

**PROPOSAL FOR PRELIMINARY EXPLORATION (G3 STAGE) FOR
GRAPHITE & VANADIUM IN ANGU BLOCK, WEST SIANG DISTRICT,
ARUNACHAL PRADESH UNDER NMEDT.**

Commodity: Graphite & Vanadium

BY



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**MMPL PRIVATE LIMITED
FR 07 SHILPANGAN, PLOT NO – LB 1,
SECTOR III, SALT LAKE, KOLKATA-700091**

Place: Kolkata

Date: November, 2025

Summary of the Block in G3 Stage Exploration

Sl.no	Features	Details
A.	Block ID	Angu Vanadium & Graphite Block
B.	Current Exploration Agency	MMPL Private Limited (Formerly Maheshwari Mining Private Limited)
C.	Previous Exploration Agency	Geological Survey of India (GSI) up to G-4 Stage
D.	G4 stage Geological Report (Previous stage Geological Report)	RECONNAISSANCE SURVEY (G-4) FOR VANADIUM AND GRAPHITE MINERALISATION IN THE METASEDIMENTARY SEQUENCE OF BOMDILA GROUP OF ROCKS IN AND AROUND SIKU ANGU AND LIPU, WEST SIANG DISTRICT, ARUNACHAL PRADESH
		Item no.: M2ASMIF-MEP/NC/NER/SU-ARA/2022/45285
E.	Commodity	Vanadium & Graphite (flaky)
F.	Mineral Belt	Khetabari Formation of Bomdila Group
G.	Completion Period with entire	14 Months
	Time schedule to complete the project	
H.	Objectives	The present exploration program (G3) has been formulated on the basis of the outcome of previous Reconnaissance work to fulfil the following objectives:
		<ul style="list-style-type: none"> Geological mapping on 1:5000 scale to delineate Carbonaceous phyllite bands hosting vanadium and graphite mineralisation and other associated lithological units within the proposed block.
		<ul style="list-style-type: none"> Topographical Contouring on 1:5000 scale, by means of surface contouring at 2 m interval.
		<ul style="list-style-type: none"> Delineation of the potential subsurface mineralized zones by Geophysical Surveys (SP survey/IP/ERT Survey).
		<ul style="list-style-type: none"> Necessary Trenching will be carried out to expose the Carbonaceous phyllite bands in gap areas.

Sl.no	Features	Details		
		<ul style="list-style-type: none"> Exploratory drilling up to second level at 200m strike interval for 1st level boreholes (30m vertical depth of intersection) and 2nd 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. 		
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)	180		
	Geological Party Days			
	Location	Cardinal points	Latitude	Longitude
		A	28.0692	94.7326
		B	28.0694	94.7466
		C	28.0508	94.7429
		D	28.0464	94.7347
		E	28.0464	94.7283
		F	28.0568	94.7283
	Villages	Angu Village		
	Tehsil			
	District	West Siang		
	State	Arunachal Pradesh		
	Area (hectares/square kilometres)			
	Block Area	3.51 Sq km		
	Forest Area			
	Government Land Area			
	Private Land Area	3.51 Sq Km (The land is held by the local community) (refer G-4 Stage Geological report-GSI)		
3.	Accessibility			

Sl.no	Features	Details
	Nearest Rail Head	Silapathar (Assam) is the nearest railway station at distance of 5 km from Likhabali, which is 200 km distant from Aalo.
	Road	Regular bus services to Aalo are available from Itanagar operated by Arunachal Pradesh State Transport Service (APSTS).
	Airport	Air services are also available from Itanagar to reach Along (Aalo).
4.	Hydrography	
	Local Surface Drainage Pattern (Channels)	The overall drainage pattern is dendritic to sub dendritic.
	Rivers/Streams	Siyom River originating in the high mountains is the major river in the Siang district. Siyom River with its tributaries Sipu River, Mebu, Pebu, Ibung and Yambung drains Siang district. Mainly, Sipu river is draining the study area.
5.	Climate	
	Mean Annual Rainfall	The annual rainfall varies from 250 cm to 500 cm. Winter starts from November and ends in early February with occasional rains.
	Temperatures (January)(Minimum)	8.1°C
	Temperatures (July) (Maximum)	37.1°C
6.	Topography	
	Toposheet Number	82L/12
	Morphology of the Area	As a part of Lesser Himalayas, characterized by rugged high mountains with deep incised valleys covered with thick vegetation. The area represents

Sl.no	Features	Details
		an undulating terrain with a maximum elevation of 1236 m towards west of study area and minimum elevation of 280 m towards east of study area.
7.	Availability of base line geoscience data	
	Geological Map (1:50000/1:12500)	Available (1:50000/1:12500 map by GSI)
	Geochemical Map (1:50000)	NGCM available
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	Not available
8.	Justification for taking up Reconnaissance Survey/ Regional Exploration	<p>Justification for taking up the investigation in G3 stage:</p> <ul style="list-style-type: none"> • Carbonaceous phyllite bands of various dimensions hosting vanadium and graphite mineralisation have been clearly identified on the surface by GSI, however its depth continuity and geometry can be defined through this G3 proposal. • Some reported values of Vanadium go up to 1,062 PPM and values of FC in BRS also goes up to 10.6%. Graphite and Vanadium appear to co-exist in the same lithology, i.e. Carbonaceous phyllite and Graphite mineralization (in form of flaky and amorphous) is understood, but distribution and occurrence of high values of Vanadium needs to be further systematically investigated.

Sl.no	Features	Details
		<ul style="list-style-type: none"> • As noted by GSI, due to dense vegetation and soil cover, the carbonaceous phyllite appears to be discontinuous, however by conducting large scale mapping at the proposed scale of 1:5000, attempt to map the strike extensions of the mineralized zones can be made to improve the controls of mineralization within carbonaceous phyllite bands. • It should be further noted that enrichment mechanism of Vanadium is not clearly understood, since the Vanadium is distributed within the phyllite matrix, exploratory drilling and trenching may shed more light towards patterns of distribution leading to further enriched economically extractable pockets of Vanadium. • The main objective of the proposed G3 program is to enhance confidence in geometry and factors contributing to enrichment of graphite and vanadium. This program will enhance understanding of the Graphite and Vanadium mineralization. <hr/> <ul style="list-style-type: none"> • MMPL has proposed a block of 3.51 sq km area for upgrading into G-3 stage of investigation, covering 3 major bands of carbonaceous phyllite. <hr/> <ul style="list-style-type: none"> • The precise location, extent (strike, dip and depth persistence) and resource of the vanadium & graphite mineralization of the prospect need to be verified in G-3 stage of investigation.

Sl.no	Features	Details
		<ul style="list-style-type: none"> To upgrade the shape of overall orebody and resource confidence level, systematic, closely spaced drilling, along with extensive trenching, is required to verify precise location, extent (strike, dip and depth persistence). Therefore, the area is proposed for upgradation to G-3 stage of exploration.

