Indian Minerals Yearbook 2020

(Part- III : Mineral Reviews)

59th Edition

GRAPHITE

(ADVANCE RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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November, 2021

14 Graphite

Graphite, also known as plumbago or blacklead or mineral carbon, is a stable form of naturally occurring carbon. Structurally, graphite is known to crystalise in hexagonal system and occurs in layered & lamellar form with grey-to-black metallic lustre and a greasy feel. Natural graphite is categorised into two commercial varieties (i) crystalline (flaky) graphite and (ii) amorphous graphite. Both flaky and amorphous varieties of graphite are produced in India. The quality of graphite depends upon its physical qualities and carbon content. Besides natural graphite, there is synthetic or artificial graphite which is manufactured on a large-scale in electric furnaces, using anthracite or petroleum coke as raw feed.

RESERVES/RESOURCES

Graphite occurrences are reported from various States but the deposits of economic importance are located in Chhattisgarh, Jharkhand, Odisha and Tamil Nadu.

As per NMI database, based on the UNFC system, the total reserves/resources of graphite as on 1.4.2015 have been placed at about 194.89 million tonnes, out of which 7.96 million tonnes are in the Reserves category and 186.92 million tonnes are placed under Remaining Resources category. Resources containing +40% fixed carbon constitute about 2.91 million tonnes and resources analysing 10–40% fixed carbon constitute 40.65 million tonnes. The balance 151.31 million tonnes fall under 'Others', 'Unclassified' and 'Not-known' grades. Arunachal Pradesh accounts for 37% of the total resources which is followed by Jammu & Kashmir (32%), Odisha (10%), Jharkhand (9%) and Tamil Nadu (4%). However, in terms of reserves, Jharkhand has the leading share of about 52% followed by Tamil Nadu (42%) and Odisha (6%) (Table-1).

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on Exploration & Development under "General Review".

PRODUCTION & STOCKS

Production of graphite at about 31,991 tonnes in 2019-20 decreased by 18% as compared to that in the preceding year.

There were eleven 11 reporting mines in 2019-20 same as in the previous year. Five principal producers accounted for 96% of the total production during the year.

About 61% of the total production in 2019-20 was accrued from two mines, each producing more than 5,000 tonnes annually, while 39% was contributed by four mines in the production range of 1,000 to 5,000 tonnes per annum.

Jharkhand was the leading producing State contributing 61% to the total output during 2019-20, followed by Odisha.

Mine-head closing stock in the year 2019-20 was 1,78,104 tonnes as against 1,77,914 tonnes in the previous year. The average daily employment of labour during 2019-20 was 164 against 237 in the preceding year (Tables- 2 to 6).

Table – 1 : Reserves/Resources of Graphite as on 1.4.2015
(By Grades/States)

(In tonnes)

Grade/State	Reserves				Remaining Resources								Total Resources (A+B)
	Proved STD111	Probable STD121	Probable STD122	Total (A)	Feasibility STD211	Pre-feasibility STD221	Pre-feasibility STD222	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
All India : Total	**4229675**	**1204423**	**2526694**	**7960793**	**9571933**	**3825575**	**3593404**	**741377**	**7368340**	**22361229**	**139464128**	**186925987**	**194886779**
By Grades													
+ 40% F.C.	178846	1121513	502465	1802824	-	188968	79358	338686	263391	242528	-	1112931	2915755
10-40% F.C.	3621958	82910	1732350	5437219	9004058	3327566	3138724	353765	2703478	13586597	3106244	35220432	40657651
Others	258346	-	57000	315346	92188	117148	68752	-	3323906	3451194	-	7053188	7368534
Unclassified	170525	-	234879	405404	444415	191893	301706	9090	7253	3856995	63439569	68250921	68656325
Not-known	-	-	-	-	31272	-	4864	39836	1070312	1223915	72918315	75288514	75288514
By States													
Andhra Pradesh	-	-	-	-	-	1195	1135	-	1122	697575	-	701027	701027
Arunachal Pradesh	-	-	-	-	-	-	-	-	-	-	72758257	72758257	72758257
Chhattisgarh	6111	-	-	6111	1230	-	-	-	-	-	-	1230	7341
Gujarat	-	-	-	-	-	-	-	-	2520805	835000	-	3355805	3355805
Jammu & Kashmir	-	-	-	-	-	-	-	-	-	1059520	61681035	62740555	62740555
Jharkhand	1518581	1204423	1450550	4173555	39262	445703	1959747	5520	1856563	6639828	2440208	13386831	17560386
Karnataka	-	-	-	-	140827	18750	48821	-	41605	149403	-	399406	399406
Kerala	-	-	16518	16518	-	8376	-	-	1088550	322606	-	1419532	1436050
Madhya Pradesh	-	-	-	-	-	-	-	-	-	3456660	2280000	5736660	5736660
Maharashtra	-	-	-	-	-	-	-	-	-	1160000	-	1160000	1160000
Odisha	209795	-	249176	458971	9314306	3312065	1415295	696021	838559	2628394	304628	18509268	18968239
Rajasthan	-	-	-	-	47600	-	165920	-	250000	1450034	-	1913554	1913554
Tamil Nadu	2495188	-	810450	3305638	28708	39486	2486	29136	647500	3866390	-	4613707	7919345
Telangana	-	-	-	-	-	-	-	-	123636	95818	-	219455	219455
Uttarakhand	-	-	-	-	-	-	-	10700	-	-	-	10700	10700

