





Prospects for Natural Graphite Flake Markets



Tirupati Graphite
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Introduction



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- Tirupati Grpahtie plc I has engaged Fastmarkets (formerly Metal Bulletin Group”), the independent research and consultancy arm of Fastmarkets, part of Euromoney Institutional Investor PLC, registered in the United Kingdom, to receive a study on the prospects of the natural graphite market
- Feel free to contact me about any aspect of this report, or for any additional information requirements you may need to further support you and your teams

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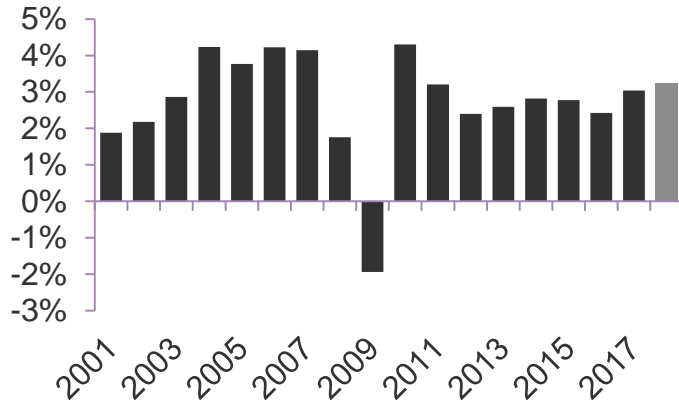


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Global Economic Outlook

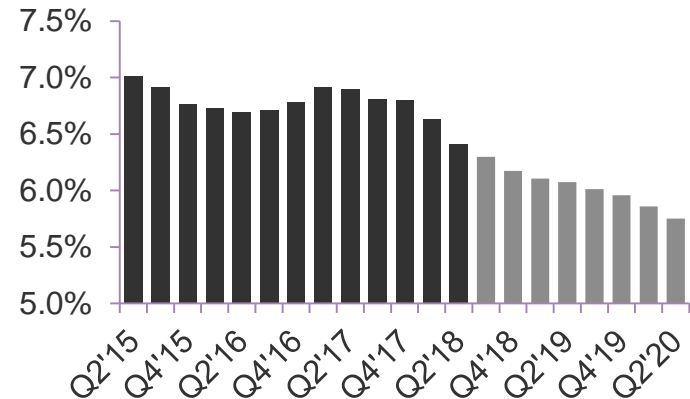


GLOBAL GDP (% CHANGE)



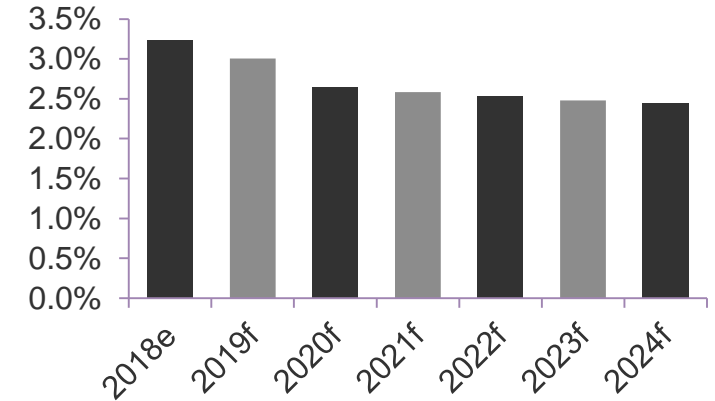
- Global output expanding with all regions positive
- Remains below rate seen prior to financial crisis
- Asia is fastest-growing region
- Recovery in Latin America & CIS
- Acceleration in North America & Europe

CHINESE QUARTERLY GDP (% CHANGE)



- Chinese economy rallied in 2016/17 on stimulus
- Turned down in Q2 2018
- Outlook is for further weakness
- On-going shift to consumption from capital investment and reduction in debt risk
- Government could potentially re-stimulate

