

Considering the Ionic Strength and pH of Process Water on Bubble-Particle Attachment of Sulfide Minerals: Implications for Froth Flotation in Saline Water

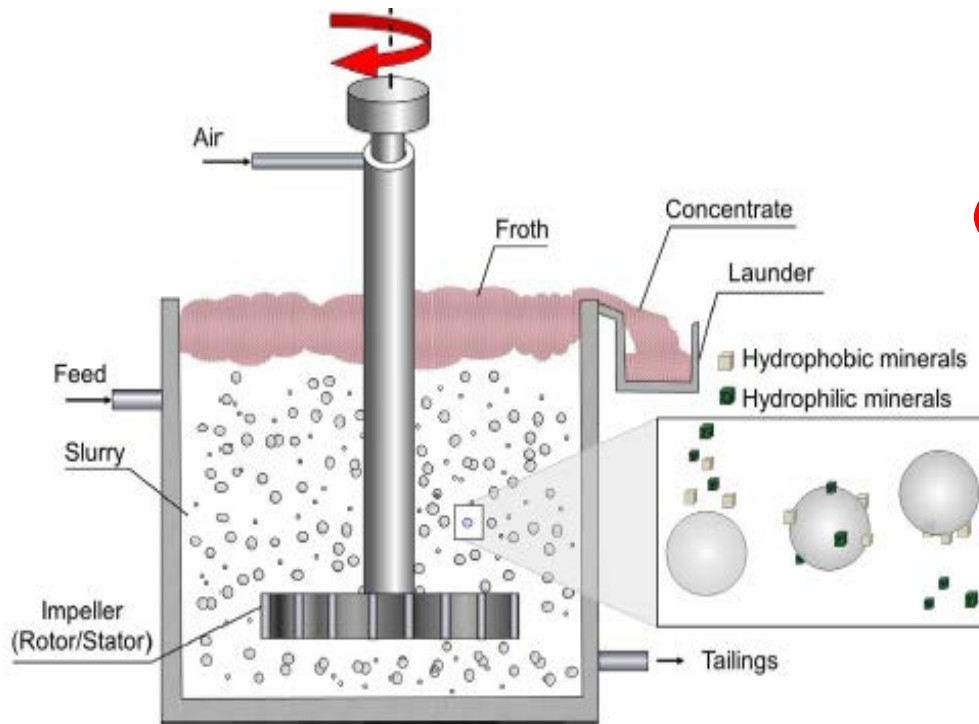
Lisa October

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J. Wiese

IMWA 2019
Perm, Russia
15-19 July 2019



Background

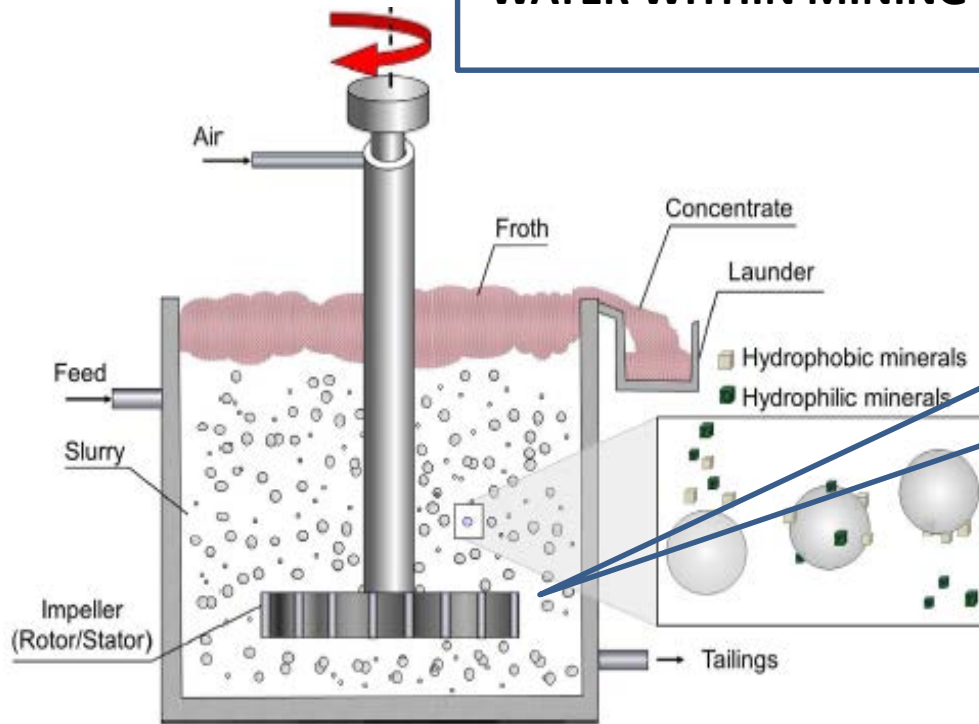


Wills and Finch (2015)

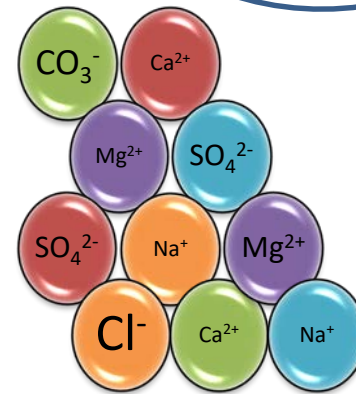
- ❖ Creating the hydrophobic mineral surface
- ❖ The formation of bubbles with a fixed size and distribution
- ❖ **The collision between the mineral and bubble and potential attachment**
- ❖ Transport of the bubble-particle aggregate through the pulp phase
- ❖ Transfer of the bubble-particle aggregate to the froth phase
- ❖ Collection of the bubble-particle aggregate from the froth phase

