DETAILED INFORMATION
ON
TUNGSTEN ORES
IN
INDIA

GEOLOGICAL SURVEY OF INDIA
1994

DETAILED INFORMATION
ON
TUNGSTEN ORES OF INDIA

CONTENTS

LIST OF PLATES

INTRODUCTION

Tungsten occurs as WO_3 in the minerals scheelite ($CaWO_4$), ferberite ($FeWO_4$), huebnerite ($MnWO_4$) and wolframite (Fe,Mn) WO_4). Tungsten, a silvery gray metal, has an atomic number of 74 and an atomic weight of 183.92. Its most outstanding physical property is its high melting point of 341O°C, the highest of all metals and three times that of copper. Tungsten is one of the heaviest of the elements, with a density of 19.3 grams per cubic centimeter at 2O°C. It has good corrosion resistance, good thermal and electrical conductivity, and a low coefficient of expansion. At temperatures above 165O°C, tungsten has the highest tensile strength of all metals. Tungsten's principal uses are in cemented carbides, alloyed steels, super alloys, electrical and electrical products, and armaments.

Tungsten concentrate is sold in units of tungsten trioxide (WO_3). Natural or synthetic scheelite concentrate, if nodulized, is ideal for direct addition to steel melts, since the calcium is removed as slag. Fine material in either synthetic or natural scheelite is not desirable because of high dust losses. Wolframite concentrate is not satisfactory for steel making because of the manganese and tin content.

Tungsten is found primarily in quartz veins and contact-metamorphic scheelite deposits. Both underground and open pit (surface) methods are used in mining operations. Tungsten concentration operations,, primarily gravity and flotation methods, usually are conducted at or near the mine site. The concentrate is processed chemically to produce tungstic acid and /or ammonium para-tungstate (APT) from which tungsten metal powder is made, generally by hydrogen reduction. The metal powder is processed further into intermediate products such as tungsten carbide and ferrotungsten.

The average crustal abundance of tungsten has been estimated at 1 to 1.3 ppm and so it is considered as one of the rarer elements in the earth's crust. In the formation of tungsten ore deposits hydrothermal solutions play a critical role. Tungsten becomes concentrated in the residual fluid of crystallising magmas as the tungsten iron, tungstic acid, or sodium tungstate and may be precipitated in wall rock contact zones usually as wolframite or scheelite. The particular mineral formed is controlled mainly by the relative amounts and activity of iron... manganese, and calcium present. All members of the wolframite series are called "black ores" in the trade and are the predominant tungsten minerals in the quartz vein deposits that comprise the bulk (60%) of the worlds reserves. Scheelite occurs in skarn rocks formed by high-temperature replacement and recrystallisation of calcareous sediments near or at the contact of intrusive igneous rocks. Scheelite accounts for about 35% of the world's tungsten deposits.

World Resource and Geological setting :

The world's historic leader in output is China. Most of the well-known Chinese tungsten deposits occur in the Nanling region, which includes Jianxi Province and parts of Hunan and Guangdong Provinces. Most Chinese ore is high grade wolframite from Jianxi Province, but scheelite from Hunan Province is also important. Significant deposits also have been found in other parts

of China, notably in Guangdong and Guznxi Provinces, and along the Tienshan fault-fold system of the northwestern part of the country, etc. Other leading Asian producers are the Republic of Korea (Sangdong Scheelite), North Korea (near Hamhung), and Thailand (Doi MCK and Khao Soon areas). United States and Canada are significant tungsten producers. Tungsten production in erstwhile USSR is centered in the North Caucasas, Transbykal, Central Asia and Kazakhstan. In North Caucasas tungsten occurs in the Tryny-Aux tungsten-molybdenum complex. In USSR Scheelite-quartz type deposits are found over wide areas where auriferous deposits are located. France's major production comes from mines at Salau. Portugal has West Europe's most extensive tungsten deposits of wolframite type. Bolivia's tungsten production comes from co-product mines producing both tin and tungsten (wolframite). In Brazil, scheelite is the predominant tungsten mineral. Australia's largest ore reserve of tungsten is at the Bold Head and Dolphin mines on King Island. Here most of the tungsten occurs as scheelite disseminated in quartz veins. Africa has a small but significant tungsten industry, with Rwanda as the leading producer.

World reserves of tungsten metal is estimated at 3.5 lakh tonnes of which China's reserve of the metal is estimated at 1.5 lakh tonnes, Canada's 0.49 lakh tonnes, Australia's 0.15 lakh tonnes, etc.

Indian Scenario:

Indian resources of tungsten are limited. Large quantities of tungsten concentrates, alloys and scrap are imported by the country every year. India imported 343 tonnes of tungsten concentrate and 68 tonnes of alloys and scrap in 1987-88. The indigenous production of tungsten metal meets only about 5% of the country's requirement.

According to IBM(1992), the all-India reserves of tungsten ore have been estimated at 23,371 tonnes or 55,026 tonnes in terms of WO_3 content. At Degana, Rajasthan, WO_3 value in vein deposits varies from 0.25 to 0.54%, while in gravel deposits, it is 0.04% on an average. In Balda deposit, Sirohi district, Rajasthan, WO_3 value ranges between 0.02 and 2.2%. In West Bengal, Bankura deposit contains, on an average 0.1% WO_3. In Kuhi-Khobna-Agargaon belt several mineralised zones have been identified in Sakoli basin in Bhandara and Nagpur districts containing 0.10 to 0.20% W in Kuhi block, 0.313% W in Khobna block. Gold ore at Mysore mine of BGML in Karnataka contains 0.43% WO_3. The tailings of the Kolar Gold Field, Karnataka have been reckoned as a potential source of scheelite. The tailing dumps at the KGF analyses 0.035 to 0.18% WO_3. The concentrates recovered contain 29.8% WO_3 from Balaghat Dump and 68° from Walker's Dump.

The GSI is carrying out investigations for tungsten in Madhya Pradesh, Maharashtra, Rajasthan, Kerala, Tamil Nadu, Gujarat, West Bengal, Haryana, Himachal Pradesh, J & K, U. P., etc. In recent years investigations have helped to locate promising new occurrences of wolframite-bearing quartz veins at Pipalia, Kotaria, Motia, Richmalia over a length of about 14 km associated with the Sewaria granite in Pali and Nagaur districts of Rajasthan. Here, apart from wolframite in quartz veins, a large number of pegmatites contain lithium-bearing phosphatic minerals. MECL in collaboration with BRGM carried out detailed exploration for tungsten in Khobna area in

Maharashtra, for tin and tungsten in Tosham area in Haryana and for graphite and tungsten in Burugubanda-Tapaskonda areas in Andhra Pradesh.

In India the tungsten deposits have low grades and reserves. Further, in majority of the prospects the fine disseminations of tungsten grains form the major part of the reserves. Thus a few laboratories, viz., of IBM, RRL and BARC have undertaken R & D programmes to find suitable beneficiation technologies to treat Indian ore types. Some success has been met with in laboratory and pilot plant scale tests. For examples, beneficiation studies, carried out on Tapaskonda graphite-tungsten deposit have concluded that the ATP route was feasible. The tests on bulk samples from Khobna, Agargaon arid Degana deposits have indicated positive results. Although bulk of tungsten resource in tailing dumps of Indian gold mines have generally very poor grade, a large quantity available in KGF and Hutti mines contain materials of better feed grades which have been found to be recoverable.

Future exploration and exploitation:

The prominent tungsten deposits of the world mostly belong to the late Palaeozoic to Tertiary in age. On the contrary, the Indian occurrences are restricted to Archaean and middle Proterozoic times in the Peninsular shield areas only. The Archaean and Proterozoic tungsten resources of the world constitute only about 10% of the total world resources, in view of this the total tungsten potential of India does not seem to be high. However besides the resources already recognised in Rajasthan, Maharashtra, Madhya Pradesh and Karnataka, many occurrences of tungsten incidences have been recorded in various other states of the Peninsular India. These are now being systematically studied and it is possible that more smaller deposits like Degana, Sewaria, Khobna, Agargaon, Tosham, etc. will be found and proved in other areas particularly associated with Proterozoic granitoids. For this purpose systematic geochemical trace elemental and rnetallogenetic study of the innumerable Proterozoic granitoids of Indian Peninsular areas and Himalayan Region are called for. Younger granitic plutons of Palaeozoic to Tertiary ages have also been recorded in Lesser and Higher Himalayas. These areas deserve systematic survey.

Most of the tungsten occurrences investigated in the country are characterised by low tenor, distributed as disseminations, stringers and small pockets in the host rocks. It need not be emphasised that advanced mining and size-reduction techniques will be needed to deal with the problem of finding ways to reduce wastage of fines. There is need to develop proper technologies in India for the recovery of fine particles in the range of 1-10 μm by any physical method and improving of the existing processes available for the recovery of 10-220 μm particles.

Tungsten mineralisation being highly erratic in distribution, it is extremely difficult to come to a conclusion on grade of a deposit. Thus, in India, we should adopt a method of simultaneous exploration-cum-exploitation for studying the economic viability of the important tungsten prospects. This manner of exploration-cum-exploitation will not only increase the indigenous tungsten production but will give rise to improvement in cost-effective mining and beneficiation technologies suitable for tungsten recovery in India.

The data incorporated in this document have been compiled mostly from GSI Reports. Sources other than GSI have been indicated in the appropriate data sheets in the text.

RAJASTHAN

Introduction

The Early to Middle Proterozoic Aravalli-Delhi Orogen (2200 - 1000 Ma) occurring in Rajasthan and adjacent areas of Haryana and Gujarat host several base metal deposits. This region also contains well known occurrences of Tungsten and Tin at Degana, Balda and Tosham which are related to the late Proterozoic to Early Palaeozoic anorogenic Malani Magmatism. Recently new areas of Tungsten mineralisation have been identified in Centra! Rajasthan which appears to be syntectonic with the Delhi Orogeny and may be distinct from the Post-tectonic Malani igneous phase.

Regional Geological Set-up:

In Balda area of Sirohi district, quartz veins and greisenised pegmatites serve as hosts for wolframite mineralisation in the Balda block and further northeast in the Dewa-ka-Bera block, skarns form the host for scheeiite mineralisation. The Tungsten mineralisation is associated and genetically connected with the leuco-granite. The enveloping rocks of the leuco-granite include a group of meta-sediments (dominantly argillaceous towards southwest and grading into a quartzite-carbonate association in the northeast) within which have been emplaced at various times the porphyroblastic gneiss (the Erinpuras), the syenites and the basic dykes. Besides Balda and Dewa-ka-Bera blocks, where small to medium sized reserves of tungsten have been proved, there are several small deposits of skarn hosted scheelite mineralisation in the similar geological environments mainly at Gautamji, Uttara, Kaldari, Barabera, Udwariya areas in Sirohi district. Rajasthan.

Significant tungsten mineralisation occurs in the western flank of the South Delhi Fold Belt in Central Rajasthan. In Degana, the mineralisation is associated with a medium grained biotite granite intruding the phyllites of the Delhi Super Group. This granite is correlated with the Jalor granite of Malani Group which is dated at 730 Ma by Crawford. The wolframite mineralisation occurs as lodes of quartz veins intruding both granite and phyllite as irregular bodies of stockwork in phyllites and certain brecciated contacts with granites; and placer concentration in gravel deposits in the foot hill region. Several promising zones of wolframite mineralisation occur in Pipaliya, Motiya, Kotariya and Richmaliya blocks in Pali and Nagaur districts. The mineralisation occurs in pneumatolytic quartz veins intruding the Sewariya granite along structurally favourable locales. In the same geological setting within calcareous environment several prospects of scheelite mineralisation occur at Bar, Babra, Padarla and Bijapur areas of Pali district.

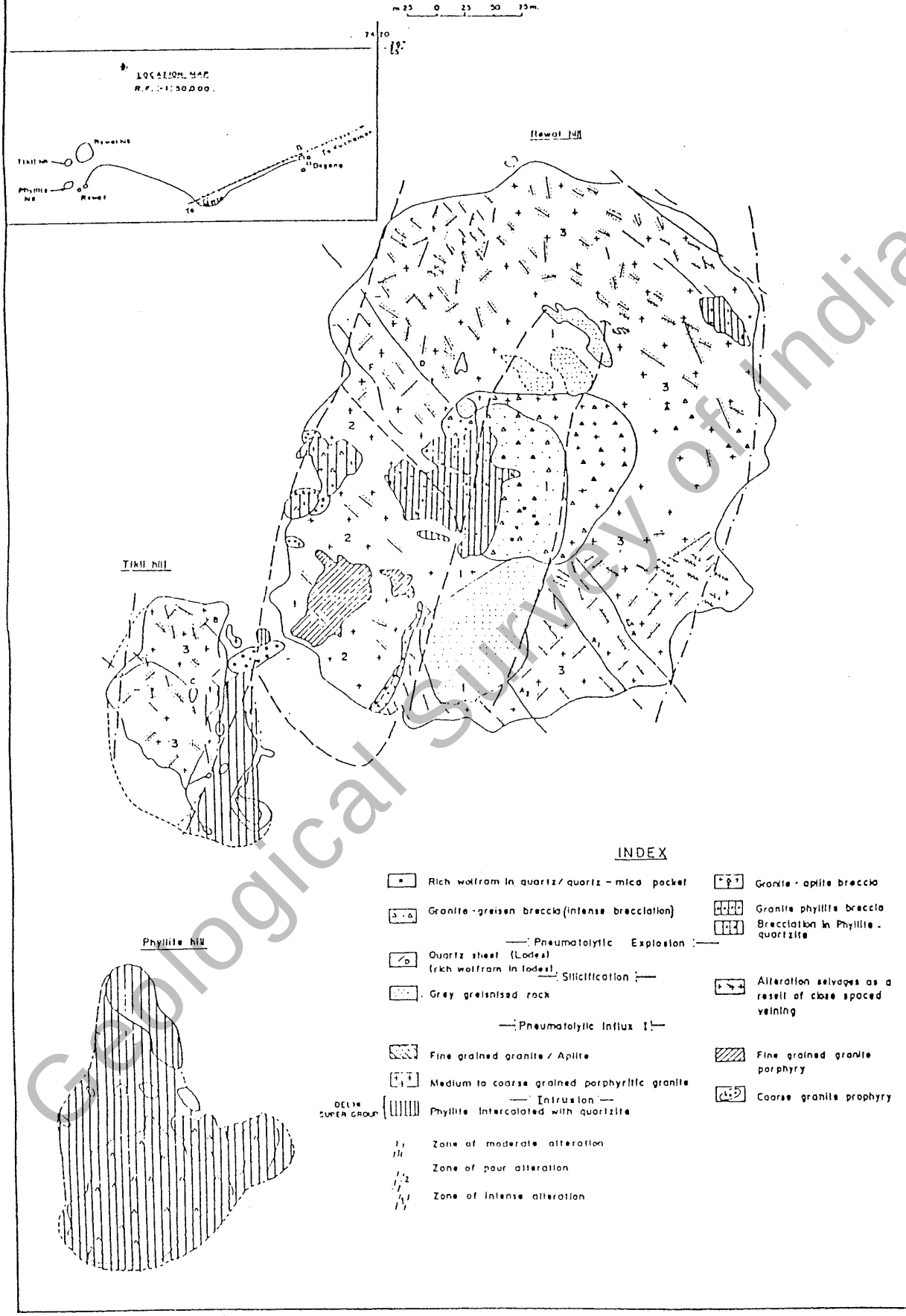
DEGANA

1. **Location:**

Belt Name	:	Malani Igneous Suite (MIS).
Prospect	:	Degana.
Location	:	Near Rewat village, 4 km west of Degana Rly. Stn.
District	:	Nagaur

GEOLOGICAL SURVEY OF INDIA

GEOLOGICAL MAP OF DEGANA GRANITE PLUTON
DISTRICT NAGAUR, RAJASTHAN



Village	:	Rewat
Toposheet	:	45J/5
Latitude	:	26°53'30"N
Longitude	:	74°16'50"E

2. **Geological Set-up:**

Intrusion of Degana Granite belonging to the Malani Igneous Suite (MIS) into late Proterozoic Delhi phyllite has resulted in the formation of three small hills namely Rewat, Tikli and Phyllite hills in an otherwise flat landscape. Rewat hill exposes two phases of granitic instructions. The first phase is the dominant phase comprising an intrusion of biotite granite followed by a weak later phase of aplite and granite porphyry. Blackish fine greisenised veinlets occur throughout the hill with gray greisenised granite and breccia horizon at the top of the hill. NW-SE trending thin quartz veins/sheets with steep to vertical clips traverse the granite across the breccia zone. The Tikli hill which is close to the SW corner of the Rewat hill exposes granite-phyllite contact. This hill is also traversed by a few thin quartz sheets having very shallow dip towards SW. The phyllite hill is a small domal hill, the central part of which is occupied by phyllite-quartzite breccia.

3. **Control of Mineralisation:**

Rich wolframite lodes are associated with the quartz sheets. Visible wolframite mineralisation occurs as erratically distributed coarse aggregates and fine disseminations. It is essentially confined to the quartz sheets, the walls of which are characteristically bound by coarse mica flakes. The grade of these veins has been established at 0.5% WO_3. Giant sized wolframite aggregates and small grains also occur within the granite breccia which occupies the apical part of Rewat hill. Wolframite aggregates as heavy as 1.5 tonnes are reported to have been recovered from here. Large scale alteration of granite along numerous criss-cross fractures has feebly mineralised the granite.

Molybdenite disseminations along with wolframite have been recorded from a few greisenised quartz veins in Tikli hill.

4. **Quantum of work done:**

1. Mapping (in 1:25000 Scale) : 35 sq.km.
2. Sampling : 430 samples from surface and underground.

5. **Reserve and Grade:**

Tentatively it has been calculated that the area contains a reserve of 50 million tonnes of granites of 0.06% WO_3.

6. **Recommendations:**

1) The newly identified quartz veins may prove to be a good source for recovery of hand packable wolframites.

2) To prove quartz vein hosted wolframite reserve, additional drilling is considered necessary. More samples of granite may be collected from under-ground mines and at different levels to bring out over all tungsten potential in the altered granite phase.

3) Rich incidence of molybdenite in some part of the area demands investigation for Mo to be taken up.

