PROPOSAL FOR RECONNAISSANCE SURVEY (G-4) FOR ASSESSMENT OF TUNGSTEN MINERALISATION IN KUHI-KHOBNA-AGARGAON GAP AREA, TEHSIL-KUHI, DISTRICT - NAGPUR, MAHARASHTRA

1.0.0 INTRODUCTION

1.1.0 Background

Tungsten is a vital metal of strategic importance in manufacturing of tools, automobiles, jet engines, defence equipments. This importance of the metal has led to intense search for this mineral in India. The Geological Survey of India has carried out extensive investigations for Tungsten in the country during 1980 to 2000, which has resulted in identification of numerous occurrences in places like Kuhi, Khobna and Agargaon in Maharashtra; Degana & Balda in Rajasthan; Burgabanda in Andhra Pradesh, KGF & Hutti in Karnataka and Bankura in West Bengal. Resources of tungsten bearing minerals are mainly distributed in Karnataka (42%), Rajasthan (27%), Andhra Pradesh (17%) and Maharashtra (9%). The remaining 5% resources are in Haryana, Tamil Nadu, Uttarakhand and West Bengal. The domestic requirement of Tungsten and its products are met mainly through imports. The total resources of Tungsten ore in the country, as per UNFC system as on 1.4.2015 have been estimated at 87.4 million tonnes containing 142,094 tonnes WO_3 content. All these resources are placed under remaining resources category.

1.1.1 Kuhi-Agargaon Tungsten belt extends over 16 kms and is located 45 km South-East of Nagpur in Maharashtra. Tungsten mineralization at Agargaon in the Sakoli Basin was first reported by J. Kellersohan in 1907. A chance find of a float Wolframite picked up from a soak pit by a villager in Kuhi in 1978 led to intensive search for Tungsten mineralization in other parts of Sakoli Basin. During the field season 1979-80, Mohan and Reddy confirmed insitu Wolframite mineralization in tourmaline-quartz-mica-greisen/veins at Kuhi and also in Khobna. They carried out regional and preliminary assessment surveys in between Kuhi and Agargaon in the field season 1981-82. There are two distinct zones of Tungsten mineralization; i) The Southern Zone-I extending over 3400m and ii) the northern Zone-II traceable over 2100m beyond which the ground is covered by soil/ laterite. These two zones are separated by about 500m width of chlorite-mica-schist. Exploration around Kuhi brought to light a moderate potential zone of Tungsten mineralization in Zone-I (South). The results of exploration carried out in Zone-I (South) block by GSI as part of the F. S. programme for 1982- 84 (1983-84) and the work carried out in Zone-II (North) block during 1984-85 shows promising results.

1.2.0 Location

1.2.1 The Kuhi Tungsten prospect is located 45 km South-East of Nagpur. A metallic road (23 km) from Pachgaon to Kuhi emanating from Nagpur-Chandrapur State highway (SH-9) serves as the main line of communication for the area. Pachgaon is 22 km from Nagpur. Khobna is connected to Kuhi by 6 km long tar road. Agargaon Tungsten deposit lies 16 km NE of Kuhi and is connected by tar road. Kuhi is a Tehsil Head quarter and big village located in the study area. Nagpur-Nagbhir Narrow-Gauge section of South-Eastern Railway passes through Kuhi (40 km). The nearest Airport is located at Nagpur.

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1.3.0 Climate

1.3.1 The area experiences warm and dry climate during most part of the year except in Monsoon when it is humid. The maximum relative humidity during summer ranges from 35% to 60% and in Monsoon varies from 50% to 90%. The maximum temperature remains more than 42° C and at times it may reach up to 47°C during May-June whereas it drops to about 10°C in winters (December & January). Occasionally wind storms lash the area in summer months. The average annual rainfall is 150 cm; which is mainly distributed during the monsoon period between June to September.

1.4.0 Geomorphology

1.4.1 The area forms part of Deccan Plateau having almost a plain ground/undulating terrain with very gentle and gradual slope towards South-West. Major landforms identified on this landscape are undulating lands, plains, hills and ridges with pediments and gently sloping alluvial plains. The relief within the study area is moderate with elevation varying from 260 m to 310 m above msl. The Kuhi prospect occupies a very narrow and low lying ridge trending in NNE-SSW direction in an otherwise soil covered and cultivated tract. The area is drained by the Nag River meandering and flowing towards north-East and finally joins the Kanhan River near Saongi.

1.5.0 Previous Work by Geological Survey of India

1.5.1 Regional Geological Mapping

1) Sengupta (1941) carried out reconnaissance surveys in Agargaon area in part of Sakoli Basin.
2) Investigation for Tungsten at Agargaon (Toposheet No. 55 O/8) was carried out by Lokras et. Al. (1969) during the period 1965 to 1968.
3) Chande, V. D. and Bhoskar, K. G. took reconnoitery traverse in the area.
4) The first report of Tungsten incidence from Kuhi came to light through a local villager in 1978. During the field season 1979-80, Mohan and Reddy examined the area between Kuhi-Agargaon-Bhandara and reported incidences of U, Nb, Ta, Au and pyrochlore at Kharbi, Khobna, Borkipet and Shahpur. Since then Geological Survey of India has carried out preliminary exploration at Kuhi, Khobna and Agargaon besides reconnaissance survey in the adjoining areas.

1.5.2 Exploratory Work (Detailed Geological Mapping, Drilling & Sampling Work) By GSI & MECL

a) Detailed mapping for Tungsten at **Kuhi (Zone-I)** was taken-up by Mohan and Jain during the field season 1981-82 and carried out exploratory drilling during field Season 1982-83 and 1983-84. During above period GSI carried out detailed Geological Mapping in an area of 1.10 Sq. Km. on 1:2000 scale, shallow Trenching (2-3 m depth) of 724 cu.m. in 15 numbers of trenches, 161 number of groove samples were collected from tourmaline quartz-mica greisen/veins, tourmalinised schist, and mica-schists exposed in the trenches and 187 number of bulk samples were collected from tourmaline quartz-mica greisen/veins zones of trenches to know the distribution of coarse Wolframite and Scheelite.
In addition to above work Geological Survey of India has carried out drilling to intersect the total width of the greisen zone both along strike and in depth to study the variation in the grade of mineralization. A total of 3573.95m of drilling was carried out in 24 inclined boreholes. Out of 24 boreholes drilled in the Kuhi area, 20 boreholes with 2970.50m were drilled in Kuhi Zone-I block.

Based on the analytical data, GSI estimated Tungsten resource of 2.5 million tonnes with grade varying from 0.10% to 0.19% W over a strike length of 640m with an average width of MINERALIZED zone of 11.47m up to a depth of 160m in the Kuhi Zone-I block.
Over the part of Kuhi zone-I block, henceforth known as Kuhi Sub-Block (Zone-I), GSI estimated resource of 1269735 tonnes of 0.173% WO_3 at 0.1% W cut-off equivalent to 0.126 % WO_3 content, taking the specific gravity as 2.80.

On the basis findings of exploratory work carried out, under mentioned further work is proposed/recommended.

1. As the MINERALIZED zones have limited lateral extension and the grade of mineralisation also varies appreciably, detailed exploration at 90m, 120m and 150m levels is required.
2. Though the MINERALIZED zone at 0.1% W cut off shows limited depth extension, the overall persistence in depth is up to 185m, it is necessary to test the possibility of mineralisation at deeper levels by exploratory drilling up to 300m depth.
3. Since the variation in grade of Tungsten mineralisation and size of W minerals is appreciable, exploratory mining preferably underground mining on two levels at 60m and 120m in the prospective block is warranted.

Keeping in view the above recommendations, **MECL** carried out detail exploration in Kuhi Sub Block (Zone-I) during the period from 6/11/2014 to 5/02/2015 and submitted the geological report in February 2016. The exploratory work carried out by MECL includes 1343.70 m drilling in 7 boreholes, survey and geological mapping in 0.50 sq.km. area 63.50 Cu.m. trenching in 3 trenches, geotechnical studies in one borehole, beneficiation studies in one trench/pit sample and one sample of MINERALIZED half core of boreholes and environmental study. MECL estimated 2.046 million tonnes resource with 0.132% WO_3. Out of these, total measured resource (331) comes to be 0.915 million tonnes with 0.132% WO_3 and indicated resource (332) are 1.131 million tonnes of 0.132% WO_3. The total resource of the Kuhi Sub-Block (Zone-I) can be categorized as 332 of UNFC. The resource is estimated over a total stretch of 604.80 m strike in 4 patches of the total strike of 1054.82m of the explored block.

