# International Mine Water Association Symposium (IMWA 2022)

Reconnect

Christchurch, New Zealand 6 – 10 November 2022

## **Editors:**

James Pope Christian Wolkersdorfer Rachel Rait Dave Trumm

Hana Christenson

Karoline Wolkersdorfer

ISBN: 978-1-7138-7233-7

### Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Printed with permission by Curran Associates, Inc. (2023)

For permission requests, please contact International Mine Water Association - IMWA at the address below.

International Mine Water Association - IMWA c/o Itasca Denver, Inc. 143 Union Blvd. Suite 525 Lakewood, CO 80228 USA

Phone: +1 303 969-8033 Fax: +1 303 969-8357

Secretariat@IMWA.info

### Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA Phone: 845-758-0400

Fax: 845-758-2633

Email: curran@proceedings.com Web: www.proceedings.com

# **Table of Contents**

Abraham, Daniel Arulraj; Jin, Fei; Okeme, llemona; Sapsford, Devin	
Detection And Measurement Of Dissolved Metals In Mine Water Using Cation-Binding Resins And Field Portable XRF	1
Bamforth, Selina Mary; Satterley, Christopher	
Evaluating Manganese in Mine Water in UK Coal Authority Mine Water Schemes	7
Barroso, Ana; Valente, Teresa Maria; Horta Ribeiro Antunes, Isabel Margarida; Marinho Reis, Amélia Paula; Canovas, Carlos Ruiz	
Evaporation-dissolution Cycles In Highly Acidic Mine-influenced Waters And Their Control Over The Secondary Paragenesis Of Sulfate Salt Efflorescences	15
Blanchard, Ryan; Kofoed, Val; Green, Mitchell	
Integrity Assessment of a Tailings Storage Facility Characterized with the Willowstick Method	21
Bothe-Fiekert, Mareike; Binder, Angela; Langefeld, Oliver	
Historic Mining Infrastructure as An Opportunity for Regional Water- & Energy Supply (Harz Mountains, Germany)	27
Cairns, Stuart; Todd, Aaron Martin Lawrence; Robertson, lain; Byrne, Patrick	
Metals Removal from Acid Mine Water by Wood-Ash Amended Biochar	33
Choopani, Atefe; Ronchi, Benedicta; Declercq, Pierre-Yves; Devleeschouwer, Xavier	
Ground Deformations Related to an Old Drainage Adit in The Abandoned Coal Concession Around Saint-Vaast (Wallonia, Belgium) Analyzed Using PS-InSAR and Piezometric Wells Time Series	39
Christenson, Hana Kirsten; Skews, Rachel; Trumm, Dave; Pope, James; Newman, Nigel; Lee, Gavin; Ross, Duncan; Boyt, Charlotte	
Enhanced Passive Treatment of Sulfate and Nitrate Enriched Mine Water: Laboratory Optimisation Experiments	47
Coetzee, Henk; Cole, Patrick; Ramugondo, Sealelo	
Estimation of Mine Water Ingress Volumes for the Witwatersrand Goldfields	53
Craw, David; Rufaut, Cathy; Pillai, Dhana; Kerr, Gemma	
Rehabilitation of Extreme Chemical Substrates on Mine Sites Without Soil in a Semiarid Climate, New Zealand	59