Figures rounded off

Table – 2: Principal Producers of Graphite, 2019-20

Name & address of producer	Location of mine	
	State	District
Krishna Kumar Poddar, 3P, Shree Gopal Complex, Court Road, Ranchi - 834 001, Jharkhand.	Jharkhand	Palamu
Pramod Kumar Agrawal, Shantikunj Farm Road Modipara, Sambalpur – 768 002, Odisha.	Odisha	Nawapara
Parijat Mining Industries (India) Pvt. Ltd, Town Hall Road, Opp. Shiavajee Maidan, Daltonganj, Palamu – 822 101, Jharkhand.	Jharkhand	Latehar
Prabhas Chandra Agrawal, Shantikunj Farm Road Modipara, Sambalpur – 768 002, Odisha.	Odisha	Nawapara
Mukesh Chavan, Nawatoli, Daltonganj Palamu - 822 101, Jharkhand.	Jharkhand	Palamu

Table – 3: Production of Graphite, 2017-18 to 2019-20
(By States)

(Qty in tonnes; Value in ₹'000)

State	2017-18		2018-19		2019-20 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**33649**	**28229**	**39030**	**36233**	**31991**	**57506**
Jharkhand	18735	19120	15831	17974	19426	20380
Kerala	240	1937	-	-	-	-
Odisha	14674	7172	23199	18259	12565	37126

Table – 4: Production of Graphite, 2018-19 and 2019-20 (By Sectors/States/Districts)

(Qty in tonnes;Value in ₹ '000)

State/District	2018-19 No. of Mines	Grade: Fixed Carbon content			Total		2019-20 (P) No.of Mines	Grade: Fixed Carbon content			Total	
		80% or more	40% or more but less than 80%	Less than 40%	Qty.	Value		80% or more	40% or more but less than 80%	Less than 40%	Qty.	Value
India	**11**	**-**	**954**	**38076**	**39030**	**36233**	**11**	**615**	**651**	**30725**	**31991**	**57506**
Public Sector	1	-	-	-	-	-	2	-	-	-	-	-
Private Sector	10	-	954	38076	39030	36233	9	615	651	30725	31991	57506
Chhattisgarh	**-**	**-**	**-**	**-**	**-**	**-**	**1***	**-**	**-**	**-**	**-**	**-**
Surguja	-	-	-	-	-	-	1*	-	-	-	-	-
Jharkhand	**4**	**-**	**-**	**15831**	**15831**	**17974**	**3**	**-**	**-**	**19426**	**19426**	**20380**
Latehar	1	-	-	3252	3252	3171	1	-	-	4676	4676	4730
Palamau	3	-	-	12579	12579	14803	2	-	-	14750	14750	15650
Karnataka	**2***	**-**	**-**	**-**	**-**	**-**	**2***	**-**	**-**	**-**	**-**	**-**
Mysore	2*	-		-	-	-	2*	-	-	-	-	-
Kerala	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Ernakulam	1	-	-	-	-	-	-	-	-	-	-	-
Odisha	**3**	**-**	**954**	**22245**	**23199**	**18259**	**5**	**615**	**651**	**11299**	**12565**	**37126**
Nawapara	2	-	-	22245	22245	15206	2	-	-	11299	11299	12099
Raygada	1	-	954	-	954	3053	3	615	651	-	1266	25027
Tamil Nadu	**1***	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Madurai	-	-	-	-	-	-	-	-	-	-	-	-
Sivagangai	1*	-	-	-	-	-	-	-	-	-	-	-

