

APCOM 2021  
**MINERALS  
 INDUSTRY 4.0**  
 The next digital  
 transformation  
 in mining  
 29 AUGUST - 2 SEPTEMBER 2021

## ABSTRACTS RECEIVED

### Keynote Address

W. Assibey-Bonsu, *Goldfields, Australia*

### Keynote Address

T. Mkhwanazi, *Kumba Iron Ore, South Africa*

### Keynote Address

A. Lane, *Deloitte, South Africa*

### Keynote Address

L. Machado, *Visagio, Brazil*

### Keynote Address

E. Topal, *Curtain University, Australia*

### Value-add insights into technology adoption and implementation in mine planning and operational execution at Kumba Iron Ore mines

T. Otto, *Anglo American, South Africa*

### The use of multi-point statistics at Tasiast Gold mine

B Poupeau<sup>1</sup> and Jean-Marc Chautru<sup>2</sup>

<sup>1</sup>Kinross Gold Corporation, South Africa and <sup>2</sup>Geovariances, France

### Optimization of pit to sag mill network using mixed integer linear programming

N. Luan Mai, Z. Saw, and C. Poveda, *Visagio, Australia*

### Development of a pragmatic IT concept for a construction contractor in Poland

K Böde<sup>1</sup> and A. Różycka<sup>2</sup>, <sup>1</sup>HOCHTIEF Polska and <sup>2</sup>Warsaw University of Technology, Poland

### Automated probabilistic domain assignment to production blast hole assays

K. Silversides and A. Melkumyan, *The University of Sydney, Australia*

### A comparison of mining cut definition and scheduling algorithms for the open-pit short-term mine planning

G. Nelis and N. Morales, *University of Chile, Chile*

### Better predict the dynamics of geometry of in-pit stockpiles using geospatial data and polygon models

M. Balamurali and K.M. Seiler, *University of Sydney, Australia*

### Conditional bias in resources estimation: A simple guide for practitioners

M.E. Rossi<sup>1</sup> and C. Badenhurst<sup>2</sup>, <sup>1</sup>GeoSystems International, Inc., USA and <sup>2</sup>SIMEC Mining, Australia

### Measuring the spatial sampling density of a deposit for mineral resources classification

M.C. Febvey<sup>1</sup>, J Rivoirard<sup>2</sup>, and B Martin<sup>1</sup>, <sup>1</sup>Geovariances, and <sup>2</sup>MINES ParisTech, France

### Mineral resource modeling of variables with inequality constraint: a case study from an iron ore deposit

S. Abulkhair and N. Madani, *Nazarbayev University, Kazakhstan*

### Haul road mapping from GPS traces in surface mining

K.M. Seiler, *Australian Centre for Field Robotics, University of Sydney, Australia*

### Development of a polynomial multivariate regression analysis (PMVRA) method for *in-situ* metal grade prediction using sedimentological and chemical assay data

\*L.C.K. Tolmay<sup>1</sup> and G.T. Nwaila<sup>2</sup>, <sup>1</sup>Tolmay Enterprises, South Africa and <sup>2</sup>University of the Witwatersrand, South Africa

### Optimization of a polynomial multivariate regression model for *in-situ* metal grade prediction

\*L.C.K. Tolmay<sup>1</sup> and G.T. Nwaila<sup>2</sup>, <sup>1</sup>Tolmay Enterprises, and <sup>2</sup>University of the Witwatersrand, South Africa

### Utilizing an alternative method for deriving Kriging variances

L.C.K. Tolmay, *Tolmay Enterprises, South Africa*

### Identification of loading processes based on IMU data

H. Aguirre-Jofré a, M. Eyre a, and D. Vogt, *Camborne School of Mines, University of Exeter, United Kingdom*

### Boosting mining production by improving truck and shovel position monitoring using low-cost IoT

H. Aguirre-Jofré a, M. Eyre a, and D. Vogt, *Camborne School of Mines, University of Exeter, United Kingdom*

### Risk and reward-based schedule optimization for underground mining

A. Loubser<sup>1</sup>, R. Luies<sup>2</sup>, S.E. Terblanche<sup>2</sup> and M. Woodhall<sup>1</sup>  
<sup>1</sup>MineRP Holdings Pty Ltd, and <sup>2</sup>Elytica, Pty Ltd, South Africa

### Application of regression polynomial theory to the determination of optimum depth and final limits between open pit and underground deep mine projects

G. Mukalay<sup>1</sup>, N. Biyukaleza<sup>2</sup>, M Mutatshi Bruno<sup>2</sup>, <sup>1</sup>SOMIKA Company, and <sup>2</sup>University of Lubumbashi, DR Congo