GLOBAL GDP OUTLOOK

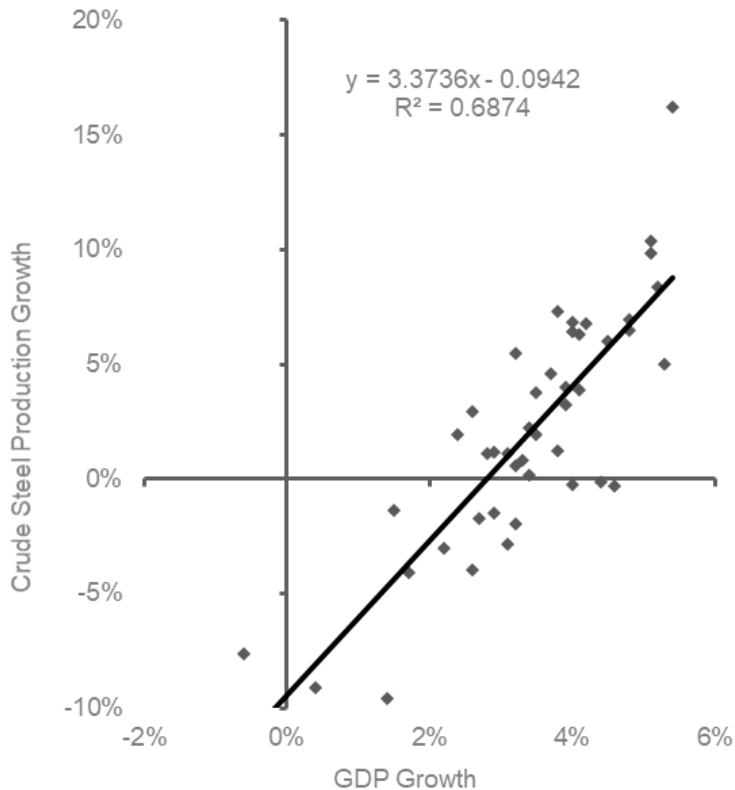


- 2018 may be peak
- Rising US interest rates in 2018
- End of QE in Europe and Japan
- Slowing Chinese growth
- Higher oil prices will choke consumption

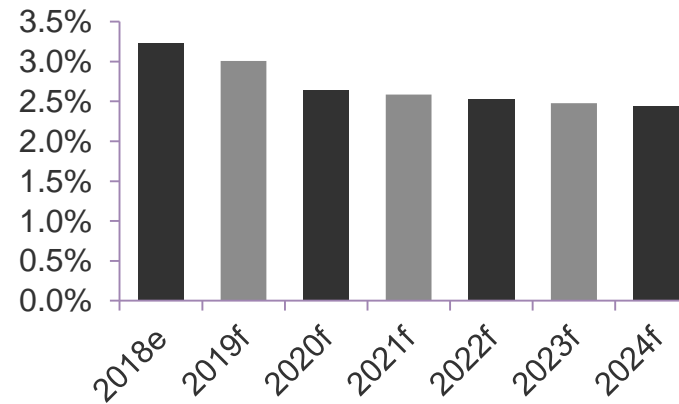
Economic outlook – Our key assumptions



Steel output is correlated to economic growth



Global GDP not returning to +4% growth



RISKS

- Decade of monetary easing coming to an end
- Global debt now at higher levels than 2008
 - Surging US economy leading to strong US dollar
 - Rising risks of emerging market currency crisis due to excess offshore debt
- Tightening credit cycle in mature & emerging markets
- China slowing, but remains robust for now, but potential excess debt
- Trade war

