Mining South Australia 2014
Whyalla

Graphite Commodity Outlook

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Breakaway Research

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Presentation Outline

- Breakaway Investment Group/Lime Street Capital Overview
- What is Graphite?
- Supply and Demand
- Graphite and the Markets
- Graphite and South Australia

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- Focused on pre-IPO or direct project investments.
- Investigating setting up an overseas strategic metal fund.

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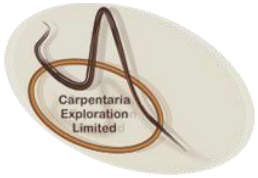
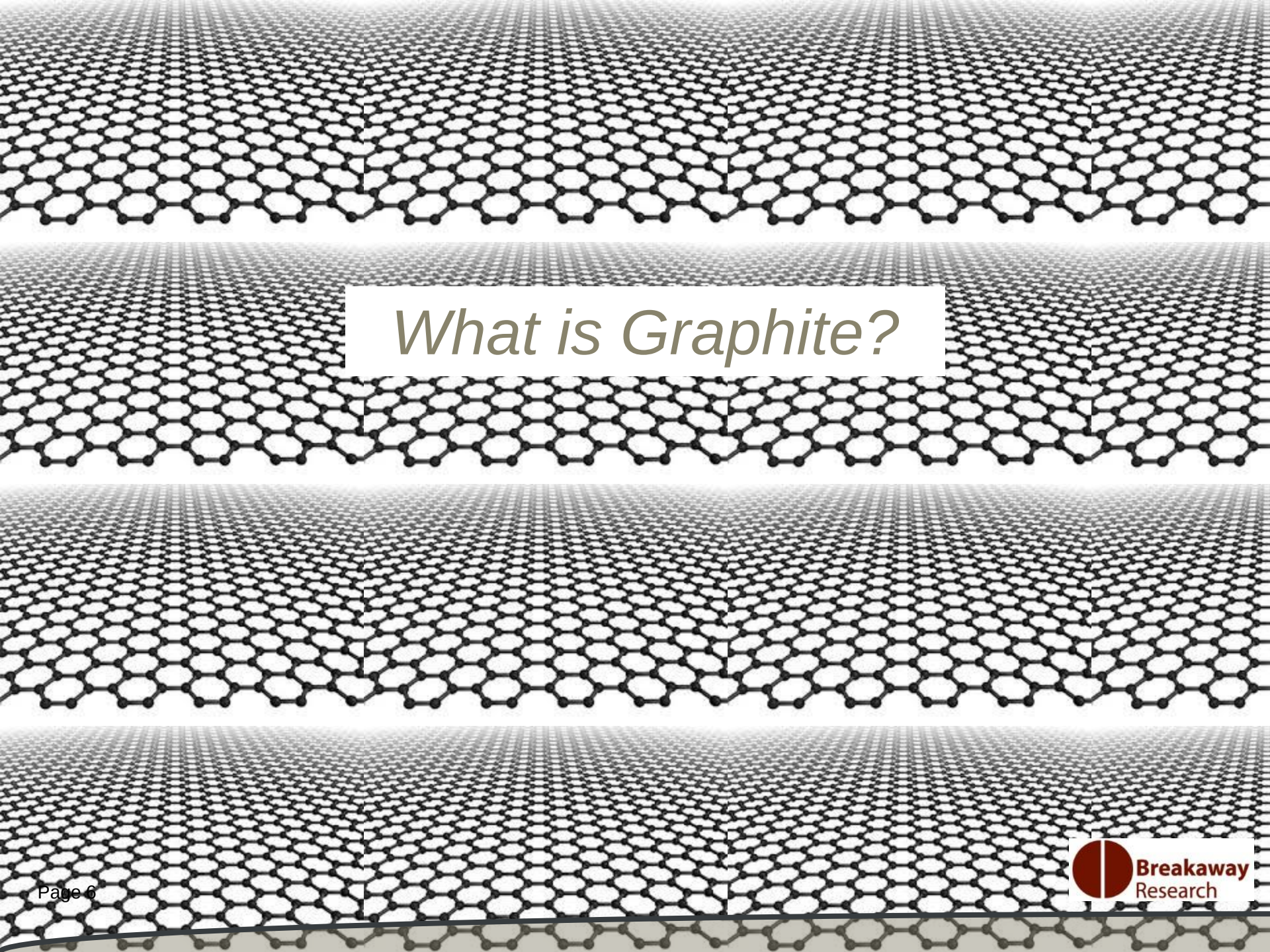
2014 and Ongoing Coverage



Graphite companies highlighted



What is Graphite?

