat 17º 45' 00" to 18º 00' 00" and long. 82º 07' 30" to 82º 15' 00" is proposed to check the geophysical anomaly with systematic sampling for bauxite, manganese, graphite, and associated mineralization as a spinoff of NGPM item (FS 2020-21). The work involves Geological mapping of 350 sq. km area on 1:25,000 scale with systematic sampling of 50 BRS, 40 PCS and 40 petrographic samples. Few samples are analysed for Ga, W and Mo

Remote sensing and PGRS studies

Spectral studies for ASTER data of about 720 Sq. Km is envisaged as per NQT of FS 2022-23 keeping in view to delineate mineralization potential of the study area. In this regard, the Spectral studies of ASTER data carried out at PGRS division, GSI, SR to cover an area of about 720 sq. km. ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) data processed to delineate Kaolin and laterite enrichment zones in combination of different band ratios using Erdas Imagine software. The laterite enrichment map prepared in band ratio of 7/5 corresponds to kaolin enrichment image (band ratio 4/5) (Fig 1.6 and Fig 1.5). Whereas the ASTER image processed for laterite enrichment moderately matches with the western margin of STM block where the laterite cappings are mapped in geological map of 1:50000 scale. Also prepared NDVI, Ferric iron

maps using ASTER data (Fig 1.4 and Fig 1.3). NDVI map depicts thick vegetation present in the study area.

ASTER data study has been carried out by using different band ratios to target mineralization available, if any.

METHODOLOGY

- Collation and integration of datasets pertaining to NGCM, NGPM Airborne Geospatial, Geology, Structural trend maps, Outcrop boundaries, Mineral occurrences, seismo-tectonics, geochronology, Aster alterations and preparation of thematic maps and consultation of all ME reports, extraction and plotting of selected data (drill, alteration mineral, geophysical etc.) in GIS platform.

- Potential field mapping (predictive geological mapping using aero geophysical datasets) Simultaneously during this period one-month Drone Survey to map the inaccessible areas.

- Mapping of demarcated Potential Mineral Zones on 1:25K, collection of samples (BRS, Regolith, PS, PCS, Hydrogeological samples)

- Samples for OM, SEM, EDX, XRD, EPMA, Geochronology Analysis of Geopghysical Property of rock samples, Magnetic susceptibility.

- Interpretation of chemical and laboratory data, plotting on the geological map and finalizing the Potential Mineral Zones.

- Field traverses to check the Potential Mineral Zones with the chemical and Lab data plotted to finalize the map before preparation of report.

- Preparation of Final Geological Report along with the finalized map showing the potential zones for mineral commodities to be taken up for G-4 Investigation. The report will comprise comprehensive data collected and interpreted from the assigned area for RMT.

- Utilization AL/ML tool for prediction of Mineral occurrences

Implementation Artificial Intelligence and Machine Learning in Regional Mineral Targeting in Alluri Sita Rama Raju Districts (65K/1 and 65K/5)

INTRODUCTION

Mineral deposits explored earlier are going to be exhausted in the near future, identification of new deposits, particularly, scarcely and deep-seated minerals of economic and strategic importance is a major challenge. It leads to an abnormal increase of exploration cost and time, limited success with the conventional approaches of exploration methods. To overcome/compliment this, we need to find new approaches, capable of providing better *insights from combined geoscience data of multi-sensor/parameters*.

In the present work, based on the available geological and geophysical data available from Bhukosh website of GSI, data visualization maps of different mineral concentrations, gravity and magnetic anomaly maps along with mineralization and structural features superimposed on study area, can help to understand the data coverage, data gaps for qualitative and AI/ML implementation. This will significantly reduce the further level of exporation. These maps are essential before any exploration/ identifying regional potential mineral blocks, Besides, Box plots, Histograms and scatter plots for geochemical data of acquired geological samples and other geophysical data. Qualitative control of data to devoid of duplicates, missing, unwanted data, outliers, is prior requirement for AI/ML implementation.

Artificial Intelligence (AI) and Machine learning (ML) algorithms are proven to be good in classification and identification/prediction of possible potential mineral zones for primary and secondary/associated minerals/host rocks/ RMT blocks. from combined geological and geophysical data.

The results provide better insights into possible new areas of potential mineral zones and also the extension of existing zones. Additional high-resolution data can improve prediction accuracy.

OBJECTIVE

The objective of the study is to identify the Regional Mineral Targeting blocks hosting large number of primary/secondary minerals as well Critical minerals and REE.

i) Prediction of various minerals or ore concentrations from geochemical data of acquired geological samples at new locations/ close grid spacing using AI/ML. The AI model's prediction or identification of a targeted minerals at a new location is based on the other associated minerals inter-relationship/pattern of variability with respect to targeted minerals.

ii) Identification of potential new mineral zones from combined geophysical data (Gravity & Magnetic), geological using AI.

iii) Preparation of relevant maps is essential for providing immediate insights into the distribution of mineral concentrations, variations in geophysical data relative to lithology and structural features and understanding the relationships among various parameters. Identification and relations among the geophysical trends and structural features for conventional interpretation and compare with AI predicted results in demarcating the RMT blocks.

