The application of flotation test work to plant design and operation

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Mintek Test Work 1987-1994

- **Laboratory Test Work**
- **Pilot Plant Test Work**
- **Full scale plant operation**
- **Development of a scale-up procedure**
- **Introduction of Unit Cells on Mill discharge**
- **Modelling of the Flotation Process**
- **Development of a flotation simulator**
- **Development of the "Mintek 2-concentrate process"**

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Optimisation Methodology

- **Establish a relationship with operations team**
- **Have monthly FIXCO meetings**
- **Conduct sampling campaigns**
- **Mineralogical analyses**
- **Fractional analysis**
- **Hot floats of pertinent streams**
- **Implementation and monitoring of agreed strategies**
- **Data analysis and feedback**

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Case Study 1

Effect of Pulp Rheology

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Project Description

- **Marula Platinum initiated project in conjunction with Metallicon Process Consulting to determine process bottlenecks and characterise plant performance**
- **Surveys identified rougher concentrate thickeners as operational bottlenecks**
- **Surveys also pointed to low cleaner efficiencies**
- **Second survey initiated to determine potential cause of low cleaner efficiencies**
- **Results from both reported here.**

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Process Description

- Nameplate capacity of 165 ktpm treating UG2 ore on Eastern Limb of Bushveld Complex
- MF2 type circuit (mill-float-mill-float) with two stage upfront crushing and SAG ball mills.
- Rougher concentrate thickened and attritioned (at SG >1.6) before density reduced (SG = 1.35 – 1.45) and fed to cleaner circuit.
- Cleaner circuit flexible to operate as 2/3/4 stage cleaners.

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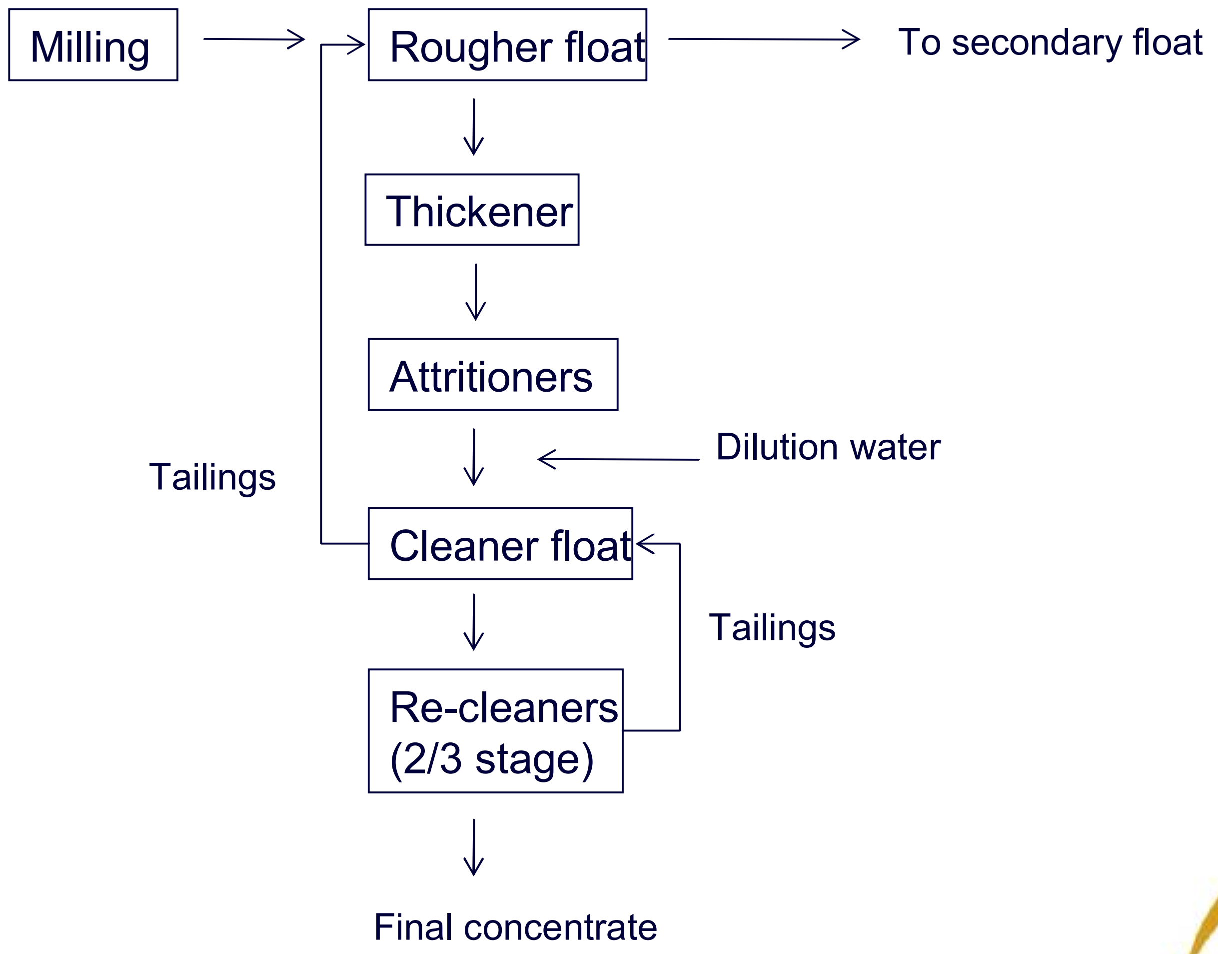
Process Flow Diagram



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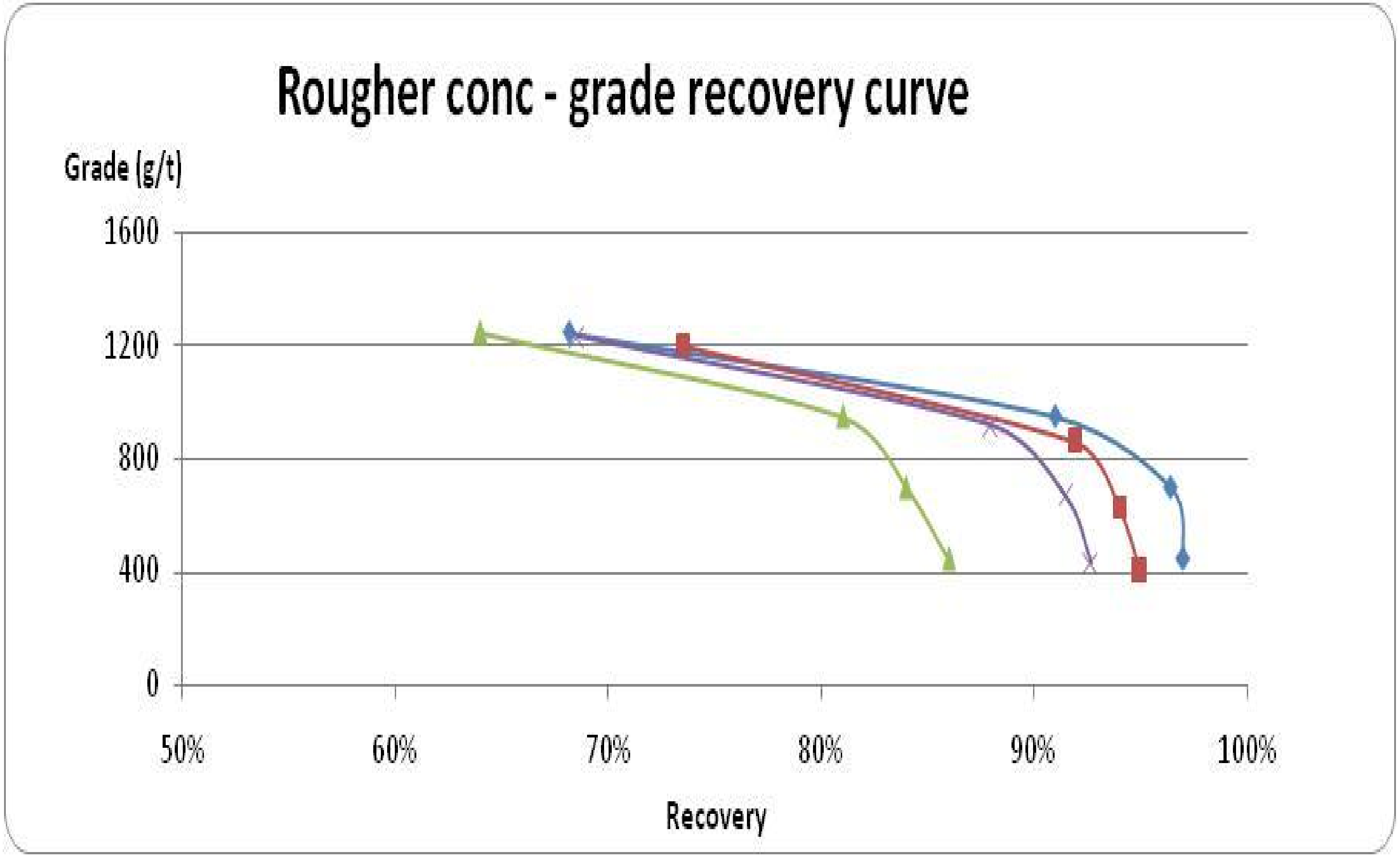
Preliminary Test Work

- Initial campaign very generalised and included hot batch floats in lab cell on major streams
- Initial campaign included mass balance sample campaigns, screening analyses and down the bank samples.
- Results from mass balance survey and routine plant data indicated high rougher efficiencies but poor cleaner efficiencies
- Data was confirmed by hot batch floats results.

