EVOLUTION OF THE ISAMILL™ INTO MAGNETITE PROCESSING

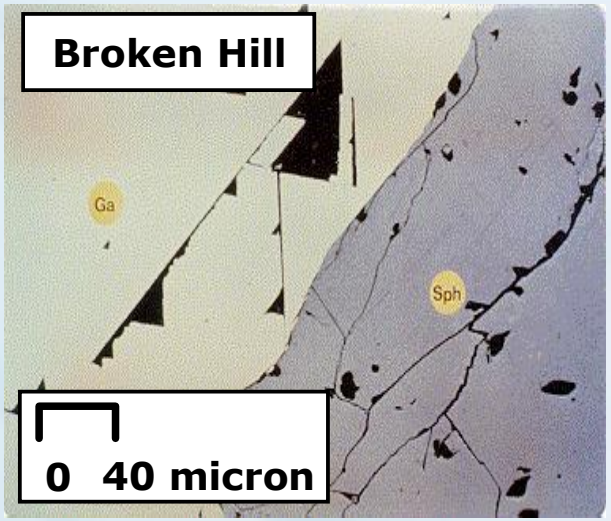
Greg Rasmussen, Xstrata Technology Pty Ltd
Tommy Do , Ernest Henry Mining
Michael Larson, Xstrata Technology Pty Ltd
Katie Barns, Xstrata Technology Pty Ltd

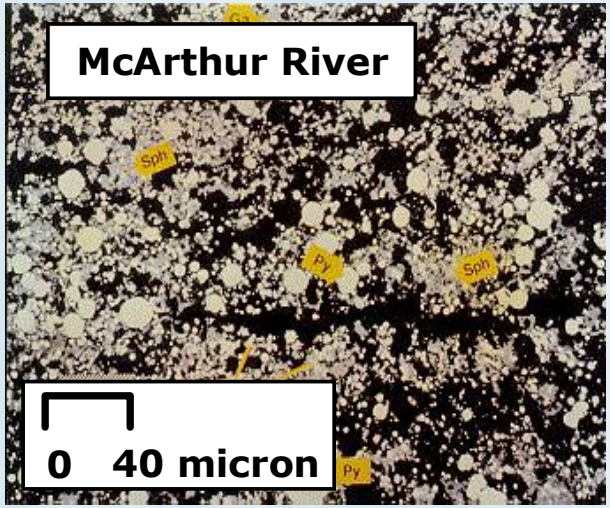
Xstrata Technology

- **Mount Isa Mines (MIM), a large Australian mining company, was acquired by Xstrata in 2003 who then merged with Glencore in 2013**
- **MIM internal technology group was re-named Xstrata Technology (XT) and became an independent technology developer and supplier to the global minerals industry with 250 staff worldwide**
- **The equipment and processes which are marketed by XT are developed in our own operations**
- **XT offers full-package solutions including:**
  - Equipment and processes
  - Engineering
  - Commissioning and Training
  - Dedicated after-market support

IsaMill™ Technology Development

- **Development of IsaMill™ driven by inability to efficiently treat fine grained orebodies**
- **Late 1980s, Xstrata required 7µm grind for new Pb/Zn orebodies in Australia**
- **Conventional mining technologies tested (1975-1990), but**
  - Too high power consumption to achieve target size
  - Ball/tower mills ineffective below 20-30µm
  - Negative influence of steel grinding on flotation





IsaMill™ Technology Development

A technology was found...

