





# Australian mining

Statistics (FY10):

8% of GDP

111.5 A\$b exports  
(including 2.5 A\$b  
mining services)

48% exports

Largest exporter of:

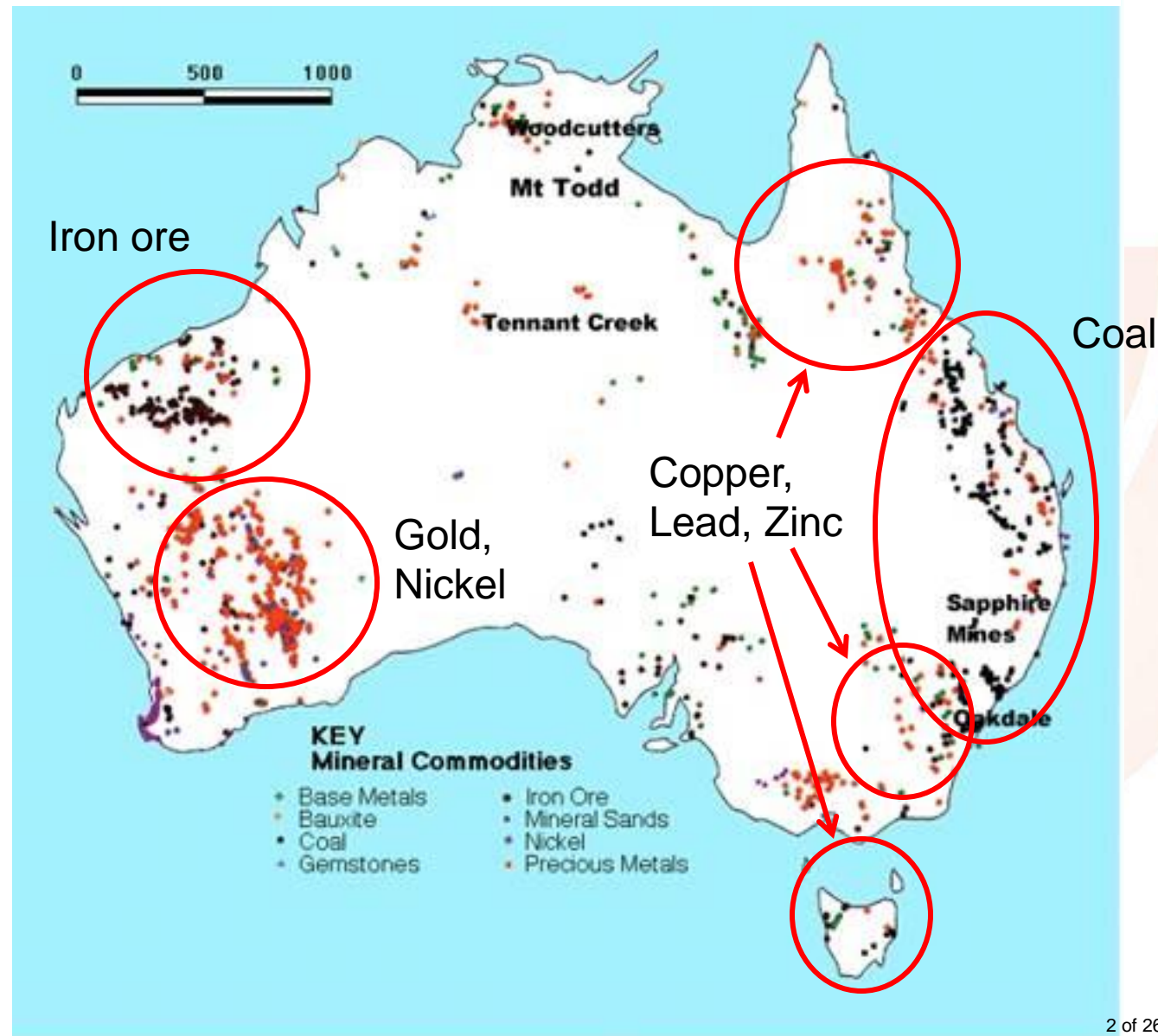
- Alumina
- Metallurgical coal
- Iron ore
- Lead

2<sup>nd</sup> largest exporter:

