

**TZMI**

**CONGRESS 2013**

**WHERE THE WORLD'S TITANIUM  
AND ZIRCON INDUSTRIES MEET**

11-14 NOVEMBER / HONG KONG

# ***Outlook for Zirconium and Rare Earth Materials until 2020***

***Hong Kong  
November 2013***



**ALKANE**  
RESOURCES LTD

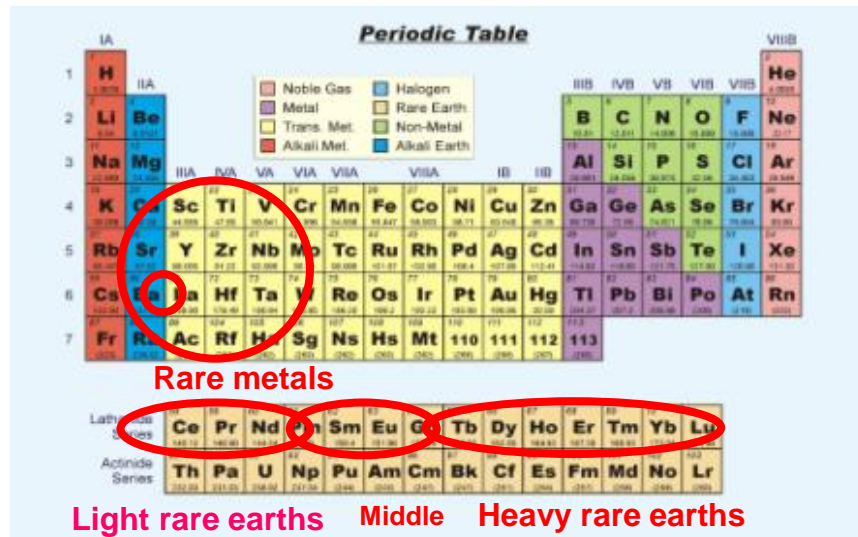
***Alister MacDonald -Technical Ceramic Marketing Services***

***Ian Chalmers – Alkane Resources Ltd***

## Rare Metals – Rare Earths

- China produces 90% of world downstream zirconium chemicals & 50% of fused zirconia
- China currently produces 80-90% of world REE output
- China is limiting the export of raw rare earths materials
- Brazil produces 90% of world niobium

