Bauxite & alumina 2015 – Non-metallurgical market review

Dr Richard Flook – Managing Principal Mosman Resources
Summary

"The world has changed, it is a very difficult market out there,“
“It's the end of the world as we know it...again”
Agenda

- Applications of bauxite and alumina
- Non metallurgical bauxite
- Chemical grade alumina
  - Specialty Calcined Alumina
  - Alumina Trihydrate
- Refractory market
- Ceramic Proppants
Applications of bauxite and alumina

Figure 1. Aluminum industry flow diagram

Source: Redrawn from Hill & Sehnke 2007
Bauxite and alumina- metal view

Figure 1. Aluminum industry flow diagram

Source: Redrawn from Hill & Sehnke 2007
Bauxite and alumina - industrial mineral view

Figure 1. Aluminum industry flow diagram

Source: Redrawn from Hill & Sehnke 2007
Bauxite & Alumina Flowchart 2014

Metallurgical
~240 M tpa

Smelter grade
alumina
102 M tpa

Aluminium
53 M tpa (52% China)

Bauxite
~ 250 M tpa

Chemical grade
alumina
6.2 M tpa

Calcined alumina
Fused alumina
Tabular alumina
Alumina cement
Alumina chemicals

Non metallurgical
~11.5 M tpa

Abrasives
Other

Other alumina sources

Brown fused alumina
Calcined bauxite
Alumina cement
Portland cement
Ceramic proppants

95%
94%
6%
5%

Source: USGS, IAI 2014
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- Ceramic Proppants
Non metallurgical bauxite markets

Non metallurgical bauxite ~7.1 M tpa (Al₂O₃)

Source: Author estimates, Aluminium SA, Ted Dickson
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Non metallurgical calcined alumina markets

- Calcined Alumina-Refractory (27%)
- Calcined Alumina-Ceramics & Catalysts (45%)
- Calcined Alumina-Abrasives & polishing (11%)
- Alumina Trihydrate-Chemical (10%)
- Alumina Trihydrate-Specialty (7%)

Chemical grade alumina 6.2 M tpa (Al$_2$O$_3$)

Source: Almatis, Nabaltec, ZXR & IHS 2015
Calcined alumina grades & derivatives

- Standard Calcined Alumina: 29%
- Tabular Alumina: 8%
- White Fused Alumina: 7%
- Special Grade Alumina: 9%
- High Alumina Cement: 12%
- Medium Soda: 5%
- Low Soda: 4%
- Spinel: 3%
- Reactives: 3%
- High Purity Alumina (HPA): 2.8 M tpa Al₂O₃

Source: Almatis 2015
Alumina Trihydrate grades & derivatives

- Aluminium Sulphate: 33%
- Aluminium Chloride: 12%
- Flame Retardants: 15%
- Zeolite: 11%
- Aluminium Fluoride: 7%
- Other aluminium chemicals: 15%
- Aluminates: 15%
- Other filler: 2%

Alumina trihydrate 3.4 M tpa Al₂O₃

Source: Nabaltec, ZXR, IHS 2015
Non metallurgical bauxite & alumina markets

Non metallurgical bauxite & alumina ~13.3 M tpa (Al$_2$O$_3$)

Source: Author estimates
Water Treatment – discussed in 2015

- **Global Water Treatment Chemical Market**
  - Corrosion Inhibitors (22%)
  - Organic Flocculants (17%)
  - Scale Inhibitors (14%)
  - **Inorganic Coagulants (13%)** (aluminium chemicals and ferric chloride)
  - Oxidisers & Biocides (10%)
  - PH adjusters (5%)
  - Others (19%)

- **Global Market ~US$26 billion**
  - Asia Pacific ~46% of global market
  - Americas ~27% of global market
  - Europe ~23% of global market
  - Market growth ~6% CAGR to 2019

- **Main Markets**
  - Industrial Water (62%)
  - Potable Water (20%)
  - Waste Water (18%)

- **Aluminum Sulfate / Polyaluminum Chloride (PAC)**
Abrasives- discussed in 2014

- **Five Categories** *(FEPA)*
  - Bonded abrasives
  - Coated & non-woven abrasives
  - Precision super-abrasives-diamond & cubic boron nitride (CBN)
  - Super-abrasives for stone and construction
  - Grains

- **Global Market** ~US$40 billion (~16 million tonnes)
  - Asia Pacific ~55% of global market
  - Europe ~20% of global market
  - Market growth ~6% CAGR to 2019

- **Main Markets**
  - machinery
  - metal fabrication
  - Transportation

- **Main alumina products are BFA & WFA**
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Non metallurgical bauxite & alumina markets

Non metallurgical bauxite & alumina ~13.3 M tpa \((\text{Al}_2\text{O}_3)\)

Source: Author estimates
What drives the refractory market?