- Thermal coal
- Zinc

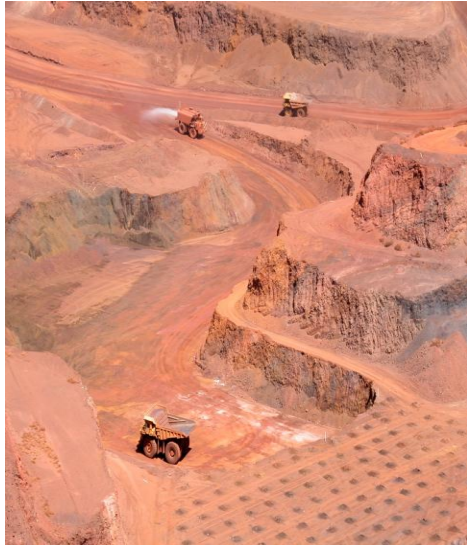
3<sup>rd</sup> largest exporter

- Uranium





# The mining boom v1 (2003-2008)



- Sustained demand from China (growth >13% pa)

Companies grew shareholder value by:

- Enlarging reserve bases via merger & acquisition (M&A)
- Medium sized companies bought out (Inco, Falconbridge, Western Mining)

Technology \$ compete with Exploration \$ and M&A \$:

New technology investment seen as high risk, requires long term investment

Australia's advantage: early government involvement; industry-driven R&D, Industry managed funds (ACARP-1985), Co-operative Research Centres.



# The mining boom v2 (2010-?)

## Demand:

- Continued demand from China (growth >10%)
- Rise of India

## Supply:

- Expansion of existing operations (deeper, bigger underground mines)
- Development of 2<sup>nd</sup> tier mines in established mining countries (metallurgical, geological complexity)
- Development of “frontier” countries (Mongolia, Philippines, Pakistan)
- Reduced M&A activity (scarcity of attractive mid-sized targets, more difficulty accessing capital)
- Greater focus on Innovation and Exploration as growth options.





# Innovation Enabling Factors

- Research intensive universities (produce specialists for all R&D providers)
- Sources of long-term research funding (Government/Industry)
- Industry-driven project selection (innovation aligned to business needs)
- Industry engagement with universities throughout the R&D process
- Strong project management (however: must allow for “serendipity”)
- Clear rules regarding Intellectual Property (co-ownership).



# Deloitte's top 10 industry challenges 2011<sup>1</sup>

- 1) Capital scarcity
- 2) Demand outstripping supply (geographic expansion into developing countries)
- 3) Social license to operate (land access, water/energy, community engagement)
- 4) New regulatory challenges (eg. MRRT, carbon tax)
- 5) Strategic investment of capital (organic growth versus M&A?)
- 6) Talent shortages (Australia - 38,000 people required by 2015)
- 7) New resource horizons (deep sea, under ice, volcanic)
- 8) Climate change disclosure (energy/emissions accounting)
- 9) Inadequate infrastructure (energy, rail, port)
- 10) New revenue sources (carbon offsets, coal to gas/liquids, renewable energy, waste recycling)