7. **Any other information:**

The run of mine ore from Degana deposit was treated for beneficiation studies by the Indian Bureau of Mines. The study reveals that wolfram is the major tungsten mineral; pyrrhotite, pyrite, chalcopyrite, sphalerite and molybdenite are the sulphide minerals found in traces. Quartz, biotite and topaz are the gangue minerals. Good liberation of wolframite is obtained even at coarse size. Response of the sample to wet high intensity magnetic separation is also satisfactory. An integrated flow sheet consisting of pre-concentration. gravity separation, flotation and magnetic separation will give a product analysing 66% WO_3.

DEWA-KA-BERA BLOCK

1. **Location:**

Prospect	:	Dewa-Ka-Bera Block
District	:	Sirohi
Village	:	Dewa-Ka-Bera
Toposheet	:	45 D/13
Latitude	:	24°57'N
Longitude	:	72°59'E

2. **Geological Set-up:**

In the area, impersistent rnarble/skarn bands can be traced for a distance of 5.5 km. To the north of it, there is a thick marble formation with thin parting of quartzite and calc-silicate rooks. Impersistent schist-quartzite occurs as parting between the thin crystalline limestone bands and the thick marble (magnesian) formation. Skarnisation is mainly restricted to the thin crystalline limestone bands. Very little or no skarnisation has been recorded in the thick marble formations in spite of the fact that it has a long continuous western contact with Erinpura Gneiss. An antiformal closure overturned towards SE and a semiformal closure occurs in the NW and SE part of the area. The drilling data suggest the following stratigraphic position of the granitic rocks in relation to the metasediments.

Leucogranite

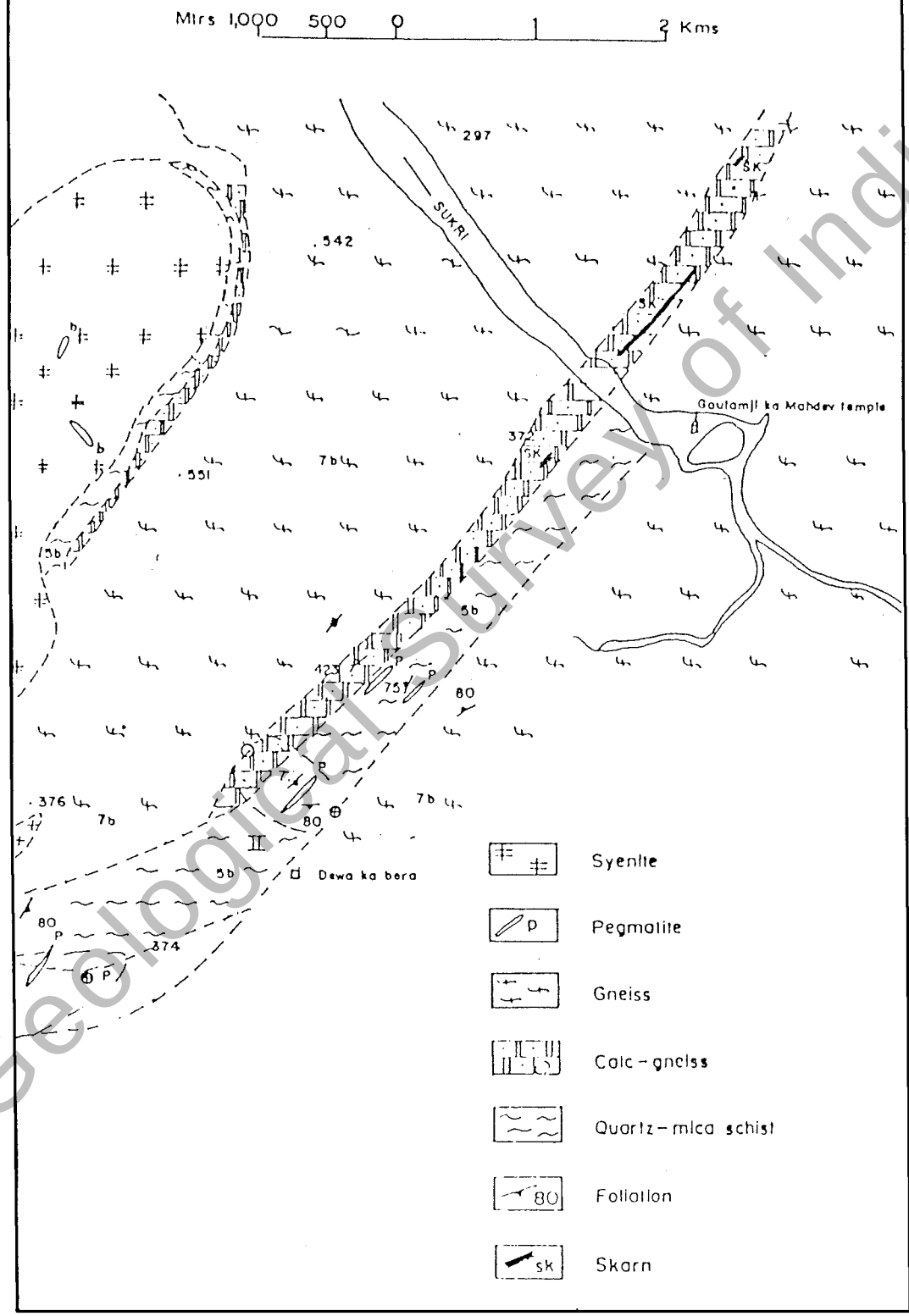
---------- intrusive contact ----------

Erinpura gneiss

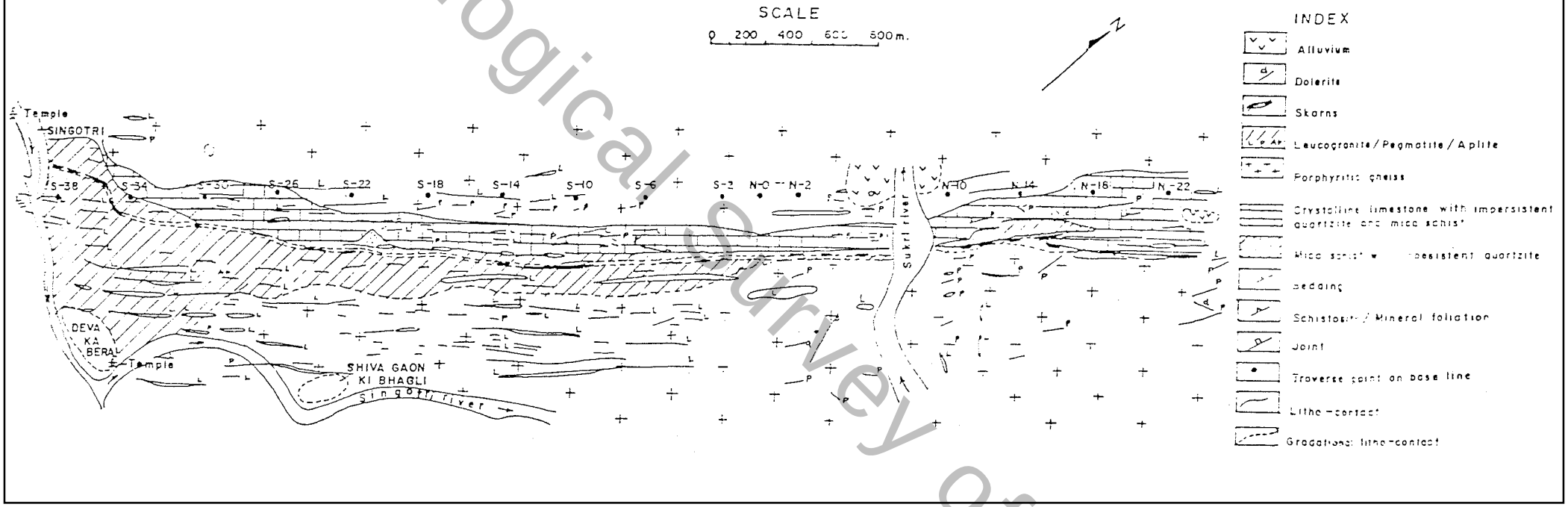
----------intrusive contact----------

Metasediments (Delhi Super group)

GEOLOGICAL MAP OF DEWA KA BERA BLOCK
SIROHI DISTRICT, RAJASTHAN



GEOLOGICAL MAP OF DEWA-KA-BERA BLOCK, SIROHI DISTRICT, RAJASTHAN



3. **Control of Mineralisation:**

Impure marble has been converted to skarn where they have been intruded by leucogranites. The leucogranites of the area have been emplaced parallel to the axial plane of the second generation folds, serving as structurally favourable avenues for emplacements.

4. Quantum of work done:

a) Geological mapping				
	(i)	1:1000 scale	:	0.75 sq.km
b) Surveying				
	(i)	Area covered by gridding	:	0.40 sq.km
	(ii)	Cross section laid	:	8.30 km.
	(iii)	Levelling traverse	:	39.50 krn
c) Trenching			:	300m
d) Sampling				
	(i)	Groove samples	:	495 Nos.
	(ii)	Bulk samples	:	1 No.
e) Drilling				
	(i)	No. of boreholes completed	:	8
	(ii)	Total meterage drilled	:	802.05m

5. **Dimension and character of ore body:**

Skarn lenses are pinching and swelling type and patchy in nature. Skarnisation is also not uniform all over the area. Scheelite mineralisation is patchy and erratic in distribution and is restricted to vesuvianite-garnet bearing skarn. Four mineralised skarn lenses have been delineated by drilling which pinch at depth.

6. **Grades and Reserves:**

A total reserves of 199 tonnes in WO_3 of four mineralised lenses having WO_3 content between 0.14% to 0.40% have been estimated. The details of the reserves and grades of four mineralised lenses are as follows :-

		Strike length (m)	Reserves (tonnes)	Grade % WO_3
1.	Zone I	140 rn	28 tonnes of 65% WO_3	0.16% WO_3
2.	Zone II	225 m	44 tonnes of 65% WO_3	0.14% WO_3
3.	Zone III	75 m	44 tonnes of 65% WO_3	0.24% WO_3
4.	Zone IV	55 m	83 tonnes of 65% WO_3	0.40% WO_3

7. **Any other information:**

Beneficiation studies were not carried out.

UDWARIYA

1. **Location:**

Prospect	:	Udwariya
District	:	Sirohi
Location	:	2.5 km north of Udwariya village.
Toposheet	:	45 D/10
Latitude	:	24°42'30"
Longitude	:	72°42'40"

2. **Geological Set Up:**

Regionally the area falls in the southwestern part of Sirohi fold belt. A large metasedimentary body of the Sirohi Group occurs as an enclave within the Erinpura granite/gneiss. This enclave is made up of andalusite-mica schist with linear intercalations of skarns of calcic type which host scheelite mineralisation. The foliation trends vary from N-S to NNE-ESW with shallow to moderate dip in either direction. The skarns are strongly deformed and fractured.

3. **Control of mineralisation:**

In Udwariya the stratabound scheelite mineralisation appears to be controlled by both lithology and structure. Skarnised calc silicate rocks occurring as intercalated bands within mica schist are locales of scheelite mineralisation. Rich tungsten mineralisation is restricted to skarns only. The NE-SW trending foliated contact zones of mica schist and skarn have served as easy channels for the ascending mineralised solutions which formed the ore.

4. **Quantum of work done:**

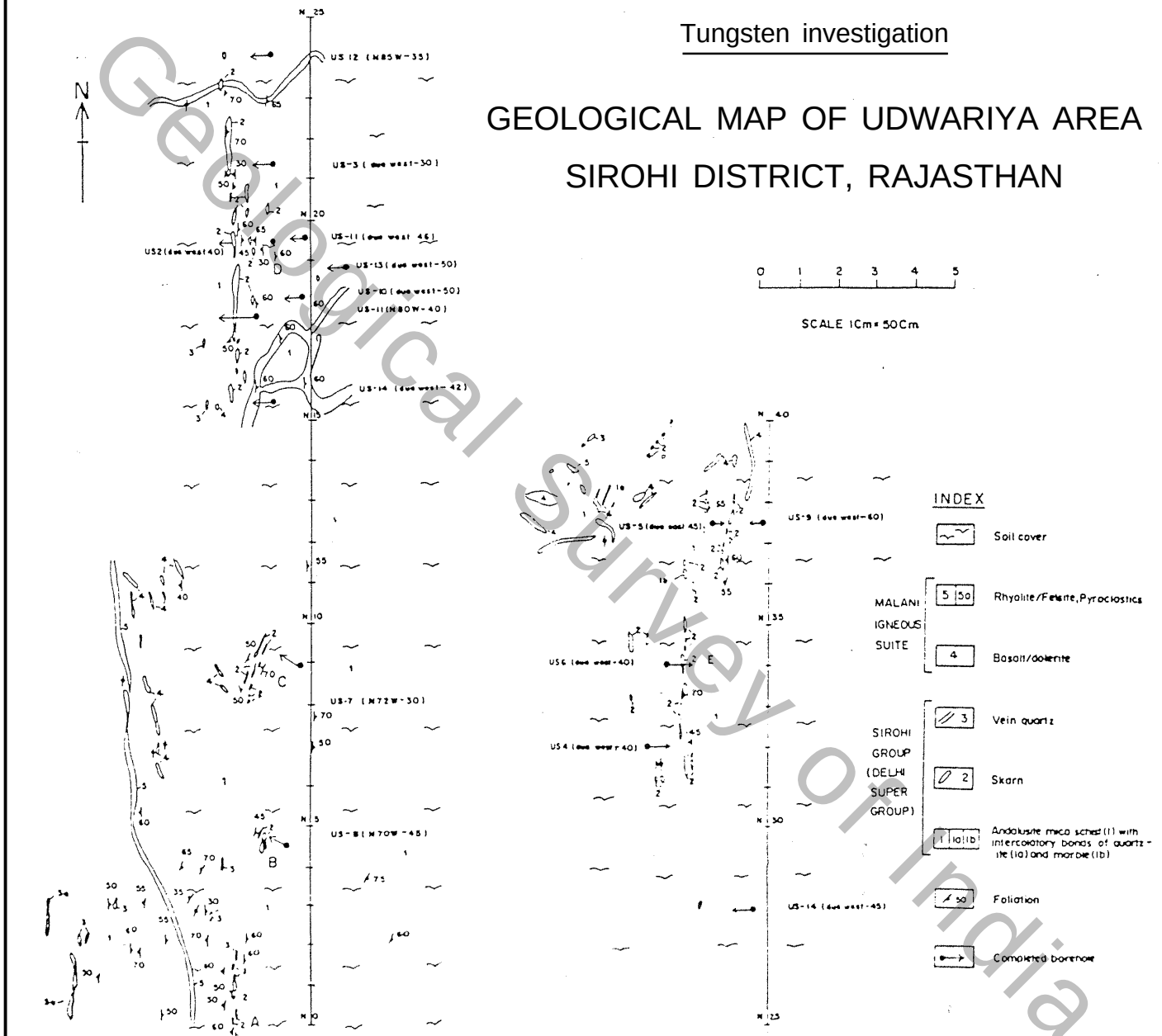
a)	Detailed geological mapping (1:1000 scale)		:	0.35 sq. km.
b)	Samples (Nos)			
	i)	Groove	:	140
	ii)	Core	:	146
c)	Drilling		:	1315.10m exploratory drilling in 15 boreholes.

5. **Dimension and Character of Ore Bodies:**

The skarn rock is developed in the form of thin bands and pockets over 2 km. strike length. These have been grouped for convenience of exploration into five zones namely A,B,C,D and E from south to north respectively. Chemical data on, groove samples received from zones A,B,C and E indicate tungsten values ranging from 0.02 to 0.07% WO_3. However, in zone D, a 230m long skarn with an average width of 2.13m and assaying 0.21% WO_3 is delineated. In zone D the depth continuity of scheelite mineralisation is traced beyond 100 m.

Tungsten investigation

GEOLOGICAL MAP OF UDWARIYA AREA
SIROHI DISTRICT, RAJASTHAN



Skarn rocks contain numerous tiny disseminations and few coarse stringers of bluish fluorescent scheelite. Scheelite distribution is erratic. Scheelite is more commonly seen associated with dark brown variety of garnet. Minor pyrite-chalcopyrite disseminations are usually associated with skarn and adjoining schists. Gangue minerals comprise quartz, calcite and calc-silicate minerals.

6. **Grades and Reserves:**

Reserves of 62,200 tonnes of scheelite ore over 800 m strike length with an average with of 1.56 m averaging 0.27% WO_3 are estimated down to 50 m depth (265m R.L.). This is equivalent to 255 tonnes of scheelite of 65% WO_3 grade.

7. **Recommendation:**

The contact metamorphic skarns occurring within metasedimentary envelope away from pegmatite or granite contact may have good tungsten potential, and the priorities for their exploration should be fixed depending upon the dimensions of the skarns.

Beneficiation studies were not carried out.

BALDA

1. **Location:**

Belt name	:	Sirohi
Prospect	:	Balda
Location	:	6 km. northeast of Sirohi dist., Rajasthan.
Village	:	Balda
Toposheet	:	45D/13
Latitude	:	34°52'30" N.
Longitude	:	72°54'30" E.

2. **Geological Set Up:**

The rocks of the area belong to the Delhi Super Group intruded by post- Delhi granites and later intrusives. The quartz-mica schist of the Delhi Super Group is intruded by an elongated granite body (Erinpura ?) 4 km. in length and 400m in width. Both the schist and granites are in turn intruded by different phases of pegmatites and quartz veins with or without tungsten mineralisation. A few aplite and dolerite veins are also present. The schist is mainly composed of quartz, biotite and muscovite with varying amount of garnet and andalusite porphyroblasts. The granite is leucocratic and medium grained composed of plagioclase, sericitised potash feldsper, quartz, muscovite and tourmaline. The accessory minerals are fluorite, topaz, apatite and iron ore minerals. There are at least three generation of quartz veins. The mineralisation is associated with the last phase pneumatolytic quartz, veins in addition to some pegmatite veins.

The main structure of the area is a doubly plunging antiform formed by the quartz-mica schist which has a general strike of NE-SW. The more prominent NE-SW shear zones conform to the axial plane schistosity of the mica schist and another prominent zone of shear confirm to the ENE-WSW trending zones of culmination and depression developed due to later cross folding.

3. **Control of mineralisation:**

In the Balda block, the wolframite mineralisation occurs in the pneumatolytic phase of granite intruding the argillites of the Delhi Super Group. The primary tungsten mineralisation (ferberite) occurs in the pneumatolytic: quartz and pegmatite veins traversing the granite and argillites and in the shear zones where the pneumatolytic invasion is more extensive.

