



Summer Jobs Program Students Presentation Afternoon 2006

Robertson Lecture Theatre, Murdoch University
Monday 6 February 2006

- 1:00 – 1:30 Registration
1:30 – 1:45 Welcome by Mark Woffenden, Parker Centre CEO
and Jane Rosser, Education Program Manager
- Session 1**
1:50 – 2:10 **Alumina & Gold** Chair: Jane Rosser
Harshad Bhikha:
Temperature Control of a Precipitator and Size Classification by Cyclosizing
(Joint Sponsors ALCOA & RIO TINTO)
- 2:10 – 2:30 Ching Yong Goh:
Removing Iron Oxide from Bauxite Using Dithionite, Citrate and Bicarbonate
(Sponsor ALCOA)
- 2:30 – 2:50 Ross Williams:
Ferrate Oxidation of Bayer Organics
(Sponsor ALCOA)
- 2:50 – 3:20 Laurence Dyer:
Iron/Ligand Systems for the *In-situ* and Heap Thiosulfate Leaching of Gold
(Sponsor PARKER CENTRE)
- 3:20 – 3:40 Afternoon Tea
- Session 2**
3:40 – 4:00 **Base Metals** Chair Jane Rosser
Jean-Pierre Veder:
Validating the Quantitative XRD Analysis of Nickel Laterite Ores
(Sponsor MINARA RESOURCES)
- 4:00 – 4:20 Jonathon Childs:
Project in Minerals Science
(Sponsor BHP-BILLITON)
- 4:20 – 4:40 Linus Naik:
AMIRA P768A Improving Heap Bioleaching – Column Test Work and Results
(Sponsor RIO TINTO)
- 4:40 – 5:00 Carla Zammit:
**An Evaluation of Methods for the Extraction of DNA from Microbes
Inhabiting a Bioleaching Environment**
(Sponsor BHP BILLITON & MINARA RESOURCES)
- 5:00 – 5:20 Saijel Solanki:
Solubility of Iron in Sulfuric Acid
(Sponsor BHP BILLITON)
- 5:20 – 5:40 Open Discussion and Close:
Mark Woffenden and Jane Rosser
- 5:40 – 7:30 Networking & Nibbles



ABSTRACTS**HARSHAD BHIKHA**, University of Cape Town, South Africa
Temperature Control of a Precipitator and Size Classification by Cyclosizing

Supervisor: Dr Iztok Livik (CSIRO Minerals - Waterford)
Project sponsored by Alcoa & Rio Tinto

In the alumina industry, the Bayer process is used to produce alumina from bauxite. In this process, precipitation of gibbsite from aluminate solution represents a central unit operation, where most of the properties of the final product are determined.

The continuous operation, carried out in industry, can be simulated on laboratory scale using a single controlled-cooling precipitator. For this purpose, a batch precipitation system, which consists of a jacketed precipitator and temperature control system, is used. The jacket temperature is controlled by manipulating the ratio at which the hot and cold streams are mixed. My task was to fine tune the temperature control system and conduct some test runs.

As a second activity, I carried out a number of cyclosizing experiments using a Warman Cyclosizer. Seed with a narrow well-defined size distribution was required for gibbsite precipitation experiments. During cyclosizer runs samples of each size fraction were taken and sent for the particle size analysis. In addition to the experimental work, mathematical modelling of a hydrocyclone was also investigated.

JONATHON CHILDS, Murdoch University, WA
Project in Minerals Science

Supervisors: Professor Mike Nicol and Dr Gamini Senanayake (Murdoch University) and
Dr Daniel Kittelty (BHP Billiton Newcastle/Perth Technology Centres)
Project sponsored by BHP Billiton

My experience in this year's Summer Jobs Program has provided invaluable insight into how hydrometallurgical research and experimentation is performed within the minerals processing industry. Hands-on practice of techniques including wet-screening, milling of materials, elemental assays, leaching and atomic absorption spectroscopy have also piqued my interest to further my studies in minerals science, leading to contemplate an Honours year project in a related field.

LAURENCE DYER, Curtin University of Technology, WA
Iron/Ligand Systems for the *In-situ* and Heap Thiosulfate Leaching of Gold

Supervisor: Dr Mathew Jeffrey (CSIRO Minerals - Waterford)
Project sponsored by the Parker Centre

The purpose of the investigation is to find alternate systems to use in the *in-situ* and heap thiosulfate leaching of gold. Prior research on thiosulfate has mainly focused on the copper ammonia system, although some work has been conducted on new ferric based systems. This project was aimed at finding viable ligands for the iron thiosulfate system.



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Electrochemical experiments were performed to evaluate the reduction of ferric complexes of EDTA, oxalate, tartrate, citrate, and acetylacetone. The effects of different pH levels, concentrations, the addition of copper to the system, and the presence and absence of oxygen on the reduction of Fe(III) were examined.

Gold powder leaching experiments were carried out under aerobic and anaerobic conditions, and it was found that leaching in the absence of air was slower than in its presence for all the systems studied. The reduction current and leach rates generally decrease with time, especially over longer intervals. Where copper is present, the reduction current decreases in almost all systems and its influence varies with time and concentration.

The pH in all systems drifts upward causing more iron hydroxide to precipitate, which led to the use of buffers. These were successful in minimising the extent of pH drifting. Potassium hydrogen phthalate has proven the most effective to this point. All the buffers used decreased the reduction current significantly in the oxalate system, and only the potassium hydrogen phthalate did not impede the acetylacetone system. However the EDTA system responded positively to all buffers producing markedly increased reduction currents. By finetuning the systems, thiosulfate leaching of gold can become more effective and efficient.