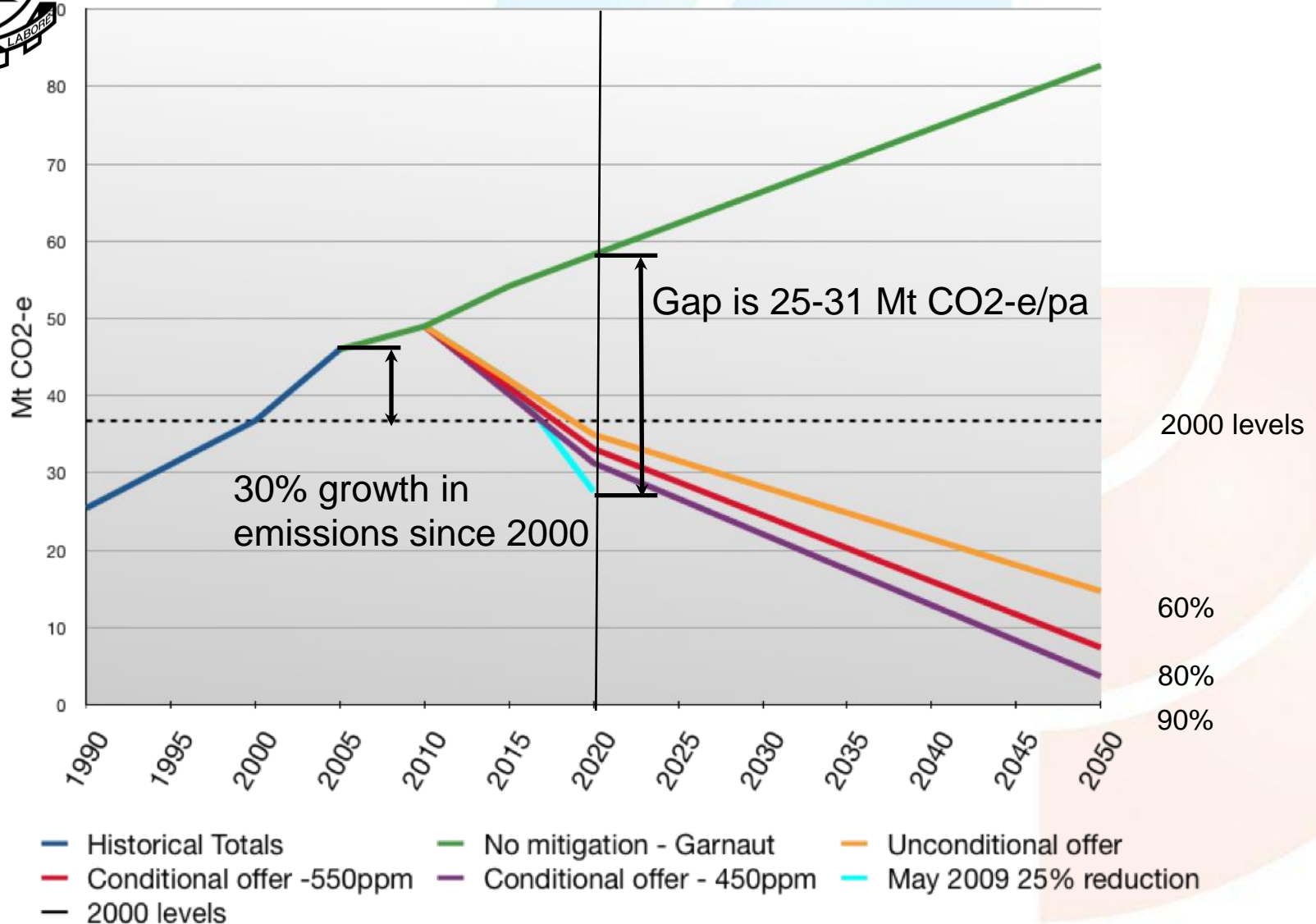
# Current Australian concerns



- New Royalties and Taxes (Concern at a 2-speed economy and “Dutch disease”)
- Skilled Labour shortages (36,000 technicians, 1800 professionals needed in next 5 years)  
Concern with labour costs (>35%)
- Licence to operate (socio-environmental concerns, approval delays, “red and green” tape)
- Water (Australia is driest continent on earth)
- Energy (introduction of a carbon tax)
- Large open pits (wall stability, large fleets)
- deeper underground operations (ore/people transport, in-situ stresses, ventilation)



