ACG AUSTRALIAN CENTRE FOR GEOMECHANICS

CSIRO | Curtin University | The University of Western Australia
Joint Venture

BIENNIAL REPORT
2009–10

contents

JOINT VENTURE PARTNERS

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION AUSTRALIA
Division of Earth Science and Resource Engineering

CURTIN UNIVERSITY
Western Australian School of Mines

THE UNIVERSITY OF WESTERN AUSTRALIA
School of Civil and Resource Engineering

chairman's foreword

Mr Ian Suckling
chairman

During 2009–2010 the ACG sustained its position as a prominent, respected contributor to the mining industry as it emerged from the tighter times resulting from the global economic problems, and accelerated into a strong recovery in activity.

In my previous foreword, for the 2007–2008 report, I mentioned how geotechnical engineering continued to grow in importance. This continues to be true, with the mining industry's efforts to satisfy an increasing appetite for resources driving endeavours to exploit deposits that are harder to mine, lower in grade, deeper or more mature. Economic pressures endure as operators work to keep costs down and pursue efficiencies; environmental pressures are increasing, as mines seek to minimise their environmental impacts; and the industry continues to strive to improve safety performance in concert with community and regulatory expectations that they do so.

The accident at Chile's San Jose mine in August 2010 received wide publicity and was one prominent event that had the effects of raising public concerns about mine safety and reinforcing the contribution to safety that geotechnical science can make.

The ACG's fields of science and endeavour – in underground, open pit and environmental geomechanics – are perfectly aligned to contribute to the industry's efforts in each of these areas. Its work on building the industry's geotechnical expertise has a well earned reputation for excellence, educating both specialists and generalists through its conferences, seminars, short courses, workshops, and publications. Its research work remains focussed and successful, being of academic merit while answering questions of serious concern to the industry. The enduring support for the Mine Seismicity and Rockburst Risk Management Project, now approaching Phase 5, is a tribute to all involved in it and a recognition of the importance placed on this work by sponsors.

The ACG's admirably energetic team continued, through 2009 and 2010, to deliver a tremendous volume of work. ACG events attracted prominent speakers and delegates from around the world, as well as praise for the professional conduct of these events. The staff also sustained a very productive office in support of the group's research, and produced a series of excellent publications.

The ACG Board of Management has benefited greatly from the guidance of my fellow industry representatives Mark Adams from Barminco Ltd, Chris Stone from BHP Billiton Nickel West and Richard Butcher from Barrick Gold of Australia. I am also grateful for the guidance of the current members from the ACG's joint venture partners, notably Winthrop Professor John Dell from The University of Western Australia, Dr Steve Harvey of CSIRO, and Dr Stephen Hall from Curtin University. Dr Hall replaces the late Professor Paul Dunn, who made a valuable contribution to the governance and direction of the ACG, as well as to the industry more widely.

I offer particular thanks to Yves Potvin for the sustained excellence of his own contribution, and for his leadership of his team.

The Australian Centre for Geomechanics continues to work hard for the benefit of the mining industry and I urge the industry to continue to take advantage of the services the ACG offers, and to support its research and development programmes.

Mr Ian Suckling – chairman

director's report

Winthrop Professor Yves Potvin director

Since its inception in 1992, the Australian Centre for Geomechanics has continued to evolve and achieve a slow yet sustainable growth in terms of its number of employees, activities and the role it plays within the Australian and global mining industries. The ACG is a mature centre with three strong streams of activities: underground mining geomechanics, open pit mining geomechanics and environmental geomechanics.

Our professional development programme is centred on the organisation of two international events annually. In 2009 the ACG hosted the "First International Seminar on Safe and Rapid Development in Mining" and the "Fourth International Conference on Mine Closure". The "Second International Symposium on Block and Sublevel Caving" and the "First International Seminar on the Reduction of Risk in the Management Tailings and Mine Waste" were held in 2010. These international events were complemented with 21 short courses, seminars and workshops, covering the three streams of mining geomechanics. This hub of activities, whilst continuing to play a pivotal role in implementing good geomechanics practices in the Australian mining industry, remains the principal source of funding for the centre.