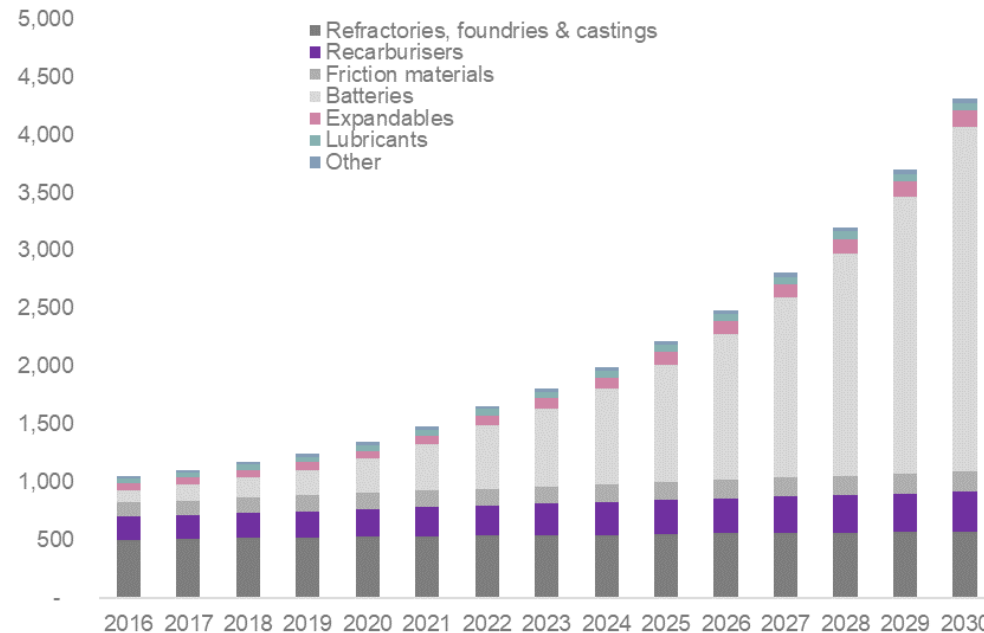
- The expansion is becoming less even, and risks to the outlook are mounting. The rate of expansion appears to have peaked in some major economies and growth has become less synchronized

Global natural flake graphite consumption trends



- Demand for natural graphite has historically been driven by the refractory, foundry and crucible sector.
- Refractory, foundry and crucible demand accounts for approximately 46% of global demand for natural graphite. The refractory industry drives the majority of this demand, whilst the foundry and crucible sectors consume smaller volumes of higher purity graphite products.

Demand for natural graphite ('000 tonnes)



~1.2m tonnes in 2018

Graphite price historically driven by steel and industrial applications; now and in future more by battery & other high growth sector demand

- The battery sector is comparatively small but rapidly growing. In 2017, we estimate that the battery sector accounted for 13% of overall global consumption of natural graphite.
- As of 2017, less than 50% of graphite consumed was within batteries for EVs. This is forecast to change in the coming years.

7% CAGR

Global expandable graphite market growth between 2017-2022

32% CAGR

Global batteries market growth between 2017-2022

Demand for graphite is expected to experience an unprecedented growth elsewhere



Over 150 graphite applications

Basic graphite properties related to the applications:

- High electrical and thermal conductivity
- Insertion chemistry (intercalation)
- Chemical stability under acidic and alkaline conditions, inertness
- Lubricity
- Low weight
- Price / performance ratio

Large Flake 20 – 80 mesh

Gaskets and Seals

Flame Retardants

Thermal sheets

Fuel cells

Plugging Agents

Expandable Graphite

Thermal Management

Medium Flake 80 – 150 mesh

Basic Refractory:

Magnesia Carbon

Alumina Carbon

Unshaped Refractory

Flame Retardants

Small Flake 100 mesh to Micronised

Paintings & Coatings

Pencils

Dry & Ni MH Batteries

Lubrication

Friction Materials

Composites

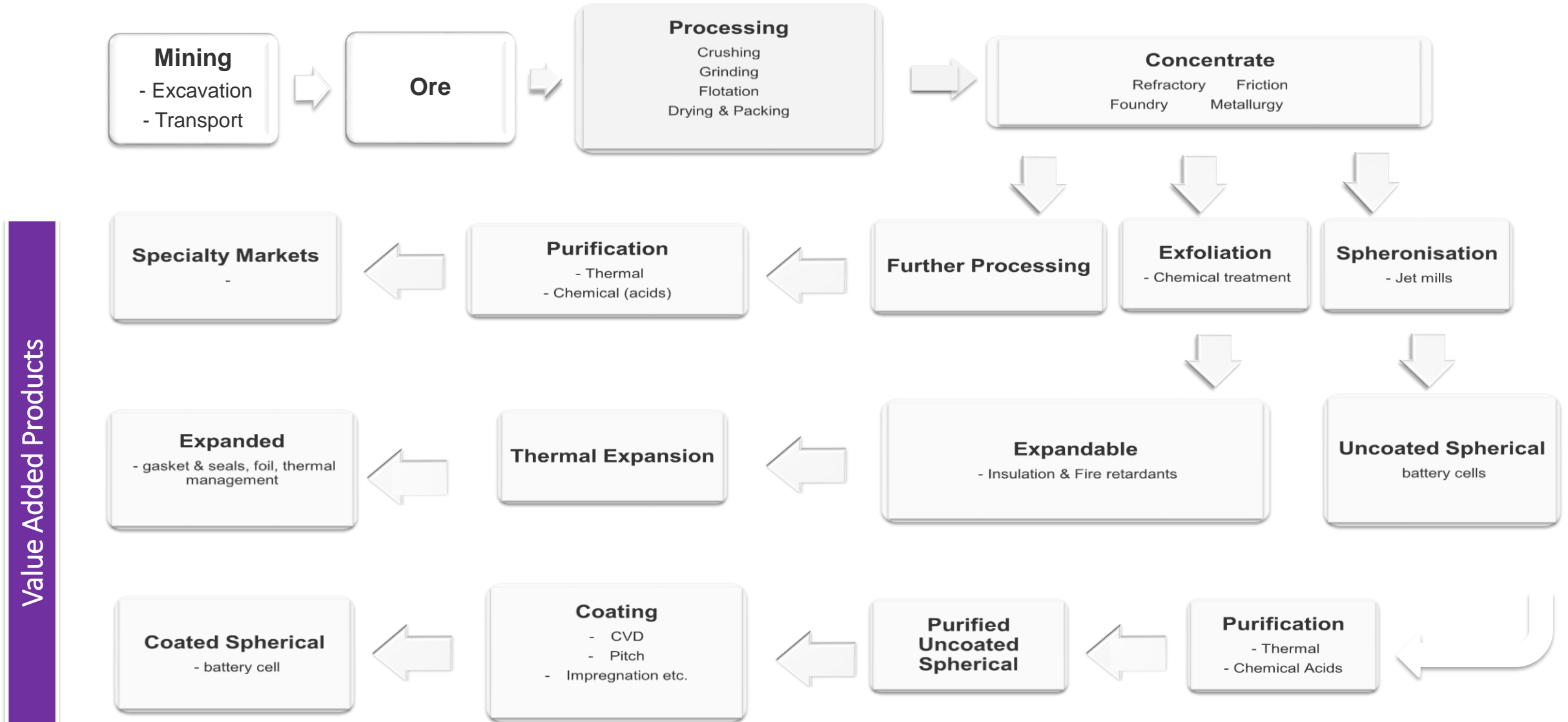
Li-ion Batteries

Aviation & Space Technology

Nuclear Technology

Sectors = High growth, over 7% CAGR projected

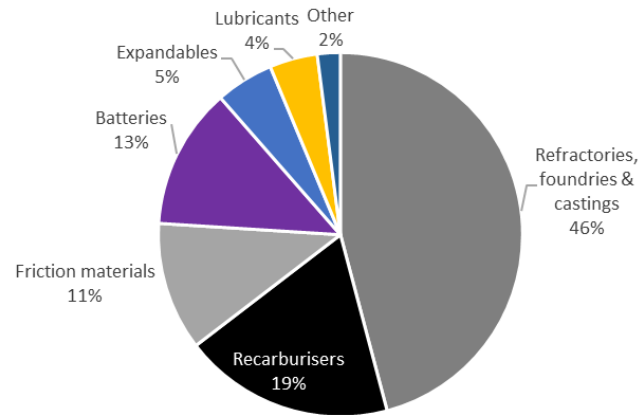
Graphite's value chain



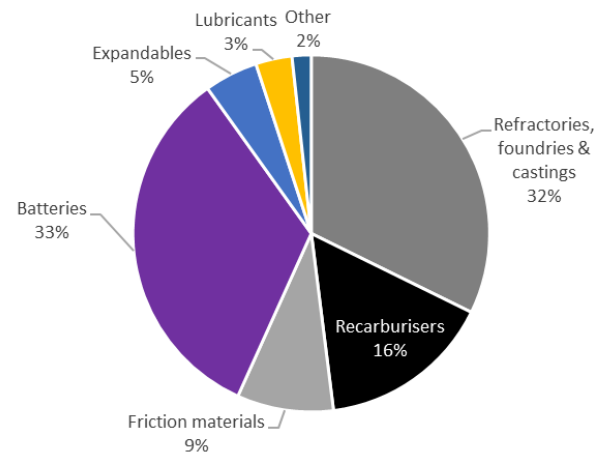
Natural graphite demand by end-user applications out to 2027



Natural graphite demand by application - 2017 (%)

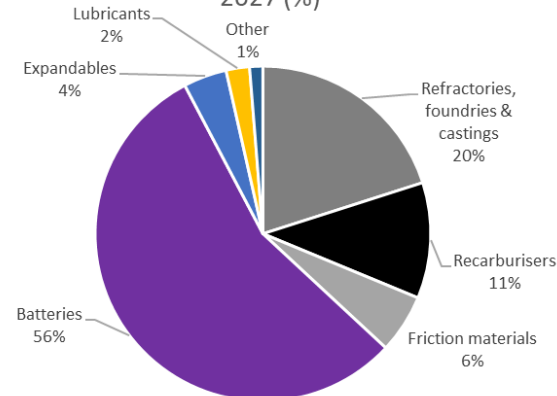


Natural graphite demand by application - 2022 (%)



Total natural graphite consumption in 2017 reached over 1.1m tonnes...

Natural graphite demand by application - 2027 (%)



... and will reach over to over 2.8m tonnes by 2027

Given the rapid increases in EV and storage facilities projected globally the global demand share of graphite in this sector will substantially rise from a 13% share in 2017 to 56% by 2027

Graphite will keep it's position as main anode material for many years

Demand for EV Lib batteries



84,000 tonnes

NATURAL SPHERICAL

SYNTHETIC

39,719
(= 99,000 tonnes flake)

47:53 %

China accounts ~45% of global graphite demand in lithium-ion batteries but will be >50% in 2025

44,076

2018

Disadvantages

- High Yield Loss
- Complicated Production

Due to performance and price issues, the ratio between natural and synthetic graphite is expected to be around 50:50 by 2022