Proposal for preliminary exploration (G3 stage) for Graphite and Vanadium in Angu block, West Siang district, Arunachal Pradesh under NMET

Introduction:

The proposed Angu Block, situated in the Angu–Siku sector of West Siang District, Arunachal Pradesh, has been carved out from the larger G4 block where the reconnaissance (G4) exploration was conducted by the Geological Survey of India (GSI) during FS 2022–23 covering 50.0 Sq Km. GSI’s investigation involved 1:12500 scale geological mapping, trench and channel sampling, bedrock sampling (BRS), and analytical studies including petrography, EPMA, XRD, and Raman spectroscopy. These studies established the presence of three strata bound carbonaceous-phyllite bands (MZ-1, MZ-2, and MZ-3) within the Khetabari Formation of the Bomdila Group, enriched in vanadium (up to 1,062 ppm) and graphite (fixed carbon up to 10.6%).

Based on the partial continuity of these mineralized bands, favourable structural disposition, and geochemical anomalies, GSI delineated a broader prospective corridor for further exploration. The current proposed block, covering about 3.51 km², 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 MMPL for G3-level exploration to undertake 1:5000-scale detailed geological mapping, trenching, geophysical surveys, 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 following proposal

1 Block Summary

Please refer to page number 1 to 6 attached with this document for Block summary.

1.1 Physiography

Physiographically, the study area being a part of Lesser Himalayas, characterized by rugged high mountains with deep incised valleys covered with thick vegetation. The area represents an undulating terrain with a maximum elevation of 1236 m towards west of study area and minimum elevation of 280 m towards east of study area. Siyom River originating in the high mountains is the major river in the Siang district. Siyom River with its tributaries Sipu River, Mebu, Pebu, Ibung and Yambung drains Siang district. Mainly, Sipu river is draining the study area. The overall drainage pattern is dendritic to sub dendritic. The western and eastern part of the study area are found be covered by dense mixed forest. Sipu River is flowing from SW to NE direction in the study area and then after confluence with Simi Korong near Doji Jeku and Lsipu Korong near Darka it flows in northward direction till its confluence with Siyom river at Aalo. Rele Korong drains the south part of Angu village, and it flows from South to North direction. Sigi Korong flows in NW to SE direction and it drains Lipu Bagra, Jeyi Bagra areas. Ene Korong flows from NE to SW direction and it drains Jadin, eastern part of Doji Jeku area.

1.2 Background Geology

1.2.1 Brief Regional Geology

The present study area falls in the western limb of a major anticline termed as “Siang Antiform”, a part of the Lesser Himalaya and exposes rock sequence of Bomdila Group of late Palaeo-Proterozoic (Figure 5-5). The systematic geological mapping of the Siang district of Arunachal Pradesh was carried out by Singh et al., (1983) on 1: 50,000 scale. They have differentiated the lithounits exposed in the area into Khetabari Formation, Ragidoke Formation of Palaeo-Proterozoic and Miri (Nikte) Formation of Early Palaeozoic. The contact between the Khetabari Formation and the Ragidoke Formation has been suggested a thrust contact (Luyor Thrust) indicated from their contrasting degree and style of deformation and metamorphism and this entire older sequence are unconformably overlain by rocks of Miri Formation. The general trend of the lithounits is NNE-SSW dipping due northwest and occasional southeasterly. The Khetabari Formation comprises low to medium grade metamorphic rocks 3- phases of deformation comprising of schistose quartzite, garnet mica schist, banded quartzite, carbonaceous phyllite, schist, metavolcanic and carbonate. This formation has been named after Siyom Valley where it occupies large area The rocks of Siyom Group are thrust over the Nikte Formation along Luyor thrust. Detached nappe of the Siyom Group

of rocks occurs at Along area as Along Klippe. Ragidoke Formation is mainly the association of phyllite, slate & quartzite showing 2- phases of deformation. The regional strike of these formations is in NE-SW direction with NW dips although sometimes dipping in SW direction.

Bomdila Group:

Bomdila Group of rocks is a sequence of low to medium grade metasediments of Palaeo-Proterozoic age with associated gneisses and younger granitoids occupying expansive areas throughout the lesser Himalaya of Arunachal Pradesh. It comprises the following Formations.

Khetabari Formation:

The metasediments comprising of sericite-quartz phyllite, garnetiferous phyllite and schists, graphitic / carbonaceous phyllite, quartzite, minor carbonates, chert and para-amphibolite exposed around Khetabari in the Lower Subansiri districts constitute the Khetabari Formation. The Yazali Formation (Das, 1979) and the Potin Formation (Kakoti *et al.*, 1969-70) of Ranga valley area are also included in this group because of similar lithological assemblage. In Pakro and Yazli areas, large enclaves of Khetabari Formation are seen in the granitic gneisses (Singh *et. al.*, 1989). Similar assemblage along the Along-Daporizo, Tai- Liromoba, Pobdi-Esimoku, and Wak-Yamcha road-sections has been grouped as Siyom Formation (Singh, *et.al*, 1983). It occurs in tectonic contact with the Miri (Nikte) and Ragidoke Formations. Light to dark green foliated basic volcanic rocks are associated with the schistose quartzite exposed in the suburbs of Along, Wak, Bame, Nyurok etc. At some places, the volcanics have been altered to chlorite-schists. However, the amygdules, represented by dark green coloured clots of chlorite, are well preserved along the foliation planes. Near Basar and Dali area they are more or less massive showing amygdules filled by secondary quartz (Pebam *et al.*, 2013).

Ragidoke/Tenga Formation:

Ragidoke Formation is tectonically overlain by the rocks of Siyom Formation. It comprises of low grade meta-sedimentaries. Along Bame-Aalo-Pangin section similar litho assemblages consisting of metavolcanics, quartzite, and carbonate rocks are described as equivalent to Tenga Formation named originally for the similar litho assemblages of the Tenga valley by Das, *et. al.*, (1975). Tenga Formation has been divided into Lower Garubuthan and Upper Reyang Member (Dhoundial *et.al.*, 1989). However, in the Bame-Panging section, the lower and the upper members of the Tenga Formation have been referred as Along and Jameri Members respectively (Kumar 1997).

Chilliepam Formation:

A thick succession of dominantly carbonate rock, unconformably overlying the Tenga Formation occurs in Tenga valley in West Kameng district. This sequence variously referred as Chilliepam Formation (Anon 1974, Jain *et. al.*, 1979), Dedza Formation (Das *et.al.*, 1975) or Menga Formation (Tripathi *et. al.*, 1983)

is well exposed around Dedza, Chilliepam, Menga, Pangin and Palin. The Chilliepam Formation can be broadly divided into two members (Kumar, 1999). The lower Kabak Member consists of a basal oligomictic conglomerate with pebbles and cobbles of quartzite in a phyllitic matrix, quartzite with impersistent bands of dolomite, massive grey to white dolomite/limestone and black to dark grey phyllite (Bhusan *et.al.*, 1991). The upper member referred to as Niumi Member (Kumar and Bora, 1984-85) comprises mainly carbonates (limestone and dolomite) with alternations of greenish grey carbonaceous phyllites. In the mapped area, this Formation is not exposed.

