

# **22<sup>nd</sup> International Biohydrometallurgy Symposium**

Selected, peer reviewed papers from the Proceedings of the  
22<sup>nd</sup> International Biohydrometallurgy Symposium,  
September 24-27, 2017, Freiberg, Germany

*Edited by*

**Sabrina Hedrich, Kathrin Rübberdt, Franz Glombitza,  
Wolfgang Sand, Axel Schippers,  
Mario Vera Véliz and Sabine Willscher**



# Table of Contents

<b>Preface</b>	v
<b>Committees</b>	xi
<b>Lecture Programme</b>	xiii
<b>Poster Presentations</b>	xxiv

## **Chapter 1: Biohydrometallurgy and Biotechnologies in the Processing of Raw Materials in the Mining Industry**

<b>Effect of Temperature Ramping on Stirred Tank Bioleaching of a Copper Concentrate</b> S. Hedrich, C. Jouliau, T. Graupner, A. Schippers and A.G. Guézennec.....	3
<b>Column Bioleaching of a Saline, Calcareous Copper Sulfide Ore</b> E. Pakostova, B.M. Grail and D.B. Johnson.....	7
<b>Production Development of Olimpiadinskoe Gold Processing Plant through BIONORD® Technology Processing</b> A. Belyi, D. Chernov and N. Solopova.....	12
<b>Bioelectrochemical Leaching of Copper Sulfide Minerals</b> M. Ranjbar, M. Esmailbagi and M. Schaffie .....	16
<b>Bioleaching of Supergene Porphyry Copper Ores from Sungai Mak Gorontalo of Indonesia by an Iron- and Sulfur-Oxidizing Mixotrophic Bacterium</b> S.K. Chaerun, F.Y. Putri, M.Z. Mubarak, W.P. Minwal and Z.T. Ichlas.....	20
<b>Comparison of Reductive and Oxidative Bioleaching of Jarosite for Valuable Metals Recovery</b> J. Mäkinen, M. Salo, H. Hassinen and P. Kinnunen.....	24
<b>The MONDO Minerals Nickel Sulfide Bioleach Project: From Test Work to Early Plant Operation</b> J. Neale, J. Seppälä, A. Laukka, P. van Aswegen, S. Barnett and M. Gericke.....	28
<b>Recent Advances in Biomining and Microbial Characterisation</b> A.H. Kaksonen, N.J. Boxall, T. Bohu, K. Usher, C. Morris, P.Y. Wong and K.Y. Cheng.....	33
<b>Linking Microbial Community Dynamics in BIOX® Leaching Tanks to Process Conditions: Integrating Lab and Commercial Experience</b> M. Smart, R.J. Huddy, C.J. Edward, C. Fourie, T. Shumba, J. Iron and S.T.L. Harrison .....	38
<b>Enzymatic Pre-Treatment of Carbonaceous Matter in Preg-Robbing Gold Ores: Effect of Ferrous Ion Additives</b> K.T. Konadu, K. Sasaki, K. Osseo-Asare and T. Kaneta .....	43
<b>Microbial Population of Industrial Biooxidation Reactors</b> A. Bulaev, A. Belyi, A. Panyushkina, N. Solopova and T. Pivovarova .....	48
<b>An XPS and XANES Study on the Bioleaching of Arsenopyrite with or without Pyrite</b> Y. Yang, W.H. Liu, C. Wang, M. Chen, R. Ram and S.K. Bhargava .....	53