4. **Quantum of work done:**

i)	Surface geological mapping		
	a) 1:1000 scale	:	2.90 sq.km
	b) 1:200 scale	:	2470 sq.km
ii)	Shallow pitting		
	a) Pitting, meterage	:	210.76 m
	b) No. of pits completed	:	409 Nos.
iii)	Trenching, meterage	:	223.80 m
iv)	Drilling	:	4837.45 m (in 49 boreholes)
v)	Surface sampling		
	a) Pit samples	:	1717 Nos.
	b) Groove samples	:	1167 Nos.
	c) Core samples	:	649 Nos.
	d) Bulk samples	:	1 No.
vi)	Exploratory mining by MECL		
	a) Sh-1, 1A and 2	:	612.00 m
	b) GV-1	:	263.70 m
vii)	Underground mining samples		
	a) Groove samples	:	272 Nos.
	b) Face samples	:	775 Nos.
	c) Bulk samples	:	70 Nos.
	d) Blast samples	:	42 Nos.
	e) Pilot plant samples	:	7 Nos.

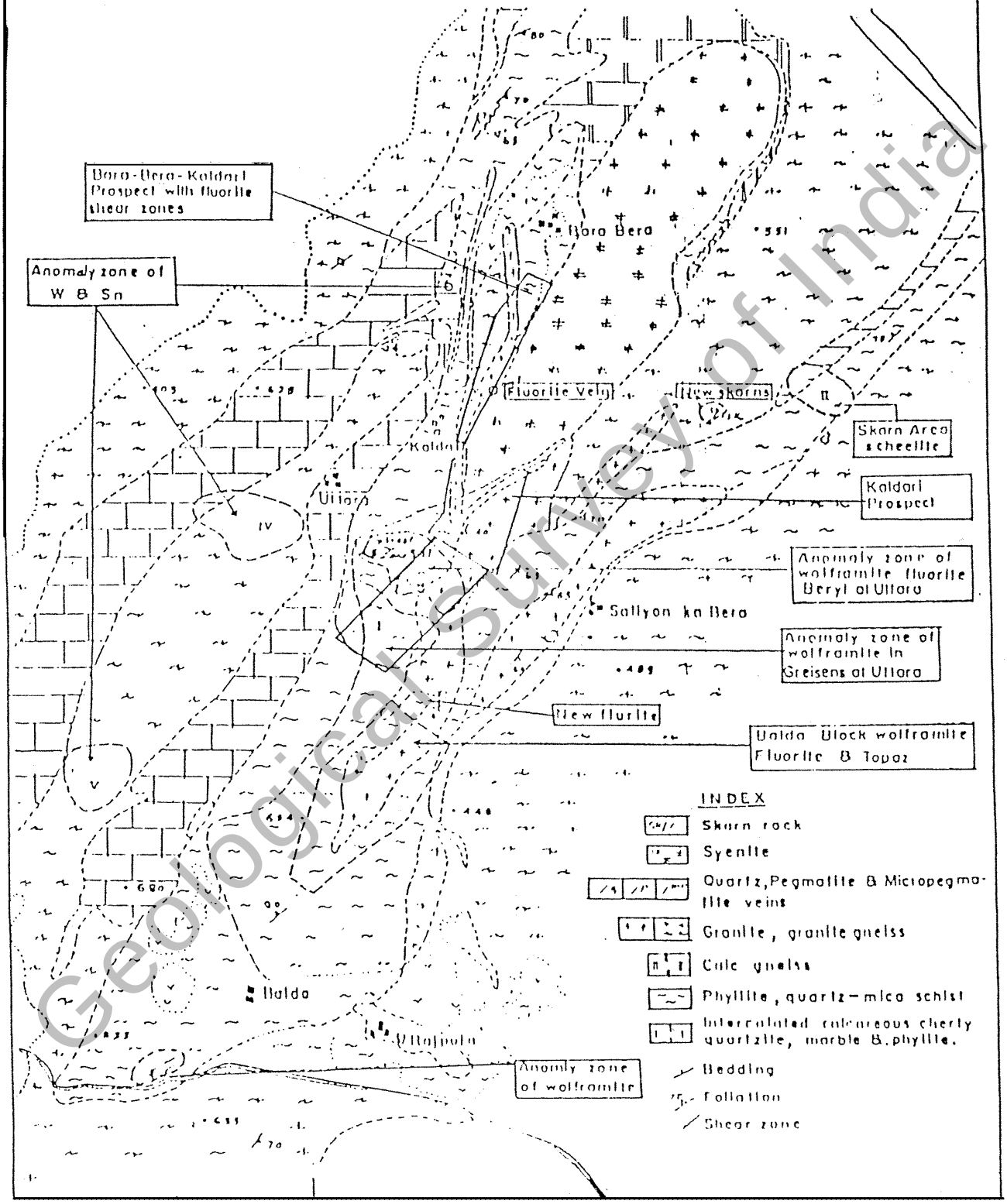
5. **Dimension and character of ore bodies:**

A total of nine shear zones have been located which have been locally named as Sh-1 & 1A, 2,3,4,4A,4B,5 and 6 and 6QV of strike lengths 160 m, 50 m, 600 m, 400 m, 200 m, 170 m, 200 m, 460 m and 150 m respectively. The widths of the shear zones vary from 1.5 m to 20 m. A greisenised vein, named (GV-1) has also been demarcated during drilling operation having a strike length of 150 m with an average width of one meter. Out of these ten mineralised zones in Balda block, considering all the surface evidences of mineralisation particularly the frequency of

GEOLOGICAL SURVEY OF INDIA

GEOLOGICAL MAP SHOWING W & Sn ANOMALY ZONES IN SIROHI DISTRICT RAJASTHAN

R. F. : 1:50,000



distribution of visible grains of wolframite in the veins/lodes and on the basis of wall rock alteration and other mineralisation criteria the most promising zones are found to be Sh-1, 1A, 2, GV-1, Sh-6 and Sh-6QV. The tungsten mineralisation occurring in the veins is very impersistant and erratic in nature. The mineral ferberite occurs as thin stringers and veins of upto 3 cm thickness. Fine to coarse discrete grains are occasionally found to occur in the form of small pockets and aggregates of fine crystals. Scheelite mineralisation is rare and when present occurs as dissemination and thin films around ferberite crystals.

The primary tungsten mineralisation occurs in the form of lodes in quartz veins and pegmatite bodies.

6. **Reserves and Grade:**

The reserves and grades of tungsten in the promising zones have only been estimated and rest of the zones being lean having poorer evidences of mineralisation were omitted.

A tentative reserve of 145392 tonnes of ore with grade varying from 0.035 to 1.06% WO_3 has been estimated in parts of Sh-1, 1A, 2, 6, Sh-6QV and GV-1, upto a depth varying from 50 to 100 m. The total reserve of 65% WO_3 concentrate from the ore is estimated at 568.78 tonnes. The summarised details of the reserves estimated are given below:

Mineralised zones	Ores reserves (tonnes)	Grade % WO_3	Reserve of 65%WO_3con.
Sh-1 & 2	61937	0.035 to 1.063	270.78
Sh-2	13161	0.19	38.47
Sh-6	14580	0.50	1,12.00
Sh-6 QV	22560	0.16	55.53
GV-1	33154	0.18	91.80
	145392		568.78

7. Any other information : Nil.

PADARLA-BIJAPUR

1. **Location:**

Location	:	15 km south of Pali tehsil hqrs.
District	:	Pali
Prospect	:	Padarla-Bijapur
Village	:	Padarla-Bijapur
Toposheet	:	45G/8 & 45H/5
Latitude	:	Between 24°5G'30" N and 25°06'30" N
Longitude	:	Between 73°15' E and 73°21' E

2. **Geological Set Up:**

The Padarla-Bijapur skarn belt striking NE-SW is a narrow linear belt of 15 km. length. The skarns of varying dimension occur as discontinuous lenses intermittently. Common rock types of the area are mica schist, calc schist, marble and small patches of amphibolite. These meta-sediments are intruded by syn-orogenic Sendra-Ambaji granitoids comprising granite gneiss, younger granites, pegmatites, aplites and quartz veins. A dominant schistosity with NE-SW strike dips 35°-70° towards SE.

3. **Control of Mineralisation:**

The lensoid skarn bodies of Padarla and Bijapur blocks are formed at/or near and/or little above the contact of granite, pegmatoid granite and pegmatites within the impure marble, calc-gneiss and mica schist host rocks. It has been observed that the skarn with limestone shows medium to coarse scheelite grains of pockety nature. Scheelite mineralisation in calc gneiss/ granulite skarns is very fine grained, sporadic and restricted along some fractures/joints. Mineralisation is rarely seen along foliations.

4. **Quantum of work done:**

1.	Mapping		
	a) Geological traverse mapping	:	25 L.km.
	b) Detailed geological mapping in 1:2,000 scale.	:	1.10 sq.km.
2.	Sampling	:	58 skarn/bedrock/stream samples. 399 core and groove samples.
3.	Drilling	:	874.15 m in 13 boreholes
4.	Excavation in 8 trenches	:	22 cu.m.

5. **Dimensions and character of ore bodies:**

Four skarn bodies in Padarla block and 3 in Bijapur block have been delineated. Detailed account of these skarn bodies are listed below:

Skarn No.	Dimension	Grade
Padarla Block:		
Skarn No. 1	50m long, 0.5m to 2m thick	0.11% WO_3
Skarn No. 2	10m long, 0.5m to 1.5m thick	0.45% WO_3
Skarn No. 3	35m long, 0.5m to 1m thick	0.48% WO_3
Skarn No. 4	70m long, 1m to 6m thick	0.13% to 0.20% WO_3
Bijapur Block:		
Skarn No. 1	60m long, 10m wide	Less than 20 ppm to 100 ppm tungsten
Skarn No. 2	30m long, 1m to 5m thick	40-50 ppm tungsten
Skarn No. 3	90m long, 2m to 11m thick	0.52% WO_3

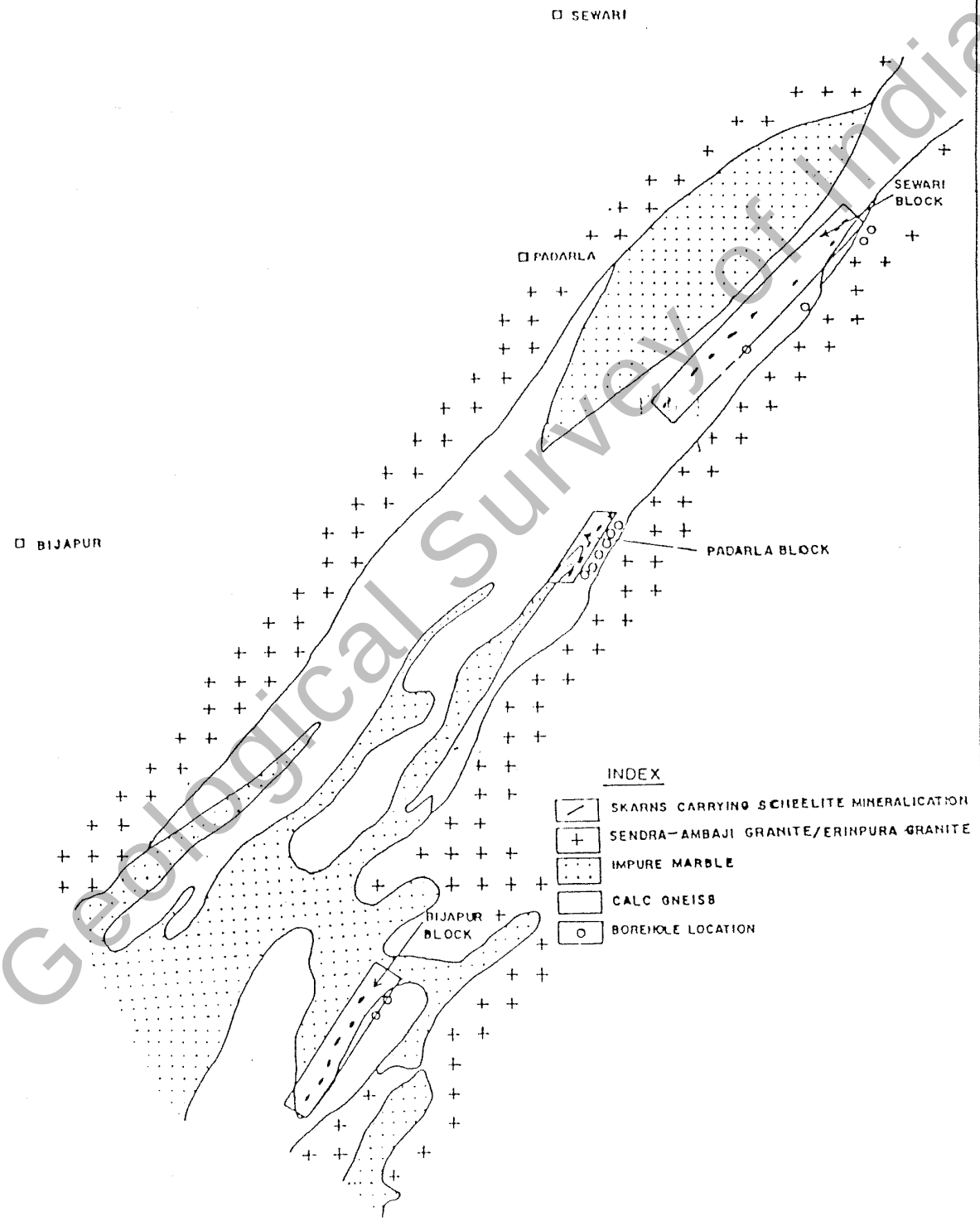
GEOLOGICAL SURVEY OF INDIA

GEOLOGICAL MAP OF PADARLA — BIJAPUR AREA
PALI DISTRICT, RAJASTHAN

SCALE

Km. 1 0 1 2 Kms.

R.F. 1:50,000



GEOLOGICAL SURVEY OF INDIA

GEOLOGICAL MAP OF PADARLA BLOCK, DISTRICT PALI, RAJASTHAN

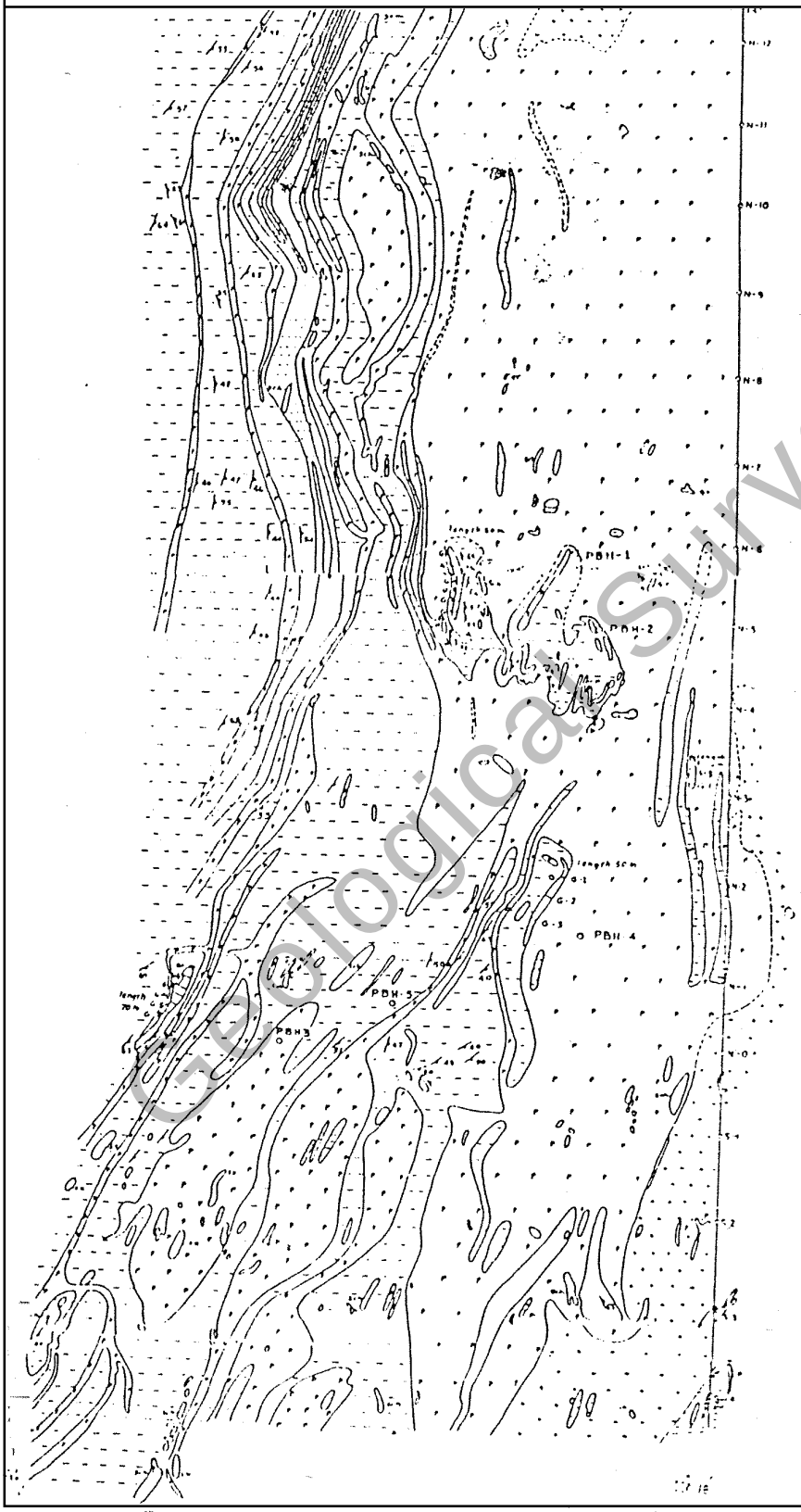
N

SCALE

Mts. 20 0 20 40 60 80 100 120 140 Mts.