Bomdila Gneiss: This has been variously referred as Bomdila Gneiss, Chakko Gneiss, Sepla Gneiss, Daporizo Gneiss and Ziro Gneiss by various workers Bakliwal *et.al.*, (1979), Singh and Ahmed (1989). It comprises biotite granite gneiss, feldspathic gneiss, and augen gneiss.

The present area is part of this Lesser Himalayan Sequence and exposes the rock types of Khetabari Formation of Bomdila Group which are intruded by the Ziro Gneiss equivalent to Bomdila Gneiss (Ahmed *et al.*, 1986-87, Khadse *et al.*, 2002).

Table-1 showing Geological succession of the study area (after Pebam et al., 2013)

	Age	Group	Formation	Member	Lithology
Lesser Himalaya	1536±23 to 1914±23 Ma	Bomdila	Bomdila/Ziro/Daporijo Gneiss		Feldspathic gneiss, augen gneiss and biotite granite gneiss
			Siyom/Khetabari/Potin	E	Greenish, very fine-grained metavolcanics with strongly foliated and massive character showing amygdules filled by secondary quartz. Volcanic agglomerate is also present
	D			Schistose quartzite, flaggy quartzite, mica schist and phyllite.	
	C			Quartzite, phyllite, garnet mica schist, magnetite-haematite quartzite and limestone.	
	B			Quartzite, magnetite-haematite quartzite and thin lenses of carbonaceous/graphitic schist	
	A		Garnet-mica schist, quartzite, sericitic quartzite and thin lenses of carbonaceous/graphitic schist and crystalline limestone.		
Palaeoproterozoic					

1.2.2 Geology of the area at G4 stage of investigation

Large scale mapping (1: 12,500) of 50 sq. km was carried out in and around Siku Angu and Lipu areas of West Siang District, Arunachal Pradesh in parts of Toposheet nos. 82 L/12 and 82 L/16.

Lithologies like Quartz Mica Schist, Schistose Quartzite, Grey Phyllite, Marble and Carbonaceous Phyllite which are the metasedimentary sequences of Khetabari Formation of Bomdila Group belonging to Paleoproterozoic age.

Description of the lithological units

Quartz Mica Schist:

It is exposed to the dominant lithology of the study area and is light to dark brownish grey in colour, fine to medium grained, at places limonitised and is composed of quartz, mica (muscovite and biotite). It is well foliated, defined by the flaky micaceous minerals (muscovite & biotite) and is intensely crenulated at places. The strike of the lithounit varies from NE-SW, NW-SE to E-W with moderate to steep dip on both sides. The schistosity in the lithounit is defined by stretched quartz grains and flakes of mica minerals. Two foliation planes with intersection and mineral lineation are prominent. At few places like north of Angu, south of Doyur Bagra, north of Takpu Bagra, Quartz Mica Schist is vertical. It is highly crenulated with prominent development of puckers/assymmetric folds near Bagra. At south of Darka, boudinaged quartz veins due to shearing are observed in grey, yellow to reddish brown coloured ferruginized quartz mica schist.

Phyllite/ Grey phyllite:

Phyllite is grey in colour, fine grained and found as intercalation with Quartzite and Quartz Mica Schist in western part of study area at N of Pushidoke. The grey phyllite is light to dark grey in colour, fine to medium grained. The grey phyllite is rich in silica content and assymmetrically folded in southeastern part of study area near Doji Jeku village. Phyllitic sheen is observed in it and fissility is present due to the parallel alignment of fine-grained platy minerals like muscovite, biotite. 1-2 cm thin graphite flakes are observed within Carbonaceous Phyllite which is associated with Quartz Mica Schist.

Quartzite (Schistose/Flaggy/ Banded): It is well exposed in the western, central and eastern part of the block. It is grey to white in colour, fine to medium grained, well foliated. The strike of the quartzite varies from NW-SE to NNE-SSW with dip easterly to southeasterly. Schistosity in quartzite is defined by the deformed quartz grains and micaceous minerals in a parallel orientation. The banded quartzite exposed near SE of Darka village and near Pigi Muli village is grey to white in colour, hard and

compact, fine to medium grained and is defined by alternate dark and light colour bands. The banded quartzite in the study area is characterized both by primary bedding and foliations in quartzite. The primary bedding in banded quartzite is characterized by compositional light and dark grey colour bands whereas the metamorphic banding is characterized by alternate quartz and mica rich bands. The alternate interbanding of Quartzite and Quartz mica Schist is also observed near SE of Darka village. A 1-2 m width zone of Mylonitic Quartzite is observed in it where there is presence of deformed quartz grains/ ribbons upto 2-5cm length along 2750 trend, which may be caused by flattening strain due to ductile deformation by a minor scale shear zone/ fault. Quartzite observed in central part near NW and SE of Angu village occur as bouldery outcrops which is medium to coarse grained, white colour. Mullion structure is observed in it which may be due to folding of the earlier foliation in quartzite. At few places quartz grains are very coarse grained giving sugary texture.

Carbonaceous phyllite:

The carbonaceous phyllite (\pm graphite) is mainly exposed in the central and northern part of the block. Different bands of Carbonaceous Phyllites have been observed which are fine grained, dark grey to black in colour and presence of graphite is confirmed as it soils finger. Limonitised zones are also observed in Carbonaceous Phyllite. Carbonaceous Phyllite is mainly associated with Quartz Mica Schist in the study area, but it is also associated as intercalation with Quartzite and Marble at few places like north of Pushidoke. The strike of the carbonaceous phyllite varies from NW-SE to NNE-SSW with dip easterly to southeasterly. At places, carbonaceous phyllite has minor silica veins (up to 1-2 cm) and also with iron leaching. 3 (Three) major Carbonaceous phyllite bands have been identified and delineated in Angu block. At 1.4 km SW of Angu, 1st band has width of 60-70 m with strike extension of about 400 m (S1 varies N10°W to N20 ° E and dipping 32 to 34° towards ENE to SE). It is associated with Quartz mica Schist and grey phyllite. At 2 km SW of Angu, 2nd band is with variable width of 60 m in north to 150-160 m in south with strike extension of about 700 m. It is also associated with Quartz mica Schist. At 1km NW of Angu, 3rd band has variable width of 200 m with strike extension of about 500 m (S1 varies from N32 ° E to N60 ° E and dipping 18 ° to 44 ° towards SE). One band is reported near Jeyi Bagra village with width of about 110-120 m with strike extension of about 600 m, but it is a zone of Quartz Mica Schist with numerous thin bands of CP. Many thin bands of Carbonaceous phyllite are observed throughout the study area. A 10-15 m width Carbonaceous phyllite band is found in association with fine to medium grained, black coloured, 5-6m thick Marble with sulphide mineralization near S of Jeyi Bagra. Another Carbonaceous phyllite band has width of 15-17m with strike extension of about 300 m near Pigi Muli, which is associated with Quartz Mica

Schist. Near Lipu Bagra village, 4-5m thick Carbonaceous phyllite band is observed within Quartz Mica Schist. Thin flakes of graphite with 1mm-1cm thickness are observed within Carbonaceous phyllite, Quartz Mica Schist at Angu, Bagra Lipu, southeast of Darka.

