CHAPTER VII

BENEFICIATION AND INDUSTRIAL APPLICATIONS

Beneficiation

About one quintal of graphite ore from each of the four mines viz., Ankli, Sewania, Virpur and Muthai, were has tested in the Ore Dressing Laboratory of Bhabha Atomic Research Centre, Trombay, Bombay. The assay of the ore varies from 2 to 18 per cent fixed carbon. The ore is essentially a quartz-mica-graphite schist and quartz-feldspar-mica-graphite gneiss in which graphite commonly occurs as minute grains and micro-flakes along the schistosity and gneissosity of the rocks respectively. The chief impurities in graphite ore are quartz, feldspar, mica, calcite, iron sulfide and silicates of calcium, magnesium and aluminium. The mineralogical composition of individual ore is as follows.

Ankli: The ore is hard and compact. It consists of graphite associated with quartz and mica as chief gangue minerals. Sphene and hematite occur as accessory minerals in graphitic schist and gneiss.

Modal Analysis

Mineral composition	%
Quartz and feldspar	46.5
Graphite	34.7
Calcite	3.2
Mica	12.3
Others	3.3
	100.0

Sewania: The ore consists of uniformly distributed graphite, associated with quartz, calcite and mica as chief gangue minerals. Graphite flakes are oriented parallel to the schistosity.

Modal Analysis

Mineral composition	%
Quartz and feldspar	19.5
Graphite	30.2
Calcite	40.3
Mica	4.5
Others	5.0
	99.5

<u>Virpur</u> : The ore is friable and shows schistose or gneissose structure. It consists of graphite flakes associated with quartz, feldspar and mica as chief gangue minerals.

<u>Modal analysis</u>

Mineral composition	%
Quartz and feldspar	64.5
Graphite	18.0
Mica	10.2
Others	7.0
	99.7

<u>Muthai</u> : The ore is a graphitic schist. It consists of graphite with associated quartz and mica as chief gangue minerals. Sphene occurs as an accessory mineral in graphitic schist.

<u>Modal analysis</u>

Mineral composition	%
Quartz	39.0
Graphite	38.0
Calcite	2.0
Mica	15.0
Others	6.0
	100.0

The proximate analysis of graphite bearing ore samples as follows:

Mine Ore	Moisture %	V M %	Ash %	F.C. % (by diff.)
Ankli	1.2	16.7	75.9	6.2
Sewania	1.5	21.0	71.8	5.7
Virpur	1.3	6.3	87.3	6.1
Muthai	0.7	15.4	73.0	11.9

Beneficiation Tests

The ore is friable and consists of lumps of less than 15 cms. The lumps were first crushed in a laboratory Jaw-crusher and then were reduced to 5 mesh (Tyler) size in crushing rolls. After thorough mixing the crushed ore was taken as a feed for all subsequent operations. Wet grinding of the ore was done in a laboratory rod-mill. 1.5 kg feed material of 5 mesh (Tyler) size and 14 kg of grinding media formed 60% solids by weight of the total load in the rod mill. The grinding time was kept at 5, 10, 15 and 20 minutes respectively. The sieve analysis of ground products was done by wet and dry methods. The results of sieve analysis are given in Table VI.

The liberation of graphite in each sieved fraction was studied under the microscope. Most of the graphite was liberated when the ore was ground to 100 mesh (Tyler) size, but the gangue minerals enclosed in graphite flakes were liberated at 200 mesh (Tyler) size. The results of the sieve analysis and liberation size studies are given in Tables VII and VIII. From the combined result it is inferred that, there is an increase in the percentage of liberation of graphite with increase in the grinding period. At minus 200 mesh fraction, the maximum liberation of graphite from Ankli, Sewania, Virpur and Muthai, was found to be 71, 53, 68 and 72 per cent respectively. The grinding period necessary to obtain the maximum liberation was kept as optimum grinding period for the flotation tests. In the rod-mill when the pulp was too thick, the grinding media was cemented to the pulp and there was no grinding action. When the pulp was too thin, the graphite and graphite-coated gangue minerals were floating and escaped grinding action. Even a little change in grinding action caused marked difference in the ash percentages of the graphite concentrates. Hence, the grinding operation was carried out at a fairly optimum and constant conditions. For rougher flotation, grinding operation was adjusted to give a product containing about 60 per cent minus 200 mesh fraction. Sodium silicate which is both a dispersant and a depressant for silica was added to the grinding circuit to increase the efficiency.

