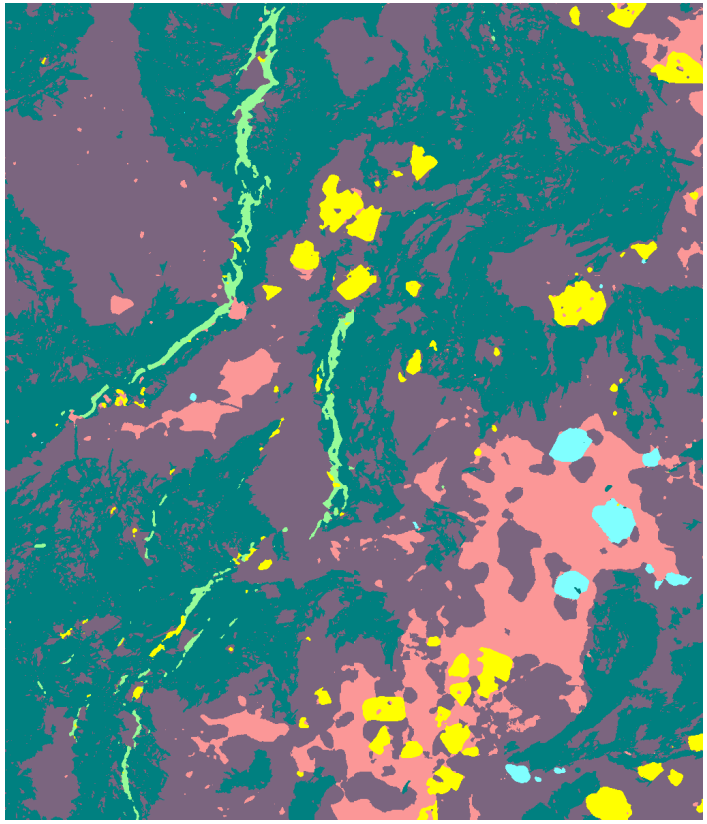
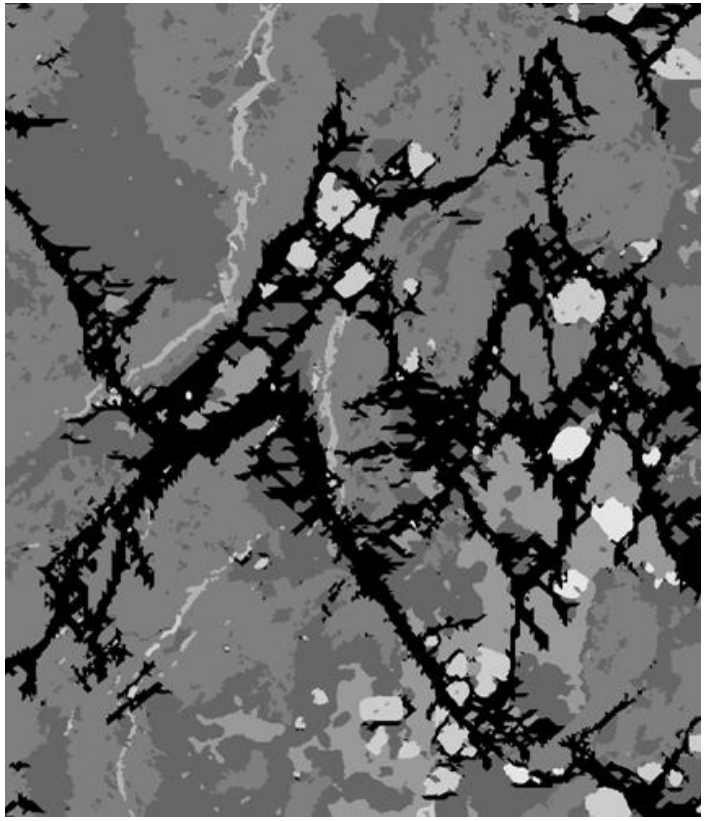