** : Only labour reported during the year.*

Table – 5 : Production of Graphite, 2018-19 & 2019-20 (By Frequency Groups)

(Qty in tonnes)

Production group	No.of mines		Production for the group		Percentage in total production		Cumulative percentage	
	2018-19	2019-20 (P)	2018-19	2019-20 (P)	2018-19	2019-20 (P)	2018-19	2019-20 (P)
India	**11**	**11**	**39030**	**31991**	**100.00**	**100.00**	**-**	-
Up to 1000	6	5	954	-	2.44	-	2.44	-
1001 to 2000	-	1	-	1266	-	3.96	-	3.96
2001 to 5000	2	3	5952	11191	15.25	34.98	17.69	38.94
5001 to 10000	2	1	15272	7916	39.13	24.74	56.82	63.68
Above 10000	1	1	16852	11618	43.18	36.32	100.00	100.00

Table – 6: Mine-head Closing Stocks of Graphite, 2018-19 & 2019-20 (By States)

(In tonnes)

State	2018-19				2019-20 (P)			
	Grade: Fixed Carbon content				Grade: Fixed Carbon content			
	80% or more	40% or more but less than 80%	Less than 40%	Total	80% or more	40% or more but less than 80%	Less than 40%	Total
India	**-**	**329**	**177615**	**177914**	**161**	**185**	**177758**	**178104**
Chattisgarh	-	-	3725	3725	-	-	3725	3725
Jharkhand	-	-	9543	9543	-	-	9964	9964
Karnataka	-	-	1742	1742	-	-	1742	1742
Kerala	-	-	130	130	-	--	-	-
Odisha	-	329	148	477	161	185	-	346
Tamil Nadu	-	-	162327	162327	-	-	162327	162327

MINING & MARKETING

Graphite mines, barring a few underground mines, are mostly small and opencast.

Active mining centres of graphite are in Palamu district in Jharkhand; Nawapara & Balangir districts in Odisha; and Madurai & Sivagangai districts in Tamil Nadu. Disseminated deposits of flaky graphite containing 5 to 20% Fixed Carbon (F.C.) are found in Palamu district of Jharkhand. In Odisha, areas in and around Balangir are the chief mining centres where several graphite grades are produced. At Balangir, a few opencast workings are deeper than 45 m from surface and the r.o.m. from such mines generally contains 10 to 20% F.C. Sargipalli underground mine in Sambalpur district, operated by M/s T.P. Mineral Industries (TPMI), produced graphite that analysed up to 40% F.C. in the past. Water seepage beyond 6 m depth is the main problem faced by almost all mine owners in Odisha.

Graphite of Balangir district is utilised mostly by the Graphite Crucible Industry. The technological changes in recent years have considerably reduced the use of graphite as a lubricant. However, recycled graphite is still used in production of clay bonded graphite crucibles.

The Sivagangai graphite is of flaky variety with 14% average Fixed Carbon (F.C.) used in the manufacture of refractory bricks, expanded graphite, crucibles and carbon brushes. It is being mined by opencast mining method.The mined graphite is subjected to size reduction by crushing, grinding, flotation and dewatering to upgrade the graphite concentrate from other gangue minerals.

Mining is considered to be easy and safe as regards graphite deposits in view of their comparatively soft nature and presence of hard rocks on either side. In order to expose graphite deposit, thickness of 1 to 2 meters of top lateritic soil is dozed out using dozer or removed by excavator and loaded through dumper and transported to separate dump yard located in non-mineralised zone in the lease area. The graphite ore obtained usually is transported to stock yard for blending. In stock yard, both high-grade and low-grade ores are stacked separately. Depending on plant requirements, blending work is carried out and blended ore is despatched for consumption.