<b>Evaluation of Long-Term Post Process Inactivation of Bioleaching Microorganisms</b> M. Bomberg, H. Miettinen, M. Wahlström, T. Kaartinen, S. Ahoranta, A.M. Lakaniemi and P. Kinnunen .....	57
<b>Bioleaching of Copper Slag Material</b> A. Schippers .....	61
<b>Biooxidation of a Refractory Gold Ore: Implications of Whole-Ore Heap Biooxidation</b> B.W. Chen, J.Z. Sun, H. Shang, B. Wu and J.K. Wen .....	65
<b>Approaches for Eliminating Bacteria Introduced during <i>In Situ</i> Bioleaching of Fractured Sulfidic Ores in Deep Subsurface</b> H. Ballerstedt, E. Pakostova, D.B. Johnson and A. Schippers .....	70
<b>Attachment of <i>Acidithiobacillus ferrooxidans</i> and Bioleaching of Chalcopyrite under Influence of Organic Substances Associated with Copper Solvent Extraction</b> X.R. Liu, H. Zhang, H.L. Yu and Y.H. Zhu .....	75
<b>Bioleaching for Removal of Chromium and Associated Metals from LD Slag</b> S. Thallner, C. Hemmelmaier, S. Martinek and W. Schnitzhofer .....	79
<b>Examining the Effects of Typical Reagents for Sulfide Flotation on Bio-Oxidation Activity of Ferrous Iron Oxidizing Microorganisms</b> M. Jafari, S.Z. Shafaei, H. Abdollahi, M. Gharabaghi, S. Chehreh Chelgani and S. Ghassa .....	84
<b>Reduction of Iron(III) Ions at Elevated Pressure by Acidophilic Microorganisms</b> R.Y. Zhang, S. Hedrich and A. Schippers .....	88
<b>The Influence of Pyrite on Galvanic Assisted Bioleaching of Low Grade Chalcopyrite Ores</b> B. Wu, H. Shang, M.L. Wu and J.K. Wen .....	93
<b>Bio-Heap Leaching of Primary Copper Sulfide Ore by JOGMEC</b> T. Shinkawa, T. Chida, S. Furukawa and T. Kamiya .....	99
<b>Fabrication and Application of Polyethylenimine/Ca-Alginate Blended Hydrogel Fibers as High-Capacity Adsorbents for Recovery of Gold from Acidic Solutions</b> J.K. Bediako, M.H. Song and Y.S. Yun .....	103
<b>Selective Chemical and Biological Metal Recovery from Cu-Rich Bioleaching Solutions</b> S. Hedrich, R. Kermer, T. Aubel, M. Martin, A. Schippers, D.B. Johnson and E. Janneck .....	107
<b>Bioleaching of Tailings Resulting from Beneficiation of Polymetallic Ores for Recovery of Valuable Metals</b> N.S. Vardanyan, G.G. Sevoyan and A.K. Vardanyan .....	113
<b>Electrochemical Process Engineering in Biohydrometallurgical Metal Recovery from Mineral Sulfides</b> C. Tanne and A. Schippers .....	118
<b>Heap Biooxidation of Gold-Sulphide and Polymetallic Ores and Tailings</b> A.V. Epiforov, A.N. Seleznev, Y.Y. Emelyanov, S.V. Balikov, L.Y. Shketova and N.V. Kopylova .....	122
<b>Screening of Important Variables of Organic Acids Degradation by <i>Phanerochaete chrysosporium</i> Using Plackett-Burman Design in Refractory Arsenic-Bearing and Carbonaceous Gold Ores</b> Q. Liu, H.Y. Yang, L.L. Tong and J. Peng .....	126

<b>Biogenic Hydrogen Sulfide for Cyanide Regeneration in Solutions during Cupriferous Gold Ores Processing</b>	
A.A. Faiberg, A.N. Mikhailova, V.E. Dementiev and S.S. Gudkov .....	131
<b>Microbial Community Analysis inside a Biooxidation Heap for Gold Recovery in Equador</b>	
C.L. Aspiazu, P. Aguirre, S. Hedrich and A. Schippers .....	135
<b>Comparative Bioleaching and Mineralogical Characterization of Black Shale-Hosted Ores and Corresponding Flotation Concentrates</b>	
A. Kamradt, J. Schaefer, A. Schippers and S. Hedrich.....	139
<b>Effect of X-Ray <math>\mu</math>CT Scanning on the Growth and Activity of Microorganisms in a Heap Bioleaching System</b>	
M. Ghadiri, S.T.L. Harrison and M.A. Fagan-Endres .....	143
<b>Pilot-Scale Bioleaching of Metals from Pyritic Ashes</b>	
E.A. Vuorenmaa, J. Mäkinen, T. Korhonen, R. Neitola and A.H. Kaksonen .....	147
<b>The Use of Heap Bioleaching as a Pre-Treatment for Platinum Group Metal Leaching</b>	
J.M. Mwase and J. Petersen .....	151
<b>Bioleaching Experiments on a Low-Grade Complex Zinc Ore from Inner Mongolia</b>	
J.F. Li, L.L. Tong, Q. Chen, Z.N. Jin and H.Y. Yang .....	155
<b>Investigation of Intermediates Evolutions during Bornite Bioleaching by Mesophilic Mixed Bacteria</b>	
X.X. Wang, M.H. Hu, X.T. Huang, R. Liao, H.B. Zhao, M.X. Hong and J. Wang.....	159
<b>A Comparison of Bioleaching Behavior of Two Pure Chalcopyrite Minerals through Investigating Chalcopyrite Crystallographic Properties</b>	
Y.S. Zhang, J.M. Zhang, B. Zhang, K.X. Chang, J. Wang, J.P. Xie, W.Q. Qin and G.Z. Qiu.....	164
<b>Effect of Marmatite on Bioleaching Behaviors of Chalcopyrite</b>	
R. Liao, J. Wang, H.B. Zhao, X.X. Wang, X.T. Huang and M.X. Hong .....	168
<b>Influence of Citrate on Metal Dissolution and Respiration Rate of Microbial Leaching Cultures</b>	
F. Giebner, J. Rolle, J. Helmich, M. Schlömann and S. Schopf.....	172
<b>Research on Bio-Leaching of Nickel-Bearing Tailings in Jilin, China</b>	
X. Wang, H.Y. Yang, L.L. Tong, Z.N. Jin and S.X. Zhao .....	177
<b>Recovery of Copper from Pyritic Copper Ores Using a Biosurfactant-Producing Mixotrophic Bacterium as Bioflotation Reagent</b>	
E. Sanwani, R.Z. Mirahati and S.K. Chaerun .....	181
<b>Insights into Heap Bioleaching at the Agglomerate-Scale</b>	
A. Cox and C.G. Bryan .....	185
<b>Comparative Variants of Microbial Pretreatment and Subsequent Chemical Leaching of a Gold-Bearing Sulphide Concentrate</b>	
I. Spasova, M. Nicolova, P. Georgiev and S. Groudev.....	189
<b>Biosynthesis of Copper Nanoparticles Using Aqueous Extracts of <i>Aloe vera</i> and <i>Geranium</i> and Bioleaching Solutions</b>	
A. Pawlowska and Z. Sadowski.....	193
<b>Nickel Bioleaching at Elevated pH: Research and Application</b>	
J.Z. Sun, B.W. Chen, J.K. Wen and B. Wu .....	197

