Development of the Jameson Cell

Laureate Professor Graeme Jameson
University of Newcastle
NSW 2308
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Outline

- Talk will be in two parts

1. The Invention

2. The Commercialisation Process

1. The Invention

- Background – mining and mineral processing
- Principles of flotation
- Existing technologies
- The problem – slow flotation of ultrafines
- Research outcomes
- The Jameson Cell
- Position today
  - Installations worldwide
  - Benefits to Australia

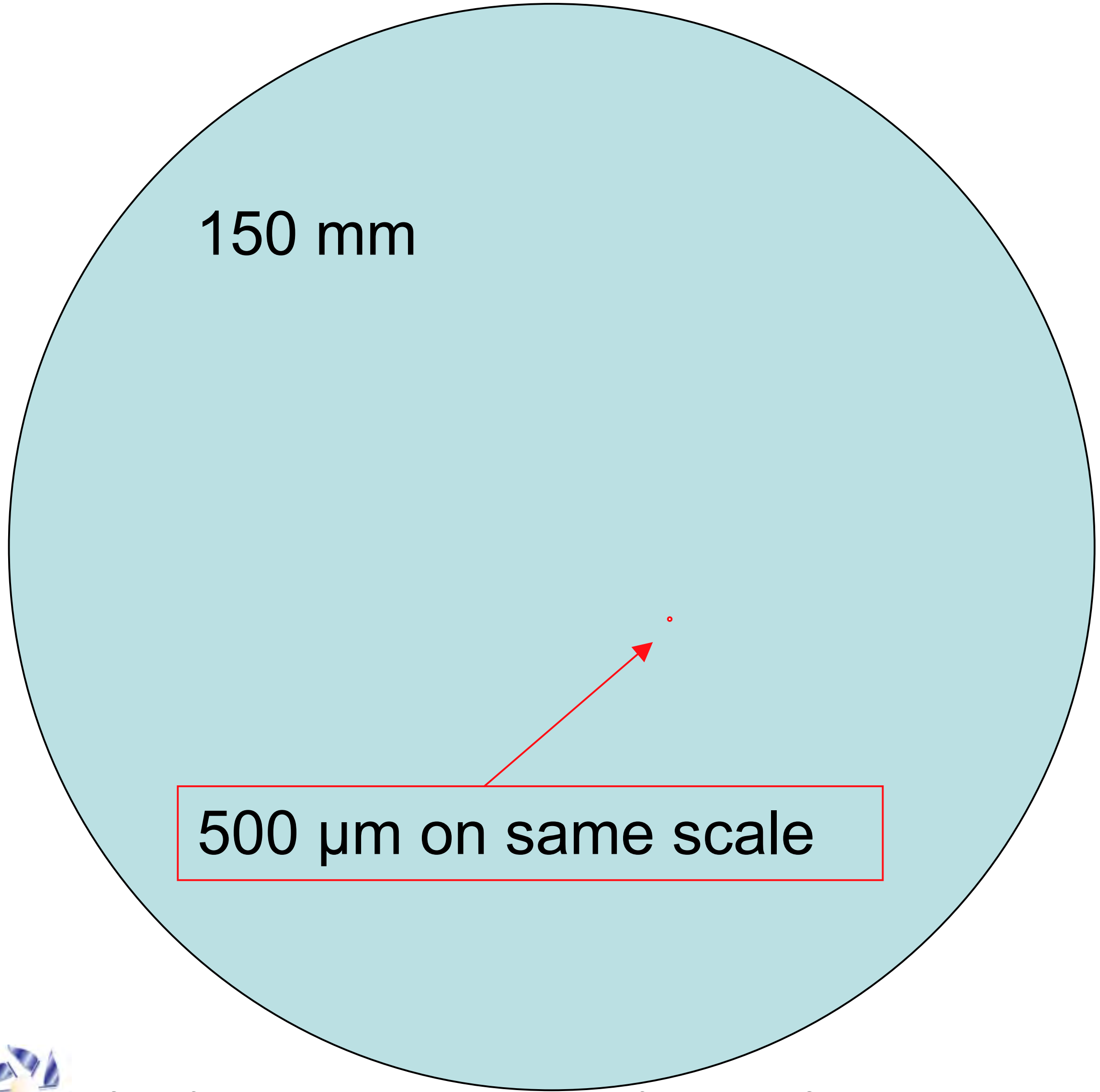
Background - Mining and mineral processing

- Ore types
  - Base metals like copper, zinc, lead, nickel
  - Gold, often associated with base metals
  - Bulk commodities - iron ore, coal
  - This talk primarily about base metals and gold
- An ore body is found by prospectors
- Mine site is developed - two main operations
  - The mine, where ore is recovered from the earth
  - The concentrator, where the valuable minerals are separated from the ore

