Biomining
Biomining is the generic term that describes the processing of metal-containing ores and concentrates using (micro-) biological technology. This is an area of biotechnology that has seen considerable growth in scale and application since the 1960s, when it was first used, in very basically engineered rock “dumps” to recover copper from ores which contained too little of the metal to be processed by conventional smelting. Refinements in engineering design of commercial biomining operations have paralleled advances in our understanding of the biological agents that drive the process, so biomining is now a multifaceted area of applied science, involving operators and researchers working in seemingly disparate disciplines, including geology, chemical engineering, microbiology and molecular biology. This is reflected in the content of this book, which includes chapters written by persons from industry and academia, all of whom are acknowledged leading practitioners and authorities in their fields.

Biomining has a particular application as an alternative to traditional physical-chemical methods of mineral processing in a variety of niche areas. These include deposits where the metal values are low, where the presence of certain elements (e.g., arsenic) would lead to smelter damage, or where environmental considerations favor biological treatment options. Commercial-scale biomining operations are firmly established in all five continents, with the exception of Europe, though precommercial (“pilot-scale”) investigations have recently been set up in Finland to examine the feasibility of extracting nickel and copper from complex metal ores, in engineered heaps. While copper recovery has been, and continues to be, a major metal recovered via biomining, ores and concentrates of other base metals (such as cobalt) and precious metals (chiefly gold) are also processed using this biotechnology.

Developments and refinements of engineering practices in biomining have been important in improving the efficiency of metal recovery. The application of heap leaching to mineral processing continues to expand and, whereas this was once limited to copper processing, considerable experience has been gained in using heaps for gold recovery in the Carlin Trend deposits of the USA. Also, in recent years, there has been industrial-scale application of a radically different approach for heap leaching (the GEOCOAT process), which is described in this book. The other major engineering approach used in biomining – the use of stirred-tank bioreactors – has been established for
over 20 years. Over this time, these systems, used mostly for processing refractory gold ores, have been found to be far more robust than was initially envisaged. Huge mineral leaching tanks are in place in various parts of the world, and are described in this book by the commercial operators who have designed and constructed the majority of them. This book also includes a chapter describing how the use of high-temperature stirred-tank bioreactors is being explored as an option to recover copper from chalcopyrite, a mineral (quantitatively the most abundant copper mineral) that has so far proven recalcitrant to biological processing.

Two other important aspects of biomining are covered in this book. One is the nature and diversity of the microorganisms that are central to the core function of bioprocessing of ores, and how these may be monitored in commercial operations. The biophysical strategies used by different microorganisms and microbial consortia for the biodegradation of the ubiquitous mineral pyrite, as well as what is known about the pathways and genetics of the enzymes involved in iron and sulfur oxidation are also described. Significant advances that are being made in what has for long been a black box – the modeling of heap reactors – are also described.

This book follows a previous text entitled Biomining: Theory, Microbes and Industrial Processes, also published by Springer (in 1997) and which became out of print a short time after its publication. We believe that, owing to the efforts of colleagues who have contributed to this completely rewritten and updated text, this book is a worthy successor.

Douglas E. Rawlings
Barrie Johnson
May 2006
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ESTEBAN M. DOMIC

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List of Contributors

Murray Bath
GeoBiotics, LLC, Suite 310, 12345 W. Alameda Parkway, Lakewood, CO 80228, USA

John D. Batty
Johannesburg Technology Centre, BHP Billiton, Private Bag X10014, Randburg, 2125, South Africa

Violaine Bonnefoy
CNRS, Laboratoire de Chimie Bactérienne, Institut de Biologie Structurale et de Microbiologie, 31 chemin Joseph Aiguier, 13402 Marseille Cedex 20, France

James A. Brierley
Brierley Consultancy LLC, 2074 E. Terrace Drive, Highlands Ranch, CO 80126, USA

David W. Dew
Johannesburg Technology Centre, BHP Billiton, Private Bag X10014, Randburg, 2125, South Africa

David G. Dixon
Department of Materials Engineering, University of British Columbia, 6350 Stores Road, Vancouver, BC, V6T 1Z4, Canada

Patrick d’Hugues
BRGM, 3 Avenue Claude Guillemin, 45060 Orléans Cedex 2, France

Chris A. du Plessis
Johannesburg Technology Centre, BHP Billiton, Private Bag X10014, Randburg, 2125, South Africa

Esteban M. Domic
DOMIC SA, Office 61, Santa Magdalena 10, Providencia, Chile, and Mining Engineering Department, Universidad de Chile, Santiago, Chile

Peter D. Franzmann
Centre for Environment and Life Sciences, CSIRO Land and Water, Private Bag No. 5, Wembley, WA 6913, Australia

Kevin B. Hallberg
School of Biological Sciences, University of Wales, Bangor LL47 4UF, UK

Todd J. Harvey
GeoBiotics, LLC, Suite 310, 12345 W. Alameda Parkway, Lakewood, CO 80228, USA
Rebecca B. Hawkes  
School of Biological Sciences and Biotechnology, Murdoch University, South Street, Murdoch, WA 6150, Australia

David S. Holmes  
Laboratory of Bioinformatics and Genome Biology, Andrés Bello University and Millennium Institute of Fundamental and Applied Biology, Santiago, Chile

D. Barrie Johnson  
School of Biological Sciences, University of Wales, Bangor LL47 4UF, UK

Anna H. Kaksonen  
Institute of Environmental Engineering and Biotechnology, Tampere University of Technology, P.O. Box 541, 33101 Tampere, Finland

Thomas C. Logan  
Newmont Mining Corporation, 10101 E. Dry Creek Road, Englewood, CO 80112, USA

Dominique Henri Roger Morin  
BRGM, 3 Avenue Claude Guillemin, 45060 Orléans Cedex 2, France

Paul R. Norris  
Department of Biological Sciences, University of Warwick, Coventry CV4 7AL, UK

Waldemar Olivier  
Goldfields Limited, St. Andrews Road, Parktown, Johannesburg, 2193, South Africa

Jochen Petersen  
Department of Chemical Engineering, University of Cape Town, Private Bag, Rondebosch, 7701, South Africa

Jason J. Plumb  
Centre for Environment and Life Sciences, CSIRO Land and Water, Private Bag No. 5, Wembley, WA 6913, Australia

Jaakko A. Puhakka  
Institute of Environmental Engineering and Biotechnology, Tampere University of Technology, P.O. Box 541, 33101 Tampere, Finland

Douglas E. Rawlings  
Department of Microbiology, University of Stellenbosch, Private Bag X1, Matieland, 7602, South Africa

Marja Riekkola-Vanhanen  
Talvivaara Mining Company Limited, Salmelantie 6, 88600 Sotkamo, Finland

José Rojas-Chapana  
Nanoparticle Technology Department, Research Center Caesar, 53175 Bonn, Germany

Thom Seal  
Newmont Mining Corporation, Carlin Operations, P.O. Box 669, Carlin, NV 89822, USA

Helmut Tributsch  
Solare Energetik Department, Hahn–Meitner-Institut Berlin, 14109 Berlin, Germany
List of Contributors

Pieter C. van Aswegen
Goldfields Limited, St. Andrews Road, Parktown, Johannesburg, 2193, South Africa

Jan van Niekerk
Goldfields Limited, St. Andrews Road, Parktown, Johannesburg, 2193, South Africa