The AI/ML implementation is planned in two phases

i) **Phase-I** : In the first Phase, i.e. before substantiating the with additional acquisition, with current available data, which is scanty, AI/ML can provide some ideas about the trends of geological and geophysical anomalous zones and some insights about the requirement of additional data to be acquired and areas.

ii) **Phase-II** : After additional data acquisition (geological, aeromagnetic, ground gravity data and geochemical data) along with existing data, AI implementation provides better solutions as the data density increases/fills the data gaps has more relevance to expected results in demarcating the anomalous RMT block and compliment the outcome from conventional approach helps to optimal scout drilling.

SCOPE OF WORK

1. Collection of available geological, geochemical, geophysical (gravity, magnetic) remote sensing, and mineralization details.
2. Combined Map of map geological super imposed with gravity anomaly, and another with magnetic anomaly along with Mineralisation and structural features.
3. Ensuring the Quality of Data: verification of the data for data available, identify the data gaps, corrections to missing values, NaN, duplicates, unwanted symbols, text as part of partial data cleaning.
4. To prepare scatter plots and box plots to visualize and understand data quality and identify outliers.
5. To prepare and visualize the georeferenced lithology map with geological structural features, reported mineralization.
6. To prepare various mineral concentration maps from geochemical data of new geological sample data. Application of AI to establish interdependence associated with Mn, W, REE and other minerals with respective to targeted minerals.
7. Prepare Bouguer anomaly contour map with spot values. Blank the data gap areas to avoid unnecessary interpolation/extrapolation
8. Superimpose Bouguer gravity anomaly contour map on geology map

- Examine to understand the gravity contour trends and correlation with lithology, structural features, dyke, faults, lineaments.

- Examine regional and local gravity anomaly lows and highs and their locations with reference to geological features and mineralization reported.
- Examine gravity anomaly gradients, its relationship with geological boundaries and structural features, etc.

9. Prepare magnetic anomaly contour maps with actual values posted to verify the correctness contours.
10. Superimpose the magnetic contours on geology map

- Remember magnetic fields are bipolar, unlike gravity fields.
- Understand magnetic anomaly features and their correlation with underlying geological features.

11. Extracting feature vectors, integrating data for testing and prediction and building AI models
12. Using AI to predict (i) new mineral concentrations by correlating associated minerals from geochemical Data (integrating data, and training and validating AI models for each targeted mineral. Prediction of new mineral zones.
13. Using AI to predict new mineral zones from gravity, magnetic, and geological data.
14. Preparation of Geospatial Map with AI predicted RMT block

DETAILS OF WORK FLOWCHART

The comprehensive workflow and Work Breakdown Structure (WBS) chart illustrates the sequential operations from data loading to AI prediction results. The figures below provide a detailed depiction of these processes.

(i) Data cleaning/preprocessing /geostatistical analysis

(ii) Available data visualization and qualitative analysis

(iii) Feature vector generation

(iv) Integration of data as per requirement

(v) AI/ML model building, evaluation

(vi) Model predictions with Test data

(vii) Identification of new potential areas of exploration

(viii) Visualization of prediction model results on spatial maps

Understanding the significance and implications of different domain variables of the data is essential when performing data cleaning or data wrangling.

Despite being time-consuming, exercise is essential to ensure data quality and relevance before modelling. Since, AI modelling identifies relationships and patterns within input data in reference to a target, the performance and validity of predictive models depend on the quality and nature of the input data (**Figure 1**).

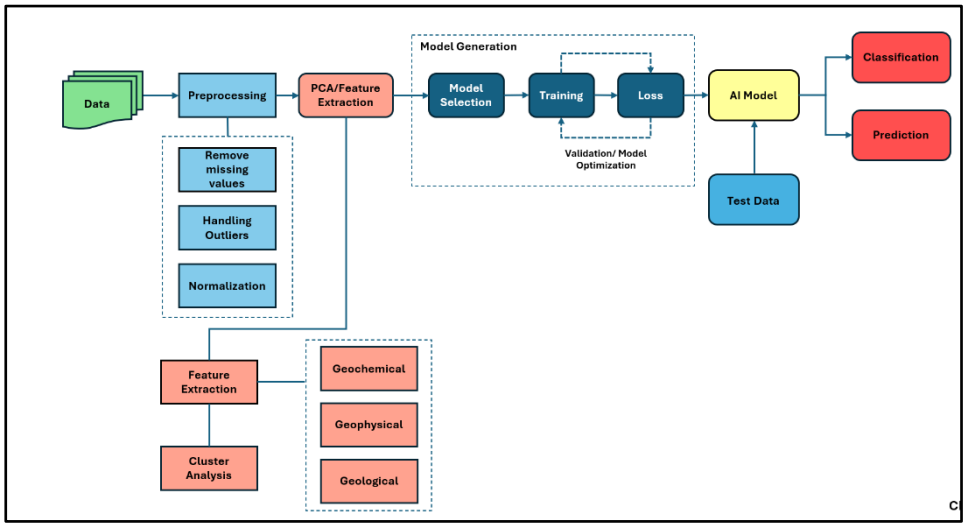


Figure 1: Scope of work - Total Work flowchart

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Integration of data

Once the relevance data/feature vectors identified as input layer, combining them is challenging as they are derived from different data domain exhibits diverse dimension, metrics etc. Normalization of the data transforms the data minimum and maximum values between 0 to one. The number of features considered for specific data type depend on their relevance. Apart from numerical data, the categorical information such as geological formation, labels and some intuition by experience can also be part of input data. Such information has to be converted into numerical form through a proper auto- encoding.
Exploration block marked on satellite terrain map (**Figure - 2**)

