UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

REAGENT RESEARCH FACILITY

Accounting for the froth in batch flotation tests

Peter Harris

5 June 2009

Froth stability

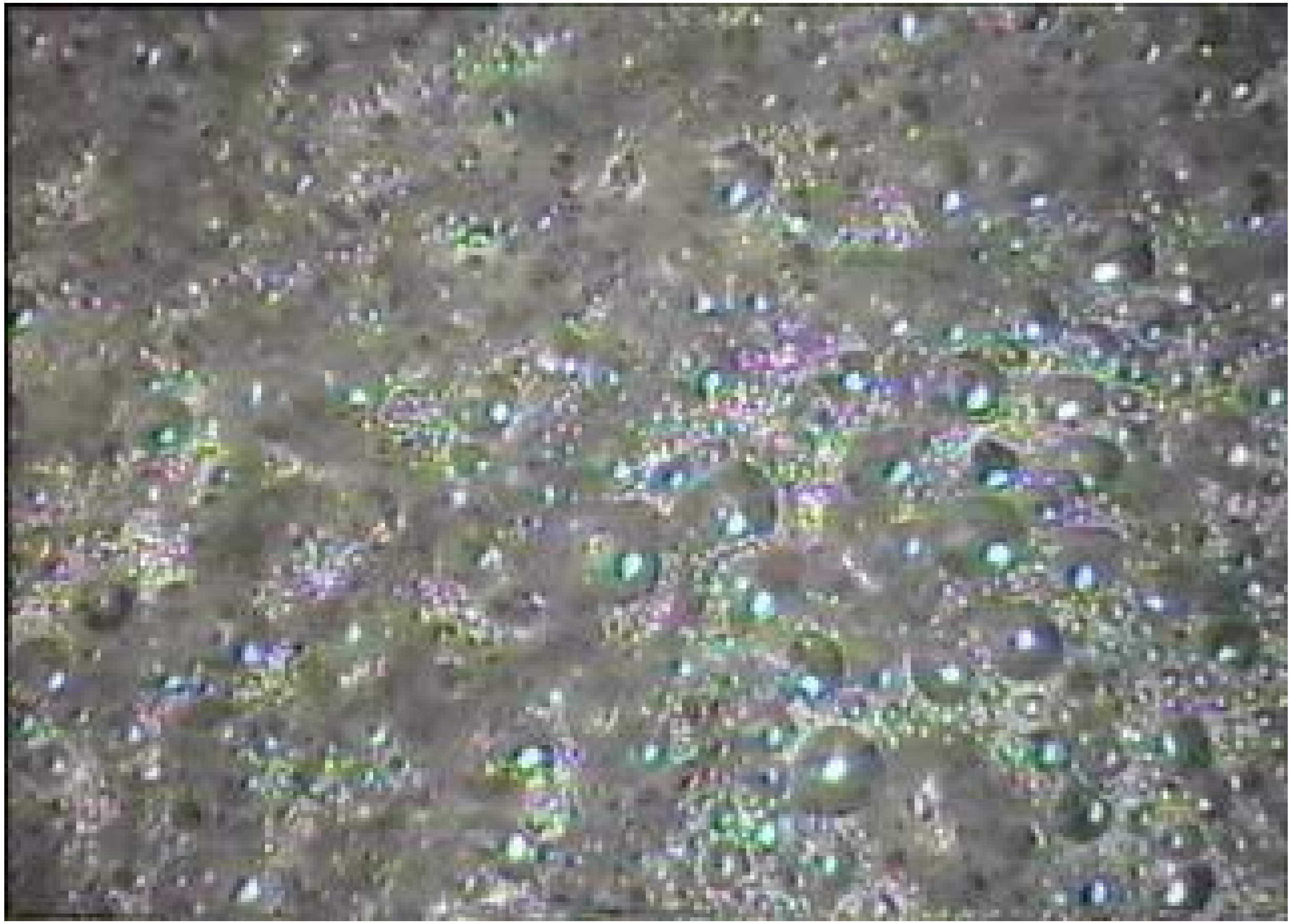
A dynamic froth is a complicated physico-chemical system which cannot be explained by a simple theory suitable for all types of foams or froths. There is no sharp transition from a weakly frothing condition to a strongly frothing one.

By necessity, flotation froths are weakly stable froths which need to breakdown rapidly for further treatment.

As a result **all reagents used in the recovery of valuable minerals by flotation can affect, either directly or indirectly, the stability of the froth.**

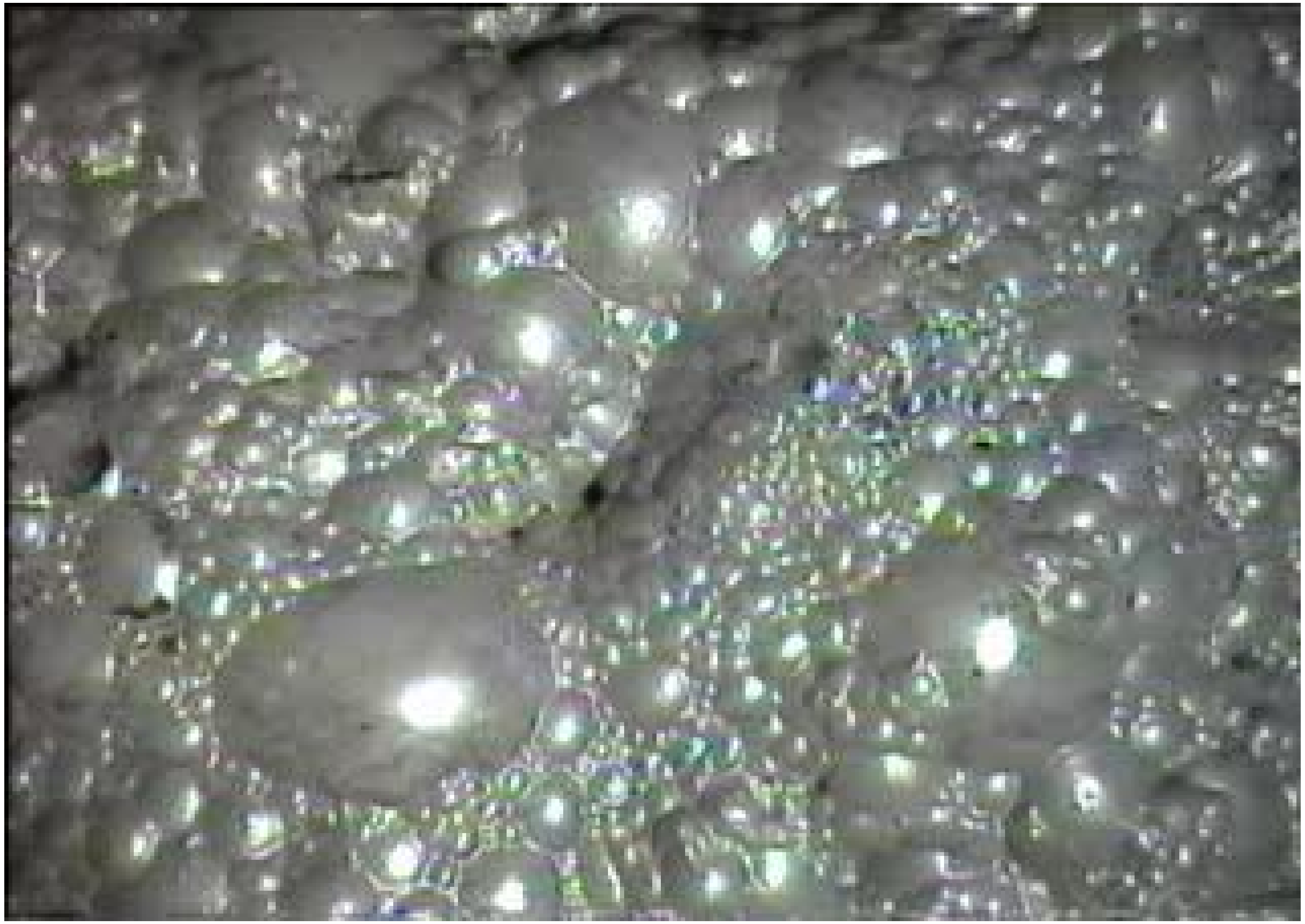
UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

Pilot plant froth A



UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

Pilot plant froth B



Direct effect

- Frother (being surface –active) affects the stability of the froth by lowering the surface tension of the liquid phase and increasing the stability of the froth films.
- Frother can also alter the bubble-size which, in turn , will affect froth stability.
- Any reagent that possesses some surface activity (i.e. has frothing properties), such as some DTP collectors, will alter the froth stability directly.

Indirect effect

- All the other reagents such as collectors, activators or depressants will influence the froth stability by altering the nature of the hydrophobic particles entering the froth. All particles that attach to the air/water interface can have a major influence on froth stability.
- Strongly hydrophobic particles can destabilise froths by bridging the froth films and collapsing bubbles
- Close-packed weakly hydrophobic particles can stabilise froths by attaching at both interfaces and preventing the thinning of the lamellae.

Indirect effect (cont.)

- The stability of the froth is then usually dependent on a combination of these two effects.
- Ignoring the effect of the froth stability on the solids recovery in a batch flotation test can lead to erroneous conclusions and inhibit the understanding of reagent interactions.

Measure of froth stability

- How can froth stability it be measured?
  Equilibrium froth height.
  Dynamic froth index (DFI)
  Froth collapse rate/ drainage rate

Not applicable to 3-phase froths

- Simplest method – **water recovered at a fixed froth height**

Batch flotation tests

Including the changes in froth stability can improve the understanding of the performance and interaction of the reagents used in batch flotation tests.

Confined to Merensky ore flotation (1% sulphides).

Depressant Research Facility.

EXPERIMENTAL DETAILS

Merensky ores milled to 60% passing 75 µm for batch flotation tests.

Synthetic plant water used throughout, natural pH 9 (80 ppm Ca, 70 ppm Mg, 1000 T.D.S).

2 cm froth height, 7 L / min air flow, 1200 rpm impeller speed.

4 concentrates at 2, 6, 12 and 20 min flotation time.

Feeds, concentrates and tails assayed for Cu, Ni and S.