<b>Biological Production of Copper Sulfide Concentrate from Flotation Tailings and Low Grade Ore</b>	
V.J. Zepeda, I. Nancucho, M. Guillen, E. Becerra, C. Escuti, D. Cautivo, D. González, C. Colipai, C. Demergasso and P.A. Galleguillos .....	202
<b>Biodesulfurization of a Coarse-Grained High Sulfur Coal in a Full-Scale Packed-Bed Bioreactor</b>	
A.D. Milan, A. Ahmadi and S.M.R. Hosseini .....	207
<b>Pyrite Oxidation by Moderately Thermophilic Microorganisms</b>	
A. Bulaev and M. Labyrich.....	211
<b>Biooxidation of a High-Grade Arsenopyritic Gold Ore Using a Mixed Culture of Moderate Thermophilic Microorganisms</b>	
H. Abdolahi, A. Ahmadi, H. Zilouei and M. Khezri .....	215
<b>Microbial Survey on Industrial Bioleaching Heap by High-Throughput 16S Sequencing and Metagenomics Analysis</b>	
M. Acosta, P.A. Galleguillos, M. Guajardo and C. Demergasso.....	219
<b>Preliminary Study on <i>In Situ</i> Realtime Quantitation of Target Bacteria on the Principle of Flow Cytometry</b>	
G. Murakami, Y. Sugai and K. Sasaki .....	224
<b>Investigating the Microbial Metabolic Activity on Mineral Surfaces of Pyrite-Rich Waste Rocks in an Unsaturated Heap-Simulating Column System</b>	
D. Makaula, R.J. Huddy, M.A. Fagan-Endres and S.T.L. Harrison .....	228
<b>The Impact of Heap Self-Heating on Microbial Activity during the Bioleaching of Low-Grade Copper Sulfide Ores</b>	
D.W. Shiers, D.M. Collinson and H.R. Watling.....	233
<b>Bioleaching of Low-Grade Chalcopyrite Ore by the Thermophilic Archaeon <i>Acidianus brierleyi</i></b>	
N. Saitoh, T. Nomura and Y. Konishi.....	237
<b>Influence of CO<sub>2</sub> Supplementation on the Bioleaching of a Copper Concentrate from Kupferschiefer Ore</b>	
A.G. Guézennec, C. Joulian, J. Jacob, F. Bodenan, P. d'Hugues and S. Hedrich.....	242
<b>Unravelling the Complexity of Heap Bioleaching</b>	
J. Petersen.....	246
<b>Copper Heap Bioleach Microbiology - Progress and Challenges</b>	
F.F. Roberto .....	250
<b>Microbial Dissolution of Iron Surface Coatings in Industrial Minerals</b>	
J. Šuba, I. Štyriaková, I. Štyriak and D. Štyriaková.....	255
<b>Chapter 2: Innovative Methods in Bioleaching</b>	
<b>Characterization and Localized Insight into Leaching of Sulfide Minerals</b>	
M. Chen, Y. Yang and M. Vepsalainen .....	261
<b>Method for the Recovery of Indium from Diluted Bioleaching Solutions</b>	
R. Vostal, U. Šingliar and M. Bertau .....	265
<b>Changes in Metal Leachability through Stimulation of Iron Reducing Communities within Waste Sludge</b>	
M. Roberts, D. Sapsford, A. Weightman and G. Webster .....	269

