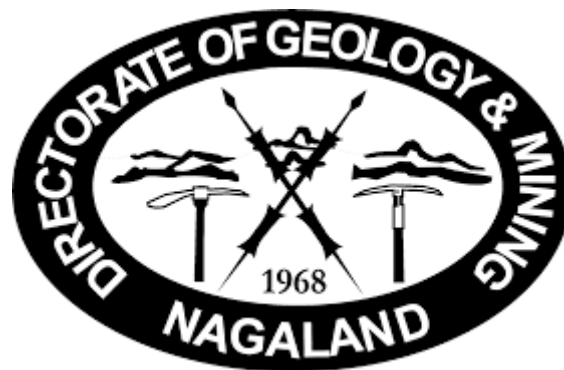


**PROPOSAL FOR PRELIMINARY EXPLORATION (G3 STAGE) FOR Ni-Co-Cr-  
MAGNETITE IN THEWATI BLOCK, MELURI DISTRICT, NAGALAND UNDER NMEDT.**

**Commodity: Ni-Co-Cr-Magnetite**

**BY**



**Directorate of Geology & Mines, Dimapur, Nagaland**

**Place: Dimapur**

**Date: January, 2026**

### Summary of the Block in G3 Stage Exploration

| Sl.no | Features  | Details  |
|-------|---|--|
| A.    | Block ID  | Thewati Ni-Co-Cr-Magnetite-PGE Block   |
| B.    | Current Exploration Agency  | Directorate of Geology & Mining, Nagaland  |
| C.    | Previous Exploration Agency   | Directorate of Geology & Mining, Nagaland (G-4 Stage)  |
| D.    | G4 stage Geological Report (Previous stage Geological Report)       | Geological Report on G-4 Level Exploration of Ni-Co-Cr-Magnetite in Mollen-Jopi-Ziphu Ridge and adjoining Areas, Naga Hills Ophiolite, Phek District, Nagaland.  |
| E.    | Commodity   | Ni-Co-Cr-Magnetite-PGE   |
| F.    | Mineral Belt  | Naga Hills Ophiolite   |
| G.    | Completion Period with entire Time schedule to complete the project | 14 Months  |
| H.    | Objectives  | <p>The present exploration program (G3) has been formulated on the basis of the outcome of previous Reconnaissance work to fulfil the following objectives:</p> <p>Geological mapping on 1:5000 scale to delineate Ni-Co-Cr bearing Magnetites/iron rocks and other associated lithological units within the proposed block.</p> <p>Topographical Contouring on 1:5000 scale, by means of surface contouring at 2 m interval.</p> <p>Delineation of the potential subsurface mineralized zones by Geophysical Surveys (Magnetic Survey).</p> <p>Necessary Pitting will be carried out to expose the Ni-Co-Cr bearing Magnetite body.</p> |

|    |   |   |                     |                     |
|----|---|---|---------------------|---------------------|
|    |   | Exploratory drilling up to second level at 200m strike interval for 1 <sup>st</sup> level boreholes (60m vertical depth of intersection) and 2 <sup>nd</sup> level boreholes (120m vertical depth of intersection). |                     |                     |
|    |   | Assessment of the resources in class 333 as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2015.   |                     |                     |
| I. | Whether the work will be carried out by the proposed agency or through out- sourcing and details thereof. | The work will be carried out by proposed agency.  |                     |                     |
|    | Components to be outsourced and name of the out-sourced agency  |   |                     |                     |
| J. | Name/Number of Geoscientists  | Field Geologist: Two numbers  |                     |                     |
|    |   | HQ Geologist: Two numbers   |                     |                     |
| K. | Expected Field days (Geology)   | 240   |                     |                     |
|    | Geological Party Days   |   |                     |                     |
|    | <b>Location</b>   | Cardinal points   | Latitude            | Longitude           |
|    |   | A   | 25° 31' 5.846''' N  | 94° 46' 26.656''' E |
|    |   | B   | 25° 31' 10.817''' N | 94° 45' 48.261''' E |
|    |   | C   | 25° 29' 50.706''' N | 94° 45' 34.579''' E |
|    |   | D   | 25° 29' 43.957''' N | 94° 45' 46.474''' E |
|    |   | E   | 25° 28' 53.216''' N | 94° 45' 37.037''' E |
|    |   | F   | 25° 28' 52.831''' N | 94° 45' 44.833''' E |
|    |   | G   | 25° 28' 50.526''' N | 94° 45' 49.395''' E |
|    |   | H   | 25° 28' 52.130''' N | 94° 45' 57.877''' E |
|    |   | I   | 25° 28' 52.011''' N | 94° 46' 16.459''' E |
|    | Villages  | Thewati   |                     |                     |
|    | Tehsil  |   |                     |                     |
|    | District  | Meluri (Previously Phek District)   |                     |                     |
|    | State   | Nagaland  |                     |                     |

|           |   |   |
|-----------|---|---|
|           | <b>Area (hectares/square kilometres)</b>  |   |
|           | Block Area                                | 4.72 Sq km  |
|           | Forest Area                               |   |
|           | Government Land Area                      |   |
|           | Private Land Area                         |   |
| <b>3.</b> | <b>Accessibility</b>                      |   |
|           | Nearest Rail Head                         | Dimapur Railway Station is the most accessible railhead.  |
|           | Road                                      | The part of the area of investigation is accessible from Reguri which takes right diversion from Akash Bridge at MS 145 of NH-151 via Lephori.  |
|           | Airport                                   | Dimapur airport is the only operational airport.  |
| <b>4.</b> | <b>Hydrography</b>                        |   |
|           | Local Surface Drainage Pattern (Channels) | Drainage system is structurally controlled with dendritic to sub-trellis pattern.   |
|           | Rivers/Streams                            | The Tizu river originates in the upper Himalayan ranges at an elevation of about 2250m and has a total length of about 165 km upto its confluence with river Zungki. Layakti nalla, Khayakti nalla, Changsulizu nalla, Washelloti nalla and Yokhriti nalla are the major perennial streams draining the region. The ShakhatuLuku nala with its tributaries is the main drainage system of the Waziho area. It flows flowing northerly to join the Tizu. |
| <b>5.</b> | <b>Climate</b>                            | The climate is sub-tropical with average annual rainfall of 200cm. The region generally experiences warm summer varying from 20°C - 30°C and very cold winter with temperature often going below freezing point.  |
|           | Mean Annual Rainfall                      | The Zungki-Tizu valley is very often cover clouds throughout the year. The annual rainfall is 200 cm.   |

|           |  |   |
|-----------|--|---|
|           | Temperatures<br>(January)(Minimum)               | 05 <sup>0</sup> C   |
|           | Temperatures<br>(July) (Maximum)                 | 32 <sup>0</sup> C   |
| <b>6.</b> | <b>Topography</b>                                | The study area is a medium to low angled N-S/NE-SW trending synformal geomorphic unit with E-W trending spars. It has medium to high denudational structural hills (MDSH - HDSH) with deep river-cut valley and also some gentle slope suitable for laterization.   |
|           | Toposheet Number                                 | 83K/14 & 83K/15   |
|           | Morphology of the Area                           | Physiographically, the area is characterized by highly rugged mountains ranges, deep gorges, parallel to sub-parallel ridges and V-shaped valleys trending NE. In the Phor-Jopi section, the hills and mountains range generally gain elevation towards the east culminating at Ngazipfu (2357m above mean sea level) while the western boundary is controlled by Jopi-Zephuhu range. Mollen at an elevation of 3075 m is the highest elevation point which forms the source of many perennial streams. The ridges are almost dissected longitudinally by a number of streams and nallas draining the area. |
| <b>7.</b> | <b>Availability of base line geoscience data</b> |   |
|           | Geological Map<br>(1:50000/1:12500)              | Available (1:50000 map by GSI & 1:12500 map by DGM Nagaland)  |
|           | Geochemical Map (1:50000)                        | NGCM available for 83K/14   |
|           | Geophysical Map<br>(Aeromagnetic, ground)        | Not available   |

|    |   |   |
|----|---|---|
|    | geophysical, Regional as well as local scale GP maps)                                 |   |
| 8. | <p><b>Justification for taking up Reconnaissance Survey/ Regional Exploration</b></p> | <p>Justification for taking up the investigation in G3 stage:</p> <ul style="list-style-type: none"> <li>• The G-4 Level Exploration of Ni-Co-Cr-Magnetite was carried out in MollenJopi-Ziphu (MJZ) Ridge and adjoining Areas, Naga Hills Ophiolite, Meluri District (Previously Phek District), Nagaland which falls within the geo-coordinates from latitudes 25°28'46.08"N to 25°38'35.81"N and longitudes 94°41'33.87"E to 94°46'53.94"E in Survey of India Toposheet number 83K/10, 11, 14 &amp; 15. However depth continuity of the ore body and geometry is to be defined through this G3 proposal.</li> <li>• As per G4 level exploration report (2021) of DGM, Nagaland, The magnetite from the Thewati, Reguri, and Northern Ziphu zones contains Fe<sub>2</sub>O<sub>3</sub> from 61.66%-74.08%; SiO<sub>2</sub> 7.52%-12.48%; Al<sub>2</sub>O<sub>3</sub>4.56-16.42%; iron (Fe) 28.03–57% along with notable amounts of nickel (0.16–1.79%), cobalt (0.02–0.35%), chromium (0.47–2.62%), and titanium (0.014–0.294%). Although these metals show appreciable enrichment, the vanadium content is 13.80–307 ppm. The samples also contain ΣPGE values of 681.262–1550.369 ppb, which adds further economic significance to these</li> </ul> |

|  |  |  |
|--|--|--|
|  |  | <p>multi-metal magnetite deposits within the block and the Naga Hills Ophiolite region.</p>  |
|  |  | <ul style="list-style-type: none"> <li>• As noted by DGM, Nagaland, the chemical analysis shows that the concentrations (wt%) of the six radicals—Fe, Ni, Co, Cr, Ti, and V—remain nearly unchanged despite differences in their mode of occurrence and stages of alteration from magnetite to hematite.</li> <li>• <b>Thewati Magnetite/Hematite:</b> Average wt% of Fe – 47.02%, Ni – 0.72%, Co – 0.06%, Cr – 1.25%, Ti – 0.192%, V – 187.16 ppm.</li> <li>• <b>Reguri Magnetite:</b> Average wt% of Fe – 46.28%, Ni – 0.70%, Co – 0.07%, Cr – 1.18%, Ti – 0.192%, V – 180.28 ppm. Overall, the elemental concentrations between the two sample sets have no significant change in concentration.</li> <li>• The Thewati magnetite–hematite deposit contains a total of <b>4.52 MT</b> of resources (reconnaissance resource by Cross Sectional Area Method).<br/>       In the <b>≥45% to &lt;55% Fe</b> category, it hosts <b>2.84 MT</b> with average grades of <b>Fe 47.21%, Ni 0.64%, Co 0.058%, Cr 1.246%, Ti 0.194%, and V 0.017%</b>.<br/>       In the <b>≥30% to &lt;45% Fe</b> category, it contributes <b>1.68 MT</b> averaging <b>Fe 32.28%, Ni 0.865%, Co 0.06%, Cr 1.01%, Ti 0.105%, and V 0.019%</b>.<br/>       Overall, Thewati area shows consistent Fe–</li> </ul> |

|  |  |  |
|--|--|--|
|  |  | <p>Ni–Co–Cr–Ti–V association across both grade ranges.</p> <ul style="list-style-type: none"> <li>• The proposed block forms part of the Thewati magnetite/hematite deposit, which hosts Ni–Co–Cr mineralization.</li> <li>• DGM, Nagaland has proposed a block of 4.72 sq km area for upgrading into G-3 stage of investigation to increase the degree of confidence.</li> <li>• The precise location, extent (strike, dip and depth persistence) and resource of the Ni-Co-Cr-Magnetite mineralization of the prospect need to be verified in G-3 stage of investigation.</li> <li>• To upgrade the shape of overall orebody and resource confidence level, systematic, closely spaced drilling, along with extensive pitting/trenching is required to verify precise location, extent (strike, dip and depth persistence). Therefore, the area is proposed for upgradation to <b>G-3 stage of exploration</b>.</li> </ul> |
|--|--|--|

## **Proposal for preliminary exploration (G3 Stage) for Ni-Co-Cr-Magnetite in Thewati block, Meluri district, Nagaland under NMET**

### **Introduction:**

The proposed Thewati (G3) Block, situated along the eastern scarp of Mollen peak, about 6 km south of New Thewati Village, Meluri district (Previously Phek District), Nagaland near Indo-Myanmar border, has been carved out from the larger G4 block where the reconnaissance (G4) exploration was conducted by the Directorate of Geology & Mining (DGM), Nagaland (2021) covering 103.00 Sq Km. DGM's investigation involved 1:12500 scale geological mapping, trench sampling, bedrock sampling (BRS), and analytical studies including petrography, mineragraphic studies & whole rock analysis. These studies established the presence of strata bound Magnetite bodies with Ni-Co-Cr mineralisation in the Thewati area with an average wt% of Fe – 47.02%, Ni – 0.72%, Co – 0.06%, Cr – 1.25%, Ti – 0.192%, V – 187.16 ppm.

