TABLE OF CONTENTS

FRIDAY 10 NOVEMBER 1989 AM

INTRODUCTION
Hans von Michaelis 1

EXPLORATION & RESOURCES
Session Chairman: Hans von Michaelis, Randol International Ltd., Golden

BASIC PRINCIPLES OF EXPLORATION FOR BEAN COUNTERS, MINING ENGINEERS, METALLURGISTS AND OTHER LAYMEN
Donald W. Kohls 9

THE LATEST IN GOLD-BASED FINANCING OF GOLD PROJECTS
C. Richard Tinsley 11

IT'S ALL IN THE BAG, ISN'T IT?
Charles Bucknam 21

MINING & MATERIALS HANDLING
Session Chairman: Leonard Harris, Newmont Mining Corporation, Denver

INNOVATIVE MACHINERY DESIGN TO REDUCE GOLD MINE OPERATING COSTS
Martin Col & Richard W. Hanson 25

COMMINUTION
Session Chairman: Leonard Harris, Newmont Mining Corporation, Denver

ADVANCES, CHALLENGES & OPPORTUNITIES IN CRUSHING & GRINDING
Hans von Michaelis 29

COMPUTER AIDED DESIGN OF A GOLD ORE GRINDING CIRCUIT
Pierre Ollivier & Phillippe Blot 39

ALANX™ CERAMIC/METAL COMPOSITES - A REVOLUTIONARY APPROACH TO WEAR
Richard S. Webb 43

Discussion Ideas - Comminution

1. When to use SAG, SABC, AG, ROM, or conventional crushing grinding circuits.
2. How safe is it to select a SAG mill? What testing is needed to make it safe?
3. How & where to use centrifugal crushing devices
4. Reducing cost of Barmac Wearparts
5. The MMD Sizer for clay ores
6. Track record of hammer mills
7. Track record of the Nordberg Waterflush Crusher
8. What can one expect from SAG and AG mills?
9. Is there a more practical PSM available?
10. Who's got a proven improved mill control system?
11. When is a ball mill a SAG mill?

See also Herbst et al, pg. 315
FRIDAY 10 NOVEMBER 1989 AM (Cont)

PRECONCENTRATION

Session Chairman: Don Foot, Control International, Inc., Salt Lake City

NOVEL ASPECTS OF GOLD RECOVERY USING COLUMN FLOTATION AT AUSTIN GOLD VENTURE.
Jim Kuipers

NOVEL SELECTIVE FLOTATION APPROACH TO REFRACTORY CARBONACEOUS ORE TREATMENT AT ROYAL MOUNTAIN KING MINE
Gary Simmons

Discussion Session

THE BP-CGA AND CARBAD PROCESSES: TECHNICAL AND COST DIFFERENCES
Chris Bonney

THE WEMCO LEEDS COLUMN FLOTATION SYSTEM IN BASE AND PRECIOUS METALS
Tim Olson

COLUMN FLOTATION USING THE TURBO-AIR EXTERNAL BUBBLE GENERATOR
Don Foot

Discussion Ideas - Preconcentration

1. How do costs & recoveries of Coal Oil Agglomeration compare with conventional treatment?
2. The Witwatersrand FUG Arrangement
3. Scavenging values from backfill
4. What do operators feel about column flotation
5. What does the Jameson Cell promise?
6. How does the Leeds Cell work?
7. How is flash flotation doing in practice?
8. Are the new flotation reagents really any good for gold?
9. What makes CPS work; is it effective?
10. Selective pyrite/arsenopyrite flotation — does it work? Is it cost effective?
11. Concentrate dewatering — Better ways?
12. Recent developments in gravity concentration

See also Tinsley, pg. 325; Jennings et al, pg. 335

REFRACTORY GOLD & SILVER PROCESSES I

Session Chairman: Wayne C. Henderson, Consultant Metallurgist, Midvale, UT

INNOVATIVE REFRACTORY GOLD TREATMENT PROCESSES
Hans von Michaelis

OXYGEN UTILIZATION IN EMERGING REFRACTORY GOLD PROCESSES
Kevin A. Foo, R. L. Leonard & J. G. Whellock
REFRACTORY GOLD & SILVER PROCESSES II (Cont)

