# Table of Contents

**VOLUME III: HYDROMETALLURGY AND ELECTROMETALLURGY OF COPPER**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>ix</td>
</tr>
<tr>
<td><strong>LEACHING OF COPPER MINERALS: THEORY AND PRACTICE</strong></td>
<td></td>
</tr>
<tr>
<td>Copper Recovery from In Situ Leach Liquors</td>
<td>3</td>
</tr>
<tr>
<td><em>A.E. Isaacson and L.D. Redden</em></td>
<td></td>
</tr>
<tr>
<td>Oxidative Leaching and Electrowinning of Copper with Fluosilic acid</td>
<td>19</td>
</tr>
<tr>
<td><em>C.J. Beyke, A.M. Wethington and A.Y. Lee</em></td>
<td></td>
</tr>
<tr>
<td>Hydrometallurgical Transformation of Chalcopyrite Concentrates using Precursors Belonging to the Cu-SO$_2$H$_2$O System</td>
<td>35</td>
</tr>
<tr>
<td><em>H. Leiva and C. Moreno</em></td>
<td></td>
</tr>
<tr>
<td>The Mechanism of Leaching of Copper-Lead Matte in Oxygenated Acidic Chloride/Sulphate Solution</td>
<td>45</td>
</tr>
<tr>
<td><em>G.J. Sparrow and R. Woods</em></td>
<td></td>
</tr>
<tr>
<td>The Cuprex Metal Extraction Process Pilot Plant Experience and Economics of a Chloride-based Process for the Recovery of Copper from Sulphide Ores</td>
<td>61</td>
</tr>
<tr>
<td><em>R.F. Dalton, G. Diaz, E. Hermana, R. Price and A.D. Zunkel</em></td>
<td></td>
</tr>
<tr>
<td><strong>BACTERIAL LEACHING AND LEACHING OF TAILINGS</strong></td>
<td></td>
</tr>
<tr>
<td>Electrochemistry of a Semiconductor Chalcopyrite Concentrate Leaching by Thiobacillus Ferrooxidans</td>
<td>73</td>
</tr>
<tr>
<td><em>A.E. Torma</em></td>
<td></td>
</tr>
<tr>
<td>Bacterial Thin Layer Leaching of Sulphide Ores</td>
<td>87</td>
</tr>
<tr>
<td><em>M. Jo, S. Bustos, R. Espejo, R. Ruiz, J. Rojas and R. Montealegre</em></td>
<td></td>
</tr>
<tr>
<td>Recovery of Copper, Antimony and Silver by Bacterial Leaching of Tetrahedrite Concentrate</td>
<td>99</td>
</tr>
<tr>
<td><em>J. Frenay</em></td>
<td></td>
</tr>
<tr>
<td>Development of the Gunpowder Leach-SX-EW Plant</td>
<td>107</td>
</tr>
<tr>
<td><em>A. Stanger, B. Middlin, R. Celmer and Z. Meka</em></td>
<td></td>
</tr>
<tr>
<td>Chuquicamata Oxide Tailing Dump Leaching Project</td>
<td>121</td>
</tr>
<tr>
<td><em>A.A. Pincheira</em></td>
<td></td>
</tr>
<tr>
<td><strong>SEPARATION AND RECOVERY PROCESSES</strong></td>
<td></td>
</tr>
<tr>
<td>Copper - PSR: Solvent-free High Efficiency Technology for Copper Recovery from Acid Leachates via Ion Chelation/Electrowinning</td>
<td>137</td>
</tr>
<tr>
<td><em>D.C. Greminger, G.A. Garcia-Huidobro, W.C. Pike and J.P. DeCarli II</em></td>
<td></td>
</tr>
<tr>
<td>Resin-in-pulp Process Applied to Copper Hydrometallurgy</td>
<td>149</td>
</tr>
<tr>
<td><em>L.E. Slobtsov</em></td>
<td></td>
</tr>
<tr>
<td>Development and Evaluation of a Laboratory-scale Continuous Circuit for the Extraction of Copper with Emulsion Membranes</td>
<td>155</td>
</tr>
<tr>
<td><em>D.N. Nilsen and G.L. Hundley</em></td>
<td></td>
</tr>
<tr>
<td>Copper Solvent Extraction from Highly Concentrated Solutions in a Zinc Sulphate Circuit</td>
<td>171</td>
</tr>
<tr>
<td><em>J.M Figueiredo, A.R. Silva and F.C. Delmas</em></td>
<td></td>
</tr>
</tbody>
</table>
Extraction Separation of Copper from Nickel and Cobalt with Respect to Treatment of Ocean Nodules