**Periodic Table**



**Rare metals**

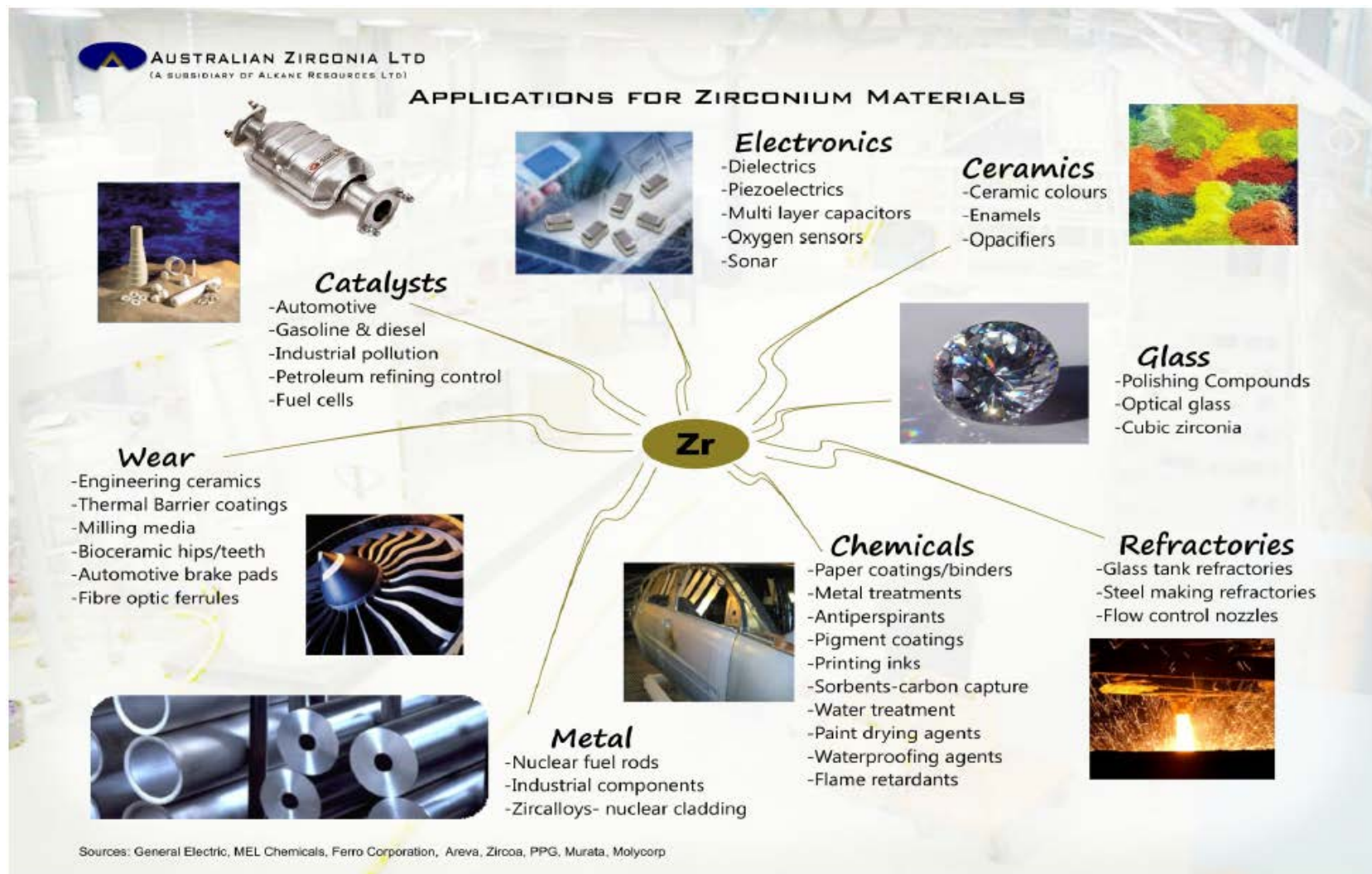
**Rare earths**

**Light rare earths**    **Middle**    **Heavy rare earths**



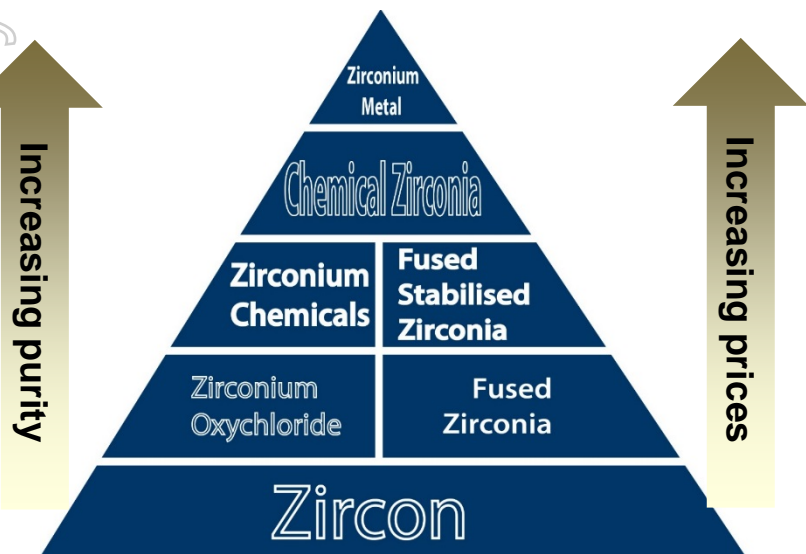
- ◆ **Green technology** is dependent on *rare metals and rare earths*
- ◆ **Increased demand** also driven by **changes in legislation**
- ◆ China has dominant position

