

See  
conference  
program  
inside!

# Ground Support 2023

10th International Conference on Ground Support in Mining

10–12 October 2023 | Hyatt Regency Perth, Western Australia

The First International Symposium on Ground Support in Mining and Underground Construction took place in 1983 under the theme of rockbolting: theory and application in mining and underground construction. This series of events has evolved over the years to cover all areas of ground support in mining and provide a documented timeline of the significant advancements in ground support technology and practice in the last 40 years. These are reflected in the improved safety statistics and performance of excavations.

Ground support remains the main means to manage rockfalls; one of the major risks in underground mines. The latest developments and applications of ground support in mining are of prime interest to mining practitioners worldwide where the objective is to mitigate rockfall.

## Conference Chair



**Associate Professor Johan Wesseloo**  
Director  
Australian Centre for Geomechanics

PRINCIPAL SPONSOR



## Ground Support 2023 Icebreaker Event

Monday, 9 October 2023  
17:00–18:30  
Trade Exhibition, North Ballroom

Register your attendance at [acggroundsupport.com/register](https://acggroundsupport.com/register)

MON   9 OCT	TUES   10 OCT	WED   11 OCT	THUR   12 OCT	FRI   13 OCT	SAT   14 OCT
Numerical Modelling Workshop	Ground Support 2023			Deformation-Based Support Design Workshop	
Welcome Function	Conference Dinner				

## Day One: Tuesday 10 October 2023

## 07:30 REGISTRATION

08:30 Welcome and introduction *J Wesseloo, Ground Support 2023 Conference Chair, Australian Centre for Geomechanics, The University of Western Australia, Australia*

## SESSION ONE: MONITORING (1) - SOUTH BALLROOM

CHAIR *A Page, Geotechnical Mining Services*08:45 KEYNOTE ADDRESS: The ground support life cycle considering real time ground-consumption monitoring *W Bawden, Mine Design Technologies, Canada*09:30 xCell Cyclops: a new technology for an efficient way of monitoring convergence in underground mines *O Vallati, Sandvik, Australia; M Farrington, Agnico Eagle Mines, Australia; P Young, S Weaver, Sandvik, Australia*

10:00 Principal Sponsor address: Jennmar

## 10:05 MORNING BREAK

## SESSION TWO: MONITORING (2) - SOUTH BALLROOM

CHAIR *P Mather, Regis Resources Ltd*10:35 High-resolution ground-deformation and support monitoring using a portable handheld LiDAR approach *S Mercer, J Morgenroth, RockMass Technologies, Canada; B Simser, Glencore, Canada*11:05 Monitoring of rock mass movement using a distributed array of wi-fi enabled extensometers *S MacGregor, P Seaward, SCT Operations, Australia; M Farrington, Agnico Eagle Mines, Australia*11:35 Automated ground support deformation monitoring: a novel method with new opportunities for geotechnical engineers *J Franke, C Gonzalez, Caroni Geospatial, Australia*12:05 Practical application of mXrap Damage Mapping application at Nova nickel mine *M Lane, IGO Limited, Australia; D Cumming-Potvin, Australian Centre for Geomechanics, The University of Western Australia, Australia*

## 12:35 LUNCH

## PARALLEL SESSIONS

## SESSION THREE A: SUPPORT FOR DYNAMIC CONDITIONS (1) - SOUTH BALLROOM

CHAIR *L Moreau-Verlaan, RockEng Inc., Canada*13:35 Estimate of ground support response under dynamic loads at El Teniente mine, Codelco, Chile *MS Celis, RA Parraguez, Codelco, Chile*14:05 Empirical charting for dynamic ground support at Flying Fox and Spotted Quoll mines *J Graham, U Waheed, IGO Limited, Australia; PA Mikula, Mikula Geotechnics, Australia*14:35 Evolution of dynamic rock support systems at the El Teniente mine *TE Rojas, A Muñoz, P Landeros Córdova, Codelco, Chile*15:05 Case study: use of rebars with microalloyed steels in tunnels with induced seismicity *A Muñoz, C Cifuentes, Codelco, Chile*