R.F. - 1:2000

Toposheet No	45 G/8
Bearing	N 80° W
Area coverage	0.28 Sq Km
Area location	25° 4' 30", 73° 2' 30"



ASSAY VALUES OF SKARN ZONES

Groove Nos.	PS-1 (Analytical Values) Sn Content in ppm	W Content	Average
1	70	170 ppm	0.11 %
2	70	0.25 %	
3	100	0.17 %	
4	100	0.13 %	
5	100	80 ppm.	
6	100	100 ppm	
7	150	100 ppm.	
8	150	0.27 %	
	PS-2		
1	30	0.45 %	0.45 %
	PS-3		
1	10	0.80 %	0.48 %
2	10	450 ppm	
3(A)	15	0.32 %	
3(B)	15	0.36 %	
	PS-4		
1	200	175 ppm	0.13 %
2	200	0.11 %	
3	100	0.48 %	
4	50	0.17 %	
5	50	100 ppm	
6	70	50 ppm	

INDEX

- Padarla bore hole location
- Quartz veins
- Skarn zones (Scheelite bearing & barren)
- Pegmatite with dominant pink felspar & quartz veins
- Pegmatite with dominant grey felspar & quartz veins
- Granite gneiss
- Calc & Mica schists with Marble bands
- Dip & strike of foliation

Scheelite mineralisation is noticed in the form of fine disseminations and large grains at places confined to pyrometasomatic vesuvianite-garnet bearing skarns and show greater concentration along fractures in the skarns. The typical skarns of Padarla area consist of vesuvianite as major mineral and those of Bijapur area contain garnet as the major mineral.

6. **Grades and Reserves:**

Grades of WO_3 of four skarn bodies delineated in Padarla block ranges from 0.11% WO_3 to 0.48% WO_3. In Bijapur block 3 skarn bodies have indicated WO_3 content from less than 20 ppm to 0.52%. The zone containing 0.52% WO_3 extends over 90m having widths ranging from 2m to 11m. Reserves of the ore bodies have not been estimated.

7. **Recommendation:**

Due to erratic and limited depth persistence the scheelite mineralisation in the area is not very attractive. Only richer skarn lenses may yield minor amounts of ore upto a shallow depth.

BAR-BABRA BLOCK - I

1. **Location:**

Location	:	E & NE of Bar
Prospect	:	Bar-Babra Block-I
District	:	Pali
Village	:	Bar
Toposheet	:	45J/8
Latitude	:	26°5'
Longitude	:	74°6' E.

2. **Geological Set-up:**

Barotiya Group of rocks, representing a part of Delhi Super Group, exposed around Birantiya contains two linear NNE-SSW trending, 10 Km. long and 3-4rn wide band as intercalation in mica schist. Due to emplacement of quartz and pegmatite veins, the western band has developed skarns. These skarns contain scheelite mineralisation.

3. Control of mineralisation:

Scheelite occurs along the bedding planes displaying a stratified disposition. Mineralisation is, therefore, strata-bound and further enrichment is probably controlled by the degree of hydrothermal alteration. Emplacement of quartz and pegmatite veins during folding appears to have mobilised scheelite along schistosity.

4. **Quantum of work done:**

1) Mapping
   a) Traverse mapping in 1:50,000 scale : 100 km^2
   b) Detailed mapping in 1:2000 scale : 0.32 km^2
2) Sampling
   a) Groove samples : 350 Nos.
   b) Core samples : 190 Nos.
3) Drilling : 3200m over 2.5 km of the mineralised strike length.

5. **Dimensions and character of ore bodies:**

A linear 10 km long zone with varying widtn (max. 10m) has been delineated. This has been divided into two blocks, Block-I and Block-II. Block-I lies immediately east of Bar village and has a strike length of 2.5 km with an average aggregate width, including partings of about 10m. In this 10m wide zone 3 continuous skarn bands occur at 2-3m interval. The width of individual skarn bands varies from 0.5 to 3m. Block-II occurs 10 km NE of Bar and has a strike length of 2.5 km with a width ranging upto 20m. Block-II also contains three skarn bands. Fine streaks of scheelite occurs in these bands.

Scheelite mineralisation at Bar is confined to skarnoids. Coarse, granular garnet, diopside, redenbergite and epidote constitute these skarnoids. Scheelite is dominantly fine grained while skarnoids are coarse grained. Scheelite is of syngenetic origin and not related to granite activity.

6. **Reserves and Grades:**

Drilling results in Block-I suggest persistence along dip upto 100m. The width of the bands decreases with depth. On the basis of analytical results of surface samples only a tentative reserve of around 450 tonnes of 65% WO_3 has been estimated over 400m strike length, 3.5m width and 0.13% WO_3 average grade.

7. **Recommendations:**

Skarnoids and retrograde skarns occurring at Babra may be drilled in future.

BAR-BABRA BLOCK-II

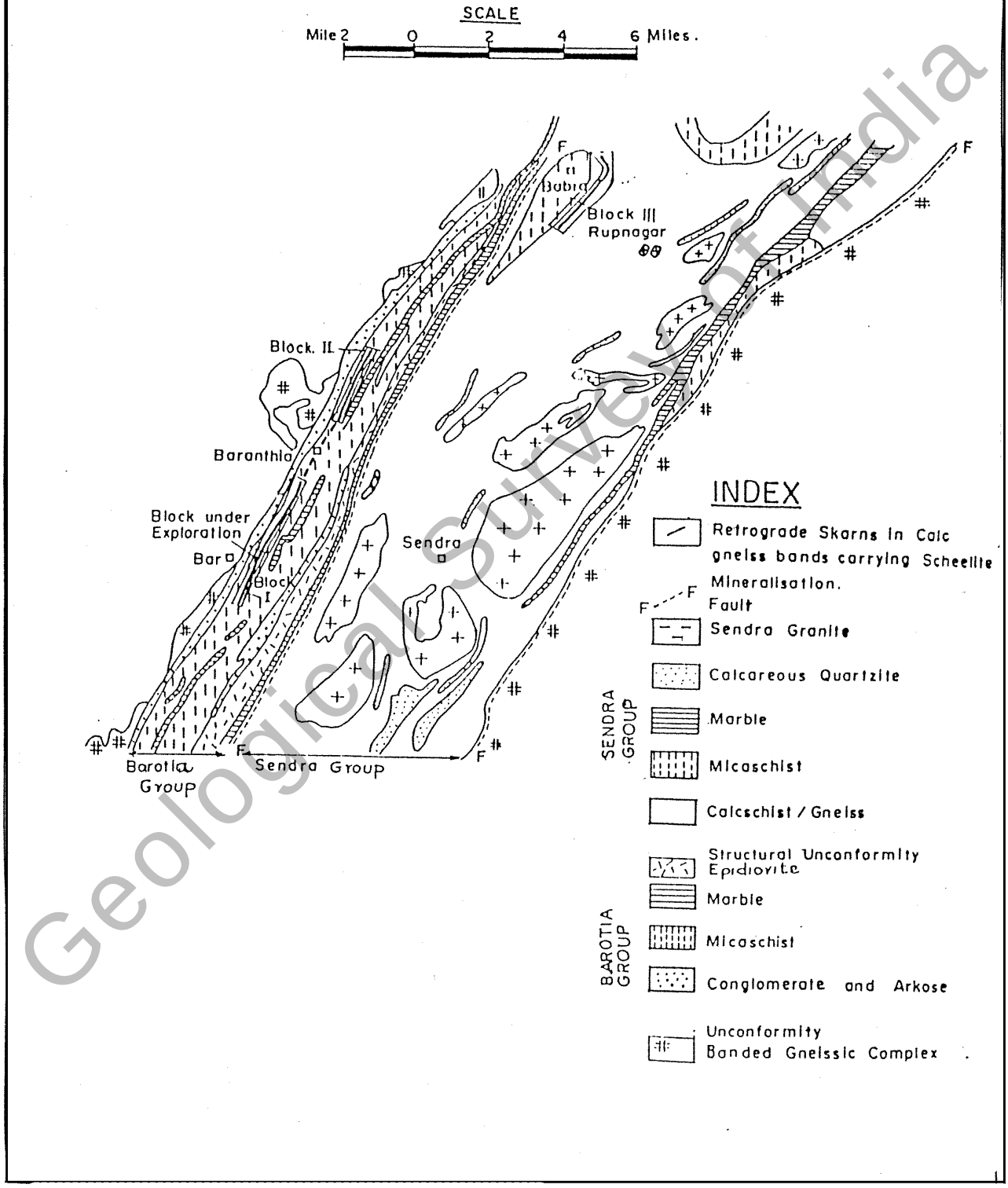
1. **Location:**

Location	:	1 km east of Babra
District	:	Pali
Prospect	:	Bar-Babra Block-II
Village	:	Babra (26°14'00"N/74°15'00"E)
Toposheet	:	45J/8
Latitude	:	28°15'-5"N
Longitude	:	74°16'00"-74°16'30"E.

GEOLOGICAL SURVEY OF INDIA

GEOLOGICAL MAP OF BAR-BABRA AREA DISTRICT PALI RAJASTHAN

(After Heron 1953)



2. **Geological Set-up:**

Sendra Group of rocks of the area includes phyllite, andalusite-mica schist, impure marble, calc schist, calc-gneiss, amphibolite, hornblende schist and biotite schist. These rocks have been intruded by pegmatites and quartz veins which are probably related to the residual phase of Sewariya Granite. Emplacement of pegmatite veins within carbonate metasediments have resulted in the formation of Skarns.

3. **Control of mineralisation:**

The scheelite mineralisation is confined to the Skarn zones near the contact between pegmatites and carbonate metasediments. The mineralised zones are very thin (10-20 cu.m) and highly erratic in distribution.

4. **Quantum of work done:**

1. Mapping
   - a) Traverse mapping in 1:50,000 scale : 100 km^2
   - b) Detailed mapping in 1:2000 scale : 0.32 km^2
2. Sampling
   - a) Groove samples : 350 Nos.
   - b) Core samples : 921.20 m
3. Drilling : 12 boreholes over 2.1 km strike length.

5. **Grades & Reserves:**

The grades of the mineralised zones vary from 100 ppm to 1% WO_3 and die out at a very shallow depth. Reserves not estimated.

TUNGSTEN MINERALISATION IN SEWARIYA GRANITE

A sizable area of W + Li + Sn mineralisation associated with the Sewariya granite in Central Rajasthan has recently been identified. Five new prospects of W+ Sn + Li mineralisation were located. At Pipaliya (26°27'30" : 74°17'20"), Motiya (26°26'30" : 74°15'30"), Kotariya (26°24'30" : 74°15'10"), Richmaliyan (26°25'00" : 74°16'30") and Bijathal (26°29'10" : 74°16'00") villages.

Out of these five prospects Pipaliya and Motiya prospects have been explored in detail.

I. Pipaliya Prospect:

1. **Location:**

Belt Name	:	Delhi Fold Belt.
Prospect	:	Pipaliya.
Location	:	Pipaliya

Village	:	Pipaliya
District	:	Pali
Latitude	:	26°27'30"
Longitude	:	74°17'30"

2. **Geological Set-up:**

The Sewariya granite (SG) pluton occurs between Banded Gneissic Complex (BGC) and Ras Marble Formation on the north-west and supracrustals of the South Delhi Fold Belt on the southeast.

The northwestern contact of SG (with BGC and Ras marble) is largely concealed whereas its southeastern contact with Bar mica schist/conglomerate of Barotiya Formation is exposed at several places. This contact is marked by a zone of strong ductile deformation characterised by extensive mylonitic fabric and down dip mineral lineations.

The SG contains innumerable enclaves of quartz-mica schist/conglomerate, pelitic resities and migmatites. The contact of conglomerate/mica schist with SG is sheared and is traversed by concordant quartz veins.

The SG batholith is made up of two granite phases. The earlier phase which forms bulk of the massif is a gray, very coarse grained, porphyroblastic rock which consists of porphyroblasts of feldspars set in a biotite-muscovite matrix. The late phase granite is equigranular, medium to fine grained non-foliated granite which consists of quartz, K. feldspar, plagioclase, biotite, muscovite, hornblende and tourmaline.

3. **Control of Mineralisation:**

Tungsten mineralisation is mainly in the form of wolframite that occurs in pneumatolytic quartz veins trending N-S to NNE-SSW intruding the SG in an en-echelon pattern along sheared contact of granite with the schist/conglomerate enclaves and along the tectonised contact of SG with Bar mica schist.

4. **Work done:**

In the initial phase of exploration detailed mapping, surface groove and trench-groove sampling and test drilling were carried out in Pipaliya prospect.

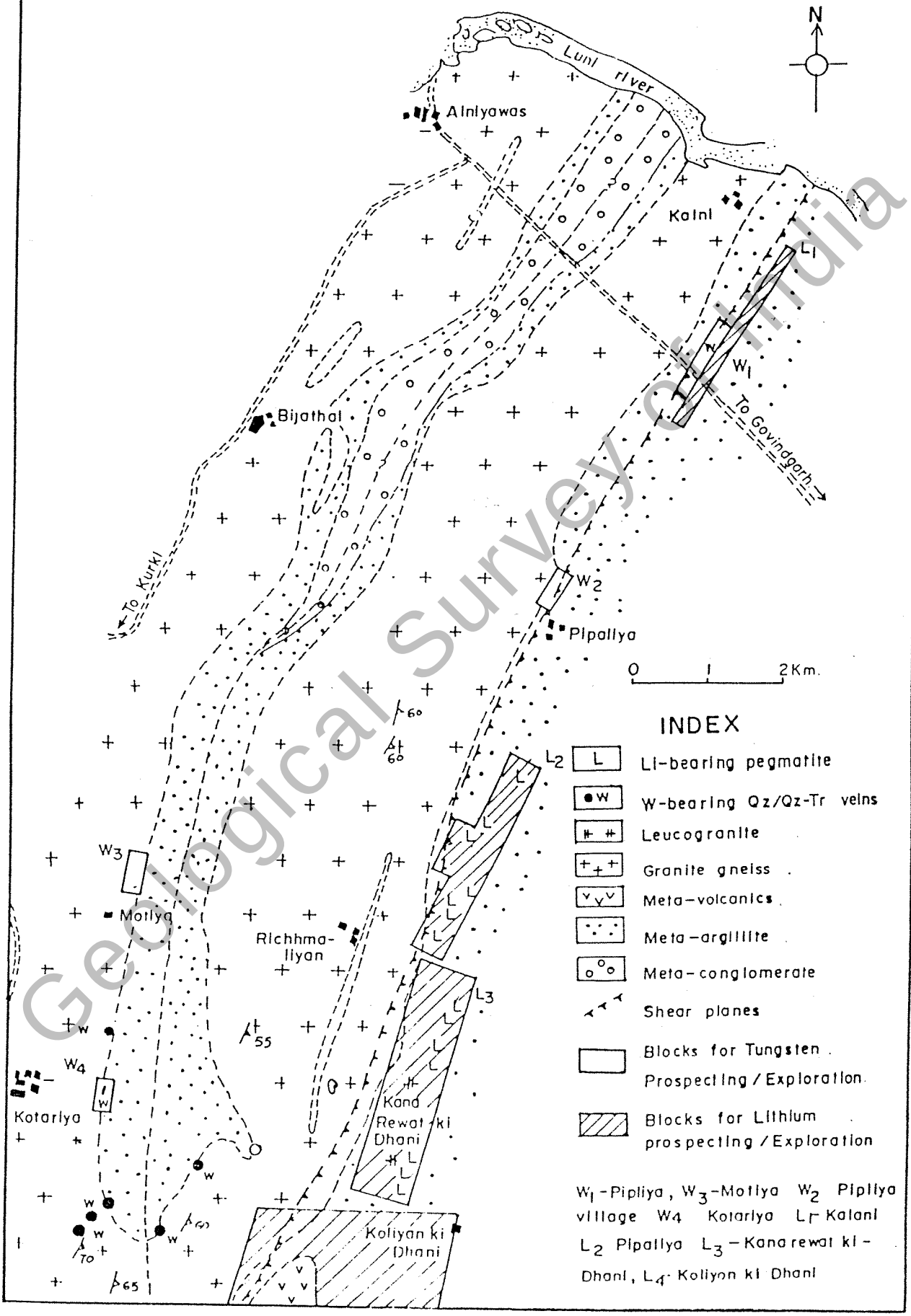
5. **Dimension of ore bodies:**

In Pipaliya block two mineralised zones have been explored. The mineralised zone in the Pipaliya North block extends over a strike length of 300m having an average width of 1.5m. In the South block the mineralised zone extends over a strike length at 400 m with an average width of 1.3m.

6. **Ore characteristics:**

Tungsten mineralisation occurs mainly in pneumatolytic quartz veins. While majority of the quartz veins are a few metres in length and a few centimeters wide, some are upto 90m long and 1m wide. Mineralisation is extremely erratic and non-homogeneous. Many of the quartz veins carry

GEOLOGICAL MAP OF KALNI-KOTARIYA AREA, PIPALIYA PROSPECT, RAJASTHAN



wolframite in significant amount while some contain a few coarse crystals and others may be barren on surface. Mineralisation is observed in (i) massive to sacchroidal textured quartz veins (ii) quartz veins with little tourmaline and (iii) quartz veins which are bordered by tourmalinesed/ graphitic veneers.

7. **Grades and Reserves:**

The mineralised zone in Pipaliya South block shows an average grade of 0.18% WO_3 while the mineralised zone in the North block the average grade of 0.23% W. Reserves has not been estimated.

8. **Recommendation:**

As the tungsten mineralisation in Pipaliya area has indicated encouraging results, the area may be considered for exploration-cum-exploitation.

II. Motiya Prospect

1. **Location:**

Belt Name	:	Delhi Fold Belt.
Prospect	:	Motiya.
Village	:	Motiya.
District	:	Pali.
Latitude	:	26°26'30"
Longitude	:	74°15'30"

2. **Geological Set-up:**

Same as Pipaliya Prospect.

3. **Control of Mineralisation:**

Same as Pipaliya Prospect.

4. **Ore characteristics:**

Same as Pipaliya Prospect.

5. **Dimension of ore body:**

The mineralised zone extends over a strike length of 200m with average width of 0.73m.

6. **Reserves and Grades:**

The average grade of the tungsten ore has been estimated as 1.0%W. Reserves has not yet been estimated. The work is under progress.

7. **Recommendation:**

Recommended for exploitation together with exploration.

KARNATAKA

In Karnataka, Scheelite mineralisation occurs in the following gold bearing schist belts -1) Kolar Schist Belt, 2) Hutti Schist Belt, 3) Chitradurga Schist Belt and 4) Mangalur Schist Belt. The scheelite mineralisation is significantly present in the gold rich portions and also in the altered wall rocks.

