

## **Optimized for Economies of Scale: High-Performing Natural Graphite for Next-Generation Li-ion Batteries**

### **2018 International Battery Seminar and Exhibit**

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# Syrah Resources:

## The only major new supplier of natural graphite

### First mover advantage – operations commenced

- First production November 2017
- Customer shipments commenced January 2018
- First revenue received February 2018

### Largest natural graphite producer

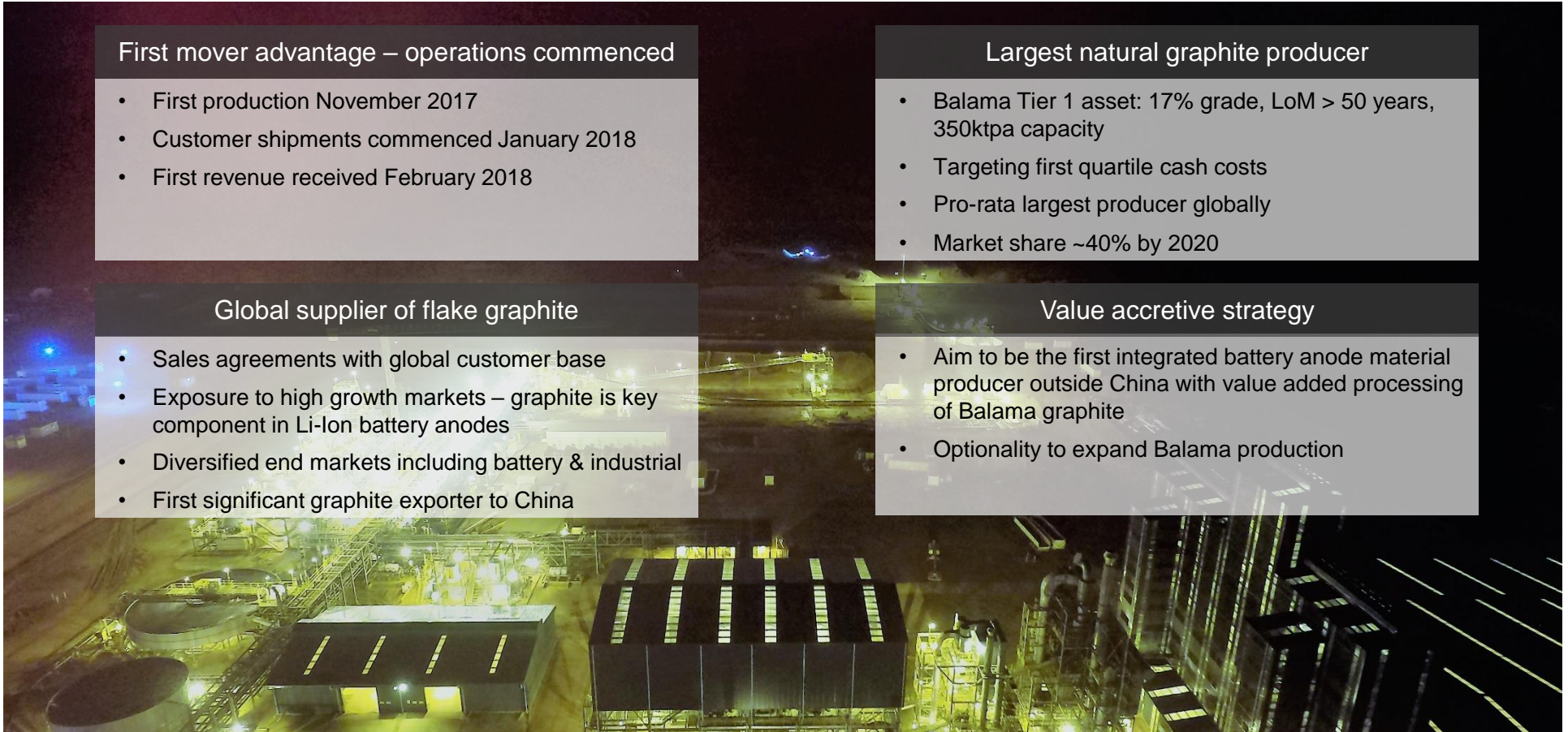
- Balama Tier 1 asset: 17% grade, LoM > 50 years, 350ktpa capacity
- Targeting first quartile cash costs
- Pro-rata largest producer globally
- Market share ~40% by 2020

### Global supplier of flake graphite

- Sales agreements with global customer base
- Exposure to high growth markets – graphite is key component in Li-Ion battery anodes
- Diversified end markets including battery & industrial
- First significant graphite exporter to China

### Value accretive strategy

- Aim to be the first integrated battery anode material producer outside China with value added processing of Balama graphite
- Optionality to expand Balama production