Gravity and Magnetic Data Feature Vectors Extraction

From gravity and magnetic anomaly data, second derivative anomalies and absolute horizontal gradient values are generated as feature vectors. The 2^{nd} derivatives and gradients are devoid of regional variations have direct bearing on local lateral changes due to subsurface structures. Spectral features also throw some insights on the depth of

causative source. Bouguer gravity anomaly map of the block and Total magnetic intensity map of the block are shown as **Figure -3 and 4**.

Label/Text Encoding

Geological information in text format needs to be converted into a numerical format for efficient computer processing. When mineralization occurrence indicates specific to a particular geological formation rather to super group or group, then the number of labels in legend quite high corresponding to formations, So, it is better to incorporate the relevant geological information, including distance matrix with respect to faults/lineaments also play important role and have bearing on mineralization, Therefore, labelled data to be auto encoded in the form sparse matrix.

LIST OF DELIVERABLES

DELIVERABLES	
1	Mn, W, Al, REE and other mineral concentration maps
2	Gravity Anomaly spot values (mGal) with mineralization super imposed on Geology map
3	Gravity Anomaly contours with mineralization superimposed on geology map
4	Gravity Anomaly 2nd derivative maps with mineralization superimposed on geology map
5	Magnetic Anomaly spot values (nT) with mineralization on geology map
6	Magnetic Anomaly contours with mineralization superimposed on Geology map.
7	Magnetic Anomaly 2nd derivative maps (nT) with mineralization superimposed on geology map.
8	AI prediction of mineral concentration maps from geochemical data for mn, al, w, ree and other minerals
9	Error maps : Predicted error between Observed and AI predicted from geochemical data for Mn, Al, REE and other minerals
10	AI predictions for Mn, W, Al, REE and other minerals from combined geological and Geophysical data.
11	Demarcation of RMT block holding all desired minerals predicted from AI/ML on Geospatial Map