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Graphite Properties

- **Crystalline form of carbon**
  - **Other forms of crystalline carbon include diamonds and coal**
- **Properties**
  - **Non-metallic**
  - **Properties of both metals and non-metals**
  - **Low frictional resistance – "greasy" texture**
  - **Conductive**
  - **High melting temperature – above 3,500° C**
  - **Non-toxic**
  - **Chemically inert**
  - **High resistance to erosion**

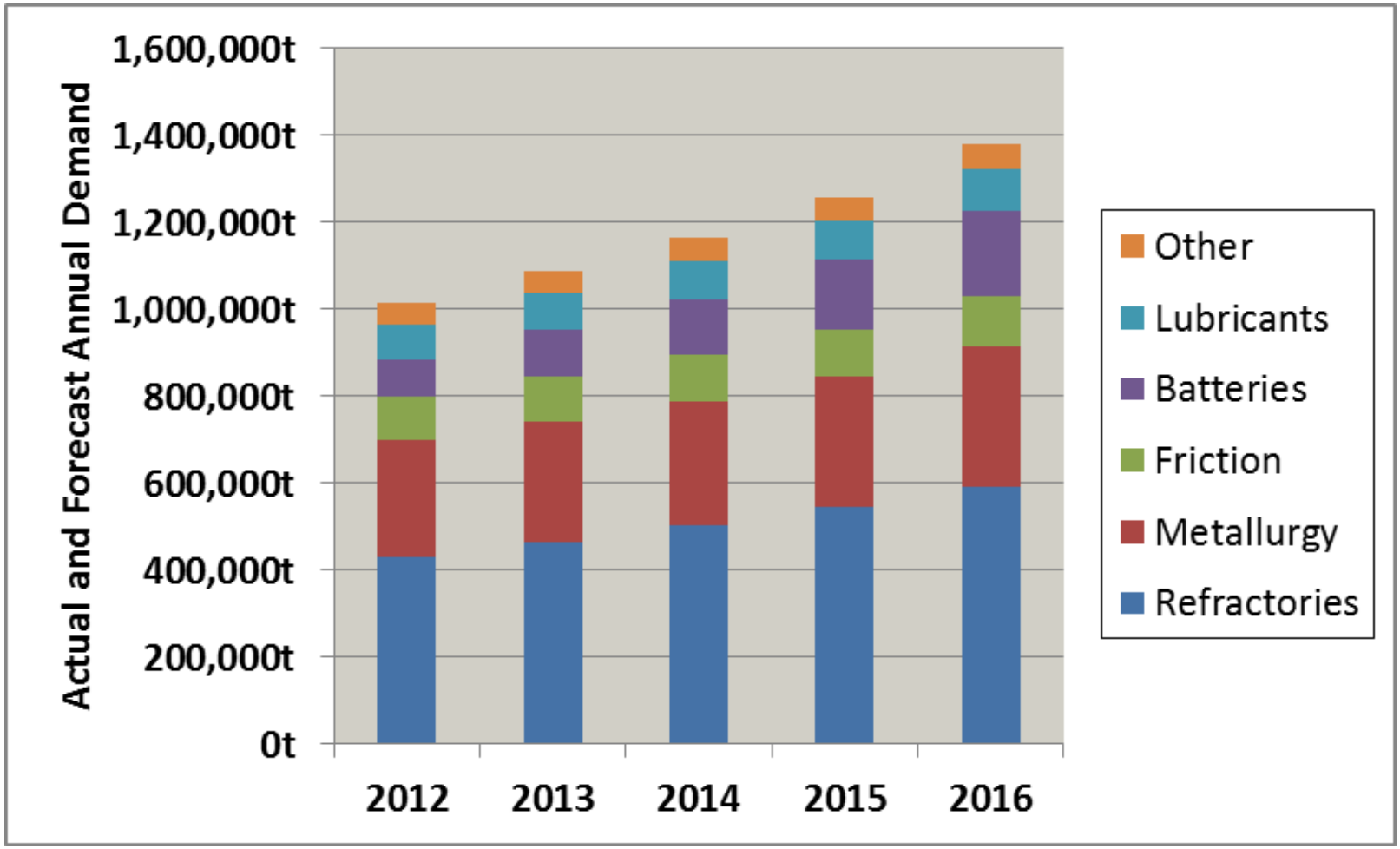
Types of Graphite

- **Natural Graphite**
  - **Three main types:**
    - **Flake – generally found in metamorphosed calc-silicate rocks**
    - **Amorphous – found in metamorphosed coal and carbon-rich rocks**
    - **Vein – poorly understood, uncommon, high grade, occur in fracture zones in metamorphic terranes**
  - **Differentiated on flake size, purity, mode of formation**
  - **Flake can be worked into other forms, included spherical and expanded**
  - **Can be upgraded to higher purity via chemical or thermal processes**
  - **Various uses, current prices from US$500-US$2,000/tonne**
- **Synthetic Graphite**
  - **High purity – 99.95%**
  - **Manufactured largely from petcoke – expensive, around US$25,000-US$50,000/tonne**
  - **Lower conductivity than natural graphite**
  - **Can be engineered to suit particular applications**
  - **Consistent quality**
- **Spherical Graphite**
  - **Manufactured from natural flake graphite**
- **Expanded Graphite**
  - **Manufactured from natural flake graphite**

Principal Graphite Uses

- **Flake**
  - **Reinforcing fibres, refractories, batteries, construction materials, lubricants, electrical components, carbon brushes, friction materials, foil, flame retardants, graphene**
- **Vein**
  - **Generally similar applications to flake**
- **Amorphous**
  - **Refractories, lubricants, friction, foundry mold facings, pencils, rubber additives, steel making, catalysts**
- **Expanded Graphite**
  - **Batteries, construction materials, foil, flame retardants**
- **Spherical Graphite**
  - **Batteries**
- **Synthetic Graphite**
  - **Reinforcing fibres, batteries, carbon brushes, EAF electrodes, nuclear reactors, steel making – carbon raiser additives, graphene**
- **There is overlap, and minor uses not listed above**

Principal Graphite Uses



Source: Industrial Minerals forecast, Shaw Stockbroking note – Syrah Website

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What Are Desirable Properties?