CHING YONG GOH, Curtin University of Technology, WA **Removing Iron Oxide from Bauxite Using Dithionite, Citrate and Bicarbonate**

Supervisor: Dr Peter Smith (CSIRO Minerals - Waterford)
Project sponsored by Alcoa

Dithionite/citrate/bicarbonate has been used previously to remove iron oxides from soil samples. Adaptation of this method to bauxites will allow the closer examination of the remaining phases (eg by X-ray diffraction) and the characterisation of the iron minerals in the bauxite. This study was therefore aimed at adapting the method to use with bauxites, determining the effects of a DCB digest on the bauxite and quantifying the amount of iron oxides removed. Preliminary results indicate that this method is effective.

LINUS NAIK, University of Cape Town, South Africa **AMIRA P768A Improving Heap Bioleaching - Column Test Work and Results**

Supervisor: Mr Mark Maley (CSIRO Minerals - Waterford)
Project sponsored by Rio Tinto

This work was undertaken as part of the ongoing AMIRA "Improving Heap Bioleaching" P768A project. The aim of the AMIRA P768A project is to provide research tools, including an integrated model, which will help optimise heap bioleaching of sulfide ores.

Leaching data have been generated by the Parker Centre from whole ore column bioleaching, conducted across a range of operating parameters including aeration, pH, and temperature. This project involved maintenance and sampling of the leaching columns.



Environmental microbes are sought-after for their leaching capabilities and their hardiness to unfavourable conditions. The microbiology work in this project involved enriching and maintaining cultures from chalcopyrite ore, and attempting to grow the microbes on solid media.

SAIJEL SOLANKI, Murdoch University, WA
Solubility of Iron in Sulfuric Acid

Supervisors: Associate Professor Peter May (Murdoch University) and
Mr Wayne Tichbon (BHP Billiton Newcastle Technology Centre)
Project sponsored by BHP Billiton

Titania production via the sulfate process involves the digestion of ilmenite in sulfuric acid followed by the precipitation of undesirable iron (II) sulfate. This project aimed to represent iron (II) sulfate solubilities in sulfuric acid solutions at various temperatures.

Since literature data are frequently reported in mass- based concentration units (mass-%, molalities) and the titania-producing industry prefers volume-based units (g/L, Molarities), densities of the mixed solutions were also evaluated to enable the conversion of concentration units. The available literature data were complemented by density and solubility data measured in this laboratory.

JEAN-PIERRE VEDER, Curtin University of Technology, WA
Validating the Quantitative XRD Analysis of Nickel Laterite Ores

Supervisor: Dr Barry Whittington (CSIRO Minerals - Waterford)
Project sponsored by Minara Resources

This work examined the accuracy of methods developed at Parker Centre for the quantification of various phases present in nickel laterite ores.

Pure lizardite, talc, goethite, quartz and fumed (amorphous) silica were obtained and used to prepare mixtures of known composition. These were then characterised using Rietveld analysis of the X-ray diffraction traces. The results indicate that the previously-developed (confidential) Parker Centre methodologies are able to estimate the amounts of lizardite, talc, quartz and goethite in lateritic samples.

ROSS WILLIAMS, Curtin University of Technology, WA
Ferrate Oxidation of Bayer Organics

Supervisors: Dr Joanne Loh and Dr Chris Vernon (CSIRO Minerals – Waterford)
Project sponsored by Alcoa

Bayer liquor is used in the Bayer process to extract aluminium (oxy)hydroxides species from bauxite ore. There are many dissolved organic compounds present in the liquor, originating from decomposed vegetation in the ore. It is beneficial to remove/destroy



these organic compounds from the liquor to improve process efficiency and product quality, as well as the reduction of noxious odours.

A possible method for the removal/destruction of organics is to oxidise the organics through the electrochemical production of ferrate ions (Fe(VI)) *in situ* in Bayer liquor. The type of steel used in the production of ferrate was investigated. UV-Vis spectrometry was utilised to quantitatively determine the ferrate production rate.

Ferrate ions were successfully produced in NaOH solutions and sodium aluminate solutions ("synthetic Bayer liquor" (SBL); essentially the 'productive' components of Bayer liquor without the organic compounds found in Bayer liquor). An inverse correlation between the concentrations of aluminium in solution and ferrate ion produced was observed. The effectiveness (as determined by a decrease in total organic carbon) of ferrate oxidation on organic compounds in Bayer-like solutions was tested by the addition of model organic compounds into SBL and in Bayer liquor.

CARLA ZAMMIT, Curtin University of Technology, WA
An Evaluation of Methods for the Extraction of DNA from Microbes Inhabiting a Bioleaching Environment

Supervisors: Dr Helen Watling (CSIRO Minerals – Waterford) and
Dr Elizabeth Watkin and Dr Lesley Mutch (School of Biomedical Sciences,
Curtin University of Technology)

Project sponsored by BHP Billiton and Minara Resources

Bioleaching is the process of using microorganisms to extract metals from their ores. Currently bioleaching is used to extract copper, cobalt, nickel and zinc from low grade or difficult to process ores. Bioleaching is an economical, efficient and environmentally friendly method of mineral processing.

There is a myriad of microorganisms inhabiting the bioleaching community. Understanding the complexity of this environment is essential to optimising the bioleaching process. A number of methods have previously been used in an attempt to understand this environment, however none have been able to completely characterise its inhabitants.

With recent advances in molecular biology, the sequence of particular genes are routinely used to characterise microorganisms. By developing a method of extracting DNA from microbes within bioleaching environments, complete characterisation of these communities is made possible. However, the extraction of DNA from microbes living in bioleaching communities is problematic. The low pH (1.8) of the environment and the iron found in the ores has inhibited attempts to extract DNA.

The aim of this project was to develop a method for DNA extraction of microbes inhabiting the bioleaching community. Commercially available DNA extraction kits along with other methods were tested and optimised to suit the bioleaching environment.