Dale, Caroline Jane; Jogand, Henri	
A Holistic Approach to Water and Salt Management in Mining : Biological Treatment Solution to Allow Direct Discharge of Excess Water Instead of Brine Production Through Reverse Osmosis treatment	65
Devleeschouwer, Xavier; Choopani, Atefe; Declercq, Pierre-Yves	
Ground Deformations Observed for Three Decades (199–2022) above Old and Deep Coal Mines Reused for Deep Gas Storage Sites (Wallonia, Belgium) Using PS-InSAR Time-series	71
Ferrier, Ainsley Camille; Clauson, Shane	
Integrating Water Planning into Operational Mine Planning	81
Flores, Hernan; Rudolph, Tobias; Möllerherm, Stefan	
Hyperspectral Sensing To Boost Mine Waste Characterization And Water Monitoring	83
Fosso-Kankeu, Elvis; Masindi, Vhahangwele; Maree, Johannes; Mamba, Bhekie; Nkambule, Thabo	
Effective Attenuation of AMD Pollution Potential Using By-product from Municipal Wastewater Treatment	91
Gautama, Rudy Sayoga; Putri, Rara Aulia; Kusuma, Ginting Jalu; Badhurahman, Abie; Dwiki, Sendy	
Study of Mining Void Utilization Model as a Flood Control in Tropical Region	99
Gcasamba, Sisanda Prudence; Ramasenya, K.; Lekgothoane, M.; Nyale, S.M.; Vadapalli, V.R.K.; Madzivire, G.; Coetzee, Henk; Sinthumule, Eth Morokane, Molefe	el;
In situ Mine Water Treatment of Flooded Underground Mines Using Waste Concrete: A Feasibility Study	105
Gemson, Wijnand; Harck, Terry; Burgess, Ryan	
Nitrate Dynamics at Mine Sites – Broader Context, Source and Management Considerations	111
Genth, Till; Rose, Lisa Jasmin; Jasnowski-Peters, Henning; Melchers, Christian	
Bulk- and Clay-mineral Quantification in the Upper Cretaceous Emscher Formation – Evaluating a Potential Hydraulic Barrier During Mine Water Rebound in the Ruhr District	115
Gómez-Arias, Alba; Yesares, Lola; Castillo, Julio; Vermeulen, Danie; Puro Walter	:ell,
Phalaborwa Complex: from Rock Drainage Characterization to Waste Revalorization	121
Green, Ros; Chapman, John	
Critical Decisions for AMD Management	127

Haanpää, Kirsi-Marja; Picken, Päivi; Lauri, Hannu; Wichmann, Anneli; Isaksson, Linus Lejon	
Nordic Experiences in Climate Change Analysis in Modelling Mining Area Environmental Impacts	a 133
Hansen, Robert Neill	
Analysis of Shallow Groundwater Monitoring data of a Platinum Mine, Bushveld Complex, South Africa – Implications for Post-Closure	139
Hayton, Stephanie; Trumm, Dave; Horton, Travis; Pope, James; Ross, Duncan; Williams, Megan	
Passive Treatment For Elevated Iron And Arsenic In Circum-Neutral Min Affected Water	e 147
Hoekstra, David Pieter; Saavedra, Victor Munoz; Milad, Carolina	
Development of a Streamflow Model Incorporating Stochastic Daily Climate, Climate Change, and El Niño La Niña Effects	153
Huisamen, Altus; Glendinning, John Edward	
Post-Mining Hydrogeology of Underground Collieries – Effects of Hanging Wall Subsidence	161
Jasnowski-Peters, Henning; Melchers, Christian	
Natural Tracers For Mine Water Fingerprinting II – a multi tracer approach to unravel underground fluid movements during Mine Water Rebound in the Ruhr District Area	167
Kennedy, Julia	
Circular Economy Potential of Widescale Implementation of Sodium Carbonate Dosing for Circumneutral Zinc-rich Mine Water in Wales	175
Kerr, Gemma; Craw, David; Pope, James	
Dissolution Rates of Arsenic Minerals in Natural and Mining Environments, New Zealand	181
Kleinmann, Bob; Sobolewski, André; Skousen, Jeff	
The Evolving Nature of Active, Passive, and Semi-Passive Mine Water Treatment Technologies	187
Kurukulasuriya, Devmi; Howcroft, William; Meredith, Karina; Timms, Wendy	
The Conundrum of Incongruent Multiple Age Tracer Results in Mine Water	195
Kusuma, Ginting Jalu; Gautama, Rudy Sayoga; Dwiki, Sendy; Badhurahman, Abie; Abfertiawan, Muhammad Sonny	
Performance of Fly Ash and Bottom Ash as Coal Combustion Product to Prevent Acid Mine Drainage Generation: Preliminary Result on A Pilot Scale	201

