

Industrial Minerals Basics

Executive Primer

Mike O'Driscoll, Director, IMFORMED



Networking and knowledge for the industrial minerals business

IMFORMED

Industrial Mineral Forums & Research

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



Key points



1. What are industrial minerals?

Unglamorous

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!



talc



paper



cosmetics

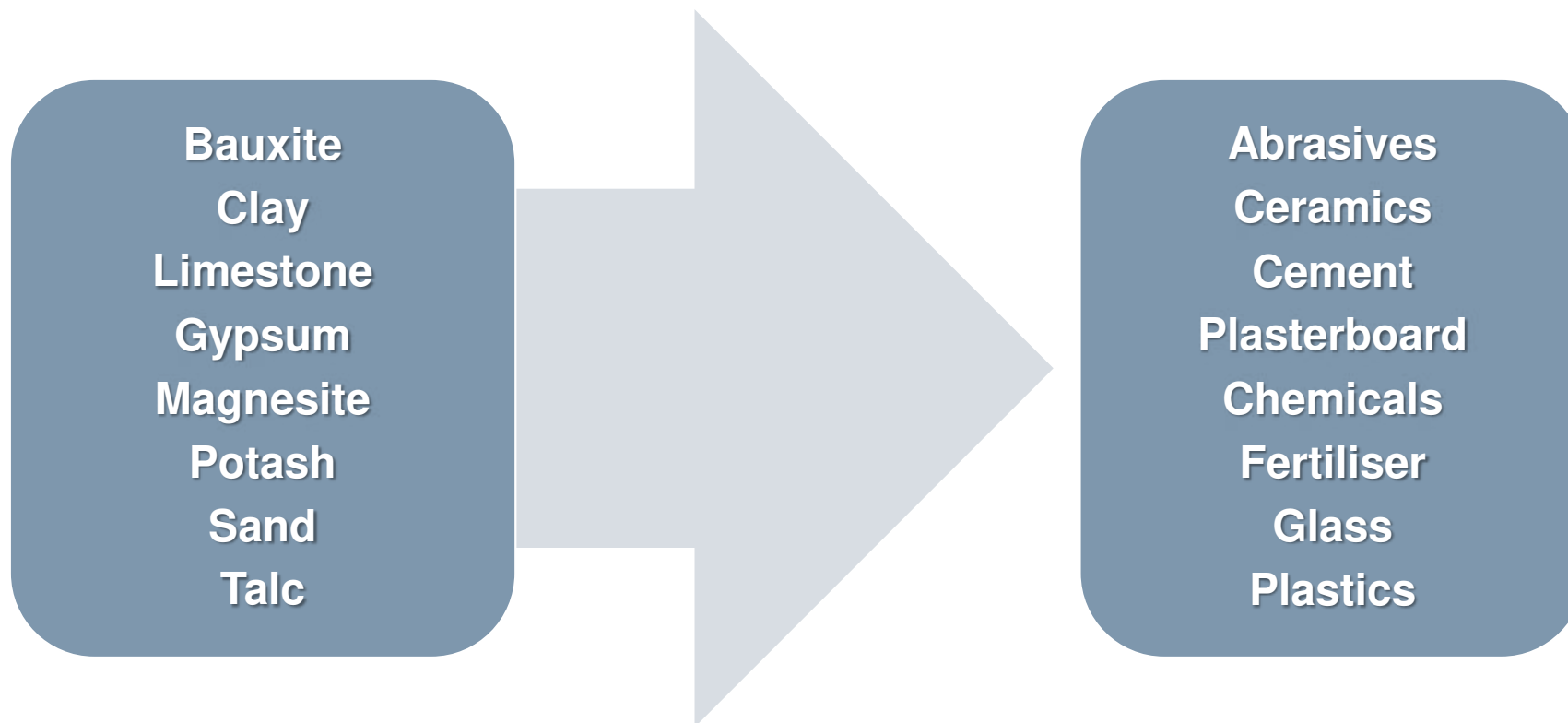


ceramics



1. What are industrial minerals?

Some examples of industrial minerals and their uses:

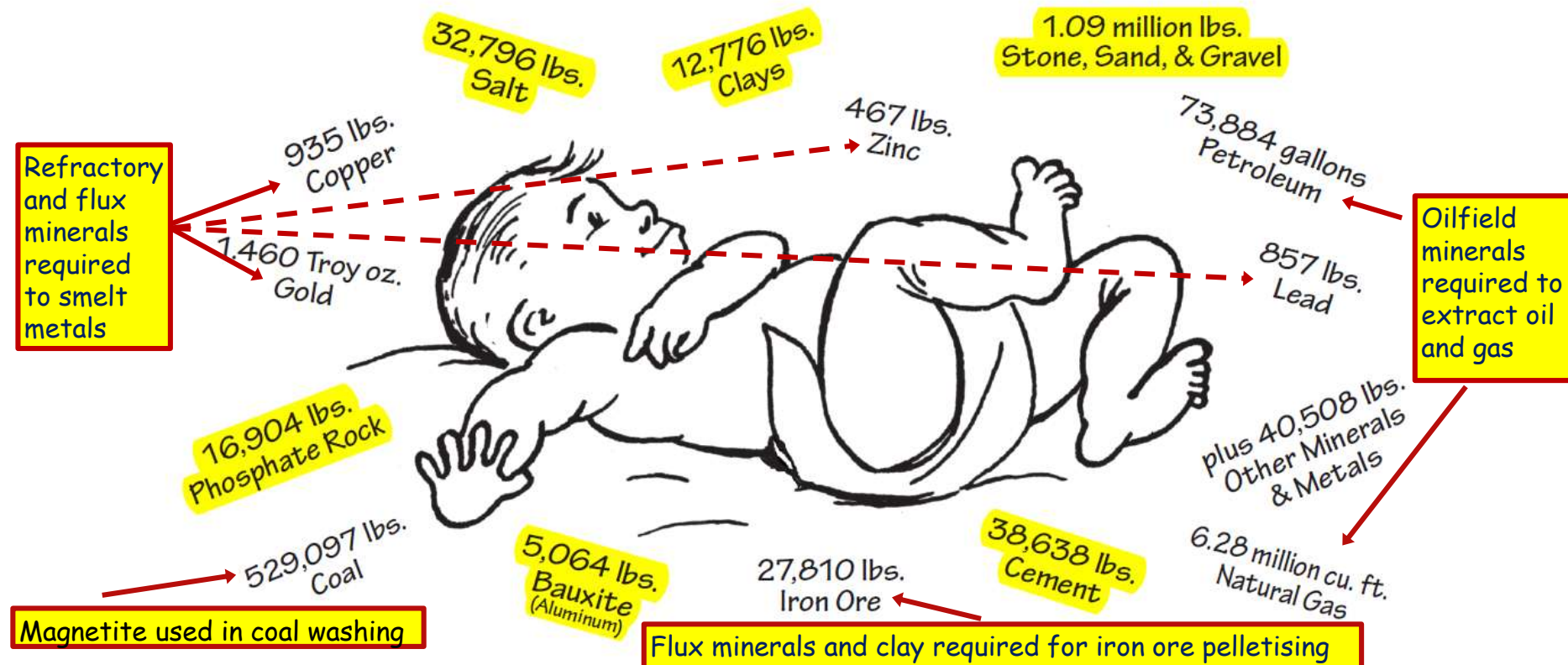



End use markets = heavy & light industry, diverse, global, consumer driven



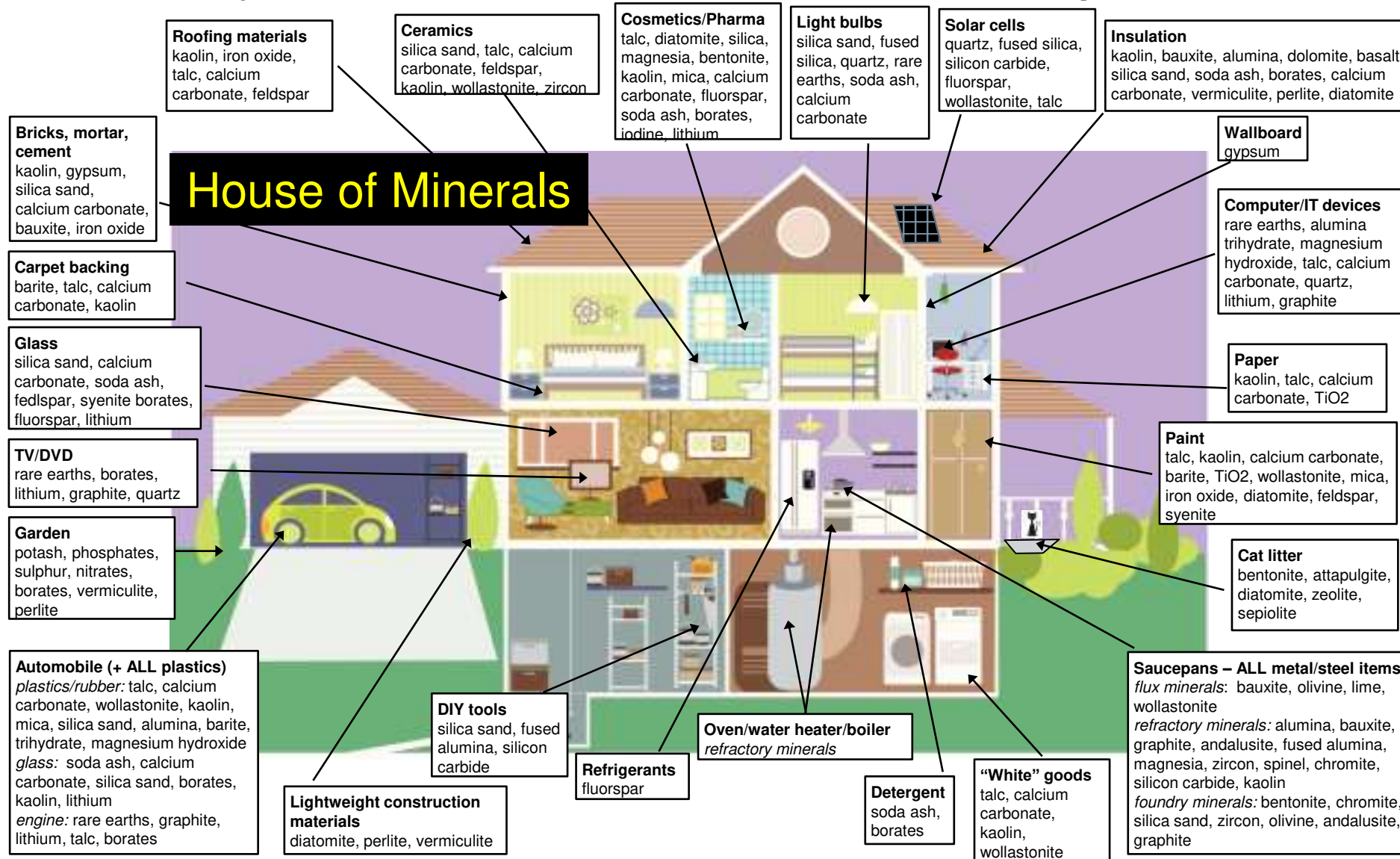
1. Why are industrial minerals so important?

Average lifetime requirements for each person born in the USA



 Industrial minerals used in range of industrial processes

1. Why are industrial minerals so important?





**AT A GLANCE
A-Z GUIDE
WHICH MINERALS
FOR WHICH
MARKETS**

MINERAL ¹ *Derivative **Synthetic	MARKETS ²								MAIN RAW MATERIAL FEEDSTOCKS ³	KEY SPECIFIED CHEMICAL COMPONENT(S) ⁴	WORLD PRODUCTION ⁵	MAIN SOURCE COUNTRIES ⁶
	Abrasives	Absorbents	Agrimarkets	Batteries	Cement	Ceramics	Chemicals	Construction				
ALUMINA*	●				●	●	●		Al ₂ O ₃	6,000	China, USA, Germany	
ANDALUSITE	○					●			Al ₂ O ₃	300	South Africa, France, Peru	
ANTIMONY TRIOXIDE*				●		●	●		Sb ₂ O ₃	110	China, Russia, Tajikistan	
ASBESTOS					●				n.a.	20,000	Russia, China, Brazil	
ATTAPULGITE		●	●						n.a.	2,220	USA, Senegal, Spain	
BADDELEYITE									ZrO ₂	9	Russia	
BARYTES (BARITE)									BaSO ₄	972	China, India, Morocco	
BAUXITE	●								Al ₂ O ₃	10,000	China, Guyana, Greece	

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

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

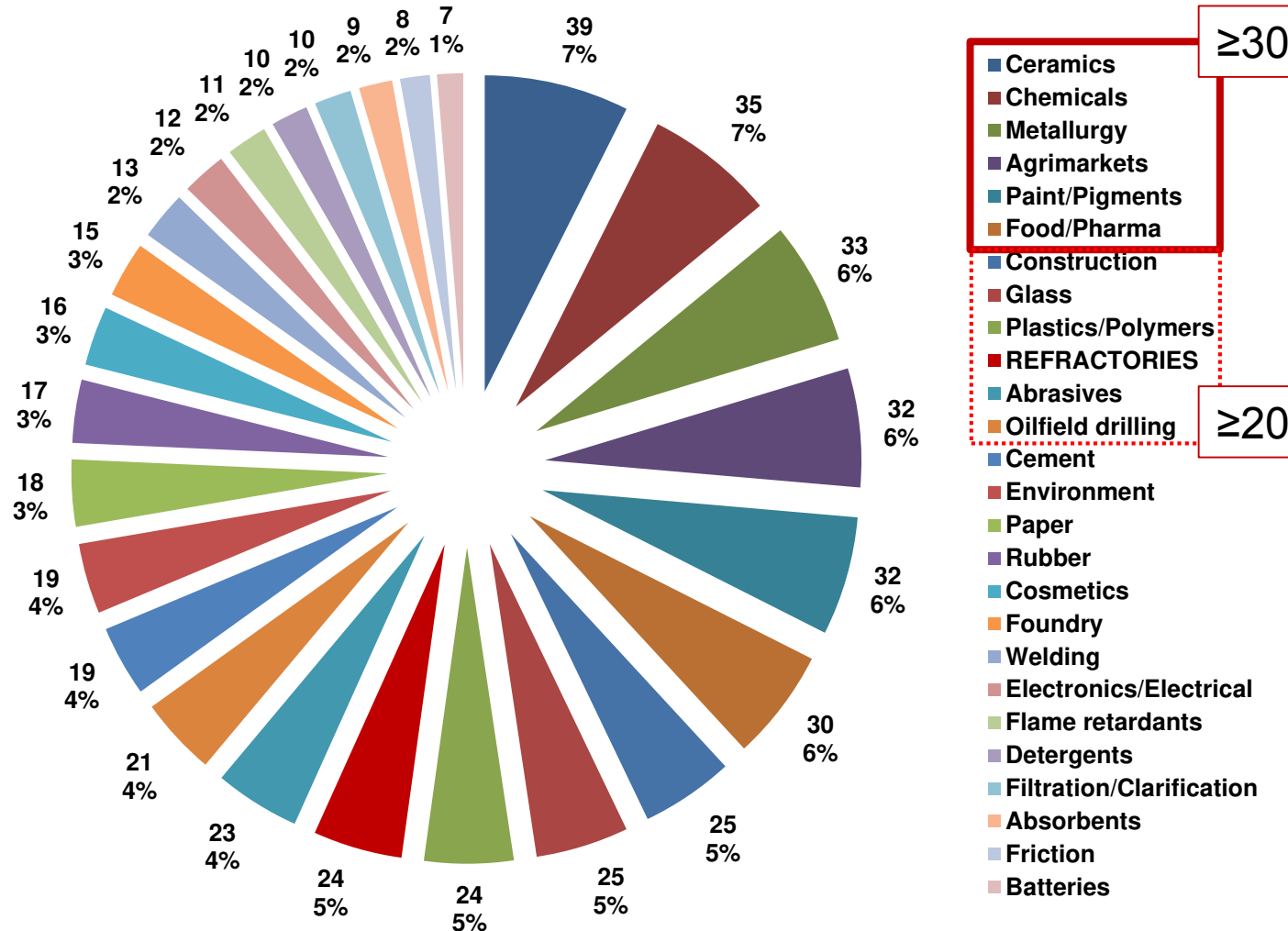
Ismene Clarke | ismene@imformed.com
+44 (0)7905 771 494
Please note: postage charges will apply

1. Why are industrial minerals so important?



“Kaleidoscope”