Base metal concentrator operations

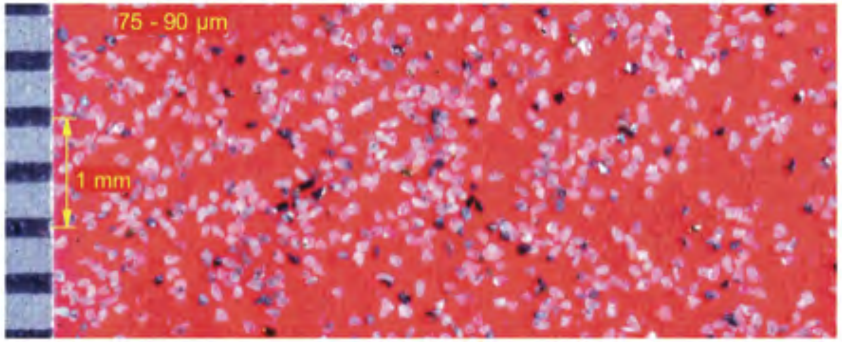
1. Grinding
   – Ore is crushed from 150 mm to ~ 150 microns
   – Fine grinding liberates the valuable components
2. Flotation
   – Finely ground ore is suspended in water
   – Reagents are added to make valuable components water repelling (hydrophobic)
   – Bubbles are introduced, stick only to the values, takes them to the top of the vessel into a froth
3. Filtration, drying, tailings disposal

Base metal concentrator operations



- Concentrator operations (typical base metal)
  - Product from mine is 150 mm in diameter
  - Must be reduced to ~ 150µm for further processing
  - Fine grinding liberates the valuable components

Ore pictures



600-710 µm

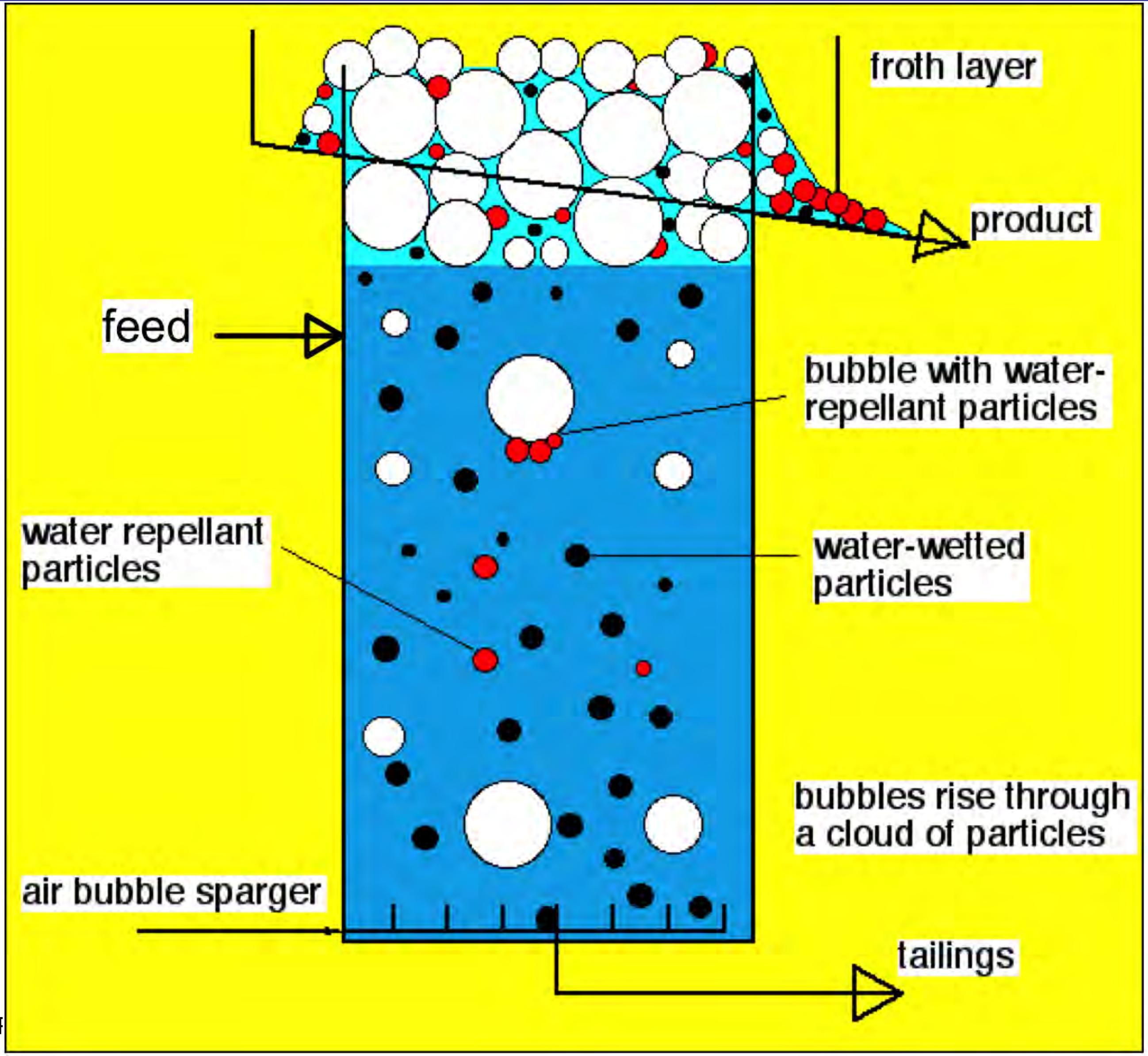
75-105 µm

- Coarsely ground ore showing lack of liberation (same scale)

