UNITED EXPLORATION INDIA PVT. LTD

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Letter No: NMET/CM/UEIPL/24/22

To
The Director & HoD
National Mineral Exploration Trust (NMET)
Ministry of Mines
F-114, Shastri Bhavan
New Delhi- 110001

It is certified that:

1. Project titled "Reconnaissance survey (G4) for Lithium, Niobium, Tantalum, Titanium & REE Minerals in And Around Bengpal-Ellingnar Block, Sukhma, Baster and Dakshin Bastar Dantewada District, Chhattisgarh" along with estimated cost of the project is submitted for consideration of NMET funding.
2. The project proposal is prepared following the guidelines prescribed in Minerals (Evidence of Mineral Contents) Rules, 2015 in case of mineral exploration project proposals.
3. The requisite approval has been obtained from the competent authority for the project proposal for NMET funding.
4. The proposal has been duly examined and concurred by associate finance in accordance with canons of financial propriety.
5. The same project proposal or project proposal with similar objectives has not been submitted to any other funding agency by this organization and the project proposal bears no duplication with existing work / ongoing project undertaken by this agency.

Yours faithfully,

UNITED EXPLORATION INDIA PVT. LTD.

Indrajit Banerjee

For United Exploration India Pvt Ltd.

Date: 15/06/2024

Place: Kolkata, West Bengal

Enclosure 1: As discussed in the 65th TCC meeting held on 28th May, 2024 it was advised to submit a detailed project report for Reconnaissance survey (G4) for Lithium, Niobium, Tantalum, Titanium & REE Minerals in And Around Bengpal-Ellingnar Block, Sukhma, Baster and Dakshin Bastar Dantewada District, Chhattisgarh.

Enclosure-1

Detailed Project Report for "Reconnaissance survey (G4) for Lithium, Niobium, Tantalum, Titanium & REE Minerals in And Around Bengpal-Ellingnar Block, Sukhma, Baster and Dakshin Bastar Dantewada District, Chhattisgarh"

Proposal For of Lithium, Niobium, Tantalum, Titanium & REE Minerals in And Around Bengpal-Ellingnar Block, Sukhma, Baster and Dakshin Bastar Dantewada District, Chhattisgarh
for Reconnaissance Survey (G4 Stage) under NMET

(Basemetals/ Ferrous/ Non-Ferrous/ Industrial/
Strategic & Critical/ Precious metals etc.)

Prepared by

United Exploration India Pvt. Ltd.

Unit 402, 4th floor, Axis Mall, Block-C
Newtown, Kolkata, West Bengal, 700156

Place: Kolkata, West Bengal
Date: 15/06/2024

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	A. Lithium pegmatites in parts of Bastar Craton, Central India by Yamuna Singh and S D Rai. (Atomic Minerals Directorate for Exploration and Research (AMD).
	B. Regional Assessment Surveys For Cassiterite and Associated Rare Minerals In Selected Blocks : Bodavada, Jangarpal, Kudripal, Chidpal Kankapal, Murgel & Tongpal-

	Marjun, Bastar District, Madhya Pradesh (FS: 1977-78)By T.M. Babu, R.N.Pal and others.
Annexure-2	Gazette Notification of Accreditation
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1 GENERAL INFORMATION OF BENGPAL-ELLINGNAR BLOCK:

	Features	**Details**
	Block ID	Bengpal-Ellingnar Block
	Exploration Agency	United Exploration India Pvt. Ltd. (UEIPL)
	Commodity	Lithium, Niobium, Tantalum, Titanium & REE Minerals
	Mineral Belt	Bastar-Malkanjgiri Belt.
	Completion period with entire time schedule to complete the project	1 Year
	Objectives	Occurrence of Cassiterite within Pegmatites has been found in this region. These pegmatites contain high value of Lithium. Lithium is a critical strategic mineral for the modern world. Hence exploration of Lithium and other REE elements within pegmatite and granitic rocks of this region attracts special attention.
	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 outsourced agency	UEIPL and its associates
	Name / number of the geoscientists	5 geoscientists will involve (2 geologist, 1 geophysicist, 1 resource geologist, 1 GIS specialists)
	Expected field days (Geology, Geological party days)	365
1	**Location**	
	Latitude	18° 44' 20.497" N - 18° 49' 4.050" N
	Longitude	81° 45' 42.845" E - 81° 56' 43.260" E
	Village	Bengpal, Ellingnar, Kumakolen, Bedavada

	Features	**Details**
	Tehsil/Taluk	Bengpal (Darbha Tehsil) and Kumakolen (Chhindgarh Tehsil)
	Districts	Sukma, Bastar and Dakshin Bastar Dantewada
	State	Chhattisgarh
2	**Area (hectares/square Kilometers)**	
	Block Area	112 Sq. Km.
	Forest Area	Partly falling in forest land.
	Govt Land Area	Data Not Available
	Private Land Area	Data Not Available
3	**Accessibility (Arial Distance)**	
	Nearest Rail Head	Jagdalpur (45 km)
	Road	NH-30 is passing through the proposed block boundary.
	Airport	Maa Danteswari Airport, Jagdalpur (44 km)
4	**Hydrography**	
	Local/Surface Drainage Pattern	The drainage pattern is dendritic to sub-dendritic with moderate drainage density.
	Rivers/Streams	Bengpal River is flowing from west to East within the Block Boundary. Jhiram River is passing through the block from NNE to SSW.
5	**Climate**	
	Mean Annual Rainfall	1386.77 mm.
	Temperature (December)(Minimum) Temperatures (June)(Maximum)	This region has a Tropical wet and dry or Savana Climate. The yearly temperature is 27.69°C (81.84°F) and it is 1.72% higher than India's averages.
6	**Topography**	
	Toposheet Number	65 F 13 and 65 F 14.
	Morphology of the area	The major part of the Ellingnar block is hilly and thickly forested except in the southern part of the hills, which is under cultivation. Generally, ground-level elevation is 244m and the maximum elevation in this block is 860 m. This hilly portion is the eastern continuity of the major, Ellingnar Hill mass to the west.

	Features	Details
7	**Availability of baseline geoscience data**	
	Geological Map (1.50k/25k)	1:50000
	Geochemical Map	Not Available
	Geophysical Map (Aero-physical, Ground geophysical, regional as well as local scale GP maps)	Not Available
8	**Justification for taking up Reconnaissance Survey/ Regional exploration**	❖ Pegmatites which were emplaced into the basic and Bengpal schistose rocks, are generally 2 to 5m wide with length varying from 80 to 1000m. Thickness of pegmatite some times swells up to 20m. The general trend of pegmatite in the block is NNW-SSE with steep westerly dips. Intensity of occurrence of pegmatite is more is basic rocks than in schist. ❖ Pegmatites are emplaced as veins along fracture and major joint planes in the basic rocks. The primary tin mineralisation as discrete cassiterite crystals within the pegmatite is noticed near Chuirwada. Pegmatites found in the area are mineralogically complex with high concentration of rare elements such as Sn, Nb, Ta, W, Li, Be, B, Pb, Va, Y, Cr etc., which form oxides, chlorides, Fluorides and sulphides considerably at lower temperatures. An aqueous gas phase as well as water saturated silicate melt participated in the complex evolution of cassiterite, columbite, associated minerals. The higher concentration of minerals of rare metals Sn, Nb, Ta, Li etc. indicates that these are of shallowed pegmatites formed at depths between 3.5 to 4 and 6 to 7 kms.(Ginsburg, 1964). The initial temperature of such type of pegmatitic

	Features	Details
		melt has been considered to be of the order of 800 to 700°C (Fersman 1940). The tin content of pegmatites varies from 10 to 2500 ppm. The lepidolites, feldspars, muscovites and magnetites from pegmatites contain significant amounts of tin varying from 30 to less than 1000 ppm. The pegmatites have been derived as a product of the differentiations of granites. The source of the solution from which the pegmatites form, is a deeply buried differentiating magma. During crystallization of the magma, fluids escaped and work upward and outward finally crystallising in the form of pegmatites. Certainly, the solutions are highly mobile and contain relatively large quantities of Na, K, Si, Be, F, B, P_2O_5, and Li and many metallic elements such as Sn, Nb, Ta and W and rare elements.

2 DETAILED DESCRIPTION OF THE PROPOSAL:

2.1 Block Summary:

2.1.1 PHYSIOGRAPHY:

The major part of the Bengpal-Ellingnar block is hilly and thickly forested except in the southern part of the hills, which is under cultivation. In general, ground-level elevation is 244m and the maximum elevation in this block is 860 m(Mula Dongri). The hill slopes are densely vegetated and in places are highly inaccessible due to the thick bamboo forest.

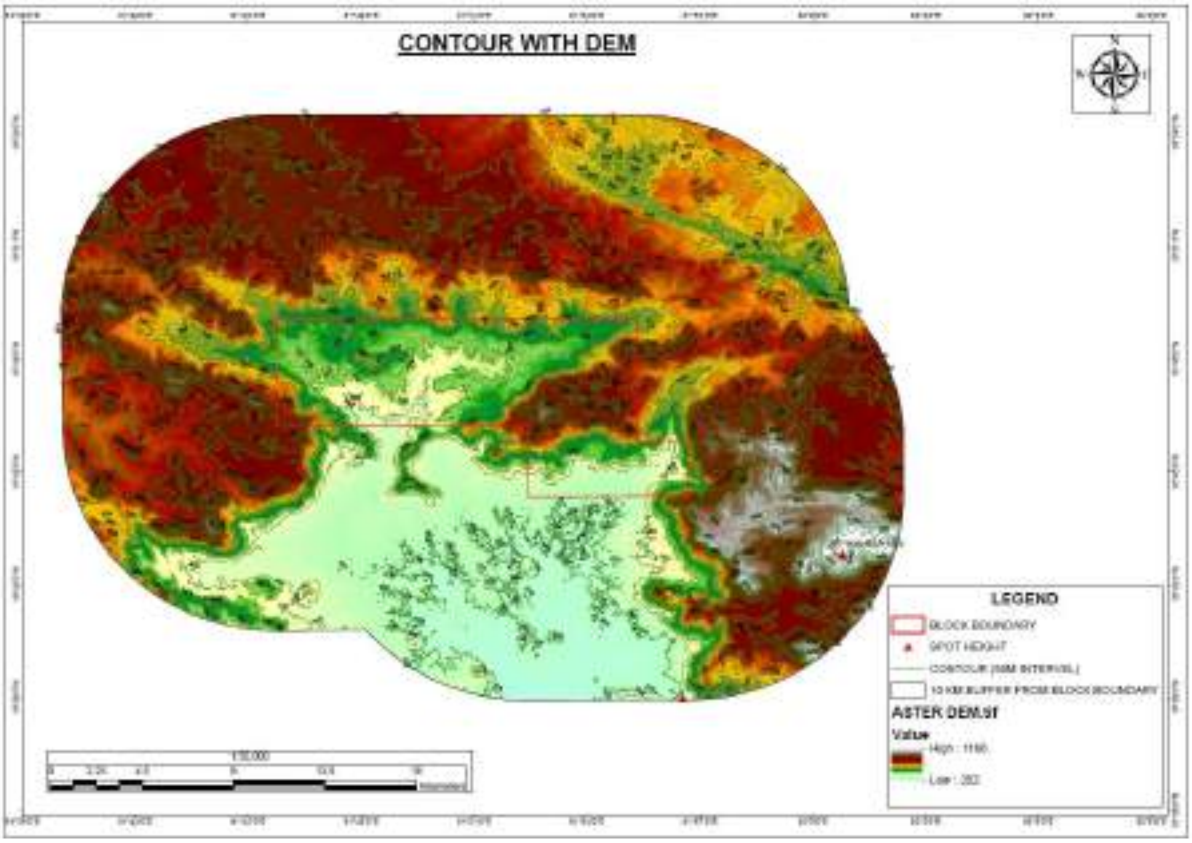

Figure 1: Physiographic map of the proposed block

2.1.1.1 Drainage:

The Bengpal-Ellingnar block is drained by Jhiram Nadi in the east and in the South, Bengpal Nadi in the west. The Jhiram flows and joins Baru; the Baru River flows southerly and ultimately meets Kolab (Sabari). There are a good number of nalas flowing through the slopes of Marjun hillock and joining in Jhiram and some of the nalas flow from 557 m. hillock of Tongpal joins the Baru River. The overall drainage pattern is dendritic in nature.

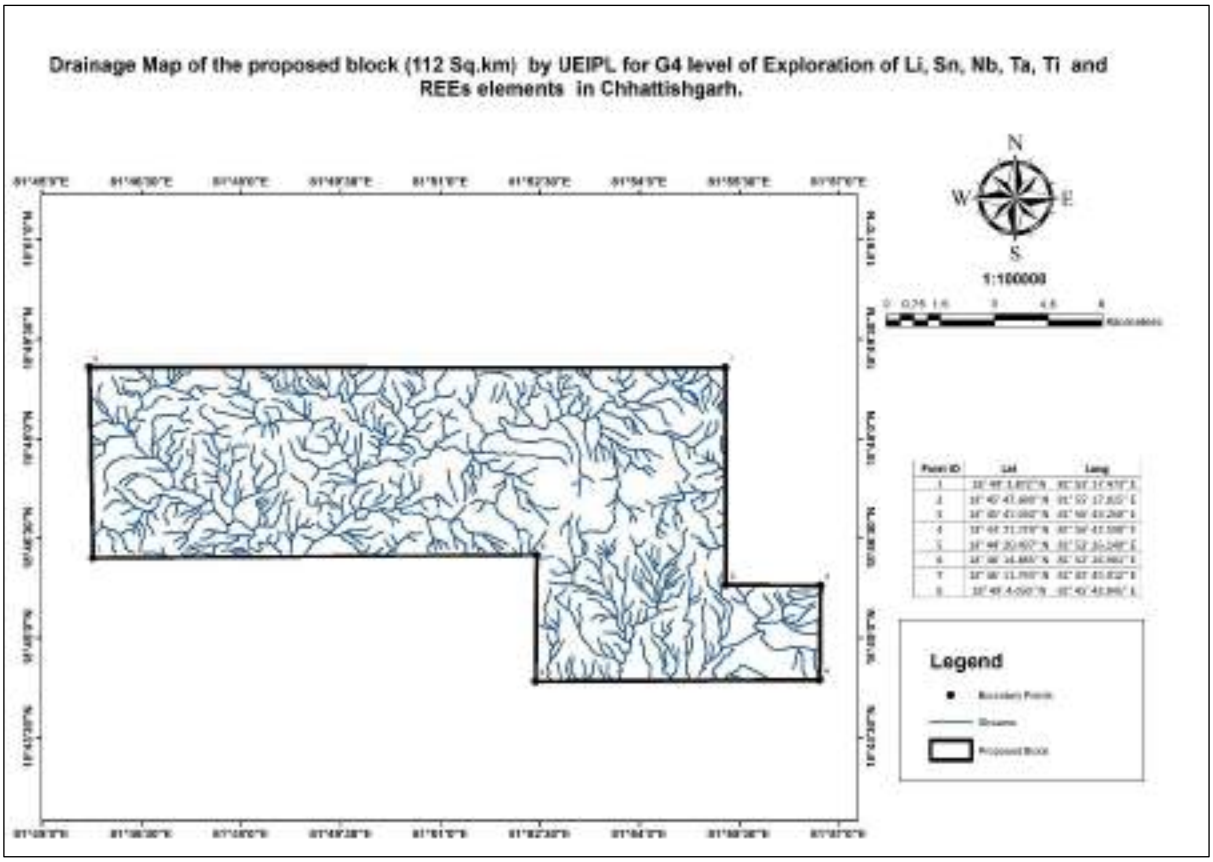

Figure 2: Map showing drainage pattern in and around the proposed block

2.1.2 BACKGROUND GEOLOGY (REGIONAL GEOLOGY & GEOLOGY OF THE BLOCK):

2.1.2.1 Regional Geology

The Bastar Craton contains a well-developed sequence of rocks that range in age from Archean to upper Proterozoic. It is located in the central part of the Indian Peninsular Shield and covers an area of 40,000 sq. km. The craton is bordered by the Chhattisgarh basin to the north, the Eastern-Ghat Khondalite-Charnockite complex to the south and east, and the Pranhita Godavari basin to the southwest.

The oldest rock exposed in the Bengpal-Ellingnar block belongs to the Bengpal Group of metasediments viz andalusite-sericite-schist, quartz-sericite-schist (equivalent to Tulsi Dongar Stage of Crook Shank, 1938). Meta basic intrusive rocks of amphibolite to epidiorite in composition, occur as sills into the Bengpal schists. Exposure of granite (apophyse) intruding into the Bengpal and Basic rocks are exposed on the banks of Baru Nadi. This might represent the younger intrusive later than the Paliam/Darba granites.

The metasediments consist of Quartzite, Quartz Sericite Schist, Andalusite-Sericite Schist, Staurolite-Gneiss, and Biotite-Cordierite Gneiss. The quartzitic rocks typically trend parallel to the foliation planes of schistose rocks in the NW-SE to NNE-SSE direction and dip towards the NE and ENE.

The pegmatite formations are mainly tabular, lens-like, and pod-like which are vertical to steeply dipping, with pinch and swell structures. They can be either simple and unzoned, or complex bodies of varying sizes (5-1000m in length, 100m in width). These formations are arranged in an NW-SE trending belt covering approximately 75 km in length and 10 km in width. While their orientations vary, they are most commonly found in an NNW-SSE direction with NNE dips. Pegmatites are found emplaced apparently along the pro-existing weaker joint and fracture planes in basic rocks and Bengpal schists.

Laterite, derived from both basic rocks and Bengpal schistose rocks, is found as cappings, but most of the Bengpal-Ellingnar block is covered by transported colluvium lateritized with pebbles. Above the colluvium, dark greyish brown silty to loamy topsoil and alluvium are found, which is mostly derived from the Baru drainage system and reclaimed nalas.

The stratigraphic table indicates that the oldest rocks in the area are low to medium-grade meta-sediments and metabasic intrusive rocks, all belonging to the Bengpal Group of the Archean age.

TABLE 1: Stratigraphic Succession of Bengpal Group of Rocks In Bastar Craton (Modified After Mishra Et. Al,.1988)

AGE	GROUP	FORMATION	ROCK TYPES	LITHOLOGICAL DESCRIPTION
ARCHAEAN	BENGPAL	Bijapur Gneiss	Acid igneous rocks	Granite, charnockite granite gneiss, including grey and pink gneiss and augen gneiss, migmatite, cordierite-sillimanite gneiss, charnockite gneiss and leptynite
			Metamorphosed Basic and ultra-Basic rocks	Metagabbro, gabbroic anorthosite, and pyroxene granulite. Amphibolite, hornblende schist, talc-tremolite schist, and metapyroxenite, metaultramafics with serpentine
			Ferrugi-nous rock ± garnet	Banded magnetite quartzite, orthopyroxene and orthoamphibole-grunerite schist ± (cummingtonite)
			Arenaceous rocks ± garnet	Quartzite, fuchsite quartzite, micaceous quartzite, sillimanite quartzite, and graphite quartzite
		Chintavagu Quartzite	Pelitic rocks ± garnet	Mica Schist, kyanite or sillimanite schist, and khondalites
			Calcareous rocks ± garnet	Calcareous quartzite±

				pyroxene, calcareous amphibolite, calcareous granulites, and gneisses

Local Geology

The rock types exposed in the Bengpal-Ellingnar block include Bengpal metasediments to the east of Bhimsen nala and metabasic rocks which form the eastern continuation of the main Ellingnar basic body. Pegmatite bodies of various sizes cross this basic body in a general NW-SE and NNW-SSE direction. These pegmatites are well exposed on the southern slopes of the hills, but their exposure is rather poor in the level ground.
The basic rock is mainly medium to coarse-grained metadiorite with patches of lighter-colored amphibolite. The relation between these two rocks could not be established due to a lack of clear evidence. Additionally, narrow basaltic dykes cut across Bengpal metasediments and metadiorite.
The Bengpal metasediments are mainly found on the eastern part of the Bhimsen Nala and to the south of the hills. In this area, it was difficult to establish a proper relationship between the basic rocks and Bengpal schist due to a lack of exposure indicating contact relationship. The quartz-sericite-schists and quartzites in the Bhimsen Nala display a bedding attitude of N60°E, steeply dipping towards the south.

Pegmatites which were emplaced into the basic and Bengpal schistose rocks, are generally 2 to 5m. wide with length varying from 80 to 1000m. Thickness of pegmatite some times swells upto 20m. General trend of pegmatite in the block is NNW-SSE with steep westerly dips. Intensity of occurrence of pegmatite is more is basic rocks than in schist

So, in the Bengpal-Ellingnar block, most of these pegmatites are mineralized to the same degree. It is also observed that a zone of alteration in, the basic rock at the contact of major pegmatite has developed quartz-biotite-apatite rock. It is interesting to record that even a small pegmatite band of a few centimeters in thickness sometimes carries coarse cassiterite crystals. Greisenisatinn in the form of the development of lepidolite-rich rocks is distinct in the major pegmatite.

Local stratigraphical succession was observed during the field work is given below:

Recent Silty to clayey topsoil Lateralised gravel horizon.

⬆

Intrusive Pegmatites and quartz veins Granite (apophyse?) Basic sills.

⬆

Bengpal Group: Sericite schist, Sericite quartzite, andalusite/sericite schist, Meta basic intrusive and acid igneous rocks.

	
Figure 3a: Quartz -sericite schist	Figure 3b: Soil and thick vegetation cover
	
Figure 3c: Exposure of Granites	Figure 3d: Mafic Rocks

Figure 3: Photographs of Bengpal-Ellingnar block during site visit

2.1.3 MINERAL POTENTIALITY BASED ON GEOLOGY, GEOPHYSICS, GROUND GEOCHEMISTRY):

Efforts were focused on the Bengpal-Ellingnar area of 3.5 square kilometres previously at a scale of 1:5,000 finding the natural accumulation of heavy minerals in the colluvial material originating from these mineralized pegmatites.

Pegmatites which were emplaced into the basic and Bengpal schistose rocks, found in the area are mineralogically complex with high concentrations of rare elements such as Sn, Nb, Ta, W, Li, Be, B, Pb, Va, Y, Cr, etc., which form oxides, chlorides, Fluorides, and sulfides considerably at lower temperatures.

The higher concentration of minerals of rare metals Sn, Nb, Ta, Li etc. indicates that these are shallowed pegmatites formed at depths between 3.5 to 4 and 6 to 7 kms. (Ginsburg, 1964). The initial temperature of such type of pegmatitic melt has been considered to be of the order of 800 to 700°C (Fersman 1940). The tin content of pegmatites varies from 10 to 2500 ppm. The lepidolites, feldspars, muscovites and magnetites from pegmatites contain significant amounts of tin varying from 30 to less than 1000 ppm.

Pegmatites within the meta-basic rocks have been found to host Li mineralization (Yamuna Singh and Rai, 1986). These pegmatites are profoundly enriched with Lepidolite and amblygonite containing Li content of approximately 3100 ppm to 36000 ppm; along with Cassiterite (45.36-74.85 % SnO_2) with subordinate Nb-Ta phases (4.36-14.45 % Ta_2O_5).

The following two tables show the analysis of Lithium minerals mostly from promising pegmatites from Baster Craton (Rai and Singh 1991).

Table 2: Partial analysis of Lepidolite from Li-Pegmatites (Wt.%) within Proposed Block

Location	Sample No	Li	Li2Oα
CWP-1 (11)	L-8	1.40	3.02
BNP-1(13)	L-9	1.85	3.99
BNP-1(13)	L-10	1.20	2.58
BNP-1(13)	L-11	1.35	2.91
BVP-2 (17)	L-12	0.31	0.67
BVP-4 (19)	L-13	1.66	2.29

Table 3: Partial analysis of Amblygonite from Li-Pegmatites (Wt.%) within Proposed Block

Location	Sample No	Li	Li2Oα
CWP-1 (11)	A-5	3.60	7.77
BVP-3 (18)	A-7	2.68	5.61

Source: Lithium pegmatites in parts of Bastar Craton, Central India by Yamuna Singh and S D Rai. (Atomic Minerals Directorate for

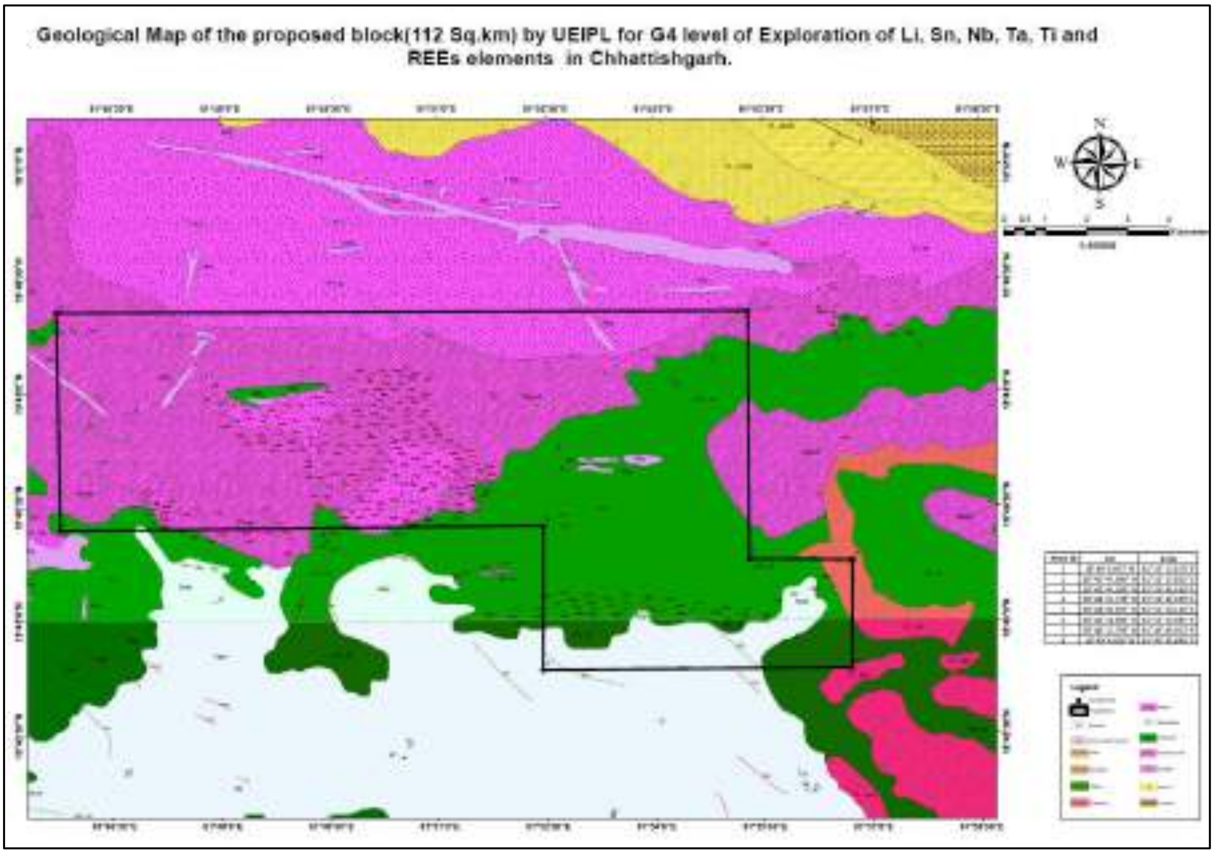

Figure 4: Geological map in and around proposed block

2.1.4 SCOPE FOR THE EXPLORATION:

a. Large scale Geological mapping in 1:12,500 scale
b. Geochemical sampling
c. Geophysical study
d. Petrographic study
e. Geological report preparation

2.1.5 OBSERVATION AND RECOMMENDATIONS OF PREVIOUS WORK:

2.2 Previous Work:

2.2.1 GSI AND AMD EXPLORATION:

The block was chosen based on the data from stanniferous pegmatites outlined by Murti-K. S et al. (1975-76), taking into account the potential accumulation of detrital cassiterite due to weathering and erosion in the major Pawade belt, which extends along the southern slopes of the primary E-W basic body (Ellinger Hill).

Reconnaissance mapping was carried out in the Bengpal-Ellingnar block on a 4" to 1-mile scale (1:15,840), and potential areas were further investigated through large-scale mapping (1:5,000), pitting, bulk sampling, and concentration using hand panning/sluicing. A total area of 25.3 sq. km was surveyed preliminarily, and prospective areas covering 5.7 sq. km were identified in the surrounding Kudripal, Jangarpal, Murgel, Chidpal-Kankapal, and Tongpal-Marjur blocks.

The Geological Survey of India (GSI) collaborated with AMD mainly for sample analysis in two areas, Kudripal and Murgel. GSI completed the assessment surveys independently, while AMD officers were involved part-time in sample collection. AMD analyzed samples for Li, SnO_2, NO_2O_5, and Ta_2O_5.

Pegmatites within the meta-basic rocks have been found to host Li mineralization (Yamuna Singh and Rai, 1986). These pegmatites are profoundly enriched with Lepidolite and amblygonite containing Li content of approximately 3100 ppm to 36000 ppm; along with Cassiterite (45.36-74.85 % SnO_2) with subordinate Nb-Ta phases (4.36-14.45 % Ta_2O_5).

The block and the surrounding area were initially mapped by Brook Shank (1932-37), and later Murti et.al. (1976-77) produced a map of the area at a scale of 1:63,360, with a focus on identifying cassiterite-bearing pegmatites. The Geological Survey of India (GSI) conducted detailed mapping at a scale of 1:5000 in 1978-79 for the exploration of lithium, tin, niobium, and tantalum in an approximately 3.5 sq. km. area at the southern base of the hill on the northern border of toposheet No.65 F/14.

The hill, which runs from east to west, is primarily made up of meta diorite with pegmatite bodies scattered throughout. The pegmatite bodies generally run in an east-northeast to west-southwest direction or northeast-to-southwest, and their thickness ranges from a few centimeters to 20 meters. Some of these pegmatites contain minerals such as cassiterite, as well as niobium and tantalum oxides. There are three main mineralized pegmatites, each about 15 to 20 meters wide and extending discontinuously for about 1 kilometer along the east-northeast to west-southwest trend.

The colluvial material around this pegmatite contains a significant amount of cassiterite crystals. An area of about 2.5 sq. km. has been covered by pitting in a 100x100 and sometimes 100x50 grid pattern. The depth of pits varies from 0.1 to 2m depending on the thickness of the colluvial horizon. Approximately 20 kg of samples collected from each pit by channeling on the four walls has been concentrated by panning and sluicing to recover the heavy minerals. The weight percentage of the heavy minerals varies from 0.1 to 1.5%.

Based on semi-quantitative analytical results from 400 samples, a total area of 1 square kilometer was identified as prospective. A significant portion of the samples within this area showed Sn (tin) concentrations of over 1000 ppm, as well as Nb (niobium) and Ta (tantalum) in many cases. XRF analysis values for Sn from about 108 samples suggest a potential area of 0.9 square kilometers in separate patches. The Sn values range from 0.41 to 30.12%. The total estimated resource of Sn metal in the Bengpal-Ellingnar block is around 230 tonnes.

The stream sediment samples collected from the small streams in the block show that the percentage of heavy elements ranges from 0.2% to 3%, with an average of 0.9%. The XRF analysis shows varying values of tin (Sn) from 0.69% to 51.48%. The Nb_2O_5 values range from 0.16% to 4.3% and Ta_2O_5 ranges from 0.15% to 3.71%. On average, the Nb_2O_5 and Ta_2O_5 values are 1.31% and 1.04% respectively, indicating that Nb_2O_5 content is higher than Ta_2O_5. The estimated tonnage of Sn in these sediments is approximately 7.5 tonnes within a depth of 1 meter in the stream bed.

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2.3 Block Boundary:

The coordinates of the corner points of the proposed block area are given below.

Block Corner Points / Cardinal Points	Latitude	Longitude
1	18° 49' 3.872" N	81° 55' 17.473" E
2	18° 45' 47.680" N	81° 55' 17.825" E
3	18° 45' 47.030" N	81° 56' 43.260" E
4	18° 44' 21.729" N	81° 56' 42.590" E
5	18° 44'20.497 " N	81° 52' 26.140" E
6	18° 46' 14.885" N	81° 52' 26.981" E

7	18° 46' 11.793" N	81° 45' 45.912" E
8	18° 49' 4.050" N	81° 45' 42.845" E

2.4 Planned Methodology

The exploration program is proposed in accordance to the objective set for reconnaissance survey (G-4) of the block. The Exploration shall be carried out as per Minerals (Evidence of Mineral Contents) Rule-2015. Accordingly, the following scheme of exploration is formulated in order to achieve the objectives. The details of different activities to be carried out are presented in subsequent paragraphs.

i) **Geological Mapping:** Geological mapping will be done in the entire area over 112 sq km on 1:12,500 scale. Rock types, their contact, structural features will be mapped. Surface manifestations of the mineralisation available along with their surface disposition will be marked on map.

ii) **Geochemical Sampling:** Regional grab/ chip/ stream sediment/ soil sampling to be carried out at regular interval.

a. Grab Sampling: During the course of Geological mapping, bed rock samples shall be collected for identifying various litho units.

b. Soil Sampling: Soil samples will be carried out in entire area to delineate mineralized zone.

c. Stream Sample: Stream samples will be carried out in entire area to delineate the zone of host rock.

iii) **Ground Geophysical Survey:** Based on the geology of the area, Magnetic survey will be conducted to delineate the pegmatite mineralization zone.

iv) **Chemical Analysis:** All samples need to analyzed for Lithium, Niobium, Tantalum, Titanium & REE Minerals.

v) **Petrographic study:** Thin sections and ore microscopy will be done to identify Lithium minerals.

vi) **Data verification and Quality Check:** Standard reporting of resources are classified and estimated by using two types of data. Data acquired from previous exploration and data generated by exploring the block. Data verification and Gap analysis is the interpretive or indirect methods. Interpretive Data may include results from mapping, seismic, magnetic, gravity and other geophysical and geological surveys. An Interpretive Data, may be used in conjunction with Explored Data to improve confidence levels.

QA/QC will be strictly followed during the collection, recording and storage of any of the data ultimately used in the geological report preparation. This programme should be concerned with, but not limited to, data verification, drill sample recovery, sample size, sample preparation, analytical methods, the use of duplicates/blanks/standards, effects of multiple periods of data acquisition and consistency of interpretation in three dimensions.

2.5 Nature Quantum and target

Components	G4	Quantum of Work
Geological Mapping	i) 1:12,500 Scale	Geological mapping 112.00 sq.km
	ii) Assessment of lithology, structure, surface mineralization and analysis of old history of mining if any	
Geochemical Survey	i) Regional grab/ chip/ stream sediment/ soil sampling	BRS:224 SS: 224 Soil Sample: 224
	ii) Recording of broad geomorphology, drainage etc.	90 days
Geophysical Survey	Magnetic Survey	Ground Magnetic and Gravity Survey: over 8200 station point
Petrographic and mineralogical studies	Principal rock types, mineral assemblage, identification of minerals of interest	**Chemical Analysis:** XRF: 250 ICPMS: 400 **Physical Analysis:** Preparation and Study of thin section for petrography: 150.