Based on the partial continuity of these mineralized bands, favourable structural disposition, and geochemical anomalies, DGM delineated a broader prospective corridor for further exploration. The current proposed block, covering about 4.72 km<sup>2</sup>, represents the most statistically probable and accessible segment of this corridor, where the mineralized zones show maximum surface continuity, better exposure, and higher analytical values.

This block has therefore been selected by DGM, Nagaland for G3-level exploration to undertake 1:5000-scale detailed geological mapping, pitting/trenching, geophysical surveys (magnetic survey), and exploratory core drilling, aimed at establishing grade continuity, subsurface geometry, and tonnage for resource estimation under UNFC code 333 (Inferred Resource).

## **Detailed description of the G3 proposal**

### **Block Summary**

Please refer to page number 1 to 7 attached with this document for Block summary.

### **Physiography**

Physiographically, the area is characterized by highly rugged mountains ranges, deep gorges, parallel to sub-parallel ridges and V-shaped valleys trending NE. In the Phor-Jopi section, the hills and mountains range generally gain elevation towards the east culminating at Ngazipfu (2357m above mean sea level) while the western boundary is controlled by Jopi-Zephuhu range. Mollen at an elevation of 3075 m is the highest elevation point which forms the source of many perennial streams. The ridges are almost dissected longitudinally by a number of streams and nallas draining the area.

Drainage system is structurally controlled with dentritic to sub-trellis pattern. The area is mostly within the catchment area of Tizu River a major river of eastern Nagaland. The Tizu river originates in the upper Himalayan ranges at an elevation of about 2250m and has a total length of about 165 km upto its confluence with river Zungki. Layakti nalla, Khayakti nalla, Changsulizu nalla, Washelloti nalla and Yokhriti nalla are the major perennial streams draining the region. The ShakhatuLuku nala with its tributaries is the main drainage system of the Waziho area. It flows flowing northerly to join the Tizu. The Turati nalla and the Chizati nalla are the two major streams draining Mimi. They flow in a west-south-west direction forming deep gorges along their course.

### **Background Geology**

#### **Brief Regional Geology**

The Mollen-Jopi-Ziphu Magnetite Ore Areas forms as part of the Naga Hills Ophiolites (NHO). The NHO occur as narrow arcuate body in the central of the NE–SW trending Naga Hills constituting the northern part of Indo-Myanmar Ranges (IMR) in the northeastern Indian states of Nagaland, Manipur, parts of Arunachal Pradesh and the adjoining areas of western Myanmar. The Phanerozoic IMR fold belt defines a convergent plate boundary, a seismically active zone where the eastern margin of the Indian continental plate is overridden by the Myanmar continental microplate from the east. The ophiolite is an allochthonous body of oceanic crust ancestry, transporting through tectonic slicing, imbrication, over thrusting, fracturing, mylonitization and tectonic agglomeration in the formation of ophiolitic melange. It shows polyphase deformation and metamorphism. The ophiolitic rocks of mantle and oceanic crust parentage at the continental plate

margin have vast potential for intensive research and economic growth. The ophiolites belt extends approximately for 200 kilometres from northeast of Chokla in Nagaland to South of Moreh in Manipur and continues further south in Indo-Myanmar range, Chin and Arakan-Yoma to Andaman and Nicobar Group of islands. In Nagaland, it extends over 90 km in length and with varying widths ranging from 2-15 km, occupying an area of about 1000 sq km.

### **Naga Metamorphics:**

Tectonic slices of metasediments, occurring east of ophiolite belt, are extensive lithostratigraphic units of schistose quartzite, quartz-mica schist, and carbonaceous phyllite exhibiting banded structures, well developed in and around Saramati peak. The sedimentary nature of this formation is indicated by the clastic nature of the rocks, bedded sequence marked by arenaceous and argillaceous alternations, current & graded beddings and cut-and-fill structures. Banded nature is observed throughout but in the upper member the banding is less conspicuous. Dominant members of this unit are schist, quartzite, gneiss, their admixtures and mylonitised/phyllonitic equivalents. Mineral assemblages indicate that metamorphism probably took place between 250° and 450° C and at 2-4 Kb. The Saramati rocks may tentatively be assigned a pre-Cretaceous age.

### **Nimi Formation:**

Nimi Formation comprises a thick sequence of folded metasediments dominantly composed of low-grade regionally metamorphosed rocks such as phyllite, feldspathic quartzite, limestone and quartz-sericite schist exposed in the eastern tectonic boundary of the NHO. The sequence is tightly folded in the form of a major NNE trending overturned anticline (Agrawal and Ghose 1986). This litho-package extends in the west of Nimi to Laluri, and in the east (except the crystalline limestone) to Saramati peak at the India-Myanmar international border. The rocks are vertically inclined and show broad and open warps, often repeated due to folding. Graded bedding and cross-bedding are also noted in the quartzite. The presence of garnet-staurolite-biotite-muscovite schist belonging to amphibolites facies in the Nimi Formation indicates a temperature exceeding 500 °C in the deeper part of the basin. An eastward increase in the grade of metamorphism is observed in these rocks towards Myanmar. Extensive occurrence of limestone (140–200m thickness) trending NNE to NE has been noted with the development of stalactites and stalagmites in caves (Agrawal and Ghose 1986). The metasediments are affected by tight isoclinal folding with steep axial planes dipping 80–85° towards SSE and show development of slaty cleavage and stripping lineation (Vidyadharan et al. 1986). Tectonically, the metasedimentary rocks can be considered as an

accretionary prism complex which has possibly developed on an east-dipping subduction zone (Roy 1989) and has progressively accreted onto the overriding continental margin in western Myanmar.

### **The Ophiolite Suites:**

The NHO is exposed as a long arcuate belt with tectonic contacts on either side with evidence of their transport into and onto the Disang flysch in the west and, in turn, have been over-ridden in places, by the Nimi Formation (Cretaceous-Lower Eocene) and Naga Metamorphics (Pre-Mesozoic) from the east. Parallel to sub-parallel tectonic slices of different litho-units of Ophiolite are arranged in an SW/N-S trending enechelon pattern. It is also unconformably overlain by a thick sequence Phokphur/Jopi Formation.

The ophiolite litho-units may be broadly classified into (i) peridotite tectonite or meta-ultramafics, (ii) spinel peridotite (spinel-bearing dunite/harzburgite/lherzolite), (iii) cumulate mafic-ultramafic sequence (peridotite, pyroxenite, layered and massive gabbroids, plagiogranite and anorthosite), (iv) dolerite and meta-dolerite (minor), (v) volcanics and volcanoclastics and (vi) pelagic sediments. Serpentinisation is ubiquitous, and both very-low (zeolite and chlorite-prehnite schists) to low-grade (greenschists) assemblages and high-P assemblages (blueschists and eclogite) occur in the NHO. Chromitite, nickeliferous magnetite and other metallic and non-metallic minerals also occur in the NHO. The presence of radiolaria and coccoliths establish the NHO to be of Maestrichtian to Paleocene age and they have a time equivalent with the Disang (Agrawal and Ghose, 1986).

### **Disang Flysch:**

Disang Flysch is made up of folded sequence of enormous thickness (3000m) of slate, graphitic slate, phyllite, siltstone and fine-grained sandstone, exposed to west of ophiolite. The NNW-SSE trending ridges and valleys of flysch show a rhythmic alternation of shale/slate and siltstone of distal shelf facies. Slaty cleavage is present often parallel to the bedding. The shale-siltstone sequence is replaced by phyllite-quartzite near the axial planes of folds, faults and thrusts. They exhibit shallow water depositional features like ripple marks, sole marks, graded bedding and cross bedding (Agrawal and Ghose 1986). The Disang sediments show tight folds, slips, despite their large thickness, fossils are rare in the Disang sediments. A limited number of bivalves, gastropods and foraminifera are reported that suggests an Upper Cretaceous-Eocene age of their deposition (Acharya et al. 1986). The Disang and Barail sediments were deposited in the distal shelf and on the continental margin, respectively, in an epicontinental sea (Vidyardharan et al. 1989).

### **Jopi/Phokphur Formation:**

Jopi/Phokphur Formation consists a clastic shallow marine sedimentary cover, unconformably overlying the NHO with a faulted eastern contact. Primarily derived from ophiolite, this immature and young repeated molassic sedimentary sequence of polymictic boulder—conglomerate—grit—greywacke/sandstone—shale/fine tuff breccia occupies the higher altitudes of the Mollen-Jopi-Ziphu-Pokphurrangeth runs along the central part of the ophiolite belt and forms a synclinal ridge. The plant fossils *Anthocephalus* sp., *Litchi* sp., *Syzygium* sp., etc., indicate a Late Eocene-Oligocene age and a possible homotaxial relationship with the Barail Group deposited over the Disang Formation elsewhere in the Naga Hills (Chattopadhyay et al. 1983).

**Alluvium/Laterites:**

Thin, isolated and scattered laterite cappings are preserved in favourable locations over both the metamorphic and cumulate ultramafics in the area (Phor and Sutsu). High level terrace deposits composed of boulder-conglomerate and sand (Tizu River). It is attributed to Recent Age.