Principles of flotation

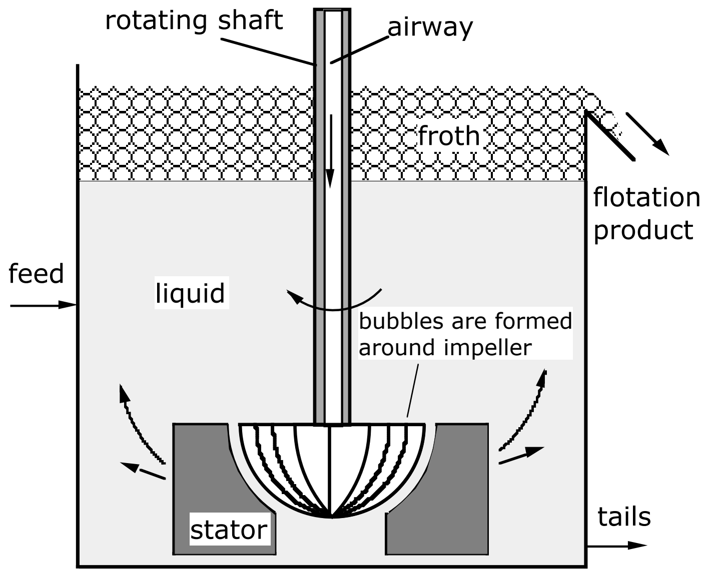
- The ore is finely ground in a suspension in water
- Collectors are added that adhere selectively to the valuable particles – values – and make them water repellent or hydrophobic
- Bubbles are introduced that collide and adhere to the values and carry them into a froth layer at the top of the vessel
- A frother may be added to help the froth to stabilise and flow out of the vessel

The flotation concept



Existing technologies

Flotation columns at Mt Isa, Qld.



Mechanical cell. Feed enters an agitated vessel, air introduced in impeller

Froth photos

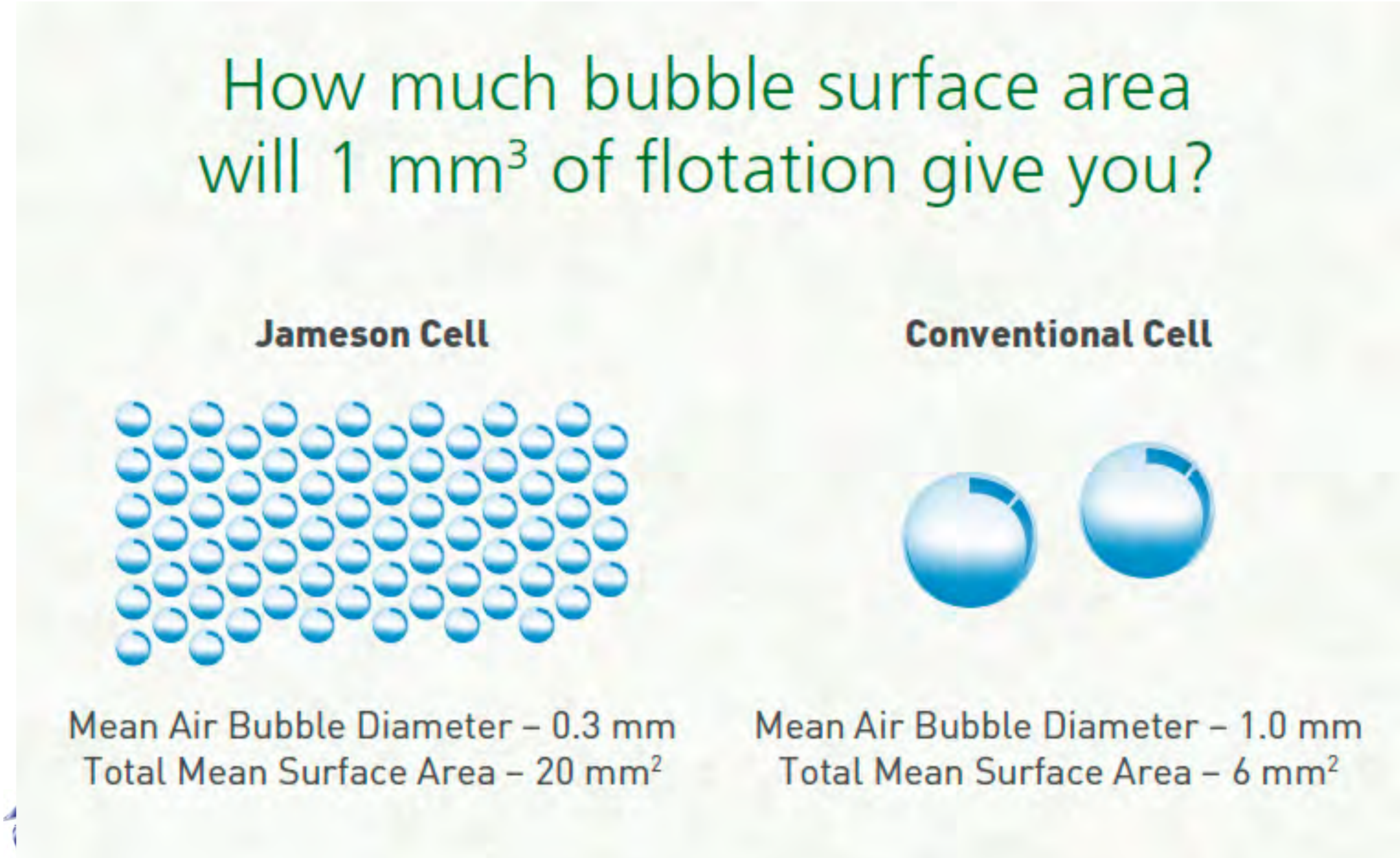
Copper froth at Northparkes mine, NSW.