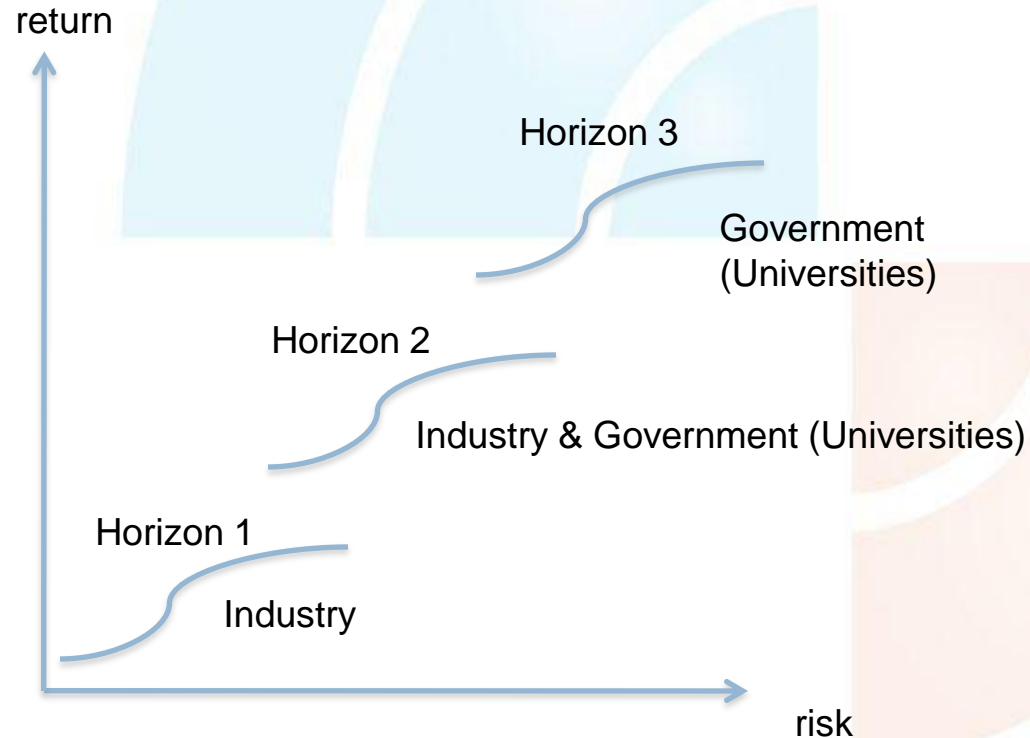
## Australian Mining Emissions Reductions Trajectories to 2050



Source: Australia's National Greenhouse Gas Accounts. National Inventory by Economic Sector (Table 2, page 11)