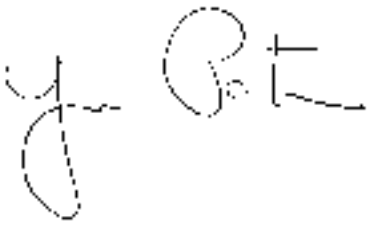
The impact of the global financial crisis on our professional development programme was felt with smaller event attendance in the first half of 2009. This was followed with a partial recovery in the second half of 2009. However, the positive side of this financially difficult year was that, within six months of the financial crisis, the ACG resumed a positive cash flow showing strong signs of resilience and long-term sustainability. In 2010, event attendance was back to pre-financial crisis levels and a surplus over expenditure was achieved.

Geomechanics research is the other field of activity where the ACG has actively contributed to the mining industry for almost two decades. The research strategy adopted by the ACG is to concentrate its effort on few, very significant areas of geomechanics research and to become a global leader in these specific subjects. During the period covered by this biennial report, Phase 4 of the "Mine Seismicity and Rockburst Risk Management Project" was well advanced, with Phase 5 in the initial stages of preparation. The project is globally endorsed with sponsors from Australia, Canada, Chile and Sweden and a budget that exceeded $1M in Phase 4. Within the scope of this project, Daniel Heal was the fifth candidate to obtain a PhD.

The project entitled, "An Effective Stress Approach to Mine Fill", under the leadership of Winthrop Professor Andy Fourie, was also successfully completed and will be followed by a second phase to be undertaken in 2011, with funding obtained through an ARC Linkage Grant. The "Mine Fill" project has already produced one PhD graduate, Matt Helinski, and is currently supporting two PhD and 16 Masters' students, confirming the role of the ACG as a major contributor to forming much needed geomechanics specialists for the mining industry.

The centre is also very active, through the work of Winthrop Professor Phil Dight, in seeking to develop a world-class research project in open pit Geomechanics, and smaller scale "pilot projects" are being conducted in collaboration with a number of mining operations.

With the financial crisis behind us, the ACG is anticipating a strong financial performance in the coming years. In the immediate future, we are aiming at further developing our open pit research activities, as well as complementing our environmental geomechanics team by filling our currently vacant professorial position



Winthrop Professor Yves Potvin – director

mine seismicity and rockburst risk management project

As the mining industry exploits deeper deposits, mine induced seismicity and rockbursts are becoming more prevalent and the effective management of rockburst risk becomes increasingly important. This is one of the main drivers behind the ACG's Mine Seismicity and Rockburst Risk Management Project.

This high impact project commenced in 1999, with Phase 4 due to be completed at the end of 2011. The overall goal of the project is to develop new and improved methods to analyse, interpret and manage seismicity and its subsequent hazard. This project also focusses on deriving strategic value from seismic data in several areas, with emphasis on the following:

- Determination of dynamic support capacity.
- Interpretation of rock mass degradation, from seismic data.
- Development of analysis techniques for cave mining situations.
- Seismic hazard assessment.

Development of the software MS-RAP has formed part of all the previous phases of the project. The software has proven extremely valuable as both a research tool and a tool for transferring technology to the sponsor sites. During this phase of the project, a major redevelopment of the software was necessary. Hence, MS-RAP v4 is under development.

Determination of dynamic support capacity

The determination of the in situ support capacity of the dynamic support system is largely unknown. This is due to the extremely complex dynamic interaction between the rock mass and the support system under rockbursting conditions. These conditions cannot be reproduced in a laboratory.

Valuable insight was obtained through a comparative study in which data from different laboratory tests and an in situ blast test were compared. This study provided a good relative strength assessment of the in situ performance of seismic system components and provided information for support design.

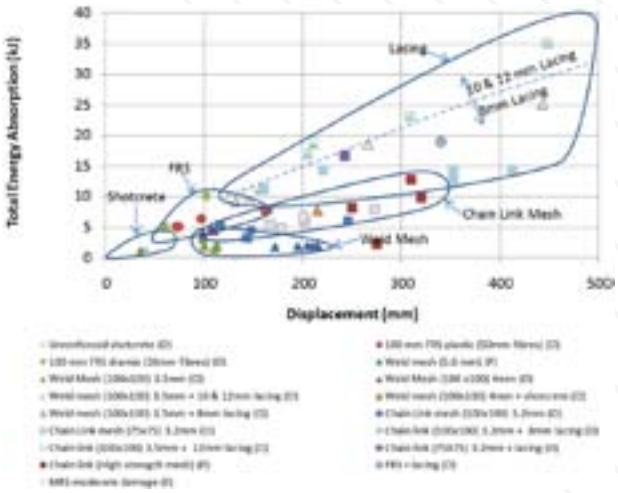


Figure 1 Compilation of drop tests performed on various surface support elements from various sources