REAGENTS

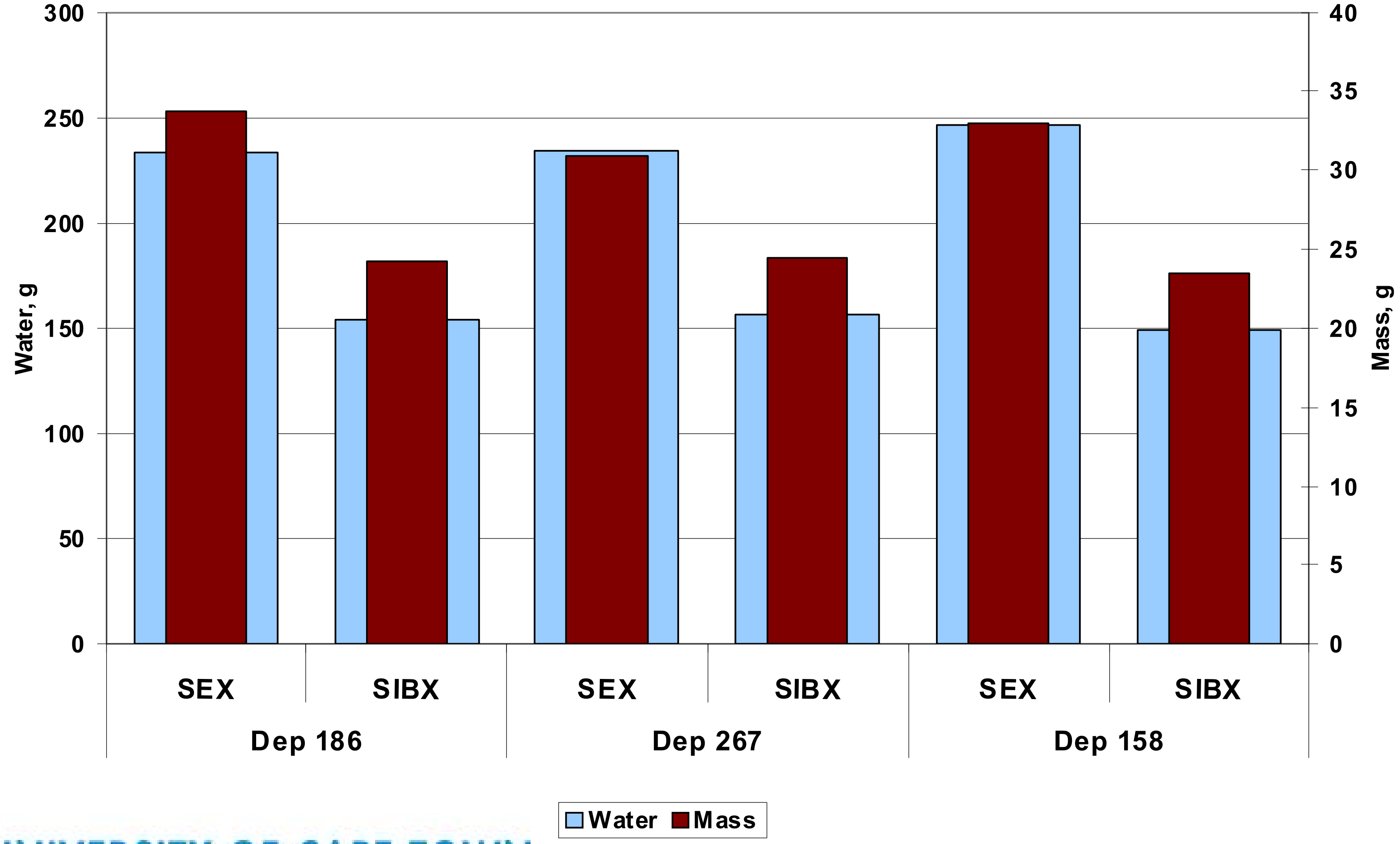
- Frother: 40 g/t DOW 200
- Collectors: SEX,SNPX,SIBX,PAX,DTP added to mill
- Activator: Cu SO_4
- Depressants:

  Guars supplied by Chemquest

  CMC's supplied by Akzo Nobel Functional Chemicals

Indirect Effect –
depressant, collector, activator

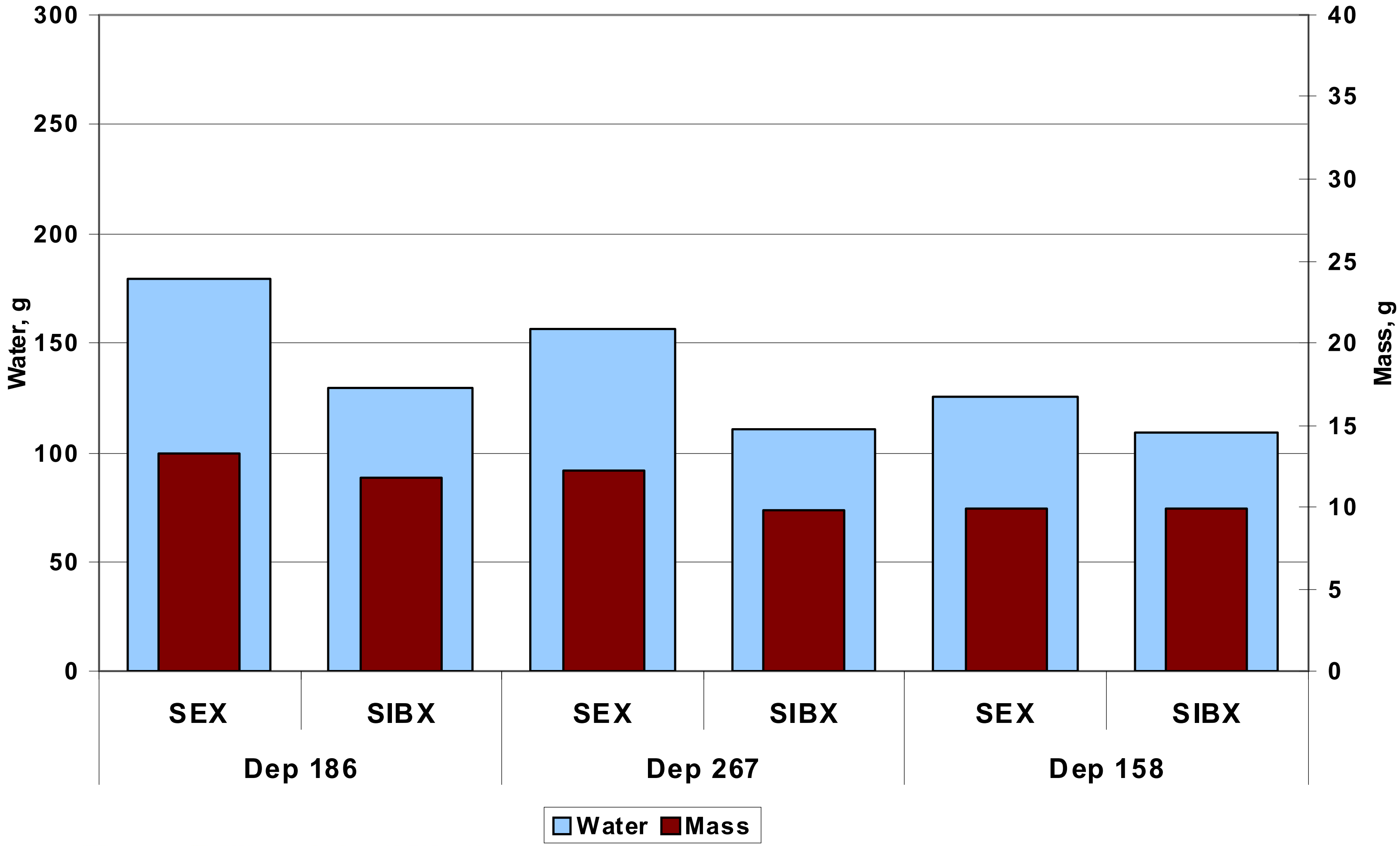
Total mass and water recoveries 3 cmc's of differing DS - 100g/t. X 50g/t. SIBX or SEX