		Digital Photographs: 150.
Synthesis of all available data **Not required in the quantum of the work**	i. Integration of regional geophysical, geological and geochemical data, if not done earlier ii. Synthesis of all available data and report writing	5 Hard copies

2.6 Project schedule

S. No.			1	2	3	4	5	6	7	8		9	10	11	12
1	Camp Setting	**Months/Days**													
2	Geological Mapping & Sampling	**days**													
3	Geophysical survey	**L.km**													
4	Geophyscist party days (HQ) for data interpretation & Report	**Days**													
5	Geologist Man days	**days**													
6	Sampler Man days	**days**													
7	Camp Winding	**months**													
8	Laboratory Studies	**Nos.**													
9	Report Writing with Peer Review	**months**													

2.7 Project cost

S. No.	Item of Work *	Unit *	Rates as per NMET SoC 2020-21		Estimated Cost of the Proposal	
			SoC-Item No. *	Rates as per SoC * (a)	Qty. (b)	Total Amount (Rs) (a*b)
1	**Geological Mapping Other Geological Work & Surveying**					
	Geological mapping, (1:12,500 scale) & Trenching , drilling work					
i	a. Charges for Geologist per day (Field) for geological mapping & trenching work, drilling work	day	1.2b	11,000	360	39,60,000
ii	b. Labours Charges; Base rate	day		494	720	3,55,680
	c. Charges for Geologist per day (HQ)	day		9,000	60	5,40,000
	Sub Total- 1					**48,55,680**
2	**Ground Geophysical Survey**					
1	Magnetic Survey	Per station	3.2a	1,800	8,200	1,47,60,000
2	Processing + Interpretation Cost (Charges for Expert Geophysicist)	day	3.18a	90	9,000	8,10,000
	Sub Total- 2					**1,55,70,000**
3	**Geochemical Survey**					
	a) Charges of Geologist	per day	1.2b	11000	168	1848000
	b) Labour Charges			494	336	165984
	Sub Total- 3					**20,13,984**
	TOTAL FIELD EXPLORATION COST					**2,24,39,664**
4	**LABORATORY STUDIES**					

S. No.	Item of Work *	Unit *	Rates as per NMET SoC 2020-21		Estimated Cost of the Proposal	
			SoC-Item No. *	Rates as per SoC * (a)	Qty. (b)	Total Amount (Rs) (a*b)
1	**Chemical Analysis**					
i)	**Geochemical Sampling-Surface samples (Bedrock/Channel /Soil/Stream sediment)**					
	a. ICPMS	Nos	4.1.14	7,731	400	30,92,400
	b. XRF	Nos	4.1.15a	4,200	250	10,50,000
2	**Physical & Petrological Studies**					
i	Preparation of thin section	Nos	4.3.1	2,353	150	3,52,950
ii	Study of thin section	Nos	4.3.4	4,232	150	6,34,800
v	Digital Photographs	Nos	4.3.7	280	150	42,000
						51,72,150
5	**Geological Report Preparation**	**5 Hard copies with a soft copy**	**5.2**	**5.2 (ii)**		**8,28,354**
6	**Peer review Charges**		**As per EC decision**			**30,000**
7	**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 less		**5,69,403**
8	**Total Estimated Cost without GST**					**2,90,39,572**
9	**Provision for GST (18% of J)**					**52,27,123**
10	**Total Estimated Cost with GST**					**3,42,66,695**

S. No.	Item of Work *	Unit *	Rates as per NMET SoC 2020-21		Estimated Cost of the Proposal	
			SoC-Item No. *	Rates as per SoC * (a)	Qty. (b)	Total Amount (Rs) (a*b)
				or Say Rs. In Lakhs		342.67

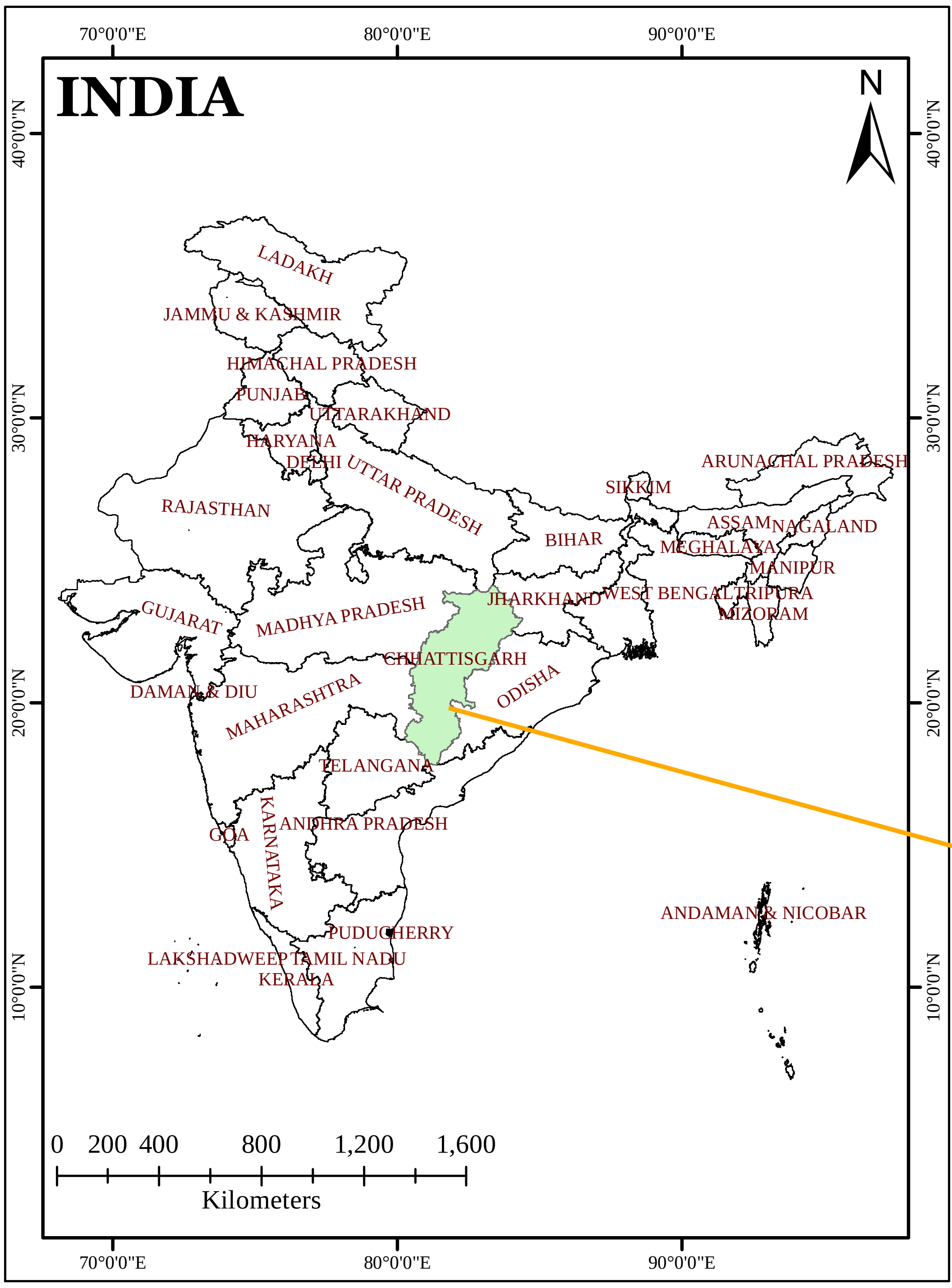
2.8 Reference

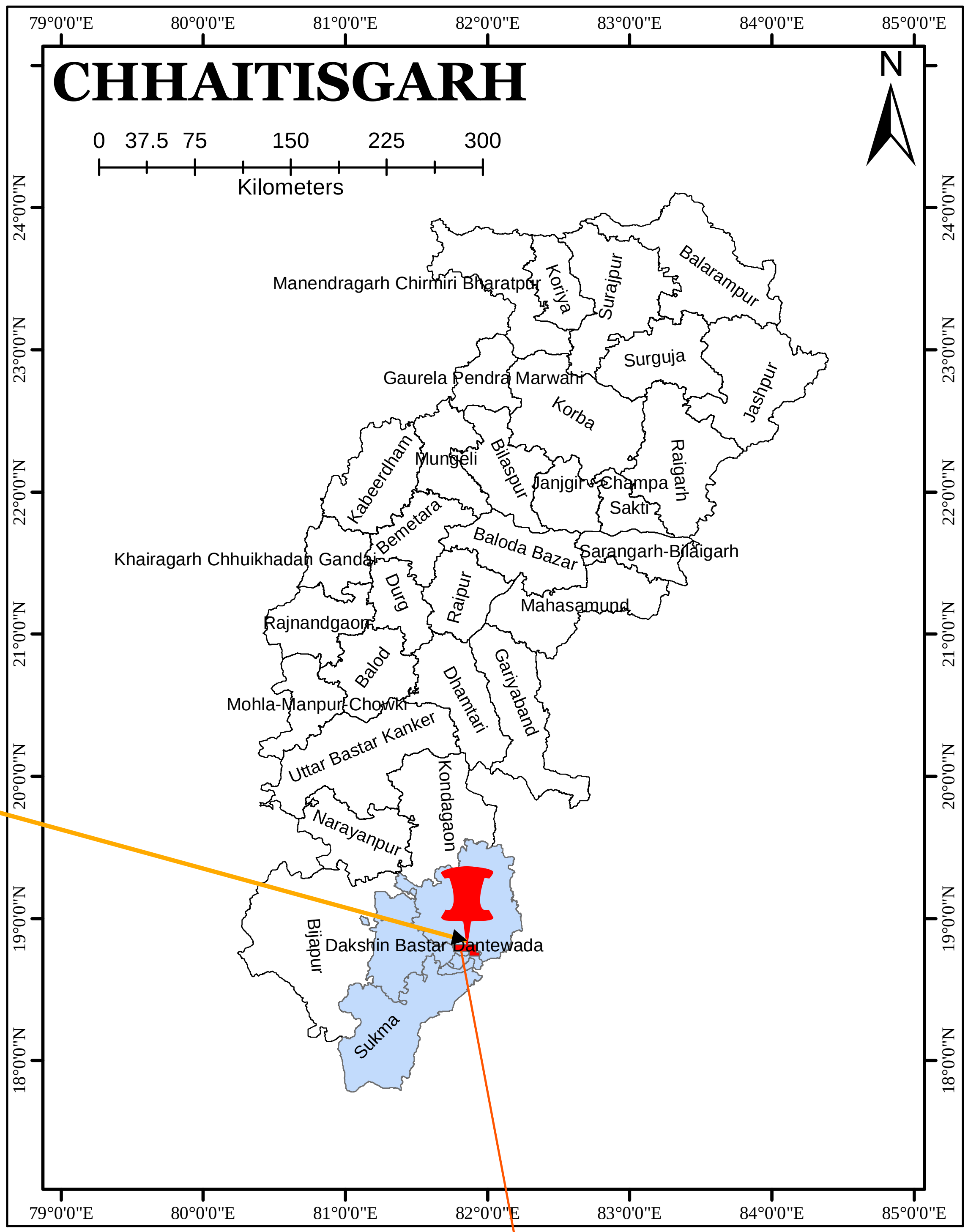
1. Lithium pegmatites in parts of Bastar Craton, Central India by Yamuna Singh and S D Rai. (Atomic Minerals Directorate for Exploration and Research (AMD).
2. Regional Assessment Surveys For Cassiterite and Associated Rare Minerals In Selected Blocks : Bodavada, Jangarpal, Kudripal, Chidpal Kankapal, Murgel & Tongpal-Marjun, Bastar District, Madhya Pradesh (FS: 1977-78)By T.M. Babu, R.N.Pal and others.

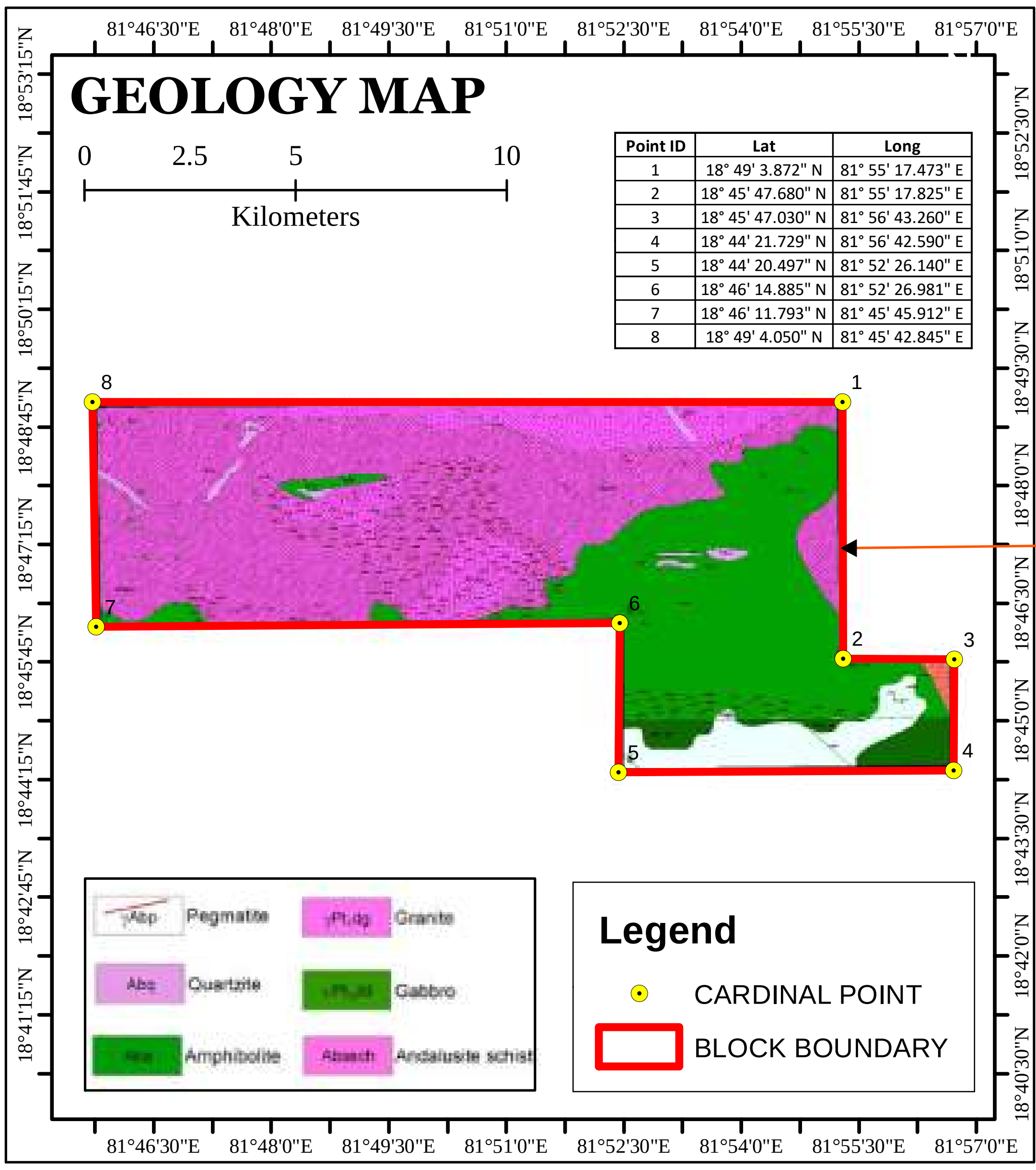
Plate-1

Geological map on 1:50,000 with location index

LOCATION MAP







Point ID	Lat	Long
1	18° 49' 3.872" N	81° 55' 17.473" E
2	18° 45' 47.680" N	81° 55' 17.825" E
3	18° 45' 47.030" N	81° 56' 43.260" E
4	18° 44' 21.729" N	81° 56' 42.590" E
5	18° 44' 20.497" N	81° 52' 26.140" E
6	18° 46' 14.885" N	81° 52' 26.981" E
7	18° 46' 11.793" N	81° 45' 45.912" E
8	18° 49' 4.050" N	81° 45' 42.845" E

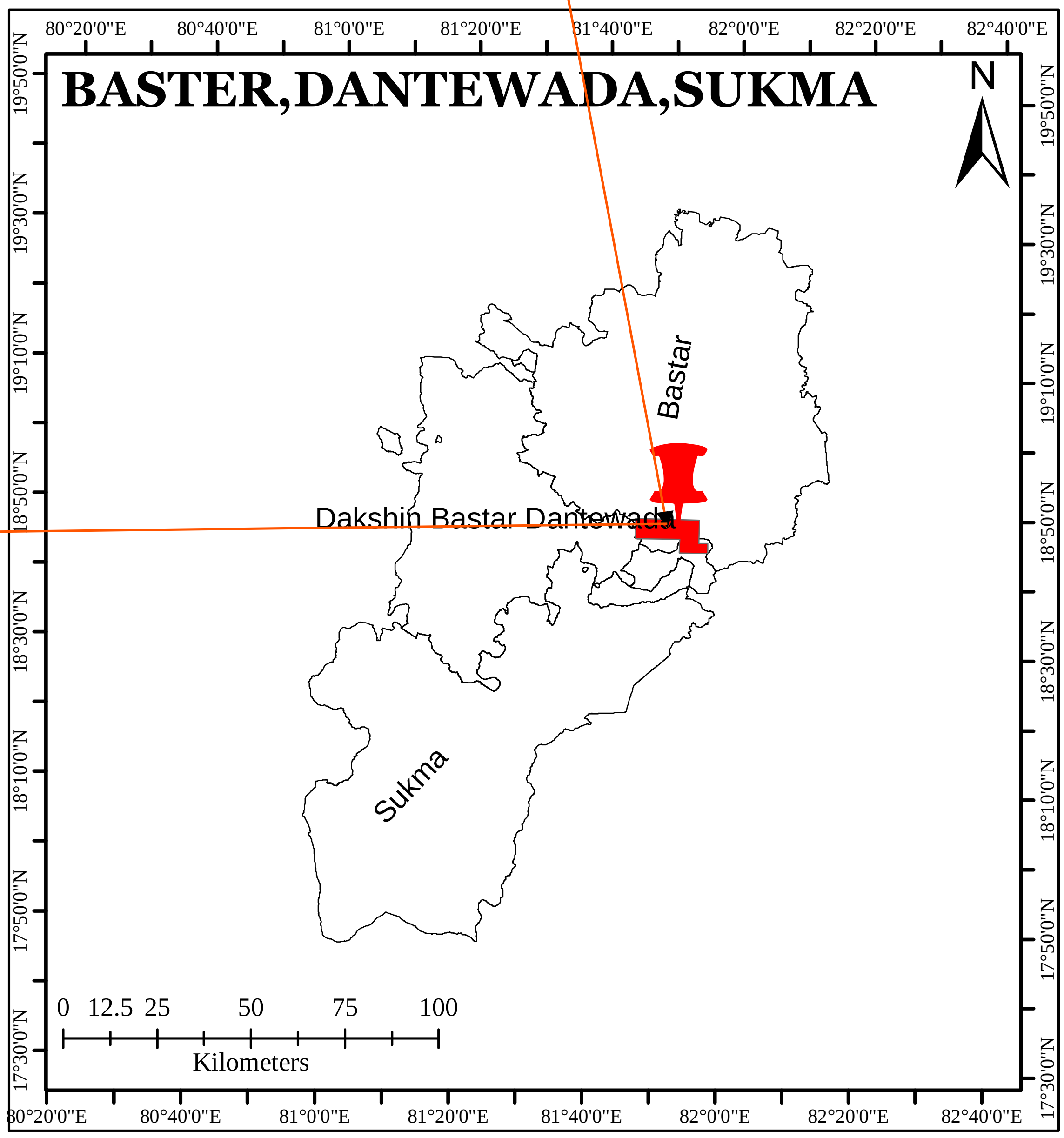
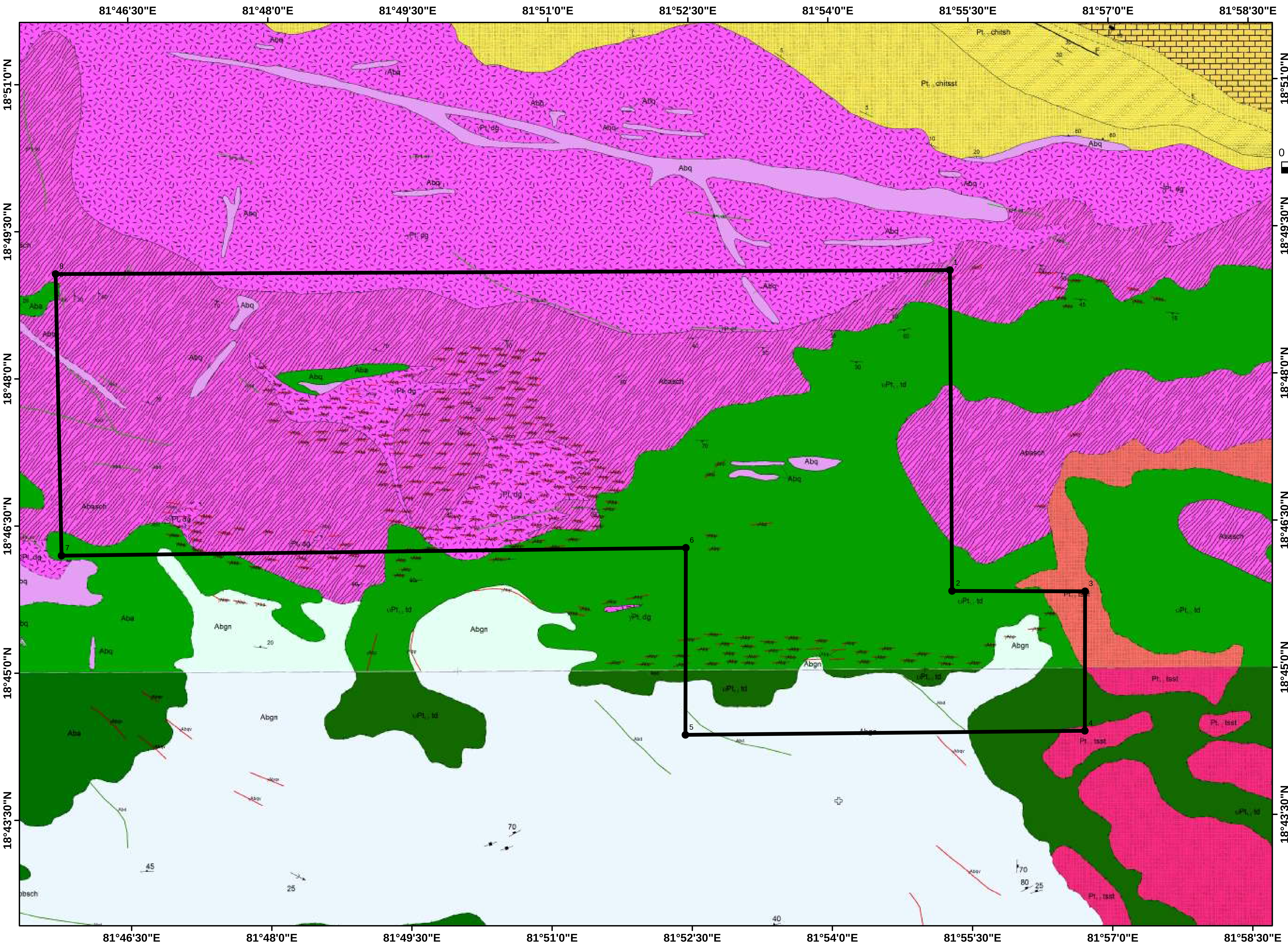
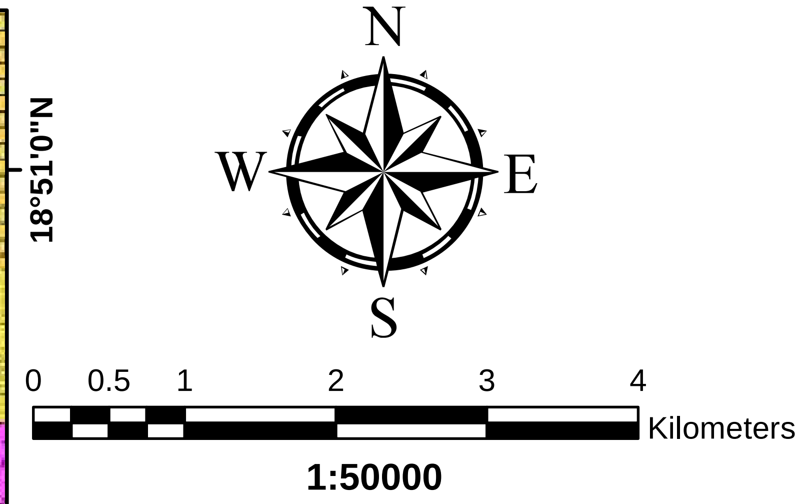


Plate-2

Geological map on 1:50,000

Geological Map of the proposed block(112 Sq.km) by UEIPL for G4 level of Exploration of Li, Sn, Nb, Ta, Ti and REEs elements in Chhattishgarh.





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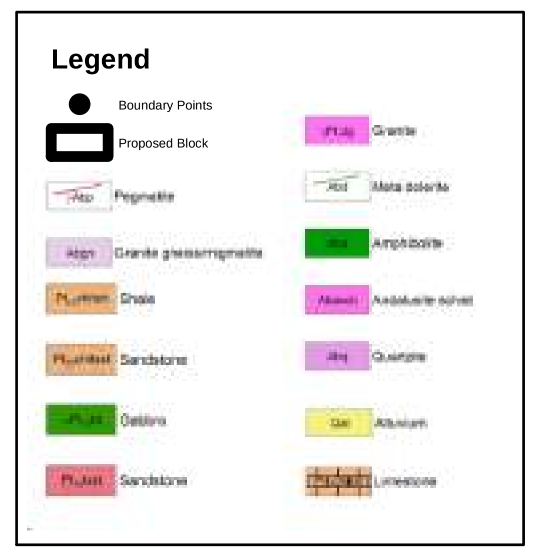


Plate-3

Ground geophysical map/s (NGPM) on 1:50,000

(Not Available)

Plate-4

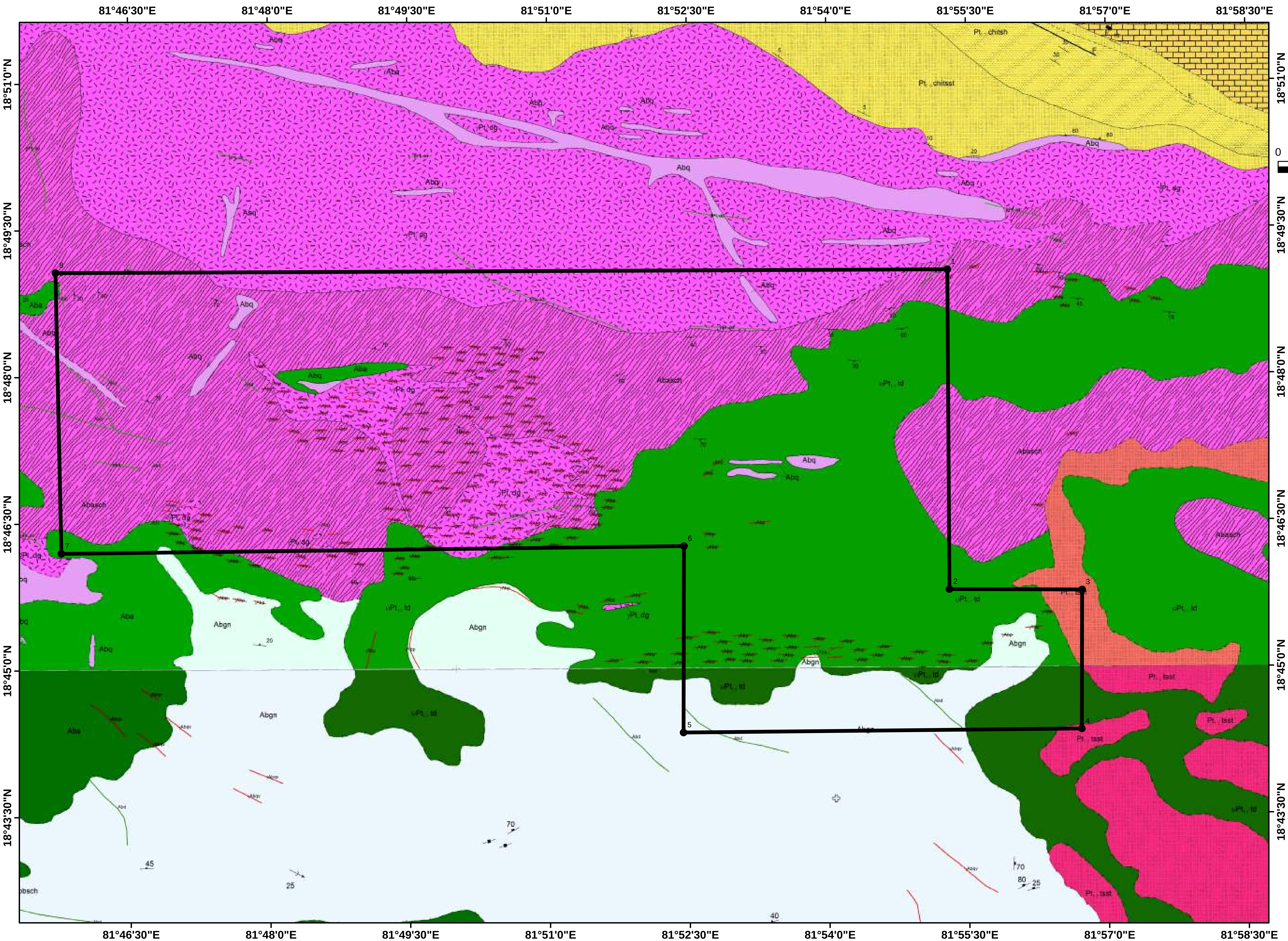
Aeromagnetic map/s

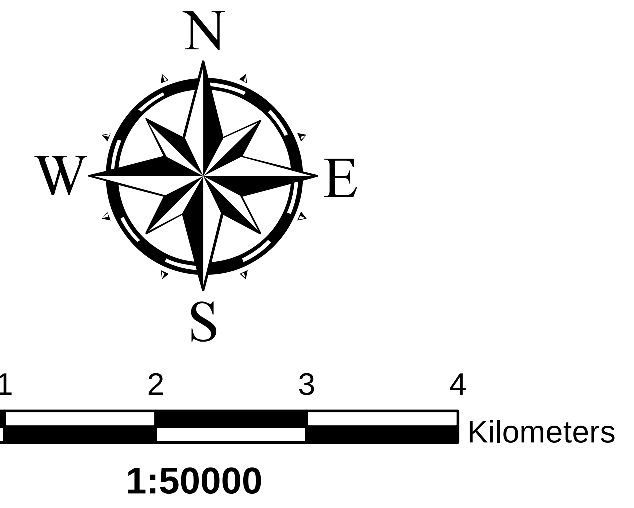
(Not Available)

Plate-5

Geological map with proposed block boundary

Geological Map of the proposed block(112 Sq.km) by UEIPL for G4 level of Exploration of Li, Sn, Nb, Ta, Ti and REEs elements in Chhattishgarh.





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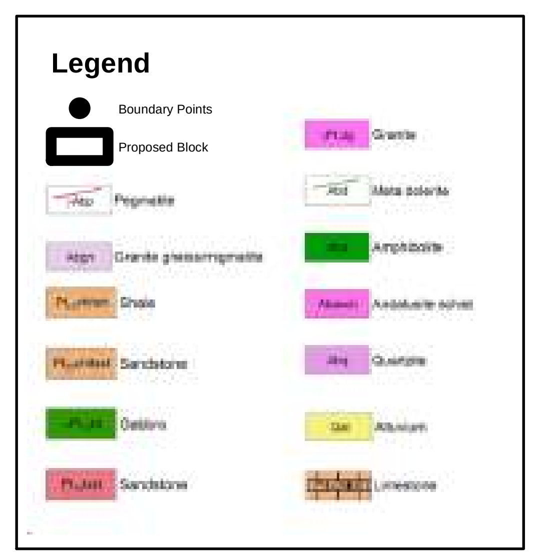


Plate-6

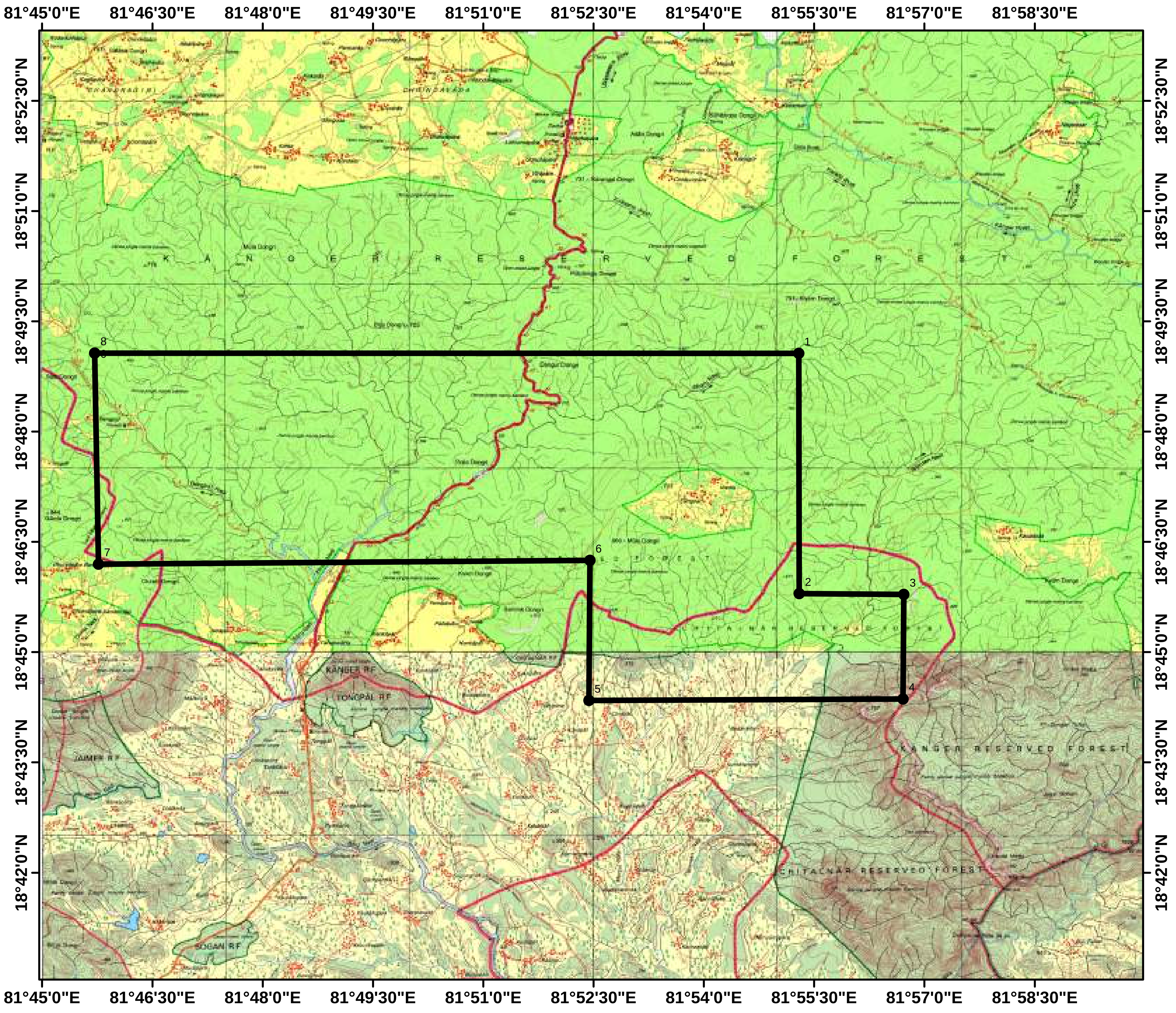
Proposed block boundary over Land use/ Accessibility map

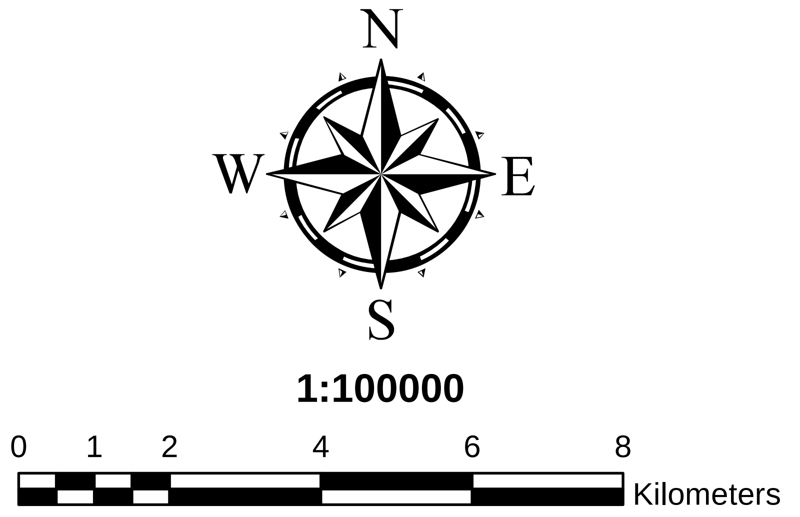
Not required at G4 stage

Plate-7

Location Map of proposed Block on Toposheet

Location of the proposed block (112 Sq.km) by UEIPL for G4 level of Exploration of Li, Sn, Nb, Ta, Ti and REEs elements in Chhattishgarh.
Toposheet No- 65F/13 and 65F/14





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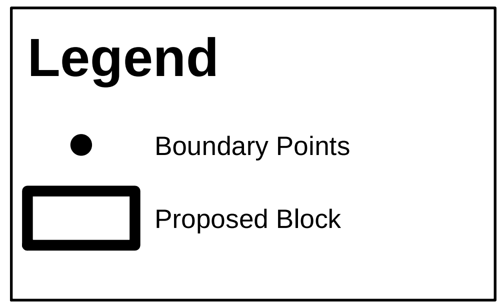

Annexure-1

Reference Paper

Lithium pegmatites in parts of Bastar Craton, Central India

Article *in* Exploration and Research for Atomic Minerals · July 1991

4 authors, including:

Yamuna Singh
Atomic Minerals Directorate for Exploration and Research

S D Rai
Atomic Minerals Directorate for Exploration and Research (AMD)

Exploration and Research for Atomic Minerals,
Vol. 4, 1991, p. 93 – 106

ISSN 0970 9231

LITHIUM PEGMATITES IN PARTS OF BASTAR CRATON, CENTRAL INDIA

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Department of Atomic Energy
Begumpet, Hyderabad - 500 016.

Abstract

Lithium pegmatites of considerable dimensions (width : 2-100 m x length : 10-1000 m) occur in the Bastar craton, Central India. These are zoned with a distinct quartz core flanked asymmetrically on either side by intermediate zones of albite ± microcline, lepidolite, and amblygonite assemblage followed by a wall zone of quartz, albite, mica, and tourmaline. Li and Ta-rich magmas seem to have operated separately in different subsystems. These pegmatitic melts are generally enriched in tin relative to niobium and tantalum. Amblygonite is present in all the pegmatites, whereas lepidolite is found in twelve pegmatites. Albitisation has played a major role in lithium mineralization.

Irregular and restricted spatial distribution of Li-pegmatites may suggest an anatectic origin for the Li-rich magmas in subsystems wherever the Bengpal metasediments (Archaean) were enriched in Li. Metasomatic replacement started mostly from the borders of quartz core and proceeded towards the wall zones. Lepidolite formed first in association with albite around quartz core, followed by amblygonite and tourmaline in the wall zones. Evidences point to crystallisation temperatures ranging from somewhat more than 600° C in parts of the granite to well below 500° C in the inner units of the pegmatites. Presence of beryl and absence of chrysoberyl indicate that vapour pressure was much less than the load pressure.

Preliminary estimates suggest that over 50,000 tonnes of lepidolite (1.0-1.85% Li) and an equal quantity of amblygonite (2.7-4.06% Li) of commercially accepted grades may be available for exploitation. Both lepidolite and amblygonite may need some prior beneficiation to reduce certain unwanted constituents to make a suitable product for the user industries.

INTRODUCTION

Owing to the unique chemical and physical properties of lithium and its compounds, there is a growing demand for this element. The largest applications of lithium are in aluminium grease, ceramic and glass, black and white television tube, porcelain, enamel frit, missile, medicine, photography, memory circuits, synthetic rubber, pharmaceutical, glass doping, and aerospace industries (James, 1981; Kunasz, 1983; Ferrell, 1984; James et al., 1991).

Lithium, electrochemically the most reactive element, is a constituent of many minerals in the Earth's crust. However, only five minerals, namely, spodumene ($LiAlSi_2O_6$), lepidolite ($KLiAl_2Si_3O_{10}(OH,F)_2$), petalite ($LiAl(Si_2O_5)_2$), amblygonite (Li Al (F, OH)

PO_4), and eucryptite ($LiAlSiO_4$) are the most common independent Li-minerals and are of commercial importance (Kunasz, 1983). These minerals commonly occur in granite pegmatites.

Lithium pegmatites in the Bastar craton are known from early 1900s (Crookshank, 1963). Since then, considerable amount of work has been carried out on the geology, structure, and mineralization in various parts of the craton (Mishra et al., 1984; Dutta et al., 1985; Mishra et al., 1988; Sarkar and Gupta, 1989; Ramakrishnan, 1990 and several other workers). Except for a few publications by the Geological Survey of India (Deshpande, 1976; 1978), describing the stray occurrences of lithium minerals in some of the pegmatites, the available literature on the lithium pegmatites of Bastar is scanty. Indeed, so far no attempt has been made to examine systematically the Li-pegmatites of Bastar craton. This paper provides a brief description of individual Li-pegmatites, discusses their petrogenesis, and evaluates their economic potential.

GEOLOGICAL SETTING

Bastar craton exposes a well-developed sequence of rocks ranging in age from Archaean to Upper Proterozoic. It forms the central part of the Indian Peninsular Shield occupying an area of 40,000 km² and is flanked by the Chattisgarh basin in the north, Eastern Ghat khondalite-charnockite complex in the south and east and the Pranhita-Godavari basin in the southwest (Figure 1).

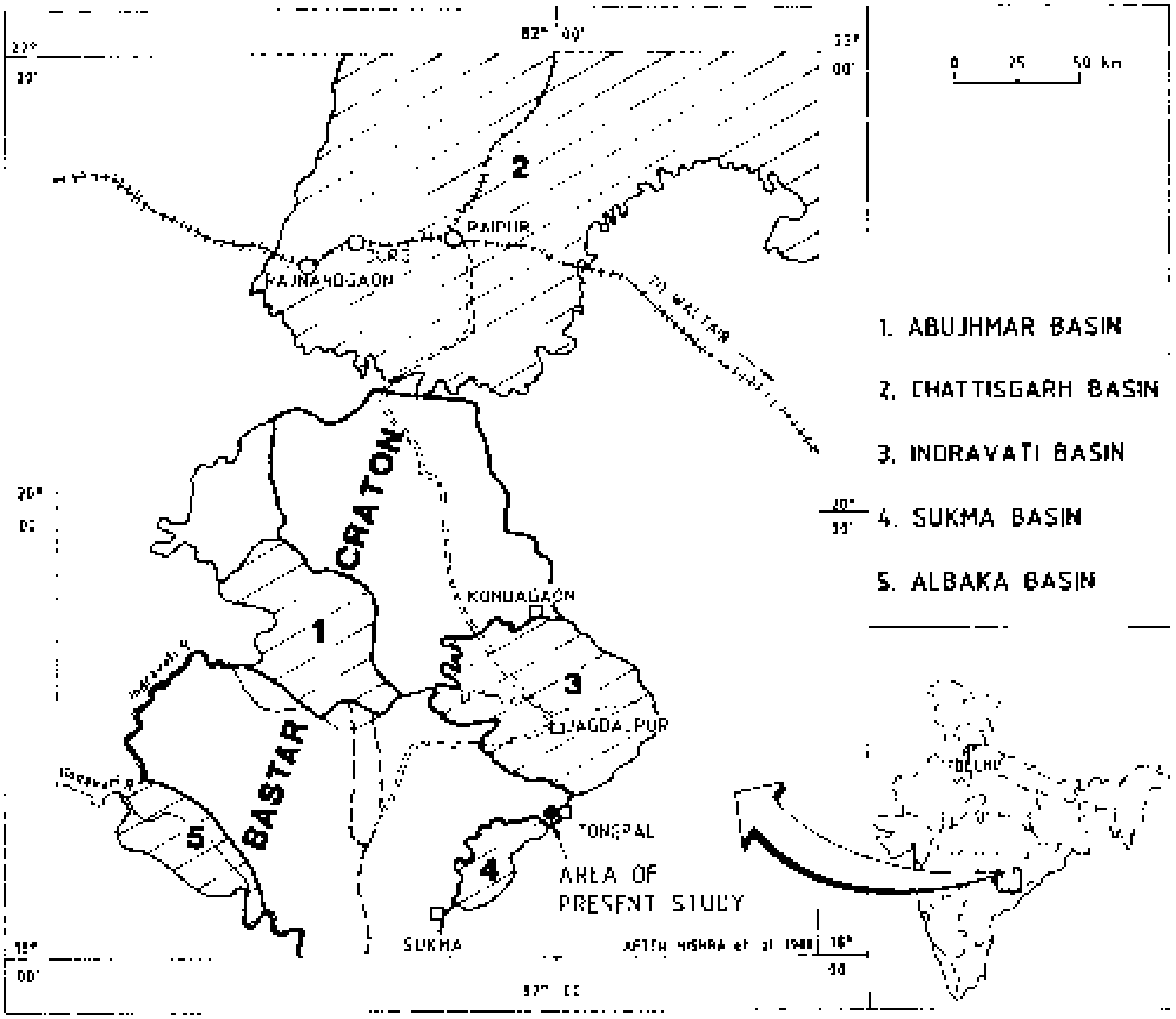

Figure 1. Location map of Bastar craton

The stratigraphic succession of the Bengpal Group in the area is given in Table 1. It is apparent from the table that the oldest rocks present in the area are low- to medium-grade metasediments and metabasic intrusives, all belonging to the Bengpal Group of Archaean age.