Grade Recovery Curves

Rougher Conc



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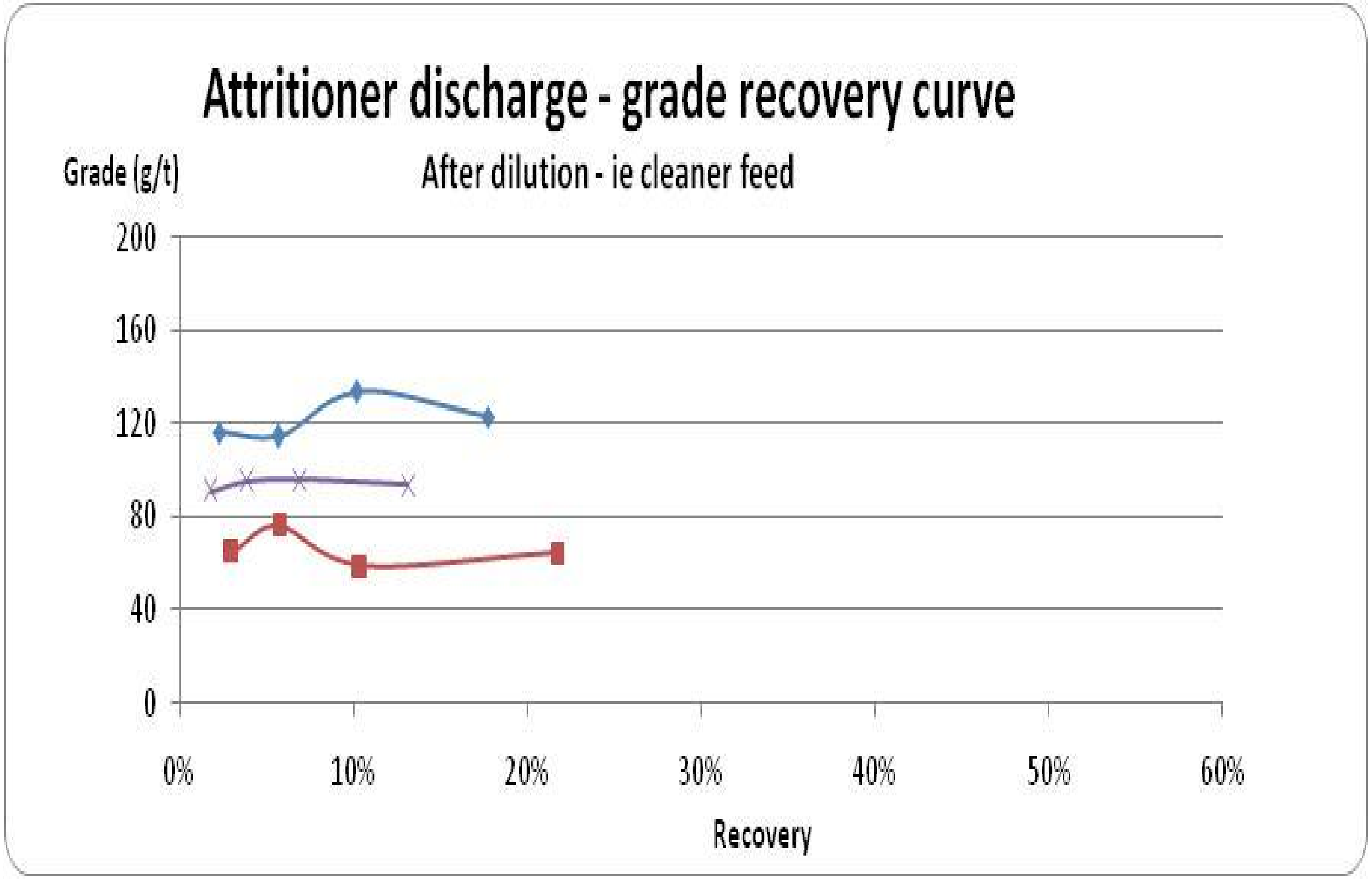
Grade Recovery Curves

Attritioner Discharge



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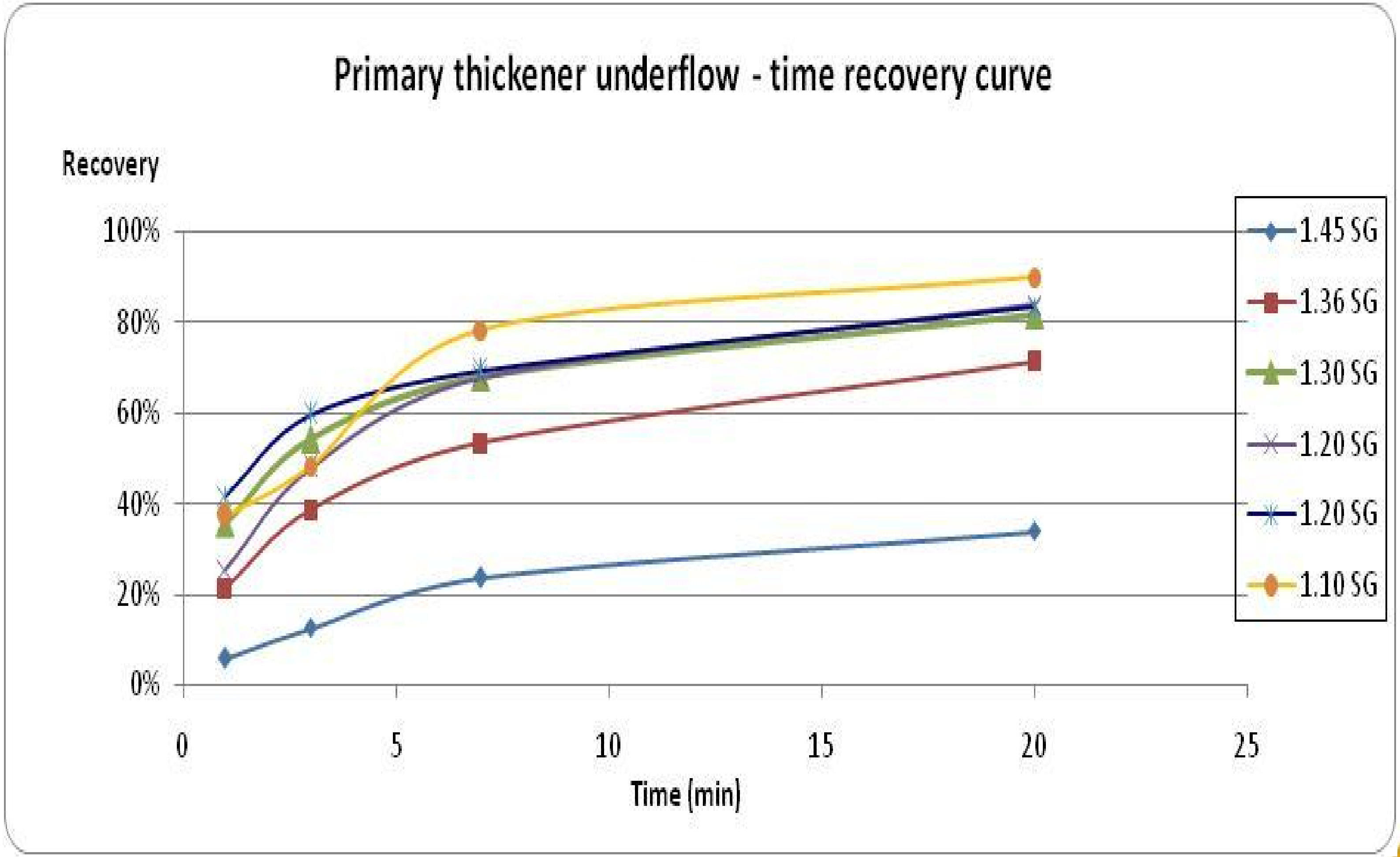
Discussion

- Three potential causes identified
  - Lack of reagents (specifically collectors) due to thickening and attritioning
  - Effect of “ageing” (or oxidisation) in thickeners (not confirmed)
  - Effect of increased density in cleaner feed compared to rougher concentrate.
- Reagent addition to cleaners increased significantly with no improvement noticed.
- Test work through hot floats and plant trials were initiated to evaluate density effect.