Tamil Nadu Minerals Ltd (TAMIN) has over 600 acres of graphite-bearing areas in Pudupatti, Kumaripatti and Senthiudayanathapuram of Sivagangai district, Tamil Nadu.

BENEFICIATION

During graphite beneficiation one of the challenges is to maximise the recovery of flaky graphite from low–grade graphite ore without breaking the flakes of graphite. This is because flaky graphite has a huge industrial demand due to its distinct properties such as excellent lubricity and higher thermal conductivity.

Graphite occurs generally admixed with country rocks, and hence, it requires beneficiation for obtaining desired grade for various end-uses. Processes for graphite beneficiation depend upon nature and association of gangue minerals present. The common processes adopted are washing, sorting, tabling, acid leaching and froth flotation. Amongst these, froth flotation process is used widely as it helps in producing a fairly high-grade graphite concentrate. Sometimes, beneficiated concentrate is further enriched by chemical treatment (acid leaching, chlorination, etc.) to obtain a very high-grade concentrate containing 98 to 99% F.C.

Prominent beneficiation plants for graphite in India are Chota Nagpur Graphite Industries and Carbon & Graphite Products, Daltonganj; Agrawal Graphite Industries, Gandhamardhan Graphite Udyog and T. P. Minerals Private Limited, Sambalpur; Tamil Nadu Minerals Ltd (TAMIN), Sivagangai, etc.

The ROM, containing an average of about 10% F.C. has to be invariably beneficiated before marketing. Indigenously fabricated equipment is used generally to upgrade the ROM to produce marketable grade graphite which contains normally 70 to 80% F.C. About 92% F.C. product has been obtained by many producers after repeated cycles of beneficiation. A few plant owners have claimed to have obtained product containing as high as 95% F.C.

Beneficiation plants in Odisha seem to have been designed for treating +10% F.C. graphite (ROM). In practice, it is seen that lower grade graphite having +5% F.C. is blended with higher grades to meet the requirements of beneficiation plant, i.e., +10% F.C. Thus, low-grade ore analysing +5% F.C. also gets used.

Tamil Nadu Minerals Ltd (TAMIN) produces flaky graphite from a mine in Sivagangai district in Tamil Nadu. The beneficiation plant located adjacent to the mine site is designed to produce 8,400 tpy of natural graphite concentrate containing 96% F.C. with 92% recovery from ROM.

USES & SPECIFICATIONS

Traditional uses of graphite are in crucibles, foundries, pencils, etc. More sophisticated applications of graphite are in refractories that are used in the manufacture of steel, cement and glass, expanded graphite-based sealing gaskets, graphitised grease, braid, brushes, brake lining, etc. It is also used for speciality applications, such as, in the Nuclear Industry, soil conditioners and graphite foils, which is used for sealing in the Chemical and Petrochemical industries as well as in the Energy, Engineering and Automotive industries. It is also used in minor amounts as a vital additive for producing foundry coatings to prevent fusion of liquid metal with sand at the mould or core face. Such coatings are either applied by spraying or painting in the form of suspension or by dusting or by rubbing as dry powders. Graphite used for coating is of high quality which does not peel off as flakes on drying and imparts a smooth surface to the casting. Graphite, a major additive to many coating systems, is known for its multifarious functions, such as, refractory, lubricant, thermal conductor, electrical conductor, UV shield, electromagnetic pulse shield, corrosion shield and pigment. It is also used as moderator in nuclear reactors and in Lithium-ion (Li-ion) batteries which is used in the electric vehicles, that require high purity flake graphite in their anode material. Li-ion battery anode are typically made of graphite, which can absorb and hold the lithium ions between the layers in its atomic structure, while at the same time conducting electric charge.

