PROPOSAL FOR PRELIMINARY EXPLORATION (G3 STAGE) FOR TIN IN KANGRA BLOCK (6.35 SQ. KM), TEHRI GARHWAL DISTRICT, UTTARAKHAND

COMMODITY: TIN

BY

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NAGPUR (MH)

PLACE: NAGPUR
DATE: 15.10.2024

Summary of the block for preliminary survey (G-3)
GENERAL INFORMATION ABOUT THE BLOCK

<table>
<tr><td></td><td>Features</td><td>Details</td></tr>
<tr><td></td><td>Block ID</td><td>Kangra Block</td></tr>
<tr><td></td><td>Exploration Agency</td><td>Mineral Exploration and Consultancy Limited (MECL)</td></tr>
<tr><td></td><td>Commodity</td><td>Tin</td></tr>
<tr><td></td><td>Mineral Belt</td><td>Higher Himalayan Crystalline Belt</td></tr>
<tr><td></td><td>Completion period with entire Time schedule to complete the project</td><td>15 months</td></tr>
<tr><td></td><td>Objectives</td><td>The present preliminary survey (G-3) has been formulated on the basis of the previous work done by MECL and GSI available geoscience data to fulfil the following objectives: -
i) To establish the strike and depth persistence of the tin mineralization identified during G-4 work.
ii) To carry out the large scale geological mapping (1:4,000) and closed space geochemical sampling in grid pattern of 100*200 meter. (bedrock/channel/pit).
iii) To carry out integrated geophysical survey i.e gravity and Magnetic to know the 3-dimension of the pegmatite’s bodies/quartz veins in subsurface.
iv) Based on the outcome of geological mapping, geophysical survey and geochemical sampling (Phase-1), 600m systematic drilling will be done in identified mineralised zone (phase 2).</td></tr>
<tr><td></td><td>Whether the work will be carried out by the proposed agency or through outsourcing and details thereof.
Components to be outsourced and name of the outsource agency</td><td>Work will be carried out by the proposed agency.</td></tr>
<tr><td></td><td>Name/Number of Geoscientists</td><td>Two nos. Geoscientist (1 Field + 1 HQ)</td></tr>
<tr><td></td><td>Expected Field days (Geology, Geophysics, Surveyor)</td><td>200 days (Field)
50 days (HQ)</td></tr>
<tr><td>1.</td><td>Location</td><td>The block proposed for exploration lies in the parts of Survey of India Toposheet No 53J/11 and is bounded by latitude 30°30'00.357" N to 30°28'36.240" N and longitude 78°40'18.078" E to 78°38'9.576" E. The area is 65km east of New Tehri town, the district headquarter and 10km east from Ghansali town.</td></tr>
<tr><td></td><td>Latitude & Longitude</td><td>
<table>
<tr><th>BB POINTS</th><th>LONGITUDE</th><th>LATITUDE</th><th>AREA</th></tr>
<tr><td>A</td><td>78° 38' 09.576" E</td><td>30° 29' 35.529" N</td><td rowspan="6">6.35 sq. km</td></tr>
<tr><td>B</td><td>78° 39' 29.455" E</td><td>30° 30' 00.357" N</td></tr>
<tr><td>C</td><td>78° 40' 18.078" E</td><td>30° 28' 45.977" N</td></tr>
<tr><td>D</td><td>78° 39' 34.782" E</td><td>30° 28' 10.157" N</td></tr>
<tr><td>E</td><td>78° 38' 56.259" E</td><td>30° 28' 36.240" N</td></tr>
<tr><td>F</td><td>78° 38' 09.895" E</td><td>30° 29' 25.944" N</td></tr>
</table>
</td></tr>
</table>

	Villages	Indwangaon, Kangra and Kyarki
	Tehsil/Taluk	Tehri
	District	Tehri Garhwal
	State	Uttarakhand
2.	**Area (hectares/ square kilometres)**	
	Block Area	6.35 sq. km
	Forest Area	It was checked in DSS portal and found as a "Go "area
	Government Land Area	Data not available
	Charagaha	Data not available
	Private Land Area	Data not available
3.	**Accessibility**	
	Nearest Rail Head	Rishikesh (155 Km via NH-7)
	Road	All the main localities are connected by all-weather motorable/ metalled road, besides these roads; there are many foot tracks to connect small localities of the area. The roads and tracks are not negotiable during winter and bad weather during monsoon. Landslides occur frequently during monsoon.
	Airport	Jolly Grant Airport, Dehradun (140 km via Risikesh-Chamba-Tehri Road)
4.	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	The Bal Ganga River is the major drainage channel in the area. The area is characterized by high drainage density and perennial streams. The perennial rivers are primarily fed by snow. However, during the dry seasons, the rivers are fed by ground water. The drainage pattern is mainly of sub-parallel type.
	Rivers/ Streams	Bal Ganga River
5.	**Climate**	
	Mean Annual Rainfall	The average annual rainfall (AAR) of the district is about 1600 mm. Rainfall varies from place to place. The southern slopes of the ridges experience more precipitation while less rainfall is noted on the northern slopes.
	Temperatures	The climate of the area varies from cold temperate, tropical to humid subtropical, the high reaches of the area experiences sub-zero temperature during the winter and pleasant in summer. Snowfall is common on higher altitudes during winter. The winter temperature (Nov-Feb) varies from sub-zero to 12ºC. The summer temperature (Mar-Oct) varies from 22º-30ºC.
6.	**Topography**	
	Toposheet Number	53J/11
	Morphology of the Area	Physiographically, the area represents a very rugged topography of the Higher Himalayas and characterized by high mountains and very deep valleys of river Bal Ganga. The prominent ridges are trending almost in north-south direction. The ground elevations of the area ranges from

		1160 to 2175 m above MSL. The ruggedness of the terrain is reflected by the presence of a number of peaks.
7.	**Availability of baseline geoscience data**	
	Geological Map (1:50K/12500)	Geological map on 1:12500 scale (Source: MECL)
	Geochemical Map	NGCM Map (Source: Bhukosh), Chemical analysis of Pokhar-Chhaili (G-4) Block (MECL)
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	-
8.	**Justification for taking up Reconnaissance Survey/ Regional Exploration**	I. The rocks of the major orogenic belts act as an ideal setting for Tin mineralization and the same is well reported across all the major orogenic belts. The proposed block falls within the Central Crystalline which is a part of the Himalayan orogenic belt. II. On the basis of the geochemical sampling done by GSI (FSP 2019-20) in toposheet no. 53J/11, the geochemical distribution pattern of Tin (Sn) shows anomalously higher concentration (12.04ppm to 185.16ppm) over granite gneisses of Bhilangana Formation (Central Crystalline Group) and quartzite of Nagnithank Formation (Lesser Himalaya) as well as over intrusive granitic bodies, near the Main Central Thrust (MCT). The mean Tin content in stream sediment is 8.83 ppm, with 85% of the samples have Tin (Sn) values higher than its crustal abundance (2.1 ppm). As the geochemical distribution pattern of Tin in north eastern part of the toposheet showed anomalous higher values, it was recommended that this area can be taken up for further investigation in terms of sampling for confirmation and if positive then it can be further enhanced in terms of geological exploration level. III. During reconnaissance survey (G4) MECL, the fifteen bedrock chip samples collected from Thati Kathur granite and associated tourmaline bearing pegmatite yielded tin value from 17 ppm to 15654 ppm. Out of fifteen samples, nine bedrock chip samples of Thati Kathur granite and associated tourmaline bearing pegmatite & tourmaline-quartz rosette yielded anomalous higher concentration tin (Sn) value from 100.03 ppm to 15654 ppm, tungsten (W) value from 11.90 ppm to 25.67 ppm, niobium (Nb) value from 5.15 ppm to 17.97 ppm, tantalum (Ta) value from 0.6 ppm to 1.96 ppm, streams sediments yield tin value from 11.06 ppm to 28.98 ppm and soil samples collected from B&C horizon yield tin value from 15.15 ppm to 26.17 ppm respectively. The chemical analysis of Thati Kathur granite and associated pegmatite indicates its stanniferous nature (Khin Zaw,1990). Tourmaline nodule (a leucocratic rim of quartz or feldspar surround the rounded or elliptical tourmaline crystal core in granites acts as an excellent indicator for Tin occurrences. Such examples are ubiquitous across the globe (San Rafael Sn-Cu deposit,