1. **Kolar Schist Belt:**

The bulk of the 80 km long and linear schist belt measuring 400 sq.km in aerial extent is made up of supracrustal rocks comprising metamorphosed basalt flows, acid flows, tuffs. BIF, graphite-sulphide schists and polymict conglomerate. These are intruded by granodiorites. Patna and Bisanattam granites emplaced in the anticlinal domes; by two small granite stocks near the central part of the North Kolar Schist Belt; and by late doleritic and dioritic dykes.

Scheelite mineralisation is generally localised in portions rich in gold either within the reef and in wall rocks near the contact. The mineralisation is generally intergrown with quartz, calcite, hornblende, diopside and feldspars and occurs as thin veins and stringers and films ranging in size from a few mm to a few Cm.

2. **Hutti Schist Belt:**

Hutti schist belt is a part of the eastern group of the schist belt covering an area of 300 sq.km and comprises dominantly metabasalts and minor acid volcanics. About 5% of the area is covered by metasedimentaries represented by cordierite bearing gneiss, garnetiferous mica schist and carbon phyllite. The schist belt is bounded on all sides by granitoids which show intrusive relationship with the schist belt.

Scheelite mineralisation occurs in close association with gold rich portions and as small lenses, stringers, veinlets. streaks, blebs and disseminations along the fractures in the quartz veins in the altered wall rock and to some extent in the cherty quartzite bands near the contact wnh gold lodes.

3. **Chitradurga Schist Belt:**

The Chitradurga schist belt extends over a strike length of about 460 km from Gadag in the north to Srirangapatnam in the south. The lithounits of this schist belt comprise metavolcanic rocks and metasedimentaries namely, graywacke-argillite suite of rocks and Banded Iron Formation.

Scheeiite mineralisation has been noticed in the north block mine of the Chitradurga Copper Unit of HGML. Scheelite is found in close association with polymetallic sulphide lodes that occur within the meta-volcanic sequence of Ingladhalu Formation. Scheelite occurs mainly as thin rim around the caught up patches of host rock and sulphide lenses in the quartzite veins and also as disseminations and stringers in the quartz veins rich in gold and sulphide minerals.

4. **Mangalur Schist Belt:**

The schist belt comprises a metamorphosed sequence of basalts, acid volcanics, andesitic basalts, gabbro, ultramafics and older metamorphics belonging to the Dharwar Super Group. These are intruded by pink and gray granites, pegmatites, quartz veins and dolerite dykes. Tungsten

mineralisation in the form of scheelite occurs in the schist belt in the late intrusive pink and gray granites and tourmaline bearing granulite rocks.

KOLAR GOLD FIELD

1. **Location:**

Belt Name	:	Kolar Schist Belt
Prospect	:	K.G.F.
Location	:	K.G.F. Mines
District	:	Kolar
Village	:	Bisanatham
Toposheet	:	57L/1, 2, 5 and 6
Latitude	:	12°40'-13°00'
Longitude	:	76°10'-78°17'
Ref. Point	:	Champion Mines of K.G.F.

2. **Geological Set-up:**

The Kolar schist belt (KSB) comprises four main formations.

The Kalhalli Formation, composed of schistose metabasalt, is locally interbedded with meta-gabbro. This formation is exposed mainly on the eastern edge of the belt.

The Yerrakonda Formation is composed of banded ferruginous quartzite (BIF) with intercalated graphitic schist, tuff and chert. The BIF, intercalated with the Champion gneiss, is exposed in the east. It is best developed along the western edge of the belt intercalated with the metabasites and to the south of central KSB (Yerrakonda hill).

The Champion Gneiss Formation partly consists of acidic metavolcanics with dominant rhyolite and subordinate andesite (lava and tuff) and partly of a volcano-detrital to detrital sequence with graywacke and polymict conglomerate. This formation is developed mainly in the eastern part of the belt.

The gold field volcanic formation which is exposed over most of the belt comprises a succession of pillowed metabasalt (komatitic and tholeiitic basalt), metagabbro and variably schistose metapyroxenite. Associated with the metabasites, especially in the north KSB is chloritic and sericitic phyllite comprising more acidic (andesitic) tuff with intercalated graphitic schist and chert.

These are intruded by granodiorites (Patna and Bisanattam granites) emplaced in the anticlinal domes and two small granite stocks near the central part of the north KSB and late doleritic and dioritic dykes striking predominantly E-W and to a less extent N-S.

3. **Control of Mineralisation:**

Significant scheelite mineralisation is observed in the Champion lode and its off-shoots, Mundy's Lode, East Lode, Muscoom and Motaggarts W. Lode. It appears that the mineralisation is mostly controlled by structure and lithology and probably by temperature differences. It is generally localised in portions rich in gold either within the reef and / or in the wall rocks near the contact. At places, scheelite is found at the contact zones of the pegmatites within the lodes; but pegmatites themselves do not contain scheelite.

4. **Quantum of work done:**

A total of 80 km of mine development was examined with UV lamp.
Sampling : 1602 nos. (groove, channel and bulk samples from the mines.)

5. **Dimensions of the ore bodies:**

On the basis of the systematic survey of the scheelite mineralisation in the KGF mines, carried out by GSI, the following significant zones of mineralisation were identified:

i) **Nundydroog Mine:** Scheelite mineralisation was observed in the cross reefs of Balaghat area in the Tenant's Shaft and Tailor Shaft workings at the 285. 420, 800, 1250, 1450 and 2000 ft. levels.

ii) **Champion reef Mines:** In the Champion reef Mines, in the Tenant's Shaft, the Mundy's lode was found to be scheelite bearing at 500', 1200', 1400' and 1500' levels. The East reef from the Tenant's and Oklay's Shafts, the Champion lode at 4000' level in Gifford's Shaft, at 8400' level in the Bullen incline area and new quartz lode East were found to be scheelite bearing having 0.3 to 0.5% WO_3.

iii) **Mysore Mine area:** In Mysore Mine area scheelite mineralisation with 0.3 to 0.5% WO_3 has been identified from the Gilbert's shaft, Henock's shaft, Crooker's shaft, Rowse's shaft, Edgar's shaft and Mctaggart's incline shaft. A total potential of 15,000 tonnes of 0.3 - 0.5% WO_3 was estimated. The major new ore potential was located from Mctaggart's west lode between 2600' and 4800' levels over a strike length of 150m by BGML

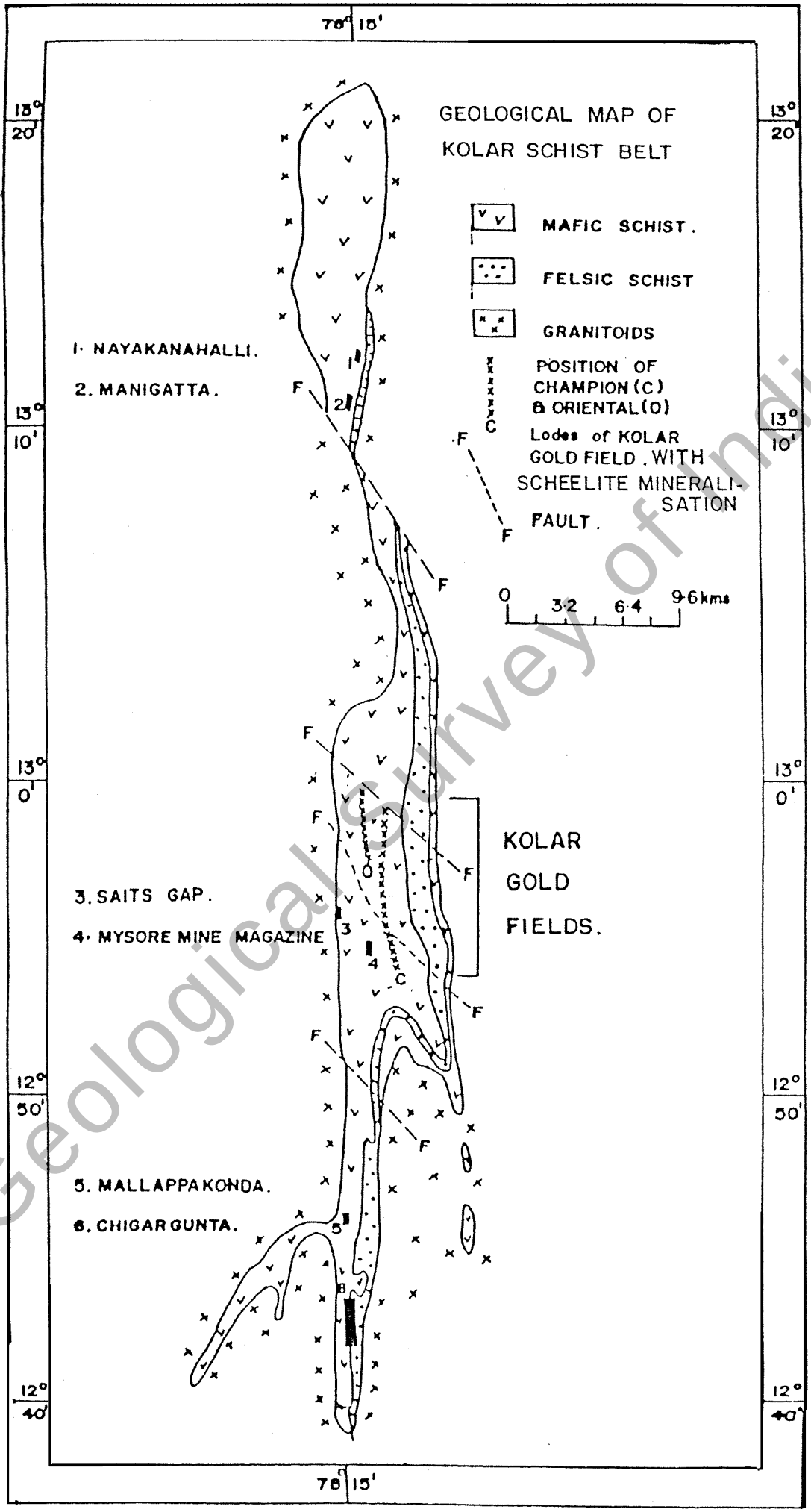
6. **Ore Characteristics:**

Scheelite mineralisation occurs as thin veins, stringers and films ranging in size from a few mm to a few cm. The scheelite mineralisation is generally intergrown with quartz, calcite, hornblende, diopside and feldspar which are common gangue minerals in the gold ore. The scheelite mineralisation is erratically distributed in the gold lodes.

7. **Grades and Reserves:**

The total reserves and grades of tungsten mineralisation in the gold lode zones are as follows:

			Quantity (Tonnes)	Grade WO_3%
I.	Nundydroog Main reef	a)	85834	0.12
	Mctaggart's	b)	27255	0.13
		b)	135205	0.073
		a+b =	248294	
II.	Champion	a)	7304	0.127
	Reef	b)	3157	0.08
		a+b =	10461	0.113
III.	Mysore Mine	a)	8122	0.532



8. **Scheelite in mill tailings:**

Systematic groove sampling and pitting were carried cut in 15 tailing dumps. 862 samples from tailing dumps were collected for analysis and a few bulk samples for beneficiation tests.

This survey indicated that there were about 34 million tonnes of old mill tailings at the time of study of which about 30 million tonnes carry less than 0.01% WO_3 and therefore, are of no consequence. Of the remaining 4.5 million tonnes, about 2.5 million tonnes of main lode tailings lie under barren West reef tailings and are not available for use. Out of the balance of 2.0 million tonnes, about 1.6 million tonnes carry only 0.03 to 0.05% WO_3. About 3.7 lakh tonnes in Walker's and old Balaghat Mines area carry 0.1 to 0.18% WO_3 and were considered important for winning scheelite.

Thus the significant dumps are the Balaghat and the Walker's dumps. The details of resources available in these dumps are as follows :

Area	Quantity (tonnes)	Average grade (WO_3%) (tonnes)	Total Quantity of WO_3 content
Balaghat	8,10,635	0.050	408.06
Walker's	1,69,802	0.180	317.00

9. **Ore Beneficiation:**

IBM carried out ore beneficiation tests on the bulk samples and produced the following results from Walker's tailing dump.

Feed : Coarse tailings	:	0.14% WO_3
Classified and tabled concentrate	:	9.31% WO_3 (70.7% recovery)
Surface roasting and magnetic separation	:	55.88% WO_3 (65.5% recovery)
	:	60.4% WO_3 (62.1% recovery)

IBM carried out pilot plant studies and indicated the possibility of recovering scheelite concentrates both from the low grade Balaghat tailings and the coarse Walker's tailings as detailed below and recommended setting up a 250 tpd plant to recover scheelite from old mill tailings.

	Balaghat	**Walker's**
Feed tonnage (tonnes)	200	50
Feed grade (%WO_3)	0.04	0.18
Recovery (%)	30	68
Concentrates (tonnes per year)	9.4	28.2

A 50 tonnes/day Pilot plant has been set up by BGML in the Mysore mine mill for studying the recoveries of scheelite from ROM ores.

10. **Recommendation:**

Although considerable resources of scheelite ore exist in the mine development of the BGML, the possibility of recovering them appear to be rather remote, as the future of the mining operations in the KGF is uncertain.

The resources available in the tailing dumps are quite substantial and the feasibility of producing scheelite concentrate from these tailings by innovations in beneficiation technology is worth evaluating.

HUTTI AREA

1. **Location :**

Belt Name	:	Hutti-Maski Schist belt
Prospect	:	Hutti Gold Mines
Location	:	Hutti
District	:	Raichur
Village	:	Hutti
Toposheet	:	47 D/16
Latitude	:	15°11.00"
Longitude	:	76°39.00"
Ref. Point	:	Hutti Gold Mines

2. **Geological Set-up:**

The Hutti-Maski greenstone belt is essentially made up of acid and basic volcanic rocks. Metasediments form about 5% of the belt and occur mostly in the eastern part. The schist belt is surrounded by granitoids.

3. **Control of Mineralisation:**

Scheelite mineralisation occurs in close association with gold rich portions as small lenses, blebs, stringers, streaks and disseminations along the fractures in quartz veins, in the altered wall rock and to some extent in the cherty quartzite bands in the immediate vicinity of gold lodes.

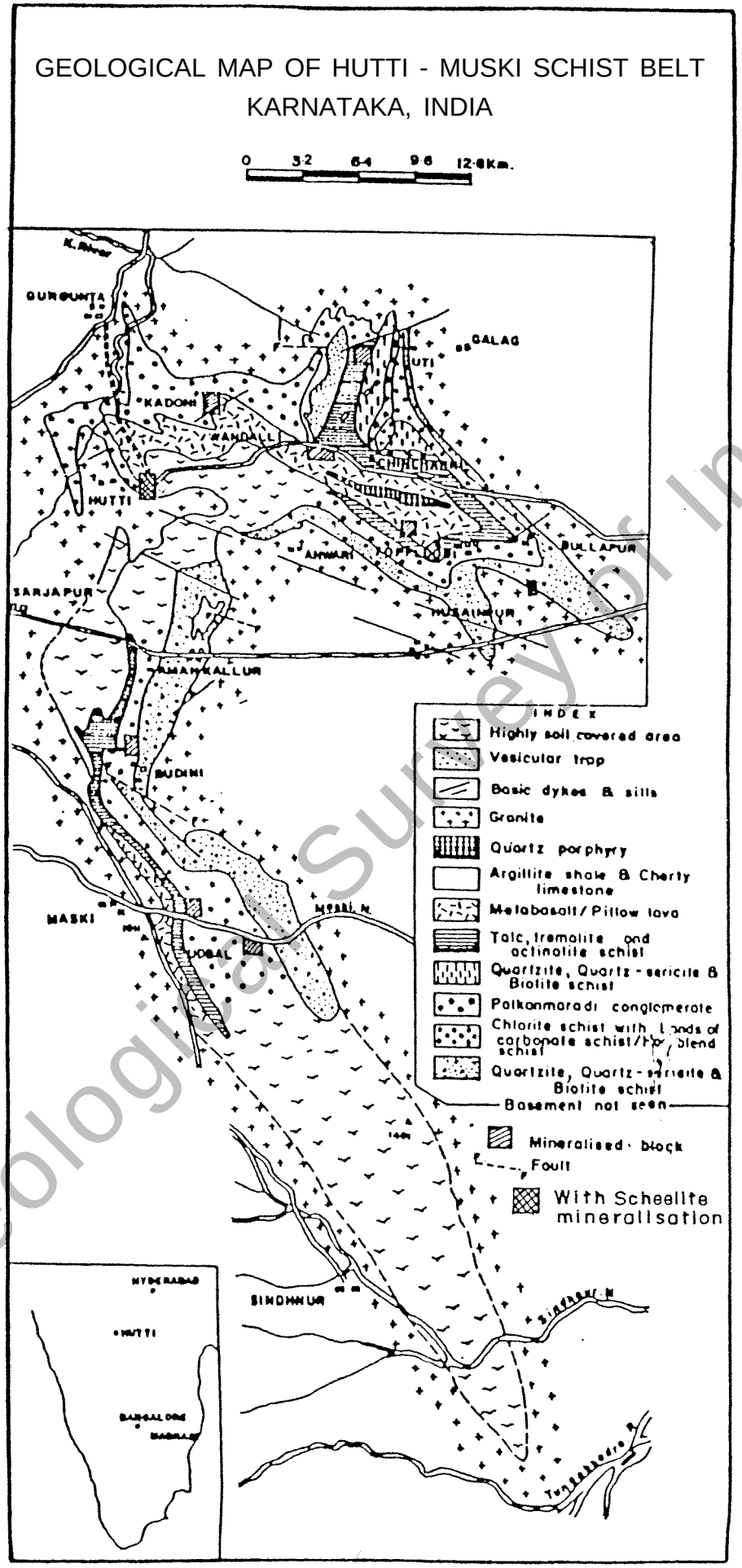
4. **Dimensions of Ore bodies:**

Out of six working lodes, only two lodes, viz. Middle and Strike Reefs are found to be comparatively rich in scheelite. Gold bearing portions carrying scheelite ore seen over fairly good strike lengths.