Background

**NEED TO RECYCLE & RECIRCULATE
WATER WITHIN MINING OPERATIONS**

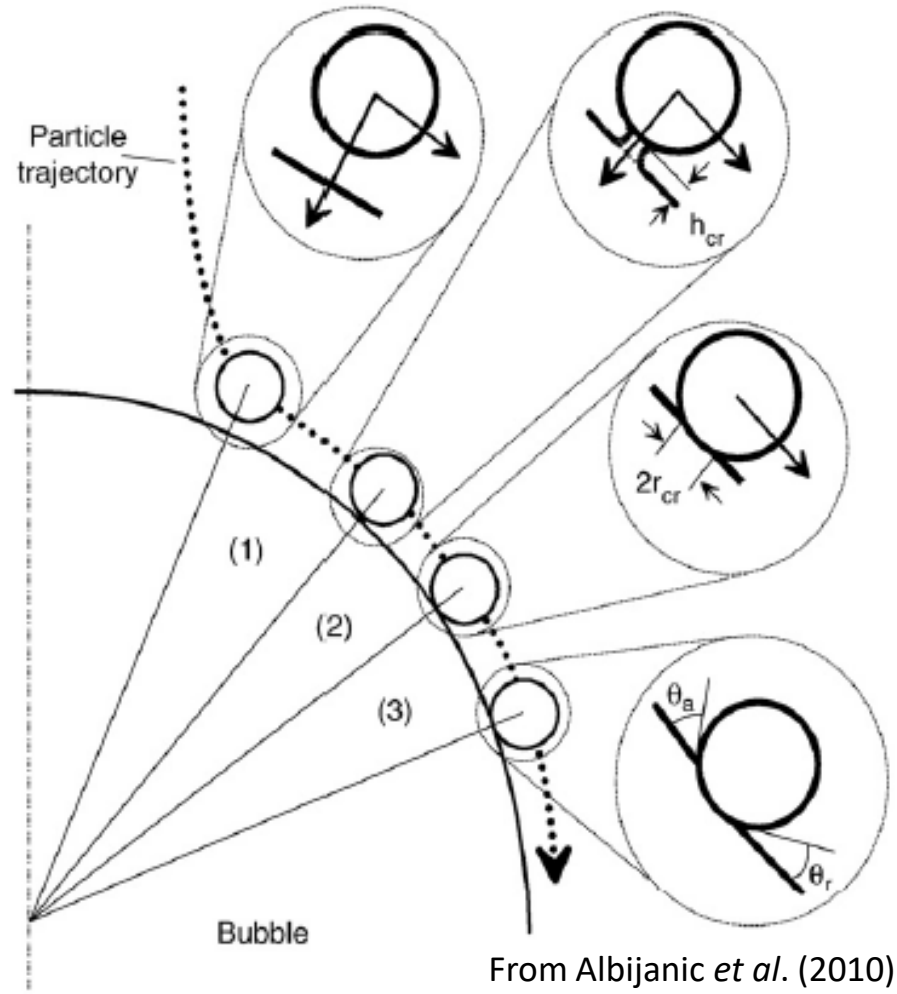
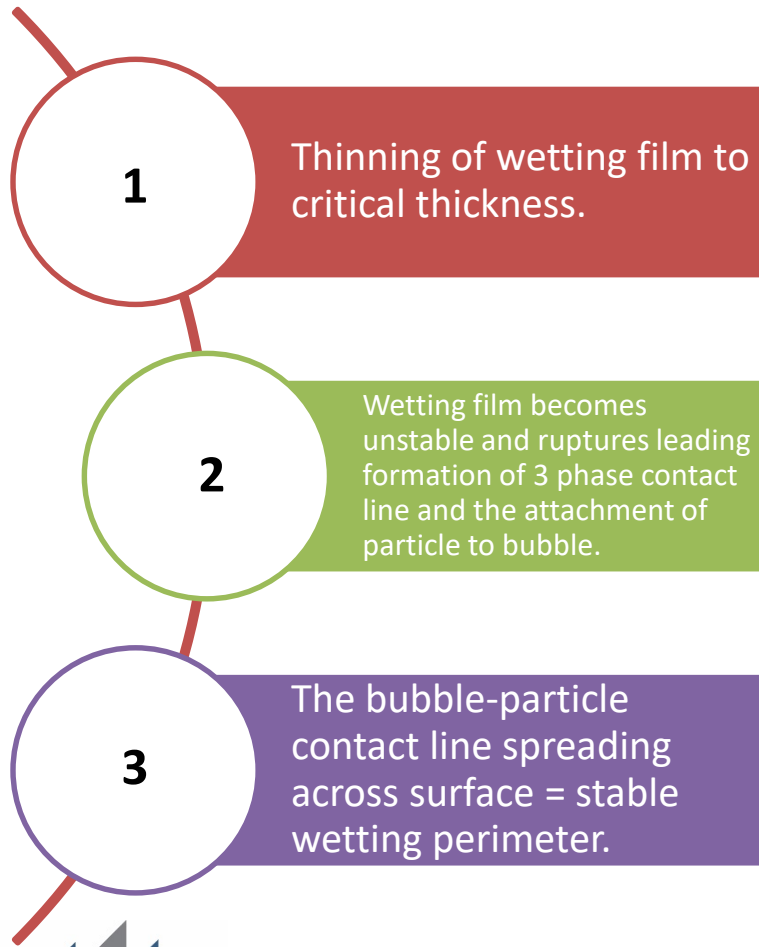


**Pulp Phase
=
80 – 85 % Water
(Muzenda, 2010)**

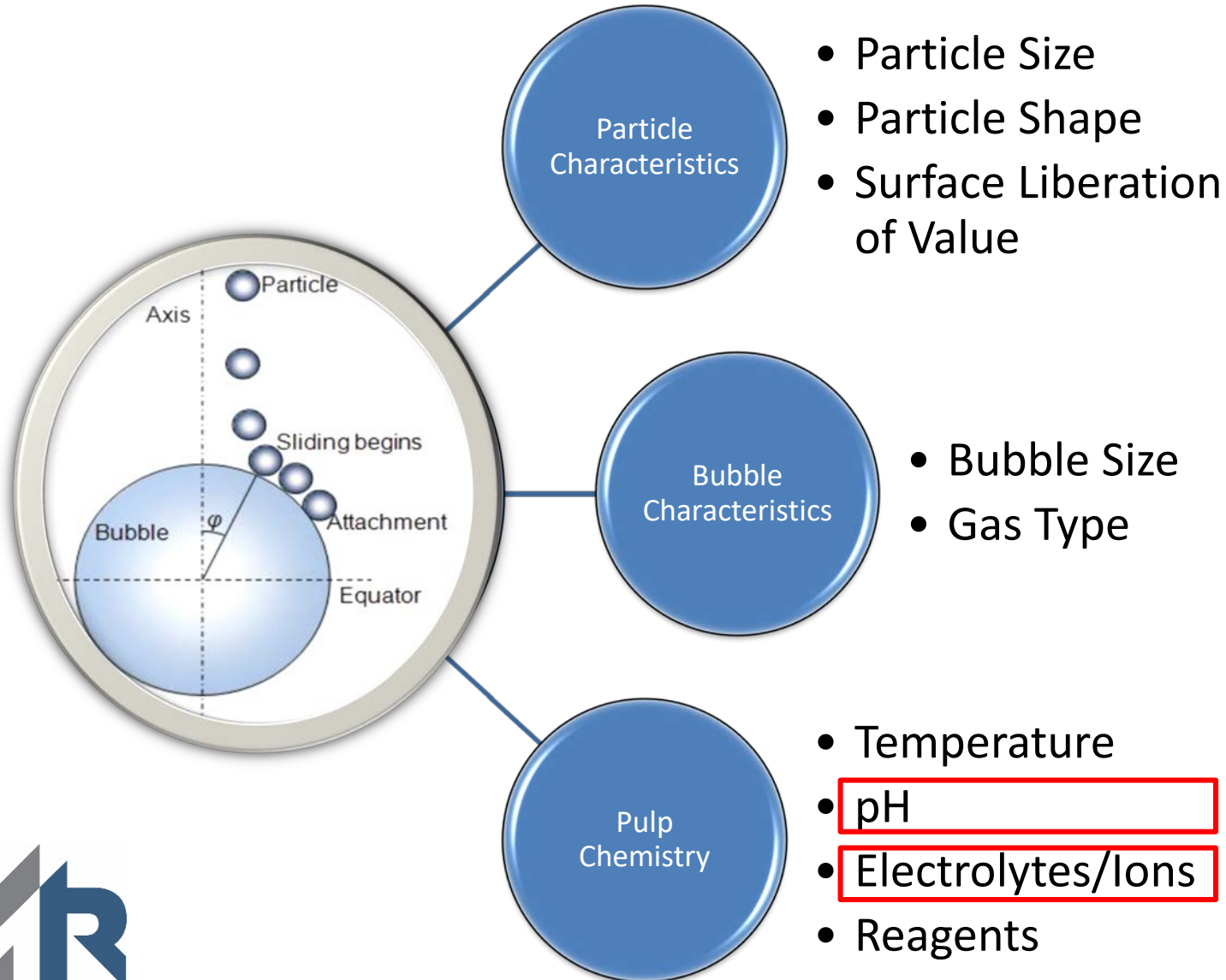


Wills and Finch (2015)