TABLE-1.A
ZONES INTERSECTED IN THE BOREHOLES DRILLED BY MECL ON 2.00m (MSW) AS TRUE WIDTH; 3.00M MINIMUM PARTING AT 0.1% WO_3 CUT-OFF

BOREHOLE No.	INTERSECTION (m)			TRUE WIDTH(m)	W%	WO_3%	LODE NO.
	FROM	TO	THICK				
MKP-1	77.90	83.20	5.30	4.68	0.1698	0.214	L-IIA1b
MKP-2	61.40	77.50	16.10	14.71	0.082	0.103	L-IV
	93.80	114.00	20.20	18.45	0.114	0.144	L-IIA
	121.25	124.00	2.75	2.51	0.080	0.101	L-IIB1a
	126.65	129.35	2.70	2.47	0.114	0.144	L-IIB1b
	133.40	139.85	6.45	5.89	0.081	0.102	L-IIB2b
MKP-3	71.05	74.20	3.15	2.98	0.077	0.097	LOCAL

	107.40	109.80	2.40	2.27	0.079	0.099	L-IVA1
	148.80	151.35	2.55	2.41	0.088	0.111	L-IIA1
	167.27	170.90	3.63	3.43	0.087	0.110	L-IIB1
	179.60	182.00	2.40	2.27	0.080	0.101	L-IIB2b
MKP-4	109.88	112.20	2.32	2.25	0.127	0.160	LIIA2a
	138.05	140.64	2.59	2.51	0.2473	0.3116	L-IIB2b
MKP-5	14.00	16.55	2.55	2.29	0.090	0.113	L-III
	27.08	34.55	7.47	6.71	0.079	0.099	L-IIA1b
	43.15	62.10	18.95	17.08	0.088	0.111	L-IIB
MKP-7	153.55	155.80	2.25	2.1	0.075	0.095	L-IVA1b

TABLE- 1.B
ZONES INTERSECTED IN THE BOREHOLES DRILLED BY GSI ON 2.000m (MSW) AS TRUE WIDTH; 3.00m MINIMUM PARTING AT 0.1% WO_3 CUT-OFF

BOREHOLE No.	INTERSECTION (m)			TRUE WIDTH(m)	W%	WO_3%	LODE NO.
	FROM	TO	THICK				
KT-1	32.30	35.60	3.30	3.16	0.087	0.109	L-IVB1a
	46.10	53.10	7.00	6.69	0.1416	0.178	L-III
KT-2	105.55	107.95	2.40	2.24	0.083	0.105	L-IVB1
	114.00	116.70	2.70	2.52	0.3465	0.4366	L-III
	136.90	139.60	2.70	2.60	0.145	0.183	L-IIA2
KT-3	45.06	48.00	2.94	2.78	0.122	0.154	L-IIA1a
KT-4	65.10	95.38	30.28	28.96	0.098	0.1239	L-II
KT-13	57.90	60.92	3.02	2.67	0.105	0.132	L-I
KT-14	198.54	200.94	2.40	2.36	0.083	0.105	L-IIA2a

b) In **Kuhi (Zone-II)** drilling of 2061.15 m in 12 boreholes to intersect greisen zones between 30m and 60 m vertical depth was carried out. A total 563 borehole core samples was processed for determination of W, Sn etc. Analyses of 563 borehole core samples show a maximum of 0.075% W and 0.05% of Sn. The geological mapping was carried out in o.30 sq. km area on 1:2000 scale. Boreholes were drilled at strike interval varying between 100 m to about 200 m. In the entire zone, 6 trenches with total excavation of 232 cu. m. and subsequent sampling i.e. groove (8 nos.), bulk samples (19 nos.) and borehole core samples (563 nos.) were completed by end of 1985-86 and the entire data incorporated in the report. The findings of the exploratory work carried out are as under.

1. The greisen zone is existing over a large strike length and also shows good development in the central part.
2. Although the greisens are persistent at depth and the surface exposures contain W mineralisation (visible), at depth the mineralisation is very poor and is not of economic significance.
3. The Sn content in some of the boreholes is interesting and there could be vertical zoning of rare metals in the area.

No exploratory work was carried out by **MECL** in **Kuhi (Zone-II)** block considering the low potentiality of the block.

c) The **Khobna (zone-I)** prospect (strike length of 1100m) was discovered by GSI in 1978 and explored by trenching and drilling (F.S. 1982-85). The work carried out includes detailed mapping of 0.7 sq km on 1:2000 scale, 1038 cu m of excavation in 15 trenches, 16 boreholes involving 3311.70 m of drilling (KB-1 to KB-16) at 100 m spacing over a strike length of 600m, to trace the strike and depth wise extent of the MINERALIZED zone. 926 no of core samples from 16 boreholes and 77 groove and bulk samples were also collected. The trenches were located at 100m to 200 m apart and depth of excavation was up to 2.50 to 3m. The exploration ended with the following conclusions.

1. In view of the variation in width and grade of mineralisation both upward and downward, detailed exploration at 90 m, 150 m and 225 m levels are required.

2. Though the strike length of mineralisation with 0.1% W cut off is limited to 500m but in view of the late pneumatolytic to hydrothermal nature of mineralisation, the depth persistence beyond 250 m is likely, and not relied out and a possible repetition of wider and richer ore body at considerably deeper levels of 300 to 400 m is also likely, and to test these possibilities, exploratory drilling at 300 to 400 m is recommended.

3. Since Tungsten mineralisation varies considerably from fine disseminations to coarse stringers and lumps as also in width the behaviors of the ore body can be accurately deciphered by exploratory mining as also the correlation from point of intersection to three dimensional disposition of ore body. Therefore, exploitation-cum-exploratory mining by open-cast up to 100-150 m depth followed by exploratory underground mining may be considered.

Detailed exploration has been pursued by **MECL** with systematic drilling of boreholes along sections across strike. After evaluating the data of GSI, 35 additional boreholes have been drilled involving 6220.70 by MECL in D1 stage and 1129.20 m in 20 Boreholes in D2 Stage over 450 m strike length at 50 m. spacing. One vertical borehole on emplacement of the future exploration shaft and three complementary inclined large diameter boreholes have also been drilled in the block. The main ore zones, as outlined by "assay contact" at 0.1% W cut-off have an average thickness of 20 m over a strike length of 400 m with a richer ore over a strike length of 100 m in the middle. In situ geological resource at 0.1% W cut-off, down to the depth of 150 m from surface, are estimated at 2.7 M tonnes at 0.23 to 0.32% WO_3. A total of 55 boreholes aggregating 7349.90 m have been completed in Khobna (zone-I)
MECL also carried out non coring drilling involving 961.00 m in 27 Boreholes.

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TABLE- 1.C

WEIGHTED AVERAGE COMPUTATIONS OF KHOBNA TUNGSTEN PROJECT

ECONOMIC ZONES COMPUTED AT 0.10% WO_3 CUT-OFF IN MECL BOREHOLE

BOREHOLE NO.	0.10% PAYLIMIT					
	DEPTH IN (M).			WO_3(%)	RRL(M)	FRL (M)
	FROM	TO	THICK			
MK-1						
ZONE 1	126.95	151.93	24.98	.193	194.18	178.12
MK-2						
ZONE 1	28.10	29.60	1.50	.148	253.17	252.11
ZONE 2	36.50	40.77	4.27	.802	247.23	244.21
MK-3						
ZONE 1	165.95	192.20	26.25	.309	149.95	129.83
MK-4						
ZONE 1	54.15	75.65	21.50	.119	243.27	230.93
ZONE 2	101.19	102.69	1.50	.296	216.28	215.42
MK-5						
ZONE 1	125.15	126.65	1.50	.107	194.69	193.72
ZONE 2	129.70	141.25	11.55	.345	191.76	184.34
ZONE 3	178.85	180.35	1.50	.156	160.16	159.19
MK-6						
ZONE 1	28.20	32.75	4.55	.549	257.63	255.02
ZONE 2	67.40	69.14	1.74	.254	235.14	234.14
MK-7						
ZONE 1	130.95	134.95	4.00	.128	191.85	189.28
ZONE 2	145.45	146.95	1.50	.334	182.53	181.56
MK-8						
ZONE 1	134.75	149.25	14.50	.403	189.54	180.21
ZONE 2	153.75	155.25	1.50	.104	177.32	176.35
ZONE 3	184.75	188.35	3.60	.173	157.39	155.07
MK-10						
ZONE 1	184.00	187.50	3.50	.158	157.99	155.74
ZONE 2	197.00	209.00	12.00	.140	149.63	141.91
MK-11						
ZONE 1	66.60	68.10	1.50	.182	236.19	235.33
ZONE 2	79.60	82.60	3.00	.245	228.73	227.01
ZONE 3	102.60	104.10	1.50	.275	215.53	214.67
ZONE 4	121.10	122.60	1.50	.186	204.92	204.05
MK-12						
ZONE 1	191.40	212.90	21.50	.137	141.82	126.61
ZONE 2	216.90	230.40	13.50	.144	123.78	114.23
ZONE 3	247.60	249.10	1.50	.312	102.07	101.00