Kuznetsova, Alsu; Afzal, Iram; Suri, Navreet; Kuznetsov, Petr; Siddique, Tariq	
Inhibition of Methanogenesis through Redox Processes in Oil Sands Tailings	209
Lemos, Mariana; Valente, Teresa Maria; Marinho Reis, Paula; Fonseca, Rita; Delbem, Itamar; Filho, José Gregório; Guabiroba, Fernanda;	203
Pantaleão, João; Magalhães, Marcus Geoenvironmental Characterization of Gold Mine Tailings from Minas Gerais and Goiás, Brazil	217
Ligavha-Mbelengwa, Lufuno; Madzivire, Godfrey; Nolakana, Pamela; Coetzee, Henk; Gomo, Modreck	
Potential Use Of Emerging Organic Contaminants As Pollution Source Tracers	223
Lukas, Eelco; Vermeulen, Danie; Gomez Arias, Alba	
Recharge Flooding	229
Lusunzi, Rudzani; Wandeers, Frans	
Speciation of Metals in Sediments of the Sabie River System by Sequential Extraction	237
Madzivire, Godfrey; Ligavha-Mbelengwa, Lufuno; Nolakana, Pamela; Coetzee, Henk	
Evaluation Of The Changes In Mine Water Quality In The Witwatersrand Basin: Basis For Proactive Long-term Solution	243
McCullough, Cherie; O'Grady, Ben	
Closure Of An Australian Pit Lake With AMD Using A Terminal Water Balance As An Evaporative Sink	247
McLachlan, Christine Jane; Walker, Barry	
Determination of acid producing potential using pXRF: A case study from Cypress Mine, Stockton Plateau	253
Molaba, Leshego Esther; Wolkersdorfer, Christian	
Investigating the Effects of Temperature on Density Stratification in a flooded Analogue Model Mine	259
Moreno, Raul; Olias, Manuel; Ruiz Cánovas, Carlos; Macias, Francisco	
Update Of Hydrological Study And Prediction Of Flood Levels Of Acidic Pit Lakes (Tharsis) mines, Spain	267
Mosai, Alseno; Richards, Heidi; Tutu, Hlanganani	
Modelling The Transport Of Pollutants From Mine Dump And Landfill Sites To Groundwater And Surface Water	273

Mothetha, Matome; Msagati, Titus; Masindi, Vhahangwele; Kebede	, Kefeni
Application of Pulverized Kaolin Clay for Remediation of Acid Mine Drainage	281
Mphahlele, Malehlogonolo Ramogohlo Rosemary; Kotzé, Izak Alder Mosai, Alseno Kagiso; Tutu, Hlanganani	t;
Recovery Of Pt And Pd From Aqueous Solutions By N,N-di(trimethoxysilylpropyl)-N'-benzoylthiourea Modified Silica Gel	291
Muedi, Khathutshelo Lilith; Masindi, Vhahangwele; Maree, Jannie; Hendrik Gideon	Brink,
Rapid Removal of Cr(VI) from Aqueous Solution Using Polycationic/di-metallic Adsorbent Synthesized Using Fe <sup>3+</sup> /Al <sup>3+</sup> Recovered from Real Acid Mine Drainage	299
Mugova, Elke; Wolkersdorfer, Christian	
Insights into the First Flush Effect – The Flooded Underground Mine a Chemical Reactor	as a 305
Mulliner, Tim; McLachlan, Christine	
Oxidation Modelling to Optimise Waste Rock Storage	311
Murray, Jodi; Walker, Barry	
Stockton Coal Mine. Management of AMD Sludge	317
Navarro, Leo; Hayton, Stephanie; Williams, Megan; Weber, Paul	
Globe Progress Lake – Closure performance monitoring and adaptive management	e 323
Netshitungulwana, Khashane Robert Tshishonga; Gauert, Christop Vermeulen, Danie; Yibas, Bisrat; Shai, Mateo; Lusunzi, Rudzani	h;
Geochemical Characterisation of the Witbank Coalfield Geological Strand Assessment of Potential Metal Impact on the Receiving Environn	
Nigéus, Susanne Pia Teresia; Maurice, Christian; Lindblom, Jenny	
Water Retention Capacity As a Measure to Evaluate the Effectiveness a Green Liquor Dregs-amended Till to Cover Sulfidic Mine Waste	of 337
Nkele, Kgolofelo Masegare; Mpenyana-Monyatsi, Lizzy; Masindi, Vhahangwele	
Effective Removal Of Manganese From Mine Effluent Contaminated River Water Using Ca-Mg-(OH) <sub>2</sub> Nanocomposite	345
Nolakana, Pamela; Ligavha-Mbelengwa, Lufuno; Madzivire, Godfre Coetzee, Henk	y;
Evaluation Of The Water Quality Impacts Associated With Relaxation Environmental Critical Levels: A Case Study In The West Rand Basin, South Africa	Of 353