### Approach for calculation of maximum widths of catch or safety berms or benches introduced at different depths of deep open pit mine projects

G. Mukalay, *SOMIKA Company, DR Congo*

### Trucks cycle optimization in open pit coal mining using integrated dispatching system data with queue theory adoption

O.A. Putri and S. Andika, and Sukrisno, *PT. Pamapersada Nusantara, Indonesia*

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### **Automated road damage detection and maintenance system at open pit coal mining environment**

M.R. Pratama and F.M. Ramadhan, *and* Sukrisno, *PT. Pampersada Nusantara, Indonesia*

### **Conditions under which an integrated approach to the transition mine problem outperforms a disintegrated approach**

A. Anani<sup>1</sup>, H. Li<sup>2</sup>, and I.O. Flores<sup>1</sup>, <sup>1</sup>*Pontificia Universidad Catolica de Chile, Chile* and <sup>2</sup>*University of Missouri–St. Louis, USA*

### **Autonomous inspection of a belt conveyor in a deep mine with the use of a legged robot**

A. Skoczylas, P. Stefaniak, S. Anufriiev, B. Jachnik, and M. Stachowiak, *KGHM CUPRUM Ltd, Poland*

### **Multidimensional failure analysis using text mining and machine learning tools**

M. Stachowiak, W. Koperska, A. Skoczylas, P. Stefaniak, and P. Śliwiński, *KGHM CUPRUM Ltd, Poland*

### **Potential application possibilities of inertial measurements on the LHD in an underground mine**

P. Stefaniak, B. Jachnik, A. Skoczylas, and S. Anufriiev *KGHM CUPRUM Ltd, Poland*

### **Advanced monitoring system for vibrating screen for sieving process in mineral processing plant**

S. Anufriiev, N. Duda, W. Koperska, and P. Stefaniak *KGHM CUPRUM Ltd, Poland*

### **Advanced LHD motion path tracking procedures based on inertial data**

A. Skoczylas, B. Jachnik, and P. Stefaniak, *KGHM CUPRUM Ltd, Poland*

### **Multidimensional analysis of energy efficiency for ventilation and air-conditioning processes based on data from industrial automation in underground mine**

B. Jachnik, P. Stefaniak, N. Duda, and P. Śliwiński, *KGHM CUPRUM Ltd, Poland*

### **The Tailings Storage Facility (TSF) stability monitoring system using advanced big data analytics on the example of the Żelazny Most Facility**

B. Bursa, W. Tymiński, B. Jachnik, S. Anufriiev, P. Stefaniak, and P. Stefanek, *KGHM CUPRUM Ltd, Poland*

### **Explosive energy distribution optimization to accommodate drilling errors by adjusting blasthole charges**

S. Klerk<sup>1</sup>, J. Sattarvand<sup>2</sup>, and M.S. Shishvan<sup>1</sup>, <sup>1</sup>*Delft University of Technology, The Netherlands* and <sup>2</sup>*University of Nevada, USA*

### **Development of a new smart evacuation modelling technique for underground mines using Mathematical Programming**

R. Meijl, J. Sattarv<sup>2</sup>, and M.S. Shishvan<sup>1</sup>, <sup>1</sup>*Delft University of Technology, The Netherlands* and <sup>2</sup>*University of Nevada, USA*

### **Implicit modelling of geological domains by support vector classifier: Tuning the parameters based on consistency of the indicator variogram**

I. Ongarbayev and N. Madani, *Nazarbayev University, Kazakhstan*

### **Prediction of comminution and recovery parameters based upon ore fingerprints constructed by geochemical and mineralogical data clustering**

J. R. van Duijvenbode<sup>1</sup>, L. Cloete<sup>2</sup>, M. S. Shishvan<sup>1</sup>, and M.W.N. Buxton<sup>1</sup>, <sup>1</sup>*Delft University of Technology, The Netherlands*, <sup>2</sup>*AngloGold Ashanti South Africa*

### **Big data and IoT platform architecture design for the mining industry**

*Poland*

### **Acquiring, collecting and making decisions based on real data from IoT devices - an architecture proposal**

*Poland*

### **How to carry out the data analysis process using an analytical platform - an example of use**

*Poland*

### **A deep learning approach for automation of joint sets recognition on 3D point clouds of rock mass surfaces**

R. Battulwar, E.E. Gohari, M. Zare, and J. Sattarvand *The University of Nevada, USA*

### **Tailings dam surface erosion monitoring using image processing and Artificial Intelligence (AI)**

F. Nasategay, E.E. Gohari, M. Zare, and J. Sattarvand *The University of Nevada, USA*

### **Support vector machines and convolutional neural networks applied to blasthole dislocation detection in open pit mines**