The BIS has prescribed the following specifications of graphite for use in various industries:

IS: 1132-1985 (Reaffirmed 2008) - graphite for use in Graphite Crucible Industry;

IS:1305-1984 (Reaffirmed 2012) - graphite for use in foundry coatings;

IS: 14852-2000 (Reaffirmed 2010) - flaky graphite for Refractory Industry;

IS: 495-1967 (First Revision, Reaffirmed 2007) - graphite flakes for lubricants;

IS: 62-2006 (First Revision, Reaffirmed 2011) - graphite for paints; and

IS: 2079-1982 (First Revision, Reaffirmed 2010) - graphite for pencil slips.

The specifications of graphite adopted for various industrial purposes are detailed as below:

Specifications of Graphite

End product	Percentage of graphite used	Quality of the graphite used	
		Fixed Carbon (F.C.)	Size (micron)
Mag-Carb refractories	12	87–90%	150–710
Alumina-Carb (graphitised) alumina refractories	8–1085%	min.	150–500
Clay-bonded crucibles	60–65	+80%	–20 to +100 mesh
Silicon carbide crucibles	35	80–89%	+150
Expanded (or flexible) graphite foils and products based thereon (e.g. sealing gaskets in refineries, fuel pumps, automobiles)	100	90% min. (preferably +99%)	250–1800
Pencils	50–60	+95–98%	50 max.
Brake-linings	1-15	98% min.	75 max.
Foundry	–	40-70%	53-75
Batteries			
a) Dry cells	–	88% min.	75 max.
b) Alkaline	–	98% min.	5-75
Brushes	–	Usually 99%	Usually less than 53
Lubricants	–	98–99%	53–106
Sintered products (e.g. clog wheels)	–	98–99%	5
Paint	Up to 75	50-55% 75% min.	Amorphous powder flake
Braid used for sealing (e.g. in ship)	40-50	95% min.	–
Graphitised grease (used in seamless steel tube manufacturing)	–	+99%	38 max.
Colloidal graphite	100	99.9%	Colloidal

CONSUMPTION

As per the information received from various graphite consuming units and estimates, the consumption of various grades of graphite during 2019-20 was 19,000 tonnes which showed a decline of about 18 % as compared to 23,200 tonnes in the preceding year. Out of the total consumption in 2019-20, graphite products (crucible, pencil etc.) were 11,700 tonnes (62%), Foundary Industry 5,500 tonnes (29%), Refractory Industry 700 tonnes (4%) and Others (Dry Cell battery, cement, Iron & Steel, Paint, paper etc.) 1,100 tonnes (6%). Industrywise consumption data are provided in Table - 7.

Table - 7 : Consumption* of Graphite 2017-18 to 2019-20 (By Industries)

(In tonnes)

Industry	2017-18	2018-19 (P)	2019-20 (P)
All Industries	**71700(23)**	**23200(16)**	**19000(12)**
Chemicals	13800	13800	-
Foundry	4800	5600	5500
Graphite products (Crucible, Pencil, etc.)	50400	2000	11700
Refractory	1200	700	700
Others (Dry cell battery, cement, iron & steel, paint, paper, etc.)	1500	1100	1100

Figures rounded off

**Includes actual reported consumption and/or estimates made wherever required and due to paucity of data, consumption may not be complete.*

( ) Number of plants reported /estimated. The apparent cosumption graphite has been estimated as 68.9 thousand tonnes.

SUBSTITUTION

In principle, it is possible to substitute graphite by either synthetic graphite, produced primarily from high carbon precursors, such as, petroleum coke and coal tar pitch (e.g. in batteries or for increasing the carbon in steel) or by replacing the product as in the case of pencils or by other compounds as in high temperature applications (e.g. refractories). In the later case, it is difficult to fully substitute graphite as it is tough to replicate the same level of performance that graphite provides.

There is a limit to how much charge graphite can store and lithium moves relatively slowly through graphite. Therefore, while considering the improvement required for large scale EV, tin and silicon may be the future competitor because of higher charge capacity and also tin conducts lithium-ion faster.

WORLD REVIEW

The world resources of graphite are believed to exceed 800 million tonnes of recoverable reserves. However, world reserves of graphite have been placed at 320 million tonnes of which Turkey accounts for 28% followed by China- (23%), Brazil (22%), Madagascar & Mozambique (8% each), Tanzania 5%, India & Uzbekisthan (2% each) and Mexico & Dem. P. R. of Korea (1% each) (Table-8).