Total number of minerals used in each market



Industrial mineral uses vary widely; minerals serve multiple markets

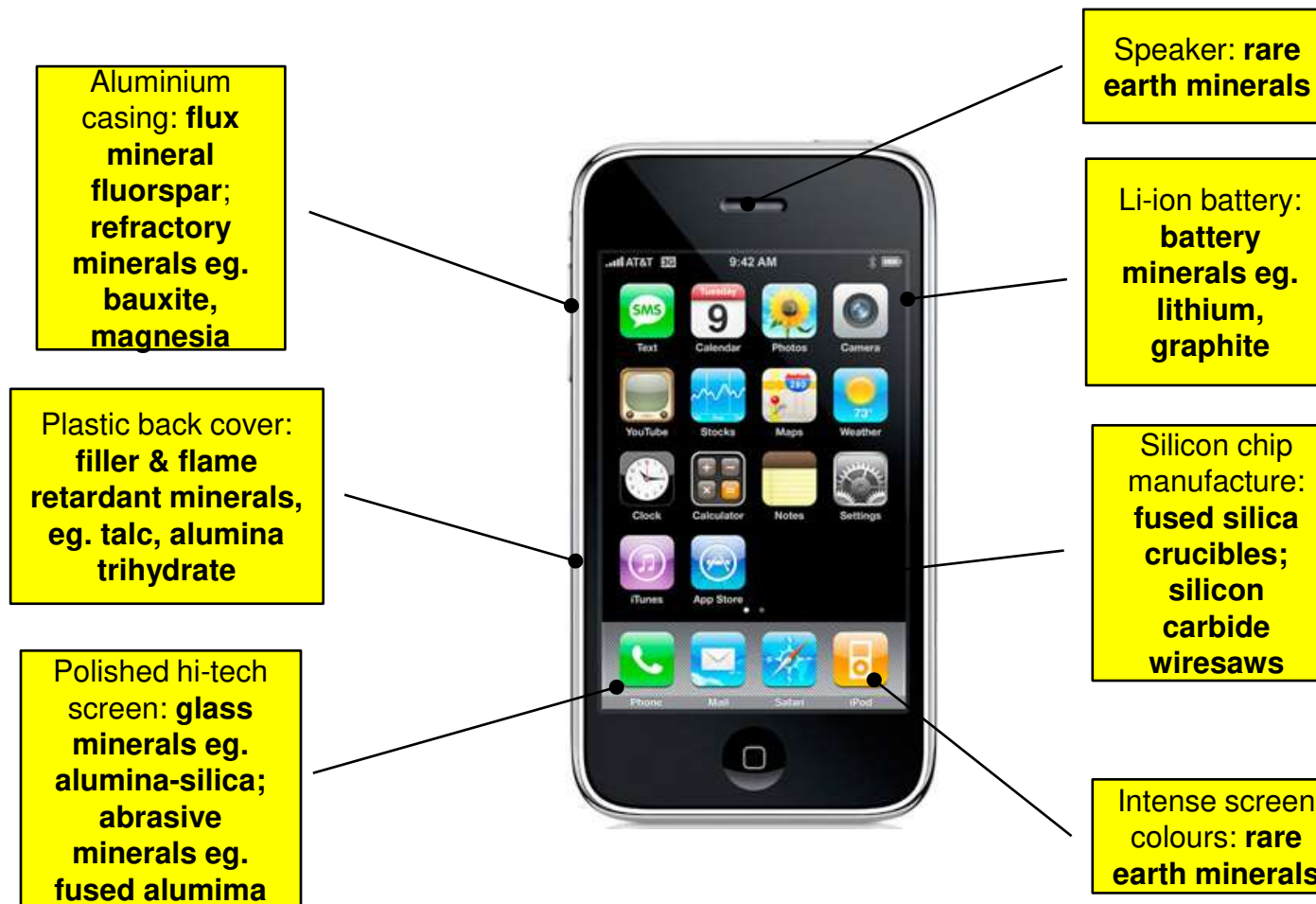
1. Why are industrial minerals so important?

New markets – smart devices, new energy, plastics



1. Why are industrial minerals so important?

Growth markets – smart devices



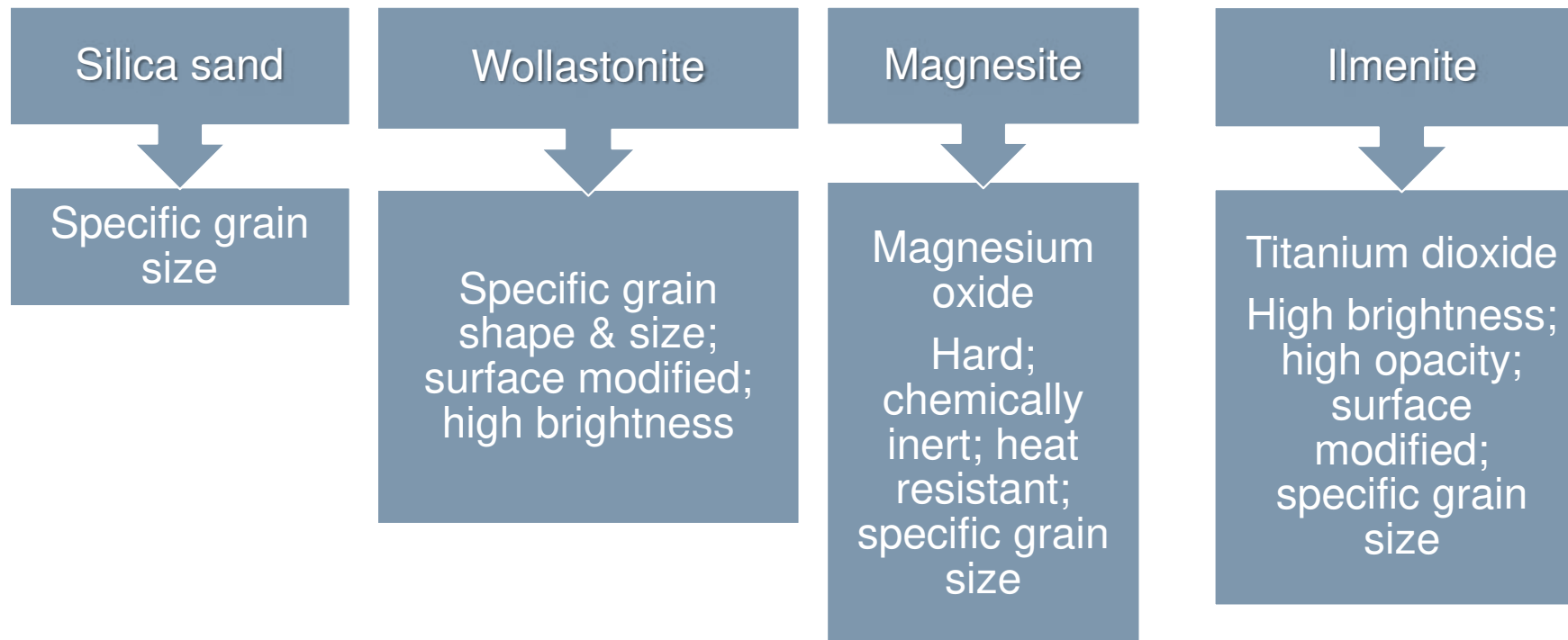
1. What are industrial minerals?

- 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?

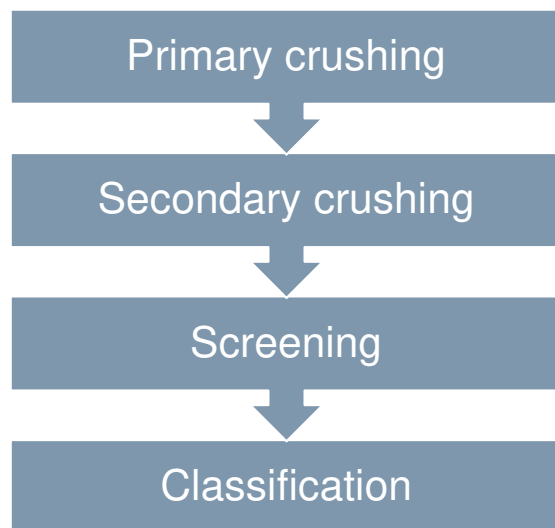
Processed to a specific modified form and/or to liberate chemical compound(s) to make an intermediate mineral product, eg.



1. What are industrial minerals?

Processing: simple and complex, eg.