UNIVERSITY OF CAPE TOWN

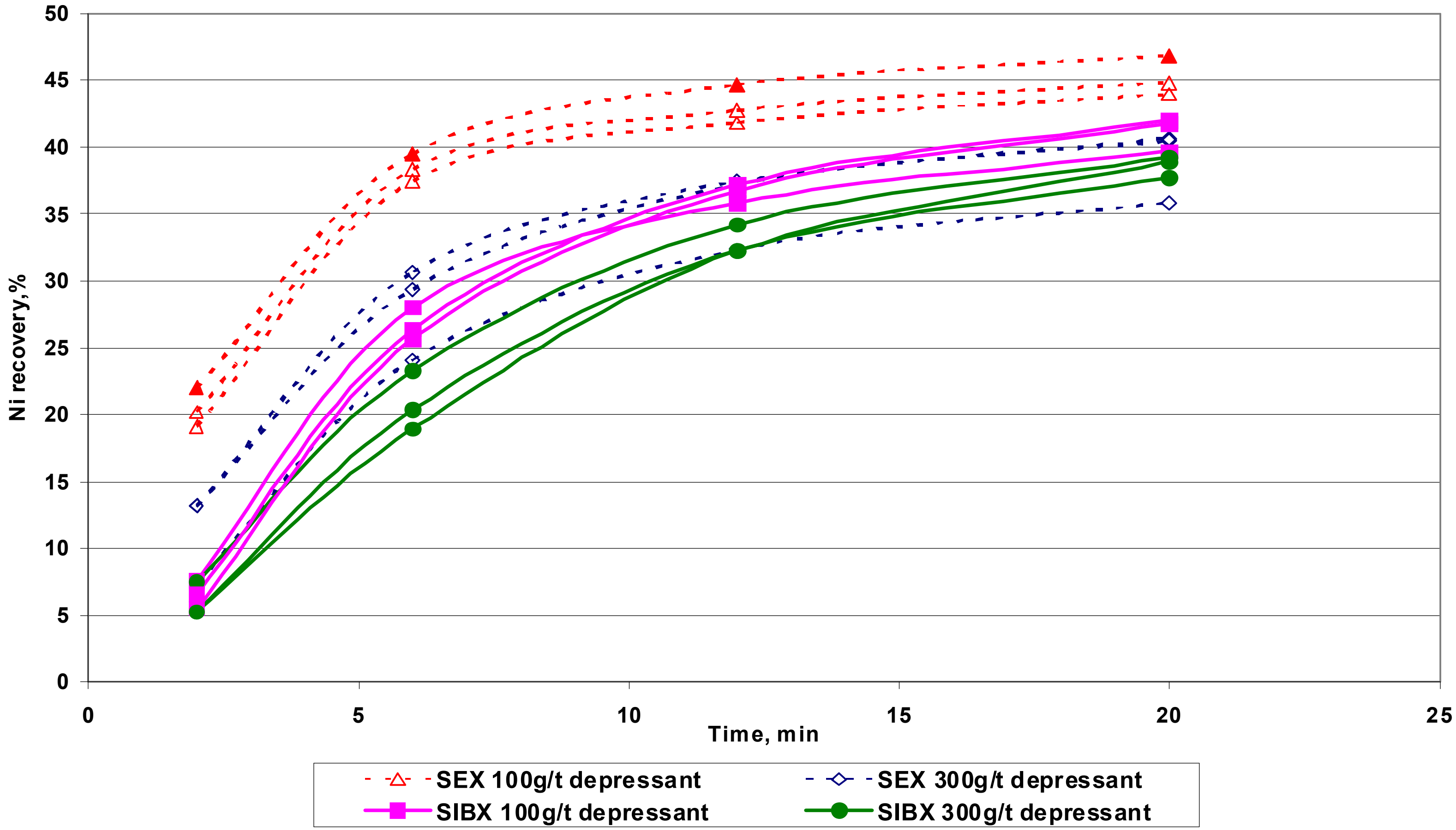
CENTRE FOR MINERALS RESEARCH

Total mass and water recoveries
3 cmc's of differing DS - 300g/t. X 50g/t



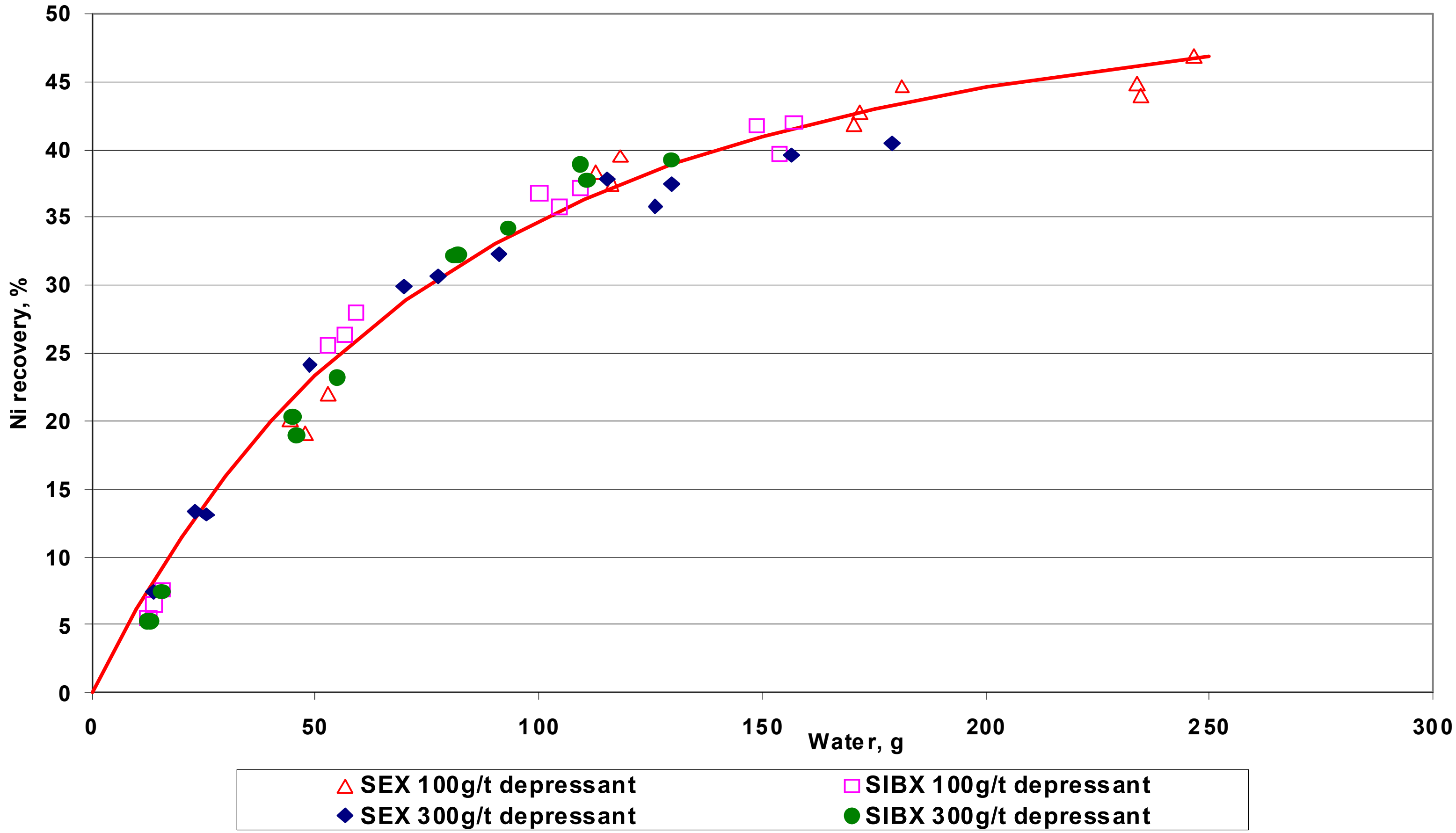
UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

Nickel recovery rate (time)



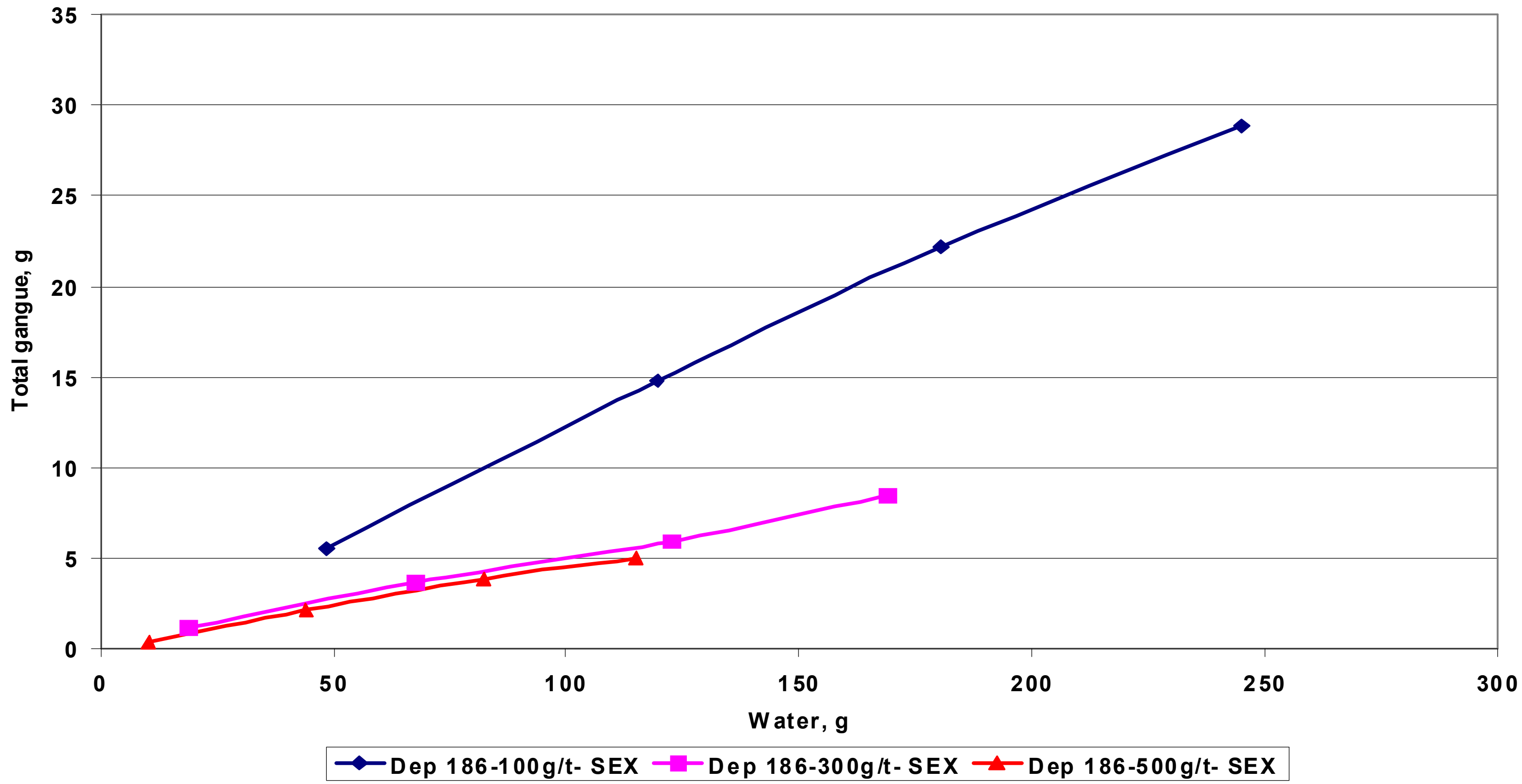
UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

Nickel recovery as a function of water recovery (g)



UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

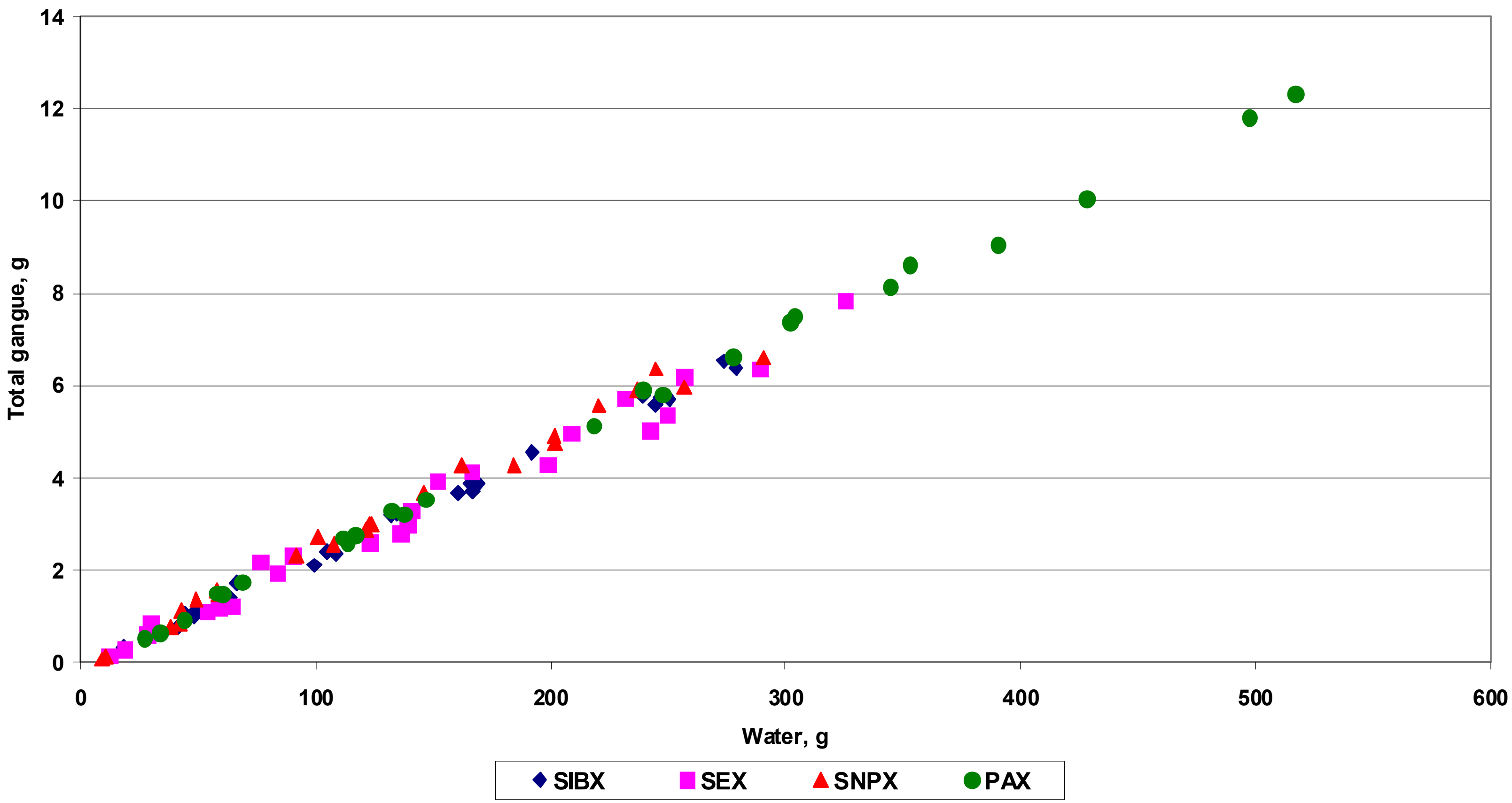
Gangue recovery vs water
Increasing depressant dosage



