Technical Development of Impurity Removal in Mineral Processing

Reduction of Arsenic in Copper Concentrates

Professor Neville Plint

Director: Sustainable Minerals 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
- Transformational Learning
- Organisation Governance and Leadership
- Social Responsibility
- Land Rehabilitation
- Health and Safety
- Water Management
- Geology
- Mining and Metallurgy
- Geology
Increasing demand and decreasing grades……

Copper supply crunch earlier than predicted – experts, Hamish Sampson, Analyst at CRU’s Copper Team. Mining.com

Brook Hunt and USGS, 2016
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

535mT Cu metal

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

Processing
- Similarity in physicochemical characteristics during flotation.
  - Lack of market for high arsenic concentrate.

Smelting
- Arsenic emissions upon roasting.
  - High financial penalties by smelters.

Hydro-met
- Not amenable to conventional leaching technologies.
  - Requirement for Safe storage of final residues.

Tailing
- Ground and surface water contaminants.
  - Requirement for safe storage of final processing residues.

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

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

<table>
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<th>High Voltage Pulse</th>
<th>Hydrofloat</th>
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<td>Coarse Particle Flotation Less Energy Increased Recovery</td>
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<td>Less water, Reprocessing</td>
<td>Less impurities in concentrates</td>
<td>Enables Coarse Particle Flotation Less Energy Higher recoveries</td>
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</table>

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
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 reutilization of P. vittata biomass were considered essential processes. Incineration technologies for P. vittata biomass are well developed. Safe landfilling 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.

Reference: Chen et al., Chapter 18. A. van der Ent et al. (eds.), Agromining: Farming for Metals, Mineral Resource Reviews, DOI 10.1007/978-3-319-61899-9_17
Pteris *vittata* can grow in tailings with levels of As over 20,000 ppm.

Ref. P. Erskine and A. van der Ent et al. unpublished results
Can plant teach us about selective separation?

Conclusion

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

Research conducted by Maedeh Tayebi-Khorami for her PhD thesis,
Supervised by M., Manlapig, E., Forbes, E., Bradshaw, D., Edraki, M
Sponsored by UQ/SMI and CSIRO

Contributions from Prof. Rick Valenta, Prof. Kym Runge and Prof. Peter Erskine
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.