Marble:

Marble is observed mainly in western part of study area near Pushidoke village and in north central part near Jeyi Bagra. There is compositional variation in marble as calcitic /dolomitic / siliceous marble. A 150-160 m width of marble band is reported for the first time by the authors in north of Pushidoke area in contact with Quartzite and Carbonaceous Phyllite. It is massive, foliated, fine to medium grained, greyish white to black in colour and it preserved primary bedding of limestone which is identified from alternate light and dark bands. The strike varies from NNW-SSE to NNE-SSW with dip towards easterly to southeasterly direction. Sulphide mineralization (Pyrite, Chalcopyrite) is observed in marble. At the contact with white coloured, coarse grained quartzite and marble, there is intense mylonitization of the lithology and stretched quartz/calcite ribbons/ porphyroclasts are present and the remaining matrix being very fine grained. Shearing in quartz ribbons and presence of enechelon quartz veins can be observed from the marble, which indicate presence of a localized shear zone which caused ductile deformation. Minor silica and calcitic gash veins across the shear plane direction (trend= 040°) and along the joint direction (trend= 110°). Pyrite, Chalcopyrite mineralization is observed in both marble and quartzite at contact. At the contact of marble and carbonaceous phyllite, thin quartz-calcite veins are observed within carbonaceous phyllite. Elephant skin weathering pattern is observed in dolomitic marble in south of Pushidoke village, where exposures of white to grey colour, fine grained, siliceous marble is also observed. These lithologies occupy the area as steep ridges.

Quartz Veins:

Numerous quartz veins are observed in the study area. Quartz vein observed in northwest of Angu village is 20-25m thick, white in colour, very coarse grained, highly brecciated with angular grains which indicates presence of a minor fault along the trend of quartz vein (100°) which crosscuts the quartz mica schist and carbonaceous phyllite units. Quartz vein observed in northeast of Angu is 30-40m thick, coarse grained and trends 045° direction. These indicate to be two separate generations of quartz veins.

Augen Gneiss (Bomdila Gneiss):

The Augen Gneiss is medium to coarse grained and consists of quartz, k-feldspar, plagioclase, biotite and muscovite as essential minerals and minor amount of calcite, garnet. The strong preferred orientation of muscovite and biotite define the main foliation, and it wraps around the porphyroclasts of k-feldspar, plagioclase, quartz and garnet. The foliation has strike S60°W dipping 35° towards southeasterly. The 15-20m width of augen gneiss unit is intrusive into the banded quartzite of

Khetabari Formation near 1km south of Darka village. Porphyroclasts of quartz and feldspar of 5mm-1cm length are present in it which shows dextral sense of shear. Garnet porphyroclasts are of 1-3mm size.

Metaconglomerate:

During a traverse in west of Darka village to check the lithology in the foothills of north side of the E-W trending ridge due to inaccessibility in southern side peak near Bagra Lipu and north of Takpu Bagra, a 40-50m width exposure of hillock of meta conglomerate is observed within banded quartzite (Figure 5-42). It is clast supported conglomerate with clasts of predominantly quartz and quartzite up to 1cm-30cm length and siliceous matrix. The clasts are very highly stretched which indicate ductile deformation due to high strain localization.

Altered Ultramafic rock: Towards 700m NE of Angu village, a 12-15m width body of altered ultramafic rock is observed which is dark grey to black in colour, coarse grained and the ultramafics show alteration to form serpentinite, carbonates and clay minerals. It occurs as sill within Quartz Mica Schist.

1.3 Geology of the proposed block area

Geology of the proposed block area consists of Quartz-mica schist, Graphite & Vanadium bearing carbonaceous phyllite/ schist, Schistose quartzite and quartz veins.

Quartz Mica Schist:

Quartz-mica schist is a dominant lithology of the study area and is light to dark brownish grey in colour, fine to medium grained, at places limonitised and is composed of quartz, mica (muscovite and biotite). It is well foliated and is intensely crenulated at places. The strike of the lithounit varies from NE-SW, NW-SE to E-W with moderate to steep dip on both sides. The schistosity in the lithounit is defined by stretched quartz grains and flakes of mica minerals. Two foliation planes with intersection and mineral lineation are prominent. At few places like north of Angu, south of Doyur Bagra, north of Takpu Bagra, Quartz Mica Schist is vertical. It is highly crenulated with prominent development of puckers/asymmetric folds near Bagra. At south of Darka, boudinaged quartz veins due to shearing are observed in grey, yellow to reddish brown coloured ferruginized quartz mica schist.

Carbonaceous phyllite:

The carbonaceous phyllite (\pm graphite) is mainly exposed in the central and northern part of the block. Different bands of Carbonaceous Phyllites have been observed which are fine grained, dark grey to black in colour and presence of graphite is confirmed as it soils finger.

Limonitised zones are also observed in Carbonaceous Phyllite. Carbonaceous Phyllite is mainly associated with Quartz Mica Schist in the study area, but it is also associated as intercalation with Quartzite and Marble at few places like north of Pushidoke. The strike of the carbonaceous phyllite varies from NW-SE to NNE-SSW with dip easterly to southeasterly. At places, carbonaceous phyllite has minor silica veins (up to 1-2 cm) and also with iron leaching. **3 (Three) major Carbonaceous phyllite bands** have been identified and delineated in Angu block. At 1.4 km SW of Angu, 1st band has width of 60-70 m with strike extension of about 400 m (S1 varies N10°W to N20 ° E and dipping 32 to 34° towards ENE to SE). It is associated with Quartz mica Schist and grey phyllite.

At 2 km SW of Angu, 2nd band is with variable width of 60 m in north to 150-160 m in south with strike extension of about 700 m. It is also associated with Quartz mica Schist. At 1km NW of Angu, 3rd band has variable width of 200 m with strike extension of about 500 m (S1 varies from N32 ° E to N60 ° E and dipping 18 ° to 44 ° towards SE).

Quartzite (Schistose/Flaggy/ Banded):

It is exposed in eastern part of the proposed Angu block. It is grey to white in colour, fine to medium grained, well foliated. The strike of the quartzite varies from NW-SE to NNE-SSW with dip easterly to southeasterly. Schistosity in quartzite is defined by the deformed quartz grains and micaceous minerals in a parallel orientation. The banded quartzite exposed near SE of Darka village and near Pigi Muli village is grey to white in colour, hard and compact, fine to medium grained and is defined by alternate dark and light colour bands. The banded quartzite in the study area is characterized both by primary bedding and foliations in quartzite. The primary bedding in banded quartzite is characterized by compositional light and dark grey colour bands whereas the metamorphic banding is characterized by alternate quartz and mica rich bands. The alternate interbanding of Quartzite and Quartz mica Schist is also observed near SE of Darka village. A 1-2 m width zone of Mylonitic Quartzite is observed in it where there is presence of deformed quartz grains/ ribbons upto 2-5cm length along 2750 trend, which may be caused by flattening strain due to ductile deformation by a minor scale shear zone/ fault. Quartzite observed in central part near NW and SE of Angu village occur as bouldery outcrops which is medium to coarse grained, white colour. Mullion structure is observed in it which may be due to folding of the earlier foliation in quartzite. At few places quartz grains are very coarse grained giving sugary texture.