The feed material after wet grinding in a laboratory rod mill for 5, 10, 15 and 20 minutes respectively was taken to a laboratory model of stainless steel conical Fagergren cell having 6 litre capacity. The flotation was carried out at a pulp density of 25 per cent solids by weight at natural pH. The mixture of diesel oil, kerosene and pine oil (8:8:1) by weight/volume was used as a reagent for flotation. This mixture was selected because, it was found that pine oil or amyl alcohol gave better recovery, while kerosene oil or diesel oil or crescylic acid gave better grade of graphite concentrate. Their consumption during rougher flotation was less than 0.5 kg/tonne and during the cleaning operations was less than 0.2 kg/tonne of graphite ore. The results of the above flotation tests are given in Tables IX and X.

From the above experiments it is concluded that further cleaning with and without depressant is necessary to increase the grade of graphite concentrate.

The rougher floats of 5, 10, 15 and 20 minutes grinding were filtered and cleaned using calgon (sodium hexameta phosphate) as a depressant. Cleaning operations were conducted with water containing 150 mg of calgon per litre of water. To study the effects of further cleaning, the rougher float of 20 minutes grinding was cleaned again with the same depressant followed by two cleaning operations using water only. Adequate conditioning time for both rougher flotation and cleaning was found to be 5 minutes. During the conditioning period of the cleaning stage, the froth was broken effectively by spraying jets of water on it to avoid entrainment. The cleaning operations were carried out at low pulp densities having about 5 per cent solids by weight.

The generalized flow-sheet is given as figure III.

Ankli graphite ore after 5, 10, 15 and 20 minutes grinding was upgraded by rougher flotation. The per cent recovery and the percentages of fixed carbon are given in Table X. The rougher concentrate of the product after 20 minutes grinding period, gave 20.2 per cent fixed carbon and 98.4 per cent recovery, while that of the product after 15 minutes grinding period gave 17.7 per cent fixed carbon and 99.2 per cent recovery. The optimum grinding period was fixed at 20 minutes since it gave 2.5 per cent higher fixed carbon although the recovery was lower by 0.8 per cent.

The first cleaning of the rougher concentrate was carried out using calgon as a depressant. Further cleaning was carried out using water only. The percentage of fixed carbon increased by 8 per cent. The per cent recovery and the percentages of fixed carbon of the float are given in Table XII.

Sewania graphite ore was upgraded by rougher flotation as mentioned earlier. The per cent recovery and the percentages of fixed carbon are given in Table X. The rougher concentrates of the product after 15 and 20 minutes grinding gave the same percentages of fixed carbon. Hence the optimum grinding period was fixed at 15 minutes to minimise the consumption of reagents used.

The first cleaning of the rougher float of the ground product after 5, 10 and 15 minutes grinding period was carried out using calgon as a depressant. The product after 20 minutes grinding was once cleaned with calgon followed by three stages of cleaning with water only. The per cent fixed carbon and per cent recovery after first cleaning were 22.4 and 99.13 respectively, while those after three stages of further cleaning were 29.4 and 98.74 respectively.

Virpur graphite ore was upgraded by rougher flotation as mentioned earlier. The per cent recovery and the percentages of fixed carbon are given in Table X. The rougher flotation of the product after 15 minutes grinding period, gave 36.4 per cent fixed carbon and 99.0 per cent recovery, while that of the ground product after 20 minutes grinding, gave 36 per cent fixed carbon and 98.9 per cent recovery. The percentages of fixed carbon and percentage recovery were found to be almost similar in both cases. Hence, 15 minutes period was fixed as optimum grinding period. The first cleaning of the concentrates of rougher floats of the ground product after 5, 10 and 15 minutes grinding period were carried out using calgon as a depressant. The per cent recovery and percentages of fixed carbon are given in Table XII.

The first cleaning of the rougher float of the product after 20 minutes grinding and addition of calgon as depressant, gave 71.1 per cent fixed carbon and 98.8 per cent recovery. Further three cleanings of the float after first cleaning were carried out using water only and gave 87.7 per cent fixed carbon and 98.7 per cent recovery.