The metasediments are represented by quartzite, quartz-sericite schist, andalusite-sericite schist, staurolite gneiss and biotite-cordierite gneiss. The quartzitic rocks usually trend parallel to the foliation planes of schistose rocks along NW-SE to NNW-SSE direction and dip with low angles towards NE and ENE. Ripple marks and current beddings point to their sedimentary parentage and shallow nature of the basin.

The metasediments contain quartz, feldspar, muscovite, garnet, chlorite, andalusite, staurolite, apatite,

Table 1. Stratigraphic succession of the Bengpal Group of rocks in Bastar craton, Central India (Modified after Mishra et al., 1988)

Age	Group	Formation	Rock types	
ARCHAEAN	BENGPAL	Bijapur Gneiss	Acid igneous rocks	Granite, charnockite, granite gneiss, Including grey and pink gneiss and augen gneiss, migmatite, cordierite-sillimanite gneiss, charnockite gneiss, and leptynite
			Metamorphosed basic and ultrabasic rocks	Metagabbro, gabbroic anorthosite, and pyroxene granulite. Amphibolite, hornblende schist, talc-tremolite schist, and metapyroxenite, metaultramafics with serpentine
			Ferruginous rock ± garnet	Banded magnetite quartzite, orthopyroxene and orthoamphibole-grunerite schist (± cummingtonite)
			Arenaceous rocks ± garnet	Quartzite, fuchsite quartzite, micaceous quartzite, sillimanite quartzite, and graphite quartzite
		Chintavagu Quartzite	Pelitic rocks ± garnet	Mica schist, kyanite or sillimanite schist, and khondalites
			Calcareous rocks ± garnet	Calcareous quartzite ± pyroxene, calcareous amphibolite, calcareous granulites, and gneisses

zircon, magnetite, ilmenite, and rutile in different proportions.

Fine- to medium- to coarse-grained melanocratic massive and occasionally foliated amphibolites, metadolerites (metagabbro) and seldom metadiorites represent the metabasic rocks, which are usually emplaced as sill-like bodies and seldom cut across the schistosity planes of the metasedimentary rocks. The exposures range in size from 10 to 30 m in width and 100 m to 5 km in length and form linear ridges. The predominant trend is in a NW-SE direction with northeasterly dips. Subaqueous volcanic effusives with pillow structures have been described from Katekalyan area by Babu (1985).

Early intrusive syntectonic granitic activity, involving limited anatexis and related migmatisation of pre-existing rocks forming gneissic granites and migmatites, took place in the late Archaean, for which Rb-Sr whole rock isochron ages range from 2528 to 2659 Ma (Sarkar et al., 1990). The gneisses around Sukma represent a typical tonalite-trondjhemite-granodiorite suite (Karkare and Shrivastava, 1985). Subsequently, the area witnessed the main granite tectonism in the Lower Proterozoic, which culminated in the emplacement of pegmatites (host rocks for rare metal mineralization) together with some quartz veins in the weak zones in the metabasic and metasedimentary rocks, and the granites. The available whole rock Rb-Sr ages of granitic rocks from different parts of Bastar craton (Paliam, Darba: 2275 ± 80 Ma; Burugudam: 2237 + 70 Ma; Pujariguda: 2110 ± 47 Ma; Cholanguda: 2301 = 53 Ma; Pandey et al., 1989) suggest that remobilisation of sialic crust, resulting in the emplacements of granitic rocks from an anatectic melt, took place during the period ca 2300-2100 Ma. The presence of highly altered andalusite tabloids (1-4 cm) in the schists bordering the granites point to the contact-metamorphic effect, and the emplacement of granites at shallow depth in the crust (Lamba and Agarkar, 1988). However, younger K-Ar age of 1345 ± 22 Ma for biotite from granitic rocks exposed in the vicinity of village Paliam (Anonymous, 1978a), may be due to the effect of loss of Ar during some late geological event. Quartz veins, traversing all the older rocks including pegmatites, perhaps mark the last phase of acid magmatism in the area. The metasedimentary rocks, metabasic rocks, granites, and the pegmatites have been invaded by dolerite dykes.

GENERAL GEOLOGY OF THE PEGMATITES

The forms of pegmatites are predominantly tabular, lens-like, and pod-like which are either simple and unzoned, or zoned and complex bodies of variable dimensions (5-1000 m or even more in length and from less than a metre to 100 m in width) disposed in a NW-SE trending belt over a length of about 75 km and a width of 10 km. Their trends are variable but most common is NNW-SSE with steep NNE dips. The pegmatites emplaced in the metasedimentary rocks, metabasic rocks, and the granites differ in frequency and in character. The frequency of pegmatites traversing the metasedimentary rocks is rather low. They are simple, sometimes graphic, unzoned and consist of feldspar with some quartz and muscovite. Simple, ribbon-like, commonly unzoned and rarely albitised and greisenised pegmatites intrude the granites. Rare-metal mineralization in them is observed only around Katekalyan. The frequency of pegmatites traversing the metabasic rocks is much higher than those traversing the metasedimentary rocks. Those pegmatites which traverse the metabasic rocks were examined in detail since commonly they are rich in rare metal mineralization.

The rare-metal pegmatites are asymmetrically zoned with a prominant quartz core, an intermediate zone where Li-Be-Sn-Nb-Ta ores predominate, a wall rock zone where microcline and albite are the main minerals together with an assemblage of quartz, feldspar, microcline and garnet. The intermediate and wall zones are frequently of uneven width on either side of the quartz core and may even be absent on one side, leading to asymmetry in zoning (Singh and Mukherjee, 1985; Lamba and Agarkar, 1988). One of the interesting features in most of them is the intense metasomatic replacement marked by albitisation and greisenisation, together with some sericitisation and kaolinisation. The replacement of potash feldspar (microcline) by albite (cleavelandite) marks the albitisation, while the development of quartz-mica aggregates marks the greisenisation phase. The intensity of Li-Sn-Nb-Ta mineralization is related to the intensity of imposed albitisation and greisenisation. Regional zonation of the pegmatites is not conspicuous as described for the pegmatite districts elsewhere (Mulligan, 1962; Norton, 1975; Stewart, 1978).

The pegmatites are vertical to steeply dipping, commonly with pinch and swell structure both along strike and depth. They occur in swarms and in isolations. The important minerals are cleavelandite, muscovite, sericite, quartz, beryl, fluorite, tourmaline, cassiterite, and columbite-tantalite. The lithium minerals include lepidolite, zinnwaldite, cookeite, and amblygonite (Deshpande, 1978). Other important rare minerals reported from the pegmatites are sterryite, tantalite-stannien (Anonymous, 1978 b), pyrochlore (Schuiling, 1983), tapiolite, samarskite (Guha and Roy Chowdhary, 1983), lollingite, hetrolite, braunite and flour-apatite (Babu, 1985).

LITHIUM PEGMATITES

Some five hundred pegmatites are known from the Bastar craton (Babu, 1989). Only nineteen of them, however, have been found to host lithium mineralization (Yamuna Singh and Rai, 1986). Spatial distribution of Li-pegmatites, which are confined to the south eastern portion of the pegmatite belt, suggests that they are essentially emplaced in metabasic rocks forming three small zones (Figure 2), as described below. Analyses of lithium minerals, mostly from promising pegmatites, are given in Table 2 and Table 3

Bekupada zone

In this zone, only two lithium pegmatites have been located.

Bekupada pegmatite-1 (BKP-1)

The pegmatite shows a trend of N 60° E - S 60° W with a length of about 1000 m and breadth of 100 m, and forms a 50 m high mound above the ground surface. The quartz core is predominantly smoky black and fractured. In addition to the main quartz core, subsidiary quartz cores are also present. Greisenisation is in the form of development of colourless, yellow, and green muscovite whereas, albitisation is marked by the presence of albite and cleavelandite.

Both amblygonite (8.74% Li_2O) and lepidolite (2.37 % Li_2O) are found in the pegmatite. Amblygonite is milky-white to greyish-white and occurs as big crystals. Lepidolite shows fine-grained granular habit with purple colour and is associated with cleavelandite. Green, compact, and soapy fluor-apatite is also occasionally associated with lepidolite.

Bekupada pegmatite-2 (BKP-2)

This pegmatite is located about 400 m west of BKP-1. Its trend is in N 60° W- S 60° E direction with a total length of about 150 m and breadth of 40 m. It rises about 30 m above the ground surface. It is greisenised and albitised and shows muscovite-quartz-cleavelandite mineral assemblage. Only stray pieces of amblygonite (8.2% Li_2O) are found in this pegmatite.

Govindpal-Mundval Zone

This zone extends over about 8 km in length in NNW-SSE direction where eight lithium pegmatites have been located.

Govindpal pegmatite-1 (GPP-1)

This pegmatite strikes in N 35° W-S 35° E direction with dip due S55°W. The dip is steeper in the southeastern end of the pegmatite. It has a length of about 375 m and width of 2-10 m. The quartz core is discontinuous, varying in width from 0.5 to 2.0 m, and consists of moderately jointed smoky and milky white quartz. The central part of the pegmatite has a distinct 2-3 m wide lepidolite zone containing sugary albite and a little quartz; the lepidolite is rose to violet-coloured, fine-grained, massive, and compact. Violet fluorite is noticed commonly along the fractures. Bordering this zone is lepidolite-cleavelandite zone with a little quartz, but without fluorite mineralization. Here, lepidolite occurs as disseminated saggregates and is fine- to medium-grained show-

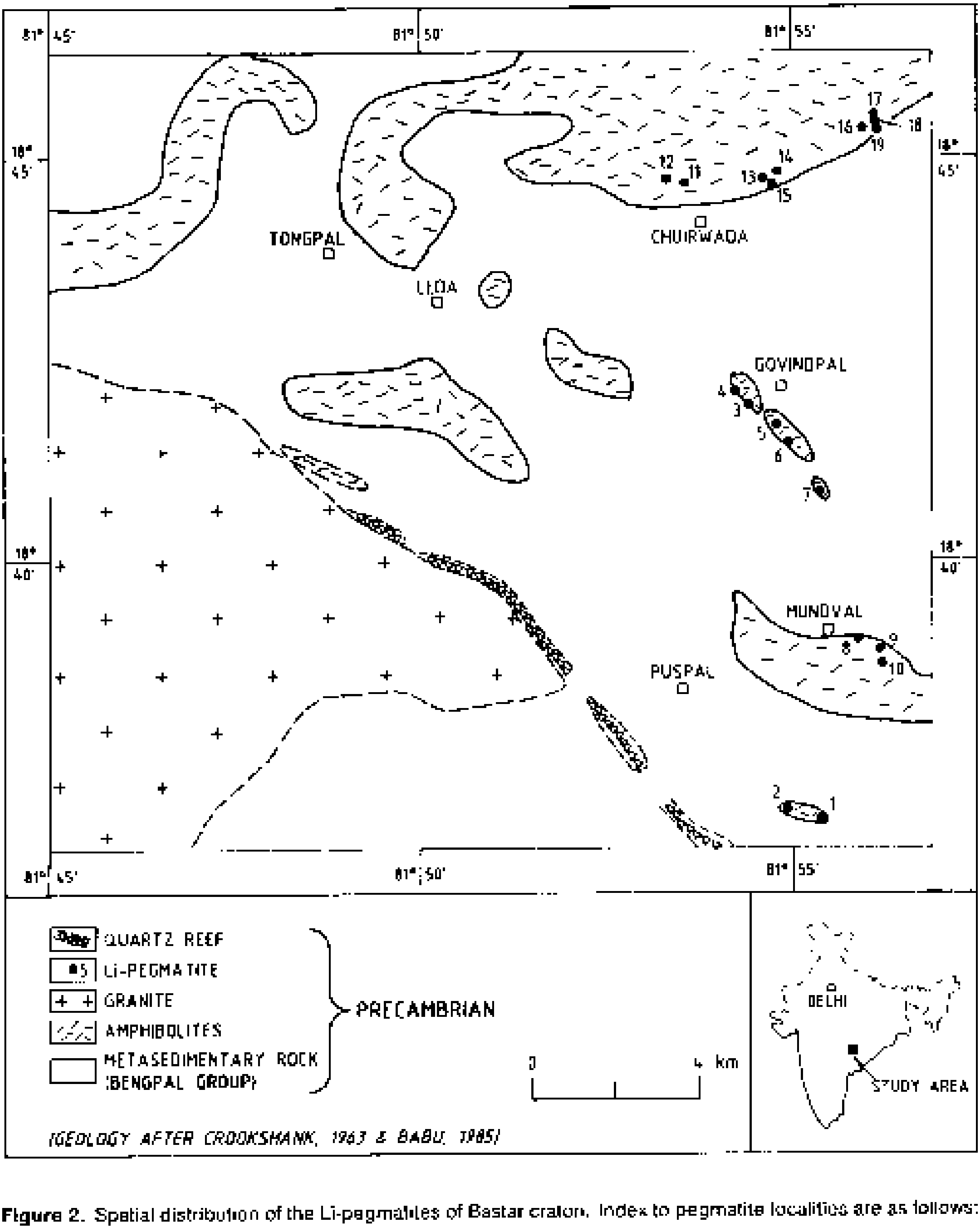

Figure 2. Spatial distribution of the Li-pegmatites of Bastar craton. Index to pegmatite localities are as follows: (1) BKP-1; (2) BKP-2; (3) GPP-1; (4) GPP-2; (5) BRP-1; (6) BRP-2; (7) CNP-1, (8) MVP-1; (9) MVP-2; (10) MVP-3; (11) CWP-1; (12) CWP-2; (13) BNP-1; (14) BNP-2, (15) BNP-3; (16) BVP-1; (17) BVP-2; (18) BVP-3; and (19) BVP-4. See text for names of these localities.

ing micaceous habit, whereas cleavelandite is of two types. The one which is more commonly associated with lepidolite is milky with platy habit and vitreous lustre (often pearly on cleavage surfaces). Fine-grained dark coloured quartz is also associated with this variety of cleavelandite. The other variety of cleave-

Table 2. Partial analysis of lepidolite/lithium mica from lithium pegmatites of Bastar craton (all data in weight percent)

Sl. No.	Pegmatite locality code	Sample No.	SiO_2^*	Li*	Li_2O^a
1.	BKP-1	L-1	61.93	1.10	2.37
2.	GPP-1	L-2	48.93	1.50	3.24
3.	CNP-1	L-3	48.92	1.40	3.02
4.	MVP-1	L-4	52.19	1.10	2.37
5.	MVP-1	L-5	48.46	1.50	3.24
6.	MVP-2	L-6	47.99	1.0	2.16
7.	MVP-3	L-7	51.86	1.25	2.69
8.	CWP-1	L-8	50.32	1.40	3.02
9.	BNP-1	L-9	51.56	1.85	3.99
10.	BNP-1	L-10	49.82	1.20	2.58
11.	BNP-1	L-11	56.28	1.35	2.91
12.	BVP-2	L-12	47.30	0.31	0.67
13.	BVP-4	L-13	52.92	1.66	2.29

* Data : Chemical Laboratory, AMD, Hyderabad. a = Computed

Table 3. Partial chemical analysis of amblygonite from lithium-pegmatites of Bastar craton (all data in weight percent)

Sl. No.	Pegmatite No.	Sample No.	SiO_2	Li	Li_2O^a	K_2O	Rb_2O	Al_2O_3	Cr_2O_3	$Fe_2O_3^*$	MnO	SnO_2
1.	BKP-1	A-1	<1.00	4.06	8.74	0.01	0.01	55.23	0.005	0.07	0.01	0.05
2.	BKP-2	A-2	<1.00	3.80	8.20	0.02	0.01	33.76	0.005	0.12	0.01	0.05
3.	GPP-1	A-3	<1.00	4.00	8.64	0.01	0.01	35 04	0.005	0.09	0.01	0.05
4.	CNP-1	A-4	<1.00	3.81	8.20	0.01	0.01	34.38	0.005	0.17	0.01	0.05
5.	CWP-1	A-5	<1.00	3.60	7.77	0.02	0.01	33.91	0.005	0.10	0.01	0.05
6.	BVP-3	A-7	10.30	2.60	5.61	1.11	0.11	31.07	0.005	0.13	0.04	0.05

Data : Chemical Laboratory, AMD, Hyderabad.

* = Total iron as Fe_2O_3 a = Computed

landite is comparatively compact, dark grey, and acicular. The cleavelandite-bearing lepidolite zones in the pegmatite consist of (i) cleavelandite-muscovite (booklets of green and colourless muscovite) and (ii) cleavelandite-quartz-garnet assemblage.

In the southern part of the pegmatite, besides lepidolite (3.24 % Li_2O), white massive amblygonite (8.64% Li_2O) with perfect cleavage and pearly lustre, occurs abundantly in pockets forming huge crystals. Green mica is occasionally associated with it.

Govindpal pegmatite-2 (GPP-2)

The pegmatite is located about 200 m NW of GPP-1. It trends in NW-SE direction with a length of about 15 m and a width of 1-1.5 m. It contains stray pieces of lepidolite and amblygonite.

Berikupli pegmatite-1 (BRP-1)

It shows NW-SE trend and dip of 75-80° towards SW. The pegmatite has a length of about 125 m and a width of 3-5 m. The quartz core of the pegmatite is predominantly smoky. Extensive greisenisation is marked in the form of booklets and radiating colourless and pale green muscovite aggregates, especially in the southeastern portion of the pegmatite. Albitisation, in the form of sugary albite (predominant) and dark grey cleavelandite, is noticed.

Amblygonite of white and pale greenish colour occurs in the central part of the pegmatite, mostly associated with quartz core, and occasionally with green mica. White variety of amblygonite is more common and forms big crystals.

Berikupli pegmatite-2 (BRP-2)

The pegmatite is located about 400 m southeast of BRP-1 and strikes in NW-SE direction, with a length of about 100 m and breadth of 5-7 m. Stray pieces of white amblygonite are noticed in this pegmatite.

Chitalnar pegmatite-1 (CNP-1)

The pegmatite strikes in N-S direction with westerly dips of 80-85°, and a length of about 100 m and breadth from 7 to 10 m. The quartz core is white or smoky and jointed. The northern part of the pegmatite is extensively albitised showing pronounced development of sugary albite, whereas the south-central and southern parts are dominantly greisenised, marked by radiating muscovite aggregates with a little quartz.

Lepidolite (3.02 % Li_2O) and amblygonite (8.2 % Li_2O) are present mainy in the central and southern parts of the pegmatite. Lepidolite occurs as compact, massive, and fine-grained aggregate on either side of the quartz core. Huge amblygonite crystals of white colour showing elephant skin structure on weathered surfaces are also found. It is interesting to mention here that amblygonite predominates over lepidolite in the southern part of the pegmatite and vice versa in the central part.

Mundval pegmatite (MVP-1)

The pegmatite has a length of about 100 m and a width of 20-25 m and trends in NW-SE direction. The quartz core is smoky. Albitisation is marked by extensive development of milky white and platy cleavelandite.

Lepidolite (2.37-3.24% Li_2O) is pale rose and medium- to coarse-grained. Stray pieces of greyish white amblygonite are present.

Mundval pegmatite-2 (MVP-2)

This pegmatite is located about 100 m northwest of MVP-1. It has a length of about 50 m and a width of 15 m, and trends in NW-SE direction, with a smoky quartz core. The pegmatite hosts fine- to medium-grained micaceous, pale-rose and prussian blue lepidolite (2.16 % Li_2O).

Mundval pegmatite-3 (MVP-3)

It is located about 100 m south of MVP-1 in the hill slope. It strikes in NW-SE direction, with a length of about 50 m and a width of 5 m. Pale rose and fine-to medium-grained, granular, aggregates of lepidolite (2.7 % Li_2O) are present in this pegmatite.

Chiurwada-Bodavada Zone

In this zone, which extends over about 5 km length in WNW-ENE direction (Figure 2), nine lithium pegmatites have been located.

Chiurwada pegmatite-1 (CWP-1)

This pegmatite strikes in N 30° E-S 30° W direction and dips at an angle of 80° towards N 60° W. It has a length of about 20 m and a width of 10 m and even more with a 2.5-3.0 m wide white and smoky quartz core. Extensive greisenisation, represented by muscovite aggregates of greenish (predominant), greyish, colourless, yellowish, olive green, and bluish (seldom) colours, are found in the northern part of the pegmatite. The muscovite shows plumose, scaly, and massive forms. Perthite and cleavelandite are seen in different parts of the pegmatite. Sugary albite and reddish brown garnet are seen associated in the outermost zone.

Lepidolite (3.02% Li_2O) and amblygonite (7.77% Li_2O) are present in the central part. The lepidolite is granular, violet coloured, and medium- to coarse-grained. The amblygonite is pale greenish-white (predominant) and greyish-white, occurs as cleavable to columnar masses of big crystals. Greyish-white amblygonite is distinguished by vitreous lustre and compact nature.

Chiurwada pegmatite-2 (CWP-2)

This pegmatite, located about 100 m west of CWP-1, has been worked extensively for cassiterite and therefore, details about it could not be ascertained. Only stray pieces of amblygonite have been found in the dumps.

Badenpal pegmatite (BNP-1)

The pegmatite has N 50° E-S 50° W trend and a dip of 75° towards S 40° E. It has a length of about 15 m and a width of 2 m, with 1.5 m wide white and smoky quartz core. Colourless and greenish muscovite, violet fluorite, olive-green flourapatite (usually massive and occasionally granular with greasy feel, occurring as fracture filling), sugary albite and cleavelandite are the common rock forming minerals.

Lithium minerals include lepidolite (2.59-3.99 % Li_2O) and amblygonite. Megascopically, lepidolite is of three types : (i) fine-grained and massive occurring in association with cleavelandite and quartz, (ii) coarse-grained, disseminated scaly granular aggregates in association with cleavelandite, sugary albite, and quartz; and (iii) cleavable lepidolite plates and booklets in association with cleavelandite and quartz. Big crystals of white amblygonite, showing brittle nature and perfect cleavage, and cleavable to columnar pieces are frequently observed. Reddish brown garnet together with quartz and feldspar is also present.

Badenpal pegmatite-2 (BNP-2)

It is located about 100 m northeast of BNP-1, and shows N 50° E-S 50° W trend and dip of 60° towards N 40° W. This pegmatite is occasionally greisenised. Quartz and perthite intergrowths and booklets of mica are often seen. Only stray pieces of amblygonite (greenish and brittle) are seen in this pegmatite.

Badenpal pegmatite-3 (BNP-3)

This pegmatite is located about 20 m west of BNP-2 and shows N 50° E - S 50° W trend and dip of 60° due N 40° W. It has a length of about 15 m and a width of 5 m. Stray pieces of white amblygonite are found in it.

Bodavada pegmatite-1 (BVP-1)

This pegmatite follows a N 50° E - S 50° W trend, dipping vertically and traceable for a length of about 25 m with a width of 3 m. Quartz core is smoky and white. Other zones are indistinct. Big platy laths of muscovite and olive-green and compact fluorapatite are present. Pale rose, prussian blue (seldom), massive and fine- to coarse-grained granular lepidolite and greyish and milky white and brittle (cleavable to columnar pieces) amblygonite are found in BVP-1.

Bodavada pegmatite-2 (BVP-2)

The pegmatite occurs about 10 m northeast of BVP-1, and follows a N 50° E-S 50° W trend. It has a length of about 30 m and a width of 10 m. Greisenisation is predominant in the southern part of the pegmatite. Pale-rose lithium mica/lepidolite (<1.0% Li_2O), and white amblygonite are noticed in the northern part.

Bodavada pegmatite-3 (BVP-3)

The BVP-3 is located about 10 m northeast of BVP-1. It strikes in a N 50° E-S 50° W direction. It has a length of about 10 m and a width of 3 m. As compared to other parts, the northern part of the pegmatite seems to be more greisenised. Only amblygonite (5.61% Li_2O) is present and shows elephant skin structure on weathered surfaces. It is greyish white in colour and has pearly lustre on the cleavage surfaces.

Bodavada pegmatite-4 (BVP-4)

It is situated about 15 m northeast of BVP-3, following a N 50 ° E-S 50° W trend, with a length of about 10 m and width of 3 m. Only lepidolite (2.29% Li_2O) is seen, which shows pale rose colour, granular and massive habit, and is associated with cleavelandite.

DISCUSSION

From the foregoing it is evident that all the Li-pegmatites are of complex nature. They have undergone extensive metasomatic processes like albitisation and greisenisation resulting in almost all the units, except the quartz core, being metasomatically replaced. Li-minerals are absent in the non-metasomatised pegmatites showing that albitisation and greisenisation have played a key role in Li-mineralization. Further, the intensity of Li-mineralization is stronger in and around albitised portions of the pegmatites, indicating that albitisation played a major role in Li-mineralization.

According to various workers (Mulligan, 1962; Ginzburg, 1972 and several others), lithium pegmatites are also tantalum-rich. In the present case, although columbite-tantalite is found in a few pegmatites occurring in the vicinities of Li-pegmatites, such as at Berikupli, Chiurwada, Badenpal, and Mundval (Ramachar et al., 1983; Bose et al., 1983), all the Li-pegmatites are devoid of Nb-Ta-rich phases. Incidentally, available analyses of mineral samples (Ramachar et al., 1983, Table 3, p.106) from Li-pegmatites indicate essentially cassiterite enrichment (45.36-74.85 % SnO_2), with subordinate Nb-Ta phase (4.36-14.45 % Ta_2O_5). Some values of Nb-Ta in the samples may be due to the presence of tantalite in cassiterite. An appreciable amount of Sn (600-1000 ppm) with low values of Nb (50- 70 ppm) and Ta (200-500 ppm) in most lepidolite samples (Babu, 1983, Table 3, p.79; Satyanarayana and Bose, 1983, Table 3, p.88) may also suggest that Li-ore forming fluids were rich in Sn relative to Nb and Ta. This is further supported by the fact that all the columbite-tantalite pegmatites known till date from different parts of Bastar craton, as for example, Alanar-Garda (Tiwary and Padlambar, 1990), Metapal-Bodenar (Ramesh Babu, 1991), Mendoli-Kawadgaon (Yamuna Singh, 1991) and several others, are characteristically devoid of Li-minerals. These salient features would, therefore, suggest that Li-mineralization in pegmatites of Bastar craton is independent of Nb-Ta mineralization, unlike the Li-Nb-Ta mineralization in pegmatites described by various workers (Mulligan, 1962; Ginzburg, 1972). Thus, it would appear that the processes that gave rise to Li-rich and Nb-Ta-rich pegmatite magmas operated independently.

The presence of cassiterite, fluorapatite, fluorite, tourmaline and lepidolite point to the fact that volatile constituents were available in the residual liquids in plenty leading to the pneumatolitic action. The volatile constituents might have reacted mostly along weaker planes of the pegmatites during the waning phase of their formation and to some extent with the parent granite near margins, as for example, near Katekalyan where cassiterite mineralization together with some fluorite is abundantly seen locally. During the course of this post-magmatic process due to action of chemically reactive aqueous solutions on the crystallising pegmatitic minerals, the Li and other rare-metals that were fixed in the lattice of the rock forming minerals might have been remobilised and reconcentrated by the rare-metal enriched volatile forming independent Li, Sn and Be minerals mainly in the albitised and greisenised portions of the pegamtites. Deshpande (1976) describes the paragenetic sequence as: Si-K-Be-Na-Li-F-Sn-Nb/Ta.

Increase in the acidity due to fluorine and boron, caused greisenisation of feldspar resulting in the formation of K-mica with liberation of quartz. Microcline has passed through the stages of albitisation, and greisenisation. This is the most probable reason for the paucity of K-feldspar in the extensively albitised and greisenised Li-pegmatites of Bastar craton.

Although the traditional view that Li-rich magma formed by concentration of lithium in the parental granitic magma is still dominant (Cerny and Meintzer, 1988), the disproportionate abundance of Li-pegmatites in clusters (Figure 2) suggests that localised processes were more important in lithium mineralization than regional processes. Granitic magma bodies of small size may be adequate to supply the constituents of even the largest and the richest Li-pegmatites as envisaged by Norton and Redden (1990), but the role of key processes in small subsystems are inadequately understood or have escaped notice entirely (Walker et al., 1989)

Melt derived from anatexis of metasedimentary rocks are believed to be the source of Li-mineralization in most cases (Norton, 1981; Stewart, 1978). In the present case, large scale anatexis involving metasediments of the Bengpal Group is envisaged to have resulted in the granite magmatism over a long span of time (2300-2100 Ma). This yielded various kinds of granitic and pegmatitic bodies, responsible for the rare-metal (Be, Sn, Nb, Ta, Li, and others) mineralization in Bastar craton (Murti et al., 1983; Bose et al., 1983; Babu, 1983; Lamba and Agarkar, 1986). Obviously, conditions must have been different in various parts of Bastar craton at any single time, and must also have changed through time in any single place. When the circumstances are viewed from this angle, the vagueness of the regional zonation pattern appears logical. The isolated clustering behaviour of Nb-Ta pegmatites (Yamuna Singh, 1991) as well as Li-pegmatites (Yamuna Singh, 1987), thus points to the existence of sub-systems and indicates that the subsystems behaved differently at different places as noticed by Norton and Redden (1990) in the case of Black Hills pegmatites. According to these workers, in a single sub-system the age sequence almost certainly is the conventional one from granitic to pegmatitic rocks, but sub-systems in different places may be of different age, and some localities may have two or more sub-systems of different ages. The localised differences in Nb-Ta and Li-mineralization in Bastar craton possibly resulted largely from differences in the composition of protoliths, and processes during anatexis. Hence, it is quite likely that wherever Bengpal schists were enriched in Li, the resultant anatectic melt was also enriched in Li, which formed a Li-rich sub-system resulting in the Li- mineralization. The irregularly restricted distribution of Li-pegmatites and their absence within the related granites of Paliam (?) are in accord with their anatectic origin as suggested by Stewart (1978) for Li-pegmatites.

According to Munoz (1971), in the absence of quartz, lepidolite can appear as a liquidous phase if HF fugacity is sufficiently high. However, possible ranges of HF fugacity controlling lepidolite phase relations during the course of pegmatitic crystallisation are not known. The phase relations to the reaction are:

$$KAlSi_3O_8 + Li_2SiO_3 + 2HF = KLi_2AlSi_4O_{10}F_2H_2O$$

High content of fluorine in lepidolite (4.48% F) (Crookshank, 1963) from Mundval pegmatite and presence of fluorite in Li-pegmatites suggests the prevalence of sufficiently high HF fugacity in the system. Although, such a fugacity was present, as manifested by abundant fluorite veins in granitic and pegmatitic rocks throughout the rare-metal pegmatite belt, possibly Li-rich sub-system was not available everywhere. This resulted in the irregularly restricted Li-mineralization in the Bastar craton. Another point that needs special mention is the low content of Fe and Mg in the granite from the area (Satyanarayana and Bose, 1983; Ramachar et al., 1983; Babu and Bose, 1983) pointing to the fact that the anatectic temperatures were mostly below the biotite solidus or that the source rocks themselves had a low content of biotite (Norton and Redden, 1990). One consequence of melting below the biotite solidus would be the observed contrast between about 30 ppm Li in granite and about 50 ppm Li in the mica schists of Black Hills, south Dakota, U.S.A. (Norton, 1981). The left-over biotite with higher Li than in muscovite in the schist (Shearer et al., 1986) explains this. Although data on the Li contents of schists and granite are not available, the possibility of melting below the biotite solidus and retention of Li in biotite of schists in parts of Bastar craton cannot be ruled out.

Natural occurrences provide important qualitative information on the pressure-temperature conditions (Sebastian and Lagache, 1991). According to Stewart (1978), Li-pegmatites form at temperatures of 500°-625°C at any pressure greater than 2 kb. Burnham and Nekvasil (1986) have shown that the H_2O saturated solidus of a composite sample from drill holes in the Harding pegmatite, Dixon, New Mexico, which is rich in lepidolite and spodumene, is 610°C at pressure of above 2 kbar, which is in good agreement with the findings of London et al., (1989). According to the above studies, and data on fluid inclusions, as well as isotope studies (Bozarov and Motorina 1969; London, 1986), crystallisation under quartz-saturated conditions is thought to occur at temperatures below 660°C and pressures below 4 or 5 kbar. High temperature would be depressed to somewhat below 600°C by the presence of potash feldspar, excess Al_2O_3, and other constituents (Stewart, 1978). London (1986) traced the evolution of the fluid in the Tanco pegmatite from high to lower temperature by study of fluid inclusions. The inclusions contain a dense hydrous fluid that is exceedingly rich in B, and also rich in Li, Na and Cs, and has 14% Al_2O_3, and 38% SiO_2. Experiments in the system $LiAlSiO_4$ - $NaAlSi_3O_8$ - SiO_2 - $Li_2B_4O_7$ - H_2O at 2 kbar indicated that the composition proceeded from Stewart's eutectic at 640°C to 500°C at a point near the $NaAlSi_3O_8$ - LiB_4O_7 sideline of the tetrahedron (London, 1986). London showed that this fluid possibly formed the albites that are the source of the Ta mined at Tanco. These are also enriched in Sn, and that albitisation took place between 470° and 420°C when the boron went into tourmaline in the wall rocks and the wall zone of the pegmatite. London concluded that the B-rich fluid was the final stage of primary magmatic crystallisation, and he regarded the formation of a subsequent low density fluid as the beginning of hydrothermal subsolidus activity.

The host rock of the Li-pegmatites of Bastar craton is amphibolite with the pegmatites in close proximity to its contact with schists. They consist of quartz core, flanked on either side or on one side by cassiterite bearing albite-lithian mica (lepidolite and zinnwaldite). The wall rock and the wall zone have tourmaline. The replacement units start mostly from quartz core, with albite (crystalline, fine-grained sugary albite and cleavelandite) ± microcline, lithian muscovite, and amblygonite in the intermediate and the wall zones. The intensity of replacement is maximum close to the quartz core. From the proximity of the occurrence of lepidolite to the cores of the pegmatites, it seems quite probable that most, if not all, lepidolite formed at subsolidus temperatures which, for pegmatitic magmas, probably means less than 600°C at 2 kb (Jahns and Burnham, 1958). Amblygonite, which mostly occurs in the middle zone and relatively away from quartz core might have formed at a temperature lower than lepidolite. The replacement units constitute nearly 60-70% of the Li-pegmatites, and thus their formation and temperature regime were a major part of the history of crystallisation of the pegmatite. It is believed that replacement started mostly at the borders of the quartz core towards wall zone, explaining the intense replacement and development of higher amount of lepidolite-albite than amblygonite near the core.

The above description points to crystallisation temperatures ranging from somewhat more than 660°C in part of the granite to well below 500°C in the inner units of the Li-pegmatites at a vapour pressure of about 2 kb or so. The vapour pressure seems to have been much less than the load pressure, for otherwise, according to Barton (1986), chrysoberyl instead of beryl would be the stable Be mineral. Beryl is common whereas chrysoberyl is not found in the Li-pegmatites of Baster craton (Yamuna Singh, 1987).

ECONOMIC CONSIDERATIONS

Estimation of lithium mineral resources of pegmatites is an intricate problem because of the very erratic mineralization in the form of pockets. However, Crookshank (1963) had estimated 10,000 tonnes of lepidolite upto a depth of 10 m from surface with 3.34% Li_2O and 4.48% fluorine. Deshpande (1978) inferred that more than 50,000 tonnes of lepidolite with Li_2O more than 3% would be available upto 5 m depth from Govindpal and Berikupli pegmatites alone. He did not consider Chiurwada, Chitlanar, Mundval, and Bekupada pegmatites. Considering all the Li-pegmatites described in this paper, the reserve of lepidolite is likely to be much more than what has been estimated by Deshpande (1978), besides the reserves of amblygonite.

According to Kunasz (1983), in commercial deposits of lepidolite and amblygonite, the concentrations are normally 1.4-1.9% Li and 3.5-4.2% Li respectively. In view of the above, it may be inferred that commercially acceptable grades of lepidolite (1.40-1.50% Li) and amblygonite (3.6-4.0% Li) are available in GPP-1, CNP-1, and CWP-1. In addition to these, commercial grade lepidolite (1.4-1.6% Li) from MVP-1 and BVP-4, and amblygonite (3.80-4.06% Li) from BKP-1 are also available. Lepidolite and amblygonite from these pegmatites may be used by the glass, ceramic, porcelain, and enamel industries without prior beneficiation, except hand cobbing.

With the exception of lepidolite from Badenpal Pegmatite (BNP-1) (3.99% Li_2O and 51.56% SiO_2), the lepidolites from other pegmatites do not conform to the specifications laid down by Bharat Electronics Limited (BEL) (<55% SiO_2 and minimum 3.5% Li_2O). However, studies with a view to upgrade Li_2O content and reduce SiO_2 content in the lepidolite by beneficiation and roasting may prove rewarding. On the other hand, ranges of 5.61 - 8.74% Li_2O and <1.0 to 10.30% SiO_2 in amblygonite (Table 2) suggest its suitability for use by BEL. From Table 3, it is also clear that concentrations of K_2O (0.01 - 1.11%), Rb_2O (0.01 - 0.11%), Cr_2O_3 (0.005%), Fe_2O_3 (0.07-0.13%), MnO (0.01-0.4%), and SnO_2 (0.05% in all) are well below their permissible limits of 3.3%, 0.01%, 0.10%, 0.35% and 0.15% respectively, except that values of Al_2O_3 (31.07-35.23%) marginally exceed the upper limit of 28%. Considering all the available data amblygonite appears to be suitable for use by BEL, if its phosphate content does not come in the way.

In view of the large tonnage of lepidolite and amblygonite and the diverse applications of lithium and its compounds, and present dependence of the country on imports, Li-pegmatites of the Bastar craton assume significance.

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(FIELD SEASON 1978- 79)

By

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REGIONAL ASSESSMENT SURVEYS FOR CASSITERITE AND ASSOCIATED RARE MINERALS IN SELECTED BLOCKS VIZ. BODAVADA, JANGARPAL- KUDRIPAL, CHIDPAL-KANKAPAL-MURGEL AND TONGPAL-MARJUN BASTAR DISTRICT, M.P.