Quartz Veins:

Numerous quartz veins are observed in the study area. Quartz vein observed in northwest of Angu village is 20-25m thick, white in colour, very coarse grained, highly brecciated with angular grains

which indicates presence of a minor fault along the trend of quartz vein (100°) which crosscuts the quartz mica schist and carbonaceous phyllite units. Quartz vein observed in northeast of Angu is 30-40m thick, coarse grained and trends 045° direction. These indicate to be two separate generations of quartz veins.

1.4 Mineral potentiality based on geology, ground geochemistry etc.

On the basis of large-scale geological mapping and geochemical interpretation, 3 majors Carbonaceous Phyllite bands are reported in Angu village, covering an area of 3.51 sq km (Proposed block). The analytical results of vanadium and graphite established in these 3 majors carbonaceous phyllite bands are as follows:

MZ1: it consists of 3 Carbonaceous phyllite bands. The major band has 30 m width, 400 m strike extension on surface (**631 ppm V** with **FC of 4.75 %** in BRS, up to **1062 ppm V** with **10.6% FC** in channel sample, **up to 589 ppm V** in PTS).

MZ2: It consists of 2 carbonaceous phyllite bands. The major band has 30-60 m width, 700 m strike length on surface (154 ppm V with **2.12% FC** in BRS).

MZ3: 60 m width, 500 m strike extension (**709 ppm V** with **FC of 3.92 %** in BRS, up to **745 ppm V** with **5.6% FC** in Channel sample, **673 ppm V** in PTS).

Laser Raman spectroscopy (LRS) study of Graphite samples by GSI-

The LRS peaks 1579cm-1, 1582cm-1, 1580cm-1 represent the **flaky nature of graphite** (Neubeck, A., et al., 2020) and peaks 1581cm-1 and 1583cm-1 along with shoulder at 1623cm-1, 1618cm-1 and 1617cm-1 and smaller peaks 1365cm-1, 1355cm-1 and 1355cm-1 and represent **vein type graphite**.

Recommendations of previous G4 stage mineral exploration report-

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

- The carbonaceous phyllite of the Khetabari Formation in Angu area is vanadium and graphite bearing.
- Major Potential graphite mineralizations of the area are restricted in Angu area.
- The area can be upgraded for further work.

1.5 Objectives

The present exploration program (G3) has been formulated on the basis of the outcomes of previous work to fulfil the following objectives:

- Geological mapping on 1:5000 scale to delineate graphite bands and other lithological units in the area.

- Topographical Contouring on 1:5000 scales, by means of surface contouring at 2 m interval.
- Delineation of the potential subsurface mineralized zones by Geophysical Surveys (SP survey).
- Necessary Trenching to be carried out to expose the graphite bands.
- Exploratory drilling up to second level at 200 m strike interval for 1st level boreholes (30m vertical depth of intersection) and 2nd 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.

2 Previous Work:

GSI has submitted the geological report of G4 stage of investigation for Vanadium and graphite in Siku Angu and Lipu area of West Siang district, Arunachal Pradesh. The geological report is attached.

3 Block description

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

Table-2 Geo-coordinate of the proposed block		
Cardinal points	Latitude	Longitude
A	28.0692	94.7326
B	28.0694	94.7466
C	28.0508	94.7429
D	28.0464	94.7347
E	28.0464	94.7283
F	28.0568	94.7283

4 Planned Methodology

In accordance with the objectives set for preliminary exploration (G3 level of exploration) in Angu block, West Siang District of Arunachal Pradesh, geological mapping in 1:5000 scale, trenching, geophysical SP 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.

4.1 Topographic Surveying

Topography survey will be carried in the area (3.51 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.

4.2 Geological Mapping

Detailed geological mapping on 1:5000 scale in the area (3.51 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.

4.3 Core Drilling

4.3.1 Borehole plan:

In phase I, 1st level boreholes will be planned to investigate the depth persistence of graphite 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 graphite mineralization at 60 m vertical depth of intersection.

4.3.2 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.

4.3.3 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 graphite bands or lithological variation. 50 nos. would be analysed by ICPMS to ascertain the presence of other trace elements.

4.4 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.

4.5 Bulk Density Determination

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

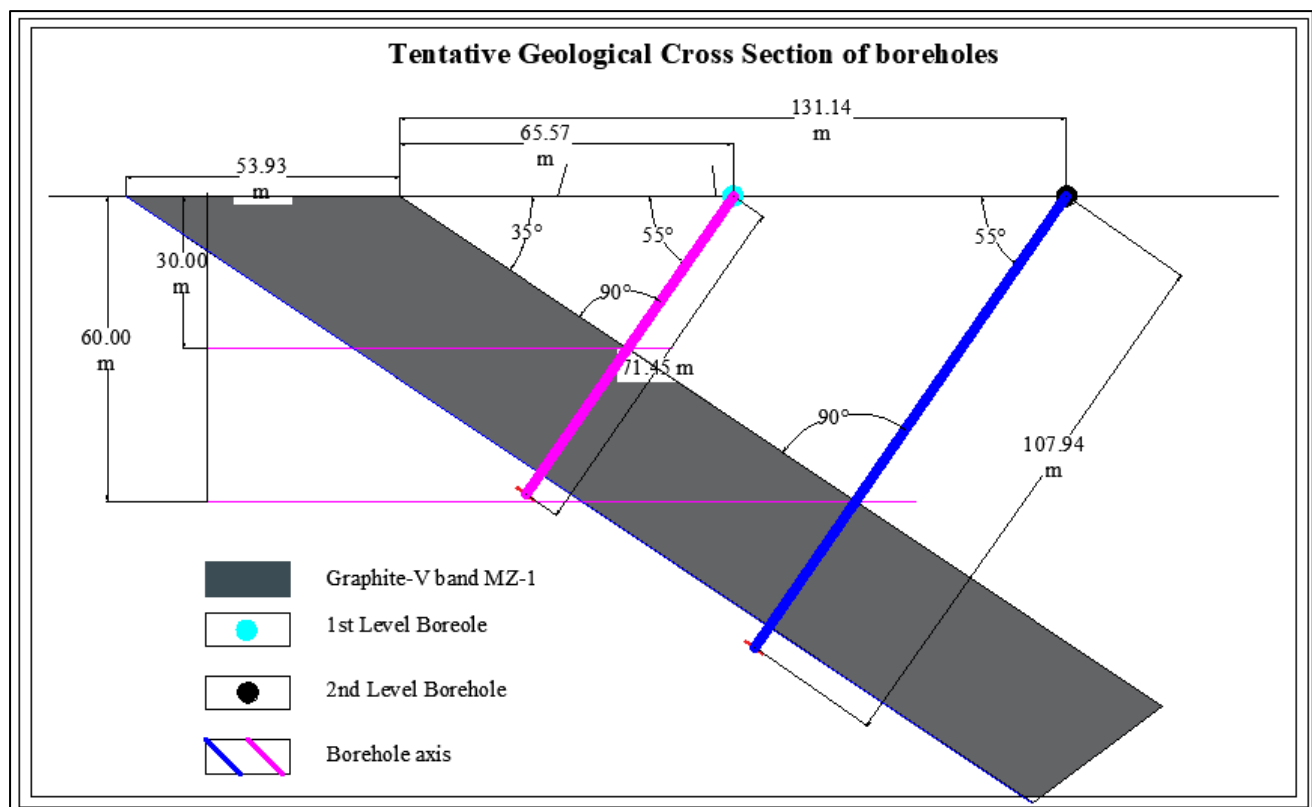
5 Nature Quantum and Target for G3 stage (Table-3)