Effect of changing density



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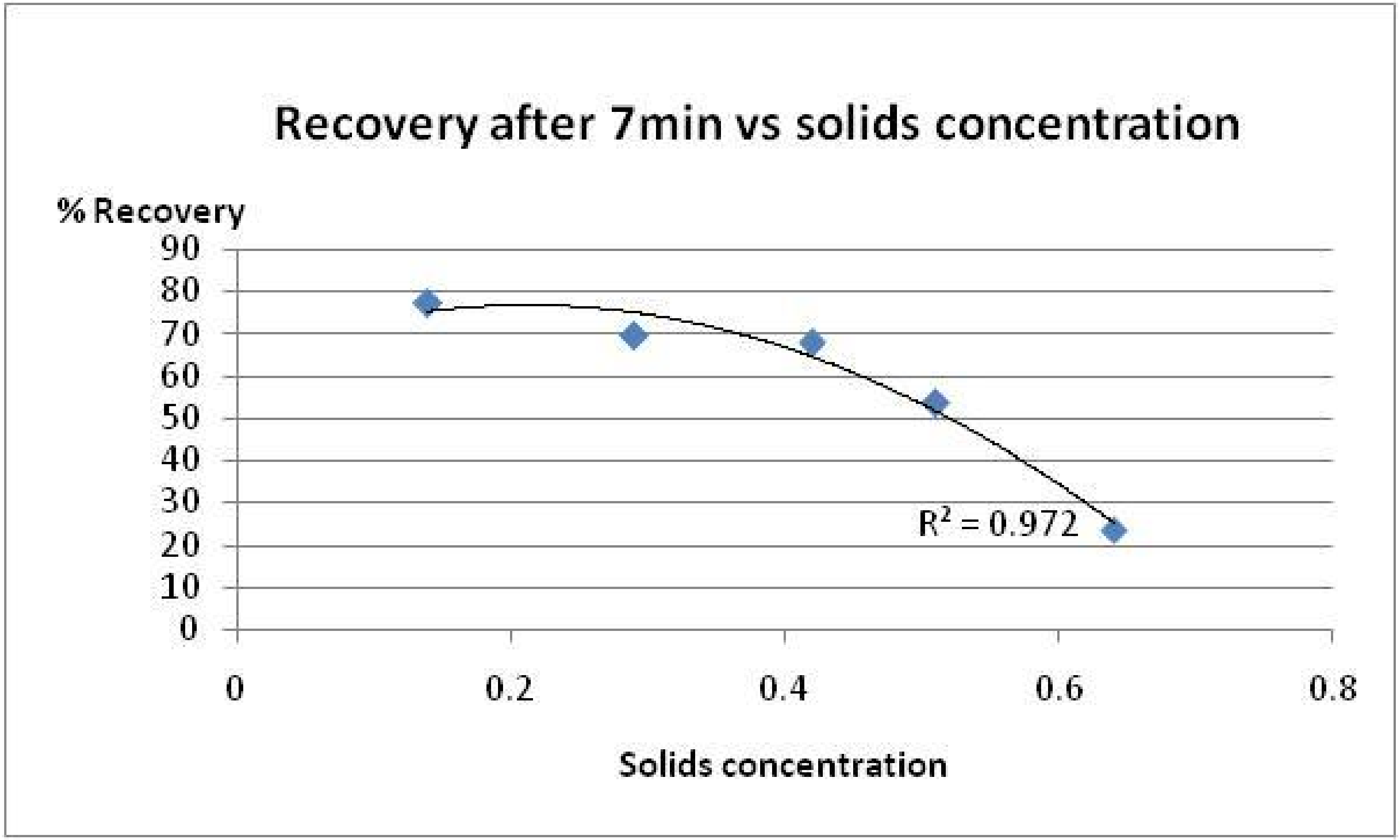
Recovery Density relationship



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Case Study 2

Tackling the chromite problem in UG2 flotation

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Characteristics of UG-2 Ore

- Major Source of PGM's
- Two major gangue phases
  - Chromite (25% to 40%)
  - Siliceous gangue phase
- Specific gravity circa 3.8
- PGM's occur in a variety of minerals
- Mode of occurrence of PGM's varies
- Low base metal sulphide content

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Challenges in Processing UG-2

- Mode of occurrence of PGM's
- Two predominant gangue phases
  - Different physical properties
  - Different chemical properties
- Concentrate mass pull limitation
- Stringent chromite specification in concentrate grade to smelter

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Typical Results on UG-2 ore

- Concentrate PGM+Au Grades
  - Range from 80 g/t to 350 g/t
- Concentrate Chromite Grades
  - Range from 2.5% to +6%
- Recoveries
  - Range from 75% to +90%

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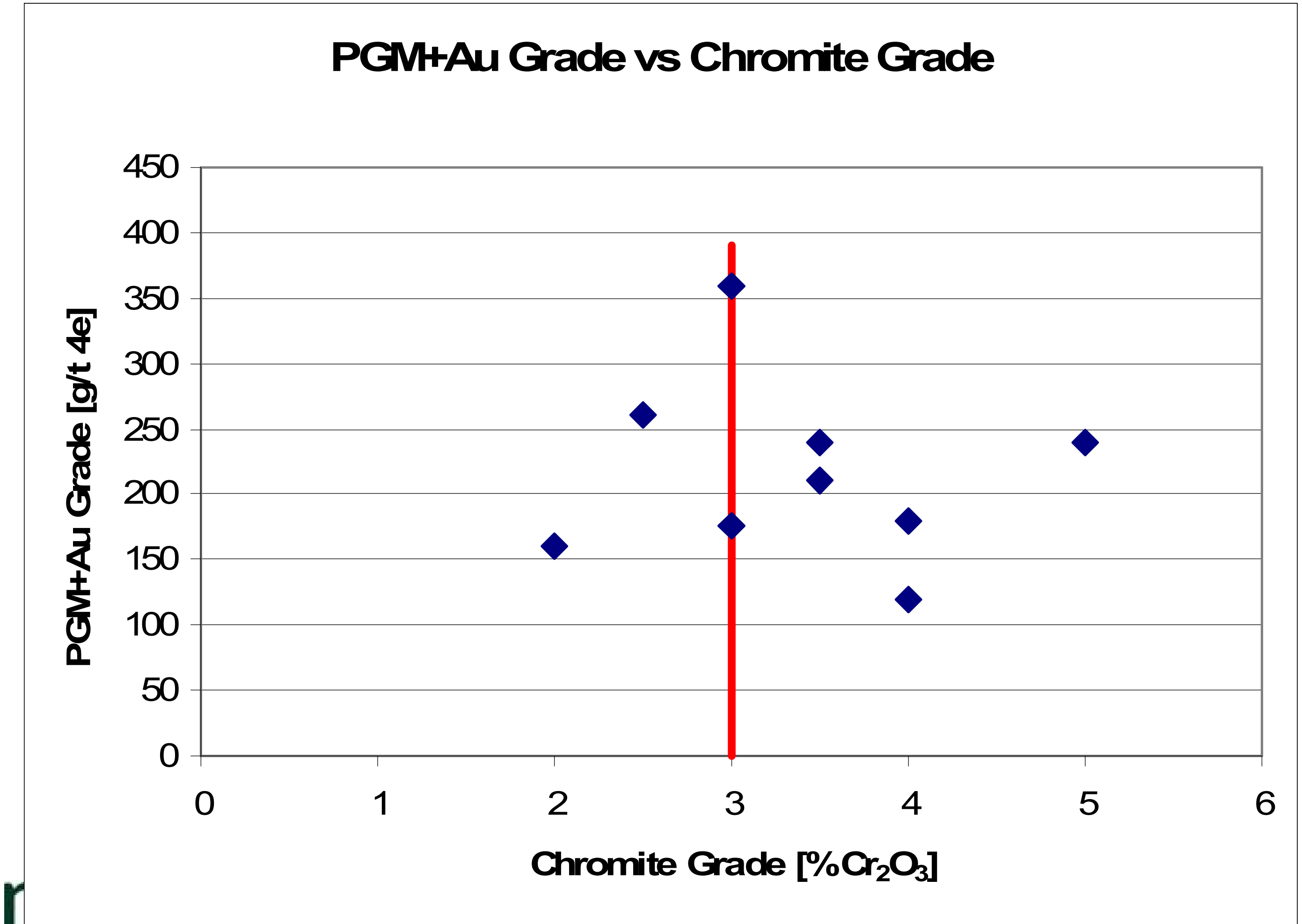
The grades in the industry