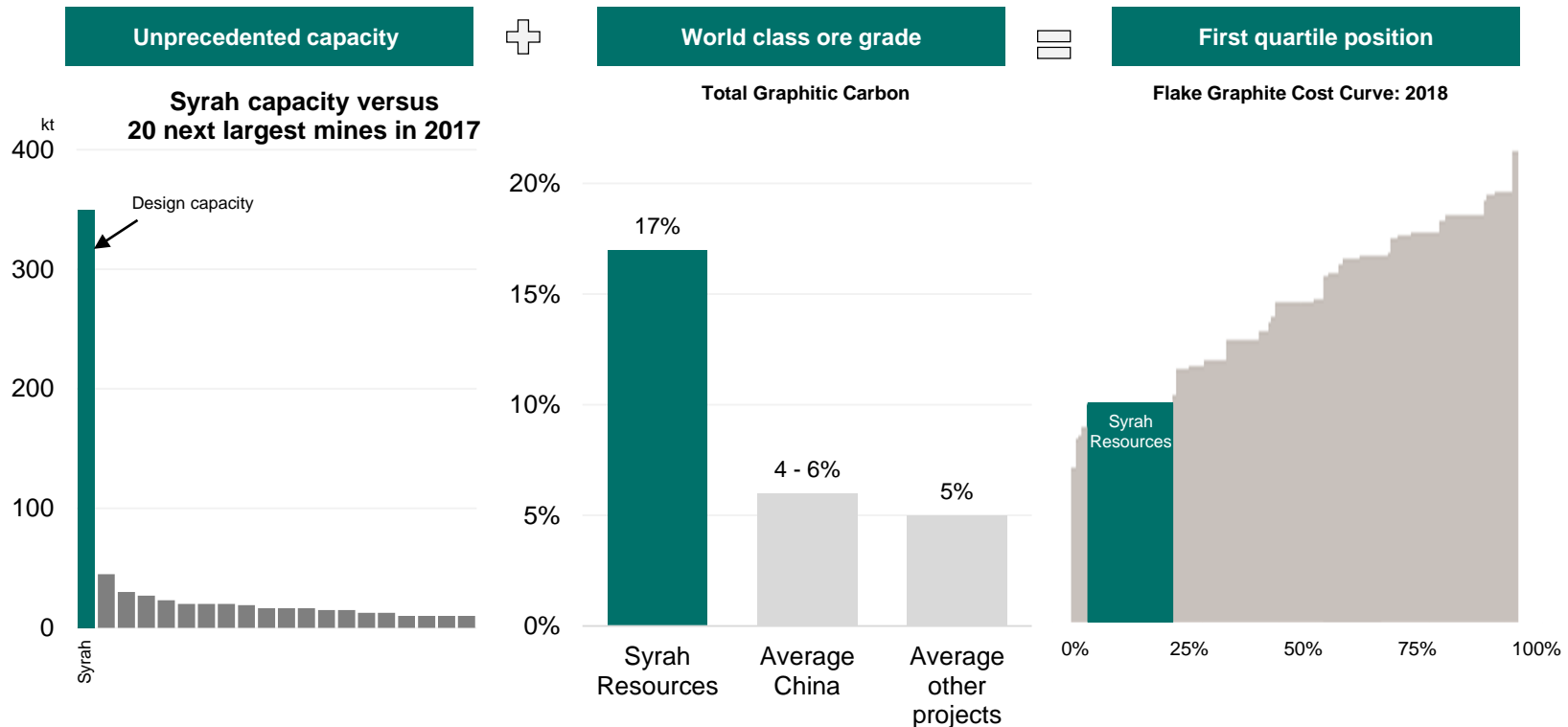


# Syrah's strategy is focussed on value; enabled by a world class deposit and fast growing market

Goals	Logic	Enablers	Timing
<b>Be the pre-eminent supplier of flake graphite</b>	<ul style="list-style-type: none"> <li>Lithium-ion battery market growth</li> <li>Industrial market for baseload demand</li> </ul>	<ul style="list-style-type: none"> <li>Low cost &lt;US\$400/t, toward US\$300/t</li> <li>High quality 95%-98% Fixed Carbon</li> <li>Large volume 350ktpa</li> </ul>	<ul style="list-style-type: none"> <li>Transitioned to operations 1 January 2018</li> </ul>
<b>Be the first major integrated Battery Anode Material producer outside China</b>	<ul style="list-style-type: none"> <li>High value-add product</li> <li>First mover advantage</li> <li>Diversification in the global supply chain</li> </ul>	<ul style="list-style-type: none"> <li>Electric vehicle market growth</li> <li>Energy storage for grid integration</li> <li>Consumer goods (3C)</li> </ul>	<ul style="list-style-type: none"> <li><b>2018- 2020</b></li> </ul>
<b>Maximise value of other options</b>	<ul style="list-style-type: none"> <li>Large scale deposit</li> <li>Lithium-ion battery market growth</li> <li>Vanadium</li> </ul>	<ul style="list-style-type: none"> <li>Expansion of Balama mine</li> <li>Battery anode material expansion</li> <li>Processing Vanadium</li> </ul>	<ul style="list-style-type: none"> <li>Options under development</li> </ul>
<b>Our Values and People underpin how we execute our strategy</b>			
<b>Deliver value for stakeholders and shareholders</b>			



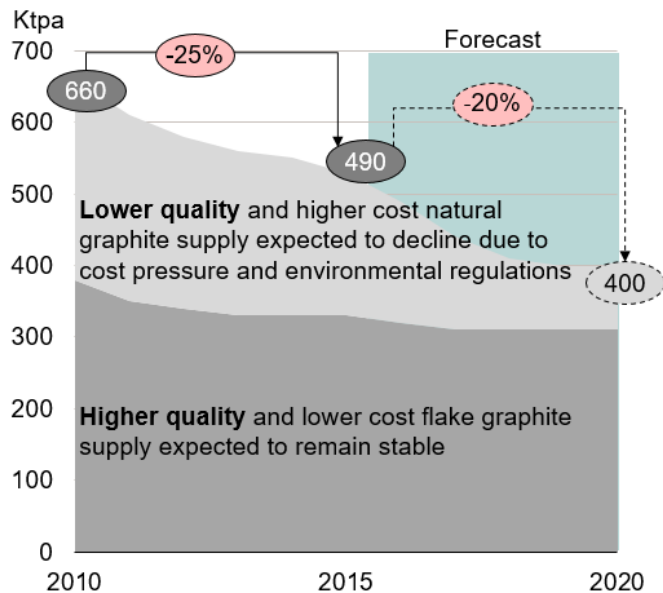
# Largest capacity, consistent high grade, low impurities, and a long life asset enables Syrah Resources to be the global graphite leader



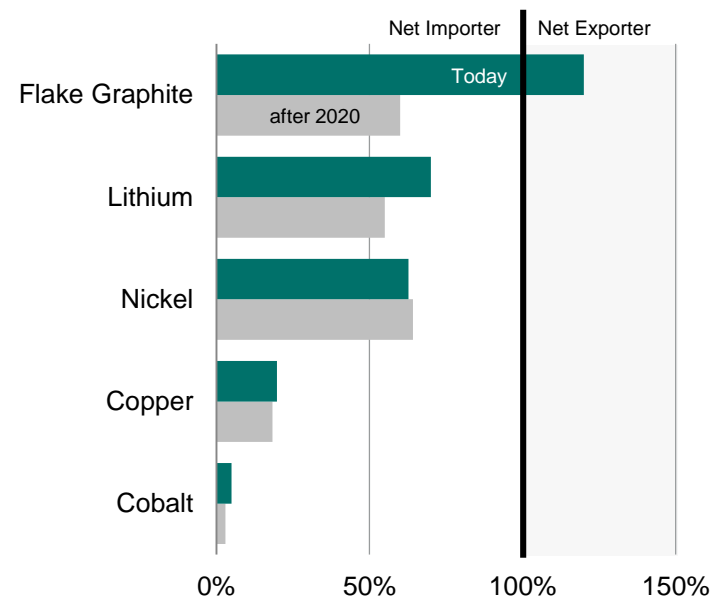
Source: Syrah Resources

# China will become a net importer of natural graphite due to declining domestic graphite resources and increasing consumption in the rapidly growing Li-ion battery market

China's domestic supply of natural flake graphite has been declining due to resource depletion and environment improvement



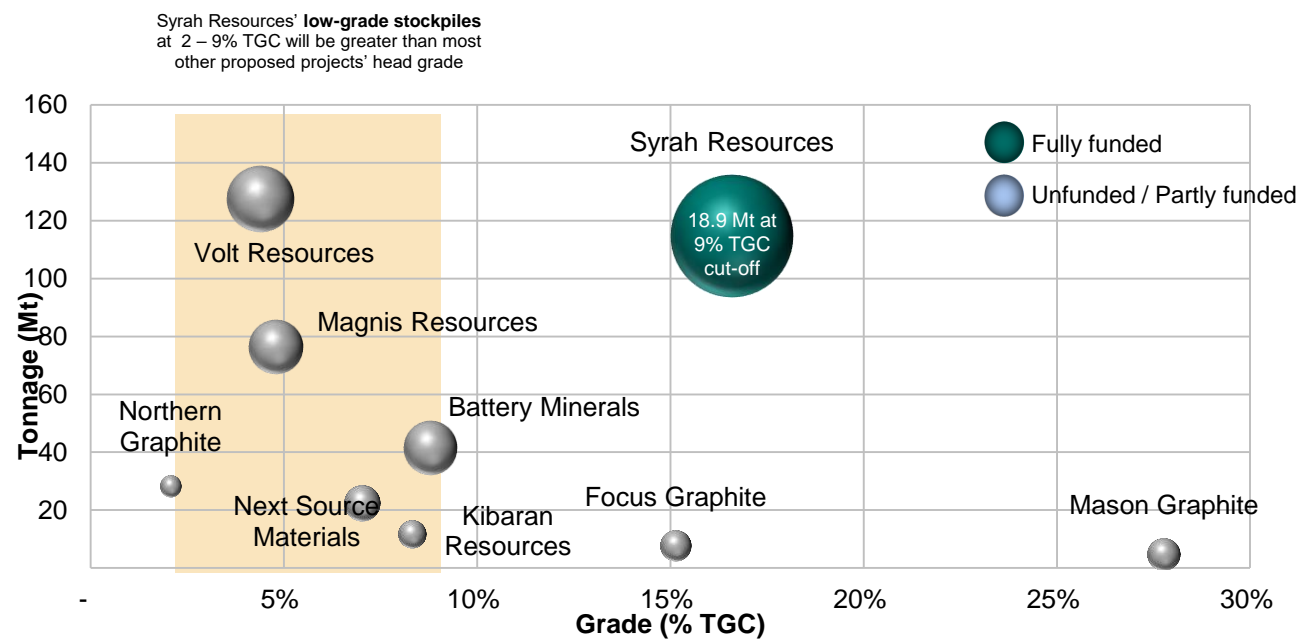
China's switch from an exporter to importer of natural will permanently and structurally change the market dynamics



Source: Syrah Resources, Woodmackenzie, CRU, Metal Bulletin

# Syrah's high grade Balama deposit has the largest defined graphite reserve globally, with a high grade expansion option

## Graphite Reserves



Source: Company filings as at September 2017  
Notes: Selected ASX and TSX listed graphite projects only and excludes Chinese producers. TGC = Total graphitic carbon