## 15:35 AFTERNOON BREAK

## SESSION FOUR A: SELF-DRILLING BOLTS - SOUTH BALLROOM

CHAIR *D Cumming-Potvin, Australian Centre for Geomechanics*16:05 Design, development and testing of the Falcon Bolt *R Galluzzi, M Holden, A Dodds, J Matthews, A Bennett, Jennmar, Australia*16:35 Dynamic impact and static testing of self-drilling dynamic bolt types installed in Normet's urea-silicate injection resin: a new path forward to reducing worker exposure to high-stress ground conditions *A Punkkinen, Normet Canada Ltd, Canada; G Li, Queen's University, Canada, and Hebei University of Engineering, China; A Taheri, Queen's University, Canada*17:05 Adopting hollow bar: lessons learned *A Bergman, E Fjellner, P Hallén, Boliden, Sweden; R Penczek, DSI Underground, Poland; K Pérez Hidalgo, Boliden, Sweden; F Scolari, DSI Underground, Italy; M Svanberg, DSI Underground, Sweden*

## 17:35 DAY ONE CLOSE

## SESSION THREE B: PORTALS AND LARGE CHAMBERS - FRESHWATER BAY ROOM

CHAIR *M Lane, IGO Limited*Geotechnical challenges during excavation of Crusher Chamber 1, Andes Norte project, El Teniente mine *R Valdivia, R Padilla, W Rodríguez, P Landeros Córdova, A Muñoz, E Rojas, Codelco, Chile*Ground support for large chambers at Didipio mine *JM Bermas, DA Dumangeng, CG Reola, OceanaGold Philippines Inc, Philippines; PB Lourence, PB Lourence & Associates, Australia*Mine portal design: considerations, methods and practices *MJ Dunn, Debswana Diamond Company, Australia; TT Parrott, Entech, Australia*

## SESSION FOUR B: VERTICAL EXCAVATION AND OREPASSES - FRESHWATER BAY ROOM

CHAIR *R Stephenson, AMC Consultants*Excavation and support of ventilation shafts with blind hole methodology in the Andes Norte project *R Navarrete, R Valdivia, Codelco, Chile; L Bisa, Consortium JEJ-CyGSA, Chile*Automated reinforcement of orepasses in the Andes Norte project *F Henriquez, R Navarrete, Codelco, Chile*Ground support methods for vertical development *CG Scott, D Sidea, SJ Masters, pitt&sherry, Australia*\*Correct as at 3 October 2023 and subject to change. See [acggroundsupport.com/program](http://acggroundsupport.com/program) for updates.

## Conference Venue and Accommodation

The ACG team is delighted to be hosting the Ground Support 2023 conference at the Hyatt Regency Hotel Perth. To learn more and book your accommodation, visit [acggroundsupport.com/conference-venue](http://acggroundsupport.com/conference-venue)

## Day Two: Wednesday 11 October 2023

### SESSION ONE: DYNAMIC TESTING OF REINFORCEMENT- SOUTH BALLROOM

CHAIR D Sewnun, Australian Centre for Geomechanics

08:30 KEYNOTE ADDRESS: Laboratory-based drop testing of rock reinforcement G Knox, University of Toronto, Canada

09:15 A comparison between laboratory and in situ dynamic testing on the MDX bolt B Darlington, O Vallati, P Young, Sandvik, Australia

09:45 MORNING BREAK

### SESSION TWO: SUPPORT FOR DYNAMIC CONDITIONS (2) - SOUTH BALLROOM

CHAIR I Morkel, IGM Geotechnical

10:15 Dynamic modelling of strainbursting around tunnels A Rigby, Institute of Mine Seismology, Australia

10:45 Delineation of hazard-based design events for dynamic support system analysis N Dadashzadeh, L Moreau-Verlaan, K Kalenchuk, RockEng Inc, Canada

11:15 Utilisation of seismic data in the assessment of displacement and energy demand imposed on ground support by strainbursts D Malovichko, Institute of Mine Seismology, Australia

11:45 Dynamic support evaluations for implementation by seismic hazard domains K Kalenchuk, N Dadashzadeh, L Moreau-Verlaan, RockEng Inc, Canada

12:15 LUNCH

### SESSION THREE A: LABORATORY TESTING OF MESH - SOUTH BALLROOM

CHAIR W Duan, Westgold Resources Limited

13:15 A review of ground support mesh testing around the world IG Morkel, IGM Geotechnical, Australia; PA Mikula, Mikula Geotechnics, Australia; RK Whiting, Rowland Whiting Technical Services, Australia

13:45 Large-scale tests of weld mesh versus high-tensile chain link mesh on mesh overlap load transfer R Brändle, Geobrugg, Switzerland; R Bucher, Geobrugg, Australia