*...not so rare, but increasingly valuable*

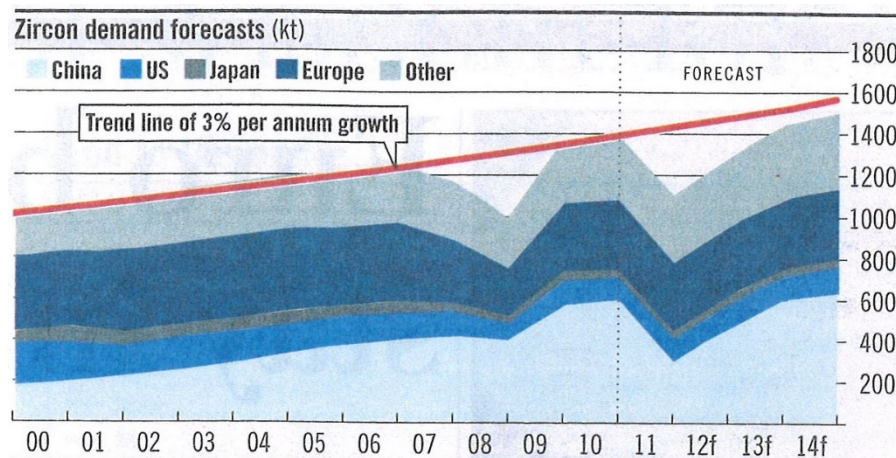
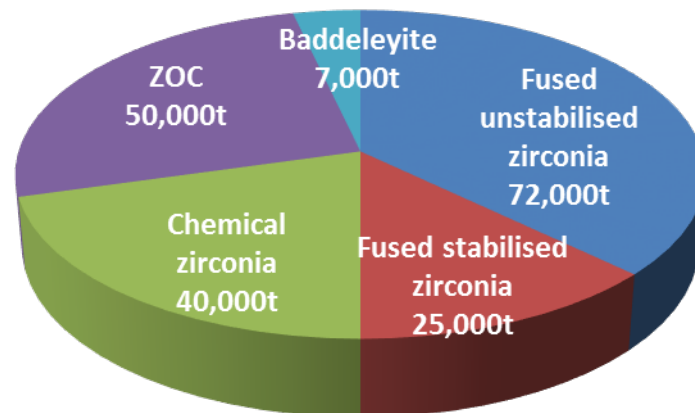


# Zirconium Industry

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**Zirconium Chemicals Output**  
 (2011 – 194,000t ZrO<sub>2</sub> basis CAGR 5-10%)



SOURCE: JPMORGAN

- Global market US\$3-4B
- Mid 2013 consumer zircon inventories running down
- Market expected to move back into under supply 2015 - 2016
- Prices starting to recover
- 18% - 20% zircon used in zirconium chemicals
- CAGR anticipated at 5% - 8% pa



# Zirconium Demand to 2020

<b><i>Zirconium materials (100% ZrO<sub>2</sub> basis)</i></b>	<b><i>2011 tpa</i></b>	<b><i>2012 tpa</i></b>	<b><i>2015f tpa</i></b>	<b><i>2020f tpa</i></b>	<b><i>2020f tpa</i></b>
Growth rate %/year			<b>7%</b>	<b>5%</b>	<b>7%</b>
Baddeleyite	7,000	6,000	8,000	8,000	8,000
Fused unstabilised zirconia	72,000	48,000	59,000	71,000	82,000
Fused stabilised zirconia	25,000	17,000	21,000	25,000	29,000
Chemical zirconia	40,000	27,000	33,000	40,000	46,000
Zirconium chemicals	50,000	43,000	53,000	64,000	74,000
<b>Total</b>	<b>194,000</b>	<b>141,000</b>	<b>174,000</b>	<b>208,000</b>	<b>239,000</b>
Zircon required (65% ZrO <sub>2</sub> )	300,000	217,000	268,000	320,000	368,000

- **21-25% of all zircon demand by 2020**  
 (48-72% increase from 2012)

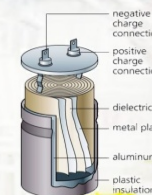
- **Availability of premium zircon for fused zirconia**
  - will require ~160-180,000t
  - low  $\text{Al}_2\text{O}_3$  with minimal particle size < 45 micron
  - availability of zircon with <300 ppm U+Th
- **Consolidation of Chinese fused and zirconium chemical industry**
- **Environmental and OH&S cost pressures**
- **Treatment of high U+Th residues for zirconium chemicals production**

**AUSTRALIAN ZIRCONIA LTD**  
(A SUBSIDIARY OF ALKANE RESOURCES LTD)

## APPLICATIONS FOR RARE EARTH MATERIALS

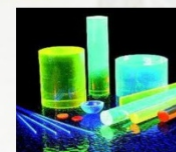
### Electronics

- Display phosphors (CRT, PDP, LCD)
- Medical imaging phosphors
- Lasers
- Fibre Optics
- Optical temperature sensors



### Ceramics

- Capacitors
- Sensors
- Colourants
- Scintillators
- Enamels
- Opacifiers



### Glass

- Optical glass
- Polishing compounds
- Thermal control mirrors
- Colourisers / Decolourisers
- Cubic zirconia