Bubble-Particle Attachment

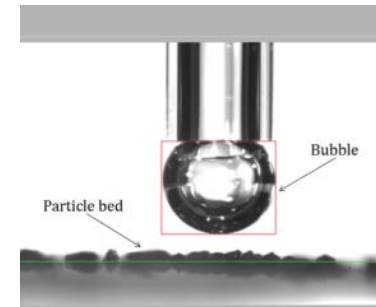


Factors Affecting B-P Attachment



Fundamental Bubble-Particle Attachment

Measuring this Parameter



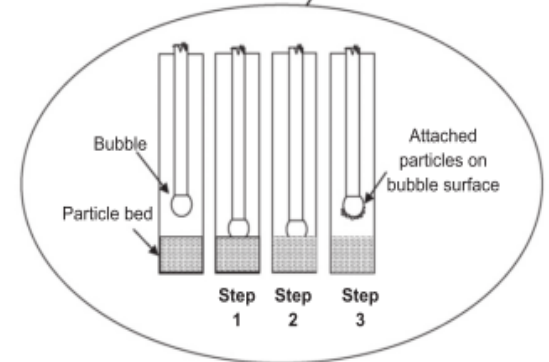
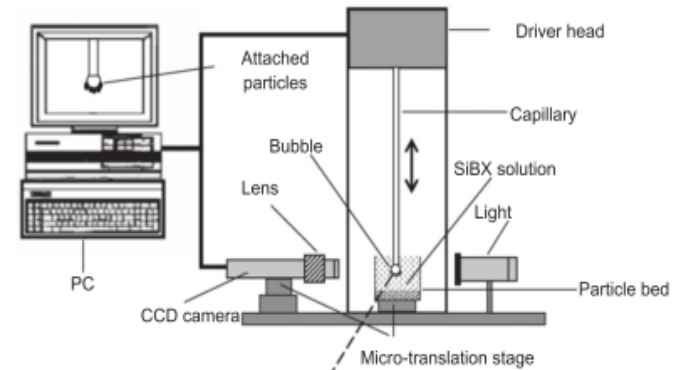
History of Attachment Timers

Sven-
Nilsson
(1934)

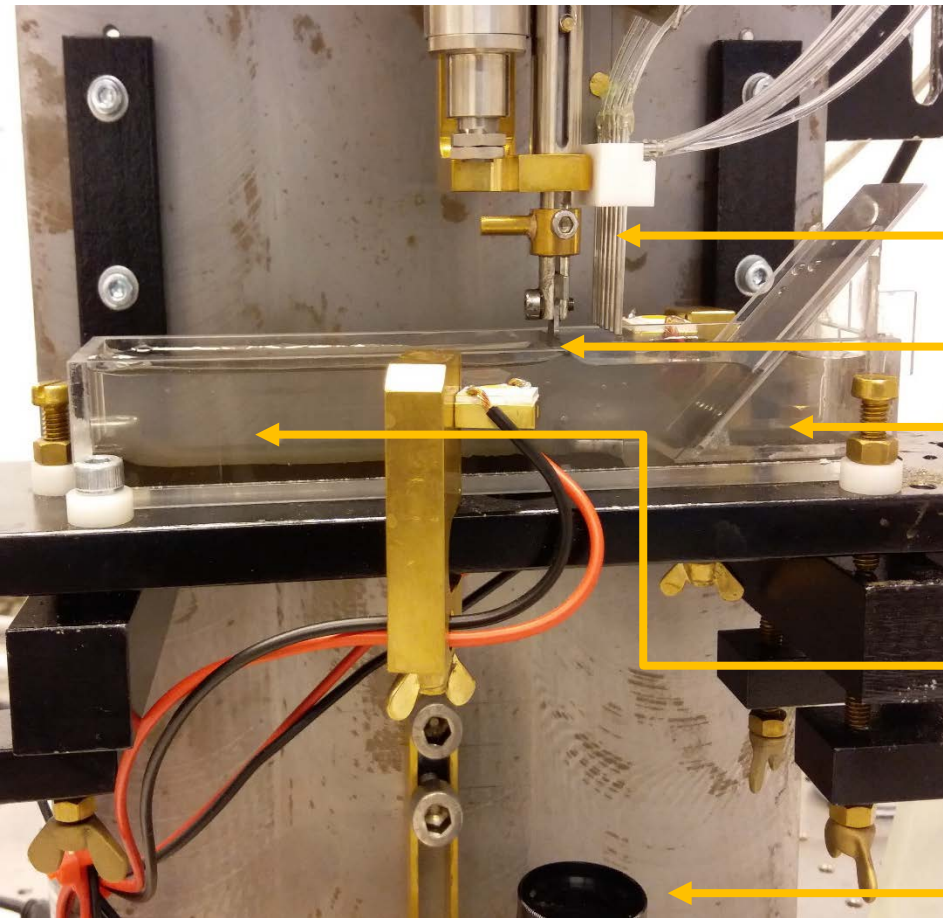
Glembotsky
(1953)

Eigeles and
Volova
(1960)

Yoon and
Yordan (1991)
Gu *et al.* (2003)
Albjanic *et al.*
(2015)