WEIGHTED AVERAGE COMPUTATIONS OF KHOBNA TUNGSTEN PROJECT

ECONOMIC ZONES COMPUTED AT 0.10% WO_3 CUT-OFF IN MECL BOREHOLE

BOREHOLE NO.	0.10% PAYLIMIT DEPTH IN (M). FROM	TO	THICK	WO_3(%)	RRL(M)	FRL (M)
MK-14						
ZONE 1	36.50	59.50	23.00	.268	253.25	240.05
MK-15						
ZONE 1	139.50	143.00	3.50	.222	164.32	161.63
MK-16						
ZONE 1	112.65	114.15	1.50	.103	202.92	201.95
ZONE 2	159.65	161.15	1.50	.784	172.69	171.73
ZONE 3	163.65	165.15	1.50	.136	170.12	169.16
MK-17						
ZONE 1	96.40	97.90	1.50	.113	208.72	207.66
ZONE 2	195.60	209.60	14.00	.484	138.56	128.65
ZONE 3	248.60	255.10	6.50	.127	101.07	96.47
MK-18						
ZONE 1	42.40	59.90	17.50	.408	246.09	234.83
MK-21						
ZONE 1	206.90	210.90	4.00	.132	144.41	141.84
ZONE 2	219.90	223.40	3.50	.106	136.05	133.80
ZONE 3	244.40	250.40	6.00	.158	120.30	116.44
MK-22						
ZONE 1	119.05	120.55	1.50	1.627	198.04	197.08
ZONE 2	213.90	215.40	1.50	.194	137.05	136.09
ZONE 3	253.90	255.40	1.50	.300	111.33	110.37
MK-23						
ZONE 1	46.20	47.70	1.50	.252	238.02	236.87
ZONE 2	161.65	163.15	1.50	.897	149.55	148.40
MK-24						
ZONE 1	52.35	57.35	5.00	.711	239.96	236.74
ZONE 2	76.90	82.90	6.00	.200	224.17	220.32
ZONE 3	88.40	91.40	3.00	.124	216.78	214.85
ZONE 4	93.40	100.90	7.50	.104	213.56	208.74
MK-25						
ZONE 1	69.50	88.00	18.50	.769	230.00	218.11
ZONE 2	123.65	128.65	5.00	.157	195.18	191.97
MK-26						
ZONE 1	103.00	106.00	3.00	.161	208.50	206.57
ZONE 2	136.00	149.50	13.50	.170	187.28	178.60

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WEIGHTED AVERAGE COMPUTATIONS OF KHOBNA TUNGSTEN PROJECT

ECONOMIC ZONES COMPUTED AT 0.10% WO_3 CUT-OFF IN MECL BOREHOLE

BOREHOLE NO.	0.10% PAYLIMIT DEPTH IN (M). FROM	TO	THICK	WO_3(%)	RRL(M)	FRL (M)
MK-27						
ZONE 1	82.55	88.05	5.50	.175	220.64	217.10
MK-28						
ZONE 1	68.00	72.50	4.50	.159	231.46	228.56
ZONE 2	99.95	108.95	9.00	.158	210.91	205.12
ZONE 3	111.45	112.95	1.50	.120	203.52	202.55
MK-30						
ZONE 1	76.60	98.60	22.00	.381	225.75	211.60
ZONE 2	103.10	105.10	2.00	.126	208.71	207.42
ZONE 3	135.75	137.25	1.50	.132	187.71	186.75
MK-33						
ZONE 1	70.00	72.00	2.00	.381	230.20	228.91
ZONE 2	76.00	113.00	37.00	.296	226.34	202.55
MK-34						
ZONE 1	77.00	85.50	8.50	.120	225.42	219.95
ZONE 2	90.00	92.00	2.00	.185	217.06	215.77
ZONE 3	96.00	97.50	1.50	.280	213.20	212.24
ZONE 4	101.00	102.50	1.50	.110	209.99	209.02
MK-35						
ZONE 1	71.00	72.50	1.50	.136	228.26	227.29
ZONE 2	81.50	88.00	6.50	.224	221.51	217.33
MK-37						
ZONE 1	2.00	5.00	3.00	.307	272.29	269.99
ZONE 2	14.50	45.00	30.50	.195	262.71	239.34
MK-38						
ZONE 1	18.00	40.00	22.00	.206	260.02	243.16
MK-39						
ZONE 1	21.25	48.25	27.00	.326	257.26	236.57
ZONE 2	61.25	64.25	3.00	.267	226.61	224.31
MK-40						
ZONE 1	20.25	24.25	4.00	.270	258.03	254.97
ZONE 2	27.75	29.25	1.50	.150	252.29	251.14
MK-41						
ZONE 1	43.50	45.00	1.50	.143	242.80	241.74

WEIGHTED AVERAGE COMPUTATIONS OF KHOBNA TUNGSTEN PROJECT

ECONOMIC ZONES COMPUTED AT 0.10% WO_3 CUT-OFF IN MECL BOREHOLE

BOREHOLE NO.	0.10% PAYLIMIT DEPTH IN (M). FROM	TO	THICK	WO_3(%)	RRL(M)	FRL (M)
MK-42						
ZONE 1	4.50	6.00	1.50	.183	270.10	268.95
ZONE 2	11.00	31.50	20.50	.315	265.12	249.41
MK-43						
ZONE 1	34.50	42.50	8.00	.111	247.09	240.96
MK-44						
ZONE 1	.50	2.00	1.50	4.025	273.30	272.15
ZONE 2	16.15	31.40	15.25	.248	261.30	249.62
ZONE 3	34.40	59.40	25.00	.736	247.32	228.16
MK-45						
ZONE 1	17.50	29.00	11.50	.215	259.80	250.99
ZONE 2	33.00	43.00	10.00	.121	247.92	240.26
ZONE 3	48.00	50.00	2.00	.110	236.43	234.90
MK-46						
ZONE 1	10.00	37.00	27.00	.190	265.20	244.51
MK-47						
ZONE 1	13.00	34.00	21.00	.358	262.52	246.43
MK-48						
ZONE 1	19.00	25.75	6.75	.169	257.86	252.69
MK-49						
ZONE 1	16.00	32.00	16.00	.288	260.00	247.74
MK-50						
ZONE 1	2.00	6.00	4.00	.120	270.66	267.59
ZONE 2	10.00	24.00	14.00	.382	264.53	253.80
MK-51						
ZONE 1	42.45	45.43	2.98	.103	241.32	239.03
ZONE 2	50.75	52.25	1.50	.110	234.96	233.81
MK-52R						
ZONE 1	9.00	10.50	1.50	.657	265.92	264.77
ZONE 2	26.00	33.00	7.00	.300	252.90	247.53
ZONE 3	38.00	40.00	2.00	.278	243.70	242.17
MK-53						
ZONE 1	3.50	5.00	1.50	.141	270.39	269.24
ZONE 2	9.00	17.00	8.00	.174	266.18	260.05
ZONE 3	31.00	42.05	11.05	.222	249.32	240.85

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WEIGHTED AVERAGE COMPUTATIONS OF KHOBNA TUNGSTEN PROJECT

ECONOMIC ZONES COMPUTED AT 0.10% WO_3 CUT-OFF IN MECL BOREHOLE

BOREHOLE NO.	0.10% PAYLIMIT					
	DEPTH IN (M).			WO_3(%)	RRL(M)	FRL (M)
	FROM	TO	THICK			
MK54						
ZONE 1	5.50	7.00	1.50	.136	268.94	267.79
ZONE 2	11.00	30.00	19.00	.200	264.72	250.16
ZONE 3	34.00	46.00	12.00	.217	247.10	237.90
MK55						
ZONE 1	5.00	19.00	14.00	.201	269.36	258.63
MK52						
ZONE 1	10.50	12.00	1.50	.247	264.77	263.62
ZONE 2	24.00	34.00	10.00	.206	254.43	246.77
MK-41R						
ZONE 1	33.10	36.10	3.00	.186	248.21	245.91
MK-57						
ZONE 1	1.00	21.55	20.55	.238	272.67	256.93