Bubble size is representative of latest reported contained graphite reserves  
Cut-off grade for Northern Graphite (Ontario, Canada) is 0.96% TGC  
Cut-off grade for Volt Resources (Tanzania) is 1.29% to 1.76% TGC  
Cut-off grade for Magnis Resources (Tanzania) that aims for a 98% Cg concentrate grade at a production level of 240ktpa from a 5Mtpa concentrator  
Cut-off grade for NextSource Materials (Madagascar) is 4.5% TGC  
Cut-off grade for Battery Minerals (Mozambique) is 4% TGC  
Cut-off grade for Kibaran Resources (Tanzania) is 5% TGC  
Cut-off grade for Focus Graphite (Quebec, Canada) is 3.1% TGC  
Cut-off grade for Mason Graphite (Quebec, Canada) is 6% TGC

# Balama graphite operations commenced in 2017, currently ramping up to becoming the largest global producer



Crushing and primary milling



Flotation cells



Flakes and fines drying; screening and bagging



Bagged product warehouse



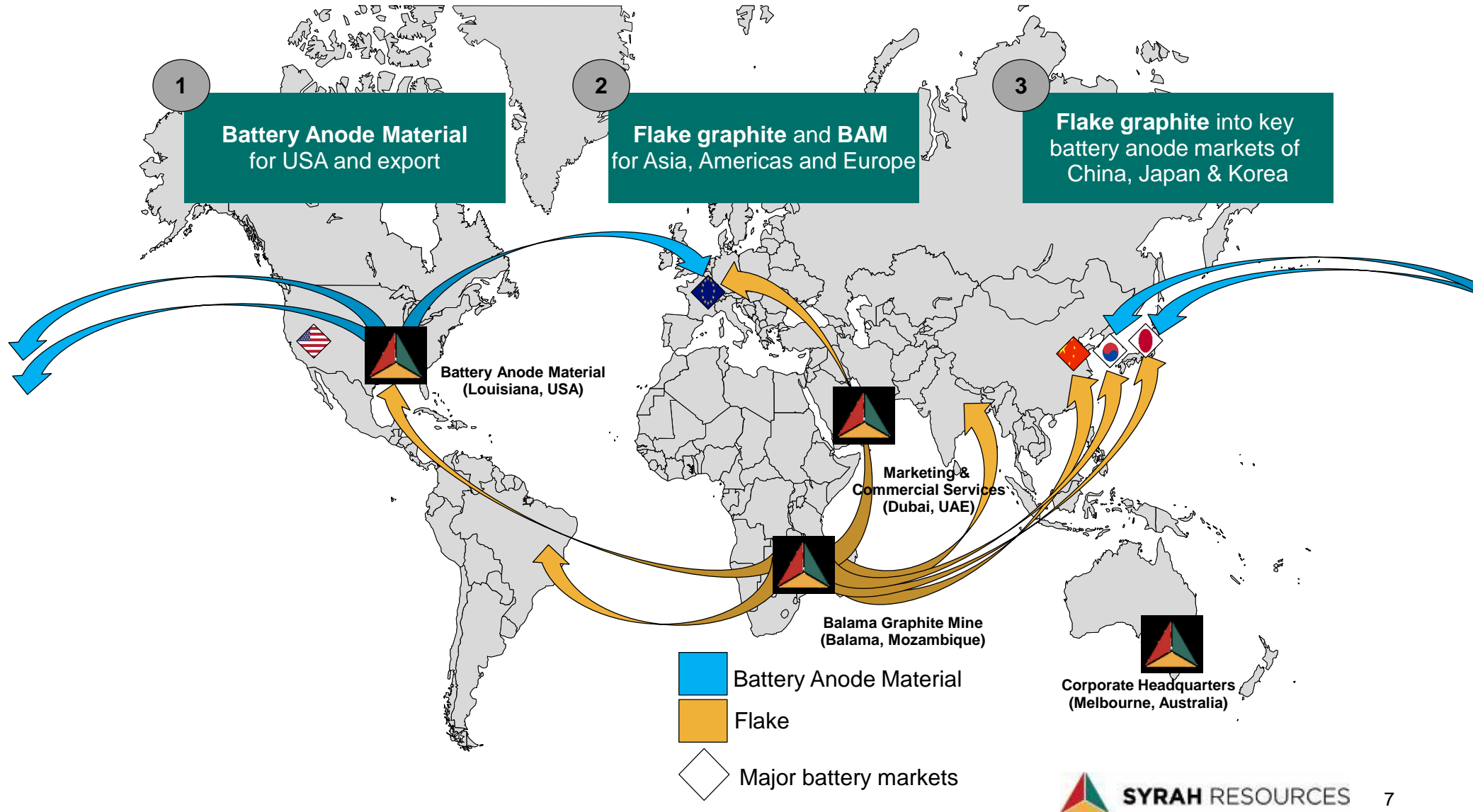
15MW Power station



Process water storage

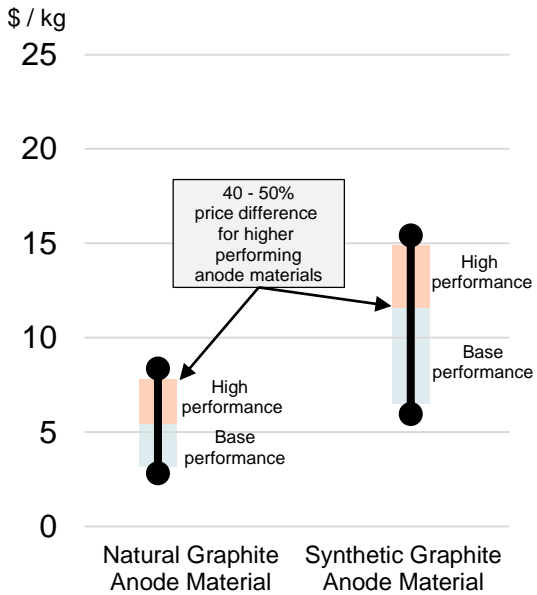


# Syrah will provide global baseload of supply of high quality flake graphite and BAM to all key battery producing markets

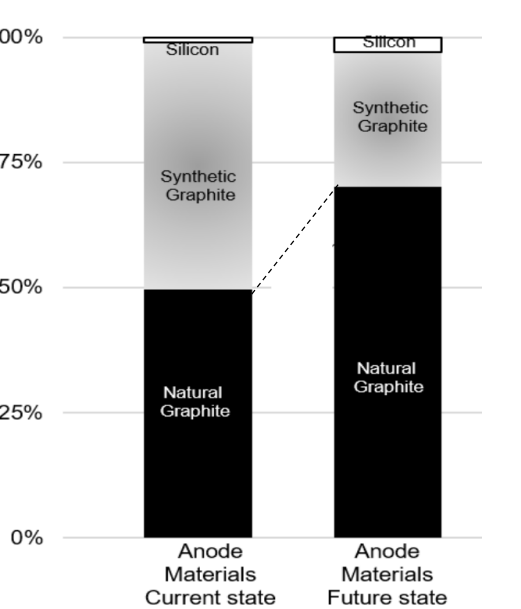


# Increased penetration of natural graphite anodes supports future demand and helps to facilitate price reduction for Li-ion batteries

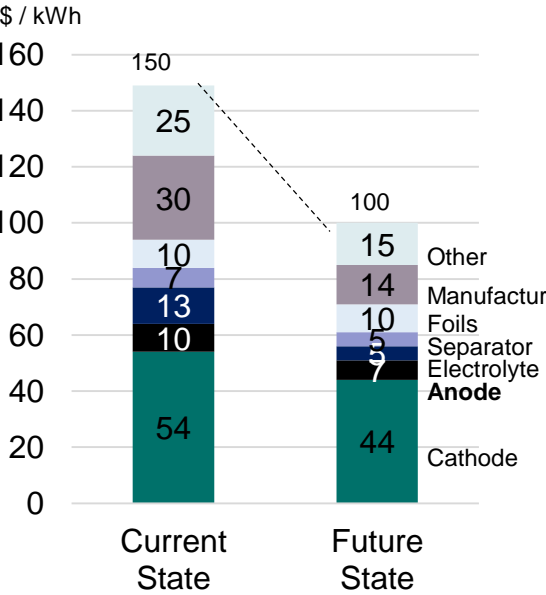
Significant difference in prices for natural and synthetic graphite anode material