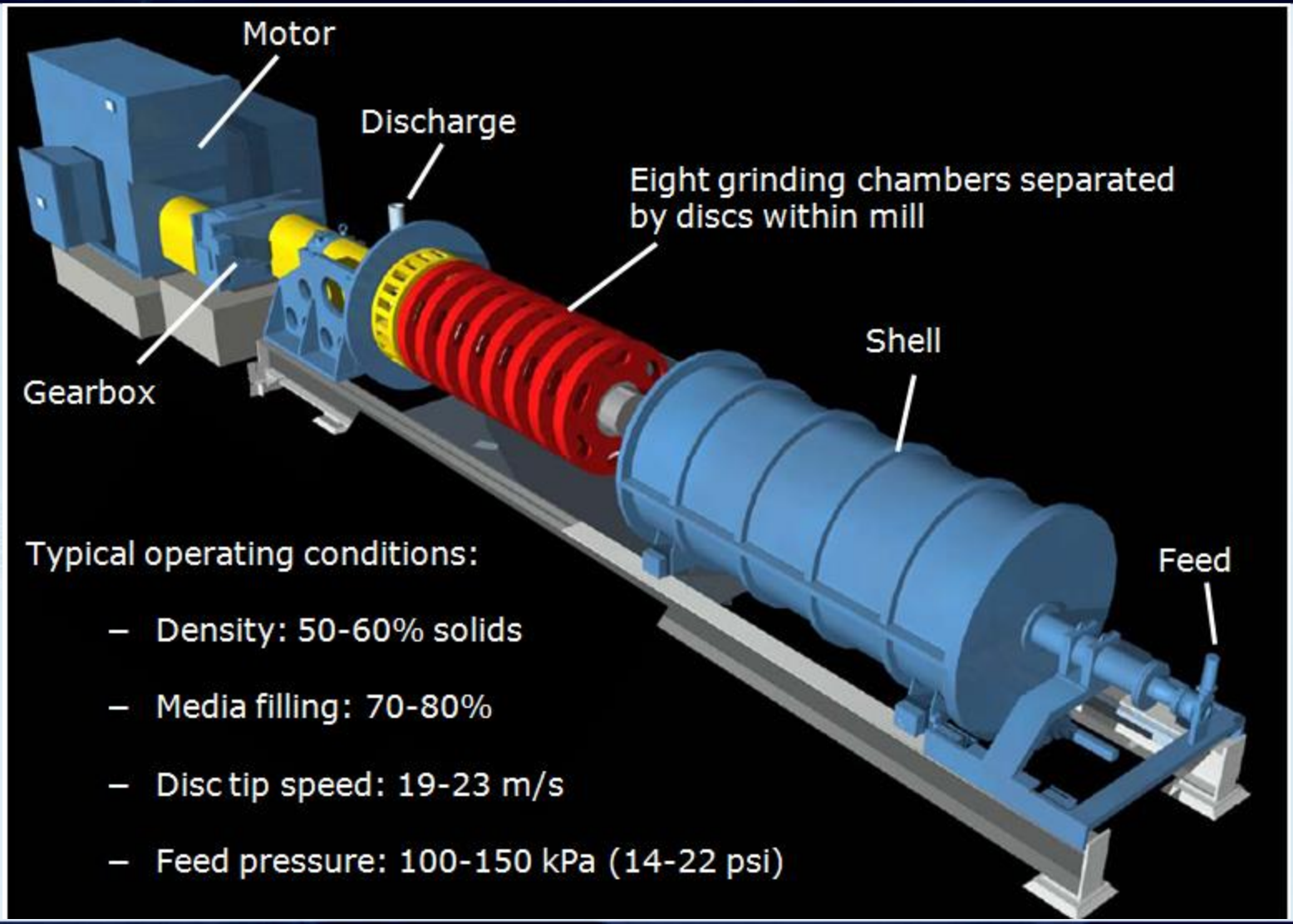
- **Horizontal Bead Mills**
  - Used in industries other than mining (pharmaceuticals, paint, food, etc.)
  - Small, batch scale
  - Very expensive and exotic media types
- **Cross-over into mining required:**
  - Much larger scale
  - Continuous operation
  - Ability to use cheap, local media

IsaMill™ Technology Development

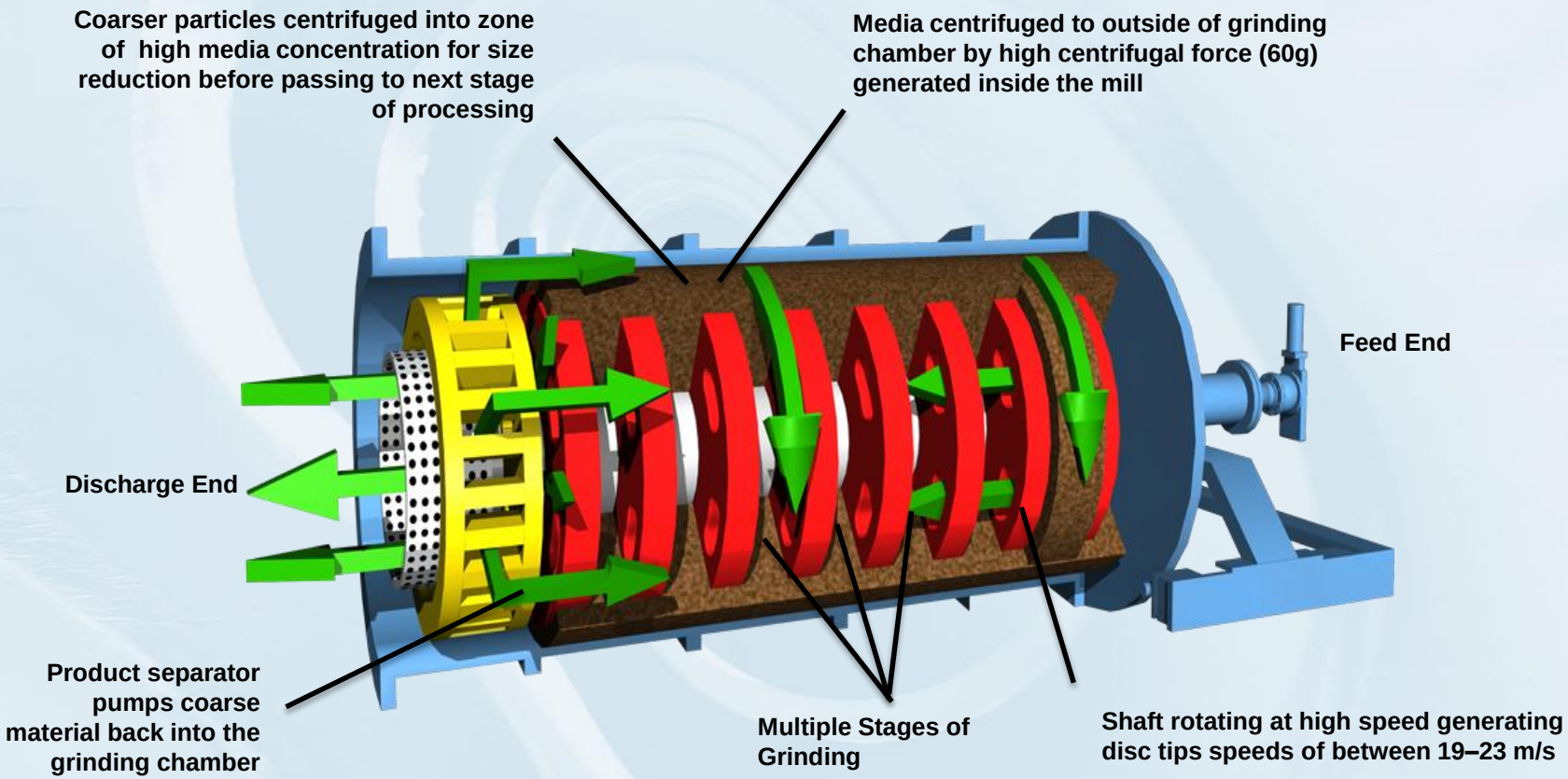
- **First large scale mill (3,000 litres, 1.1 MW) was developed jointly by Xstrata and Netzsch and named the IsaMill™**
- **First installed at Mount Isa Mine, 1994**
- **Enabling technology for McArthur River Mine, 1995**

