Industrial Minerals Basics

Executive Primer

Mike O’Driscoll, Director, IMFORMED

Networking and knowledge for the industrial minerals business

imformed.com
• Launched in January 2015
• Extensive experience & reputation
• Market research
• Specialist conferences

Coming in 2016…
Mineral Recycling
Mineral Logistics
Magnesia Minerals & Markets
Oilfield Minerals & Markets
Graphite Supply Chain
1. What are industrial minerals & why are they so important?

2. How is the market structured?

3. How is the market driven?

4. Summary
   - Key takeaways
   - Key factors influencing success
   - Potential investment indicators

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1. What are industrial minerals?

Unglamourous

Mundane

Rubble

The Third World of the Mining Industry!
1. What are industrial minerals?

Not this!
1. What are industrial minerals?

But this!

Actually, there’s much, much more!!...
1. What are industrial minerals?

- Minerals and rocks exploited for their **non-metallurgical value**.

- Physical/chemical properties for a wide variety of industrial and domestic uses.

- Can’t live without them!
1. What are industrial minerals?

Some examples of industrial minerals and their uses:

Bauxite
Clay
Limestone
Gypsum
Magnesite
Potash
Sand
Talc

Abrasives
Ceramics
Cement
Plasterboard
Chemicals
Fertiliser
Glass
Plastics

End use markets = heavy & light industry, diverse, global, consumer driven
1. Why are industrial minerals so important?

Average lifetime requirements for each person born in the USA

- 935 lbs. Copper
- 1460 Troy oz. Gold
- 529,097 lbs. Coal
- 16,904 lbs. Phosphate Rock
- 12,776 lbs. Clays
- 32,796 lbs. Salt
- 467 lbs. Zinc
- 73,884 gallons Petroleum
- 857 lbs. Lead
- 6.28 million cu. ft. Natural Gas
- 5,064 lbs. Bauxite (Aluminum)
- 27,810 lbs. Iron Ore
- 3,638 lbs. Cement
- 1.09 million lbs. Stone, Sand, & Gravel
- Plus 40,506 lbs. Other Minerals & Metals

Oilfield minerals required to extract oil and gas

Magnetite used in coal washing

Refractory and flux minerals required to smelt metals

Flux minerals and clay required for iron ore pelletising

Industrial minerals used in range of industrial processes

Source: Original baby schematic Mineral Information Institute www.mii.org

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1. Why are industrial minerals so important?

Roofing materials
- Kaolin, iron oxide, talc, calcium carbonate, feldspar

Ceramics
- Silica sand, talc, calcium carbonate, feldspar, kaolin, wollastonite, zircon

Cosmetics/Pharma
- Talc, diatomite, silica, magnesia, bentonite, kaolin, mica, calcium carbonate, fluorspar, soda ash, borates, talc, lithium

Light bulbs
- Silica sand, fused silica, quartz, rare earths, soda ash, calcium carbonate

Solar cells
- Quartz, fused silica, silicon carbide, fluorspar, wollastonite, talc

Insulation
- Kaolin, bauxite, alumina, dolomite, basalt, silica sand, soda ash, borates, calcium carbonate, vermiculite, perlite, diatomite

Insulation
- Kaolin, bauxite, alumina, dolomite, basalt, silica sand, soda ash, borates, calcium carbonate, vermiculite, perlite, diatomite

Insulation
- Kaolin, bauxite, alumina, dolomite, basalt, silica sand, soda ash, borates, calcium carbonate, vermiculite, perlite, diatomite

Wallboard
- Gypsum

Paint
- Talc, kaolin, calcium carbonate, barite, TiO2, wollastonite, mica, iron oxide, diatomite, feldspar, syenite

Bricks, mortar, cement
- Kaolin, gypsum, silica sand, calcium carbonate, bauxite, iron oxide

Carpet backing
- Barite, talc, calcium carbonate, kaolin

Glass
- Silica sand, calcium carbonate, soda ash, feldspar, syenite, borates, fluorspar, lithium

TV/DVD
- Rare earths, borates, lithium, graphite, quartz

Garden
- Potash, phosphates, sulphur, nitrates, borates, vermiculite, perlite

Automobile (+ ALL plastics)
- Plastics/rubber: talc, calcium carbonate, wollastonite, kaolin, mica, silica sand, alumina, barite, trihydrate, magnesium hydroxide, glass: soda ash, calcium carbonate, silica sand, borates, kaolin, lithium