Greater use of natural graphite expected

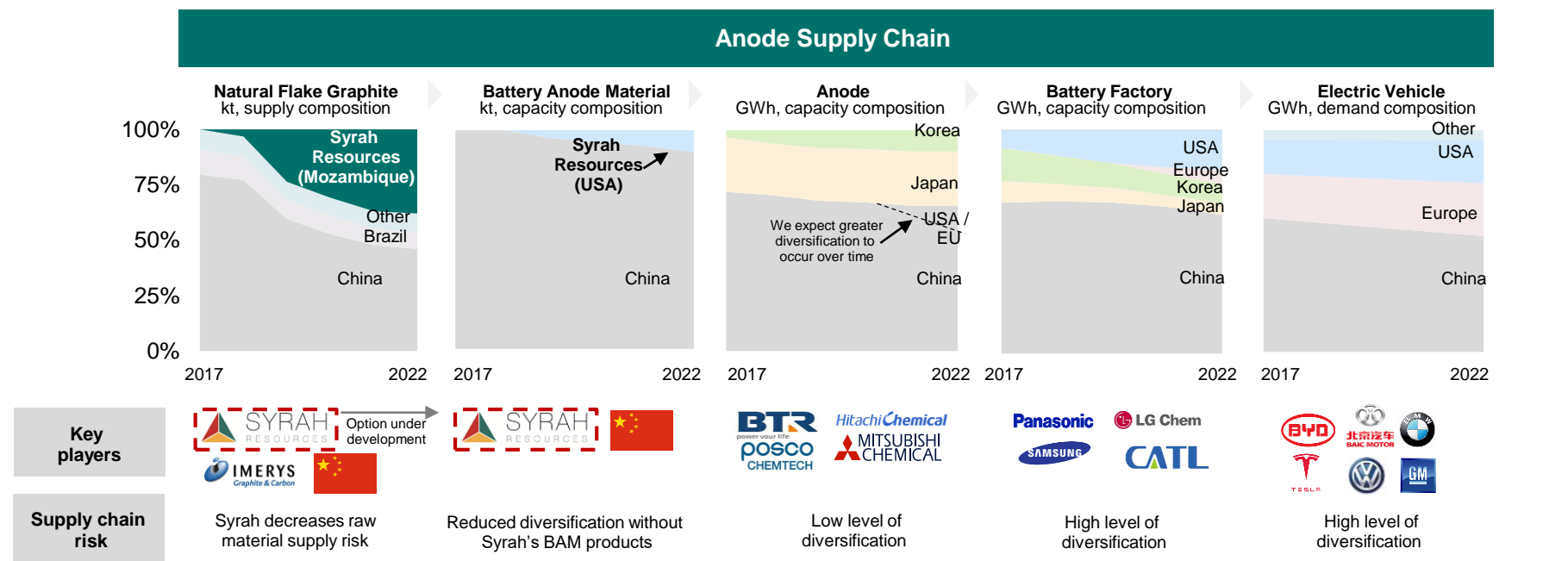


which will assist in overall battery reduction costs



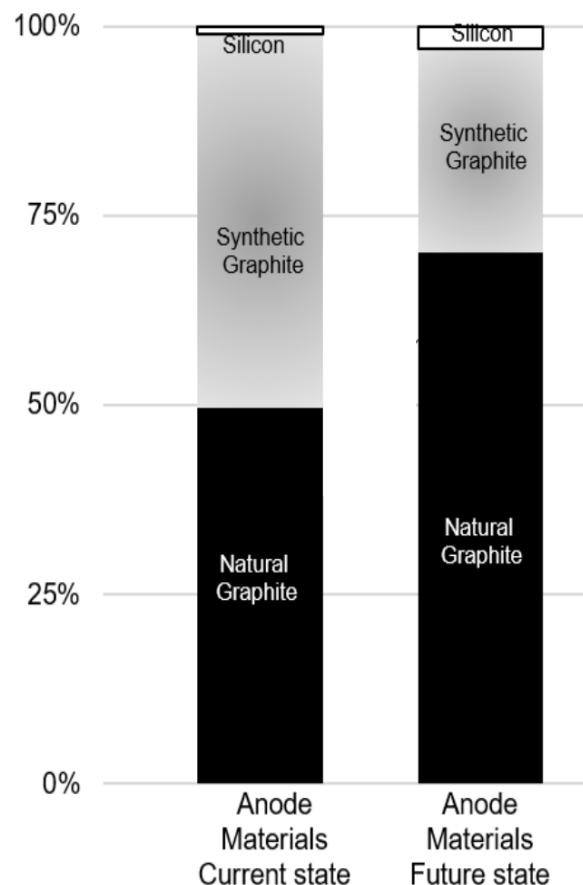
Source: Syrah Resources, Bernstein

# Syrah's BAM production will provide a strategic alternate source of anode material



Source: Syrah Resources

# Syrah offers enhanced natural graphite market access and may enable a large shift in the Li-ion battery markets globally



Source: Syrah Resources

**In anticipation of an expanding Li-ion battery market, the choice of materials will be decided by:**

1. Cost
2. Reliability
3. Processability, and
4. Access

**Therefore, natural graphite anode materials are receiving greater attention and can drive significant opportunity for the industry.**

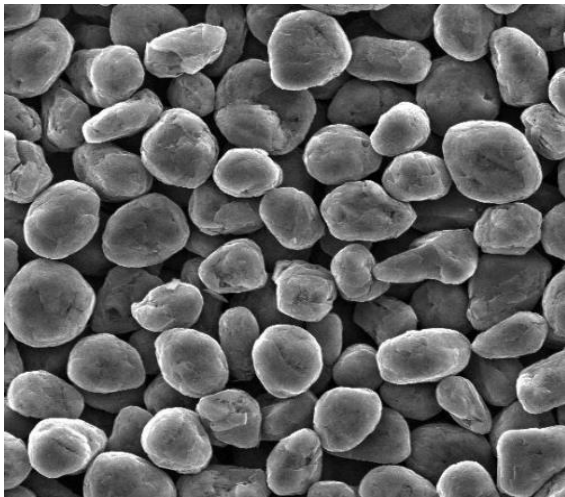


# Graphite will maintain dominance for the foreseeable future and natural graphite will increase market share as cost pressure increases

Artificial Graphite xEV, grid	Natural Graphite xEV, grid, portable electronics	Silicon Alloy Anodes Emerging but mixed with graphite presently
<div>more energy</div> <div>better cycle life</div>		
<b>Key issues</b> <ul style="list-style-type: none"> <li>• High cost</li> <li>• High graphitization energy use</li> </ul> <b>Mitigating solutions</b> <ul style="list-style-type: none"> <li>• Mix with natural graphite</li> <li>• Develop low cost graphitization</li> </ul>	<b>Key issues</b> <ul style="list-style-type: none"> <li>• Low temperature performance</li> </ul> <b>Mitigating solutions</b> <ul style="list-style-type: none"> <li>• Surface coating/modification</li> </ul>	<b>Key issues</b> <ul style="list-style-type: none"> <li>• Cycle life</li> <li>• Electrode expansion/cell dimensional stability</li> <li>• Low first cycle efficiency</li> <li>• Cost</li> </ul> <b>Mitigating solutions</b> <ul style="list-style-type: none"> <li>• Si-nano-particles composite</li> <li>• Mix with larger percentage of natural and/or artificial graphite</li> <li>• Limit discharge cut-off voltage</li> </ul>



# Syrah's graphite will enter the market at multiple levels and the materials meet Li-ion battery industry requirements



- ❑ **Syrah graphite precursor anode and finished anode materials match existing top anode performers in processability and performance**
- ❑ **7 month benchmarking study completed**
  - Supported by Cadenza Innovation
- ❑ **Syrah precursor anode competitive against natural graphite sources from China, Japan and Korea that supply into existing Li-ion anode production**
- ❑ **Finished Syrah anode achieves performance matching multiple industry leading graphite anode materials**
  - Tested both carbon coated and un-coated materials
- ❑ **Critical performance requirements achieved:**
  - >360 mAh/g; >92% 1st cycle efficiency
  - High density loadings at >1.6 g/cc and 3.6 mAh/cm<sup>2</sup>
  - Preliminary cycle life data completed
    - >250 cycles at 1C/1C