Jameson and students collecting samples at nickel concentrator flotation cells (Poseiden)

The R&D process for the Jameson Cell

- Start point – at Imperial College London, 1969
  - Encouraged to look at the fundamentals of fine particle flotation, < 20 μm
  - Known that the rate of capture of ultrafines by bubbles was very slow – reason was not known
  - From 1969 to 1978, a series of PhD students investigated the problem
- Research showed that rate of flotation of fines could be increased by reducing the bubble size to ~300 μm and increasing bubble concentration
- Target shifted – theory was needed, to predict sizes of bubbles produced by various means – to drive the search for improved ultrafines capture

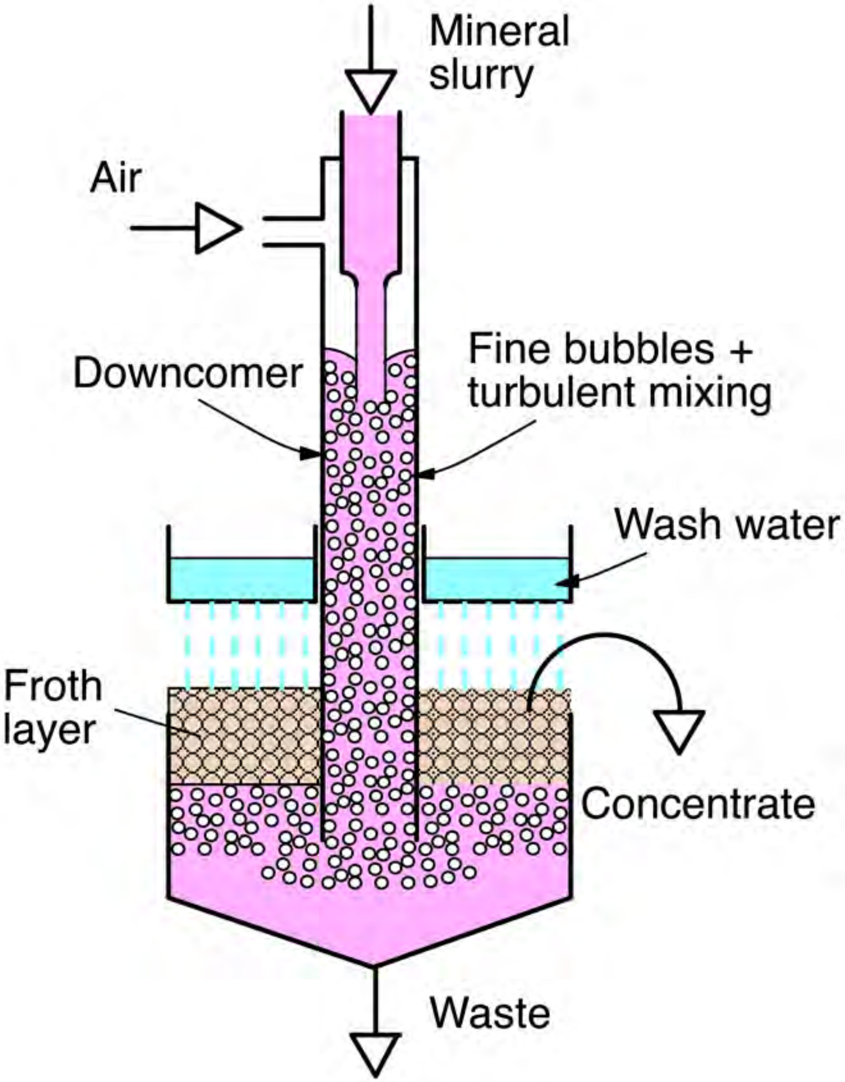
Bubbles
Current technologies typically 1 mm diameter