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Various Strategies

- Reagent optimisation
- Circuit configuration
- Application of alternative technology
- Compromising recovery to meet specifications

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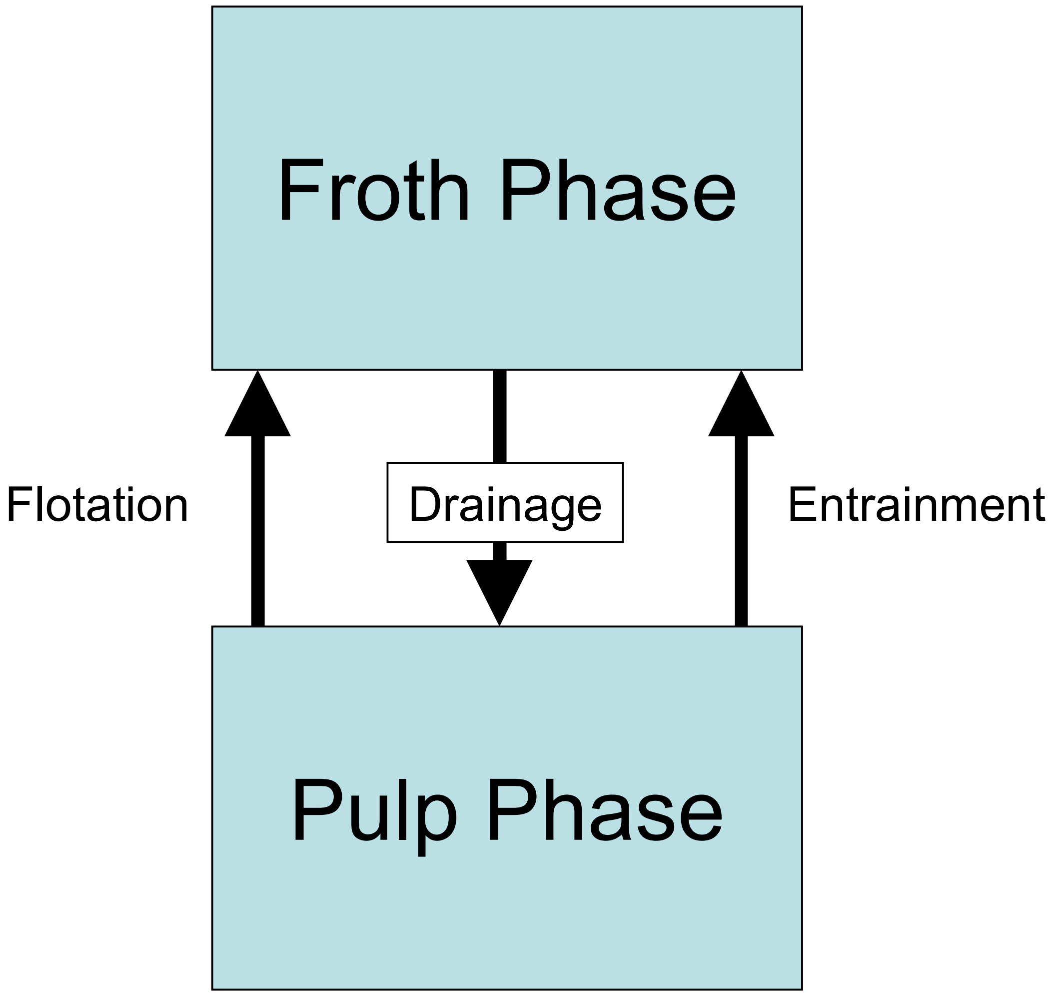
Sub-Processes in Flotation



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Sub-processes in UG-2

- Flotation
  - PGM+Au (primary)
  - Copper and Nickel Sulphides (primary)
  - Siliceous Gangue (secondary)
  - Chromite (negligible)
- Entrainment
  - PGM+Au (secondary)
  - Copper and Nickel Sulphides (secondary)
  - Siliceous Gangue (primary)
  - Chromite (primary)

Strategy

- Maximise PGM+Au recovery through flotation
- Minimise chromite recovery through entrainment
- Judiciously add depressant to reduce silicates recovered by flotation
- …. without increasing chromite grade

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Laboratory study

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Laboratory Testwork

- Batch testwork in Denver D12 machine
- Grind : 80% -75 micron
- Reagents
  – Copper Sulphate
  – SIBX
  – Depressant (CMC)
  – Frother (Dow 200)
- Test parameters
  – Solids Concentration
  – Frother Concentration
  – Depressant Concentration