### Metal Alloys

- Hydrogen storage (NiMH batteries, Fuel cells)
- Superalloys
- Aluminum / Magnesium
- Lighter flints



## Rare Earths

### Magnets

- Electric motors
- Disk drives
- Power generation
- Actuators
- Microphones and Speakers
- Magnetic Resonance Imaging (MRI)
- Anti-lock brake systems
- Electric drive & propulsion
- Magnetic storage disk
- Microwave power tubes
- Magnetocaloric alloys
- Magnetostrictive alloys



### Catalysts

- Automotive catalytic converter
- Petroleum refining
- Diesel additives
- Chemical processing
- Industrial pollution scrubber



### Other

- Fluorescent lighting
- Water Treatment
- Pigments
- Fertilizer
- Medical Tracers
- Coatings

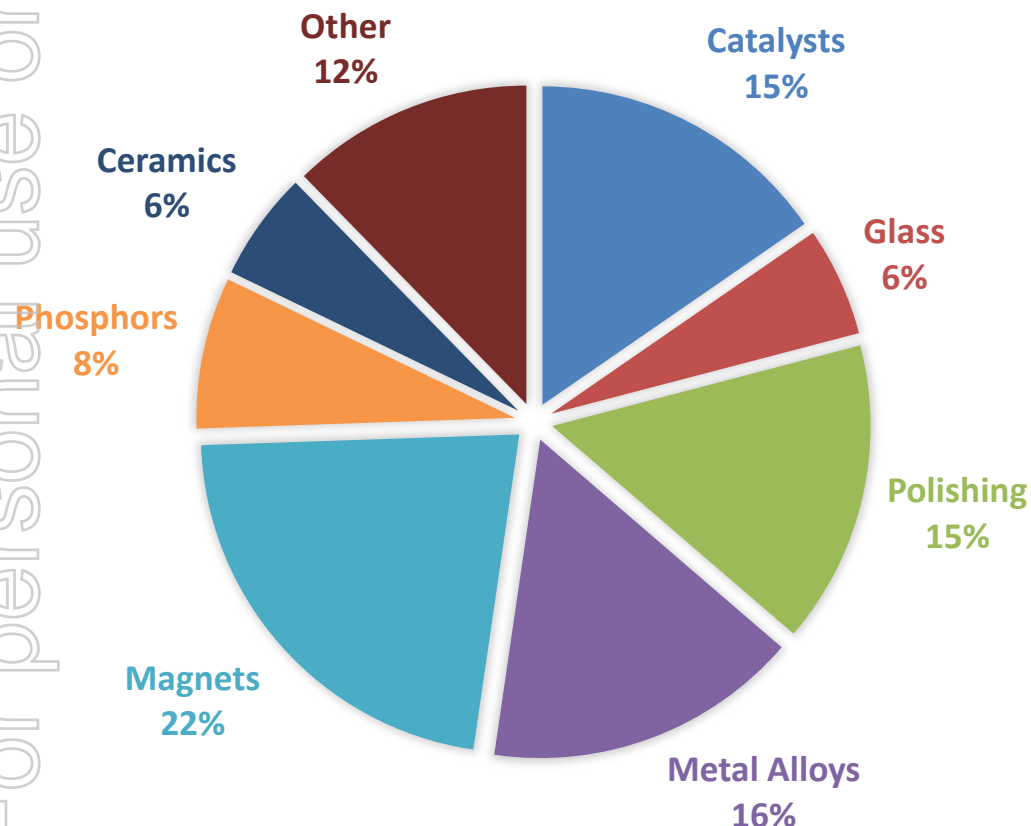


Sources: Google images, GM, Acer

- **Global Market 'Value': US\$3-5 B (US\$30-50/kg REO)**
- **Estimated global demand in 2013: 110-125,000t REO**
- **China dominant:**
  - producing 80-100% REO (80-90% of global supply)
    - almost 100% of heavy rare earths
  - consuming 80-90,000t REO (60-70% global demand)
- **Japanese consumption: 10-20,000t REO**
  - still replacing, reducing, and recycling
- **China: cutting production, stockpiling and consolidating**
  - up to 70% of heavy rare earths from illegal mining
- **Lynas and Molycorp adding ~30,000tpa of LREEs over 2-4 years**
- **China short of HREEs. ROW devoid of HREE production**