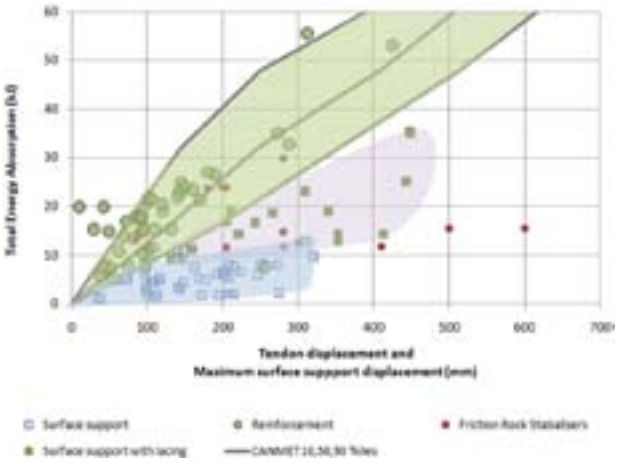


Figure 2 Total energy absorption and displacement of reinforcement and surface support dynamically loaded using drop weight tests compiled from data from various sources

Interpretation of rock mass degradation, from seismic data

Rock mass degradation in brittle rock is generally co-seismic and as such the seismicity can be interpreted as a proxy for rock mass degradation/damage. This part of the project investigated the use of different seismic parameters as that can serve as a proxy for rock mass damage. A comparative study between different possible methods was performed by applying it to three different caving databases. It appears that the results from the different methods are generally similar. The direct interpretation of the seismic parameters with respect to an absolute rock mass damage/degradation state does not appear to be achievable. This work, however, forms a component in the tracking of the cave in block cave mining.

Development of analysis techniques for cave mining situations

Seismic data provides a means of tracking the zone of maximum seismic activity, i.e. seismogenic zone. This data has been used, with other data to interpret the cave development over time. Interpretation of the caving process from seismic data is, however, subjective and arbitrary. This project developed a method for tracking the cave development and relating the different seismic character of various zones in the rock mass to different rock mass states. The method combines a threshold seismic rock mass damage parameter with the temporal change in the seismic character of different zones in the rock in order to derive from that an interpretation of the caving state of the rock mass. Although promising results were obtained, further work is necessary to refine the method. The new developments within MS-RAP v4 include the import and analysis of non-seismic data with seismic data.

Seismic hazard assessment

Seismic hazard assessment forms an important part of the software capabilities of MS-RAP. The hazard assessment methods developed in previous phases of the project and implemented into MS-RAP v3 were further developed and refined. Several fundamental changes were made and implemented.

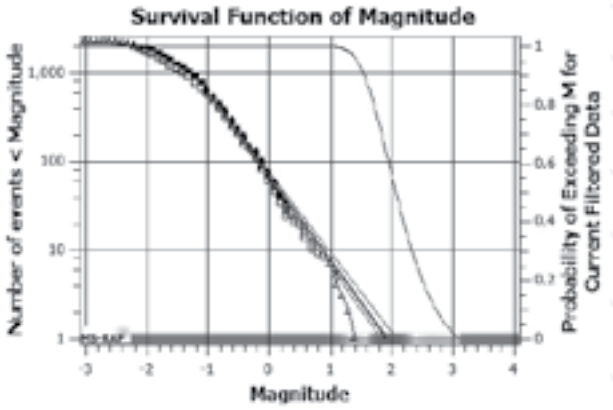


Figure 3 Guttenberg-Richter relationships of data with probabilistic assessment of seismic response

Development of MS-RAP v4

During this period, major effort was invested into the development of the software component. It became necessary to change the development strategy and philosophy for the development of MS-RAP v4. The development strategy changed from a "one size fits all" approach to the development of generic analysis components that can be adapted and altered to enable customisation or development of new analysis methods.

This development strategy change has proven very valuable both from researcher and site user perspectives. From a research point of view, new analysis capabilities were developed that were not previously possible. From a site user point of view, it has proven extremely beneficial as existing analysis methods could easily be adapted to suit specific site conditions better, and in several cases, site specific tools could be built using the generic built-in modules.