		Southeastern Peru, Cape Granite Sn-Zn-W mineralization Suite, South Africa, Xuebaoding W-Sn-Be Deposit, Sichuan Province, China etc.). On the basis of above anomalous higher concentration tin values in bedrock chip samples, potential area in and around Indwangaon, Kangra and Kyarki village were identified. Considering anomalous higher concentration of tin values in bedrock chip samples & geological set up potential area in and around Indwangaon, Kangra and Kyarki village are promising. Hence, MECL proposed to take up preliminary survey (G-3) i.e. large-scale geological mapping (1:4,000), closed space sampling in grid pattern, chemical analysis work for tin mineralisation and Geophysical Survey in Phase -1 and after the outcome of phase -1, systematic drilling of 600m will be done in Phase -2.

PROPOSAL FOR PRELIMINARY SURVEY (G-3 STAGE) FOR TIN IN KANGRA BLOCK (6.35 SQ. KM), TEHRI GARWAL DISTRICT, UTTARAKHAND

1.0.0 INTRODUCTION

1.1.0 General

Tin is one of the earliest metals known and used mainly in bronze implements. It is a scarce element having an incidence of about 2 ppm in the earth's crust. Its unique combination of properties like non-toxic nature, high malleability, chemical inertness and ease with which it can form an amalgam and alloy with other metals has given it a special status among non-ferrous metals. Pure tin is a silvery-white metal which is soft and malleable. It does not occur naturally as metal. By far, the most important tin mineral is cassiterite (SnO_2), which theoretically, in its purest form contains 78.77% tin. But usually it includes impurities of Nb, Ta, Zr, Sc, W and Fe. The less common tin ore is stannite (Cu_2SnFeS_4). Tin is now used mostly for tin plating, soldering special alloys and in making bronze.

In India, tin ore occurrence in primary as well as secondary forms have been reported from Bihar, Chhattisgarh, Haryana, H.P, Rajasthan, J&K, Karnataka, Odisha and West Bengal. However, the only workable economic deposit in the form of alluvial or placer deposit occur in Bastar and Dantewada district of Chhattisgarh.

The total reserves/resources of tin ore in the country as per NMI data, based on UNFC system as on 1.4.2015, is placed at 83.73 million tons containing about 1,02,413 tons metal within which about 4,419 tons ore containing 154 tons metal are placed under 'Reserves' category and the bulk, i.e., about 83.72 million tons containing about 1,02,259 tons metal are placed under 'Remaining Resources' category. As per DMG Chhattisgarh, the total recoverable reserves of cassiterite concentrate are 19,544.58 tons in Tongpal area, Katekalyan area and Padapur-Bacheli area. Out of 19,544.58 tonnes,18,837.16 tons are placer deposit. The entire resources of tin are located in Chhattisgarh and Haryana. About 64% of the total ore/metal resources are located in Haryana and 36% in Chhattisgarh, while nominal resources are located in Odisha.

Cassiterite which was reported in Dantewada district (Bastar district in formerly Madhya Pradesh) by the Directorate of Geology and Mining and was found being associated with

the lepidolite-bearing pegmatites. However, in Govindpal-Tongpal area of Dantewada district, Chhattisgarh, tin in the form of cassiterite is being mined from the sediments deposited in the streams. The stream sediments are dug manually with conventional implements. Subsequent panning of these sediments helps in separating the lighter gangue minerals, while the heavier part is recovered as cassiterite. Chhattisgarh is the only tin producing State in India.

During the recent past no large-scale deposit for Tin and associated minerals has been discovered in India. Moreover, the possibility of working of small mineral bodies in proximity to each other, through technological advances and increased operational efficiency cannot be ruled out. Therefore, it is necessary and imperative to locate and explore further potential areas for Tin mineralisation.

1.2.0 Location & Accessibility of the Area

The block proposed for exploration lies in the parts of Survey of India Toposheet No 53J/11 and is bounded by latitude 30°30'00.357" N to 30°28'36.240" N and longitude 78°40'18.078" E to 78°38'9.576" E. The area is 65km east of New Tehri town, the district headquarter and 10km east from Ghansali town. All the main localities are connected by all-weather motorable/ metalled road, besides these roads; there are many foot tracks to connect small localities of the area. The roads and tracks are not negotiable during winter and bad weather during monsoon. Landslides occur frequently during monsoon. Jolly Grant Airport, Dehradun is the nearest airport which is situated at about 140 km from the proposed block and Rishikesh is the nearest railway station which is about 165 km away.

1.3.0 Physiography, Drainage and Vegetation:

Physiographically, the area represents a very rugged topography of the Higher Himalayas and characterized by high mountains and very deep valleys of river Bal Ganga. The prominent ridges are trending almost in north-south direction. The ground elevations of the area ranges from 1160 to 2175 m above MSL. The ruggedness of the terrain is reflected by the presence of a number of peaks

The Bal Ganga River is the major drainage channel in the area. The area is characterized by high drainage density and perennial streams and rivers. The perennial streams and

rivers are primarily fed by snow. However, during the dry seasons, the rivers are fed by ground water. The drainage pattern is mainly of sub-parallel type.

The area is occupied by mixed tropical forests throughout its extent however along the main drainage course agricultural land occurs. Hilly terrains are very much covered with different floral species. The important deciduous floral species are *Moru Oak (Quercus dilatata),* Kharsu*(Quercus semecarpifolia),Banj (Quercus leucotrichophora),*Burans (*Rhododendron arboretum*, Kaphal (*Myrica esculenta)*Sal (Shorearobusta), Mahua (Madhulikalatifolia), Tendu (diospyros melanoxylon), Amla (Emblicaofficivalis), Mango (Mangifera pyros indica), Jamun (Eugenia jambolana), Saja (terminalia tomentosa) and Bel (aeglemarmeto). The coniferous forests in this zone are Chir Pine (*Pinus roxburghii),* Kali Pine (*Pinus wallichiana*), Chilgoza pine (*Pinus gerardiana)* and Deodar, Cedar (*Cadres deodar*a), Fir (*Abieispindrow, abiesspectabillis)* places give a pristine look to the slopes.