McArthur River Mine, Australia

IsaMill™ Overview



IsaMill™ Operating Principle



IsaMill™ Grinding Chamber

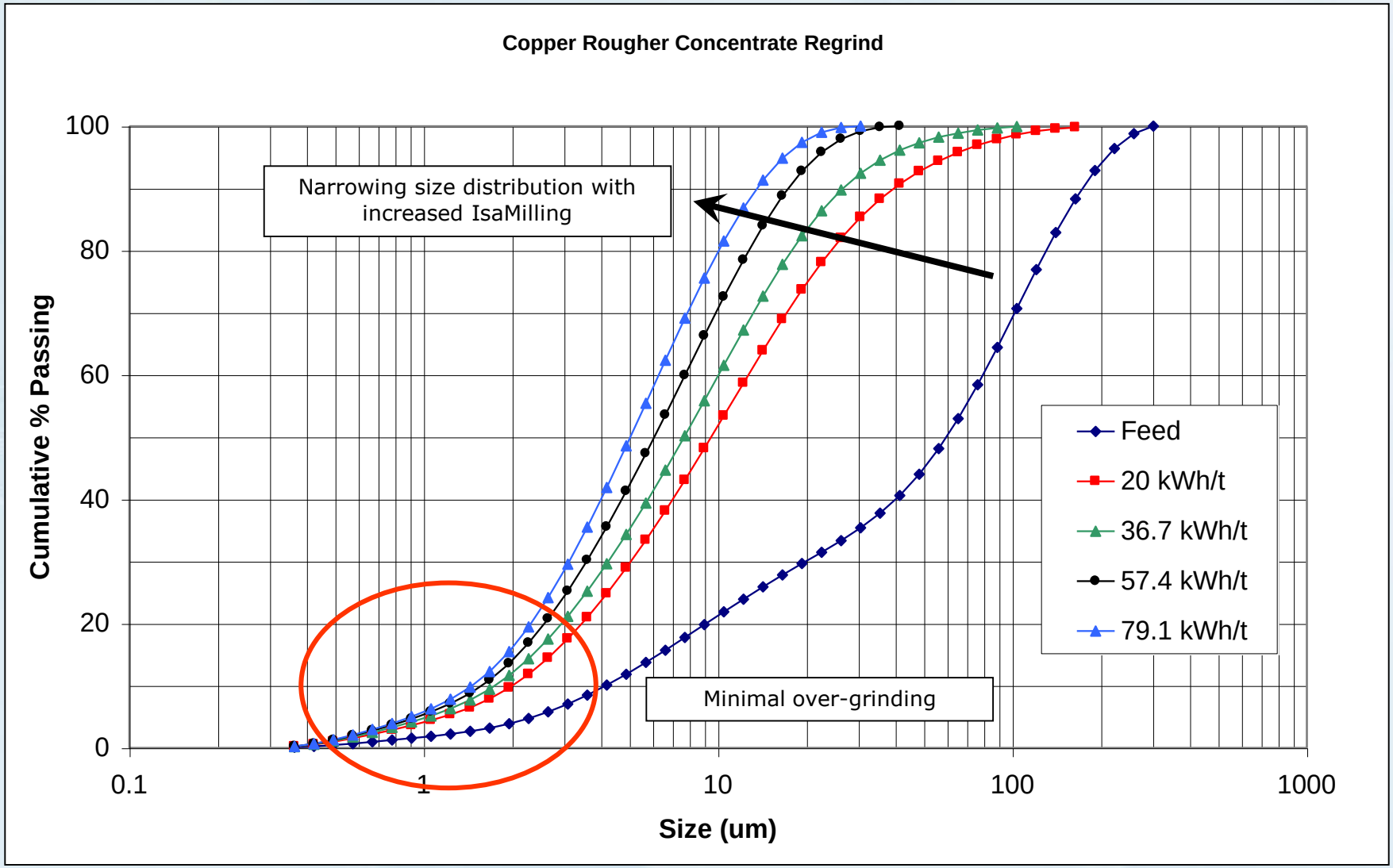
IsaMill™ Operating Principle

IsaMill™ Scale-Up "Signature Plot" Test

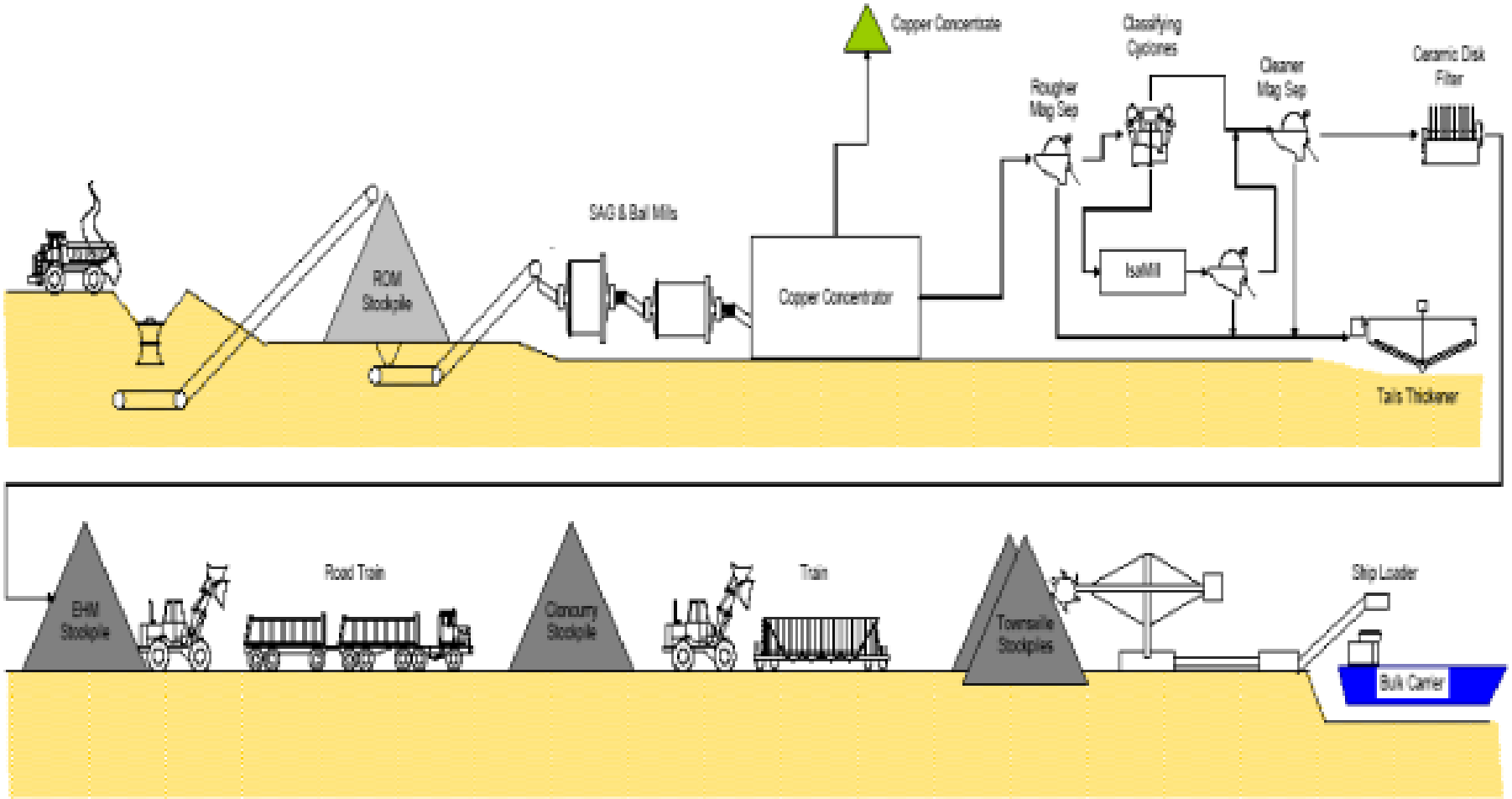
- **Used for sizing IsaMills™**
- Semi-Continuous test producing specific energy not a work index
- Conducted in 4-litre IsaMill™ similarly proportional to full-scale
- Uses identical media to full-scale
- Conducted similar same operating conditions as full-scale- **Same grinding mechanism**
  - Feed density, feed pressure,, mixing pattern, power intensity, residence time
- No correction factors, 1:1 scale-up

