"BENEFICIATION OF GRAPHITE FROM SIVA GANGA AREA RAMNAD DISTRICT TAMIL NADU SOUTH INDIA"

PROF K. KAMESWARA RAO
DEPARTMENT OF GEOLOGY
ANDHRA UNIVERSITY
WALTAIR - 530 003
ANDHRA PRADESH
I N D I A.

A. NARASIMHA MURTY
RESEARCH SCHOLAR
DEPARTMENT OF GEOLOGY
ANDHRA UNIVERSITY
WALTAIR - 530 003
ANDHRA PRADESH
INDIA.

ABSTRACT:- Graphite which associates with quartzites, granite gneisses and pegmtites in Siva Ganga area, Ramnad District, Tamil Nadu was subjected to beneficiation studies. The carbon content in the feed varies from 21.37% to 24.45%. In order to get a maximum recovery of graphite concentration, different techniques are used. Those are namely Tabling flotation, etc., The different size fractions were subjected to flotation tests using pine oil and Kerosene as frothers, Sodium Silicate as deppresser, sodium Hydroxide/Sodium carbonate as PH controllers. Different size fractions, with different chemical reagent combinations gave different products of flotation. A mixed product assaying 52% carbon is subjected to reflotation with potassium ethyal xanthate as collector and pine oil as frother gave 81.4%. The product assaying 81.4% fixed carbon which in turn, leaching with 'E' Chemical Reagent Mix gave 89.0% fixed carbon. Concentrate Optimisation Studies with reference to flotation chemicals, Ball-Rod mill revolutions, grinding media, classifier - over flow and underflow, pulp density were also carried out.

INTRODUCTION:- The promising deposits are located about 7 Kms North West of Siva Ganga town are approachable by a cart-track from pudupatti village (2 Km on Siva Ganga - Melur Road) in Ramnad District of Tamil Nadu (in the long. 78° 3 0' lat . 9°20' present in 58K/11 survey of India toposheet).

During early 1960s the Geological Survey of India has reported the occurrences of graphite in this area but not much work was done. Later on the State Geology branch carried out detailed prospecting and drilling for Graphite in this area, During early 1969 to the middle of 1971. (Gopalan and Paramasivan 1969-71). The detailed prospecting work and drilling have indicated that graphite bearing zones do not confine to any set pattern and are often irregular in shape. The concentration varies from band to band. There is a lateral variation in quality in which largely dependent up on the extent of shearing, fracturing and effects of intrusion of granites and pegmetites. Typical analysis are given table №1. The graphite is mainly associated with Quartz, Feldspar and ruby mica. The Graphite is of low grade and hence benificiation studies were taken up to render it suitable to industrial application.

MODE OF OCCURRENCE:- It is associated with Quartzo feldspathic gneiss and granite gneiss. The rocks in the area are of crystalline nature and form part of Archean Complex. A promising shear zone is noticed for a strike length of 5 Km between Kamaliamman temple and Meenakshipuram village and again for 1.5 Km between Arasanur and Keeranur Villages. The Quartzites, Quartz graphite schist and granite gneiss in this area are highly sheared and altered. The younger granites and pegmatites have intruded along the fracture planes and also along the joints in the above rocks. The graphite in this area occurs as discontinuous patches. It has been proved to persist for a strike length of 5.61 Km in an almost East West direction with each zone varying in widths from about a metre to a maximum of 12 Mts. Individual zones are seldom more than 250 mts in lenght and roughly extends for about 700 mts. Thegraphite bearing rocks occur almost as parallel bands and

three such parallel zones could be noticed in this area. The graphitic zones pinch, swell and branch into miner stringers The graphitic bearing schist and gneisses have been deeply decomposed by weathering to a soft man consistingchiefly of Quartz, graphite, mica and clay.

ORIGIN:- The origin of graphite is by two different processes.
(1) The regional metamorphism of the carbonaceous impurities in the original argillaceous sediments.
(2) Contact metasomatism of the earlier calcareous sediments may have yielded graphite. This is evidenced by the distinctive high temperature non metalic mineral assemblages like Wollastonite, Epidote, Grassularite, Andredite, Diopside etc., and the erratic nature and irregular pattern of the deposit.