14:15 A laboratory-scale dynamic test of load distribution elements at Rancagua testing facility M Hinojosa, JA Vallejos, E Marambio, Universidad de Chile, Chile; G Fischer, G von Rickenbach, Geobrugg, Chile

14:45 AFTERNOON BREAK

### SESSION FOUR: SUPPORT MECHANISMS - SOUTH BALLROOM

CHAIR A Kusui, Beck Engineering

15:15 Simulating static pull tests, shear tests and dynamic drop tests to identify basic parameters for subsequent support design PM Dight, Australian Centre for Geomechanics, The University of Western Australia, Australia

15:45 Performance in shear of mechanical hybrid rockbolts G Knox, J Hadji Georgiou, University of Toronto, Canada

16:15 Effect of mobilised length on the performance of a padded energy-absorbing rockbolt DL Venter, Epiroc, Australia; G Knox, Epiroc, South Africa

16:45 DAY TWO CLOSE

18:30 DINNER - OPTUS STADIUM



### SESSION THREE B: CORROSION - FRESHWATER BAY ROOM

CHAIR R Hassell, Mining & Civil Integrity Testing

An acidic water corrosive environment and ground support strategies at the Grasberg Block Cave mine, Indonesia JPE Hamman, REP Belseran, B Kriska, T Ramadhan, AY Sugiyanto, H Banda, PT Freeport Indonesia, Indonesia

Accelerated galvanic corrosion between graphitic rock from underground mines and metal coupons C Stazick, G Feagan, S Sunderman, Centers for Disease Control and Prevention, National Institute for Occupational Health & Safety, Spokane Mining Research Division, USA

### SESSION THREE C: PRE-TENSION - FRESHWATER BAY ROOM

Importance and development of pre-tension on bolt support systems: implications to hanging wall beam stability MN Masitise, M Muzavazi, Mohlalefi Engineering, South Africa

SESSION SPONSOR



## Keynote Speakers



Dr Will Bawden

President

Mine Design Technologies, Canada

**Keynote title:** The ground support life cycle considering real time ground-consumption monitoring



Greig Knox

PhD Student

University of Toronto,  
Canada

**Keynote title:** Laboratory impact testing of rock reinforcement



## Day Three: Thursday 12 October 2023

### SESSION ONE: GROUND SUPPORT DESIGN AND MAINTENANCE (1) - SOUTH BALLROOM

CHAIR J Burns, Rio Tinto, Canada

08:30 Numerical forecast of central access ground support behaviour at Cadia East PC1-2 E Ghazvinian, Itasca Consulting Group, Inc, USA; C Orrego, Newcrest Mining Limited, Australia; M Fuenzalida, Itasca Consulting Group, Inc, USA

09:15 Suggested framework for design effort and acceptance criteria for underground mine excavations MJ Dunn, Debswana Diamond Company, Australia; PHJ de Graaf, Anglo American, Australia

09:45 MORNING BREAK

### SESSION TWO: GROUND SUPPORT DESIGN AND MAINTENANCE (2) - SOUTH BALLROOM

CHAIR D Tyler, Newcrest Mining Limited

10:15 Vuggy and cavernous rock mass conditions: implications for the early detection, management, ground support and development of tunnels TT Parrott, Entech, Australia; L Montaldi, Regis Resources, Australia; S Muir, Entech, Australia; J Gibb, Entech, New Zealand

10:45 Evolution of ground support designs for blasthole stoping in kimberlite at Diavik Diamond Mine JM Burns, Rio Tinto, Canada

11:15 A numerical approach for a displacement-based ground support capacity consumption forecast S Dehkoda, Beck Engineering, Australia; F Reusch, G Putzar, Beck Engineering, Germany. Presented by A Kusui, Beck Engineering

11:45 LUNCH

### PARALLEL SESSIONS

### SESSION THREE: GROUTING - SOUTH BALLROOM

CHAIR N Gamble, Glencore

12:45 Improving underground development cycle time using performance mine grouts A Safari, IGO Limited, Australia; P Jere, Sika Australia, Australia

13:15 Application of modern pumpable polyester resin to the mining cycle T Roberts, D Faulkner, Jennmar, USA; R Koekemoer, Komatsu, Canada