Oven/water heater/boiler
- Refractory minerals

Lightweight construction materials
- Diatomite, perlite, vermiculite

DIY tools
- Silica sand, fused alumina, silicon carbide

Refrigerants
- Fluorspar

Detergent
- Soda ash, borates

“White” goods
- Talc, calcium carbonate, kaolin, wollastonite

Saucepans
- All metal/steel items

Flux minerals: bauxite, olivine, lime, wollastonite

Refractory minerals: alumina, bauxite, graphite, andalusite, fused alumina, magnesia, zircon, spinel, chromite, silicon carbide, kaolin

Foundry minerals: bentonite, chromite, silica sand, zircon, olivine, andalusite, graphite

Source: Original house schematic Pinkpig
### AT A GLANCE
A-Z GUIDE WHICH MINERALS FOR WHICH MARKETS

- Leading industrial minerals
- Main raw material feedstock
- Key specified chemical component
- World production
- Main source countries
- Leading consuming markets

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**MINERAL MARKET MATRIX**

For a copy of the Mineral Market Matrix® Wall Chart, please ask me or contact:

**Ismene Clarke | ismene@imformed.com**

+44 (0)7905 771 494

*Please note: postage charges will apply*
1. Why are industrial minerals so important?

Industrial mineral uses vary widely; minerals serve multiple markets.
1. Why are industrial minerals so important?

New markets – smart devices, new energy, plastics
1. Why are industrial minerals so important?

Growth markets – smart devices

**Aluminium casing:** flux mineral fluorspar; refractory minerals eg. bauxite, magnesia

**Plastic back cover:** filler & flame retardant minerals, eg. talc, alumina trihydrate

**Polished hi-tech screen:** glass minerals eg. alumina-silica; abrasive minerals eg. fused alumina

**Speaker:** rare earth minerals

**Li-ion battery:** battery minerals eg. lithium, graphite

**Silicon chip manufacture:** fused silica crucibles; silicon carbide wiresaws

**Intense screen colours:** rare earth minerals

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1. What are industrial minerals?

- Large volume, low value commodities.
- Extracted from surface and underground mines.
- Crude ore undergoes mineral processing (refining) to make the desired grade for each market application.
- Grades are transported and traded to local, regional, and international markets.
1. What are industrial minerals?

Processed to a specific modified form and/or to liberate chemical compound(s) to make an intermediate mineral product, eg.

- Silica sand
  - Specific grain size

- Wollastonite
  - Specific grain shape & size; surface modified; high brightness

- Magnesite
  - Magnesium oxide
    - Hard; chemically inert; heat resistant; specific grain size

- Ilmenite
  - Titanium dioxide
    - High brightness; high opacity; surface modified; specific grain size
1. What are industrial minerals?
Processing: simple and complex, e.g.
1. What are industrial minerals?

There are also **synthetic industrial minerals** processed from natural industrial minerals, such as:

- Magnesite + Bauxite → Spinel
- Bauxite, kaolin → Mullite
- Lime + Carbon Dioxide → Precipitated Calcium Carbonate
- Quartz + Coke → Silicon carbide
- Limestone + Salt + Coal + Ammonia → Soda ash

Correct processing is key to producing grade meeting market specifications.
1. What are industrial minerals?

**Metallic/Non-metallic synergies:** certain minerals have both metallic and non-metallic value; the dominant market use may hold sway over availability of the mineral for the less dominant value, eg.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Non-metallic use*</th>
<th>Metallic use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bauxite</td>
<td>Abrasives, refractories</td>
<td>Aluminium metal</td>
</tr>
<tr>
<td>Chromite</td>
<td>Foundry, chemicals</td>
<td>Chrome, Ferrochrome</td>
</tr>
<tr>
<td>Lithium</td>
<td>Ceramics, glass, batteries</td>
<td>Lithium metal</td>
</tr>
<tr>
<td>Magnesite</td>
<td>Chemicals, refractories</td>
<td>Magnesium metal</td>
</tr>
<tr>
<td>Manganese</td>
<td>Batteries, pigments</td>
<td>Manganese metal</td>
</tr>
<tr>
<td>Quartz</td>
<td>Glass, ceramics</td>
<td>Silicon metal</td>
</tr>
<tr>
<td>Rutile</td>
<td>White pigment</td>
<td>Titanium metal</td>
</tr>
<tr>
<td>Zircon</td>
<td>Ceramics, refractories</td>
<td>Zirconium metal</td>
</tr>
</tbody>
</table>

* Examples of end uses, not complete list
1. Why are industrial minerals so important?