J.V. Lopez, E.E. Gohari, and J. Sattarvand, *The University of Nevada, USA*

### **Investigation of the effect of smart underground mine evacuation technologies in virtual reality simulations**

S.J. Gaab and J. Sattarvand, *The University of Nevada, USA*

### **Design and manufacturing of a virtual reality-assisted teleoperated excavator platform**

M. Salimov and J. Sattarvand, *The University of Nevada, USA*

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### Three-dimensional simulation of rockfall trajectory in open-pit mines

B. Peik, E.E. Gohari, M. Zare, B Abbasi, and J. Sattarvand  
*The University of Nevada, USA*

### Application of direct sampling multiple-point statistics algorithm for stochastic resource and reserve estimation under grade uncertainty for a paleoplacer gold deposit

M.I. Mabala, *The University of the Witwatersrand, South Africa*

### Short-term mine production scheduling in open-pit mines considering blending in stockpiles and ore processing plant

D. Mariño and F. Manríquez, *University of Chile, Chile*

### Combining optimization and simulation of short-term mine production scheduling in open-pit mines to generate schedules with high adherence

L. Navea, F. Manríquez, H. González, and N. Morales, *University of Chile, Chile*

### Short-term open-pit mine production scheduling optimizing multiple objectives accounting for truck fleet allocation to shovels

F. Vargas and F. Manríquez, *University of Chile, Chile*

### Modelling of covid-19 transmission in relation to aerosol transport and virus exposure in an underground mining environment using computational fluid dynamics

N.C. Dhlamini, M.A. Mahboob, and F.T. Cawood, *University of the Witwatersrand, South Africa*

### A hybrid method of meta-heuristic algorithm and lagrangian relaxation for the long-term production schedule problem at the open-pit mining

K. Tolouei and E. Moosavi, *Islamic Azad University, Iran*

### An adaptive hybrid approach: combining meta-heuristic algorithm and lagrangian relaxation approach for the open-pit mine's long-term production scheduling problem

K. Tolouei and E. Moosavi, *Islamic Azad University, Iran*

### 3D modeling for mineral resource estimation of the Darreh-Zereshk copper deposit using the indicator kriging approach

Z. Bagheri<sup>1</sup> and E. Moosavi<sup>2</sup>, <sup>1</sup>*Isfahan University of Technology*, and <sup>2</sup>*Islamic Azad University, Iran*

### A genetic algorithm model for optimizing long-term open-pit mine production scheduling

P.M. Muke<sup>1,2</sup>, A.S Nhleko<sup>2</sup> and C Musingwini<sup>2</sup>, *Institut Supérieur des Techniques Appliquées, Democratic Republic of Congo*<sup>1</sup> and <sup>2</sup>*University of the Witwatersrand, South Africa*

### A dual interchange algorithm (DIA) for global optimization of production schedules in open-pit mine planning

R.A. Phillips, M.M. Ali, and C. Musingwini, *University of the Witwatersrand, South Africa*

### Self-learning infill drilling for strategic mine planning: Simultaneously optimizing the value of additional information in a mining complex under grade uncertainty

Z. Levinson and R. Dimitrakopoulos, *COSMO Stochastic Mine Planning Laboratory, Canada*

### Underground mining network optimization

S. Li, Z Shao, M. Balci, and M. Kumral *McGill University, Canada*

### Spatial clustering as an aid to optimize infill drill holes configuration during exploration campaigns

S. Hmoud and M. Kumral, *McGill University, Canada*

### Towards a wholistic approach to sustainable mine development and safety management

E. Abou-Jaoude and M. Kumral, *McGill University, Canada*

### Data science applied to silicomanganese plant data to identify valuable relationships

B. Hattings<sup>1,2</sup>, P. van Vuuren<sup>2</sup>, A. Alberts<sup>2</sup>, J. Steenkamp<sup>1,3</sup>, and Q. Reynolds<sup>1,4</sup>, <sup>1</sup>*Mintek*, <sup>2</sup>*North-West University*, <sup>3</sup>*University of the Witwatersrand*, and <sup>4</sup>*Stellenbosch University, South Africa*

### Prediction equation for the direct estimation of sigma heat in underground heat transfer processes

A. Pandey and S. Sastry, *Indian Institute of Technology, India*

### Processing and characterization of CNTs reinforced copper nanocomposites for underground mining applications

S. Mishraa, K. Das, S. Das, *Indian Institute of Technology, India*

### Fine chromite processing: unlocking additional value and environmental benefits

K. Shame-Letsoaloa, *Mintek, South Africa*

### Short interval management system – SIMS

N. Pretorius, *Cyest IMS, South Africa*

### Smart Equipment Allocation Decisions and Short-Term Stochastic Production Planning Updating in Mining Complexes through Reinforcement Learning

