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Geochemical Exploration and Processing Studies for Graphite and Tungsten Minerals from Burugubanda-Tapaskonda Areas of East Godavari District

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Graphite-tungsten mineralization occurs in the graphite schists associated with khondalites from Burugubanda-Tapaskonda areas of East Godavari district. Geochemical and geophysical methods of exploration followed by soil and stream sediment sampling clearly demarcated the zones of tungsten mineralization in association with the graphite ore bodies. The fixed carbon and tungsten contents varies from 6.5-10.5 % Folin-Ciocalteu reagent and 0.1-0.5 % WO_3, respectively. The low grade graphite deposits as well as tungsten minerals were subjected to processing studies adopting different techniques to achieve maximum percentage of recovery. The final product of recovery assaying 60-80 % Folin-Ciocalteu reagent and 60-65 % WO_3.

Key Words: Exploration, Tungsten minerals, Graphite, Burugubanda, Tapaskonda.

INTRODUCTION

Graphite was reported to occurs at Burugubanda-Tapaskonda areas. Rampachodavaram mandal, East Godavari district, Andhra Pradesh (Latitudes 17º15′ -17º30′, Longitudes 81º45′-82º E in survey of India toposheet 65G/15). Krishnaswamy[1] and Parthasaradhi *et al.*[2] reported the occurrence of graphite-tungsten mineralization in these areas. Rao *et al.*[3] studied these deposits in detail with reference to mineral beneficiation. Potential areas demarcated for tungsten mineralization are Burugubanda, Chinagalikonda, Sitapali-Utla, Marripalem-Murrikonda areas. The deposit at Tapaskonda area is one of the biggest deposits having reserves of about 10 M.T. with 0.1 % WO_3 and 7.5 % F.C. Presence of tungsten minerals in the country rocks as well as in pegmatitic bodies indicates that they may be used as good prospecting tools for the identification of crystalline graphite deposits.

As a part of economic evaluation of tungsten-graphite mineralization, the study on the dispersal of tungsten minerals in the stream sediments and soils has been taken up to find out *in situ* ore deposits as heavy concentrates of tungsten in the vicinity of Burugubanda-Tapaskonda areas. To obtain maximum recovery from the low grade deposits of the study area, feasibility tests have also been carried out on the graphite (by foliation) and 0.1-0.5 % WO_3 content bearing tungsten tailings (by gravity separation methods).

EXPERIMENTAL

Occurrence of graphite alongwith accessory tungsten mineralization in the graphite schists/gneisses associated with graphitic garnetiferous sillimanite gneisses (kondalite group) of the study area (Fig. 1). Quartzites, leptynites, calcium silicates/ calcium granulites are the other litho units of the khondalite group. Basic and intermediate variants of the charnockite group occur as narrow interbanded ridges in the kondalite group of rocks. Graphite occurs as three lensoidal bodies varying from few centimeters to few meters in width and about 180-200 m in strike length and often reaching the depth of 80-100 m. General NE-SW trend of strike direction gives rise to North Easterly plunging anticlinal fold limbs dipping towards East and West directions with a steep dip of 60-80º. Graphite mineralization is confined to the Western limb of the plunging fold mainly at the contacts of pegmatitic intrusives and quartz vein intercalations. Graphite was intimately associated with altered feldspar, mica quartz, garnet, sillimanite and zircon in varying proportions. Graphite schists/ gneisses are the host rocks for the tungsten mineralization. Wolframite and scheelite are the most predominant accessory minerals which occur in the form of lustrous coarse crystalline, massive, granular and disseminated varieties. Some crystals of tungsten minerals weigh up to 0.5 kg.