5. **Grades and Reserves:**

Systematic sampling of scheelite rich zones of the Middle and Strike reefs have been carried out. On the basis of sampling, the following estimates of ore reserve have been made :

GEOLOGICAL MAP OF HUTTI - MUSKI SCHIST BELT KARNATAKA, INDIA



Level	Width in metres.	Value WO_3%	Tonnes	Remarks
Middle Reef between 1,400' & 2,000' levels.	2.31	0.15	62,902	Funher work in progress.
Strike Reef between 900' & 1,000' levels	2.29	0.09	39,961	-do-
Total:	2.30	0.13	102,863	

6. **Recommendation:**

The beneficiation studies carried out by LURGIE, West Germany on a 70 tonnes bulk sample from Hutti with 0.04% WO_3 sent by HGML yielded a concentrate of 68 to 74% WO_3 with 77% recovery. After completing feasibility study a beneficiation plant for the production of scheelite concentrate from the ore has been set up by HGML under the technical guidance and advise of LURGIE. It is understood that, because of the prevailing low price for scheelite concentrate in the International and domestic markets, the HGML are not in a position to economically win the scheelite from the ore.

OTHER OCCURRENCES

Besides the major tungsten occurrences minor occurrences of scheelite mineralisation, associated with sulphides, gold and silver mineralisation has also been reported from following schist belts of Karnataka.

A. **Chitradurga Area:**

1.

Belt Name	:	Chitradurga Schist Belt
Prospect	:	Ingaldhalu
Location	:	Ingaldhalu
District	:	Chitradurga
Village	:	Ingaldhalu
Toposheet	:	57 B/8
Latitude	:	14°11'15"
Longitude	:	76°20'45"

2. **Geological Set-up:**

The area comprises rock units belonging to the Precambrian Dharwar Super Group which include low grade metavolcanics and a younger group of rneta-sediments. These are traversed by sills and dykes of gabbro, dolerite and quartz veins.

3. **Scheelite Mineralisation:**

Scheelite mineralisation is noticed in two parallel gold lodes over a strike length of 200m along with sulphide mineralisation as disseminations and stringers within quartz veins. The samples from the quartz vein have assayed 0.12 to 0.14% WO_3 with an average value of 0.13% WO_3. High gold (upto 10 g/t) and sliver values (3.80 to 14.80 g/t) are also associated with this mineralisation.

B. **Mangalur Area:**

1.

Belt Name	:	Mangalur Schist Belt
Prospect	:	Mangalur
Location	:	Mangalur
District	:	Gulbarga
Village	:	Mokangavi
Toposheet	:	55 D/10
Latitude	:	16°33'25"
Longitude	:	76°38'20"
R.L. Surface	:	517 m.

2. **Geological Set-up:**

The schist belt comprises a metamorphosed sequence of basalt, acid volcanics, andesitic basalt, gabbro, ultramafics and older metamorphics belonging to the Dharwar Super Group. These are intruded by pink and gray granites, pegmatites, quartz veins and dolerite dykes.

The schist belt has possibly undergone three phases of deformation.

3. **Tungsten Mineralisation:**

Lithogeochemical samples of pink and gray granite and tourmaline bearing granules collected during reconnaissance survey, have indicated W values ranging from 50 to 1000 ppm.

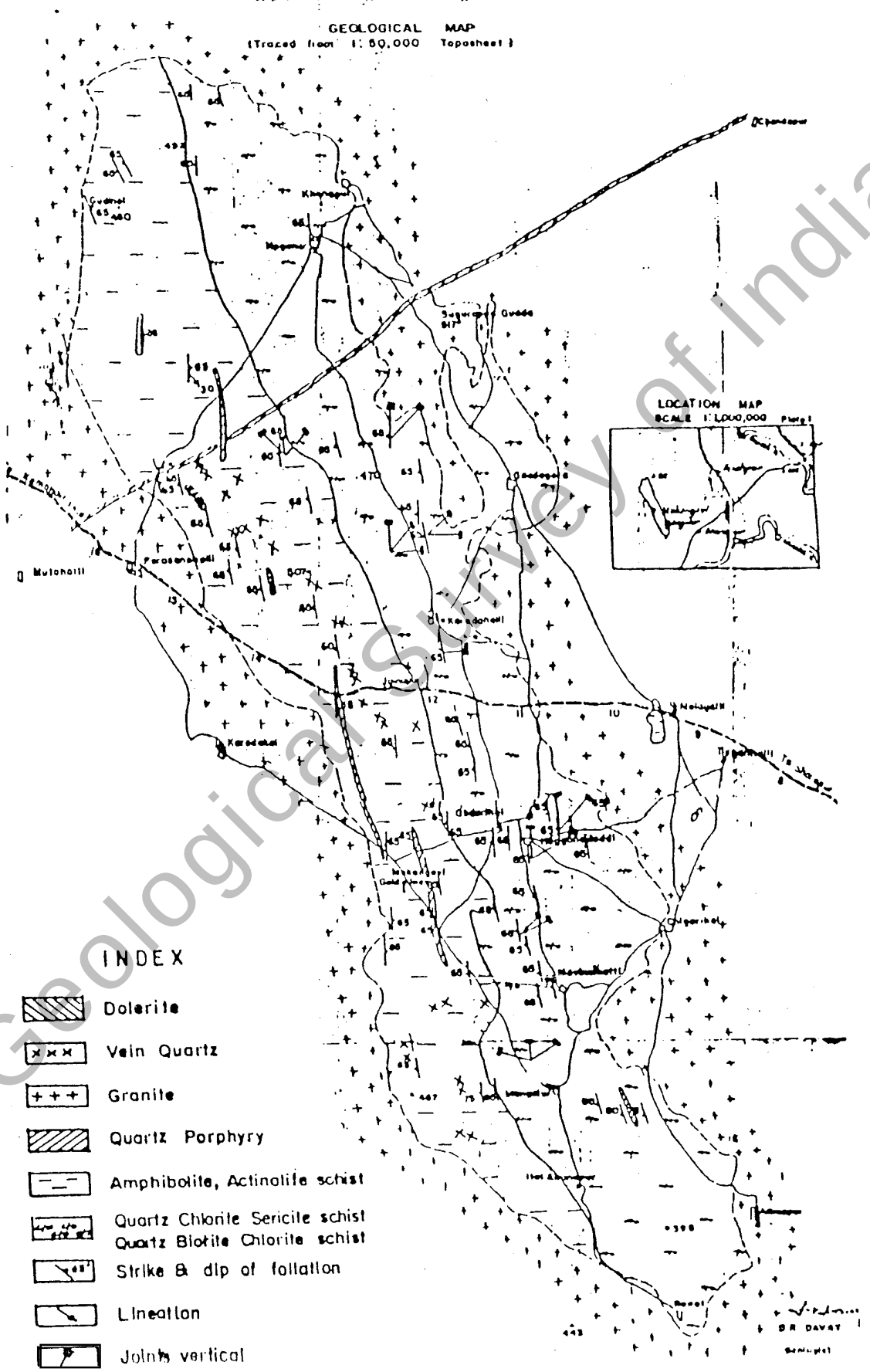
76° 30' 76° 40'

GEOLOGICAL SURVEY OF INDIA

PRELIMINARY INVESTIGATION FOR GOLD IN MANGALUR SCHIST BELT, SHORAPUR TALUK, GULBARGA DISTRICT, KARNATAKA

(Part of Toposheet No. 56 D/10)

GEOLOGICAL MAP
(Traced from 1:50,000 Toposheet)



MADHYA PRADESH

The Madhya Pradesh as its name implies occupies the central position of the country. It extends over an area of 42,840 sq.km. The state constitutes mostly the northern part of the Deccan plateau. The central shield region of Indian Peninsula comprises Archaean gneissic complexes, late Archaean composite batholiths, end Archaean-early Proterozoic fold belts and mid-late Proterozoic platform covers. In the Central Indian Shield a major ductile shear zone trending ENE-WSW and extending for over 500 km. in length with width of 0.02 to 4 km. has been demarcated. The shear zone separates two distinct lithotectonic blocks, viz. the northern tectonic block "Bundelkhand Protocontinent". The former occupies Betul-Raigarh-Sidhi region and shows ENE-WSW tectonic elements, while the later occupies Bastar region and displays NW-SE to near N-S trends.

Both the gneissic provinces enclose remnants of early to Mid-Archaean granite-greenstone and granulite belts, implying growth of Archaean continent through multiple cratonisation. Archaean cratonisation shows a diachronous spread upto early Proterozoic and culminates in the evolution of composite batholithic provinces dominated by homophanous K-granites viz. Bundelkhand granite and Dungargarh granite complexes in the northern and southern provinces respectively. The Bundelkhand Protocontinent comprises the Bundelkhand Batholithic Complex, Mahakosal Fold Belt, Betul-Balaghat-Raigarh granite-greenstone belt with their structural trends concordant to the shear zone. Deccan Protocontinent with NW-SE to N-S structural trends, discordant to the trend of the shear zone consists of Bastar Granite Gneiss Complex, Bailadila Fold Belt, Sakoli Belt, Kotri Fold Belt and Sonakhan Granite-Greenstone Belt.

Madhya Pradesh is richly endowed with various mineral deposits of coal, copper, iron ore, limestone, dolomite, bauxite and manganese; other minerals of lesser importance are andalusite. barytes, clay, ochre, steatite etc. In the Dongargarh Batholithic Complex occurs the Malanjkhand copper deposit with 115 million tonnes of ore containing 1.13% Cu. Primary gold mineralisation has been recorded in Pandripani and Tapkara areas in Raigarh district. Here gold is associated with quartz veins, mylonite and altered wall rocks in a ductile shear zone. Gold has also been noticed in brecciated quartz veins along a shear zone near Kosabani and Tingipur in Ellaspur district. Presence of alluvial gold are known from Raigarh and Bastar districts.

Evidences of sulphide mineralisation has been recorded from Jabalpur, Sidhi, Raigarh, Betul, Panna, Chhatarpur, Raipur, Hosangabad and Shahdol districts. Tin mineralisation associated with pegmatite in Katekalyan and Kondaras-Dorgi and Banglur areas of Bastar district has been investigated and small reserves have been proved. Regional prospecting for tungsten is being carried out in Raigarh, Betul and Raipur districts. No significant mineralisation has been located so far.

Regional and local scale prospecting work has so far identified the following occurrences of tungsten mineralisation in Jhabua and Raigarh districts.

Name of Block	Toposheet No.	District	WO_3 Value	Host rock	Dimension (m)
1. Alirajpur	46J/4.8	Jhabua	100 ppm	Quartz veins in Calcareous meta-sediments and amphibolite.	
2. Sikirma	64N/15	Raigarh	–	Biotite gneiss, amphibolite	Q.veins 800 m x 100 m area
3. Sajbahar	64N/15	Raigarh	100 ppm to 0.3%	Quartz-Tourma-line vein	4 veins length : 1 - 5 m width : 6-20 cm veins
4. Golidih	64N/15	Raigarh	–	Quartz-Tourma-line vein	Veins over 150 m x 5 m area.
5. Samdama	64N/15	Raigarh	100 ppm to 0.3%	Quartz-Tourma-line vein	Veins over 100 m x 1 m
6. Junwain	64N/15	Raigarh	200 ppm to 0.4%	Quartz-Tourma-line vein	10 veins Length : 2-50 m Widths : 15-60 cm
7. Bardih	64N/15	Raigarh	600 ppm to 0.24%	Quartz-Tourma-line vein	4 veins Length : 4-10 m Width : 2-11 cm
8. Lawakara	64N/15	Raigarh	200 ppm to 1.22%	Quartz-Tourma-line vein	2 veins Length : 10-54 m Width : 20-40 cm

CHUNALOMA PROSPECT

1. **Location:**

Belt Name	:	Betul Belt
Prospect	:	Chunaloma
Location	:	2 km N of Chunaloma village
District	:	Betul (M. P)
Tehsil	:	Betul
Village	:	Chunaloma
Toposheet	:	55 G/9
Latitude	:	21°349'50"
Longitude	:	77°41'00"

2. **Geological Set-up:**

The area of Chunaloma prospect exposes mainly metasedimentaries, granitoids and porphyroblastic biotite gneiss which are traversed by acid and mafic veins. These rocks are unconformably overlain by Gondwana sediments occurring as cappings.

The sheelite mineralisation occurs in the calc silicate rocks which occur as lensoidal bodies within the metasedimentaries. These rocks are profusely traversed by acid intrusive veins. The pneumatolytic zone trending E-W having width of 100 to 150 m. has also been recorded in the area in which development of tourmaline and rarely beryl has been recorded.

General trend of the rocks is E-W with moderate to subvertical dips towards north. The area has undergone polyphase deformation.

3. **Control of Mineralisation:**

The mineralisation shows a lithological control as the scheelite mineralisation is restricted ordinarily to the calc silicate rocks of the area. No other tungsten bearing mineral except scheelite has been noticed.

4. **Quantum of work done:**

The total quantum of exploration work carried out in the area is as follows :-

a)	Detailed geological mapping on 1:1000 scale.	:	1.00 sq km
b)	Trenching & Pitting	:	66 cu.m
c)	Drilling	:	531.80 m
d)	Sampling (Borehole Core, trench and channel)	:	529 Nos.
e)	Soil samples	:	195 Nos.

5. **Dimensions of ore body:**

On the basis of analytical data for lensoidal calc-silicate bodies which show tungsten mineralisation have been delineated. The details are given below:

Body No.1: This calc-silicate lensoidal body is about 22 m long and 9.90 m wide. In the central part of the lense good concentration of scheelite mineralisation is found. A sample collected from this body has analysed 0.22% W over a zone of 2 m width. Average assay value for the entire lense is 462 ppm W.

Body No.2: A lensoidal body exposed in Sasbahu river section shows vein and disseminations of scheelite mineralisation. It is 35 m long and about 16 m wide in its central part. The analytical results are not encouraging except the samples collected from eastern part of the body where a zone of 3.5 m width shows an average assay value of 818 ppm W.

Body No. 3: A lensoidal calc-silicate body measuring 12 m x 4.40 m shows scheelite mineralisation under UV lamp. A total of 5 samples were collected out of which 3 samples have given better tungsten values, varying from 450 ppm to 0.11% W over a width of 2.40 m. Average assay value for 2.40 m wide zone is 950 ppm W.

Body No. 4: A lensoidal calc-silicate body having dimensions of 11 m x 4.90 m shows tungsten analysis of one sample as 1.14% representing a width of 1.25 m. All other samples shows poor grade of mineralisation.

A total of four authentication boreholes were drilled to know the depth persistence of exposed mineralised calc-silicate lenses. On the basis of results of drilling, these calc silicate lenses do not have much depth persistence.

6. **Ore characteristics:**

The scheelite mineralisation occurs only in calc-silicate rocks in the form of veins, stringers, specks and fine disseminations. The calc-silicate rocks contain diopside, tremolite-actinolite, garnet, calcite, quartz, epidote and zoisite.

7. **Recommendation, if any for further work:**

On the basis of the chemical analytical results of channel samples, trench samples, soil samples and a few results of core samples, the tungsten mineralisation does not seem to be very promising in the area. Therefore, further drilling in the area has been suspended.

Tungsten mineralisation in the form of scheelite is confined to calc-granulite bodies. Some of the calc-granulite bodies occurring within the pegmatoidal granite or at the contact of pegmatoidal granite with migmatites also contain scheelite mineralisation. The calc-granulite bodies within the biotite gneiss are devoid of mineralisation. Scheelite occurs sporadically in the form of specks, fine disseminations, streaks and thin veinlets mostly parallel to the foliation and rarely as irregular patches. Occasional concentration of mineralisation has been noticed in the vicinity of broad warps and axial region of mesofolds at Kambalipatti. Besides, scheelite has been found to be concentrated in the pyrite, pyrrhotite and chalcopyrite rich portions within the pyroxene-rich layers of the calc-granulite.

The intensity of the mineralisation varies widely from band to band and also in the same band as well. Rich ore shoots of upto 2% tungsten thus, suddenly disappear over a short distance.

Besides scheelite, the mineralised calc-granulite in Kambalipatti area contains Sn values upto 0.18%.

Based on mineralite survey the following three calc-granulite bands are found to be of significance follow-up investigations.

1. Kambalipatti-Aloganachikoli band
2. Karungalakudi-Aivadampatti-Somagiri band.
3. Savarapatti-Vanjinagaram-Rayarpatti band.

KAMBALIPATTI PROSPECT

1. **Location:**

Prospect	:	Kambalipatti
Location	:	Madurai district.
District	:	Madurai
Taluk	:	Melur
Toposheet	:	58 J/8
Latitude	:	10°08'00"
Longitude	:	78°23'00"

2. **Geological Set-up:**

In the Kambalipatti about 80% of the area is under soil cover and only limited outcrops are seen. The calc-granulite band is about 2.4 kms. long with an outcrop width of 450 to 700 m and is flanked by pegmatoidal granite and quartzite in the east and migmatite in the west. Few small bodies of pegmatoidal granite, granite and quartzites occur within the calc granulite. Thin quartz veins and schrol rock are also present. General trend of foliation varies from NE-SW in the southern part of the area to near north- south in central part. The strike of the foliation is erratic with several mesofolds with north to northwesterly plunges at angles of about 30°.

3. **Control of Mineralisation:**

The scheelite mineralisation is restricted to only the calc granulite bands occurring within the pegmatoid granite bodies or at their contact zones. It occurs in the form of fine disseminations, streaks, thin veinlets and rarely as patches. Two thin pegmatite veins also contain scheelite mineralisation with tungsten values of 40 ppm to 600 ppm. Richer concentrations are generally seen in zones with appreciable garnet and in zones of numerous thin quartz veins. To expose the mineralised zone twenty trenches with lengths varying from 5 m to 54 m and depth upto 5 m with a constant width of 1.5 m were opened in the area. A 40 m long mineralised zone with tungsten content upto 1.1% (average content 0.57% W) is delineated in trench no. KT-19.

4. **Quantum of work:**

i)	Drilling (m)	:	851.10 m (in completed boreholes).
ii)	Trenching	:	20 trenches (length 05 to 54 m).

5. **Dimensions of ore body:**

Based on mineralite survey, mapping, trenching and drilling data, a strike length of 300 m tungsten mineralisation comprising two ore bodies have been delineated. In all 35 ore shoots with tungsten cement of 0.02% to 0.42% were intersected in six of the eight boreholes and they constitute about 28% of the thickness of the mineralised zone. The width of the mineralised zone in borehole KBH-1 is 47.12 m which reduces to 10.15 m in the deeper intersection of borehole KBH-8 suggesting that the mineralised zone persists over a vertical death of about 100 m, and it tapers in the down dip direction.