# Syrah graphite enables both near-term supply and high performance product roadmaps for next generation technology

## Precursor graphite fits into fast time-to-market products...

Anode Product	Launch	Key Attributes
Carbon Coated	H1 2019	<ul style="list-style-type: none"><li>&gt;360 mAh/g</li><li>&gt;92% 1<sup>st</sup> cycle efficiency</li></ul>
Graphite Coated	H1 2019	<ul style="list-style-type: none"><li>Enhanced electrode density</li></ul>
Blend w/ Artificial Graphite	End 2019	<ul style="list-style-type: none"><li>Optimized for superior energy density</li></ul>

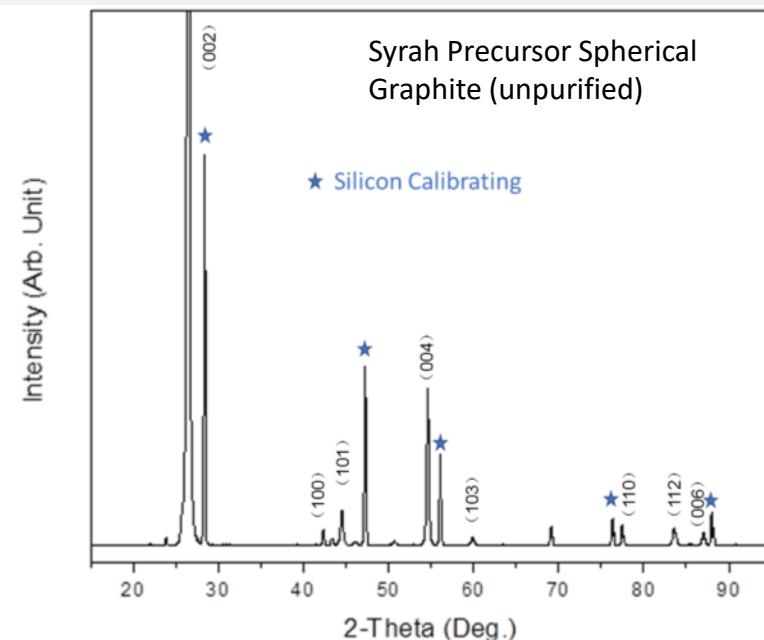
## ...and opens potential pathway to industry-leading options

Anode Product	T2M	Key Attributes
High Energy Blend	Early 2020	<ul style="list-style-type: none"><li>&gt;420 mAh/g</li><li>Si</li></ul>
High Rate Formulation	Mid 2020	<ul style="list-style-type: none"><li>80% charge in 30 mins</li></ul>
Cost-Optimized Performance	End 2020	<ul style="list-style-type: none"><li>High source (mine) utilization</li><li>Formulated for performance</li></ul>

Source: Results based on laboratory testing by Cadenza Innovation

# Syrah precursor material crystallinity matches existing Li-ion anode precursors enabling easy supply chain entry

Unpurified Samples	Syrah Spherical Graphite	Competitor A	Competitor B
$d_{002}$ (Å)	3.3572	3.3574	3.3572
Degree of Graphitization (%)	96.29	96.06	96.24
Lc (002) (nm)	54	52	59
La (101) (nm)	74	82	76

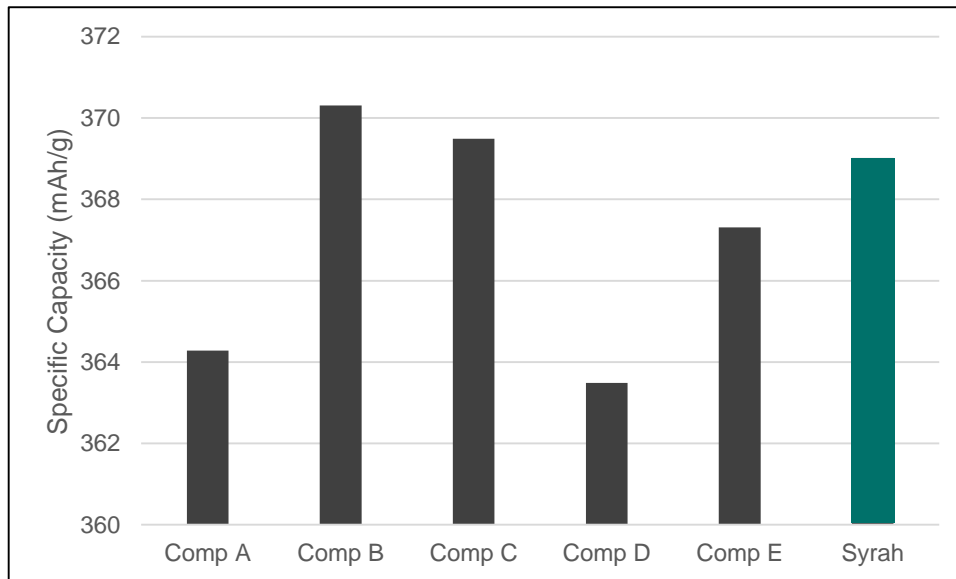


Purified Samples	Syrah Spherical Graphite	Competitor A	Competitor B	Competitor C	Competitor D	Competitor E
$d_{002}$ (Å)	3.3572	3.3572	3.3572	3.3575	3.3574	3.3575
Degree of Graphitization (%)	96.24	96.24	96.34	95.88	96.09	95.94
Lc (002) (nm)	51	45	57	48	56	47
La (101) (nm)	67	77	85	73	72	71

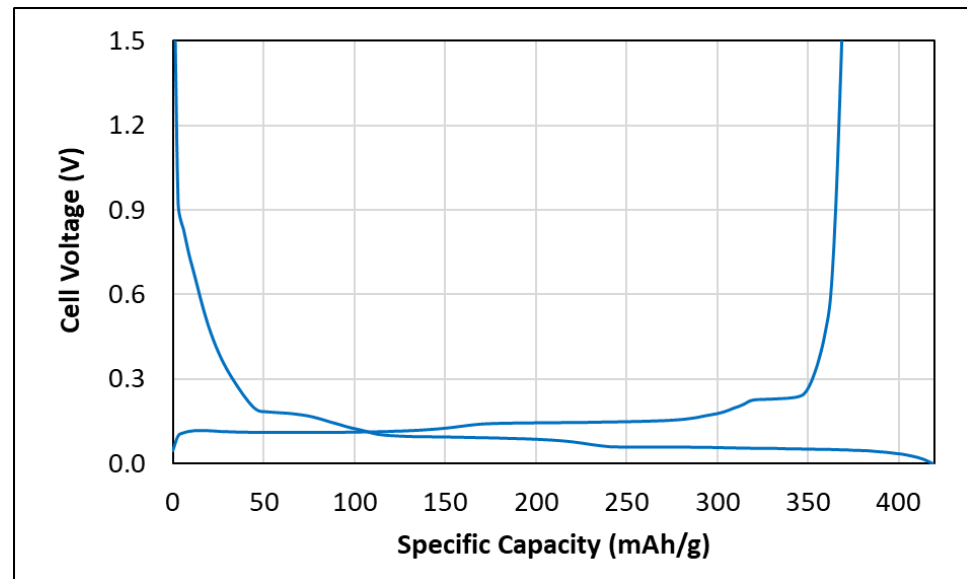


# Syrah precursor demonstrates high 365-370 mAh/g capacity – near theoretical capacity of graphite

## Comparison of purified precursors

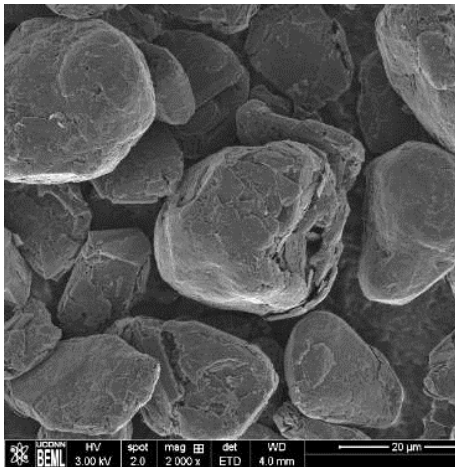


## Syrah Precursor Capacity Measurement

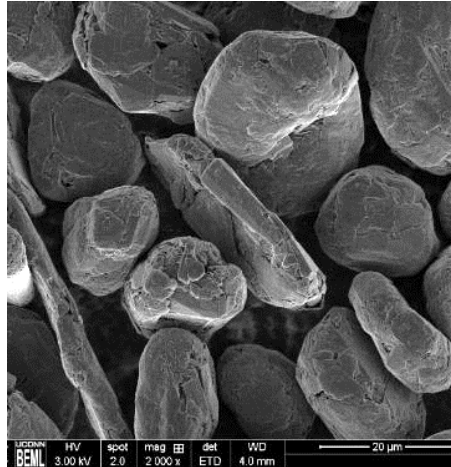


Testing conditions:  
C/20 charge discharge rate  
PVDF electrode formulation  
Density 1.65g/cc