4-litre IsaMill™

Reduced Overgrinding



Unlocking the Value of Waste: Ernest Henry Mining Case Study



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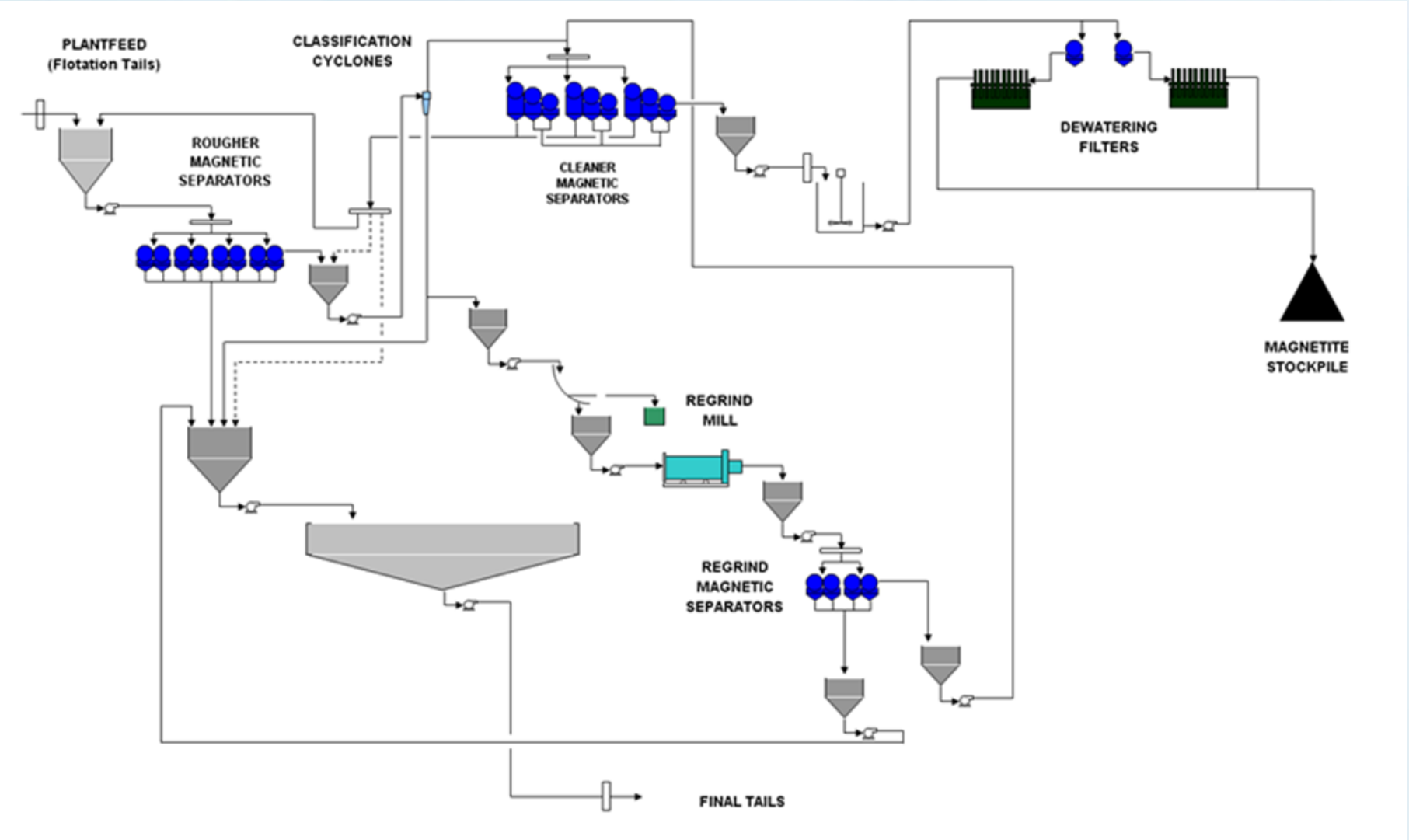

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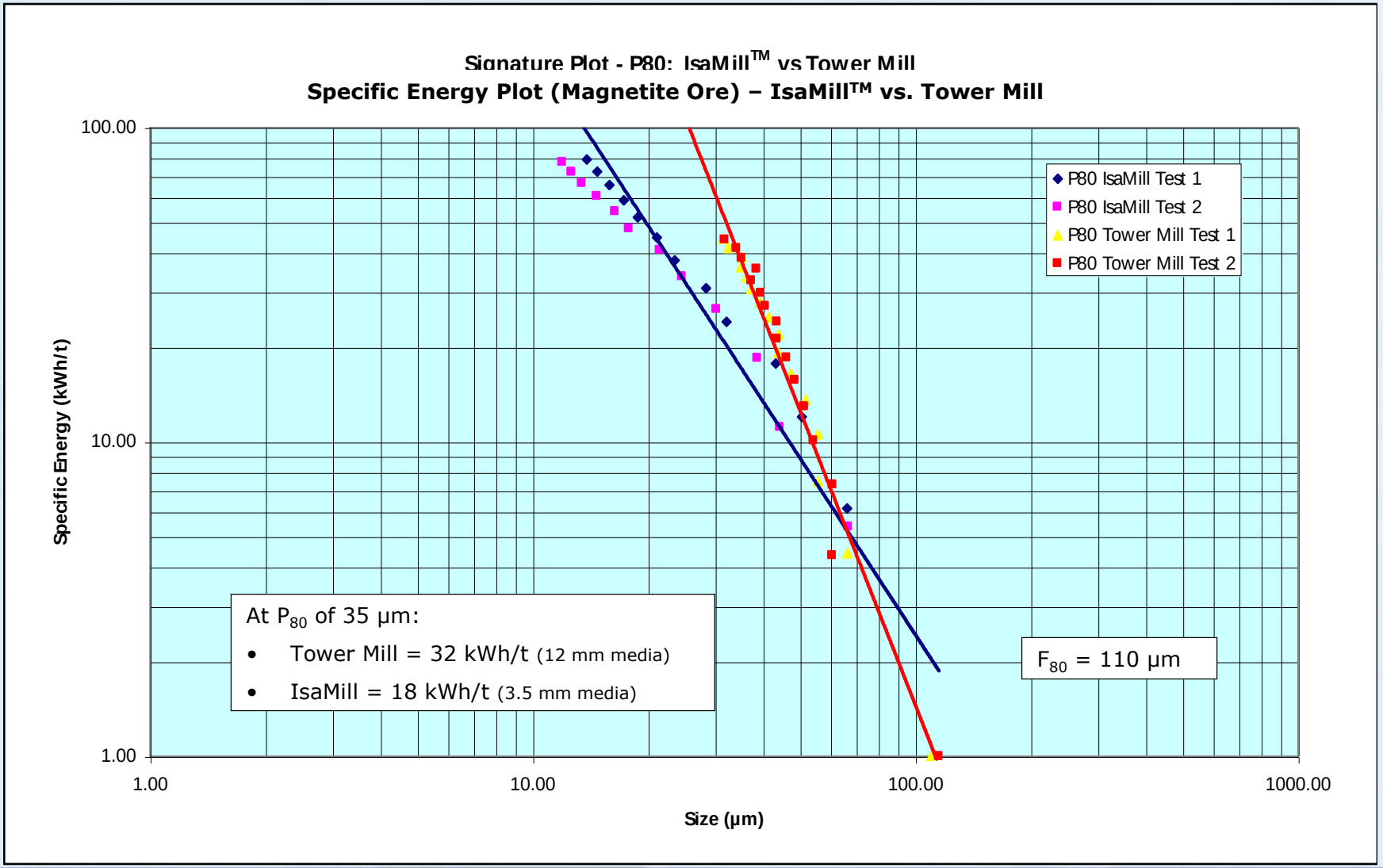