- **Mineralisation Grade**
  - **Most deposits are around 5-10% TGC, higher grade deposits to +25% TGC**
- **Simple Beneficiation**
  - **In addition to resulting in comparatively low operating costs, this will also minimise grinding (and hence size reduction) of the graphite in the ore**
- **High Purity Concentrate**
  - **Expensive post concentration upgrading minimised**
  - **No or limited deleterious elements – dependent upon application – most critical for electronic and battery uses**
- **Large Flake Concentrate**
  - **Rule of thumb (but not universal) is the larger the flake size, the higher purity**
  - **Thermal and chemical purification increases production costs**
  - **Larger flake allows producer to sell at prices normally achieved through post concentration upgrading**
  - **Previously the Chinese cost structure and lax environmental standards allowed low cost purification, thus depressing flake graphite prices**

Supply and Demand

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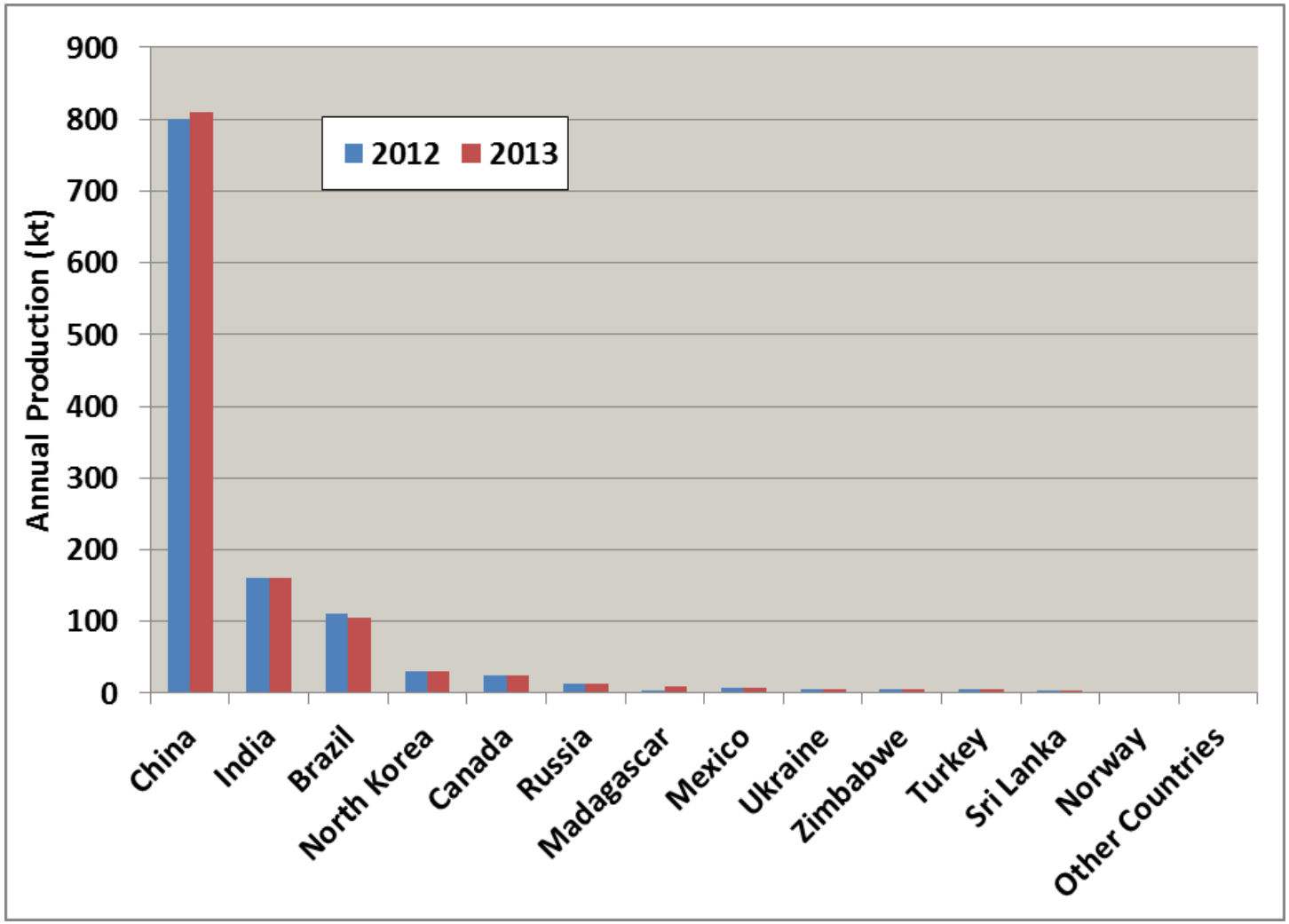
Natural Graphite Supply