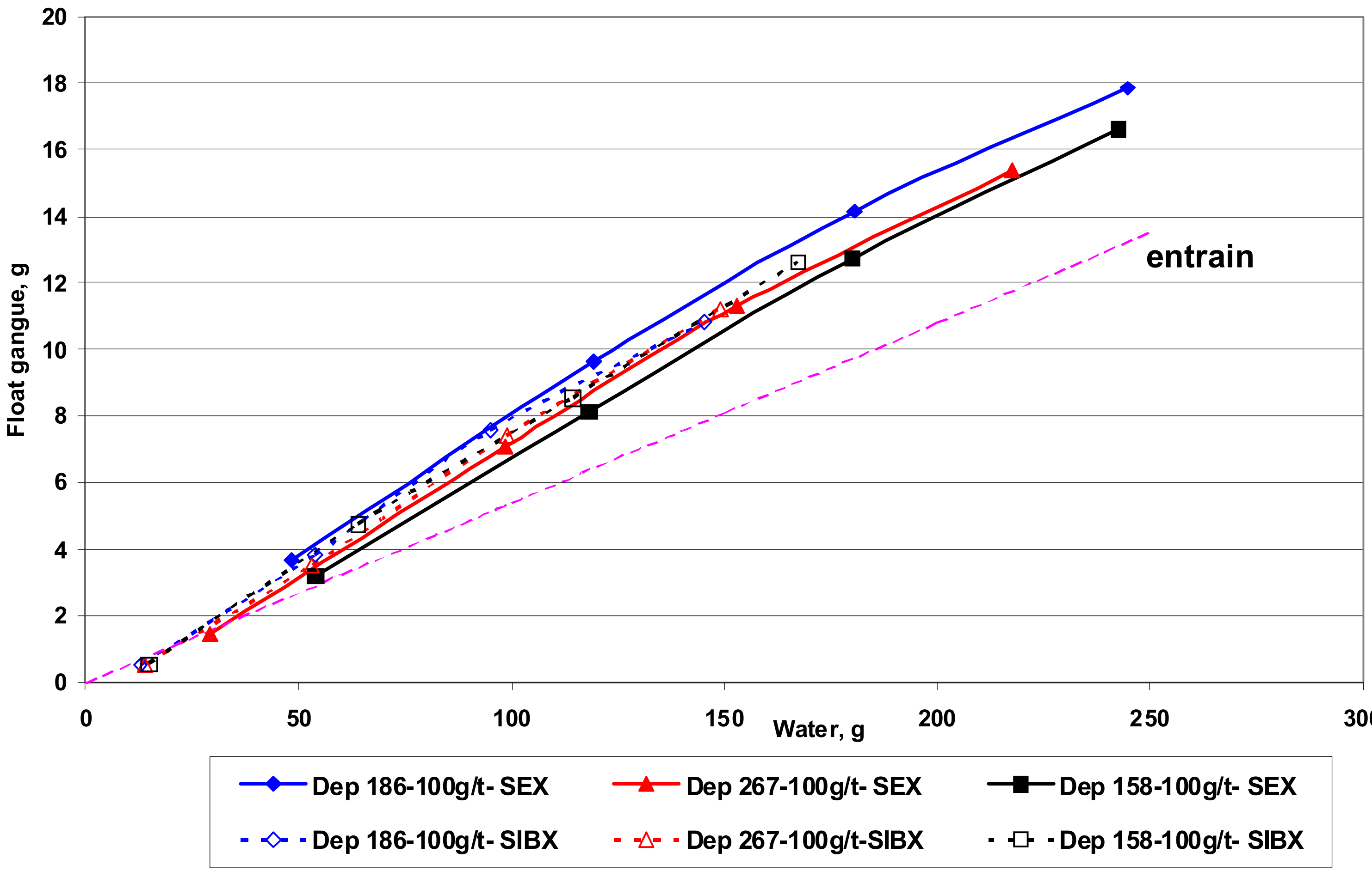
Entrainment

On the assumption that the complete depression of naturally floating gangue occurs at high depressant dosage, any gangue reporting to the concentrate does so by entrainment only. This entrainability factor (slope) can be used to decouple floatable gangue from entrained gangue.

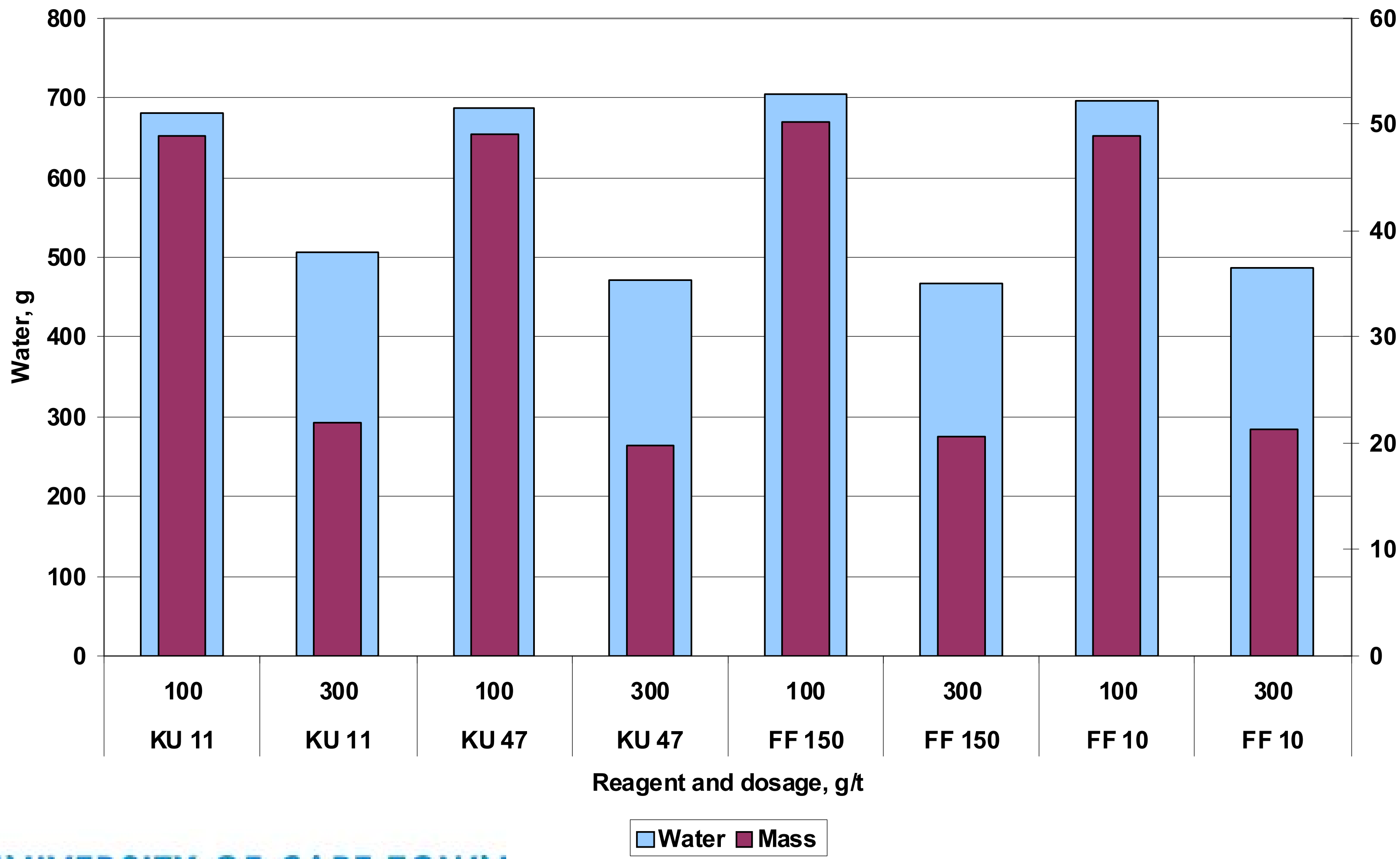
Gangue recovery vs water at high depressant dosage (500g/t) all X