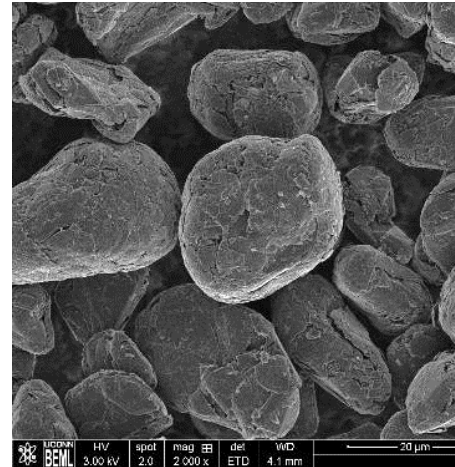
# Syrah precursors have similar spherical shape and particle size distribution as industry leading precursor materials



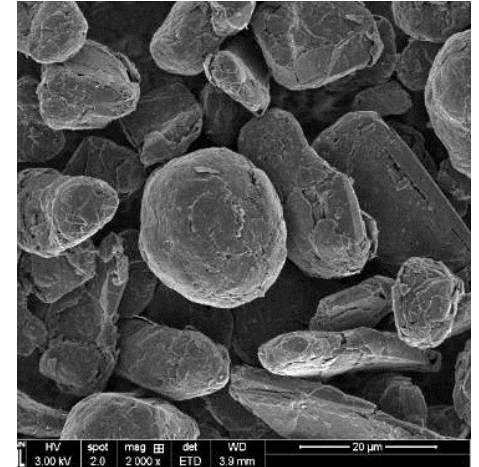
**Spherical Natural Graphite  
Comp A**



**Spherical Natural Graphite  
Comp B**



**Spherical Natural Graphite  
Comp C**

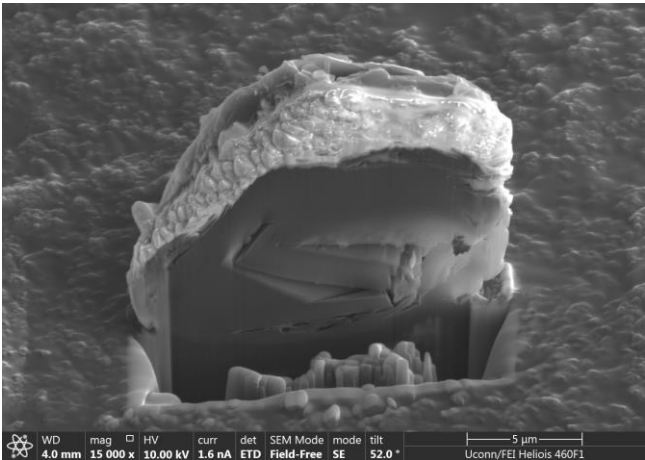
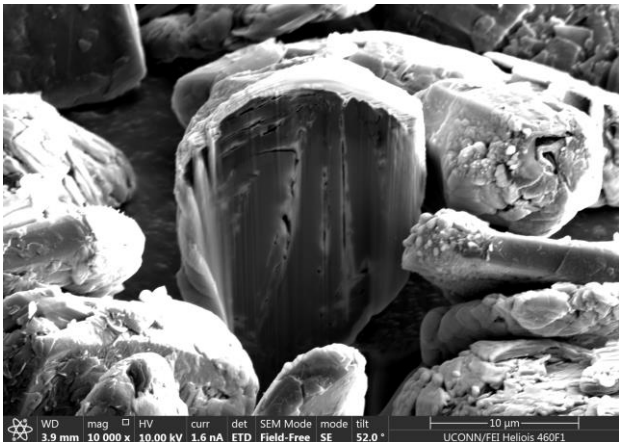
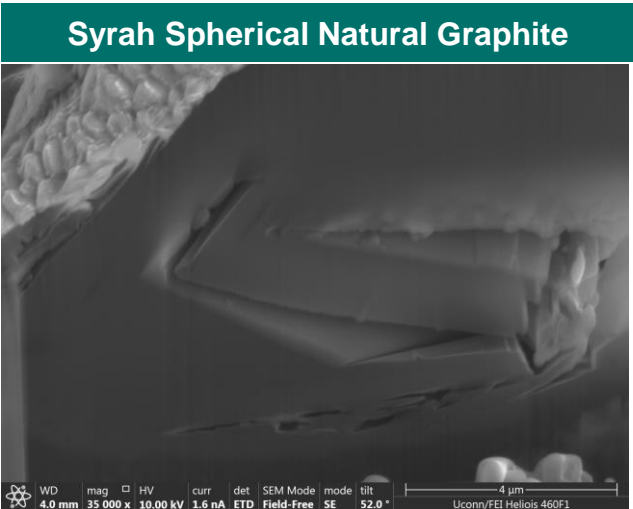
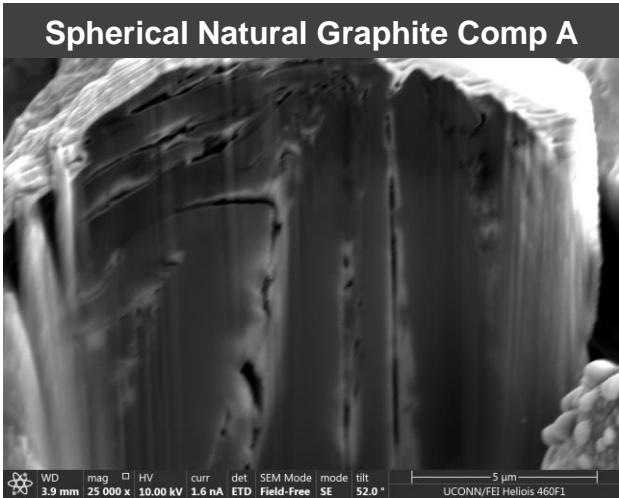