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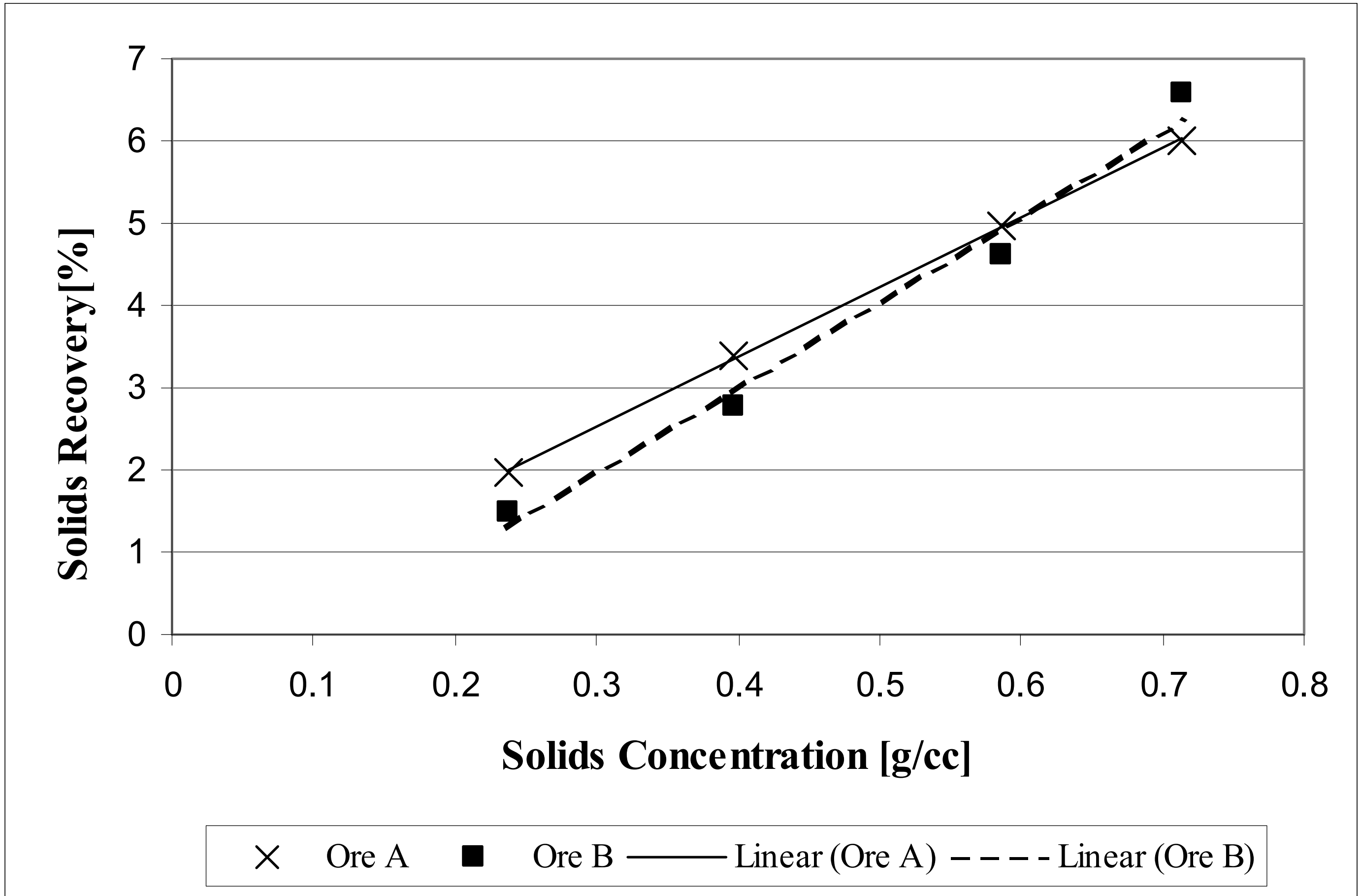
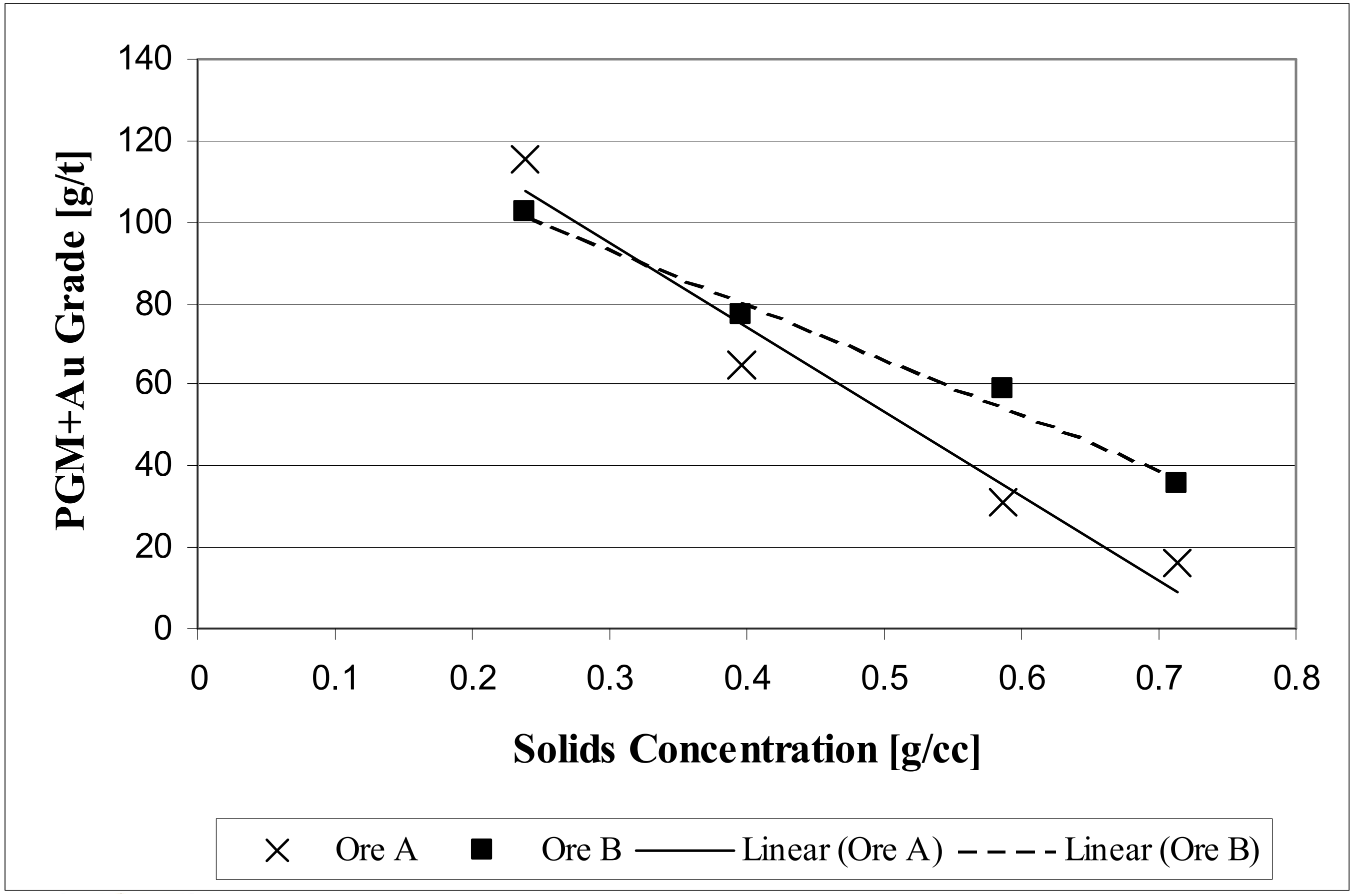
Effect of Solids Concentration on Solids Recovery



Effect of Solids Concentration on PGM+Au Grade



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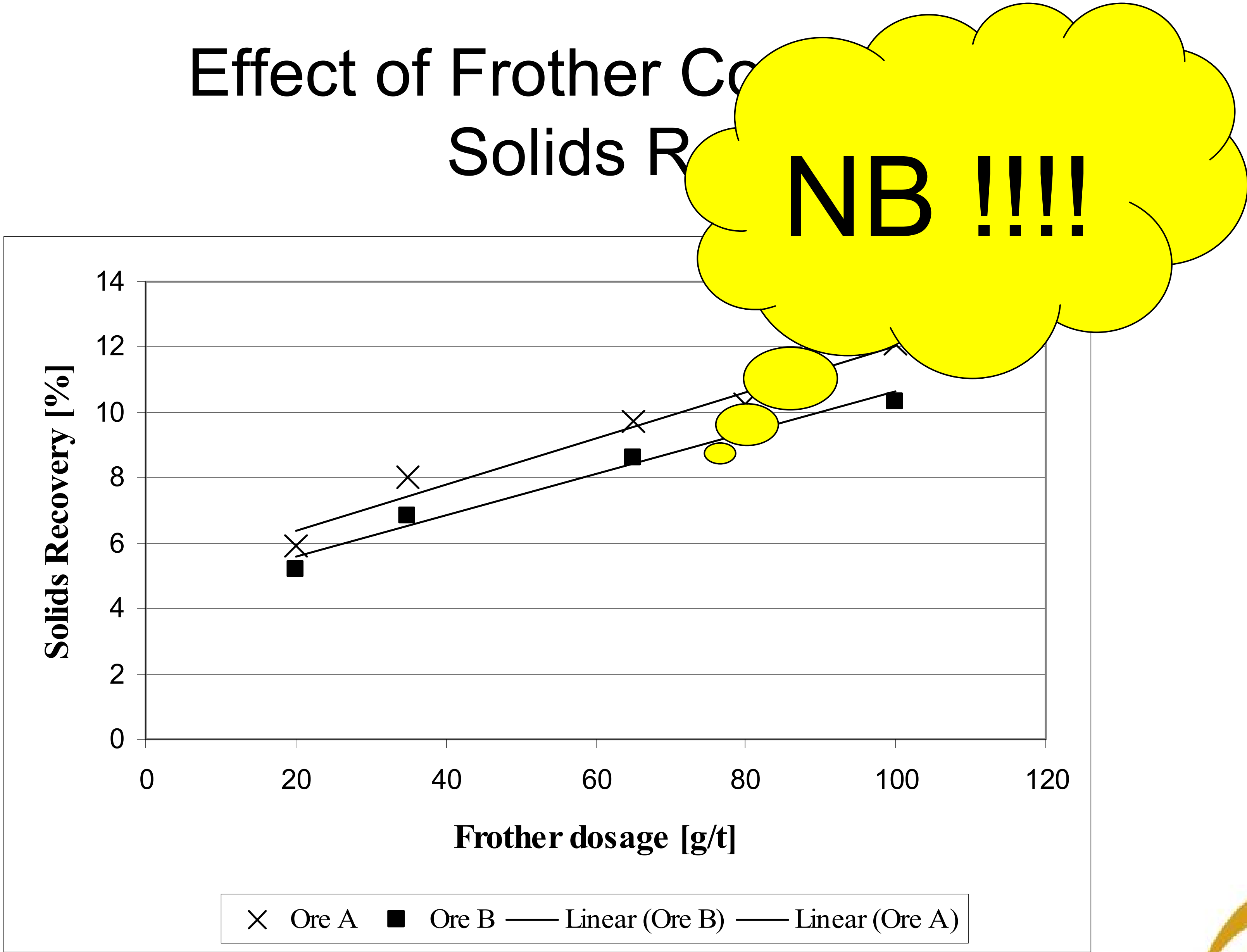
Effect of Frother Co
Solids R



