Technical Development of Impurity Removal in Mineral Processing

Reduction of Arsenic in Copper Concentrates

Professor Neville Plint

Director: Sustainable Minerals Institute
The University of Queensland’s Sustainable Mineral Institute

Our purpose is to create change for

Responsible Resource Development
The University of Queensland’s Sustainable Mineral Institute

- Future Focused
  1. Game changing leaders
  2. Partnerships
  3. Global impact
  4. Infrastructure

UQ is a top 50 University

Institute’s strengths
- 1. Values driven
- 2. Independent
- 3. Breadth and Depth
- 4. Multi-disciplinary

Ranked No 1 in the world for mining and minerals engineering 2018
Shanghai Rankings global subject rankings
Integrated, applied research addressing global challenges

Unlocking Complex Orebodies
Transforming Mine Lifecycles
Digital Mine
Organisation Governance and Leadership
Transformational Learning

Health and Safety
Social Responsibility
Water Management
Land Rehabilitation
Geology
Mining and Metallurgy
Geology

Integrated, applied research addressing global challenges
Increasing demand and decreasing grades……

Copper supply crunch earlier than predicted – experts, Hamish Sampson, Analyst at CRU’s Copper Team. Mining.com
Complex Orebodies Program - Undeveloped copper deposits

*S&P Market Intelligence; deposits that contain >500kT Cu metal & are not production-visible
Complex Orebodies Program - Undeveloped copper deposits

Prof. Rick Valenta – Program Lead and Director, Sustainable Mineral Institute. Complex orebody program.
Complex concentrates


From 2010 to 2016, in this dataset:
Only three mines have decreased arsenic content in concentrate
14 mines have the same arsenic content in concentrate
19 mines have increased arsenic content in concentrate

Prof. Rick Valenta – Program Lead and Director, Sustainable Mineral Institute. Complex orebody program.
Challenges of arsenic management across the value chain

**Mining**
- Economics of selective mining
- Similarity in physicochemical characteristics during flotation.
- Lack of market for high arsenic concentrate.

**Processing**
- Arsenic emissions upon roasting.
- High financial penalties by smelters.

**Smelting**
- Not amenable to conventional leaching technologies.
- Requirement for Safe storage of final residues.

**Hydro-met**
- Ground and surface water contaminants.
- Requirement for safe storage of final processing residues.

**Tailing**

Adapted from Maedeh Tayebi-Khorami, IMPC 2018 conference presentation
Is it possible to remove Arsenic bearing minerals by flotation?

Chalcopyrite \((\text{CuFeS}_2)\) – 34wt% - Cu

Chalcocite(\(\text{CuS}_2\))

Enargite \((\text{Cu}_2\text{AsS}_4)\) – 48wt%Cu

Dr. Lisa Forbes – Research leader, Sustainable Mineral, Separations
What feed do we need for down stream processes?
Focus of our research

Run of Mine Ore → Comminution & Classification → Electrochemically Controlled Flotation → Low Arsenic High Copper Concentrate → Smelter Treatment

FOCUS AREA

High Arsenic High Copper Concentrate → Further Treatment (Roasting/Leaching)

Low Arsenic Low Copper Tails → Tailings Dam

Dr. Lisa Forbes – Research leader, Sustainable Mineral, Separations
Opportunity – selective separation

Bulk Flotation
Eh +200

Arsenic Separation
Eh 0

Copper Flotation
Eh +200

High Cu - Low As Concentrate

Low Cu - High As Concentrate

Reference: Senior (2006), single mineral study
Can this approach be applied to a complex copper ore?

A Complex Copper Ore Deposit

Size-by-Size Chemical and Mineralogical Characteristics

Flotation Testwork at Different Eh Values

- Liberation Characteristics
- Surface Chemistry
- Water Chemistry
- Gangue Mineralogy

Adapted from Maedeh Tayebi-Khorami, IMPC 2018 conference presentation
Ore deposit behaves differently

Adapted from Maedeh Tayebi-Khorami, IMPC 2018 conference presentation
Differential size reduction

Adapted from Maedeh Tayebi-Khorami, IMPC 2018 conference presentation
Proposed flowsheet using size deportment and electrochemistry

New developments that have the potential to enhance separation

- High Voltage Pulse: Communion Preconditioning
- Hydrofloat: Coarse Particle Flotation, Less Energy, Increased Recovery
- Flotation Optimisation: Less Energy, Higher Recoveries, Less Impurities
- Microwave Dewatering Tailings: Less water, Reprocessing
- New Reagents: Less impurities in concentrates
- Classification – Flotation Performance

Reference: Kym Runge – Group Lead SMI-JKMRC
International collaborations to address arsenic

REAK - REDUCTION OF ARSENIC IN COPPER CONCENTRATES

Proposal Preparatory meeting
Alzenau, July 5th

Fraunhofer
ISC
PROJEKTGRUPPE IWKS

CRICOS code 00025B
Land rehabilitation using phyto-extraction

Element Case Studies: Arsenic

Tongbin Chen, Mei Lei, Xiaoming Wan, Xiaoyong Zhou, Jun Yang, Guanghui Guo, and Wen Cai

Arsenic contaminated soil is a major issue in PR China. The discovery of an As hyperaccumulator fern, *Pteris vittata* opens a door for phytoextraction of As-contaminated soils. *In situ* phytoextraction projects using *P. vittata* have been established that achieved high removal rates of As. The first phytoextraction project in the world was established in Chenzhou, Hunan Province. Subsequently, more phytoextraction projects were established in Guangxi Zhuang Autonomous Region, Yunnan Province, Henan Province and Beijing. During these field-based projects, the safe disposal and re-utilization of *P. vittata* biomass were considered essential processes. Incineration technologies for *P. vittata* biomass are well developed. Safe landfiling has been applied for the disposal of the burned ash of *P. vittata* when the amount of that ash is small. When the ash amount is large, a recycling method has to be applied. Agromining of Ni has been successfully achieved, but agromining of As is at present only an idea, owing to the low commercial value of As. Nevertheless, production of a biofuel resulting from the incineration process, together with the recycling of As, could be a potential opportunity for agromining of this metalloid.
Pteris vittata can grow in tailings with levels of As over 20,000ppm.
Can plant teach us about selective separation?

Conclusion

• Manage arsenic at source
• Value chain optimization – flexible integrated circuits
• Opportunities for further research
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Thank you

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References


Smith, L.K., Davey, K.J., Bruckard, W., 2012. The Use of Pulp Potential Control to Separate Copper and Arsenic - An Overview Based on Selected Case Studies, XXVI International Mineral Processing Congress, New Delhi, India, pp. 5057 - 5067.