Positive feedback about the change in software design philosophy and the changes to the software itself was received from the pre-release users.

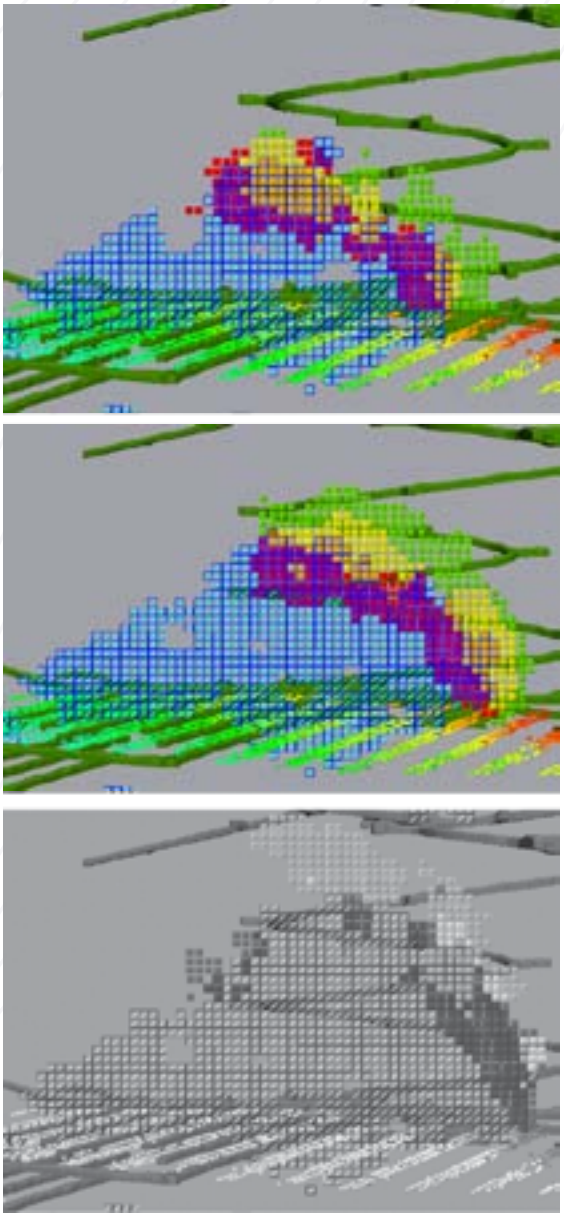


Figure 4 Tracking the seismogenic zones using seismic density parameters

Phase IV sponsors

Acknowledgements

Phase IV of this research project is financially supported and assisted by the following sponsors:

Minerals and Energy Research Institute of Western Australia (MERIWA)

Major sponsors

Barrick Gold of Australia Ltd
BHP Billiton Nickel West Pty Ltd
BHP Billiton Olympic Dam Pty Ltd
Independence Gold NL – Lightning Nickel Pty Ltd
Luossavaara-Kiirunavaara AB (LKAB)

Minor sponsors

Agnico-Eagle Mines Ltd
AngloGold Ashanti Australia Ltd
BCD Resources (Operations) NL
Codelco Chile, Division El Teniente
Gold Fields of Australasia, St Ives Mine
Kirkland Lake Gold Inc.
MMG Australia Ltd, Golden Grove Operations
Newcrest Mining Ltd
Newmont Asia Pacific
Perilya Ltd, Broken Hill Mine
Xstrata Copper Kidd Creek Mine
Xstrata Nickel (Cosmos Nickel Project)

Dr Johan Wesseloo
Project leader

Paul Harris
Software developer

Winthrop Professor
Yves Potvin

an effective stress approach to mine backfill

Phase 1

Winthrop Professors Andy Fourie and Martin Fahey from The University of Western Australia and Dr Matthew Helinski, research associate, Australian Centre for Geomechanics commenced this research project in 2007. June 2010 marked the completion of the project entitled, "Effective stress approach to mine backfill – Phase 1". This project was very successful, delivering significant outcomes in understanding, as well as conveying this new knowledge to the industry through several journal publications, and in excess of fifteen mining conference papers and magazine articles. In addition to the two Professors who undertook this research, two PhD students and more than 15 final year students also contributed to this project.

The objective of the project was to improve our understanding of the cemented mine backfill deposition process for the purpose of:

1. Developing a rational approach for estimating the stress imposed on containment barricades.
2. Modifying curing strategies to better reflect in situ curing conditions.