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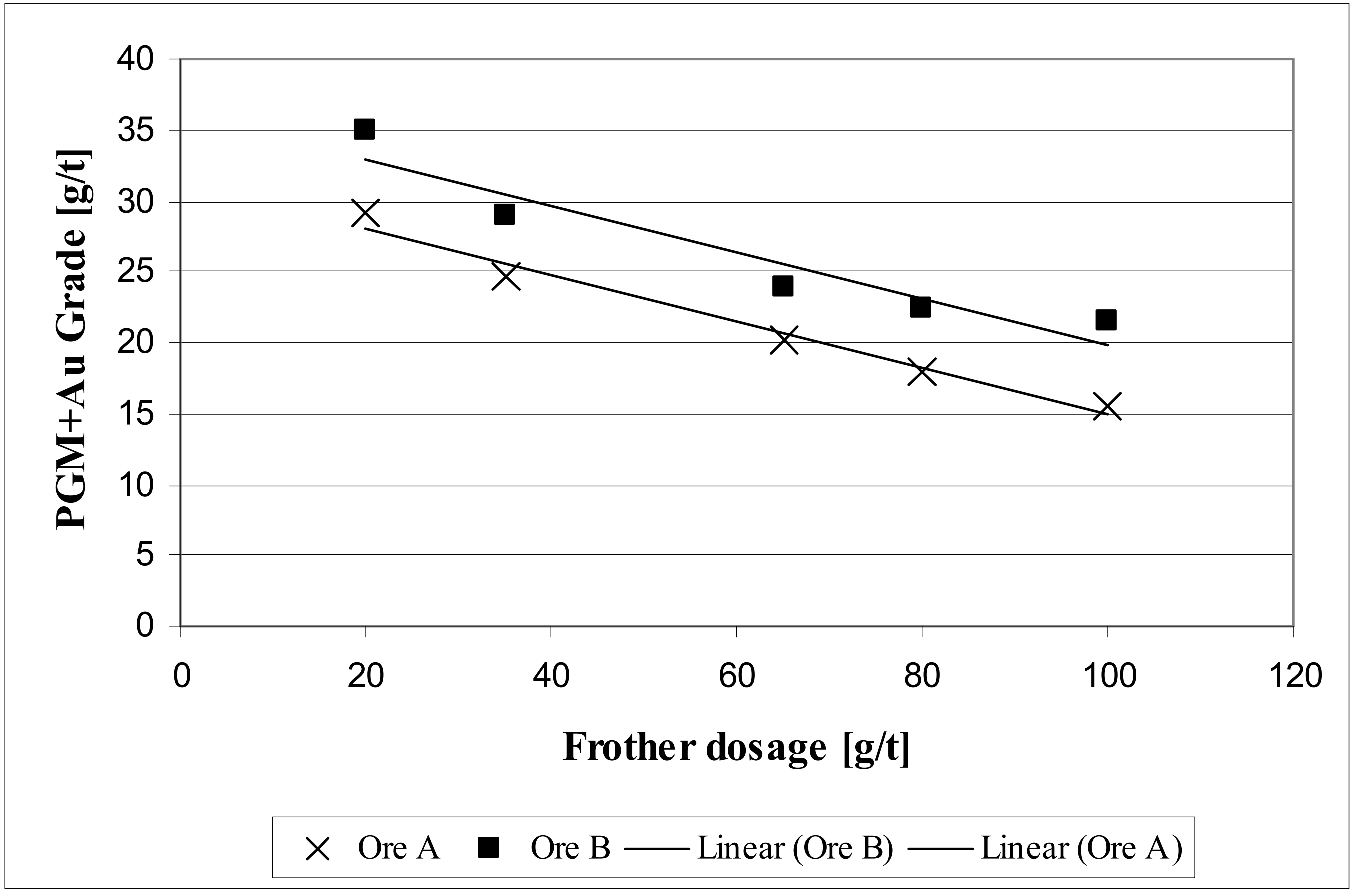
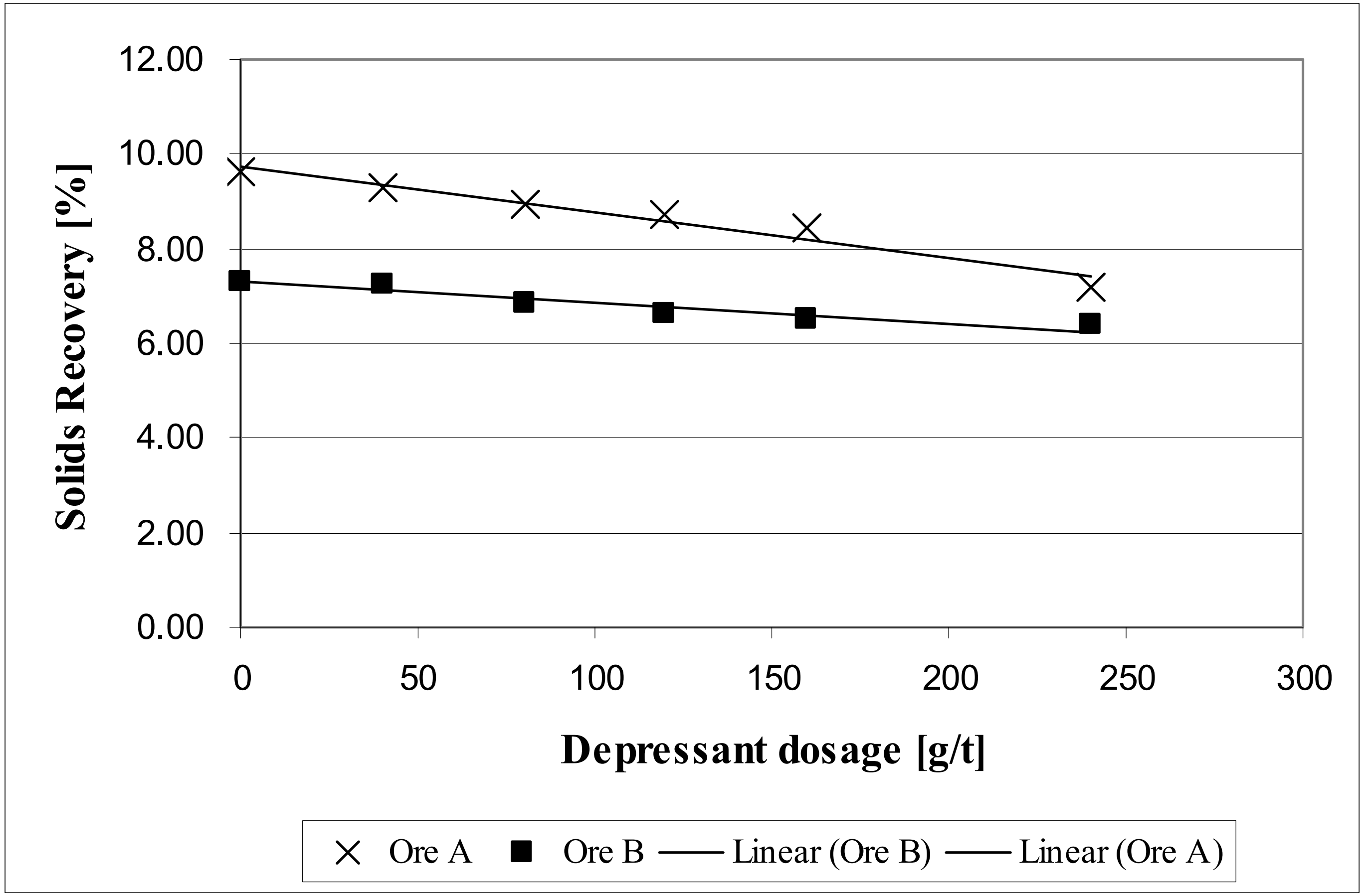
Effect of Frother Concentration on PGM+Au Grade