**REE DEMAND 2016**



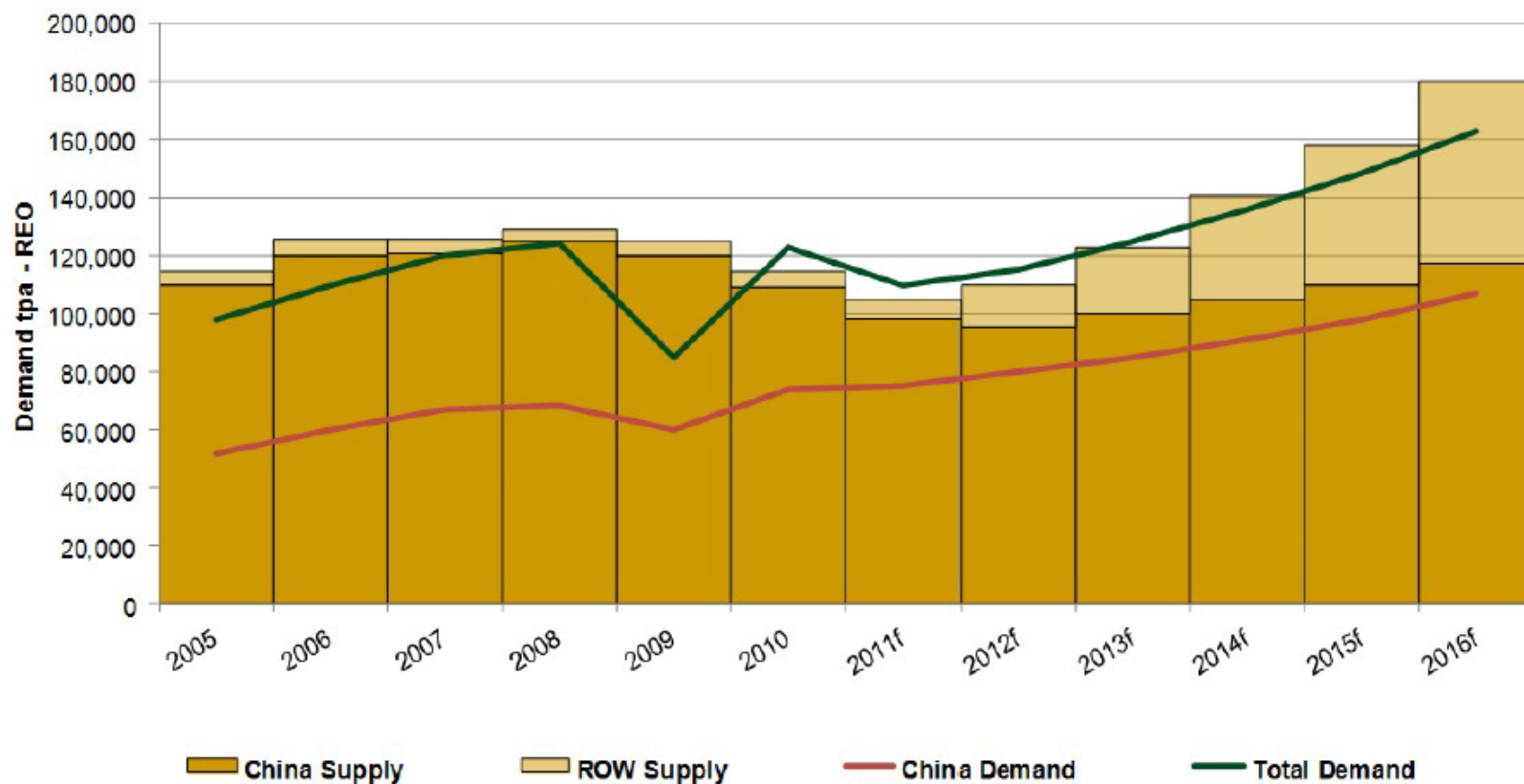
- Total REE consumption 2012 115,000t with annual growth estimated at 5-10% to be 162,000t in 2016
- China produces about 90% of world supply and consumed about 65%, with Japan 15% and the US 14%
- The REE industry is “imbalanced” with potential oversupply of light rare earths (Ce & La) and undersupply of heavy rare earths and neodymium
- Nd, Eu, Tb, Dy and Y are considered to be in critical supply through to at least 2020

