SMI JKMRC
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Surface chemistry and flotation – A potential application in GeoMet

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GeoMet

- Prediction of flotation performance of ores is an important aim of Geometallurgy
- Mineralogy and ore texture affects recovery, but…
- There will also be surface chemistry effects from other minerals present in the system in combination with reagents and water quality which will affect recovery response
- Surface chemistry analysis has the potential to be included in a geometallurgical study to help predict flotation performance or determine the mechanisms (or reasons) why different ore types respond differently
- Potential to address problems with specific ore types and optimise recoveries

CORRELATING SURFACE CHEMISTRY WITH PARTICLE HYDROPHOBICITY AND FLOTATION

PhD Overview

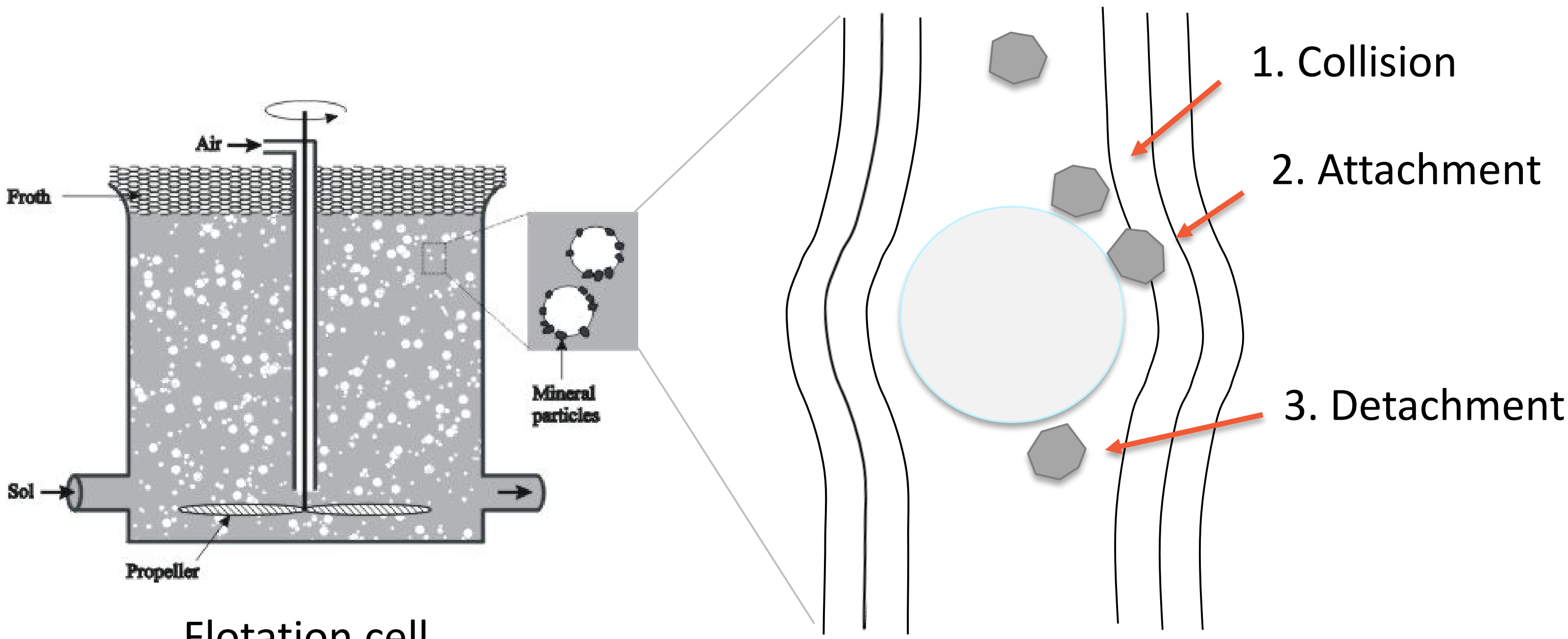
Ian Wark Research Institute, UniSA

AMIRA P260

The University of Queensland
Australia
SMI JKMRC
Julius Kruttschnitt Mineral Research Centre

Background - Flotation

3 sub-processes:



Flotation cell

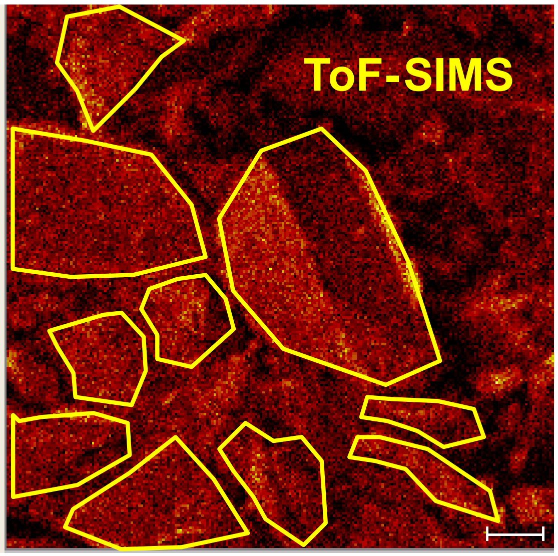
$$E_{Collection} = E_{Collision} \cdot E_{Attach.} \cdot E_{Stability}$$

Surface chemistry

Dai, Z, Fornasiero, D & Ralston, J 1999, 'Particle-bubble attachment in mineral flotation', *Journal of Colloid and Interface Science*, vol. 217, pp. 70-76.

PhD: Correlating surface chemistry with particle hydrophobicity and flotation

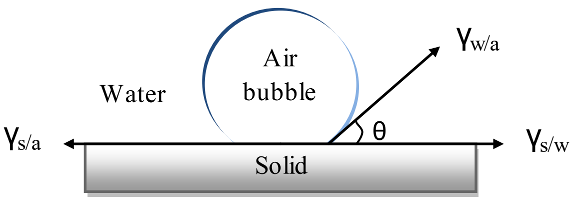
Surface analytical techniques



Surface chemistry

Flotation

Recovery



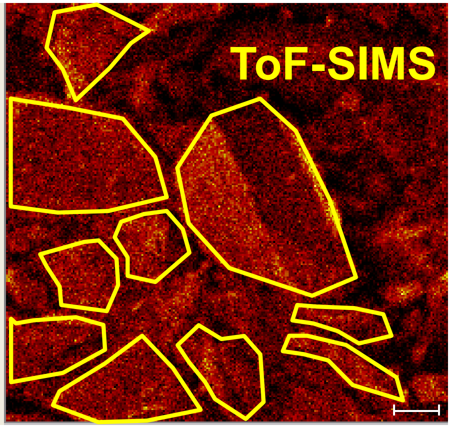
Modified after Wills (1988)