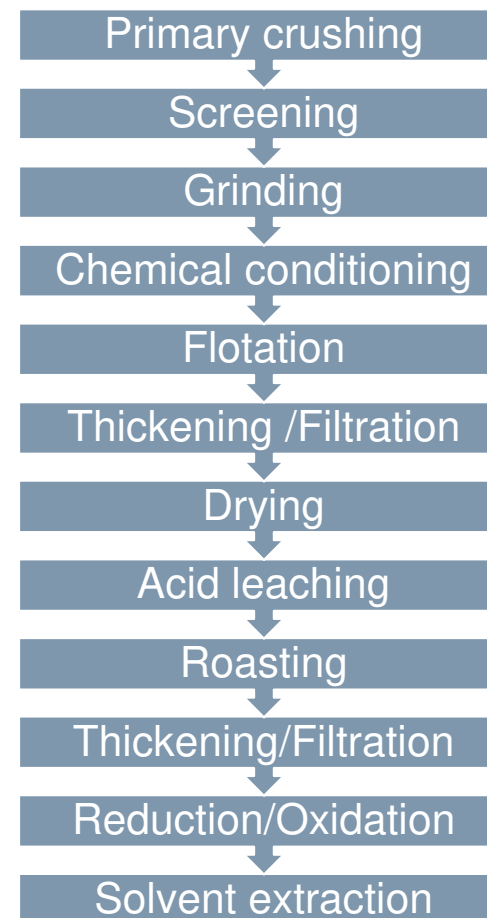
Construction aggregates



Talc

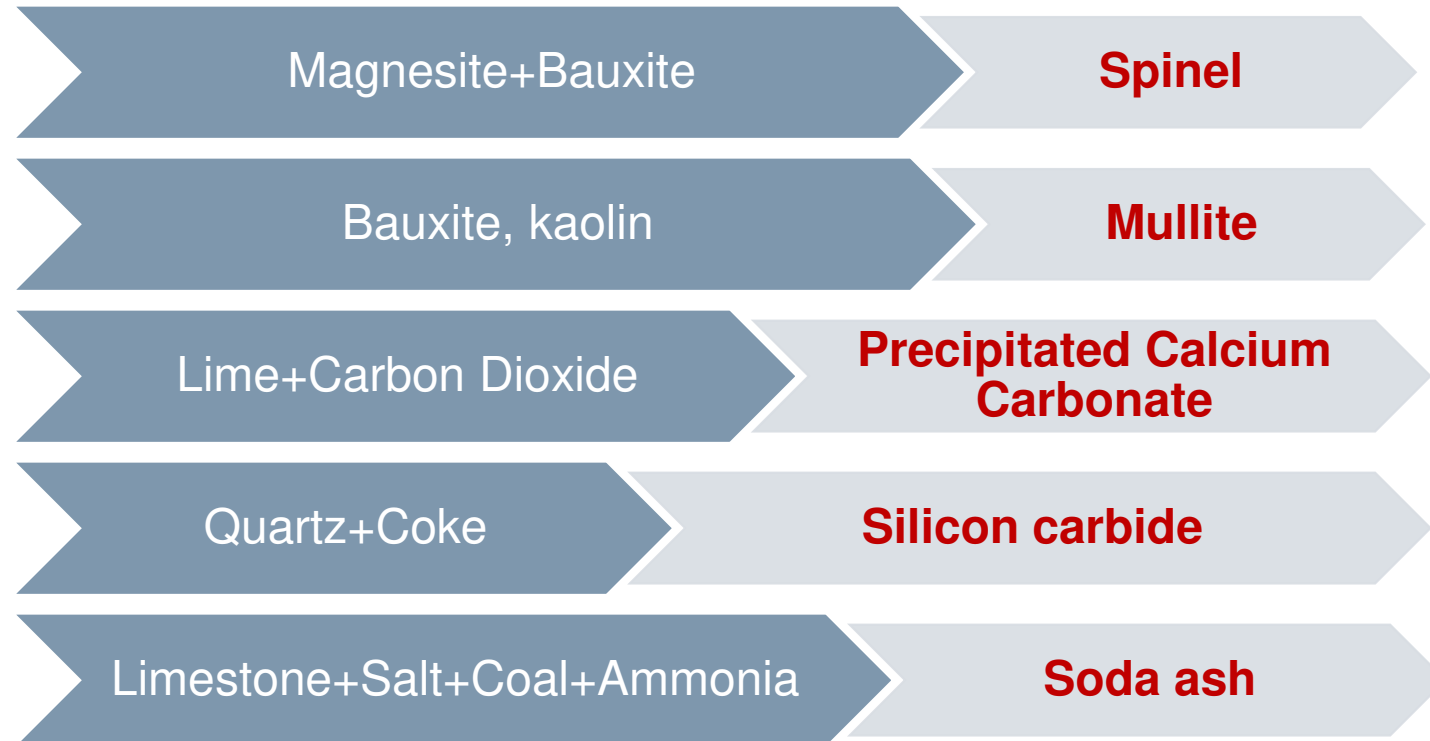


Rare earths



1. What are industrial minerals?

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



Correct processing is key to producing grade meeting market specifications



1. What are industrial minerals?

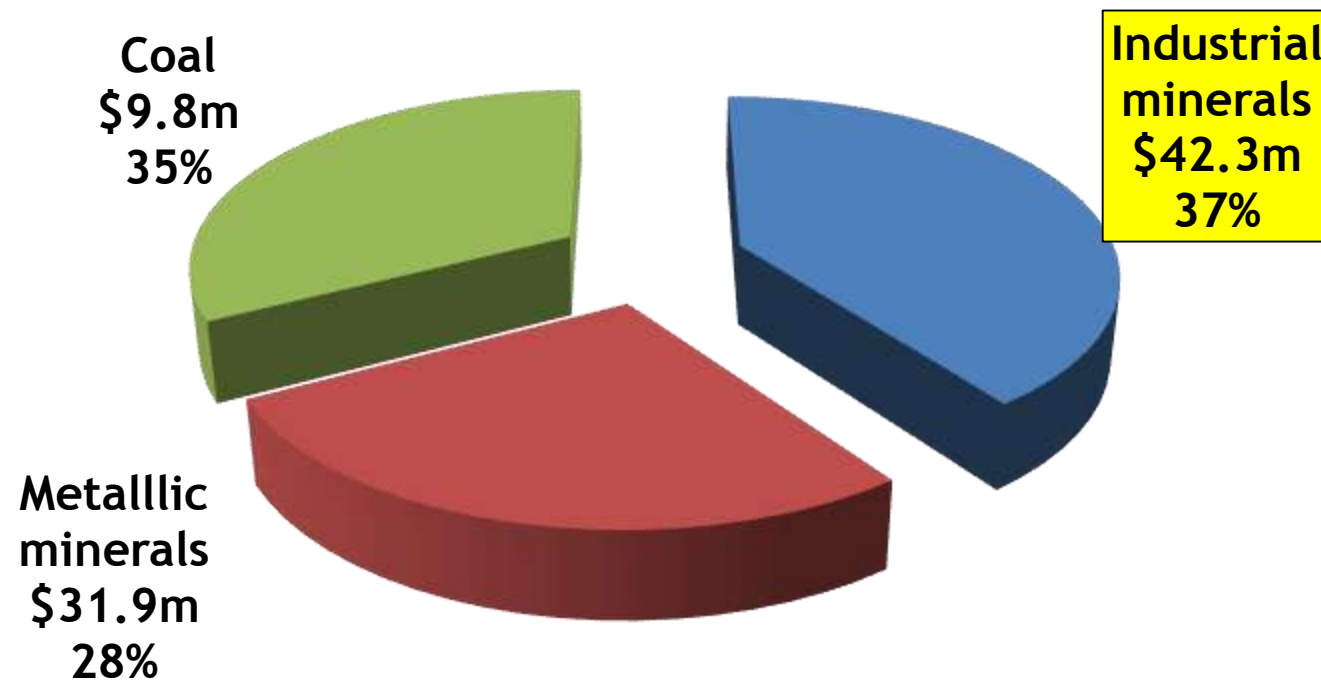
Metallic/Non-metallic synergies: certain minerals have both metallic and non-metallic value; the **dominant** market use may hold sway over availability of the mineral for the less dominant value, eg.

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



1. Why are industrial minerals so important?

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



1. What are industrial minerals?

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



Commodity	No. mines	Output (tonnes)	Value (US\$m)
Gold	45	211	8,600
Silver	42	1,170	718
Copper	27	1,370,000	9,700
Construction sand & gravel	6,600	911,000,000	7,000
Phosphate	11	27,100,000	2,400
Barytes	4	720,000	90