Nordstrom, D. Kirk; Campbell, Kate M.; Alpers, Charles N.	
Quantifying Mineral Precipitation Processes during Dilution, Mixing, and Neutralization of Acid Rock Drainage	359
Oldham, Carolyn; Singh, Ana Catarina; Kanse, Lisette; Bourgault, Chant	al
Developing The Business Case For Responsible Acid And Metalliferous Drainage (AMD) Management	365
Parhi, Pradeep Kumar; Rao, M. S.; Asnani, C. K.	
Groundwater Hydrology Studies around a Carbonate Hosted Flatly Dipping Uranium Deposit and Environmental Management	373
Paulsson, Oscar; Widerlund, Anders	
Geochemical Loading Rates from Open Pit Walls at the Åkerberg and Laver Mine Sites in Relation to Pit Lake Water Quality	379
Potgieter, Gerhard; Jacobs, Karin; Cason, Errol; DeFlaun, Mary; van Heerden, Estariëthe	
Optimizing Denitrification Efficiencies at Low-Temperature Conditions for the Enhancement of Site-Specific Bioremediations Solutions	385
Primo Doncel, Maria de la Paloma; Möllerherm, Stefan; Rudolph, Tobias Goerke-Mallet, Peter	5;
PostMinQuake: Diagnosis Of Post-Mining Induced Seismicity In Former European Hard Coal Basins	393
Ramugondo, Selaelo Jacquelene; Molapo, Donald; Coetzee, Henk; Tegeg Kefyalew	n,
The effectiveness of upgrading the Van Ryn Canal as an option to reduce water ingress into the underground mine workings in the East Rand of the Witwatersrand Basin in Gauteng Province, South Africa	397
Robinson, James; Dodd, Jason; Andrews, Ian; Milton Thompson, Olivia	
Successful Construction of a Full Scale Passive Sulfate Treatment System	403
Romero Matos, Jonatan; Ruiz Cánovas, Carlos; Macías Suáres, Francisco León Cortegano, Rafalen; Millán Becerro, Ricardo	);
Wildfire Effects On A Watercourse Affected By Acid Mine Drainage (Odiel River, SW Spain)	411
Rose, Lisa Jasmin; Genth, Till; Jasnowski-Peters, Henning; Melchers, Christian	
First Petrophysical Data Compilation on the Effectiveness of an Extensive Hydraulic Barrier During Mine Water Rebound in the Ruhr District – the Upper Cretaceous Emscher Formation	417
Rufaut, Cathy; Craw, David; Weightman, Erin; Pillai, Dhana; Lee, Gavin	
The Macraes Gold Mine Irrigation Project, New Zealand	421