SATELLIT TERRAIN MAP

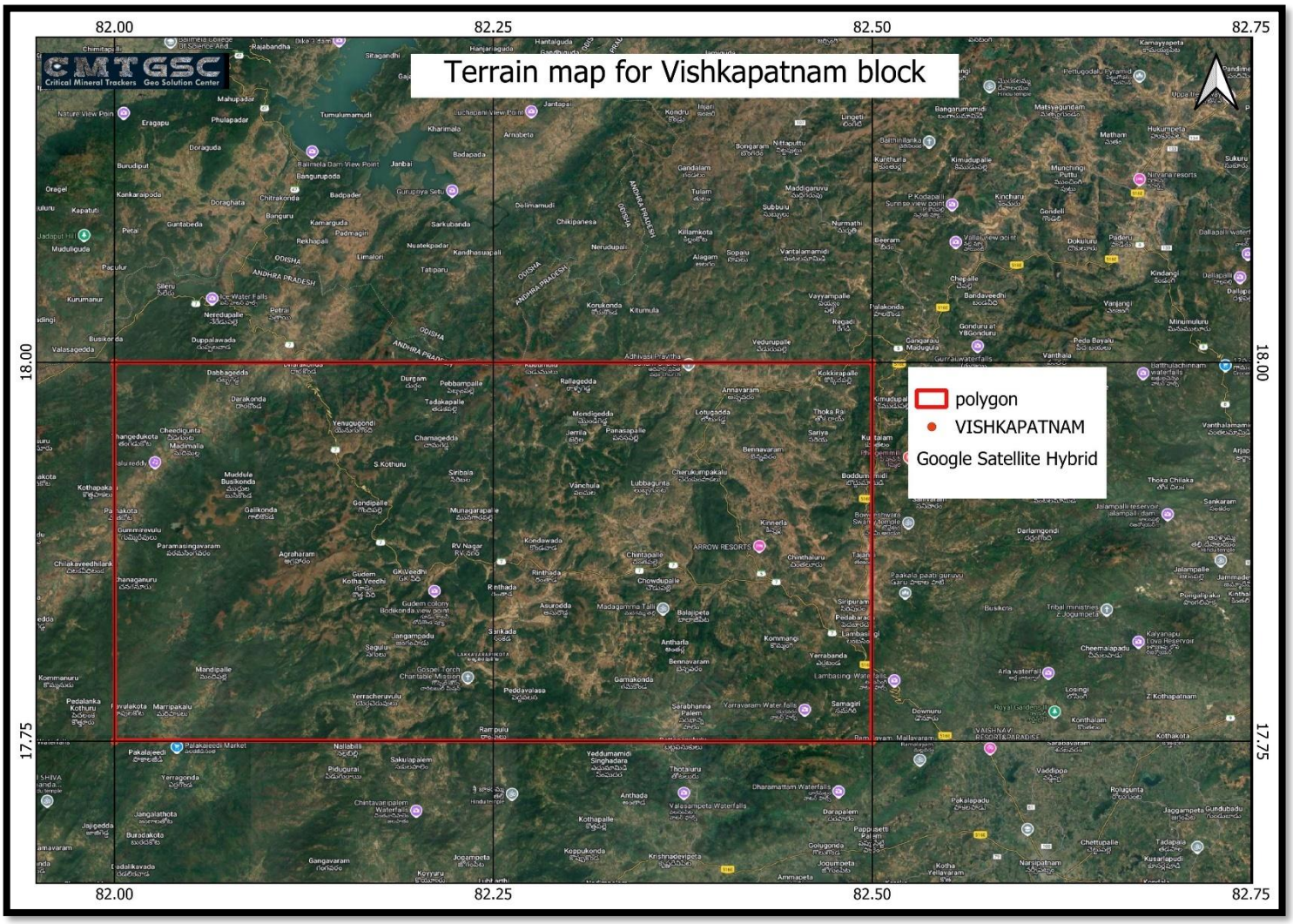

Figure – 2: Exploration block marked on satellite terrain map.

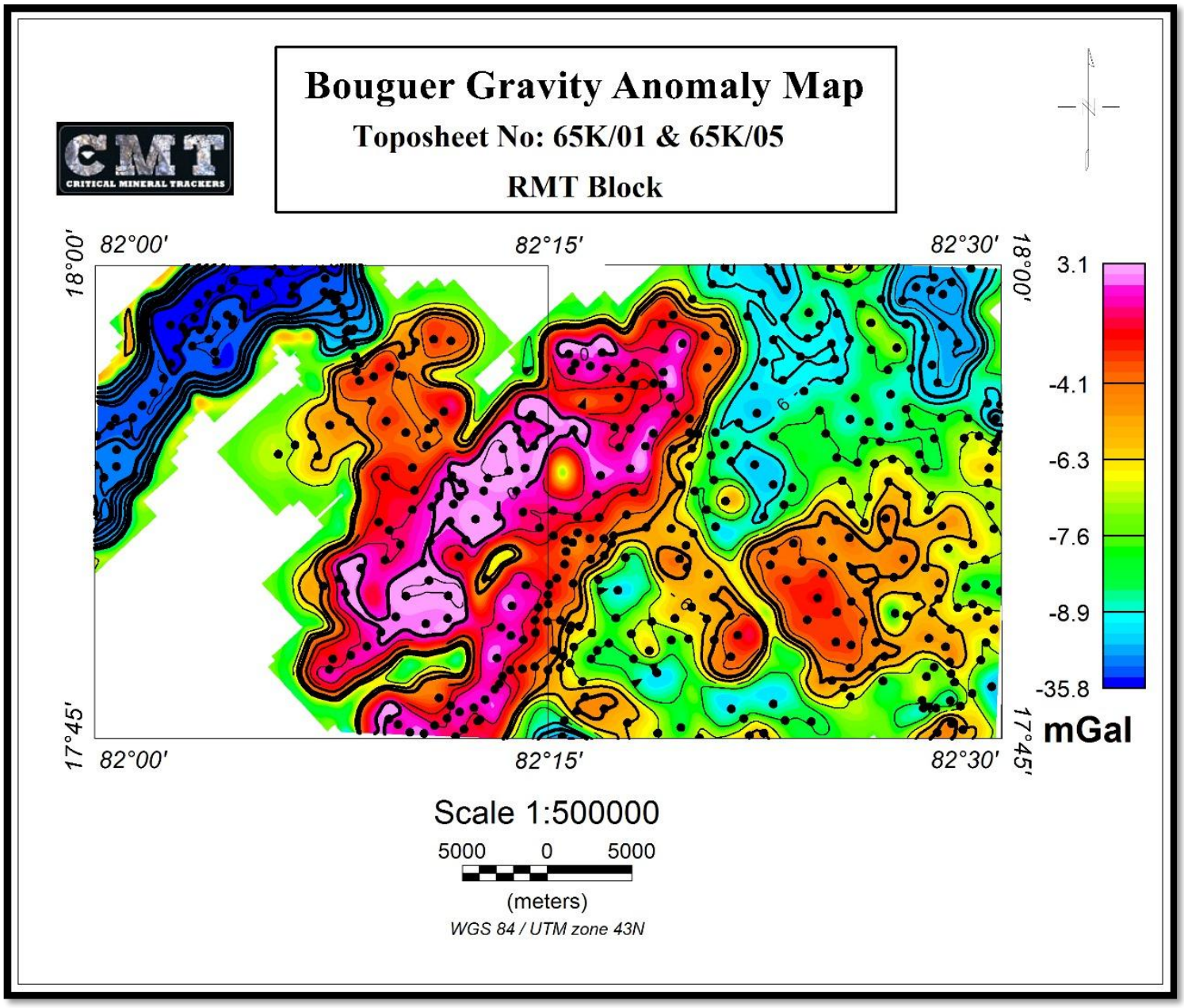

Figure -3: Bouguer gravity anomaly map of the RMT block.