World production of graphite was 1.1 million tonnes in 2019 same as in the preceding year. China continued to be the leading producer, with a share of about 64% which is followed by Mozambique (10%), Brazil (9%), Madagascar (5%) and Dem. P.R of Korea (4%) (Table-9).

A generalised view of the development in various countries with countrywise description sourced from latest available publication of minerals yearbook 'USGS 2017' is furnished below:

Brazil

Brazil was one of the leading country of graphite with estimated production of 90,000 tonnes of marketable natural graphite in 2017. Nacional de Grafite Ltda. was the only producer of natural flake graphite in Brazil during 2017. High-grade crystalline flake graphite projects were being developed in Brazil with at least two companies conducting or considering graphite exploration and development.

Canada

Canada was one of the leading country of graphite with a production of 40,000 tonnes of natural flake graphite reported from two active open pit mines in 2017. About 80% production reported from the Lac des Iles flake graphite mine in Quebec, operated by Imerys Graphite & Carbon, and approximately 20% from the Black Crystal flake graphite quarry in British Columbia, owned by Eagle Graphite Corp. During 2017, 24 potential graphite producers were exploring and developing flake graphite projects in Canada.

Table – 8 : World Reserves of Graphite (Natural) (By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total *(rounded off)*	**320000**
Brazil	70000
China	73000
India*	8000
Korea, Dem. P.R	2000
Madagascar	26000
Mexico	3100
Mozambique	25000
Norway	600
Sri Lanka	1500
Tanzania	17000
Turkey	90000
Uzbekisthan	7600

Source: *USGS Mineral Commodity Summaries, 2021*
**India's reserves of graphite as per NMI database, based on UNFC system as on 1.4.2015 have been placed at about 7,960 thousand tonnes.*
Austria, Canada, Germany, Pakistan, Russia, Ukraine, United States and Vietnam are included in world total.

Table – 9 : World Production of Graphite (By Principal Countries)

(In tonnes)

Country	2017	2018	2019
World Total (Rounded off)	**1000000**	**1100000**	**1100000**
China[de]	625000	693000	700000
Mozambique	802	106773	113803
Brazil[b]	90000	95000	96000
Madagascar	12852	54587	53400
Korea, Dem. P.R.[c]	140000	40000	40000
*India[ac]	33649	39370	32936
Austria[ai]	24400	25000	20000
Turkey	0	16752	16800
Russia	25200	17800	16600
Other countries	56749	49190	42789

Source: *BGS World Mineral Production, 2015-19,*
a: Crude
b: Including beneficiated and directly shipped material
c: Years ended 31 March following that stated
d: Including flake graphite
i: Sales
** India's productiom of graphite during 2017-18, 2018-19 and 2019-20 was at 34 thousand tonnes, 39 thousand tonnes and 31 thousand tonnes, respectively.*

FOREIGN TRADE

Exports

In 2019-20, exports of graphite (natural) increased by 50 % to 609 tonnes as compared to 405 tonnes in the previous year. Graphite (natural) was exported mainly to Malaysia (31%), Tanzania (26%), Sudan (12%), Bangladesh (6%) and UAE, China, Iraq & Mauritania (3% each).

The exports of graphite (artificial) decreased considerably by 22% to 24,747 tonnes in 2019-20 from 31,594 tonnes in the previous year.

Graphite (artificial) was exported mainly to Germany (32%), Bhutan (20%), UAE (8%), USA (7%), Oman (6%), Bangladesh & Kuwait (5% each) and South Africa (4%).

The exports of graphite crucibles drastically decreased by 64% to 20 tonnes in 2019-20 from 56 tonnes in the preceding year, while those of silicon carbide crucibles also decreased by 3 % to 3,023 tonnes in 2019-20 from 3,128 tonnes in the previous year. Graphite crucibles were mainly exported to USA (40%), Ethopia (35%) and Sri Lanka (10%). Silicon carbide crucibles were exported mainly to UAE (23%), USA, Egypt & Turkey (7% each), South Africa & Germany (5% each), Korea & Thailand (4% each) and UK & Indonesia (3% each). Exports of graphite bricks and shapes drastically decreased by 84% to 95 tonnes in 2019-20 from 597 tonnes in the preceding year. Graphite bricks and shapes were mainly exported to Nepal (25%), Ethiopia (23%), South Africa (13%), Nigeria & Oman (11% each) and Jordan (4%) (Tables - 10 to 14).