**Market imbalanced but overall CAGR 6% - 12% seems likely by 2016**

## Forecast Supply and Demand for Selected Rare Earths in 2016

<u>Rare Earth Oxide</u>	<u>Demand @ 150-170,000tpa REO</u>	<u>Supply @ 180-210,000</u>
Cerium	50-70,000t REO	70-80,000t REO
Neodymium	30-35,000t REO	25-30,000t REO
Dysprosium	800-850t REO	1,000t REO
Terbium	450-500t REO	250-300t REO
Yttrium	9-10,000t REO	7-8,000t REO

# REE Industry Supply/Demand



- **Demand in 2020: 200-240,000 tpa REO**
- **Demand trends:**
  - Greater availability of non- Chinese products
  - Greater total supply chain management
  - Higher consumption of HREEs if available
- **Supply in 2020: 240-280,000 tpa REO**
- **Supply trends:**
  - Limited scope for pure LREE projects outside China
  - Significant opportunity for HREE projects as availability of HREEs will remain an issue
  - Ongoing consolidation of industry worldwide



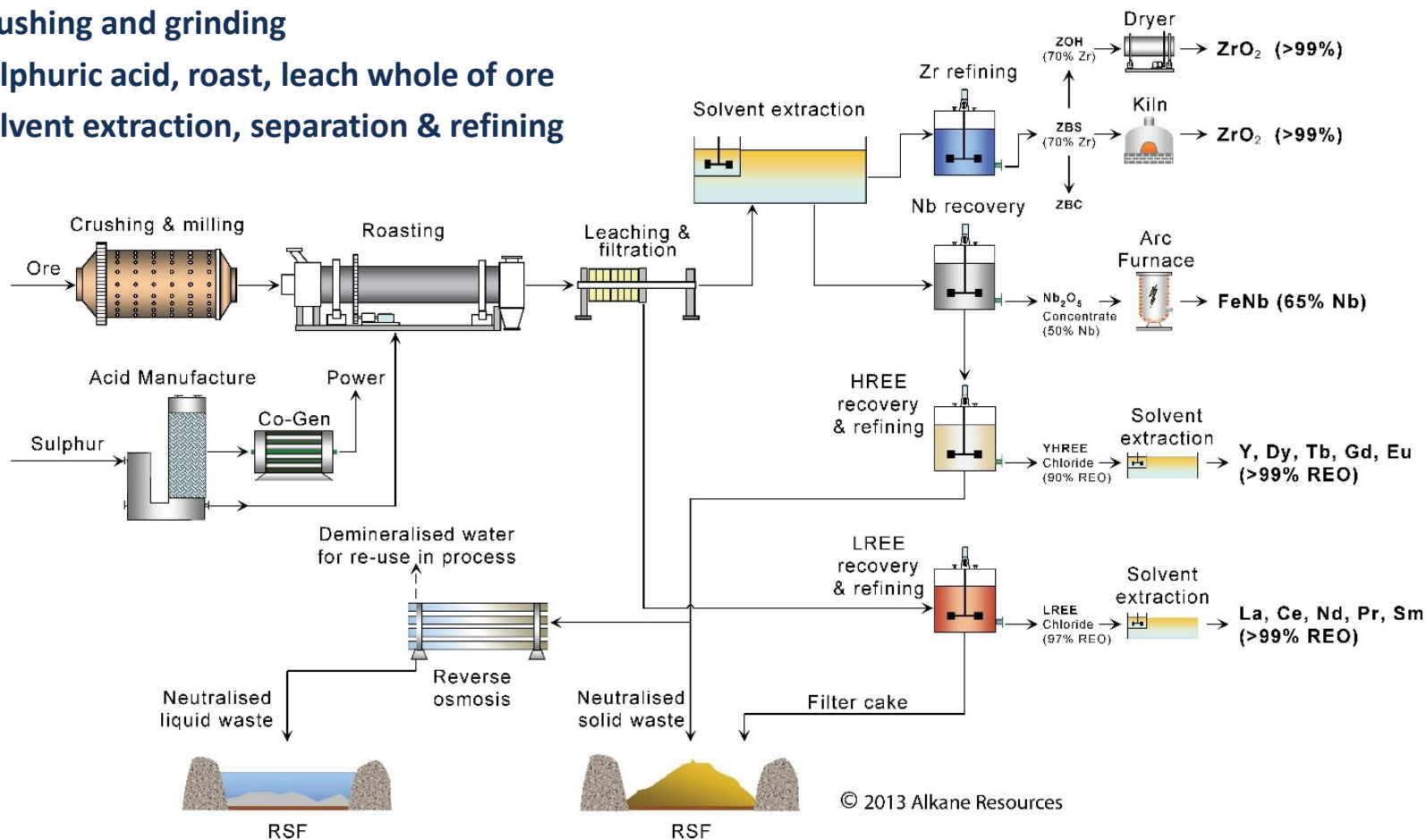
# The Dubbo Zirconia Project

- A very large\* polymetallic resource of the metals zirconium (hafnium), niobium (tantalum), yttrium and rare earths
- Important and strategic metal mix, including 25% heavy rare earth
- Open pit life of at least 70 years
- Demonstrated flow sheet with pilot plant and products for market evaluation
- Robust technical and financial feasibility completed
- Strong market interest in products
- Growing and diverse markets

\*resource and reserve statement appended



- Simple open cut mining operation
- Crushing and grinding
- Sulphuric acid, roast, leach whole of ore
- Solvent extraction, separation & refining