- Steel - 67%
- Cement & lime - 13%
- Other - 20%

(mineral processing, glass, ceramics etc)

Which in turn are driven by
- Construction - 50%
- Automobiles - 15%
- Other - 35%

(machinery, engineering etc)

China produces 65% of the world’s refractories
World GDP & Steel and Cement Production

> 97% correlation

Source: World Bank, USGS & WSA
Global Growth-short term

...downside risks to the world economy appear more pronounced than they did just a few months ago.

1. Prospects for World GDP Growth\(^1\) (Percent change)

- WEO baseline
- 90 percent confidence interval
- 70 percent confidence interval
- 50 percent confidence interval
- 90 percent confidence interval from April 2015 WEO

Source: IMF WEO October 2015
## Global Growth-long term

<table>
<thead>
<tr>
<th>Rank</th>
<th>1870</th>
<th>2014</th>
<th>2030</th>
<th>2050</th>
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<tr>
<td>1</td>
<td>China</td>
<td>China</td>
<td>China</td>
<td>China</td>
</tr>
<tr>
<td>2</td>
<td>India</td>
<td>USA</td>
<td>USA</td>
<td>India</td>
</tr>
<tr>
<td>3</td>
<td>UK</td>
<td>India</td>
<td>India</td>
<td>USA</td>
</tr>
<tr>
<td>4</td>
<td>USA</td>
<td>Japan</td>
<td>Japan</td>
<td>Indonesia</td>
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<td>5</td>
<td>Germany</td>
<td>Germany</td>
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<td>Brazil</td>
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<tr>
<td>6</td>
<td>France</td>
<td>Russia</td>
<td>Brazil</td>
<td>Mexico</td>
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<tr>
<td>7</td>
<td>Italy</td>
<td>Brazil</td>
<td>Russia</td>
<td>Japan</td>
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<tr>
<td>8</td>
<td>Japan</td>
<td>France</td>
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<tr>
<td>10</td>
<td>Indonesia</td>
<td>UK</td>
<td>UK</td>
<td>Germany</td>
</tr>
</tbody>
</table>

GDP by PPP(purchasing power parity) rankings

Source: HSBC 2012 & PWC 2015
World Steel Production 2014

North America: 121 million tons

Brazil: 34 million tons

Europe: 169 million tons

Russia: 71 million tons

All other: 135 million tpa

Asia total 1132 million tons: 68% of world total

South Korea: 71 million tons

China: 823 million tons

Japan: 111 million tons

India: 83 million tons

World total 1662 million tons

Source: World Steel Association
Steel Outlook 2015 (April 2015)

- NAFTA: -0.9%
- Europe: 2.1% to 2.8%
- CIS: -7.3%
- Asia & Oceania: 0.6%
- Middle East & Africa: 2.8% to 7.3%
- Central & Southern America: -3.4%

World: Growth rate 0.5% 2015; 1.4% 2016

Source: World Steel Association April 2015
Steel-actual after 7 months 2015

NAFTA: -6.7%

Europe: -0.5%

CIS: -7.2%

Middle East & Africa: 1.8%

Asia & Oceania: -1.7%

Central & Southern America: -0.3%

Above 7 months 2014

Below 7 months 2014

World: Growth rate -2.1% 7 months 2015

Capacity utilisation 68.4%, -4.2 percentage points below July 2014.