13:45 How the strength and deformability of thixotropic resins depend on their structure and what is the true thixotropic behaviour of the mixture M Petranek, Normet International Ltd, Czech Republic; S Korec, SChem a.s., Slovakia; H Golasovská, K Jiříčková, SChem a.s., Czech Republic

14:15 Trial of high early-strength grout-hardening accelerating admixture for cable bolts M Lane, IGO Limited, Australia; M McInnes, Sika Australia, Australia

14:45 AFTERNOON BREAK

### SESSION FOUR: STABILISING POOR GROUND - SOUTH BALLROOM

CHAIR JP Hamman, PT Freeport Indonesia, Indonesia

15:15 A case study for rebar-reinforced shotcrete arches and void filling at the Grasberg Block Cave mine, Indonesia A Setiawan, B Cahyono, B Kriska, R Ginting, D Napitupulu, PT Freeport Indonesia, Indonesia

15:45 Stabilising drawpoints for breccia stopes CG Reola, OceanaGold Philippines Inc, Philippines; PB Lourence, PB Lourence & Associates, Australia; JM Bermas, DA Dumangeng, OceanaGold Philippines Inc, Philippines

16:15 Installation of lattice girders with Toussaint-Heintzmann yielding elements in poor ground O Belov, Rio Tinto, Mongolia; T Roberts, Jennmar, Australia; KJ Ma, Jennmar, USA; J Ooi, Rio Tinto, Australia; B Baasanjav, Rio Tinto, Mongolia

16:45 FAREWELL ADDRESS AND CLOSE J Wesseloo, Ground Support 2023 Conference Chair, Australian Centre for Geomechanics, The University of Western Australia, Australia

\*Correct as at 3 October 2023 and subject to change. See [acggroundsupport.com/program](http://acggroundsupport.com/program) for updates.

## Professional Development Hours

Attendance at Ground Support 2023 may entitle you to up to 20 PD hours.

Please email [info-acg@uwa.edu.au](mailto:info-acg@uwa.edu.au) for your certificate of attendance, post-event.

PROFESSIONAL DEVELOPMENT HOURS	
UP TO <b>19.5</b>	<b>PD</b> HOURS

## Conference Dinner

Venue: Optus Stadium, Victory Lounge, Access via Gate D

Address: 333 Victoria Park Dr, Burswood WA 6100

Date: Wednesday 11 October 2023

Time: 18:30

Dress: Smart casual

Registered attendees will enjoy an evening of networking, sweeping views and a sit-down, three-course dinner in one of Perth's most exciting venues, Optus Stadium, situated on the banks of the picturesque Swan River.

Dinner is now SOLD OUT.



# Associated event

## The Role of Numerical Modelling in Ground Support Design Workshop

9 October 2023 | South Ballroom, Hyatt Regency Hotel, Perth, Western Australia

*From pre-feasibility studies to rehabilitation*

### About the Workshop

Mine-wide and detailed local-scale numerical modelling has become a standard tool for geotechnical decision-making throughout the mine cycle. The use of empirical methods, kinematic analysis and an evolutionary process of incremental support system improvements appear to dominate the ground support design and selection process during the mining cycle.

This workshop will explore the role of numerical methods in ground support design, and its strengths and limitations, as well as examine areas where value can be added with numerical modelling informing decision-making.

Several experts will present on different topics followed by a panel discussion to further explore some of the presented ideas.

### Workshop facilitator



Associate Professor Johan Wesseloo  
Director  
Australian Centre for Geomechanics

#### WORKSHOP PROGRAM – 9 OCTOBER 2023\*

08:00–08:30	REGISTRATION
08:30–08:45	Introduction <i>Johan Wesseloo, Australian Centre for Geomechanics</i>
08:45–09:15	Looking for answers while stumbling through a maze of tunnels <i>Frans Basson, Newmont Australia</i>
09:15–10:00	The application of elastic numerical modelling to guide ground support requirements in hard rock mines <i>Gerhard Hofmann, AngloGold Ashanti, South Africa</i>
10:00–10:15	Floor and panel discussion
10:15–10:45	MORNING BREAK
10:45–11:30	Computer-aided ground support design – past, present and future <i>Abou Vakili, Mining One Pty Ltd</i>
11:30–12:15	The role of numerical modelling in ground support applied to caving <i>Ehsan Ghazvinian &amp; Miguel Fuenzalida, Itasca, USA</i>
12:15–12:30	Floor and panel discussion
12:30–13:30	LUNCH
13:30–14:15	Forecasting ground support performance: numerical modelling across the entire mine cycle – proxies or actual mechanisms? <i>Cristian Orrego, Newcrest Mining Limited</i>
14:15–15:00	Case studies – using numerical modelling in ground support design <i>Ayako Kusui, Beck Engineering Pty Ltd</i>
15:00–15:30	AFTERNOON BREAK
15:30–17:00	Floor and panel discussion
17:00	WORKSHOP CLOSE - Drinks and nibbles