(Field Season 1978 - 79)

CONTENTS

REGIONAL ASSESSMENT SURVEYS FOR CASSITERITE AND ASSOCIATED RARE MINERALS IN SELECTED BLOCKS VIZ. BODAVADA, JANGARPAL- KUDRIPAL, MURGEL, CHIDPAL, KANKAPAL AND TONGPAL-MARJUN BASTAR DISTRICT, MADHYA PRADESH.

(FIELD SEASON 1978-79)

SUMMARY:

The regional assessment surveys in selected blocks in 65 F/13 and 14 were continued (during the FS 1978-79) in Bastar district, M.P. As per the programme drawn up in the Objective Scheme of Exploration (1978-81), the regional surveys were aimed at resource evaluation of mainly the colluvial tin resources and partly the primary Sn potentialities in the. pegmatites by resorting to systematic bene-ficiation studies.

The programme was modified because of the fact that the ore dressing equipments were in position only by the end of July’ 79 and secondly the proposed mining venture in collaboration through MEC did not come through. The departmental Mining Unit could also only be deployed by the end of July' 79 after the closure of the operations in Rowghat Iron Ore Project.

The suitable modification included intensifying the preliminary surveys over a large area (25.3 sq. kms) for identifying the prospective areas by bulk sampling and obtaining the concentrates by hand-panning/sluicing. This hand enabled to delineate narrow target areas in several blocks which are ear-marked for systematic beneficiation studies in the subsequent field seasons.

The regional assessment surveys were carried out in Bodavada, Murgel, Chidpal-Kankapal,

Tongpal-Marjun and Kudripal-Jangarpal, Madkamiras blocks.

The blocks were selected earlier by utilising the data of stanniferous pegmatites delineated by Murti-K. S et, al. (1975-76) and considering the possibility of the accummulation of detrital cassiterite due to secondary agencies of weathering and denudation, in the major celluvium (Pawade)belt developed all along the southerly slopes of the major E-W basic body (Ellingar Hill). In each of the blocks, reconnaissance mapping was carried out on 4" to 1 mile scale (1:15,840) and the prospective areas were investigated by large scale mapping (1:5,000), pitting, bulk sampling and concentration by hand panning/sluicing.

A total of 25.3 sq. kms. area was investigated by preliminary, surveys and the prospective areas delineated to be of 5.7 sq. kms. in Bodavada, Kudripal, Jangarpal, Murgel, Chidpal-Kankapal and Tongpal-Marjur blocks.

Out of these, the GSI had the collaboration of AMD mostly for analysis of samples in two blocks viz. Kudripal and Murgel. GSI had carried out the assessment surveys completely. AMD officers were associated on part-time basis while collection of samples. The analysis of the concentrate samples (255 Nos.) were carried for SnO_2, NO_2O_5 & Ta_2O_5 by the AMD.

The sample concentrates from the other blocks were analysed in GSI (CR) by spectrographic screening and by XRF at Central Chemical Laboratory, Calcutta. The analytical results were received in batches up till June' 80.

The present report incorporates the results of the regional assessment surveys carried out by the various officers as shown below :-

Name of block	Authors
Bodavada	R.N. Pal
Jangarpal-Kudripal	T.M. Babu
Tongpal-Marjun	B. Satyanarayana
Chidpal-Kankapal-Murgel	T.B. Mahapatra & S.N. Upadhye
X-ray and mineralogical studies.	B. Satyanarayana and S.K. Bose

PRESENTATION:

The investigations carried out by different authors are incorporated in parts for blocks viz., Bodavada, Jangarpal, Kudripal, Murgel, Chidpal - Kankapal and Tongpal-Marjun which are self contained.

The salient aspects are given below:

(a) In the Bodavada block, over an aggregate area of 0.9 sq. kms, a resource potential of 237 tonnes of Sn and besides Nb_2O_5+ Ta_2O_5 can be indcated in the colluvium.

(b) In Jagarpal block, over an area of 1.3 sq. kms. a resource potential of 106 tonnes of Sn, 77 tonnes of Nb_2O_5 and 67 tonnes of Ta_2O_5 can be anticipated.

(c) In Kudripal block, over an area of 2 sq. kms. a resource potential of 51 tonnes of Sn, 51 tonnes of Nb_2O_5, and 37 tonnes of Ta_2O_5 are possibly available.

(d) In Chidpal, Kankapal and Madkamiras blocks, with 1.05 and 0.4 sq. kms. areas respectively, an aggregate of 75 tonnes of cassiterite equivalent to 50 tonnes of Sn metal are likely to be available.

(e) In the Murgel block, over 2.8 sq. kms area, about 103 tonnes of SnO_2, 37 tonnes of Nb_2O_5 and 45 tonnes of Ta_2O_5 are likely to be available.
(f) In respect of Tongpal-Marjun block, very preliminary work was carried out during 1978-79 and the detailed work has to be carried out subsequently for resource evaluation.

COORDINATION

The above work of regional assessment surveys (1978-79) was co-ordinated by M. Suryanarayana; R. D. Patil was associated on part-time,

S. K. Bose, Director DORIS under whose supervision and charge, the project was monitored. R.K. Sundaram, Dy. D.G., GSl (CR) under whose over-all guidance, the programme was implemented.

R.S. Gandhi, Driller and V. K. Sethi, Asstt. Drilling Engineer, formed the drilling team; the chemical (instrumental) analysis viz. spectrographic screening were carried by D. R. K. Murthy and S. Khandekar, Chemists.

The logistic supports from the Workshop Division under the charge of B. R. Goyal, Director (Mech) and the Stores Division under the charge of Ram Swaroop, were received.

P A R T – I

PRELIMINARY ASSESSMENT SURVEYS FOR Sn, Nb, Ta POTENTIALITIES IN BODAVADA BLOCK, BASTAR DISTRICT, M. P.

By
Dr. R.N. Pal

INTRODUCTION

The presence of Sn, Nb and Ta minerals in Bodavada block of Bastar district, falling in toposheet 65 F/14, have called for special attention to assess the potentialities of the above important rare and critical minerals, in detail. Accordingly, a programme for detail investigation of Sn, Nb and Ta minerals was chalked out and the work was taken up in small blocks around the placer which appeared to be potential. The Bodavada block is at the north eastern border of 65F/13 and also extends to southern border of 65 F/14 along the course of Bhimsen nala (plate No.13). Reconnaitory traverses were taken in an area of 8 sq. kms. for selecting the prospecting area of detail mapping and 3.5 sq. kms area has been mapped in detail on 1:5000 scale.

The major part of the block is hilly and thickly forested except in southern part of the hills, which is under cultivation. In general, ground-level elevation is 800' (244 m,) and the maximum elevation in this block is 1500' (457 m.) This hilly portion is the eastern continuity of the major, Ellingnar Hill mass to the west, occupies the southern Part of. 65 F/14 sheet.

The block is located at about 20 kms. NE of Tongpal and can be approached partly through Kachha road and partly by cart-track upto the base of the hills. The hill slopes are densely vegetated and at places are highly inaccessible due to thick bamboo forest,

PREVIOUS WORK:

The block falls within the area which was earlier mapped by brook Shank (1932-37). Later, Murti et.al. (1976-77) mapped this area (1:63,360 scals) with special emphasis on locating the cassiterite bearing pegmatites. They have demarcated a few greisenised, zoned and unzoned pegmatites but no cassiterite bearing pegmatite have been reported in this block.

PRESENT WORK

Traverses have been taken around this block to locate the area for detailed study and investigation. Detail geological mapping (1:5,000 scale) has been carried out in an area of about 3.5 sq. kms. and the cassiterite bearing pegmatites have been located. 400 nos. of samples have been collected mainly from the colluvial horizon on a grid pattern. Each sample weighing about 20 kgs. was taken which was concentrated by hand-panning. The heavy concentrates have been processed and sent for chemical analysis. About 60 nos. of stream sediment samples have also been collected from the streams cutting across the cassiterite bearing pegmatites. The samples after preparing the concentrate have been sent for analysis for Sn, Nb, Ta and W. After plotting the analytical results, potential areas of concentration of these minerals have been demarcated (plate-)

TARGETS ACHIEVED:

Reconnaissance mapping	8 sq. kms.
Large scale mapping (1:5,000)	3.5 sq. km.
No. of pits & excavation (323 nos)	411 cu. m.

No. of samples collected & concentrated	455 nos.
Geochemical samples collected	400 nos.

GEOLOGY

The rock types exposed in this block are the Bengpal metasediments to the east of Bhimsen nala and the metabasic rocks which forms the eastern continuity of the major Ellingnar basic body. Pegmatite bodies of various dimensions traverses this basic body in a general NE-SW & ENE-WSW directions. These pegmatites are well-exposed on the southern slopes of the hills and in the level ground, the density of exposure is rather poor.

The basic rock is mostly medium to coarse grained, dark coloured, hard massive and stands out prominently in the form of hill. The mineral composition is mainly hornblende and plagioclase which indicates that this is mainly metadiorite body. But there are some patches of lighter coloured amphibolite mainly composed of actinolite / tremolite and plagioclase. The relation between these two metabasic rocks could not be established due to the absence of clear out evidence. There is another type of basic rock which is present in the form of narrow basaltic dykes cutting across both the Bengpal metasediments and the metadiorite. These are very fine grained dark coloured and occur as thin bands of even 6" to 8".

The Bengpal metasediments are mainly exposed on the eastern part of the Bhimsen nala and also to the south of hills. But in this small area proper relationship between the basic rocks and Bengpal schist could not be established due to lack of exposure indicating contact relationship. The quartz-sericite-schists and quartzites exposed in the Bhimsen nala show a bedding attitude of N60°E steeply dipping towards south. But the quartzites which occur at the top of the hills (Kukrimetta and Jatametta) east of Bhimsen, are well bounded subhorizontal bands. This sub-horizontal quartzite bands overlies the basic body at the east of Bhimsen nala. There appears to be a structural disconformity between the schistose, rocks exposed at the lower level and quartzites at the higher level. The schist is mainly quartz-muscovite, biotite-sericite-schist with development of andalusite concentrated in narrow bands. Some tourmaline has also developed near the contact of pegmatite with schist.

The pegmatite bodies traverse both the basic rocks and metasediments. But - the major cassiterite bearing pegmatite bodies in this block, are within the basic body. There is a 200 to 300m, wide zone of pegmatite emplacement trending NE-SW to ENE-WSW and extends for about 1 km. Three major pegmatite bodes have been located in this zone besides a number of small bodies. These pegmatite bodies are 15 to 20 m. thick and can be traced continuously for about 250 to 300m. having ENE-WSW trend. One of these pegmatites, show very good zoning with a quartz core and lepido ite bearing zones on both the sides of quartz core. But zoning in other two pegmatites are not very marked. The mineralisation appears to be more in one of the pegmatite which is less coarse grained sometimes sugary and contain more garnets. The felspar is mainly cleavelandite. This is highly weathered and incidence of elluvial crystals rises to more than 1% at places. Beryl is commonly present. The zoned pegmatites also show incidence of cassiterite crystals on the surface of pegmatites.

Though the crystals may not be always detected in-situ on the pegmatite the rubble material over the pegmatite body after treatment and concentration gives some crystals- which indicates the tin mineralisation of the pegmatites to the same degree. So in this area, most of these pegmatites are mineralised to same degree. It is also observed that a zone of alteration in, the basic rock at the contact of major pegmatite has developed quartz-biotite-apatite rock. It is interesting to record that even a small pegmatite band of few centimeters thickness sometimes carries coarse cassiterite crystals. Greisenisatinn in the form of development of lepedolite rich rocks is distinct in the major pegmatite.

The pegmatites present within the Bengpal metasediment east of Bhimsen nala do not carry any visible mineralisation. These pegmatites are richer in quartz and mica. At places, coarse tourmaline has developed profusely nearby the pegmatite body in the, Bengpal schist.

EXPLORATION:

An area of 3.5 sg. kms. area was mapped in detail (1:5,000 scale) to delineate the mineralised pegmatites and the nature of colluvial material present in this area. Priority was given to locate the natural concentration of heavy minerals in the colluvial material derived from these mineralised pegmatites. It is observed that the incidence of cassiterite crystals found in the pegmatites is sporadic except in few spots where concentration is more. But the crystals could be easily picked up from the colluvial material just by the side of these pegmatites. So the colluvial material around these mineralised pegmatites were first taken up for detailed investigation to assess the detail concentration of heavy and rare minerals including cassiterite by natural weathering processes.

The southern slopes of the hill and the adjoining level ground are mostly covered with colluvial material derived mainly from the basic rocks and the associated pegmatites. This colluvial horizor extends all along the base of the east-west trending hill and width varies from 500m.to 1 km. The nature of colluvium is an aggregation of pebbles of basic rock and pegmatite with some occasional boulders at the hill slope and base of the hill. Always from the hill base towards south, the pebbly horizon is overlain by a murrain and soil horizon. In the eastern part of the block, part of the colluvium is overlain by the alluvium of Bhimsen nala (T_2 surface) just along the banks of the nala. Big rounded boulders of quartzites and basic rocks are found at the base of the sandy alluvial material, which are correlated as belonging to the Govindpal foliation T_3.

About 2.5 kms = length and 1 km. width of this colluvial horizon along the hill base was covered by pitting and sampling on a grid pattern. Sample lines were given at 100. interval across an E-W trending base line. Samp e points are located at 100m. and 50 m. depending on the uniformity of the colluvial horizon. If the horizon is more or less uniform, the samples are taken at 100m. interval. In the zone where the pegmatite bodies are exposed and the colluvial horizon contain more pegmatite fragments, the sample is taken at 50m. interval. At the hill slopes also, the samples are collected at 50m.

interval

Samples collected by putting pits at every sample point. Pits were put preferably upto a depth of 2 m. or upto bed rock at each sample point. Samples were collected by cutting channel on all the four walls of the pits. The materials from all the four walls were mixed to prepare one composite sample. In the pits, where the depth is more than 1.5 m., two samples were collected from the upper 1 m. and lower horizon. But in this area there is no good development of distinct horizons. The depth of the pits vary from 1m. to 2m. The thickness of colluvial cover at the hill slope is 0.5 to 1 m and increases towards south. Presently, samples were taken upto a depth of 2m. where the bed rock is not encountered.

The weight of each bulk sample taken, is 20 kg. which was concentrated by sluicing and hand - panning to obtain the heavies. The weight of each concentrate was noted before sending for analysis to know the weight percentage of the concentrate.

About 400 nos. of pit samples were collected and sent for chemical analysis after concentration.

ALLUVIAL EXPLORATION:

About 50 nos. of samples were also collected from the small streams flowing over the mineralised pegmatites to know the concentration of heavies. In this case, the samples were collected by putting 1 m. deep pits in the nala bed and cutting channels on the four walls. The material from all the four walls was mixed to make one composite sample. The stream sediments are mixed pebbly and sandy material with some boulders at the base of the hill. The weight percentage of the concentrates obtained from these samples after panning and sluicing varies from 0.2 to 3%, Thus, an incidence of crystals in a good number of samples and the percentage of crystals are sometimes as high as 0.75%. The XRF analytical values of 25 samples varies from 0.69 to 51.48% with an average of 8% Sn.

The weight percentage of heavy concentrates of the pit samples varies from 0.1 to 1.5%. The maximum wt. percentage, is obtained near the. mineralised pegmatites and decreasing away from it down the slope. Similarly, the incidence of crystals in the concentrates decreases away from the pegmatites. So it is clear that maximum concentration of heavy minerals have taken place in the colluvial horizon adjacent to the mineralised pegmatites.

Plotting of the heavy concentrates and the semi-quantitative analysis data, indicate four different arras of concentration of these minerals in the colluvial horizon. The details of each area is given below:

EASTERN PATCH:

This is a plain area bordered by hills in the north and west and Bhimsen nala in the east. Exposure of one major cassiterite bearing pegmatite is present in this area. Also, the hills of basic rocks in the north and west of this area contain bands of cassiterite bearing pegmatite. The total potential area is about 0.65 sq. kms. with average thickness of colluvial material 1.5 m. The weight percentage of heavy concentrates is about 0.4%. Most of the samples within this area analyses more than 1000 ppm. Sn and also in many cases more than 1000 ppm of Ta.

WESTERN HILL PATCH:

This area is on the western part of the above area and covers, partly the top of the western hill and its eastern slope. Major cassiterite bearing pegmatite bands are exposed here and the concentration of Sn, Nb, Ta minerals have taken place in the rubbles/ colluvial material derived from these pegmatites. The area demarcated is about 0.09 sq. kms. having an average thickness of about 1m. Colluvial material. The wt.% of concentrates is 0.2%. Most of the samples in this area analyses more than 1000 ppm. of Sn and some samples also show more than 1000 ppm. of Ta values.

SOUTHERN SLOPE 'C' :

This area falls on the southern slope of the hill in the western part of the block. Small bands of pegmatite are present within basic rocks in this area. Sn, Nb, Ta minerals are present in the rubbles at the hill slopes. The total area is about 0.087% sq. kms. with average depth of the rubble/colluvial material 1m. The wt % of the concentrate recoveries is 0.25%. Most of the samples analysed in this area show more than 1000 ppm. of Sn.

SOUTH – WESTERN AREA 'D' :

This area is in the western part of the block and falls in the plain area south of the hill. There is no exposure in this area and it is covered with soil. The average depth of the soil and colluvial material is 1.5m.and the area is about 0.17 sq. kms. The wt % of concentrate in this area is 0.22%.

A total of 108 nos. of XRF data from the pit samples have been plotted. The values range from 0.41 to 30.12%.

Out of this 108 values of samples, 83 values falls in the area 'A' which covers an area of 0.55 sq. kms. The values in this area range from 0.41 to 30.12% with an average of 3.28% Sn. The average depth of the colluvial horizon is 1.5 m. and the density of the material is taken as 1.75. The average weight percentage of the concentrate in this area is 0.4% So the probable tonnage of Sn in this area is calculated as :

$$\frac{0.55 \text{ sq. kms. } x\ 1.5\ x\ 1.75\ x\ 0.4\ x\ 3.28 \text{ (Assay)}}{100\ x\ 100}$$

= 189 tonnes.

11 nos. of XRF value in the area ‘B’ covers an area of 0.09 sq. kms. The values in this area range from 0.43% to 26.82% S with an average of 5.04%. The average depth of colluvial horizon in this area is 1 m. and the density of the material is taken as 1.75. The average wt% of the concentrates is 0.2%. So the probable tonnage of Sn in this area is calculated as:

$$\frac{0.09 \text{ sq. km. } x\ 1\ x\ 1.75\ x\ 0.2\ x\ 5 \text{ (Assay)}}{100x100}$$

= 15.75 tonnes.

6 nos. of XRF value in the area 'C' covers an area of 0.08 sq. kms. The values range from 0.67 to 4.13% with an average of 2.3% assay of Sn. The average wt% is 0.25%. The depth of colluvium is 1m. and density of material is taken as 1.75. So the probable tonnage is calculated as:

$$\frac{0.08 \text{ sq. km. } x\ 1\ x\ 1.75\ x\ 0.25\ x\ 2.3}{100\ x\ 100}$$

= 8.05, say 8 tonnes.

8 nos. of XRF values in the area 'D' covers an area of 0.14 sq. kms. The XRF values range from 0.56 to 9.74% with an average of 2% Sn. The weight percentage is .25% and the depth is 1.5 m. So the probable tonnage is 18 tonnes.

However, with subsequent receipt of the

complete XRF analytical data and by further processing and recalculation, the main potential area 'A' was found to be 0.50 sq. kms. and the average grade of Sn to be 109 ppm. So by taking into account an area of 0.5 sq. kms. with average thickness of colluvium 1.5 m, and head-assay for Sn 109 ppm the estimate of reserves become 143 tonnes out of total concentrate of 5250 tonnes.

ALLUVIAL C ASSITERITE POTENTIAL :

The aggregate length of the small stream in the potential area is 3 kms. with an average width of 2m. The average weight percentage of heavy concentrate is 0.9% upto a depth of 1m. So the probable tonnage of Sn content in these stream sediments may be calculated as :

$$\frac{3000 \text{ x } 2\text{m. x } 1\text{m x } 1.75 \text{ x } .9(\text{wt\%}) \text{ x } 8\% \text{ (Assay)}}{100 \text{ x } 100}$$

=7.5 tonnes.

Nb - Ta Analysis :

The quantitative analytical results of most of the concentrates of pit sample which indicates more than 1000 ppm. of Nb_2O_5 and Ta_2O_5 have not yet been received. So the assessment of these oxides can not be furnished. However, the XRF analysis of 28 samples of stream sediment concentrates indicates Nb_2O_5% ranging from 0.16 to 4.3% and-Ta_2O_5 varies from 0.15 to 3.71%. The average Nb_2O_5 and Ta_2O_5 values are 1.31% and 1.04% respectively. Analysis of only 8 pit sample concentrates which have been received so far indicate Nb_2O_5 values varying from 0.16 to 4.35% and Ta_2O_5 from 0.19 to 3.3%. The average Nb_2O_5 and Ta_2O_5 values are 1.5% and 1.12% respectively. It is observed from the analysis of both stream sediment samples and pit samples, that Nb_2O_5 content is more than Ta_2O_5 content.

SUMMARY AND CONCLUSIONS :

Detail mapping (1:5000 scale) for exploration of Sn, Nb & Ta have been carried out in an area of about 3.5 sq. kms. in southern base of the hill in the northern border of toposheet No.65 F/14. This E.W trending hill is composed of mainly metadiorite with bands of pegmatite bodies emplaced within it. The trend of these pegmatites bodies are in general ENE-WSW to NE-SW and thickness varies from a few centimetres to 20m. Some of these pegmatites are mineralised as indicated by the presence of crystals of cassiterite and Nb and Ta oxides. There are three major mineralised pegmatites having width of about 15 to 20m. and extends discontinuously for about 1km. in the EnE. WSW trend. The colluvial material around these pegmatite contain significant amount of cassiterite crystals. About 2.5 sq. kms. area has been covered by pitting in 100x100 and some times 100 x 50 grid pattern. The depth of pits vary from 0.1 to 2m. depending on the thickness of colluvial horizon. About 20 kg. of samples collected from each pit by channeling on the four walls, have been concentrated by panning and sluicing for recovering the heavy minerals. The weight percentage of the heavy minerals Varies from 0.1 to 1.5%.

From the semi-quantitative analytical results of 400 samples, a total area of 1 sq. km. was delineated as prospective. A major part of the values within this area indicated more than 1000 ppm. of Sn and also Nb & Ta in many cases. Plotting of XRF analysis values for. Sn of these samples (about 108 nos.) indicate a potential area of 0.9 sq. kms. in separate patches. The Sn values ranges from 0.41 to 30.12%. The total resource of Sn metal in this block is estimated of about 230 tonnes. The XRF analysis values for Nb & Ta have not yet been received. The stream sediment samples collected from the small streams in this block, gives weight percentage of heavies varying from 0.2 to 3% with an average of 0.9% and XRF analysis values varies from 0.69 to 51.48% of Sn. The Nb_2O_5 values of these samples vary from 0.16 to 4.3% and Ta_2O_5 ranges from 0.15 to 3.71%. The average Nb_2O_5 and Ta_2O_5 values are 1.31% and 1.04% respectively and indicate that Nb_2O_5 content is more than Ta_2O_5. The probable tonnage of Sn in these stream sediments is about 7.5 tonnes upto a depth of 1m. in the nala bed.

So the resource potential with respect to Sn, Nb and Ta in this block is quite encouraging in part of the area. Further collection of bulk samples and processing in the ore-dressing plant have been carried out to obtain a clear idea of the deposit.

PART-II
PRELIMINARY ASSESSMENT OF RESOURCES OF CASSITERITE AND ASSOCIATED RARE METAL MINERALS IN JANGARPAL BLOCK, BASTAR DISTRICT, MADHYA PRADESH

FIELD SEASON 1978-79

BY

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ABSTRACT:

In course of reconnaitory traverses taken in May, 1978 around Jangarpal village, in irrigation canal-cutting incidence of cassiterite mineralisation has been found by the author for the first time in an quartz-vein traversing the Bengpal quartz sericite schist. The colluvial and alluvial cassiterite in this area are found to be of significance. Two zones of secondary concentration of tin ore were observed; the sandy, loam top zone (A Horizon) and the lower lateritised, pebbly (gravelly) zone (B-Horizon) the latter being elatively richer in concentrations. Besides, Sn values of interest are also found in the weathered Bengpal schists (C-Horizon). Further confirmatory studies are to be carried out for understanding the genetic relationship of tin mineralisation in Bengpal schists (i.e. epigenetic or syngenetic) or have been accumulated as detrital concentrations in the upper layers of the bed rock.

Consequently, preliminary investigation was carried out during the field season 1978-79 and has led to the possibility of locating cassiterite ore which can yield 106 tonnes of Sn metal in the colluvial material of 1.53 million tonnes over an

potential area of 1.38 sq. km. out of 2.2 sq. km. area investigated.

The average grade of Sn in the colluvium based on the hand-panning and sluicing, works out to be above 40 gms/tonne which is likely to undergo an upward revision by the beneficiation studies in progress. In addition, the combined Nb_2O_5 and Ta_2O_5 contents in the colluvium are 54 gms/tonne. The rare metal association not only adds more to the value of the ore but enables economic exploitation with the combined tenor of Sn, Nb and Ta.

Detailed exploration by close spaced pitting, collection of bulk samples and systematic beneficiation on large bulk samples, is recommended for better recovery and estimation of resources.

INTRODUCTION

H. Crookshank (1935-38) carried the regional geological mapping in the entire area; and Shri K.S. Murti et. al carried detailed systematic mapping in the area falling in 65 F/14 of which Jangarpal also falls a part.

In May, 1978, fairly good incidence of cassiterite crystals has been encountered by the author in an irrigation canal cutting through Bengpal schists during reconnaitory traverses near Jangarpal village (65 F/14). Further search around the area yielded 1.32 kgs. of cassiterite crystals varying in size from fraction of a cm. to 5 cm. A trial pit near the irrigation canal yielded encouraging results with 0.15 wt.% of cassiterite.

Regional assessment of the area has been taken up during the field season 1978-79 to explore and delineate the extent and potentiality of the occurrence (under the item No.I/65F/CR/MP/76/8) The report embodies the work carried out by the author during the field season 1978-79 and results thereof.

LOCATION AND APPROACH :

Jangarpal block is situated about 0.5 km. west of Jangarpal village which lies 3.5 kms. NNE of Puspal and 11 kms. ESE of Tongpal. The block is limited by Murgel nala to the north, Kummarupada village to the south, Bhimsen nadi towards east and Kokavada village towards west. The area is bounded by latitudes 18°41' : 18°39' and longitudes 81°53' : 81°54' and falls in part of toposheet 65 F/14 in Bastar district, Madhya Pradesh.

Tongpal-Puspal metal road passing through the area is an all weather jeepable road and is the main approach to the block. Tengpal is situated on the Jagdalpur-Knnta state high-way at a distance of 56 kms. from Jagdalpur and 50 kms. from Konta. The nearest rail head is Jagdalpur connected to Kirandel-Waltair section of South-eastern Railway.

TOPOGRAPHY AND DRAINAGE

The area forms a flat terrain with gentle undulation and isolated mounds formed of quartz reefs and basic bodies. Two small (basic) hillocks of 131 ft. (39.93 m.) and 110 ft. (33.53 m.) from ground level stand as land marks in the north eastern side of the block. The highest point in the area is 265.17 m. a top the hill NW of Jangarpal and the lowest point is 215.4 m. in reclaimed channel.

The area is drained by south-easterly flowing Murgel nala, a tributary to Bhimsen nadi, Besides several smaller tributaries are bunded, sediment and brought under cultivation, so much so that the nala courses for good lengths are difficult to identify in the ground.

<u>SCOPE AND QUANTUM OF THE WORK</u> :

The main objective is to assess the overall potentialities of cassiterite and associated columbite and tantalite mineral in the area with study in regard to the geological set up, controls of mineralisation besides delineating the zones rich in secondary concentration of cassiterite and heavy minerals in the colluvial and alluvial horizons was carried out. Towards achieving this, the following work was carried out:

a)	Large scale mapping (1:5000 scale)	••	2.2. sq. km.
b)	Traverse mapping (1:5000 scale)	••	13.2 L. Km.
c)	Pitting	••	123
	No.of pits		
	Total excavation		264 cu. mtrs.
d)	Bulk samples	••	258
e)	No. of geochemical samples	••	369
f)	No. of primary dispersion samples	••	20
g)	Drilling (1 borehole)	••	50.35 m.
h)	Surveying	••	12 L. Km,
	Traversing		
	Levelling	••	20 L. Km.

<u>GEOLOGICAL SET UP</u> :

The Bengpal meta-sedimentaries comprising sericite schist.and quartz sericite schists (Tulsi Dongar stage of Crook Shank, 1938) are theoldest rocks exposed in the area. Basic rocks of epidiorite to amphibolite in composition, appear to have been intruded as sills into the Bengpal schists. Pegmatites followed by quartz reefs emplaced into the pre-existing basic and

Bengpal schistose rocks. Lateritisation has been commenced with the leaching of iron oxides from the basic and schistose bed rack. Overlying lateritised gravel bed, greyish brown silty to clayey top soil capping has been noticed in the area.

The generalised geological sequence is given below:

	Recent	Silty to clevey soil & alluvium Lateritised Colluvium.
Protertzoic	Intrusives	Quartz veins Pegmatites Ganites (not exposed in the area) Basic rocks (epidiorite to amphibolite)
	Tulsi-Dongarstage	Bengpal, Schist (Sericite schist and quartz sericite schist)

The area around the block is practically soil covered with isolated hillocks of basic rock. However, based on the bed rock exposed by pitting (in course of exploration) and after the; study of the rock types exposed along nalas and canal cuttings the area has been mapped by tape and compass traverses, on large scale (l:5,000).

The Bengpal meta-sedimentaries exposed mainly along nala sections are buff colorured sericite schists and quartz sericite schist, highly weathered and rich in iron oxide content imparting reddish brown colouration. The Bengpal schists have been rendered friable and soft due to weathering, Micaceous sheen is exhibited due to high sericite content. In thin section, sericite, quartz, plagioclase, biotite, chlorite minerals are present and exhibit equigranular texture. The general foliation of Bengpal schists is NW-SE.

with steep easterly dips.

Basic intrusive exposures generally form as detached isolated mounds and hillocks around the area due to differential weathering with Bengpal schist. Conspicuous field relationship in the area is not noticeable with regard to the nature of origin, as these are subjected to high degree of alteration and as such basic rocks are devoid of vesicular or amygdaloidal structures. However, due to the wide aerial extent and alignment of major basic bodies with respect to the schistose country rocks, it (the former) can be considered as concordant sills. Basic rocks are medium grained., melanocratic in nature with composition varying from meta-diorite to amphibolite. Basic rocks are veined by secondary quartz and epidote at places. Petrographic study of basic rocks of Jangarpal area indicates the equigranular granoblastic texture with hornblende, plagioclase, actinolite, chlorite, biotite and sub-ordinate quartz. At place, in basic rocks micro mineral lineation is consipicuous. Plagioclase is Souseritised at places.

Pegmatites exposed around the block are generally 2 to 5m. thick and trending NNW-SSE with steep westernly dips and continue hardly 20m.on the surface. Pegmatites encountered in the area are unzoned and comprise mainly plagioclase and microcline with quartz and incipient development of mica. No visual cassiterite crystals have been found in the pegmatites or in the surrounding colluvial zone Pegmatites were emplaced mainly into the basic rocks and at places in the Bengpal schistose rocks.

Quartz veins trending NW-SE are found emplaced into the Bengpal schists (8 Nos.), and basic rocks (5 Nos) in the area. The quartz veins vary in width from 1m. to 20m. and extend in length from 20 to 115m. Quartz veins are sheared and found with ramifications of secondary silicification. At places, well developed euhedral crystals of quartz found in vugs within quartz reefs. The shears/joints strike NNE with steep westerly dips. Cassiterite mineralisation has been noticed in one of the quartz vein, gnesis of which is discussed later in the report.

The area is covered by a thin capping of soil and alluvium, represented by grey to brown silty to clayey and loamy soil followed by a lateritised gravel zone. These two units forms the colluvium and very in thickness from few centimeters upto two meters, overlying the bed rock.

TYPES OF OCCURRENCES OF TIN MINERALISATION

Three types of tin occurrences have been noticed in the area, viz. primary, colluvial and alluvial.

PRIMARY:

Tin mineralisation is mainly in the form of coarse cassiterite (SnO_2) crystals and as fine grains in pegmatites and quartz vein. The tin mineralisation in quartz veins represents late to post pegmatitic phase, while the pegmatitic tin is related to pneumatolysis.

In Jangarpal block for the first time in the area cassiterite bearing quartz vein emplaced in Bengpal scricite schistose rocks has been located. However, the quartz vein is about 1m. wide and is exposed for about 10m. length. Cassiterite occurs as coarse lumps embeded within the quartz vein. In the major part of the area which is covered cassiterite occurs mainly in very fine form (-10 mesh size) dispersed (secondary) within the lateritised gravel horizon (colluvial) and in the alluvial fill sediment of the reclaimed nala.

COLLUUIAL:

The quartz veins, pegmatites and bed rock carrying tin an decomposition in situ and after undergoing mechanical disentigration had liberated the cassiterite grains, while chemical leaching of the felspathic matrix material has also helped in releasing the cassiterite crystals and grains which are transported to shorter distance along palaeo-slopes due to gravity and gave rise to the stanniferous and rare mineral bearing colluvium.

ALLUVIAL :

Due to water action the primary and colluvial cassiterite that has been broken down to varying degrees of mechanical disentigration has further transported and concentrated as placers in the streams and river bed (palaeo and present channels).

GENESIS OF CASSITERITE AND ALLIED MINERALISATION :

It is widely known fact that the cassiterite mineralisation is mainly farmed from the emanations of gases of the pneumatolitic stage from the pegmatitic melt. Pegmatites found in the area are mineralogically complex with high concentration of rare elements such as Sn, Nb, Ta, W, Li, Be, B, Pb, Va, Y, Cr etc., which form oxides, chlorides, luorides and sulphides considerably at lower temperatures. An aqueous gas phase as well as water saturated silicate melt participatec in the complex evolution of cassiterite, columbite, tantalite, lepidolite, beryl, wolframite, tourmaline and other associated minerals.

Baruskov (from Multigan) has suggested that tin as a salt of complex hexabasic acid of the type of Na, Sn (F, OH) that breaks down in a neutral or slightly alkaline medium at PH values of 7.0 to 7.5 at which Sn $(OH)_4$ is precipitated. Disintegration of the Sn $(OH)_4$ yields cassiterite.

In Jangarpal area, discrete crystals of cassiterite are found embedded within quartz reef traversing the foliation planes of Bengpal sericite schist. This indicates distinct, transportation and deposition of tin ions in siliceous solution in hydrothermal, late pegmatitic stage. However, alongwith cassiterite mineralisation in Jangarpal area, no sulphides are visible. But the cassiterite crystal itself contains upto 1000 ppm. of Cu and 80 ppm. of Pb. These factors indicate that there might have been a distinct hydrothermal phase succeeding the pneumatolitic activity in pegmatites. The occurrence of cassiterite within quartz vein in Jangarpal area may be due to the preferred localisation of metasomatic ores governed by selective metasomatism (Mac Allister). Morey determined that the solubility of SnO_2 is 3 ppm., and Nb_2O_5 and Ta_2O_5 are 28 and 30 ppm. respectively in steam at 500° C and 1000 bar pressure and this is indicative of the formation of cassiterite and allied minerals in hydrothermal phase.

METHODOLOGY OF EXPLORATION:

GENERAL:

After carrying out large scale mapping and examination of the area, a block of 2.2 sq. kms. has been selected for exploration. The block has been mapped on 1:5,000 scale by tape and compass traverse. The rock contacts viz., basic and Bengpal schists have been traced; quartz reefs and pegmatites have been mapped and the reclaimed channels hove been demarcated on the map (vide plate No. II)

With North-south trending base line and East-west running cross line the block has been gridded on 200m.x100m. grid (200m.line interval and 100m.pit interval) Pits were put down on grid points over an area of 2.2 sq. kms. Pits are-1m.x1m.in cross section and generally 2m, deep.Bed rock has been exposed in the pits in most of the cases. However, the pits laid in reclaimed channel, rarely could go up to 2.8m.and not upto the bed rock as the thickness of the alluvium is more than 2.5m. Shallow level of, water table in reclaimed channel are as (hardly 2m.) hampered the progress of pitting work.

SAMPLING :

In the pits, three distinct horizons could be observed. From surface upto 0.50m.greyish brown silty to clayey soil (A-Horizon) is encountered. Underlying the soil horizon, from 0.50 to 1.75m. lateritised or oxidised soil (B-Horizon) with gravel mainly of sub-rounded quartz pebbles(2 to 5 cm. diameter) is found. This overlies highly weathered clayey horizon which might have been derived from the weathering of the bed rock (in situ) viz. basic rock or sericite schist.

The different horizons in each pit have been logged and the thickness measured. Then channels of 30 cm. wide and about 15 cm. deep were cut on all the four walls of the pit. The length of the channel varies from 0.50 to 1 m. corresponding to the thickness of the horizon. The material derived (about 40 kgs) from the channel on the four walls has been properly mixed, coned and quartered and 20 kgs. of the sample has been collected. Separate samples have been collected, for different horizons in each pit. To checkup the incidence of tin and other rare metals in weathered bed rock in some of the pits bulk samples of weathered bed rock has also been collected.

For knowing the distribution of Rb, Cs, Li associated with Sn, Nb & Ta in the soil and colluvium, geochemical soil samples also have been collected from the pits.

<u>PROCESSING OF SAMPLES</u> :

Pit (bulk) samples (each 20 kqs). was dried first 'and then sieved through 1/4 and 1/8" sieves and three fractions have been obtained. Sieving and sizing of the material was done for separate treatment to achieve better recovery of concentrated while sluicing and panning. The coarser +1/4 fraction comprising mainly quartz pebbles and basic rock pieces is examined for any coarse crystals of $c_8$ssiterite which have been picked up and the rest has been rejected. The other -1/4 or +1/8 fraction viz. lateritic pellets, quartzo-felspathic grains and clayey concretions is subjected to sluicing and panning and coarse to fine grains of cassiterite crystals have been recovered. Finally, the last-1/8 fraction which is mainly clayey to sandy in nature is subjected to the following processes.

First the material was kept in a bucket of water and de-sliming had been done by constant stirring and decanting the slimes. The residual material was subjected to sluicing. Locally made wooden sluices were adopted for the purpose. Sluice used here was nothing but a 3m.long wooden log in which 30cm.wide and 15 cm. deep channel was carved, keeping a closed end on one side and opening on the other. The sluice is fixed at about 3°inclin-ation. The sample is kept at the closed and over which a jet of water is alloyed to flow by a tube with a constant velocity. The heavies settled nearer to the jet end of the sluice whereas the lighter material viz. clayey and quartz-felspathic etc., washed away by the flowing water. The washed out material from the tail end of the sluice was collected and panned (by alluminium pans) and the remnant of concentrate, if any, were recovered.

All the concentrates recovered at different fractions of each sample were mixed, dried and weighed in chemical balance. The weights of coarser Cassiterite crystals and fine grains were recorded separately.

HEAVY MINERAL CONCENTRATES

The composition of heavy mineral concentrates is of wide range depending upon the bed rock composition of the colluvium and the nature of the parent rock from which the soil has been derived. The black concentrate constitutes mainly of ilmenite, magnetite, garnet, rutile, sphene, cassiterite, columbite, tantalite, tourmaline and in some cases monazite and rarely wolframite.

Spectrographic analysis of the heavy mineral concentrates exhibit a wide range of elements in varying proportions. Sn, Nb & Ta Values in the concentrates vary from 50 ppm. upto more than 1000 ppm. Quantitative determinations (XRF) of tin in some of the concentrates shoot up to 15.63% Sn metal.