- **2013 production of around 1.1Mt**
  - **Similar to that of nickel (~1.4Mt), 9x that of rare earths (~120kt)**
  - **~50% flake, 50% amorphous**
  - **Vein graphite from Sri Lanka (~4,000tpa)**
- **Production dominated by China**
  - **Around 75% of 2013 global production**
  - **Around 70% of Chinese production is amorphous and fine flake**
  - **Exports expected to decline – 20% export duty and 17% VAT**
  - **Production cuts – environmental concerns**
  - **Previous dumping, e.g. 1980's caused price crashes**
- **Other producers include India (14%), Brazil (10%)**
- **Customers looking for diversity of supply**
- **High economic importance, concentrated supply**

Annual Production



Source: USGS

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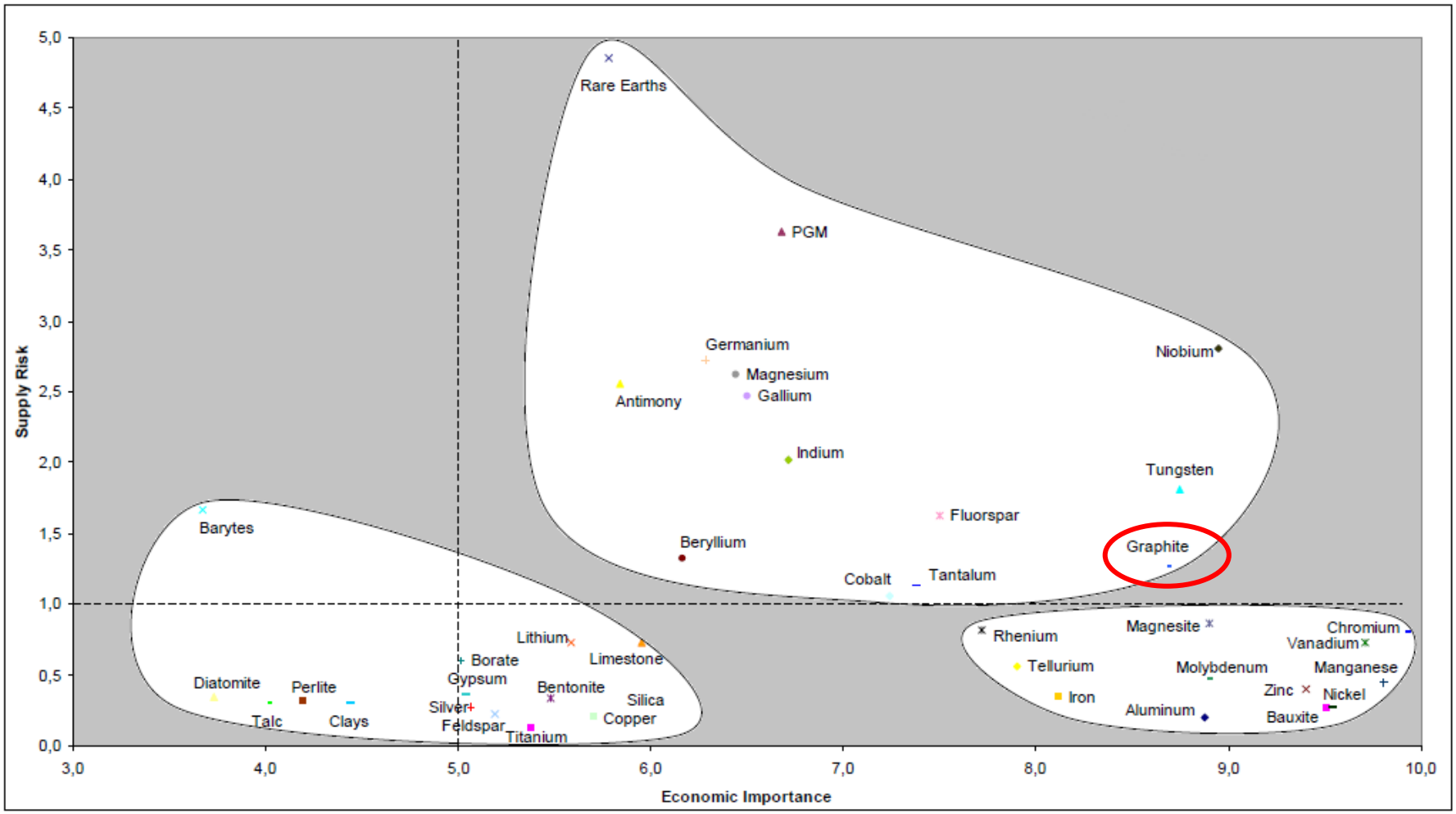
EU Metals Grouping