Disadvantages

- More costly & energy-intensive vs Natural
- Lower Capacity vs Natural

186,500
(= 466,000 tonnes flake)

188,000

2022

50:50 %

100% supplied by China



374,515 tonnes



73% supplied by China, 15% Japan, 12% Other

New Natural Graphite Flake Projects



Significant increases in supply are expected from ex-China countries, such as Mozambique, Madagascar, Guinea and Brazil, with substantial new graphite production facilities planned. However, there are challenges:

- **Increasingly high market entry barriers**

- High market entry barriers exist, particularly increasing in high growth, value-adding processing applications e.g. Lib, expandables, composites etc.
- Syrah Resources' Balama flake graphite mine in Mozambique that came online in October 2017. The company missed its production target for the first half of 2018 and has since reduced its output guidance for 2018 from 160,000 tonnes to 101,000-106,000 tonnes

- **Limited graphite projects in the pipeline (at least short-term)**

- No new projects are expected to come on stream in 2019 except Tirupati Graphite in Q1 2019 with 9,000 tonnes and additional 18,000 tin Q4 2019 to total 27,000 tonnes

- **New projects take a long time to come to market**

- Bringing a new mine into production takes time and requires significant technical knowledge to meeting the increasing complexities of consumer requirements. A unique skill set is required for value-added grades