The graphite from Virpur graphite ore was easily liberated and gave good percentages of fixed carbon and recovery.

Muthai graphite ore was upgraded by rougher flotation as mentioned earlier. The per cent recovery and the percentages of fixed carbon are given in Table X. The concentrate of the rougher float of the ground product after 20 minutes grinding, gave 25 per cent fixed carbon and 99.6 per cent recovery. The optimum grinding period was fixed at 20 minutes, since it gave the highest percentage of fixed carbon.

The first cleaning of rougher concentrate was carried out using calgon as a depressant. Further cleaning was carried out using water only. The percentage of fixed carbon increased by 7.6 per cent. The per cent recovery and the percentages of fixed carbon of the float are given in Table XII.

Graphite ore of Ankli, Sewania and Muthai is amorphous and consists of very fine, disseminated grains. The proximate assay of the clean floats, clean tails and rougher tails indicates that the graphite is not fully liberated even in minus 200 mesh fractions (Table XI). In this case, two or three cleanings of the float did not improve the grade of the graphite concentrate substantially, so further grinding of the rougher float was necessary. Finer grinding was considered uneconomical because of greater reagent consumption. Virpur graphite was fully liberated at minus 200 mesh (Tyler) size.

The results of the analysis of the final concentrates of various graphite deposits are as follows:

Locality	Variety	Fixed carbon, % by wt. (by difference)
Ankli	Amorphous	28
Sewania	Amorphous	29
Virpur	Flaky	87
Muthai	Amorphous	32

Industrial applications

Natural graphite is classified for industrial purposes on the basis of the physical form of graphite particles into the following three types:

1. Flake,
2. Lump and chip
3. Amorphous.

Virpur graphite is flaky in nature while graphite of Muthai, Sewania and Ankli is of amorphous type. Flaky variety consists of isolated, flat, plate-like particles with angular, rounded or irregular edges. It is graded according to carbon content, flake size and kinds and amounts of impurities. Quartz and mica are the main impurities present.

Amorphous graphite is microcrystalline graphite having extremely fine grained texture, which can be identified only under microscope. Carbon content and particle size of graphite are important factors for its use in various industries.

The final concentrate from Virpur, Muthai, Sewania and Ankli contains 87, 32, 29 and 28 per cent fixed carbon (by weight).

From the above results, it is concluded that the Virpur flake graphite can be commercially used in manufacturing dry cells, refractories, crucibles for melting metals and lubricants, while amorphous graphite from other localities can be used as foundry facings, moulds and lubricants.

Table VI : Sieve analysis of products ground for different periods

Graphite Mine (1)	Sieve fraction in Mesh (Tyler) (2)	5 mts grinding (wt %) (3)	10 mts grinding (wt %) (4)	15 mts grinding (wt %) (5)	20 mts grinding (wt %) (6)
Ankli	+ 48	1.2	0.7	0.3	0.2
	- 48+65	5.1	1.8	1.0	0.6
	- 65+100	7.5	6.4	5.1	3.2
	-100+150	14.4	14.0	12.8	11.8
	-150+200	6.3	6.1	7.7	7.5
	-200	65.5	71.0	73.1	76.7
		100.00	100.00	100.00	100.00
Sewania	+ 48	6.8	0.9	2.8	6.0
	- 48+65	9.08	4.3	5.7	7.4
	- 65+100	10.5	10.5	8.9	8.2
	-100+150	10.8	14.1	11.7	9.0
	-150+200	3.9	5.9	4.7	3.4
	-200	58.92	64.3	66.2	66.0
		100.00	100.00	100.00	100.00

contd....

Table VI (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
Virpur	+ 48	1.6	1.2	0.6	0.2
	- 48+65	8.4	6.2	4.6	0.7
	- 65+100	19.8	18.9	17.4	3.1
	-100+150	22.7	21.1	21.6	15.5
	-150+200	8.1	8.7	8.8	12.8
	-200	39.4	43.9	47.0	67.7
		100.00	100.00	100.00	100.00
Muthai	+ 48	1.0	0.6	0.3	0.2
	- 48+65	4.5	3.0	1.0	0.5
	- 65+100	6.0	5.0	3.5	2.0
	-100+150	15.0	12.5	14.2	10.5
	-150+200	7.5	7.0	8.5	8.0
	-200	66.0	71.9	72.5	78.8
		100.00	100.00	100.00	100.00