1.4.0 Previous Work

Srivastava V.K. & Rajan T.N. (1966-67) carried out mapping in parts of Tehri and Uttarkashi district on 1:50,000 scale, covering an area of 220 sq km. The area represents three distinct tectonic units namely i) Garhwal Group of rocks, ii) Gangi Kedarnath crystalline unit, and iii) Bhilangana crystalline unit, separated from each other by tectonic Main Central Thrust (MCT) contacts. The Garhwal tectonic unit represents the autochthon, which forms the basement for the overridden Central Himalayan Crystalline Group of rocks

Sinha P.K & Das D.P (1974) carried out detail studies in parts of Tehri district, Uttar Pradesh on 1:50,000 scale covering an area of about 315 sq. kms. According to them, Central Himalayan Thrust demarcates the boundary between the “Central Crystallines” and the Garhwal Group in the Mandakini-Balganga sector.

According to Rao, P.N. (1978), the contact of undifferentiated crystalline rocks of the Bhilangana Formation with metasedimentary rocks of Ghansali Formation (≡ Berinag Formation) along a thrust plane (“Thayeli Thrust”) represents MCT in the study area.

Chauhan D.S et.al. (2013) carried out specialized thematic mapping to establish tectonostratigraphy and tectonic setting between Bhilangana Formation and Crystalline

Group. They described that crystalline rocks of Bhilangana Formation override the sedimentary/ meta-sedimentary rocks of Garhwal Group along a thrust plane which has been correlated with MCT. The Bhilangana Formation is a part of Central Crystalline Group. The chemical signatures of the granite gneiss of Bhilangana Formation and Central Crystalline reveal its per-potassic, per-aluminous in nature and S-type granite.

During FS 2019-20 geochemical mapping was carried out by GSI in toposheet no. 53J/11 falling in parts of Tehri Garhwal district of Uttarakhand as a part of National Geochemical Mapping Program (NGCM).

A total of 665 sq. km area in toposheet no. 53J/11 was geochemically mapped with collection of 168 nos. of composite stream sediment/slopewash samples,9 nos. of soil C horizon and regolith sampling each. The stream sediments/slopewash samples were made to pass through a -120 mesh size sieve so as to prepare 500 grams of unit cell sample. A total 168 nos. of composite samples were prepared by coning and quartering of four adjacent unit cell samples. Apart from this, 09 nos. each of soil regolith and C-horizon samples were collected.

Based on the analytical results geochemical distribution maps and contour maps the concentration of trace elements does not show any promising occurrences in the study area, though many elements show their abundance more than their crustal abundance. All REEs and Hf, Ta, U shows chemical coherency and relatively enrichment towards the north-eastern corner of the toposheet over granite gneiss of Bhilangana Formation of Central Crystalline Group. The geochemical distribution pattern of tin in north eastern part of the toposheet showed anomalous higher concentration (12-185 ppm) than its crustal abundance (2.1ppm). The tin anomalous area can be taken up for further investigation in terms of duplicate sample analysis for confirmation. If there is any positive signature, it can be taken up for large scale mapping and orientation survey etc.

Mineral Exploration and Consultancy Limited (MECL) has carried out G4 level exploration with large scale geological mapping, bed rock chip samples, stream sediment and soil sampling in Pokhar Chhaili block and identified potential area for tin mineralisation. During the LSM it is observed that the tin mineralisation is hosted in Thati

Kathur granite and associated tourmaline bearing pegmatite & tourmaline-quartz rosette. The tourmaline bearing pegmatite veins in Thati Kathur granite are varying in dimension from 1-2m width to 8-10m in length nearby Indwangaon, Kangra and Kyarki villages. Very small multiple quartz veins were also seen at many places in the block. The fifteen bedrock chip samples collected from Thati Kathur granite and associated tourmaline bearing pegmatite yielded tin value from 17 ppm to 15654 ppm. Out of fifteen samples, nine bedrock chip samples of same lithology yielded anomalous higher concentration tin (Sn) value from 100.03 ppm to 15654 ppm, tungsten (W) value from 11.90 ppm to 25.67 ppm, niobium (Nb) value from 5.15 ppm to 17.97 ppm, tantalum (Ta) value from 0.6 ppm to 1.96 ppm, streams sediments yield tin value from 11.06 ppm to 28.98 ppm and soil samples collected from B&C horizon yield tin value from 15.15 ppm to 26.17 ppm respectively

1.5.0 Regional Geology

The proposed study area falls in the Central Crystalline of Higher Himalayan. The evolution of Himalaya is a result of continent-continent collision between Indian and Eurasian plates during tertiary time. The major structural features associated with the Himalaya from south to north are Himalayan Frontal Thrust (HFT), Main Boundary Thrust (MBT), Main Central Thrust (MCT), South Tibetan Detachment (STD) and Indo-Tsang Po Suture Zone (ITSZZ). These structural features mark the southern boundary of Sub- Himalaya, Lesser Himalaya, Higher Himalaya, Tethys Himalaya and Trans-Himalaya, respectively (Heim and Gansser, 1939; Valdiya, 1980).

The Garhwal Group of rocks is subdivided into three Formations viz. the Rautgara Formation, the Pithoragarh Formation and the Berinag Formation. The Central Crystallines of Higher Himalayan rocks are subdivided into Bhilangana Formation, Munsiyari Formation which is equivalent to the Helang Formation and Mana Formation of Palaeoproterozoic age. In the present study area Quartzite & Metabasic rock of Berinag Formation which is equivalent to Nagnithank Formation and Thati Kathur granite & granite gneiss of Bhilangana Formation is present.

The stratigraphic succession in the area is presented as follows:

Table 1: Generalized tectono-stratigraphy of the study area (Adopted from GSI Published maps, Chauhan et. al. 2013.)

<table>
<tr><th>Age</th><th>Group</th><th>Formation/Complex</th><th>Member</th><th>Lithology</th></tr>
<tr><td rowspan="6">Palaeoproterozoic</td><td rowspan="6">(North)

Central Crystalline Group</td><td>Helang Formation</td><td></td><td>Garnet- mica schist, granite gneiss, biotite schist, psammitic gneiss, graphitic schist, crystalline limestone, quartzite and amphibolites</td></tr>
<tr><td colspan="3">Panwali/Buddha Kedar/Munsiari/Jutogh Thrust (MCTII)</td></tr>
<tr><td rowspan="2">Bhilangana Formation</td><td>Pokhar</td><td>Monotonous sequence of biotite granite gneiss (porphyroblastic) with bands of sericite-quartz schist, and amphibolite</td></tr>
<tr><td>Guttu</td><td>Monotonous sequence of biotite granite gneiss (porphyroblastic) with bands of sericite-quartz schist +talc+chlorite, schistose quartzite with occasional tourmaline bearing gneiss, rare limestone and amphibolite</td></tr>
<tr><td colspan="3">Bhilangana/Thayeli Thrust (MCT I)</td></tr>
<tr><td>Mesoproterozoic</td><td>Garhwal

(South)</td><td>Nagnithank/Berinag Formation</td><td></td><td>Quartzite, Quartz arenite, slate and basic metavolcanics</td></tr>
</table>

Description of various rock formations in the proposed Area:

Garhwal Group: Rocks of the Garhwal Group are well developed in the northern part of the proposed area and shows rock formation of Nagnithank Formation. They are exposed in the southern part of the area along the Balganga river section.