Source: USGS 2015 data

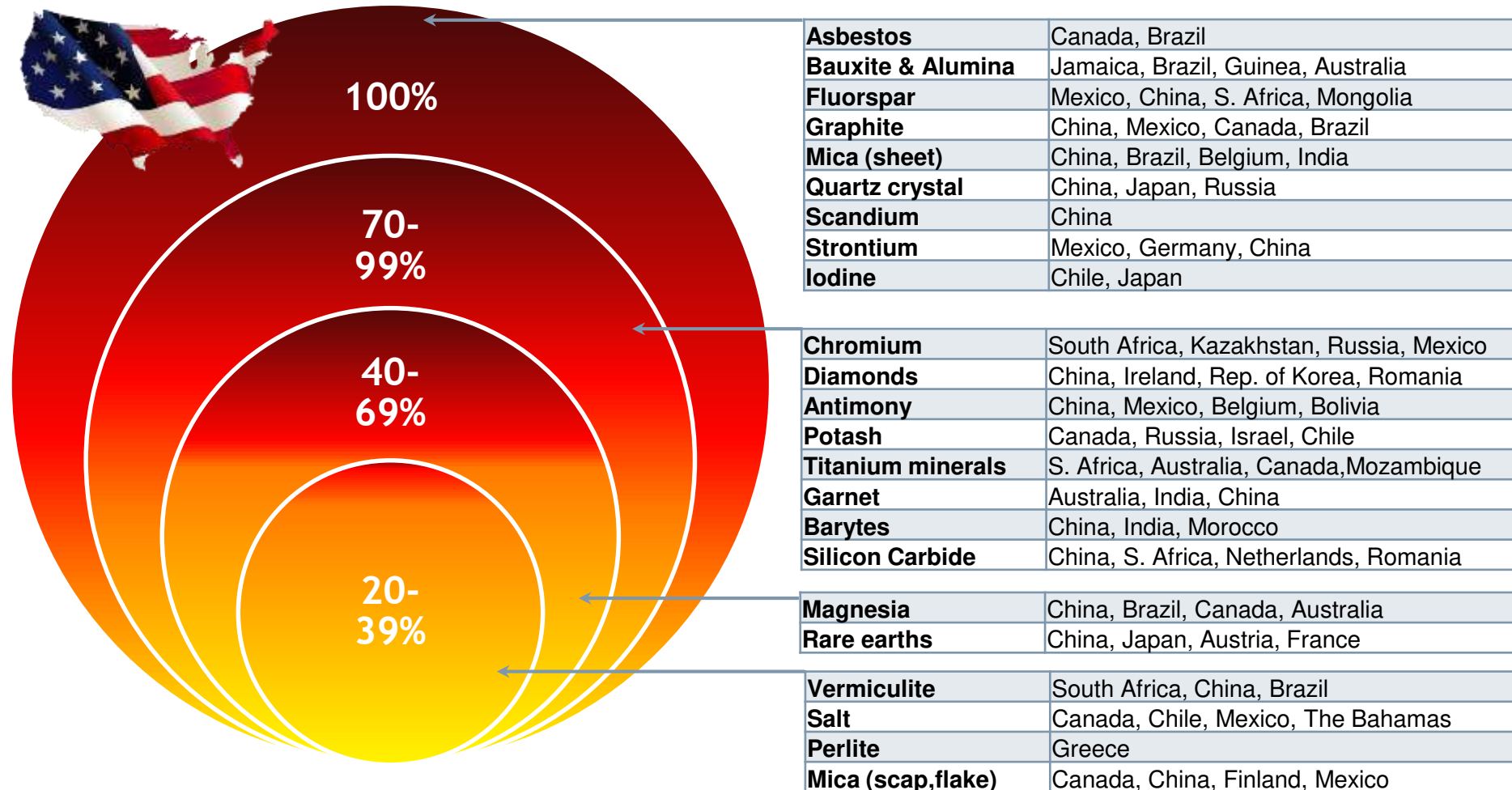


Industrial minerals are generally high volume, low value commodities



1. Why are industrial minerals so important?


The USA relies on significant industrial mineral imports



1. Why are industrial minerals so important?

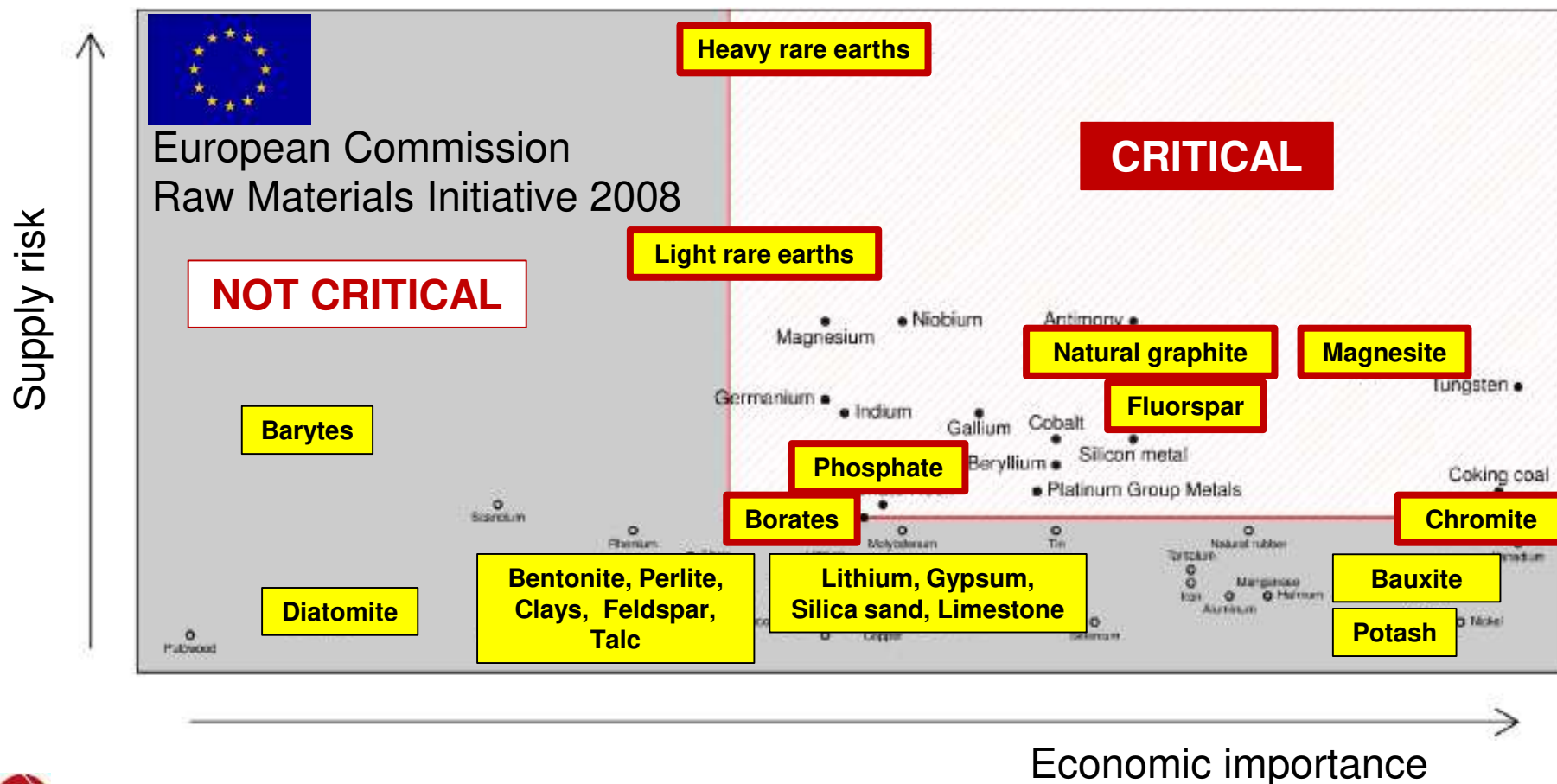
Emergence of “Critical Minerals” and their assessment



 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?

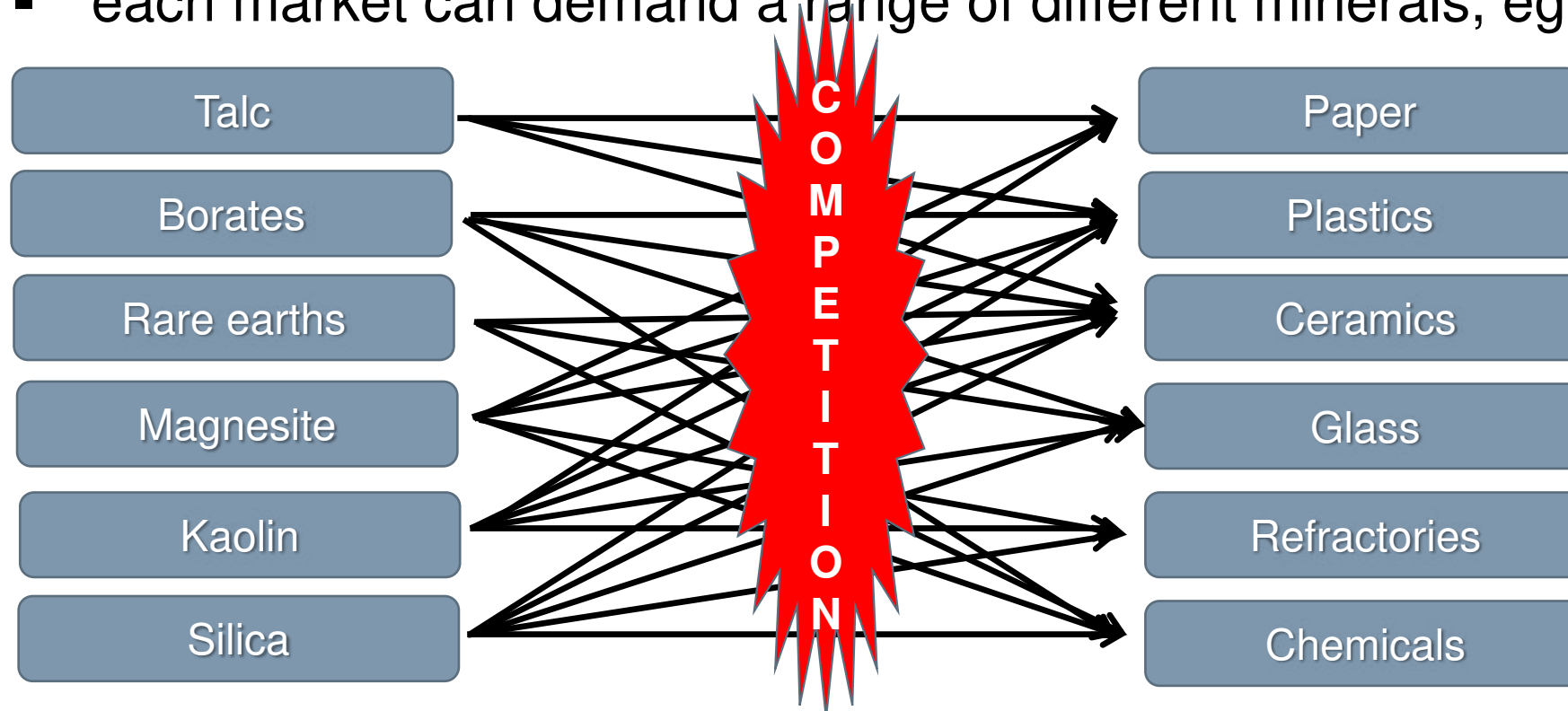
Owing to the scarcity of resources and supply issues, certain industrial minerals are considered “critical” to industries eg.