Table VII : Liberation of percentage of graphite in 5 mts grinding

Graphite Mine (1)	Sieve fraction in Mesh (Tyler) (2)	Graphite (%) (3)	Composite graphite (%) (4)
Ankli	+ 48	13	75
	- 48+65	19	55
	- 65+100	14	64
	-100+150	15	64
	-150+200	36	22
	-200	57	20
Sewania	+ 48	8	83
	- 48+65	12	77
	- 65+100	16	65
	-100+150	15	59
	-150+200	26	45
	-200	43	35

Table VII (contd.)

(1)	(2)	(3)	(4)
<u>Virpur</u>	+ 48	45	36
	- 48+65	48	29
	- 65+100	66	12
	-100+150	37	10
	-150+200	42	7
	-200	55	5
<u>Muthai</u>	+ 48	21	70
	- 48+65	25	63
	- 65+100	28	69
	-100+150	22	61
	-150+200	35	43
	-200	68	15

Table VIII : Liberation of percentage of graphite in 10, 15 and 20 mts grinding

Graphite Mine	G/C.G. (%)	Sieve fraction in Mesh (Tyler)	10 mts grinding (%)	15 mts grinding (%)	20 mts grinding (%)
(1)	(2)	(3)	(4)	(5)	(6)
Ankli	G.	+ 48	14	14.6	11
	C.G.	"	77	73	77
	G.	-150+200	31	24	20
	C.G.	"	35	42	36
	G.	-200	66	67	71
	C.G.	"	13	15	12
Sewania	G.	+ 48	7	8	10
	C.G.	"	80	87	81
	G.	-150+200	20	29	32
	C.G.	"	42	48	45
	G.	-200	44	47	53
	C.G.	"	32	27	16

contd...

G. = graphite

C.G. = composite graphite

Table VIII (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
Virpur	G.	+ 48	44	47	46
	C.G.	"	40	43	17
	G.	-150+200	37	48	38
	C.G.	"	11	7	7
	G.	-200	57	62	68
	C.G.	"	4	4	3
Muthai	G.	+ 48	20	18	12
	C.G.	"	68	66	62
	G.	-150+200	33	32	28
	C.G.	"	47	31	43
	G.	-200	70	71	72
	C.G.	"	13	12	12

Table IX : Proximate analysis of rougher float/tail products.

Graphite Mine (1)	Grinding period (mts) (2)	F/T (3)	VM (%) (4)	Ash (%) (5)	F.C. (by diff.) (6)
Ankli	5	F	15.39	70.3	14.3
	"	T	17.43	82.5	0.1
	10	F	16.9	68.0	15.1
	"	T	17.02	82.8	0.2
	15	F	15.71	66.6	17.7
	"	T	17.76	82.2	0.1
	20	F	14.98	64.8	20.2
	"	T	17.39	82.35	0.2
Sewania	5	F	22.93	67.90	9.2
	"	T	20.95	79.70	0.1
	10	F	22.32	67.35	10.3
	"	T	20.74	81.00	0.1
	15	F	21.75	67.50	10.7
	"	T	20.75	80.65	0.1
	20	F	22.07	67.30	10.6
	"	T	21.01	79.85	0.1

F = Rougher float   T = Rougher tail
VM = Volatile matter   F.C.= Fixed carbon = 100-(Ash+VM)

Table IX (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
Virpur	5	F	6.78	59.50	33.7
	"	T	4.06	95.85	0.1
	10	F	7.15	56.55	36.2
	"	T	4.17	95.70	0.1
	15	F	6.88	56.65	36.4
	"	T	4.06	95.90	0.1
	20	F	7.31	56.65	36.0
	"	T	4.20	95.95	0.1
Muthai	5	F	13.79	67.45	18.7
	"	T	16.02	84.2	0.1
	10	F	13.52	65.9	20.6
	"	T	15.83	83.45	0.7
	15	F	14.46	68.05	17.4
	"	T	16.41	83.45	0.1
	20	F	13.41	61.55	25.0
	"	T	16.05	83.75	0.1