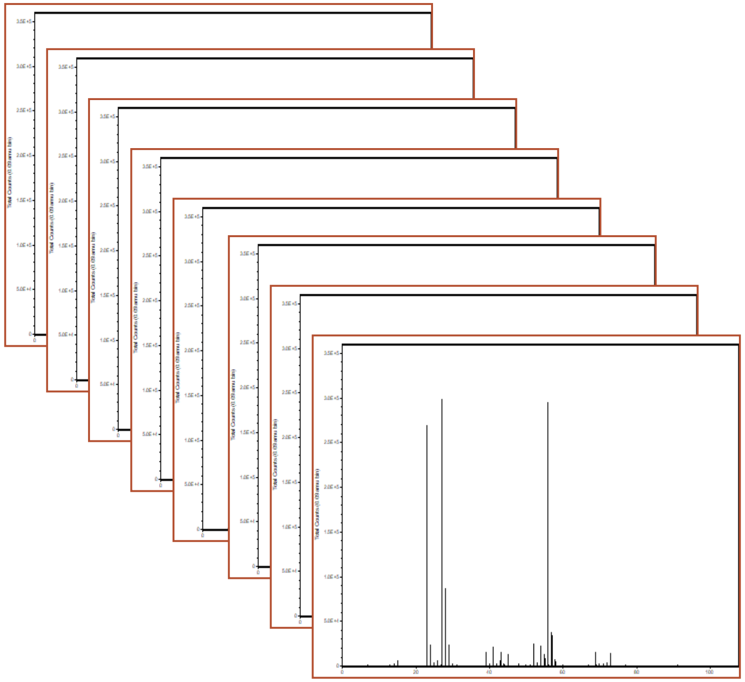
Contact angle measurement

Hydrophobicity

Surface analytical techniques – ToF-SIMS

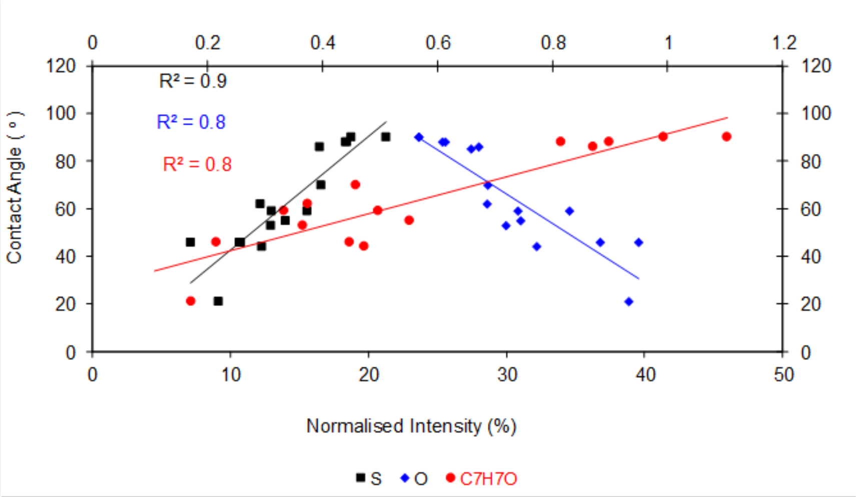
ToF-SIMS: Time-of-Flight Secondary Ion Mass Spectrometry





Correlation of ToF-SIMS surface chemical signals of chalcopyrite ($CuFeS_2$) with contact angle

Statistical model for calculating the contact angle



$$\Theta = 45.7 - 1.2 I_O + 3.1 I_S + 15.8_{Coll}$$

Oxidation — Mineral matrix — Collector

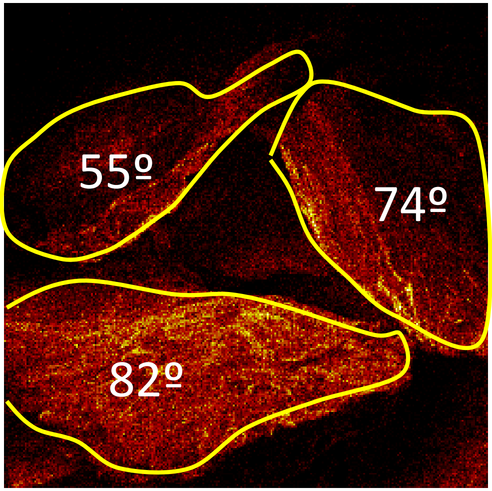
Unique features of the method:

- individual particles are analysed down to a few microns
- is independent of particle size;
- can be used for particles or flat surfaces
- does not require pre-treatments

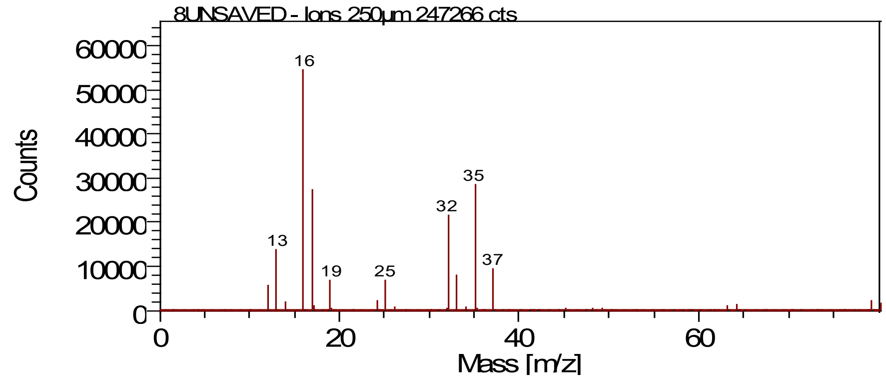
Brito e Abreu, S., Brien, C. & Skinner, W. 2010, 'ToF-SIMS as a new method to determine the contact angle of mineral surfaces', *Langmuir*, 26, 8122-8130.

What can the ToF-SIMS method do?