Nagnithank Formation: This is well developed lithounit in the study area covering a vast stretch from east to west in southern part of the area, all the prominent peaks in southern part of the area are composed of this quartzite. It is exposed in Balganga river valley section, in the north it is bounded by Bhilangana/Thayeli Thrust (MCT I) which separates it from the Central Crystalline Group of rocks. Nagnithank Formation comprises of quartzite with associated metabasics rock of Meso-Proterozoic age. The general trends of these rocks are N50°W-S50°E to N10°W-S10°E with 45-55° dip in NE or SW directions. The prominent sets of joints are NW-SE with steep to vertical dips in SW direction, N 25°E-S 25°W with 70°-80° dip on either side.

Meta-basic rocks: Meta-basic rocks in the area are represented by extrusive as well as intrusive phases. The intrusive phase is represented by dolerite dykes, which has profusely intruded into quartzite. These are massive to weakly foliated, medium to coarse grained. At some places, feldspar porphyroblasts have developed in it.

Central Crystalline Group: The Bhilangana Formation, the crystalline unit, exposed in the study area. The rocks of Bhilangana Formation are thrusted over the low-grade rocks of Lesser Himalaya (Nagnithank Formation of Garhwal Group) along the Main Central Thrust (Thayeli/Bhilangana Thrust).

Thati Kathur Granite

This intrusive granite body lies at the contact of quartzite of Garhwal Group and rocks of Bhilangana Formation. It is exposed east of Chamiyala and in and around Kangra village It is dominantly composed of quartz, feldspar, biotite and tourmaline. The granite has developed some crude foliation defined by parallel alignment of biotite, yet retaining the igneous texture at several places. The granite at some places is intruded by multiple small tourmalines bearing pegmatite veins. The tourmaline bearing pegmatite veins in Thati Kathur granite are varying in dimension from 1-2m width to 8-10m in length nearby Indwangaon, Kangra and Kyarki villages The occurrence of tin mineralization is observed in Thati Kathur granite and associated tourmaline bearing pegmatite, tourmaline-quartz rosette and quartz veins. The presence of tourmaline, quartz, chlorite, biotite, high felspar, zircon, tourmaline-quartz rosette, tourmaline nodules and specks of cassiterite in

pegmatite associated with Thati Kathur granite also indicates that it has gone under hydrothermal alteration. The presence of tourmaline and tourmaline-quartz rosette and tourmaline nodules in granite-related Sn-W hydrothermal systems is attributed to the high boron concentration in peraluminous felsic magmas. Boron-rich fluids play a significant role, leading to post-magmatic replacement and metasomatic alteration of the host rocks (Balen, et. al. 2011& Rozendaal, et. al. 1995). The chemical analysis of Thati Kathur granite and associated pegmatite indicates its stanniferous nature (Khin Zaw,1990).

Photo 1: Field photograph showing exposure of Thati Kathur granite with tourmaline & specks of sulphides west of Kangra village.

Photo 2: Tourmaline-nodule with K-feldspar megacrysts, North of Kangra Village

Photo 3: Photograph showing tourmaline, iron oxide in bedrock chip samples MPCH/BR/45.

Photo 4: Photomicrograph (MPCH/BR/45) showing very fine segregation of cassiterite as seen under reflected light. Magni : 200X

2.0.0 Proposed programme for Exploration

Mineral Exploration and Consultancy Limited (MECL) has carried out G4 level exploration with large scale geological mapping, bed rock chip samples, stream sediment and soil sampling in Pokhar Chhaili block and identified potential area for tin mineralisation in and around Indwangaon, Kangra and Kyarki villages. The fifteen bedrock chip samples collected from Thati Kathur granite and associated tourmaline bearing pegmatite yielded tin value from 17 ppm to 15654 ppm. Out of fifteen samples, nine bedrock chip samples of same lithology yielded anomalous higher concentration tin (Sn) value from 100.03 ppm to 15654 ppm, tungsten (W) value from 11.90 ppm to 25.67 ppm, niobium (Nb) value from 5.15 ppm to 17.97 ppm, tantalum (Ta) value from 0.6 ppm to 1.96 ppm, streams sediments yield tin value from 11.06 ppm to 28.98 ppm and soil samples collected from B&C horizon yield tin value from 15.15 ppm to 26.17 ppm respectively. The tin occurrences in and around Indwangaon, Kangra and Kyarki villages warrant further detailed investigation.

3.0.0 Objective of the proposed exploration work:

The present preliminary survey (G-3) has been formulated on the basis of the previous work done by MECL and GSI available geoscience data to fulfil the following objectives:

i) To establish the strike and depth persistence of the tin mineralization identified during G-4 work by MECL.

ii) To carry out the detailed geological mapping (1:4,000) and closed space geochemical sampling in grid pattern (bedrock/channel/pit).

iii) To carry out integrated geophysical survey i.e gravity and magnetic to know the 3-dimension of the pegmatite's bodies/quartz veins in subsurface.

iv) Based on the outcome of geological mapping, geophysical survey and geochemical sampling (Phase-1), 600m systematic drilling will be done in identified mineralised zone (phase 2).

4.0.0 Methodology of Proposed Exploration

The exploration shall be carried out as per Mineral (Evidence of Mineral Contents) Rule-2015 and Mineral Auction Rules-2015. The details of various activities to be carried out are presented in subsequent paragraphs.

4.1.0 Geological Mapping: Geological mapping will be carried out on entire 6.35 sq km area in 1:4000 scale. Rock types, their contact, structural features will be mapped. Surface manifestations of the ore bodies available along with their surface disposition will be marked on map.

4.2.0 Geochemical Sampling

Surface Sampling (Bed Rock/ Channel/ Pitting/trenching): During the course of Geological mapping the Bed rock, pitting samples shall be collected in 100*200m grid pattern from the mineralised/potential area. Total 300 primary samples will be collected for analysis by ICPMS. Total 45 Check samples (5% internal + 10% External) will be analyzed for the same.

4.3.0 Geophysical Survey: On the basis of above properties, Integrated Geophysical Surveys i.e. Gravity and Magnetic have been planned to carry out in the potential area marked by geological mapping. The Approximate time period to conduct the survey will be around 3 months.

4.3.0 Topographic Survey: The triangulation network would be laid down in the block area with the help of DGPS & Total Station and the same would be tied up with the GTS triangulation station present in the nearby area. Topographical survey will be carried out in the block area in which G-3 stage of exploration is to be carried out. All the surface features will be picked up and marked on a map on 1: 4000 scale. The block boundary will be surveyed by DGPS & total station in WGS-84 Datum for demarcation of Block Boundary points.

4.4.0 Core Logging: Geological core logging will be carried out systematically by recording carefully the minute details and physical/lithological characters of the rock formations including colour, core recovery, grain size, weathered zone, texture, banding, mineralogical composition, micro-structural/structural details, lithological variations along with of tin ore in boreholes

4.5.0 Core Drilling: The present exploration scheme will be prepared after the Phase -1 outcome and TCC review by proposing 10 nos of vertical/inclined boreholes based on the geological mapping, bed rock chip/channel/pit sampling and geophysical survey carried out in Phase-1 exploration programme.