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.

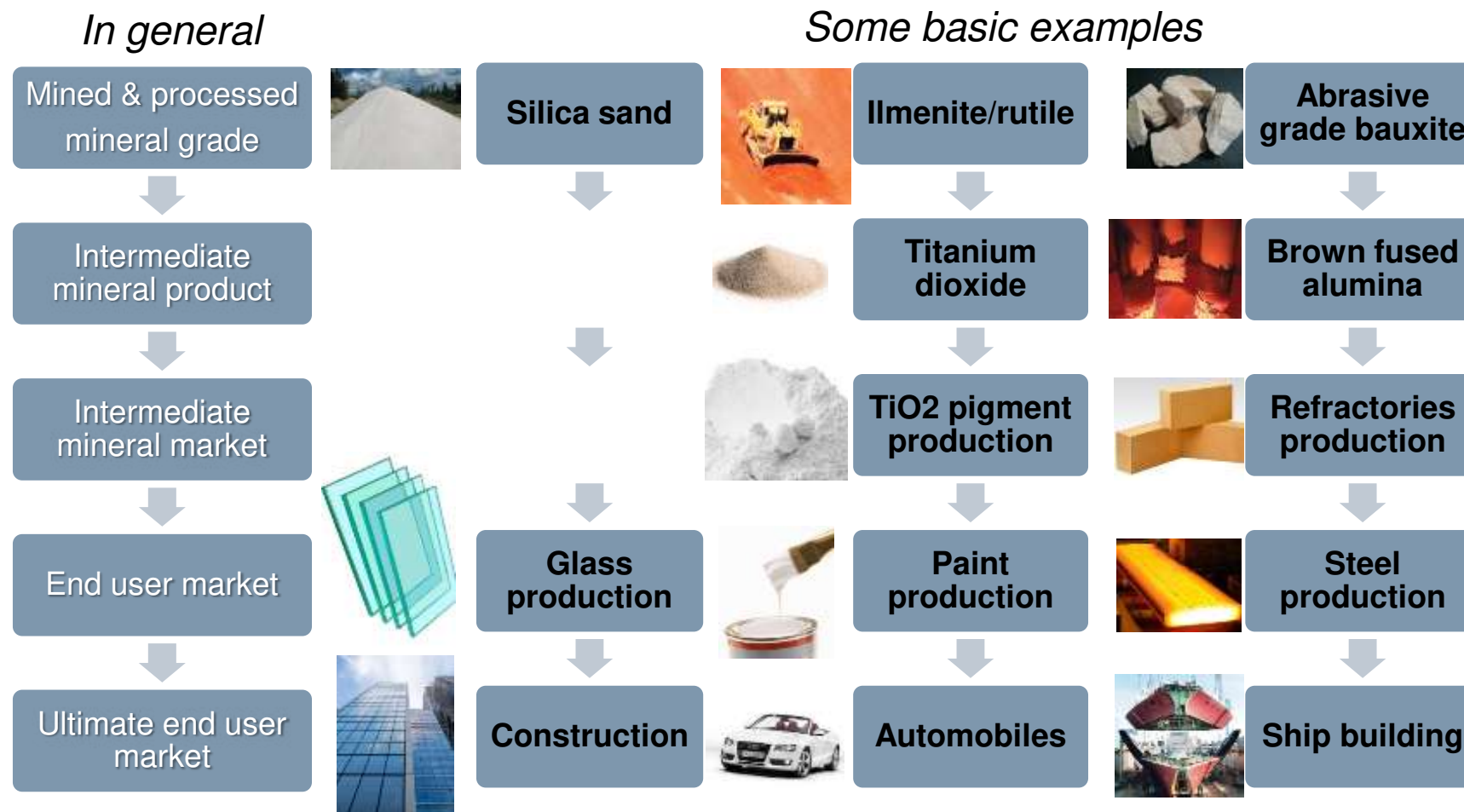


The World Wide Mineral Web!



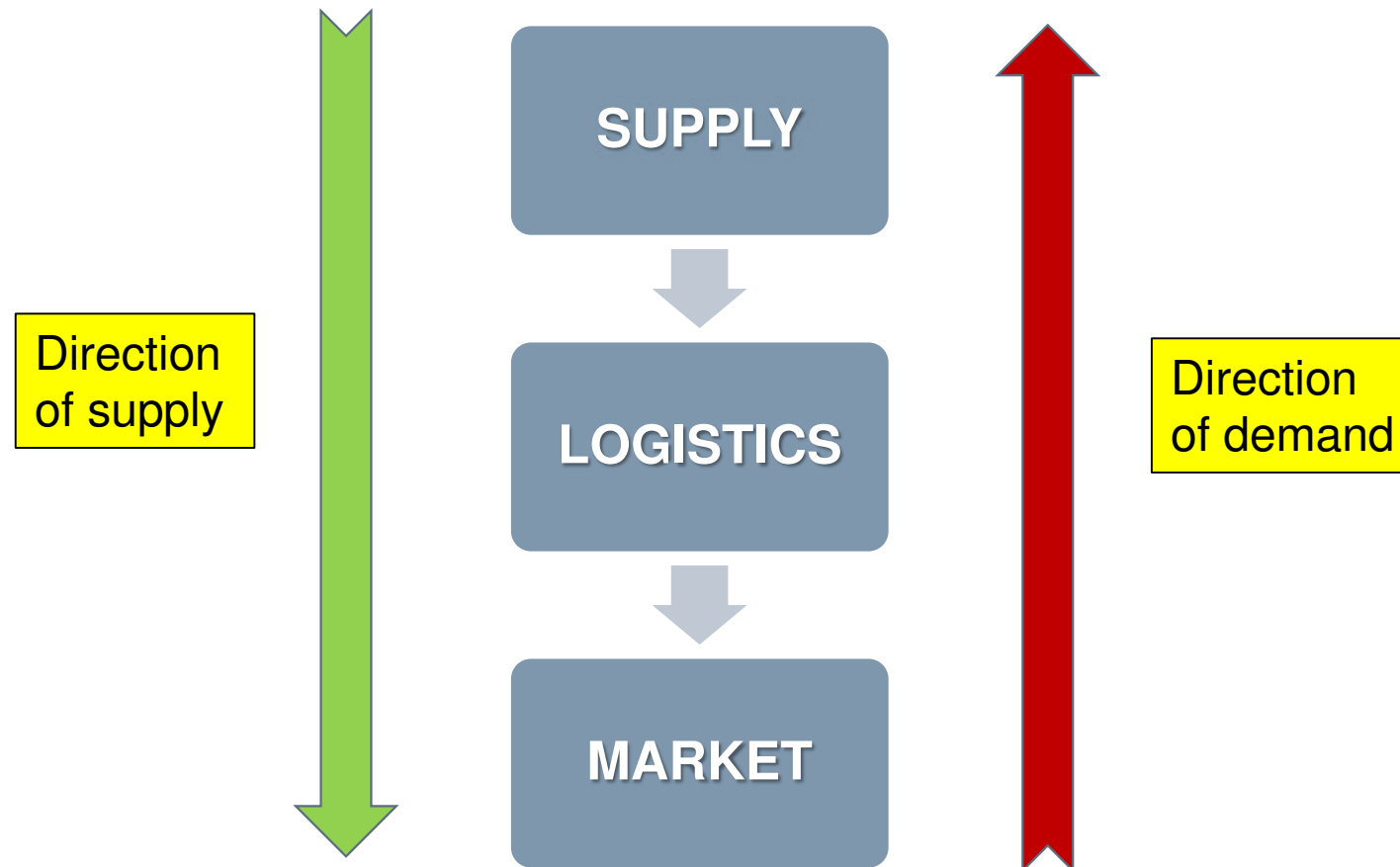
2. How is the market structured?

Based on the supply chain of the mineral from mine to market.