Table – 10 : Exports of Graphite (Natural)
(By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**405**	**22958**	**609**	**32629**
Malaysia	10	1207	190	11081
Tanzania	190	8363	158	6733
Sudan	8	481	72	3748
Bangladesh	42	2083	35	1760
Bulgaria	-	-	++	1474
UAE	++	20	16	1236
China	++	6	16	1030
Iraq	18	834	18	813
Mauritania	-	-	20	796
Indonesia	4	836	2	737
Other countries	132	9129	81	3221

Figures rounded off

Table – 11: Exports of Graphite (Artificial)
(By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**31594**	**3745543**	**24747**	**3555900**
Germany	9301	1880231	7971	2098318
USA	6338	728170	1702	401302
Bhutan	4431	214923	4952	209278
UAE	1704	130022	1922	128201
Oman	1316	60800	1421	67346
Belgium	96	29512	124	62903
Kuwait	1863	106600	1180	58525
Bangladesh	1157	68299	1265	51072
UK	413	50774	290	44046
South Africa	359	15970	1006	42483
Other countries	4615	460242	2912	392427

Figures rounded off

Table– 12 : Exports of Graphite Bricks & Shapes (By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**597**	**5707**	**95**	**5142**
Bangladesh	510	3289	7	1383
Jordan	4	666	4	1012
Nepal	-	-	24	734
Nigeria	-	-	10	501
China	-	-	++	342
Oman	-	-	10	297
South Africa	-	-	12	236
Ethiopia	56	445	22	168
Germany	-	-	++	162
Saudi Arabia	-	-	1	154
Other countries	27	1308	5	153

Figures rounded off

Table– 13 : Exports of Graphite Crucibles (By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**56**	**6888**	**20**	**2253**
Sri Lanka	-	-	2	795
Peru	-	-	1	619
Kuwait	-	-	1	297
Russia	-	-	++	174
USA	10	3645	8	139
UK	-	-	++	81
Hong Kong	++	21	++	75
Ethiopia	29	2198	7	54
Bhutan	-	-	++	11
Nepal	1	28	++	6
Other countries	16	997	1	5

Figures rounded off

Table – 14 : Exports of Silicon Carbide Crucibles (By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**3128**	**671354**	**3023**	**690398**
UAE	391	64722	690	135876
USA	214	66770	203	76141
Egypt	208	58853	219	56101
South Africa	130	49683	144	50730
Germany	176	42360	140	44391
Korea, Rep. of	106	34539	118	41141
Turkey	222	51117	210	40797
Thailand	134	24896	110	23567
UK	134	19690	104	22566
Indonesia	66	19147	76	18622
Other countries	1347	239576	1009	180466

Figures rounded off

Imports

Imports of graphite (natural) decreased marginally by 12% to 41,405 tonnes in 2019-20 from 47,053 tonnes in the preceding year. Graphite (natural) was imported mainly from China (61%), Madagascar (16%), Mozambique (15%) and Brazil (3%).

Imports of graphite (artificial) drastically decreased by 30% to 47,512 tonnes in 2018-19 from 68,289 tonnes in the previous year. Imports of graphite (artificial) were mainly from China (54%), Norway (10%), Germany & UAE (6% each), France (4%), Poland & USA (2% each) and remaining 16% share was contributed by other countries.

Imports of graphite bricks and shapes drastically increased manifold to 9,408 tonnes in 2019-20 from 9 tonnes in the preceding year. Imports of graphite bricks and shapes were mainly from USA (92%) followed by China (8%) and remaining share was contributed by Japan & Germany. Imports of graphite crucibles drastically decreased by 99% to 1 tonne in 2019-20 from 79 tonnes in the preceding year. Italy was the only supplier country. Imports of silicon carbide crucibles increased by 31% to 63 tonnes in 2019-20 from 48 tonnes in the previous year. Imports were mainly from China (33%), Japan (32%), Germany (19%) and USA (8%) (Tables - 15 to 19).