In almost all the cases, the Cassiterite in the concentrates is in fine form (-10 mesh). However, in 15 cases coarse cassiterite crystals generally in +1/4 size fractions have been encountered. A list of the samples in which coarse cassiterite crystals of

+ 1/4" size recovered is given below:-

Sample No.		Wt. of original bulk sample (Kgs)	Wt. of coarse cassiterite crystals (gms)	Wt. of coarse crystals.
JA 6	B	20	1.45	0.00725
JA 8	B	20	11.80	0.059
JA 8	C	20	1.50	0.0075
JA 10	B	20	1.45	0.00725
JB 9	B	20	1.20	0.006
JB 10	B	20	1.50	0.0075
JC 4	B	20	0.40	0.002
JE 10	B	20	3.60	0.018
JE 12	B	20	3.00	0.015
JF 7	B	20	4.40	0.022
JM 5	A	20	0.80	0.004
JM 12	B	20	2.40	0.012
JN 1	A	20	1.00	0.005
JK 0	B	20	1.90	0.0095
JK 2	A	20	1.40	0.007

RESOURCE EVALUATION OF Sn, Nb, Ta POTENTIALITIES

From the data of 244 samples -generated from 123 pits (covering 2.2 sq. kms. area) an attempt has been made to indicate the potentialities, of tin ore in the block. The resources are of possible category which needs confirmation tests by pitting and sampling on closer grid and adoptation of ore dressing techniques for better recovery by treating larger quantities of bulk samples. More over as is evident the distribution and concentration of tin in the heavies is non-uniform in nature owing to several factors viz. the variation of thickness of alluvium/ colluvium, the palaeo-slopes, mechanical disintegration and controls of transportation etc., With the limitations of distribution and treatment and recovery of heavies, (by panning) an attempt was made to project the resources.

PROCESSING OF THE DATA:

The following parameters are utilised to arrive at the resources:

1) Bulk density of the colluvium
2) Wt % of the heavy mineral concentrates
3) Quantitative assay (XRF data) of Sn content in the concentrates.
4) Surfacial area of ore bearing horizon.
5) Thickness of colluviurn.

BULK DENSITY OF COLLUVIUM:

To know the bulk density of the colluviurn, the material for one unit of cubic meter from several pits located in different parts of the block has been taken up and weighed. The material encountered, varied from silty to clayey soil and lateritic pebbly and bouldery horizons. The material has been sun dried first to remove the water content and weighed with spring balance and the values are reproduced below:-

Pit No.	Description	Dimension (m)	Volume (cu. m,)	Weight (Kgs)
JF 9	Siity soil	1x1x1	1	1765
JF 12	Hard laterite with quartz boulders	1x1x1	1	1810
JN 9	Loose sand with Lat pellets	1x1x1	1	1750
JN 12	Silty to clayey soil	1x1x1	1	1750
JA 0	Dark grey silty soil with quartz rubbles		1	1735
		Average :	1cum	1750

Bulk density of the material $\frac{\text{Weight}}{\text{Volume}}$

Weight = 1750 Kgs or
1.750 tonnes
Volume = 1 cu. m.

Bulk density = $\frac{1.750}{1}$

= 1.750 tonnes/cu. m.

Wt % OF HEAVY MINERAL CONCENTRATES :

Wt% of the heavies (concentrates) has been calculated with respect to the original weight of each sample. The values of 'A' and 'B' horizons have been plotted separately (vide plate No. III) and isoconcentrates maps have been prepared for values 0.1% 0.2% and 0.3% values. The maximum wt% of heavy mineral concentrate in 'A' horizon is 2.25% and in 'B' horizon it is 2.06%. The average wt% of the concentrates in 'A' horizon is 0.338 and that of 'B' horizon is 0.344 in the area investigated.

After plotting the wt% values of the concentrates the average wt% of each line has been calculated. The average wt% of A & B horizons of all the lines with minimum and maximum range is shown in the table.

Sample line	Wt% of conc. A - horizone Range				Wt% of conc. B - horizone Range			
	No.of Sample	Min.	Max.	Average	No. of sample.	Min.	Max.	Average
1	2	3	4	5	6	7	8	9
JN	12	0.050	0.926	0.378	12	0.075	1.700	0.385
JM	12	0.201	0.251.	0.535	12	0.063	1.551	0.482
JL	10	0.063	0.625	0.225	10	0.125	0.550	0.277
JK	8	0.063	0.301	0.206	8	0.175	0.500	0.358
JJ	9	0.050	0.750	0.250	9	0.067	0.750	0.271
JA	12	0.880	1.195	0..273	10	0.115	0.488	0.235
JB	12	0.050	0.725	0.190	12	0.068	0.500	0.124
JC	12	0.135	1.160	0.416	12	0.140	2.063	0.607
JD	12	0.358	1.660	0.903	12	0.358	1.605	0.732
JE	12	0.500	0.575	0.133	12	0.063	0.225	0.130
JF	12	0.500	0.676	0.216	12	0.500	0.377	0.187

No. of colluvial bulk samples collected from 'A' horizon	...	123
No. of colluvial bulk samples collected from 'B' Horizon.	...	121
Average wt% of concentrates 'A' horizon	...	0.338
Average wt% of concentrates 'B' horizon	...	0.344

CHEMICAL ANALYSIS OF THE CONCENTRATES :

All the samples (concentrates) have been scanned spectrographically first for Sn, Nb, Ta W. Those samples which have analysed more than 1000 ppm. of Sn (limit of spectrographic scanning) were sent for quantitative determination of X-ray fluorescence.

Elements analysed by spectrographic screening are Sn, Nb, Ta, W, Mo, Bi, Be and Pb. The values of Sn, Nb and Ta have been shown in Plate No. V Sn, Nb and Ta values range from less than 10 ppm to more than 1000 ppm. Tungsten values range from less than 100 ppm to 200 ppm. in general. At some places like Jf 12A, JJ OA, JJ1A, JJ 5B, JK 0B and JL 0A, it ranges from 400 to 500 ppm. Houever, in isolated stray cases, W content in the heavy mineral concentrates rises from 700 ppm. to more than 1000 ppm. as in JA 98, JJ 5A, JK, 4A, JF 3 A and JJ 08 sample points.

Molybdenum, Bismuth and Beryllium values are generally less than 410,120 and 110 ppm. respectively. Rarely, molybdenum and Bismuth values analysed upto 30 ppm. (sample No.JE 7B & JK 2A). Practically, Beryllium in the concentrates is below detection limit (L10 ppm.)

In heavy mineral concentrates Pb values range from less than 10 ppm. to as high as 1000 ppm. In most of the samples, Pb values range from 20 to 300 ppm. Whenever the Sn, Nb and Ta values increase, Pb values also show rising trend. The higher anomalous Pb values in the concentrates is indicating one of the possibility of using Pb as indicator element (path finder element) as it appears that Sn, Nb and Ta in the block show the affinity to the sulphide mineralisation which may be possibly attributed to late pegmatitia and early hydrothermal stage.

THICKNESS OF THE COLLUVIUM :

As already indicated, the stanniferous colluviurn overlying the highly weathered bed rock can be divided into two horizons 'A' & 'B'. A horizon is represented by dark greyish brown silty to clayey top soil constituting of very fine quartzo felspathic, micaceous and clayey mineral grains with humus material. B-horizon comprises lateritised zone rich in iron oxide content with sub-rounded to well-roundec quartz, quartz sericite schist and basic rocks, embedded in a reddish brown ferruginous soil. Thickness of A-horizon ranges from 0.06 to 1.60m. (average 0.633m) and that of B-horizon from 0.12 to 2.55m. (average 0.90 m.). The thickness of A & B horizons of different pits in different line with ranges are given in the plate No.V.

It is interesting to note that the heavy mineral concentrates are relatively richer in B-horizon. as expected than in A-horizon. Thus, the B-horizon is relatively more potential than A-horizon but the latter also contributes to the resources. However, the incidence of coarser grains and crystals of cassiterite, columbite and tantalite are found only in B-horizon where as A-horizon contains fine concentrates of heavies.

DELINEATION OF THE POTENTIAL ZONE :

After processing and plotting of all the data (vide plate No.V) a picture of the resource potentiality of the enriched tin bearing horizon has been attained. Examination of the data will reveal that all the heavy mineral concentrates analysed more than 1000 ppm. of Sn, is indicative of the grade with economical significance. As a first step, all the pit points which have given rise to the heavy mineral concentrate analysing more than 1000 ppm of Sn has been delineated. As mentioned earlier, all the samples analysed +1000 ppm Sn, has been sent for quantitative determination by XPF methods. The quantitative values of Sn have been plotted. Where ever, the XPF quantitative data is not available owing to the small quantity of sample the average of Son % in each line has been calculated with availabe data and computed.

Out of 123 pits which were laid covering 2.22 sq. km. area, only in 79 places the concentrates analysed more than 1000 ppm. of Son following within a zone of 1.38 sq. kms. For the delineated zone (possible potential horizon) the average thickness of the colluvium has been calculated, After plotting the zone on a graph sheet the area of the horizon has also been deciphered and the volume of the ore bearing colluvium has been, arrived at as 15,31,800 cu. m. As indicated earlier, the bulk density of the material is of the order of 1.75 tonnes/cu.m. The product of the volume and the bulk density projects the weight of the ore bearing horizon potential zone.

GRADE AND RESERVE CALCULATION :

The important factors which speak of the grade and lead to the calculation of reserves of the potential zone of the block are :-

1) Wt% of the heavy mineral concentrates.
2) The assay Sn% of the concentrates.

$$\text{Grade} = \frac{\text{Wt\% of the conc.x Assay Sn\%}}{100}$$

Average Wt% of the heavy mineral conc - 0.258%
Average Assay (Sn%) - 1.534%

$$\text{Grade} = \frac{0.258 \times 1.534}{100}$$

= 0.00396% or 39.6 ppm of Sn

Reserve = Volume x Bulk density x Grade

Area of potential zone -1.38 sq. kms. (13.80,000 sq. m.)

Average thickness of the horizon - 1.11m.

volume = Area x Thickness
1380000 x 1.11
15,31,800 cu.m.

Bulk density = 1.75 tonnes/cu.m.

Grade= 0.00396%Sn

$$\text{Reserves} = 15{,}31{,}800 \times 1.75 \times \frac{0.0\ 0396}{100}$$

= 106.153 tonnes of Sn metal

Thus, in Jangarpal block explored in a potential area of 1.38 sq.kms. from 15,31,800 cu.m. of ore bearing material of 0.00396% Sn grade the calculated probable reserves are 106.153 tonnes of Sn metal.

Average Grade = 0.00396 % Sn
Reserves = 106.153 tonnes.

These figures have been arrived at from the data collected from the bulk pit samples over a regional grid of 100x200m, covering an area of 2.2sq.km. Thus the figures of the grade and reserves are having the limitations of its own due to the non-uniformity of dispersion and distribution of cassiterite bearing heavy mineral content. However, with the data available at hand, the reserves are of "probable" in nature arid may be nearer to the proved grade of Jangarpal block.

NIOBIUM AND TANTALUM MINERALISATION :

Along with tin, important elements found in the concentrates are niobium and tantalum. Out of 244 samples analysed, 121 samples assayed more than 1000 ppm by spectrographic screening. The samples analysed more than 1000 ppm. have been sent for XRF studies for quantitative determination of rare metal contents. The list of the samples analysed quantitatively for Nb_2O_5 and Ta_2O_5 is given below .

Sample No.	Original wt. of sample	Weight of conc.	Weight % of conc	Nb_2O_5	Assay Ta_2O_5
	(Kgs.	(gms)	(%)	(%)	(%)
JE 3 B	20	12.50	0.063	0.40	0.34
JM 3 A	20	110.00	0.550	0.20	0.10
JM 2 B	20	35.00	0.175	0.89	0.64
JL 2 B	20	72.50	0.363	0.21	0.26
JM 5 B	20	185.00	0.925	0.35	0.20
JL 9 A	20	25.00	0.125	0.41	0.29
JL 8 A	20	50.00	0.250	0.48	0.42
JY 4 A	20	65.00	0.325	0.22	0.12
JE 2 B	20	45.00	0.225	0.97	1.28
JL 5 A	20	30.10	0.151	0.68	0.51

Sample No.	Original wt. of sample (Kgs.	Weight of conc. (gms)	Weight % of conc (%)	Nb_2O_5 (%)	Assay Ta_2O_5 (%)
J 9 A	20	40.20	0.201	1.20	0.89
JL 5 B	20	75.20	0.376	0.33	0.25
JN 10A	20	60.20	0.301	0.41	0.59
JN 9B	20	50.80	0.254	0.61	0.54
JN 3 B	20	15.00	0.075	2.67	3.35
JM 12B	20	105.10	0.526	0.93	0.96
JE 7 B	20	35.00	0.175	4.43	2.12
JM 7 B	20	40.10	0.201	0.78	0.83
JM 9 A	20	50.00	0.250	2.34	2.94
JM 10B	20	15.00	0.075	0.57	0.42
JB 9 A	20	20.00	0.100	3.72	4.46
JE 4 A	20	21.00	0.105	1.48	0.78
JK 0 A	20	35.00	0.175	0.27	0.18
JK 1 B	20	75.20	0.376	0.97	0.74
JK 0 B	20	75.00	0.375	0.64	0.75
JK 5 B	20	100.00	0.500	0.37	0.26
JF 10A	20	25.00	0.125	1.31	1.23
JJ 2 B	20	50.00	0.250	0.46	0.31
JJ 0 B	20	42.50	0.213	0.04	1.37
JJ 0 A	20	55.00	0.275	1.96	1.90
JL0 B	20	62.50	0.313	0.48	0.42
JF 2 B	20	39.00	0.76	0.76	0.78
		Averages	0.268	1.08	0.94

Presuming that the quantitative assay data (by XRF method) of 32 samples received for Nb_2O_5 and Ta_2O_5 will be of the some trend with the rest of the samples analysed more than 1000 ppm. by spectrographic screening the resource position of Jangarpal block has been calculated.

<u>RESOURCE POSITION OF Nb_2O_5</u>

The concentrates analysed for Nb_2O_5 ranges from 0.20 to 2.67% with an average of 1.08% for 32 samples.

Potential area	•••	1.38 sq. kms.
Thickness of colluvium	••	1.11 m.
Volume of colluvium	••	13,80,000 x 1.11
		= 15,31,800 cu.m.
Bulk density		= 1.75 tonnes/ cu.m.
Wt% of concentrates		= 0.268%
Average assey of Nb_2O_5		= 1.08%
Nb_2O_5 grade		$= 0.268 \times \frac{1.08}{100}$
		= 0.0029%
Reserve		= Volume x Bulk density x Grade
		$= 15,31,800 \times 1.75 \times \frac{0.0029}{100}$
		= 77.74 tonnes.

RESOURCE POSITION OF Ta_2O_5

The concentrates analysed Ta_2O_5 ranges from 0.10 to 4.46% with an average of 0.94% for 32 samples analysed.

Potential area	•••	1,38 sq. kms.
Thickness of colluvium	•••	1.11 m.
volume of colluvium	•••	13,80,000 x 1.11
	=	15,31,800 cu.m.
Bulk density	=	1.75 tonnes/cu.m.
Wt % of concentrates	=	0.268%
Average assay of Ta_2O_5	=	0.94%
Ta_2O_5 Grade	=	$0.268 \times \frac{0.94}{100}$
	=	0.0025% Ta_2O_5
Reserve	=	Volume x Bulk density x Grade
	=	$15,31,000 \times 1.75 \times \frac{0.0025}{100}$
	=	67.02 tonnes

	Grade	Reserves .
Nb_2O_5	0.0029%	77.74 tons
Ta_2O_5	0.0025%	67.02 tons

BED ROCK GEOCHEMISTRY

To study the primary dispersion pattern of tin and to understand the provenence, bed rock (litho – geo - chemical) sampling has been carried out. From the fresh out-crop (after removing the weathered surface) number of chips have been collected and a composite sample, has been prepared. After powdering upto-220mesh size the samples have been sent for assay. The results of the analytical values of Sn, Nb and Ta content in bed rocks, have been given below:

Rock type.	Sample No.	Location	Assay		
			Sn	Nb	Ta
Pegmatite	PDTMB/17	1. Km north of Jangarpal village Jangarpal block	300	150	L500
Pegmatite	PDTMB/29	Jangarpal block 100m. S3° E of JM2 pit-	15	L50	L500
Pegmatite	PDTMB/11	4 km. stone to Puspal	L10	L50	L500
Pegmatite	PDTMB/31	Just NW of Jangarpal block	30	L50	L500
Pegmatite	PDTMB/32	-do-	20	L50	L500
Pegmatite	PDTMB/33	-do-	20	L50	L500
Quartz reef	PDTMB/14	Jangarpal block West of .815 hill	L10	L50	L500
Quartz reef	PDTMB/12	Jangarpal south of JA8 pit	L10	L50	L500
Quartz reef	PDTMB/6	Jangarpal ½ km. SW of .881 hill	L10	L50	L500
Bengpal schist	PDTMB/4	Jangarpal block 100m.east of .881 hill.	10	L50	L500

Rock type	Sample No.	Location	Assay		
			Sn	Nb	Ta
Basic rock	PDTM/3	1 Km. NE of Jangarpal village SE of .881 hillock	L10	L50	L500
Laterite	PDTMB/2	½ km. SE of .881 hill near Jangarpal village.	L10	L50	L500

In pegmatites Sn content ranges from L10 to 300 ppm. Nb is generally less than 50 ppm except in one case in the area 1km.north of Jangarpal village analysed 150 ppm. Ta is below detection limit. The pegmatite which analysed higher Sn & Nb content is exposed in Bhimsen river section 1km. north of Jangarpal village.

The quartz veins distributed in other parts Jangarpal block(other than the thin vein at JA8 pit) are paractically devoid of Sn, Nb & Ta content(below detection limit), Basic rocks and in-situ lateritic capping are barren of tin in Jangarpal block. However, Bongpal schist analysed at places 10 ppm. of Sn.

Along the selected three lines of the grid pattern of the block, bulk pit samples (20kg) of the weathered bed rock underlying the colluvial horizon has been collected and heavy mineral concentrates have been recovered after powdering and panning. The analytical values of the concentrates have given rise certain interestingly high values of Sn, Nb & Ta. The details of the Spectrographic assay values of the concentrates of the weathered bed rocks are given in the table enloug

Sample No	Description	Length of channel (m)	Wt. of sample (Kg)	Wt. of conc. (gms)	Wt. % of cone.	Assay		
						Sn	Nb	Ta
1	2	3	4	5	6	7	8	9
JA 0C	Highly weathered basic rock.	0.71	20	150	0.750	15	50	L500
JA 1C	Quartz sericite schist	1.60	20	31.50	0.163	10	500	L500
JA 3C	Weathered sericite schist	0.37	20	70.00	0.350	40	100	L500
JA 4C	-do-	0.25	20	17.50	0.088	100	50	L500
JA 6C	-do-	1.38	20	27.40	0.137	700	50	L500
JA 8C	Highly weathered quartz sericite schist.	0.35	20	22.50	0.113	1000	300	G1000
JA 10C	Weatheree sericite schist	1.32	20	42.50	0.213	500	100	L500
JA 12C	Highly weathered basic rock with sericite quartz vein.	0.73	20	97.50	0.488	500	50	L500
JB 0C	Weathered sericite schist.	0.05	20	97.50	0.488	500	50	L500
JB 1C	-do- rich in iron oxide.	0.07	20	28.00	0.140	1000	200	G1000
JB 2C	Weathered sericite schist.	0.65	20	17.50	0.88	500	100	L 500
JB.3C	-do-	0.80	20	32.50	0.163	500	100	L500
JB 4C	-do-	0.99	20	12.50	0.063	300	200	L500
JB 6C	Highly weathered sericite schist.	1.22	20	5.00	0.025	1000	300	L500
JB 7C	Weathered Bengpal schist.	0.50	20	25	0.125	1000	100	500
JB 8C	Highly weathered sericite schist.	1.21	20	22.50	0.113	1000	300	500
J8 9C	-do-	0.23	20	12.50	0.063	1000	400	L 500
JB10C	-do-	0.29	20	12.50	0.063	1000	100	L 500

1	2	3	4	5	6	7	8	9
JB12C	Highly weathered sericite schist	0.23	20	20.00	0.100	1000	200	L500
JC1C	Quartz sericite schist.	0.43	20	37.50	0.188	200	250	1500
JC3C	-do-	1.05	20	79.00	0.395	100	70	LS00
JC4C	-do-	0.85	20	127.50	0.638	100	200	L500
JC5C	Highly weathered pegmatite	0.70	20	62.50	0.313	1000	150	L500
JC 8C	Weathered sericite schist.	0.33	20	130.50	0.653	350	100	L500
J C 9C	-do-	0.78	20	45.50	0.228	400	300	L500
J C10C	-do-	0.41	20	27.50	0.138	600	200	L500
J C12C	-do-	0.47	20	12.25	0.61	300	200	L500

The burried pegmatites which have been exposed in JC5 pit has given rise- 0.313% of concentrates analysing 0.38% Sn and 150 ppm. of Nb. This indicates that there might be several such soil covered highly potential pegmatites which have given rise to the colluvium rich in c assiterite bearing heavy mineral concentrates in the block.

The concentrates derived from weathered basic rock assayed 15 to 500 ppm. of Sn and 50ppm.of Mb. However, Sn content of the concentrates of weathered quartz sericite schist ranges from 10 to G1000 ppm. Niobium and tantalum values ranges from 50 to 500 ppm. and L500 to 500 ppm. respectively. Out of 24 concentrate samples of weathered Bengpal schistose bedrock samples analysed, 8 samples (i.e. 33.3% of samples) have analysed more than 1000 ppm. Sn.

The higher anamolous values of Sn content in Bengpal schists below the colluvium (concentrates) needs further study. Tin rich concentrates might have been derived due to the water action (fluctuation, of water table) the fine heavy minerals by virtue of high specific gravity could have trickled down to lower levels in the colluvium and accummulated in the upper layers of the weathered Bengpal schist along joint, foliation and other weak planes or secondly, due to the pegmatite and quartz veins emplacement within Bengpal schistose rocks, the tin ions could have possible diffused and dispersed along with the volatiles (carrying the Sn, Nb, Ta, W, OH, F, B) into the bed rock and hence dispersion zone could have occurred. The genetic relationship of tin mineralisation in the Bengpal schists needs further studies, as to whether the mineralisation is entirely due to pneumatolysis.

DRILLING

To know the depth extension of the mineralised quartz vein encountered in JA 8 pit point one borehole (JPL-) has been drilled in Jangarpal block. The details of the borehole is given below : -

Borehole No.	-	JPL-1
Location	-	25m.east of JA-8 pit
Depth drilled	-	54.00 m.
Bearing		Due east.
Incliniation	-	400
Date of commencement	-	31.7.1979.
Date of closing	-	-

SUMMARISED LITHOLOG OF THE BOREHOLE

0.00 to 0.65	-	Dark brown silty top soil
0.65 to 3.20	-	Latcritic horizon with sub-angular quartz rubbles and weathered quartz-sericite schist, pieces.
3.20 to 30.00	-	Highly weathered quartz sericite schist, yellowish brown to buff coloured, Unconsolidated with bands of ferrugenous material ernplaced along schistosity and joint planes.

30.00 to 37.00	Partly weathered quartz sericite schist with bedding plane schistosity subtending 30° to 35° to the core axis.
37.00 to 54.00	Consolidated hard, dark, grey coloured quartz sericite schist with stringers of quartz cutting the Bengpal schist along schistosity planes.

The borehole has revealed that there is no depth extention of the mineralised quartz vein which is found exposed in JA-8 pit. The quartz vein may be pinching down below. However at depth (below 37.00m) intensive silicification with quartz stringers emplaced into the Bengpal schist as thin ramifications have been encountered. This indicates the presence of secondary silicification at depth which might have brought the mineralised solutions of tin ions in silica rich solutions and precipitated in very fine disseminations as a part of hydrothermal phase succeeding the pegmatitic stage.

CHEMICAL ANALYSIS OF THE CORES :

The core of the borehole has been split into hair vertically and one half has been sampled to check the incidence of tin and other rare metals. The analytical values of the core along with depths have been given below:-

Sample No.	Depth	Rock type	Assay							
			Sn	Nb	Ta	W	Mo	Bi	Be	Pb
1	2	3	4	5	6	7	8	9	10	11
JPL/1	0 to 1.0	Silty soil	L10	L50	L500	L100	L10	L20	L10	L10
JPL/2	1.0 to 2.0	Lat. soil	10	“	“	“	“	“	“	“
JPL/3	2 to 3.0	Laterite	L10	“	“	“	“	“	“	“
JPL/4	3.20 to3.70	Weathered schist.	“	“	“	“	“	“	“	“

1	2	3	4	5	6	7	8	9	10	11
JPL/370	3.70 to 3.90	Weathered schist.	10	75	L500	L100	L10	L20	L10	L10
JPL/l350	13.50 to 13.70	-do-	L10	L50	"	"	"	"	"	"
JPL/1600	18.00 to 18.20	-do-	"	"	"	"	"	"	"	"
JPL/5	30 to 31.50	-do-	"	"	"	"	"	"	"	"
JPL/6	31.50 to 33.50	-do-	"	"	"	"	"	"	"	"
JPL/7	37.00 to 39.00	-do-	"	"	"	"	"	"	"	"
JPL/8	51.65 to 54.00	Bengpal schist with qtz. Stringers.	150	"	"	"	"	"	"	"

All the above values indicate that the Bengpal schist samples do not have any significant mineralisation except at one place between depths 51.65 to 54.00 where Bengpal schist is emplaced with thin ramifications of quartz has analysed 150 ppm. of Sn which indicates again that in content may be dispersed stage in quartz stringers formed after the pegmatitic stage.

However, the entire core of the borehole of Bengpal quartz sericite schist has been crushed in the Beneficiation plant and made as one composite sample by the co-ordinator subjected to the field beneficiation studies. The original sample assayed 450 ppm. of Sn and the concentrates assayed more than 1000 ppm. of Sn for which quantitative data is awaited.

SUMMARY AND CONCLUSIONS

1) In the area investigated tin mineralisation occurs as discrete coarse crystals and usually as fine grains in the colluvial and alluvial horizons.

(2) Though there is distinct enrichment of heavy mineral concentrates in the lateritised gravel ("B") horizorn, the overlying silty to clayey top soil (A- horizon) can not be completely neglected as this also contributes to the resources.

(3) In the delineated potential horizon of 1.38 sq. km. a resource potential equivalent to 106 tonnes of tin has been estimated in the colluvium of 1.53 million tonnes with the average incidence of about 40 ppm. But the rare minerals viz., columbite and tantalite (Nb & Ta) and to a lesser degree W content would add to the total reserves and might improve the value of the ore material further. So it is worthwhile to assess the Nb, Ta & W content in the ore, quantitatively. It is suggested that CHO showld also provide XRF data for Nb, Ta and W also.

(4) The grade and reserve figures mentioned are based on the hand sluicing, panning of the groove samples of the pits. It is possible that by adopting the treatment of large bulk samples, the recovery of heavies might improve and separation of minerals by magnetic and electrostatic separators before analysis (to remove magnetic gangue fraction) will give a better picture.

(5) For detailed exploration it would be necessary to adopt closely spaced pitting, collection of bulk pit dump samples and adoptation of ore beneficiating methods for better recovery of concentrates by tabling. The extent of such work can be modulated by working out correct factor on selected lines.

(6) The lateral extension of the stanniferous zone in the colluvium in the adjoining areas of Jangarpal block, need be investigated as it is evident from the concentrate-map of Jangarpal that the ore bearing horizon also extends outside the block.

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I will be failing to my duties if I do not acknowledge the sincere work carried out by the Bastar Adivasi labourers without them, it is almost impossible to carry out the present work.

LOCALITY INDEX

Locality	**Toposheet**	**Latitude &**	**Longitude**
Jangarpal	65F/14	18°40'N	81°54'E
Kokavada	65F/14	18°39'30”	81°52'
Kummarapada	65F/14	18°40'	81°52'30"
Puspal	65F/14	18°38'	81°53'
Tongpal	65F/14	18°44'	81°48'

LIST OF PLATES

REGIONAL ASSESSMENT OF CASSITERITE AND ASSOCIATED RARE MINERALS IN COLLUVIAL HORIZONS OF KUDRIPAL BLOCK, BASTAR DISTRICT, MADHYA PRADESH

(FIELD SEASON 1978-79)

BY
T.M. BABU
GEOLOGIST (JR)

ABSTRACT :

With the objective of assessing the colluvial tin and rare metal potentialities of Kudripal block, systematic regional assessment survey has been taken up in an area of 2 sq. kms. The work carried out, included large scale mapping, pitting, bulk sampling, recovery of concentrates by hand panning/sluicing and assessment of tin, niobium and tantalum ores in colluvium and partly drilling investigation in primary pegmatites for testing the depth extension and behaviour of mineralisation in general.

From the data of 156 pits in the colluvium, the resource potential in Kudripal block indicated 51.59 tonnes of SnO_2 and Nb_2O_5 and 37.52 tonnes of Ta_2O_5 over an area of 2.0 sq. kms. However, the combined grade of SnO_2 and rare minerals (Nb_2O_5+ Ta_2O_5) in the colluvium is 30 gms/ tonne. The figure is likely to undergo upward revision when the systematic beneficiation studies (now in progress) are completed.

After demarcating several potential zones enriched in SnO_2 content (in the concentrates), one distinctly significant zone is found over an area of 0.1675 sq. kms with grade of 109 gms/ tonne (0.0109% SnO_2) and reserves of 42.01 tonnes.

INTRODUCTION:

Regional assessment for cassiterite and associated rare metal minerals in parts of Bastar distt., Madhya Pradesh in a few selected blocks in parts of topdsheet 65 F/13 & 14, were continued during the field season 1977-78.

In Kudripal block, though little work for primary mineralisation in the pegmatites was done earlier. It is not conclusive because the systematic bulk treatment of primary pegmatie material by beneficiation (which is more time-consuming) are yet to be done. However, the area which has been delineated due to earlier work, has been systematically examined by the author during the field season 1978-75 for assessment of tin ore and associated rare minerals under the item No. l/65F/CR/MP/76/8.

The work projected in the report forms part of the field work carried out from November 1978 to May 1979. The collection of samples has been taken up under joint GSI-AMD collaboration programme 1979. Analysis of concentrates for SnO_2, Nb_2O_5 Ta_2O_5 has been carried out by Atomic Minerals Division.

LOCATION AND APPROACH:

Kudripal block (2 sq. kms) under investigation during the FS 1978-79 is located in the central part of the operational area of 65 F/14. It is situated 8 kms. SE of Tongpal village and is bounded by Suganghat village to the north-west, Baliras to the south-east, Kudripal to the west and Madkamiras to the eastern side Baru nadi flowing from the north - westerly to south-easterly direction lies along the western side of the block. The area falls within latitudes 18°42’:18°41’30” and longitudes 21°51’ : 81°51’40" as a part of toposheet 65F/14 in Bastar district, Madhya Pradesh.

Tongpal-Pushpal metal road passing through Kudripal block is an all-weather jeepable road and forms the approach to the area. Tongpal the nearest Post-office is situated on Jagdalpur-Konta. State highway at a distance of 56 kms. from Jagadalpur and 50 kms. from Konta.The nearest raill-head is Jagdalpur, connected to Kirandel Waltair section of South-eastern Railway.

TOPOGRAPHY AND DRAINAGE:

The area forms a flat terrain with gently undulating mounds (similar to that of turtle back topography) formed due to the pegmatite exposures. Average altitude of the area is about 800' (244 m.)

North-east and south-western parts of the area are covered by linear strips of alluvium i.e. quaternary sediments. Isolated small exposures of laterite and basic rock are seen in the central and eastern part of the block. Thickness of soil cover varies from 0.5 m. to more than 3 m. overlying weathered bed rock.

The area is drained by Baru-Murgel and its tributaries. Baru nadi and Murgel flow along southwesterly direction. In the north-eastern part of the area, there are several shallow drainage channels (of (Murgel) which are reclaimed and brought under cultivation. The banks of the reclaimed channels form colluvial areas with occassional exposures of laterite. Alluvium of the reclaimed channels is superimposed on the colluvium.

PREVIOUS WORK DONE IN THE BLOCK :

Systematic mapping in the area and identification of cassiterite bearing pegmatites was first done by Shri K.S. Murti et. al. Exploratory work by geochemical surveys for cassiterite mineralisation in Kudripal block has been taken up in the field season 1975-76 (M.S. Deshpande et. al 1976).

During the field season 1976-77, the block has been taken up for regional assessment. 14 trenches (240 cu. m.) were put down to expose the pegmatites. Pitting at an interval of 50 and 100m. has been carried out. Totally 526 pits were put down and 933 samples have been collected (M. Suryanarayana et.al F. S. 1976-77).

In the FS 1977-78, the work in the block is oriented for assessment of primary mineralisation, 22 new shallow, renches were also put down in addition to the deepening of old trenches. Totally, 472 samples have been collected.

Although the assessment of the primary tin mineralisation in the pegmatites was taken up, it is not conclusive and requires large scale beneficiation for determining the grade which is not uniform.

SCOPE AND QUANTUM OFPRFSENT WORK:

The main objective of taking Kudripal block for the FS 1978-79 is to assess the over-all potentialities of cassiterite and associated columbite and tantalite minerals in the colluvial horizon. An attempt has been made to study the tin mineralisation and geological set up, controls of mineralisation besides delineation of zone-rich in secondary concentration of cassiterite and heavy minerals in colluvial and alluvial horizons. After delineating the potential horizon, the estimation of grade to assess the resources of Sn, Nb & Ta was taken up.

To examine the depth extension, structures, behaviour of pegmatites for tin mineralisation at depths, drilling investigation has been taken up.

Total quantum of work carried out in the block, is given below:

a)	Large scale mapping (1:5,000 scale).	••	2 sq. km.
b)	Traverse mapping.	••	13 L. Km.
c)	Pitting	••	156
	Total excavation	••	364 cub. mts.
d)	Bulk samples	••	260 nos.
a)	No. of geochemical samples.	••	300 Nos.

f)	No. of bed rock samples		….	30 nos.
g)	Drilling	No.of boreholes	….	7 nos.
		Total meterage	….	124.45 m.
h)	Surveying	Traversing	….	14 L.Kms.
		Levelling	….	10 L.Kms.

GEOLOGICAL SET UP:

The oldest rock exposed in the block belong to the Bengpal Group of metasediments viz andalusite-sericite-schist, quartz-sericite-schist (equivalent to Tulsi Dongar Stage of Crook Shank, 1938). Meta basic intrusive rocks of amphibolite to epidiorite in composition, occur as sills into the Bengpal schists. Exposure of granite (apophyse) intruding into the Bengpal and Basic rocks, is exposed on the banks of Baru nadi. This might represent the younger intrusive later than the Paliam/Darba granites. Samples for age determination were collected and sent to Geochronology Laboratory, GSI, Calcutta, in 1978 and the data are yet to be received. Pegmatites, are found emplaced apparently along the pro-existing weaker joint and fracture planes in basic rocks and Bengpal schists. Laterite derived, both from basic rocks and Bengpal schistose rocks, is found as cappings in some places around Kudripal. However, most of the area is covered by transported colluvium lateritised with with pebbles. Overlying the colluvium, dark greyish brown silty to loamy top soil/alluvium is derived mostly from the Baru drainage system and reclaimed nalas.

The generalised geological sequence is given below :

Recent	Silty to clayey top soil Lateritised gravel horizon.
Intrusives	Pegmatites and quartz veins Granite (apophyse ?) Basic sills.
Bongpal Group	Sericite schist, Sericite quartzite, andalusite/ sericite schist.

BENGPAL META-SEDIMENTS:

It is the oldest rock type met in the area. Bengpal Schistose rocks ere represented by sericite schist, suricite-quartzite, andalusite schist etc, belonging to Tulsi Dongar stage of Bengpal Group - (Crook Shank). Bengpal schists are exposed mainly along nala sections, south and south-western side of Kudripal block, north of Baliras village and in the Baru river sections. The general trend of schistose rocks and the bedding plane schistosity is WNW -ESE with steep north-easterly dips as it is recorded in Baru river sections and in nala sections SW of Baliras. In almost all the cases, the schists are highly weathered and are friable. In this section, the minerals observed are sericite, quartz, plagioclase, biotite and chlorite. The andalusite tabloids embedded within the schists are also highly weathered and only altered products of sericite, sillimanite. could be noticed in the tabloids. The side and shape of andalusite tabloids vary very much. In Baru river section, it is sub-rounded to rounded whereas in Kudripal block (near KJ-7 pit), the tabloids attain elliptical and prismatic shape.

BASIC INTRUSIVES:

Basic rocks cover most of northern side of the block as sheet like bodies intruded into Bengpal schistose rocks. Basic rocks are melanocratic coarse to medium grained and range in composition from epidiorite to amphibolite. At places, basic rocks are veined by secondary quartz and epidote. Petrographic examination of basic rocks in Kudripal block, indicate equigranular grano-blastic texture with hornblende, plagioclase, actinolite, chlorite, epidote with subordinate quartz, and ferrugenous apaque minerals. Plagioclase is sausaritised at places. Small enclaves of basic xenoliths found within pegmatites in some borehole cores, which indicates that pegmatites are younger to the basic activity. Basic rocks are subjected to high degree of alteration and are devoid of vesicular or amygdoloidal features nor are there any linearity to indicate that these are dykes. However, the general shape indicate that basic rocks might have formed as concordant sills in the schistose rocks and sub-sequently undergone deformation.

PEGMATIITE:

Pegmatites which were emplaced into the basic and Bengpal schistose rocks, are generally 2 to 5m. wide with length varying from 80 to 1000m. Thickness of pegmatite some times swells upto 20m. (Southern side of Kudripal block) and in places it is hardly 20 c. ms. General trend of pegmatite in the block is NNW-SSE with steep westerly dips.

Intensity of occurrence of pegmatite is more is basic rocks than in schist. Pegmatites are emplaced as veins along fracture and major joint planes in the basic rocks.

Pegmatites exposed in Kudripal block, are unzoned, coarse grained mainly of quartz-felspathic composition with incipient mica (greisen) and garnet. At places, smoky quartz is encountered in the pegmatites. Microscopic examination of pegmatite shows microcline with characteristic cross-hatched twinning with euhedral quartz grains, tiny flakes of muscovite, patches of albitic plagioclase, micro-cline-perthite and garnet.

COLLUVIUM:

Dark brownish semi-consolidated silty to clayey top soil horizon, very fine grained mixture of quartz felspar and sericite with thickness ranging from 0.30 to 1.5m. overlies the lateritic gravel horizon. The underlying formation is formed of partly sorted sub-rounded to rounded pebbles, cobbles and boulders of basic rock and Bengpal schistose rocks.

TIN AND ALLIED RARE METAL MINERALISATION

Tin mineralisation in the area can be broadly grouped into two types (l) Primary mineralisation in pegmatites and (2) Secondary mineralisation in colluvial and alluvial horizons. Tin, mainly in the form of Cassiterite associated with Nb & Ta occurs as discrete coarse crystals and as fine grains in the pegmatite is attributed to pneumatolytic process. Though pegmatites are found in basic rocks and in Bengpal schistose rocks, incidence of cassiterite in the pegmatites intruding the basic rocks is more, Secondary colluvial concentration is due to the decomposition of pegmatites after weathering (mechanical disintegration) and denudation and very limited transportation by gravity to shorter distance along palaeoslopes and deposited over the bed rock. Alluvial concentrations are due to water action of the primary and colluvial cassiterite broken down to varying degrees of mechanical disintegration and further transported and concentrated as placers in the streams and in river bed (palaeo and reclaimed channels).