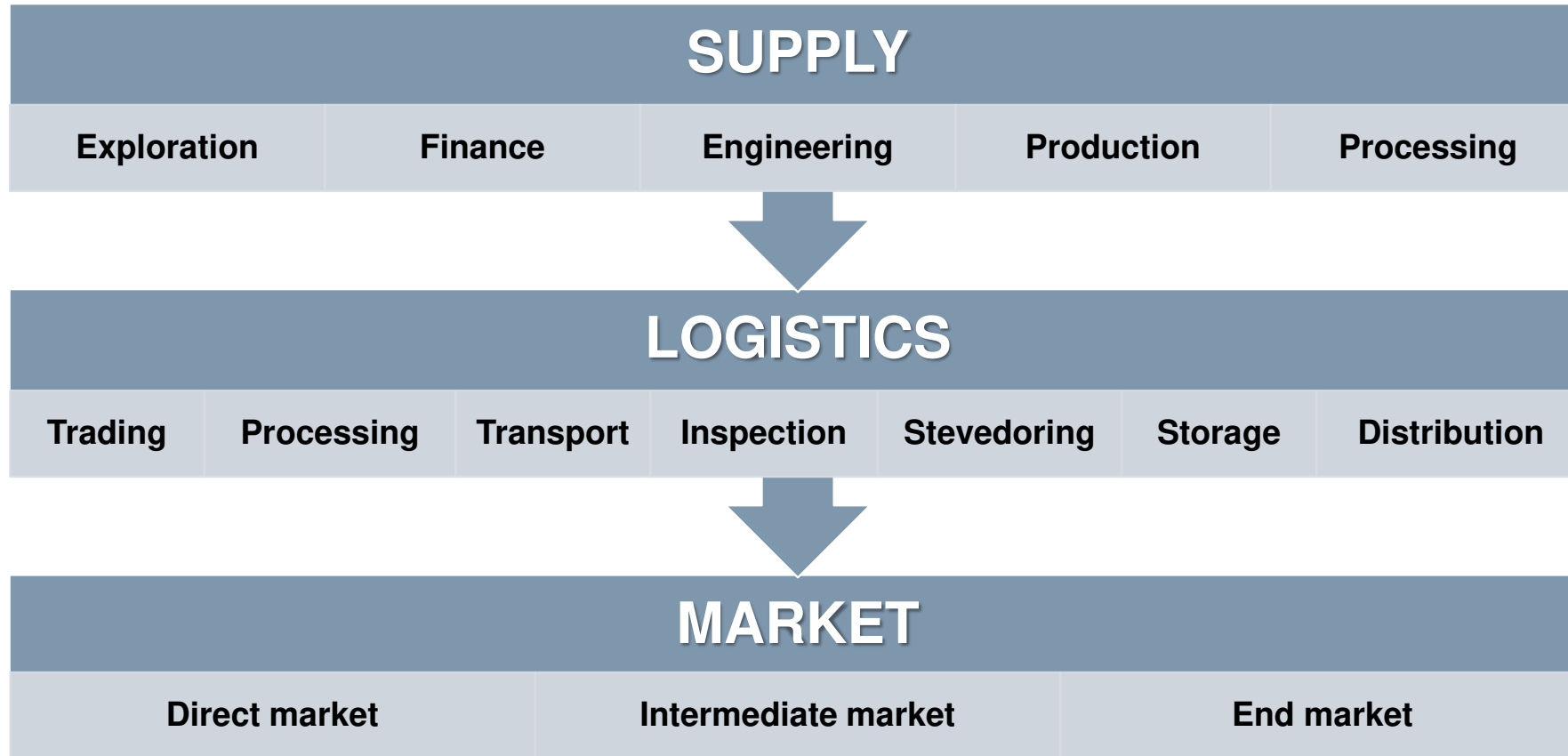
2. How is the market structured?

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.

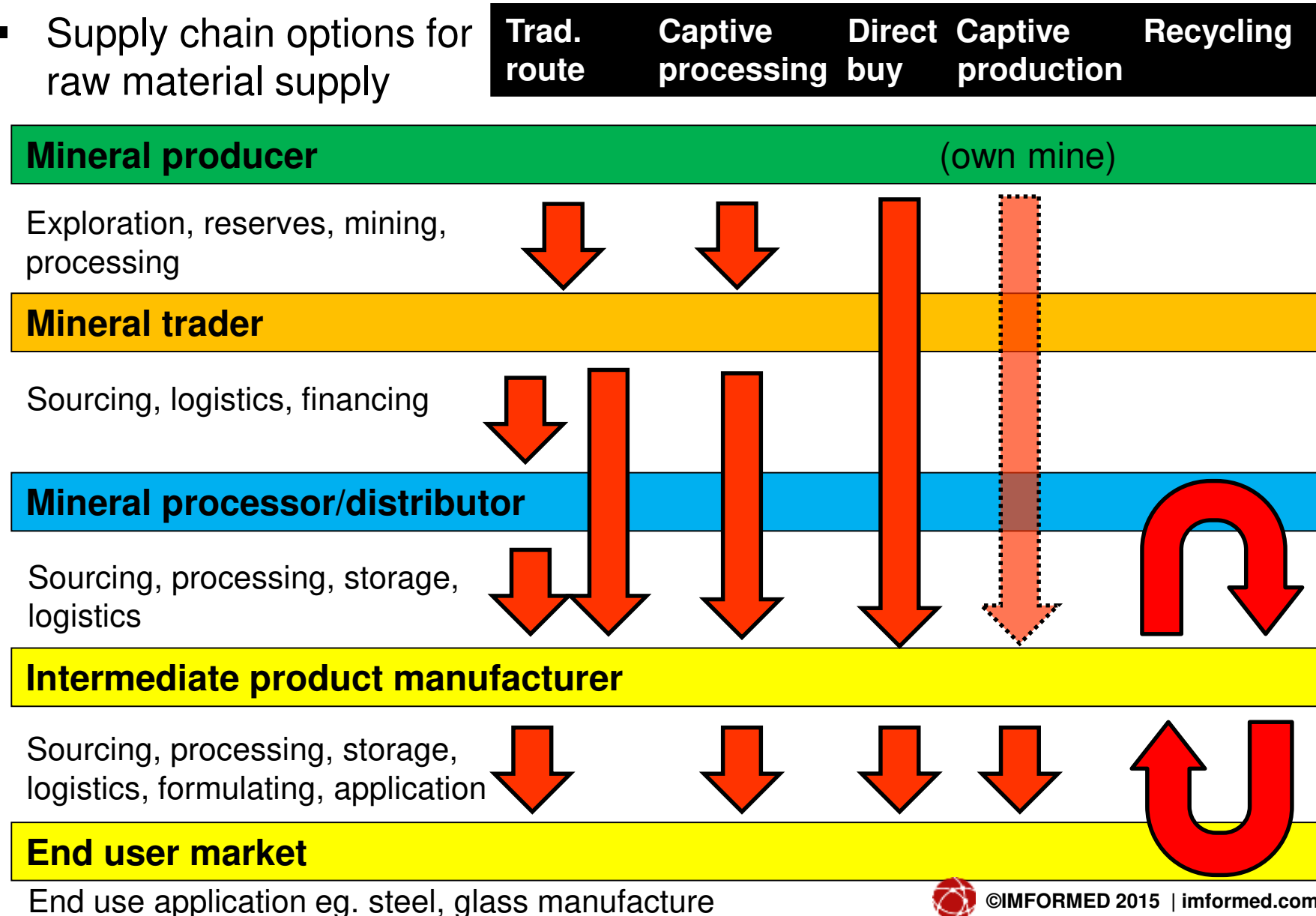


Each industrial mineral has its own specific supply chain characteristics



2. How is the market structured?

- Supply chain options for raw material supply



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.