Source: World Steel Association August 2015
China Steel Company Profitability

% Profit Margin of China Large-medium Sized Steel Enterprises

Source: CISA, www.mysteel.net
Steel dumping cases - Arrium Australia

<table>
<thead>
<tr>
<th>Export countries</th>
<th>Hot-Rolled Structural</th>
<th>Rod in Coil (Wire Rod for Mesh)</th>
<th>Rod in Coil (Wire Rod for Mesh)</th>
<th>Rebar</th>
<th>Rebar</th>
<th>Hollow Structural Sections</th>
<th>Hollow Structural Sections (anti-circumvention inquiry)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Korea, Taiwan, Thailand, Japan</td>
<td>Indonesia, Taiwan, Turkey</td>
<td>China</td>
<td>Korea, Malaysia, Singapore, Spain, Thailand, Turkey, Taiwan</td>
<td>China</td>
<td>Thailand</td>
<td>China, Korea, Malaysia</td>
</tr>
<tr>
<td>Investigation initiated</td>
<td>24 Oct 13</td>
<td>10 Apr 14</td>
<td>12 Aug 15</td>
<td>17 Oct 14</td>
<td>1 Jul 15</td>
<td>21 Jul 14</td>
<td>11 May 15</td>
</tr>
<tr>
<td>Preliminary measures (securities)</td>
<td>Up to ~20% (Mar 14)</td>
<td>Up to ~10% (Mar 15)</td>
<td>(Mar 15)</td>
<td>To be confirmed</td>
<td>To be confirmed</td>
<td>12% to 31% (Mar 15)</td>
<td>To be confirmed</td>
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<tr>
<td>Final measures</td>
<td>(imposed revised Aug 15 following appeal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Due by Nov 15</td>
<td></td>
</tr>
<tr>
<td>% Manufacturing product base</td>
<td>~15%</td>
<td>~15%</td>
<td>~35%</td>
<td></td>
<td></td>
<td>&gt;95% ATM</td>
<td></td>
</tr>
</tbody>
</table>

“China Steel Flood” - China has 400 million tonnes (MT) of surplus capacity

- Further anti-dumping applications being evaluated

Source: Arrium 2015
World Cement Production 2014

United States: 83 million tons
Brazil: 72 million tons

Turkey: 75 million tons
Iran: 75 million tons

Egypt: 50 million tons

Saudi Arabia: 63 million tons
All other: 687 million tpa

Russia: 69 million tons

China: 2500 million tons
Japan: 58 million tons
South Korea: 48 million tons

India: 280 million tons

Indonesia: 60 million tons
Vietnam: 60 million tons

Asia total 3250 million tons: 78% of world total

World total 4180 million tons

Source: USGS & author estimates
Cement Outlook 2015 (February 2015)

North America: 3 to 6%
Western Europe: 0 to 3%
Central & Eastern Europe: -2 to 1%
Asia: 4 to 7%
Middle East & Africa: 5 to 8%
Latin America: 0 to 3%

World: Growth rate 2 to 5%

Source: Lafarge 2015
Cement Outlook 2015 (July 2015)

North America: 3 to 6%

Western Europe: -1 to 2%
  Down 1%

Central & Eastern Europe: -2 to 1%
  Down 2%

Asia: 2 to 5%
  Down 2%

Middle East & Africa: 3 to 6%
  Down 2%

Latin America: -10 to -7%
  Down 10%

World: Growth rate 1 to 4%
  Down 1%

Source: Lafarge 2015
Cement Outlook 2015 (July 2015)

North America: 3 to 6%

Western Europe: -1 to 2%
- Down 1%

Central & Eastern Europe: -2 to 1%
- Down 2%

Asia: 2 to 5%
- Down 2%

Middle East & Africa: 3 to 6%
- Down 2%

Latin America: -10 to -7%
- Down 10%

China actual production down 6% (H1)
- Down 1%

World: Growth rate 1 to 4%
- Down 1%

However these downgraded forecasts may be still too optimistic

Source: Lafarge 2015, China NBS & Roskill
World Cement - structural change

- **Mergers**
  - Merger of Lafarge and Holcim to form world’s largest producer
  - Heidelberg bid for Italcementi

- **Expansions**
  - Dangote expanding in Africa (Mali, Kenya, Zambia, Senegal, Ethiopia, Cameroon, Niger and Nepal using Chinese plants from Simona)
  - CRH picking up assets (spending $7.5 B)
  - Chinese global investments and equipment
  - US cement consumption still expected to increase 7.5% 2015 and 7.9% 2016

- **Postponements**
  - Semen Indonesia to halt 2015 expansion plans & Egypt postpones new cement plant

- **Cost reduction**
  - Cemex selling assets to reduce debt
  - Holcim to burn shoes to create cement in Vietnam

- **Global** cement plant utilisation~60 %, only about 50 % in China
- “Zombie” cement factories of China
China Refractory Trends 2000-14

1) Decreasing specific consumption
2) Increased % monolithic

Source: The Association of China’s Refractories Industry
China Steel Production Forecasts

"The world’s largest steel industry is entering a turning point," CISA 2015

China Steel Production (Million tonnes, LHS)

Change (%YoY, RHS)

Source: World Steel Association, UBS 2015
Refractory outlook 1

- **China steel production** was expected to increase to about 1-1.2 billion tonnes - now expected to peak at about 850 M tpa in 2020 (although BHP Billiton are still predicting 0.935-0.985M tpa, Aug 2014)

- **China steel consumption** to grow marginally from 710 M tpa in 2014 to 720 M tpa in 2015 and peak at 740 M tpa in 2017 before declining to 630 M tpa by 2025 & 567 M tpa by 2030

- **China refractory steel specific consumption** was about 30/Kg steel in 2000 and is expected to reach about 13Kg/t steel by 2020

- Deutsche Bank expects **property-related cement demand** will contract by 10% in China in 2015. Demand linked to **infrastructure** projects however may increase by 12%, boosted by China’s silk road project.