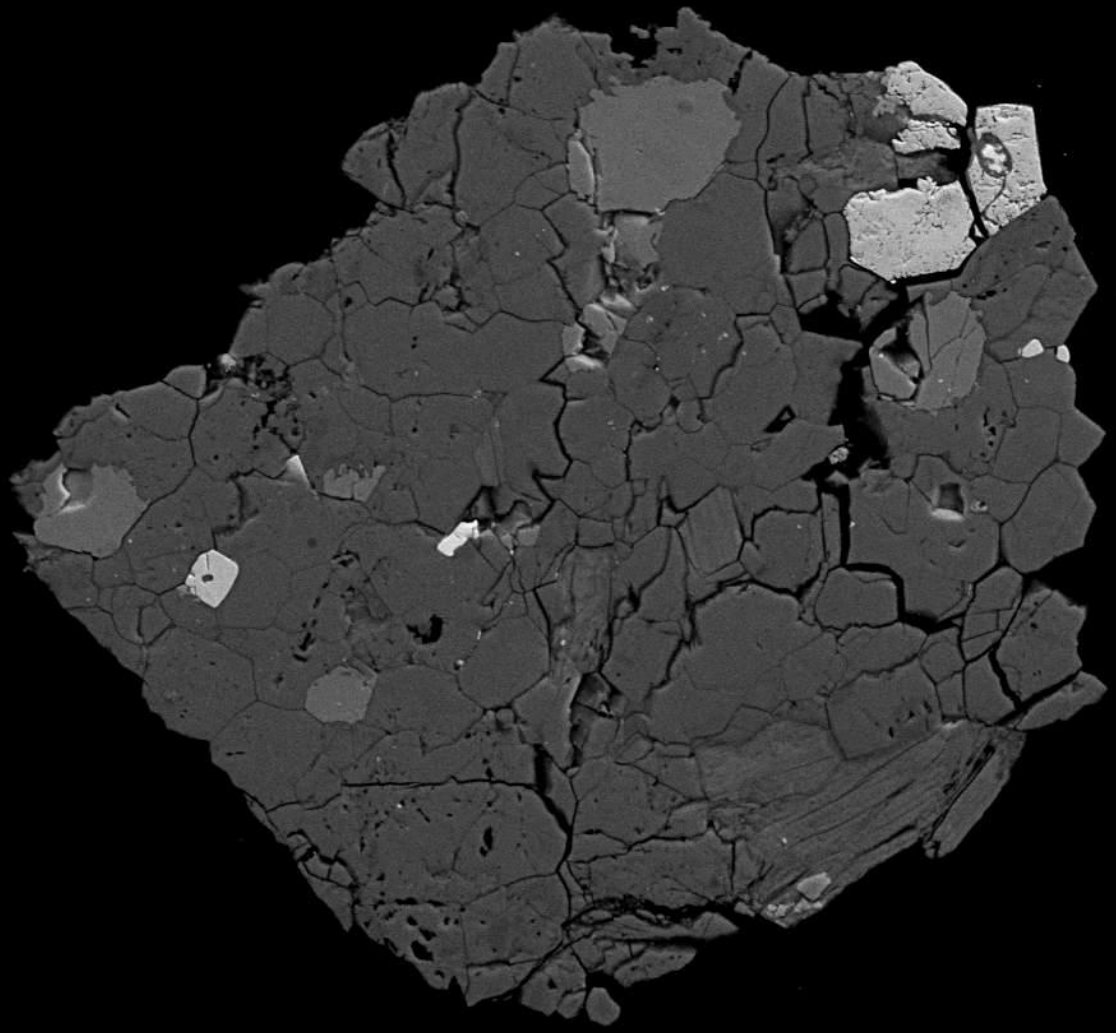
Texture-driven non-random fracture