Primary tin and associated rare metal mineralisation is mainly attributed to the pneumatolitic stage of pegmatitic melt. Pegmatites found in the area are mineralogically complex with high concentration of rare elements apart from Sn, Nb, Ta and other trace elements like W, Li, Be, B, Pb, Va, Y, Cr, Mo etc. which form oxides, chlorides, fluorides and sulphides, considerably at low temperature. Aqueous gas phase as well as water saturated silicate melt participated in the complex evolution of cassiterite, columbite, tantalite, lepidolite, beryl, wolframite, tourmaline and other associated minerals. Presence of greisenised zones (quartz and muscovite intercalations) in pegmatites, formed due to reaction of gases, indicate the distinct pneumatolitic phase.

The higher concentration of minerals of rare metals Sn, Nb, Ta, Li etc. indicates that these are of shallowed pegmatites formed at depths between 3.5 to 4 and 6 to 7 kms. (Ginsburg, 1964). The initial temperature of such type of pegmatitic melt has been considered to be of the order of 800 to 700°C (Fersman 1940). The pegmatites of this area may be of pegmatoid phase of Fersman, distinguished by two phase-physico-chemical state (homogenised gaseous liquid or fluid and solid) with the main event of crystallisation of tourmaline, muscovita, beryl and other minerals containing volatile compounds (water, fluorine, boron etc,) formed at 600 to 500° C.

Field observations and the available geochemical data of the trace-elements of the pegmatites, indicate that though pegmatites contain higher-incidence of Sn, Nb & Ta content than the parental granite (Darba/Paliam), the enrichment of tin ions and the formation of discrete crystals is definitely due to consequent pneumatolitib and late pegmatitic-early hydrothermal process.

METHODOLOGY OF EXPLORATION :

During the current field season emphasis is mainly on to assess the potentialities in the colluvium. Drilling has been taken up to study the behaviour of pegmatites at depths and the nature of mineralisation at depths.

Based on previous data, an area of 2 sq. kms. (2km.x1 km.) has been chosen for regional assessment of colluvial mineralisation. The block has been divided into 200m x 100m (200m. line interval and 100m.pit interval) with N30°W- S30°E trending base line and N60°E- S60°W cross lines. However, in the center of the block where potential mineralised zones ore concentrated, additional cross lines at 100m. interval had been taken up (vide plate-III). Pits were put down on grid points over an area of

2 sq. kms. Pits were 1m x 1m in cross section and generally 2m deep. Weathered bed rock has been exposed in the pits in many of the cases, However, in certain pits wherever the colluvial thickness(lateritic gravel) is more than 2m and when-ever the pit points failwithin the reclained channels,the bed rock could not be exposed in the pits.

The area has been mapped on 1:5,000 scale by theodolite survey and by tape and compass to study the disposition pattern of pegmatites and to demarcate the colluvial zones of interest.

COLLECTION OF SAMPLES:

In most of the pits, 3 distinct horizons could be delineated viz. greyish brown silty to loamy top soil with humus material (A-Horizon) is generally 0.50m. in thickness. Underlying the top soil horizon from 0.50 to 1.50 m. (in certain cases more than 2 m.) lateritised soil (B-Horizon) with mostly sub-rounded to well rounded quartz pebbles (1 to 10 cms. diameter), basic rocks and andalusite tabloids was uncountered. Because of the roundness of quartz pebbles and andalusite tabloids, it may be inferred that the laterite in many of the cases is of transported in nature. B-horizon overlies the lower clayey horizon derived from the weathered bed rock (In-situ) viz, basic rock or sericite schist. In the colluvial area, the. exposure of a pegmatite can be recognised by a gentle surface expression i.e.mound covered by rubbles of quartz and sometimes with eluvial cassiterite crystals.

The thickness of the different horizons in the pits is recorded by logging. Channels of 30 cms. Wide and about 15 cm. s deep, were cut on all the four walls of the pits. The length of the channel varies from 0.50 to 1.00 m. depending on the thickness of the horizon. The material derived (about 40 to 50 kgs) from the four channels has been mined properly coned and quartered and 20 to 25 kgs of the samples has been collected. Separate samples have been collected for different horizons in each pit. Geochemical samples have also been collected from some pits to study the trace elements particularly of Rb, Li, As besides Sn, Nb, Ta.

<u>TREATMENT OF SAMPLES</u> :

Colluvial bulk samples collected from the pits, were sun-dried, first to remove moisture content if any and each sample (25 Kgs) was passed through 1/4 and 1/8" sieves to get three size fractions. The coarser +1/4" fraction, mainly consisting of quartz pebbles of basic rock and felspar, after checking carefully for coarse cassiterite, such crystals are hand picked and the rest of the material has been rejected. The other -1/4 or +1/8" fraction (viz, lateritic pellets, quartzo-felspathic grains and clayey concretions) was subjected to sluicing and panning and coarse to fine grains of cassiterite crystals have been recovered. The fine -1/8" fraction which is mainly clayey to sandy in nature with fine heavy minerals was subjected to the following treatment. The material placed first in a bucket of water and by continuous stirring and decenting the slime (de-sliming) all the clayey material has been removed. Later, it has been subjected to sluicing. Locally made wooden sluices were adopted for the purpose. Sluice used here is nothing but a 3m. long wooden long in which 30 cm. wide and 15 cm. deep channel is carved, keeping a closed and on one, side and opening on the other. The sluice is fixed, at about 3° inclination. The sample is kept at the closed end over which a jet of water is allowed to flow by tube with constant velocity. The heavies settle nearer to the jet end of thesluice whereas the lighter materials viz. clayey and quartzo- felspathic impurities are washed away by flowing water which is collected and panned (in alluminium pans) and the remnent concentrates if any, are also recovered.

All the concentrates recovered from treatment of different fractions of each sample are, mixed together (fines and coarse crystals) dried and weighed in chemical balance. The weights of coarser cassiterite crystals and fines are recorded separately

Sieving and sizing of the bulk sample has been carried out for separate treatment to achieve bettor recovery of concentrates while sluicing and panning. A party consisting of two labourers can treat 3 bulk samples per day.

HEAVY MINERAL CONCENTRATES :

The heavy mineral concentrates recovered by sluicing and panning from the bulk samples comprise mainly ilmenite, magnetite, rutile, garnet, tourmaline, cassiterite, columbite and tantalite in varying proportions with sand. The composition of the concentrates Varies depending upon the nature of parent rock and from which the colluvium has been derived.

Non-magnetic fractions of concentrates derived from Kudripal block analysed 3.15% of SnO_2; 2.95% of Nb_2O_5 and 2.85% of Ta_2O_5 on an average. But W, Mo, Bi, Be analysed in all the cases are less than 100 ppm. except in one stray case (KD 58), W analysed 100 ppm.

Though relatively there is enrichment of concentrates in the B-horizon, the overlying silty top soil A-horizon, can not be totally neglected as cassiterite content is in very powdery form in the concentrates. ,

RESOURCE EVALUATION :

In Kudripal block, based on the preliminary work carried out during FS 1976-78, a tentative estimate of 97 tonnes of cassiterite over an area of 1 sq. km. was indicated.

Based on the detailed work carried out, the author in this chapter has worked, out the possible resources of cassiterite, columbite an d tantalite mineralisation with grade recovery of concentrates obtained by panning/sluicing. The resources would need confirmation by collection of large bulk samples, adoptation, of ore derssing techniques (tabling etc.) for better recovery. All the data projected here, is based on the 'sluiced' and 'panned' concentrates recovered. Moreover, as it is evident, the distribution and concentration of tin and other heavies in the colluviurn is non-uniform in nature owing to several factors viz., the variation of thickness of colluviurn, the palaeoslope s, mechanical disintegration and controls of transportation etc. The analytical data for SnO_2 Nb_2O_5 and Ta_2O_5 are worked out by the AMD as a part of collaboration.

The important parameters considered to work out the grade and resources, are given below :-

1) Weight percentage of the heavy mineral concentrates.
2) Quantitative assay (XRF data) of SnO_2, Nb_2O_5 and Ta_2O_5 content in the concentrates.
3 Bulk density of the colluviurn.
4 Thickness of colluviurn.
5 Surfacial area of ore bearing horizon.

Wt% OF HEAVY MINERAL CONCENTRATES :

Weight percentage of concentrate has been calculated taking into consideration the weight of concentrated (fines and crystals) recovered with respect to the original weight of each bulk sample. As already stated, the concentrates includes, ilme-nite, magnetite, rutile, zircon, monazite, garnet with cassiterite, columbite and tantalite forming a part of the total.

The wt% of concentrates of 'A' and 'B' horizons have been plotted separately and iso - concentrate maps prepared with a contour interval of 0.05%. In 'A' horizon, wt% of concentrates ranges from 0.01 to 1.12% (average 0.18%) and in 'B' horizon, the wt% ranges from 0.01 to 2.69% (average 0.39%). The details are as follows:

No. of colluvial bulk samples collected from 'A' Horizon.	…	112
No. of colluvial bulk samples collected from 'B' horizon.	...	124
Average wt% of concentrates of 'A' horizon	…	0.18%
Average wt% of concentrates of 'B' horizon.	…	0.39%

ANALYSIS OF THE CONCENTRATES:

All the concentrates recovered from each bulk sample after weighing and crushing to-110 mesh have been sent for Sn, Nb & Ta analysis to Atomic Mineral Division, Hyderabad who carried out the chemical analysis. From the concentrates, first the magnetic fraction, including ilmenite has been removed; non-magnetic fraction was subjected bromoform separation to- yield bromo-lights and the bromo-heavies. The bromo-heavies for each concentrate have been analysed by X-ray flworesence (XFF) method for quantitative estimation of SnO_2 Nb_2O_5 and Ta_2O_5. The analytical results are incorporated in Appendix – I.

SnO_2 percentage in the non-magnetic bromo-heavies fraction of the concentrates varies from 0.025% to 19.79% (average 3.15%); Nb_2O_5 percentage is of the order of 0.276% to 11. 50% (average 2.95%) whereas Ta_2O_5 percentage ranges from 0.035 to 14.92% (average 2.85%).

The feed assay is the actual mineral content (SnO_2, Nb_2O_5, Te_2O_5) in the original bulk sample and the details are discussed under the sub-chapter of reserve calculations.

BULK DENSITY OF THE COLLUVIUM:

The colluvial material derived from the three test pits located in different parts of the block, has been weighed and the bulk density of the colluvium was calculated.

The colluvial material varied from silty to loamy soil and lateritised gravel. The excavated material has been dried first to remove the moisture content and then weighed. The volume of the pit was calculated by measuring the dimensions of the pit accurately. The details of volume of weights with pit-numbers are given below :-

Pit No.	Description	Dimension mts.	Volume cu.m.	Weight tons.	Bulk density
KM-10	Silty soil and 1ateritic gravel horizon	1.5x1 .2x1.95	3.510	6.149	1.752
KD-0	Silty to loamy soil rich in iron oxides	1.2 x 1. 3 x 1.30	2.028	3.609	1.780
KF-8	Silty soil with lateritic pallets	1.4 x 1. 2 x 2.00	3.360	5.793	1.720
			Average		1.752

Average bulk density is 1.752 tonnes/cu.m.

THICKNESS CF COLLUVIUM:

The colluvium overlying the weathered bed rock as mentioned earlier can be distinguished as two horizons. The top 'A' horizon is represented by dark greyish brown silty to loamy soil constituting of very fine quartz-felspathic, micaceous and clayey minerals with humus material. The underlying 'B' horizon comprises lateritised zone rich in iron-oxides content with sub-rounded to well rounded quartz, quartz sericite schist and basic rocks.

Thickness of 'A' and 'B' horizons vary in different places depending on the nature of bed rock, palaeo-slopes etc. In this block, thickness of 'A' horizon, ranges from 0.95 to 1.95 m. with an average of 0.62m.whereas the thickness of 'B' horizon ranges from 0.03 to 2.06 m. with an average of 0.72m. Thus, the total thickness of colluvium is 1.34m.on an average.

The details of variation and average thickness of colluvium are given below:-

Line	Horizon	Thickness		
		Minimum	Maximum	Average
1	2	3	4	5
KM	A-Horizon	0.10	1.28	0.90
	B-Horizon	0.24	2.06	0.93
KA	A-Horizon	0.12	1.38	0.67
	B-horizon	0.19	2.12	0.79
KB	A-horizon	0.05	1.50	0.45
	B-horizon	0.30	1.40	0.65
KC	A-horizon	0.05	1.30	0.63
	B-horizon	0.14	1.63	0.81
KD	A-horizon	0.05	1.16	0.56
	B-horizon	0.11	1.66	0.78
KE	A-horizon	0.05	1.57	0.53
	B-horizon	0.11	1.85	0.78
KF	A-horizon	0.05	1.36	0.62
	B-horizon	0.26	1.14	0.58
KH	A-horizon	0.10	1.40	0.65
	B-horizon	0.42	1.58	1.01
KI	A-horizon	0.05	1.65	0.67
	B-horizon	0.03	1.42	0.62
KG	A-horizon	0.05	1.95	0.71
	B-horizon	0.20	1.00	0.47
KK	A-horizon	0.05	1.50	0.53
	B-horizon	0.30	1.30	0.82
KL	A-horizon	0.05	1.25	0.50
	B-horizon	0.10	1.15	0.42
Average	A-horizon	0.05	1.95	0.62
	B-horizon	0.03	2.06	0.72

SURFACIAL AREA OF ORE-BEARING HORIZON':

For resource evaluation of the block, the complete area investigated i.e. 2 sq. km. (2 km. length and 1km. width) has been considered. However, for calculation of grade and reserves for SnO_2, Nb_2O_5 and Ta_2O_5 only enriched and potential zones of SnO_2 have been included. The details of the potential areas calculated has been discussed in the succeeding chapters.

GRADE AND RESERVE CALCULATIONS OF SnO_2, Nb_2O_5 & Ta_2O_5

The grade or the head-assay of the colluvium can be calculated with the product of wt% of heavy mineral concentrate and the assay Sn% of the concentrates.

$$\text{Grade} = \frac{\text{Wt\% of the concentrate x Assay Sn}}{100}$$

For each and every sample, the grade (feed assay) data are given in the appendix-I. The average grades for SnO_2, .Nb_2O_5, Ta_2O_5 for each line of pits have been computed by the author and given in the table below :-

Line No.	Horizon	Minimum	SnO_2%		Nb_2O_5%	Ta_2O_5%	Total rare metal oxides
			Maximum	Average	Average	Average	
1	2	3	4	5	6	7	8
KM	A	0.00005	0.0013	0.0004	0.0004	0.0003	0.0011
	B	0.0001	0.0018	0.0005	0.0007	0.0005	0.0017
KA	A	0.00004	0.0014	0.0004	0.0000	0.0004	0.0016
	B	0.00007	0.0012	0.0005	0.0008	0.0006	0.0019
KB	A	0.0004	0.0017	0.0010	0.0014	0.0008	0.0032
	B	0.00004	0.0024	0.0007	0.0007	0.0004	0.0018
KC	A	0.00004	0.0032	0.0010	0.0014	0.0009	0.0033
	B	0.00004	0.0071	0.0012	0.0008	0.0005	0.0025
KD	A	0.0003	0.0039	0.0012	0.0019	0.0011	0.0041
	B	0.0001	0.0077	0.0019	0.0021	0.0012	0.0052
KE	A	Traces	0.0032	0.0014	0.0021	0.0011	0.0046
	B	Traces	0.0065	0.0014	0.0009	0.0006	0.0029

1.	2	3	4	5	6	7	8
KF	A	0.0002	0.0037	0.0017	0.0030	0.0027	0.0072
	B	0.0001	0.0596	0.0088	0.0045	0.0052	0.0185
KH	A	Traces	0.0011	0.0003	0.0005	0.0003	0.0013
	B	Traces	0.0025	0.0005	0.0006	0.0003	0.0014
KI	A	0.0001	0.0007	0.0003	0.0003	0.0002	0.0008
	B	0.0001	0.0005	0.0002	0.0004	0.0002	0.0008
KJ	A	0.0001	0.0008	0.0004	0.0006	0.0003	0.0013
	B	0.0001	0.0042	0.0009	0.0012	0.0008	0.0029
KK	A	0.0001	0.0004	0.0002	0.0002	0.0002	0.0006
	B	Traces	0.0002	0.0001	0.0001	0.0001	0.0003
KL	A	Traces	0.0004	0.0002	0.0002	0.0001	0.0005
	B	Traces	0.0008	0.0003	0.0002	0.0002	0.0007
Overall		Traces	0.0039	0.0007	0.0011	0.0007	0.0025
Averages			0.0596	0.0014	0.0011	0.0009	0.0034

Grade

Average SnO_2 in the colluvium : 0.0011% (11 ppm)
Average Nb_2O_5 -do- : 0.0011% (11 ppm)
Average Ta_2O_5 -do- : 0.0008% (8 ppm)

Total rare metal content : 0.0030%

(SnO_2+ Nb_2O_5+Ta_2O_5) :

Resources = Volume x Bulk density x Grade
Surfacial area investigated - 2 sq.km.
Thickness of colluvium - 1.34 m.
(A + B Horizons)
Volume of the colluvium = 20,00,000 x 1.34
= 26,80,000 cu. mts.
Bulk density =1.75 tonnes/cu.mts.

Resources of SnO_2 $= \frac{26,80,000 \times 1.75 \times 0.0011}{100}$
= 51.59 tonnes.

Resources of Nb_2O_5 $= \frac{26,80,000 \times 1.75 \times 0.0011}{100}$
= 51.59 tonnes.

Resources of Ta_2O_5 = $\frac{26,80,000 \times 1.75 \times 0.000.8}{100}$

= 37.52 tonnes

Over-all grade and resources of Kudripal blocks

Metal	Average Grade	Resources
SnO_2	0.0011% (11 ppm)	51.59 tonnes
Nb_2O_5	0.0011% (11 Ppm)	51.59 tonnes
Ta_2O_5	0.0008% (6 ppm)	37.52 tonnes

DEMARCATION OF POTENTIAL CASSITEFITE BEARING HORIZONS :

As it is evident from plates, the distribution pattern of SnO_2 is not uniform in nature. At several selected zones, because of the presence of cassiterite bearing pegmatites in the vicinity, the colluvium has exhibited higher values. An attempt has been made to delineate such relatively rich zones of colluvium. To achieve this; as a first step, the pits which have given the concentrates (non-magnetic bromo-heavies fraction) analysing more than 2% SnO_2 or more were grouped together into a zone. From this block, 5 such zones have been delineated. The remaining areas have beer, demarcated as lean zones with the concentrates analysing 0.5 to 2% SnO_2 and less than 0.5% SnO_2. As the lean zones were of very poor grade (i.e. less than 3 ppm of SnO_2 or 0.0003% SnO_2), those were not taken into consideration for calculation.

The average thickness of colluvium of different enriched zones has been calculated and the volume of the material in each case has been arrived at. Grade of SnO_2% (cassiterite) of each zone has been computed taking the average wt% of concentrates and overage assay% of concentrate.. Knowing the volume of colluvium and the average grade of the ore(?) the reserves have been calculated for the fiye demarcated zones. The details of grade and reserves have been given in in the table below:

Zone	Area sq. kms.	Average thickness of collu'm	Tonnage of colluviue	No. of samples coo-conc llected	Avr'ge wt% of conc	Ave'ge SnO_2% of conc.	Ave'ge Grade% SnO_2%	Peserue tons.
1	2	3	4	5	6	7	8	9
I	2, 35,00	0.90	3,70,125	31	0.031	3,801	0.0012	4.44
II	1,67,500	1.34	3,92,787	23	0.307	3.551	0.0109	42.81
III	40,000	1.69	1,18,300	10	0.073	2.094	0.0015	1.77
IV	1,77,500	1.52	4,72,150	19	0.027	3.065	0.0008	3.78
V	75,000	1.14	1,49,625	5	0.010	3.240	0.0003	0.45

Total :
6,95,000 Total reserves (SnO_2) 53.25

Total area explored	-	2 sq. kms.
Lean zone	-	1.305 sq. kms.
Enriched zone (conc. more than 2%)	-	0.695 sq. kms.
Area of potential zone (grade 0.0109)	-	0.1675 sq. kms.

Thus, as it is clear from the data mentioned above, the only zone with economical significance is situated in the center of the block almost running parallel to the base-line and lied in between KC and KI line. Average grade obtained from the colluvium is 0.0109% of SnO_2 (or 109 gms.per tonne) with the total reserves of 42.81 tonnes.

TAILING ANALYSIS:

The XRF analysis for tailings in respect of 9 samples indicate that the Nb_2O_5 ranges from 9 to 270 ppm (average 116 ppm), Ta_2O_5 from trace to 142 ppm. (average 40 ppm) and SnO_2 from T to 22 ppm.(average 4.4 ppm). These data may have a bearing regarding the values of rare metal and tin oxide in the tailings and in the over-all samples. This would be known when beneficiation tests are carried out. The wt% of bromo-heavies in tailings varies from 6.16 to 48.97% (average 19.5%) This is a significant factor and hence tailings data are important to consider. The weight% of bromo-heavies in the concentrates very from .002 to 0.592% (average).

<u>DRILLING</u> :

Drilling investigation in primary pegmatites in Kudripal block has been taken up with a view to decipher the depth extension, behaviour and potentialities of pegmatities. Test drilling was carried out to understand the pinching and swelling nature of peg-matites, zoning at deeper levels and to check-up the variation in mineralogy at depth.

As the pegmatites of Kudripal block have been found to extend upto 6 m. depth as in KPT-1 trench, it has been proposed to intersect the pegmatites at shallow depths i.e. 15m. vertical depth in the first stage.

Seven inclined boreholes were drilled in the block to intersect the pegmatites exposed in the trenches. As the pegmatites are south-westerly dipping, the boreholes have been given with north-easternly bearings with inclination of 40° to 60° angle. First and third borehole points have been located near the cross trench KPT-1. Fourth and fifth borehole points have been located 100m. S30°E near KPT-VII trench and N30°W near KPT-IX trench respectively. One vertical borehole KPL-2 has been given in Kudripal reclaimed channel to study the thickness of alluvium and to check up the incidence of mineralisation.

<u>RESULTS OF DRILLING</u> :

Drilling investigation has thrown some light on the behaviour and pattern of pegmatites. Examination of pegmatite cores below 15m. depth reveals that there is no variation in the mineralogical composition of pegmatites. As the pegmatites exposed in trenches, the composition is mainly quartz-felspathic through out with small pockets of muscovite at places and tiny grains of garnet. No zoning is evident in the pegmatites even at depths. Width of pegmatites remains unchanged over that exposed on the surface. Thus, it can be concluded that the pegmatites are not exhibiting pinching and swelling behaviour down to a depth 15 to 50m. Visual examination of the cores did not reveal presence or enrichment of cassiterite mineralisation at depth. The mineralised pegmatite exposed in KPT-IX trench (where visual grains or crystals are visible) which has been intersected in the borehole KPL-5 at a depth of 25 m. has not shown presence of any such mineralisation. The mineralisation being non-uniform treatment of bulk samples in larger quantity (100-200 kg) would be attempted later.

The inclined boreholes drilled near the cross trench KPT-1 has indicated that the persistence of fine parallel pegmatites down to a depth of 50m, without any appreciable change in the attitude and width as well as mineralisation from that at the surface. The steeper dips of pegmatites have been emplaced along the fracture planes in the basic rock. They are not affected by any major post pegmatitic phase of folding. The earlier idea that the parallelism of pegmatites might be because of repetition due to folding (1976-77 FS progress report) gets revised.

CHEMICAL ANALYSIS :

The pegmatite core samples have been crushed to -80 mesh and sent for Sn, Nb, Ta and other trace elements analysis,

Pegmatites encountered in KPL-1 borehole located near KPT-1 cross trench analysed less than 10 to 50 ppm. of Sn. Out of 13 samples, two samples analysed 100 and 500 ppm. Thus, the average tin content is 65 ppm. However, Nb, Te, W, Mo, Bi, Be and Pb are below detection limits in the reclaimed channel. In

In borehole KPL-2 the top soil and gravel horizons analysed 10 and 20 ppm of Sn & Nb respectively. The concentrates of gravel horizon of KPL- 2 borehole analysed more than 1000 ppm of Sn. Tin content in KPL-3 borehole ranges from 10 to 20 ppm. except one pegmatite sample which analysed 400 ppm with an average of 38 ppm. In KPC-3 borehole, Nb content ranges from less than 50 to 100 ppm with 25 ppm as an average content. In borehole KPL-4, pegmatite analysed less than 10 ppm. of Sn and less than 50 to 50 ppm of Nb.

SUMMARY AND CONCLUSIONS:

1) The distribution pattern of cassiterite and associated columbite, and tantalite mineralisation is generally irregular and non-uniform in nature. The colluvium derived from mineral bearing potential pegmatite exhibits higher concentration in the vicinity of the pegmatite with appreciable mineralisation. However, such zones are very much restricted and pockety in nature.

2) Although, there is enrichment of heavy mineral concentrates in the lateritised gravel 'B' horizon in most of the cases, the overlying silty to clayey top soil 'A' horizon cannot be set aside as it consititutes also tin and rare metal horizon of importance where concentrates are in very fine form.

3) The over-all resources in the block calculated by taking all the data available with their limitations are 51.59 tonnes of SnO_2: 51.59 tonnes of Nb_2O_5 and 37.52 tonnes of Ta_2O_5. However, the over-all grade of' the colluvium is 8 to 11 ppm of Sn, Nb and Ta rare metal contents.

4) The most potential zones in the block with significant enrichment of SnO_2 over an area of 0.1675 sq. kms. with a grade of 109 gms. per tonne (l09 ppm)

holds a resource of 42.81 tonnes.

5) The results of drilling have revealed that the depth persistence of pegmatites upto 50m. depth exists with the thickness and the composition maintained. These pegmatites occur as veins and are not affected by deofrmation later than their formation.

ACKNOWLEDGEMENTS :

The author express his sincere thanks to Shri S. K. Bose, Director, DOPIS under whose guidance and support the work has been completed. Thanks are also due to Shri M. Suryanarayana, Geologist (sr) and Co-ordinator of the investigation.

The chemical analysis of concentrates of Kudripal block has been carried out by Atomic Mineral Division in joint collaboration programme for which the author expresses his sincere thanks.

In carrying out the survey work of Kudripal block and in preparation of plates, the untiring support put in by Shri D. Sengupta, STA (Survey) is thanfully acknowledged. Finally, the author would not like to forget the hard work put in by Bastar Adivasi labourers (the unprevileged class of our society) who contributed much in carrying out the work.

LOCALITY INDEX :

Locality	Toposheet	Latitude & Longitude	
Baliras	65F/l4	18°41’	81°52’
Jangarpal	-do-	l8°40’	81°64'
Kudripal	-do-	18°41'	81°51’
Madkamiras	-do-	18°42’	81°52’45”
Pushpal	-do-	18°38’	81°53’
Suganghat	-do-	18°42’	81°50'30"
Tongpal	-do-	18°44’	81°48’

PLATES

1) Location Map of Kudripal block.
2) Physiography Map of Kudripal block.
3) Geological Map of Kudripal block
4) Iso-concentrate Map of Kudripal Colluvial horizon.
5) Colluvial profiles of Kudripal block.
6) Resource Evaluation of Kudripal block
7) Potential zones of cassiterite bearing colluvium of Kudripal block.
8) Location map showing the drill points in Kudripal block.
9) Cross section of KPL-1 borehole.
10) Cross section of KPL-2 borehole.
11) Cross section of KPL-3 borehole and KPT-I cross trench
12) Cross section of KPL-4 borehole

Borehole No.	:	KPL-1
Unit No.	:	VOL. 20 (330-\/77)
Location	:	Kudripal block KPT-I trench 24m. S60°W from pegmatite-I.
R.L.	:	248m. from M. S. L.
Bearing	:	N55°E
Inclination	:	40°
Depth drilled	:	35.00 m.
Commenced on	:	1-1-1979
Closed on	:	

SUMMARY OF THE BOREHOLE LOG OF KPL-1

0.00 to 1.05	-	Clayey top soil, Very fine grained buff coloured silt at upper levels. At places, grains of basic rock.
1.05 to 7.50	-	Highly weathered metabasic rock (epidiorite?) unconsolidated powdery core.
0.50 to 22.90	-	Metabasic rock (Amphibolite?) Medium grained hard core with fracture planes at places subtending 30° to 25° to the core axis.
22.90 to 24.25	-	Metabasic rock (Epidiorite) Highly weathered with distinct foliations of schistosity almost parallel to the core axis.
24.25 to 26.30	-	Metabasic rock (Amphibolite) medium to coarse grained with amphibole needles not showing any preferred orientation.
26.30 to 27.75	-	Pegmatite with cought up patches of basic rock and tiny grains of garnet and muscovite (greisen?) pockets.
27.75 to 28.27	-	Metabasic rock (Amphibolite)
28.27 to 28.72	-	Pegmatite with muscovite-greissen pockets, Mainly of quartzo-felspathic in composition with rare minute grains of garnet.
28.72 to 33.50		Meta basic rock-amphibolite
33.50 to 35.00		Meta basic rock-epidiorite.

Borehole No.	-	KPL-2
Unit No.	-	V0L.20 (330-V77)
Location	-	Abandoned channel, Kudripal block, 50m.south of O/E700 point.
R. L.	-	247.84 m.
Bearing	-	Vertical borehole
Inclination	-	90°
Depth drilled	-	18.65 m.
Commenced on	-	5.2.1979
Closed on	-	25.2.1979

SUMMARY OF THE BOREHOLE LOG OF KPL-2 :

0.00 to 0.50	-	Top soil. Greyish brown silty soil containing angular to sub-rounded pieces (1 cm. in diameter) of quartz upto 30%.
0.50 to 1.70	-	Yellowish brown ferrugenous soil.
1.70 to 3.10	-	Lateritised gravel horizon. Reddish brown clayey soil with pebbles of quartz (upto 3 cm.) sub-rounded to rounded and andalusite tabloids.
3.10 to 7.00	-	Sandy soil. Yellowish grey in colour fine to medium grained with tiny flakes of mica with a few grains of mafics.
7.00 to 7.10	-	Loose boulder of quartz (sub-rounded).
7.10 to 9.00	-	Sandy soil fine grained with tiny flakes of sericite.
9.00 to 13.35	-	Gravel horizon with rubbles and cobbles of quartz sub-rounded to well rounded upto 5 cm. in diameter.
13.35 to 18.65	-	Sericite schist (Bengpal). Greenish grey coloured fine grained with quartz and felspathic minerals. Foliations are subtending 450 to the core axis. At 13.60m.depth, a thin (0.5 cm.) felspathic vein is cutting perpendicular to the foliation planes.

Borehole No.	-	KPL-3
Unit No.	-	V0L. 20 (330-V77) & G859
Location	-	Kudripal block, KPT-I cross trench.
R. L.	-	253.25m.
Bearing	-	N55°E.
Inclination	-	40°
Depth drilled	-	42.70m.

SUMMARY OF BORE HOE LOG OF KPL-3 :

0.00 to 00.25	-	Top soil with pieces of quartz
0.25 to 2.50	-	Lateritised gravel horizon with well rounded pebbles of quartz.
2.50 to 8.50	-	Highly weathered basic rock. Powdery friable in nature fine grained with felsic and mafic minerals.
8.50 to 0.05	-	Diorite. Very coarse grained melanocratic with pyroxene and plagioclase.
9.05 to 14.50	-	Feldspars. Fins Grained buff grey powder mainly of felspathic material (may be of weathered pegmatite).
14.50 to 14.70	-	Basic rock. Coarse grained grained diorite.
14.70 to 15.20	-	Pegmatite. Mainly felspathic in nature with rare grains of garnet.
15.20 to 27.65	-	Basic rock (Diorite) from 24.50 to 25.00 weathered due to fracturing.
27.65 to 29.55	-	Pegmatite with inclusions of basic Patches and minor pockets of mica books and grains of garnet in a dispersed stage. Fine veins of epidote at places.
29.55 to 31.55	-	Basic rock-coarse grained. Same as above.
31.55 to 34.60	-	Pegmatite with patches of basic rock with grains of garnet.
34.60 to 41.00	-	Coarse grained basic rock-Diorite.
41.00 to 42.70	-	Very fine grained amphibolite with more of hornblende and subordinate plagioclase felspar.

Bore hole No.	:	KPL-4
Unit No.	:	CO-59
Location	:	Kudripal KPT-VII trench
	:	11.75 m. S40°W of trench.
R.L.	:	251.4 m.
Bearing	:	N40°E
Inclination	:	60°
Depth drilled	:	28.10m.
Commenced on	:	14.4.1979
Closed on	:	22.4.1979

SUMMARY OF THE BOREHOLE LOG OF KPL-4

0.00 to 0.60	-	Silty top soil. Fine grained dark brown in colour with hums material.
0.60 to 1.80	-	Lateritic horizon. Yellowish brown in colour with grains of quartz and pellets of laterite.
1.80 to 3.40	-	Highly weathered meta basic rock. Friable medium grained dark yellowish in colour (epidiorite).
3.40 to 5.70	-	Weathered basic rock. Partly consolidated medium coarse grained mainly of hornblende needless amphibolite.
5.70 to 14.70	-	Highly weathered meta basic rock (epidiorite) Yellowish brownish coloured, Friable, medium grained.
14.70 to 16.85	-	Amphibolites Medium grained dark, grey coloured compact with hornblende and actinolite needless, with subordinate plagioclase.
16.85 to 17.95	-	Highly weathered basic rock (Epidiorite) Yellowish-brown in colour.
17.95 to 23.20	-	Pegmatite with caught up patches of basic material. Coarse grained mainly of quartz-felspathic in composition with pickets of muscovite mica and grains of garnet.
23.20 to 28.10	-	Amphibolite (metabasic), Mainly. hornblende with subordinate plagioclase.

PART - III

A REPORT ON THE REGIONAL ASSESSMENT Of CASSITERITE IN MURGEL, CHIDPAL AND KANKAPAL BLOCKS IN PARTS OF BASTAR DISTRICT, MADHYA PRADESH

(FIELD SEASON 1978- 79)

BY
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INTRODUCTION

The work in Chidpal-Kankapal-Madkamiras blocks was first initiated as a part of systematic mapping by M. P. Circle-II during the FS 1975-76 in toposheet II 65F/13 and 14 and number of pegmatites have been located in Basic and Bengpal metasedimentaries. The incidence of alluvial cassiterite mineralisation in drainage area of Murgel, a stream joining the Bhimsen nala in toposheet 65 F/14 was first recorded by M.L. Deshpande et.al. in 1975-76 during the course of regional stream sediment surveys.

In order to delineate the nature and extent of secondary tin mineralisation, in Murgel drainage, systematic prospecting was taken up by M. Suryanarayawa et.al. during FS 1976-77-78 in an area of 10 sq. km. As a part of detail exploration, an area of 2 sq. km. bounded by latitude 18°43' : 18°45' and longitudes 81 5S' :81 55’ in toposheet 65F/14 was covered by close spaced pitting, bulk sampling, detailed mapping during FS 1978-79. Also 2.82 sq. km. area of alluvial and colluvial horizon bounded by latitudes 18°43’30" and longitudes 81°53’ : 81°53’30" in toposheet 65F/14 was covered by pitting, sampling, hand-panning and processing for obtaining concentrates with theco-ordination of AMD for chemical analysis.

In Madkamiras block, bounded by latitude 18°41'30":18°42’30” and longitude 81°52’ : 81°53' in toposheet 65F/14, incidence of cassiterita crystals both in eluvial and colluvial profiles was first noticed by authors during 1978-79. So, detail surveys comprising large scale mapping and pitting were initiated over an area of 0.17 sq. km.

Chidpal block which is bounded by latitude 81°53' : 81°54’37": in toposheet 65F/14 has geological continuity of Bedhanpal and Hurgel blocks where the cassiterite mineralisation is encouraging. Hence, regional assessment surveys in this block has been initiated in FS 1978-79 by pitting, bulk sampling and detailed mapping over 3.2 sq. km. Crystals of cassiterite have been noticed by authors in colluvial profile.

Also in Kankapal block which is adjacent to Chidpal area bounded by latitude 18°45’30” : 18°46’ and longitude 81°50' : 81°51’ in toposheet 65F/13, exploration has been taken up in FS 1978-79 over an area of 2.2 sq. km. by pitting, bulk sampling and detailed mapping. Details of investigation carried out in different blocks, are incorporated block-wise in text.

MURGEL BLOCK

INTRODUCTION:

The incidence of alluvial cassiterite mineralisation in the drainage area of Murgel, a stream joining the Bhimsen nala in toposheet 65F/14 was first recorded in 1975-76 by Shri M.L. Deshpande et.al during the course of regional stream sediment surveys.

In order to delineate the nature and extent of secondary tin mineralisation, systematic prospecting was taken up during FS 1976-77-78 by M. Suryanarayana et. al. An area of about 10 sq. km. adjoining the Murgel and Bhimsen nalas was initially explored by pitting and collecting bulk samples on a regional grid of 250m.x150m. in FS 1976-77. During 1977-78, exploration was intensified in an area of 1 sq. km. by close spaced pitting and bulk sampling was continued during FS 1978-79 over an area of 2 sq. km. In addition, an area of 1 sq. km. has been explored jointly by GSI & AMD during the field season 1978-79.

LOCATION

The Murgel-Bhimsen block extends from the Bhimsen river in the east upto Chidpal in the west, bounded in north by the east-west trending foot-hills, comprising a major basic body traversed by pegmatites. Ths area of operation is bounded by latitudes 18°43’ : 18°45’ and longitudes 81°52’ : 81°55’ in toposheet 65F/14. (Plate-I).

A kutcha jeepable road from Tongpal to Name (via leda) passes close to the area of investigation. Tongpal, the main Post-Office for this area falls on Jagdalpur-Konta bus route and is about 10 kms. from the area. The area is not accessible during mansoon.

GEOMORPHOLOGY:

Except for two isolated small mounds represented, by silicified zone near Kummakoleng and the basic body south of Chidpal with a maximum elevation of 254.16m. the area under reference is almost plain with an altitude of 243.8 m. and show a gentle southerly slope. The Murgel nala with its number of tributaries forming dendritic pattern flow to the south draining the foot-hills of the basic hill-ranges, constitute the drainage and had thereby aided in the concentration of detrital tin in the colluvial/alluvial formations in the vicinity. The colluvial zone occupies the foot -hills of the major basic body and extends into alluvial area in the southern part of the block.

QUANTUM OF WORK :

On the strength of the analytical data of concentrate samples collected during FS 1976-77 and 1977-78, an area around cross lines MB-11,8,7 and 2.5 was delimited for detailed exploration. The survey, layout far mapping and sampling by pitting comprise an east-west base line in. the, centre of the area with cross lines laid at 200 m, interval. The mapping on scale 1:5,000 was carried out over an area of 4.25 sq. km. The pits in the colluvium ranging in depth from 0.50m. to 2.50m.,were made along the cross lines at 150m. interval for collection of bulk samples. Besides, pitting in alluvium was done at 100m. interval along the Murgel nala course upto its confluence with Bhimsen -nala to trace the southerly extension of cassiterite placers. The bulk samples each weighing 20 to 30 kg., were collected separately from the different horizons (colluvial/alluvial) and sometimes from the weathered bed rock, below the colluvial profile to identify the relative concentrations of Sn, Nb & Ta.

About 279 pits were made and 312 bulk samples were collected.

The sample of colluvial/alluvial material was collected by cutting a 20 cm. x 10 cm. vertical groove on all the four walls of the pit upto the bed rock and the bulk material is reduced by coning and, quartering to about 25 kg. The material was dried, crushed to fine size and then subjected to hand-sluicing/ panning to obtain the concentrate samples.

The concentrates were weighed and visual cassiterite grains if any in the concentrates were separated and their weight recorded. The concentrates are ground to 60 mesh and sent for analyses after coning and quartering. A few samples from the tailings fraction are also sent for analysis after grinding it to-60 mesh.