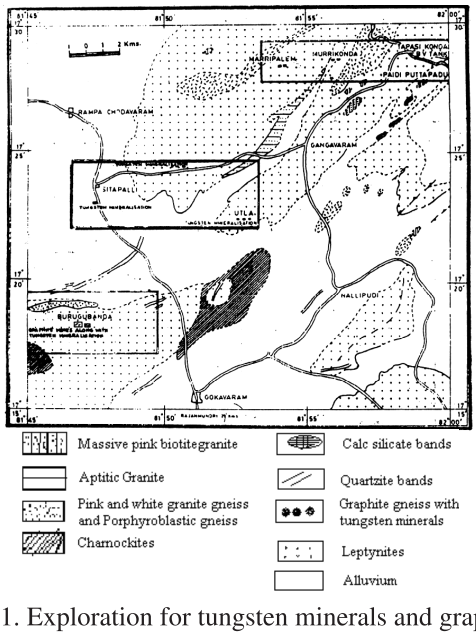

Fig. 1. Exploration for tungsten minerals and graphite

Geochemical exploration: Stream sediments and soil samples have been systematically collected from the (i). Burugubanda-Chinagalikonda areas; (ii) NE region *i.e.*, around Sitapalli-Utla areas and (iii) further NE *i.e.*, around Marripalem-Murrikonda, Tapaskonda, Pydiputta areas. After drying the samples were sieved through 80 mesh and then subjected to micro chemical and spot tests for tungsten. Tungsten content estimated by colourimetric method suggested by Stanton[4]. Geophysical surveys for graphite in Eastern Ghats have also been carried out by Bhattacharya *et al.*[5]. Estimated range of tungsten. The data reveals that the stream sediments and soil samples of these regions carry more tungsten values than the other regions where threshold values are about 10-12 ppm tungsten (Table-1).

TABLE-1
TUNGSTEN VALUES IN THE STREAM AND SOIL SAMPLES

Area of collection	Nature of sample	Tungsten content	Remarks
Burugubanda	Stream sediment	80-135	Megascopic tungsten Mineralization is seen in pegmatites and Quartz veins
Chinagalikonda	Soil sediment	40-80	
Sitapalli	Stream sediment	60-90	Tungsten minerals
Utla	Soil sediment	30-70	Not observed
Tapaskonda	Stream sediment	75-110	Fine disseminations of tungsten minerals are seen pegmatite and quartz veins
Pydiputta Marripalem	Soil sediment	60-80	

Active mining operations are going on in Burugubanda area. Prospecting pits on Chinagalikonda area hill top (Fig. 2) region were exposed graphite bodies at A, B1, B2 and C points with significant geochemical and geophysical anomalies. Similarly geochemical anomalies at Sitapalli-Utla area, Marripalem, Pydiputta, Tapaskonda areas have revealed low grade graphite deposits with tungsten values. Active prospecting work by pitting, trenching and drilling methods were going on all the loads which yield low grade graphite ore.

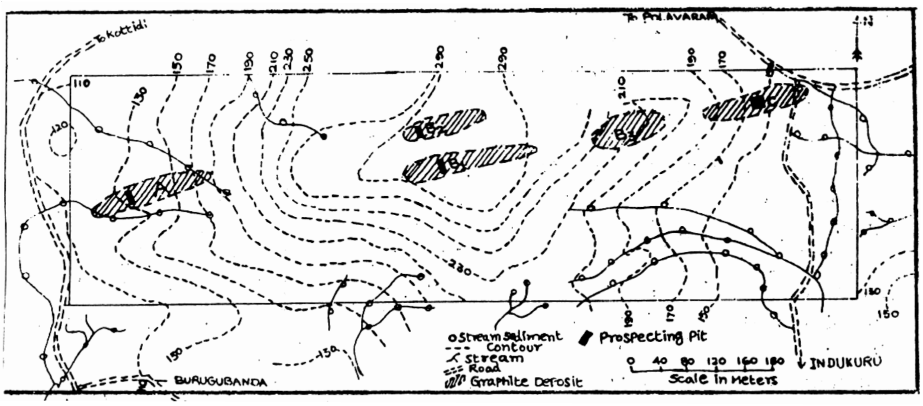

Fig. 2. Map showing graphite-tungsten mineralization in Chinagalikonda

Representative samples have been collected from the mine faces and prospecting pits. Burugubanda samples contain medium to fine grained graphite flakes along with feldspar, mica, quartz, garnet, zircon, wolframite and scheelite. Tapaskonda samples do not exhibit any visual tungsten minerals apart from other associated minerals. Optical properties of the tungsten minerals are given in Table-2.

TABLE-2
OPTICAL PROPERTIES OF TUNGSTEN MINERALS

Mineral	Polishing property	Hardness	Reflectivity	Etching	Characteristic property
Wolframite (Burugubanda)	Takes good polish cleavages visible	High	Internal reflections in oil	Negative to all reagents	Low anisotropism Extinction
Wolframite (Tapaskonda)	Poor polish cleavages visible	Medium	Internal reflections in oil	Negative to all reagents	Low anisotropism alternation on grain boundaries and cracks
Scheelite	Good polish	Medium softer than Wolframite	Low reflectivity	Negative to all reagents	Scratches and cracks

Processing studies: The graphite material from different locations of the study area were collected. After crushing the samples were ground to 100 mesh and then subjected to flotation tests for the recovery of graphite. Flotation was carried out in Denver sub 'A' cell using the flotation reagents kerosene as collector, pine oil as frother, sodium silicate as depressor, sodium carbonate as pH controller. The pulp is conditioned for 3 min at 30 % pulp density and the froth collected for about 1.5 min (Table-3).

