### Support Design—Ballroom East

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>13:30–13:45</td>
<td>Support method for underground engineering in hard rock with high geostress: a case study of the Baitihan hydropower project, China</td>
</tr>
<tr>
<td>14:00–14:15</td>
<td>Support design for tunnels with deep overburden in weak rock</td>
</tr>
<tr>
<td>14:15–14:30</td>
<td>Stable span re-design and support optimization for a shallow hard-rock bord-and-pillar mine on the Great Dyke: the case of Unki Mine, Zimbabwe</td>
</tr>
</tbody>
</table>

### Seismicity—Meeting Room 2.41–2.46

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>13:30–13:45</td>
<td>Relating seismic source mechanisms to damage phenomena in platinum mines of the western Bushveld Complex</td>
</tr>
<tr>
<td>13:45–14:00</td>
<td>Observational studies in South African mines to mitigate seismic risks: challenges and achievements</td>
</tr>
<tr>
<td>14:00–14:15</td>
<td>Microseismic events for slope stability analysis—a case study at an open pit mine</td>
</tr>
<tr>
<td>14:15–14:30</td>
<td>Investigations of rockburst propensity of artificial samples containing different aggregates</td>
</tr>
<tr>
<td>14:30–14:50</td>
<td>Examination of potential rock edge controlled rockfalls using non-linear bond-slip behaviour</td>
</tr>
</tbody>
</table>

### Surface Mining Slope Stability—Ballroom East

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>16:00–16:15</td>
<td>Slope design considerations for shallow open pit mines: a case study at Matamawan Mine, Northern Cape Province, South Africa</td>
</tr>
<tr>
<td>16:15–16:30</td>
<td>Identification of potential rock wedge controlled rockfalls using ground-based LIDAR techniques: a case study in Eastern Taiwan</td>
</tr>
<tr>
<td>16:30–16:45</td>
<td>Optimization of slope design in Kansanshi Mine</td>
</tr>
<tr>
<td>16:45–17:00</td>
<td>Techniques for measuring three-dimensional displacement vector using ground-based interferometric synthetic aperture radar</td>
</tr>
<tr>
<td>17:00–17:15</td>
<td>Ottoko gold mine—a case study in pit slope design</td>
</tr>
</tbody>
</table>

### Seismicity (continued)—Meeting Room 2.41–2.46

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:45–16:00</td>
<td>Location and source mechanism of a microseismic event in a mine using a single seismogram</td>
</tr>
<tr>
<td>16:00–16:15</td>
<td>Calibration of modelled seismicity in South African mines using a potency-based method</td>
</tr>
<tr>
<td>16:15–16:30</td>
<td>Technology transfer for minimizing seismic risk in South Africa's platinum mines, F. Essrich, J.W.L. Hanekom, and J. Bower</td>
</tr>
</tbody>
</table>

### Microseismic Monitoring and Stability Analysis

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>16:45–17:00</td>
<td>Microseismic monitoring, warning and mitigation of rockburst in the deep tunnels of NEELUM-JHELUM Hydroelectric project, Pakistan</td>
</tr>
</tbody>
</table>

### ISRM Advisory Forum—Meeting Room 1.43 and 1.44

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>17:00–17:30</td>
<td>ISRM Advisory Forum—an open discussion on current issues in rock mechanics and seismology</td>
</tr>
</tbody>
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Franklin Lecture — Numerical modelling of tabular excavations: Old problems and new solutions

Mid Morning Refreshments

Keynote Session: Rock engineering as a creator of value

Keynote Session: Lessons learned from large failures: multiple causes include adverse design, geology, and support

High performance dynamic rupture and rockburst hazard potential in deep tunnelling

M.S. Diederichs, Queen's University, Canada

Sponsor Presentation—New Concept Mining

Lunch
UNDERGROUND MINING—BALLROOM EAST

09:35–09:50
An empirical and numerical approach to quantifying raise bore-hole stability
Y. Rajpal* and J.W.L. Hanekom†,
*Middlit Consulting (Pty) Ltd, South Africa, University of Pretoria, South Africa
09:50–10:05
Reassessing continuous stope closure data using a limit equilibrium displacement discontinuity model
Kirk Madison and J.A.L. Napier, University of Pretoria, South Africa
10:05–10:20
Rockburst prevention via destress blasting of roof competent rocks in hard coal longwall mining
P. Koncin‡ and J. Schreiber*, "Institute of Geonics of the Czech Academy of Sciences, Czech Republic, †GreenGas, Inc., Czech Republic
10:20–10:35
A study of multi-reef pillar extraction in the Ventersdorp Contact Reef
J.C. Ederhuyse and D.F. Malan†, "SibanyeGold, South Africa, †University of the Witwatersrand, South Africa