The primary objective of this study was to develop a theory for representing the deposition/consolidation/cementation/ arching that takes place when filling a stope with any hydraulically transported tailings-based fill product, such as hydraulic fill or paste. This was achieved by breaking down the problem into a series of sub-mechanisms, which could be easily characterised in laboratory-based element tests. These mechanisms were then coupled numerically to allow the overall behaviour to be modelled.

The process of consolidation (or the development of effective stress in the fill) is fundamental to the arching mechanism and, consequently, the stress distribution during filling. Therefore, during the early stages of the project, the focus was on understanding the various components of the constitutive model that influence the consolidation of a cementing soil such as cemented mine backfill. In addition to the aspects that influence the consolidation of conventional mine tailings such as state-dependent stiffness and permeability, it was necessary to develop models for representing the development of stiffness and reduction in permeability as a consequence of cement hydration. Additionally, a new constitutive model for representing the "self-desiccation" mechanism was developed, which is associated with a reduction in pore water pressure due to the volumetric changes that occur during the cement hydration process (Helinski et al., 2007a). All of these mechanisms were combined in a one-dimensional consolidation analysis program called CeMinTaCo (Helinski et al., 2007b).

Using this one-dimensional model it was possible to illustrate some interesting and previously unrecognised phenomena, such as how the combination of a low-permeability cemented backfill and the self desiccation mechanism can actually result in lower pore pressures, i.e. higher effective stress, than would be the case with a high permeability fill, which is counter-intuitive to the conventional consolidation theory. This provided the first insight into reasons for the often-observed low bulkhead stresses in some paste fills.

In parallel with developing CeMinTaCo, an element testing regime that allows the relevant material properties to be characterised was also developed. Specifically, the testwork methodology included a Rowe cell test to determine the behaviour of the material immediately after deposition, and a hydration cell test to determine the evolution of material properties during cement hydration. The Rowe cell is a conventional laboratory element test that relates the material state to stiffness and permeability. The hydration cell test required development of a new apparatus (see Figure 1).

As the distribution of stress in a paste fill mass during filling depends on consolidation and arching onto the stiffer surrounding rock mass, the next step was to develop a model that could adequately assess the arching process. This model was developed using finite element logic in a new program called Minefill-2D (Helinski et al., 2010). To verify the ability of Minefill-2D to represent the consolidation/arching interaction, a series of scale model experiments were carried out using The University of Western Australia's geotechnical centrifuge (Figure 2).

As the timescale of "conventional" consolidation is accelerated in a centrifuge experiment (for the scaled-up version), but cement hydration continues at the same rate, it was not possible to fully couple consolidation, cement hydration and arching in the

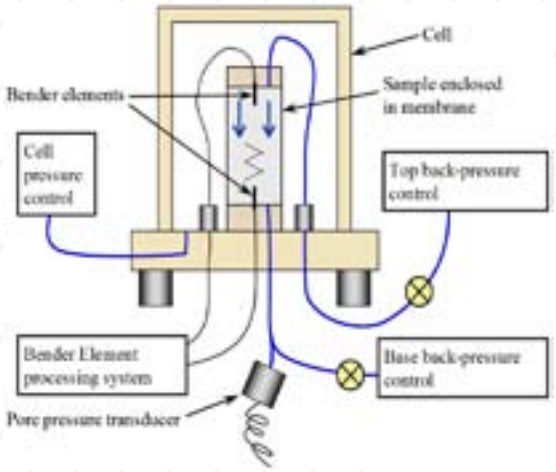
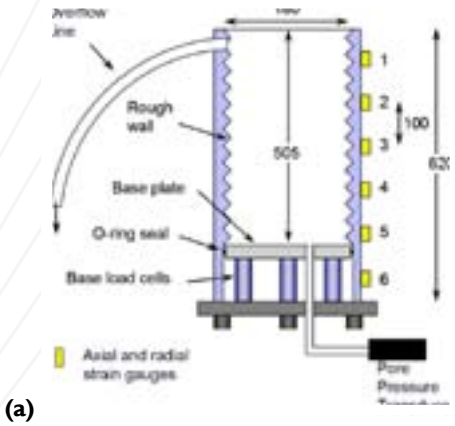


Figure 1 Schematic showing a hydration cell experimental setup



(a)

(b)

Figure 2 (a) Schematic; (b) photograph of centrifuge experiment

centrifuge experiment. However, comparison with experimental results showed that conventional consolidation and arching, and their interaction, could be accurately represented using Minefill-2D for both cemented and uncemented materials (Helinski, 2007).