TABLE- 1.D

WEIGHTED AVERAGE COMPUTATIONS OF KHOBNA TUNGSTEN PROJECT

ECONOMIC ZONES COMPUTED AT 0.10% WO_3 CUT-OFF IN GSI BOREHOLE

BOREHOLE NO.	0.10% PAYLIMIT					
	DEPTH IN (M).			WO_3(%)	RRL(M)	FRL (M)
	FROM	TO	THICK			
KB-1						
ZONE 1	73.38	86.60	13.22	.117	218.07	207.94
ZONE 2	92.70	99.95	7.25	.400	203.27	197.71
KB-2						
ZONE 1	65.85	110.25	44.40	.629	224.34	190.32
ZONE 2	124.45	125.95	1.50	.192	179.44	178.29
ZONE 3	134.10	135.60	1.50	.449	172.04	170.89
ZONE 4	142.75	148.60	5.85	.115	165.41	160.93
ZONE 5	154.10	164.60	10.50	.247	156.72	148.67
KB-3						
ZONE 1	101.15	102.75	1.60	.100	209.16	208.13
ZONE 2	117.45	120.30	2.85	.111	198.68	196.85
ZONE 3	136.45	157.00	20.55	.235	186.46	173.25
KB-4						
ZONE 1	146.15	149.50	3.35	.758	202.90	201.22
KB-5						
ZONE 1	162.80	166.50	3.70	.209	170.92	168.54
ZONE 2	174.15	175.65	1.50	.290	163.62	162.66
ZONE 3	187.10	188.60	1.50	.120	155.29	154.33
KB-6						
ZONE 1	147.80	149.30	1.50	.112	189.60	188.73

(20)

WEIGHTED AVERAGE COMPUTATIONS OF KHOBNA TUNGSTEN PROJECT

ECONOMIC ZONES COMPUTED AT 0.10% WO_3 CUT-OFF IN GSI BOREHOLE

BOREHOLE NO.	0.10% PAYLIMIT					
	DEPTH IN (M).			WO_3(%)	RRL(M)	FRL (M)
	FROM	TO	THICK			
KB-7						
ZONE 1	67.25	75.10	7.85	.434	237.42	233.50
ZONE 2	79.55	94.65	15.10	.158	231.27	223.72
ZONE 3	98.20	99.70	1.50	.223	221.94	221.19
ZONE 4	136.85	139.00	2.15	.193	202.61	201.53
ZONE 5	141.95	143.45	1.50	.610	200.06	199.31
KB-11						
ZONE 1	259.10	261.95	2.85	.412	79.56	77.38
ZONE 2	271.85	273.35	1.50	.123	69.79	68.64
ZONE 3	290.10	292.10	2.00	.150	55.81	54.27
KB-12						
ZONE 1	64.60	66.75	2.15	.129	230.66	229.28
ZONE 2	72.20	88.15	15.95	.107	225.78	215.52
ZONE 3	93.80	96.10	2.30	.109	211.89	210.41
KB-13						
ZONE 1	38.10	39.60	1.50	.159	249.70	248.74
ZONE 2	51.50	56.30	4.80	.285	241.09	238.00
KB-14						
ZONE 1	290.10	293.00	2.90	.387	89.66	87.80
ZONE 2	295.45	296.95	1.50	.117	86.22	85.26
KB-15						
ZONE 1	88.65	90.50	1.85	.132	219.80	218.61
ZONE 2	211.70	213.20	1.50	.162	140.68	139.71
ZONE 3	236.45	241.75	5.30	.128	124.76	121.35
ZONE 4	245.45	246.95	1.50	.831	118.97	118.01

TABLE- 1.E

WEIGHTED AVERAGE COMPUTATIONS OF KHOBNA TUNGSTEN PROJECT

ECONOMIC ZONES COMPUTED AT 0.10% WO_3 CUT-OFF IN MECL NON-CORING BOREHOLE

BOREHOLE NO.	0.10% PAYLIMIT					
	DEPTH IN (M).			WO_3(%)	RRL(M)	FRL (M)
	FROM	TO	THICK			
MKV-1						
ZONE 1	3.00	35.00	32.00	.181	269.98	237.98
MKV-2						
ZONE 1	13.00	36.00	23.00	.300	260.51	237.51
MKV-3						
ZONE 1	6.00	28.00	22.00	.223	267.46	245.46
MKV-4						
ZONE 1	30.50	32.00	1.50	.253	242.87	241.37
MKV-5						
ZONE 1	2.00	5.00	3.00	.135	271.12	268.12
MKV-6						
ZONE 1	30.00	34.00	4.00	.206	243.44	239.44
MKV-7						
ZONE 1	26.00	35.00	9.00	.708	247.27	238.27
MKV-8						
ZONE 1	7.00	32.00	25.00	.272	266.03	241.03
MKV-9						
ZONE 1	1.00	36.00	35.00	.285	272.24	237.24
MKV-10						
ZONE 1	1.00	35.00	34.00	.131	272.09	238.09
MKV-11						
ZONE 1	.00	16.00	16.00	.204	273.00	257.00
ZONE 2	24.50	26.00	1.50	.130	248.50	247.00
MKV-12						
ZONE 1	1.00	3.00	2.00	.175	272.14	270.14
MKV-13						
ZONE 1	.00	35.00	35.00	.261	273.19	238.19
MKV-14						
ZONE 1	.00	34.00	34.00	.298	273.34	239.34
MKV-15						
ZONE 1	15.50	17.00	1.50	.117	257.98	256.48

WEIGHTED AVERAGE COMPUTATIONS OF KHOBNA TUNGSTEN PROJECT

ECONOMIC ZONES COMPUTED AT 0.10% WO_3 CUT-OFF IN MECL NON-CORING BOREHOLE

BOREHOLE NO.	0.10% PAYLIMIT DEPTH IN (M). FROM	TO	THICK	WO_3(%)	RRL(M)	FRL (M)
MKV-16						
ZONE 1	16.50	18.00	1.50	.117	257.32	255.82
MKV-18						
ZONE 1	1.00	33.00	32.00	.205	272.60	240.60
MKV-19						
ZONE 1	1.00	19.00	18.00	.154	272.22	254.22
MKV-20						
ZONE 1	.50	2.00	1.50	.155	272.21	270.71
ZONE 2	25.00	34.00	9.00	.375	247.71	238.71
MKV-21						
ZONE 1	.00	35.00	35.00	.192	273.29	238.29
MKV-22						
ZONE 1	.00	22.00	22.00	.134	272.85	250.85
ZONE 2	32.00	33.50	1.50	.109	240.85	239.35
MKV-23						
ZONE 1	1.00	3.00	2.00	.143	271.56	269.56
ZONE 2	12.00	14.00	2.00	.748	260.56	258.56
ZONE 3	23.00	24.50	1.50	.100	249.56	248.06
MKV-24						
ZONE 1	1.00	3.00	2.00	.115	271.07	269.07
ZONE 2	10.00	32.00	22.00	.202	262.07	240.07
MKV-25						
ZONE 1	1.00	33.00	32.00	.328	270.82	238.82

d) GSI carried out 2782.25m drilling in 20 boreholes in **Khobna (Zone-II)** block and 425 nos. of samples analyzed for W. The maximum value of 0.06%W is seen in one sample only while others show much less values and as such, it can be concluded that although good surface mineralisation is seen over Khobna Zone-II, the Wolframite-Scheelite mineralisation is very poor even at the depth of 30m from surface.

Although the greisenised zones continue over the strike length of 1300m, the Tungsten content is poor even at shallow depth whereas the tin content is higher (0.06%Sn) compared to those in Khobna Zone-I and that may be due to a closer proximity of the

granite body in Zone-II compared to that in zone-I. Hence no further detailed work in Zone-II is required.