6. **Grades and Reserves:**

The reserves in the Kambalipatti prospect were estimated at 1.0 m tonnes of average 0.05% W for the entire mineralised zone and 6.25 million tonnes of 0.13% W for the ore shoots at 0.02% cut off.

7. **Any Other Informations:**

Ore beneficiation study of the mineralised calc granulite weighing 1000 kg of Kambalipatti area was carried out by IBM. The study by IBM concluded that the composite concentrate of –48 mesh assaying 53.30% WO_3 and 0.88% Sn and a WO_3 recovery of 80.30% is suitable as feed for preparation of (i) Ammonium para tungstate (ii) Metal powder and (iii) Tungsten carbide.

The composite non-magnetic final concentrate at –48 mesh assaying 66.83% WO_3 and a recovery of 73.30% WO_3 is useful for making (i) Ferrotungsten and (ii) Steel making.

7. **Recommendation:**

The mineralisation is not of any economic significance. No further work has been recommended.

KARUNGALKUDI - SOMAGIRI PROSPECT

1. **Location:**

Prospect	:	Karungalkudi - Somagiri
Location	:	Madurai
District	:	Madurai
Taluk	:	Malur
Toposheet	:	58 J/8
Latitudes	:	10°10'00"N and 10°06'00"N
Longitudes	:	78°22'00"E and 78°18'00"E

2. **Geological set up:**

The area is located in the southern part of the 11.5 km long Karungalakudi-Aivadampatti-Somagiri Calc-granulite band. It extends in a NNE-SSW direction between Somagiri hill in the south to the northern end of Pallakudi tank in the north over a strike length of about 3.2 km. With an outcrop width ranging from 300m. in the south to 1.2 km. in the north. The calc-granulite band occurs between pegmatoidal granite in the east and migmatite in the west. General trend of foliation is N30°E - S30°W, dipping at 30° - 60° towards west.

Scheelite shows have been located at number of places between Somagiri hill and Pailakudi tank. These shows are sporadic but seven grab samples collected from the PWD canal dump yielded tungsten content from 270 ppm to 0.39%.

3. **Control of Mineralisation:**

Scheelite mineralisation in the form of dissemination, streaks and veinlets is confined to the calc-granulite bands.

4. **Quantum of work:**

i)	Trenching	:	17 nos.
ii)	Drilling	:	7 nos.
iii)	Sampling Geochemical Soil sample	:	441 nos.

5. **Dimensions of ore body:**

3-7 thin zones of scheelite mineralisation is identified in 7 borehole intersections distributed over a thickness of 150m of calc-granulite.

6. **Grades and Reserves:**

Out of 441 soil geochemical samples 272 analysed W values 2 ppm and the remaining samples yielded values between 2 and 24 ppm groove samples, collected from six trenches yielded W content upto 0.18%. No reserve has been estimated.

7. **Recommendation:**

As most of the analytical results are low and the mineralisation is too widely dispersed over thick calc granulite band, the mineralisation is not considered for any follow-up investigation.

WEST BENGAL

The state of West Bengal covers an area of 87176 sq. km. The state is covered by diverse rock types from Archaean metamorphites to Sub-Recent and Recent alluvium. Even though three-fourth of the area is covered by alluvial deposits, the remaining small area abounds in a wide variety of hard rocks. The metamorphites include various types of schists and gneisses of Pre-Cambrian age with acid and basic intrusives. The sedimentaries include essentially the Gondwanas belonging to Permo-Carboniferous to Triassic age and the Siwaliks belonging to the Tertiaries. The basic flows belong to the upper-Mesozoic age and forms a conspicuous horizon set between these two broad sedimentary groups of rocks. For convenience of description, the state is divided into three distinct geomorphological units viz., (i) the Extra-Peninsular region of the north, (ii) the Peninsular mass of the southwest and (iii) the alluvial and deltaic plains of the south and east.

The chief minerals of economic importance in West Bengal are represented by coal, dolomite, fire-clay, china-clay, silica sand, limestone, ochre, apatite, base metals and wolframite. The wolframite occurrences are found in Chhendapathar and Porapahar areas in Bankura district.

Chhendapathar (22°45' : 86°45'):

In this area wolframite occurs in quartz veins and reefs which traverse the Archaean phyllites and quartzites forming low ridges. The wolframite bearing veins are 1.22 to 1.83 m thick and dip at 30° - 60°. The mineralisation is sparse and sporadic. Some veins contain wolframite mineralisation of 0.1% grade. Minor hand picking produces upto a tonne of wolframite every year.

Porapahar (23°23' : 86°47'):

At Porapahar, tungsten ore is detected as disseminated grains and patches in the two quartz veins striking NNE-SSW in sericite quartzite but no regular deposit has been found.

Satnala-Arhala (22°45'00"N and 86°43'30" - 86°00'00"):

The area is located in western extension of Chhendapathar area described above. The lithological assemblage includes mica schist, quartzite. calc-granulite, granites, quartz veins and skarn rock. Wolframite mineralisation occurs as disseminations within quartz veins. The results were not encouraging.

HARYANA

The Middle Proterozoic Delhi Fold Belt occurring in Rajasthan hosts several mineral deposits. The same belt continues to its northern adjacent state of Haryana, but no significant mineralisation has been found excepting the Tosham Sn-W deposit. The country rocks belong mostly to Ajabgarh Group and have been intensively invaded by Malani Suite of rocks represented by rhyolites and granites. The alteration zones are mostly composed of quartz-muscovite-sericite and are characterised by W and Sn mineralisation with minor sulphides in Tosham area. Numerous occurrences of malachite stains and presence of sulphides have been recorded in quartzite, impure limestone and calc-silicates giving rise to skarns at places at the contact of pegmatite. In Mahendragarh district skarn environment has been recognised at several places and investigated for tin and tungsten. In Mahendragarh district, carbonatite-albitite associated with the Khetri Copper Belt of Rajasthan has been recorded over a 20 km long segment. Incidences of U, Cu, Bi, Au, Pb are also reported from this segment of Mahendragarh district.

TOSHAM

1. **Location:**

Belt Name	:	Tosham Igneous Complex
Prospect	:	Tosham
Location	:	150 km WNW of Delhi
District	:	Bhiwani
Village	:	Tosham
Latitude	:	28°55'13"N
Longitude	:	75°55'00"E
R.L. Surface	:	398 m

2. **Geological Set-up:**

The rocks of the area belong to the Delhi Super Group of Pre-Cambrian age. The exposures of granite and rhyolite occur in isolated patches in a vast stretch of aeolian sands. The dome shaped Tosham hill forms a prominent topographic high above the plains. The three main units identified in the area are : Quartz-feldspar porphyry, central mass of rhyolite forming steep vertical cliff, porphyritic granite and metasediments at the south eastern slope. The granite appears to have intruded the metasediments and subsequently, both these formations have been intruded by hypabyssal rhyolite which forms the core of the Tosham hill.

The foliation trend of the metasediments is N20° to 40°E, parallel to the long axis of the hill and to the main rhyolite body. Dips are moderate to steep towards SW. Bedding and foliation are mostly co-axial, suggesting isoclinal folding. The granite is affected by a system of joints and

fractures 5-10 m apart, most prominent set trends NNE with a 40° dip to the SE which has been intruded by numerous aplite dykes varying, from a few cm. to a metre thick. Two prominent fracture zones called "shear zones" trending NNE and NNW. with sub-vertical attitude, occur on the western and eastern faces of Tosham hill. They are 5-10 m wide and marked by close spaced open fractures with iron oxide and rarely malachite stain. They can be traced over 200 to 300 m lengths and converge to the north under the cover of recent sediments. These can be identified as crushed and weathered zones in drill holes down to a depth of 200 m.

3. **Control of Mineralisation:**

The mineralisation in the Tosham deposit is polymetailic hosted by the metasediments, granite and rhyolite with cassiterite being the chief tin ore mineral. The other associated minerals include, wolframite, chalcopyrite, gold, galena, pyrite, arsenopyrite, sphalerrie, stannite. pyrrhotite, bismuthinite, cubanite, covellite, etc.

Wolframite, the main tungsten mineral occurs intimately associated with quartz-sulphide veins as fine (0.02mm) to coarse (1 cm) grains intergrown with gangues as well as sulphides. It also occurs as exsolved blebs within chalcopyrite.

Mineral zonality is observed from the relative variation in the contents of tin, tungsten and copper. In comparison to tungsten-copper, the upper levels are relatively enriched in tin.

The bulk of mineralisation occurs at or near the granite- metasediment or granite-rhyolite contact in the western and eastern mineralised zones with reference to the Tosham hill.

4. **Quantum of Work:**

A) **GSI**

Drilling (m)		:	14,215.75 m.
Core samples		:	7416 nos.
Petrological Samples		:	344 nos.

B) **MECL**

Drilling (m)		:	16060 m.
Underground exploration		:	
	a) Shaft	:	52 m.
	b) Drive	:	87 m.
	c) Cross-out	:	85 m.
Sampling			
	a) Channel (1.4 to 4 kg)	:	941 nos.
	b) Fresh Grid Chip (8 kg)	:	156 nos.
	c) Fresh Channel	:	143 nos.
	d) Fresh Chip	:	313 nos.
	e) Blast (Bulk 10 tonnes reduced to 1 tonne)	:	125 nos.

N.B. : The exploration in Tosham has been primarily carried out for tin mineralisation by GSI and MECL. During the last phase of the work the exploration is being continued by GSI for tungsten mineralisation in the deeper levels.

5. **Dimensions of Ore body:**

Tungsten mineralisation of continuous nature forming a zone over 600 m strike length with steep dips occurs at the northern extremity of the western mineralised zone.

6. **Grades & Reserves:**

The tungsten mineralisation is associated with copper and minor tin. It averages 0.16%W, 0.53% Cu and 0.05% Sn over an average width of 8.13 m.

Based on regional exploration, ore reserves of tungsten have been estimated at 2.23 million tonnes upto a depth of 237 m below MSL.

KERALA

The state forms a narrow strip of the country between the Arabian sea on the West and Western Ghats on the east. Though the state is not very rich in mineral resources, it is endowed with large deposits of clays and beach sands containing valuable minerals like ilmenite and monazite, besides bauxite, glass-sand, iron ore, limestone, gold, graphite etc.

Geologically, the region of Kerala is occupied by four major rock formations: (i) crystalline rocks of Archaean age; (ii) sedimentary rocks of Tertiary age; (iii) Laterites capping the crystallines and the sedimentary rocks; and (iv) Recent to sub-recent sediments forming low-lying areas and river valleys. The crystalline rocks comprise chiefly charnockites, the khondalite suite of granulitic and gneissic rocks, granites and granitic gneisses and schists traversed by basic dykes, pegmatite and quartz veins.

In recent years reconnaitory regional scale search for tungsten has been carried out. Some occurrences of tungsten mineralisation has been recorded. So far no prospect significant from the view of further detailed exploration has been located.

Scheelite incidences have been recorded in the following localities in Palakkad district; in Toposheet No. 58 A/12/SE.

	Block	Locality	Latitude	Longitude
1.	Kadamara-Uthukuzhy	Arakatty, Kadamara	11°04'10"	76°41'33"
			11°04'56"	76°42'22"
2.	Nellipadi	Agali	11°05'08"	76°39'30"
3.	Uthukuzhy-Chavadiyur	Near Agali	11°03'55"	76°41'03"
			11°04'25"	76°41'33"
4.	Sambarkode	Near Agali	11°05'75"	76°39'30"

Scheelite mineralisation is mainly hosted by medium to coarse grained hornblende gneisses and talc-tremolite-actinolite rocks. While in hornblende gneiss the scheelite occurs as feeble concentrations along the quartzo- feldspathic material parallel to the banding of the gneiss. In talcose rocks it occurs as isolated specks and occasionally as disseminations. Petrographic studies reveal that the scheelite is associated with and replacing calcic plagiolase. Analytical results gave values generally below 10 ppm. No further work has been recommended in these localities.

MAHARASHTRA

The geological formations found in the State include those of the Precambrian (Late Archaean-early Proterozoic), Palaeozoic, Mesozoic, Tertiary and Quaternary periods. Most part of the State is covered with a thick pile of basalt flows. The south-western corner adjoining Goa, exposes Precambrian rocks over a small area. In the eastern part are the Precambrian and Gondwana rocks, while the Quaternary deposits are confined to the courses of the major rivers.

Late Archaean to early Proterozoic Sakoli Belt occupies a triangular area in parts of Nagpur, Bhandara and Chandrapur districts and forms one of the most significant Proterozoic basins of the Central segment of the Indian Peninsular from economic point of view. The Sakoli Group comprises felsic (rhyolite) and mafic (basalt) submarine lavas and associated tuffaceous sediments (chlorite phyllite. carbon phyllite, iron formation etc.), intrusives (dunite, harzburgite, chromite, pyroxenite, amphibolite, diabase, granne, pegmatite and quartz veins) and mica schists with garnet, staurolite, magnetite, chloritoid, kyanite and sillimanite at places; and quartzite, sandstone, shale and graywacke. The important mineralisation of the Sakoli Belt are, W, Cu, Pb, Zn, Mo, Au, Ag, Nb & Ta ores mostly related to submarine volcanism and acid magmatism.

An area of 220 sq.km. of Sakoli basin falling in parts of Nagpur and Bhandara districts was surveyed regionally for tungsten mineralisation by reconnaitery traverses and stream sediment sampling. The surveys led to the identification of a number of blocks. The tungsten mineralisation in the Sakoli basin occurs in the form of wolframite and scheelite enriched by granite magmatism from the sparse distribution of scheelite in volcano- exhalated basins. The associated rock types are banded garnet-quartz- amphibole schist, biotite-muscovite schist, amphibolite, metabasic volcanics, tourmaline-quartz rocks.

About 1600 sq.km. area in parts of Sausar basin in Maharashtra has also been surveyed regionally in search of tungsten mineralisation. The results obtained so far are not encouraging.

Several blocks in Maharashtra have been identified and explored in detail. These are Agargaon, Kuhi, Khobna, Bhaonri and Ranbori.

KUHI PROJECT

1. **Location:**

Belt Name	:	Sakoli
Prospect	:	Kuhi
Location	:	45 km. SE of Nagpur
District	:	Nagpur
Tehsil	:	Kuhi
Village	:	Kuhi
Toposheet	:	55 O/8
Latitude	:	21°01'
Longitude	:	79°22'
Ref. point	:	Kuhi village (Lat. : 21°01' Long. : 79°22')
R.L. Surface	:	270 m to 281 m.

2. **Geological Set-up:**

The Kuhi tungsten prospect forms a part of the Western margin of the Sakoli basin.

The rock types exposed in the area comprise quartz chlorite sericite schist, chlorite-mica schist with porphyroblasts of garnet, staurolite and magnetite and garnet-amphibole-quartz rock cf the Sakoli group of lower to middle Proterozoic age. The pelitic metasediments have been affected by granitic activity. The general trend of the foliation is NE-SW but it swerves to ENE-WSW with steep dip on either direction.

3. **Control of Mineralisation:**

Intense pneumatolytic and hydrothermal processes related to granitic activity introduced tungsten mineralisation, which is restricted to intense zones of tourmalinisation/greisen in the mica schist country rock. Greisen zones were developed at the contact of schists and gneissic rocks. The tungsten mineralisation is confined to two separate zones viz. Zone-I (Southern Zone) and Zone-II (Northern Zone).

4. **Quantum of work:**

Geological Survey of India carried out systematic geological mapping on 1:50,000 scale followed by detailed mapping, pitting and trenching, sampling and drilling under detailed exploration.

The total quantum of work carried out is given below :

a)	Detailed geological mapping (1:2000 scale)	:	1.1 sq.km.
b)	Trenching (Cu.m.)	:	724
c)	Drilling (m) in 24 boreholes	:	3573.95
d)	Sampling (Nos)		
	i) Groove samples	:	161
	ii) Bulk samples	:	187
	iii) Drill core samples	:	1243

5. **Dimensions of ore body:**

Tungsten Mineralisation is wider and richer at 60 m level (as indicated by boreholes), where the width varies from 1.99 m to 17.90 m and grade varies from 0.10% to 0.197%W.

6. **Ore characteristics, Grades and Reserves:**

Tungsten Mineralisation is manifested as fine disseminations, stringers and discrete crystals of wolframite/scheelite in tourmaline-quartz-mica veins/greisens traversing concordantly the schist. The greisens are disposed in an en-echelon pattern and their width varies considerably.

A total resource of 2.5 million tonnes of tungsten ore is indicated upto 160 m depth over a strike length of 640 m with an average width of 11.47 m containing 0.1 to 0.197%W. This is equivalent to 7373 tonnes of wolframite- scheelite concentrates of 65% WO_3.

RESOURCES OF TUNGSTEN IN KUHI BLOCK WITH 0.1% AND ABOVE "W"

Bore hole No.	Strike length (m)	Dip length (m)	True width (m)	Assay W%	Volume (cu.m)	Specific gravity	Tonnage	Reserve 'W' in tonnes
KT-1	95	120	17.90	0.144	204060	2.8	571368	822.76
KT-2								
KT-4	100	180	10.10	0.14	181800	"	509040	712.65
KT-3								
KT-14	122	150	1.99	0.123	36417	"	101967	125.42
KT-11	150	120	14.10	0.197	253800	"	710640	1399.96
KT-19	75	180	14.00	0.16	189000	"	529200	846.72
KT-13	100	75	4.16	0.10	31200	"	87360	87.36
							2509575	3994.87

2.5 million tonnes of 0.1 to 0.197% WO_3
7373 tonnes of 65% WO_3

KHOBNA PROSPECT

1. **Location:**

Belt Name	:	Sakoli
Prospect	:	Khobna
Location	:	46 km. SE of Nagpur
District	:	Nagpur
Tahsil	:	Kuhi
Village	:	Khobna
Toposheet	:	55 O/8
Latitude	:	21°04'
Longitude	:	79°25'
Ref. point	:	Khobna village (Lat. 21°04' Long. 79°22')
R.L. Surface	:	270 m to 281 m.

2. **Geological Set-up:**

The Khobna tungsten prospect forms a part of the northwestern margin of the Sakoli basin. The rock types exposed in the area belong to middle Proterozoic age and comprise quartz-chlorite-sericite schist, chlorite-mica schist with porphyroblasts of garnet, staurolite and magnetite and garnet-amphibole-quartz rock. The pelitic metasediments have been affected by granitic activity. The general trend of the foliation is NE-SW but it swerves to ENE-WSW with steep dip on either direction.