- **China refractory production** is expected to decline from 29 M tpa in 2013 to 26 M tpa by 2017 (CAGR -3%)

Source: The Association of China’s Refractories Industry, BHP Billiton, China Metallurgical Industry Planning Association & Author estimates
Refractory outlook 2

- “Peak” world refractories has arrived.
- World refractories consumption of 36.85Mt in 2014
- World consumption is forecast to decline by -1.1%pa to 2020
- Decrease of 1.4% pa in steel refractories and decrease of 0.8% pa in cement & lime refractories
- World refractory consumption of 34.55Mt in 2020
Refractory Alumina-mixed outlook

- **World refractory consumption** is declining **BUT**...
- **Higher quality steels** in China will require higher performance refractories
- China will continue to **increase monolithic** refractory production as % of total refractory production
- **Alumina products** are mainly used in steel (73%) and cement (13%) production
- **Developing steel producers** (China and India) use about 0.5Kg of Al\(_2\)O\(_3\) per tonne of steel compared to 1.2 – 1.5 Kg in Japan, EU & USA
- **Summary**: Potential decline in overall refractory consumption could be offset by increase in alumina specific consumption
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Non metallurgical bauxite & alumina markets

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Source: Author estimates
Global Shale Gas

Global shale gas basins, top reserve holders

- Canada: 11.0 Tln cubic metres
- U.S.: 24.4 Tln cubic metres
- Mexico: 19.3 Tln cubic metres
- Argentina: 21.9 Tln cubic metres
- Poland: 5.3 Tln cubic metres
- Libya: 8.2 Tln cubic metres
- Algeria: 6.5 Tln cubic metres
- Brazil: 6.4 Tln cubic metres
- South Africa: 13.7 Tln cubic metres
- China: 36.1 Tln cubic metres
- Australia: 11.2 Tln cubic metres

Assessed basins:
- With resource estimate
- Without resource estimate

Source: EIA, BP & Reuters

Reuters graphic/Catherine Trevethan
In 1995, the first horizontally drilled and hydraulically fractured well in shale was completed in the USA.

Horizontal drilling combined with fracking permitted the greater recovery of oil and gas than that from a vertical hole.

Proppants (small spherical compression resistant particles) are used in drilling fluids to hold fractures open and allow gas/oil to be removed.
Ceramic Proppant World Producers

- **Carbo Ceramics Inc**, world largest ceramic proppant producer (USA & China)
- **Saint-Gobain Proppants** (Fort Smith & Bauxite, Arkansas USA & China)
- **Mineracao Curimbaba Lda** (Brazil)
- **Imerys S.A.** (Andersonville, Georgia USA and during 2013 acquired Georgia-based ceramic proppant manufacturer Pyramax, LLC)
- **JSC Borovichi Refractory** Plant (Borovichi, Russia)
- **FORES Refractory** Plant (Ekaterinburg, Russia)

Increasing number of manufacturers in China (>4 M tpa capacity). Most of these companies produce intermediate-density ceramic proppants

Chinese proppant imports into the United States started in 2010 and contributed to a subsequent over-supply of ceramic proppants

Source: Carbo Ceramics Inc Annual Report 2014
USA Ceramic Proppant Market (2014)

- **US ceramic proppant capacity** was 1.4 million tonnes
- **US ceramic proppant demand** was 2.0 million tonnes in 2014
- **The US market** is dominated by three major domestic suppliers:
  - CARBO Ceramics with four plants and 0.83 million tonnes capacity.
  - St Gobain with two plants and 0.24 million tonnes capacity.
  - IMERYS with two plants and 0.33 million tonnes capacity.
- **Imported proppant** grew from 37% of the market in 2013 to 49% in 2014, or 1 million tonnes
- **Exporters** from Brazil (Mineração Curimbaba), Russia (Fores) and China all increased their shipments to the US.
- **China** is the largest source of imports into the US. The majority of these shipments were bauxite based intermediate and high strength proppants.
- **Ceramic proppant imports** are falling in 2015 as the market declines in line with oil and gas prices.