No exploratory work was carried out by **MECL** in **Khobna (Zone-II)** block considering the low potentiality of the block.

e) Agargaon: (GSI)

Agargaon Tungsten deposit is located 8 km. North-East of Khobna Tungsten deposit and had been explored by surface drilling and limited mining by GSI since 1965 and continued up till 1977. GSI has carried out large scale mapping in 70 sq.km. area on 1:15840 scale and detail mapping in 0.60 sq.km. on 1:500 scale. 24 nos boreholes involving 3053.16 m drilling along with primary & composite samples has been completed. 2260 Cu. m. excavation in 102 no pits/trenches along with sampling have been done. Geophysical investigation (Resistivity, magnetic & electromagnetic) has been carried out in 0.24 sq.km. Apart from this, exploratory mining i.e. shaft sinking (depth-23m, cross cut-8.5m. & drive-9.0 m) and collection of bulk sample for beneficiation studies has been done.

Conclusions & recommendations:

Geophysical survey indicated two high resistivity zones, one along the zone of visible mineralization and other 300 m. to the South East. The quartz veins at the surface in the second zone are devoid of any ore mineral. Based on the various studies in Agargaon Tungsten deposit, the physical extension of the ore body has been demarcated over a strike length of 1679m. up to a depth of 120m. The potential in situ reserves of about 2.234 million tonnes has been estimated up to the depth of 50m. The deposit was considered to be uneconomical due to low grade of the order of 0.043 to 0.062% WO_3. However re-examination of data reveals that a promising strike length of 320m. can be taken up for detail exploration which contain about 0.27% WO_3 in zone B of Agargaon deposit.

MECL carried out detail exploration work in 0.30 sq.km. area along 320 m. strike length of Zone-B of GSI which was recommended for detail exploration up to 120 mRL. to ascertain thickness, grade and geometry of the ore body. 739.95m drilling has been done in 7 bore holes associated with sampling and analytical work. MECL estimated total probable reserves 0.57 million tonne of 0.32% WO_3. The beneficiation of the bulk sample yielded the final concentrate of 53.54% WO_3 with 43.6% WO_3 overall recovery. The stipulated 65% grade could not be achieved due to very low content of the valuable mineral in the feed.

TABLE- 1.F

THE DETIALS OF ORE ZONE AT 0.1% WO_3 CUT-OFF INTERSECTED IN BOREHOLES DRILLED BY GSI

BH.No.	R.L.(m)	Inclination	Section	Ore Zone at 0.1% WO_3 Cut-off			
				From (m)	To (m)	Thick.(m)	Grade WO_3%
AG-2	250.35	45°	-	62.25	63.75	1.50	0.536
				70.00	73.25	3.25	0.125
				123.65	125.15	1.50	0.206
				129.70	135.00	5.30	0.215
AG-2A	247.79	45°	-	10.65	12.15	1.50	0.123
				33.05	34.55	1.50	0.130
				144.30	145.80	1.50	0.183
AG-3	254.65		S1	18.75	20.25	1.50	0.107
				27.72	29.22	1.50	0.139
				38.50	41.52	3.02	0.620
				27.72	41.52	13.80	0.157*
AG-4	248.99	45°	S3	56.05	57.55	1.50	0.167
				60.30	61.80	1.50	0.708
				56.05	61.80	5.75	0.312
AG-5	246.30	55°	S5	15.60	17.10	1.50	0.118
				37.03	38.53	1.50	0.110
				51.35	53.85	1.50	0.115
				57.35	58.85	1.50	0.143
				67.07	68.57	1.50	2.900
				71.45	72.95	1.50	0.157
				51.35	72.95	21.60	0.237*
AG-5A	258.50	45°	S5	19.03	20.53	1.50	0.120
				34.08	35.58	1.50	0.135
				37.53	40.22	2.66	0.906
				46.95	48.45	1.50	0.208
				34.08	47.25	13.17	0.270*
AG-6	249.18	55°	S7	68.16	69.66	1.50	0.121
				91.90	102.02	10.12	0.132
AG-10	254.67	60°	-	53.47	54.97	1.50	0.131

TABLE- 1.G

THE DETIALS OF ORE ZONE AT 0.1% WO_3 CUT-OFF INTERSECTED IN BOREHOLES DRILLED BY MECL

BH.No.	R.L.(m)	Inclination	Section	Ore Zone at 0.1% WO_3 Cut-off			
				From (m)	To (m)	Thick.(m)	Grade WO_3%
MAT-1	248.22	45°	S6	11.50	18.50	7.00	0.165
				35.50	39.50	4.00	0.150
				45.00	46.50	1.50	0.135
MAT-2	246.34	45°	S4	79.60	81.10	1.50	0.106
MAT-3	249.53	45°	S5	106.60	114.70	7.50	0.374
				129.60	137.10	7.50	0.536
				106.60	137.10	30.50	0.239*
MAT-4	248.44	45°	S4	125.25	128.75	3.50	0.192
				144.25	152.75	8.50	0.360
				125.25	152.75	27.50	0.153*
MAT-5	253.86	45°	S3	15.30	16.80	1.50	0.225
				33.30	34.80	1.50	0.247
MAT-6	254.70	45°	S2	5.30	20.80	15.50	0.194
				56.80	58.30	1.50	0.570
				62.30	63.80	1.50	0.290
MAT-7	247.59	45°	S3	No ore zone of 1.50m			

*DILUTED ZONE

f) <u>North of Kuhi -South of Khobna (1981-1982): (GSI)</u>

GSI mapped an area of 4.2 sq. km on 1:5000 scale between Kuhi and Khobna Tungsten prospects. 48 rock chips/channel samples across different lithology were collected, 388 cu m pitting in 230 pits has been carried out and 210 nos. of bulk samples collected from 200m by 100m grid interval pits in the area.

Conclusion & Recommendation:

1) Rich Wolframite mineralisation is located in pit no. N42/0. One small trench put near this pit also exposed Wolframite/Scheelite bearing greisens. This trench lies 400m SW from 175m long Tungsten MINERALIZED zone, the area between the newly located incidence and the old zone of mineralisation hold promise for locating new Wolframite bearing greisens. This area is therefore, recommended for further detailed work by pitting, trenching as the area is occupied by soil cover.

2) In pit no N2/E2 and N4/E1 quartz tourmaline mica greisen have been met with. These greisen occur in the strike continuity of Kuhi mineralized zone and are located 700 m NE of it. Although during pitting no Wolframite was found but the area is congenial for locating Wolframite mineralization because of the existence of favourable geological set up. This however, needs confirmation by putting pits and trenches in the intervening area.

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g) Saongi-Chapegarhi Block (1985-87): (GSI)

Quantum of work carried out is as follows: SAONGI BLOCK

1.	Detailed mapping (1:2000 scale)	3.5 Sq km
2.	Trenching/pitting	154 cu m
3.	Collection of bulk samples	16 nos.
4.	Groove samples	16 nos.
5.	Core samples	494 nos
6.	Drilling	2367.80m (21 boreholes)

Conclusion & Recommendation:

i) The zoning of low W and lean Sn is suggestive that the block is relatively of deeper section i.e. an up thrown block compared to the Agargaon block.

ii) That the major Tungsten zone might have been already eroded away leaving a lean one in which case a possibility of tin-niobium-tantalum mineralization at greater depth is likely.

iii) Further deeper levels of the lithounits present in this area are far more favourable to the (deeper) zoning of Sn, Nb and Ta, relatively of high temperature, in comparison to the W.

Geological Survey of India concluded that the area is not encouraging from the point of view of economic Tungsten content/mineralization and further work is not required in the area.

h) Pandegaon, Saongi-South & Salwa-Bir Bothali area: (1986-88) (GSI)

Quantum of work carried out by GSI is as under:

1. Detail Mapping (1:5000) of 15.6 sq.km.
2. Pitting and trenching (3 to 4 m Depth) of 1396 cu m (200x200m grid).
3. 282 no of soil, bed rock chip and groove sampling (100x100m grid)

The area is mostly covered by a thick soil cap (2 to 4 m.) and laterite (1 to 2 m.) and comprises Sakoli metasediments like mica schist, phyllite, quartz schist, micaceous quartzite, ferruginous quartzite, minor amphibolite and granite gneiss. Several greisen zones have been noticed in the block and some have been investigated by cross trenching to delineate their strike length and width. However, no visible Wolframite or Scheelite was noted in most

of the greisen outcrops and no anomalous 'W' values were recorded in any of the bedrock sample of any other rock type. 'Sn' values up to 50 ppm were recorded in a few samples.

Recommendation:

Geological Survey of India concluded that the block does not appear to be promising for Tungsten or any other strategic mineral occurrence.