DPP Filtration, PLS, SX, Zr and Nb recovery



Y and HREE refining and recovery

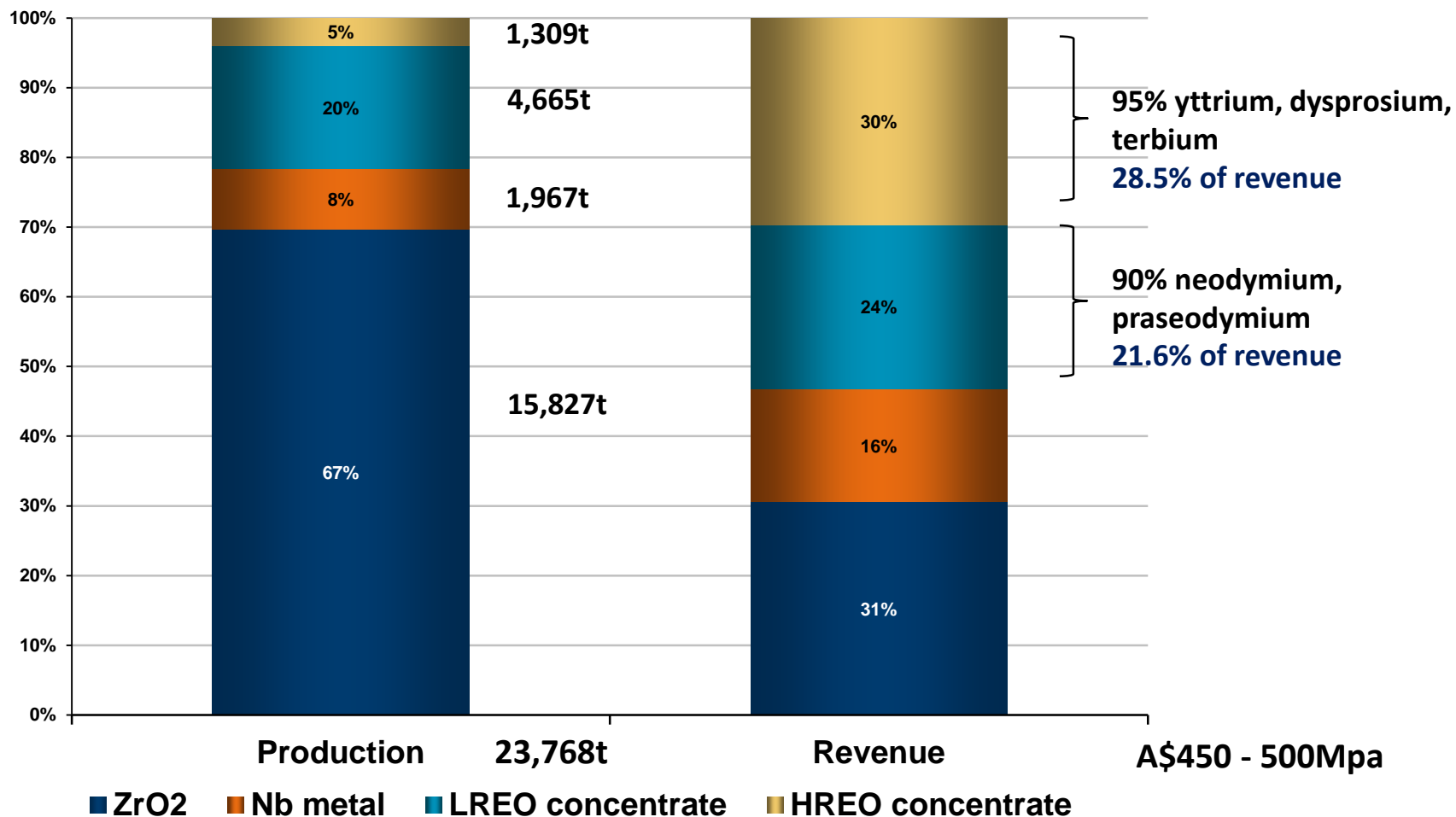


Zirconium refining and precipitation



Reverse osmosis and water recycle

# Product Output @ 1Mtpa





## AZL MoU's and Agreements to secure 100% of output



### Zirconium (Zr)

- Leading chemical company to develop applications and markets in Asia for zirconia produced by DZP
- European manufacturer/trading company to market DZP products in Europe and North America
- Ceramic colours laboratory developed in Perth to produce test products for ceramic tile industry

### Niobium (Nb)

- JV with European Treibacher Industrie AG to produce and market ferro-niobium
- Test work for tantalum recovery

### Light rare earths Heavy rare earths

- Japan's Shin-Etsu Chemical toll treatment JV for separation and sale

# DZP Major Milestones

Major Milestones	2013	2014	2015	2016
Environmental Impact Statement	■ ■			
Project Approval Process		■ ■ ■ ■		
Project Financing Program	■ ■ ■ ■	■ ■		
EPC / EPCM tender → award		■ ■ ■		
Detailed design / Long lead orders		■ ■ ■ ■		
CONSTRUCTION			■ ■ ■ ■ ■ ■ ■ ■	■
PRODUCTION				■ ■ ■ ■ ■ ■ ■ ■

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## Competent Person

The information in this presentation that relates to mineral exploration, mineral resources and ore reserves is based on information compiled by Mr D I Chalmers, FAusIMM, FAIG, (director of the Company) has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as Competent Person as defined in the 2004 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. Ian Chalmers consents to the inclusion in the presentation of the matters based on his information in the form and context in which it appears.