A New Attachment Timer



Needles

Shovel

Collection
Bin

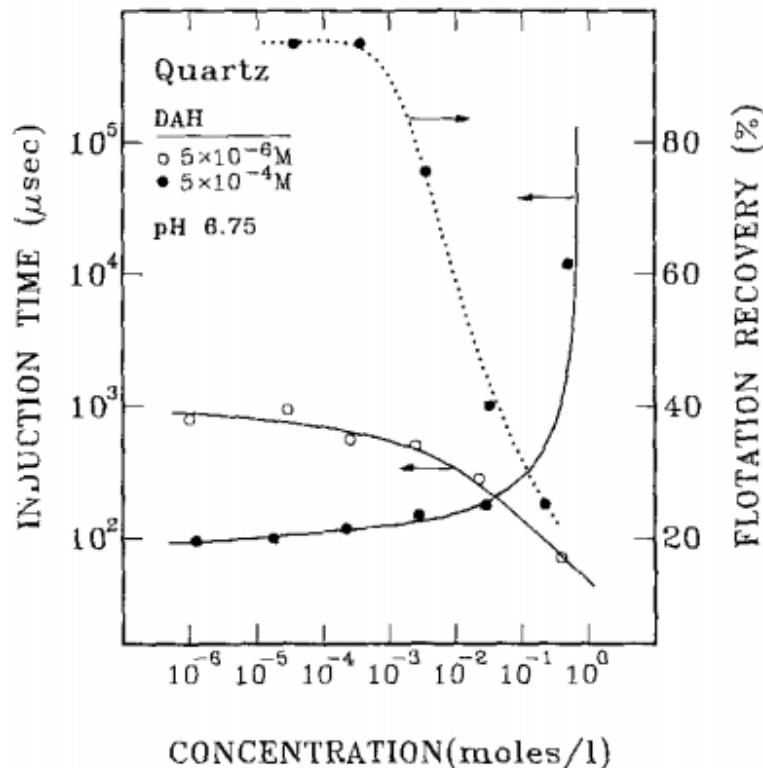
Pool with Particle
Bed and Water

Camera

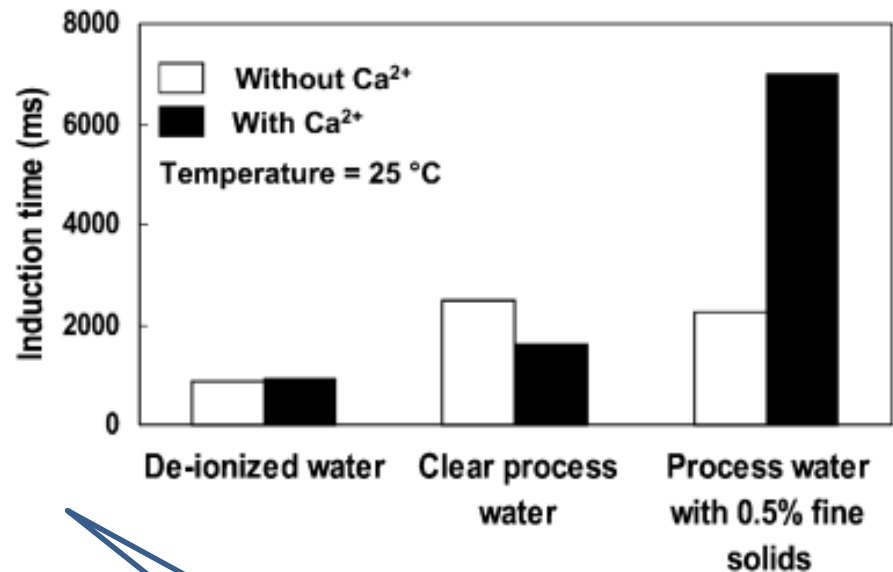


Effect of Electrolytes on B-P Attachment

KCl-Quartz



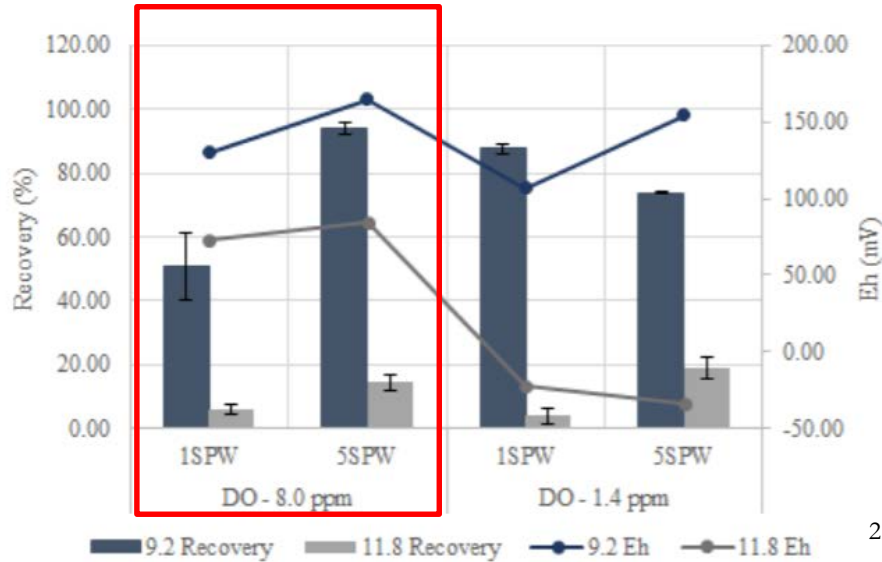
Bitumen



What happens in a complex water system?

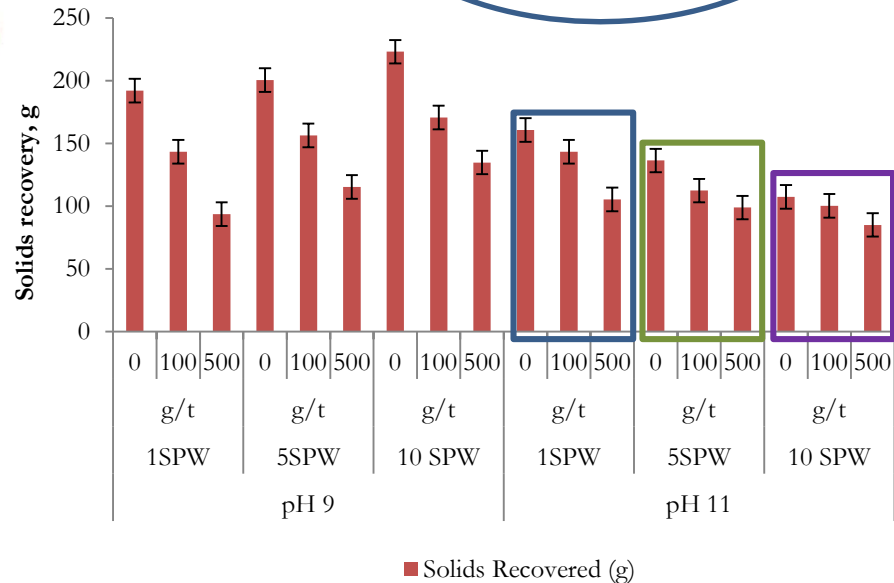
From Yoon and Yordan (1991), Gu *et al.* (2003)

Effect of IS and pH



Recovery ↑ with ↑ IS,
↓ Recovery with ↑ pH
At pH 11: Recovery ↑ with ↑ IS

Recovery ↑ with ↑ IS,
↓ Recovery with ↑ pH



■ Solids Recovered (g)

From Tadie *et al.* (2016), Manono *et al.* (2017)

Key Question

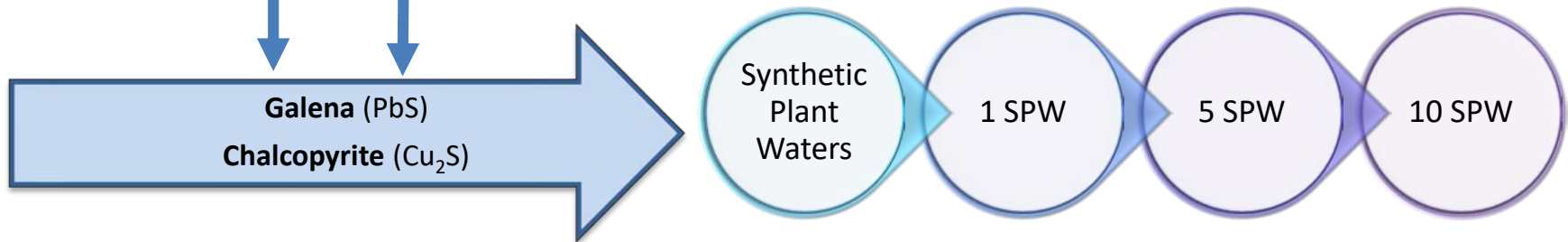
But How Does an Increase in both Ionic Strength and pH of Process Water Affect the Fundamental Bubble-Particle Attachment Process?