Source: First Bauxite Corporation 2015
## USA Ceramic Proppant Capacity (2015)

<table>
<thead>
<tr>
<th>Company</th>
<th>Plant</th>
<th>Capacity (‘000 tpa)</th>
<th>Feedstock</th>
<th>Status</th>
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<tbody>
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<td>Eufaula, AL</td>
<td>125</td>
<td>kaolin</td>
<td>Active</td>
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<tr>
<td></td>
<td>McIntyre, GA</td>
<td>125</td>
<td>kaolin &amp; bauxite</td>
<td>Idled</td>
</tr>
<tr>
<td></td>
<td>Toomsboro, GA</td>
<td>455</td>
<td>kaolin</td>
<td>Active</td>
</tr>
<tr>
<td></td>
<td>Millen, GA</td>
<td>115</td>
<td>kaolin &amp; bauxite</td>
<td>Active</td>
</tr>
<tr>
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<td>New Iberia, LA</td>
<td>10</td>
<td>Alumina &amp; kaolin</td>
<td>Idled</td>
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<tr>
<td>Imerys Oilfield Solutions</td>
<td>Andersonville, GA</td>
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<td>kaolin</td>
<td>Idled</td>
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<tr>
<td></td>
<td>Wrens, GA</td>
<td>225</td>
<td>kaolin</td>
<td>Active (reduced)</td>
</tr>
<tr>
<td>St Gobain Proppants</td>
<td>Fort Smith, AR</td>
<td>90</td>
<td>bauxite</td>
<td>Idled</td>
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<tr>
<td></td>
<td>Bryant, Saline, AR</td>
<td>150</td>
<td>bauxite</td>
<td>Active</td>
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<tr>
<td>USA Capacity 2014</td>
<td></td>
<td>1,395</td>
<td></td>
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<tr>
<td><strong>USA Capacity 2015</strong></td>
<td></td>
<td>1,080</td>
<td>down 23%</td>
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</table>

Source: IMFORMED 2015, Carbo Ceramics 2015
USA Ceramic Proppant Growth Forecast

Long term market 3.5 million tonnes pa

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<td>Demand</td>
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<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
<td>3.0</td>
<td>3.5</td>
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Assumed Oil Price

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017-20</th>
<th>2021-25</th>
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<tr>
<td>US$/bbl</td>
<td>55-60</td>
<td>60-65</td>
<td>70-80</td>
<td>85-90</td>
</tr>
</tbody>
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Source: First Bauxite Corporation 2015
USA Ceramic Proppant Growth Forecast

Long term market 3.5 million tonnes pa

Potential bauxite market (~60% Al₂O₃, ~30% LOI) ~ 2.5 million tpa

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Source: First Bauxite Corporation 2015
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<td>70-80</td>
<td>85-90</td>
</tr>
</tbody>
</table>

Source: First Bauxite Corporation 2015
Drilling Activity depends on Oil Price

U. S. Rotary Rig Count
Total Active Rigs

January 2012 - August 14, 2015

Sources: Baker Hughes, Energy Information Administration (DOE), WTRG Economics

WTRG Economics ©2015

www.wtrg.com
(479) 293-4081

23/10/2015
Crude Oil Price

“Crude has lost half its value in the past year. U.S. production has jumped to the highest level in more than 40 years. Prices collapsed after the OPEC decided to maintain production rather than sacrifice market share.”

“OPEC could potentially boost crude oil production to 33 million barrels a day, the most ever, after international sanctions are removed against Iran.”

Source: www.infomine.com, Cameron
...and Fracking Opposition
The Shale Gas Revolution

- It’s Not Over, It’s Just On Hold (http://energyfuse.org)
- Higher-cost oil and gas supply will be required (BHP Billiton)
- In 2018 the industry will once again be booming (Raymond James)
- Shale will be a new swing producer (Medley Global Advisors)
- And then there are China shale resources …
Thank You - & now the good news

Mining to rise out of the downturn in 2017
Dr Richard Flook has worked for both suppliers and consumers of minerals with global companies including, Steetley plc, Anglo American, Commercial Minerals (now Sibelco), Normandy Mining Ltd, Omya AG and Shinagawa Refractories.

Richard has been CEO, Managing Director & Director of Asian and Australasian companies. He has specialized in new business opportunities including strategic planning, trading, market development and acquisitions in the industrial minerals industry and has been involved in managing and developing mineral operations and businesses in Asia and Australasia.

Richard is a Fellow of the Australasian Institute of Mining & Metallurgy (FAusIMM (CP)), the Australian Institute of Company Directors (FAICD) and the Australian Institute of Energy (FAIE). He is a graduate of Sydney University (BSc First Class Honours, PhD) and the University of NSW (Master of Commerce).

Since commencing his own consulting business in 2014, Richard’s clients have come from five continents.