

Proceedings of the 18th Symposium
on Environmental Issues and Waste Management
in Energy and Mineral Production

Eleonora Widzyk-Capehart
Asieh Hekmat · Raj Singhal
Editors

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Symposium
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and Waste Management
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Production

SWEMP 2018—Selected Works

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Foreword



Raj Singhal



Mohan Yellishetty

This Symposium on Environmental Issues and Waste Management in Energy and Mineral Production (SWEMP) is the 18th in a series of biannual symposia on the subject matter. The basic aim of this series of symposia is to contribute to the development of methods and technologies for assessing, minimizing and preventing environmental problems connected with mineral and energy production.

This symposium has come to be recognized as a leader in promoting international technology transfer. A wide range of high-quality papers from North and South America, Europe, Australia, Africa and Asia have been attracted. Major topics to be covered are as follows: Control of Emissions in Mining Processes; Emerging Monitoring and Measurement Technologies; Environmental Chemistry and Toxicology: Health Hazard and Safety Issues; Environmental Issues in Deep Mining: Mine Ventilation, Refrigeration and Worker Health; Risk and Environmental Impact Assessment; Life Cycle Assessment; Management of Mining and Hazardous Waste and Waste Stabilization; Tailings Treatment, Recycle, Disposal; Mine Closure; Mine Rehabilitation and Reclamation; Remediation and Bioremediation; Water and Effluents: Treatment and Management; and Sustainability: Economic, Social and Climate Change.

SWEMP 2018 derives its strength from the coalition of various worldwide institutions. It is organized by the Advanced Mining Technology Center, University of Chile and University of Concepcion, Chile, in collaboration with the Department of Landscape Ecology, Faculty of Environmental Sciences, Czech University of Life Sciences, Czech Republic; Faculty of Agriculture University of South Bohemia, Czech Republic; The International Journal of Mining, Reclamation and Environment; The Department of Mining, Metallurgical and Materials Engineering, Universite Laval, Canada; National Technical University of Athens, Greece; University of Cagliari, Italy; Centre for Environmental Engineering Research and Education (CEERE), University of Calgary, Canada; Institute of Land Reclamation and Ecological Restoration, China University of Mining and Technology, Beijing, China; Columbia University, USA; Virginia Polytechnic Institute and State University, USA; Mining Engineering, McGill University; Imperial College London; Lulea University of Technology, Sweden; Faculty of Geoengineering, Mining and Geology, Wroclaw University of Technology, Poland; Hokkaido University, Mineral Resources Engineering Department, Japan; Polish Academy of Science, Poland, Finnish Environment Institute (SYKE), Finland; Mining Engineering Department, Istanbul University, Turkey; Edith Cowan University, Australia; Resources Engineering, Monash University, Australia; and others.

The organization and success of such a symposium are due mainly to the tireless efforts of many individuals, authors included. All members of the Organizing Committee and conference chairpersons have contributed greatly. The support of our plenary session speakers, invited speakers and co-chairs is gratefully acknowledged. In addition, recognition is accorded to my chairpersons of this symposium Dr. Asieh Hekmat, Dr. Eleonora Widzyk-Capehart and Dr. Andreina Garcia who together with their local Organizing Committee made SWEMP 2018 a success. I also wish to acknowledge the contribution of Mohini Singhal (my wife) who has been involved with SWEMP since its inception. She is a committee member of MPES/SWEMP organization and is an associate editor of the *International Journal of Mining, Reclamation and Environment*.

As the International Chair and Founder of this series of symposia, I would like to recognize the guidance and support of Rector, Prof. Ing. Petr Sklenicka, C.Sc., Czech Republic, our honorary chair. We are grateful to Dr. Patricio Aceituno, Dean, Facultad de Ciencias Fisicas y Matematicas, Universidad de Chile and Dr. Luis Moran T. Dean, Facultad de Ingenieria, Universidad de Concepcion for accepting to hold this symposium under their tutelage.

This symposium is designed to provide a forum for the presentation, discussion and debate of state-of-the-art and emerging technology in the field of environmental management. Authors from over 20 countries with backgrounds in science, technology and management representing government, industry and academia concerned with energy and mineral production have contributed to these Proceedings.

Calgary, Canada
Melbourne, Australia

Dr. Raj Singhal
Dr. Mohan Yellishetty
Chairs, International Organizing Committee

Preface



Eleonora Widzyk-Capehart



Asieh Hekmat

During most of Chile's history, from 1500 to the present, mining has been an important economic activity: sixteenth-century mining was oriented towards the exploitation of gold placer deposits using *encomienda* labour; after a period of decline in the seventeenth century, mining resurged in the eighteenth and early nineteenth centuries, this time revolving chiefly around silver and, in the first half of the twentieth century, copper mining has come to the forefront.

Chile is a global mining power. It is the largest copper producer, supplying 32% of worldwide production and the third largest producer of molybdenum. It also occupies leading positions in the processing of other minerals. Mining has been a pillar of national progress for a long time. Mining has been a leading force to power development and attract investment; it is a crucial contributor to the progress made in the quality of life the country has enjoyed in recent decades. However, mining operations have the potential to affect the environment for future generations.

To be more environmentally sustainable, mining companies worldwide are making efforts to minimize the footprint of their activities throughout the mining cycle and after the completion of their activities. In Chile, the mining industry with

the support of the Government and through the engagements with national and international scientific communities is taking significant steps towards sustainable mining by developing and integrating practices that reduce the environmental impact of mining operations. These practices include measures, such as reducing water and energy consumption, minimizing land disturbance and waste production, preventing soil, water and air pollution at mine sites, and conducting successful mine closure and reclamation activities.