Experimental Programme

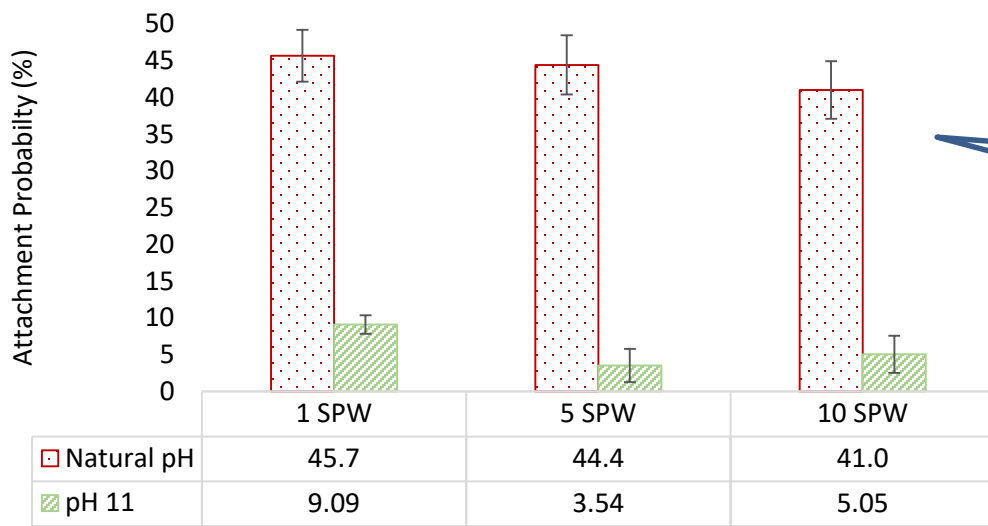
pH Modifiers: NaOH/HCl

Collector: SIBX



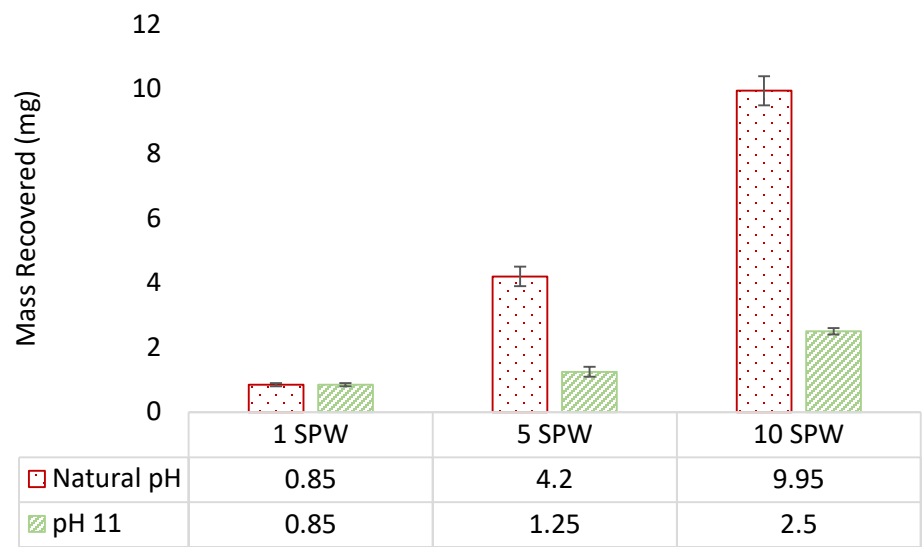
Water type	Ca ²⁺ ppm	Mg ²⁺ ppm	Na ⁺ ppm	Cl ⁻ ppm	SO ₄ ²⁻ ppm	NO ₃ ⁻ ppm	CO ₃ ²⁻ ppm	TDS mg/L	Ionic Strength mol/L
1SPW	80	70	153	287	240	176	17	1023	0.0213
5 SPW	400	350	765	1435	1200	880	85	5115	0.0977
10 SPW	800	700	1530	2870	2400	1760	170	10230	0.1860