Table X : Rougher flotation results for products ground for different periods

Ankli

pH of tap water = 7.3 pH of pulp (natural) = 9.0

Grinding period (mts) (1)	F/T (2)	Wt. (%) (3)	F.C. (%) (4)	Product (gm) (5)	Recovery (%) (6)
5	F	47.8	14.3	683.54	99.2
"	T	52.2	0.1	5.22	0.8
10	F	45.6	15.1	711.5	99.0
"	T	54.4	0.1	5.3	0.8
15	F	41.9	17.7	741.6	99.2
"	T	58.1	0.1	5.8	0.8
20	F	37.2	20.2	751.44	98.4
"	T	62.8	0.2	12.56	1.6

Sewania

pH of tap water = 7.3 pH of pulp (natural) = 9.2

5	F	65.6	9.2	603.52	99.4
"	T	34.4	0.1	3.44	0.6
10	F	62.3	10.3	641.69	99.4
"	T	37.7	0.1	3.77	0.6
15	F	62.6	10.7	669.82	99.4
"	T	37.4	0.1	3.74	0.6
20	F	59.0	10.6	626.46	99.4
"	T	41.0	0.1	4.09	0.6

F = Rougher float; T = Rougher tail

Table X (contd.)

Virpur

pH of tap water = 7.3 pH of pulp (natural) = 9.0

(1)	(2)	(3)	(4)	(5)	(6)
5	F	22.2	33.7	748.14	99.0
"	T	77.8	0.1	7.78	1.0
10	F	20.9	36.2	756.58	99.0
"	T	79.1	0.1	7.91	1.0
15	F	21.2	36.4	771.68	99.0
"	T	78.8	0.1	7.88	1.0
20	F	20.6	36.0	741.6	98.9
"	T	79.4	0.1	7.9	1.1

Muthai

pH of tap water = 7.3 pH of pulp (natural) = 9.1

5	F	62.0	18.7	1159.4	99.7
"	T	38.0	0.1	3.8	0.3
10	F	54.3	20.6	1118.58	97.2
"	T	45.7	0.7	31.99	2.8
15	F	59.0	17.4	1026.6	99.6
"	T	41.0	0.1	4.1	0.4
20	F	48.3	25.0	1207.5	99.6
"	T	51.7	0.1	5.2	0.4

Table XI : Proximate analysis of clean float/rougher tail/clean tail products

Graphite Mine	Grinding period (mts)	CR/RT/CT	V.M. (%)	Ash (%)	F.C. (by diff.)
(1)	(2)	(3)	(4)	(5)	(6)
Ankli	5	CF	14.58	63.60	21.8
	"	RT	17.59	82.30	0.1
	1"	CT	17.64	82.40	0.1
	10	CF	13.8	56.85	29.3
	"	RT	17.21	83.20	0.1
	"	CT	17.45	82.80	0.1
	15	CF	14.04	55.90	30.1
	"	RT	17.23	83.15	0.1
	"	CT	17.50	82.75	0.1
	20	CF	14.06	57.65	28.2
	"	RT	17.04	83.30	0.1
	"	CT	17.32	82.85	0.1

CF = Clean float RT = Rougher tail

CT = Clean tail.

Table XI (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
Sewania	5	CF	21.44	61.30	17.3
	"	RT	20.63	80.25	0.1
	"	CT	21.45	79.80	0.1
	10	CF	21.06	60.10	18.8
	"	RT	20.79	80.65	0.1
	"	CT	21.38	80.00	0.1
	15	CF	21.55	58.50	19.9
	"	RT	21.39	79.15	0.1
	"	CT	21.53	78.55	0.1
	20	CF	19.68	50.90	29.4
	"	RT	21.66	78.70	0.1
	"	CT_1	21.89	78.30	0.1
	"	CT_2	22.69	77.55	0.1
	"	CT_3	23.66	75.50	0.8

contd...

Table XI (contd.)

(1)	(2)	(3)	(5)	(5)	(6)
Virpur	5	CF	5.53	48.30	46.2
	"	RT	4.09	96.05	0.1
	"	CT	6.53	93.70	0.1
	10	CF	5.01	33.55	61.4
	"	RT	4.05	96.25	0.1
	"	CT	6.63	94.20	0.1
	15	CF	4.84	25.60	69.6
	"	RT	3.97	95.60	0.4
	"	CT	6.55	93.40	0.1
	20	CF	4.05	8.6	87.3
	"	RT	3.99	96.05	0.1
	"	CT_1	5.43	94.5	0.1
	"	CT_2	6.99	93.15	0.1
	"	CT_3	7.23	90.90	1.9

contd...