4.6.0 Core Sampling: For preparation of samples, the borehole core will be splitted into two equal halves by using core splitter. One half will be powdered to (-) 200 mesh size and the other half will be kept for future studies. The powdered material will be mixed thoroughly and about 100 gram of samples will be taken for chemical analysis by successive coning and quartering as primary samples and rest of the material (-200 mesh size) will be kept as duplicate half for future reference. It will generate about 120 Nos. primary samples and 12 nos. check samples (10%External check of Primary samples). The sample length towards the floor marked by non-mineralised zone also needs to be adjusted as per variations of the litho-units. Even if the floor is distinctly differentiated by the presence of non-mineralized zone, at least 3 nos. samples before and after the mineralized zone need to be drawn to mark the floor of the non-mineralized zone decisively.

4.7.0 Specific Gravity: 06 nos. samples from drill core of mineralised zone from the boreholes will be subjected to specific gravity determination at MECL petrology laboratory by Walker steel yard balance method. This will be used for resource estimation.

4.8.0 XRD analysis: 20 nos. of samples from surface and drill core of mineralised pegmatite/quartz veins will be subjected to XRD analysis for crystalline phase identification within rocks, which is essential to understanding their mineralogy, chemistry, and formation conditions.

4.9.0 SEM analysis: 05 nos. of samples from surface and drill core of mineralised pegmatite/quartz veins will be subjected to SEM analysis to know the chemical composition of different tin mineral phase present in the rock and textural relations between metallic and silicate minerals through high resolution back scattered electron imaging.

4.10.0 Petrological & Mineralogical Studies:

During the course of Geological mapping 05 samples from various litho units from surface will be studied for petrography. 10 samples will be taken up from mineralized zones and will be studied for the ore mineral assemblages and their distribution, alteration, enrichment etc in polished sections.

5.0.0 Quantum of work

The quantum of work proposed by MECL in Kangra block is given in the Table below.

Sl. No.	ITEMS OF WORK	UNIT	Proposed Quantum for Kangra Block
			G-3
1	Geological Mapping (1:4000 scale)	Sq. Km	6.35
2	Topographic Survey (5m contour interval)	Sq. Km	6.35
3	Borehole fixation and Block boundary DGPS Survey	Nos.	16 (10 Bhs + 6 Boundary points)
4	Drilling (Core)	m.	600 (10 Bhs)
5	Geochemical Samples & Core samples (Primary + Check) for 34 Elements by ICPMS	Nos.	420
6	Check Samples (10%) for 34 Elements by ICPMS	Nos.	42
7	Petrography (05) and Mineragraphy (10)	Nos.	15
8	Specific Gravity	Nos.	6
9	XRD Analysis	Nos.	20
10	SEM analysis	Nos.	05
10.0	Gravity and Magnetic survey	Nos.	1000
10	**Exploration Report [As per Mineral (Evidence of Mineral Contents) Rule-2015] /UNFC**	Nos.	1
	The 2nd Phase of work to be decided after review of Geological Mapping, Geochemical Sampling/Channel/Geophysical		

6.0.0 Manpower Deployment

Manpower deployment List will be provided later.

7.0.0 Time schedule and Cost estimates

The proposed exploration programme is planned for G-3 Level.

The proposed time schedule:

PRELIMINARY SURVEY (G-3 STAGE) FOR TIN IN KANGRA BLOCK (6.35 SQ.KM AREA) DISTRICTS- TEHRI GARHWAL, UTTARAKHAND																		
			1	2	3	4		5	6	7	8	9	10	11	12	13	14	15
1	Camp setting	Month																
2	Geologist days (Field)	Month																
3	Sampling days, core sampling	Party days																
4	Geophysical Survey																	
5	Core drilling (2 rig)	Party days																
6	Camp winding																	
7	Laboratory studies	Month																
8	Geologist days (HQ)	Month																
9	Report writing/ Peer review	Party days																
	* Commencement of project will be reckoned from the day the exploration acreage is available along with all statutory clearances.																	
	*Time loss on account of monsoon/agricultural activity/forest clearance/local law and order problems will be addition to above time line.																	

Review

8.0.0 Cost estimates:

The Project cost with provisional escalation is estimated at **Say. Rs. 883.38 Lakh** in G-3 level of exploration**.** The cost has been estimated based on actual schedule of rates mandated in the circular on 61/1/2018/NMET dated 31st March 2020 for propositional projects of MOM, which is Rs. 883.38 Lakh. The detail of item wise cost estimate is given in the summary Table.

Summary of Cost Estimates:

Sl. No.	Item	Total Estimated Cost (Rs.)
1	Geology and Survey Work	1,30,93,168
2	Excavation	6,69,330
3	Geophysical Survey	1,91,60,856
4	Drilling	3,54,20,220
	Sub total	**6,83,43,574**
5	Laboratory Studies	38,24,327
6	Report	21,65,037
7	Peer Review	30,000
8	Proposal Preparation	5,00,000
	Total	**7,48,62,938**
9	GST (18%)	1,34,75,329
Total cost including 18% GST		**8,83,38,267**
SAY, in Lakhs		**883.38**

Details and breakup of the cost estimation proposed:

COST ESTIMATE FOR PRELIMINARY SURVEY (G-3 STAGE) FOR TIN IN KANGRA BLOCK (6.35 SQ.KM AREA) DISTRICTS-TEHRI GARHWAL, UTTARAKHAND
Total Area - 6.35 sq. km; Completion Time - 15 Months

S.N	Item of Work	Unit	Rates as per NMET SoC 2020-21			Estimated Cost of the Proposal		Remarks
			SoC-Item -Sl No.	Rates as per SoC	Additional Rate for Exploration work in remote and inaccessible terrain in North Eastern States and Himalayan terrain (3.35 times higher than the normal SoC)	Qty.	Total Amount (Rs)	
1	**Geology & Survey**							
1.1	Geologist man days (1 No.) for geological map & Report (HQ)	day	1.3	9,000		50	4,50,000	
1.2	Geologist (Field) man days for core logging/mapping/	day	1.3	11,000	36,850	200	73,70,000	

	Sampling/topographic survey							
1.3	Unskilled Labour (Field) (2 workers per geologist)	day	5.7	526	1,762	400	7,04,840	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
1.4	Survey Party Days for topographic survey	days	1.6.1a	8,300	27,805	60	16,68,300	
1.5	Unskilled Labour (Survey) (4 workers per Surveyer)	Days	5.7	526	1,762	240	4,22,904	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
1.6	Sampling man days - Sampler, Labour charge not included	day	1.5.2	5,100	17,085	60	10,25,100	
1.7	4 labours/ party (Rs 526/day/labour) (As per rates of Central Labour Commissioner) for sampling work	day	5.7	526	1,762	240	4,22,904	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
1.8	Determination of co-ordinates and Reduced Level (RL) of boreholes by DGPS including boundary	Nos.	1.6.2	19,200	64,320	16	10,29,120	Boreholes 10 Nos. + Block Boundary 06 Nos.

	corner points.							
	Sub-Total 1						**1,30,93,168**	
2	**Excavation**							
2.1	Pitting/Trenching (upto 2m)	Cu.m	2.1.1	3,330	11,156	60	6,69,330	
	Sub-Total 2						**6,69,330**	
3	**Geophysical Survey**							
3.1	Magnetic-Gravity Survey	Per Station	3.1b	4,500	15,075	1,000	**1,50,75,000**	
3.2	Charges for one Geophysicist per day at field	day	3	11,000	36,850	90	**33,16,500**	
3.3	Charges for one Geophysicist per day at HQ	day	3	9,000		15	**1,35,000**	
3.4	4 labours/ party (Rs 526/day/labour) (As per rates of Central Labour Commissioner)	day	6	526	1,762	360	**6,34,356**	
	Sub-Total 3						**1,91,60,856**	
4	**Drilling**							
4.1	Drilling -hard rock (up to 300m)	m	2.2.1.5a	12,650	42,378	600.00	2,54,26,500.00	
4.2	Land / Crop Compansation (in case the BH falls in agricultural Land)	per BH	5.6	20,000	67,000	10.00	6,70,000.00	As per actual
4.3	Construction of concrete Pillar	per borehole	2.2.7a	2,000	6,700.00	10.00	67,000.00	