Individual particle contact angle



ToF-SIMS



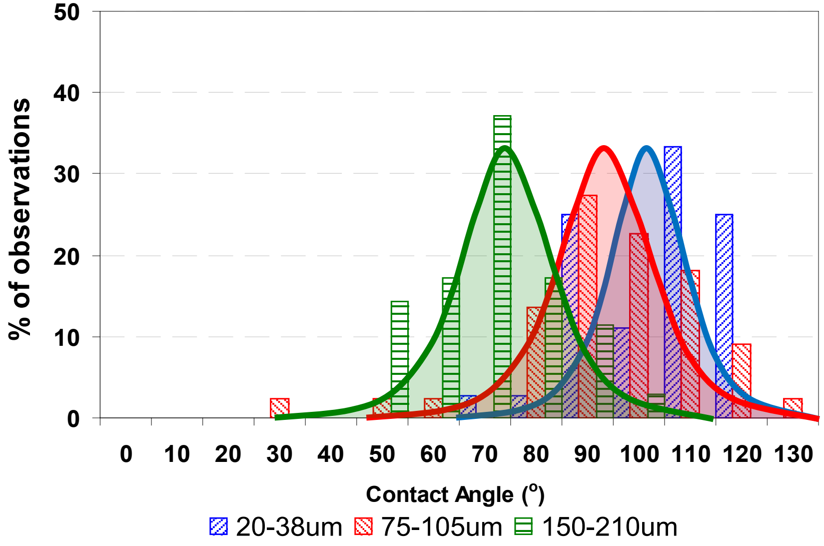
Contact angle

Statistics

Distribution of contact angles in processing streams!

$$\theta = 45.7 - 1.2 I_O + 3.1 I_S + 15.8_{Coll}$$

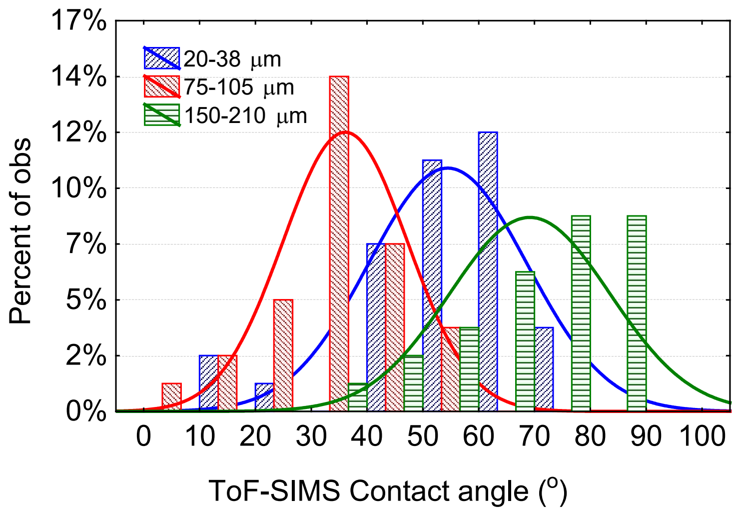
Mapping of hydrophobicity distribution in a flotation feed

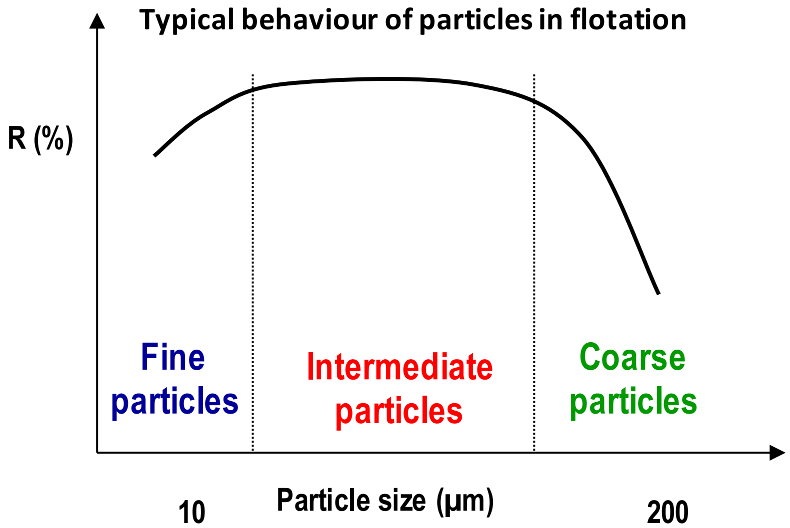


- Distributions have different means (different surface chemistry) according to the liberation class
- Broad contact angle distribution, regardless of particle size

Brito e Abreu, S. & Skinner, W., 2011, 'ToF-SIMS-derived hydrophobicity in DTP flotation of chalcopyrite: contact angle distributions in flotation streams', *International Journal of Mineral Processing*, 98, 35-41.

Mapping of hydrophobicity distribution in a flotation con





Fine and coarse particles need to be more hydrophobic than intermediate ones in order to float similarly for the same hydrodynamic conditions

Fine and coarse particles have lower collection efficiency than the intermediate range

Brito e Abreu, S. & Skinner, W., 2011, 'ToF-SIMS-derived hydrophobicity in DTP flotation of chalcopyrite: contact angle distributions in flotation streams', *International Journal of Mineral Processing*, 98, 35-41.