Table 1: Lithostratigraphic Succession of Naga Hills Ophiolites (Eastern part of Nagaland- Modified after Agrawal)

| Age                        | Formation                        |                  | Lithology  |
|----------------------------|----------------------------------|------------------|--|
| Recent to sub recent       | Alluvium and High-level terraces |                  | Laterites and alluvium   |
| Oligocene                  | Jopi Formation (= Lower Barail?) |                  | Ophiolite derived younger sedimentary cover of repeated sequence of polymictic Conglomerate, grit, sub greywacke, sandstone and tuffaceous shale |
| ~~~~~unconformity~~~~~     |                                  |                  |  |
| Late Cretaceous TO Eocene  | Disang Flysch                    | Tectonic contact | -Ophiolite Complex   |
| -----Tectonic contact----- |                                  |                  |  |
| Mesozoic?                  | Nimi Formation                   |                  | Phyllite, schist, limestone and quartzite with occasional serpentinite intrusion.  |
| -----Tectonic contact----- |                                  |                  |  |
| Post Mesozoic?             | Naga Metamorphics                |                  |  |

### Geology of the area at G4 stage of investigation

Geological mapping of Mollen-Jopi-Ziphu and adjoining area Block were carried out on 1:12,500 scales covering area about 103 sq.km (Plate II) for delineation of rock types and structures by means of fieldworks, ancillary data, and laboratory work and data analysis to demarcate mineralized zones/areas and their surface disposition on the outcrops. The litho-units mapped are briefly described below as:

#### Description of the lithological units

##### *Ultramafic complex*

##### **Tectonised peridotite:**

Peridotite tectonite or meta-peridotite are dominated by dunite followed by harzburgite, lherzolite and wehrlite (N.C Ghose, 2014). They contain resorbed or euhedral to anhedral grains of dark-

coloured opaques or deep brown high-Cr chrome spinel. They are essentially spinel without plagioclase. The mode of deformation varies from brittle to ductile in these rocks. (N.C Ghose et al, 2014) These rocks occur as highly sheared bodies or as polygonal to ovoid masses within a matrix of crushed serpentinites. Foliation is generally to be haphazard. Podiform chromitites and magnetite occur in the area. Lateritic soils are formed in the surrounding area. The peridotite tectonites are often associated with spinel, some of which are veined by magnetite. Three types of spinel peridotites have been distinguished. In the order of abundance, these are: (i) Spinel harzburgite, (ii) Spinel lherzolite and (iii) Serpentinite/dunite. (N.C Ghose et al, 2014)

### **Serpentinites**

Peridotites are pale green, olive green to black in colour. Most of the exposed peridotite bodies show pervasive serpentinisation. Serpentinite bodies ranging in size from a few metres to several kilometres is the dominant component of the ultramafic suite of the area. The serpentinites display a wide variety of textures, viz., massive, mesh or reticulate, ribbon, fibrous, bladed, sheared and brecciated (Ghose and Fareeduddin 2011). Besides serpentine and relict olivine and pyroxene, other minor phases are opaque/chrome-spinel, talc, tremolite, chrysotile, calcite, biotite, muscovite and chlorite. Three structural types of serpentinites have been recognised, e.g. (a) massive or blocky, (b) sheared and (c) cross-fibred veins. The first is dominantly composed of antigorite with minor lizardite, whereas the last one is mainly composed of chrysotile (Ghose et al. 1986; Ningthoujam et al. 2012). Mesh (honeycomb) texture is common, consisting of primary, secondary and tertiary chords (veins) of serpentine enclosing fractured grains of olivine and pyroxene. The Ni-Co-Cr bearing magnetite mineral ore and laterites are mainly deposited in serpentinite rock or serpentinised peridotite.

### ***Cumulate ultramafics***

The cumulate litho-assemblages may be classified as (i) peridotite (dunite, harzburgite lherzolite and minor wehrlite), (ii) pyroxenite (olivine websterite, websterite, olivine clinopyroxenite and clinopyroxenite). These dark green to black coloured rocks, coarse to very coarse grains, range in compositions from peridotite to pyroxenite.

(i) **Peridotites:** The dominant rock types in the cumulate ultramafics are the peridotites which are varying in composition from dunite, harzburgite, lherzolite and wehrlite. The cumulate peridotites show a protogranular texture with medium- to fine-grained, granular, tabular or smoothly curved olivine crystals. High forsterite content of olivine (Fo 84-90) is comparable to that of the alpine

peridotite (Ghose et al. 1986; Singh et al. 2010, this study). The peridotites of cumulate sequence host the strata bound nickeliferous magnetite deposits in the NHO.

(ii) **Pyroxenites:** The peridotites grade into olivine-websterite, olivine clinopyroxenite and clinopyroxenite. The rocks developed well layering with moderately strong preferred orientation defined alignment of clinopyroxene laths. The dominant phase in all the three types is clinopyroxene which occurs as coarse grained (3.20-3.45mm) equant to tabular grains in olivine-websterite or as post cumulus oikocryst enclosing resorbed olivine grains in olivine-clinopyroxenite and clinopyroxenite.

### **Diabasic Dykes**

The mafic diabase dikes are rare and occur as intrusives in the ultramafic cumulates. The width of these dykes vary from 1 m to 5m with limited strike length. They are medium-to fine-grained, showing ophitic to sub-ophitic texture, and consist of plagioclase, clinopyroxene, magnetite and secondary chlorite. Prismatic or sub-rounded grains of clinopyroxene are altered to fine needles of radiating tremolite, epidote and iron oxides. (Ghose et al. 2014). The diabasic dykes are characterized by relatively high Fe (Venkataramana et al. 1984).

### **Mafic volcanic complex**

Mafic volcanics constitute the second most dominant component after ultramafics in the area. The volcanics are tectonically overlain and underlain by serpentinite bodies. Their contacts with the other members of the suite are usually tectonic. These mafic volcanics are interlayered, intercalated and intermixed with pelagic sediments, viz., radiolarian cherts, green and grey cherts and crystalline limestone (Agrawal and Ghose 1986). Two distinct types of volcanic rocks are present viz. (a) sheet flow (b) pillow lava, part of the volcanoes are metamorphosed.

### **Sheet volcanoes**

Sheet flows vary in thickness from 3 to 6m and are at places interbedded with dominantly radiolarian cherts and grey to white limestone. Multiple flows differing in colour, glass content, vesicularity, granularity, texture, structure, degree of metamorphism and alteration are noted. They are mostly basaltic in composition. The rocks are fine to very fine grained, olive green to greenish grey in colour. They are rounded to elliptical vesicles which vary from less than 2mm to more than 1cm. The mafic and felsic minerals show different stages of low-grade alteration. The common secondary minerals include palagonite, chlorite, quartz, calcite and tremolite (Venkataramana et al. 1984).

### **Pillow lavas**

Basaltic rocks with typical pillow structures are rare in cross-section, at least three zones can be recognized; an outer glassy chilled margin having variable thickness (1-3 cm). This is followed inwards by a zone rich in vesicles and a central massive portion with very few vesicles.

### **Metavolcanics**

The metabasalts, encased within a serpentinitic melange, preserve a tectonically disturbed metamorphic sequence. It is associated with minor ultramafic rocks and schist-phyllite-gneiss-quartzite rocks. They show schistosity besides, layered metabasics are well-exposed in parts of Khayoti Nalla. They are well jointed and cut across by veins. They are often highly fractured and sheared. The basalts are metamorphosed very-low to low-temperature zeolite-prenhite-greenschist facies assemblages, and high-pressure blueschist facies and type-C eclogite.

### **Plagiogranite**

The plagiogranite are leucocratic, fine to coarse grained and occur as veins, dykes and small stocks within cumulate ultramafics and layered gabbro at few places. The mafic minerals in the plagiogranites mostly confined to the vein-country rock boundary decrease towards the centre of the vein. These rocks showing wide variation in texture from granophyric to hypidiomorphic, comprise essentially plagioclase, quartz, minor augite, hornblende, magnetite and sphene.

### ***Associated Sediments interbedded with mafic volcanics***

The pelagic oceanic sediments associated with mafic volcanics rocks are radiolarian chert and crystalline limestone. The sedimentary suites have undergone low-grade greenschist facies metamorphism and deformation (N.C. Ghose et al 2014)

### **Radiolarian Chert**

The silica-rich cryptocrystalline cherts are extensively preserved among the oceanic sediments because of their resistance to weathering. They show a variety of colours including light grey, bluish grey, light green, dull to bright red and brown. They occur as beds of varying thickness from few centimetres to about 30m (Ziphu, Mollen). These are often interlayered with volcanics (Ziphu-Washello) with or without limestone or occur as lensoid bands slivers arranged *en echelon* within peridotite. They occur as thin beds and lenses (1–10 m) intermixed and interlayered with volcanics, ash and limestone in large outcrops. Slices and lenses of cherts are also found in serpentinites. They

are massive, highly jointed, fractured and sheared with the development of microscopic folds and faults, and breccia with networks of recrystallised quartz veins.

### **Crystalline Limestone**

These are bedded, varying in colour from white to grey, and are often intercalated with minor chert bands and shaly partings. Petrographically they are of two types *viz.* fine grained siliceous micrite with minor clayey materials and sparite. There are medium grained containing rhombohedral calcite grains with characteristic cleavage.

### **Phokphur/Jopi Conglomerates**

#### **Shale/fine tuff breccia**

The sandstone and shale exhibit similar composition of clast and matrix. The shales are tuffaceous, interbedded with fine and coarse tuff, and display various shades of colour such as chocolate brown, reddish brown, purple, dark green and pink. The matrix is red due to the dominance of ferruginous matter. Clasts of serpentinite, pyroxenite, gabbroid and mafic-intermediate-acid volcanics, metabasic, radiolarian chert, arenite, quartzite, greywacke and argillite, containing discrete idiomorphic mineral grains of orthopyroxene, clinopyroxene, plagioclase, glaucophane, ilmenite, garnet, epidote and opaque are present (N.C Ghose et al, 2014). The weakly metamorphosed units in the lower part of the sequence show alternation of slate and phyllite with quartzite, whereas uppermost units are unmetamorphosed (Vidyadharan et al. 1986). This unit is unconformably underlain by serpentinised ultramafic and overlain by the polymictic conglomerate.

#### **Polymictic Conglomerate**

The conglomerate contains clasts of serpentinite, gabbro, basalt, chert (with or without radiolaria), crystalline limestone, quartz, jasper, quartzite, sandstone, phyllite and slate embedded in a reworked tuffaceous to siliceous cement. The tuffaceous matrix constitutes up to 50 % by volume of the rock. They grade upward into grit-lithic greywacke- siltstone-sandstone-shale/tuff. It consists of angular to subrounded boulders, cobbles and pebbles embedded in tuffaceous shale.

## **Geology of the proposed G3 area**

Geology of the proposed block area consists of Sandstone-Conglomerate, Tuf. Sandstone-shale, serpentinites & Metavolcanics.

### **Polymictic Conglomerate**

The conglomerate contains clasts of serpentinite, gabbro, basalt, chert (with or without radiolaria), crystalline lime- stone, quartz, jasper, quartzite, sandstone, phyllite and slate embedded in a reworked tuffaceous to siliceous cement. The tuffaceous matrix constitutes up to 50 % by volume of the rock. They grade upward into grit-lithic greywacke- siltstone-sandstone-shale/tuff. It consists of angular to subrounded boulders, cobbles and pebbles embedded in tuffaceous shale.

### **Shale/fine tuff breccia**

The sandstone and shale exhibit similar composition of clast and matrix. The shales are tuffaceous, interbedded with fine and coarse tuff, and display various shades of colour such as chocolate brown, reddish brown, purple, dark green and pink. The matrix is red due to the dominance of ferruginous matter. Clasts of serpentinite, pyroxenite, gabbroid and mafic-intermediate-acid volcanics, metabasic, radiolarian chert, arenite, quartzite, greywacke and argillite, containing discrete idiomorphic mineral grains of orthopyroxene, clinopyroxene, plagioclase, glaucophane, ilmenite, garnet, epidote and opaque are present (N.C Ghose et al, 2014). The weakly metamorphosed units in the lower part of the sequence show alternation of slate and phyllite with quartzite, whereas uppermost units are unmetamorphosed (Vidyadharan et al. 1986). This unit is unconformably underlain by serpentinitised ultramafic and overlain by the polymictic conglomerate.

### **Serpentinites**

Peridotites are pale green, olive green to black in colour. Most of the exposed peridotite bodies show pervasive serpentinitisation. Serpentinite bodies ranging in size from a few metres to several kilometres is the dominant component of the ultramafic suite of the area. The serpentinites display a wide variety of textures, viz., massive, mesh or reticulate, ribbon, fibrous, bladed, sheared and brecciated (Ghose and Fareeduddin 2011). Besides serpentine and relict olivine and pyroxene, other minor phases are opaque/chrome-spinel, talc, tremolite, chrysotile, calcite, biotite, muscovite and chlorite. Three structural types of serpentinites have been recognised, e.g. (a) massive or blocky, (b) sheared and (c) cross-fibred veins. The first is dominantly composed of antigorite with minor lizardite, whereas the last one is mainly composed of chrysotile (Ghose et al. 1986; Ningthoujam et

al. 2012). Mesh (honeycomb) texture is common, consisting of primary, secondary and tertiary chords (veins) of serpentine enclosing fractured grains of olivine and pyroxene. The Ni-Co-Cr bearing magnetite mineral ore and laterites are mainly deposited in serpentinite rock or serpentinised peridotite.