While ongoing verification of the cemented characteristics against element tests indicates the ability of Minefill-2D to adequately represent cement hydration, it was necessary to undertake full-scale field tests to develop confidence in its ability to model the full-scale cemented mine backfill deposition process. These studies were undertaken at Barrick's Kanowna Belle Mine (KB) and Panoramic Resources' Savannah Nickel Mine (SNM). These two sites were selected as KB represents a fine-grained tailings paste, which was expected to be heavily dependent on self-desiccation to achieve consolidation; and SNM, a coarser material with much greater consolidation likely to be achieved prior to cement hydration. The field studies involved both earth pressure cells and piezometers, and comparison between the field experiments and back analysis with Minefill-2D using laboratory-derived material input parameters showed a very good correlation, as presented in Helinski et al. (2011a). These results illustrated that the developed theory provided a good method for representing the cemented mine backfill deposition behaviour.

On the basis of this verification, it was clear that Minefill-2D was the first tool that captures all of the mechanisms that control the cemented mine backfill deposition process. While this provided the first method for estimating the development of effective stress and bulkhead stresses during filling for a specific situation, it also served as a tool for developing and verifying strategies for identifying where it was appropriate to simplify the analysis process and develop rational systems for managing both the bulkhead stability and curing strategies.

An example of this was presented in Fahey et al. (2009), in which an analytical solution was applied that uses the coefficient of consolidation immediately after deposition, and the vertical rate of rise, to characterise the controlling mechanisms in the consolidation process. Once the backfill has been characterised in this manner, i.e. as a consolidating or non-consolidating fill, Table 1 can be used to determine suitable analysis and management strategies. This framework is suitable for managing

the filling process in both paste and hydraulic fill systems.

In this table, the non-dimensional time factor T is defined as:

$$T = \frac{m^2 t}{c_v} = \frac{mH}{c_v}$$

where m is the vertical rate of rise, c_v is the coefficient of consolidation, t is the filling duration, and H is the filled height at time t.

Table 1 Cemented mine backfill framework

Consolidating Fill ($T < 1$)	Non-Consolidating Fill ($T > 100$)
Analysis with mechanical analysis coupled with steady-state seepage induced pore pressures to calculated barricade stresses	Analysis requires full coupling of filling, consolidation and cement hydration
Little point in fill rest/cure period after covering barricade because of low stresses during initial stages of filling	Rest/cure period after covering barricades useful to ensure that hydration and, therefore, consolidation commences
Manage accumulation of steady state seepage induced pore pressure to ensure calculated barricade stress is not exceeded	Pore pressure good indicator of the onset of hydration – manage duration of rest/cure period with pore pressure monitoring
Barricade stress sensitive to: Number of drawpoints Flows through drawpoint	Barricade stress sensitive to: Binder type and content Mix density Vertical rate of rise
Significant pore water flows through drawpoint expected. Engineered barricade drainage system useful. Potential to erode waste rock barricades	Little water expected to report to barricades, specific wall drainage typically not necessary
Effective stress applied to fill material immediately after placement	Effective stress not applied to fill until "initial set" of binder
Application of effective stress during curing independent of mix design dependent on boundary conditions, i.e. vertical rate of rise and drawpoint configuration	Application of effective stress unique for each mix design and largely independent of boundary conditions, i.e. vertical rate of rise and drawpoint configuration
Considerable volumetric compression during filling	Little volumetric compression during filling

Phase 2

Phase 2 of this project is funded as an ARC Linkage Project and the industry sponsors are Barrick Gold of Australia Ltd and Panoramic Resources Ltd. This phase involves an increased focus on field testing, as well as the development of a three-dimensional numerical model to allow the three-dimensional aspects of a typical stope to be taken into account in the modelling. Field testing will utilise a variety of instrumentation regimes to carry out a series of field-based sensitivity studies. The field studies will focus on measuring the evolution of stress and pore pressure during filling as well as post-fill coring of fill masses, to compare the characteristics of the recovered core with the characteristics of quality-control laboratory testwork. It will provide our project sponsors with calibrated, site-specific information that may allow reductions in the cement content of the pastefill, and shortened cycle times by allowing earlier exposure of filled stopes.