Attachment Probability: Galena

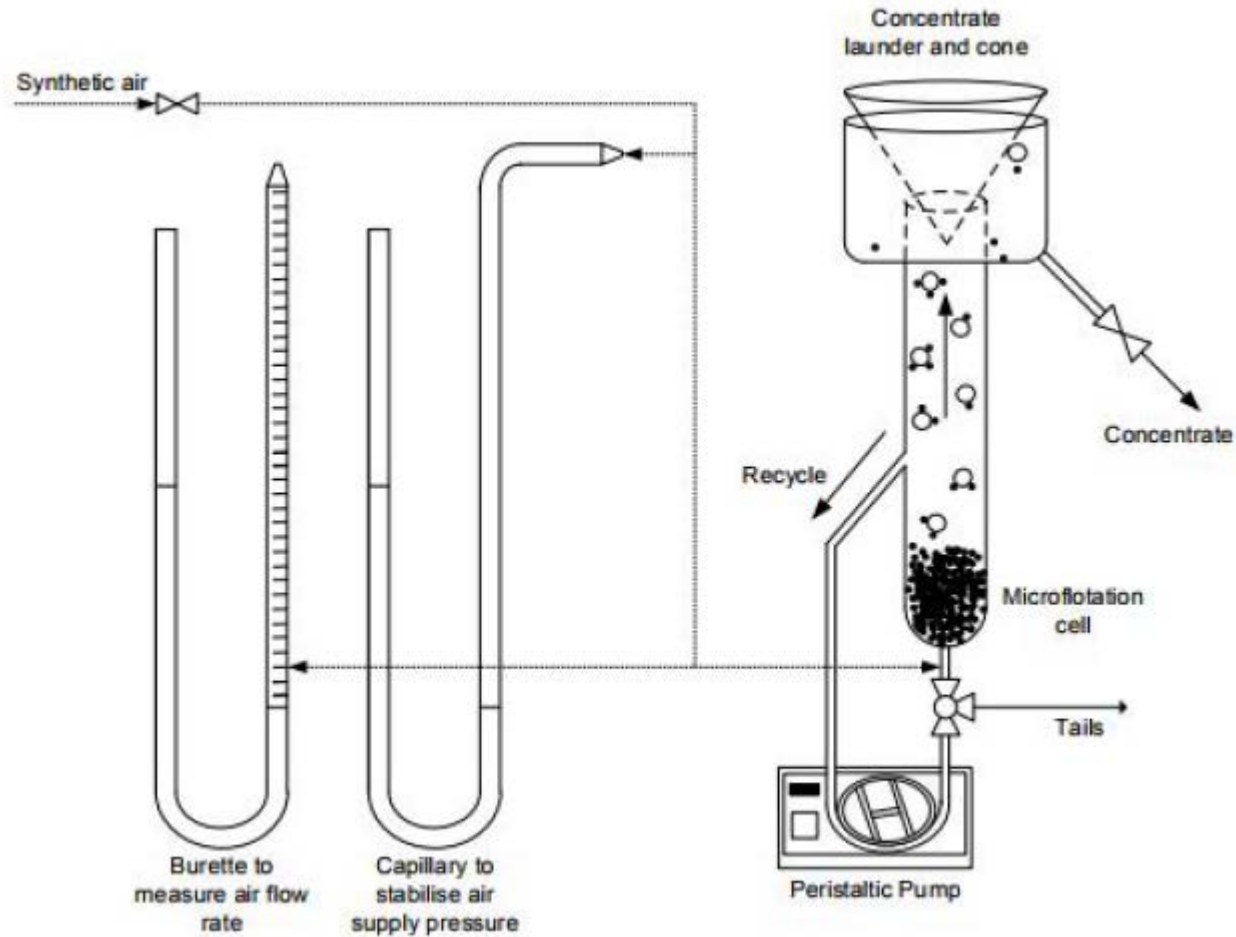


↑ pH = ↓ Attachment Probability

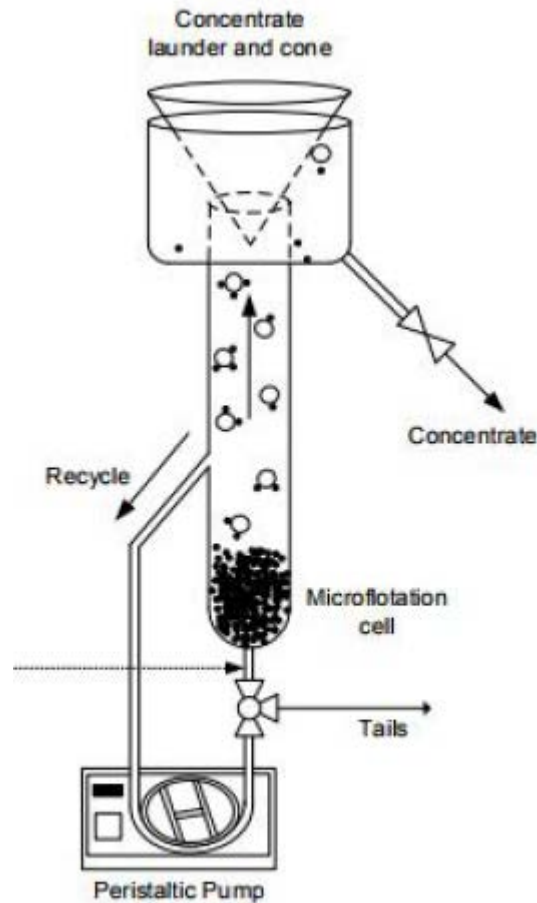
↑ pH = ↓ Mass Recovered;
 ↑ IS = ↑ Mass Recovered



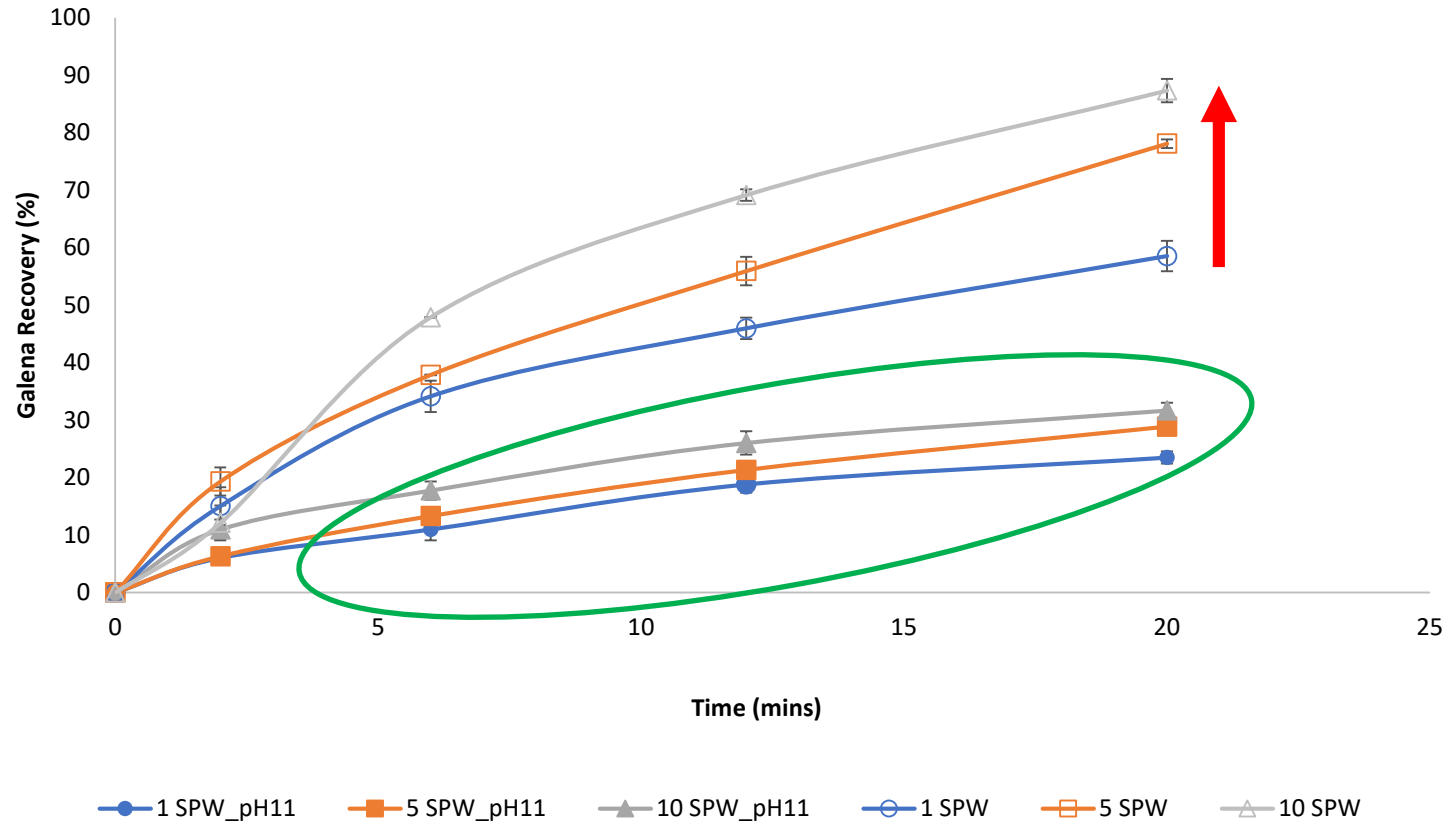
Fundamental B-P Attachment Vs Classical Microflotation



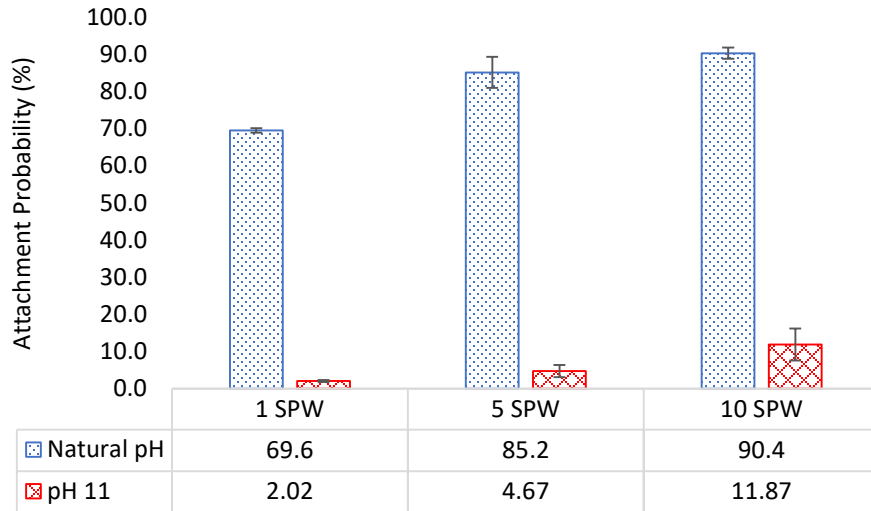
Fundamental B-P Attachment Vs Classical Microflotation



