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The complications involved in processing graphite ore from Tapaskonda area, East Godavari district, Andhra Pradesh

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ABSTRACT

Graphite is one of the most versatile non-metallic minerals because of its diverse properties. To make the graphite suitable to any group of industry need special type of treatment or processing of the ore. Efforts are made to study the feasibility of economic processing to get a commercial grade of graphite to suit the specific industrial uses and at the same time recovering the tungsten values from the identified sources are in progress. The various complications and implications are discussed. Burugubanda graphite deposit (SW) zone does not pose any difficulty, but Tapaskonda graphite (NE) zone posses complications during grinding to coarse medium and fine sizes and recovery of tungsten values at various stages by suitable processes like jigging, tabling, hydrocyclones. The gravity recovery is maximum in fine sizes –200 mesh giving a grade more than 90% F.C. and 88-90% of recovery. During comminution process and size seperation the complications are explained. After crossing all the complications we could achieve a final grade of graphite assaying 90% F.C. with 85% of recovery. After obtaining preconcentrates of WO_3 we could finally achieve the 60% WO_3 marketable grade is 65% WO_3. Further studies are in progress to have a detailed mineralogical, particulate and geochemical studies of tungsten and graphite and other associated minerals so that we can suggest a suitable method to have a better grade of tungsten concentrate considering the large promising potentialities of the ore in Andhra Pradesh.

INTRODUCTION

Previous work is done by Pardhasaradhi and Appavadhanulu[2], Kameswara Rao *et.al.*[1] and others. Tapaskonda graphite deposit even though of low grade variety because of its association with tungsten minerals it got prominance for detailed exploration. It is one of the major deposits of 11 million tonnes as reserve with 7 to 15% graphite content and 0.1 to 0.18% WO_3 content. Graphite has many industrial applications and its association with tungsten which has many industrial and in defence purpose and is one of the most strategic minerals of India. Our country needs about 2500 tonnes/year and is expected to reach 4500 tonnes/year by the turn of the century. The intense prospecting activity undertaken in this country has led to the establishment of an in situ geological resource bases of nearly 30,000 tonnes of tungsten metal at a cut of grade of 0.1% WO_3. Effort to study the feasibility of economically viable processing of graphite and recovery of tungsten values is in progress and during the experiments the complications and implications are discussed in the present paper.

MINERALOGICAL,CHARACTERISTICS OF THE ORE SAMPLE

The Tapaskonda ore sample was stage crushed with intermediate screening to all passing through 5mm screen and a representative sample was drawn from the whole lot for determining mineralogical, chemical and particulate characteristics. Although this sample chemically assayed 0.102% WO_3, microscopic examination did not reveal wolframite grains. However some samples were showing stringers of wolframite mineral.

Tapaskonda sample is more weathered than Burugubanda sample. The few wolframite grains obtained by heavy media separation account only for a fraction of total WO_3 content of the ore as obtained by chemical analysis. Tapaskonda ore was lithologically more schistose with lesser quantity of quartz feldspathic patches and in the inter veining feldspathic quartz veins. Rarely one can see megascopically identifiable nuggets, ore lenses or stringers of wolframite and presumably wolframite occurs as fine disseminations only. Discrete wolframite identified, occurs either as coarse euhedral grains with incipient alteration or as highly porous aggregates of crisscrossing fine needles. Varying degree of alterations of wolframite along grain boundaries, cracks are observed. The tungsten may occur as other forms of minerals such as anthoinite ($AlWO_4(OH)H_2O$), welinite (WO_3SiO_3) or some sort of tungsten ochre or wolframoixiolite [(Nb, W, Fe, Mn)O_2] confirmed by X-ray diffraction studies. The mineralogical composition of Burugubanda and Tapaskonda samples are given in Table 1.

Table 1 : Mineralogical composition of Burugubanda and Tapaskonda ore samples

Mineralogical constituents	Percentage by weight	
	Burugubanda	Tapaskonda
Quartz + feldspar	85.70	88.40
Graphite	10.40	7.10
Garnet, Sillimanite, Zircon etc.	2.00	1.60
Iron Oxides, Rutile & Tungsten min. sulphides	1.90	2.90
	100.00	100.00

Size analysis of crushed samples were carried out and the distribution of mass and tungsten content as a function of particles size were estimated. The results are given in the Table 2.