### **Metavolcanics**

The metabasalts, encased within a serpentinitic melange, preserve a tectonically disturbed metamorphic sequence. It is associated with minor ultramafic rocks and schist-phyllite-gneiss-quartzite rocks. They show schistosity besides, layered metabasics are well-exposed in parts of Khayoti Nalla. They are well jointed and cut across by veins. They are often highly fractured and sheared. The basalts are metamorphosed very-low to low-temperature zeolite-prehnite-greenschist facies assemblages, and high-pressure blueschist facies and type-C eclogite.

**Thewati Magnetite deposits:** Thewati Magnetite deposit occurs along the eastern scarp of Mollen peak, about 6 km south of New Thewati Village near Indo-Myanmar border.

The magnetite body overlies a serpentinite (serpentinised peridotite) of ultramafic basement and is overlain by khakhi grey sandy shale/fine sandstone whose beds are conformable to each other. The tabular magnetite body generally trends N–S, however it varies locally from NE–SW near Goose camp to NW-SE further south towards Indo-Myanmar border. It dips at 30–54° towards NW and towards SW.

Thewati Deposit has been divided into two sub-block due to strike discontinuity of ore body attributing to intermittent nature of the ore deposition, as:(i) North Sub-block covers an area of 0.05 sq.km (200mx250m) near the Goose camp in the north and in the south (ii) South Sub-block covers an area of 0.21 sq.km (848mx250m), further south near Indo Myanmar border in the south.

### **Mineral potentiality based on geology, ground geochemistry etc.**

On the basis of large-scale geological mapping and geochemical interpretation of G-4 Level Exploration of Ni-Co-Cr-Magnetite in Mollen-Jopi-Ziphu Ridge and adjoining areas (2021), The magnetite from the Thewati, Reguri, and Northern Ziphu zones contains Fe<sub>2</sub>O<sub>3</sub> from 61.66%-74.08%; SiO<sub>2</sub> 7.52%-12.48%; Al<sub>2</sub>O<sub>3</sub> 4.56-16.42%; iron (Fe) 28.03–57% along with notable amounts of nickel (0.16–1.79%), cobalt (0.02–0.35%), chromium (0.47–2.62%), and titanium (0.014–0.294%). Although these metals show appreciable enrichment, the vanadium content is 13.80–307 ppm. The samples also contain ΣPGE values of 681.262–1550.369 ppb, which adds

further economic significance to these multi-metal magnetite deposits within the block and the Naga Hills Ophiolite region.

- **Thewati Magnetite/Hematite deposit:** Average wt.% for Thewati area is as follows:

Fe – 47.02%, Ni – 0.72%, Co – 0.06%, Cr – 1.25%, Ti – 0.192%, V – 187.16 ppm.

- The Thewati magnetite–hematite deposit contains a total of 4.52 MT of resources (reconnaissance resource by Cross Sectional Area Method). In the  $\geq 45\%$  to  $< 55\%$  Fe category, it hosts 2.84 MT with average grades of Fe 47.21%, Ni 0.64%, Co 0.058%, Cr 1.246%, Ti 0.194%, and V 0.017%. In the  $\geq 30\%$  to  $< 45\%$  Fe category, it contributes 1.68 MT with an average grades of Fe 32.28%, Ni 0.865%, Co 0.06%, Cr 1.01%, Ti 0.105%, and V 0.019%. Overall, Thewati area shows consistent Fe–Ni–Co–Cr–Ti–V association across both grade ranges.

#### **Recommendations of previous G4 stage mineral exploration report-**

The recommendations of previous G4 stage mineral exploration report are as follow-

- Thewati magnetite deposits can be taken for further G2/G3-level exploration for more precise resource estimation after extensive repairing of an old logging road upto Goose camp.
- Geophysical survey may be carried out to assess the strike extension of Reguri deposits as drilling is not feasible as of today though logging road are constructed towards it.
- Geophysical survey to ascertain the northern strike extension of the magnetites body of on the eastern slope of Mollen-Jopi ridge with the eastern margin of Jopi conglomerates as its border from northeast of Mollen peak to Washello village.
- Few scouts drilling is recommended for Ziphu magnetite deposit prior to undertaking of G2/G3-level exploration.
- Geochemical sampling of soil at closer grid with shallow-medium pitting and trenching may be carried out for systematic Resource estimation of Ni-Co-Cr laterites or soils in the mineralised area of the present Block and its northern extension as per the existing reports.

- G4-level exploration may continue on both the southern and northern extension of the present block.

### Objectives

The present exploration program (G3) has been formulated on the basis of the outcomes of previous reconnaissance (G4) work done by DGM, Nagaland to fulfil the following objectives:

- Geological mapping on 1:5000 scale to delineate Ni-Co-Cr bearing Magnetites/iron rocks and other associated lithological units within the proposed block.
- Topographical Contouring on 1:5000 scales, by means of surface contouring at 2 m interval.
- Delineation of the potential subsurface mineralized zones by Magnetic Survey.
- Necessary Pitting/Trenching to be carried out to expose the ore body.
- Exploratory drilling up to second level at 200 m strike interval for 1<sup>st</sup> level boreholes (30m vertical depth of intersection) and 2<sup>nd</sup> level boreholes (60m vertical depth of intersection).
- Assessment of the resources in class 333 as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2015.

### Previous Work:

DGM Nagaland has submitted the geological report entitled **G-4 Level Exploration of Ni-Co-Cr-Magnetite in Mollen-Jopi-Ziphu Ridge and adjoining Area, Naga Hills Ophiolite, Phek District, Nagaland.**The geological report is attached.

### Block description

The detailed co-ordinate of the proposed Thewati block is given below-

| <b>Table-2 Geo-coordinate of the proposed Thewati block</b> |                     |                     |
|---|---------------------|---------------------|
| Cardinal points   | Latitude            | Longitude           |
| A   | 25° 31' 5.846''' N  | 94° 46' 26.656''' E |
| B   | 25° 31' 10.817''' N | 94° 45' 48.261''' E |
| C   | 25° 29' 50.706''' N | 94° 45' 34.579''' E |
| D   | 25° 29' 43.957''' N | 94° 45' 46.474''' E |
| E   | 25° 28' 53.216''' N | 94° 45' 37.037''' E |
| F   | 25° 28' 52.831''' N | 94° 45' 44.833''' E |
| G   | 25° 28' 50.526''' N | 94° 45' 49.395''' E |
| H   | 25° 28' 52.130''' N | 94° 45' 57.877''' E |
| I   | 25° 28' 52.011''' N | 94° 46' 16.459''' E |

### Planned Methodology

In accordance with the objectives set for preliminary exploration (G3 level of exploration) in Thewati block, Meluri (previously Phek District) of Nagaland, geological mapping in 1:5000 scale, Pitting, geophysical Magnetic survey, two phase exploratory drilling, chemical analysis of the samples (BRS, PT and core samples), petrological and mineralogical studies are proposed in the block. The exploration will be carried out as per Minerals (Evidence of Mineral contents) Rules-amended in 2021. Accordingly, the details of different activities to be carried out are provided in subsequent columns.

### Topographic Surveying

Topography survey will be carried in the area (4.72 Sq. Km), and all the surface features will be marked in the 1:5000 scale plans. The block boundary will be surveyed by DGPS / total station in

WGS-84 Datum and demarcation of the boundary pillars to enable the block auctionable. The reduced level and coordinate of the boreholes would be surveyed by DGPS/ total station.

### Geological Mapping

Detailed geological mapping on 1:5000 scale in the area (4.72 Sq. Km) will be carried out by taking geological traverses. The contacts of different lithologies, structural features, etc. will be recorded in detail. The detailed geological map on 1:5000 scale will be generated as an outcome.

### Geophysical Survey

A surface geophysical survey, particularly a Drone-based Magnetic Survey, is proposed for delineation and identification of mineralised zones within the Thewati (G3) Block, Meluri District, Nagaland. The survey is intended to map subsurface magnetic variations associated with mineralisation, and to aid in the selection of drilling targets.

**A total of approximately 62-line kilometres (Lkm) of Drone Magnetic Survey is proposed, to be carried out at a 100 m line spacing, covering the identified prospective area.**

**PROPOSED MAGNETIC SURVEY LAYOUT OF THE BLOCK  
(150m profile spacing and 50m station spacing)**

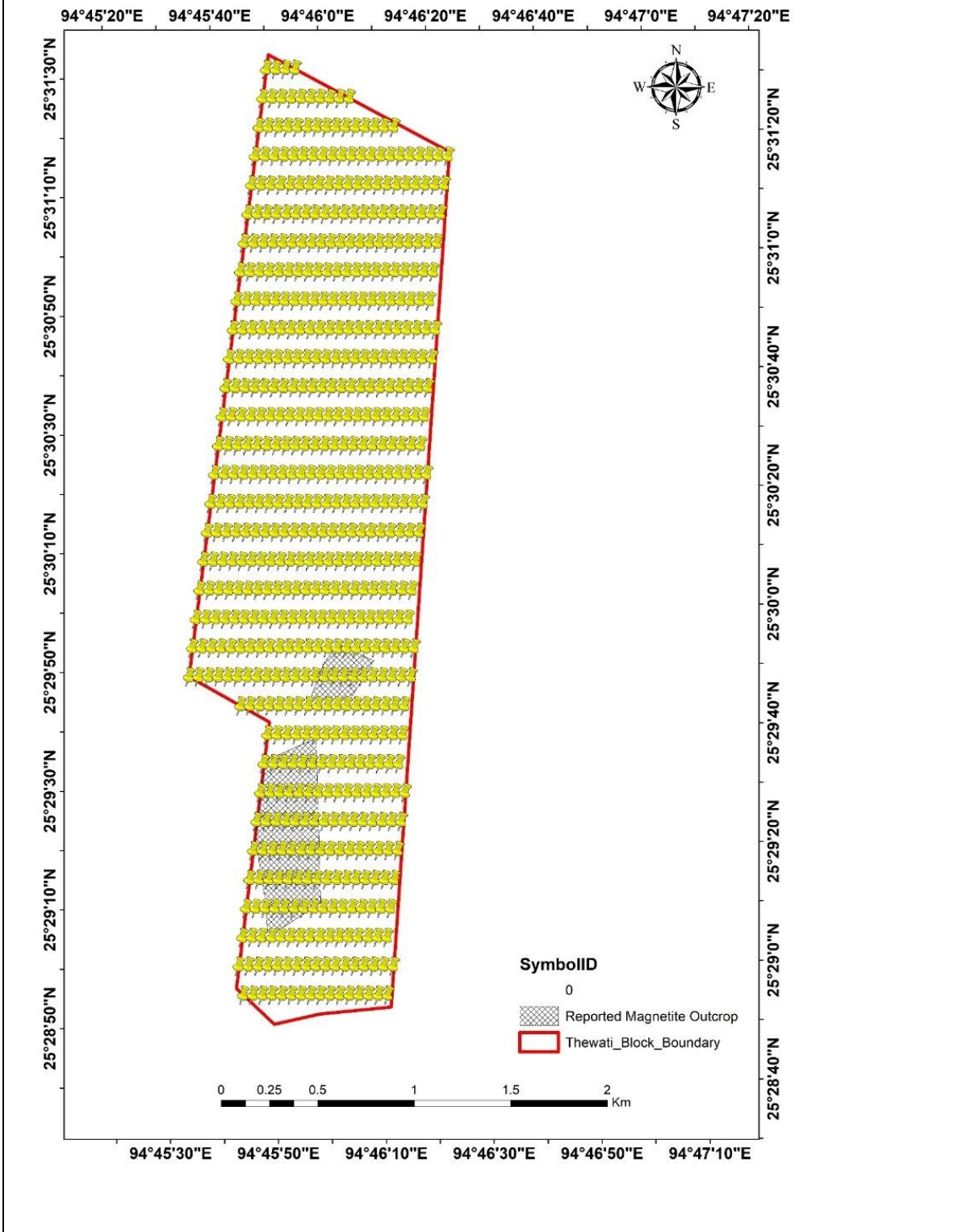


Fig- Proposed Drone borne Magnetic Survey layout for Thewati (G3) Block.