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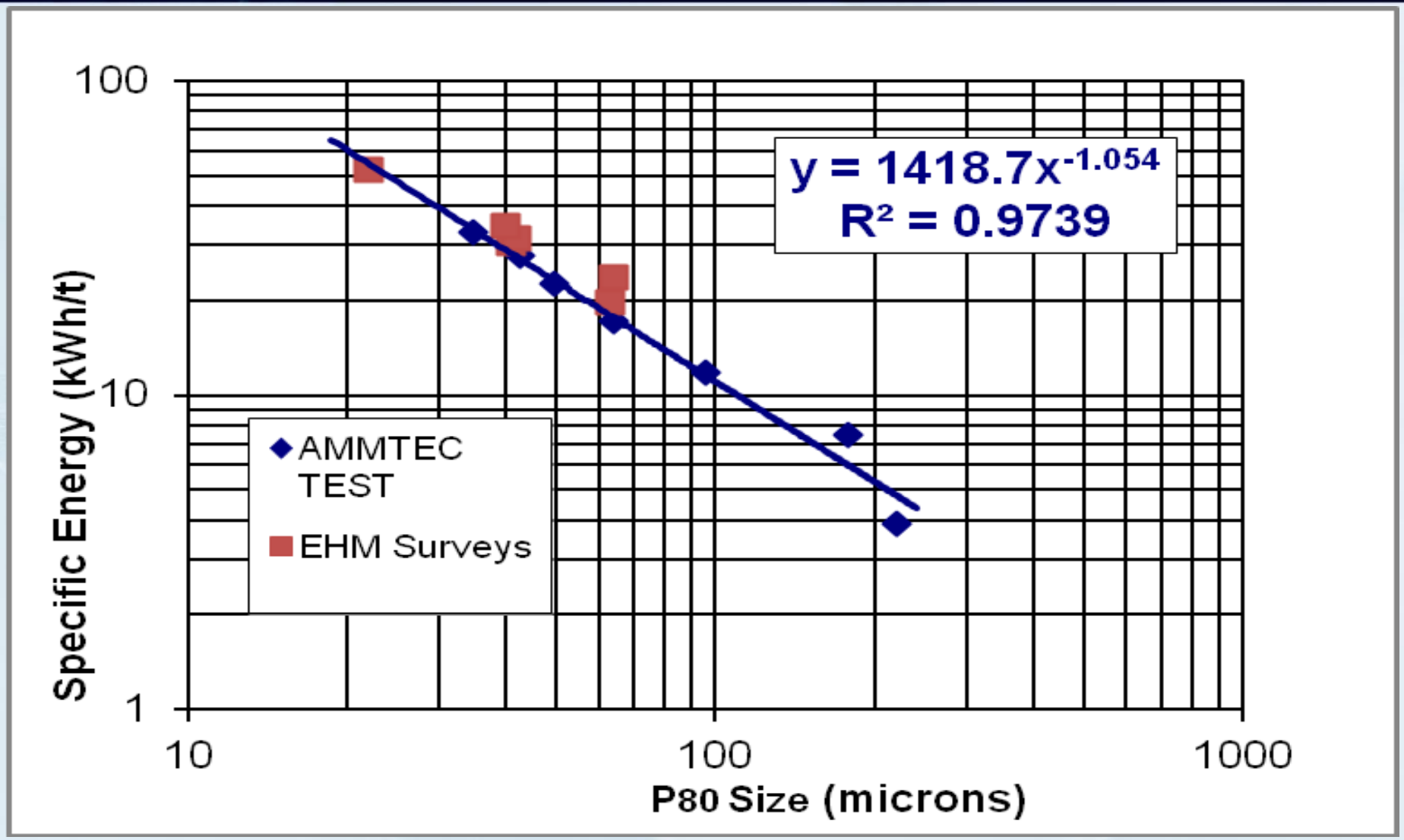