Microflotation: Galena

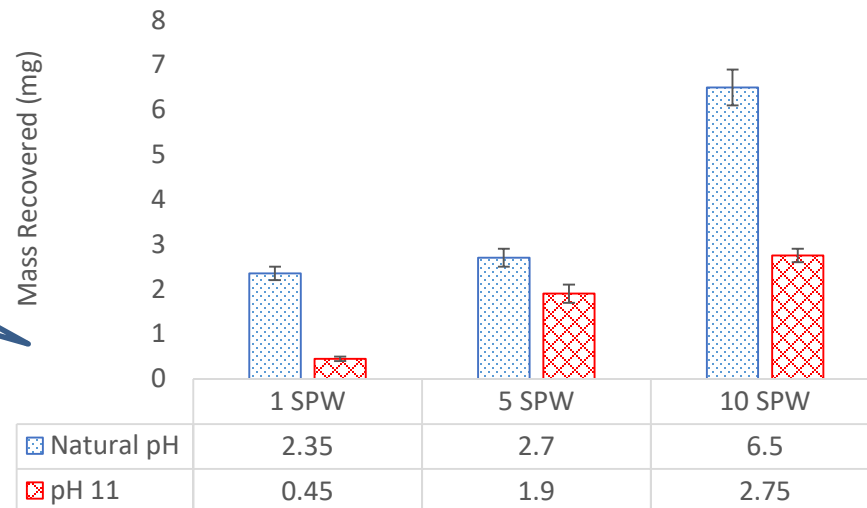


Attachment Probability: Chalcopyrite

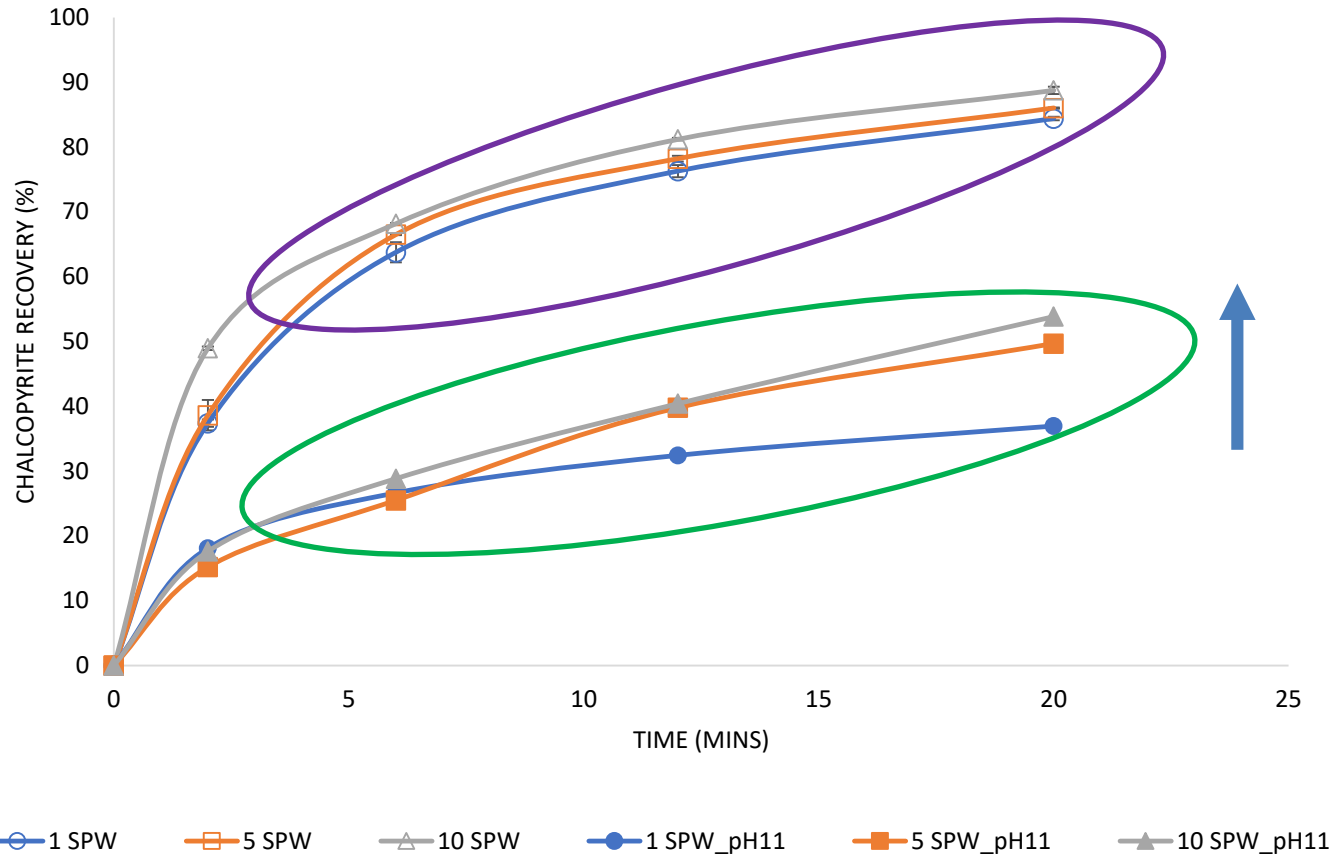


↑ pH = ↓ Attachment Probability
 ↑ IS = ↑ Attachment Probability

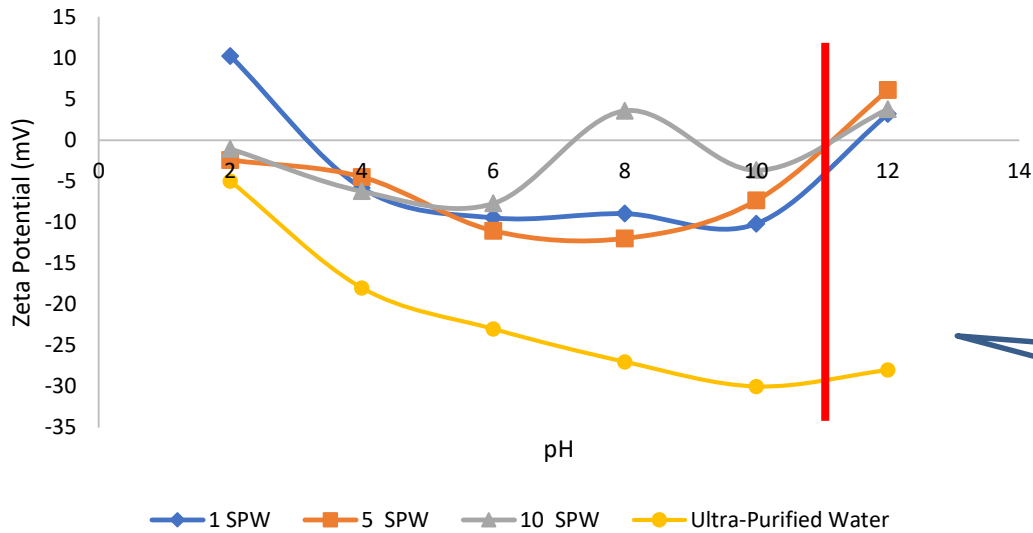
↑ pH = ↓ Mass Recovered
 ↑ IS = ↑ Mass Recovered