**Spherical Natural Graphite  
Syrah**

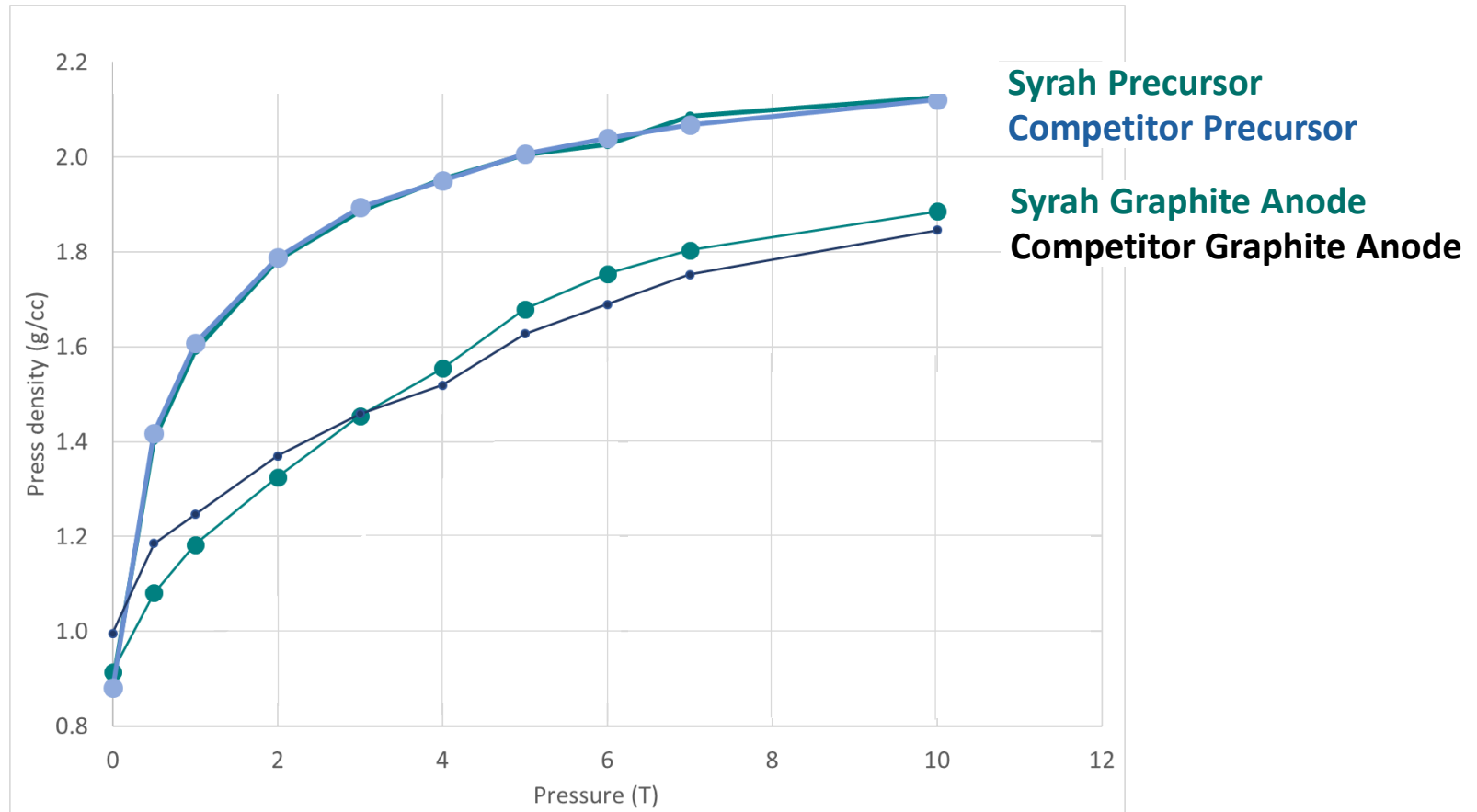
Source: Cadenza Innovation

# Syrah is producing spherical natural graphite with a structure comparable to industry leading competitors

## Cross sectioning of particles with Focused Ion Beam SEM analysis



# Both the Syrah precursor and finished materials match the density characteristics of industry leading materials

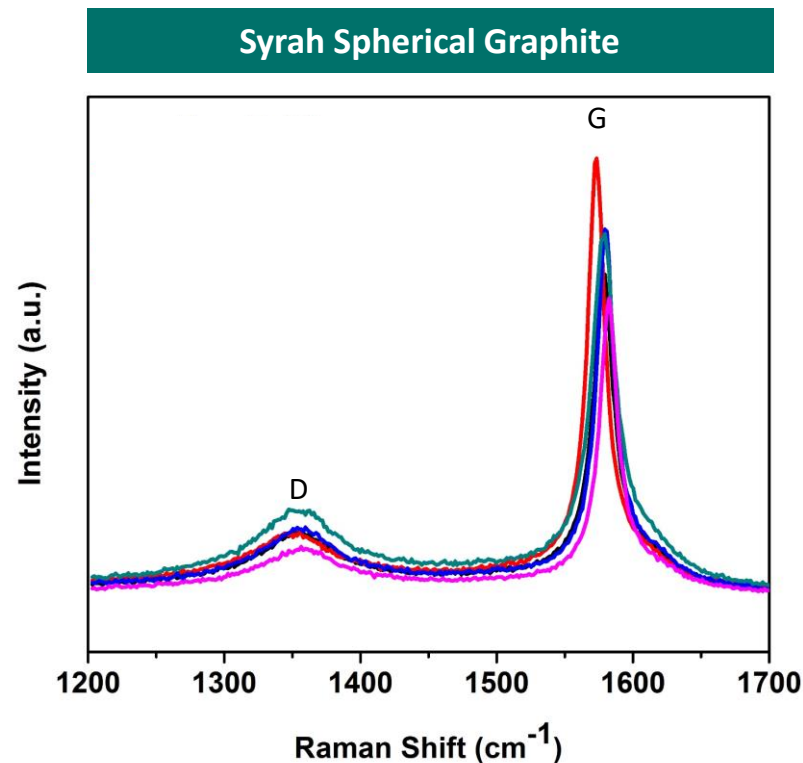
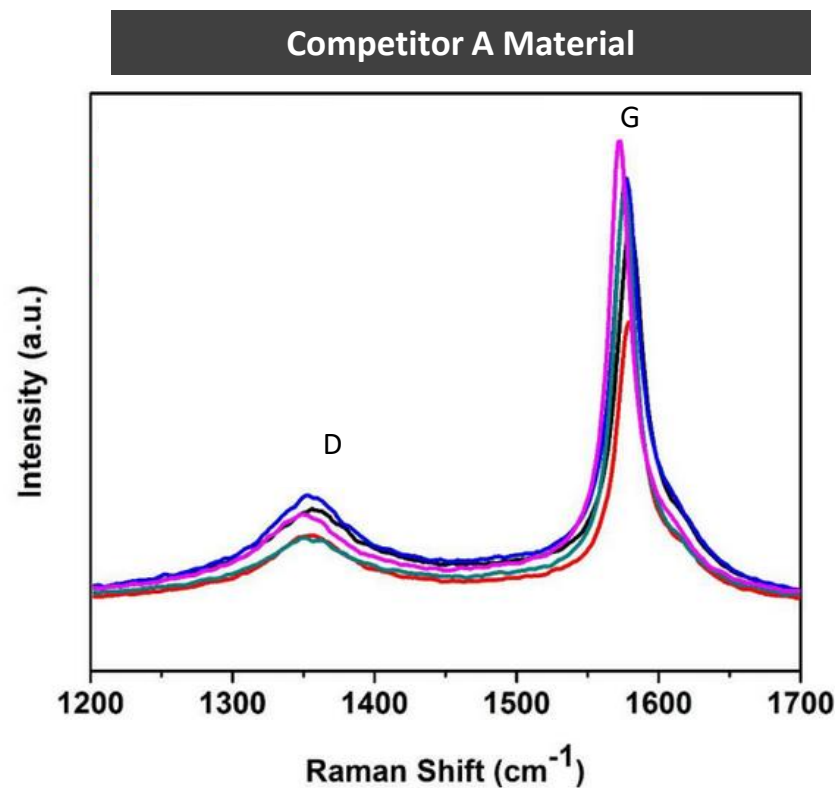