<b>Mechanism of Silver-Catalyzed Bioleaching of Enargite Concentrate</b> K. Oyama, T. Hirajima, K. Sasaki, H. Miki and N. Okibe .....	273
<b>Bioleaching of Chalcopyrite with Two Different Metallogenic Types: A Mineralogical Perspective</b> S. Deng, G.H. Gu, J. Ji and B.K. Xu.....	277
<b>Investigation of Controlled Redox Potential with Pyrite during Chalcopyrite Bioleaching by Mixed Moderately Thermophiles</b> X.T. Huang, J. Wang, H.B. Zhao, M. Gan, R. Liao, J.W. Liyu, X.X. Wang, M.X. Hong, W.Q. Qin and G.Z. Qiu.....	281
<b>From Knowledge to Best Practices in Bioleaching</b> C. Demergasso, R. Véliz, P.A. Galleguillos, S. Marín, M. Acosta, V. Zepeda, J. Bekios and J. Zeballos.....	285
<b>Microbial Community Composition of Mine Wastes in Cornwall and West Devon (UK)</b> T. Scaffi, A. Buckling and C.G. Bryan.....	290
<b>Incorporation of Indigenous Microorganisms Increases Leaching Rates of Rare Earth Elements from Western Australian Monazite</b> M.K. Corbett, J.J. Eksteen, X.Z. Niu and E.L.J. Watkin .....	294
<b>Reductive Dissolution of a Lateritic Ore Containing Rare Earth Elements (REE) Using <i>Acidithiobacillus</i> Species</b> I. Nancucheo, D.B. Johnson, M. Lopes and G. Oliveira.....	299
<b>The Mechanism of In and Ge Occurrence in Sphalerite Crystal and the Influence on Properties: A DFT (Density Function Theory) Simulation</b> L.L. Tong, H.Y. Yang, J.N. Xu, P.C. Xu and C. Li.....	303
<b>Innovative Biohydrometallurgical Approaches in the EU Project FAME</b> S. Reichel, M. Martin, C.G. Bryan, C. Vila, A. Fiúza and W. Reimer.....	307
<b>Fabrication of Magnetic Polymer Composite Sorbents and its Application for Recovery of Platinum from Acidic Solution</b> M.H. Song, D.H.K. Reddy, J.K. Bediako, S. Lin and Y.S. Yun.....	311
<b>Process and Cost Improved Agitator Solutions for Bioleach Reactors</b> J.C. Jung and W. Keller .....	315
 <b>Chapter 3: Properties of Microbial Agents, Interaction Mechanisms of Microbial Agents and Processed Media</b>	
<b><i>In Situ</i> Characterization and Molecular Mechanisms Evaluation of Interfacial Interaction between Minerals and Bioleaching Microorganisms</b> J.L. Xia, H.C. Liu, Z.Y. Nie, L.Z. Liu, H.R. Zhu, L. Wang, Y. Yang, Y.L. Ma, X. Pan, Y.D. Zhao, C.Y. Ma, L. Zheng, X.J. Zhen, L.J. Zhang and W. Wen .....	321
<b>Mineralogical Dynamics of Primary Copper Sulfides Mediated by Acidophilic Biofilm Formation</b> R.A. Bobadilla-Fazzini .....	325
<b>Molecular Regulatory Network Involved in Biofilm Structure Development by <i>Acidithiobacillus thiooxidans</i> Includes Pel Exopolysaccharide Machinery</b> M. Diaz and N. Guiliani.....	330
<b>Mineral Specific Biofilm Formation of “<i>Acidibacillus ferrooxidans</i>” Huett2</b> F. Schieferbein, M. Bauer, A. Klingl and S. Schopf.....	334