3. **Control of Mineralisation:**

The quartz-chlorite-mica schist with porphyroblasts of garnet and magnetite is the main host rock, affected by granitic activity leading to the formation of greisen zones which vary in thickness for 15 to 65 m. These greisen zones are mostly conformable to the schistose rocks. They appear as veins from 1 cm to 3 m in thickness with pinch and swell structure containing either tourmaline and quartz or quartz with mica. Besides, greisen contains varying quantities of K-feldspar, chlorite, apatite, calcite, scheelite, fluorite, sphene, topaz and opaque minerals. The granite greisen is a leucocratic, crudely foliated rock. Studies of drill cores indicate that the ratio of quartz rich to tourmaline rich greisen is of the order of 70:30.

4. **Quantum of work:**

Details of work done by GSI (1975-85) and MECL (1986-91) during D-1 and D-2 stage exploration are given below :

A pre-feasibility study on the Khobna tungsten deposit was also carried out by MECL in collaboration with BRGM.

Sl.No.	Item	GSI (1975-85)	MEC (1986 - 91) D-1	D-2
1.	Geological mapping (1:2000)	0.75 sq.km	-	-
2.	Pitting/Trenching	15 nos. 1030 cu.m.	-	3 pits 94.45 m.
3.	Drilling A. Core (meterage)	16 bhs. 3311.70	35 bhs 6220.70	20 bhs 1129.90
	B. Non-core		-	27 bhs 961.0 m.
4.	Sampling			
	* Primary Sample			
	. core samples	926	4563	898
	. non-core samples	-	-	693
	. Channel samples	-	-	560
	. Chip samples	-	-	169
	. Blast samples	-	-	125
	* Check samples	-	178	66
	* Composite samples	-	56	-
	* Fire assay	-	122	-
	* Spectroscopic	-	66	-
	* Mozley Test	-	18	11
	* Heavy Media	-	-	19
	* Hand Panning	-	-	88
5.	Beneficiation (Lab & semipilor scale)	-	10	6
6.	Petrological studies	-	126	23
7.	Specific gravity determination	-	178	152

5. **Dimensions of ore body:**

The shallow (30 m level) and deeper (150-225 m level) borehole inter- sections indicate that the host rock showing alteration features maintain the overall width corresponding to the cross section and compare well with 60 m - 90 m intersections. However, the ore bearing horizon of 0.1% cut off shows pinching both upwards and downwards with reference to 60 m level.

6. **Grades and reserves:**

Tungsten mineralisation is manifested as fine disseminations, stringers and discrete crystals of wolframite/scheelite in tourmaline-quartz-mica veins/greisens traversing concordantly in the schists. The greisens are disposed in an en-echelon pattern and their width varies considerably.

According to GSI's estimates, a total of 4.82 million tonnes of tungsten ore is indicated upto a depth of 225 m over a strike length of 600 m with an average width of 16.91 m and an average grade of 0.24%W.

According to the BRGM-MECL report, the total reserves established by drilling upto a depth of 195 m (80-275 MRL) amounts to 3.04 million tonnes at a grade of 0.31%WO_3 or 9522 tonnes of contained WO_3 mostly in the form of scheelite.

7. **Any Other Information:**

According to BRGM-MECL pre-feasibility study, the project reserves, including mining dilution and recovery, amounts to 1.32 million tonnes of ore at 0.313%WO_3 or 4420 tonnes of WO_3 mostly in the form of scheelite.

Semi-pilot plant scale beneficiation studies have given encouraging results and the BRGM and IBM tests have clearly established the amenability of the ore to produce marketable scheelite concentrate of 65% to 73%WO_3 with recoveries ranging from 55 to 75% by standard gravity, flotation and magnetic separation techniques.

AGARGAON PROSPECT

1. **Location:**

Belt Name	:	Sakoli
Prospect	:	Agargaon
Location	:	58 km. SE of Agargaon
District	:	Nagpur
Tahsil	:	Kuhi
Village	:	Agargaon
Toposheet	:	55-O/8
Latitude	:	21°06'
Longitude	:	79°29'
Ref. point	:	Agargaon village Rajola hill Lat. 21°06' Long. 79°29'
R.L. Surface	:	258 m.

2. **Geological Set-up:**

The area in the vicinity of the deposit is occupied by steeply dipping and intricately folded meta-sediments of the Sakoli series. Forming part of the westerly plunging Sakoli synclinorium, these metasediments have a regional ENE-WSW trend. The lithounits present are tourmaline bearing chlorite schist, phyllite, sericite quartzite, migmatite and amphibolite.

3. **Control of Mineralisation:**

The tungsten mineralisation is confined to a shear zone trending ENE-WSW coinciding with igneous activity responsible for intrusion of granite and its related derivatives along with the ore forming solutions.

4. **Type of Exploration and Quantum of Work:**

About 70 sq.km. of area around the deposit has been mapped on scale 1:15,840.

i)	Detailed mapping (1:5000)	:	0.6 sq.km.
ii)	Trenching	:	2260 cu.m.
iii)	Drilling (in 24 boreholes)	:	3053.16m.
iv)	Exploratory Mining	:	23 m deep shaft 8.5 m long cross and a 9.0 m long drive.
v)	Sampling : 1. Groove samples	:	356 nos.
	2. Core samples	:	1800 nos.

5. **Dimension of Ore body:**

A 1400 m long, 10 to 115 m wide and over 100 m deep zone of tungsten mineralisation is delineated.

6. **Grades and Reserves:**

Crystals of wolframite are usually present in the body of the brecciated quartz vein or at the periphery of the quartz vein lenses in contact with tourmaline schist or tourmaline breccia. Scheelite occurs in the form of tiny disseminated grains, encrustation or as thin stringers in the quartz veins as well as in the tourmaline schist.

An ore reserve of 2.23 million tonnes upto 50 m depth with grades of 0.04 to 0.27% WO_3 equivalent to 2015 tonnes of wolframite/scheelite concentrate of 65% WO_3 grade has been estimated from Agargaon.

MECL has recalculated the ore resource of this deposit for a strike length of 304 m (in the high grade section) to 0.4 million tonnes of ore with 0.27% WO_3 grade which is equivalent to 1661 tonnes of 65% concentrate upto a depth of 77m.

7. **Any other Information:**

Beneficiation studies on the bulk samples drawn from this deposit have been carried out by IBM. A sample with 0.2%WO_3 feed grade, on jigging, tabling and magnetic separation yielded a +65% WO_3 concentrate with 48% recovery. Exploitation of this deposit is yet to commence.

RANBORI BLOCK 'A'

1. **Location:**

Belt Name	:	Sakoli Basin
Prospect	:	Ranbori Block A
Location	:	3 km. South of Ranbori village
District	:	Nagpur
Mandal	:	Bhiwapur
Village	:	Ranbori
Toposheet	:	55 P/5
Latitude	:	20°52'
Longitude	:	79°58'
Ref. Point	:	Ranbori Lat. 20°52' Long. 79°58'
R.L. Surface	:	270m. above MSL.

2. **General Geological set-up:**

The Ranbori 'A' block forms the northern extension of Bhaonri Zone-I block. This block forms a part of the south-western limb of a fold which has its north eastern limb along Pular-Parsori-Khapri-Thutanbori blocks. The area occupies the extreme SW corner of the Sakoli Basin. These formations show three phases of folding and two phases of metamorphism. Lithounits in the Ranbori 'A' Block comprise essentially a submarine mafic metavolcanic suite with a minor subvolcanic ingredient and these are associated with chemogenic and hydrothermal sediments. The rocks exposed are metabasalts, meta-gabbro, chlorite-sericite phyllite, carbonaceous phyllite, banded garnet-amphibole bearing quartzite, chloritoid-andalusite-magnetite bearing muscovite-quartz schist and tourmalinites which are intruded by quartz veins. The metabasalts show evidences of hydrothermal alteration with the indication of chloritisation, epidotisation, carbonatisation, silicification, felspathisation etc.

3. **Controls of Mineralisation:**

These rocks contain polymetallic mineralisation of tungsten-copper-zinc-lead with traces of silver. The tungsten ore in the form of scheelite occurs as streaks, disseminations and stringers within the vein quartz swarms traversing the meta-basalt and the banded garnet quartzite.

4. **Quantum of work:**

In Block 'A' a total of 19 inclined boreholes were drilled across all the mineralised zones.

a.	Detailed geological mapping on 1:1000	:	4 sq.km.
b.	Trenching (Cu.m)	:	830
c.	Drilling (m) (19 boreholes)	:	4964.75
d.	Samples - Drill core	:	145 nos.

5. **Dimensions of ore body:**

Ranbori 'A' block stretches over 2 km. along N-S. Three zones of scheelite bearing host rocks are present. Three zones are 300 m to 500 m apart and extend over 1.5 km. length each.

6. **Grades and Reserves:**

	Av. Grade		Resources
Tungsten	0.14%W	:	
	or, 0.176% WO_3	:	2.53 million tonnes
	or 65% WO_3	:	6883 tonnes (concentrates)

BHAONRI ZONE - I

1. **Location:**

Belt Name	:	Sakoli Basin
Prospect	:	Bhaonri Zone I
Location	:	9 km. NW of Bhiwapur
District	:	Nagpur
Mandal	:	Bhiwapur
Village	:	Bhaonri
Toposheet	:	55 P/5, P/9
Latitude	:	20°50'
Longitude	:	79°30'
Ref. point	:	Bhaonri Lat. 20°50' Long.79°30'
R.L. surface	:	General - 261m to 269m
Highest	:	281m

2. **General Geological set-up:**

The Bhaonri Zone-I forms the NE part of the polymetallic mineralised belt of Kolari-Bhaonri area falling in the SW part of the Sakoli Basin. The rock types consist of gray-crown phyllite (metatuff), gray garnetiferous cherty quartzite. banded garnet-quartz-muscovite-biotite-chlorite schist, metabasic volcanics and quartz-tourmaline rock which are intruded by swarms of vein quartz. A major part of the block is under soil cover.

The Bhaonri area trending NW-SE. represents a pan of the SW limb of a mesoscopic cross fold with a WNW-ESE axis. The rocks are metamorphosed from green schist to upper amphibolite facies.

3. **Controls of Mineralisation:**

Scheelite occurs as specks and stringers with minor sulphides of Cu, Zn and Fe parallel to the bedding plane in the host rock, garnetiferous quartzite. In the metabasic rock stratabound scheelite occurs in association with pyrite. chalcopyrite, sphalerite, pyrrhotite in the vein quartz

swarms, possibly generated during regional metamorphic remobilisation. The mineralisation associated with garnet bearing chert is stratabound and stratiform type, related to hydrothermal exhalative phase.

4. **Quantum of work done:**

Detailed mapping sq.km.(1:2000)			:	106
Trenching (cu.m)			:	659
Drilling (m)			:	5568.40
Samples (Nos.)	-	Trench	:	89
	-	Surface	:	89
	-	Drill Core	:	3301
	-	Bulk	:	2

5. **Dimensions of Ore body:**

Tungsten mineralisation trending NW-SE is noted over 1.51 km. strike length, out of which the north western 510 m stretch is the richest. The central 450 m section contains comparatively lesser number of mineralised zones with lower grade, while the remaining 550m stretch in SE is comparatively poor in grade as well as width.

6. **Grades and Reserves:**

In the Zone-I prospect, the tungsten ore resources estimated for a strike length of 600m for the north-western part upto a vertical depth of 250m is as under:

Grade of %W	Resources M. Tonnes	W. metal (Tonnes)	65% WO_3 concentrate (tonnes)	Average grade % WO_3
+ 0.10	7.89	11,870	23010	0.189
+ 0.15	2.63	5,292	10259	0.253

ANDHRA PRADESH

Andhra Pradesh has an area of 2,76,800 sq.km. The State is occupied by lithological assemblages of diverse ages ranging from Archean to Recent and is endowed with rich mineral wealth. A major pan of the area is occupied by the Indian Peninsular Shield referred to as Darer Craton constituted cf Archaean granite-gneiss with a few widely separated narrow greenstone belts in the southern part. The craton is bounded by the Eastern Ghats mobile belt in the northeast whereas in the northern part it abuts against the taphrogenic Godavari Valley with lithopiles of Proterozoic rocks (Pankhal, Albaka, Penganga, Sullavai, etc.) and Gondwana sediments which are partially covered by Deccan trap effusives. Proterozoic platform sedimentary sequences (Cuddapah, Kurnool, Palnad) also occupy large tracts in south-central part. Quaternary sediments with minor Cretaceous-Tertiary patches are mostly confined to the coastal area of the State. Laterite of Tertiary age is seen along the coast and as blanket cappings in the main land and particularly in the Eastern Ghats where they constitute bauxite deposits of immense economic potential. The State is a leading producer of limestone, barytes and coal. Other minerals of commercial significance include apatite, asbestos, base metals, bauxite, chromite, clay, diamond, gold, graphite, iron ore, mica, petroleum and natural gas.

In Andhra Pradesh, tungsten mineralisation occurs in three geological set-up viz. (i) Wolframite associated with graphite bearing gneisses of Eastern Ghat Belt, (ii) Scheelite associated with calc-granulite-skarn zone assemblage, also of Eastern Ghat Belt and (iii) Scheelite associated with gold in the greenstone schist belts.

In the Eastern Ghat Belt, there are more than hundred occurrences of graphite within the graphite bearing gneisses. These graphite bearing gneisses occur as irregular, stratiform lensoidal bodies of various dimensions (500m maximum length). These gneisses are often traversed by pegmatites and feldspathic quartz veins which carry visible wolframite of ferberite variety. Such wolframite bearing veins have been reported from Kavadigundla, Khamman district, Burugubanda and Tapaskonda in East Godavari District.

Scheelite mineralisation has been reported from a number of localities viz., Nandipadu, Sunnapu-Batti, Narayanapuram areas, Khammam district, within the calc-granulite skarn rocks.

Scheelite occurs mainly as thin stringers, disseminations and veins within the calc-granulites. Large scale geological mapping on 1:25,000 scale has been initiated in Nandipadu. Sunnapu-Batti and Narayanpuram areas to delineate the mineralised zones.

Preliminary exploration has been carried out by GSI in Burugubanda and Tapaskonda areas. In Burugubanda area a reserve of about 86.4 tonnes cf wolframite has been estimated. The exploration work in Tapaskonda extension zone is being continued.

BURUGUBANDA - TAPASKONDA PROSPECT:

1. **Location:**

Belt Name	:	Burugubanda-Tapaskonda Belt, Eastern Ghats Complex.
Prospect	:	Burugubanda-Chinnagalikonda Tapaskonda-Etipalle blocks.
Location	:	Burugubanda, Chinnagalikonda, Tapaskonda, Etipalle.
State	:	Andhra Pradesh
District	:	East Godavari.
Taluk	:	Rampachodavaran.
Village(s)	:	Burugubanda, Tapaskonda
Toposheet	:	65 G/11 and 15.
Coordinates	:	17°18'30" : 81°47'00" (Burugubanda)
	:	17°16'20" : 81°45'15" (Chinnagalikonda)
(Lat.& Long.)	:	17°29'40" : 81°49'25" (Tapaskonda)
	:	17°28'20" : 81°58'00" (Etipalle)

2. **Geological Set-up:**

The rock types in the area include (i) Khondalite suite of rocks comprising garnet-sillimanite gneiss, graphite schist/gneiss, calc-silicate rocks and quartzite; (ii) Pyroxene-granulite (basic charnockite) and (iii) a group of migmatitic rocks, formed by the granitisation of the above rocks, namely, garnet-biotite gneiss, garnetiferous quartzo-feldspathic granulite (leptynite), garnet-biotite-ilmenite gneiss, hypersthene-biotite gneiss and acid charnockite. Veins of quartz and pegmatite intrude into all the rocks both concordantly and discordantly.

3. **Control of Mineralisation:**

Tungsten mineralisation is associated with quartz-rich pegmatites that traverse graphite gneiss as parallel lit-par-lit veins. Wolframite with very minor amounts of scheelite occur as pockets and veins.

4. **Quantum of work done:**

Mapping	:	Geological traverse Mapping on 1:50,000 scale	:	565 sq.km.
		Geological traverse Mapping on 1:25,000 scale	:	40 sq.km.
		Detailed mapping on 1:1000 (only Burugubanda)	:	0.5 sq.km.
Sampling	:	Bed rock	:	499 nos.
		Stream sediment	:	276 nos.

5. **Dimensions of ore bodies:**

Graphite gneiss which is the host rock for tungsten mineralisation occurs as lensoidal bodies over a strike length of 180m with an average width of 5 to 6m. Length and width of wolframite streaks vary from 1 cm to 10 cm and 0.1 cm to 3 cm respectively. Also occasional lumps measuring 3 x 1 cm in dimensions are recorded.

6. **Grades and Reserves:**

Grades :
a) Graphite gneisses analysed values ranging from 2 to 780 ppm (W).
b) Quartzo-feldspathic veins analysed values ranging from 2-700 ppm (W).
c) Calc-granulite analysed 2 to 400 ppm (W).
d) Pink granite analysed 2 to 50 ppm W. However, visible pockets, nests and veins of wolframite present in them are susceptible to hand picking.

Reserves : 86 tonnes of recoverable tungsten ore (inducing 9.7 tonnes of indicated reserves upto 15m depth) have been estimated upto a depth of 100m with a recoverable grade of 0.25 kg to 0.80 kg per cubic metre of graphite ore (only for Burugubanda block). Remaining blocks studied in detail by NMDC.

Beneficiation tests carried on the bulk samples for the area indicate 0.8 kg to 0.25 kg of tungsten concentrates are recoverable from every cubic metre of the graphitic zone. The recovery of concentrates from the hand picked tungsten ore is 40% by weight.

7. **Any other informations:**

NMDC is continuing exploration in Tapaskonda area. IBM, BRGM and BARC are carrying out tests on beneficiation aspects. A bulk sample on beneficiation has given 79-80% recovery for graphite concentrates and 15% recovery with 22% WO_3 for "W" concentrate. Samples have also been sent for beneficiation tests to Humboldt, Germany RRL-Bhubaneswar and MINTAK, South Africa. Mine feasibility report recommends establishment of a plant with 1000 tpd graphite concentrate with 200 tonnes cf concentrate of tungsten per year. It has been found that APT route of beneficiation was practicable and quick and the operation costs are low.