S. No	Nature of Work	Unit	Tentative quantum to be proposed
1	Geological mapping (DM on 1:5000) (sq km)	sq km	3.51
2	Survey work-		
	a) Topographic survey- DGPS/ Total station/Drone	sq km	3.51
	b) DGPS survey for fixation of borehole and cardinal points	Point of observation	28
3	Geophysical survey (SP survey) (L.km)	L km	15
4	Technological		
	a) Surface Exploration- Trenching (cu. m)	Cu m	150
	b) Sub surface exploration – Drilling (m)	Per m	2000
5	Geochemical survey		
	a) Channel samples (groove samples) (nos.)	Nos.	50
	b) Trench samples (nos.)	Nos.	150
	c) Core samples (nos.)	Nos.	600
6	Petrographic/ mineralographic studies		
	a) Preparation of thin section	Nos.	10
	b) Ore microscopy of core samples (nos.)	Nos.	10
	c) Sp. Gravity/ Bulk density (nos.)	Nos.	5
7	Chemical analysis		
	a) Proximate analysis (BRS/Groove-50, Trench samples -150, Core- 600)	Nos.	800

S. No	Nature of Work	Unit	Tentative quantum to be proposed
	b) Proximate analysis (10% external check)	Nos.	80
	c) ICPMS analysis (REE/Trace elements with 10% external check)	Nos.	200+20=220
	d) Additional Trace Elements with 10% external check	Nos.	600+60
	e) Petrochemical studies	Nos.	10
8	TGC (Total Graphitic Carbon)	Nos.	100
9	Raman Spectroscopy	Hrs.	12

6 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 graphite mineralization. The 1st level borehole will be planned at 30 m vertical depth of intersection and 2nd level boreholes will be planned at 60 m vertical depth of intersection. The drilling will be performed in two phases. In phase I, 1st level boreholes will be drilled, and in phase-II, 2nd level boreholes will be drilled. So, 1st level = 71.35m x 11 = 784.85 m and 2nd level = 107.94 x 11 = 1,184.34 m. Total drilling meterage = 1,972.19 m or say 2,000m.



7 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).

Table-4 Time Schedule/Action Plan for preliminary exploration (G3 stage) in Angu block, West Siang district, Arunachal Pradesh under NMEDT																		
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 (SP survey) (L.km)			█														
5	Surface exploration-Trenching (cu. m)			█	█	█												
6	Bed rock samples (nos.)				█	█												
7	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) may be affected due to monsoon (April-October).

The breakup of expenditure is given in table 5.

8 List of Plates

Sl. No	Description
I	Boundary of proposed block on toposheet number 82L/12
II	Proposed block overlaid on Geological map of Siku Angu and Lipu block on 1:12500 scale
III	Geology of Proposed block
IV	Proposed tentative borehole location on map for the proposed block

9 Annexures-I

A field visit was made by a team of MMPL's geologist to Proposed Angu Block:

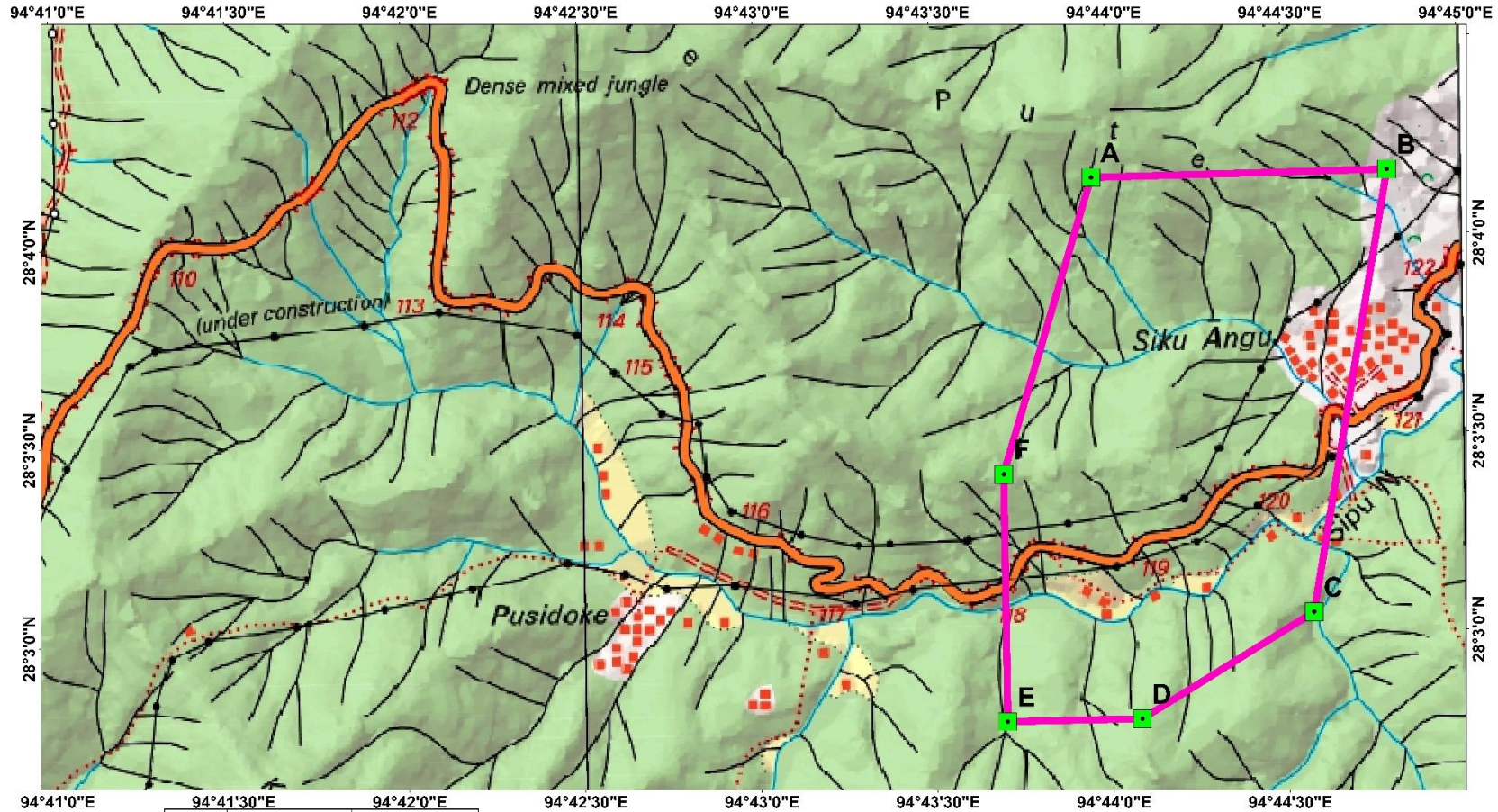
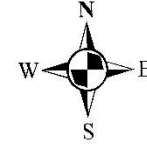
List of Field photographs taken during traverse by MMPL-