Early forms of Jameson Cell

- Bubble generation very challenging
  - Need to produce billions of small bubbles per second
  - Operating environment very difficult - wet, dirty, hot
  - Equipment must be robust, simple to construct and maintain, no small holes to block
  - Must be able to inject high local energy flows, to break up the bubbles and make them contact the particles
  - New theory was used to design a simple laboratory apparatus that would meet the specifications

Jameson Cell – Principles of operation



Reagents added to slurry to make the values hydrophobic

Slurry enters as a high-speed jet

Air is entrained into the shear layer around the jet, forming fine bubbles

The fine values collide with bubbles and are captured and carried into the froth as concentrate

First trials – Renison Bell tin mine, Zeehan, Tasmania December vacation, 1986

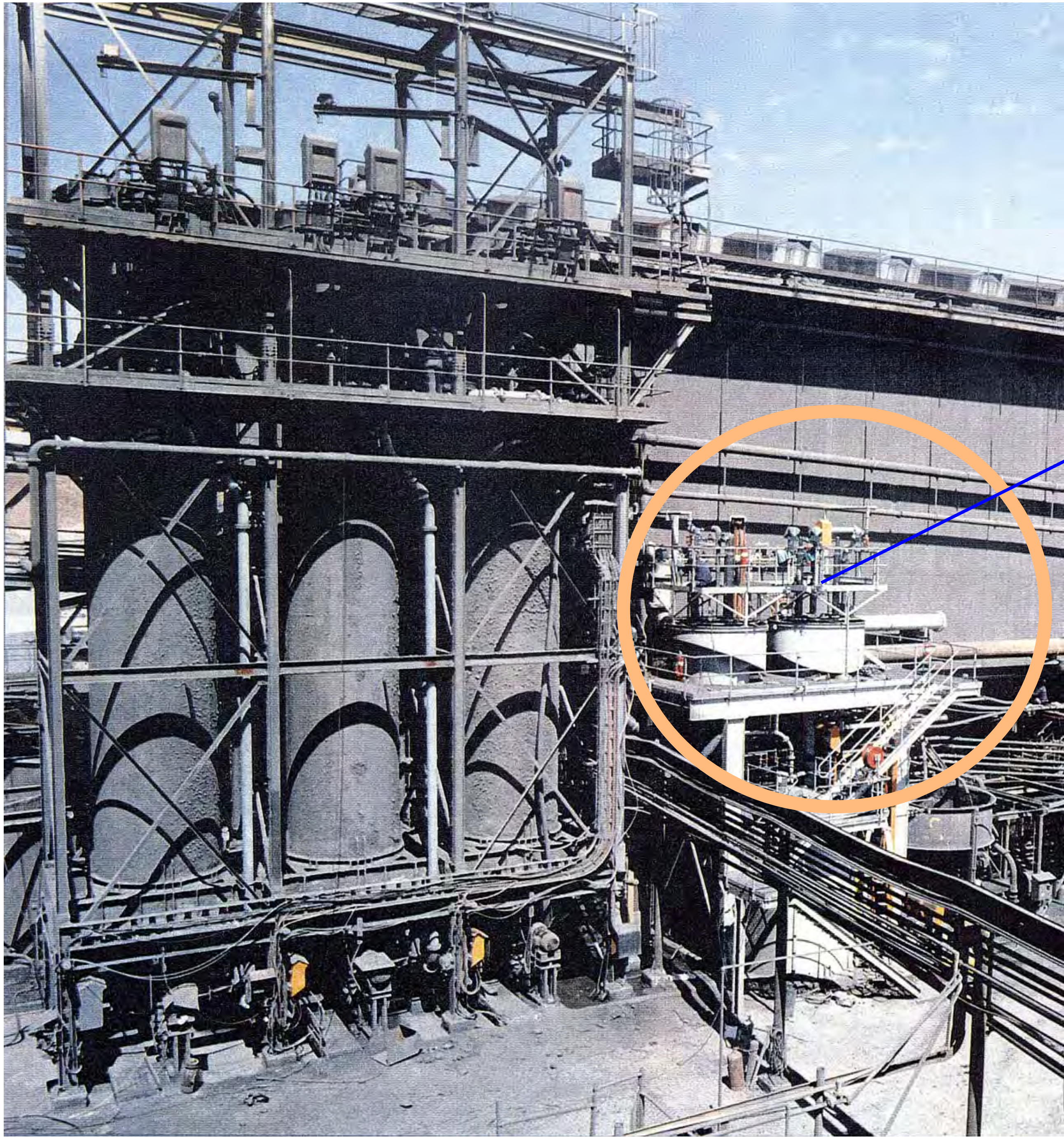
- Simple construction, wooden sides, perspex front and back
- Liquid was injected as a vertical jet in right hand chamber, air entrained by the jet
- Froth formed in left hand column
- The apparatus quickly failed but the general idea was proven
- Further developed in the lab at Newcastle

Mt Isa trials

- Jameson submitted provisional patent application for the Cell in 1986, and approached Mt Isa Mines Limited for permission to do test work.
- Results were encouraging, and in 1989, MIM negotiated a license agreement with Tunra Ltd, on behalf of the University of Newcastle, for the Jameson Cell.
- Mt Isa Mines Limited was taken over by Xstrata Ltd, and last year, by Glencore
- The Cell is marketed and supported by XT Australia.