GEOLOGY

The area of operation is mostly covered by soil and alluvium and the outcrops are rare. The thickness of the soil varies from less than a meter to as much as 3.0 m. at places. The area is occupied mainly by the Bengpal Group of rocks comprising quartz sericite schist with intercalations of sericite quartzite and andalusite schist which are exposed in the Murgel nala section and its tributaries. These are intruded by meta-basic rocks (epidiorite) that are generally weathered into yellowish to greenish buff clayey material. Although, exposures of granite are not seen in the area, two outcrops of granite apophyses were noticed to the east of the operational area. The pegmatite outcrops are very few. One major NE-SW trending pegmatite located in the northern part of the block near Chuirwada is being investigated by the Department of Geology and Mining Madhya Pradesh State. The pegmatite is 400m. long and 5 to 10m.wide. It shows zoning with the quartz core in the centre and good development of lepidolite, albite, zinnwaldite, beryl, garnet, fluorite alongwith cassiterite columbite-tantalite mineralisation. The geological succession is given below:-

ARCHAEAN	Quarternary formation	Soil/Alluvium
	Intrusives	Pegmatites Granite apophyses Basic rocks.
	Bengpal Group	Quartz-sericite schist. Anadlusite.sericite schist.

TIN MINERALISATION

The location and geomorphological setting being favorable, the exploration in the block was carried out mainly for colluvial and alluvial types of tin mineralisation. Tin occurs as detrital cassiterite varying usually from very fine (30 mesh) to occassionally as crystals upto 1 cm, and is very irregularly distributed in the colluvial/alluvial profile resting on the bed rock. The primary tin mineralisation as discrete cassiterite crystals within the pegmatite is noticed near Chuirwada and has been worked in part by Department of Geology and Mining, M. P.

FINDINGS :

The thickness of colluvial/alluvial horizon varies from 1.3 to 3.1 m. A typical colluvial profile exhibits a top thin layer of dark soil upto 0.25 m. followed by brownish grey to yellowish grey soil containing small fragments of ferrugenous material gradually grading into the weathered bed rock. The wt% of concentrates recovered from the pit samples by hand-panning ranges from 0.08 to 0.58% (average 0.2%)

The spectrographic scanning of 90 concentrate samples done so far indicate that 14.3% of the total samples assay 1000 and more than 1000 ppm Sn. The Nb and Ta content upto 1000 ppm. has been found in one and 11 samples respectively. The W has been detected upto more than 400 ppm in two samples.

CONCLUSION :

About 14.3% of 90 samples have analysed more than 1000 ppm. Sn and 12.1% of 90 samples have analysed more than 1000 ppm. Ta; while only one sample out of 90, has analysed more than 1000 ppm. of Nb.

Almost all the samples analysed less than 100 ppm of W except two samples which analysed 400 and 500 ppm. respectively over 2 sq. km. area.XRF result in terms of % from CHQ is awaited. However, beneficiation test may improve the percentage of Sn, Nb, & Ta.

MADKAMIRAS BLOCK

INTRODUCTION :

A pegmatite body near Madkamiras was mapped during the systematic mapping by the officers of the M. P. Circle-II in 1976-77 field season. The incidence of cassiterite crystals in the elluvial and colluvial profile was first noticed by the authors during FS 1978-79 and detail surveys comprising large scale mapping (1:1000) and pitting were initiated in this block in FS 1978-79.

LOCATION AND ACCESSIBILITY

The Madkamiras block is located to the south of Madkamiras village. It is bounded by latitude 18° 41'30" : 18°42'30" and longitude 81°53' in toposheet 65 F/14 (plate No. 1) A cart-track of 5 – km., connects the area to fair-weather road going to Tongpal (10km.) via leda.

GEOMORPHOLDGY

This block is predominantly covered by Bengpal and basic rocks. In southern part of block, it has undulating topography. The main drainage in this block is of Murgel stream and its tributaries flowing towards south easterly. The highest peak 313.6m (1035 feet) is on Kokalpal hillock in this area formed of basic rock.

QUANTUM OF WORK DONE :

An area of 0.17 sq. km. was covered by large scale mapping over cross lines laid at 50 m. interval. The pitting was carried out on a 50m. x 50m.grid.

The quantum of work carried out in this block is given below:-

1. Large scale mapping (1:1000)	- 0.17 sq. km.
2. Pitting	-.91 cu. m.
3. Bulk sampling	- 94 nos.

Bulk samples were collected from the pits by drawing channels on all the four walls of the pit and scooping out about 20 to 30, kg. of material from the colluvial profile over the bed rock. The samples were subjected to sluicing and hand panning by using water for separating the heavy concentrates and the light tailings. The concentrates were weighed; and visual cassiterite grains if any in the concentrates were separated and their weight recorded. The concentrates are ground to -60 mesh and sent for analyses after coning and quartering. A few samples from the tailings fractions are also sent for analysis after-grinding it to -60 mesh.

TIN MINERALISATION :

The authors during reconnaissance of the area could collect a few medium to coarse loose crystals (upto 1.5 cm) of cassiterite from the colluvium. The crystals; being presumably released from the nearby cassiterite bearing pegmatite. Surface examination of the pegmatite outcrop has not, however, shown the presence of insitu cassiterite within the pegmatite.

By sluicing and panning of the colluvial material from the pits, small grains of cassiterite are sometimes obtained in the concentrates.

FINDINGS :

The thickness of the colluvial profile varies from 0.50 to 2.05 m. with an average of 1.28 m. A generalised section of the colluvial profile over the bed rock (Bengpals) show top 0.10 m, to 0.30 m. of dark grey to brownish grey soil on the top, followed by yellowish grey to greenish grey clayey material with pebbles of quartz. The wt% of the concentrates obtained by sluicing and panning of about 20 to 30 kg. of material from-the individual pit varies from 0.03 to 0.38% and the average weight percentage of the concentrates is 0.13%. A few cassiterite crystals were obtained from some of the pits.

A spectrographic analysis of 93 samples indicate that tin assay exceeds 1000 ppm. in case of 28 samples. In six and seventeen samples, the assay for niobium and tantalum is found to be more than 1000 ppm. and ranges from 500 to 1000 ppm. in case of four and 28 samples respectively. The tungsten content is generally less than 100 ppm.

CONCLUSION :

About 33% of 94 samples have shown more than 1000 ppm of Sn, Nb and Ta covering an area of 0.04 sq. km, area. The estimates of the resources of Sn, Nb & Ta would be worked out after the quantitative analytical data is obtained.

However collection of bulk dump samples and recovery of the concentrates by tabling would give clear picture of the potential of the area.

CHIDPAL BLOCK

INTRODUCTIONS :

The work in the Chidpal block was first initiated as a part of systematic mapping by the officers of M. P. Circle-II and ten pegmatites have been located. The area represents the geological continuity of the Bedhanpal and Murgel blocks where the surveys earlier arried nut by GSI for cassiterite and associated rare metal mineralisation during FS 1977-78 have given encouraging results. Moreover, in the adjoining Chuirwada area, the Department of Geology and Mining, M. P. has been conducting the prospecting operations for cassiterite since 1976. Hence the regional assessment surveys in the Chidpal block were taken up during field season 1978-79.

LOCATION AND ACCESSIBILITY

The Chidpal block is bounded by latitude 18°44’ : 18°45’ and longitude 81°54’37" in toposheet 65 F/14 (Plate-l). It is situated to the east of Kankapal block and NW of Murgel block. The block is connected by a 7 km. cart-tract from Kokalpal village, which is well connected to Tongpal by a fair weather road.

GEOMORPHOLOGY :

The area falls at the foot-hills of the major basic body (Ellingar hill range) trending east-west. The topography is gently undulating with southerly slope. The highest and the lowest contours passing through the block are 1000 m. and 850 m. respectively. The northern part of the block is mainly occupied by the basic rock traversed by the pegmatites and forming the mounds, the greater part of the block to the south forms a gently sloping flat ground covered by Pawade Colluvium.

Number of small streams flowing towards south down the hill range on the north constitute sub-parallel drainage pattern and join the Murgel nala.

QUANTUM OF WORK

In this block, with an area of 3.2 x 1.0 km., pitting was carried out on 200m. x 100m. grid. The follouing is the quantum of work carried out in this block:

1. Reconnaissance mapping. (1:15,840) ... 659 km.
2. Detailed mapping (l:5000) ... 5.5 sq. km.
3. Pitting ... 251 cu. m.
4. Samples ... 324 nos.

GEOLOGY:

The oldest rocks met within this area are the Bengpal metasedimentaries represented by sericite quartzite and and alusite schist. The basic rocks that are intrusives into the Bengpal, occupies the major portion in the block.

A few pegmatites trending E-W and NE-SW are noticed in the area Their strike length and width varies from 70 to 100 m. and 10 to 30m. respectively. The mounds of the basic rock SE of Chidpal possibly represent the younger dykes. The geological succession in the area investigated is as follows: -

	Quaternary formation	Soil/ Alluvium
ARCHAEAN	Intrusives	Basic Dyke Pegmatites Basic rocks (sills)
	BENGPAL GROUP	Sericite Quartzite Andalusite schist

SAMPLING :

About 20 to 25 kg. of representative sample of the colluvial/alluvial material from the pits was collected by cutting a groove (15 cm. wide and 6 cm. deep) upto the bed-rock on all the four walls of the pit. The material was then subjected to sluicing, followed by hard panning and the samples of heavy concentrates as well as tailings from the individual pit material was obtained as described earlier in this report.

<u>TIN MINERALISATION</u> :

The primary cassiterite mineralisation was not noticed in the pegmatites exposed in the block although a few cassiterite crystals have been recovered from the colluvium in the close proximity of the pegmatites and presumably derived from it. A few coarse to medium crystals (upto 1 cm) were occassional noticed in the colluvial profile particularly in the eastern part of the area.

<u>FINDINGS</u> :

An area of 3.2 sq. km. was covered by pitting and sampling and about 185 bulk samples were collected. The thickness of the colluvial profile as exposed in the pits vary from 0.58 to 2.15m. with an average of 147 m. A generalised section of the colluvium show a top layer of grey soil varying from 0.10 to 0.45 m. followed by a greyish brown soil containing pieces mainly of quartz, weathered basic rock and highly weathered schist.

The weight percentage of the heavy concentrates obtained by panning, the colluvial/alluvial samples range from 0.18 to 0.73% with an average of 0.12%. The spectrographic analysis of a total of 185 samples (concentrate) indicate that the Sn, Nb and Ta content is generally very low; in the range of 10 to 350 ppm; less than 50 to 250 ppm. and less than 500 ppm. respectively. In case of 4 samples, only the Sn, Nb, & Ta content individually exceeds 1000 ppm. Apart from this assay, Sn and Nb and Ta together, is found to be upto 1000 ppm. and more in 5 and 28 samples respectively. The tungsten content is uniformly less than 100 ppm.

The demarcation of the potential area which however appears to be very limited in this block could be done only after the quantitative analytical results are available.

KANKAPAL BLOCK

INTRODUCTIONS

The systematic mapping carried out by the officers of M. P. Circle-II during the FS 1976-77, has revealed the presence of a few pegmatite in the area around Kankapal. At the same time regional assessment surveys for cassiterite mineralisation were being conducted by DORIS in the adjoining Bedhanpal block. As the cassiterite mineralisation was expected to extend in Kankapal area, regional assessment surveys in the Kankapal block were taken up in the FS 1978-79.

LOCATION :

The area is bounded by latitude 18°45'30" : 18°46'00" and longitude 81°50' : 81°51' in the toposheet 65 F/l3. (Plate-I) Kankapal village is situated in the centre of the block and is connected to leda and Kokalpai villages which fall on Tongpal to Govindpal fair weather road by a cart-track over a distance of about 5 km.

GEOMORPHOLOGY:

The area represents a flat ground encircled by steeply rising hills on all the sides-except on south. The lowest contour along the foot-hills is 950' and the surrounding hills rise to a maximum height of 1977'. To the west and north is Kukdi Dongri with it, peaks reaching the height of 1756' and 1962' whereas to the east, lies the Bendak Dongri with a maximum peak of 1977'. The lowest contour at the foot-bills bordering the flat ground is 950'. The area has a gentle slope to the south. The unique topography of the area has possibly resulted due to the differential erosion of the Bengpal schists against the quartzites. A nala flowing in south-westerly direction between Kukdi Dongri and Bendak Dongri passes through the area and maintain its course further southwards. Apart from this nala, number of minor streams originating from the surrounding hills, flow down and disappear at the foot-hills.

QUANTUM OF WORK DONE:

The following work was carried out in this block ;

1)	Reconnaissance mapping (l:15,840)	• • •	5 sq. km.
2)	Detailed mapping (1:5000)	• • •	3. sq. km.
3)	Pitting	• • •	120 Nos.
4)	Sampling	• • •	130 Nos.

The pits upto a depth of 2 m. were made on a grid pattern over an area of 2.2 sq. km. About 20 to 25 kg. of colluvial/alluvial material from each pit was collected by cutting a groove (15 cm. wide and 6 cm. deep) upto the bed-rock on all the four walls of the pit. The entire material was then subjected to wet treatment by sluicing and hand panning and two separate fractions viz. heavy concentrates as well as tailing from each bulk sample were obtained. The weight of the visual cassiterite crystals in the heavy concentrates if any is recorded separately along with the total weight of the concentrates. The concentrate and tailings fractions both are crushed to - 60 mesh and representative samples were sent for spectrographic analysis of Sn, Nb, Ta and W.

GEOLOGY:

The plain area in the block is mostly covered by soil and appears to be underlain by the Bengpals mainly the quartz sericite schist that are exposed in the pits. The outcrops of the sericite quartzite are noticed along the foot-hills of Kukdi Dongri and Bendak Dongri, The intrusive basic rocks are confined to the higher altitude on the surrounding hills. Four pegmatites traversing the basic rock and one within the Bengpal schist were mapped in the area. Their length and width varies from 30 to 100m. and from 10m. to 15 m. respectively.

The geological succession in the area is as follous:-

	Quaternary formation	Soil/alluvium
Archaean	Intrusive	Pegmatite Basic rocks
	Bengpal Group	Sericite quartzite Quartz sericite schist

TIN MINERALISATION:

The primary cassiterite mineralisation was not observed in the outcrops of the pegmatites present in the block. But a few coarse to medium crystals of cassiterite (upto 1 cm. wide) were rarely recovered from the colluvium while collecting the bulk samples from the pits. Such an incidence of detrital cassiterite crystals, is very rare suggesting that the primary cassiterite mineralisation in the block is very poor.

FINDINGS: -

An area of 2.2 sq. km. was covered by pitting and a total of 130 bulk samples were collected. The thickness of colluvial horizon as exposed in the pits vary from 0.07 to 2.2 m. with an average of 1.52 m. The wt% of the heavy concentrates range from 0.03 to 0.51% with an average of 0.13%. Spectrographic analysis of a total of 130 concentrate samples has indicated that Sn assay is 1000 ppm. in 2 and more than 1000 ppm. in only 4 samples. Nb and Ta content is 1000 ppm and above in only one and nine samples respectively. The assay for tungsten is uniformly less than 100 ppm.

On the basis of Sn assay of 1000 ppm in the concentrates, about 0.16 sq. km. of potential area between the cross lines W7 & W9 has been delineated for further work provided the quantitative analytical data confirms the presence of the workable grade of the tin ore in this area.

<u>RESOURCES</u>:

In the blocks- viz. Chidpal, Kankapal and Mad-kamiras, the prospective areas of 1 sq. km. 0.5 sq. km. and 0.4 sq. km. respectively with an average thickness of colluvium of 1.5 and 0.1 weight percentage of concentrates in these areas, an aggregate of 4550 tonnes of concentrates may be available. An average of 3.80% Sn is obtained for 36 samples and the head assay is 38 ppm. Further data are awaited. An assay of 1.0% Sn has been considered; this would give 49.87 say 50 tonnes of Sn metal out of 75 tonnes of cassiterite present.

<u>CONCLUSIONS</u>:

Sporadic distribution of tin mineralisation does not reveal any significance as per the chemical analysis in Chidpal, Kankapal blocks .About 16% of samples show more than 1000 ppm. of Sn, Nb, Ta assay in about 1 sq. km. area. Head assay of this is very poor showing less than 1 ppm. except five pits showing more than 100 ppm, and 18 pits 10 to 50 ppm. respectively, on the basis of crystals.

MURGEL BLOCK EXTENSION (GSI AND AMD COLLABORATION)

INTRODUCTION :

The incidence of cassiterite was first reported in 1975-76 by Shri M.L. Deshpande et.al during the course of regional stream sediment surveys. Further in l976-77-78-79 exploration has been taken up for regional assessment of cassiterite and other associated minerals. A Part of the area of about 1 sq. km area by pitting has been carried out jointly by GSI AMD to know specially the association of niobium tantalum with cassiterite mineralisation.

LOCATION AND ACCESSIBILITY:

The Murgel operational area is situated east of Kupidi and west of Chuirwada villages. Operational area is bounded by latitudes 18°43' : 18°43'30" and Longitudes 81°53' : 81°53'30" in toposheet 65 F/14. The area is connected by a fair weather Kutcha road, 3 km. from Nama. Nama is connected by a fair weather road for about 12 km, upto Leda, Leda lies 4 km from Tongpal-Puspal metal road. This area is not accessible during monsoon period.

GEOMORPHOLOGY :

The area is predominantly covered by soil and alluvium and is gently undulating plain. The colluvial boundary starts from the foot hills of the major basic body and extends upto further south. The general altitude of block is 243.8 m. (800') with occassionally small mounds having maximum height of 254.16 m. (283'). The colluvium derived from major basic body is the target for locating cassiterite and associated minerals. The Murgel nala with its tributaries originated from the major basic body in the north drains towards south forming dendritic pattern :

QUANTUM OF WORK DONE :

1. Pitting

Pits along nala	•••	45
Pits on a grid	•••	28

2. Samples ••• 88

GEOLOGY

The exposures of rock formations in this area are scanty and mostly covered by recent formations but at places exposures of Bengpal schists are noticed in nala sections. In north of the operational area near Chuirwada, pegmatites are traversing the basic rock, oldest rock in this area is of Bengpals and followed by basics. The tentative geological succession is as follows:-

Quaternary formations	Spil/Alluvium
Intrusives	Pegmatites Basics
Bengpal	Quartz sericite schist.

TIN MINERALISATIONS:

During the course of exploration, visual crystals of cassiterite and associated minerals could not be seen. Colluvial horizon as exposed in the pits varies in thickness from 1.4 to 2.3 m. The recovery of heavy concentrates from the bulk samples varies from 0.282 to 4.26 mt% of Nb_2O_5: 0.18 to 4.16 mt% of Ta_2O_5; and 0.1 to 33.82 wt % in case of SnO_2.

The calculated, feed assay from different samples in case of Nb_2O_5 varies from 0.0001 to 0.0020%; in case of Ta_2O_5 0.000l to0.0015% and in case of SnO_2 0.0001 to 0.0159%.

SAMPLING AND TREATMENT:

Bulk samples of 20 kg. from each pit has been collected by coning and quartering. The entire material excavated from the pit. The sample material has been treated by panning. After panning, concenrtrates were collected and checked for incidence of crystals. And then concentrates were weighed and crushed to 60 mesh size. These are sent for analysis to AMD.

TENTATIVE PROJECTED POTENTIALITY OF SnO_2 :

(1) Colluvial area :

Tonnage = Area x Thickness x Bulk density x % of Sn or SnO_2

L x W = 2,000m. x 600m.= Area

$$= \frac{2000 \times 600 \times 1.7 \times 1.75 \times 0.001}{100}$$

= 35.70 tonnes.

(2) Alluvial area

$$\text{Tonnage} = \frac{2700 \times 600 \times 1.2 \times 1.75 \times 002}{100}$$

= 68.04 tonnes.

Total tonnage = 68.04 + 35.70 = 103.74 tonnes.

TENTATIVE PROJECTED POTENTIALITY OF Tn_2O_5:

(1) Colluvial area :

$$\text{Tonnage} = \frac{2000 \times 600 \times 1.7 \times 1.75 \times 0.0008}{100}$$

= 28.56 tonnes.

(2) Alluvial_area

$$\text{Tonnage} = \frac{2700 \times 600 \times 1.2 \times 1.75 \times 0.0005}{100}$$

= 17.01

Total tonnage = 17.01 + 28.56 = 45.57 tonnes.

TENTATIVE PROJECTED POTENTIALITY OF Nb_2O_5 :

(1) Colluvial area

$$\text{Tonnage} = \frac{2000 \times 600 \times 1.7 \times 1.75 \times 0.0008}{100}$$

= 16.8 tonnes.

(2) **<u>Alluvial area</u>**

Tonnage = $\frac{2700 \times 600 \times 1.2 \times 1.75 \times 0.0006}{100}$

=20.04tonnes

Total tonnage = 20.4 + 16.8 = 37.2 tonnes.

CONCLUSION:

Geological Survey of India and Atomic Mineral Division, collaboration work has been undertaken in part of the Murgel area over 1.62 sq. km. in alluvial and 1.2 sq. km. in colluvial area, GSI has identified the area and carried out pitting, sampling, hand panning for obtaining concentrates and processing over, 2.82 sq. km. (colluvial and alluvial) area with the co-ordination of AMD for chemical analysis. Based on the chemical analyses from AMD, resource potential in the alluvial and colluvial area would be 103.74 tonnes of SnO_2; 37.2 tonnes of Nb_2O_5 and 45.57 tonnes of Ta_2O_5.

Systematic beneficiation studies have been taken up during the field season 1979-80 for better recovery. This would increase the resources potentialities of Sn, Nb & Ta of the area considerably.

LOCALITY INDEX

Locality	Toposheet	Latitude	Longitude
CHAUTNAR	65 F/14	18°42'30"	: 81°53'
CHUIRWADA	65 F/14	18°44'	: 81^{c}53'
CHIDPAL	65 F/14	18°43'30"	: 81°52'
KANKAPAL	65 F/13	18°46'	: 81°51'
KOKALPAL	65 F/14	18 43'	: 81°52'
KUMMAKOLENG	65F/14	18°43'	: 81°54'10"
LEDA	65F/14	18°43'15"	: 81°50"
MADKAMIRAS	65F/14	18°42'	: 81°52'45"
NAMA	65F/14	18°42'30"	: 81°54'
PUSPAL	65F/14	18°43'	: 81°49'
TONGPAL	65F/14	18°44'	: 81°48'

PART-IV

A REPORT ON THE REGIONAL ASSESSMENT SURVEYS IN TONGPAL AND MAHJUN BLOCKS, BASTAR CASSITERITE INVESTIGATION

(FIELD SEASON 1978-79)
BY

B. SATYANARAYANA
GEOLOGIST (Jr)

INTRODUCTION :

Genesis of placer deposits like cassiterite and rare minerals (Nb, Ta) is dependant on the presence of Sn, Nb and Ta minerals in the source rocks, combination of chemical and physical processes of weathering to disintegrate the minerals from the host rock and stream gradients steep enough to move the products of weathering and gradient variation that will serve as riffles to separate the lights from heavies. The eluvia or soils produced from the deeply weathered pegmatites that are wide spread in different prospective blocks including Tongpal and Marjun. Indicated the incidence of cassiterite and associated rare minerals viz. culumbite – tantalite mineralisation. It is believed that the deep trapical weathering process dissolves the silicates in pegmatites and leaving concentrations of such resistant accessories as cassiterite, columbite and tantalite in the soils and sands. Thus the cassiterite and its accompanying rare minerals in the alluvium clearly owe their source from erosion of the pegmatites. The cassiterite and the associated minerals viz. columbite and tantalite are too brittle to endure transport exceeding a few kms. Hence, prospecting by putting test pits combined with hand-panning the alluvial and colluvial samples utilising the high specific gravity of the minerals, are resorted to assess the potentialities of the ore bodies in and around the prospective blocks.

Based on the earlier geological work carried out and the conclusions drawn, the author has undertaken the programme of regional assessment of the potentialities in Marjun and Tangpal prospective blocks during FS 1978-79 by mapping on 1:5,000 scale an area of 5.7 sq. km. in Tongpal blcbck and 2.1 sq.km. in Marjun block.

PREVIOUS WORK :

Crookshank (l932-36) has carried out geological mapping and brought out the incidence of lepidolite in the pegmatites near Govindpal and Mundval. These were subsequently investigated by DGM, MP. Murti et.al in their recent Systematic mapping with emphasis on locating the, cassiterite bearing pegmatites (some of which are associated with lepidolite) have brought out a number of stanniferous pegmatites including those in the area under investigation by the auther.

LOCATION AND ACCESSIBILITY:

Tongpal is a village, 55 kms. south of Jagdalpur on the Kanta-Jagdalpur state high-way. A Rachha road between Tongpal and Marjun exists across Baru river which can be negotiated only during dry season. Both the blocks fall in toposheet 65 F/14 of Survey of India.

GEOMORPHOLOGY:

The Marjun hillock (2603') 853 m. and the hillock (l700') 557 m. north of Tongpal from the southern continuity of the Ellingnar hill ranges falling in toposheet 65 F/13. The average elevation of the low lying plains is of the order of 800' (263 m.) The high elevation and ground above 263 m. is occupied by the metabasic rocks. The pegmatite occurs at the foot-hill at an elevation of 443 m. and the Bengpal schists form the low lying plains.

The area is drained by Jamair nadi in the west and Baru nadi in the south. The Jamair flows easterly and joins Baru; the Baru river flows southerly and ultimately moots Kolab (Sabari). There are good number of nalas flowing through the slopes of Marjun and joins in Jameir and some of the nalas flowing from 557 m. hillock of Tongpal joins the Baru river.

GEOLOGY OF THE OPERATIONAL AREA:

The geological formations encountered in the area comprise of Archaeans represented by quartz sericite schist, sericitc schist and andalusite schists belonging to Bengpal metasedimentary group, intrusives of basic rocks, granites, pegmatites and basic dykes.

The Bengpal metasedimentary rocks confined to the north of Tongpal and south of Marjun consist of quartz, sericite, microcline, biotite and chlorite in quartz sericite schists and tabloids of andalusite crystals, sericite and a few opaques in andalusitesericite schists.

The basic rocks occur enclosing the pegmatites in both Marjun and Tongpal blocks. They consist of plagioclase, diopsidic-augite and hypersthene. Basic rocks contain biotite at the contacts of pegmatites.

The granites are predominant in the SW and south of the area. They are traversed by pegmatites and vein quartz. They are medium to coarse grained consisting of quartz, microcline, biotite and a few opaque minerals. Fluorite, malachite, chaloo-pyrite and tin bearing magnetites are seen in Paliam granites. The magnetites at Kasanpal contain 400 ppm. of Sn and less than 500 to more than 1000 ppm. of tantalum. Under are microscope, the matrix (in magnetite) contains magnetite and laths of ilmenite. Whereever ilmenite laths are seen, a few grains of cassiterite were found associated with it.

Bengpal metasedimentaries and basic rocks were traversed by pegmatites. The general mineral assemblage of pegmatites in Marjun is quartz, microcline, green mica, lithium muscovite, lepidolite, beryl, garnet and magnetite and the mineral assemblege of pegmatites at Tongpal is quartz, microcline and muscovite, The tin content in lepidolites, feldspars, muscovites and magnetites separated from pegmatites, range from - 30 to less than 1000 ppm.

Pegmatites traversing basic rocks, showed incipient greisenisation at Marjun block.

<u>TONGPAL BLOCK</u>:

The block is located a few hundred meters north of Tongpal village extending from Buddapada village in the east to Tahakwada village in the north covering about 5.7 kms. length. It is bounded by the Baru river in the west and the tributaries of Murgel in the east. The maximum elevation of the hillock is 557m and the operational area includes the flanks of major hill upto the height of 443m. Good number of nalas flowing from the west and southerly slopes of the area form tributaries to Baru nadi.

The three main pegmatites located in the north, central and eastern part of the flanks of 557 m. hillock, trend N50°E - S50°W; N55°W - S50°E and N-S respectively. There are a good number of small off-shoots of pegmatites which trend in different directions. The mineral assembelge of pegmatites include quartz, microcline perthites and muscovites. The pegmatite is simple and unzoned. The quartz occurs as colourless as well as smoky; the feldspar is pink as well as white in colour; the muscovite contains no inclusions. The mica book averages 2 inches in diameter and 1 inch in thickness.

In order to assess the colluvial and –alluvial zones for cassiterite and occompanying columbite and tantalite minerals, a base-line has been selected along- N65°E- S55°W in the north-west portion and it was extended towards east and north-east perpendicular to the main base-line covering a total length of 5.7 km. and about 40 cross lines were laid to cover the entire area. A total of 80 shallow pits have been put down in this block and 143 samples were collected.

The pitting has been carried out most judiciously on lines 500 m. apart. The general pit interval is 100m. and in changes according to the terrain and the source rock. In the north, pitting was carried out on 0, T1, T2, T3, T4, T5, T6, T7 & T8 and in the east T1 to T14 and T13A to T13L over an aggregate length of 5.7 kms. The colluvial horizon is formed of fragments of laterite, weathered and lateritised basic rock and weathered pegmatites. However, in the north of the operational area in OW, OW2, OW3, pits, instead of pegmatites, the tabloids of and alusites were encountered. Good numbers of pits were given in the nalas flowing from the slope of the hillock to the foot of the hillock and extending about a few hundred meters towards the plain agricul land.

Though the incidence of cassiterite is in existence in many places around this area, the areal extent of mineralised horizon has yet to be established by more detailed work, 6 out of 143 samples given for analysis, indicated more than 1000 ppm of tin.

<u>MARJUN BLOCK</u>:

The Marjun block lies at about 3 kms. south of Marjun village whose R. L. is 853 m. It extends from western-most corner north of Jamair nadi to tiras in the north-east upto the Kokalpal village in the south extending over a length of 2.5 km. It is bounded by the Jamair nadi and its tributaries in the south and Baru and its tributaries in the east. The main pegmatite extends more than 3 km. in length and 500 m. in width. It trends N65°E-S65°W with the southerly dips varying from 30° to 45°. In many places in the- block, small off-shoots of pegmatites trending in different direction were exposed showing contact with basic rock. A small patch of quartz sericite schist of Bengpals occurs in Jamair nadi south of the block. The pegmatites range from small lens shaped bodies to roughly tabular and irregular masses. They are medium to coarse grained. The mineral assemblege is quartz, perthite, lithium-muscovite, lepidolite, yellowish green beryl and garnet. The mica book average half inch in diamter and quarter inch in thickness. Magnetites and ilmenites are the opaques in pegmatites. Though, there are a good number of pegmatite bodies occurring in the block, they apparently consist of interconnected bodies that are part of large complex pegmatite body.

A base line has been selected along the strike of the main pegmatite body which trends N65°E-S65°W. About 8 cross lines were put west of 00 base line point and 22 cross lines extend from the top of the hillock to the agriculture fields in the south. There are more than 15 small nalas flowing from the top of the hillock to the down. The pits were put on all the nalas in 50 to 100m. interval according to terrain convenience.

A total of 75 shallow pits were dug (l to 2.5 m.) and 104 samples were collected. The colluvial block extends about 2.5 km. in length and 800 m. width. The pitting has been carried out most judiciously on the lines 500m. and 50m. pit interval according to convenience. In the west, pitting was carried out on

OT-1 to T8 and in the east it was carried out on T1 to T22 cross lines. The colluvium is formed of weathered to lateritised basic rock and weathered to fresh pegmatite. Good number of pits were put on the nalas on 50m. interval. The samples were collected by cutting channels on the four malls of the pit.

The incidence of cassiterite is indicated north of litiras and part of 00' lines. But they do not have large areal extent.

ANALYSIS :

While carrying out the large scale mapping on 1:5,000 scale around Tongpal and Marjun, the author collected a few crystals of cassiterite, tantalite near Tahakwada, NE of Tongpal and in pits T3, I, J, K, L in north-western parts of Tongpal block and near Litiras of Marjun block. However, a few grains of cassiterite and tantalite were recovered in the concentrates after sluicing and panning the colluvial material in T13, I, 0W2, S10 pits of Tongpal block and MN5A, T8SA, MP12, MP10, T11 & T8 pits of Marjun block.

The thickness of the colluvial profile varies from 0.20 to 2.50m. with an average of 1.10 m. A generalised section of the colluvial profile in NE portion of Tongpal block over the Bengnal rock is 00 - 0.30 top grey soil followed by greenish grey clayey material with pebbles of andalusite, tabloids, quartzites and basic rocks. In the NW portion of Tongpal, the profile over the basic rock is 00-0.25 top grey soil followed by yellowish brown clayey material with pegmatites and basic rock material. The wt% of the concentrates obtained by sluicing and panning-of 10 to 20 kg. of material from-the individual pits varies from 0.07 to 0.62% and the average of the concentrate is 0.25% for 143 samples. Out of these 143 samples, 6 samples have given more than 1000 ppm. of tin in Tongpal varying from 0.11

to 0.34% Son. 4 samples (on So, S3, S6 and S9 survey lines) In Tongpal have given more than 1000 ppm. of Nb. However, 26 samples have analysed more than 1000 - ppm. of tantalum. This points out that the area is more thantaliferous than stanniferous.

In the Marjun block, the general profile of the colluvium over the basic rock in the area is 0.00 to 0.20 of top grey soil followed by yellowish clayey soil with pebbly basic rock and pegmatites and quartz veins. The thickness of the colluvium varies from 0.50 to 2.20 with an average of 1.2m, 104 samples were collected. The concentratss obtained after sluicing and panning, 10 to 20 kg. material varies from 0.10 to 0.60% with an average of 0.25%.

Eight of the samples have analysed Sn% varying from 0.10 to 4.74% (average 2.4% Sn). In T6 and T2 survey lines, Nb has analysed more than 1000 ppm. 32 samples have analysed more than 1000 ppm. of tantalum. Here also the prospect appears to be more tantaliferous than stanniferous.

As the tin values; analysed more than 1000 ppm. and are quite scattered, it is difficult to evaluate the deposit.

As the large number of samples analysed more than 1000 ppm. of Ta, it is worth-while to explore for tantalum in the area.

	No. of samples collects	Weight of sample	Wt% of conc.	Average	Spectrographic Assay		
					Sn	Nb	Ta
Tongpal Block	143	10 to 20 kg.	0.07 to 0.62.	0.25	∠ 10 to 1000 (0.34%)	∠ 50 to 1000	∠ 500 to 1000
Marjun block	104	10 to 20 kg.	0.01 to 0.60	0.25	10 to ∠ 1000 (4.74%)	∠ 50 to 1000	∠ 500 to 1000

LITHOLOGY OF THREE TYPICAL PITS :
TONGPAL BLOCK

Depth in mts. Eron	To	Thickness in mts.	Description
1	2	3	4
Pit No. OW4 Location : 500m. east of Tahakwada.			
0.00	0.20	0.20	-Top grey humus rich soil
0.20	1.30	1.10	-Greyish yellow sandy soil with pebbles of quartzite-felspars quartz and basic rock with sericite and mica flakes.
1.30	2.25	0.95	-Light grey weathered quartz sericite schists with tabloids of and alusite crystals.
Pit No. S9T8 Location: 1. km. NE of Jangarpal village.			
0.00	0.10	0.10	-Dark grey to black clayey soil.
0.10	0.70	0.60	-Yellowish brown coarse grained silty sand containing pebbles & cobbles of basic rock.
0.80	1.25		-Dark grey, fine to medium grained sand containing pebbles of basic rock.
1.25	1.50		-Weathered basic rock.
Pit No. Tl3-L Location : 1.5 km. s west of Budhapada.			
0.00	0.15	0.15	-Humus rich top grey soil
0.15	0.6 0		-Light grey medium to coarse grained silt with pebbles of quartz and feldspar grain and basic rock.

1	2	3	4
0.60	1.20		Pebbles and cobbles of quartz, basic rock mixed with coarse sand containing feldspar grains and muscovite flakes.
1.20	1.40		Weathered pegmatite.
Pit No. MN 58			
Location : 500 m. N. E. of Jamair village			
0.00	0.20	0.20	Dark grey clayey soil.
0.20	0.85	0.65	Pebbles and cobbles of basic rock, quartz mixed with coarse sand.
0.85	1.30	0.45	Light grey loose medium to coarse grained sandy soil with pebbles of quartz, pegmatite & basic rock and sericite flakes.
Pit No. T1S			
Location : 100 m. south of T1 section & Marjun block.			
0.00	0.20	0.20	Humus rich sediment'.
0.20	0.80	0.60	Dark grey sand with coarse grains of quartz mixed with a few felspar grains.
0.80	1.20	0.40	Greyish yellow soil with pebbles of pegmatite, basic rock and some muscovite flakes.
1.20	1.40	0.20	Weathered pegmatite.

WEIGHT PERCENTAGE AND GRADE OF Sn OF SAMPLES SHOWING MORE THAN 1000 ppm

Sr. No.	Sample No.	Sn%	Wt% of the conc	Grade
1	2	3	4	5
Tongpal block:				
1.	W2 A	0.11	0.32	0.00035
2.	T1	0.34	0.45	0.0015
3.	T2	0.10	0.21	0.0002
4.	T5	0.10	0.28	0.0003

1	2	3	4	5
5.	T13 LA	0.27	0.26	0.0007
6.	Th-A	0.19	0.20	0.0004
Merjun block				
7.	T6 SB	0.10	0.55	0.0005
8.	T8 S B	0. 10	0.45	0.0004
9.	T11 B	0.74	0.30	0.002
10.	MN£ A	0.20	0.65	0.0013
11.	MP8	0.89	0.28	0.0025
12.	MP10	4.74	0.25	0.012
13.	MP10S	1.11	0.20	0.002
14.	MP12	2.37	0.12	0.0020

CONCLUSIONS AND RECOMMENDATIONS:

The investigation records the methods empllyed for rapid evaluation of mineral potential in (a) involving the systematic sampling of the pits given in alluvial, colluvial and eluvial horizons of Marjun and Tongpal blocks and the spectrographic analysis of the heavy mineral fractions obtained after hand-panning the pit material, (b) systematic mapping on 1:15,000 scale to locate many more primary stanniferous pegmatites and any structural features controlling the mineralisation.

Generally, the distribution of cassiterite and associated columbite-tantalite minerals in the soil is determined by physical rather than chemical laws. It is an established fact that the cassiterite grains in deeply weathered soil tend to penetrate into the deeper parts of the apparent plastic rock, until they reach a less weathered bed rock above which they accumulate. That is the reason why the author has ensured that the pit was dug until the bed rock was encountered. The pits are preferably confined to the slopes and floors of the valley and the beds and banks of the minor tributaries of Jamair and Baru rivers. The detrital material consists of clay, silt, sand, gravel, pebbles cobbles and boulders. Locally the gravel and sand are concentrated in the depressions. Measured quantities of the pit samples, were panned until a concentrate of heavy mineral had been obtained which was weighed. The weight% of heavy mineral concentrate varied considerably from place to place. However, it was noted generally that the higher weight values were, recorded from the pits where the pegmatites were located and the low values were obtained where the basic rocks and Bengpal metasedimentary rocks were located. The spectrographic analysis indicated the scattered occurrence of stanniferous and tantalifemus colluvium. The distribution pattern of tin and tantalum values indicate that the sources are confined to the pegmatite bodies and their adjacent contacts.

White 16 locations indicated tin values varying from 0.1% to 4.74%, the rest indicated low values ranging from less than 10 ppm. to 1000 ppm and in case of tantalum about 68 llcations indicated more than 1000 ppm the exact percentage values are yet to receive and the rest indicated values ranging from less than 500 to 1000 ppm..

It is an enigma why it happened so ?. The reasons may be presumed as:

1) During igneous action, the rapid emplacement might have induced mass escape of gases containing tin and associated niobium and tantalum minerals.

2) As cassiterite and accompanying celumbite and tantalite are too brittle, prolonged denudation upto pleistocene must have resulted in intense dis-inte-gration of cassiterite into very fine grain size and during hand-panning, these finer size cassiterite and tantalite could not be recovered.

3) However, the investigation records the incidence of tantaliferous and stanniferous colluvium and alluvium.

West of Marjun, over ridges and sphurs, where weathering was deep with soil profile exceeding a few tens of feet and still farther worth may be worth-trying for cassiterite and tantalite.