- a. Flaky graphite bands within Carbonaceous phyllites
- b. Flaky graphite bearing phyllites accompanied with layer parallel quartz veins
- c. Amorphous graphite bands alternating with kaolinized quartzo-feldspathic veins
- d. Graphite bands in ferruginised phyllite
- e. The graphite mineralization is accompanied by limonitic alteration in Phyllites
- f. Graphite bands within Carbonaceous phyllites trending North/25 due 90.

Location of Proposed Angu Vanadium & Graphite Block on SOI Toposheet No. 82L/12



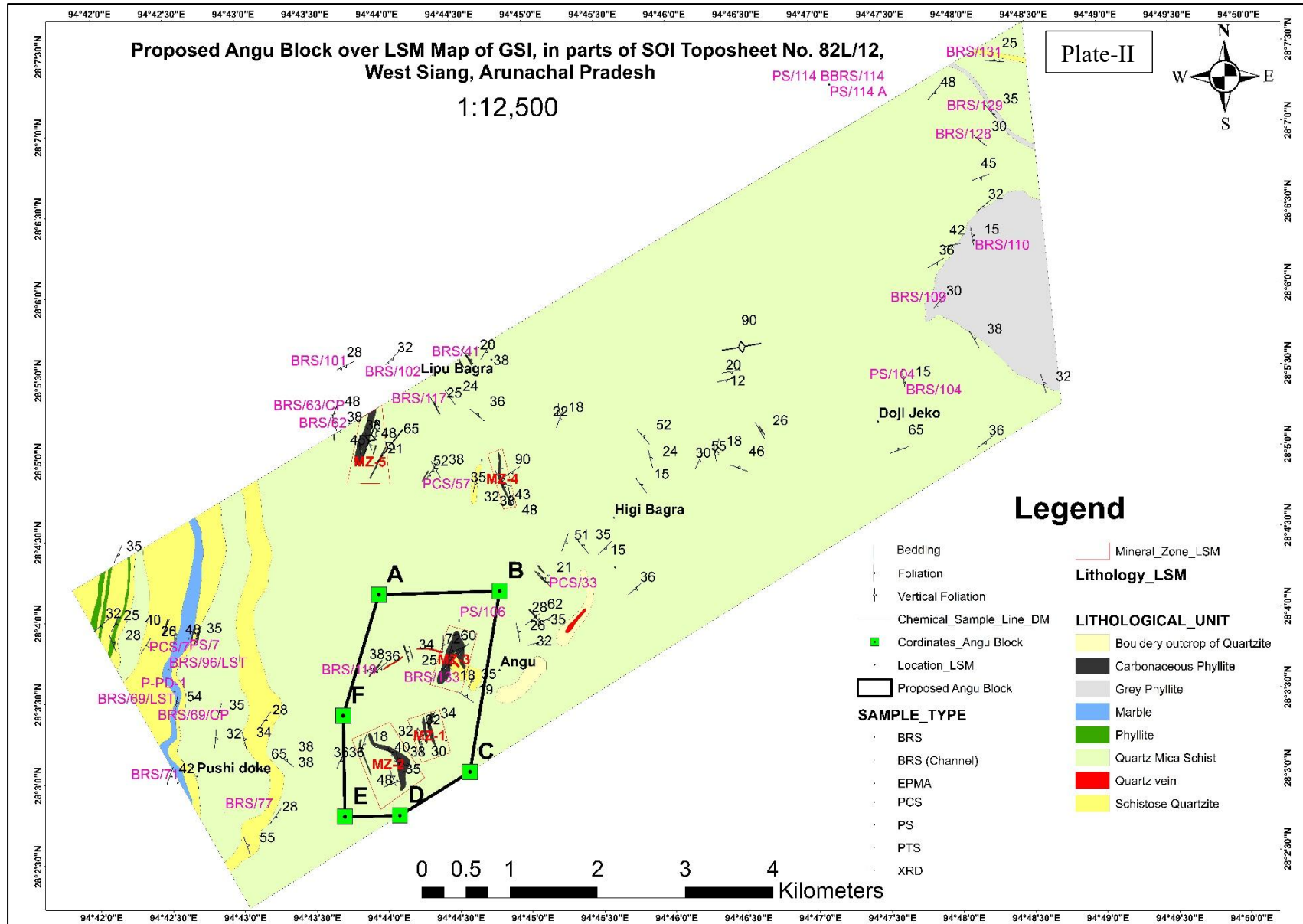
Plate-I

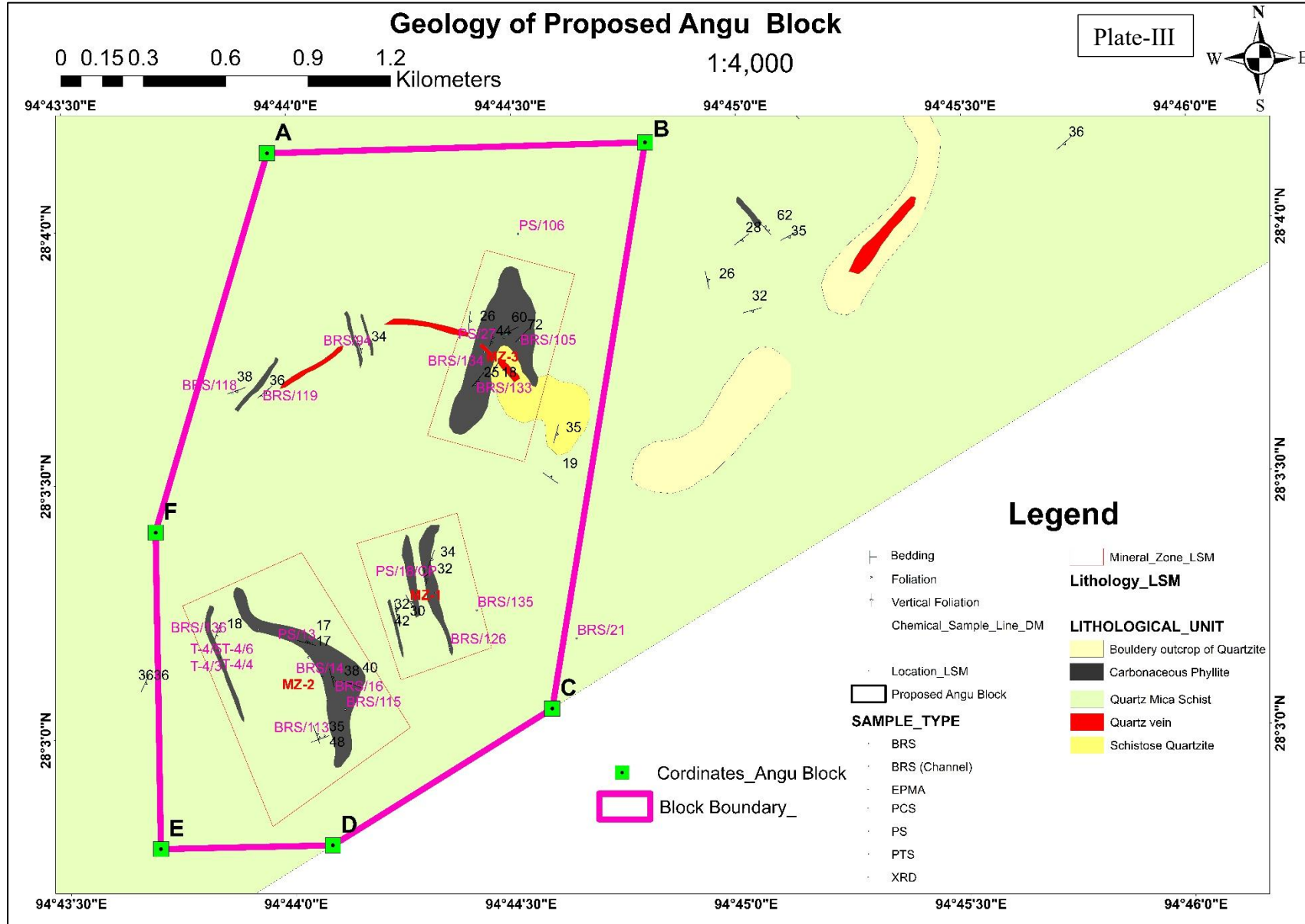