INVESTIGATION TECHNOLOGY—MEETING ROOM 2.41–2.46

09:35–09:50
The determination of crustal stress orientation based on the borehole geometric shape using panaromic stereopair imaging technology
C. Wang, X. Zou, and Z. Han, Chinese Academy of Sciences, China
09:50–10:05
The sub-surface profiler: a giant leap for ground penetrating radar
A. Pienaar, Reutech Mining, South Africa
10:05–10:20
Rock failure modes under uniaxial compression and indirect tension
A. Basu, Indian Institute of Technology India
10:20–10:35
Innovative technologies for monitoring underground excavations during construction and operational
A. Carri, L. Chiapponi, R. Savi, and A. Segalin, University of Parma, Italy
10:35–10:50
An acoustic approach to the estimation of rock mass state and prediction of induced seismicity parameters: theory, laboratory experiments, and case study
L.A. Nazarova, L.A. Nazarov, V.L. Shkuratnik, M.I. Protasov, and P.V. Nikolenko, Russian Academy of Science, Russia
10:50–11:05
Experimental studies of variably saturated flow from a horizontal discontinuity to the vertical with and without an intersection
B.F. Jones, L.B. Brouwers†, M.A. Dippenaar*, and J. Louis Van Rooy†
†GG&E Consulting (Pty) Ltd, South Africa, †Fugro Middle East, United Arab Emirates, Dubai, †University of Pretoria, South Africa
11:05–11:20
Design of an in situ testing device for the backfill of mechanized driven tunnels in hard rock
M. Lagger, M.R. Henzinger, and W. Schubert, Graz University of Technology, Austria
11:20–11:35
Analytical and experimental investigation of the hard rock indentation process
S. Souissi and E. Hamdi, Université de Tunis El Manar, Tunisia
11:35–11:50
Characterizing microtremor signals of a slope with deep-seated gravitational deformation
Y.C. Chiu, P.C. Lo, T.T. Wang, National Taiwan University of Technology, Taiwan
11:50–12:05
Progress of brittle micro-fracturing in crystalline rocks under cyclic loading conditions
E. Ghazvinian* and M.S. Diederichs
†University of Parm a, Italy
12:05–12:20
InSAR monitoring for mines: an integrated approach
D. Colombo*, F. Bellotti*, P. Farina*, A. Jonson*, †University of Parm a, Italy
†SibanyeGold, South Africa, †Queen’s University, Canada
12:20–13:20
Lunch

TUNNELS AND CAVERNS—BALLROOM EAST

13.00–13.15
Microseismicity-based feedback analysis of the stability of deep underground caverns at the Houziyan hydropower station, China
B. Li*, Z. Zhou†, C. Shah‡, N. Xu, and F. Dai†, "College of Water Resources and Hydropower, Sichuan University, China, †Powerchina Chengdu Engineer- ing Corporation Limited, P.R. China
13.15–13.30
Dam foundation curtain grouting management based on 3D geological model and monitoring system
K. Fan*, Y. Wang*, Q. Fan*, Bingyu Ren, "China Three Gorges Corporation, China, †Tianjin University, China
13.30–13.45
Cautious blast design and practice in close proximity to a railway tunnel and residential buildings
H.A. Bliqin†, Y. Dagaasari†, and B. Uurturk*, "Middle East Technical University, Turkey, †Curtin University, Australia, †Polyval Energy Coal Mine, Turkey
13.45–14.00
Issues related to the long-term stability of unlined water tunnels of Norwegian Hydropower – a review of a case
K.K. Panthi, Norwegian University of Science and Technology (NTNU), Norway
14.00–14.15
Failure mechanism of karst cave wall during tunneling
J. Wang†, Y. Deng*, L. Liu†, L. Ribo Wu, X. Liu†, and W. Liu†, "Tongji University, China, University of Mining & Technology, China, †State Key Laboratory for Geo Mechanics and Deep Underground Engineering, China, †Key Laboratory of Geotechnical and Underground Engineering of Ministry of Education, China
14.15–14.30
Afternoon Refreshments
14.30–14.45
Geotechnical design refinement in parallel with construction - Boschkop Abstraction Works, South Africa
A.T. Morgan, Geotechnical Engineers, Geod Geotechnical Engineers, South Africa
14.45–15.00
Slope stabilization and rock support at Metolong Dam, Lesotho
A.S. Sifhoho and M. Wainstein, Grieb Consulting Engineers Pty Ltd, South Africa
15.00–15.15
Feedback analysis and real-time supporting method for large underground hydraulic caverns under high geo-stress condition: A case study of Chinese Baitelan underground powerhouse
Q. Fan*, Q. Jiang‡*, and X. Duan*, "China Three Gorges Corporation, China, †Institute of Rock and Soil Mechanics, Chinese Academy of Sciences
**AfriRock International Symposium—Preliminary Programme**