Position today

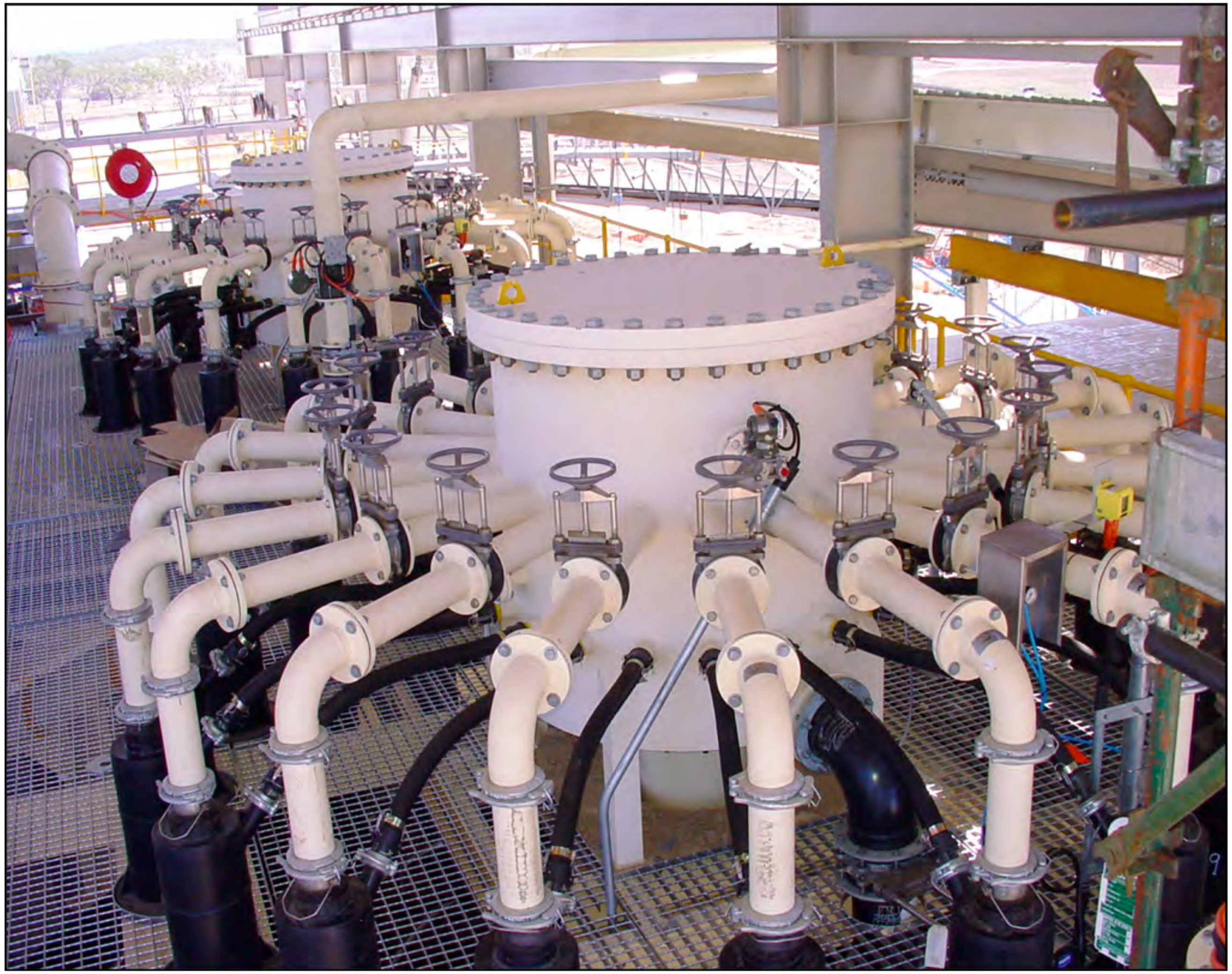
- Jameson Cell installations worldwide
  - Coal - thermal and metallurgical
  - Base metals - copper, lead, zinc, antimony etc
  - Solvent extraction liquor - to remove kerosene haze from acid copper sulfate solution before electrolysis
  - Oil sands in Canada - remove bitumen droplets from aqueous suspension
  - Potash - separate potassium chloride from sodium chloride
- Non-metallurgical – Industrial wastewater treatment