<b>16S rRNA and Multilocus Phylogenetic Analysis of the Iron Oxidizing Acidophiles of the <i>Acidiferrobacteraceae</i> Family</b>	
F. Issotta, P.C. Covarrubias, A. Moya-Beltrán, S. Bellenberg, C. Thyssen, W. Sand, H. Nuñez, C. Mena, D.S. Holmes, R. Quatrini and M. Vera Véliz .....	339
<b>Proteins Binding to Immobilized Rusticyanin Detected by Affinity Chromatography</b>	
J. Kucera, O. Janiczek, J. Smoldas and M. Mandl.....	344
<b>Inhibition Kinetics of Iron Oxidation by <i>Leptospirillum ferriphilum</i> to Residual Thiocyanate Present in Bioremediated Cyanidation Tailings Wastewater</b>	
C.J. Edward, A. Kotsiopoulos and S.T.L. Harrison.....	350
<b>Fungal Mineralization Processes in Rio Tinto</b>	
M. Oggerin, N. Rodríguez and R. Amils .....	354
<b>Genetic Basis of Metal Resistance in <i>Acidiphilium</i> sp. DSM 27270 (Yenapatur)</b>	
F. Isotta, R.A. Bobadilla-Fazzini, A. Moya-Beltrán, P.C. Covarrubias, R. Quatrini and P. Martinez .....	358
<b>Microorganisms Oxidize Iron (II) Ions in the Presence of High Concentrations of Sodium Chloride - Potentially Useful for Bioleaching</b>	
D. Huynh, S. Kaschabek, W. Sand and M. Schlömann .....	364
<b>Expression of Candidate Cold Stress and Metabolic Related Genes in <i>Acidithiobacillus ferrivorans</i> PQ33 Strain Using Ferrous Iron as Electron Donor</b>	
G. Guerra-Bieberach, R. Ccorahua-Santo, A. Eca, J. Bernaldo, T. Sánchez, C. Rojas-Ayala and P. Ramirez .....	368
<b>Bioleaching of Pyrite by Iron-Oxidizing Acidophiles under the Influence of Reactive Oxygen Species</b>	
D. Huynh, S. Bellenberg, M. Vera Véliz, A. Poetsch and W. Sand .....	372
<b>Transcription Dynamics of CBB-Pathway Genes in <i>Acidithiobacillus thiooxidans</i> Growing under Different CO<sub>2</sub> Levels</b>	
S. Marín, M. Acosta, P.A. Galleguillos, Y. Villegas, D. Cautivo, V.J. Zepeda and C. Demergasso .....	376
<b>Microbial Ferrous Ion Oxidation versus Ferric Ion Precipitation at Low Temperature Conditions</b>	
E.C. Chukwuchendo and T.V. Ojumu .....	381
<b>Comparative Study of NaCl-Tolerance Mechanisms in Acidophilic Iron-Oxidizing Bacteria and Archaea</b>	
J. Rivera-Araya, M. Schlömann and G. Levicán .....	385
<b>Use of Specific Metal Binding of Self-Assembling S-Layer Proteins for Metal Bioremediation and Recycling</b>	
M. Vogel, S. Matys, F. Lehmann, B. Drobot, T. Günther, K. Pollmann and J. Raff.....	389
<b>Biochemical Aspects of Energy Metabolism in <i>Sulfobacillus thermotolerans</i></b>	
A. Panyushkina, V. Melamud and I. Tsaplina .....	394
<b>Adhesion Studies of Microorganisms on Natural Ore Material</b>	
N. Eisen, F. Straube, S. Schopf and M. Schlömann.....	398
<b>The Effect of Initial Solution pH on Surface Properties of Ferric Ion Precipitates Formed during Biooxidation of Ferrous Ion by <i>Leptospirillum ferriphilum</i></b>	
B. Mabusela and T.V. Ojumu .....	403
<b>The Mechanism of Skutterudite Acid Leaching: A DFT Study of H<sup>+</sup> Effect on CoO (010) Surface</b>	
J.N. Xu, H.Y. Yang, L.L. Tong, Z.N. Jin and Y. Song.....	408