**Conference Day 3—Plenary Ballroom East**
5 October 2017—Thursday

07:30-08:30 Registration & early morning refreshments
08:30-08:35 Emergency Procedures - CTICC
08:35-08:40 Opening Ceremony
W.C. Joughin, Conference chairperson and ISRM VP for Africa

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### UNDERGROUND MINING—BALLROOM EAST

#### NUMERICAL MODELLING—BALLROOM EAST

08:45-10:00 A multi-objective hybrid prediction model of slope deformation based on fuzzy optimization algorithm
J.B. Zhu and C. Li, Yangtze River Scientific Research Institute, China

10:00-10:15 Benchmarking of debris flow experimental testing using combined finite element-discrete element method FEM/DEM
F. Vagnon*, A.M. Ferro, J.P. Lahcen, and J. Xiang, University of Turin, Italy, Imperial College of London, London

10:15-10:30 Numerical model calibration: process or luck?
J.W.L. Hangekorn* and B.C. Othula, Middling Consulting (Pty) Ltd, South Africa

10:30-10:45 Modelling rock salt dissolution in the foundation of a large dam
C. Vibert*, J. Schliefkat, and V. Lbsaut, Tractebel-Coyne et Beller, France, University of Leuven, Belgium

10:45-11:00 Calibration of a numerical model for bore-and-fill mining
D.P. Robey*, B.L. Alejano, and P. Velasco, ISRM UCD, South Africa

11:00-11:15 Comparison of observational, empirical and 3D discrete numerical methods to estimate subsidence over longwall coal faces
I. Pérez-Rey*, B.L. Alejano, and P. Velasco, ISRM UCD, South Africa

11:15-11:30 Characterization and numerical modelling of standard and cabled-strapped pillars in a hematite mine
L.R. Alejano*, U. Castro-Figuera*, I. Pérez-Rey*, F. Garcia-Bastante*, and J. Arzúa*, University of Vigo, Spain, Universidad Católica del Norte, Chile

11:30-11:45 Numerical simulation of hydraulic fracturing process on mixed ground
J. Wang†, Y. Deng†, X. Liu, H. Peng†, V. Wu; L. Wu; Z. Wu*, Tong University, China, State Key Laboratory for Geo Mechanics and Deep Underground Engineering, China, Key Laboratory of Environmental Protection & Safety in Foundation Engineering of Transportation, China, East China Architectural Design & Research Institute, China

11:45-12:00 Geotechnical characterization and revision of the pillar design for a hard-rock bord and pillar mine
J. Walls* and P. Mouruz*, SRK Consulting (Pty) Ltd, South Africa, JeWal Geotechnical (Pty) Ltd, South Africa

12:00-12:15 A comparison between LEM and FEM based sensitivity analysis for a soil slope

12:15-13:30 Lunch

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### GEOTECHNICAL INVESTIGATIONS—MEETING ROOM 2 2.41–2.46

09:45-10:00 Geomechanical evaluation enabled stimulation optimization of a tight gas reservoir in Egypt
M. Salam*, A. Abd-Elmaqoud, B. Crane*, S. Squires*, and L. Matzvar*, Khalda Petroleum, Egypt, Halliburton, Egypt, Halliburton, United States

10:00-10:15 Experience gained from in situ stress measurements conducted in Southern Africa during the past ten years
M.F. Handley*, P. Piper*, H. Kato†, and T. Clements†, Groundwork Consult, South Africa, 3D-Geosciences, Japan

10:15-10:30 Advanced information on rock mass properties in large open pits by analysing production drill rig parameters in real time

10:30-10:45 Unravelling the structural mysteries of the Bermuda Triangle at Lonmin’s Saffy Shaft
A.G. Harterberg*, M. de Plessis, and A.E. W Frieze*, Lonmin Platinum Ltd, Mankana, South Africa, Terra Explora Consulting, South Africa

10:45-11:00 The influence of geological structures—an often-overlooked important aspect affecting the stability of operating mines
G.C. More O’Ferrall* and M. du Plessis†, First Quantum Minerals Limited, Zambia, Lonmin Platinum Ltd, Mankana, South Africa