Table XI (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
<u>Muthai</u>	5	CF	13.71	62.95	23.3
	"	RT	16.09	84.90	0.1
	"	CT	17.66	83.80	0.1
	10	CF	13.21	62.25	24.5
	"	RT	16.88	84.80	0.1
	"	CT	16.81	84.45	0.1
	15	CF	12.93	58.05	29.0
	"	RT	16.49	83.90	0.1
	"	CT	17.23	83.70	0.1
	20	CF	12.06	55.25	32.6
	"	RT	16.31	84.50	0.1
	"	CT	16.92	83.75	0.1

Table XII : Results of cleaning of rougher float with Calgon (Sodium hexameta phosphate)

pH of tap water = 7.3,

pH of Calgon 150 mg/litre = 6.6

Graphite Mine (1)	Grinding period (mts) (2)	CF/RT/CT (3)	Wt. (%) (4)	F.C. (%) (5)	Product (gm) (6)	Recovery (%) (7)
Ankli	5	CF	35.2	21.8	767.36	99.1
	"	RT	50.8	0.1	5.08	0.7
	"	CT	14.0	0.1	1.40	0.2
	10	CF	25.4	29.3	744.22	99.0
	"	RT	53.7	0.1	5.37	0.7
	"	CT	20.9	0.1	2.09	0.3
	15	CF	25.2	30.1	758.52	99.0
	"	RT	48.7	0.1	4.87	0.6
	"	CT	26.1	0.1	2.61	0.4
	20	CF	26.9	28.2	758.58	99.0
	"	RT	50.1	0.1	5.01	0.7
	"	CT	23.0	0.1	2.30	0.3

CF = Clean float   RT = Rougher tail

CT = Clean tail

contd...

Table XII (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sewania	5	CF	40.2	17.3	695.46	99.1
	"	RT	40.7	0.1	4.07	0.6
	"	CT	19.1	0.1	1.91	0.3
	10	CF	38.3	18.8	720.04	99.1
	"	RT	46.2	0.1	4.62	0.6
	"	CT	15.5	0.1	1.55	0.3
	15	CF	34.9	19.9	694.51	99.1
	"	RT	45.2	0.1	4.52	0.6
	"	CT	19.9	0.1	1.99	0.3
	20	CF	25.6	29.4	752.64	98.74
	"	RT	48.3	0.1	4.83	0.63
	"	CT_1	18.0	0.1	1.80	0.24
	"	CT_2	5.0	0.1	0.50	0.07
	"	CT_3	3.1	0.8	2.48	0.32

contd...

Table XII (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Virpur	5	CF	17.8	46.2	822.36	99.0
	"	RT	75.8	0.1	7.58	0.9
	"	CT	6.4	0.1	0.64	0.1
	10	CF	12.8	61.4	785.92	98.9
	"	RT	78.5	0.1	7.85	1.0
	"	CT	8.7	0.1	0.87	0.1
	15	CF	11.6	69.6	807.36	98.9
	"	RT	81.1	0.4	8.11	1.0
	"	CT	7.3	0.1	0.73	0.1
	20	CF	9.1	87.3	794.43	98.7
	"	RT	76.0	0.1	7.60	0.9
	"	CT_1	12.8	0.1	1.28	0.2
	"	CT_2	1.5	0.1	0.15	–
	"	CT_3	0.6	1.9	1.14	0.2

contd..

Table XII (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Muthai	5	CF	49.1	23.3	1144.03	99.6
	"	RT	40.4	0.1	4.04	0.3
	"	CT	10.5	0.1	1.05	0.1
	10	CF	45.5	24.5	1114.75	99.5
	"	RT	43.9	0.1	4.39	0.4
	"	CT	10.6	0.1	1.06	0.1
	15	CF	39.7	29.0	1151.3	99.5
	"	RT	48.6	0.1	4.9	0.4
	"	CT	11.7	0.1	1.2	0.1
	20	CF	36.2	32.6	1180.12	99.5
	"	RT	52.9	0.1	5.29	0.4
	"	CT	10.9	0.1	1.09	0.1