# Innovation Horizons

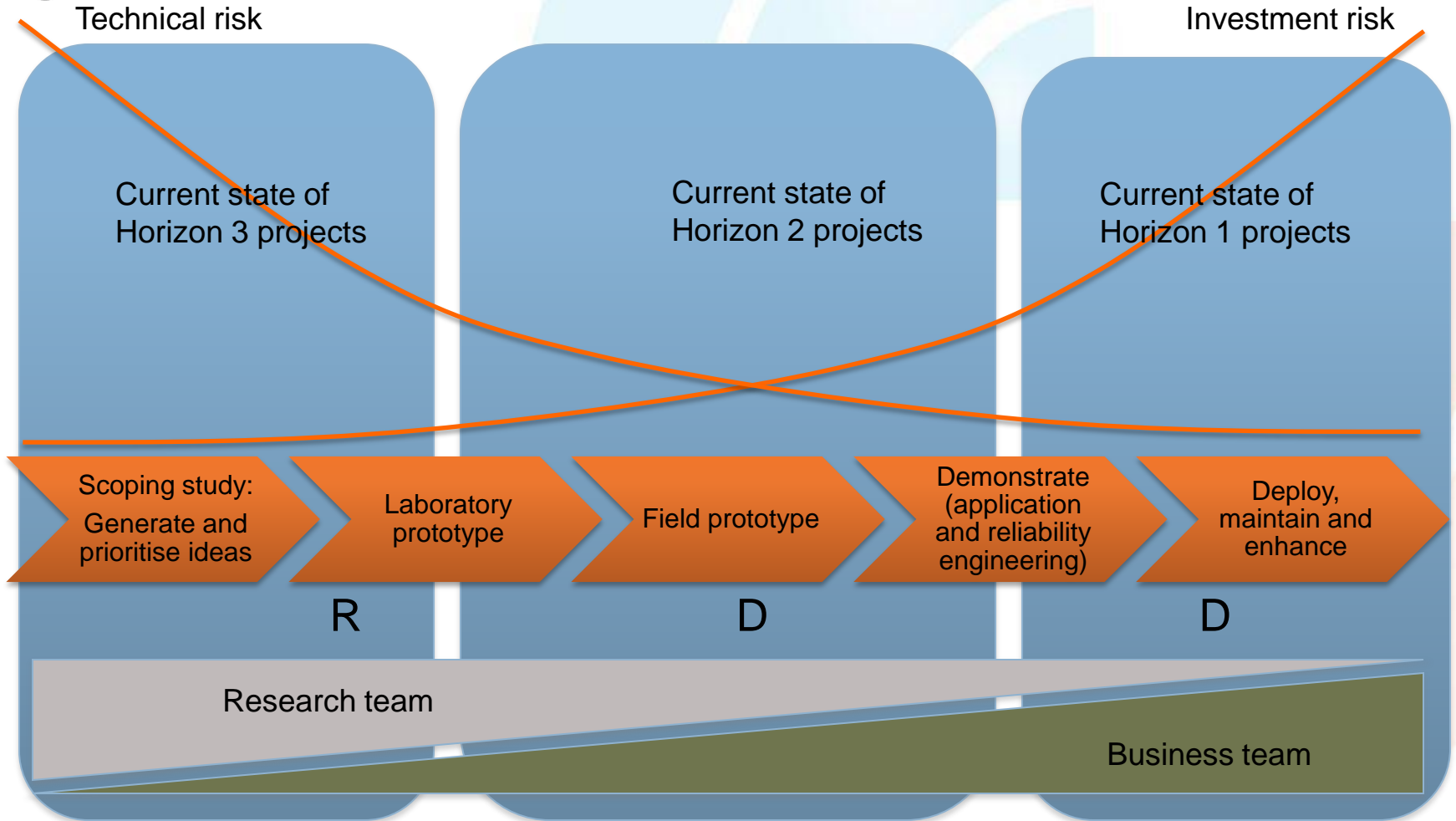


- Horizon 1: Short term 1-3 years, incremental advantage (tools and processes)
- Horizon 2: Medium term 3-8 years (major changes to existing tools and processes)
- Horizon 3: Step change technologies >8 years (innovative new processes and tools)

Ref: Baghai, E, Coley, S & White, D. "The Alchemy of Growth: Practical insights for building the enduring enterprise"  
McKinsey & Co., New York, 1999



# Innovation value chain





# Innovation partnerships

- Horizon 1 technologies – require direct engagement with suppliers (ie “Demonstrator” expertise required).
- Horizon 2 technologies – require researcher and supplier R&D interaction (eg. collaborative models, CRCMining)
- Horizon 3 technologies – require more researcher involvement (direct engagement with select universities and R&D providers. Demonstrated project management expertise is a must).
- 1980’s – In-house mining R&D (expensive and inflexible).
- 2010 – Technology leaders employ “innovation networks”.



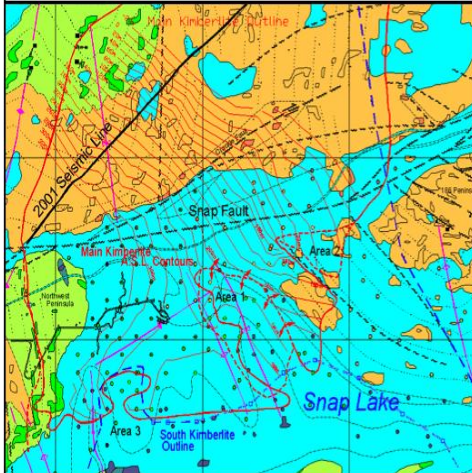
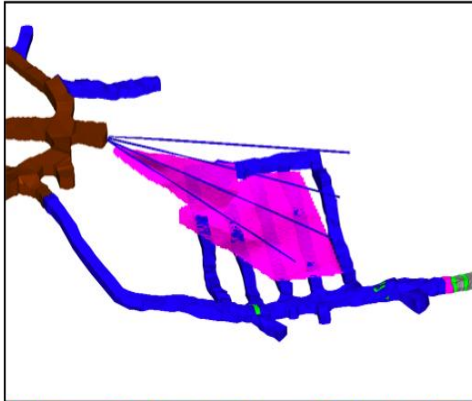
# Horizon 1 Technologies



- Remote operating centres (monitoring, advanced analytics, systems integration, centralized diagnostics) – Rio Tinto, Codelco
- Automation and tele-operation of select unit operations (drills, trucks, dozers) – Komatsu, Caterpillar.
- Blasting technologies (electronic detonators and wireless) – Orica, Enaex
- “Truckless mining” (shovel-sizer-conveyor systems) – MMD, Sandvik
- Operator training (virtual reality) – Immersive Technologies, UNSW