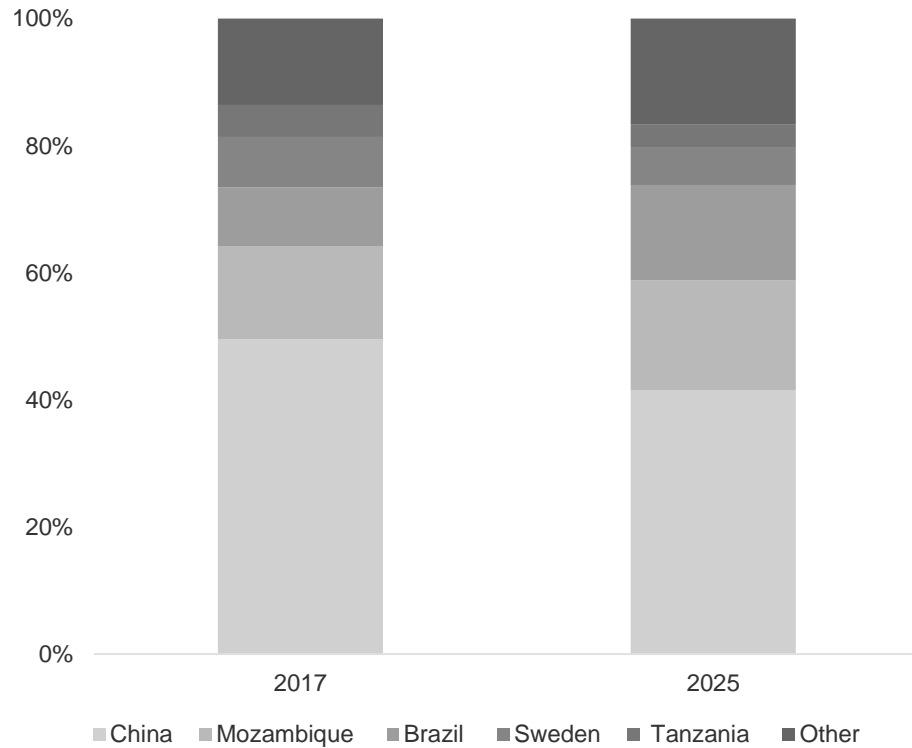
Undoubtedly, there is a real market need for reliable and secure high quality graphite suppliers outside China there are supply-side challenges

- Strong cost pressures from car OEM's but no compromise in quality
- Material consistency & logistical issues mean lengthy output ramp up's.
- Financing/mining lease/sovereign risk issues (particularly affecting African-based operations)
- Lengthy process to build trust and end-user customer base as product samples are insufficient
- Not all flake graphite deposits are created equal to meet required market demand