\*Program subject to change. See [acggroundsupport.com/program](https://acggroundsupport.com/program) for updates

See [acggroundsupport.com/numerical-modelling-workshop](https://acggroundsupport.com/numerical-modelling-workshop) for workshop presenters and panellists.

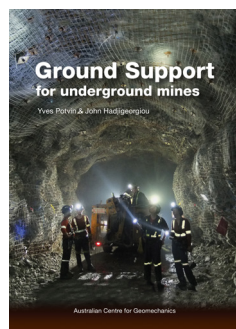


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The ACG's Online Repository of Conference Proceedings aims to provide the mining geomechanics fraternity with open access to peer-reviewed conference papers that may assist readers to maintain and develop their skills, knowledge and capabilities.

The collection of papers available includes a number of previous Ground Support conferences. View the wide range of underground mining papers available at [papers.acg.uwa.edu.au](https://papers.acg.uwa.edu.au)



The *Ground Support for underground mines* book, as well as many other ACG underground publications, is available for purchase online at [acg.uwa.edu.au/shop/gssso](https://acg.uwa.edu.au/shop/gssso)

## Workshop on Deformation-Based Support Design and Rockburst Hazard Assessment

13:00–17:00 AWST, 13 October 2023 & 07:30–12:00 AWST, 14 October 2023

Traders Lounge, Hyatt Regency Hotel, Perth, Western Australia

### About the Workshop

This workshop focuses on support design for excavations in brittle rock, where displacements induced by sudden stress fracturing may consume much of the support's capacity. It deals with the functionality of the support in deforming ground and with the consequences of mining-induced support damage. It offers quantitative means to estimate the capacity of integrated support systems and a systematic approach to compare it with the static and dynamic demands imposed on the ground support.

This workshop presents an integrated approach of deformation-based support design (DBSD) using support demand and support capacity-assessment tools, and an innovative approach developed in collaboration with Newcrest Mining for rockburst hazard assessment (RBHA) using geological, stress, mining sequence, ground support and seismic data.

### Topics

- 1 Deformation-based support design
  - 1.1 Deficiencies of common support design approaches
  - 1.2 Overview of strainburst process and DBSD principles
  - 1.3 DBSD steps to overcome limitations of common ground-motion-centric design approach
  - 1.4 Motivation and justification of change in design method and need for change management
  - 1.5 Estimation of support demand
  - 1.6 Estimation of remnant capacity of integrated support systems
  - 1.7 Assessment of effectiveness of integrated support systems using the displacement safety margin concept
- 2 Rockburst hazard assessment
  - 2.1 Terminology – shakedown and strainbursting damage mechanisms, rockburst potential and rockburst hazard
  - 2.2 Input of rockburst hazard assessment – rock mass properties, geometry of excavations, stress model, seismic data, ground support
  - 2.3 Utilisation of seismic data – assessment of strainbursting depth and duration of bulking, probability and percentage of the dynamic realisation of extreme depth of failure, increase in the depth of failure and consumption of ground support capacity
  - 2.4 Calculation and presentation of results – mapping of parameters and results to tunnel nodes, displacement versus energy plot of ground support capacity and demand, safety margin of displacement, annual rate of exceedance of R0, R3 and R5 damage
  - 2.5 Utility of RBHA for forensic analyses and forecasting on future hazards

### Workshop facilitators



**Professor Peter Kaiser**  
Emeritus Professor  
Laurentian University, Canada



**Dr Dmitriy Malovichko**  
Director and Head of Applied Seismology  
Institute of Mine Seismology



**Dr Alex Rigby**  
Senior Seismologist  
Institute of Mine Seismology

Learn more about the content and view workshop timings at

[acggroundsupport.com/deformation-based-workshop](https://acggroundsupport.com/deformation-based-workshop)

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Crawley WA 6009



+61 8 6488 3300



info-acg@uwa.edu.au



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