## Core Drilling

### Borehole plan

In phase I, 1st level boreholes will be planned to investigate the depth persistence of mineralization up to 30 m vertical depths of intersection. The borehole spacing will be 200 m or less.

In phase II, 2nd level boreholes will be planned based on the reference of 1st level boreholes with positive outcome to investigate the depth persistence of the mineralization at 60 m vertical depth of intersection.

### Core Logging

The drilled cores will be logged systematically viz. details of litho-units, colour, texture, structural feature, mineralization, besides the recovery, rock quality designation (RQD) and type of ore deposit would be recorded.

### Core Sampling

The drilled core will be split into two equal halves longitudinally and one part would be preserved in the core box. The other half will be powdered to 70 micron (200 mesh size) followed by coning and quartering to reduce size of the sample into four parts (250 g each). One part of the sample will be sent to chemical laboratory for proximate analysis, second part to be preserved in the camp as duplicate sample, third part to be sent for chemical analysis for minor and trace elements by ICPMS and the fourth part would keep as either check sample or sample to be used for any other specific purpose.

The length of each sample will be kept 0.50 m-1.0 m depending upon the width of the mineralised bands or lithological variation. 200 nos. of samples would be analysed by ICPMS to ascertain the presence of other trace elements.

### SEM & EPMA Studies

The Ni–Co–Cr-bearing magnetite deposit of the Naga Ophiolite Belt represents a complex, multi-metallic ore system hosted in ultramafic–mafic assemblages. Field observations and bulk geochemical data alone are insufficient to resolve:

- Mode of occurrence of Ni, Co and Cr (lattice-bound vs discrete mineral phases)
  - Micro-textural relationships between magnetite, chromite, silicates and secondary phases
- Hence, high-resolution micro-analytical techniques (SEM & EPMA) are essential.

### Petrographic and petrochemical Studies

Thin and polished section studies of the outcrop samples and the core samples will be studied for detailed petrographic and mineralogical characteristics. These samples will be collected from ore zones and associated rocks. A provision of 10 nos. specimens for both petrographic and petrochemical studies will be kept for the proposed area.

### Bulk Density Determination

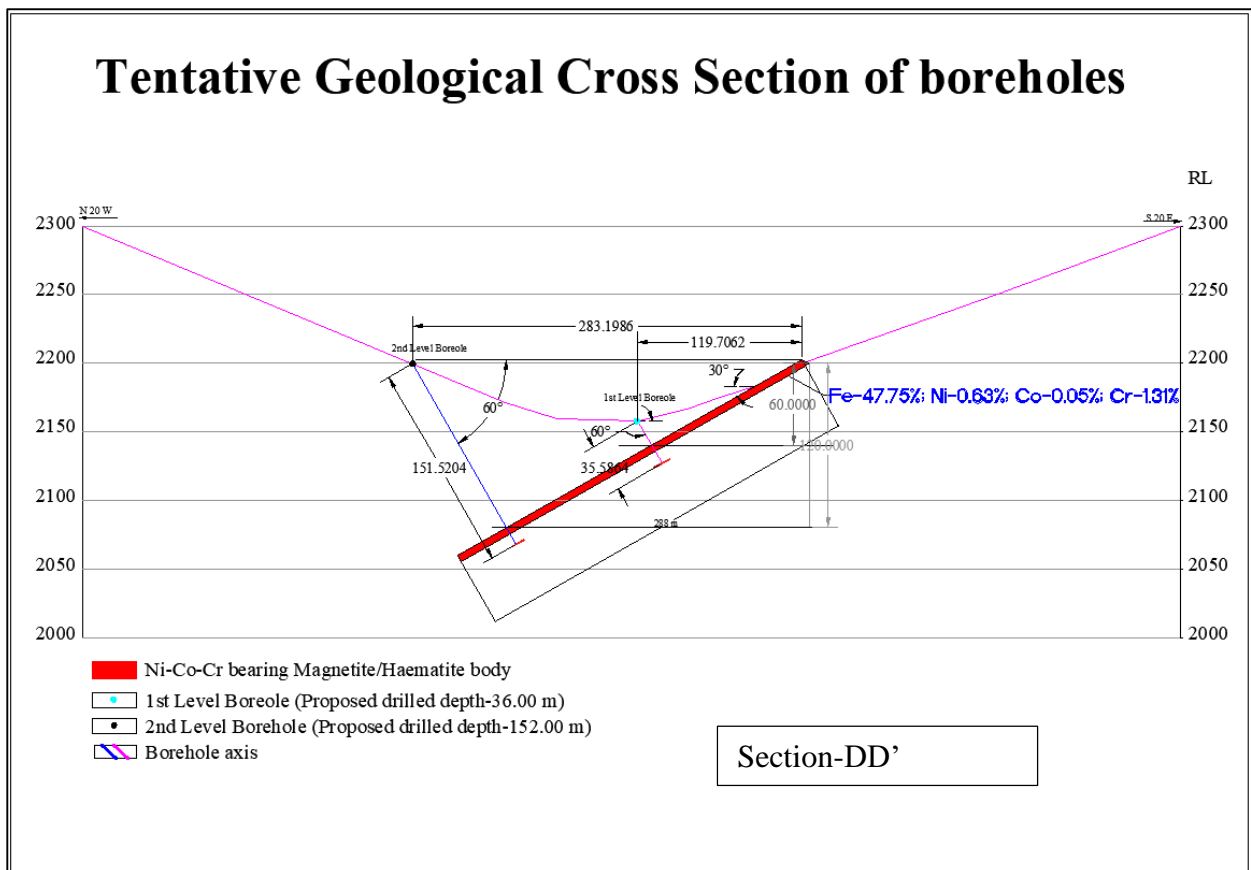
In addition, bulk density determination of 5 nos. samples will be carried out for the proposed block.

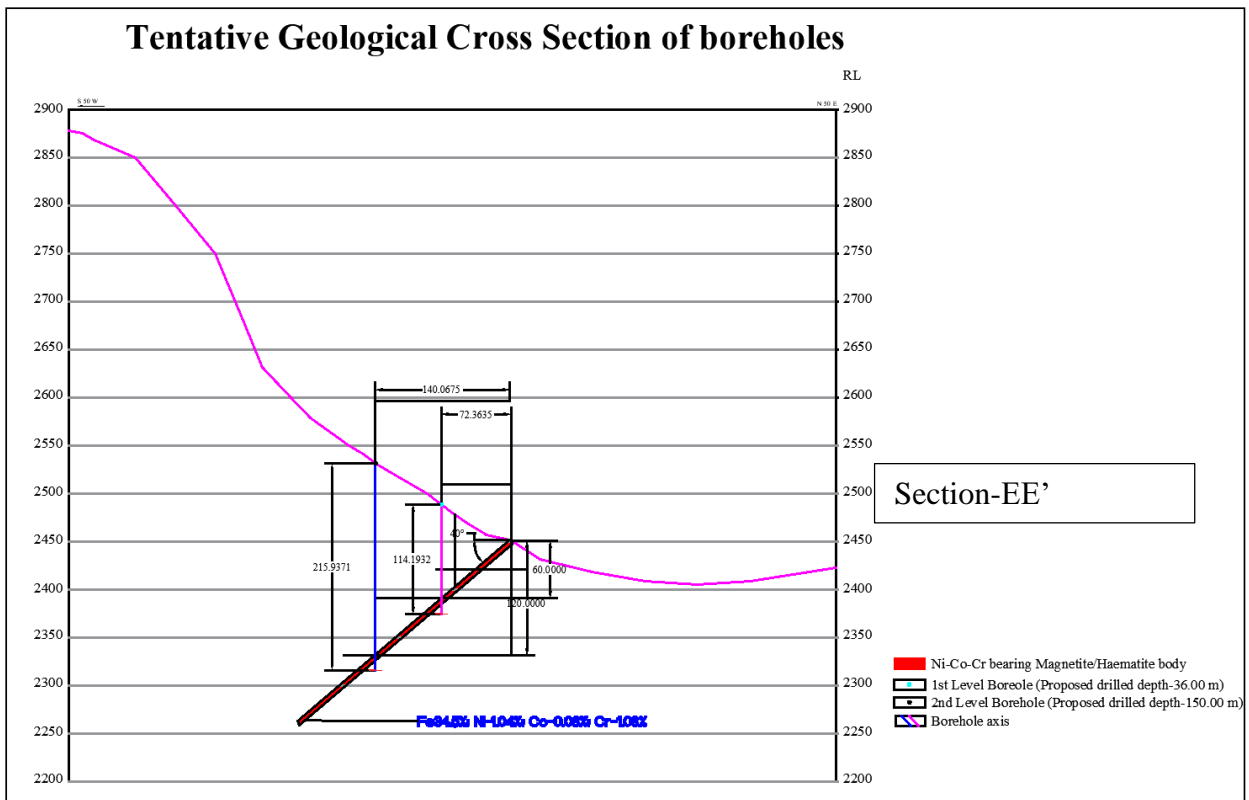
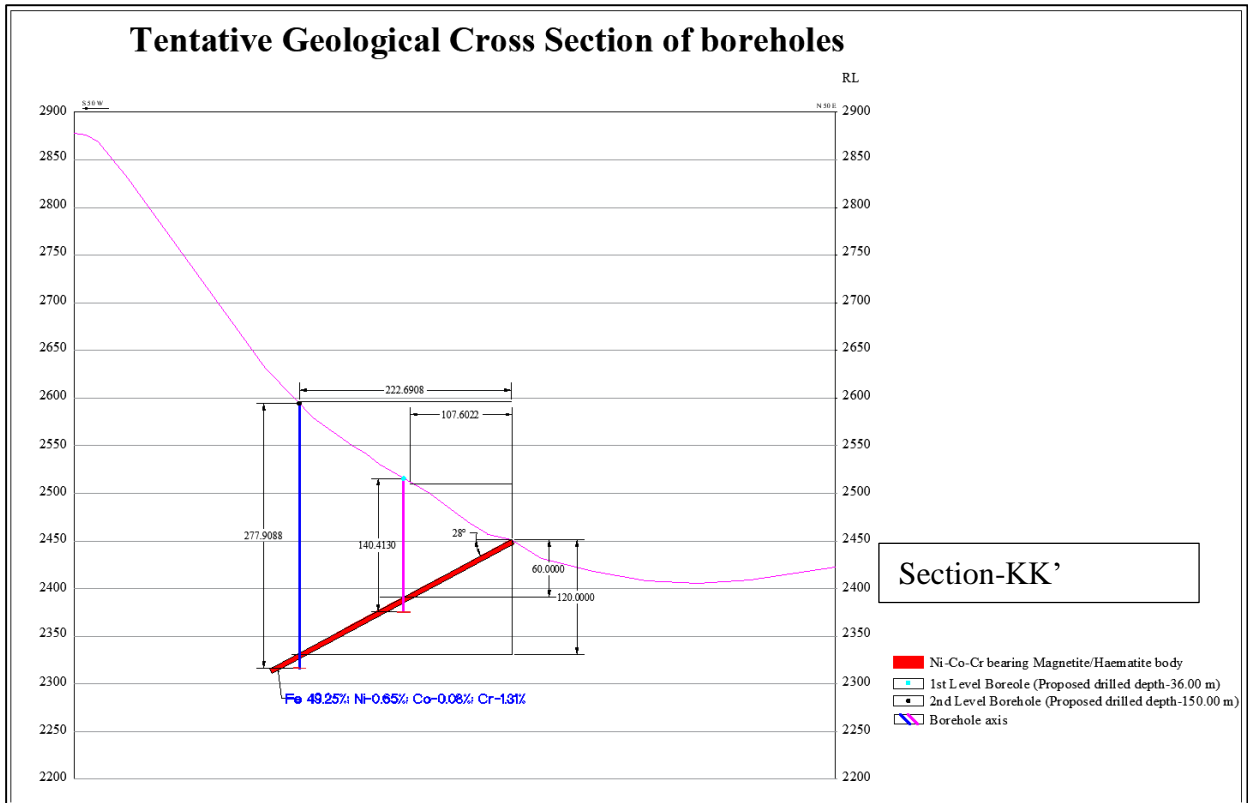
Nature Quantum and Target for G3 stage (Table-3)