1.5.3 Geophysical Survey carried out by (GSI)(1984-86):

Geophysical surveys was carried out by GSI in two phases during 1984-86 with the objective of locating zones favorable for Tungsten mineralization in the Kuhi-Agargaon area, which was earlier geologically explored (Lokras et al., 1969, Reddy, 1980 Jain, 1982; Jain et al., 1982 etc.).

In the first phase (FS 1984-85), test geophysical surveys were carried out by GSI in the Kuhi-Khobna block, where a few zones of Tungsten mineralization were reported earlier following extensive geological investigations and drilling. These test surveys were aimed at developing a methodology for locating concealed Tungsten ore deposits in the Sakoli Basin by establishing correlation between measured geophysical parameters and mapped geological units in this area.

In the beginning of the second phase (FS 1985-86), GSI carried out surveys employing a variety of geophysical methods in an area of 0.3 sq km over a proved mineralized zone (Khobna zone-I) to examine the utility of these techniques in locating the Tungsten ore. Results of these investigations and the test surveys made in the Kuhi-Khobna area indicated that a combination of resistivity (gradient array technique) and magnetic methods is adequate to locate greisen zones, which are locations of Tungsten mineralisation. With this observation as the guiding factor the investigations were continued in the 2nd phase (85-86) in Kharbi, Chapegarhi and Saongi areas up to Agargaon using resistivity (gradient array) and magnetic methods.

Geophysical surveys (FS 1985-86) brought out several such anomaly zones in the area between Khobna and Agargaon. Noteworthy are two elongated zones, striking over a distance of nearly 3km each, traced in the Saongi-Agargaon block.

All the mineralized zones fall within the schistose rocks, except Zone-II of Kuhi block, which is located within gneisses.

Conclusion:

Geophysical investigations in this area were successful in bringing out several anomaly zones (characterized by high resistivity and magnetic associations) which may point to greisenised zones within schists a situation favourable for Tungsten mineralisation.

Thus, zones of high resistivity in association with magnetic anomaly may indicate greisens within schists, in this area. Similarly, high resistivity anomalies in non-magnetic zones may point to barren quartz veins. Most of the MINERALIZED zones in Kuhi-Khobna area are characterized by high resistivity and moderate to strong magnetic anomalies.

Since most of the established MINERALIZED zones in Kuhi-Khobna block fall in the high resistivity and magnetic anomaly zones, testing of such geophysical anomalies by scout drilling is highly desirable. The Southern anomaly zone, which lies in a soil covered terrain and is geologically unexplored, deserves immediate attention, as it appears to be the extension of Agargaon MINERALIZED zone and indicates continuation further into the Salwa block in the SW, where a few greisens zones have been reported.

Magnetic anomalies, which have been more or less continuously recorded in the Kuhi–Khobna block, disappeared near Kharbi village. Between Kharbi and Chapegarhi, magnetic surveys drew a blank indicating absence of schistose rocks in this area. Resistivity zones however persist and extend further towards East into Chapegarhi block without any magnetic association. These may indicate barren quartz veins.

2.0.0 Geological Setting

2.1.0 Bhattacharjee (1937) observed that rock units in the area display three sets of foliations, cleavages, nearly at 60° angle to each other, following the three different tectonic styles, viz. Eastern Ghats, Satpura and Godavari. This arrangement of the rock units has been referred by him as 'Bhandara Triangle' and the area under review forms the sub vertical limb of this triangle. The triangular arrangement of main Sakoli outcrops was first recorded by Bhattacharjee. Sausar series (now Group) are known to occur towards north of the Sakoli metasediments. According to Bhattacharjee and Chatterjee the bulk, if not the whole of Sakolis, stratigraphically overlies the Sausars and that the uppermost stage of the latter may be a more highly metamorphosed equivalent of the lowest of the Sakolis. On the basis of radiometric studies, Sarkar (1964) felt that the Sausar series may be stratigraphically younger than the Sakoli gneisses. The mineralized zone at Kuhi falls on the Western limb of the Sakoli Basin.

2.2.0 Geology of the Area

	Quaternary		Alluvium
M I D D L E	P R O T E R O Z O I C S	SAKOLI GROUP	Quartz veins / pegmatites (barren) Greisens and quartz veins (locale of Tungsten mineralization) (Boron metasomatism) Granite/Gneiss-pegmatite Metabasic rock, ferruginous Quartzite, quartz chlorite- sericite schist, chlorite mica schist

2.2.1 The rock types of Kuhi area belongs to Sakoli Group of rocks of Middle Proterozoic age. The Kuhi, Khobna and Agargaon Tungsten prospect lies towards the South-Western, central and north Eastern part of Kuhi-Agargaon Tungsten belt respectively (in Toposheet No. 55 O/8) in the Western part of Sakolis. The rock type exposed in the area comprise quartz-chlorite-mica-schist, mica-schist, chlorite-mica-schist (with porphyroblasts of garnet and magnetite), feldspathised schist and quartzite. The pelitic metasediments have been affected by granitic activity leading to the formation of migmatite and gneisses. Pneumatolytic and hydrothermal processes related to granite emplacement resulted in Tungsten mineralization which is confined to tourmaline-quartz mica/greisens/veins traversing the schists, near the contact of the gneisses. With the data of the surface and sub-surface work the following geological sequence has been worked out.

2.2.2 Description of rock-types

i) Quartz-chlorite-mica-schist: It is medium grained crudely foliated rock with grey to light green colour. It is the most widely developed formation. It is mainly composed of dark to pale green flakes of chlorite, grains of colourless to smoky quartz and varying amounts of muscovite and sericite. The various schistose units such as quartz chlorite-sericite schist, chlorite-mica-schist and quartz mica-schist represent lithological and mineralogical variations. Locally porphyroblasts of chloritoid, pink garnet and magnetite are seen. Tiny needles of tourmaline and coarse mica flakes are commonly seen.
Both towards north and South the schistose units near the contact of granite gneisses grade into migmatite.

ii) Gneisses and Migmatites: Exposures of these rocks are met with only in a few trenches and boreholes. Fresh section of granitic gneiss was observed further north-East of the area. They show well developed gneissosity with parallel arrangement of quartz,

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feldspar and mica. The feldspar is generally flesh coloured. Both muscovite and biotite are observed in the gneiss. The contact between the gneiss and schist is marked by high degree of felspathisation of the schists and with the presence of thin veins of quartz and pegmatites.

iii) Quartz vein: Quartz veins are seen concordantly emplaced in mica schist (and gneisses) along foliation. These are white in colour, massive in texture and made-up quartz with occasional mica flakes, chloritoid and tourmaline crystals. As observed towards West of Kuhi village, some of the quartz veins have length of about 70-80m and width varying from 5 to 10m. Some of the core samples show the presence of crystals of pyrite in the quartz vein.

iv) Pegmatite: Veins of pegmatite traversing schist and gneisses are seen in the area. Tourmaline (crystal) bearing quartz-vein and pegmatites are seen in mica schists and gneisses. But in comparison with the mineralized granulated tourmaline-quartz mica greisen, the quartz veins and pegmatites with tourmaline crystals are considered to be devoid of Tungsten mineralization suggesting their emplacement later than the MINERALIZED greisen. As observed in most of the borehole cores, tourmaline (crystals) bearing quartz and pegmatite veins show no Tungsten mineralization.

v) Greisens: Sheared and highly granulated rock consisting essentially of tourmaline-quartz and mica is called greisen. The country rock chlorite mica schist is traversed along the foliation by tourmaline-quartz mica veins/greisens. Tourmaline-quartz mica veins, which are carriers of Tungsten minerals (Wolframite and Scheelite) show intense brecciation. The dominant mineral of the greisen is tourmaline with considerable amount of quartz. The light coloured silver shining mica is seen in small amounts invariably.