Source: European Commission

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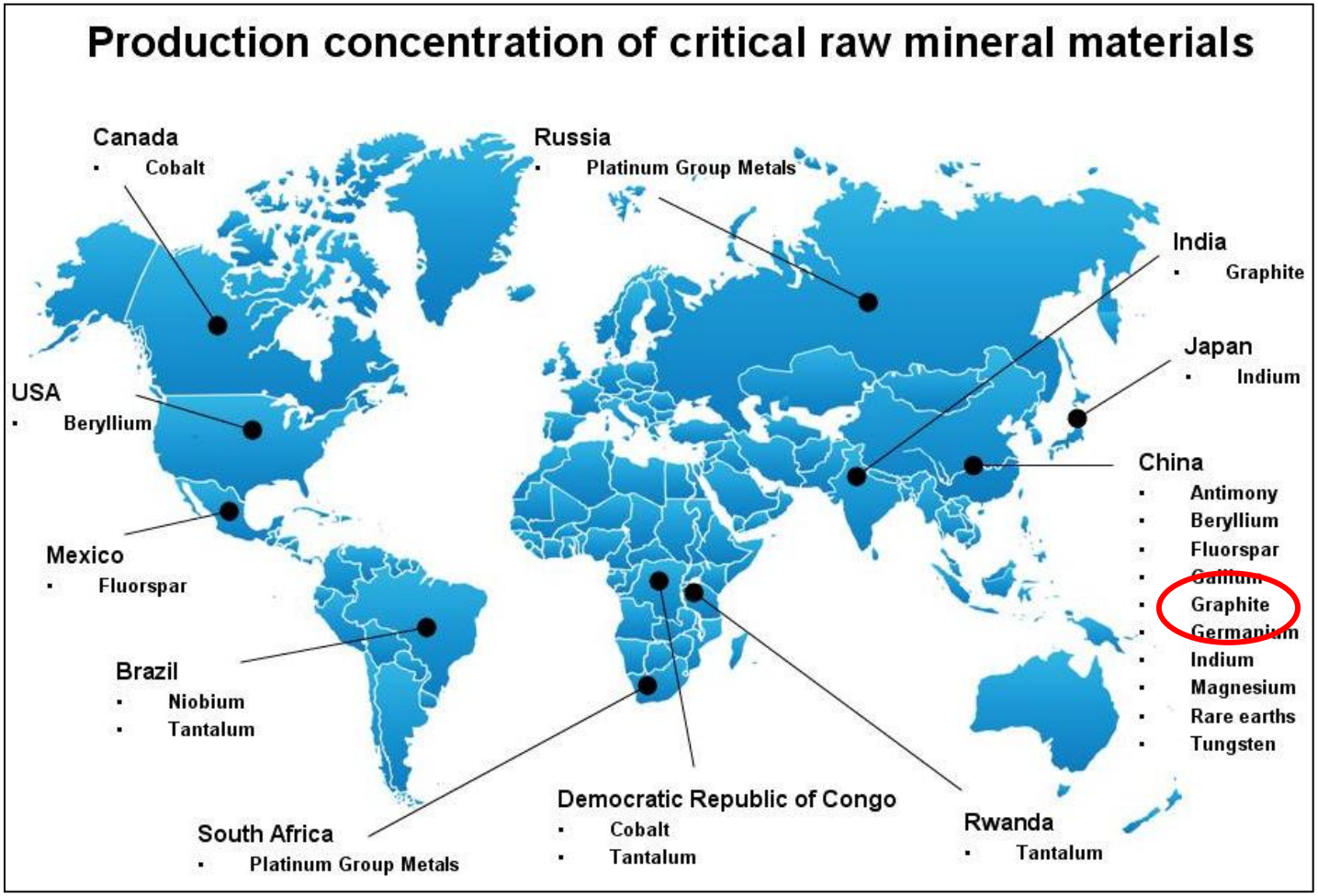
Production Concentration



Source: European Commission

**The Platinum Group Metals (PGMs) regroups platinum, palladium, iridium, rhodium, ruthenium and osmium*

***Rare earths include yttrium, scandium, and the so-called lanthanides (lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium and lutetium)*