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

Primary
demand
drivers

- 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

Key influencing factors

- 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



**Share of
global production**

Rare earths	97%
Refractory bauxite	95%
Fused magnesia	81%
Mica (scrap/flake)	69%
Flake graphite	61%
Wollastonite	59%
Brown fused alumina	55%
Silicon carbide	55%
Fluorspar	53%
Barytes	48%
Dead burned magnesia	44%
Talc	30%
Vermiculite	22%



3. How is the market driven?

Influencing factor example: Pricing

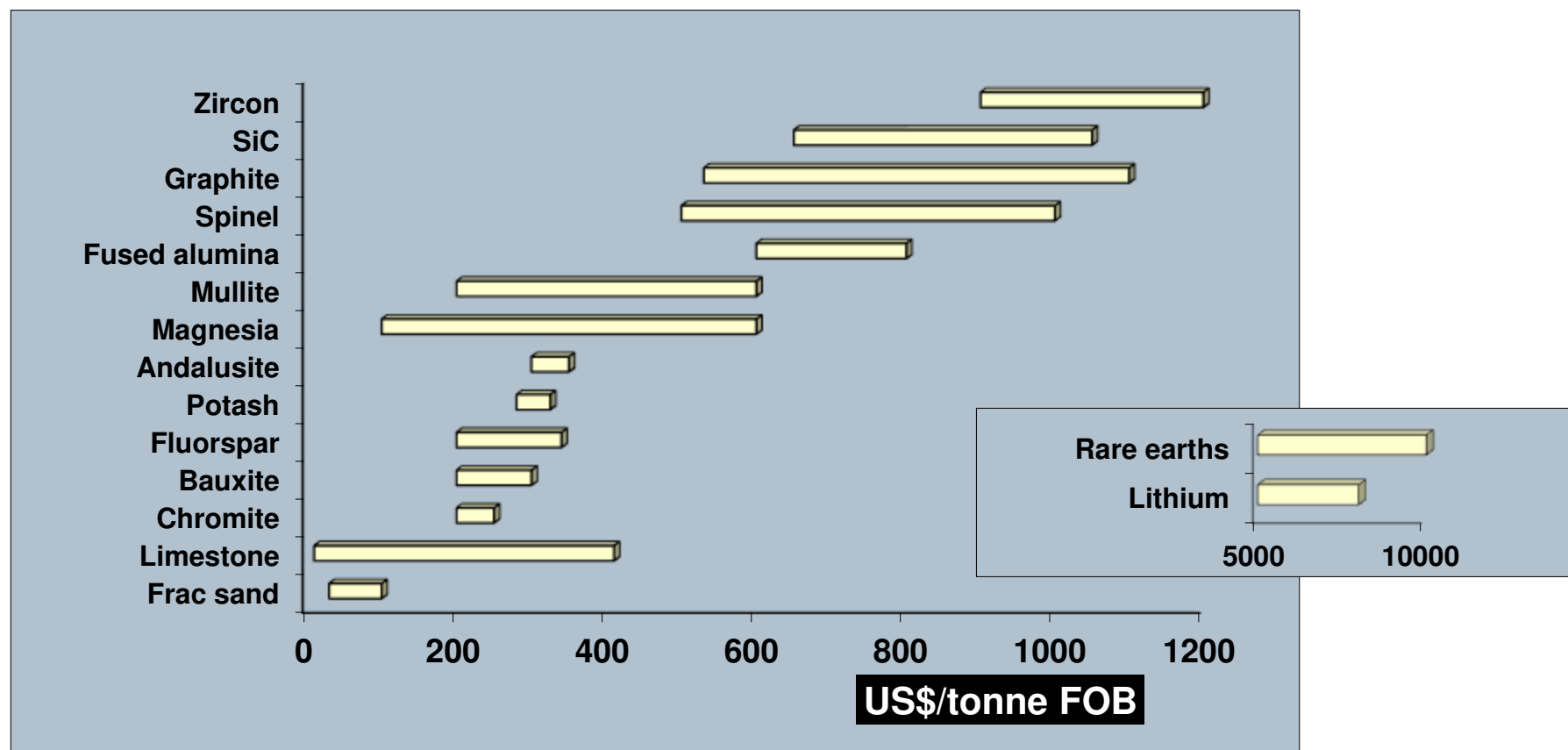
- Pricing is opaque, there is no exchange.
- Apart from a few minerals, there is no formal listing of prices.
- Pricing contracts are often long term
- Prices are influenced by a range of factors




3. How is the market driven?

Influencing factor example: Pricing

- Ball-park price ranges for industrial minerals

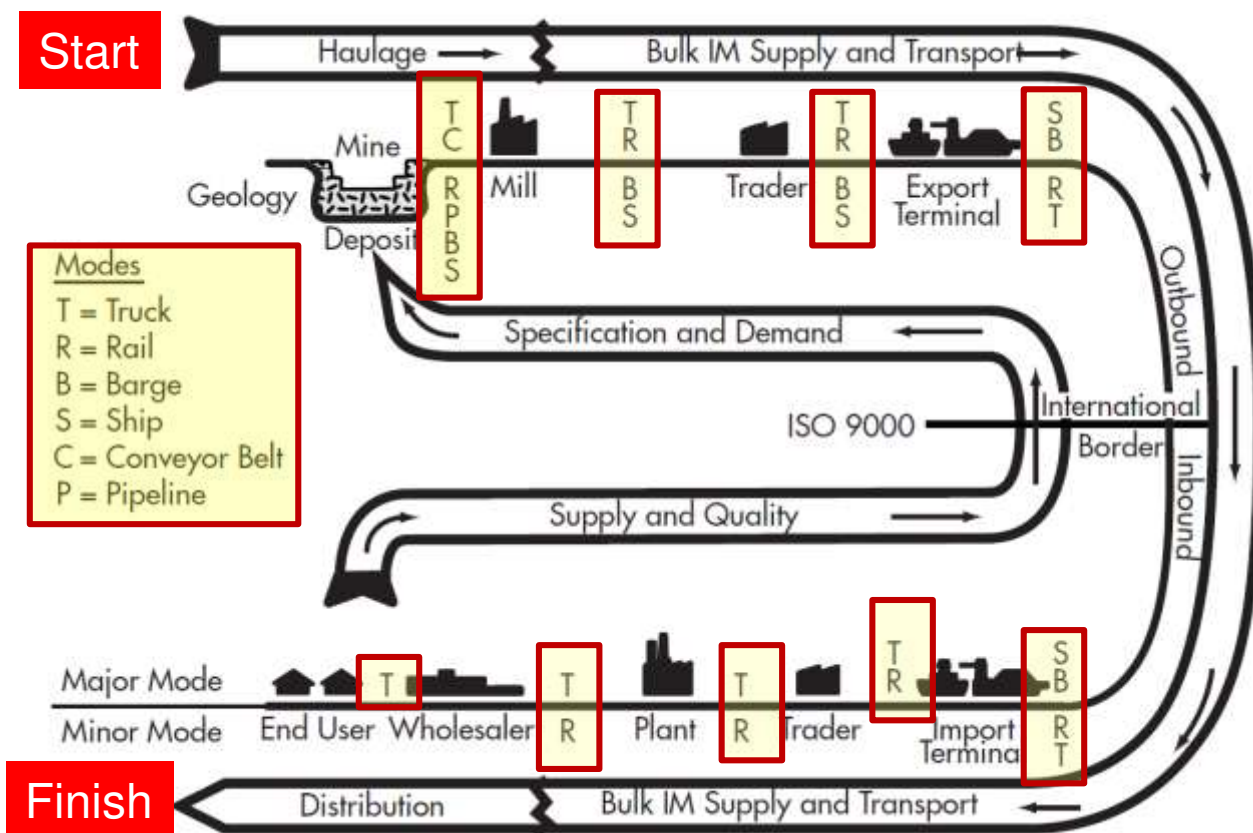


 Grade range per mineral; more processing = higher price

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.

3. Market drivers. Influencing factor example: Limited sources

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



4. Summary: Key Takeaways

Fundamentals of the industrial minerals market

High volume, low value commodities

Used in a wide variety of industrial and domestic uses = fragmented market

Of economic, sometimes strategic, importance, essential to modern industry & life

Certain industrial minerals have synergies and influence with metals markets

Minerals may be classified or grouped by the markets they serve, but...

Minerals supply multiple markets, each with different requirements and dynamics

Supply chain structure of three broad business tiers: supply, logistics, and market

Processing key to meet market specs, different markets require different grades

Logistics account for a large share of the final delivered price of the mineral

IMs are consumer market driven: no market = no demand = no mineral development

Market performance is influenced by primary economic drivers and specific factors

IM pricing is opaque, specific to markets and buyer/seller relationships



4. Summary: Factors influencing success

Reserves

- High quality, sufficient volume

Marketable grade

- Mineral must meet market specifications

Consistency

- In grade spec. and volume availability

Market demand

- Essential to have market & knowledge of it

Financing

- Funding for all aspects of project

Processing

- Ensure correct and complete process route

Logistics

- Secure optimum logistics system & routes

Flexibility

- Awareness to diversify products & markets



4. Summary: Potential investment indicators

Approach by mineral or by market

Typical opportunity indicators

Examples

New/growth markets by application

smart devices; Li-ion batteries; solar/wind power; fertiliser; plastics; fracking; insulation

New/growth markets by region

BRIC; N-11 (Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, Turkey, South Korea and Vietnam)

New/growth markets by evolution

recycling, Secondary Raw Materials

Limited developed mineral sources

andalusite; barite; bauxite; chromite; fluorspar; graphite; lithium; rare earths; zircon

Competition/Substitution

asbestos [graphite,wollastonite]; bauxite [andalusite]; bromine [magnesia]

World/Economic/Geopolitical events

China, Cuba, Iran, N. Korea; Afghan conflict, Fukushima accident, Olympic Games





Thank you for your attention

If you have any questions or comments about this briefing,
or would like more information, please contact me.



mike@imformed.com ▪ +44 (0)1372 450 679 ▪ mobile +44 (0)7985 986 255

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

MAG FORUM 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



enquiries@imformed.com ▪ +44 (0)1372 450 679 ▪ mobile +44 (0)7985 986 255