| S. No | Nature of Work  | Unit                 | Tentative quantum to be proposed |
|-------|---|----------------------|----------------------------------|
| 1     | Geological mapping (DM on 1:5000) (sq km)   | sq km                | 4.72                             |
| 2     | Survey work-  |                      |                                  |
|       | a) Topographic survey- DGPS/ Total station/Drone                                    | sq km                | 4.72                             |
|       | b) DGPS survey for fixation of borehole and cardinal points                         | Point of observation | 28                               |
| 3     | Geophysical survey (Drone Magnetic survey) (L.km)                                   | 100 m line interval  | 62 LKm                           |
| 4     | Technological   |                      |                                  |
|       | a) Surface Exploration- Trenching (cu. m)   | Cu m                 | 100                              |
|       | b) Sub surface exploration – Drilling (m)   | Per m                | 3450                             |
| 5     | Geochemical survey  |                      |                                  |
|       | a) Channel samples (BRS/groove samples) (nos.)                                      | Nos.                 | 100                              |
|       | b) Pit/Trench samples (nos.)  | Nos.                 | 100                              |
|       | c) Core samples (nos.)  | Nos.                 | 300                              |
| 6     | Petrographic/ mineralographic studies   |                      |                                  |
|       | a) Preparation of thin section  | Nos.                 | 10                               |
|       | b) Ore microscopy of core samples (nos.)  | Nos.                 | 10                               |
|       | c)SEM   | Hrs.                 | 18                               |
|       | d)EPMA  | Hrs.                 | 18                               |
|       | c) Sp. Gravity/ Bulk density (nos.)   | Nos.                 | 5                                |
| 7     | Chemical analysis   |                      |                                  |
|       | a) Analysis of major oxides samples by XRF (BRS-100, Trench samples -110, Core-300) | Nos.                 | 510                              |
|       | b) Analysis of major oxides samples by XRF (10% external check)                     | Nos.                 | 51                               |
|       | c) Analysis for precious metals by fire assay technique with 10% external check     | Nos.                 | 150+15                           |
|       | d) ICPMS analysis (34 elements/Trace elements with 10% external check)              | Nos.                 | 200+20=220                       |
|       | d) Petrochemical studies  | Nos.                 | 10                               |

## Exploratory drilling

Based on the positive outcomes of geological mapping, trenching, bed rock and trench sampling, and geophysical SP survey, boreholes will be planned to establish the depth persistence and strike length of Ni-Co-Cr-Magnetite mineralization. The 1<sup>st</sup> level borehole will be planned at 60 m vertical depth of intersection and 2<sup>nd</sup> level boreholes will be planned at 120 m vertical depth of intersection considering low lying gentle dip of the ore body and undulated topography. The drilling will be performed in two phases. In phase I, 1<sup>st</sup> level boreholes will be drilled, and in phase-II, 2<sup>nd</sup> level boreholes will be drilled. So, drilled depth of 1<sup>st</sup> level boreholes vary from 35 m to 140 m = 71.35m x 11 = 784.85 m and 2<sup>nd</sup> level = 107.94 x 11 = 1,184.34 m. Total drilling meterage = 1,972.19 m or say 2,000m.





#### Manpower deployment

Two geologists, two geophysicists, one surveyor with required labourers and two drilling rigs with drilling crew will be deployed as per the requirement of the time schedule chart (Table: 4).

| <b>Table-4 Time Schedule/Action Plan for preliminary exploration (G3 stage) in Thewati block, Meluri district, Nagaland under NMET</b> |  |        |   |   |   |   |   |        |   |   |   |    |    |    |    |    |  |  |
|--|--|--------|---|---|---|---|---|--------|---|---|---|----|----|----|----|----|--|--|
| S. No  | Nature of Work   | Months |   |   |   |   |   |        |   |   |   |    |    |    |    |    |  |  |
|  |  | 1      | 2 | 3 | 4 | 5 | 6 | REVIEW | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |  |  |
| 1  | Camp Set up  | █      |   |   |   |   |   |        |   |   |   |    |    |    |    |    |  |  |
| 2  | Geological mapping (DM) (sq km)                          | █      | █ |   |   |   |   |        |   |   |   |    |    |    |    |    |  |  |
| 3  | Topographic survey- DGPS/ Total station/Drone            | █      | █ |   |   |   |   |        |   |   |   |    |    |    |    |    |  |  |
| 4  | Geophysical survey (Magnetic Survey) (L.km)              |        |   | █ |   |   |   |        |   |   |   |    |    |    |    |    |  |  |
| 5  | Surface exploration-Pitting/Trenching (cu. m)            |        |   | █ | █ | █ | █ |        |   |   |   |    |    |    |    |    |  |  |
| 6  | Bed rock samples (nos.)                                  |        |   |   | █ | █ | █ |        |   |   |   |    |    |    |    |    |  |  |
| 7  | Pit/Trench samples (nos.)                                |        |   |   | █ | █ | █ |        |   |   |   |    |    |    |    |    |  |  |
| 8  | DGPS survey for fixation of borehole and cardinal points |        |   |   |   |   |   |        |   | █ |   |    |    |    |    |    |  |  |
| 9  | Sub surface exploration – Drilling (m)                   |        |   |   |   |   |   |        |   | █ | █ | █  |    |    |    |    |  |  |
| 10   | Receipt of analyses and processing of analytical data    |        |   |   |   |   |   |        | █ | █ | █ | █  | █  |    |    |    |  |  |
| 11   | Ore body modelling and GR preparation                    |        |   |   |   |   |   |        |   |   |   |    |    | █  | █  | █  |  |  |

Note: Field activities (drilling etc.) may be affected due to monsoon.

## BREAK UP OF EXPENDITURE

The breakup of expenditure is given in table 5.

| Estimated Cost for Preliminary Exploration (G3 Stage) For Ni-Co-Cr-Magnetite in Thewati Block, Meluri District, Nagaland Under NMET   |  |       |                      |                      |                                |                   |   |
|---|--|-------|----------------------|----------------------|--------------------------------|-------------------|---|
| Total area - 4.72 Sq.km; Borehole - 20 (10 BH first level + 10 BH second level) ; Meterage - 3450 m (1115 m first level+ 2335 m second level, Period of completion - 14 months, Review - After Geophysics and 1st level boreholes |  |       |                      |                      |                                |                   |   |
| SL.No   | Item Of Work*  | Unit* | Rate As Per NMET SOC |                      | Estimated Cost of the Proposal |                   | Remarks   |
|   |  |       | SOC. Item No         | Rate As Per SOC* (a) | Qty. (b)                       | Total             |   |
|   |  |       |                      |                      |                                | Amount (Rs) (a*b) |   |
| A   | Detailed Geological Mapping  |       |                      |                      |                                |                   |   |
|   | Other Geological Work & Surveying  |       |                      |                      |                                |                   |   |
|   | Geological mapping (1:5000), Pitting/Trenching & Drilling work   |       |                      |                      |                                |                   |   |
| i   | a. Charges for 2 Geologist per day (Field) for Geological mapping & Trenching work, drilling activity (without labour) | day   | 1.2.1a               | ₹ 14,500.00          | 240                            | ₹ 34,80,000.00    |   |
| ii  | b. Labours charges; Base rate (for 2 labours per geologists)   | day   | 5.7                  | ₹ 541.00             | 480                            | ₹ 2,59,680.00     | Amount will be reimbursed as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher. |

|                     |  |   |        |             |     |                       |  |
|---------------------|--|---|--------|-------------|-----|-----------------------|--|
| iii                 | c. Charges for Geologist per day (HQ)  | day                                     | 1.2.1a | ₹ 10,500.00 | 60  | ₹ 6,30,000.00         |  |
| iv                  | Charges for one Sampler per day (1 Party)  | one sampler per day                     | 1.2.1b | ₹ 7,850.00  | 30  | ₹ 2,35,500.00         |  |
| v                   | Charges for Labour   | day                                     | 5.7    | ₹ 541.00    | 120 | ₹ 64,920.00           |  |
| <b>Sub Total- A</b> |  |   |        |             |     | <b>₹ 46,70,100.00</b> |  |
| <b>B</b>            | <b>Trenching/Pitting</b>   |   |        |             |     |                       |  |
| i                   | Trenching  | per cu.m                                | 2.1.1  | ₹ 4,125.00  | 100 | ₹ 4,12,500.00         |  |
| <b>Sub Total- B</b> |  |   |        |             |     | <b>₹ 4,12,500.00</b>  |  |
| <b>C</b>            | <b>Survey work</b>   |   |        |             |     |                       |  |
| i                   | Charges for one qualified surveyor (Topographic survey, surface contouring at specific interval) | day                                     | 1.3.1  | ₹ 10,500.00 | 30  | ₹ 3,15,000.00         |  |
| ii                  | DGPS Survey for BH fixation and Cardinal Points of block   | Per Point of observation of observation | 1.3.2  | ₹ 24,000.00 | 28  | ₹ 6,72,000.00         | 20 BH and 8 Cardinal Points of block boundary. |
| iii                 | Labours Charges for survey work; Base rate   | day                                     | 5.7    | ₹ 541.00    | 120 | ₹ 64,920.00           |  |
| <b>Sub Total- C</b> |  |   |        |             |     | <b>₹ 10,51,920.00</b> |  |
| <b>D</b>            | <b>Ground Geophysical Survey (Outsource)</b>   |   |        |             |     |                       |  |
| i                   | Charge for Magnetic survey   | Line km                                 | 7a     | ₹ 8,000.00  | 62  | ₹ 4,96,000.00         | Outsource                                      |
| ii                  | Charges for Geophysicist at Headquarters   | day                                     | 3.19a  | ₹ 10,500.00 | 30  | ₹ 3,15,000.00         | Outsource                                      |
| <b>Sub Total- D</b> |  |   |        |             |     | <b>₹ 8,11,000.00</b>  |  |
| <b>E</b>            | <b>Drilling (after review) (Outsource)</b>   |   |        |             |     |                       |  |

|                     |   |              |           |             |      |                  |   |
|---------------------|---|--------------|-----------|-------------|------|------------------|---|
| i                   | Systematic Drilling (Hard rock) (HQ) first level BH)  | per m        | 2.2.1.1 d | ₹ 20,000.00 | 1115 | ₹ 2,23,00,000.00 | 10 BH 1st level @60m vertical depth of intersection (Considering low lying ore body exposed in slopes & undulated topography of the terrain)  |
| ii                  | Systematic Drilling Medium (Hard rock) (HQ)   | per m        | 2.2.1.1 d | ₹ 20,000.00 | 2335 | ₹ 4,67,00,000.00 | 10 BH 2nd level @120m vertical depth of intersection (Subject to successful intersection in first level BH and subsequent approval of NMET-TCC)                                       |
| iii                 | Borehole deviation by multi shot camera   | per m        | 2.2.5     | ₹ 330.00    | 575  | ₹ 1,89,750.00    |   |
| iv                  | Land / Crop Compansation (in case the BH falls in agricultural Land)  | per borehole | 5.6       | ₹ 20,000.00 | 20   | ₹ 4,00,000.00    | As per actuals as certified by local authorities subject to a maximum of 20000 per borehole. (Considering low lying ore body exposed in slopes & undulated topography of the terrain) |
| v                   | Construction of concrete Pillar (12"x12"x30")   | per borehole | 2.2.7     | ₹ 2,000.00  | 20   | ₹ 40,000.00      |   |
| vi                  | <b>Miscellaneous Charges:</b> (Transportation of Drill Rig & Truck associated per drill (2 rig),Accomodation Charges for drilling Camp,Drilling Camp Setting/Winding up Cost,Road Making & Drill Core Preservation) |              | 2.2.9     |             |      | ₹ 25,00,000.00   | 10% of drilling cost with a maximum ceiling of 25 lakh.   |
| xi                  | Drill Core Preservation   | per m        | X         | ₹ 1,590.00  | 400  | ₹ 6,36,000.00    |   |
| <b>Sub Total- E</b> |   |              |           |             |      | ₹ 7,27,65,750.00 |   |
| <b>F</b>            | <b>Laboratory Studies</b>   |              |           |             |      |                  |   |
| <b>1</b>            | <b>Chemical Analysis</b>  |              |           |             |      |                  |   |