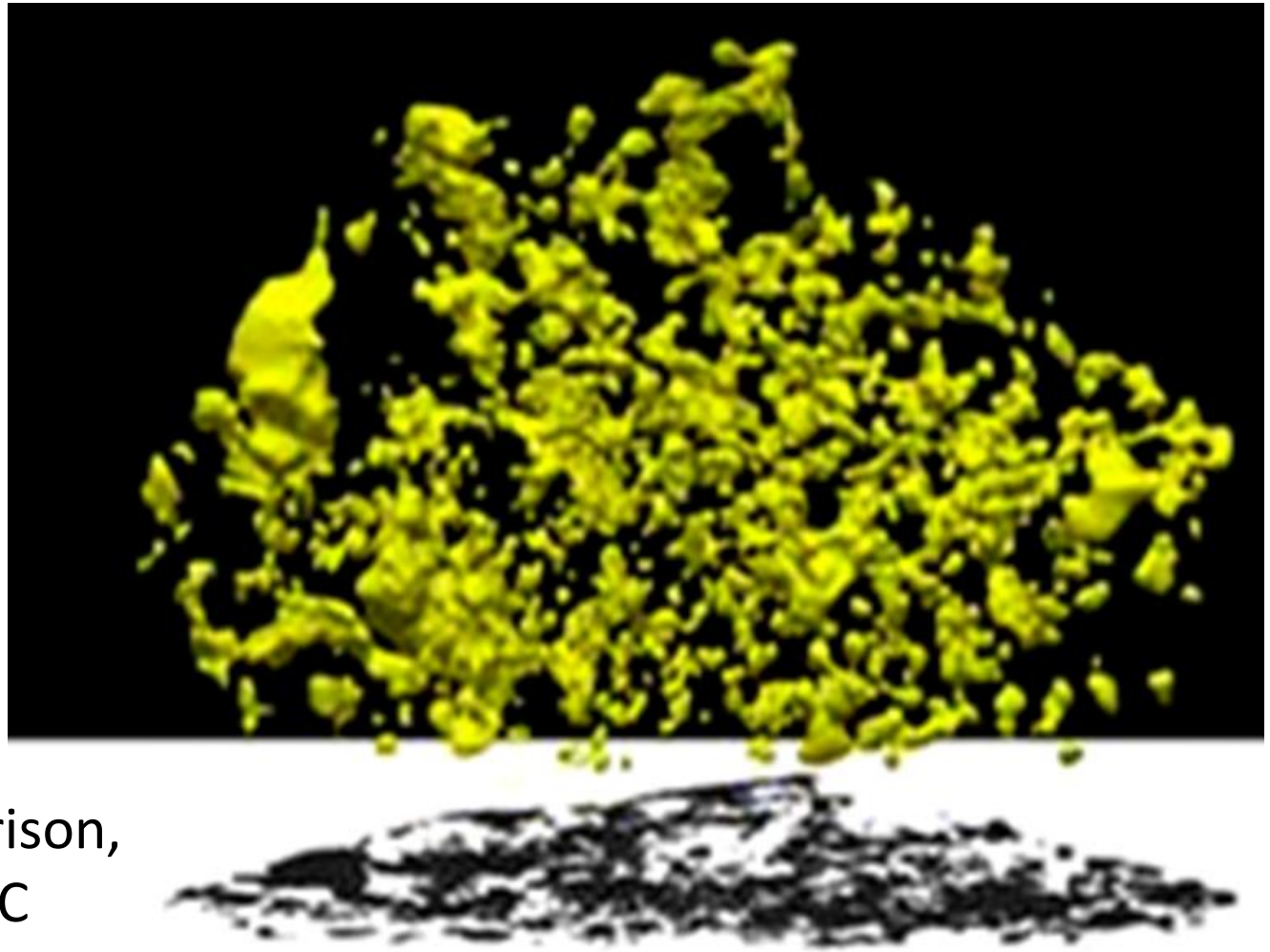


Yicai Wang (JKMRC)