6. Oxygen mass transfer efficiency... the options
7. New ways of dealing with preg robbers
8. Dealing with heavy metals in oxidized systems
9. Economics and costs of the options—What does it take for a profitable venture at current gold & silver prices?
10. Titanium autoclaves and dry oxygen
11. Environmental constraints
12. Dealing with foam & sulfur when cyaniding bio-oxidised products

See also Carter et al, pg. 329; Canterford, pg. 343; Neeling et al, pg. 347, Liddell et al, pg. 349

ENVIRONMENTAL

Session Chairman: John Gormley, Denver Knight Piesold, Denver

IMPROVED UNDERSTANDING IN DETOXIFICATION OF CYANIDE LEACH LIQUORS USING PEROXIDE 151
Fred W. DeVries

REAGENT COST SAVINGS IN TAILINGS POND DETOXIFICATION 155
David J. Collins

MIGRATORY BIRDS AND TOXIC MINE PONDS: THE NEVADA EXPERIENCE 159
Fenton Kay & Robert P. McQuivey

OVERVIEW OF CURRENT REGULATIONS OF CYANIDE 161
Norm Greenwald

APPLICATION OF TETRA'S CrystaBOND SERVICE FOR TREATMENT OF GOLD MINE ACID WASTEWATERS 165
Bryan Morrison & James B. Pfeiffer

Discussion Ideas - Environmental

1. How much cyanide in a pond is toxic to birds?
2. Why are some ponds with less cyanide more toxic?
3. Can waterfowl taste? Can taste be a deterrent?
4. Could safe decoy pond habitats work?
5. Conditions under which FeSO₄ does not work.
6. Conditions under which peroxide does not work.
7. Cost of pond detoxification
8. Non-cyanide tailings pond bird mortalities
SATURDAY 11 NOVEMBER 1989 AM

Special Breakfast Seminar

THE FATE OF CYANIDE IN SOILS
    Terry Chatwin

LEACHING

Session Chairman: Robert S. Shoemaker, Robert S. Shoemaker, Inc., Grass Valley, CA

INNOVATIVE MECHANICAL DESIGN SAVES REAGENT COSTS AT
NEWMONT'S RAIN PLANT AT CARLIN
    Jim Komadina & Leonard Harris

PEROXIDE ADDITION IMPROVES GOLD RECOVERY AND SAVES
REAGENTS AT PINE CREEK GOLD MINE
    Vivienne Lee, Peter Robinson & Fred Merz

PRACTICAL USE OF OXYGEN FOR GOLD LEACHING IN CANADA
    Jacques McMullen & Rob Thompson

CSI'S MODULAR PLANT FOR THE ON-SITE MANUFACTURE OF
CYANIDE
    Daniel W. Kappes

SAVE CYANIDE YOU DID NOT KNOW YOU WERE LOSING — DON'T
BLOW YOUR TOP
    Mike Costello & Hans von Michaelis

COMMENTARY ON GOLD CYANIDATION IN COVERED TANKS
    Hans von Michaelis

ECONOMIC ASSESSMENT OF AVR FOR TAILINGS DETOXIFICATION
AT A CANADIAN MILL
    George Hope, Jacques McMullen & Marlene Lanouette

THE RECOVERY OF CYANIDE FROM SLURRIES
    Terry I. Mudder & A. J. Goldstone

FIELD PILOTING RESULTS FOR VITROKEL™ CYANIDE RECOVERY
AND THE ECONOMICS COMPARED WITH OTHER PROCESSES
    Denis Kidby

UPDATE ON THE KAMYR CILO PROCESS
    Jim McMaster

APPLICATION OF THE ATEC ZX OXYGENATION™ SYSTEM TO
CYANIDE LEACHING OF GOLD & SILVER
    Wayne C. Henderson, Michael E. Sweeney & David A. Torke
FRIDAY 10 NOVEMBER 1989 AM (Cont)

REFRACTORY GOLD & SILVER PROCESSES I (Cont)