V. Kumar, B.D. Pandey and D. Bagchi

IMPURITY CONTROL AND BY-PRODUCTS

Continuous Decopperization Process for Molybdenite Concentrates

I. Wilkomirsky and J. Aravena

Leaching of Copper from Cuajone Molybdenite Concentrates

A. Chung Ching, E. Socolich and R.J Voisey

The Potential for Recovery of Cobalt from Copper Leach Solutions

K.C. Sole and J.B. Hiskey

Development of an Antimony Removal Process for Copper Electrolyte

Y. Sasaki, S. Kawai, Y. Takasawa and S. Furuya

Alternatives for the Treatment of Arsenic-containing Copper Industrial Bleed Streams

K.S. Gritton and J.E. Gebhardt

Germanium, Rhenium and Selenium: New Valuable By-products to be Recovered at Chuquicamata

P. Morales, J. Aravena, J. Salas, G. Sanchez and J. Roman

Separation of Selenium, Tellurium, Platinum and Palladium in the Precious Metals Plant of ENAMI

C. Barria

The New Precious Metal Refinery at CCR Division, Noranda Minerals Inc.

B. Lessard and D. Vleeschhouwer

COPPER ELECTROREFINING, CATHODE SUBSTRATES AND ANODE PASSIVATION

Electrochemical Evaluation of Gas Sparging Effects on Copper Deposition in the Presence of Additives

D.A. Uceda, J.D. Scott and T.J. O'Keefe

Electrorefining of Copper Anodes with High Silver Levels

V. Baltazar and J. Caissey

Copper Electrocrytallization and the Continuous Monitoring of Electrorefining Additives

R. Winand, M. Degrex and V. Bastin

Electrochemical Behaviour of Industrial Copper Anodes in an Acidic Copper Sulfate Medium

C. Compère, E. Fréchette and E. Ghali

A Mineralogical Study of Anode Passivation in Copper Electrorefining

T.T. Chen and J.E. Dutrizac

Behaviour of Anode Impurities in Copper Electrorefining

F. Noguchi, N. Iida, T. Nakamura and Y. Ueda

Nucleation and Growth of Copper Electrodeposits on Titanium Substrates

H. Sun, J.-L. Delplancke, R. Winand and T.J. O'Keefe

The Dependence of Diversified Mother-plate Structure on the Starter Sheet Surface Structure for the Electrorefining of Copper

T. Karwan, J. Króś, J. Karwan-Baczeńska and S. Nosal

Interlaboratory Analytical Studies in the Copper Refining Industry

C.J. Weatherell

ELECTROREFINING TANKHOUSE OPERATIONS AND MODERNIZATION

Southern Copper Tankhouse Modernization

R. Lai and R.J. Edmonds
Report on the Progress of the Tankhouse Modernization Program at CCR
   D. Rompré, V. Baboudjian and J. Thiriar

Modernization Program at the Phelps Dodge Copper Refinery in El Paso
   J.L. Owings and G.L. Bailey

Electrolytic Copper Refining — Tank Room Data
   J.H. Schloen

High Current Density Operations at Magma Copper Company's Electrolytic Refinery
   M.C. Nielson

The New Copper Tankhouse at Norddeutsche Affinerie
   M. Landau and H. Traulsen

Development of the Kidd Process Permanent Stainless Steel Cathode Technology at Falconbridge Limited, Kidd Creek Division
   D.J. Kemp, O. Matwijenko and J.D. Scott

The Hazelett Continuous Cast Anode Efficiency in Handling and Processing in the Tankhouse
   P.C. Regan and J.M. Dompas

Tankhouse Material Handling Optimization at CCR
   J. Thiriar, G. Karkas, P.J. Wymouth, J.W. Palmer and W.M. Sztribely

COPPER ELECTROWINNING
Factors in the Design of Copper Electrowinning Tankhouses
   B.J. Ledeboer

Productivity Increase and Energy Conservation in Copper Electrowinning
   P. Paschen, M. Langfellner and G. Mori

Deposition of Suspended Particles in a Copper Electrowinning Cell
   J.W. Graydon and D.W. Kirk

COPPER REFINING DEVELOPMENTS
An Update on Inco's Use of the Double Cavity Mould Technology for Warpage Control
   V.K. Blechta and R.A. Roberti

In-line Automated Continuous Sampling of Cathode Copper: An Industry Unique and Flexible Approach to Random Sample Collection
   P.E. Warren, W.G. Hughes, V. Robinson and O. Matwijenko

The Electrorefining of Copper-rich Mattes using Particulate Anodes
   D.J. McKay and E. Peters

Continuous Electrolytic Deposition of Fine Copper Powders at Vertical Vibrating Electrodes
   G. Schulz and R. Kammel

Development of the Shanghai Copper Industry
   C. Guochen, L. Yaozhing and L. Zenggu

The Use of Fractal Dimension with an Aggregation Model to Characterize Experimental Copper Electrodeposits
   S.A. Godorr, B.D. Young and T.W. Bryson

Authors' Index

Keyword Index