Microflotation: Chalcopyrite



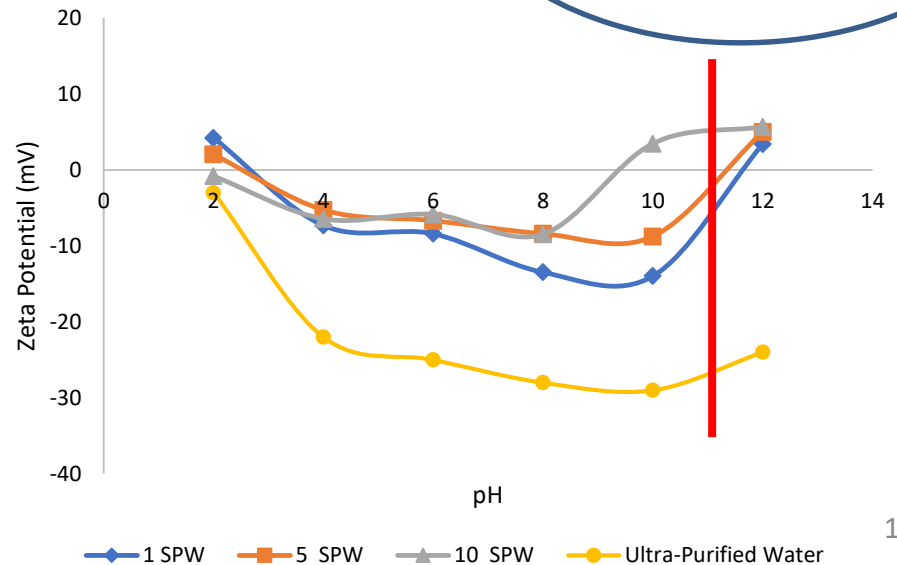
Zeta Potential



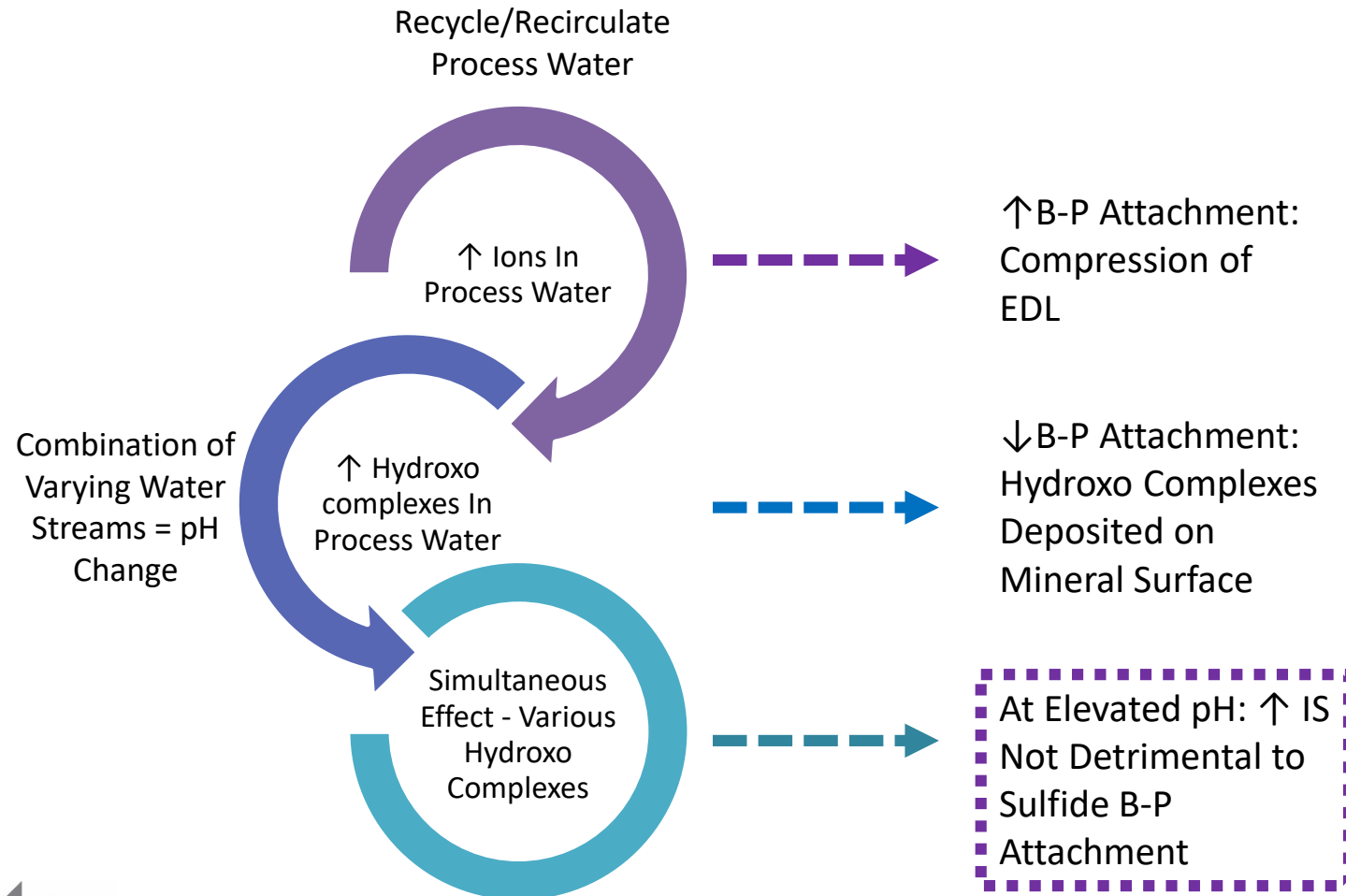
Potential difference across phase boundaries between solids & liquids. Measure of electric charge on particles suspended in liquid.

↑ IS = ↑ Zeta Potential of Galena
pH 11 : ↑ Zeta Potential

↑ IS = ↑ Zeta Potential of Chalcopyrite
pH 11 : ↑ Zeta Potential



Value of this Work



Acknowledgements



science
& technology

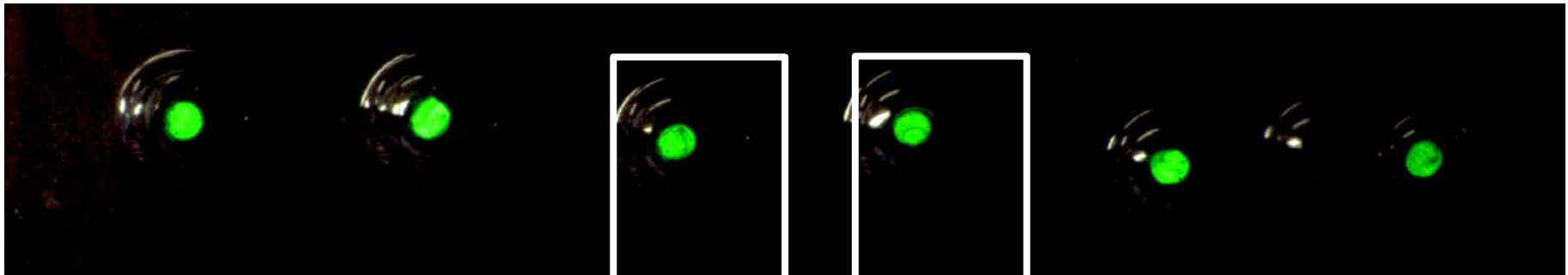
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA



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Measuring Attachment Probability

Before Attachment



After Attachment

