Table of Contents

iii Australian Centre for Geomechanics  
v Committees  
 vii Technical Reviewers  
 ix Preface  
 xi Sponsors

**OPENING ADDRESS**

3 Monitoring — the good, the bad and the ugly  
*PJ Pells, Pells Consulting, Australia*

**KEYNOTE ADDRESSES**

27 Soil suction — what it is and how to successfully measure it  
*AM Ridley, Geotechnical Observations Ltd, UK*

47 The challenges of supplying good quality and useful data for significant projects  
*M Beth, Soldata Group, France; E Audige, C Fagan, Soldata Oceania Pty Ltd, Australia*

63 Performance monitoring as a risk management tool in dam safety  
*WA Marr, Geocomp Corp., USA*

89 The measurement and interpretation process to determine the state of stress in rock including the effects of fluid pressure  
*i Gray, Sigra Pty Ltd, Australia*

**CASE STUDIES**

93 Precision survey monitoring with a reflectorless total station  
*CJ Hope, SW Dawe, Monir Precision Monitoring, Canada*

107 LiDAR — systems for stability proof of a reservoir dam  
*J Hofmann, M Löwen, RA Herrmann, University of Siegen, Germany*

117 Depth position errors in inclinometer surveys and false displacement results  
*PE Mikkelsen, GeoMetron Inc PS, USA; E DiBiagio, Norwegian Geotechnical Institute, Norway*

125 The measurement of fluid pressure in rock and soil  
*i Gray, B Neels, Sigra Pty Ltd, Australia*

137 Improving existing monitoring systems in six dams by automation and central data management  
*V Caci, SISGEO S.r.l., Italy; H Stahl, AF-Consult Switzerland AG, Switzerland; E Bekiri, S Milevski, M Glavinceski, JSC Macedonian Power Plants, Macedonia*

149 Automated structural health monitoring and data analysis of the first cable-stayed suspension bridge in Switzerland  
*J Woellner, Leica Geosystems AG, Switzerland*

161 New multi-inclinometric geotechnical monitoring systems — the importance of alignment calibration and testing for reliability and correct data interpretation  
*V Foglino, L Foglino, S Foglino, M Lovisolo, C.S.G. S.r.l., Italy*
EMERGING TECHNOLOGIES

175 Update on European and international geotechnical monitoring standards
W Steiner, B+S AG, Switzerland; M Beth, Soldata Group, France; H Bock, Q+S Consult, Germany; M Clegg, Geosense Ltd, UK; J Golser, Geodata Group, Austria; B Möller, FMGeo AB, Sweden; G Pezzetti, SMAK s.o.s., Italy; AM Ridley, Geotechnical Observations Ltd, UK; R van der Salm, Fugro Geoservices b.v., Netherlands; CH Spalton, Geosense Ltd, UK; L de Vos, Flemish Government, Belgium; PH Welter, Service Public de Wallonie, Belgium; H Wörsching, Solexperts AG, Switzerland

185 Improvement of pseudo-3D pit displacement mapping technique through geodetic prism data integration
M Salvani, Australian Centre for Geomechanics, The University of Western Australia, Australia; K Abbott, MMG Limited, Australia; PM Dight, Australian Centre for Geomechanics, The University of Western Australia, Australia

195 Shape Accel Arrays — comparative performance in a mining application
GE Swarbrick, SJ Clarke, Pells Sullivan Meynink, Australia

207 Detection of subsidence affecting civil engineering structures by using satellite InSAR
R Kauther, R Schulte, Federal Waterways Engineering and Research Institute (BAW), Germany

219 Geotechnical data handling from A to Z
A Thorarinsson, Vista Data Vision, Iceland

233 Performance monitoring — case studies of tracks stabilised by geosynthetic grids and prefabricated vertical drains
B Indraratna, SK Navaratnarajah, S Nimalkar, C Rujikiatkamjorn, University of Wollongong, Australia; T Neville, Australian Rail Track Corporation Ltd, Australia

CIVIL TUNNELLING

249 Wireless data collection systems in the real world
PC Scott, Itmsoil Australia, Australia; J Paretas-Martinez, J Pérez-Arcas World sensing, Spain; KR Malcolm, Itmsoil Australia, Australia

261 Innovative InSAR approach to tackle strong nonlinear time lapse ground motion
J García Robles, O Mora, B Salvó, Altamira Information, Spain

275 Instrumentation and monitoring management for a mass rapid transit project in Kuala Lumpur, Malaysia
CE Ooi, LH Ooi, MMC-Gamuda KVMRT (T) Sdn Bhd, Malaysia

289 The new Wynyard Walk pedestrian tunnel in Sydney — a monitoring challenge
M Jarvis, VMT Tunnel Guidance Pty Ltd, Australia; S Schneid, VMT GmbH, Germany