Floating gangue vs water. 100g/t cmc (active- content). Different DS

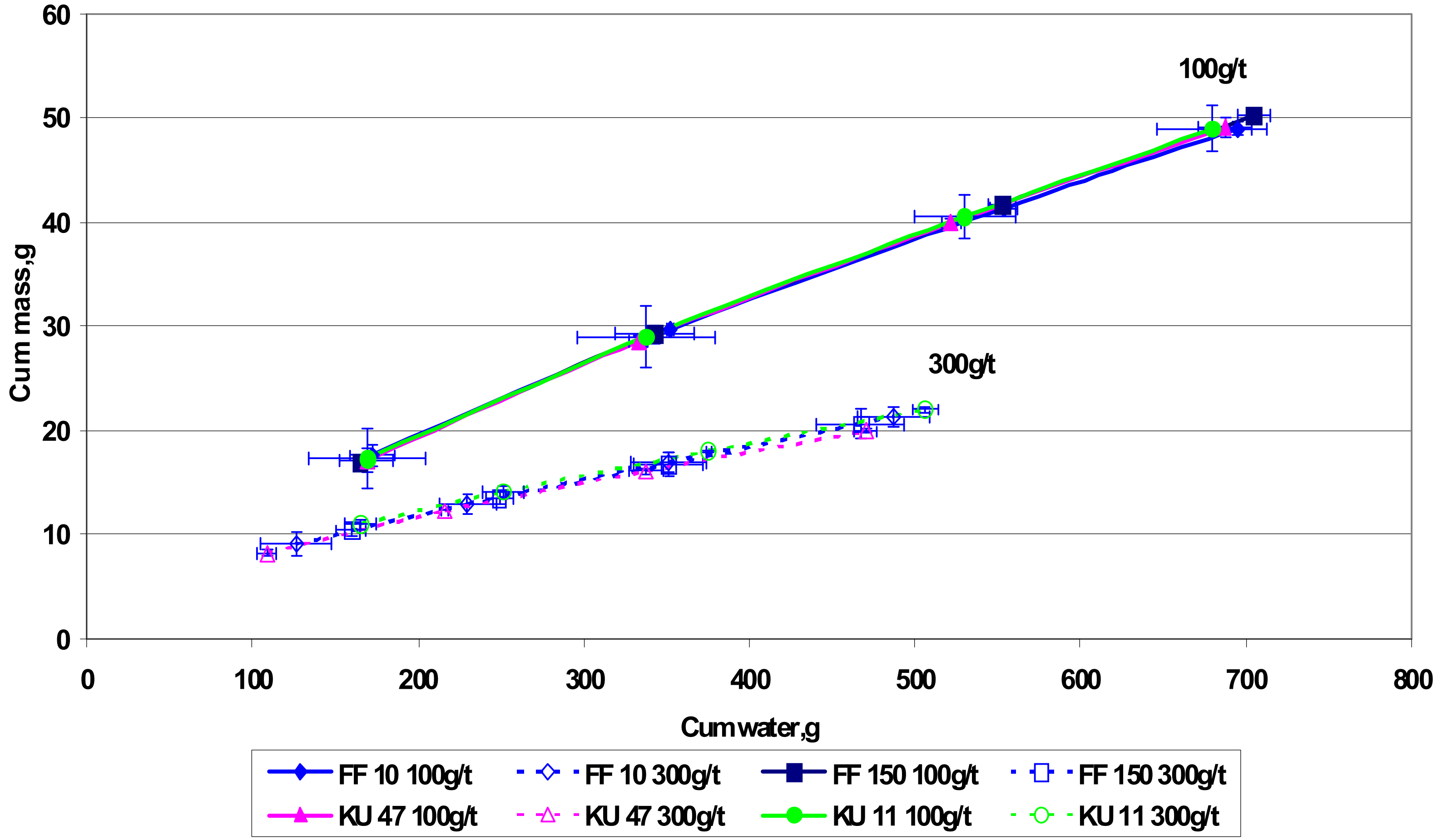


Total mass and water
4 purified cmc's (100-300g/t) – similar DS



UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

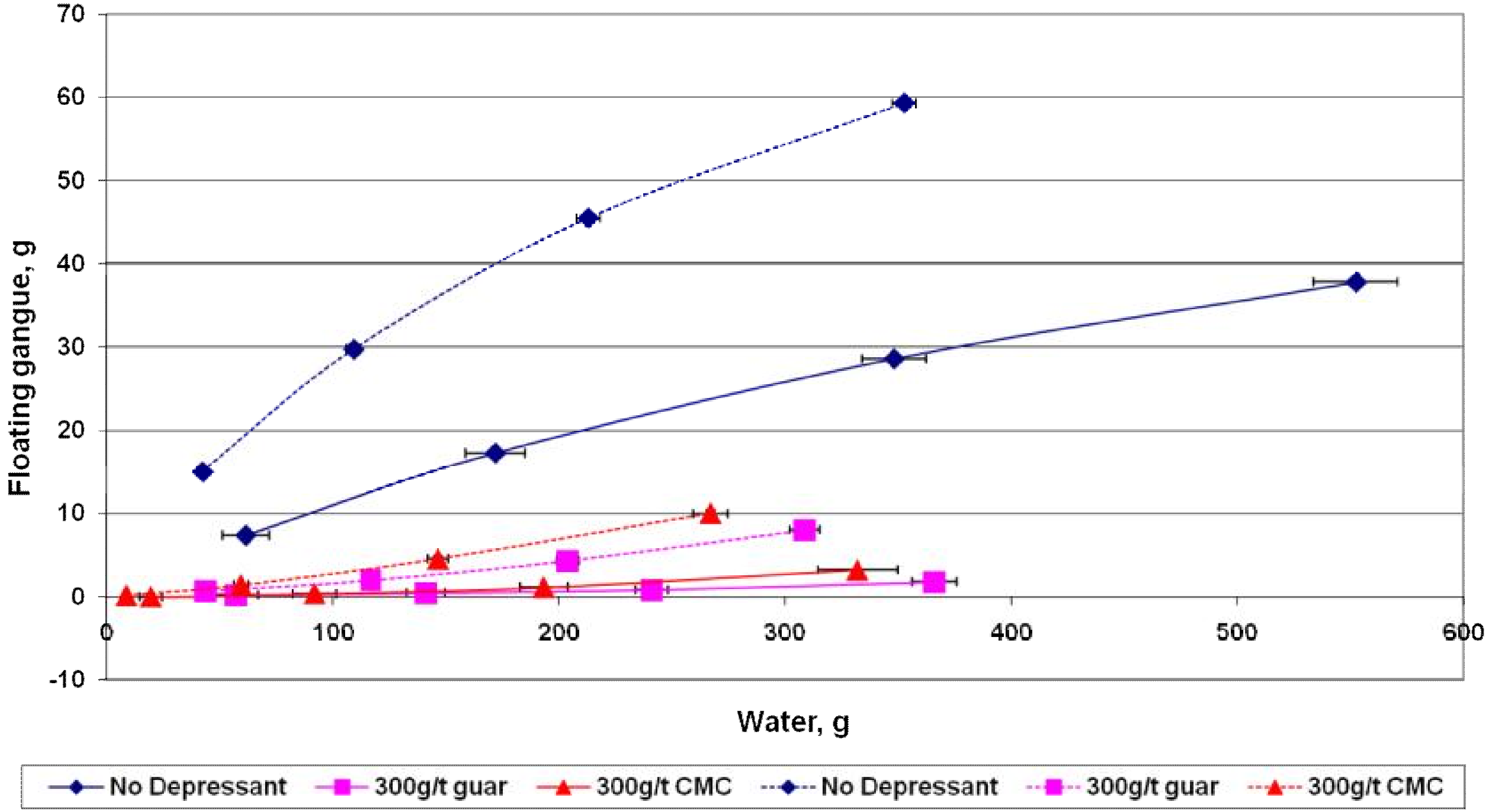
Mass vs water purified cmc's