Cathy Evans,
JKMRC

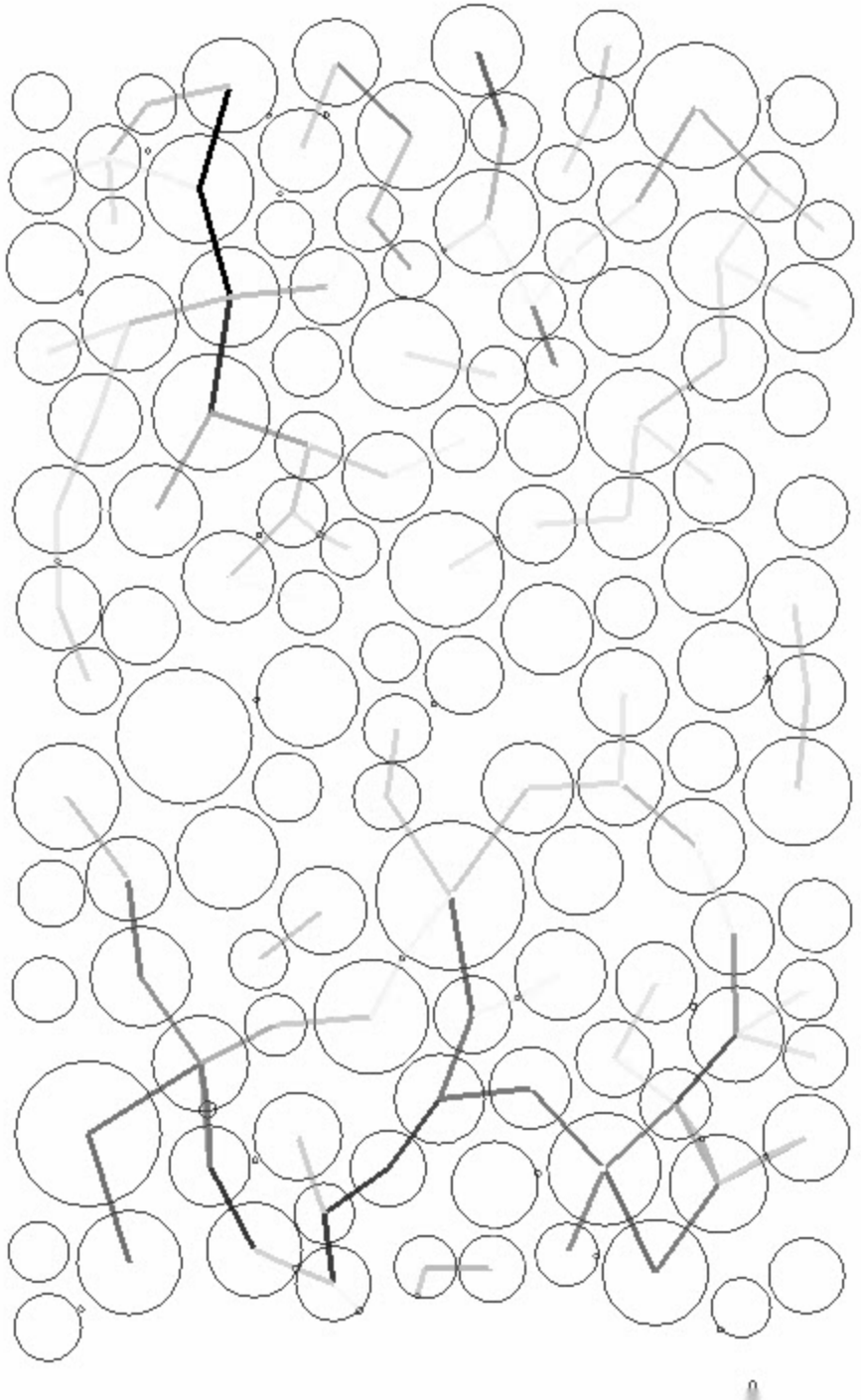
What have we learned in the last 20 years?
Tomography

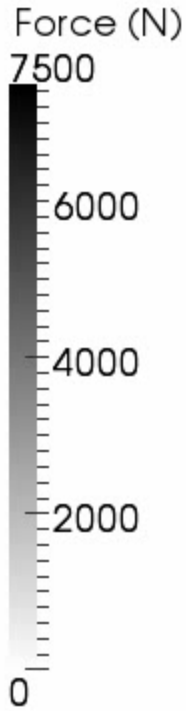


Rob Morrison,
JKMRC

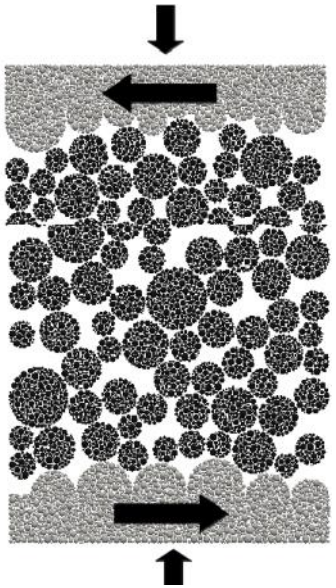
What have we learned in the last 20 years?

- The physics of breakage ……





Dion Weatherley, JKMRC



What have we learned in the last 20 years?

- Efficient classification is key to efficient comminution.
- We have improved models of cyclone classification.
- 3-product cyclone

What have we learned in the last 20 years?

- Very fine grinding is economically possible with stirred mills.

IsaMill

Vertimill

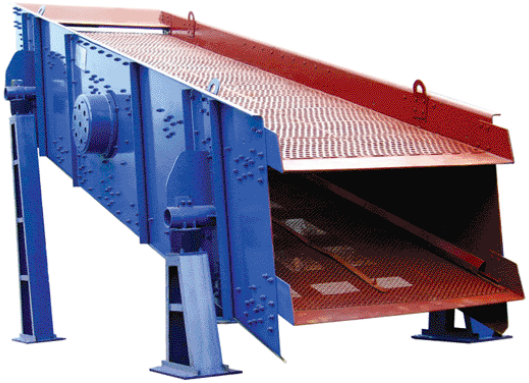
What have we learned in the last 20 years?