TABLE-3
RESULTS OF FLOTATION PROCESS ON DIFFERENT GRAPHITE MATERIALS

Location of the sample	Percentage of F.C. in feed	1st flotation percentage of F.C. in concentrate	2nd flotation percentage of F.C. in concentrate	3rd flotation percentage of F.C in concentrate
Burugubanda	10.50	48.30	67.50	80.50
Chingalikonda	6.50	33.40	43.60	60.30
Utla	7.10	39.30	50.30	62.50
Pydiputta	6.90	37.50	42.60	60.30
Tapaskonda	7.30	38.50	50.50	35.50 *-200# (70.30) -400# (87.50)

*: Tapaskonda sample -200# and -400# gave better concentrate after 3rd flotation.

RESULTS AND DISCUSSION

Feed material for this process is the tailings obtained after the graphite flotation. The tailings contain tungsten minerals with 0.100-0.125 % WO_3 contents. Taking the advantage of the specific gravity (wolframite 7.1-7.9; scheelite 5.9-6.9), the tailings were subjected to hydrocyclone experiments. Coarse fraction was subjected to gravity separation methods like jigging, tabling processes. Coarse heavy fraction underflow from cyclone was subjected to tabling operation repeatedly to get a final product of nearly 160 g. Results of the experiments were given in Table- 4. The cyclone underflow was subjected to panning. Panning concentrate fraction of 19.20 % obtained with 45.75 % WO_3 content. But the actual marketable grade of wolframites is 65 % WO_3. Pan concentrates and cyclone underflow contains garnet, magnetite-ilmenite minerals which can be separated by high intensity magnetic separation before going to wilfly table experiments.

TABLE-4
RESULTS OF HYDRO CYCLONE WASHINGS OF TABLE TAILS

Feed to cyclone (g)	After washing underflow (g)	WO_3 content before washing (%)	WO_3 content after washing (%)	Remarks
5000	2485	0.250	0.425	Ratio of concentration nearly twice each time recovery 95 %
2485	1260	0.415	0.825	
1260	635	0.825	1.585	
635	330	1.585	3.085	
330	162	3.085	6.125	

Number or tabling experiments have been carried out using cyclone underflow as the feed material with 6.125 % WO_3. The results obtained at optimal conditions are only presented in Table-5. There are considerable loss in the tails and these are treated as middlings which were subjected to tabling and the 80 mesh fraction was subjected to flotation experiments. This process did not yield satisfactory results but it can be used/applied to obtain an unknown product as pre concentrate which can be subjected to other suitable process to obtain a better concentrate.

TABLE-5
TABLING EXPERIMENT RESULTS (FEED-500 g PULP DENSITY AT 25 %; RIFFLE SPACING AND STROKE LENGTH CONSTANT)

Table tilt o-	Particle size ASTM	Ratio of flow of water (L/min)	Quantity of conc. (g)	Tungsten content WO_3		Remarks
				Before test	After test	
5.0	-40 + 45	5	28.00	0.35	6.25	
5.0	-45 + 80	5	21.50	0.35	8.12	
2.5	-80	5	21.50	0.65	15.12	
5.0	-80	5	20.60	0.65	15.50	1st repeat
Cyclone under flow						2nd repeat
5.0	250	5	125.50	0.125	25.10	3rdrepeat
5.0	250	5	123.25	25.100	51.10	Loss in tiles
5.0	250	5	206.25	51.200	62.40	
5.0	100	5	90.80	62.400	67.90	

The table concentrates with 51.5 % WO_3 gave good concentrates after repeated tabling, but good quantity of middlings were collected with a recovery of 82 %.

The concentrates with magnetite, ilmenite and garnets have been separated giving a final concentrate assaying 66.2 % WO_3.

Samples from Tapaskonda did not respond so clearly for the recovery of either graphite or tungsten minerals at coarser sizes. But upto 85 % recovery of graphite the grades of 85 % F.C and upto 48 % WO_3 content at 200 mesh size which is not economical at the present juncture. Improved methods of processes have to be taken up and the studies are in progress.

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