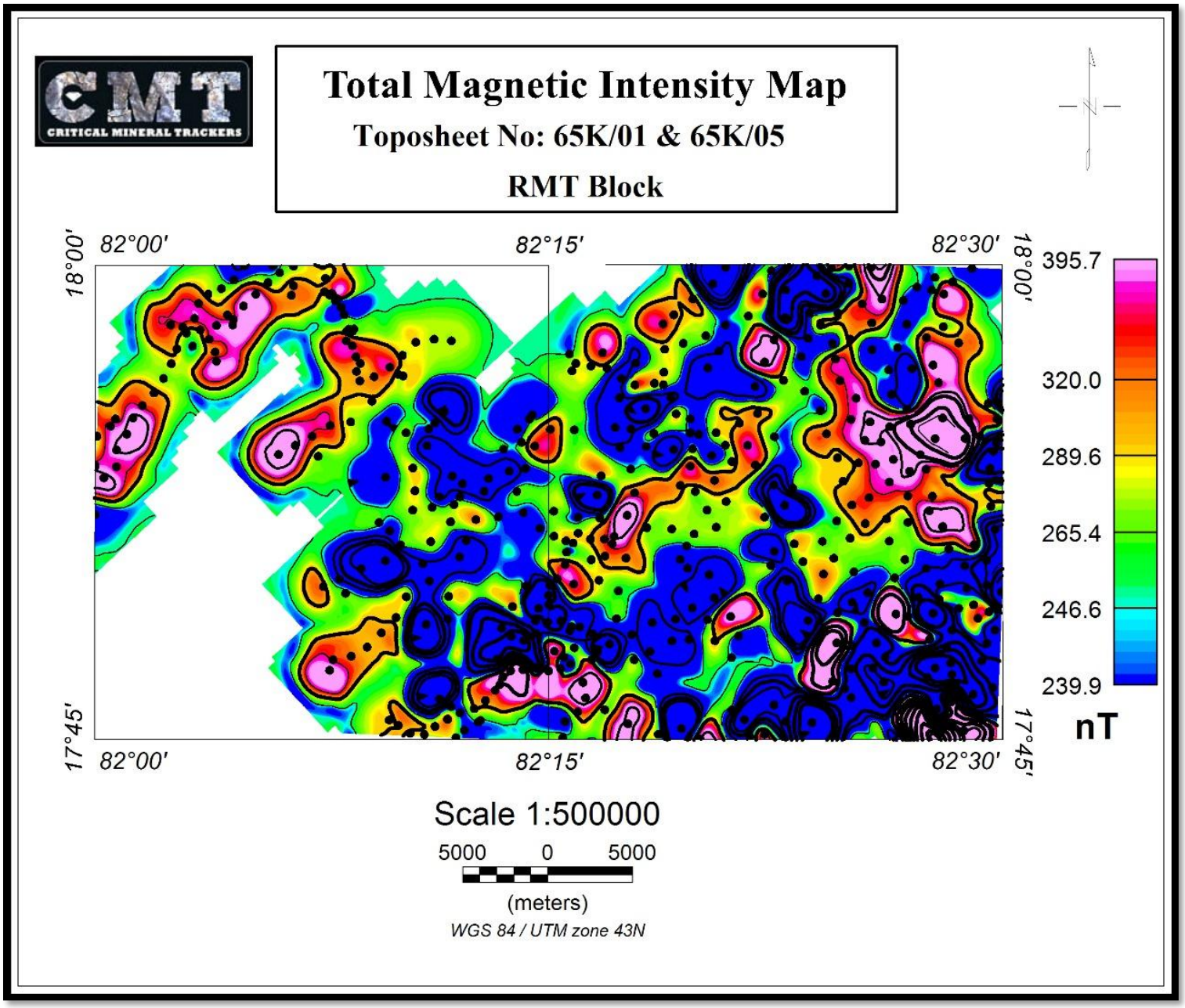

Figure -4: Total Magnetic Intensity map of RMT block.

a) Nature and Quantum for Regional Mineral Targeting

Area – 1450 sq.km

Collation and integration of datasets

Aero-Geophysical studies

AI-ML driven mineral prospectivity modelling

Preparation of thematic maps

Geological Mapping of potential mineral zones on 1: 25000 scale

Sampling

Geochronology studies

Chemical analysis

Identification gap areas

Prospective Analysis, Identification of mineral system and potential areas for G4 investigation

b) MANPOWER DEPLOYMENT

1. Six (6) Senior Geologists
2. Twelve (12) Geologists
3. Two (2) Senior Geophysicists
4. Two (2) Geophysicists

Note: All the above are tentative and vary as per the necessity arising during the course of project execution