TRACE ELEMENTS IN THE AREA :

As absolute pure cassiterite and associated columbite - tantalite concentrates seldom occur and are always contaminated by other minerals to a degree ranging from traces to percentages. The author studied, some concentrate samples under hand lens and binacular microscope and sent all the samples for spectrographic analysis for W, Mo, Bi, Zr & Ti elements to know the presence of other minerals. The concentrate is composed of Zircon, rutile, ilmenite, monazite, garnet, magnetite, tourmaline, haematite and quartz. Zircon crystals are of purple, pink and brown shades occurring in a rounded size generally in -60 mesh size. Ilmenite occurs in blue-grey and black colours in flat or tabular euhedral crystals in an average grain size ranging from - 35 to -- 60 mesh. Garnets are usually pale-pink, fine to coarse grained with enhedral faces in a grain size-65 mesh. Magnetite occurs as honey yellow grains. Tourmaline occurs as black to greenish brown colour with an average grain size ranging from -35 to -60 mesh. Cassiterite occurs as dark grey to brown fine to coarse grained with a maximum of -100 mesh size. Columbite and tantalite occurs as black bladed grains with sub-metallic to sub-resinous lustre in a grain size ranging from - 80 to - 100 mesh.

The spectrographic analysis for Mo, Bi, Zr and Ti were atained for the concentrates. W varies from less than 100 to 100 ppm, with two samples analysing 1000 and 200 ppm. respectively. No varies from less than 10 to 50 ppm. Bi analysis ranges from less than 20 to 30 ppm and Zirconium values analyse from 50 to more than 1000 ppm. Titanium values range more than 1000 ppm. indicating the presence of ilmenite and rutile in abundance in the concentrates.

The above mentioned associated minerals in the concentrates in varying proportions owe their existence mainly to the primary pegmatite rocks Prollnged denudation of those rocks resulted their accumulation in the concentrates. Because of the similarity of specific gravity-Zircon (4.2 to 4.7), Ilmenite (4.50 to 5.00), Monazite (4. 90 to 5. 30), Garnet (3. 15 to 4.80), Haematite (4.9 to 5.30), were recorded allngwith the cassiterite (6.0 to 7.1) and Columbite-tantalite (5.2 to 6.1).

PART - V

X-RAY AND MINERALOGICAL STUDIES OF BASTAR CASSITERITE AND ASSOCIATED PEGMATITES

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INTRODUCTION :

The 500 N odd reported major and minor tin occurrences the world over, when statistically plotted, indicated that the Precambrian pegmatites, palaeozoic granites, mosozoic greisen and contact zones and volcanic rock of tertiary age have given rise to more tin deposits. The distribution pattern of tin occurrences for the different continents viz., Europe, Africa, North America and South-east Asia, when compiled, have shown: (i) the tin belt of U. K. belonging to Hercynian granite passed from Cornwall into Brittany and in its continuation in Italy-the granite blocks included in lavas of Etna of Tertiary, contain cassiterite (ii) The iberian tin belt strikes through Spain and Portugal and is said to be the continuation of South-east Africa-Nigerian belt. (iii) the Rondonia-Guyana of South America seems to have its extension in the Liberia-Morrocco belt on the African side, (iv) in North-America, the Rocky Mountain belt seems to be North American counter part of the Andean belt (of Bolivia and Argentina) and (v) The East-Brazilian belt seems to be the direct counter-part of South - west Africa and Nigerian belt (Shuiling, 1967).

R.D. Shilling (personal communication) feels that the Indian tin occurrences might link up with a belt through Western Australia and might continue through the Southern tip of Madagaskar into the East African belt. He feels, if it is true, there may be tin occurrences in the South-eastern part of India.

Thus, the geology of the Bastar area is best with interesting problems in geology, geochemistry and mineral exploration. The author had collected about 30 cassiterite crystals and two magnetite samples and separated about 17 rock forming minerals from pegmatites and the samples are subjected to detailed petrographic, mineragraphic, X-ray and trace elemental studies to throw light on the genesis of tin, on the grade of tin and on the quality of tin ores from Bastar region.The results are presented in the following pages.

METHODS OF STUDY

About 30 cassiterite and two magnetite crystals were collected from the primary pegmatites as well as colluvial and alluvial placers from Mundval, Jangarpal, Berykupli, Chuirwada, Kachheriras, Govindpal, Madkemiras and Mundaguda blocks. About 20 pegmatite samples were collected and the minerals in pegmatites were hand-picked. Still the mineral contains some portion of the associated minerals. The minerals were separated under Frantz Iso-dynamic Separator. The final stage of separation was carried out by using a binocular microscope and removing unwanted grains if any by hand-picking. Thus, the purity-of samples is 96%. In case of lepidolite and muscovite, the minerals were jigged on glazed paper and the purity of mineral ranged from 98% to 99%, The samples thus obtained, were sent to chemical laboratories for spectro-chemical analysis of trace elements.

With regard to cassiterite samples, a crystal of cassiterite was crushed into small pieces and these pieces were powdered, in steel mortar, until all the powder is passed through-100 mesh. The powder obtained thus is subjected to coning and quartering till about 2 gms. of powder is obtained. The powder was sent for spectrochemical analysis of trace elements and volumetric determination of Sn and W elements to the Central Regional Chemical Laboratories.

DETERMINATION OF ELEMENTS

Sn in cassiterites was determined volumetrically and alsl a few crystals were analysed for W, Nb and Ta elements. Nb, Ta, W, Mo, Bi, Be, Ti, Mn, V, Zr, Cu and Pb elements were determined by spectrochemical methods.

GEOLOGY OF THE AREA

The geological formations encountered in the area comprise of Archaeans represented by quartz sericite schists, sericite schists and andalusite schists belonging to Bengpal metasedimentary group, intrusives of basic rocks, granites, pegmatites and basic dykes.

The tin content in Bengpal group of rocks varies from 500 to 800 ppm (6 samples). In Mundaguda, the Bengpal metasedimentaries traversed by pegmatites have given rise to rich cassiterite mineralisation.

The tin content in basic rocks range from 30 to 70 ppm (20 samples).

The pegmatites traversing the granites at Kasanpal, contain magnetite. The magnetite contain 400 ppm. of Sn and lessthan 500 to more than 1000 ppm. of tantalum. Under ore micro-scope, the matrix contain, magnetite and laths of ilmenite are seen in the matrix. Where-ever -ilmenite laths are seen a few grains of cassiterite ere also, found associated with it. Whether the Darba/paliam granites is related with the tin bearing pegmatites is crucial question. Generally, it is believed that the potash granites are uranium-rich and soda-granites are tin-rich. But the presence of significant amount of uranium in Darba granites poses a problem. The tin content in Paliam granites vary from 10 to 60 ppm and in Darba granite it is 120 ppm. Prof. Hosking (1969) believes that cassiterite as direct accessory of granite, was a very rare event and may not in fact exist at all and the normal granites even in tin-rich areas has usually less than 12 ppm. Sn, implying that very little, if any, primary SnO_2 existed. Santokh Singh (1969) supported (Hosking with an evidence, indicating that the original granite has been subjected to subsequent pneumatolytic and hydrothermal alteration. Further, the presence of minerals like tourmaline, topaz, muscovite, sericite and chlorite indicate that the granite has been subjected to post consolidation alteration. The whole rock analysis of two Paliam granites are given below:-

	Bogan Granite	Paliam Granite
SiO_2	73.77	72.85
$A1_2O_3$	14.45	14.05
FeO	1.44	2.34
Fo_2O_3	0.80	1.10
TiO_2	0.48	0.56
MnO	0.02	0.02
CaO	1.57	1.71
MgO	0.52	0.41
Na_2O	2.32	1.91
K_2O	3.66	4.02
$-H_2O$	0.10	0.10
$+H_2O$	0.30	0.23
P_2O_5	0.09	0.09

Bengpal metasedimentaries, basic rocks and granites were traversed by pegmatites at several places. The pegmatites are occurring as zoned as well as unzoned. Mineralogically, most of the pegmatite bodies studied, are very simple consisting essentially of quartz, plagioclase perthite and muscovite in varying propostions, but the tin occurs in both zoned and unzoned pegmatites. The general mineral assemblege of pegmatites is quartz, microcline, clevalandite felspar, green mica, lithia muscovite, lepidolite, beryl, amblygonite, fluorite, garnet, ilmenite, magnetite, cassiterite, columbite-tantalite and wolframite (?). The tin content of pegmatites varies from 10 to 2500 ppm. The lepidolites, feldspars, muscovites and magnetites from pegmatites contain significant amounts of tin varying from 30 to less than 1000 ppm.

Most of the theories assume that the pegmatites have been derived as a product of the differentiations of granites. The source of the solution from which the pegmatites form, is a deeply buried differentiating magma. During crystallisation of the magma, fluids escaped and work upward and outward finally crystallising in the form of pegmatites. Certainly, the solutions are highly mobile and contain relatively large quantities of Na, K, Si, Be, F, B, P_2O_5 and Li and many metallic elements such as Sn, Nb, Ta and W and rare elements. The formation of the pegmatite may be a continuous process beginning with a silicate rock solutions similar to a granite magma but richer in water and other volatile elements. During crystallisation, the solution changes progressively so that the late residual fluid move like concentrated aqueous solution.

Pegmatites traversing the basic rocks show incipient greisenisation at several places, notably at Kudripal and Marjun blocks. The rock type known as Greisen occurs commonly in tin-rich provinces; often cllsely connected with areas of intense mineralisation. Basically, it is composed of quartz, muscovite, often captain topaz and minor fluorite and cassiterite. It occurs as selvedges along vein margins as dykes as well as large masses developed from the alteration of granite by late stage hydrothermal fluids. The greiscn contact zones have given rise to tin mineralisation in Kudripal and Marjun blocks.

TIN MINERALISATION:

Tin occurs in the form of cassiterite in association with Nb, Ta, W, Fe and Ti in primary pegmatites, traversing the basic rocks as well as metasedimentaries (Mundaguda) and also as secondary mineralisation in colluvial and alluvial material close to the pegmatite outcrops at several prospecting blocks.

The cassiterite in the alluvium has clearly derived by erosion from the pegmatites, The cassiterite and its accompanying minerals are too brittle to endure transport exceeding 1 or 2 km. and there, in case a convenient place for deposition does not occur close to the vein, the ore minerals get very fine grained and are scattered. This seems to have happened in case of Bastar cassiterite.

The cassiterite occurs as pockets, sub-angular masses, small, veins of a combination of stringers intersecting each other in various directions in the form of net-work, while pegmatites is impregnated with particles and crystals of cassiterite over certain areas. Cassiterite is also often seen occuring with well tetragonal prisms with fine terminations, though the fragments in alluvial have been more or less rounded to sub-rounded by attrition. The ore varies in colour from black to dark brown. Under ore microscope, dassitarite is colourless to dark brown in colour. The inclusions viz. the columbite and tantalite are irregular in shape and show no crystallographic control of the cassiterite. Cassiterite shows intense pleochroism. It contains more than 1% Ta_2O_5 and Nb_2O_5. The fracture planes of cassiterite were filled with quartz in a few sections. The cassiterite is associated with lepidolite, muscovite, feldspar, quartz, garnet and magnetite.

a) X-RAY DATA OF CASSITERITE :

Cassiterites were studied by x-ray diffracto-meter technique to know the crystal structure and the variations of unit cell dimension with change in composition. It contains 0.3% of Nb_2O_5 and 0.05% of Ta_2O_5 contents. The unit cell values were determined and compared with the normal standard cassiterite sample.

RANGE OF Sn CONTENT IN ROCKS AND MINERALS

Name of the Mineral	Rangeof Sn in ppm.	No. of samples
1	2	3
Columbite-tantalite	800 to 1500	6
Magnetite	400	2
Lepidolite	300 to 1000	4
Felspars	30 to 800	7
Smoky quartz	15	1
Garnets	10	2
Muscovite	400	1
Granite (Paliam)	10 to 60	13

(Taken from M. L. Deshpande)

1	2	3
Bengpal schist	500 to 800	06
		(M.L. Deshpande)
Basic rocks	30 to 70	20

CHEMICAL ANALYSIS OF COLUMBITE-TANTALITE

Oxides in%	OM1	OM3	OM6
FeO	13.43	4.83	14.23
MnO	5.89	10.99	3.38
TiO_2	0.30	0.48	0.50
SnO_2	0.08	0.15	0.10
Nb_2O_5	50.50	56.50	68.05
Ta_2O_5	29.65	26.05	9.55

UNIT CELL DIMENSION:

L = B = r = 90°

Standard cassiterite	a	=	4.738°	C	=	3.180
Bastar Cassiterites	a	=	4.740°	C	=	3.154
BS/1495	a	=	4.730°	C	=	3.186
BS/1507	a	=	4.728°	C	=	3.188
BS/1512	a	=	.4.730°	C	=	3.184
BS/1504	a	=	4.726°	C	=	3.188
BS/1517	a	=	4.726	C	=	3.176

The X-ray data of cassiterite under study showed much variation from the standard cassiterite. Hence it is presumed that the presence of Nb, Ta and W have got some effect on the cell dimention of the cassiterite.

b) ANALYTICAL RESULTS OF CASSITERITE :

The Sn value in 30 cassiterite crystals vary from 51.19 to 70.92%. The other major oxides present are Nb_2O_5 varying from 0.43 to 2.07% Ta_2O_5 upto 0.1% and WO_4 contain upto 0.1%. Cu and Zr are present in significant amounts. Mo, Bi, Be, V and Pb are moderate to low in content. Hence it is evident that a number of metallic cations are known to enter into the solid solution in cassiterite and the table showing the ionic radii of the main elements is given below (Wedepoll 1969)

ION	Ionic Radii
Fe^{+2}	0.74 A°
Fe^{+3}	0.64 A°
Mn^{+2}	0.80 A°
Mn^{+3}	0.66 A°
Mn^{+4}	0.60 A°
Nb^{+4}	0.74 A°
Nb^{+5}	0.69 A°
Ta^{+5}	0.68 A°
Ti^{+3}	0.76 A°
Sn^{+2}	0.93 A°
Sn^{+4}	0.71 A°

From the analytical data of cassiterite (table-I) from different blocks, it is observed that the cassiterite from Mundaguda revealed the presence of Sn varying from 67.36 to 70.92% with an average of 69%- the highest of the values so far obtained. The Nb, Ta and W are more than 0.1% each, no varies from 30 to 50 ppm; Zr is from 600 to 1000 ppm; Cu ranges from 10 to 150 ppm and Pb varies from 30 to 1000 ppm.

Jangarpal cassiterite has the lowest Sn value viz. 54.30% and alsl low Nb and W being 500 and 700 ppm. respectively Mn arrd Ti are less than 0.1%. The presence of mangano-ilmenite and tantalite is suspected. Zr is 1000 ppm; Cu and Pb are low-50 ppm. each.

In the cassiterites from Berykupli, Kachheriras and Madkamiras, Sn varies from 63.9 to 67.97%, Nb,Ta and W are more than 0.1%; Mo varies from 20 to 50 ppm; Ti

Ti is 0.1% in Berykupli while it is 50 to 300 ppm. in Kachheriras and Madkamiras. Zircon is moderate and varies from 400 to 700 ppm; Cu varies from 10 to 50 ppm; lead is 30 to 350 ppm.

In Chuirwada Cassiterite Sn value is 59.6%; columbite and tantalite are predominant. Ti and Mn are high (0.1%) Zr varies from 20 to 1000 ppm; Cu and Pb varies from 50 to 400 ppm. The high content of Mn and Ti are indicating of the presence of Mangano-ilmenite.

TABLE -II
TRACE ELEMENTS IN CASSITERITES AND COLUMBITE

Mineral No.	Sn %	Nb PPM	Ta PPM	W PPM	Mo PPM	Ti PPM	Mn PPM	Zr PPM	Cu PPM	Pb PPM
1	2	3	4	5	6	7	8	9	10	11
M/5	67.36	1000	1000	1000	1050	1000	300	1000	10	400
M/4	70.92	1000	1000	1000	40	1000	300	1000	150	30
M/5	68.55	1000	1000	1000	40	1000	200	800	100	200
M/6	69.44	1000	1000	1000	30	1000	100	600	100	1000
J/1	54.30	500	1000	700	20	1000	1000	1000	1000	40
B/1	67.00	1000	1000	1000	50	1000	900	1000	20	70
C/1	67.95	1000	1000	1000	50	1000	1000	250	50	10
C/2	51.19	1000	1000	1000	20	1000	1000	1000	50	400
K/1	69.29	1000	1000	1000	30	1000	100	500	50	70
K/2	69.29	1000	1000	1000	20	1000	70	700	20	50
K/3	68.99	1000	1000	1000	20	1000	50	500	20	30
K/4	59.65	1000	1000	1000	20	1000	70	600	10	250
K/5	69.47	1000	1000	1000	30	1000	50	400	10	70
Ma/1	69.10	1000	1000	1000	20	1000	300	300	10	30
Ma/3	68.40	1000	1000	1000	20	1000	200	400	20	20
G/1	66.92	1000	1000	1000	30	1600	100	300	10	400
G/4	67.51	1000	1000	1000	40	800	1000	200	30	10
G/5	68.59	1000	1000	1000	30	700	200	400	10	150
G/6	64.84	1000	1000	1000	40	1000	100	300	10	700
G/7	67.96	1000	1000	1000	30	500	70	300	10	10
Mu/1	64.99	1000	1000	1000	30	1000	600	200	10	50
Mu/2	65.73	1000	1000	1000	40	1000	1000	300	10	70
Mu/3	66.17	1000	1000	1000	30	1000	1000	300	10	40
Mu/4	66.91	1000	1000	1000	30	1000	150	300	10	40
Mu/5	68.10	1000	1000	1000	30	1000	150	300	10	40
Mu/6	66.32	1000	1000	1000	30	1000	1000	300	10	30
B/2 - Tantalite		1000	1000	1000	20	1000	1000	1000	50	50
G/2 - Tantalite		1000	1000	1000	150	1000	1000	200	30	1000
G/3 “	0.00	1000	1000	1000	20	1000	1000	200	30	20

Note M – Mundaguda, J – Jangarpal, B – Berykupli, C – Chuirwada, K – Kachheriras, M – Madkamiras, G – Govindpal, Mu – Mundava, Bi, Be and V are less than 10 ppm. in all the samples except G/2 tantalite in which Bismuth is 150 ppm.

The Govindpal samples contain 64.84 to 68.69% of Sn with an average of 66.7%. NB, Ta and W are more than 0.1% each; No varies from 10 to 40 ppm. Ti ranges from 500 to 1000 ppm; Mn varies from 70 ppm. To 0.1% and Zr varies from 200 to 400 ppm; Cu ranges from 10 to 30 and Pb from 10 to 700 ppm; W, Bi Mo and Be are detected but low in content.

From the analysis, it is found that there is low Zr with higher Sn values and high Mn and Ti values with low Sn values. Zircon shows general decrease from 1000 to 200 ppm in the increasing order of Sn from 50 to 655. The Mn and Zr are sympathetic and Pb and Cu are antipathetic relationship. Mn is high in Zened pegmatites and low in unzoned pegmatites.

NIOBIUM AND TANTALUM MINERAL ISATION

Because of their similar ionic radii and charge (trivalent and pentavalent), both niobium and tantalum occur together in nature in varying proportions and commonly substitute for each other in minerals. The ionic potential of Nb and Ta is sufficiently high to form normally stable tetrahedral and octo-hedral complexes (Wedepohl 1969). Such complexes crystallize as independent mineral species when sufficiently abundant in the magma; if not sufficiently abundant, they are scavenged as minor or trace constituents within the lattices of titanium or titanium accessory mineral. In this case, the traces of Nb and Ta may be freed by late albitisation or greisenisation, beneficiated or remobilized to crystallize as independent minerals. Minerals occurring in nepheline syenites-syenites, sodic-alkali granites are generally niobium rich, whereas those in lithium pegmatite are tantalum-rich (Ginzburg 1972).

The fonlumbite is block in colour, brittle in nature, luster is vitreous to submetallic. It shows anisotrophism and deepred to reddish brown internal reflection. The microfractures of columbite is often traversed by stringer of quartz and in some cases of ilmenite material.

ANALYTICAL RESULTS OF COLUMBITE-TANTALITE

The analysis of three columbite-tantalite minerals from Bastar, indicated Nb_2O_5 varying from 50.50 to 68.05%; Ta_2O_5 from 9.55 to 29.65%. The other major elements present (Table-I) are, FeO varying from 4.83 to 14.23%; MnO - 3.88 to 10.99%; TiO_2 –0.30 to 0.50 and SnO_2 from 800 to 1500 ppm. One columbite drystal recorded 150 ppm. of bismuth. Almost all the minerals analysed, indicated more than 1000 ppm. of tungsten. Cu, Mo, Bi, V, Be, Pb and Zr are the other elements tried and detected in the cassiterite-tantalite minerals. Nb and Ta are characteristically oxyphile forming a number of complex minerals or they enter isomorphously into minerals or iron, mangnese, titanium, rare-earths, uranium, thorium, zirconium, tungsten, tin, bismuth and antimony, Tantalum shows a closer relationship with zirconium tin, the rare-earths of yttrium group, uranium and lithium. Niobium shows closer relationship with titanium tungsten, thorium, the rare-earths of Cerium Group and sodium. A magnetite crystal occurring in pegmatite traversing the granite body indicated more than 1000 ppm. of tantalum In lepidolite Ta content varies from less than 500 to more than 1000 ppm. In muscovite it is 500 ppm. Nb content ranges from less than 50 to 100 ppm. in lepidolite and 50 ppm. in feldspars. Cu, Be, Zr and Pb are in moderate ranges in tantalites and Mo and V are in low ranges.

ANALYTICAL RESULTS OF ASSOCIATED ROCK FORMING MINERALS

Among the rock forming minerals from pegmatites, lepidolites, feldspars and muscovites have detected significant amounts of Sn, Nb and Ta and garnets and smoky quartz associated with cassiterite crystals have shown poor results. In lepidolites, Sn, Ta and Nb ranges from 300 to more than 1000 ppm; less than 500 to more than 1000 ppm and less than 50 to 100 ppm. respectively. In muscovites, Sn, Ta and Nb contents are 400 ppm, 750 ppm. and 500 ppm. respectively. The variation of Sn, Ta and Nb are 30 to 800 ppm; less than 50 ppm and less than 50 to 50 ppm in feldspars. The tin content in smoky quartz is 15 ppm and in garnets it is 10 ppm Cu, Ti and Mn are in significant amounts, Bi, Zr and Pb are in moderate ranges and Mo, Bi and V are in low ranges in all the minerals.

From the analytical data of Sn, Nb and Ta, it is evident that lepidolites, feldspars and muscovite minerals allowed the isomorphous substitution of these elements in their lattices and their concentration in the minerals indicated their probable abudance in rock melt of the magma from which they were formed.

TABLE -III
CHEMICAL ANALYSIS OF ROCK FORMING MINERALS

Mineral No.	Sn	Nb	Ta	Be	Pb	Cu	Zr	Ti	Mn	V
Q1	15	50	500	10	10	75	15	100	50	10
F1	30	50	500	10	10	150	150	200	70	10
F2	30	50	500	10	20	75	10	200	1000	10
F3	100	50	500	10	50	200	10	150	1000	10
F4	70	50	500	50	20	150	10	150	250	10
F5	30	50	500	10	20	50	20	70	400	10
F6	30	50	500	10	20	100	200	100	150	10
F7	800	50	500	10	70	50	50	10	100	10
F8	150	50	500	10	10	50	10	200	1000	10
M1	400	50	500	10	10	150	10	1000	1000	150
L1	1000	50	500	10	10	100	50	150	1000	10
L2	1000	100	1000	10	10	100	10	300	1000	10
L3	300	50	500	10	20	75	10	250	1000	10
L4	1000	70	500	150	200	100	50	500	1000	10
G1	10	50	500	10	10	10	70	20	1000	10
G2	10	50	500	10	10	10	100	70	1000	10
MG 1	400	50	500	10	100	1000	10	1000	1000	100
MG 2	50	1000	10	20	10	10	10	1000	1000	70

Note: Q – Quartz, F – Felsper, M – Muscovite, L – Lepidolite, G- Garnet, Mg. Magnetite.

CONCLUSIONS:

The presence of Sn and Ta elements in significant amounts in lepidolite. Felspers and muscovite of pegmatite indicate that the rock melt from which these minerals were formed, is rich in stanniferous and tantaliferous fluids. Intensive investigations for the location of lithium-rich pegmatites may be rewarding.

The exsolution inter-growths of columbite and tantalite crystals in cassiterite seem to indicate that niobium and tantalum were derived from the same hypogene solutions from which cassiterite was formed.

The x-ray data indicates that the presence of Nb, Ta and W in cassiterite altered the unit cell dimensions of the cassiterite to some extent.

The average tin content of cassiterite from Bastar is more than 65% which is considered to be high grade. Almost all the cassiterites contain significant amounts of Nb, Ta & W. Whether these elements are present in sufficient quantities to render profitable extraction from the cassiterite crystals, requires quantitative estimation of good number of cassiterite crystals.

The cassiterite and its accompanying minerals are too brittle to endure transport exceeding one or two kms; hence the ore minerals during the transport may get very fine grained. As the favourable conditions viz-suitable rock like lithium pegmatites, tropical weathering process and water transport are made available in Bastar, prospecting by the test pits and stream sediment surveys at selected localities may be rewarding,

ACKNOWLEDGEMENTS

The, authors thank. Shri R.K. Sundaram, Deputy Director General, GSI (CP) for the facilities provided. Our sincere thanks to S/Shri V.S. Sathe, D.R.K. Murthy, Chemists (Sr); A.K. Khandekar and S.B. Joshi, Asstt. Chemists for the chemical analysis of the samples; I.P. Singh, Mineralogist (Sr) for X-ray data and M. Suryanarayana, Geolonist (Sr) and T.B. Mahapatra, Asstt. Geologist far the help rendered at various stages.

LOCALITY INDEX

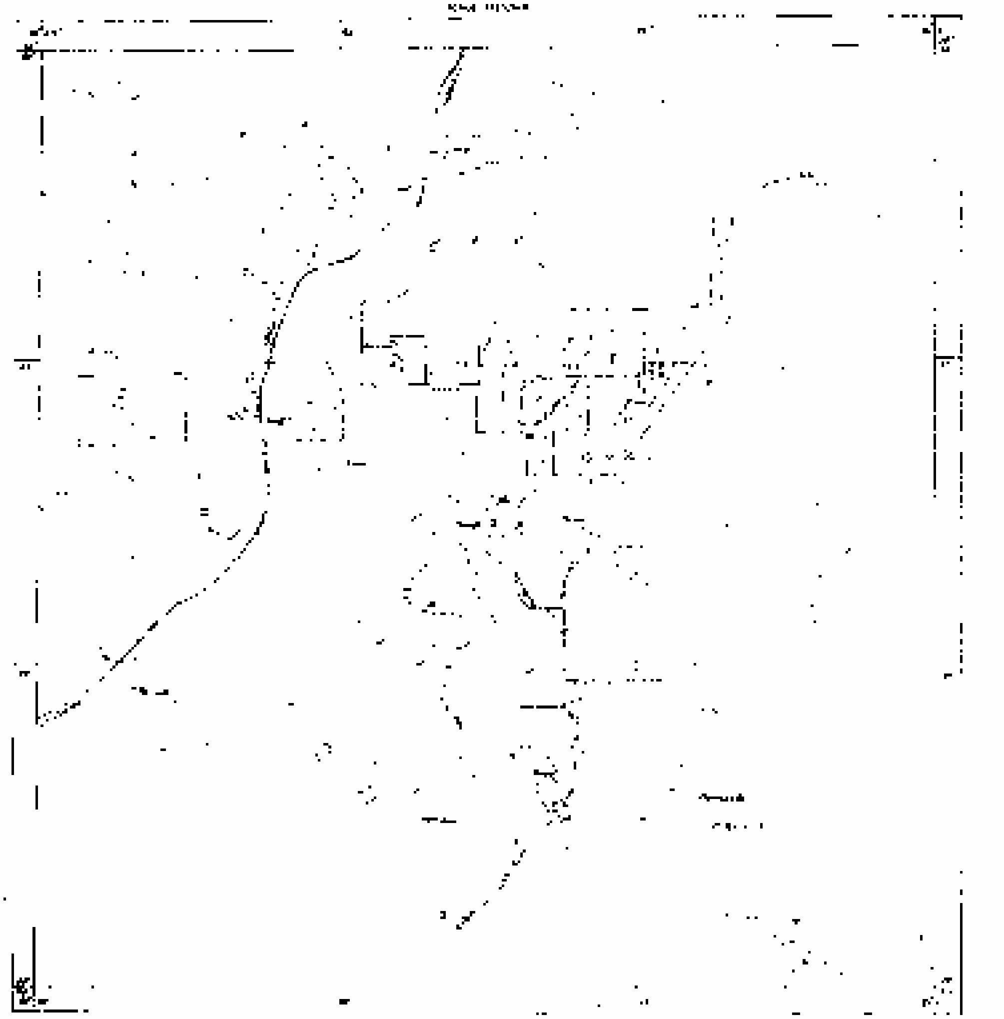
Name	Toposheet	Latitude &	Longitude
Bogan	65F/14	18°14' 30”	: 81°47'30”
Chuirwada	65F/14	18°44’	: 81°53’
Darba	65F/13	18°52'	: 81°52'
Govindpal	65F/14	18°42’30”	: 81°54'
Jangarpal	65F/14	18°40’	: 81°54'
Kachheriras	65F/14	18°42'	: 81°54’
Kudripal	65F/14	18°41'	: 81°51'
Kasanpal	65F/14	18°41’30"	: 81°47'
Madkamiras	65F/14	18°42’	: 81°52'45”
Mundval	65F/14	18°36'30”	: 81°57'
Paliam	65F/14	18°39’	: 81°47'

[illegible]

[illegible]

[illegible] INVESTIGATION

[illegible]



[illegible]

LIST OF PLATES

PLATE NO

Annexure-2

Gazette Notification of Accreditation

रजिस्ट्री सं. डी.एल.- 33004/99 REGD. No. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

सी.जी.-डी.एल.-अ.-07042022-234959
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असाधारण
EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (i)
PART II—Section 3—Sub-section (i)

प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

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खान मंत्रालय

अधिसूचना

नई दिल्ली, 7 अप्रैल, 2022

सा.का.नि. 284(अ).—केंद्रीय सरकार, खान और खनिज (विकास और विनियमन) अधिनियम, 1957 (1957 का 67) की धारा 4 की उपधारा (1) के दूसरे परंतुक द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए और भारतीय गुणवत्ता परिषद् के राष्ट्रीय शिक्षा और प्रशिक्षण प्रत्यायन बोर्ड (क्यूसीआई-एनएबीईटी) द्वारा प्रदत्त प्रत्यायन के परिणामस्वरूप, उक्त अधिनियम की धारा 4 की उपधारा (1) के उक्त दूसरे परंतुक के प्रयोजनों के लिए भारत सरकार के खान मंत्रालय के आदेश संख्या एम.VI-16/15/2021-खान VI, तारीख 12 अगस्त, 2021 (जिसे इसमें इसके पश्चात् प्रत्यायित प्राइवेट खोज अभिकरणों की अधिसूचना के लिए उक्त मार्गदर्शक सिद्धांत कहा गया है) द्वारा जारी किए गए प्रत्यायित प्राइवेट खोज अभिकरणों की अधिसूचना के लिए मार्गदर्शक सिद्धांतों में यथा विनिर्दिष्ट ''प्रवर्ग 'क' खोज अभिकरण'' के अधीन मैसर्स यूनाईटेड एक्सप्लोरेशन इंडिया प्राइवेट लिमिटेड को अधिसूचित करती है।

2. अभिकरण, प्रत्यायित प्राइवेट खोज अभिकरणों की अधिसूचनाओं के लिए उक्त मार्गदर्शक सिद्धांतों में विनिर्दिष्ट शर्तों की अनुपालना के साथ भावी संक्रियाएं करेगा।

3. यह अधिसूचना राजपत्र में इसके प्रकाशन की तारीख को प्रवृत्त होगी और अधिसूचना की तारीख से तीन वर्ष की अवधि के लिए या उसकी समाप्ति तक या प्रदत्त प्रत्यायन की समाप्ति तक, जो भी पहले हो विधिमान्य होगी।

[फा. सं. एम-VI-16/22/2022-खान VI]

डॉ. वीणा कुमारी डरमल, संयुक्त सचिव

MINISTRY OF MINES

NOTIFICATION

New Delhi, the 7th April, 2022

G.S.R. 284(E).—In exercise of the powers conferred under the second proviso to sub-section (1) of section 4 of the Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957) and consequent upon accreditation provided by the National Accreditation Board for Education and Training of the Quality Council of India (QCI-NABET), the Central Government hereby notifies the M/s. United Exploration India Private Limited under 'Category A Exploration Agencies' as specified in the guidelines for notification of accredited private exploration agencies issued by the Government of India in the Ministry of Mines vide order No. M.VI-16/15/2021-Mines VI, dated the 12th August, 2021 (hereafter referred to as the said guidelines for notification of accredited private exploration agencies) for the purposes of the said second proviso to sub-section (1) of section 4 of the said Act.

2. The agency shall carry out prospecting operations in compliance with the conditions specified in the said guidelines for notifications of accredited private exploration agencies.

3. This notification shall come into force on the date of its publication in the Official Gazette and shall remain valid for a period of three years from the date of notification or till expiry or termination of the accreditation granted, whichever is earlier.

[F. No. M-VI-16/22/2022-Mines VI]

Dr. VEENA KUMARI DERMAL, Jt. Secy.

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and Published by the Controller of Publications, Delhi-110054. MANOJ KUMAR VERMA

Annexure-3

Details of Project Members and Associates

❖ ABOUT UNITED EXPLORATION INDIA PRIVATE LIMITED:

United Exploration India Private Limited (UEIPL) is an emerging consulting firm managed by professionals and performed by a perfect mixture of technical experience and energy, in field of mining, geology & survey wherein end-to-end solutions is being offered to client.

UEIPL is an ISO 9001:2015 company and has also been accredited under the scheme of QCI NABET as an Exploration (APA) and Mine Planning Preparation Agency (MPPA). A detail of the company can be sought out in the company's website www.unitedexploration.co.in.

UEIPL has been engaged in several nos. of exploration projects in India which involves around 4.00 lakhs meter of drilling supervision. Besides Exploration and Drilling Projects in both Coal and Non-Coal, UEIPL has also been engaged by several esteemed clients for carrying out different reports like:

- Geological Report of Coal & Non Coal,
- Mining Plan & Mine Closure Plan (for both Major and Minor Minerals),
- Environmental Impact Assessment & Environmental Management Plan Study,
- Technical Assessment reports during auctioning of both coal and mineral blocks,
- Due-diligence Reports for both Coal & Minerals,
- Forest and Environment Clearances (through our associate M/s CEMC Limited, Bhubaneswar, also a NABET accredited company),
- Hydro-geological Study,
- Geophysical Survey for Groundwater survey and mineral exploration
- GIS and Remote Sensing for Land Information System,
- Topographic and Stack (Volume) Survey work with DGPS and/or ETS.
- Detailed Project Report and Feasibility Reports
- District Survey reports

Besides the knowledge base report preparation, UEIPL also entered to caterthe drilling needs of various clients.

❖ STRENGTHS:

The strength of the organization is skilled human resources with an enriched versatility with senior renowned professionals. The team is well composed of:

- 16 Geologists.
- 5 Mining engineers.
- 1 Geophysicist.
- 3 Surveyors.
- 2 drilling operators & other supporting staffs.
- 2 Civil Engineers.
- 1 Electrical Engineer.
- 5 Other Administrative officers and Staffs.

❖ ASSETS:

Beside our well-trained human resources UEIPL has a huge support of modern software's & equipment's.

- **SOFTWARE'S:**
  - GEOVIA Minex 6.3.
  - GEOVIA SURPAC 2022
  - ARES Commander 2020 for survey data analysis, volumecalculation.
  - AutoCAD 2020 for survey data analysis, volume calculation.
  - Arc-GIS Software.

- **SURVEY EQUIPMENTS:**
  - Three number of Total Stations: SOKKIA CX 65, SOKKIA CX 101, SOKKIA 107.
  - One Scanner: TRIMBLE STS 730

- **DRILLING EQUIPMENTS:**
  - 1 number KDR-500 and 1 umber KDR 750- 500 to 700m drilling capacity.
  - 2 number of Voltas 180 drill rig driven by P4 Engine. Capacity- 300

meters.

- 1 number Joy-12B of 250m drilling capacity.

❖ TEAM PROFILE:

Name	Qualification	Technical Experience
Mr. JoydeepBanerjee	M.sc. Geology, RQP- IBM. MAusIMM., Project Coordinator under NABET Scheme of Prospecting/ Exploration Agency (APA) & Mining Plan Preparing Agency (MPPA).	Having more than 20 years of experience in the field of mineral industry and has obtained vast experiences in the field of coal exploration, Iron Ore exploration, Bauxite exploration, Chromite Exploration, Graphite Exploration etc. Throughout his career he has worked in both the domestic and overseas environment for exploration and mining project implementations. His strength lies in a thorough understanding of resource modeling and effective utilization of modeling software's. He is also an expert in the field of Remote sensing & GIS.
Mr. Indrajit Mukherjee	M.Sc in Geology	More than 23 years of Experience in Geological field, more than 12 years of experience in Forest Clearence.
Dr. Sukhen Majumder,	M. Tech (2005) in Applied Geology, IIT, Kharagpur. Ph.D. (2009) in Structural Geology, IIT-Kharagpur. MAusIMM. Technical Area Expert (Geo/HG) under NABET Scheme of Prospecting/ Exploration Agency (APA) & Mining Plan Preparing Agency (MPPA).	14 years of experience. Specialized in mineral exploration and project management, particularly in metals. His skills include exploration project management, detailed structural mapping, geological-geotechnical logging and sampling, geochemical surveys, profile mapping, litho-stratigraphic correlation, database management, quality analysis and quality check in compliance with international standards, preparing geological reports. He has worked in various exploration projects, mostly in different parts of India and Africa.
Mr. Supratik Roy	M.Tech in Geology and M.sc in Geology	More than 10 years of experience in Geological and Geophysical field.
Mr. Debnath Adhikary	M.Sc (Tech) from Banaras Hindu University.	More than 5+ years of experience. Mr. Adhikary is being engaged in exploration job since joining in this organisation. Assisted in different Geological Report Preparation works.

Name	Qualification	Technical Experience
Mr. Deep Konar	M.Sc. in Geology from IIT Bhubaneswar.	5.0 years of experience in managing exploration project. Prepared geological report. Software modeling through Surpac.
Mr. Shouvik Sen	M. Sc Applied Geology from Calcutta University	1 year experience in project management, geological mapping, sampling, database preparation, geological report preparation.
Sk. Rabiul Islam	B.Sc. Hons. Surveyors Competency Certificate from DGMS. Technical Area Expert (SUR) under NABET Scheme of Prospecting/ Exploration Agency (APA) & Mining Plan Preparing Agency (MPPA).	More than 15 years of experiences. Surveying & leveling, assist to prepare Mining Plan/Review of Mining, Forest Diversion proposal, liaison work with Indian Bureau of Mines, Forest department, Pollution Control Board.
Ms. Jinia Rahaman	M. Sc in Geography from Vidyasagar University; P.G. Diploma in Applied Geoinformatics (Remote Sensing & GIS)	Ms. Rahaman is having 2 years of experience and has been engaged in various GIS related job.

❖ ASSOCIATES FOR OUT SOURCE JOBS:

Job Type	Organization	Expertise
Chemical analysis	SHIVA Lab, Bangalore	The laboratory is accreditated by NABL, APEDA, FASSAI, ISO 9001:2015 Certified and recognized by other governmental departments.