<b>Production of Amphiphilic Hydroxamate Siderophores Marinobactins by <i>Marinobacter</i> sp. DS40M6 for Bioflotation Process</b>	
S. Schrader, S. Kutschke, M. Rudolph and K. Pollmann.....	413
<b><i>In Situ</i> Characterization of Superficial Organic Composition Changes of Thermoacidophilic Archaea <i>Acidianus manzaensis</i> YN-25 in Response to Energy Substrate</b>	
L.Z. Liu, X. Pan, X. Xia, Y.H. Zhou, Z.Y. Nie and J.L. Xia.....	417
<b>Construction of a Cell Surface Engineered Yeast Aims to Selectively Recover Molybdenum, a Rare Metal</b>	
M.F. Chien, N. Ikeda, K. Kubota and C. Inoue .....	421
<b>Introduction to High-Throughput Sequencing Technologies and Review of its Application in Bioleaching</b>	
P. Lei, M. Gan, B.J. Yang, X.D. Liu, S.B. Yang and S. Zhou.....	425
<b>Type IV Secretion Systems Diversity in the <i>Acidithiobacillus</i> Genus</b>	
R. Flores-Ríos, A. Moya-Beltrán, P.C. Covarrubias, L.G. Acuña, O. Orellana and R. Quatrini.....	429
<b>EPS Characterization of a Cell Wall-Lacking Archaeon <i>Ferroplasma acidiphilum</i></b>	
R.Y. Zhang, V. Blanchard, M. Vera Véliz and W. Sand.....	434
<b>Metagenome-Derived Draft Genome Sequence of <i>Acidithiobacillus ferrooxidans</i> RV1 from an Abandoned Gold Tailing in Neuquén, Argentina</b>	
R. Ulloa, A. Moya-Beltrán, F. Issotta, H. Nuñez, P.C. Covarrubias, E.R. Donati, R. Quatrini and A. Giaveno .....	439
<b>Phage Display - A Promising Tool for the Recovery of Valuable Metals from Primary and Secondary Resources</b>	
S. Matys, F.L. Lederer, N. Schönberger, R. Braun, F. Lehmann, K. Flemming, S. Bachmann, S. Curtis, R.T.A. MacGillivray and K. Pollmann.....	443
<b>Simplified Expression and Production of Small Metal Binding Peptides</b>	
R. Braun, S. Matys, N. Schönberger, F. Lederer and K. Pollmann .....	447
<b>Investigation of Fluoride Tolerance in <i>Acidithiobacillus ferrooxidans</i></b>	
J.M. Tao, L.Y. Ma, C. Qin, H.Q. Yin, Y.L. Liang, G.Z. Qiu and X.D. Liu .....	452
<b>Potential Bioleaching Effects in <i>In Situ</i> Recovery Applications</b>	
C. Richter, H. Kalka and H. Märten.....	456
<b>Identification of Sulfur Activation Relevant Protein Genes of Extremely Thermophilic <i>Acidianus manzaensis</i></b>	
H.C. Liu, J.L. Xia, Z.Y. Nie, Y.L. Ma, Y. Yang, L.Z. Liu, X. Pan and P. Yuan .....	461
<b>Evolution of Compositions and Contents of Capsule and Slime EPSs for Adaptation to and Action on Energy Substrates and Heavy Metals by Typical Bioleaching Microorganisms</b>	
Z.Y. Nie, H.C. Liu, J.L. Xia, H. Liu, Y.L. Cui and G.Z. Qiu.....	466
<b>Resistance of Moderately Thermophilic Acidophilic Microorganisms to Ferric Iron Ions</b>	
A. Bulaev .....	471
<b>Effect of Galactose on EPS Production and Attachment of <i>Acidithiobacillus thiooxidans</i> to Mineral Surfaces</b>	
P. Aguirre, A. Sánchez Rodríguez, J.C. Gentina and A. Schippers.....	476



<b>Molecular Response of the Acidophilic Iron Oxidizer “<i>Ferrovum</i>” sp. JA12 to the Exposure to Elevated Concentrations of Ferrous Iron</b>	
S.R. Ullrich, A. Poehlein, G. Levicán, M. Schlömann and M. Mühling .....	482
<b>The Surface Chemistry Characterization of Pyrite, Sphalerite and Molybdenite after Bioleaching</b>	
S. Ghassa, H. Abdollahi, M. Gharabaghi, S. Chehreh Chelgani and M. Jafari .....	487
<b>Monitoring of Biofilm Development on Surfaces Using an Electrochemical Method</b>	
O. Fysun, A. Maher, H. Brehm, B. Wilke and H.C. Langowski .....	492
<b>EIS Studies of Chalcopyrite Involving Iron(II) Ions</b>	
F.A.A. Delfino, D. Bevilacqua and A.V. Benedetti .....	496
<b>Thermochelin, a Hydroxamate Siderophore from <i>Thermocrispum agreste</i> DSM 44070</b>	
T. Heine, M. Mehnert, R. Schwabe and D. Tischler .....	501
<b>Siderophore Purification via Immobilized Metal Affinity Chromatography</b>	
T. Heine, M. Mehnert, R. Schwabe and D. Tischler .....	505
<b>Revisiting the Chrome Azurol S Assay for Various Metal Ions</b>	
M. Mehnert, G. Retamal-Morales, R. Schwabe, S. Vater, T. Heine, G.J. Levicán, M. Schlömann and D. Tischler .....	509
<b>Gallium Mobilization in Soil by Bacterial Metallophores</b>	
R. Schwabe, B. Obst, M. Mehnert, D. Tischler and O. Wiche .....	513
<b>On the Immobilization of Desferrioxamine-Like Siderophores for Selective Metal Binding</b>	
M.K. Anke, K. Szymańska, R. Schwabe, O. Wiche and D. Tischler .....	517
<b>Are there Viruses in Industrial Bioleaching Econiches?</b>	
P.C. Covarrubias, R. Muñoz, R.A. Bobadilla-Fazzini, P. Martinez and R. Quatrini .....	521
<b>Diversity of Thermophilic Iron-Pyrite-Oxidizing Enrichments from Solfataric Hot Springs in the Chilean Altiplano</b>	
S. Barahona, J. Cortés, M. Hengst, C. Dorador and F. Remonsellez .....	526
<b>Comparative Analysis of Functional Gene Diversity of Acid Mine Drainage and its Sediment by Geochip Technology</b>	
L. Tan, H. Yun, X.Y. Xu, J. He, H.Y. Wu, G.Z. Qiu, X.X. Liu and J.P. Xie .....	531
<b>Investigation of a Bioflotation Interface with Infrared Spectroscopy</b>	
T. Firkala, F.L. Lederer, K. Pollmann and M. Rudolph .....	537
<b>Leaching of Pyrite by <i>Acidithiobacillus ferrooxidans</i> Monitored by Electrochemical Methods</b>	
A. Saavedra and E. Cortón .....	541
<b>X-Ray Diffraction of Iron Containing Samples: The Importance of a Suitable Configuration</b>	
Y.M. Mos, A.C. Vermeulen, C.N.J. Buisman and J. Weijma .....	545
<b>Chapter 4: Biosorption, Bioremediation and Biopurification in the Environmental Engineering</b>	
<b>Biogenic Iron Compounds for Hazardous Metal Remediation</b>	
L. Castro, M.L. Blázquez, F. González, J.A. Muñoz and A. Ballester .....	551