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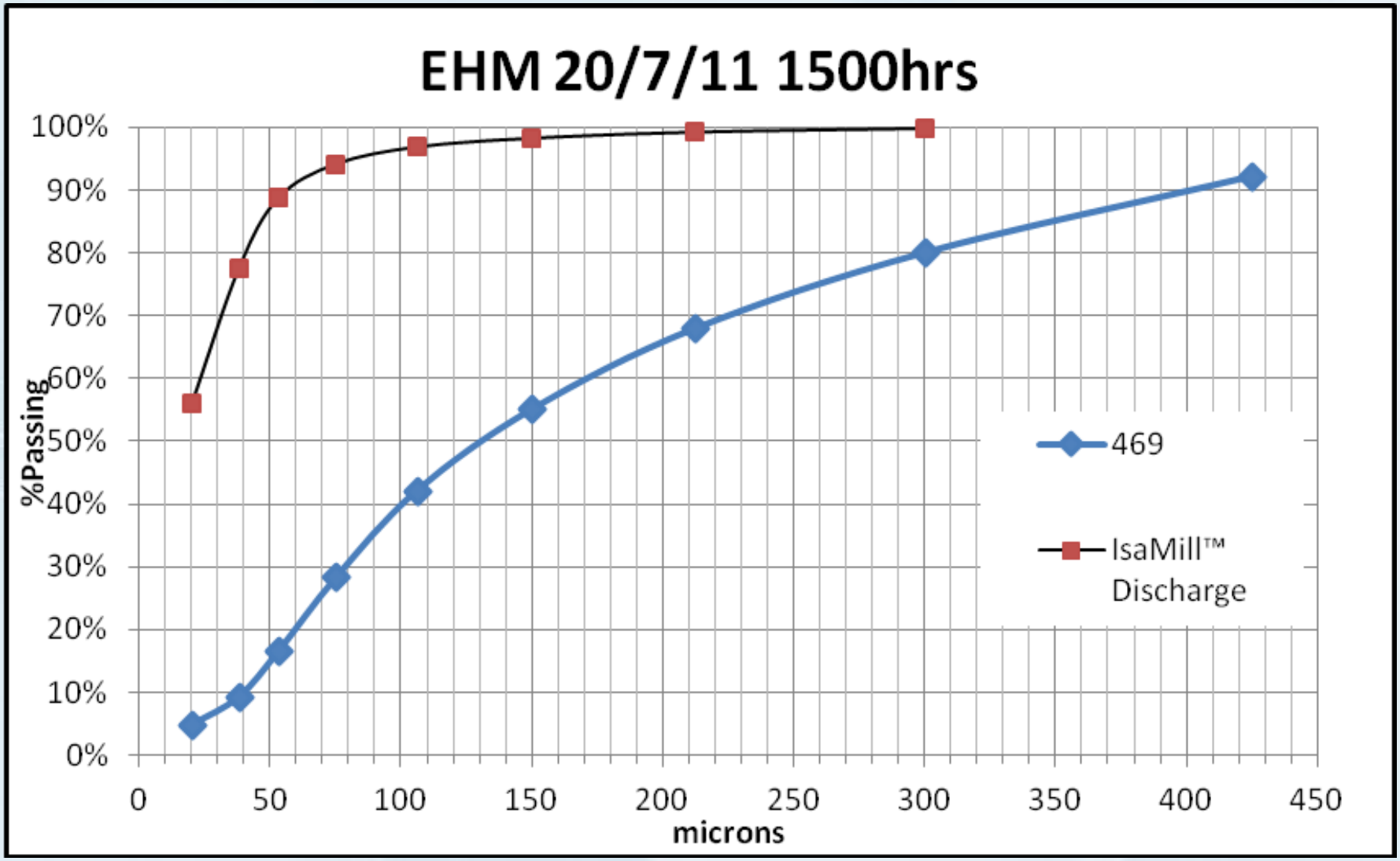