Table 2: Weight and tungsten distribution as a function of particulate size in Tapaskonda sample

Particle sizes mesh	Weight (%)	Assay, (%) WO_3	Distribution (%) WO_3
+6	11.48	0.11	11.30
–6 + 10	18.36	0.12	16.80
–10 + 16	12.40	0.10	11.85
–16 + 22	14.35	0.09	12.05
–22 + 45	3.80	0.10	3.55
–45 + 60	3.65	0.13	4.15
–60 + 80	4.95	0.12	5.20
–80 + 100	7.85	0.13	11.35
–100 + 120	5.50	0.13	7.15
–120 + 200	4.50	0.10	4.15
–200 + 400	4.90	0.12	5.05
–400	8.21	0.13	8.05

LIBERATIONS STUDIES

Detailed liberation studies were carried out on carefully crushed graphite sample of Tapaskonda. The ground material was sieved to different closed size fractions and each size fraction was subjected to heavy media separation using bromoform (sp. gr. 2.814). The bromo light and heavy fractions (B.L., B.H.) were chemically analysed for their WO_3 content. Both bromo lights and bromo heavies products obtained from each set of size fractions were microscopically examined and quantitative estimations of both fully liberated and composite wolframite values were carried out. The liberation data is given in the Table 3.

Table 3 : Liberation data on Tapaskonda ore sample

Particle size mesh	Weight (%)	% of WO_3	% of WO_3 distri-bution	% of Heavy media fraction	% of Lights	% of WO_3	% of WO_3 distri-bution
−6+10				B.H.(F.L)			
−10+16				B.H.(comp)	0.85	1.90	14.25
−16+25	45.11	0.13	52.80	B.L.(comp)	40.00	0.10	37.55
(−6 + 25)							
−25+45				B.H.(F.L)			
−45+60				B.H.(comp)	1.20	0.60	5.20
−60+70	12.40	0.10	14.95	B.L.(comp)	19.95	0.07	9.75
(−25+70)							
−70+80				B.H.(F.L)			
−80+100				B.H.(comp)	0.50	0.85	3.60
(−70+100)	12.80	0.15	7.15	B.L(comp)	6.75	0.07	3.55
−100+120				B.H.(F.L)			
−120+200				B.H.(comp)	0.70	1.70	8.40
(−100+120)	10.00	0.15	13.40	B.L.(comp)	11.20	0.06	5.00
				B.H.(F.L)			
−200+400	4.90	0.13	5.60	B.H.(comp)	0.60	1.20	2.70
				B.L.(comp)	4.80	0.01	2.80
				B.H(F.L)			
−400	5.40	0.16	5.10	B.H.(comp)	0.80	1.35	2.30
				B.L.(comp)	4.30	0.01	2.80
Head	100	0.13	99.00		98.90		

B.H. - Bromo heavies B(comp)-Bromo composite; B.L. - Bromo lights
B(F.L.) - Bromo fully liberated.

In the case of Tapaskonda sample no distinct grain of wolframite could be seen significantly except in coarse fraction. During heavy media separation the phase separation was incomplete. However liberation estimates were completed with judicious corrections wherever needed and the data is given in the Table 3. No wolframite grains liberated or composite could be identified in both the heavy media fractions except in the coarsest size fractions. The maximum liberation obtained was in –100+120 mesh which come to about 60%. There is no much improvement in the liberation in –200 mesh fraction. The very low liberation in +70 mesh size indicate that it is not possible to achieve quantitative recovery of wolframite values in Tapaskonda ore in coarse sizes.

So attempt is made to recover tungsten in –200 mesh and finer sizes. But at the fine size separation of graphite by flotation process poses problems as the graphite smears the gangue minerals considerably and they also come out along with graphite concentrates diluting the graphite concentrate. So care must be taken to prevent the smearing effect or atleast minimise the smearing effect. Application of flotation process at –200 mesh and later on on filteration is another problem and finally drying to a minimum of 1% moisture.