COST ESTIMATE RMT BLOCK INVESTIGATION		
IN PARTS OF TOPOSHHETS 65K/1 AND 65K/5 ALLURI SITARAMARAJU DISTRICT ANDHRA PRADESH		
S.NO	**ITEMS**	**COST ESTIMATE (Rs)**
1	Geological Work	4,52,93,760
2	Survey Work	9,18,360
3	Core drilling	1,84,11,700
4	Laboratory Studies	2,44,77,900
5	Geophysical studies	14,08,49,000
6	Preparation of Project Proposal	3,80,000
7	Preparation of Final Geological Report	20,00,000
8	Peer Review	30,000
9	**Total (without GST)**	**23,23,60,720**

ACTION PLAN AND NQT FOR RMT IN 65K/1 & 65K/5 OF

ANDHRA PRADESH

Total Duration of the Project	**18 Months**
Total Area of the block	**1450 Sq Km (2 full Toposheets)**

Work Schedule – **I$^{st\ to}$ 3rd Month**: Collation and integration of datasets pertaining to NGCM, NGPM Airborne Geospatial, Geology, Structural trend maps, Outcrop boundaries, Mineral occurrences, seismo-tectonics, geochronology, Aster alterations and preparation of thematic maps and consultation of all ME reports, extraction and plotting of selected data (drill, alteration mineral, geophysical etc.) in GIS platform.

4th to 7th Month – Potential field mapping (predictive geological mapping using aero geophysical datasets) Simultaneously during this period one-month Drone Survey to map the inaccessible areas.

8th to 15th Month – Mapping of demarcated Potential Mineral Zones on 1:25K, collection of samples (BRS, Regolith, PS, PCS, Hydrogeological samples) Samples for OM, SEM, EDX, XRD, EPMA, Geochronology Analysis of Geophysical Property of rock samples, Magnetic susceptibility.

15th & 16th Month – Interpretation of chemical and laboratory data, plotting on the geological map and finalizing the Potential Mineral Zones.

17th Month – Field traverses to check the Potential Mineral Zones with the chemical and Lab data plotted to finalize the map before preparation of report.

18th Month – Preparation of Final Geological Report along with the finalized map showing the potential zones for mineral commodities to be taken up for G-4 Investigation. The report will comprise comprehensive data collected and interpreted from the assigned area for RMT.

References

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2. Geological Mapping in parts of toposheets 65K/1 in Visakhapatnam district AP on 1:50000 scale field season 1984-85 by K.Nagarajan, T.Rajesham, D.Sundaravanan and P.B.Sarolkar

3. Geological Mapping in parts of toposheets 65K/5 in Visakhapatnam district AP on 1:50000 scale field season 1980-81 by P.F.Augustine, B.P. Pande and K.Shankar

4. “Zircon and monazite geochronology from the Rengali-Eastern Ghats province: Implications for the tectonic evolution of the eastern Indian terrane” ; by Shankar Bose et.al (2021) vol.355, Precambrain Research.

5. “Geology and Mineral Resources of South India”; by K. Mahender Reddy and R. Bharathi, Special Publication, First Edition, Geological Survey of India, 2020

Timeline: 18 Months

Sno	Activity	Unit	Months																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Days
1	Geologist Party Days HQ	Days									REVIEW										45 days
2	Geologist Party Days Field including sampling	Days																			150 days
4	Laboratory Studies	Days																			120 days
5	Interpretation	Days																			50 days
6	Survey Party Days	Days																			15 days
7	Core drilling																				60 days
8	Post Field Interpretation	Days																			20 days
9	Report Compilation & Submission	Days																			15 days

Title of Project: REGIONAL MINERAL TARGETING							
RMT BLOCK ALLURI SITARAMARAJU DISTRICT, AP							
TOPOSHEETS: 65K/1 & 65K/5							
Name of the Exploration Agency – Critical Mineral Trackers, Hyderabad							
Total Area - 1450 sq.km; Completion Time -18 months							
S. No	**Item of Work**	**Unit**	**Rates as per NMET SoC**		**Estimated Cost of the Proposal**		**Remarks**
			SoC-Item-Sl No.	**Rates as per SOC**	**Qtm**	**Total Amount (Rs)**	
A	**Geological Work**						
1	Geological work/studies like geochemical studies, geochemical orientation survey , water sampling, surface sampling , outcrop sampling (BRS/PS/PCS/Groove/Chip/Grab/ Channel/Soil/SSS/Heavy Mineral), pit & trench logging and sampling, core logging and core sampling, preparation of beneficiation samples, skeletonization of cores etc. including planning for sampling, Boreholes etc., consultation of literature, maps, reports etc. (where Geological Mapping is not carried out)	1450 Sq.km	1.5.1a(b)	11000	3240	3,56,40,000	6 Senior Geologists and 12 Geologists - 180 days*18=3240-man days

	b) Charges for one Geologist per day in Field (without labour)						
2	Geological work/studies like geochemical studies, geochemical orientation survey , water sampling, surface sampling , outcrop sampling (BRS/PS/PCS/Groove/Chip/Grab/ Channel/Soil/SSS/Heavy Mineral), pit & trench logging and sampling, core logging and core sampling, preparation of beneficiation samples, skeletonization of cores etc. including planning for sampling, Boreholes etc., consultation of literature, maps, reports etc. (where Geological Mapping is not carried out) a) Charges for one Geologist per day at HQ	One Geologist Per Day	1.5.1a(a)	9000	360	32,40,000	3 Geologists . Pre-field Three months + one month report writing = 4 months 90+30=120 days(including Remote sensing studies 120*3=360