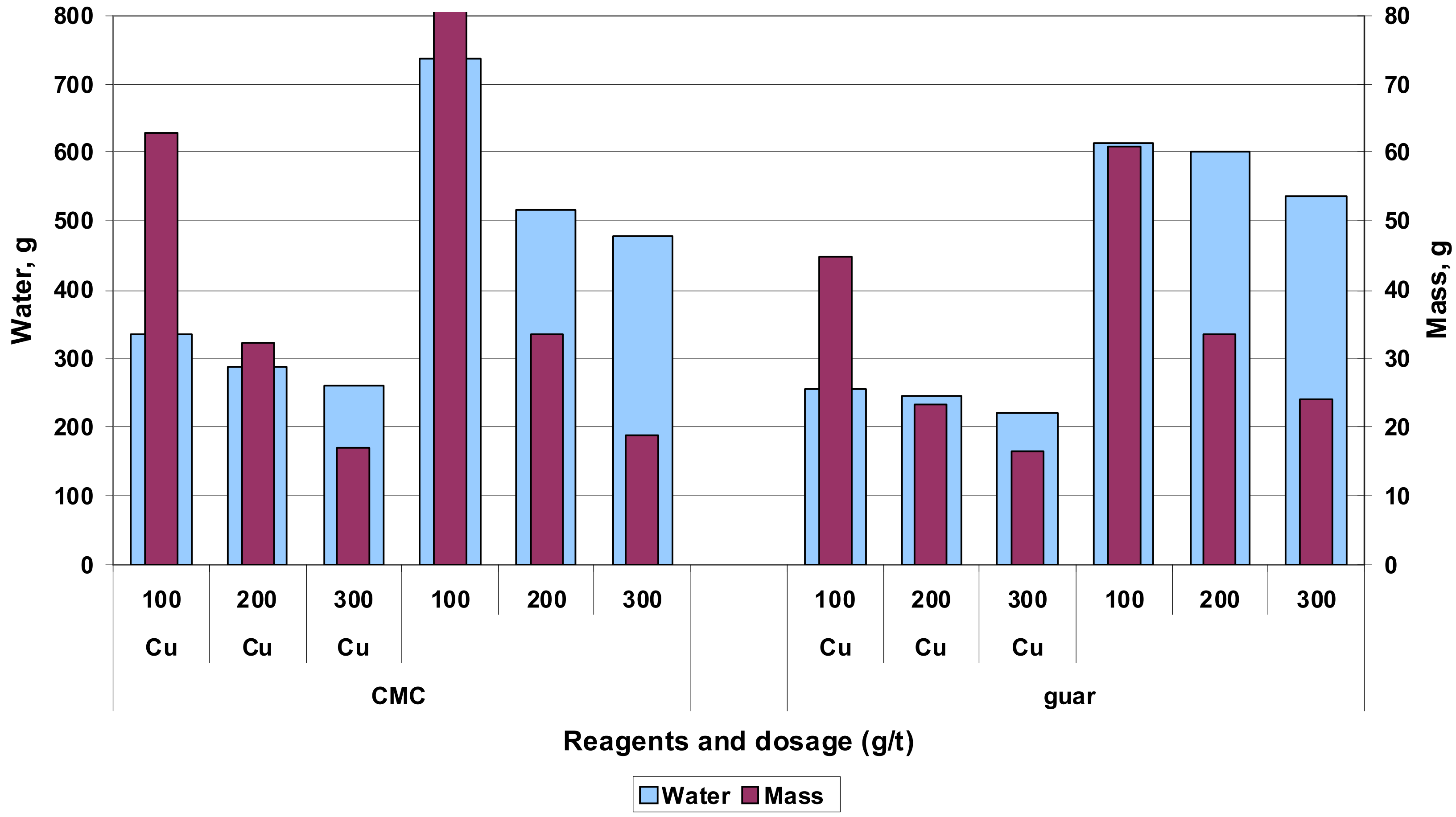
UNIVERSITY OF CAPE TOWN

CENTRE FOR MINERALS RESEARCH

Floating gangue vs water recovered Merensky ores – different source



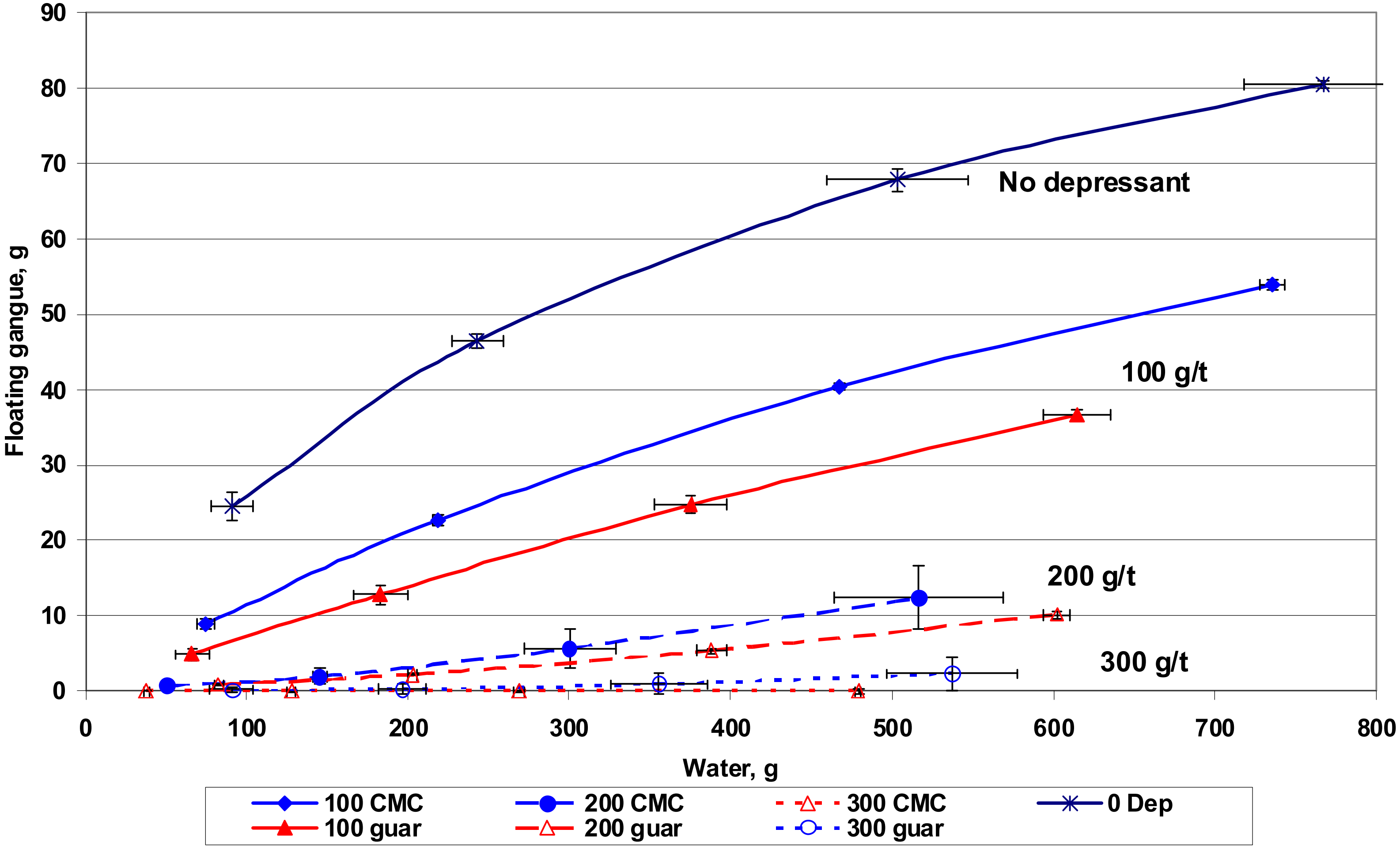
Effect of depressant type, dosage and Cu activation on froth stability