J. Pedro de Carvalho and R. Dimitrakopoulos, *McGill University, Canada*

### Mining in Jupyter

N. Morales, E. Jélvez, G. Díaz, and F. Soto, *University of Chile, Chile*

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### Efficient stochastic mixed integer linear programming framework for integrated mine planning and waste management

S. Yaw Amponsah, O. Mbadozie, P. Matthias Takouda, and E. Ben-Awuah, *Laurentian University, Canada*

### Genetic algorithm for mining-related stochastic optimization problems

S. Yaw Amponsah, P.P.M. Takouda, and E. Ben-Awuah, *Laurentian University, Canada*

### Optimizing the ramp design in an open pit mine

I. Kaabachi<sup>1</sup>, F. Meunier<sup>1</sup>, and N. Morales<sup>2</sup>, <sup>1</sup>*Universit Paris and* <sup>2</sup>*Universidad de Chile, France, Chile*

### Short- and medium-term planning of underground mining operations

O.V. Nagovitsyn, S.V. Lukichev, and V.V. Laptev, *Mining Institute of Kola Science centre of Russian academy of science, Russia*

### Simulation of autonomous intelligent supervisor for continuous mining systems

P. Pablo Vasquez-Coronado, S. Acheampong, A. Maremi, and E. Ben-Awuah, *Laurentian University, Canada*

### Advanced process control for coal flotation: A case study of the approach and benefits of a structured digitalization program

P. Rambalee<sup>1</sup>, N. Pillay<sup>1</sup>, T. Bohmer<sup>1</sup>, L. Auret<sup>2</sup>, A. Haasbroek<sup>2</sup> and Z. Horn<sup>2</sup>, <sup>1</sup>*Anglo American and* <sup>2</sup>*Stone Three, South Africa*

### Hybrid modelling of industrial flotation circuits with causal models and machine learning

J.T. McCoy<sup>1</sup>, L. Auret<sup>1</sup>, and A.C. Steyn<sup>2</sup>, <sup>1</sup>*Stone Three and* <sup>2</sup>*Anglo American, South Africa*

### Application of system dynamics principles to surface mining problems

S. Uludag and L. Pretorius, *University of Pretoria*

### Evaluation of In-Pit Crushing and Conveying (IPCC) systems productivity in a limestone mine

D. Wachira and J. Githiria  
*Taita Taveta University*

### Prediction and measurement of blast induced rock fragmentation-A case study of Kajiado County Quarries-Kenya

M.E. Kiamba<sup>1</sup>, B.O. Alunda<sup>1</sup>, D.K. Maina<sup>1</sup>, and K R Muthua<sup>2</sup>  
<sup>1</sup>*Taita Taveta University and* <sup>2</sup>*Wuhan University of Technology, Kenya and China*

### Digital twin for surface mining value chain: Integrated simulation and optimization of mining operation

A. Moradi-Afrapoli and H. Askari-Nasab  
*University of Alberta, Canada*

### Production and supply chain transformation into industry 4.0

S.D. Dessureault<sup>1</sup> and M Kahraman<sup>2</sup>  
<sup>1</sup>*The Mosaic Company, USA, and* <sup>2</sup>*Gumushane University, Turkey*

### Uncertainty estimates for geomtallurgical models

M.E. Rossi, *GeoSystems International, Inc., USA*

### Mitigating the influence of outliers on kriging estimation

D. Fourie<sup>1</sup>, C. Morgan<sup>1</sup>, R.C.A. Minnitt<sup>2</sup>  
<sup>1</sup>*Harmony Gold Mining Company Limited and* <sup>2</sup>*University of the Witwatersrand, South Africa*

### The grouping and segregation error in particular materials

R.C.A. Minnitt, *University of the Witwatersrand, South Africa*

### Modelling a complex gold mineralization environment with multiple-point statistical simulation

Y. van der Grijp, *AngloGold Ashanti South Africa*

### Two-stage mine planner for simultaneous drill, blast and dig scheduling

A. Qadir, *The University of Sydney, Australia*

### Optimal Slope: a software determining optimal pitwall profiles which maximise mining financial returns while minimizing carbon footprint

S. Utili<sup>1</sup>, A. Agosti<sup>1</sup>, and N. Morales<sup>2</sup>, <sup>1</sup>*Newcastle University, United Kingdom and* <sup>2</sup>*University of Chile, Chile*