- HPGR has a role for the right ore and in the right flowsheet

Boddington, WA

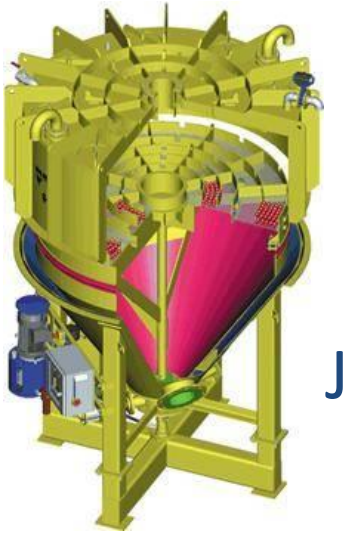
What have we learned in the last 20 years?

- Pre-concentration is a real option



Screen

Sorter

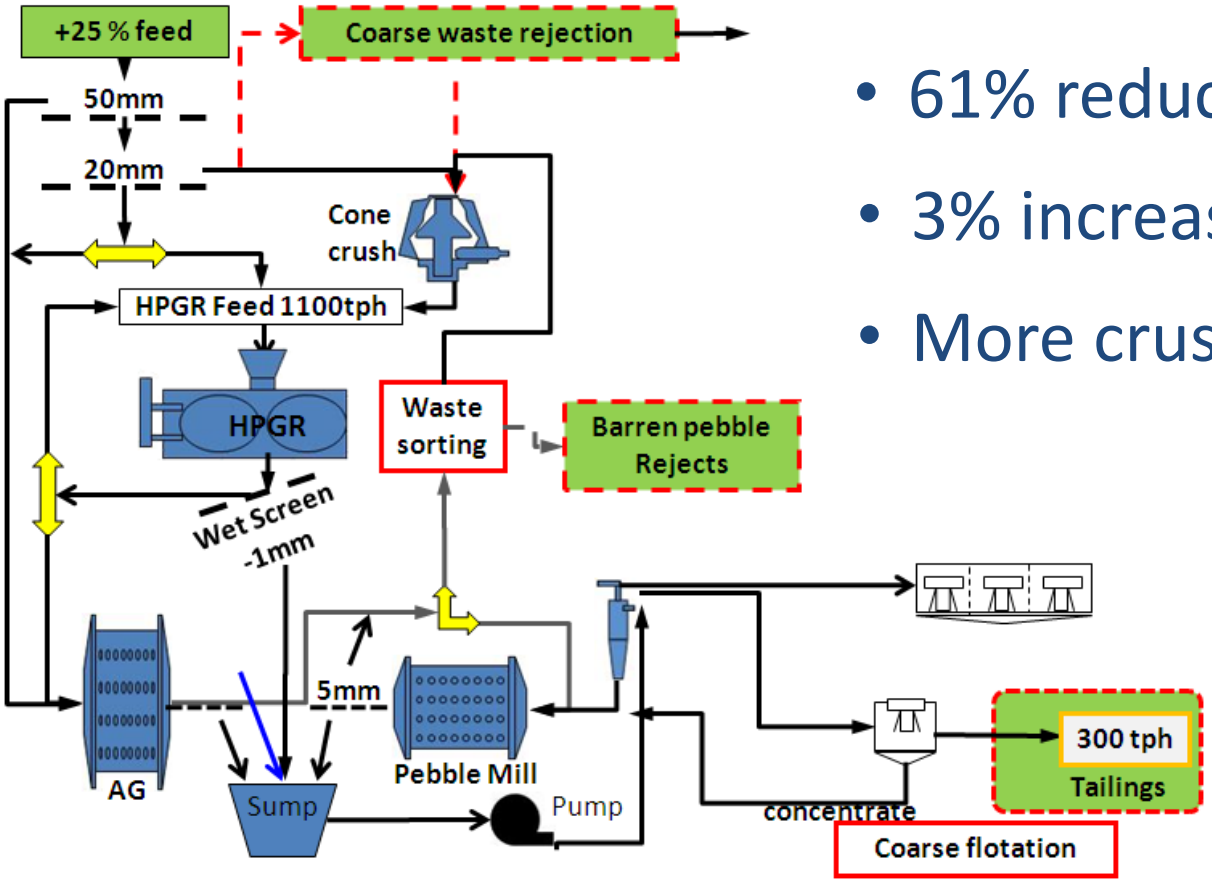


Jig

DMS

What have we learned in the last 20 years?