3	Satellite imagery (Ortho-corrected PAN-A/F(2.5m)(Cartosat-3)	Two scenes	NA		ACTUALS		ACTUALS
4	Hyperspectral Imaging				ACTUALS	NRSC	Analysis - Remote sensing & GIS Analysis
5	sampling: 6 months	180 days	1.5.2	5100	720	36,72,000	180 days - 4 samplers*180=720
6	Labour(2 labour) attached to sampler	180 work days labour days	5.7	476	1440	6,85,440	4 samplers*2=8*180=1440 labour days
7	Labour (180 Field days) per team:4 workers : 180*24=4320 labour days for 6 teams (two geoglist teams)	Per Team of 2 Geologists 6 Team @ 4 labour = 24 Labour Labour/Field workers	5.7	476	4320	20,56,320	Hilly terrain Rugged surface nearly 1100 sq.km 6 geologist teams 180 field days 4320 labour days @ 4 labour
	Sub-Total -A					**4,52,93,760**	
B	**Survey Work:**						
1	Surveyor: Related Work - Fixation & connection of boundary points(10 no's),10 Bh by Total station/DGPS	One surveyor	1.6.1a	8,300	90	7,47,000	Surveyor: Related Work & Fixation & connection of boundary points(10 no's),10 Bh by Total station/DGPS

2	Labour	4 labours with surveyor	5.7	476	360	1,71,360	surveyor *4 labour = 90 days= 90*4 =360
	Sub-total-B					**9,18,360**	
C	**Core Drilling**						Expected Mineralization Bauxite,Graphite,Apatite,Vermiculite,Magnetite,Marble / Crystalline limestone ,Phlogophite mica,Ochre
1	Scout drilling(coring) :10 BHs points(each 200 m depth)	Per meter	2.2.1.4a	11,500	2000		As necessary, based on the recommendations after review meeting to find out REE and critical mineral proposing deeper BHs 10 Nos @200m for locating concealed deposits. **Note: The unit rate may vary basing on Rock formation** Sampling : Every 5m
2	Construction of BH pillar(12”*12”*30”)	Per pillar	2.2.2a	2000	10	20,000	10 pillars
3	Bore hole plugging by cement	Per meter	2.2.7b	150	150	22,500	i) NQ Size : 15m @ 150 - 10 Nos

4	Transportation of Drill Rig	Per km	2.2.8	36	700	25,200	Shifting of Rig from Hyderabad
5	Monthly Acoomidation Charges for drilling Camp	Monthly basis	2.2.9	50,000	8	4,00,000	
6	Drilling Camp setting Cost	Per Camp	2.2.9a	2,50,000	1	2,50,000	
7	Drilling Camp Winding Cost	Per Camp	2.2.9b	2,50,000	1	2,50,000	
8	Approach Road making for Flat Terrain	Per km	2.2.10a	22,020	200	44,04,000	It may vary as per actuals
9	Approach Road making for Rugged Hilly Terrain	Per km	2.2.10b	32,200	300	96,60,000	It may vary as per actuals
10	**Mob & demob drilling machine & inner BH shifting	Per shifting	lumpsum		0	0	lumpsum
11	Compensation for 10 Bhs		5.6	20,000	10	2,00,000	10BHs
12	Drill core preservation in GI boxes	Per meter	5.3	1590	2000	31,80,000	2000 m core
	Sub total-C					**1,84,11,700**	
D(A)	**Geochemical Methods**						
1	**Portable XRF**	Per unit	NA		1	30,00,000	For Rapid field screening - As per approved cost by NMET File No. 6/4/2015 - NMET-Part(1)/367 dated 22.02.2023 , item No. 6

2	**Geologist Man days for handling Portable XRF**	Per Manday	1.5.1a (b)	11000	360	39,60,000	2 Geologists required for handling portable XRF for Rapid field screening -180 days *2 = 360 DAYS
D	**Laboratory Studies**						
1	Samples BRS and Regolith for major oxides	per sample	4.1.15a	4200	400	16,80,000	
2	Samples BRS and Regolith for 14 elements	Per sample	4.1.13	5380	400	21,52,000	Analysis for major , Minor, trace ,REE and PGE Elements
3	Samples BRS and Regolith for 34 elements	Per sample	4.1.14	7731	400	30,92,400	
3	Regolith selective 150 no	Per sample	4.1.13	5380	150	8,07,000	
4	Regolith selective 150 no	per sample	4.1.14	7731	150	11,59,650	
5	Regolith selective 150 no	Per sample	4.1.15a	4200	150	6,30,000	
6	PCS Major, Minor,Trace and REE	per sample	4.3.1	2353	50	1,17,650	
7	PCS Major, Minor,Trace and REE	per sample	4.3.4	4232	50	211600	
8	PGE 5 elements	per sample	4.1.5d	11800	10	118000	
9	For Graphite 150 samples	per sample	4.1.16	3000	150	450000	volatile matter, fixed carbon,graphite carbon ,organic carbon,moixutre