303 Subsidence monitoring of the Seattle viaduct tunnelling project with Homogeneous Distributed Scatterer InSAR
J Eppler, M Kubanski, MDA Systems Ltd., Canada

315 InSAR-derived time series analysis of tunnel construction-induced ground deformation in urban landscapes
B Macdonald, JP Iannacone, G Falorni, TRE Canada Inc., Canada; C Gionnico, Tele-Rilevamento Europa, Italy

329 A mechanical method for monitoring and data visualisation of small deformations in underground structures
H Zhang, S Akutagawa, Kobe University, Japan

339 Heuristic methods of back-analysis of tunnel response from field measurements using simulated annealing
M Gutierrez, Khalifa University, United Arab Emirates; S Vardakos, Parsons Brinckerhoff, USA; X Caichu, Tongji University, China

353 Thermomechanical errors in a horizontal in-place inclinometer
SJ Clarke, Pells Sullivan Meynink, Australia

365 Rock blasting — peak particle velocity against distance
CW Boon, LH Ooi, MMC-Gamuda KVMRT (T) Sdn Bhd, Malaysia

373 Monitoring concrete segmental lining tunnels with fibre-optic and conventional instrumentation
S Gil Lorenzo, M Elshafie, K Soga, R Mir, University of Cambridge, UK; P Wright, CH2M Hill, UK; M Clegg, Geosense Ltd, UK
385 Monitoring of a shallow cover tunnel driven under live railway tracks
DMares, North Strathfield Rail Underpass Alliance, Australia; E Nye, Matt MacDonald Australia Pty Ltd, Australia

397 Use of monitoring data during construction to refine cavern design
B Shen, TR Nash, R Bertuzzi, SJ Clarke, Pells Sullivan Meynink, Australia

409 Robust monitoring for high risk underground excavations
MSolcher, Pells Sullivan Meynink, Australia

423 Instrumented test shaft in soft ground
A Thut, Solexperts AG, Switzerland; CRabaiotti, Basler & Hofmann AG, Switzerland; HWärsching, Solexperts AG, Switzerland

WATER FLOW AND MONITORING

439 A new method for interpreting changes in arbitrary engineering quantities by using optic fibre
SAkutagawa, Kobe University, Japan; YMachijima, LAZOC Inc., Japan; KTatayama, Kankyo Sogo Technos, Japan

453 Field instrumentation of a preloading project with prefabricated vertical drains
AMehdizadeh, Swinburne University of Technology, Australia; FKokharian, Amirkabir University of Technology, Iran

465 Quarrying-induced subsidence investigated by combining contact and remote monitoring systems
PBozzano, CEsposito, Sapienza University of Rome, Italy; PMazzanti, A Rocca, NHAZCA S.r.l., Sapienza University of Rome, Italy

475 Application of distributed temperature sensors in piping-prone dikes
SBersan, University of Padova, Italy; ARKoelewijn, Deltares, Netherlands; PSimionini, University of Padova, Italy

487 Nude vibrating wire piezometer installations — no filter response zone and no engineered grout
AMazur, LM Schaeten, WYLam, PHSetiawan, Fugro Geotechnical Services Ltd., Hong Kong

501 Importance of monitoring temperature in the improvement of groundwater models — an example from an open pit mine in Papua New Guinea
EdeSousa, MFowler, GE Swarbrick, Pells Sullivan Meynink, Australia

511 Automatic water level and water quality monitoring
AGujral, A Bhalla, DKBiswas, Encardio-rite Electronics Pvt. Ltd., India

UNDERGROUND MINING

527 Earthworks — if stiffness is important specify and test for it
DPiccolo, GMostyn, Pells Sullivan Meynink, Australia

539 Highlighting and quantifying seismic data quality concerns
IGMorkel, JWesseloo, PHarris, Australian Centre for Geomechanics, The University of Western Australia, Australia

551 Sublevel open stoping hanging wall instrumentation program at the Dugald River underground mine
JFCarswell, MMGLimited, Australia; JPlayer, MineGeoTech Pty Ltd, Australia; Rde Vries, RHassell, MMGLimited, Australia

565 Geotechnical monitoring of railway infrastructure subject to mine subsidence-induced horizontal closure
ASteindler, ALeventhal, THull, GHD Geotechnics, Australia; JMather, John Matheson & Associates, Australia; ISheppard, Tahmoor Underground Glencore, Australia

581 The use of microseismic acquisition for vibration monitoring applications
IPinnock, ESG Solutions, Australia; DSCollins, YTaya, ZHasseini, ESG Solutions, Canada