Industrial minerals account for the largest sector of US mine production by value.

- Coal: $9.8m, 35%
- Metallic minerals: $31.9m, 28%
- Industrial minerals: $42.3m, 37%

Source: USGS 2015 data
1. What are industrial minerals?

Comparison of mined metallic and **non-metallic** commodities in the USA

<table>
<thead>
<tr>
<th>Commodity</th>
<th>No. mines</th>
<th>Output (tonnes)</th>
<th>Value (US$m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
<td>45</td>
<td>211</td>
<td>8,600</td>
</tr>
<tr>
<td>Silver</td>
<td>42</td>
<td>1,170</td>
<td>718</td>
</tr>
<tr>
<td>Copper</td>
<td>27</td>
<td>1,370,000</td>
<td>9,700</td>
</tr>
<tr>
<td><strong>Construction sand &amp; gravel</strong></td>
<td>6,600</td>
<td><strong>911,000,000</strong></td>
<td><strong>7,000</strong></td>
</tr>
<tr>
<td>Phosphate</td>
<td>11</td>
<td>27,100,000</td>
<td>2,400</td>
</tr>
<tr>
<td>Barytes</td>
<td>4</td>
<td>720,000</td>
<td>90</td>
</tr>
</tbody>
</table>

Source: USGS 2015 data

Industrial minerals are generally high volume, low value commodities
1. Why are industrial minerals so important?

The USA relies on significant industrial mineral imports

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos</td>
<td>Canada, Brazil</td>
</tr>
<tr>
<td>Bauxite &amp; Alumina</td>
<td>Jamaica, Brazil, Guinea, Australia</td>
</tr>
<tr>
<td>Fluorspar</td>
<td>Mexico, China, S. Africa, Mongolia</td>
</tr>
<tr>
<td>Graphite</td>
<td>China, Mexico, Canada, Brazil</td>
</tr>
<tr>
<td>Mica (sheet)</td>
<td>China, Brazil, Belgium, India</td>
</tr>
<tr>
<td>Quartz crystal</td>
<td>China, Japan, Russia</td>
</tr>
<tr>
<td>Scandium</td>
<td>China</td>
</tr>
<tr>
<td>Strontium</td>
<td>Mexico, Germany, China</td>
</tr>
<tr>
<td>Iodine</td>
<td>Chile, Japan</td>
</tr>
<tr>
<td>Chromium</td>
<td>South Africa, Kazakhstan, Russia, Mexico</td>
</tr>
<tr>
<td>Diamonds</td>
<td>China, Ireland, Rep. of Korea, Romania</td>
</tr>
<tr>
<td>Antimony</td>
<td>China, Mexico, Belgium, Bolivia</td>
</tr>
<tr>
<td>Potash</td>
<td>Canada, Russia, Israel, Chile</td>
</tr>
<tr>
<td>Titanium minerals</td>
<td>S. Africa, Australia, Canada, Mozambique</td>
</tr>
<tr>
<td>Garnet</td>
<td>Australia, India, China</td>
</tr>
<tr>
<td>Barytes</td>
<td>China, India, Morocco</td>
</tr>
<tr>
<td>Silicon Carbide</td>
<td>China, S. Africa, Netherlands, Romania</td>
</tr>
<tr>
<td>Magnesia</td>
<td>China, Brazil, Canada, Australia</td>
</tr>
<tr>
<td>Rare earths</td>
<td>China, Japan, Austria, France</td>
</tr>
<tr>
<td>Vermiculite</td>
<td>South Africa, China, Brazil</td>
</tr>
<tr>
<td>Salt</td>
<td>Canada, Chile, Mexico, The Bahamas</td>
</tr>
<tr>
<td>Perlite</td>
<td>Greece</td>
</tr>
<tr>
<td>Mica (scap,flake)</td>
<td>Canada, China, Finland, Mexico</td>
</tr>
</tbody>
</table>

Source: USGS 2015 data
1. Why are industrial minerals so important?

Emergence of “Critical Minerals” and their assessment

Industrial minerals are economically important, and in some cases have strategic value, but this will be relative to the end user market dynamics.
1. Why are industrial minerals so important?