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPLICATIONS OF ULTRA-FINE MILLING &amp; THE ATTRITION REACTOR IN THE TREATMENT OF REFRACTORY GOLD ORES</td>
<td>109</td>
</tr>
<tr>
<td>Keith S. Liddell</td>
<td></td>
</tr>
<tr>
<td>COST BENEFIT CONSIDERATIONS FOR INNOVATIVE APPLICATIONS OF BIOHYDROMETALLURGY</td>
<td>115</td>
</tr>
<tr>
<td>P. Brad Marchant</td>
<td></td>
</tr>
<tr>
<td>SCALEUP EXPERIENCES IN BIO-OXIDATION OF REFRACTORY GOLD ORES AND CONCENTRATES</td>
<td>123</td>
</tr>
<tr>
<td>Ralph P. Hackl &amp; Frank R. Wright</td>
<td></td>
</tr>
</tbody>
</table>

FRIDAY 10 NOVEMBER 1989 PM

REFRACTORY GOLD & SILVER PROCESSES II

Session Chairman: Mary Korpi, Newmont Gold Company, Denver

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPTIONS FOR DEALING WITH HIGH COPPER GOLD ORES</td>
<td>129</td>
</tr>
<tr>
<td>Hans von Michaelis</td>
<td></td>
</tr>
<tr>
<td>TREATMENT OF SULPHIDE GOLD CONCENTRATE CONTAINING COPPER WITH THIOSULPHATE SOLUTION</td>
<td>131</td>
</tr>
<tr>
<td>Gong Qian &amp; Hu Jieue</td>
<td></td>
</tr>
<tr>
<td>POTENTIAL APPLICATIONS OF SMALL SCALE PLASMA FURNACES FOR THE SMELTING OF REFRACTORY ORES IN THE GOLD INDUSTRY</td>
<td>137</td>
</tr>
<tr>
<td>R. Knight, M. J. Murawa &amp; Kenneth Reid</td>
<td></td>
</tr>
</tbody>
</table>

Panel Discussion
Both Refractory Session speakers and Chairmen plus:

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>REFRACTORY GOLD TREATMENT AT SAO BENTO, BRAZIL</td>
<td></td>
</tr>
<tr>
<td>Ted da Silva</td>
<td></td>
</tr>
<tr>
<td>COMMENT ON SHASHE – A SMALL SCALE GOLD MINE IN BOTSWANA</td>
<td></td>
</tr>
<tr>
<td>David J. Collins</td>
<td></td>
</tr>
<tr>
<td>WHAT TO BE AWARE IN CYANIDATION OF BIO-OXIDISED PRODUCTS</td>
<td></td>
</tr>
<tr>
<td>Ralph Hacki</td>
<td></td>
</tr>
<tr>
<td>BIOLEACHING: BIOREACTOR DESIGN ISSUES</td>
<td></td>
</tr>
<tr>
<td>E. Alair Griffin</td>
<td></td>
</tr>
<tr>
<td>SEMINAR ON RISK MANAGEMENT IN PRESSURE OXIDATION PLANT DESIGN AND OPERATION</td>
<td></td>
</tr>
<tr>
<td>P. G. Mason</td>
<td></td>
</tr>
</tbody>
</table>

Discussion Ideas

1. Ferric leaching of refractory gold concentrates
2. Bio-oxidation for ferric ion regeneration
3. Effect of and control of arsenite in bio-oxidation of arsenopyrite
4. Improved engineering parameters, e.g., agitation, aeration, cooling & heating needs for bio-oxidation
5. Better bugs: What are the economics of the expected benefits?
SATURDAY 11 NOVEMBER 1989 AM (Cont)

LEACHING (Cont)

AN INTEGRATED APPROACH TO CYANIDATION OPERATING STRATEGY 235
David M. Menne

NON-CYANIDE LIxivIANTS SPECIAL NICHE APPLICATIONS & OUTLOOK 239
Hans von Michaelis

Panel Discussion
All Leaching Session speakers plus:

OBSERVATIONS ON GAS/LIQUID MISSING IN STIRRED TANKS 241
Ken De Graaf

AVR RESEARCH AT CANMET 243
Ron Molnar

THE KAMYR COUNTER – CURRENT TOWER LEACHING PROCESS 245
Jim McMaster

Discussion Ideas

1. Panel discussion: Saving on Reagents
2. Does oxygen supersaturation accelerate leaching?
3. What factors impact the H + CN = HCN equilibrium?
4. Down to how low a pH does cyanide leach gold?
5. Integrating cyanide recovery with detoxification
6. Improved pre-aeration concepts
7. Novel techniques to improve oxygen mass transfer efficiency
8. Does cyanidation need “dissolved” or “free” oxygen?
9. Calcium cyanide pro’s and con’s
10. Cyanide on-line monitoring savings & economics
11. Factors affecting thiosulphate leaching of gold
12. Comments on leaching gold with amino acids in the USSR
13. Optimising gold leaching from aurostibnite at Hemlo
14. The effect of pH on gold leaching from pyrrhotite ores
15. The Mennetech Dynamic Leach Monitor saves cost

See also Bull, pg. 405

SATURDAY 11 NOVEMBER 1989 PM

HEAP LEACHING

Session Chairman: Gene E. McClelland, McClelland Laboratories, Inc., Sparks, NV

AGGLOMERATION WITH PULP—A CONCEPT TO IMPROVE THE ECONOMICS OF HEAP LEACHING 247
Jock McGregor & Gene E. McClelland

SELF-CLEANING POND DESIGN TO SOLVE A COMMON PROBLEM 251
R. Bruce Thorndycraft
SATURDAY 11 NOVEMBER 1989 PM (Cont)

HEAP LEACHING (Cont)

DESIGN AND OPERATION OF HEAP LEACH AT CARSON HILL GOLD MINING CORPORATION
Craig McKenzie

Discussion Ideas - Heap Leaching

1. Saving reagent costs
2. Improving metallurgical control
3. Heap leaching without agglomeration
4. Agglomeration without patent infringement?
5. Calcium cyanide applications in heap leaching
6. Is there a benefit in oxygen injection into some heaps?
7. Alternative ways to get oxygen into heaps
8. Anaerobic leaching with cyanide?
9. What really happens in low pH heaps and vats?
10. Leaching ores containing cyanide soluble copper
11. Drip irrigation saves cyanide and water—What are its limitations?
12. What is a “Smart Contract?”
13. Prospects for in situ leach
14. Cyanide titration with high zinc values in solution
15. Prospects for non-cyanide lixiviants for heap leaching

See also Thorndycraft, pg. 359

GOLD & SILVER RECOVERY

Session Chairman: Jim Avraamides, Western Australian Chemistry Center, Perth

LATEST GOLD & SILVER RECOVERY INNOVATIONS INCLUDING A DESCRIPTION OF THE FIRST COMMERCIAL RIP PLANT FOR GOLD
Hans von Michaelis

THE MECHANISM OF ADSORPTION OF AUROCYANIDE ONTO ACTIVATED CARBON—the LATEST DEVELOPMENTS
M. D. Adams

PRACTICAL ASPECTS AFFECTING GOLD ADSORPTION & CARBON FOULING
Steve Labrooy

INNOVATIVE ASPECTS AT BODDINGTON GOLD MINE
Graham Hill

RHEOLOGY AND THE CIP PROCESS AND THE BENEFITS OF ON-LINE VISCOSITY MONITORING AND CONTROL
A. D. Thomas, Norman T. Cowper, Scott L. Barham & A. J. Starkey

THE AAC “PUMP-CELL” — A NOVEL APPROACH TO THE DESIGN AND OPERATION OF CIP GOLD RECOVERY CIRCUITS
Rod M. Whyte, P. Dempsey & W. Stange
SATURDAY 11 NOVEMBER 1989 PM (Cont)

GOLD & SILVER RECOVERY (Cont)

DESIGN FEATURES OF THE COMBUSTION AIR VERTICAL CARBON REGENERATION KILN 295
Peter J. Stewart

GOLDEN JUBILEE RESIN-IN-PULP PLANT FOR GOLD RECOVERY 297
Daan Seymore & Chris A. Fleming

Panel Discussion
All Gold & Silver Recovery Session speakers plus:

THE RECOVERY OF GOLD & MERCURY FROM CYANIDE LEACH CIRCUITS AND THEIR COMPLETE SEPARATION USING VITROKELE™ 309
Dennis Kidby