Effect of Depressant Concentration on Solids Recovery



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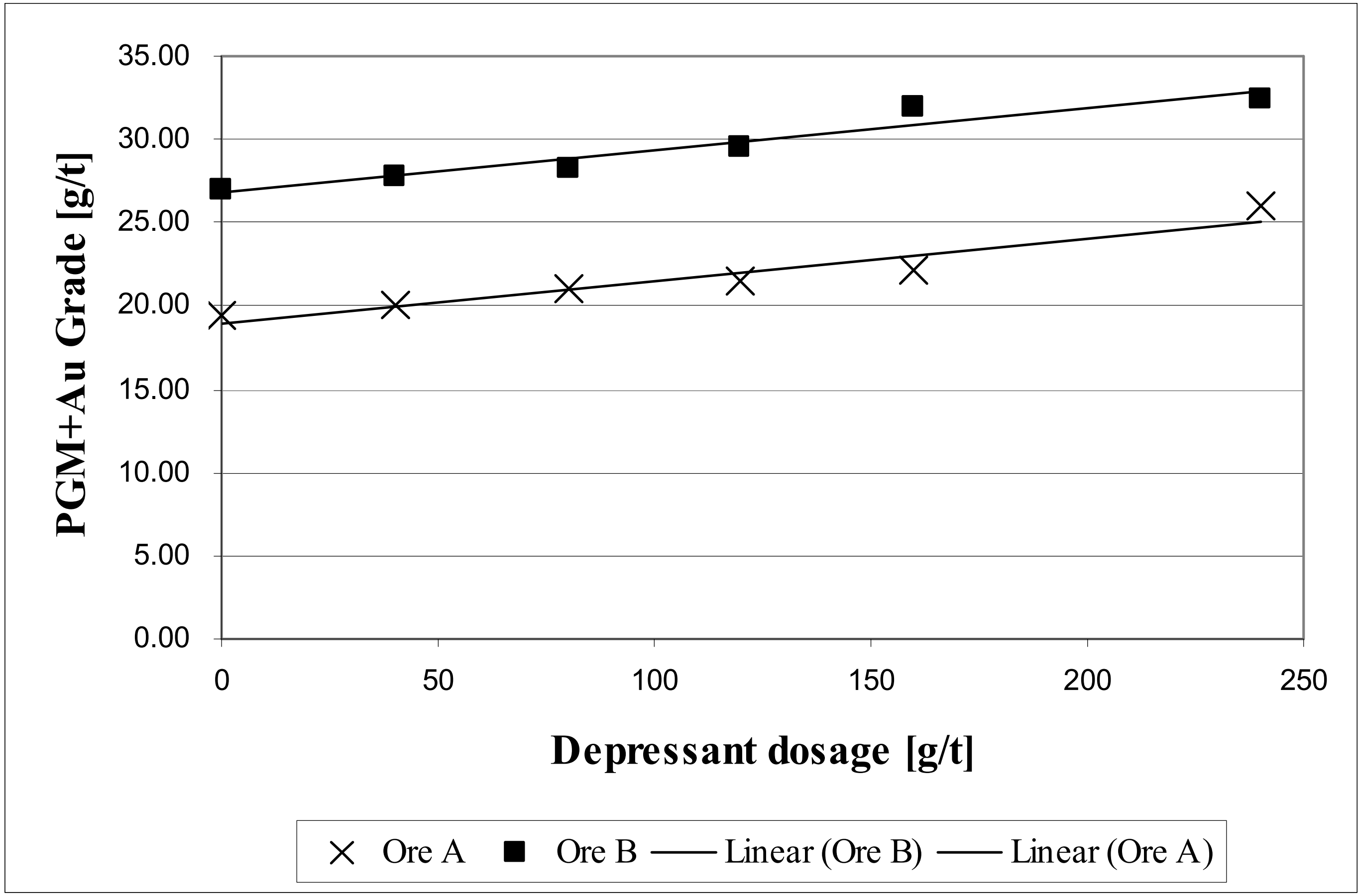
Effect of Depressant Dosage on PGM+Au Grade



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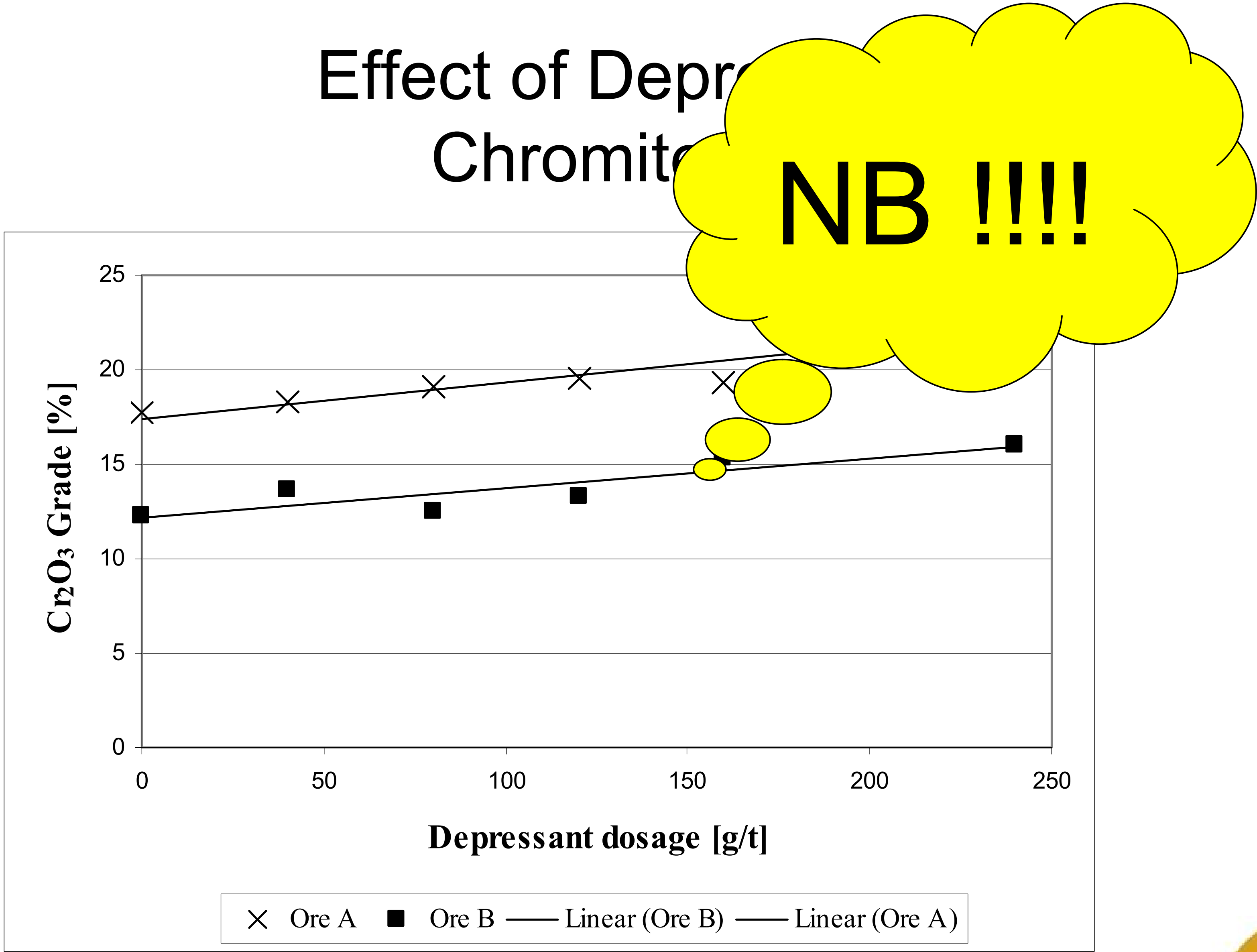
Effect of Depr
Chromit



Observations on Plants

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Plant Observations

- Depressant is successful in improving PGM+Au grade
- Depressant may result in an increase in chromite grade
- Selection of depressant dosage points is important

- Frother and solids concentration have a significant effect on entrained solids to concentrate