Key supply-side market conclusions



Natural Graphite Supply, 2017 - 2025

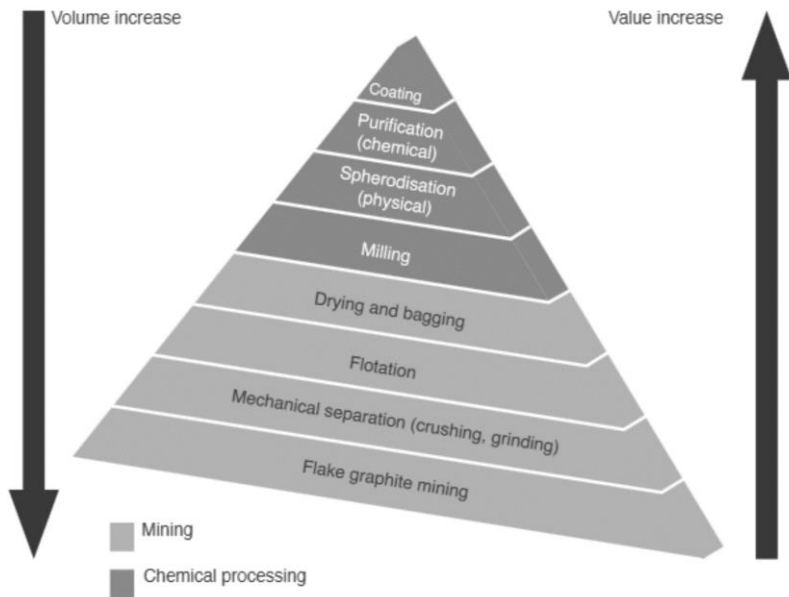


- In 2016, China accounted for approximately 60% of natural graphite production, however environmental restrictions have reduced graphite production.. It will remain the largest producer of natural graphite, ~ 750,000 tpy, however increases in supply from other countries will mean China's dominance will reduce over the next 5 years. In the production of spherical graphite, for use in battery anodes, China will continue to control the majority of the processing and production. However, Chinese mines reportedly lack significant large and jumbo flake graphite therefore creating a market opportunity for any new large flake size producers.
- Any new project to come to market and survive will have to meet following key criteria in today's demand environment
 - Low stripping ratio
 - Resources / reserves for > 10 years (> 10 Mt)
 - High yield of highest-quality marketable products (> 94% Carbon, >75 micron)
 - Favourable jurisdiction and logistics
 - Low operating costs
 - Short timeframe to production (< 2 years)
 - Offtake (sales) agreements in place
 - Experienced management with strong understanding of graphite markets
- This means not all the ~1.3m tpy planned new graphite supply projects will come to fruition. We expect start-up's to take up more of a modular approach to supply increases over the forecast period accordingly.
- We expect significant global production deficits emerging particularly in large flake and battery application areas, thereby providing upward pressure on market prices.

Graphite Price Outlook



Price analysis & forecasts



MESH SIZE		PRICE
Classification	Size	
LUMPS	1	
	8	\$\$\$
JUMBO FLAKE	32	
LARGE FLAKE	50	\$\$\$
	80	
MEDIUM FLAKE	100	\$\$
	150	
FINES	200	\$
	300	

CARBON CONTENT		PRICE
Classification	C%	
HIGH PURITY/SPHERICAL (>99%)	99.9999%	
	99%	\$\$\$\$\$
VEIN (90-99%)	98%	\$\$\$\$
	97%	\$\$\$\$
FLAKE (85-97%)	96%	\$\$\$\$
	95%	\$\$\$\$
	94%	
	93%	
	92%	\$\$\$
	91%	
AMORPHOUS (60-85%)	90%	
	89%	\$\$
	88%	
	87%	
	86%	\$
	85%	
	80%	\$

Flake graphite prices are dictated by three factors:

Carbon purity:

Flake graphite concentrate with a greater carbon purity receive a premium price because they require less processing to remove disruptive impurities. A carbon content of 90% C and above is generally required in all refractory, foundry and crucible applications. The most common grade used in refractory applications is around 92% C, but some major producers will demand a purity of up to 96% C to ensure the integrity of their products. The price of grades <94% C increase at an accelerated rate as the carbon content increases, due to the greater cost involved in refining the material towards the higher purities required for high-tech and more specialist applications.

Mesh size:

Similar to high-carbon purity grades, larger mesh sizes demand a premium. Tighter supply conditions for these grades dictate that prices escalate rapidly at mesh sizes larger than +80 mesh. Larger mesh size also improves the material's conductivity for higher-value applications.

The rise of offtake agreements and more sophisticated customer requirements for added value processing and applications