- Novel flowsheets can reduce energy consumption



- 61% reduction in energy
- 3% increase in recovery
- More crushing, less grinding

Malcolm Powell
JKMRC

What have we learned in the last 20 years?

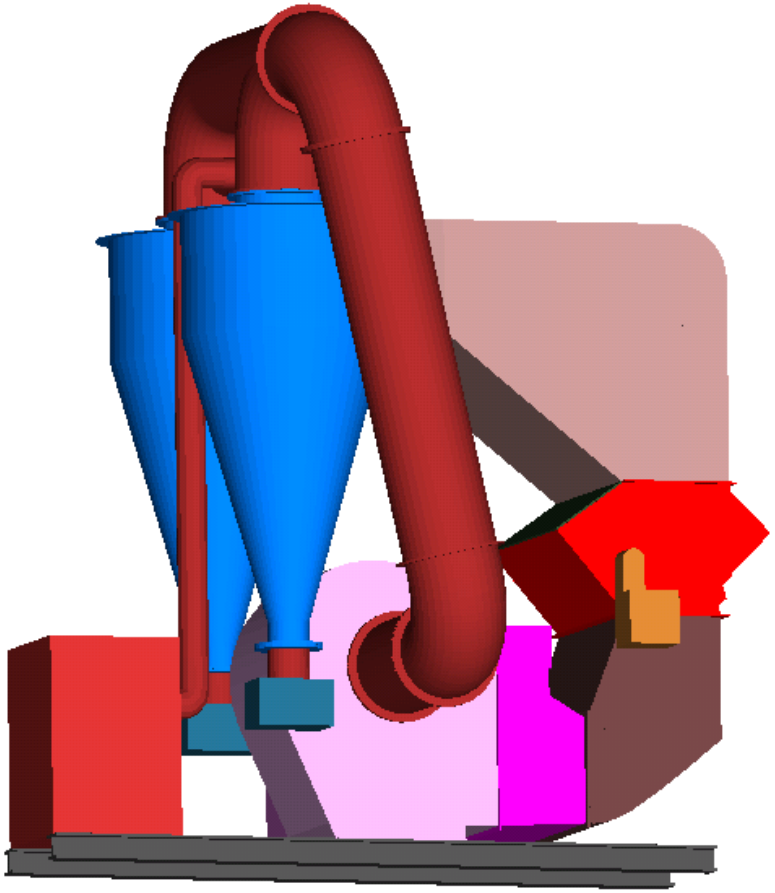
- SelFrag *may* actually be different.

Frank Shi, JKMRC

What have we learned in the last 20 years?

- Air-milling *may* actually be different.

Plasma mill



What have we learned in the last 20 years?

- Feed particle size and shape matter.
- Repeated impact and damage matter.
- Comminution models are now less empirical and more fundamental.

$$t_{10} = M\left\{1 - \exp\left[- f_{mat} \cdot x \cdot k\left(E_{cs} - E_{\min}\right)\right]\right\}$$

Shi and Kojovic (2007)
from Vogel & Peukert

Three key questions:

2. Can we reduce comminution energy consumption substantially?

Yes

- 10-30% using what we know now
- Over 50% with new technology

Three key questions:

3. What are the drivers for comminution energy reduction?

….. will we do anything about it?

Drivers for comminution energy reduction:

- Cost
- Competition
- Compliance
- Community
- Culture
- Crisis

Is energy-efficient comminution doomed?

Action now…

- **INTEGRATION AND APPLICATION OF WHAT IS ALREADY KNOWN**
- Training and professional development

Longer term research targets…

- Exploit fundamental understanding of breakage.
- 3-product cyclone.
- Pre-concentration.
- Improved metrics (eg kWh/t metal); benchmarking.
- SelFrag.
- Air milling.

Barriers to action…

- Inappropriate metrics (technical and financial)
- Inadequate incentives and KPIs
- Conservatism and risk-aversion
- IP issues
- Silo mentality
- Human frailties

Drivers for comminution energy reduction:

- **Cost**
- Competition
- **Compliance**
- Community
- Culture
- **Crisis**

…encouragement from the top

"…we must reduce our emissions from our own operations …(and)…*contribute our own technical and market expertise to find solutions* [to climate change]*"*

Andrew Mackenzie
CEO, BHP Billiton
4th March 2014

The measure of a man is what he does with power

- *Plato* *(429-347 BCE)*

SMI JKMRC
Julius Kruttschnitt Mineral Research Centre