Columns & J-Cells

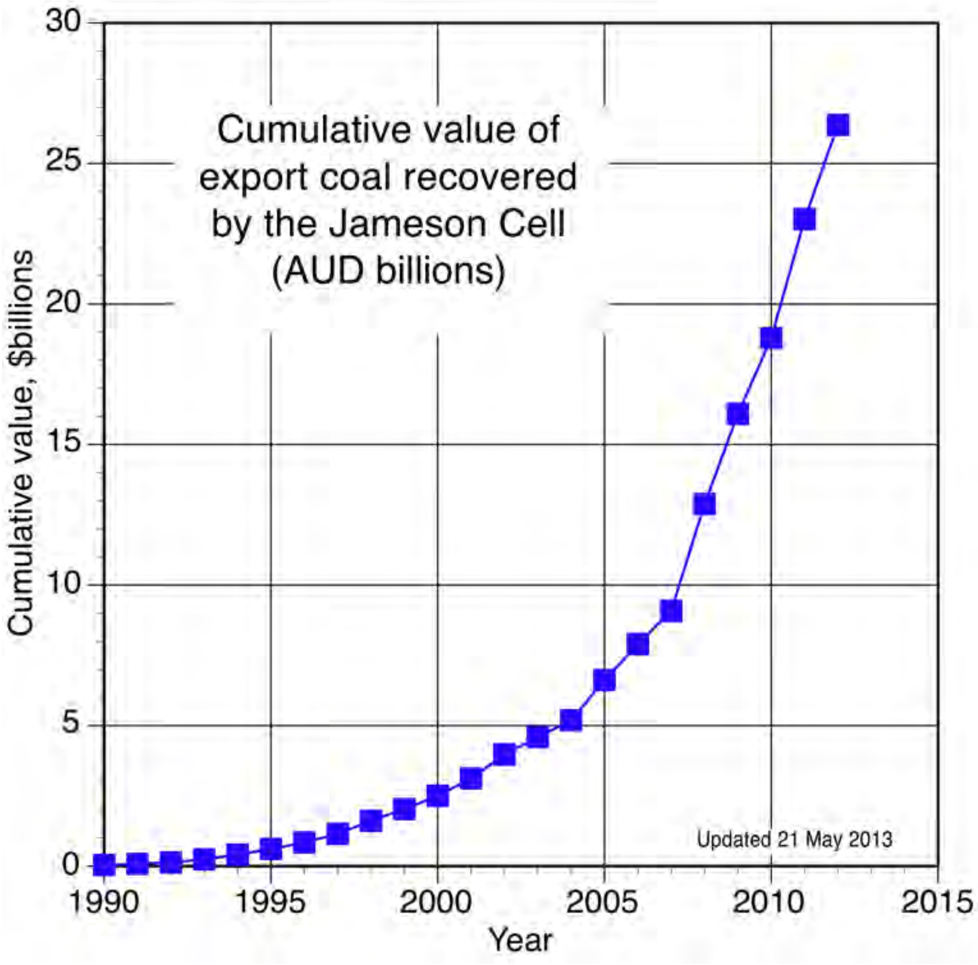
- Lead/zinc concentrator, Mt Isa, Qld, 1992
- Each J-cell has same capacity as one column

Hail Creek, Qld

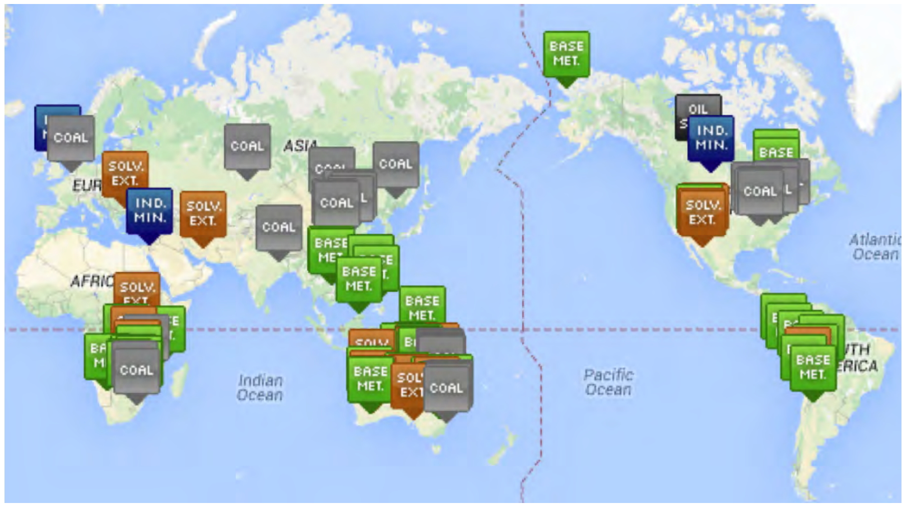


Prominent Hill, SA

Worldwide installations



- Over 330 Cells in operation worldwide (161 coal, 116 base and precious metals, 41 SX-EW, 13 other)
- Important contribution to the Australian economy
- Cumulative value of export coal nearly $30 billion to date