|          |  |            |         |             |     |                |   |
|----------|--|------------|---------|-------------|-----|----------------|---|
| i)       | <b>Geochemical Sampling-Surface samples (BRS/Channel )</b>   |            |         |             |     |                |   |
| a        | Analysis of major oxides samples by XRF  | Nos        | 4.1.17a | ₹ 4,200.00  | 510 | ₹ 21,42,000.00 | BRS-100,PIT/TRENCH-110,CS-300 (TOTAL-510) |
| b        | Analysis of major oxides samples by XRF (10% Check samples)  | Nos        | 4.1.17a | ₹ 4,200.00  | 51  | ₹ 2,14,200.00  |   |
| c        | Analysis for PGE (ICP-MS Ni-S Fire assay technique)  | Nos        | 4.1.6   | ₹ 13,600.00 | 150 | ₹ 20,40,000.00 |   |
| d        | Analysis for PGE (ICP-MS Ni-S Fire assay technique) (10% Check samples)  | Nos        | 4.1.6   | ₹ 13,600.00 | 15  | ₹ 2,04,000.00  |   |
| e        | Analysis for precious metals by fire assay technique (Au & Ag)   | Nos        | 4.1.5a  | ₹ 5,000.00  | 50  | ₹ 2,50,000.00  |   |
| f        | Analysis for precious metals by fire assay technique (10% Check samples)   | Nos        | 4.1.5a  | ₹ 5,000.00  | 5   | ₹ 25,000.00    |   |
| g        | HR-IC PMS (REE & Trace elements)   | Per Sample | 4.1.16f | ₹ 7,400.00  | 200 | ₹ 14,80,000.00 |   |
| h        | Check samples (10% External) HR-IC PMS (REE & Trace elements)  | Per Sample | 4.1.16f | ₹ 7,400.00  | 20  | ₹ 1,48,000.00  |   |
| <b>2</b> | <b>Physical &amp; Petrological/mineragraphic Studies</b>   |            |         |             |     |                |   |
| i        | Preparation of Standard thin section of rock   | Nos        | 4.3.1   | ₹ 500.00    | 10  | ₹ 5,000.00     |   |
| ii       | Complete petrographic/ ore microscopic study/ mineragraphic report of rock sample (along with 5 nos. digital photomicrographs) | Nos        | 4.3.4   | ₹ 2,800.00  | 10  | ₹ 28,000.00    |   |
|          | petrochemical studies  | Nos        | 4.1.17a | ₹ 4,200.00  | 10  | ₹ 42,000.00    |   |

|                     |   |                                       |            |  |          |                         |  |
|---------------------|---|---------------------------------------|------------|--|----------|-------------------------|--|
| iv                  | Bulk density analysis   | Nos                                   | 4.8.3      | ₹ 2,500.00   | 5        | ₹ 12,500.00             |  |
| v                   | SEM   | Hrs.                                  | 4.4.2      | ₹ 3,500.00   | 18       | ₹ 63,000.00             | As per actuals . The cost is given based on market research  |
| vi                  | EPMA  | Hrs.                                  | 4.4.1      | ₹ 10,500.00  | 18       | ₹ 1,89,000.00           |  |
| <b>Sub Total- F</b> |   |                                       |            |  |          | <b>₹ 68,42,700.00</b>   |  |
| <b>G</b>            | <b>Total A to G</b>   |                                       |            |  |          | <b>₹ 8,65,53,970.00</b> |  |
| <b>H</b>            | <b>Geological Report Preparation</b>  | <b>5 Hard copies with a soft copy</b> | <b>5.2</b> |  |          | <b>₹ 7,50,000.00</b>    | <b>Reimbursement will be made after submission of the Final Geological Report in Hard Copies (5 Nos) and the soft copy to NMET.</b>  |
| <b>I</b>            | <b>Peer review Charges</b>  | <b>As per EC decision</b>             |            | <b>₹ 30,000.00</b>                                       | <b>1</b> | <b>₹ 30,000.00</b>      |  |
| <b>J</b>            | <b>Preparation of Exploration Proposal (5 Hard copies with a soft copy)</b> | <b>5 Hard copies with a soft copy</b> | <b>5.1</b> | <b>2% of the Cost or Rs. 3.8 Lakhs whichever is less</b> |          | <b>₹ 5,00,000.00</b>    | <b>EA will be reimbursed after submission of the Hard Copies and the soft copy of the final proposal along with Maps and Plan as suggested by the TCC-NMET in its meeting while clearing the proposal.</b> |
| <b>K</b>            | <b>3D Ore Body Modeling using compatible software</b>                       | <b>Lumpsum</b>                        | <b>5.4</b> |  |          | <b>₹ 5,00,000.00</b>    | <b>As rates varies from mineral to mineral and on mode of occurrence, hence charges applicable would be as per actual, based on market survey</b>  |
| <b>L</b>            | <b>Total Estimated Cost without GST</b>                                     |                                       |            |  |          | <b>₹ 8,83,33,970.00</b> |  |

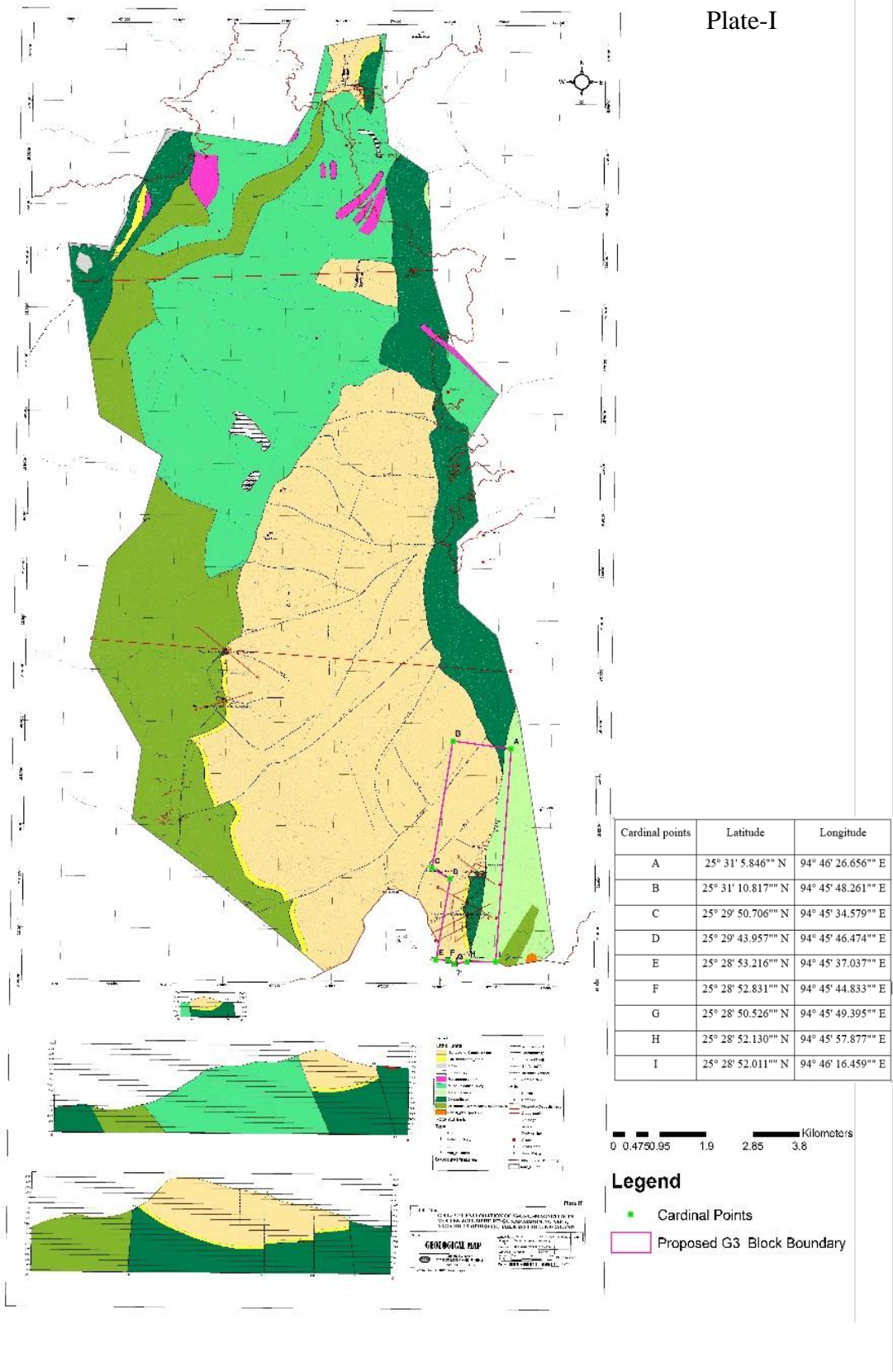
|   |                                      |                      |  |
|---|--------------------------------------|----------------------|--|
| M | Provision for GST (18% of L)         | ₹<br>1,59,00,114.60  | GST will be reimbursed as per actual and as per notified prescribed rate |
| N | <i>Total Estimated Cost with GST</i> | ₹<br>10,42,34,084.60 |  |
|   | <i>Rs. In Lakhs</i>                  | ₹ 1,042.34           |  |

## List of Plates

| <b>Sl. No</b> | <b>Description</b>   |
|---------------|--|
| I             | Boundary of proposed block over LSM Map of DGM, Nagaland           |
| II            | Geology of Proposed block  |
| III           | Proposed tentative borehole location on map for the proposed block |