Beneficiation studies on Tapaskonda sample after making preliminary beneficiation studies were carried out after grinding the sample to pass through –25 mesh. The coarse size was subjected to multistage jigging. The jig tails were ground in a rod mill and mixed with –25 mesh. Graphite was floated initially and the flotation sink fraction was subjected to tabling process. The results are in Table 4. The jig concentrate assayed only 1.5% WO_3 and contained 8.7% of tungsten values. No visible grains are seen even after 3 cleanings of the rougher jig concentrate. Tabling of final jig concentrate after grinding also did not give any good result worth mentioning. The graphite float assayed 30.50% F.C. with 95% recovery.

Since jigging experiments could not recover the tungsten values in coarse sizes, another test i.e., further crushing and grinding of the material to –l mm and the material is subjected to screening to give different sizes –100+200; –200+400; –400 which were processed separately after floating the graphite from all sizes and the sinks were subjected to shaking tables (Wilfly). The results are given in the Table 4. Table concentrates are further subjected to panning experiments to test the feasibility of the process further.

Table 4 : Beneficiation results on Tapaskonda sample

Paricle size mesh	Tabling			Panning		
	WO_3 in feed	WO_3 in conc.	Ratio of concentration	Before	After	Ratio of concentration
+100	1.65	2.35	1.42	2.35	7.05	3.00
–100+200	1.80	3.15	1.75	3.15	10.45	3.31
–200+400	2.05	4.20	2.04	4.20	13.60	3.23
–400	2.65	5.35	2.01	5.35	18.05	3.37

The above results suggest that in the process of tabling the ratio of concentration is nearly twice in the case of finer sizes where as the panning process gave a better yield with a ratio of concentration more than 3 and uniform in all the size ranges. Based on the above results the flow sheet has shown in Fig.1 is suggested.

The graphite floats from –100+200 and –200 mesh fractions do not carry much tungsten values but the graphite from +100 mesh carried nearly 25–30% of the tungsten values probably due to non-liberation of the tungsten graphite coating on the tungsten minerals. These two graphite floats were ground in a rod mill to –200 mesh to contain mostly –400 mesh and the material was subjected to graphite flotation using kerosene as collector, sodium silicate as depressant and sodium carbonate as pH controller and pine oil as frother. Now the float contains only 3.5% tungsten values retaining most of the tungsten values in sinks. The 3.5% of tungsten values might have received the graphite coating due to smearing or they might have been locked up in the graphite particles intricately.