2. The Commercialisation Process

- After 20 years, only part-way through
- Inventors have to be patient
- But engineers know how to keep their minds on the job

The commercialisation process

- Laboratory testing
- Provisional patent application Sept 1986
- Generate funding
- Prototype and pilot plant development
- First sales – Peko Warrego, Newlands Coal, MIM Lead-zinc concentrator, 1989
- License negotiations 1988-89
- Work with licensee, seconded from University 1990-92
- 1993 – support licensee whenever requested

Patent applications

- Do it yourself – provisional application 1986 - $50 - gives one year to find out if the invention has legs
- Inventor had long been interested in patent practice. Had a good amateur knowledge of the system in Australia, the US and the UK
- As one-year deadline approached, located a patent attorney in Sydney, wrote the final specification, cost about $800 - a good relationship - still working with the same attorney
- Patent assigned to Tunra Ltd on behalf of the University
- Tunra reimbursed the patent costs and assumed ongoing responsibility
- Final specification filed 1987, priority date 1986
- Invention was not disclosed to others until the provisional had been filed.

Funding

- Funded by surplus from an R&D contract with an equipment supplier, through Tunra Ltd, the University of Newcastle technology transfer company
- Cash flow assisted by slack in the Tunra accounting system
- The R&D is low cost
- All up cost to license agreement ~ $60,000
- Most of the work was done by the inventor
- Very little was contracted to others other than the obvious – engineering fabrication, insurance, transport

Prototypes and scale-up

- First trial at Renison Bell tin mine, on a feed from operating flotation circuit
- The basic concept was proven but the way of implementing it was flawed – quickly remedied
- Excellent relationship was developed with Mt Isa Mines in their copper and lead-zinc concentrators at Mt Isa
- Permission given to trial the new machine in 1987
- MIM appointed a graduate metallurgist to work on the device full-time in 1988
- Tested against existing equipment, found to be superior

Commercialisation example

- Peko Wallsend Copper-gold mine, near Tennant Creek, NT.
- Problem – concentrate was low-grade, 26% copper when it should have been 34% - trucking lots of fine rock to smelter at Mt Isa 650 km away

Inventor's role

- On-site testing of pilot plant
- negotiate price and obtain purchase order
- design in conjunction with site engineers
- find right materials of construction – low wear, corrosion resistance
- create engineering drawings
- arrange transport, insurance brokers, risk assessment
- operating instructions, commissioning and training
- Result: Payback time six weeks

License negotiations

- The development work was done at the Mt Isa mine
- The company decided to take a license, using a technology subsidiary Mt Isa Technology Management (MTM)
- I Negotiated with MTM, with Tunra manager
- The R&D Scene in 1985 very light weight compared with today
- Rudimentary legal infrastructure – few specialists in IP licensing – normally handled by commercial lawyers – we found a good man in Newcastle
- Negotiations were protracted, more than a year, but the agreement has stood the test of time
- License concluded April 1989

Role of the University

- No formal structures, generally ignorant of industry and the outside world
- Freedom for me to move – no committees to report to, nobody in the way
- Uni hostile to the profit motive – dominated by Arts people, still fighting the 1968 wars
- I kept a low profile – gained respectability by good success with ARC grants and academic publications
- Normal teaching and research duties of professor and head of department
- No support from university requested or obtained

Role of the University technology company

- TUNRA Limited, established 1969, second oldest in the country
- At the time, independently run, at arms length from the university
- Generally very helpful
- The Board Chairman was an accountant, but a technology groupie - loved and appreciated good science and engineering - highly respected figure in Newcastle business circles - bit of a cowboy
- Now known as Newcastle Innovation, subsumed into the university. Finis.

Would I do it again?

- Yes (if I were younger!)
- Answer depends on one’s motivation
- I’m an academic engineering scientist
- Strongly driven to solve important practical problems through good science
- Financial return is welcome but not essential
- I have a good day-job, not a disaster if an invention fails to take off
- Most inventions fail – only a tiny fraction of patents are ever commercialised – but people who have been successful are likely to do it again

Advice to would-be inventors

For mainstream inventors:

- Pick an important problem that is widely recognized but for which there is no current solution
- Stay away from marginal improvements, not worth the effort
- Best if your invention can do something that no other can do
- The further you develop the invention on your own, the greater the attractiveness to an end user (reduced risk) and the greater the return to yourself
- Build strong relationships with possible end-users
- Believe in yourself and what you’re doing

Further advice for would-be inventors

For blue sky thinkers:

- The invention should create its own market
- Best to choose a product for a market that doesn’t exist, but which can be immediately be seen to have a massive upside if there’s a new invention or discovery

Summary

- The Jameson Cell is a text-book case of a successful technological development
  - Many years of basic research
  - Identification of the solution to a problem
  - Finding a practical way of implementing the solution
  - Working with leading industry practitioners to bring the new machine to the market place

Acknowledgements

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