Owing to the scarcity of resources and supply issues, certain industrial minerals are considered “critical” to industries eg.

- Heavy rare earths
- Light rare earths
- Natural graphite
- Magnesite
- Fluorspar
- Barytes
- Diatomite
- Bentonite, Perlite, Clays, Feldspar, Talc
- Lithium, Gypsum, Silica sand, Limestone
- Borates
- Potash
- Chromite
- Bauxite
- Magnesite
- Fluorspar
- Barytes
- Diatomite
- Bentonite, Perlite, Clays, Feldspar, Talc
- Lithium, Gypsum, Silica sand, Limestone
- Borates
- Potash
- Chromite
- Bauxite

Source: Original chart European Commission
2. How is the market structured?

The industrial minerals business can be confusing:
- each mineral can serve up to 4-20+ different markets
- each market can demand a range of different minerals, eg.

Talc  
Borates  
Rare earths  
Magnesite  
Kaolin  
Silica  

Paper  
Plastics  
Ceramics  
Glass  
Refractories  
Chemicals  

The World Wide Mineral Web!
2. How is the market structured?
Based on the supply chain of the mineral from mine to market.

In general
- Mined & processed mineral grade
- Intermediate mineral product
- Intermediate mineral market
- End user market
- Ultimate end user market

Some basic examples
- Silica sand
- Ilmenite/rutile
- Abrasive grade bauxite
- Titanium dioxide
- Brown fused alumina
- TiO2 pigment production
- Refractories production
- Paint production
- Steel production
- Glass production
- Construction
- Automobiles
- Ship building
2. How is the market structured?

Supply chains can be simplified into three key business tiers
2. How is the market structured?

These three tiers host a range of functional sectors.

<table>
<thead>
<tr>
<th>SUPPLY</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration</td>
<td>Finance</td>
<td>Engineering</td>
<td>Production</td>
<td>Processing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOGISTICS</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Trading</td>
<td>Processing</td>
<td>Transport</td>
<td>Inspection</td>
<td>Stevedoring</td>
<td>Storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Distribution</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MARKET</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct market</td>
<td>Intermediate market</td>
<td>End market</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each industrial mineral has its own specific supply chain characteristics
2. How is the market structured?

- Supply chain options for raw material supply

<table>
<thead>
<tr>
<th>Mineral producer</th>
<th>Trad. route</th>
<th>Captive processing</th>
<th>Direct buy</th>
<th>Captive production</th>
<th>Recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(own mine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Exploration, reserves, mining, processing

- Mineral trader

- Sourcing, logistics, financing

- Mineral processor/distributor

- Sourcing, processing, storage, logistics

- Intermediate product manufacturer

- Sourcing, processing, storage, logistics, formulating, application

- End user market

End use application eg. steel, glass manufacture
3. How is the market driven?

“Without a market, an industrial mineral deposit is merely a geological curiosity”

Peter Harben, Industrial Minerals Consultant
3. How is the market driven?

- To have any value, and any potential for development, an industrial mineral source must be able to economically deliver an acceptable product to a market in demand.

- Industrial minerals are absolutely essential in the manufacturing of all kinds of products.

- Thus, the performance of the mineral consuming market drives industrial mineral demand.

| Key | No market = no mineral demand = no mineral development |
3. How is the market driven?

Industrial mineral market trends are shaped by:

A. Primary demand drivers which impact the overall market performance in a state or region

- Economy
- Population
- Development
3. How is the market driven?

Industrial mineral market trends are shaped by:

B. Key influencing factors specific to the trade of minerals, markets, and regions

- Resource-market proximity
- Specific market demand trends
- Limited resource distribution
- Reliance on imports
- China
- Pricing
- Logistics
- World events
3. How is the market driven?