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Future Demand Drivers

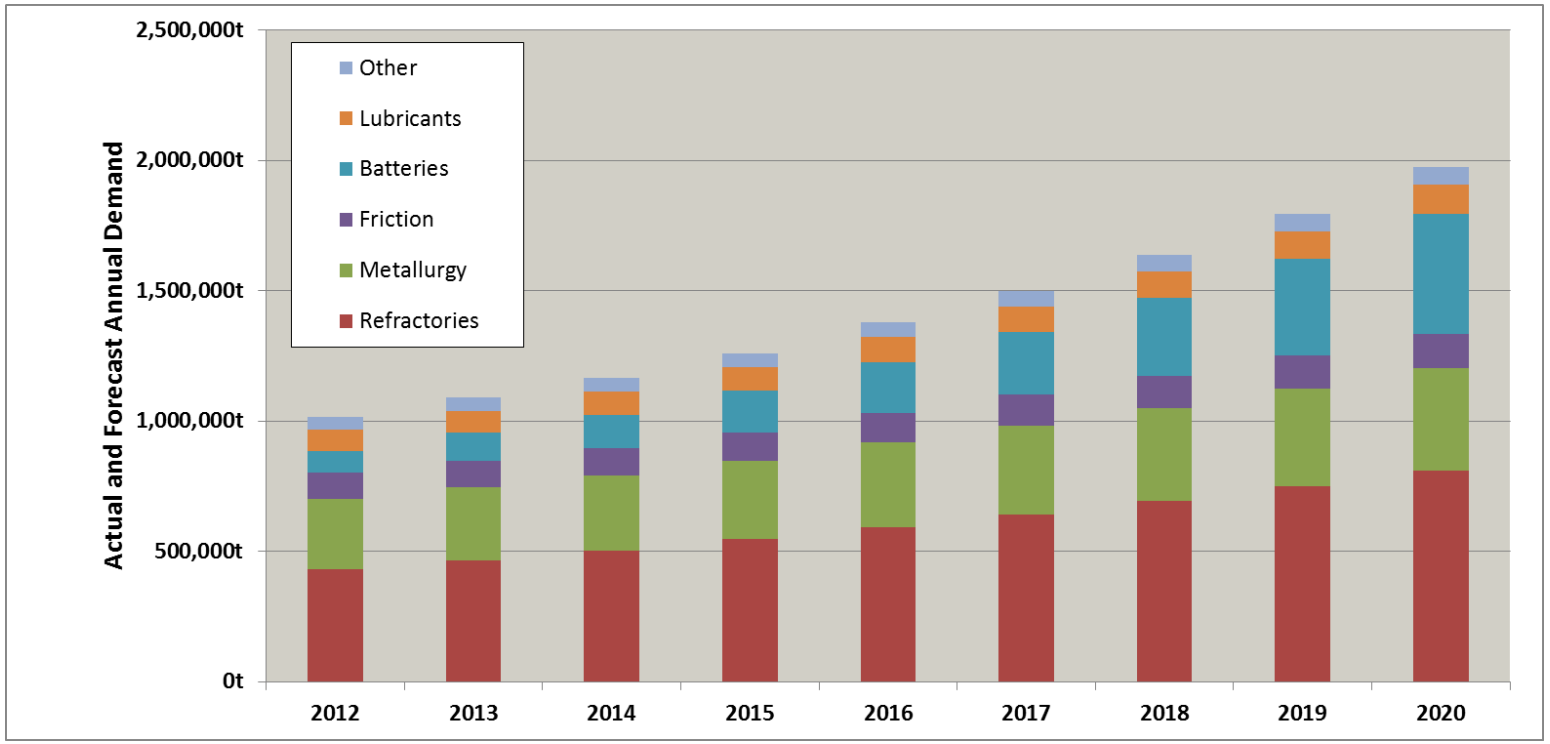
- **Base demand forecast to grow at a steady 6% per annum**
  - **Includes refractories, friction applications etc.**
- **Batteries are forecast to be key demand driver – up to 25% annual growth**
  - **Higher purity flake required**
  - **Quality is critical - battery producers require reliable supply of constant quality material with no deleterious elements**
  - **Approximately 60% is supplied by natural flake and 40% by synthetic graphite – synthetic can provide the reliability of quality**
  - **Used in electronic devices, electric vehicles**
  - **Graphite used as anode**
  - **A Li-ion battery typically contains 10-30x more graphite than lithium**
  - **Milling to spherical graphite is a growing requirement to improve compaction – this leads to wastage of up to 60% in the milling process to lower value fine material**
  - **The average electric vehicle will require around 40kg of spherical graphite, which, prior to milling will require up to 100kg of high purity, large flake to allow for wastage**
  - **Some commentators have estimated, that with a 10% market penetration, 6 million electric vehicles could be produced in 2020, adding the demand for up to 360,000tpa of flake graphite, assuming demand is met 60% by flake, and 40% by synthetic graphite**
  - **Key consumers potentially include Tesla (proposed US$5 billion battery facility), and China (mandating 30% of new Government vehicles be powered by renewable sources by 2016)**
  - **Alternative anode types include titanite, silicon etc. – still under R & D, relatively expensive, challenges to be overcome**

Future Demand Drivers

- **Pebble Bed Reactors**
  - **Under development in a number of countries, including the US, with China being the most advanced**
  - **Uranium fuel is enclosed in a graphite sphere**
  - **Traditional reactors use synthetic graphite for the moderator in nuclear control rods**
  - **Pebble bed reactors could potentially use up to 75% natural graphite**
  - **Still largely under development – operational issues have become apparent**
- **Graphene**
  - **Touted as the new "miracle" material**
  - **A single atom thick sheet of carbon**
  - **Superfast conductor, thin and flexible**
  - **A large number of potential uses, including ultrafast conductors**
  - **Still extensive R and D to be carried out**
  - **To be considered a technology, and not a graphite play**
  - **Currently no significant impact on demand**

Forecast Demand to 2016

- **Graph below based on Industrial Minerals forecasts to 2016, extrapolated at constant growth rates to 2020**
  - **Base demand growth of 6% CAGR**
  - **Battery demand growth of 24% CAGR – will result in total demand growth of around 8% CAGR by 2020, resulting in a total demand of ~ 2Mtpa by 2020, including 460ktpa for batteries**



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Pricing

- **Price for base market applications largely dependent upon purity and flake size**
- **Pricing is opaque – settled directly between buyer and seller**
- **Prices quoted largely for the base applications**
- **Premium pricing structure for high purity flake for battery and electronic applications**
- **Premium pricing for Sri Lankan vein graphite**
- **Synthetic graphic commands prices of up to US$50,000/t**
- **Spheroidal and expanded graphite can cost up to US$20,000/t**
- **Price fall in 1980's due to dumping of Chinese graphite onto the market – were after hard currency**
- **This sent a number of operations bankrupt**
- **Rises to 2011 due to increasing industrialisation in China and other developing countries**