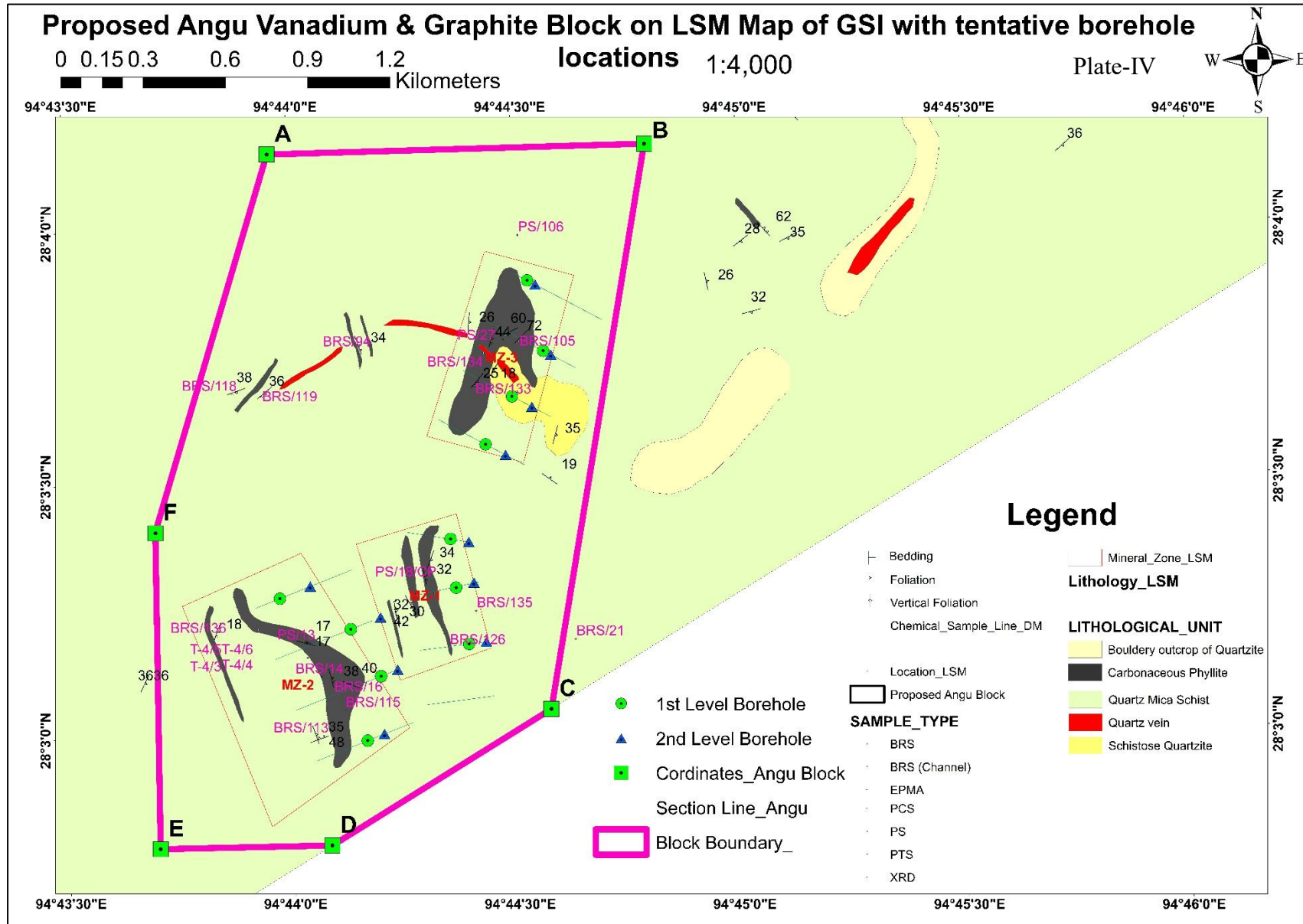
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D	28.0464	94.7347
E	28.0464	94.7283
F	28.0568	94.7283

Legend

- Cordinates_Angu Block
- Block Boundary_









Reference:

- **Deepanker, S. K., & Majhi, S. K. (2022–23).** Report on reconnaissance survey for vanadium and graphite mineralisation in the metasedimentary sequence of Bomdila Group of rocks in and around Siku Angu and Lipu, West Siang District, Arunachal Pradesh (G-4) (Toposheet Nos. 82L/12 and 82L/16; Item No. M2ASMIF-MEP/NC/NER/SU-ARA/2022/45285). Geological Survey of India.