Table – 15 : Imports of Graphite (Natural) (By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**47053**	**2328880**	**41405**	**1863219**
China	34742	1489400	25189	948798
Madagascar	4950	349377	6543	381378
Mozambique	4444	187986	6355	248014
Brazil	1476	104527	1060	77889
Germany	179	64856	253	57957
USA	398	45654	271	38400
Vietnam	-	-	568	16878
Sri Lanka	82	12942	86	13413
UK	215	17460	155	12348
Belgium	76	6680	141	11705
Other countries	491	49998	784	56440

Figures rounded off

Table – 16 : Imports of Graphite (Artificial) (By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**68288**	**6739304**	**47512**	**4870672**
China	31834	3116539	25821	2251296
Germany	4542	1006832	2993	996636
France	2311	324491	1934	373387
Norway	4409	255901	4592	269823
Japan	2989	848593	434	221804
USA	1147	193751	882	152936
UAE	4580	234122	3046	126616
Poland	1583	163002	884	95647
UK	336	35485	644	81361
Korea, Rep. of	524	71341	318	54477
Other countries	14033	489248	5964	246689

Figures rounded off

Table – 17 : Imports of Graphite Bricks & Shapes (By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**9**	**10434**	**9408**	**16171**
USA	-	-	8663	7797
China	8	4607	741	5884
Japan	++	867	4	2459
Germany	1	4960	-	-

Figures rounded off

Table – 18 : Imports of Graphite Crucibles (By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**79**	**10195**	**1**	**2573**
Italy	++	1564	1	1982
Germany	1	346	++	296
Japan	++	222	++	273
USA	-	-	++	18
China	3	7358	++	4
Bahrain	75	645	-	-
Bulgaria	++	57	-	-
France	++	1	-	-
UAE	++	2	-	-

Figures rounded off

Table – 19 : Imports of Silicon Carbide Crucibles (By Countries)

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**48**	**8627**	**63**	**20743**
USA	26	2930	5	8212
Italy	++	1415	2	5519
Germany	3	1329	12	3627
China	4	421	21	1722
Czech Republic	-	-	++	514
Japan	8	588	20	443
UK	++	530	2	422
Canada	2	259	1	283
Korea, Rep. of	++	402	-	-
Spain	5	398	-	-
Other countries	++	356	-	-

Figures rounded off

FUTURE OUTLOOK

Worldwide demand for combined natural and synthetic graphite is expected to rise along with improvements in the global economic conditions. Demand is also expected to augment further with the development of non-carbon energy applications, such as, batteries used in electric vehicles, electric devices and energy storage devices that use graphite. The graphite reserves having +40% Fixed Carbon are rather limited in the country. Detailed exploration of graphite deposits in Odisha, Jharkhand, Jammu & Kashmir and Kerala should be carried out. Cost-effective beneficiation technologies for low-grade graphite ore need to be developed. Silicon carbide-graphite crucibles are being diversified and manufactured to improve upon the use of inferior grade material with less quantity and at the same time ensuring longer life of crucible.

Of late, a few emerging & important specialised applications of exfoliated graphite have been reported especially in the manufacture of sealings, gaskets, braids and brushes. New products of synthetic graphite, such as, graphite fibres/ropes and graphite insulation blankets have been introduced. In the world scenario, there seems to be a rapid diversification in respect of potential large-volume end-use for natural graphite, such as, in heat sinks, also called spreader shield, which is a graphite foil material that conducts heat only in two directions. It has thermal conductivity above aluminium and almost equal to copper. These are used for dissipating heat in laptop computers, flat-panel displays, wireless phones, digital video cameras, etc. Such emerging & high growth applications of graphite are certainly causing noticeable impacts on the demand & consumption patterns within the country & globally.

The demand for high purity graphite is increasing exponentially due to increase in the demand of lithium-ion batteries for electric vehicles, laptops, smartphones, home/business applications and traditional uses for expanded graphite foils are also the potential areas that are expected to be major drivers for graphite consumption. It represents 23% of global flake graphite demand. The demand for graphite in the Battery segment is forecasted to double in the next six years.