**Influencing factor example: China**
Remains a significant supplier of minerals to world markets, as well as a growing (if stalled!) mineral consumer

<table>
<thead>
<tr>
<th>Mineral Type</th>
<th>Share of Global Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rare earths</td>
<td>97%</td>
</tr>
<tr>
<td>Refractory bauxite</td>
<td>95%</td>
</tr>
<tr>
<td>Fused magnesia</td>
<td>81%</td>
</tr>
<tr>
<td>Mica (scrap/flake)</td>
<td>69%</td>
</tr>
<tr>
<td>Flake graphite</td>
<td>61%</td>
</tr>
<tr>
<td>Wollastonite</td>
<td>59%</td>
</tr>
<tr>
<td>Brown fused alumina</td>
<td>55%</td>
</tr>
<tr>
<td>Silicon carbide</td>
<td>55%</td>
</tr>
<tr>
<td>Fluorspar</td>
<td>53%</td>
</tr>
<tr>
<td>Barytes</td>
<td>48%</td>
</tr>
<tr>
<td>Dead burned magnesia</td>
<td>44%</td>
</tr>
<tr>
<td>Talc</td>
<td>30%</td>
</tr>
<tr>
<td>Vermiculite</td>
<td>22%</td>
</tr>
</tbody>
</table>
3. How is the market driven?

**Influencing factor example: Pricing**

- Pricing is opaque, there is no exchange.
- Apart from a few minerals, there is no formal listing of prices.
- Pricing contracts are often long term
- Prices are influenced by a range of factors
3. How is the market driven?

Influencing factor example: Pricing

- Ball-park price ranges for industrial minerals

Grade range per mineral; more processing = higher price
3. How is the market driven?

**Influencing factor example: Logistics**

One of the most important components; often overlooked, it can make or break it.

- Mine to market logistics = many stages.
- Cost can account for up to 70% of the final delivered mineral price.

Source: Logistics graphic Santini, Barker, & Bentzen 2006
### Market drivers

**Influencing factor example:** Limited sources

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Principal Source Country*</th>
<th>Principal End Use Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andalusite</td>
<td>France, South Africa</td>
<td>Refractories; Ceramics</td>
</tr>
<tr>
<td>Barytes</td>
<td>China, India, Morocco</td>
<td>Oilfield; Chemicals; Fillers</td>
</tr>
<tr>
<td>Bentonite</td>
<td>Greece, India, Turkey, USA</td>
<td>Oilfield; Foundry; Absorbents; Metallurgy</td>
</tr>
<tr>
<td>Bauxite</td>
<td>China, Guyana</td>
<td>Refractories; Abrasives; Proppants</td>
</tr>
<tr>
<td>Borates</td>
<td>Argentina, Chile, Turkey, USA</td>
<td>Chemicals; Glass; Agriculture; Ceramics; Detergents</td>
</tr>
<tr>
<td>Chromite</td>
<td>South Africa</td>
<td>Foundry; Refractories; Chemicals</td>
</tr>
<tr>
<td>Fluorspar</td>
<td>China, Mexico, South Africa, Mongolia, Spain</td>
<td>Chemicals; Ceramics; Glass; Metallurgy</td>
</tr>
<tr>
<td>Graphite</td>
<td>Brazil, China, India</td>
<td>Refractories; Foundry; Batteries</td>
</tr>
<tr>
<td>Kaolin, refined</td>
<td>Brazil, USA</td>
<td>Paper</td>
</tr>
<tr>
<td>Lithium minerals</td>
<td>Argentina, Australia, Chile, USA, Zimbabwe</td>
<td>Glass; Ceramics; Chemicals; Batteries</td>
</tr>
<tr>
<td>Magnesite</td>
<td>Brazil, China, Greece, Russia, Slovakia, Turkey</td>
<td>Refractories; Agriculture; Chemicals; Construction; Environment</td>
</tr>
<tr>
<td>Nitrates</td>
<td>Chile</td>
<td>Agriculture</td>
</tr>
<tr>
<td>Olivine</td>
<td>Norway</td>
<td>Foundry; Refractories; Abrasives</td>
</tr>
<tr>
<td>Phosphates</td>
<td>Jordan, Morocco, Russia</td>
<td>Agriculture; Chemicals</td>
</tr>
<tr>
<td>Potash</td>
<td>Belarus, Canada, Israel, Jordan, Russia</td>
<td>Agriculture; Oilfield; Chemicals</td>
</tr>
<tr>
<td>Rare earths</td>
<td>China</td>
<td>Glass; Ceramics; Catalysts; Magnets</td>
</tr>
<tr>
<td>Titanium minerals</td>
<td>Australia, Mozambique, Madagascar, Norway, Sierra Leone, South Africa, Ukraine, Vietnam</td>
<td>Pigments</td>
</tr>
<tr>
<td>Wollastonite</td>
<td>USA, China, India</td>
<td>Ceramics; Fillers; Metallurgy</td>
</tr>
<tr>
<td>Zircon</td>
<td>Australia, South Africa</td>
<td>Ceramics; Refractories; Chemicals</td>
</tr>
</tbody>
</table>