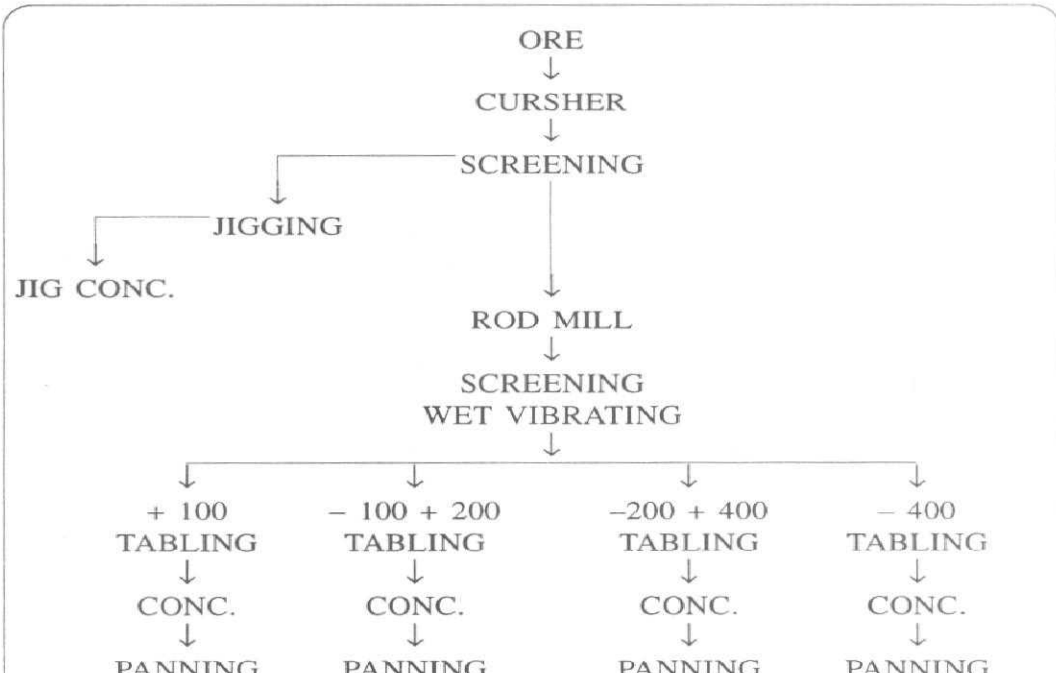

Fig. 1 : Flowheet for the concentration of Tapaskonda Ore.

One important test has been carried out to test the efficiency of the recovery of tungsten values which behaves with complexity, four sizes of (+100; –100+200; –200+400; –400) of Tapaskonda sample sinks weighing 150 grams and 50 grams of pure tungsten mineral wolframite of the same size is mixed well and subjected to panning (40cm. dia; 7.5 cm deep with bevelled sides and slightly rough plain bottom). The pan concentrates along with the original WO_3 added is completely recovered with no losses except in the case of –200+400 mesh the loss is about 0.15% WO_3 minerals which is quite expected. This indicates that the free completely liberated tungsten minerals from graphite can be recovered. So, gravity separation methods are quite susceptable in the Tapaskonda samples also provided we have complete liberation of the minerals. The tungsten associated with other minerals geochemically cannot be recovered. The experimental results are given in Table 5.

Table 5 : Experimental results on synthetic mixture

Particle size mesh	Tapaskonda sample flotation sinks	WO_3 in the (Tapaskonda) flotation sinks	Pure WO_3 mineral added (Gms)	Total %WO_3 regained after panning	Loss during panning
+100	150 gr	1.65	50	51.62	0.030
–100+200	150	1.80	50	51.78	0.020
–200+400	150	2.05	50	52.00	0.050
–400	150	2.65	50	52.65	0.035

DISCUSSION

Burugubanda – Tapaskonda graphite deposit is one of the biggest promising deposit with considerable quantities of WO_3 minerals. An attempt is made to recover both graphite and tungsten minerals from Burugubanda – Tapaskonda deposit. Burugubanda forms S–W end of the deposit disconnected and continued to NE giving rise to biggest deposit of the belt. Burugubanda deposit material is easily susceptable for recovery of graphite and WO_3 minerals easily to get a marketable grade with 90% recovery, whereas Tapaskonda deposit is not easily susceptable for recovery of graphite and WO_3 minerals from gangue and graphite and graphite from gangue minerals. The maximum separation or liberation is at –200 mesh and 400 mesh. Even at the size repeated operation of flotation for graphite and panning and tabling and cyclone separation for recovery of WO_3 minerals, from –100 mesh downwards. Maximum recovery and separation is possible at around 400 mesh. Even the WO_3 concentrates do not need the market grade it has to be further treated to give the marketable grade. Further work with respect to Tapaskonda area is in progress.

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REFERENCES

[1] Rao, K. Kameswara, Murali, N. Sivaram and Rao, K. Prabhakara, (1995), 'Revoery of tungsten minerals from graphite deposits of Burugubanda area, East Godavari District, Andhra Pradesh', *Energy, Environment and Resource Development*, (Eds. Sastri S.R.S., Rao, R. Bhima., Reddy, P.S.R., and Ray, H.S.), Allied Publishers, New Delhi, pp.216-221.

[2] Pardhasarathy, E.V.R., and Appavadhanulu, K., (1976), 'Tungsten mineralisation near Burugubanda', East Godavari District, Andhra Pradesh, G.S.I. Misc. Publication No. 23(2), pp.570-579.