# Location of Proposed G3 Thewati Block over Large Scae Map of DGM, Nagaland

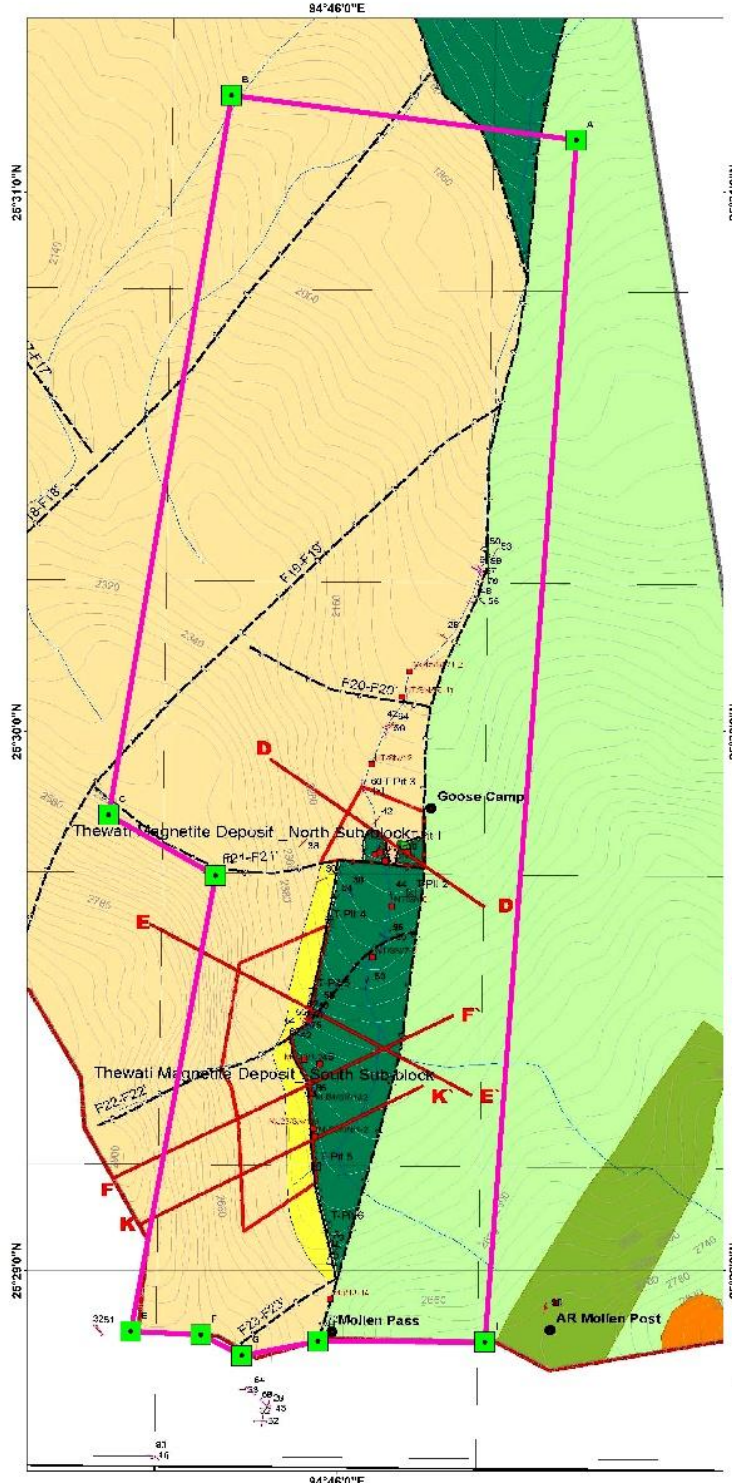
Plate-I



# Geology of Proposed Thewati (G3) Block, Phek district, Nagaland

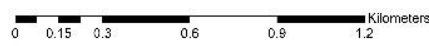


Plate-II

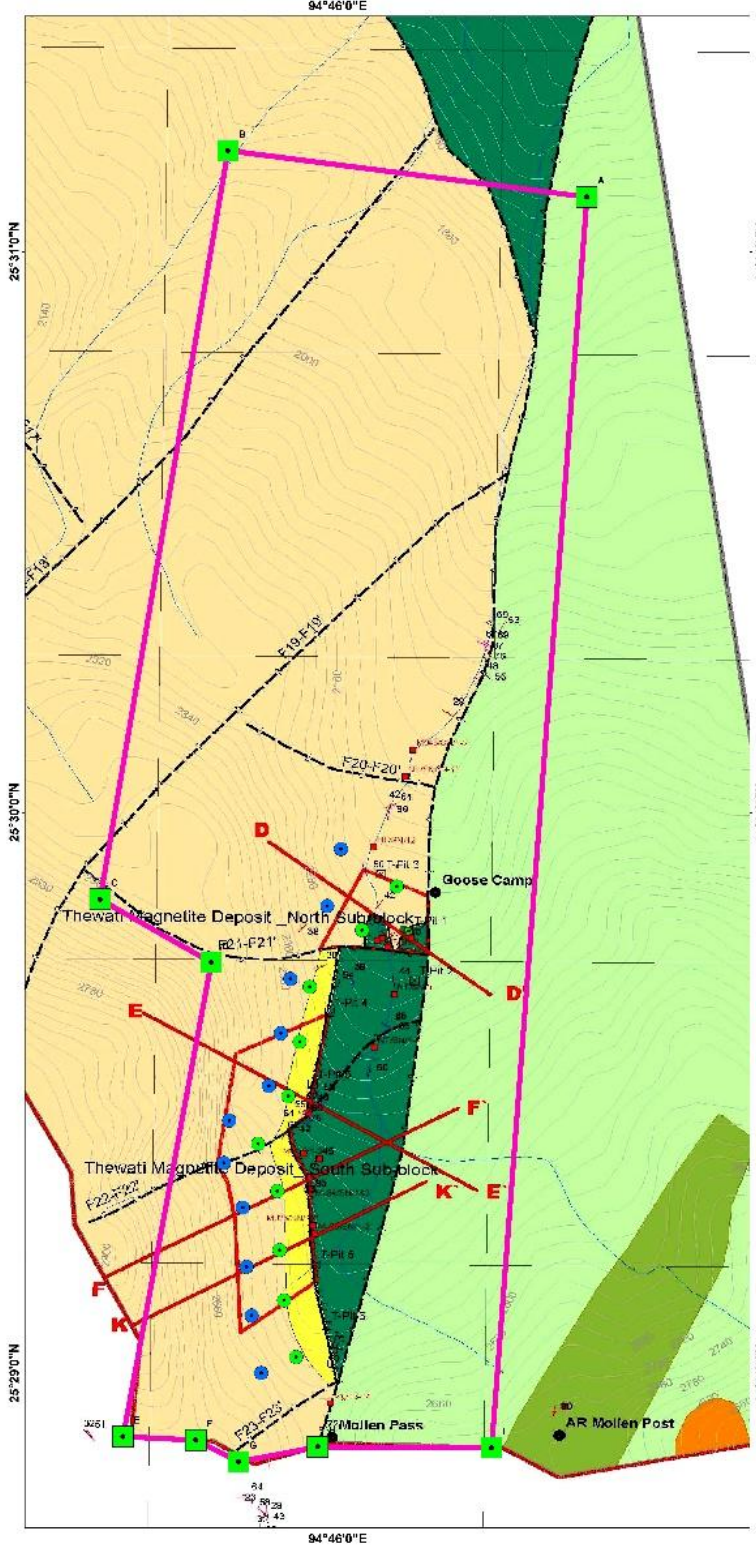


## Legend

- Cardinal Points
  - Proposed G3 Block Boundary
- 
- Legend**
- |   |  |
|---|--|
| <p><b>Litho_units</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #f4a460; border: 1px solid black;"></span> Sandstone_Conglomerate</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ffff00; border: 1px solid black;"></span> Tuf. sandstone_shale</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #cccccc; border: 1px solid black;"></span> Shale</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #cccccc; border: 1px solid black; border-style: dashed;"></span> Limestones</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #00ff00; border: 1px solid black;"></span> Radiolarian Chert</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #00ff00; border: 1px solid black;"></span> Mafic Volcanics Comp</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #90ee90; border: 1px solid black;"></span> Metavolcanics</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #008000; border: 1px solid black;"></span> Serpentinites</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #800000; border: 1px solid black;"></span> Ultramafic Cumulate (Unclassified)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ffa500; border: 1px solid black;"></span> Schist_phy_gn_qzite</li> </ul> <p><b>Rock Attitude</b></p> <p><b>Type</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black;"></span> Bed</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-left: 1px solid black;"></span> Foliation/Scsty</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-left: 1px dashed black;"></span> Joint</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-left: 1px dotted black;"></span> Vert_Foliation</li> </ul> <p><b>Structural features</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; border-top: 1px solid black;"></span> Litho-Contact</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-top: 1px dashed black;"></span> Unconformity</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-top: 1px dotted black;"></span> Inferred Fault</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-top: 1px solid black; border-bottom: 1px solid black;"></span> Syntormal fold</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-top: 1px dashed black; border-bottom: 1px dashed black;"></span> Tectonic Contact</li> </ul> | <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px solid black;"></span> Sample Nos.</li> </ul> <p><b>Pits</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px solid black;"></span> Barren</li> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px solid black;"></span> Sampled</li> </ul> <p><b>Magnetite Deposits Area</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px solid red;"></span> Magnetite Deposits Area</li> </ul> <p><b>Other Features</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black;"></span> Cross_sections</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black;"></span> Drainage</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black;"></span> Contour_line</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black;"></span> Village</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black;"></span> Local Spots</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black;"></span> Peak_Points</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black;"></span> International_Boundary</li> <li><span style="display: inline-block; width: 15px; height: 10px; border-bottom: 1px solid black;"></span> MJZ_Bound</li> </ul> |
|---|--|



# Geology of Proposed Thewati (G3) Block with proposed tentative Boreholes , Phek district, Nagaland



## Legend

- Cardinal Points
  - Proposed G3 Block Boundary
- 
- Legend**
- |   |   |
|---|---|
| <p><b>Litho_units</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span> Sandstone_Conglomerate</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ffffcc; border: 1px solid black;"></span> Tuf. sandstone_shale</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #cccccc; border: 1px solid black;"></span> Shale</li> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px solid black; border-style: dotted;"></span> Limestones</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ffcccc; border: 1px solid black;"></span> Radiolarian Chert</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #90ee90; border: 1px solid black;"></span> Mafic Volcanics Comp</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #c8e6c9; border: 1px solid black;"></span> Metavolcanics</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #4db6ac; border: 1px solid black;"></span> Serpentinites</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #81c784; border: 1px solid black;"></span> Ultramafic Cumulate (Unclassified)</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #ffb74d; border: 1px solid black;"></span> Schist_phy_gn_qzite</li> </ul> <p><b>Rock Attitude</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px solid black;"></span> Bed</li> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px dashed black;"></span> Foliation/Scsty</li> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px dotted black;"></span> Joint</li> <li><span style="display: inline-block; width: 15px; height: 10px; border: 1px dashed black;"></span> Vert_Foliation</li> </ul> <p><b>Structural features</b></p> <ul style="list-style-type: none"> <li><span style="border-bottom: 1px dashed black; width: 20px;"></span> Litho-Contact</li> <li><span style="border-bottom: 1px dotted black; width: 20px;"></span> Unconformity</li> <li><span style="border-bottom: 1px dashed black; width: 20px;"></span> Inferred Fault</li> <li><span style="border-bottom: 1px dashed black; width: 20px;"></span> Syntormal fold</li> <li><span style="border-bottom: 1px dashed black; width: 20px;"></span> Tectonic Contact</li> <li><span style="color: red;">●</span> Sample Nos</li> </ul> | <p><b>Pits</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; border: 1px solid black;"></span> Barren</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: green; border: 1px solid black;"></span> Sampled</li> <li><span style="border: 1px solid red; display: inline-block; width: 15px; height: 10px;"></span> Magnetite Deposits Area</li> <li><span style="border-bottom: 1px solid black; width: 20px;"></span> Cross_sections</li> <li><span style="border-bottom: 1px solid black; width: 20px;"></span> Drainage</li> <li><span style="border-bottom: 1px solid black; width: 20px;"></span> Roads</li> <li><span style="border-bottom: 1px solid black; width: 20px;"></span> Contour_line</li> <li><span style="color: red;">■</span> Village</li> <li><span style="color: black;">●</span> Local Spots</li> <li><span style="color: black;">▲</span> Peak_Points</li> <li><span style="border-bottom: 1px solid red; width: 20px;"></span> International_Boundary</li> <li><span style="border: 1px solid black; display: inline-block; width: 15px; height: 10px;"></span> MJZ_Bound</li> </ul> |
|---|---|



### **Reference:**

- Lhoupenyi, D. & Walling, I., G-4 Level Exploration of Ni-Co-Cr-Magnetite in Mollen–Jopi–Ziphu Ridge and Adjoining Areas, Naga Hills Ophiolite, Phek District, Nagaland. Geological Report, Directorate of Geology & Mining, Government of Nagaland, Dimapur, (2021).