11:00-11:15 Development of a rock mass quality model for an open pit mine
M. Morales*, K.K. Panthi*, and K. Botsialas†, Norwegian University of Science and Technology (NTNU), Norway, The Mining Company, Norway

11:15-11:30 Experimental study on hydraulic conductivity of a rock joint
S.B. Choi, H-Y. Jeong, S. Lee, and S. Jeon, Seoul National University, Korea

11:30-11:45 Geological and hydrogeological reference conditions for rock engineering—an example for grading design at Åspö Hard Rock Laboratory, Sweden
Å. Fransson* and J. Petersson†, Chalmers University of Technology, Sweden, Halliburton, United States

11:45-12:00 Active ultrasonic imaging and interfacial characterization of stationary and evolving fractures in rock
P. Pourahmad† and B.G. Guzina*, University of Colorado Boulder, USA, University of Minnesota, USA

12:00-12:15 Application of rock mass classification and blastability index for improving wall control at a hard-rock mine in Botswana
G Segastio† and T. Zvarivadza, The University of the Witwatersrand, South Africa

12:15-13:30 Lunch

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### UNDERGROUND MINING—BALLROOM EAST

13:30-13:45 Assessment of the potential to extract hard rock strike pillars to improve overall extraction ratio
K.S. Le Bron*, P. Piper*, and G. Jude*, MBL Consulting, South Africa

13:45-14:00 Groundwork Consulting, South Africa, Geoscience, South Africa

14:00-14:15 Coal pillar slopping—assessing the stability of snooks
S.Z. Pethö*, K.B. Le Bron* and C. Silva*, Glencore Coal, South Africa

14:15-14:30 Glencore Consulting, South Africa, MBL Consulting, South Africa

14:30-14:45 Review of remnant mining practices in Southern African Gold Mines
T. Rangasaamy* and H. Yilmaz* Middlitt Consulting, South Africa, University of the Witwatersrand, South Africa

14:45-14:50 Geotechnical input into shaft sinking on the Platreef project
A. Cooper, A. Brits, A. Mborgonya, F. Fredericks, and T. Hudson, Ivanplats, South Africa

14:50-14:55 Fundamental understanding of underground pillar design processes and methods
J.W.L. Hangekorn*, Middlitt Consulting (Pty) Ltd, University of Pretoria, South Africa

14:55-15:00 Performance evaluation of the Pabobo castle pillar at Chirano Gold Mines in Ghana
E.O. Mensah† and J.J. Rani, Kinross Chirano Gold Mines Ltd, Ghana, Kinross Gold Corporations, Canada

15:00-15:15 Stope performance assessment at the Goldcorp Elenore Mine using bivariate analysis
S. Guido†, M. Grenon†, and P. Garmaen*, Goldcorp-Elenone Mine, Canada, Université Laval, Canada

15:15-15:30 Design of stoping sequence at deeper horizons for a lead-zinc mine in a sheared rock mass
J.L. Porath*, C.P. Verma*, S. Dutta†, and A. Jhal* CSP-Central Institute of Mining & Fuel Research (CIMFR), India, Hindustan Zinc Limited, India

15:30-15:45 Coal pillar slopping—partial extraction of coal pillars ensuring panel stability
K.S. Le Bron*, L. Sekwele†, and D. Snyman†, MBL Consulting, South Africa, Exxaro South Africa

15:45-16:00 Afternoon Refreshments

16:00-16:15 Best paper and Young Participant’s Awards

16:15-16:30 Closing Ceremony
W.C. Joughin, Conference chairperson and ISRM VP for Africa

16:30-16:45 The ISRM VP for Africa 2018 ISRM International Symposium in Singapore (10-15 min)

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### PETROLEUM—MEETING ROOM 2 2.41–2.46

14:45-15:00 Hydraulic fracturing in plastic deformed low-permeability reservoirs
Y. Wang* and K. Karaulanov*, Petro-Geotech Inc., Canada, Petro-Geotech Inc., Greece

15:00-15:15 Simulating fractured reservoirs by a coupled two phase dual porosity model
Y. Wang, Petro-Geotech Inc., Canada

15:15-15:30 Stability of large underground rock caverns for crude oil storage operated below atmospheric pressure
N. Gateier and H.D. Nyugen, Geostock Entropose, France

15:30-15:45 Borehole stability and sand production in gas reservoirs
E. Papamichos†, Aristotle University of Thessalonik, Greece, SINTEF Petroleum Research, Greece, Norway

15:45-16:00 Afternoon Refreshments