Natural Graphite – Indicative Pricing

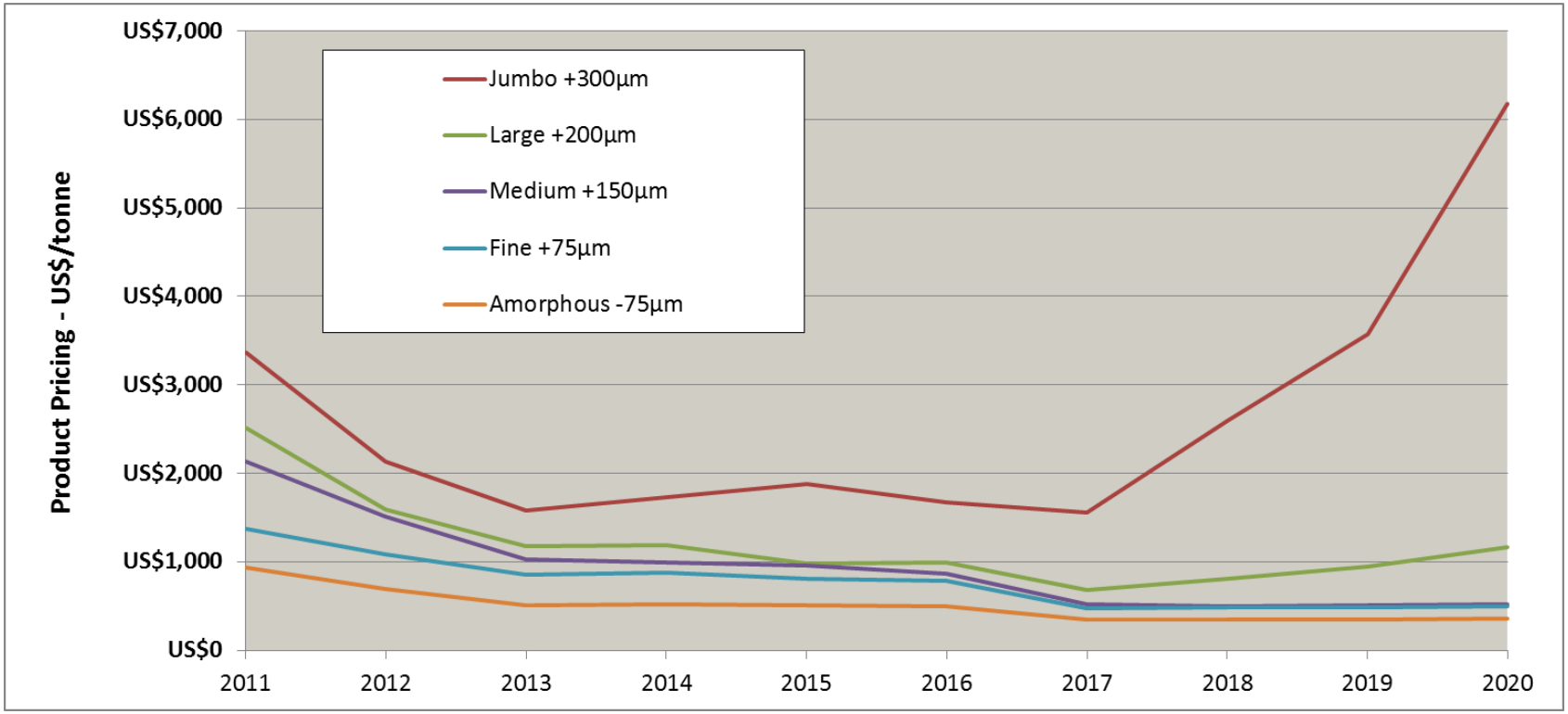
Graphite Product	Purity (%)	Mesh Size	Flake Size	Current Price (US$/t)	Forecast 2020 Price (US$/t)
Jumbo Flake	96-98%	+48	>300µm	$2,300	$6,175
Large Flake	94-97%	+80-48	177 - 300µm	$1,300	$1,165
Medium Flake	94-97%	+100-80	148 - 177µm	$950	$517
Small Flake	94-97%	+200-100	74 - 148µm	$750	$493
Fine Flake & amorphous	80-85%	-200	<74µm	$550	$359
Vein	+98%	N/A		Similar pricing to equivalent flake	
Synthetic	99.95%			$7,000 - $20,000	

Source: Various, including Stormcrow Capital for price forecasts

Forecast Pricing

- **Price rises in larger flake sizes**
  - **Largely due to forecast demand for higher purity material for batteries and other new technology**
  - **Improvements in processing technology will make it upgraded flake an increasing viable alternative for the more expensive synthetic product**
- **Prices for finer flake, amorphous flat**
  - **Most common forms**
  - **Plentiful supply**
  - **No significant demand increase**
  - **Increase in mine supply of larger flake will also result in increased finer flake supply as typically deposits contain a range of flake sizes**