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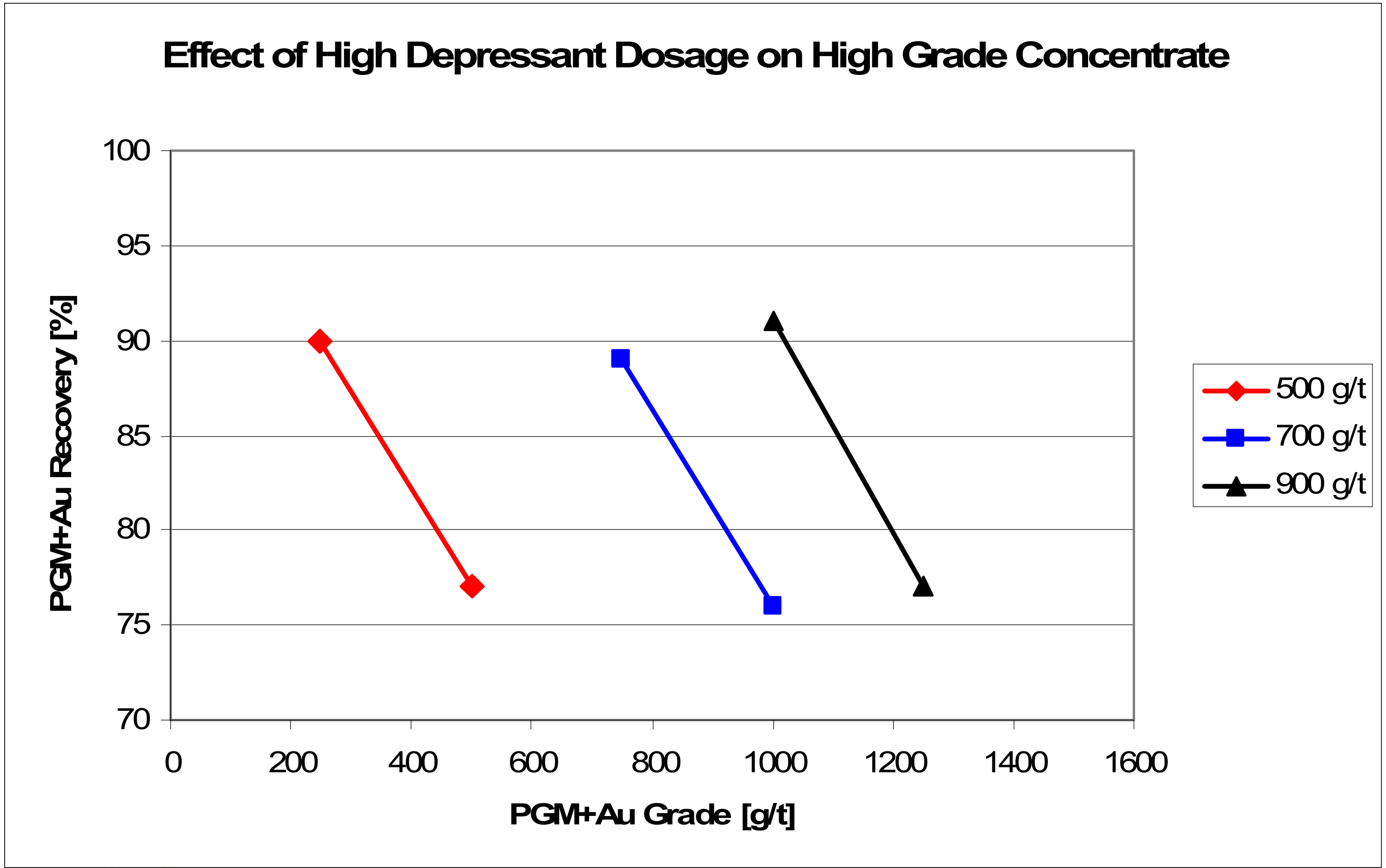
Effect of High Depressant Dosage on Fast Floating Fraction



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Application of findings

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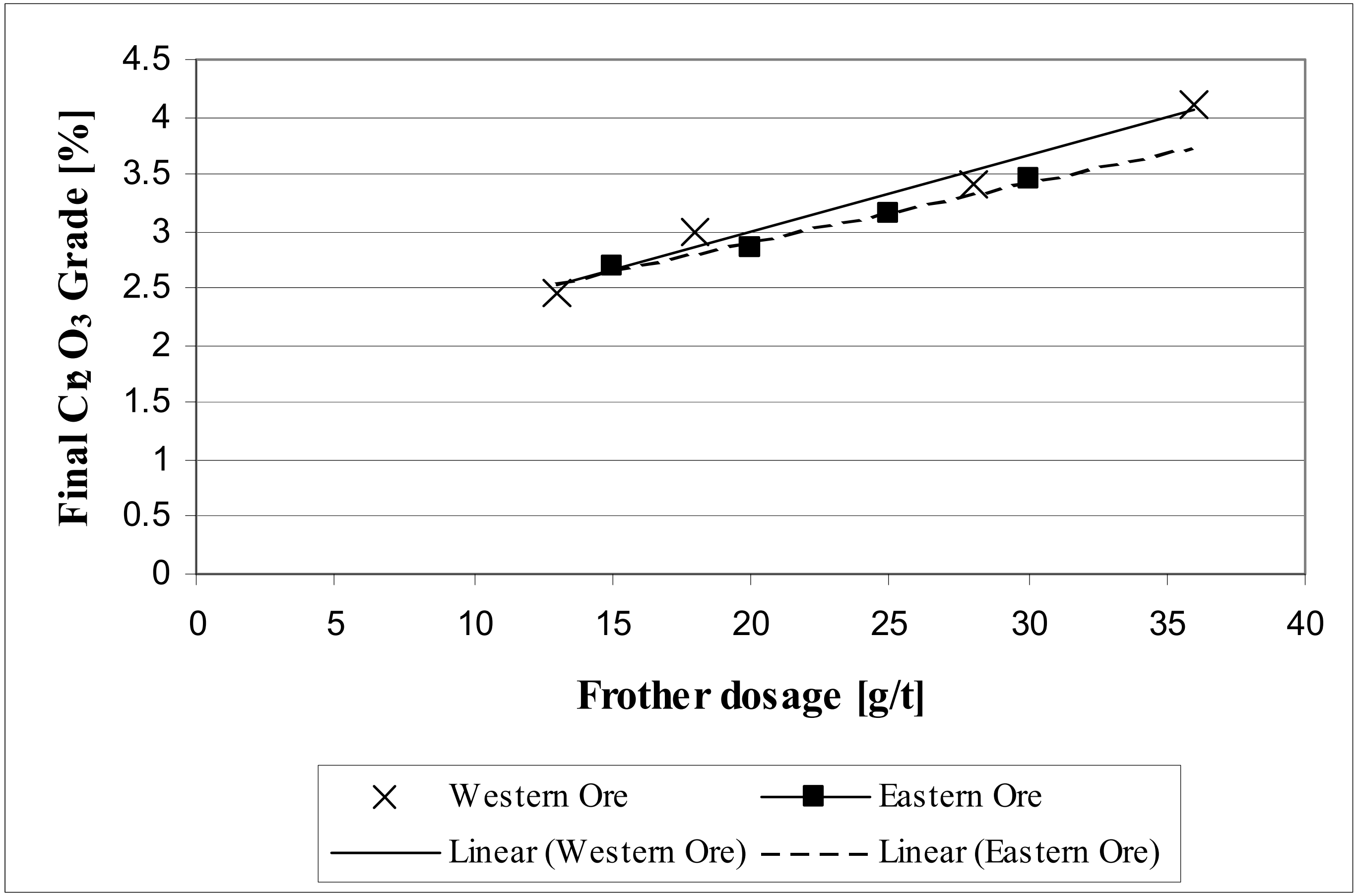
Successful reduction in final concentrate chromite grade



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Conclusions and Recommendations

- Chromite and PGM+Au grade targets can be successfully achieved through reagent optimisation
- Effect of solids and frother concentration on entrained mass is significant
- Increased depressant may result in an increase in chromite grade
- Selection of depressant dosage points is important
- Optimisation of reagent suite by starting from scratch
- Greater understanding of entrainment required

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PGM+Au Grade

- Been able to increase grades from circa 100g/t to over 200g/t

- No decrease in PGM+Au recovery
- No increase in chromite grade

- Major reduction in tonnage to the smelter

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Challenges

- Interrupting the comfort zone
- Lack of buy-in
- Inappropriate flotation cell sizing
- Skills shortage
- Unstable feed characteristics
- Poor plant control

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