## Dubbo Zirconia Project – Mineral Resources

Toongi Deposit	Tonnage (Mt)	ZrO <sub>2</sub> (%)	HfO <sub>2</sub> (%)	Nb <sub>2</sub> O <sub>5</sub> (%)	Ta <sub>2</sub> O <sub>5</sub> (%)	Y <sub>2</sub> O <sub>3</sub> (%)	REO (%)
Measured	35.70	1.96	0.04	0.46	0.03	0.14	0.75
Inferred	37.50	1.96	0.04	0.46	0.03	0.14	0.75
<b>Total</b>	<b>73.20</b>	<b>1.96</b>	<b>0.04</b>	<b>0.46</b>	<b>0.03</b>	<b>0.14</b>	<b>0.75</b>

These Mineral Resources are based upon information compiled by Mr Terry Ransted MAusIMM (Alkane Chief Geologist) who is a competent person as defined in the 2004 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. Terry Ransted consents to the inclusion in the report of the matters based on his information in the form and context in which it appears. The full details of methodology were given in the 2004 Annual Report.

## Dubbo Zirconia Project – Ore Reserves

Toongi Deposit	Tonnage (Mt)	ZrO <sub>2</sub> (%)	HfO <sub>2</sub> (%)	Nb <sub>2</sub> O <sub>5</sub> (%)	Ta <sub>2</sub> O <sub>5</sub> (%)	Y <sub>2</sub> O <sub>3</sub> (%)	REO (%)
Proved	8.07	1.91	0.04	0.46	0.03	0.14	0.75
Probable	27.86	1.93	0.04	0.46	0.03	0.14	0.74
<b>Total</b>	<b>35.93</b>	<b>1.93</b>	<b>0.04</b>	<b>0.46</b>	<b>0.03</b>	<b>0.14</b>	<b>0.74</b>

These Ore Reserves are based upon information compiled by Mr Terry Ransted MAusIMM (Alkane Chief Geologist) who is a competent person as defined in the 2004 Edition of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. The reserves were calculated at a 1.5% combined ZrO<sub>2</sub>+Nb<sub>2</sub>O<sub>5</sub>+Y<sub>2</sub>O<sub>3</sub>+REO cut off using costs and revenues defined in the notes in ASX Announcement of 16 November 2011. Terry Ransted consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.