LATEST DEVELOPMENTS IN THE DERRICK CIP/CIL INTERSTAGE SCREEN 311
Bob Reinhofer

COMMENTS ON MOUNT MORGANS CAROUSEL CIP 313
Gary Johnson

ION EXCHANGE RESEARCH AT CANMET 311
Ron Molnar

AAC IMPROVEMENTS TO THE NKM/NORKAL SCREEN 313
Peter T. Sutherland

Discussion Ideas

1. Is further improvement in CIP/CIL contactors needed?
2. Is further improvement in CIP/CIL screens needed?
3. Benefits & disadvantages of carousel systems
4. Why is gold RIP & CIX so close to practical reality?
5. Gold selective resin progress
6. Advances in resin substrates for gold RIP
7. Upflow column limitations for CIX, what alternatives?
8. Practical aspects of gold adsorption & carbon fouling
9. High performance spherical carbon at a lower price?
10. Latest screens for CIP and CIL
11. Photomicrographic inspection of carbon finds cracks
12. Dealing with mercury in vertical regeneration kilns?
13. Cyanide recovery improves gold recovery?
14. CIP applications with high copper or silver ores

See also Wall et al, pg. 363; Stewart & Baxter, pg. 371; Stewart, pg. 375; Martin et al, pg. 377
MODEL BASED CONTROL OF SAG MILLS USING REAL-TIME EXPERT SYSTEMS
H. A. Herbst, L. B. Hales, W. T. Pate

ADVANCES IN FINE GOLD RECOVERY FROM ALLUVIALS
C. Richard Tinsley

COMPARATIVE ECONOMICS OF REFRACTORY GOLD ORE TREATMENT PROCESSES
R. Wayne Carter & John E. Litz

FLASH FLOTATION OF SULFIDE & OXIDE ORES AT ECHO BAY MINES
Mel Jennings and Frank P. Traczyk

APPLICATION OF THE ARTECH/CASHMAN PROCESS FOR REFRACTORY GOLD RECOVERY
John H. Canterford

ENHANCED GOLD EXTRACTION BY BIO-OXIDATION
G. Neeling, M. Chan & P. A. Spencer

THE RECOVERY OF GOLD REFRACTORY TELLURIDE CONCENTRATES BY THE METPROTECH FINE MILLING PROCESS
Keith S. Liddell & Robert C. Dunne

RECOVERY LOSSES AT HEAP LEACHES – AN ATTITUDE PROBLEM
R. Bruce Thorndycraft

THE INTRODUCTION OF NOVEL DAVY CIP TECHNOLOGY FOR THE RECOVERY OF GOLD AT ASHANTI GOLDFIELDS, GHANA
N. C. Wall, E. Bicker & M. Crowe

COST BENEFIT ANALYSIS OF HIGH CARBON ACTIVITY LEVELS
Peter J. Stewart and Ken G. Baxter

CARBON REGENERATION KILNS – CORROSION AND CONTROL THEREOF
Peter Stewart

GROUNDWATER QUALITY – ECONOMIC CONSIDERATIONS
Richard E. Martin, Adrian Griffin & Stuart Finley
THE HISTORICAL IMPORTANCE OF GOLD IN THE WORLD'S MONETARY SYSTEMS 383
F. D. Collender

WORLD GOLD SUPPLY AND DEMAND – WILL NEW PRODUCTION SWAMP THE MARKET? 387
Monika Biernacki

FUTURE OF THE GOLD PRICE IN VARIOUS CURRENCIES 393
Paul Samoff

INTERRELATIONSHIPS BETWEEN GOLD PHYSICAL AND PAPER GOLD MARKETS 397
Paul Samoff

HOW TO SET UP A RESEARCH AND DEVELOPMENT FUND 401
C. Richard Tinsley

PROJECT MANAGEMENT IN INDONESIA 403
Louis Mostert

Other Papers

THE CYANOSTAT SYSTEM FOR ON-LINE MEASUREMENT OF FREE CYANIDE CONCENTRATION IN MILL PULPS & SOLUTIONS 405
Rex Bull

Delegate List xi
Author Index xv