	(12"x12"x30")							
4.4	Transportation of Drill Rig & Truck associated per drill (for 2 rig)	Km	2.2.8	36	120.60	5,200.00	6,27,120.00	2600 Km to and fro for one rig
4.5	Monthly Accomodation Charges for drilling Camp (up to 2 Rigs)	month	2.2.9	50,000	1,67,500.00	6.00	10,05,000.00	
4.6	Drilling Camp Setting Cost	Nos	2.2.9a	2,50,000	8,37,500.00	2.00	16,75,000.00	
4.7	Drilling Camp Winding up Cost	Nos	2.2.9b	2,50,000	8,37,500.00	2.00	16,75,000.00	
4.8	Road Making (Rugged-Hilly Terrain)	Km	2.2.10b	32,200	1,07,870.00	10.00	10,78,700.00	
4.9	Drill Core Preservation	per m	5.3	1,590	5,326.50	600.00	31,95,900.00	
	Sub-Total 4						**3,54,20,220**	
5	**Laboratory Studies**							
5.1	Primary + Check Sample - 34 Elements of ICPMS (Primary+Internal check+ External check)	per sample	4.1.15	7,731	NA	462.00	35,71,722.00	Borehole samples-120, Closed space sampling in grid pattern-300, check samples-42
5.2	Preparation of thin section	Nos	4.3.1	2,353	NA	5	11,765.00	
5.3	Complete petrographic study report	Nos	4.3.4	4,232	NA	5	21,160.00	
5.4	Preparation of Polished Section	Nos	4.3.2	1,549	NA	10	15,490.00	

5.5	Complete Mineragraphic study report	Nos	4.3.4	4,232	NA	10	42,320.00	
5.6	Whole Rock Analysis(Major Oxides)	Nos	4.1.15a	4,200	NA	6	25,200.00	
5.7	XRD	Nos	4.5.1	4,000	NA	20	80,000.00	
5.8	SEM	per hour	4.4.2	2,940	NA	16	47,040.00	
5.1	Specific gravity of rock	per sample	4.8.1	1,605	NA	6	9,630.00	
	Sub-Total -5						**38,24,327**	
6	**Total 1 to 5**						**7,21,67,901**	
7	**Geological Report Preparation**	**5 Hard copies with a soft copy**	**5.2**	Detailed exploration with cost of work exceeding ₹ 300 lakh: A minimum of ₹ 9 lakh or 3% of the value of work whichever is more subject to a maximum amount of ₹ 20 lakh and ₹ 10,000/- per each additional copy			**21,65,037**	
8	**Peer review Charges**		**As per EC**				**30,000**	

			decision					
9	**Preparation of Exploration Proposal (5 Hard copies with a soft copy)**	**5 Hard copies with a soft copy**	**5.1**	**2% of the Cost or Rs. 5.0 Lakhs whichever is lower**			**5,00,000**	EA has to submit 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.
10	**Total Estimated Cost without GST**						**7,48,62,938**	
11	**Provision for GST (18% of G)**	**%**					**1,34,75,329**	GST will be reimburse as per actual and as per notified prescribed rate
12	**Total Estimated Cost with GST**						**8,83,38,267**	**or say Rs. 883.38 Lakh**

Note - If any part of the project is outsourced, the amount will be reimbursed as per the Paragraph 3 of NMET SoC and Item no. 6 of NMET SoC. In case of execution of the project by NEA on its own, a certificate regarding non outsourcing of any component/project is required.

9.0.0 Justification:

I. The rocks of the major orogenic belts act as an ideal setting for Tin mineralization and the same is well reported across all the major orogenic belts. The proposed block falls within the Central Crystalline which is a part of the Himalayan orogenic belt.

II. On the basis of the geochemical sampling done by GSI (FSP 2019-20) in toposheet no. 53J/11, the geochemical distribution pattern of Tin (Sn) shows anomalously higher concentration (12.04ppm to 185.16ppm) over granite gneisses of Bhilangana Formation (Central Crystalline Group) and quartzite of Nagnithank Formation (Lesser Himalaya) as well as over intrusive granitic bodies, near the Main Central Thrust (MCT). The mean Tin content in stream sediment is 8.83 ppm, with 85% of the samples have Tin (Sn) values higher than its crustal abundance (2.1 ppm). As the geochemical distribution pattern of Tin in north eastern part of the toposheet showed anomalous higher values, it was recommended that this area can be taken up for further investigation in terms of sampling for confirmation and if positive then it can be further enhanced in terms of geological exploration level.

III. During reconnaissance survey (G4) MECL, the fifteen bedrock chip samples collected from Thati Kathur granite and associated tourmaline bearing pegmatite yielded tin value from 17 ppm to 15654 ppm. Out of fifteen samples, nine bedrock chip samples of Thati Kathur granite and associated tourmaline bearing pegmatite & tourmaline-quartz rosette yielded anomalous higher concentration tin (Sn) value from 100.03 ppm to 15654 ppm, tungsten (W) value from 11.90 ppm to 25.67 ppm, niobium (Nb) value from 5.15 ppm to 17.97 ppm, tantalum (Ta) value from 0.6 ppm to 1.96 ppm, streams sediments yield tin value from 11.06 ppm to 28.98 ppm and soil samples collected from B&C horizon yield tin value from 15.15 ppm to 26.17 ppm respectively. The chemical analysis of Thati Kathur granite and associated pegmatite indicates its stanniferous nature (Khin Zaw,1990). Tourmaline nodule (a leucocratic rim of quartz or feldspar surround the rounded or elliptical tourmaline crystal core in granites acts as an excellent indicator for Tin occurrences. Such examples are ubiquitous across the globe (San Rafael Sn-Cu deposit, Southeastern Peru, Cape Granite Sn-Zn-W mineralization Suite, South Africa, Xuebaoding W-Sn-Be Deposit, Sichuan Province, China etc.).

On the basis of above anomalous higher concentration tin values in bedrock chip samples, potential area in and around Indwangaon, Kangra and Kyarki village were identified.

Considering anomalous higher concentration of tin values in bedrock chip samples & geological set up potential area in and around Indwangaon, Kangra and Kyarki village are promising. Hence, MECL proposed to take up preliminary survey (G-3) i.e. large-scale geological mapping (1:4,000), closed space sampling in grid pattern and chemical analysis work for tin mineralisation in Phase -1 and after the outcome of phase -1, systematic drilling of 600m will be done in Phase -2.

10. 0.0 References:

1. Nag, Renu; Pal, Ashish K., 2020. Geochemical mapping in toposheet no. 53J/11 covering parts of Tehri Garhwal District of Uttarakhand, Interim Report of Field Season 2019-20.