<b>Optimization of Bioscorodite Crystallization for Treatment of As(III)-Bearing Wastewaters</b>	
M. Tanaka, T. Hirajima, K. Sasaki and N. Okibe.....	555
<b>Chemical vs. Biological Crystals, all the Same?</b>	
J. Weijma, P. Gonzàles-Contreras and C.N.J. Buisman .....	559
<b>Microbial Recycling of Precious and Rare Metals Sourced from Post-Consumer Products</b>	
N. Saitoh, T. Nomura and Y. Konishi.....	563
<b>Microbial Production of Schwertmannite: Development from Microbial Fundamentals to Marketable Products</b>	
S. Reichel, E. Janneck, D. Burghardt, S. Peiffer, G. Kießig, T. Koch, I. Arnold and J. Laubrich.....	568
<b>Rare Earth Elements Recovery and Sulphate Removal from Phosphogypsum Waste Waters with Sulphate Reducing Bacteria</b>	
J. Mäkinen, M. Bomberg, M. Salo, M. Arnold and P. Koukkari.....	573
<b>The Use of Algal Biomass to Sustain Sulfidogenic Bioreactors for Remediating Acidic Metal-Rich Waste Waters</b>	
A.L. Santos and D.B. Johnson .....	577
<b>Integrated Sulfate Reduction and Biosorption Process for the Treatment of Mine Drainages</b>	
D. Cotoras, C. Hurtado and P. Viedma.....	582
<b>Detoxification of Heap after Gold Leaching Using Biodegradation</b>	
M.P. Belykh, S.V. Petrov, A.Y. Chikin, G.I. Voiloshnikov and N.L. Belkova.....	587
<b>Development of Metal Ion Binding Peptides Using Phage Surface Display Technology</b>	
N. Schönberger, S. Matys, K. Flemming, F. Lehmann, F. Lederer and K. Pollmann .....	591
<b>Recycling of Florescent Phosphor Powder <math>Y_2O_3:Eu</math> by Leaching Experiments</b>	
R. Auerbach, K. Bokelmann, S. Ratering, R. Stauber, S. Schnell and J. Zimmermann .....	596
<b>Analysis of Microbial Communities Associated with Bioremediation Systems for Thiocyanate-Laden Mine Water Effluents</b>	
R.J. Huddy, F. Kadzinga, S.F. Rahman, R. Kantor, J.F. Banfield and S.T.L. Harrison .....	601
<b>pH and Soil Additive-Depending Uptake of Various Metals and Metalloids by <i>Helianthus tuberosus</i> from a Uranium Containing Test Field Site</b>	
L. Jablonski, S. Willscher, J. Wittig and D. Kuehn .....	605
<b>Biosorption of Heavy Metals Using Organic Waste from Tequila Processing</b>	
R.E. Rivera Santillan, F. Patricio Ramirez, Y. Ayala Pichardo, E. Ordaz Romero and V. Sanchez Jimenez.....	609
<b>South African Coal Tailings Bioflotation for Desulphurization Using <i>Mycobacterium phlei</i></b>	
M.A. Fagan-Endres and S.T.L. Harrison .....	613
<b>Bioleaching of Cadmium from Contaminated Paddy Fields by Consortium of Autotrophic and Indigenous Cadmium-Tolerant Bacteria</b>	
Y. Deng, X.D. Liu, H.W. Liu, H.D. Jiang, L.F. Xu, Y.H. Xiao, X.D. Hao, H.Q. Yin and Y.L. Liang .....	617