Generally tourmaline-quartz-mica greisens / veins occur as lenses due to folding. They vary in width from a few cm to more than 2m and are emplaced concordantly in the mica schist country rock in en-echelon pattern.

a) Tourmaline-quartz mica greisen: it is black gray coloured granular rock consisting mainly of tourmaline, quartz and a little quantity of mica. This rock type is a usual carrier of Wolframite mineralization. Quartz core of the greisen is whitish and highly granulated with rich concentration of Wolframite and Scheelite. The mica which is present in small amount is of silvery white flakes. In many places the greisen shows alternate bands of quartz, mica and tourmaline. At places small veinlets of quartz traversing the tourmaline part of the greisen can be noticed.
The immediate contact of the tourmaline quartz-mica greisen with the schistose country rock shows tourmalinisation of the schists.

b) Quartz core of the greisen: It is whitish coloured, saccharoidal textured quartz vein in which Wolframite is concentrated either as disseminations or as large crystals. Disseminated specks of Scheelite and stingers can also be seen under ultra violet lamp. Concentration of Wolframite/Scheelite is mainly within the quartz core of tourmaline-quartz mica greisen.

c) Quartz-tourmaline-greisen: Towards North West of the Kuhi this type of greisen is very commonly observed traversing the feldspathised schist. It is composed mainly of quartz with sub-ordinate amount of tourmaline and very little mica.

Concentration of Wolframite is more in the earlier type of greisen, where tourmaline dominates over quartz than in this type where quartz is dominant over tourmaline.
At many places the mica-schist country rock is tourmaline rich due to boron metasomatism and all the variations between mica-schists and tourmaline schists are seen.

2.2.3 Structure: Due to the paucity of outcrops in the area (being soil covered) the available structural data are limited.

a) Foliation: Foliation is characterized by preferred orientation of mica and chlorite flakes and elongation of quartz grains. The lithounits have foliation trending NE-SW to E-W direction with steep dips towards South. Towards South-West of Kuhi the trend is E-W with dip towards north. Near Kuhi Railway station the schist trends in north-South direction with Easterly dip, representing the F-3 trend of cross folding. This place also represents the closure of the syncline.

b) Folds: The area has suffered three phases of deformation viz. NNE-SSW (F-1 tight isoclinal folds), N 60°E – S 60°W (F-2 isoclinal folds) and ENE-WSW (F-3, cross folds open). These phases of deformation have resulted in culminations and depressions.
In Kuhi the tourmaline zones together with country rocks form a syncline with plunges towards north-East. The limbs show a general steep Southerly dips.

3.0.0 Tungsten Mineralisation

3.1.0 The tourmaline-quartz mica greisens traversing the country rocks viz. Chlorite mica schist is Wolframite / Scheelite bearing. The mineralized greisens are concordantly emplaced along primary foliation of country rocks. Tourmaline-quartz mica veins are highly deformed and the associated Wolframite crystals show fracturing. The development of secondary Scheelite occurs as small coatings and disseminations along the fractures and cleavages of earlier formed Wolframite.
The individual greisens have been grouped into two major zones (I & II). These zones vary in width from a few meters to 100m and in strike length can be traced up to 3400m. However, the widths of the individual greisens vary from few cms to more than 3m. The mineralized zone extends along NE-SW direction with general Southern dips, which is in conformity with the regional trend. The main ore minerals of Tungsten are Wolframite and Scheelite.

i) Wolframite: The presence of Wolframite in tourmaline-quartz mica greisen is characterized by its crystal shape (as bladed crystals of 1.5 cm. dimension), well developed cleavage planes and its brownish black streak. Wolframite has high specific gravity of 6.7 to 7.5 and hardness varies between 4.5 to 5.5. With high content of iron over manganese, the ore mineral is termed as ferberite ($FeWO_4$).

ii) Scheelite: Scheelite is readily identified by its bluish white fluorescence with ultra-violet light. It is brittle with dull white to brownish pink colour, white streak and hardness of 4.5. The specific gravity varies between 5.8 and 6.2. Scheelite also occurs as secondary alteration product derived from Wolframite. There are greisens free from coarse Wolframite but have fine specks and stringers of Scheelite. The

major Scheelite is of primary origin related to hydrothermal mineralisation in association with sulphides.

The visible Tungsten mineralization is mainly observed in tourmaline quartz mica greisen and quartz core of greisen. But to a lesser extent it also occurs in tourmalinised schist. As observed from the trenches that most of the Wolframite crystals were won from the quartz core of the tourmaline-quartz mica greisen than in the adjoining tourmalinised schist.

Visible coarse Tungsten minerals are not observed in tourmalinised schist or chlorite mica schist, but the rocks on analysis have given values as high as 0.1% W indicating the presence of mineralization in very finely disseminated form.

Minor disseminations of molybdenite, chalcopyrite and pyrite also occur in association with Tungsten mineralization.

iii) Observations on Mineralisation :

a) Brecciated tourmaline-quartz mica veins/greisens traversing the mica schists are the carriers of Tungsten mineralization as Wolframite and Scheelite. At no place the tourmaline quartz mica greisen shows discordant relationship with the country rock.
b) Wolframite is the major mineral with subordinate Scheelite in the greisens intersected in many of the borehole. In some of the borehole cores only Wolframite is noticed.
c) In some other borehole cores it is also noticed that Scheelite and Wolframite in the greisen occur more or less in equal proportions.
d) Minor secondary Scheelite being alteration products of Wolframite is also observed along cleavage and fracture planes of Wolframite crystals.
e) Coarse Wolframite (crystals) mineralization is not uniform. The size of the greisen has no relation with the size of Wolframite crystals. Inside the village Kuhi, between borehole KT-9 and KT-11 a small exposure of tourmaline quartz mica greisen is noticed. It has a strike length of about 5m with maximum width of 2m. When part of the greisen was examined for wolfrmite/Scheelite, not much recovery of Wolframite was observed. Along the strike extension of the same zone just north-East of Kuhi, a small tourmaline quartz mica vein of 40 cm width has yielded good recovery of Wolframite crystals (Trench No.I). So the size of the tourmaline quartz mica vein/greisen has no relation with the grade of Tungsten.
f) Massive quartz veins of younger phase are devoid of granulated tourmaline and do not carry any Tungsten mineralization.

iv) **Control of Mineralisation:** At Kuhi Tungsten mineralization is controlled by lithology and structure. It is observed that rich Tungsten concentration is restricted to tourmaline-quartz mica greisens and quartz core of the greisens. Tourmaline-quartz mica greisens / veins emplaced concordantly in the tourmalinised schist and chlorite mica schist are the locale of Tungsten mineralisation. The NE-SW trending foliated contact zones of chlorite mica schist and gneisses have served as easy channels for the mineralizing vapours and solutions which formed ore bearing greisens and quartz veins emplaced concordantly along the foliation planes in the schists.

v) **Genesis of Mineralisation**: From field and drill core studies the Tungsten mineralization presumably formed in a polyphase manner. The county rock (with tourmaline-quartz-mica-greisens) schist is bound in either side by gneisses. Boron metasomatism of schists with simultaneous emplacement of greisens carrying Wolframite perhaps occurred in the first phase (Pulse). This was followed by Scheelite with minor quantities of pyrite, chalcopyrite and molybdenite. Thus, it appears that the Tungsten mineralization as Wolframite perhaps formed during the late Pneumatolytic stage and continued into hydrothermal stage as Scheelite with associated sulphides.

The MINERALIZED zones intersected in the boreholes drilled by GSI in Kuhi Zone-I, District- Nagpur Maharashtra, calculated on 0.10 % W cutoff is given in the table below: -

4.0.0 Proposed Exploration by MECL

4.1.0 Background

4.1.1 Tungsten mineralization at Agargaon in the Sakoli Basin was first reported by J. Kellersohan in 1907. This has led to the identification of Kuhi-Khobna-Agargaon belt in North-Western part of Sakoli Basin where a number of small Wolframite-Scheelite prospects were discovered and investigated by GSI.

A chance find of a float Wolframite picked up from a soak pit by a villager in Kuhi in 1978 led to intensive search for Tungsten mineralization in other parts of Sakoli Basin. Reconnoitery survey was carried out in various blocks by GSI in the Kuhi-Khobna-Agargaon belt and in adjoining area and based on positive outcome of this preliminary work; GSI initiated further detail work in Kuhi, Khobna and Agargaon area. MECL also carried out detail exploration in these 3 blocks. In the entire Kuhi-Agargaon Tungsten belt, the Wolframite mineralisation is intimately associated with tourmaline. The tourmaline is schistose/granulated type and contains fractures filled with quartz and mica. Where ever in the area such type of tourmaline is seen either in the laterite or as float in covered ground, it is to be investigated by trench or by close spaced pits.

The geophysical anomalies established by GSI in the intervening area between these blocks and adjoining area are still unexplored and needs to be proved by drilling. Thus a few scout boreholes are required to be drilled in the intervening areas. Also the entire Kuhi-Agargaon belt is covered with soil/ laterite and a very few scattered outcrops are available in the area; hence greisen bodies with Tungsten mineralisation in the country rock i. e. mica schist needs to be delineated with help of resistivity and magnetic geophysical survey.