10	samples for ore microscopic study	per sample	4.3.4	4232	100	423200	50 Samples - 2 hours for each sample
11	SEM-EDX	per hour	4.4.2	2940	100	294000	
12	XRD	per sample	4.5.1	4000	50	200000	
13	EPMA	per Hour	4.4.1	9000	30	270000	Available only with GSI their rate is 9000 per hour - One hour for sample (30 *1 = 30 Hours)
14	Core Samples for 14 elements include PGE	Per Sample	4.1.13	5380	400	2152000	Analysis for REE 14 Elements and 34 Elements by ICPMS Technique
15	Core Samples for 34 elements	Per Sample	4.1.14	7731	400	3092400	
16	Hydro-geological sampling	per sample	4.1.8a	3680	100	368000	
17	Geophysical property-magnetic susceptibility	per sample	Not Available	1000	300	300000	information obtained from NABL accredited lab
	Subtotal-D					**2,44,77,900**	
E	**Surface Geophysical Survey**						
1	Electrical resistivity	Per Station	3.5a	70,650	200	1,41,30,000	ERM required to find out depth of bedrock in plain areas. 400 sq.km Plain area. proposing one station per 2 Sq.km 400/2=200

2	Magnetic surveys Drone (10–30-line km)	Per station	3.2a	5000	10000	5,00,00,000	Drone Lidar and high-resolution Drone Magnetic survey (250 Sq.Km area)
3	Gravity -Magnetic method -Regional /Detailed (0.5 to 200) sq.km depending on the objective)	Per station	3.1b	4500	5000	2,25,00,000	As necessary
4	Geo Physicist Man days (Field Man-days)		3.18a	11000	360	39,60,000	4 Geophysicist*90days= 360-man days
5	AI/ML modelling per sq.km	1450 sq.km	New tool			54,01,250	**per sq.km Rs 3725**
6	Geo Physicist Man days (HQ)		3.18b	9000	360	32,40,000	4 Geophysicist*90days= 360-man days
7	Radiometric survey by using scintillometer	250 sq.km	Not Available		1	6,00,000	Scintillometer - Radiation survey for identifying radioactive minerals by using scintillation meter or radiation meter As per approved cost by NMET File No. 6/4/2015 - NMET-Part (1)/367 dated 22.02.2023, item No. 7
8	Geologist Man days for Radiometric survey by using scintillometer	Per Manday	1.5.1a (b)	11000	360	39,60,000	2 Geologists required for Radiometric survey by using scintillometer -180

							days *2 = 360 man-days
8	Gamma - Ray Spectrometric Survey		Not Available		1	22,00,000	To find REE's which are associated with Th,U and K As the services not available it is proposed to take up by engaging 1 technical person and 1 Geologist The rate " Single beam portable RS-120 super SCINT Handheld Gamma-Ray 190-1100 Nm (Instrument)
9	Geologist Man days for Gamma Ray survey by using Spectrometer	Per Manday	1.5.1a (b)	11000	360	39,60,000	2 Geologists (1 Technician) required for Gamma Ray survey by using Spectrometer -180 days *2 = 360

10	Electromagnetic surveys (Profiling / Sounding)	sounding	3.7a	21,197	750	1,58,97,750	To find REE's which are associated with Th,U and K 200m space profiling may provide data on REE hosting conductive minerals in the selected areas. Per sq.km 25No's required for profiling. Proposing the survey for 30sq.km as necessary 30*25 = 500 soundings
11	S.P & shallow electrical resistivity (10–20-line km)	line km	3.3c	60,000	250	1,50,00,000	As the expected mineralization of graphite in the block area this method of geophysical survey Proposed
	Sub-total-E					**14,08,49,000**	
	TOTAL (A+B+C+D+E)					**22,99,50,720**	
F	**Preparation of Exploration Proposal**		5.1		1	3,80,000	

	(5 Hard copies with a soft copy)			2% of approved Project cost or 3.8 lakhs whichever is lower 5 hard copies and soft copies			2% of approved Project cost or 3.8 lakhs whichever is lower 5 hard copies and soft copies
G	**Geological Report** (5 Hard copies with a soft copy)		5.2	maximum ceiling amount 20 lakhs	1	20,00,000	maximum ceiling amount 20 lakhs
	peer review charges					30,000	
	Project Cost without GST					**23,23,60,720**	
	18% GST					**4,18,24,930**	
	Total Project Cost					**27,41,85,650**	