<b>Bioremediation of Complex Pollutants from the Oil Industry Containing Cobalt and Molybdenum Catalysts</b> S. Miletić, T. Jednak, J. Avdalović, V. Beškoski, M. Ilić, G. Gojgić-Cvijović and M.M. Vrvić.....	622
<b>Biodegradation of Thiocyanate and Cyanide in CIL Leaching Waste's Liquid Phase</b> A. Belyi, A. Teleutov, A. Revenko, N. Solopova, V. Sekachev, A. Malashonok and G. Krasilnikov .....	626
<b>Utilization of Fe-Oxide Composites for as Removal from Aqueous Solutions</b> A. Bekényiová, Z. Danková, I. Štyriaková and D. Štyriaková .....	630
<b>Intensification of Arsenic and Zinc Mobilization by Combination of Bio-Chemical Leaching with EDTA in the Soil and Sediment Bioremediation</b> I. Štyriaková, D. Štyriaková, A. Bekényiová and J. Šuba .....	634
<b>Comparative Analysis of the Sulfate-Reducing Performance and Microbial Colonisation of Three Continuous Reactor Configurations with Varying Degrees of Biomass Retention</b> T. Hessler, T. Marais, R.J. Huddy, R. van Hille and S.T.L. Harrison .....	638
<b>Investigation of the Ga Complexation Behaviour of the Siderophore Desferrioxamine B</b> R. Jain, F. Cirina, P. Kaden and K. Pollmann.....	643
<b>Removal of Arsenic from Aqueous Solution by <i>Aeromonas hydrophila</i></b> L. Castro, M.L. Blázquez, F. González, J.A. Muñoz and A. Ballester .....	647
<b><i>In Situ</i> Bioremediation of Tailings by Sulfate Reducing Bacteria and Iron Reducing Bacteria: Lab- and Field-Scale Remediation of Sulfidic Mine Tailings</b> X.Y. Liu, M.J. Zhang, Y.B. Li, Z.N. Wang and J.K. Wen .....	651
<b>Immobilization of Arsenic by a Thermoacidophilic Mixed Culture with Pyrite as Energy Source</b> S. Vega, J. Weijma and C. Buisman .....	656
<b>Genomic Characterization of the Arsenic-Tolerant Actinobacterium, <i>Rhodococcus erythropolis</i> S43</b> G. Retamal-Morales, M. Mehnert, R. Schwabe, D. Tischler, M. Schlömann and G. Levicán .....	660
<b>Microbiological As(III) Oxidation and Immobilization as Scorodite at Moderate Temperatures</b> Y. Era, T. Hirajima, K. Sasaki and N. Okibe.....	664
<b>Investigating the Bioleaching of an Arsenic Mine Tailing Using a Mixed Mesophilic Culture</b> E. Ngoma, K. Shaik, D. Borja, M. Smart, J.H. Park, H.J. Kim, J. Petersen and S.T.L. Harrison.....	668
<b>Manganese Removal from Metal Refinery Wastewater Using Mn(II)-Oxidizing Bacteria</b> S. Kitjanukit, K. Takamatsu, K. Takeda, S. Asano and N. Okibe .....	673
<b>Microbially Catalysed Selenate Removal in an Inverse Fluidised Bed Reactor</b> K.Y. Cheng, M.P. Ginige and A.H. Kaksonen .....	677
<b>Evaluation of Substrate Consumption Kinetics in Different Support Materials for Biotrickling Filters Aiming Biogas Desulfurization</b> L.F. Hidalgo, J.L. Santos, S.P. Tayar, A. Sarti, M.C. Palmieri, R.d.B. Solcia Guerrero and D. Bevilacqua.....	682

---

<b>Adsorption of Chromium (VI) and Desorption as Chromium (III) from the Aqueous Chromium (VI) Solution Using Persimmon Gel</b>	
T. Tsuruta and T. Hatano .....	687
<b>Optimization of Ni, Cu and Zn Recovery in Bioleaching of Electronic Scrap</b>	
M. Mostafavi, F. Rashchi, S. Beikzadeh Noei and N. Mostoufi.....	692
<b>Bioleaching of Valuable Components from a Pyrometallurgical Final Slag</b>	
P. Georgiev, I. Spasova, V. Groudeva, M. Nicolova, A. Lazarova, M. Iliev, R. Ilieva and S. Groudev.....	696
<b>Keyword Index</b> .....	701
<b>Author Index</b> .....	707