(6)

4.2.0 Objectives

i. To prove the existence/occurrence of ore body/ mineralized zones indicated by geophysical anomaly i.e. resistivity and magnetic anomaly zones already established by GSI and to ascertain potentiality of Tungsten mineralisation in the intervening area between Kuhi, Khobna and Agargaon by drilling scout boreholes.

ii. To drill scout boreholes to know the continuity of mineralized zones in the gap area of Kuhi-Khobna area.

iii. To establish the consistency & reliability of the grade of ore zone over a promising strik length up to 50m vertical depth.

iv. To estimate the Tungsten resources in the gap area.

v. To study mineralogical characteristics of ore.

5.0.0 Methodology of Proposed Exploration

5.1.0 Topographic Surveying: The block area of the prospect would be tied up by triangulation network. Cross section lines will be laid down in the field. Proposed boreholes will be located on ground and their co-ordinates and RL's will be determined. Efforts will be made to locate GSI boreholes on ground and RL, coordinates of same will be determined as far as possible.

5.2.0 Detailed Geological Mapping: The detailed geological map prepared by GSI/MECL will be updated by taking traverses along section lines. All the geological features like lithological contacts, structural features, old working etc. will be marked on map. The detailed mapping will be done on 1:10000 scale. This map will be used as base map for exploration in the study area to orient the exploratory drilling.

5.3.0 Surface Drilling:

5.3.1 The proposed drilling programme has been oriented mainly to explore promising tourmaline quartz mica greisen containing Tungsten mineralisation/zones established by surface geophysical survey i.e. Resistivity & Magnetic up to 50 m depth from surface & in some boreholes up to intersection of 2nd anomaly zone proposed along four section lines.

Boreholes PBH-1 & 2 are proposed on section line A-A'; PBH-3 on section line B-B'; PBH-4 on section line C-C'; PBH 5 on section line D-D' to intersect the ore zone/ greisen indicated by Resistivity & Magnetic anomaly.

A total of 945.00 m of drilling in 5 boreholes have been proposed.

The location of proposed boreholes is presented in Borehole location map (Plate No.-III), and Geological cross sections, (Plate No.-IV). The details of proposed boreholes is given in Table-5.1

SL. N0.	Section Line No.	Proposed BH. No.	Bearing (Azimuth in degree)	Angle from horizontal (in degree)	Proposed depth of boreholes (m)
1	A-A'	PBH-1	N45W	45^0	80.00
2	A-A'	PBH-2	N45W	45^0	205.00
3	B-B'	PBH-3	N45W	45^0	175.00
4	C-C'	PBH-4	N45W	45^0	160.00
5	D-D'	PBH-5	N45W	45^0	325.00
				Total	**945.00**

5.4.0 Core logging and Sampling

5.4.1 Core logging: Borehole cores will be logged systematically. The mineralized zones are associated with tourmaline – quartz mica greisens traversing the country rocks viz. chlorite mica schists is Wolframite/ Scheelite bearing.

5.4.2 A. Drill Core Primary & Check samples: The primary samples will be prepared for greisen and mineralized portion of each borehole. The mineralized & greisenised core portion at 0.50m length interval will be splitted longitudinally into two equal halves. One half of the core will be preserved for reference while the other half of the core will be powdered to (-) 100 mesh size. The sample will be mixed thoroughly, conned & quartered and half portion of the sample will be further grinded to (-)200 mesh size and 100 gram of samples will be sent for WO_3 % determination, check samples analysis etc. Check samples (10% of primary samples) will be analyzed in MECL, Chemical Laboratory, Nagpur as **Internal Check Samples**. Around 5% Check samples will be analyzed in any other NABL accredited laboratory as the **External Check Samples**. Thus a total of **1295 No (1130 Primary + 110 Check and 55 External check)** of samples will be prepared for analysis of Tungsten. 110 numbers of samples shall be analyzed for Cr, Mo, Sn, Ta, Nb, V & Sn.

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B. Composite samples: From drill core primary samples, about 30 nos of composite samples from all the Tungsten MINERALIZED zones / lodes will be prepared. All the composite samples will be analyzed for Tungsten. 10 composite samples will also be analyzed for Mo, Ni & Co. Trace elements study (15 elements) i.e. W, Cu, Pb, Zn, Ni, Co, Sn, Nb, Ta, Mo, Bi, Ag, V, Zr, & Ga will be carried out on 20 nos composite samples by ICP-MS method. 20 composite samples will be subjected to XRD studies for mineral phase analysis.

5.4.3 Petrological & Mineragraphic studies: 20 rock specimens from host rock and other litho units will be subjected to petrographic studies and mineragraphic studies will be done on 20 nos. of specimen from mineralized zone/lodes.

5.4.4 Specific Gravity determination: 30 nos. of drill core lump specimen from ore bearing host will be sent to laboratory for specific gravity determination.

5.5.0 Report Preparation:- All the data generated as a result of exploration along with synthesis of earlier GSI/MECL data would form the data base for exploration report. The report will be submitted in digital format.

6.0.0 The quantum of work proposed is given in Table-6.1

Table - 6.1 - Quantum of work proposed

Sr. No.	Item of Work	Unit	Quantum
1	Geological mapping (1:12500 scale)	Sq.Km.	57.00 Approx.
2	Drilling (Scout Boreholes)	m.	945 m (5 BHs)
3	Laboratory studies		
	Primary+ Internal Check samples+ External Check samples **(Borehole Core Samples)**		
	i. For Tungsten	Nos.	1130+110+55=1295
	ii. For Mo, Sn, Ta, Nb, Ni & Co.	Nos.	110
	Composite samples **(borehole Core Samples)**		
	i. For Tungsten	Nos.	30
	ii. For Co, Ni & Mo	Nos.	10
4	. Physical Analysis		
	a. Trace Element studies by ICP-MS (15 elements)(W, Cu, Pb, Zn, Ni, Co, Sn, Nb, Ta, Mo, Bi, Ag, V, Zr, Ga)	Nos.	20
	b. XRD studies	Nos.	20
5	Petrological Studies		
	a) Petrographic Studies	Nos.	20
	b) Mineragraphic studies	Nos.	20
	c) Specific Gravity Determination	Nos.	30
6	Exploration Report (digital format)	Nos.	1

(2)

7.0.0 Time schedule and Cost estimates

7.1.0 Time schedule: The proposed exploration programme is planned in such a way that all the activities like, camp setting, winding, drilling, survey and associated geological work and laboratory work will be completed within 5 months' time. Report writing including Peer Review of report will take another 4 months' time overlapping one month with other field works. Thus the total duration of the project shall be completed in 8 months from the date of commencement of the project.

The bar chart showing activity wise time schedule is placed at Table-7.1.

7.2.0 Cost estimates: The Project cost with provisional escalation is estimated at **Rs. 126.564 Lakhs.** The details of item wise cost estimate with inbuilt actual escalation as on 31.3.17 and same has been considered for subsequent years is given in Table No. 7.2. The summary of the item wise cost is given below:

Summary of Cost estimates

Sl. No.	Item	Estimated Cost (Rs.)
1	Drilling	7306521/-
2	Geological Activities	1415990/-
3	Laboratory Study	1353645/-
4	Core Preservation	464650/-
5	Sub Total (1 to 4)	10540806/-
6	Exploration Report (1% of Sl. No 5) or 175000 whichever is Higher	175000/-
7	Peer Review	10000/-
8	Subtotal (5+6+7)	10725806/-
9	GST (18% of Sl. No 8)	1930645/-
	Grand Total	**12656451/-**

Or Say, 126.564 lakhs

8.0.0 Justification

i.	Tungsten being a strategic mineral with very high demand in Indian market, a lot of exchequer (foreign currency) is being incurred on import of Tungsten.
ii.	High Priority has been accorded to strategic minerals (Tungsten etc.) in the National Mineral Policy -2008.
iii.	The mineralized zones intersected in GSI boreholes are open in dip and strike direction hence the continuity of the lodes require further proving.
iv	The geophysical anomaly zones established by GSI in Kuhi-Khobna-Agargaon area needs to be validated by drilling scout boreholes.
v	The block lies in close vicinity to other blocks i.e. Khobna and Agargaon. Hence these blocks together will be helpful in cluster mining in future.