Correlation of ToF-SIMS of chalcopyrite ($CuFeS_2$) with flotation recovery

Con/Tail Discriminating Models

- Fine and intermediate particle sizes:

$$Z = -0.7 I_{Cu} + 0.8 I_{Mg} - 1.6 I_{O} + 0.4 I_{S_2/SO_2}$$

- Coarse particle size:

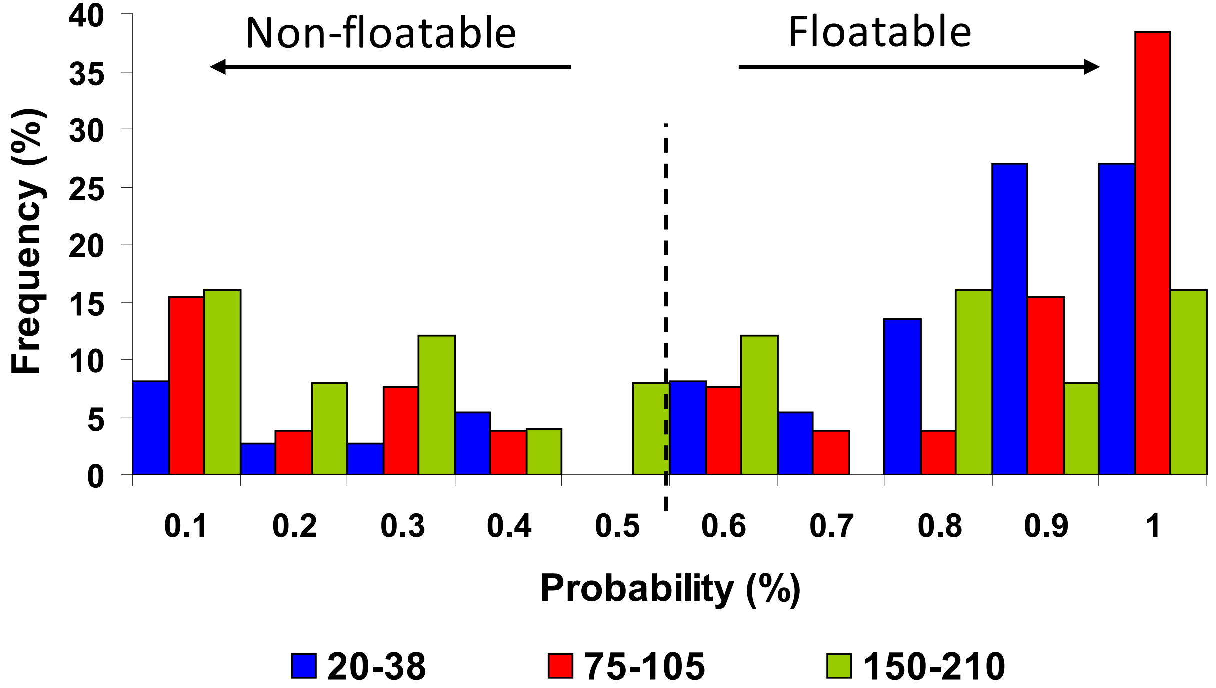
$$Z = -0.6 I_{Si} + 1.2 I_{O}$$

Note: In other systems, different ToF-SIMS signals may be key in discriminating between con and tail surface chemistries. In this case, oxidation and locked gangue are more important for the separation.

Brito e Abreu, S. & Skinner, W., 2011, 'Predicting the surface chemistry contribution to the flotation recovery of chalcopyrite by ToF-SIMS', *Minerals Engineering*, 24, 160-168.

Correlation of ToF-SIMS of chalcopyrite ($CuFeS_2$) with flotation recovery

Probability of group membership of particles in a feed sample



Brito e Abreu, S. & Skinner, W., 2011, 'Predicting the surface chemistry contribution to the flotation recovery of chalcopyrite by ToF-SIMS', *Minerals Engineering*, 24, 160-168.

Summary

- New method for determining the contact angle of mineral surfaces using ToF-SIMS
- The method can be applied to determine mineral hydrophobicity distributions within processing streams (plant or lab) and adds unique capabilities for interpreting flotation response (e.g., the mechanisms underlying flotation) and optimising flotation
- Surface chemistry analysis can be used to develop models to predict hydrophobicity and flotation recoveries
- Can be applied to more complex systems where other surface species can be impacting on hydrophobicity and differentiating between con and tail (e.g. presence of other minerals, depressing effect of adsorbed inorganic/organic solution species, etc.)
- Potential to be incorporated in GeoMet models to predict flotation response?

Thank you!

Questions and ideas welcome!