Source: Results based on laboratory testing by Cadenza Innovation



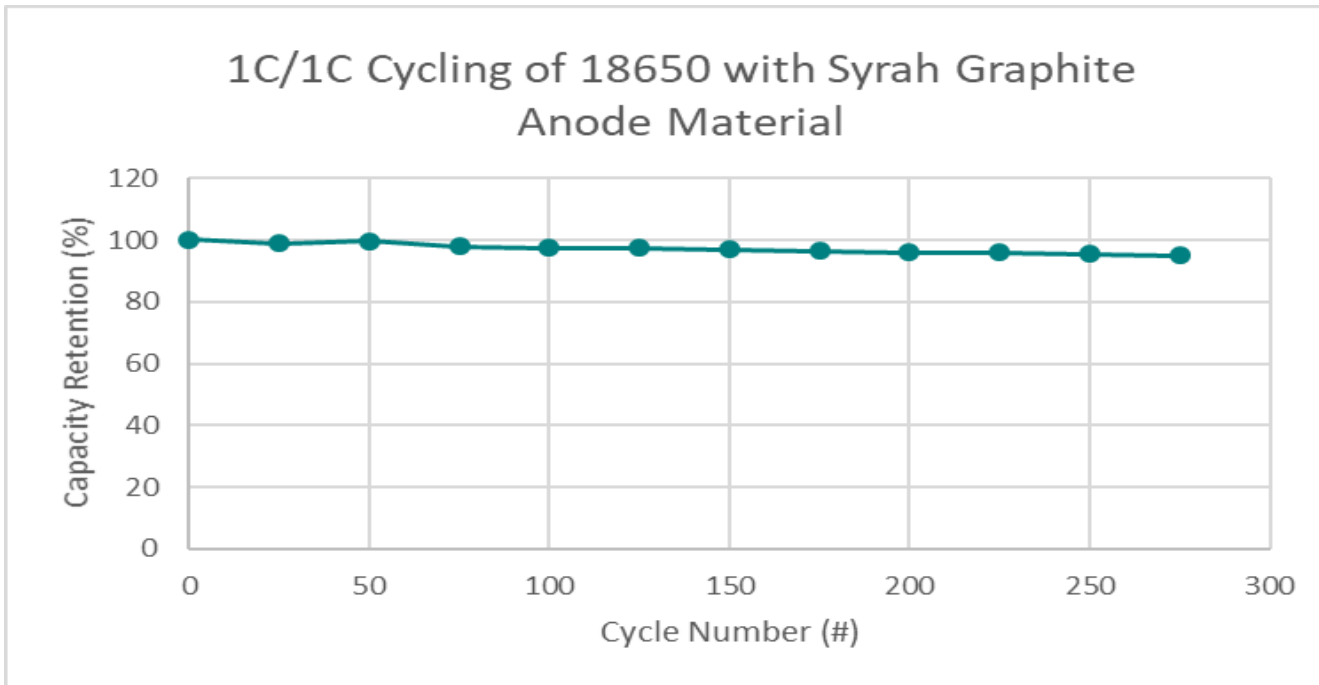
# Finished Syrah anode material matches key surface and density characteristics of industry leading materials

## Raman Analysis



Source: Results based on laboratory testing by Cadenza Innovation

# Initial cycle life data from customer trials is promising



- ❑ 1C/1C cycle life data in industrial scale cells built with development materials
- ❑ Additional testing on pilot scale materials is in progress

Source: Results based on laboratory testing by Cadenza Innovation

# Syrah Resources Entering the Li-ion Battery Market

## Today:

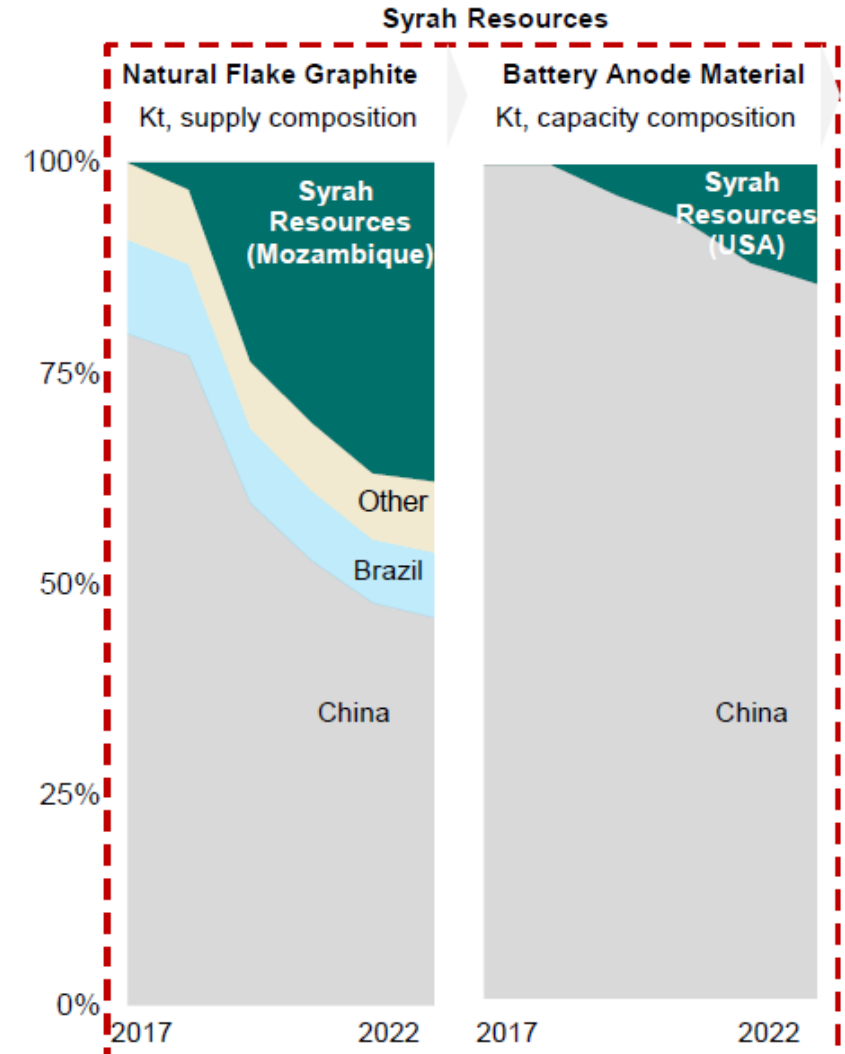
- ❑ Sales of flake graphite from Balama Operation in Mozambique to Battery Anode Material producers
- ❑ Continuing development, testing and benchmarking of battery anode material from Chinese pilot plant and customer plants

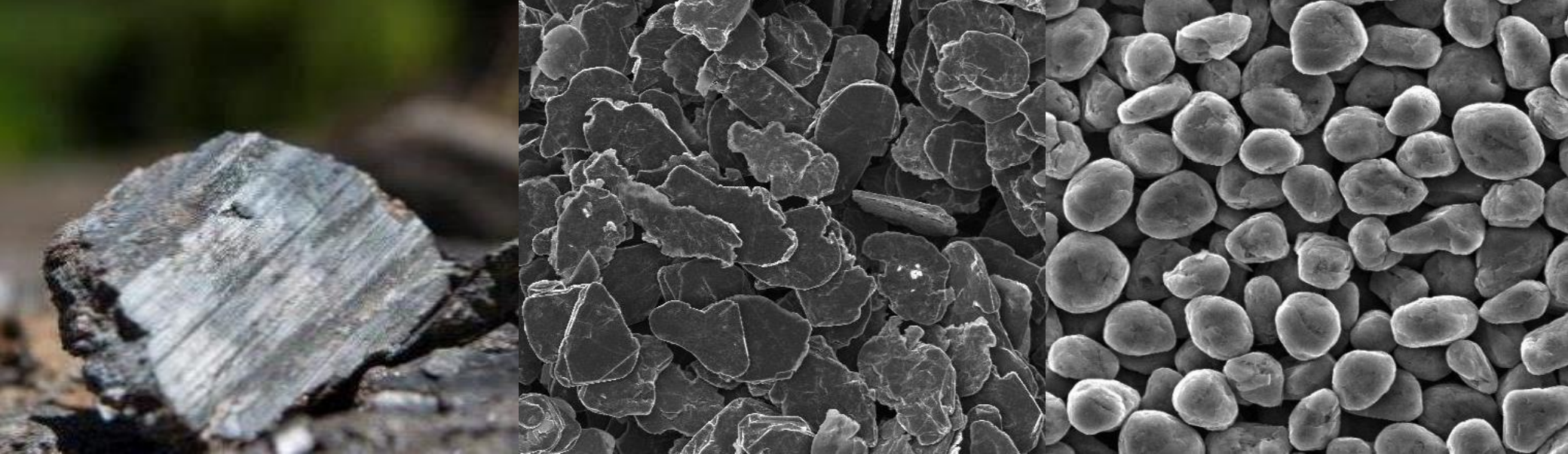
## Throughout 2018:

- ❑ Development of manufacturing capacity for battery anode precursor material in USA
- ❑ Ongoing engagement with customer base on specifications

## 2019-22

- ❑ Increasing proportion of Balama sales into battery market
- ❑ Sales of anode precursor materials from USA production
- ❑ Pilot production and commercialization of finished graphite anode materials in the USA and exports





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