*Main supply sources and exporters of industrial mineral grade that influence global trade in that mineral

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4. Summary: Key Takeaways

Fundamentals of the industrial minerals market

<table>
<thead>
<tr>
<th>High volume, low value commodities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used in a wide variety of industrial and domestic uses = fragmented market</td>
</tr>
<tr>
<td>Of economic, sometimes strategic, importance, essential to modern industry &amp; life</td>
</tr>
<tr>
<td>Certain industrial minerals have synergies and influence with metals markets</td>
</tr>
<tr>
<td>Minerals may be classified or grouped by the markets they serve, but…</td>
</tr>
<tr>
<td>Minerals supply multiple markets, each with different requirements and dynamics</td>
</tr>
<tr>
<td>Supply chain structure of three broad business tiers: supply, logistics, and market</td>
</tr>
<tr>
<td>Processing key to meet market specs, different markets require different grades</td>
</tr>
<tr>
<td>Logistics account for a large share of the final delivered price of the mineral</td>
</tr>
<tr>
<td>IMs are consumer market driven: no market = no demand = no mineral development</td>
</tr>
<tr>
<td>Market performance is influenced by primary economic drivers and specific factors</td>
</tr>
<tr>
<td>IM pricing is opaque, specific to markets and buyer/seller relationships</td>
</tr>
</tbody>
</table>
4. Summary: Factors influencing success

<table>
<thead>
<tr>
<th>Factor</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserves</td>
<td>High quality, sufficient volume</td>
</tr>
<tr>
<td>Marketable grade</td>
<td>Mineral must meet market specifications</td>
</tr>
<tr>
<td>Consistency</td>
<td>In grade spec. and volume availability</td>
</tr>
<tr>
<td>Market demand</td>
<td>Essential to have market &amp; knowledge of it</td>
</tr>
<tr>
<td>Financing</td>
<td>Funding for all aspects of project</td>
</tr>
<tr>
<td>Processing</td>
<td>Ensure correct and complete process route</td>
</tr>
<tr>
<td>Logistics</td>
<td>Secure optimum logistics system &amp; routes</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Awareness to diversify products &amp; markets</td>
</tr>
</tbody>
</table>
4. Summary: Potential investment indicators

Approach by mineral or by market

<table>
<thead>
<tr>
<th>Typical opportunity indicators</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>New/growth markets by application</td>
<td>smart devices; Li-ion batteries; solar/wind power; fertiliser; plastics; fracking; insulation</td>
</tr>
<tr>
<td>New/growth markets by region</td>
<td>BRIC; N-11 (Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, Turkey, South Korea and Vietnam)</td>
</tr>
<tr>
<td>New/growth markets by evolution</td>
<td>recycling, Secondary Raw Materials</td>
</tr>
<tr>
<td>Limited developed mineral sources</td>
<td>andalusite; barite; bauxite; chromite; fluorspar; graphite; lithium; rare earths; zircon</td>
</tr>
<tr>
<td>Competition/Substitution</td>
<td>asbestos [graphite, wollastonite]; bauxite [andalusite]; bromine [magnesia]</td>
</tr>
<tr>
<td>World/Economic/Geopolitical events</td>
<td>China, Cuba, Iran, N. Korea; Afghan conflict, Fukushima accident, Olympic Games</td>
</tr>
</tbody>
</table>
Thank you for your attention
If you have any questions or comments about this briefing, or would like more information, please contact me.

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Upcoming conferences

MINERAL RECYCLING FORUM 2016
Inntel Hotels Rotterdam Centre, Rotterdam 14 - 15 March 2016
Secondary raw material sources, supply, processing, and markets

MINERAL LOGISTICS FORUM 2016
Inntel Hotels Rotterdam Centre, Rotterdam, 11-13 April 2016
The networking and knowledge hub for the industrial minerals logistics market

MAGFORUM 2016
Magnesium Minerals & Markets Conference
Meliá Hotel, Vienna, 9-11 May 2016

OILFIELD MINERALS & MARKETS FORUM HOUSTON 2016
The Houstonian Hotel, Houston, 5-7 June 2016

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