2. Zhu, X.; Raschke, M.B.; Liu, Y. Tourmaline as a Recorder of Ore-Forming Processes in the Xuebaoding W-Sn-Be Deposit, Sichuan Province, China: Evidence from the Chemical Composition of Tourmaline. *Minerals* **2020**, *10*, 438.

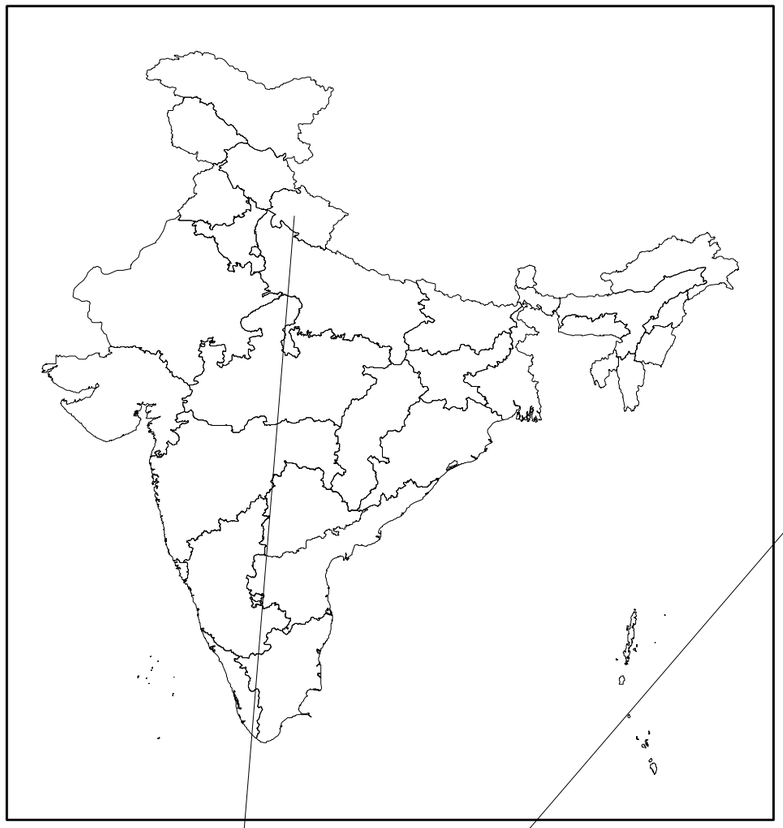
3. Mlynarczyk, Michael S.J.; William-Jones, Anthony E. Zoned Tourmaline Associated with Cassiterite: Implications for Fluid Evolution and Tin Mineralization in The San Rafael Sn–Cu Deposit, Southeastern Peru. *The Canadian Mineralogist*, Vol.44, pp. 347-365 (2006).

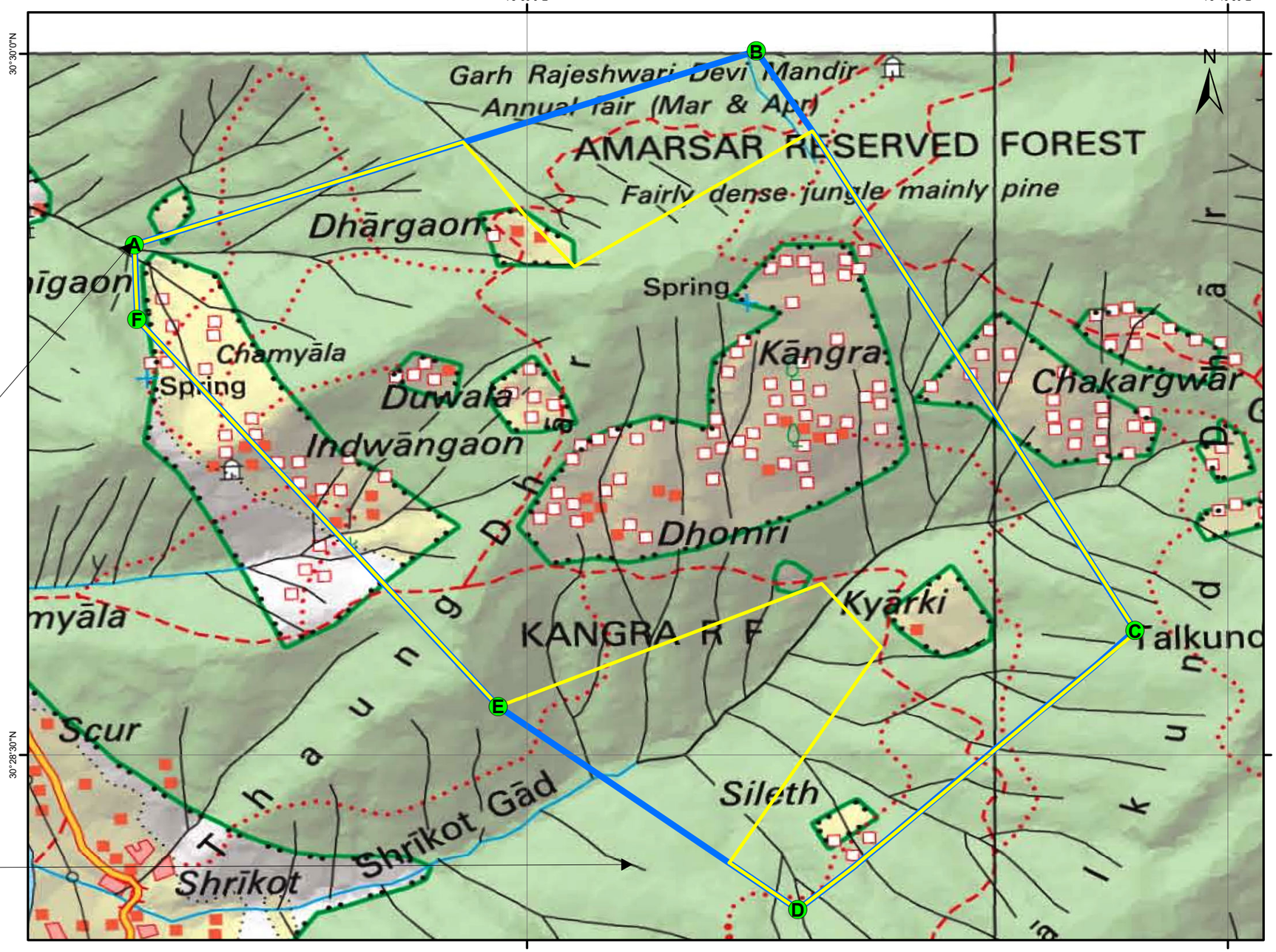
4. Rozendaal, A.; Bruwer, L. Tourmaline nodules: indicators of hydrothermal alteration and Sn-Zn-(W) mineralization in the Cape Granite Suite, South Africa. *Journal of African Earth Science*, Vol.1, pp.141-155 (1995).

5. Balen, D. and Broska I. (2011), Tourmaline nodules: products of devolatilization within the final evolutionary stage of granitic melt? Geological Society, London, Special Publications 2011, v.350, p53-68.

List of Plates:

1. Block Location Map of Kangra Block in Toposheet no. 53J/11, Tehri Garhwal District, Uttarakhand State.
2. Regional Geological Map of Kangra Block area (After GSI), Tehri Garhwal District, Uttarakhand State (Scale 1: 100,000).
3. Block Geology Map of Kangra Block area (After MECL) with Tin value in Bedrock sample, Tehri Garhwal District, Uttarakhand State (Scale 1: 12500).