In this context, the 18th International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production (SWEMP 2018) is one of the most important events of the 2018, bringing together the scientists and the industry to share experiences and the latest advances towards innovative solutions in Santiago, Chile, in November 2018.

Contributions from SWEMP 2018 discuss methods and technologies for assessing, minimizing and preventing environmental problems associated with mineral and energy production. Topics include environmental impacts of harmful emissions and spontaneous combustion, risk and environmental impact assessments of mining, management of mining and hazardous waste, waste stabilization, tailings' treatment, stabilization and design, water and effluents treatment and management, mine ventilation, and emerging monitoring and measurement technologies.

We present you with the Proceedings of SWEMP 2018, which we hope would enable the holistic reflection and the practical application of "environmental issues and waste management" towards a sustainable future.

With Best Regards and Buena Suerte,

Santiago, Chile
Concepción, Chile

Dr. Eleonora Widzyk-Capehart
Dr. Asieh Hekmat
Chairs, SWEMP 2018 Organizing Committee

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Because the History of our Mining Industry is written by all,
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Contents

Part I Emissions and Spontaneous Combustion

Comparative Evaluation of CO₂ Emissions in Europe and Turkey Using GIS	3
N. Demirel	
Industrial Wind Erosion: PM Emission from the Erodible Flat Surfaces of Tailing Basins	15
V. Dentoni, B. Grosso, G. Massacci, M. Cigagna, C. Levanti, C. Corda and F. Pinna	
Ash, Volatile Matter and Carbon Content Influence on Spontaneous Combustion Liability of Coal-Shales	29
M. Onifade and B. Genc	
Effect of the Heat Input by Dolerite Intrusions and the Propensity for Spontaneous Combustion in the Highveld Coalfields, South Africa	39
E. R. Mokone, T. Zvarivadza and F. Sengani	

Part II Risk and Environmental Impact Assessment

Mud Inflow Risk Assessment in Block Caving Operation Based on AHP Comprehensive Method	51
A. Hekmat, A. Anani, F. Tapia and I. Navia	
The Impact of Sand Mining on the Fluvial Environment: Case Study of Nzhelele River in Limpopo Province, South Africa	67
F. Sengani and T. Zvarivadza	
Evaluation of Factors Influencing Slope Instability: Case Study of the R523 Road Between Thathe Vondo and Khalvha Area in South Africa	81
F. Sengani and T. Zvarivadza	

Environmental Issues with Best Management Practices in Energy and Mineral Production	91
Gurdeep Singh	
Numerical Evaluation of Incremental Visual Impact	111
V. Dentoni, B. Grosso, G. Massacci, M. Cigagna and C. Levanti	
Possible Environmental Risks Associated with Steel Slag: A Batch Study	121
S. Biliangadi, V. N. L. Wong, M. Yellishetty, A. Kumar Dikshit and S. Majumdar	
 Part III Management of Mining and Hazardous Waste and Waste Stabilization	
Application of Fly Ash to Acidic Soil to Improve Plant Growth in Disturbed Land of Open-Cut Mining	129
A. Hamanaka, H. Yamasaki, T. Sasaoka, H. Shimada and S. Matsumoto	
An Investigation of the Geotechnical Properties of Coal Combustion By-products from Matimba Power Station in Lephalale, South Africa	139
L. Magunde, F. Sengani and T. Zvarivadza	
Environmental Management and Metal Recovery: Re-processing of Mining Waste at Montevecchio Site (SW Sardinia)	149
P. P. Manca, G. Massacci and C. Mercante	
 Part IV Mineral Processing and Tailings Treatment, Recycle, Disposal	
Universal Flotation Reagent Produced from Plant Waste	163
S. Yefremova, L. Bunchuk, Yu. Sukharnikov, E. Li, A. Niyazov, S. Shalgimbayev, Yu. Hain and A. Zharmenov	
Laboratory Studies to Examine the Effects of Adding Cement to Various Layers of a Surface Paste Tailings Storage	169
S. Tuylu, A. Bascetin and D. Adiguzel	
Numerical Modelling of Pb-Zn Mine Tailing Dam Based on Soil Stability	181
A. Bascetin, S. Tuylu, D. Adiguzel, H. Eker and E. Odabas	
In Situ Evaluation of Mechanical Properties of Phosphate Tailings for Exploring Reuse Potential: Case Study of a Phosphate Mine, South Africa	189
T. T. Mayisa, M. E. Nengovhela, F. Amponsah-Dacosta, F. Sengani and T. Zvarivadza	

Part V Water and Effluents: Treatment and Management

Assessment of Groundwater Quality: Case Study of Tshivhasa, Limpopo Province, South Africa 205

F. Sengani and T. Zvarivadza

Coke-Based Carbon Adsorbent 217

S. Yefremova, A. Kablanbekov, K. Anarbekov, L. Bunchuk, A. Terlikbayeva and A. Zharmenov

Part VI Mine Ventilation

Analysis of Ventilation System and Assessment of Hazards in the Process of Progressing Liquidation of Workings in Mine ‘S’ 227

Wacław Dziurzyński, Marek Grzywacz and Jerzy Krawczyk

Part VII Emerging Monitoring and Measurement Technologies

Data Acquisition System for Position Tracking and Human-Selected Physiological and Environmental Parameters in Underground Mine 241

P. Stefaniak, J. Wodecki, A. Michalak, A. Wyłomańska and R. Zimroz

Development of a Dust Violation Control Tool from Plant Data 249

Mustafa Erkayaoglu

Finding the Right Time to Mine: A Real Options Analysis of Landfill Mining Projects 257

M. Menegaki, D. Damigos, A. Benardos and D. Kaliampakos