Questioning Traditional Circuit Design – Western Australian Case Study

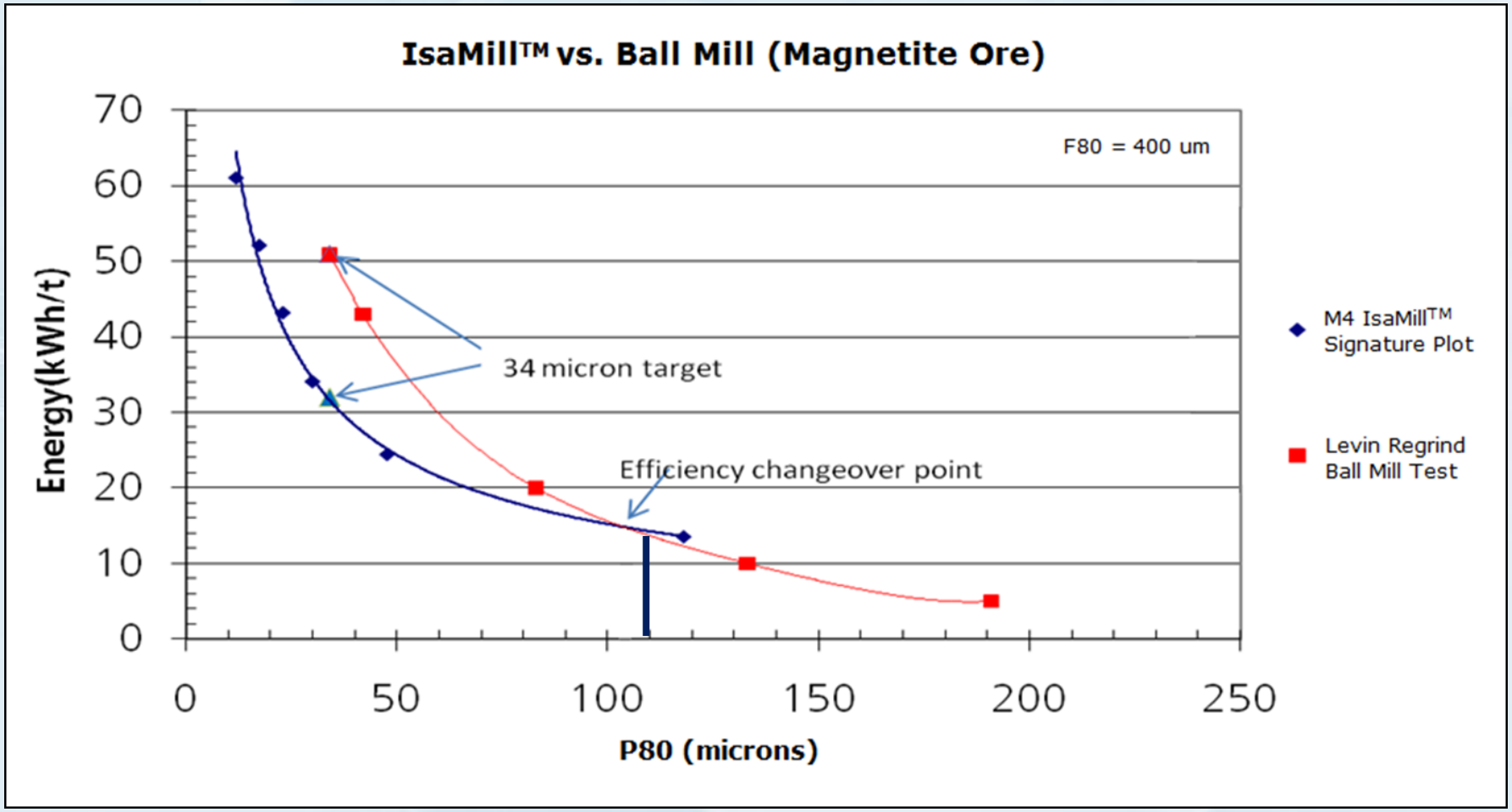
- The development of Western Australian magnetite deposits has resulted in the design of some of the largest grinding mills and plants in the world.
- As a result of the predicted power consumptions required coupled with the remoteness of the proposed installations the push to design ever more energy efficient circuits has been paramount.
- As reported by David, Larson and Li (2011) the development of one of these deposits with a feed tonnage of 3800 tph and a final product size requirement of 34 µm meant the grinding requirement would be extensive.
- The testwork design therefore had to look at optimization of the process flowsheet to take advantage of the strengths of various grinding technologies to reach the final grind size while ensuring adequate liberation and gangue rejection along the way

Questioning Traditional Circuit Design – Western Australian Case Study

- Grinding work - Pilot autogenous primary milling, laboratory work (Levin test) and pilot secondary ball milling, laboratory and limited continuous secondary IsaMill testing, laboratory tertiary, limited continuous and pilot IsaMill testwork,
- Magnetic separation testwork - Davis tube and pilot magnetic separation tests of the different intermediate and final products,
- Hydroseparating tests of the final IsaMill magnetic concentrate,
- Sulfide flotation tests of the final magnetic concentrate, and
- Final concentrate filter testing by vendors.

Questioning Traditional Circuit Design – Western Australian Case Study

- Secondary ball (using the Levin test) and IsaMill™ testwork was completed to establish the most efficient energy use of the two technologies.



Questioning Traditional Circuit Design – Western Australian Case Study

- The following table shows the relative energy and media costs comparison in using a single stage ball mill vs a single stage IsaMill™ vs two stage ball and IsaMilling to achieve 34 µm product.

	Section Feed Rate (t/h)	Specific Energy (kWh/t)	Installed Power (MW)	Annual Media Cost Estimate ($AUD million)
Autogenous Mill 770 µm Product	3800	8.5	40	$0
Option 1:Single Stage Ball Mill 34 µm Product	2200	47	114	$86
Option 2: Single Stage IsaMill 34 µm Product	2200	34	78	$57
Option 3: Ball Mill 100 µm Product	2200	12	34	$13
IsaMill 34 µm Product	1720	13	24	$11
Option 3 Total			58	$24

- When compared against a traditional single stage ball mill circuit the flowsheet designed for this circuit has resulted in grinding power savings of nearly 50% (56 MW) and $60 million annual savings in grinding media.

The Evolution of the IsaMill into Magnetite Processing

The evolution of IsaMill™ technology from an ultrafine grinding technology to a mainstream and regrind technology has resulted in wide acceptance in many metalliferous applications where utilizing the IsaMill™'s key advantages of energy efficiency, high intensity and circuit efficiency.

These advantages have now been transferred to the magnetite flowsheet development and plant design.

The Evolution of the IsaMill into Magnetite Processing

Thank you to:

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