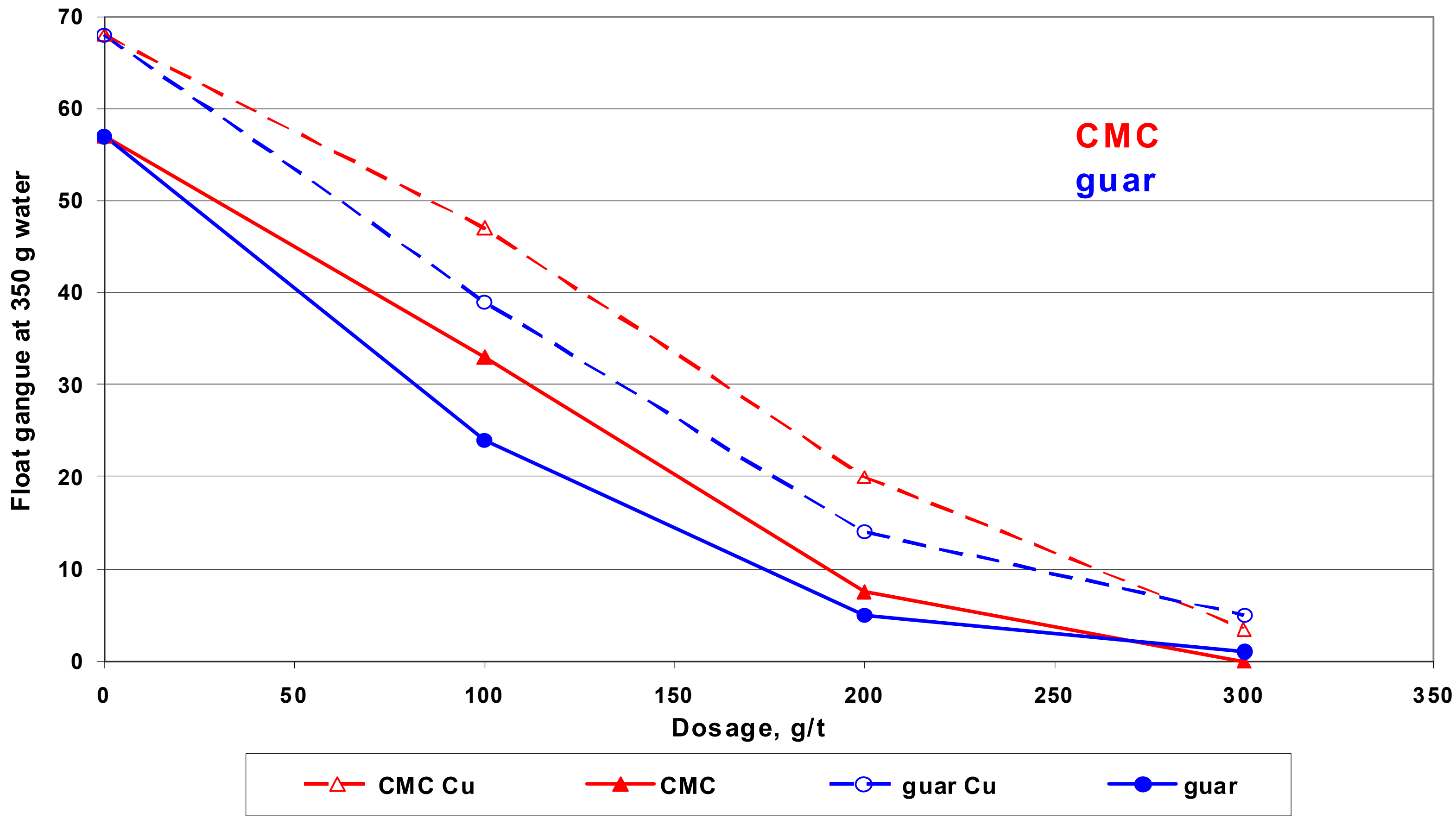
UNIVERSITY OF CAPE TOWN

CENTRE FOR MINERALS RESEARCH

Effect of increasing depressant dosage on floatable gangue

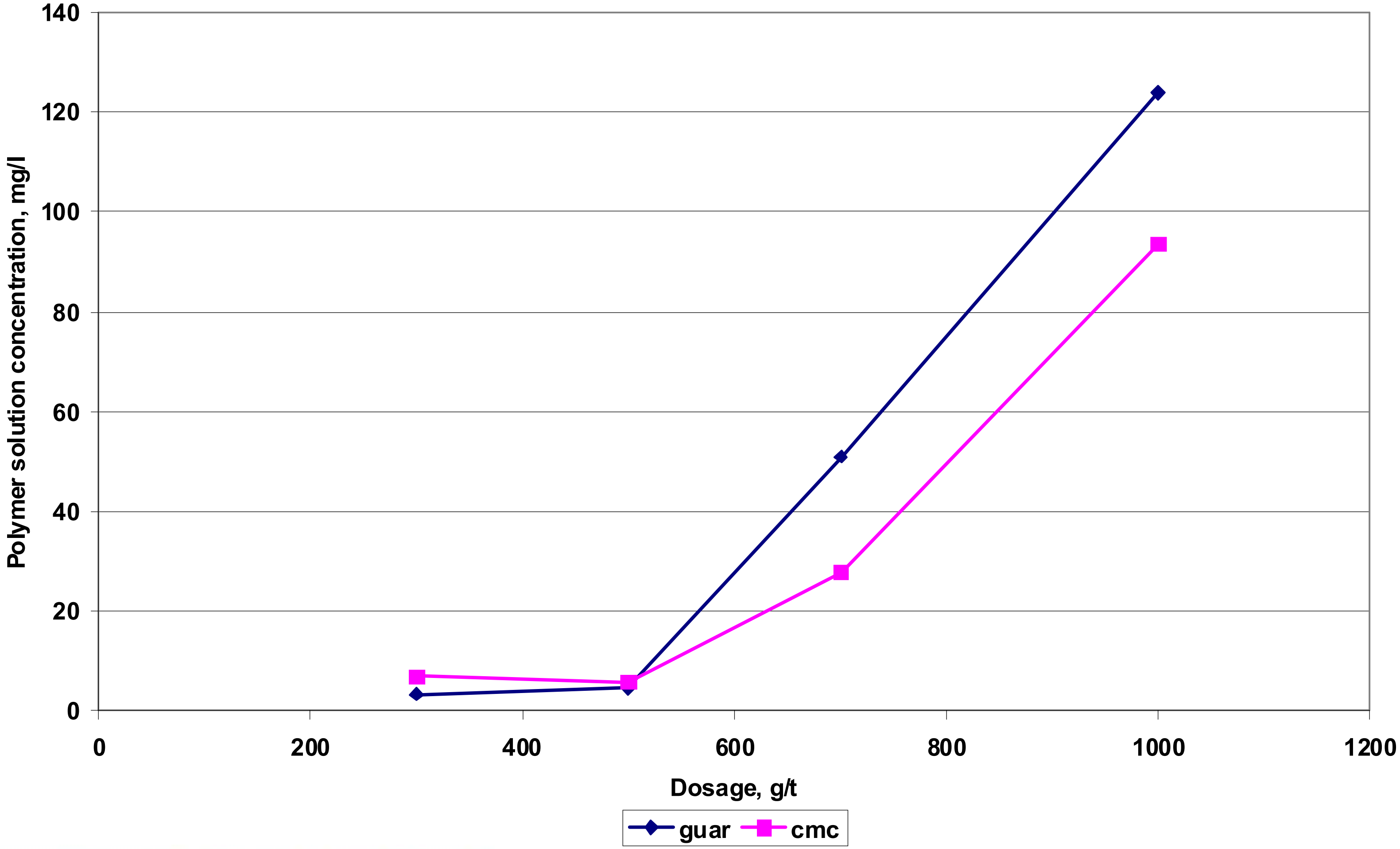


Floatable gangue at fixed water recovery – effect of depressant dosage



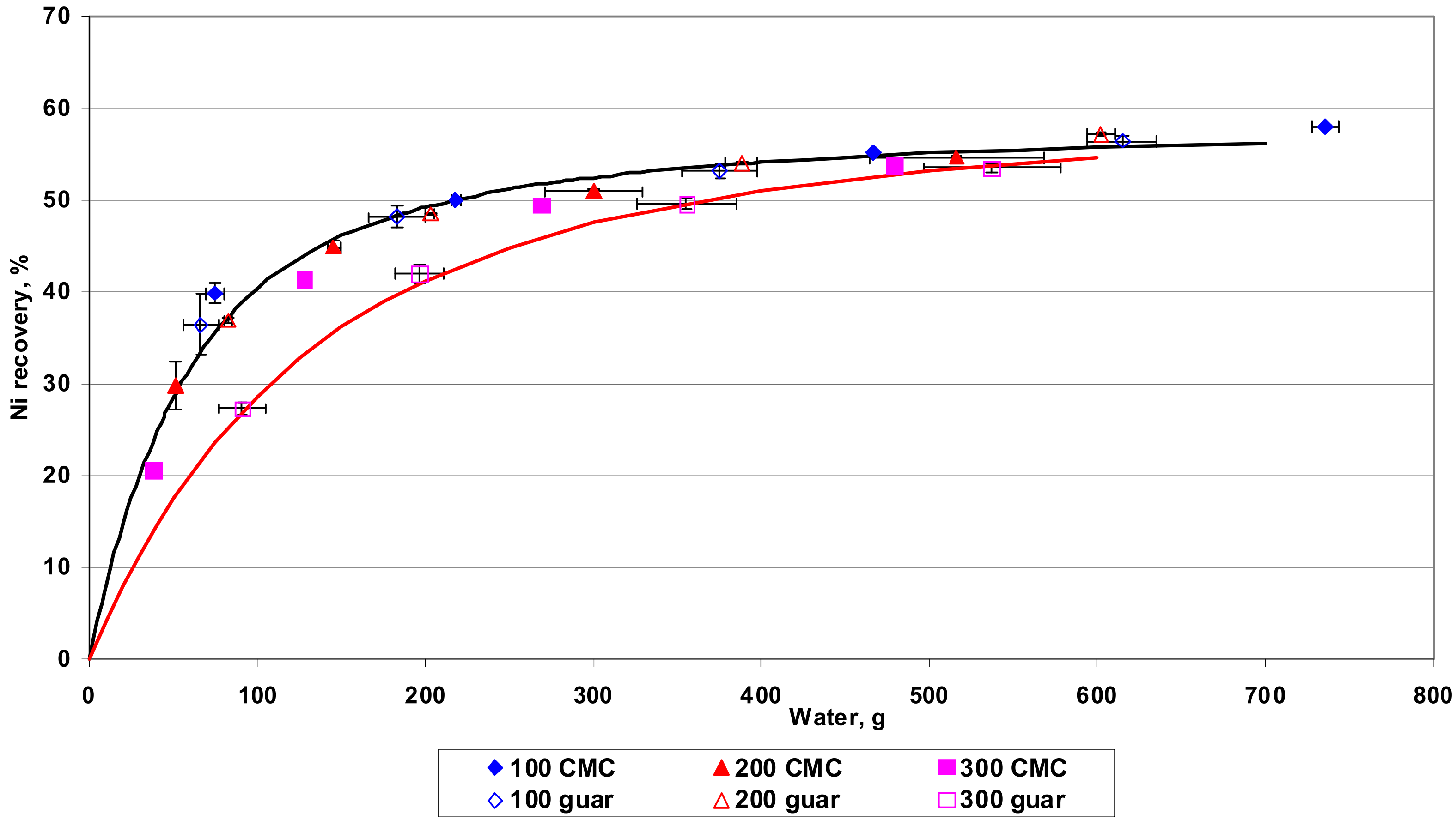
UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

Solution depressant concentration – increasing dosage



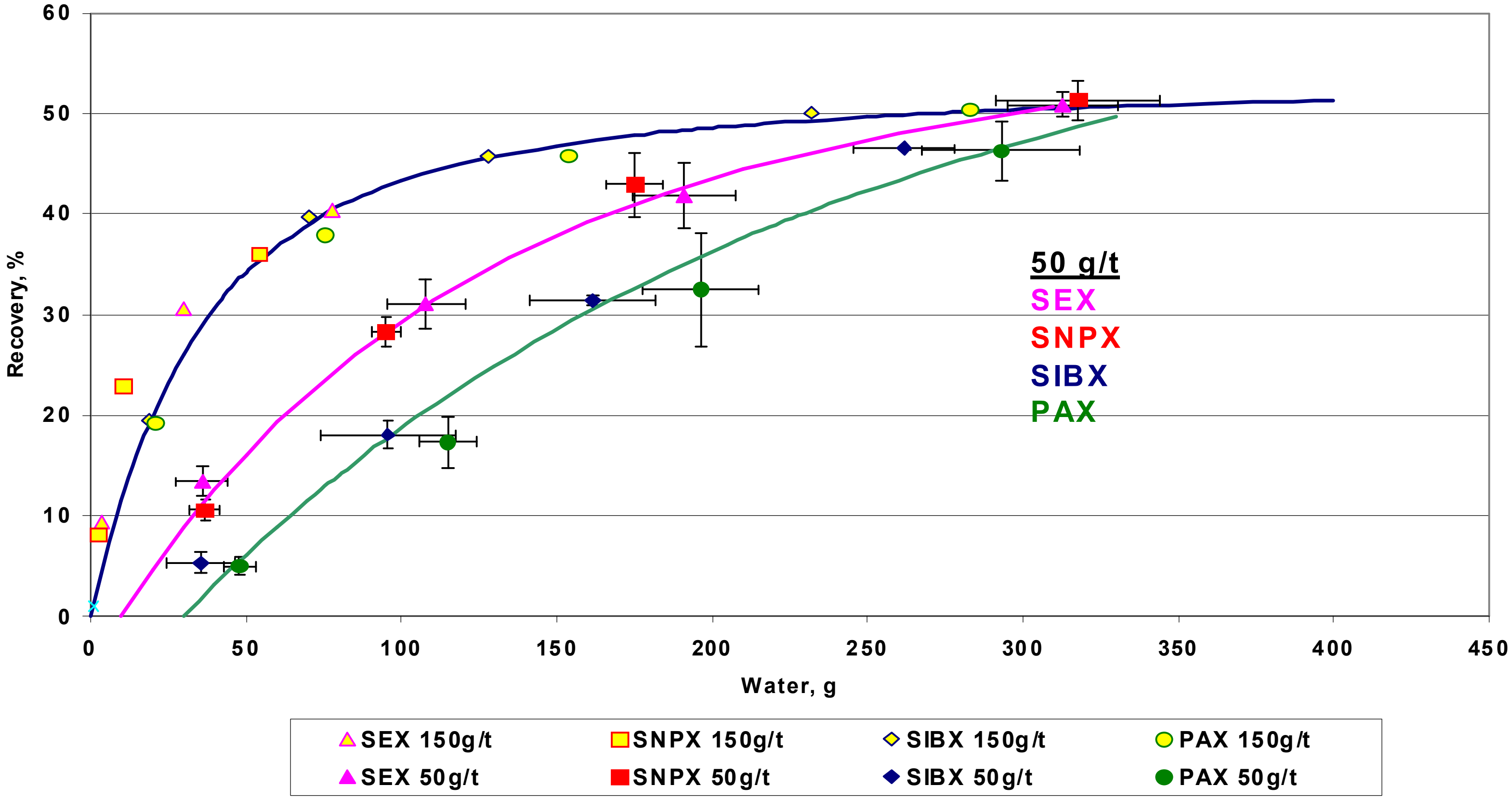
UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