Forecast Pricing



Source: Stormcrow Capital forecast, SVM presentation July 8, 2014

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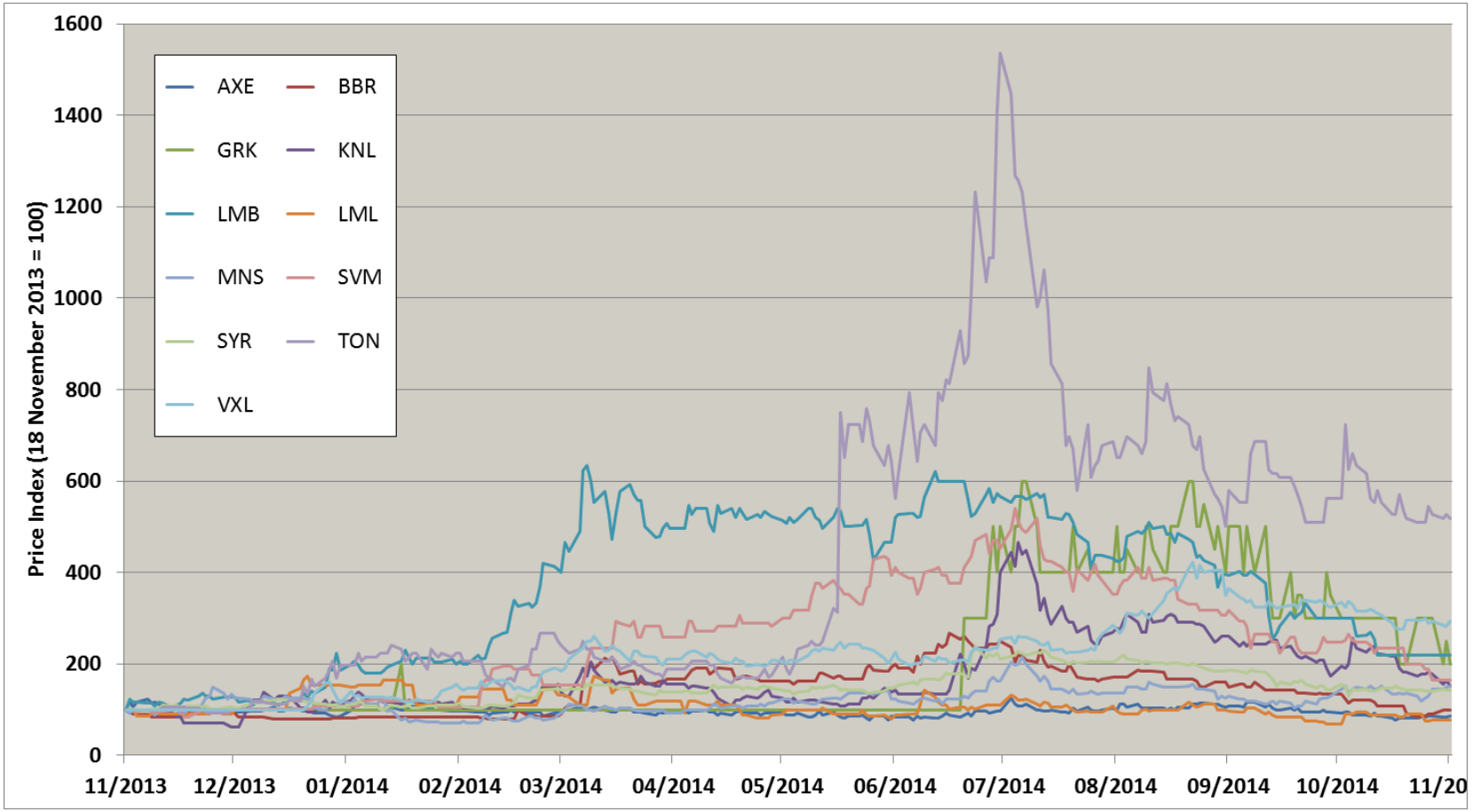
Graphite and The Markets

ASX Market Performance

- **A number of ASX listed hopefuls**
- **Initial bubble in mid 2012 – stock prices decreased to pre-bubble levels**
- **Interest reignited in early-mid 2014, prices peaked in August/ September**
- **Now waning, but appears to be to levels higher than before**
- **Current wane in prices similar to general malaise in the small resources**
- **Is the current interest real, or another bubble?**
- **Wheat being sorted out from the chaff – some will fall by the wayside**
- **Real progress now being made on projects, including offtake agreements**
- **Production now restarting at Valence Industries' Uley Mine**

ASX Market Performance

- **Graph shows prices of ASX-listed graphite explorers/developers indexed to 100 as of November 18, 2013**



Source: IRESS, Breakaway Analysis

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Graphite in South Australia

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Graphite in South Australia

- **Mineralisation located on the eastern Eyre Peninsula**
- **Hosted in the Paleoproterozoic Hutchison Formation**
- **Generally occurs in graphitic schists and gneisses**
- **High grade graphite associated with pegmatites recently found at the Uley Mine near Port Lincoln**
- **Uley is Australia's only current graphite producer**
- **Mineralisation at Uley discovered in 1866, operated periodically between 1890's and 1951**
- **Restarted 1987, operated until 1993 when low prices forced it to shutdown**
- **Now producing from stockpiles, plan to restart mining**
- **Other explorers also operating in the Eyre Peninsular**
- **Prospective for further discoveries of potentially economic mineralisation**
- **Results of exploration to date support the prospectivity of the Eyre Peninsula**

Thank-you…

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