589 Experience of using the ANZI strain cell for stress change monitoring
KWMifis, DSelmo, JBTodd, JWPuller, JANemcik, ZSimonovski, SCT Operations Pty Ltd, Australia
601 Improving strata management through the development of remote reading instrumentation systems
KM MacAndrew, Golder Associates (UK) Ltd, UK; C Mans, L Chadwick, Anglo American, Australia; N Owen, NAME Services, Australia; L Sneath, Golder Associates (UK) Ltd, UK

613 Battery-powered wireless monitoring system for geotechnical, hydrology and microseismic sensors using the MineHop mesh network
A Dulmage, Mine Design Technologies Inc., Canada; N Ruddell, Mine Design Technologies Australia, Australia

621 Performance of ground anchors in a Mass Rapid Transit project in Malaysia
CW Boon, LH Ooi, YY Low, MMC-Gamuda KVMRT (T) Sdn Bhd, Malaysia

631 Implementation of fibre-optic vertical extensometers for safety monitoring
C Rabaiotti, Basler & Hofmann AG, Switzerland; M Iten, F Fischli, Marmota Engineering AG, Switzerland

TRANSPORT CORRIDORS

647 Monitoring of consolidation behaviour of marine clay treated with vacuum and surcharge at the Port of Brisbane
B Indraratna, University of Wollongong, Australia; AS Balasubramaniam, Griffith University, Australia; H Poulos, Coffey Geotechnics, Australia; C Rujikiatkamjorn, University of Wollongong, Australia; J Ameratunga, Coffey Geotechnics, Australia; D Perera, University of Wollongong, Australia

657 Monitoring pavement relief of the Hume Highway during undermining
GE Swarbrick, Pells Sullivan Meynink, Australia; P Meers, D Lee Shoy, Roads and Maritime Services, Australia; DJ Kay, Mine Subsidence Engineering Consultants, Australia; HG Buys, AECOM, Australia

671 Remote monitoring of road deformation adjacent to an open cut mine using wire extensometers
SP Darmawan, R Moniaga, Geotesta Pty Ltd, Australia; D Marks, J Kirjan, Department of Transport and Main Roads Queensland, Australia

677 Use of instrumented static load tests on deep foundations for optimisation of geotechnical design
WR Wood, J Sinnreich, Fugro-Loadtest, USA; AJ Simmonds, Geokon Inc., USA

COAL MINING AND ASSOCIATED EXCAVATIONS

693 Real-time monitoring of cut slopes and the importance of identifying the mode of failure
DR Pope, GD Kennedy, AG Smith, Pells Sullivan Meynink, Australia

705 Impact on stability of boreholes in brown coal overtime and changes to in situ stress
WE Bamford, RS Potdar, Bamford Rock Testing Services, Australia

CARBON SEQUESTRATION

717 Design and deployment of an integrated instrumentation system in a monitoring well at Aquistore Geological CO2 storage project, Saskatchewan, Canada
G Zambrano-Narvaez, R Chalaturnyk, University of Alberta, Canada; K Worth, Petroleum Technology Research Centre, Canada

SLOPE STABILITY

729 Structural interpretation from Televiewer surveys
RDH Thomas, JM Neilson, HF Wilson, P Lamb, Coffey International Ltd, Australia

743 An acoustic emission slope displacement rate sensor — case studies
N Dixon, D Codeglia, A Smith, G Fowmes, Loughborough University, UK; P Meldrum, British Geological Survey, UK

757 Landslide-inventory maps updated by means of persistent scatterer interferometry — the Portella di Mare case study, Sicily, Italy
A Novellino, D Di Martire, M Ramondini, D Calcaterra, Federico II University of Napoli, Italy
Monitoring an unstable road embankment for public safety purposes by terrestrial SAR interferometry
A Brunetti, P Mazzanti, NHAZCA S.r.l., Sapienza University of Rome, Italy

Wireless landslide monitoring — triggering factors and dynamic behaviour
C Abancó, J Paretas-Martínez, E Falgás, J Pérez-Arcos, Worldsensing, Spain; M Hürlimann, Technical University of Catalonia, Spain

On the use of ground-based synthetic aperture radar for long-term slope monitoring to support the mine geotechnical team
L Leoni, N Coli, P Farina, F Coppi, A Michelini, IDS Ingegneria Dei Sistemi SpA, Italy; TA Costa, TAV Costa, Vale S.A., Brazil; F Costa, IDS Brasil, Brazil

Field test of long range terrestrial laser scanner and ground-based synthetic aperture radar for area monitoring in open pit mines
A Fowler, A Geier, Laser Measurement Systems GmbH, Austria

Increasing reliability in terrestrial laser data for slope failure monitoring
A Afana, G Hunter, 3D Laser Mapping Ltd, UK; N Rosser, J Williams, R Hardy, Durham University, UK

Instrumentation — the next generation needs an industry champion
PM Burton, Geotechnics, New Zealand

Author Index