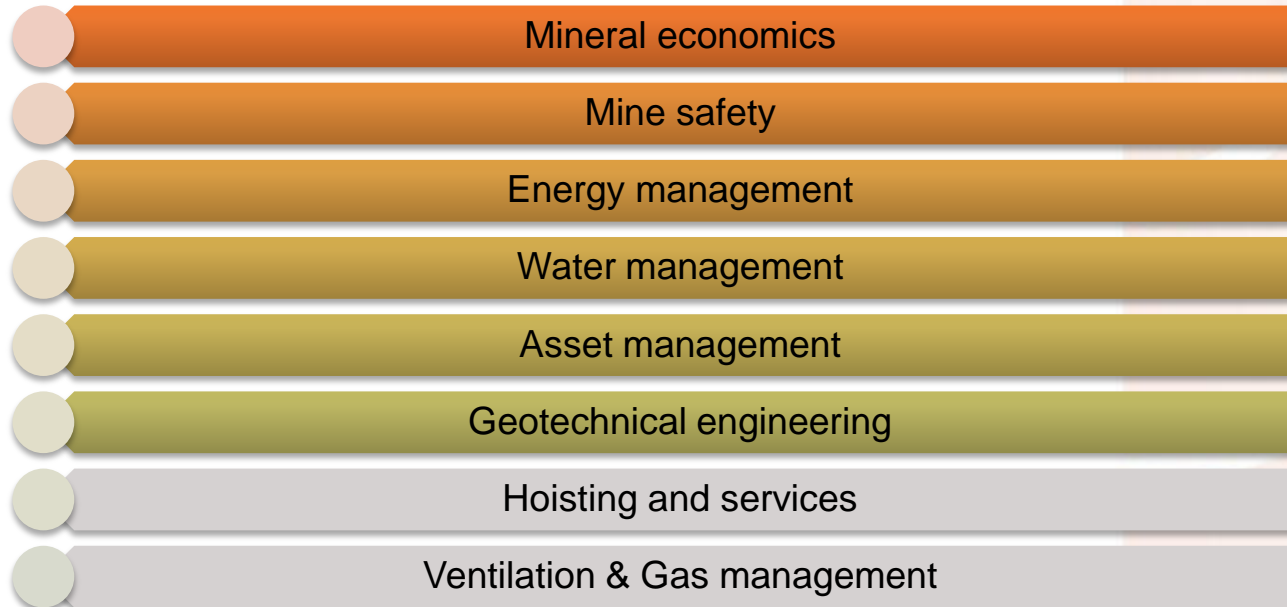
# Horizon 2 technologies



- Routine use of geophysics in mining (eg. borehole radar)
- Mechanical rock cutting (rapid development) – Atlas Copco, Joy Mining.
- Continuous mining - eliminates drilling, blasting and crushing – Fortescue Mining
- Instrumented rock bolts (detect changes in stress field)
- Dry sorting technologies (magnets etc)
- In-situ leaching (underground, low grade deposits)
- Geothermal energy supply to mines



# The mining value chain





# Future technology needs

- What is the largest bottleneck in the value chain?
  - In Australia this is increasingly around permitting (socio-environmental issues).
- eg. Copper production: the SAG mill. Answer – do away with milling. How? Mechanical breakage and continuous mining
- Three technologies that are likely to change the face of mining:
  - Mechanized rock cutting
  - At-face sorting
  - In-situ processing



# Horizon 3 technologies

- Electro-mechanical rock breakage (heat-quench cycle)
- Bio/nano mining
- Magnetic levitation for shaft transport





## Some final words on Universities ...

- Current mining programs lack critical mass of researchers
- Have a poor record of delivery (pushed to publish at the expense of innovation).
- Cannot attract bright early career researchers
- Must work collaboratively (with industry and other universities) to tackle big projects and to enhance attractiveness of a research career path.



# Thank you!



- Questions?
- Need more details?
- To obtain related publications, write to: [p.knights@uq.edu.au](mailto:p.knights@uq.edu.au)