The evidence for the regionally metamorphosed origin is that the shear, fracture and joints seem to have provided through channel ways for the younger intrusives like the granites and pegmatites to traverse the earlier rocks and produce the resultant effects. The composition and structure of the earlier rocks like the Quartzites, Garnetiferous biotite gneisses etc., are also affected by shearing.

Typical analysis of a few samples of graphite from this area given in table 1:-

Table-1

Sl. No.	% of Graphite	Moisture	Volatiles	Ash	Fixed Carbon in concentrate
1	14.20	1.28	8.81	33.94	55.97
2	13.40	0.22	3.87	15.93	79.98
3	17.00	0.23	4.05	15.30	80.42
4.	13.60	0.05	3.39	17.61	78.50
5	16.50	0.27	3.51	15.66	80.56
6	31.06	0.27	5.20	09.29	85.24
7	27.36	0.05	4.55	09.91	85.49
8	31.35	0.20	5.06	14.11	80.63
9	17.30	0.41	7.25	17.64	74.70
10	12.50	0.14	5.90	06.49	87.40

The table shows that the general concentration of graphite in the rock varies from 10 to 32% of which 75% to 80% could be recovered by suitable Beneficiation methods. The fixed carbon in the concentrates varies from 70% to 85%.

BENEFICATION OF GRAPHITE:- The Graphite ore samples were crushed with Jaw crusher and crushing rolls. The product of size 1 cm to ⅛ cm is subjected to ball mill/Rod mill to 35mesh. A representative sample of 500 gms was subjected to size analysis to know the content of carbon in different size fractions. The details are given in table 2.

TABLE - 2

Sl. No.	Mesh size A.S.T.M	Weight of the material in Grams.	Weight persentage	Percentage of carbon
1	+18	55	11.0	21.37
2	-18 +25	50	10.0	23.01
3	-25 +35	75	15.0	25.80
4	-35 +45	70	14.0	25.96
5	-45 +80	74	14.8	29.97
6	-80 +100	53	10.6	33.33
7	-100 +170	38	07.6	27.13
8	-170 +230	34	06.8	27.98
9	-230	51	10.2	23.72

The coarser +45 mesh and finer -170 mesh sizes contain more gangue minerals than the intermediate sizes. Material of all sizes in between -18 +100 mesh was subjected to flotation tests. The laboratory tests are carried out in a single tank type and the pilot plant test are carried out in banks of flotation cells. Concentration by flotation may be considered interms of two groups of variables. First chemical conditions, the interaction of chemical reagents with the mineral particles to make one selectively hydrophobic; Second physical mechanical conditions which are determined by the flotation machine Characteristics.

TABLE - 3

S. No.	Mesh size A.S.T.M.		Feed taken for flotation		Concentration Obtained		% recovery	Ratio of concentration
			Wt. in gms	%of Carbon	Wt. in gms	%fixed Carbon		
1	-18	+35	500	24.54	225	42.48	78.18	1.73
2	-35	+45	500	25.96	225	50.30	87.19	1.94
3.	-45	+80	500	29.97	215	66.80	95.84	2.22
4	-80		500	33.33	235	68.68	96.84	2.06

Tables 3, 4, 5, 6 and 7 shows the results of flotation tests with different chemical combinations which belong to group one of variables.

REAGENTS USED

Colleector = Pot. ethyl Xanthate
Frother = Pine oil
PH controller= Sodium Carbonate

TABLE - 4

S. No.	Mesh size A.S.T.M.		Feed taken for flotation		Concentration obtained		% recovery	Ratio of concentration
			Wt. in gms	%fixed Carbon	Wt. in gms	%fixed Carbon		
1.	-18	+35	500	24.45	200	55.09	91.76	2.25
2	-35	+45	500	25.96	218	56.00	94.05	2.15
3	-45	+80	500	29.97	215	66.00	94.69	2.20
4	-80	+00	500	33.33	200	82.65	99.18	2.48

REAGENTS USED:

Collector = Linoleic acid
Frothers = Pine oil
PH Controller= Sodium Carbonate

TABLE - 5

S. No.	Mesh size A.S.T.M	Feed taken for flotation		Concentration obtained		% recovery	Ratio of concentration
		Wt. in gms.	% fixed Carbon	Wt. in gms.	% fixed Carbon		
1	-18 +35	500	24.45	230	50.00	94.06	2.04
2	-35 +45	500	25.96	235	53.15	95.76	2.04
3	-45 +80	500	29.97	245	58.70	95.97	1.96
4	-80	500	33.33	217	76.25	99.93	2.29

REAGENTS USED:

Frothers = Pine oil
Kerosene oil

PH Controller = Sodium carbonate

TABLE - 6

S. No.	Mesh size A.S.T.M	Feed taken for flotation		Concentration obtained		% recovery	Ratio of concentration
		Wt. in gms.	% fixed carbon	Wt. in gms.	% fixed Carbon		
1	-18 +35	500	24.45	170	56.25	78.91	2.30
2	-35 +45	500	25.96	215	56.75	93.99	2.18
3	-45 +80	500	29.97	230	61.45	94.32	2.05
4	-80	500	33.33	190	84.10	95.88	2.53

REAGENTS USED:

Frothers = Pine oil
PH controller = Sodium Carbonate

TABLE - 7

S. No.	Mesh Size A.S.T.M		Feed taken for flotation		Concentration obtained		% recovery	Ratio of concentration
			Wt. in gams.	% fixed Carbon	Wt. in gms.	% fixed Carbon		
1	-18	+35	500	24.45	180	56.50	83.19	2.31
2	-35	+45	500	25.96	225	56.98	96.21	2.19
3	-45	+80	500	29.97	235	63.14	99.01	2.10
4	-80		500	33.33	090	87.25	99.11	2.62

REFLOTATION:-

TABLE - 8

S. No.	Mesh Size A.S.T.M		Feed taken for flotation		Concentration obtained		% recovery	Ratio of concentration
			Wt. in gms	% fixed Carbon	Wt. in gms.	% fixed Carbon		
1*	-18	+35	500	52.44	300	70.50	80.78	1.34
2	-35	+45	500	55.00	300	76.80	93.55	1.40
3	-45	+80	500	59.38	360	78.50	95.18	1.32
4	-80		500	81.44	460	88.30	99.74	1.08

From the tables 3,4,5,6 and 7, it is evident that the flotation yielded concentrates varying from 42.5 to 87.5% of carbon. The flotation reagents combination of pine oil and Sodium carbonate was found suitable as it has yielded 65% of graphitic carbon on an average. The concentrates were refloted using pine oil as frother, sodium carbonate as PH controller. The results are given in table 8 and 9 respectively.

Two series of flotations gave an average concentrate grade of 79% fixed carbon. The main impurities in the concentrates are Quartz and feldspar which are intricately interlocked in the cleavages of graphite. In order to eliminate these impurities and to increase, if possible, the graphitic carbon content all the concentrates were taken and reground in a small rod mill grinding time varying from 1 to 5 minutes, and reflotated using pine oil and sodium carbonate as frother and PH controller respectivelly in specially designed cells belonging to several group of variables, (Errol G. Kelly; 1982)namely physical-mechanical conditions. The flotation cell design is different from a 'conventional Denver flotation Cell' mechanism. The pnysico mechanical conditions control air introduction mechanism, impeller Baffles, rotation of impeller, pulpdensity, maintenance of all particles in suspension, bypssing or short circulating through the machine, dead space of the volume of machine, dispersal of fine air bubbles throughout the pulp, promotes particle bubble adhesion, promotes aquiscent pulp region immediately below the froth to minimize pulp entrainment in the froth and turbulant disruption of the Froth layer, and to promote sufficient depth of froth to permit drainage of entrained particles.