BB POINTS	LONGITUDE	LATITUDE	AREA
A	78° 38' 09.576" E	30° 29' 35.529" N	6.35 sq. km
B	78° 39' 29.455" E	30° 30' 00.357" N	
C	78° 40' 18.078" E	30° 28' 45.977" N	
D	78° 39' 34.782" E	30° 28' 10.157" N	
E	78° 38' 56.259" E	30° 28' 36.240" N	
F	78° 38' 09.895" E	30° 29' 25.944" N	

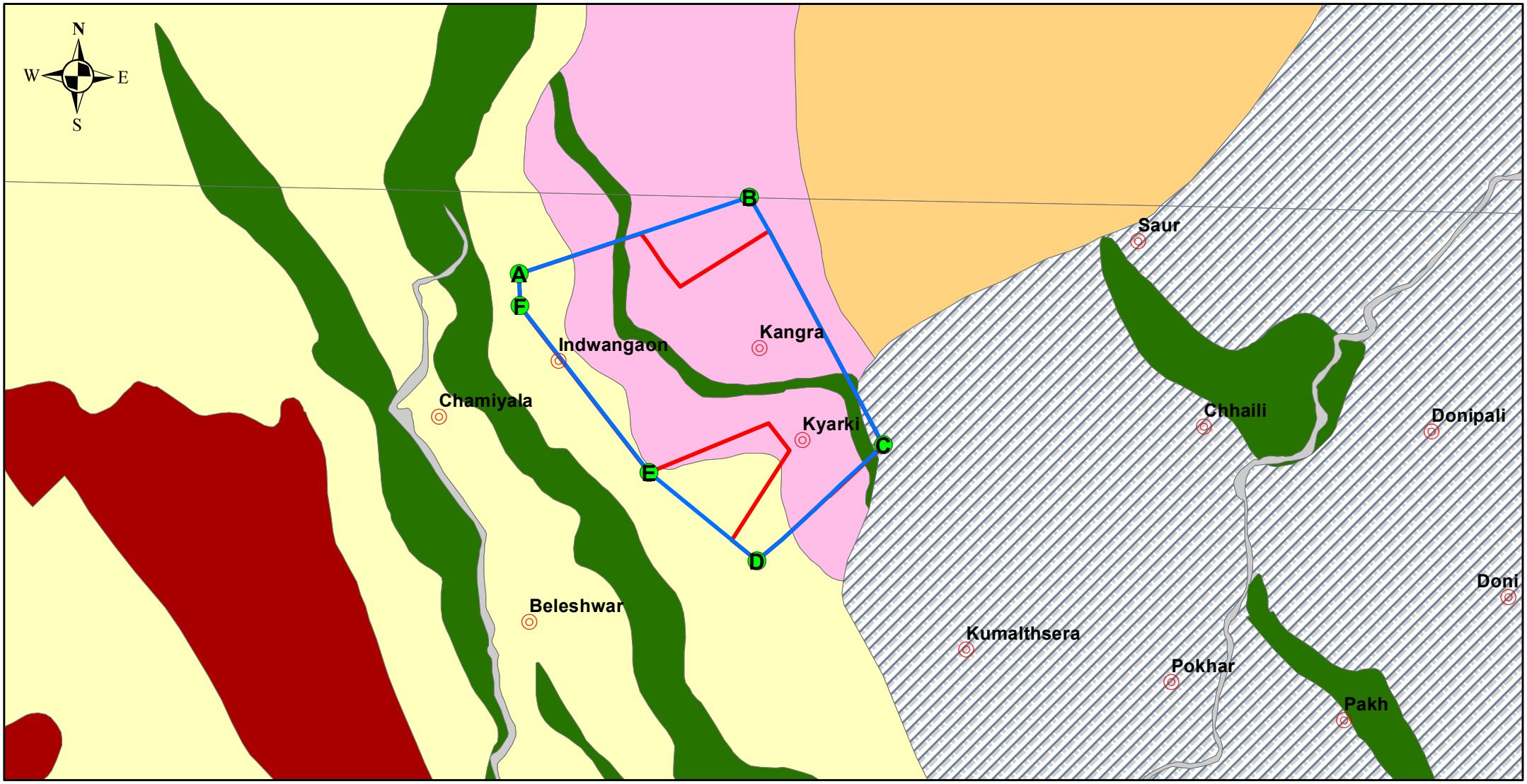
0 0.25 0.5 KM

PARTS OF TOPOSHEET NO 53J/11

- Cardinal Points
- Proposed G-3 Kangra Block
- Accessible Area

मिनरल एक्सप्लोरेशन एंड कंसल्टेंसी लिमिटेड
(पूर्व में मिनरल एक्सप्लोरेशन कार्पोरेशन लिमिटेड)
खान मंत्रालय, भारत सरकार का उद्यम, मिनीरत्ना-I सीपीएसई
MINERAL EXPLORATION AND CONSULTANCY LTD.
(Formerly Mineral Exploration Corporation Ltd.)
Ministry of Mines, Govt of India Enterprise, MINIRATNA-I CPSE
An ISO 9001:2015, 14001:2015 & 45001:2018 Certified Company
MECL

REGIONAL GEOLOGICAL MAP SHOWING KANGRA (G-3) BLOCK, TEHRI GARHWAL, UTTARAKHAND



Legend

- Locality
- Proposed G-3 Block Boundary
- Accessible Area
- BASIC META-VOLCANICS
- BASIC ROCKS (EPIDIORITE)
- BIOTITE GNEISS, QUARTZITE AND SCHIST
- GREY SAND, SILT AND CLAY
- PORPHYRITIC NONFOLIATED GRANITE
- QUARTZITE AND SLATE WITH BASIC METAVOLCANICS
- QUARTZITE, SCHIST/PHYLLITE AND AMPHIBOLITE

1 cm = 1 km

0 0.5 1 2 Km

MAP SOURCE: BHUKOSH, GSI

Plate II

78°37'30"E 78°40'0"E 78°42'30"E 78°45'0"E

30°30'0"N 30°27'30"N 30°25'0"N

N W E S

A B C D E F

Sn-15654 Sn-1554 Sn-43 Sn-79 Sn-131 Sn-1376 Sn-158 Sn-271 Sn-17 Sn-25 Sn-345 Sn-100.03 Sn-25 Sn-125 Sn-83

Indwangaon Kangra Chamiyala Kyarki Saur Chhaili Donipali Beleshwar Kumalthsera Pokhar Pakh Doni Thayeli Saruna Phalenda Ghansali Dhabsaur Silos Akhori

Legend

- Locality

Structural Data

- Bedding
- Foliation
- Joint
- Bhilangana Thrust/MCT-I
- Proposed G-3 Block Boundary

Lithology

- 10 Thati Kathur Granite with tourmaline bearing pegamtites
- 9 Amphibolite
- 8 Tourmaline bearing Granite Gneiss
- 7 Quartz-Sericite Schsit
- 6 Mylonite Gniess
- 5 Non Foliated Granite Gneiss
- 4 Biotite Granite Gneiss
- 3 Granite Gneiss
- 2 Meta basic rock
- 1 Quartzite

- BRS with Tin Value (ppm)
- Accessible Area

1:12500

Plate III