Ruiz Cánovas, Carlos	
Towards a Sustainable Restorarion of a Watershed Strongly Polluted & Acid Mine Drainage (AMD): the Case of the Odiel River (SW Spain)	oy 427
Ryanta, Albert; Saputra, Muhammad Nur Wangsa; Senduk, Marco; Anggoro, Dhoni; Husodo, Ibnu	
Successful Installation of Indonesia's First Dual ESP System for Dewatering Applications	433
Sartz, Lotta; Bäckström, Mattias	
Mesocosm Experiments Performed in 1975, 1993 and 2017 to Determ Changes in Release Rates of Zinc from Sediments Affected by an Old Mining Operation	nine 439
Saxby, Tim; Buckley, Sarah	
Central Region Water Resilience Project - Sustaining production in a changing climate	445
Schmidt, Nadja; Eulenberger, Sven; Jenk, Ulf	
Final Flooding of the Königstein Uranium Mine – Supporting Activities and Implications for Monitoring	453
Shabalala, Ayanda Nomaswazi	
Comparative Study Of Leaching of Metals From Pervious Concrete Incorporating Coal Fly Ash And Ground-granulated Blast-furnace Slag	459
Simcock, Robyn	
Mediating Risk of Acid Generation – The Roles of Vegetation Direct Transfer	467
Sinclair, Eden; Weber, Paul	
Managing Legacy AMD to Achive Sucessful Mine Closure	469
Stanley, Peter Clive; Thorn, Peter; Williams, Tom; Siddorn, Louise; Co Dave	ooke,
A River System Approach to Mine Water Mitigation and Management	483
Szczepiński, Jacek	
Impact of Dewatering of the Planned Lignite Open Pit in Poland on the Water Environment on the Basis of Groundwater Flow Model	491
Todd, Aaron Martin Lawrence; Robertson, Iain; Walsh, Rory P.D.; By Patrick; Edwards, Paul; Williams, Tom	rne,
Using Tracer Injection and Synoptic Sampling, and Salt Dilution Flow to Gauge Metal Fluxes in a Temperate Watershed in the UK	o 497
Totsche, Oliver; Kunze, Katja	
Rehabilitation of the Lusatian Water Balance, in Consideration of Climate Change and the End of Lignite Mining	503

Trumm, Dave; Moynihan, Eamon; Young, Jill; Pope, James	
Passive Treatment Of AMD Using a Full-Scale Upflow Mussel Shell Reactor, Echo Coal Mine, New Zealand	511
Tuck, Jeff; Hayton, Stephanie; Hartwell, Sioban	
Predictive Water Balance and Mass Load Modelling for Mine Water Through a Passive Treatment System	517
Tuheteru, Edy Jamal; Kusuma, Ginting Jalu; Gautama, Rudy Sayoga; Pranoto, Kris; Palinggi, Josef	
Comparison of Pit Wall Leaching Test in the Field and Laboratory	519
Vadapalli, Viswanath Ravi Kumar; Coetzee, Henk; Gcasamba, Sisanda; Ramasenya, Koena; Ntholi, Thakane; Nyale, Sammy; Sinthumule, Etl Morokane, Molefe	nel;
Integrated and Sustainable Mine Water Management Solution for Witwatersrand Gold Fields	529
Vaezihir, Abdorreza; Mahjoubi, Reza; Aghili, Somayeh; Mazaheri, Nader Haji Ahmadi, Morteza	;
The Role of Natural Attenuation in Decrease of Metal Concentration in a River Polluted by AMD Released from Sungun Mine (NW of Iran)	535
Walter, Stefanie; Mugova, Elke; Wolkersdorfer, Christian	
Public Opinion on Mine Water in Three Former German Hard Coal Mining Regions	541
Walton-Day, Katherine; Gusek, James; Newman, Connor	
Opportunities to Improve Water Quality during Abandoned Mine-Tunnel Reclamation	545
Wang, Jiaqi; Zhang, Qiang; Wang, Yunbo; Gao, Difa	
Detection and Sealing Technology of River-goaf Water Supply Channel and Their Application	553