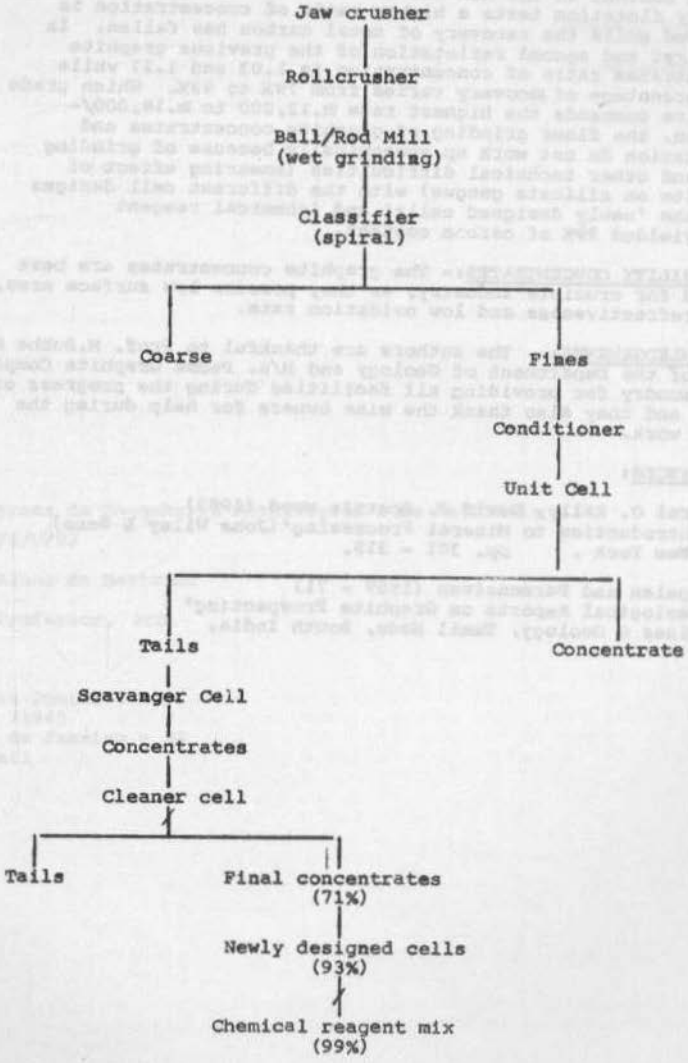
With this the concentrates gave 93% of graphitic carbon on an average. Further improvement in fixed carbon content, the concentrates are subjected to different chemical reagent mixes for different times to yield final product.

TABLE - 09

Serial Number	Chemical reagent mix	Time of leaching in minutes	% of carbon in the product
1	A	100	98.2
2	B	200	98.4
3	C	300	98.6
4	D	400	98.8
5	E	500	99.0

The methodology was tested at a nearby beneficiation plant (M/S Padma Graphite Company, Rajahmundry). Material with 22% carbon was fed and subjected to flotation process. A concentrate of about 79% graphitic carbon was obtained. This later gave rise to 93% fixed carbon and ultimately yielded 99% fixed carbon.

THE FLOW DIAGRAM IS GIVEN BELOW



DISCUSSION:- Rod mill grinding has yielded a product mostly of the zize range -18 +120 mesh: (containing higher quantities of carbon content.) Different size ranges were selected for flotation tests with different reagent combinations. As the carbon content in the Run off mine ore is as low as 21% in the primary flotation tests a higher ratio of concentration is achieved while the recovery of total carbon has fallen. In the first and second reflotation of the previous graphite concentrates ratio of concentration is 1.03 and 1.22 while the percentage of recovery varies from 79% to 93%. Which grade and size commands the highest rate Rs.12,000 to Rs.18,000/- per ton, the finer grinding of graphite concentrates and reflotation do not work up economically because of grinding cost and other technical difficulties (smearing effect of graphite on silicate gangue) with the different cell designs like the 'newly designed cells' and 'chemical reagent mix' yielded 99% of carbon content.

SUITABILITY CONCENTRATES:- The graphite concentrates are best suited for crucible industry, as they possess low surface area, high refractiveness and low oxidation rate.

ACKNOWLEDGEMENTS:- The authors are thankful to Prof. M.Subba Rao, Head of the Department of Geology and M/s. Padma Graphite Company, Rajahmundry for providing all facilities during the progress of work, and they also thank the mine owners for help during the field work.

REFERENCES:

1. Errol G. Kelly, David J. Spottis wood (1982)
'Introduction to Mineral Processing'(John Wiley & Sons)
New York . pp. 301 - 319.

2. Gopalan and Paramasivan (1969 - 71)
'Geological Reports on Graphite Prospecting'
Mines & Geology, Tamil Nadu, South India.