Ni recovery
- increasing depressant dosage



UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

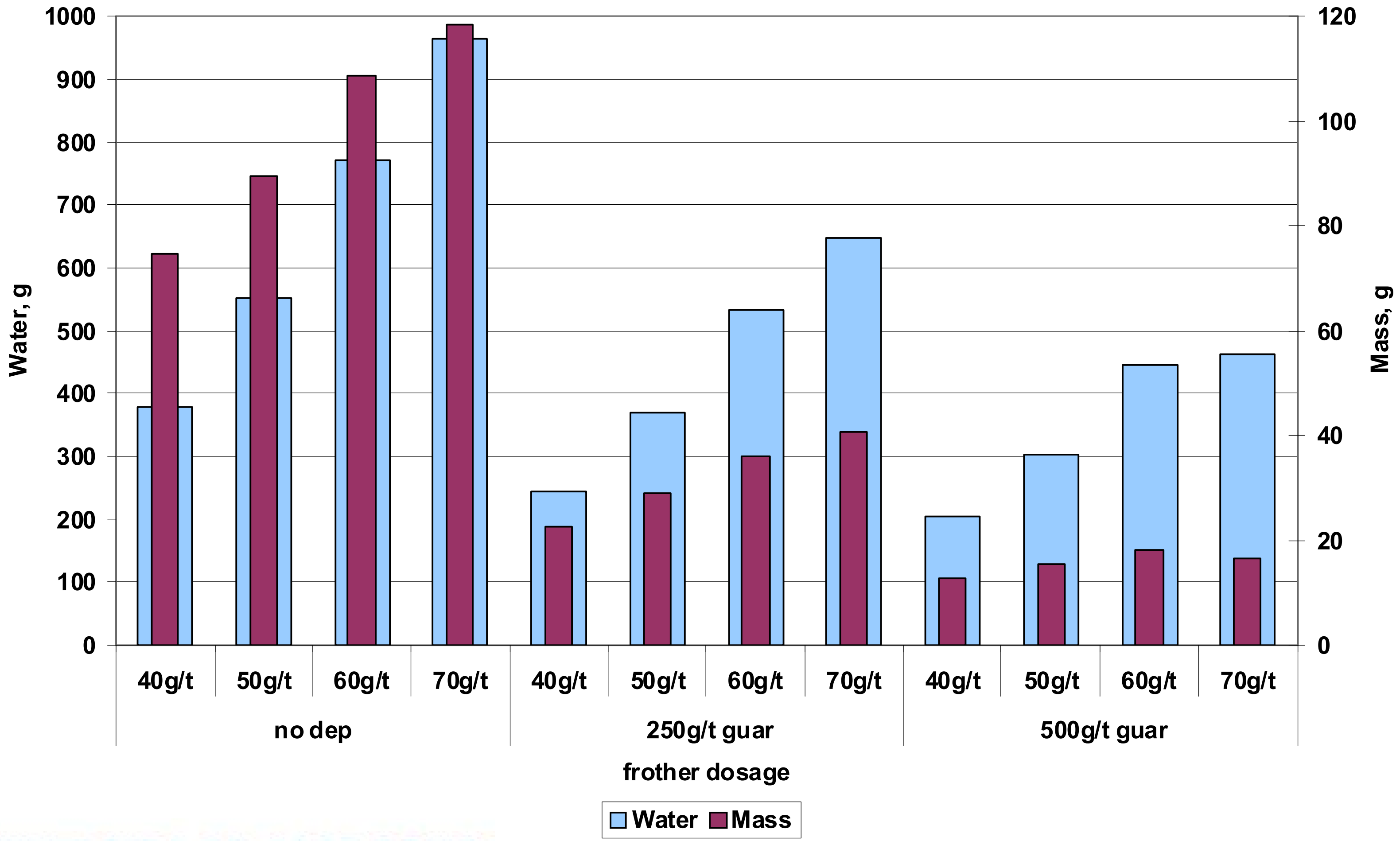
500g/t guar – Effect of increasing X dosage from 50g/t to 150g/t



UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

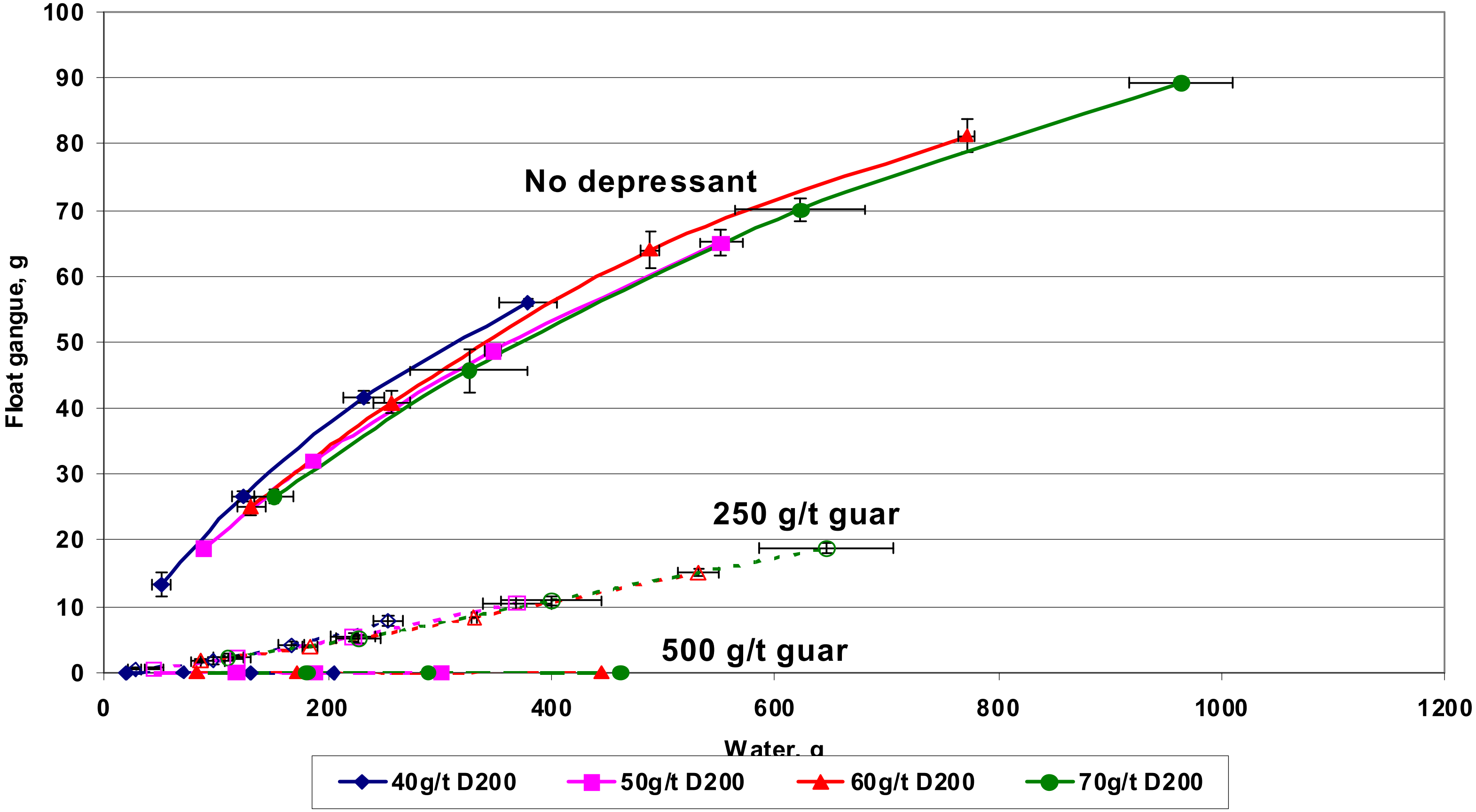
Direct Effect - Frother Dosage

Total mass and water recoveries – increasing frother dosage



UNIVERSITY OF CAPE TOWN
CENTRE FOR MINERALS RESEARCH

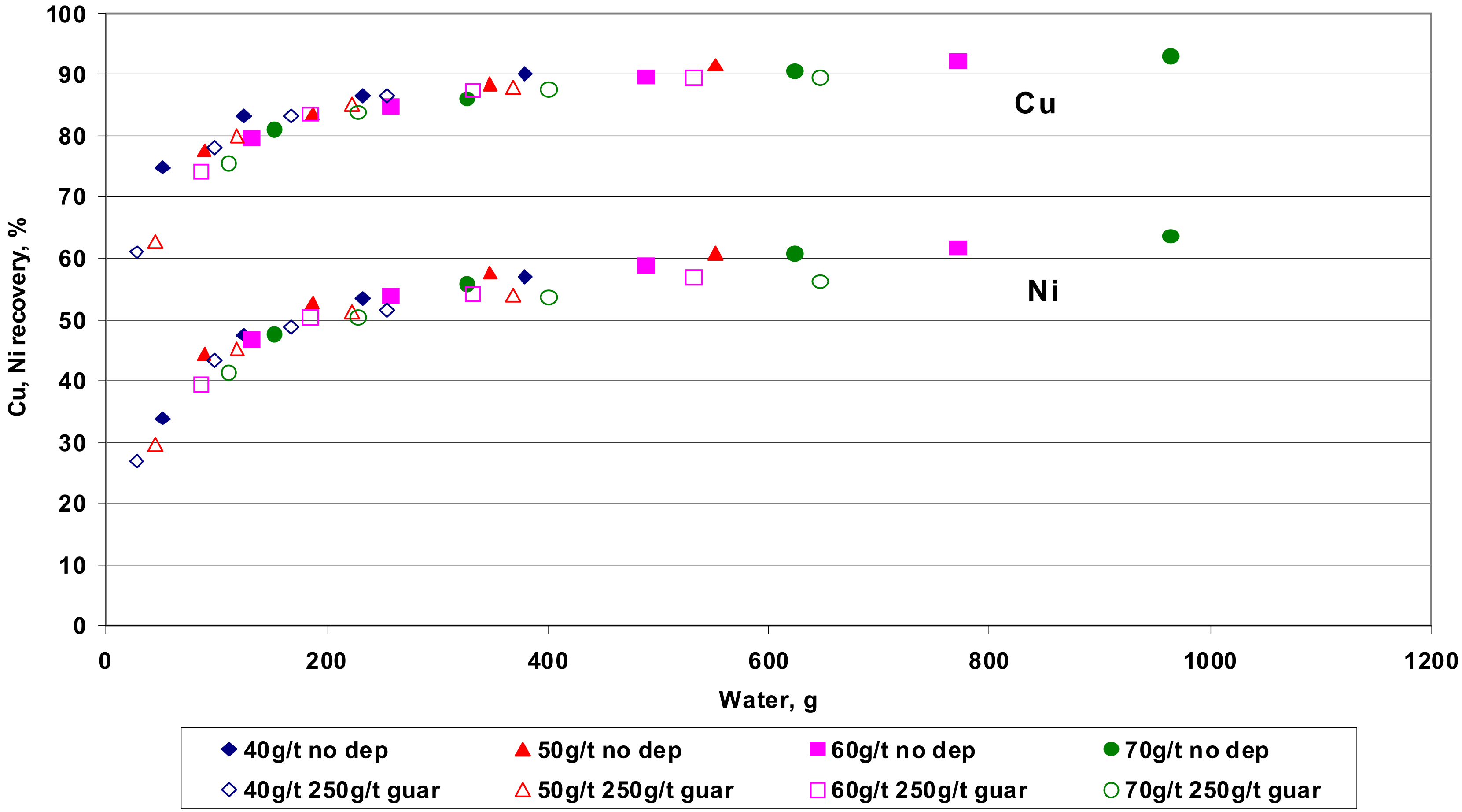
Effect of frother dosage on floatable gangue recovery



UNIVERSITY OF CAPE TOWN

CENTRE FOR MINERALS RESEARCH

Increasing frother concentration Cu, Ni recoveries vs water – 150g/t X



UNIVERSITY OF CAPE TOWN

CENTRE FOR MINERALS RESEARCH

Summary

- The stability of the froth is influenced by the nature of the hydrophobic particles entering the froth.
- Using water as a measure of froth stability allows a better understanding of the role and interaction of the reagent suite.
- Allows a better determination of the comparative behaviour of the various reagents.
- Does not replace classical grade-recovery curves.

The people who really count

Thanks to:

Jenny Wiese
Jules Kitenge
Bernard Oostendorp
Rene van der Merwe
Sam Morar (videos)

Sponsors: **Anglo Platinum, Impala, Lonmin**