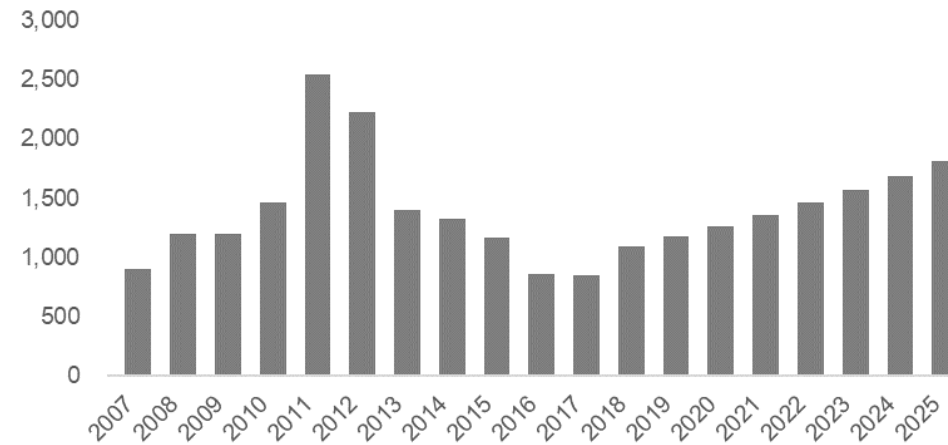


Natural Flake Price Forecasts by size/purity



Grade		CIF Europe								
Mesh Size	Carbon	2017	2018	2019	2020	2021	2022	2023	2024	2025
+32Mesh	92	1,932	2,070	2,174	2,282	2,378	2,478	2,582	2,690	2,803
+32Mesh	94	2,100	2,210	2,323	2,441	2,551	2,666	2,786	2,911	3,042
+32Mesh	95	2,150	2,270	2,406	2,551	2,699	2,855	3,021	3,196	3,381
+32Mesh	96	2,200	2,360	2,549	2,753	2,962	3,187	3,429	3,690	3,970
+32Mesh	97	2,350	2,470	2,668	2,881	3,111	3,360	3,629	3,920	4,233
+48Mesh	92	1,564	1,670	1,770	1,876	1,980	2,088	2,203	2,325	2,452
+48Mesh	94	1,700	1,810	1,919	2,034	2,146	2,264	2,388	2,519	2,658
+48Mesh	95	1,750	1,855	1,985	2,124	2,251	2,386	2,529	2,681	2,842
+48Mesh	96	1,800	1,915	2,049	2,192	2,346	2,510	2,686	2,874	3,075
+48Mesh	97	1,850	1,970	2,128	2,298	2,482	2,680	2,895	3,126	3,376
+80Mesh	92	741	900	927	955	983	1,013	1,043	1,075	1,107
+80Mesh	94	790	960	1,008	1,058	1,111	1,167	1,225	1,286	1,351
+80Mesh	95	820	1,030	1,102	1,179	1,262	1,350	1,445	1,546	1,654
+80Mesh	96	880	1,150	1,242	1,341	1,449	1,565	1,690	1,825	1,971
+80Mesh	97	900	1,250	1,363	1,485	1,619	1,764	1,923	2,096	2,285
+100 -80Mesh	92	808	850	893	901	906	910	915	920	924
+100 -80Mesh	94	878	920	929	938	943	948	953	957	962
+100 -80Mesh	95	976	960	979	999	1,009	1,019	1,029	1,039	1,050
+100 -80Mesh	96	969	970	999	1,029	1,060	1,086	1,114	1,141	1,170
+100 -80Mesh	97	1,040	1,065	1,097	1,130	1,164	1,193	1,223	1,253	1,285
+200Mesh	92	745	800	816	832	849	866	883	901	919
+200Mesh	94	810	830	847	864	881	898	916	935	953
+200Mesh	95	803	845	862	879	897	915	933	952	971
+200Mesh	96	847	870	887	905	923	942	961	980	999
+200Mesh	97	950	970	989	1,009	1,029	1,050	1,071	1,092	1,114
-200Mesh	92	386	550	532	510	485	455	435	415	400
-200Mesh	94	420	570	576	551	522	489	463	443	429
-200Mesh	95	400	470	549	520	498	482	467	447	437
-200Mesh	96	450	570	641	634	621	588	576	552	534
-200Mesh	97	500	635	692	685	670	635	622	596	577

Large flake graphite 94-97% C. + 80 mesh, average \$/tonne



- Strong CAGR price growth in high purity and large flake distribution particularly.
- Synthetic graphite commands a significant premium to natural flake graphite, given it's a man-made, environmentally damaging and high energy intensive product.
- This will act as a significant advantage to natural flake consumption levels and help support natural flake prices over the forecast period.

Contact



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