Article references are available on request.

Acknowledgements

Phase I (ACG Effective stress approach to mine backfill) of this research project is financially supported by:

Barrick Gold of Australia Ltd
BHP Billiton Nickel West Pty Ltd
Panoramic Resources Ltd

Phase 2 (UWA Effective stress approach to mine backfill) of this research is financially supported by:

Barrick Gold of Australia Ltd
Panoramic Resources Ltd

Winthrop Professor Andy Fourie

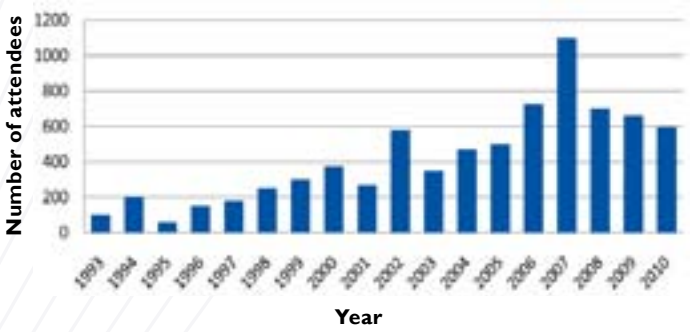
Dr Matt Helinski
Research fellow

Winthrop Professor Martin Fahey

geomechanics education and training courses

During 2009 and 2010, the ACG's further training and education programme attracted a substantial number of mining professionals. As a leading provider of specialist and advanced training and education for mining personnel and geotechnical practitioners in mining and environmental geomechanics, the ACG successfully supported industry to reach their business and training objectives. More than 1200 mining personnel attended ACG events during 2009 and 2010 (see graph).

ACG event attendances 1993-2010



THE ACG'S GEOMECHANICS TRAINING AND EDUCATION PLATFORM PROVIDES A SOLID BASE FOR THE TRANSFER OF TECHNOLOGICAL DEVELOPMENTS AND PRACTICES BASED ON KNOWLEDGE GATHERED FROM LOCAL AND INTERNATIONAL SOURCES

2009 EVENTS

Managing Seismic Risk in Mines Short Course
Perth, Western Australia, 24 March 2009

Practical Rock Mechanics Course
Perth, Western Australia, 25–26 March 2009

First International Seminar on Safe and Rapid Development Mining
Perth, Western Australia, 6–7 May 2009

CSIRO Automation Concepts in Mining Development Headings Workshop
Perth, Western Australia, 4 May 2009

International Forum on Development Productivity
Perth, Western Australia, 5 May 2009

Geotechnical Engineering in Open Pit Mines Seminar
Brisbane, Queensland, 9–11 June 2009

CSIRO Open Pit Mining Geomechanics Research Applications Seminar
Brisbane, Queensland, 12 June 2009

Blasting for Stable Slopes Short Course
Perth, Western Australia, 14–15 July 2009

Fourth International Conference on Mine Closure
Perth, Western Australia, 9–11 September 2009

Applying Numerical Models to Mining Problems: Theory and Case Studies Seminar
Perth, Western Australia, 14–15 October 2009

Mine Backfill Seminar
Perth, Western Australia, 10 November 2009

Advanced Ground Support in Underground Mining Course
Perth, Western Australia, 11–13 November 2009

Practical Soil Mechanics in Mining Short Course
Perth, Western Australia, 1 December 2009

Tailings Management for Operators Seminar
Perth, Western Australia, 2–3 December 2009

2010 EVENTS

Practical Rock Mechanics in Mining Short Course
Perth, Western Australia, 24–25 March 2010

Preconditioning Workshop
Perth, Western Australia, 19 April 2010

Second International Symposium on Block and Sublevel Caving
Perth, Western Australia, 20–22 April 2010

Environmental Geochemistry of Mine site Pollution – An Introduction, Short Course
Perth, Western Australia, 26–27 May 2010

Advanced Application of Seismology in Mines Short Course
Perth, Western Australia, 8–11 June 2010

Mining in Saprolites Workshop
Perth, Western Australia, 26 July 2010

Open Pit Rock Mass Modelling Seminar
Perth, Western Australia, 29–30 July 2010

Ground Support in Mining (basic level) Short Course
Perth, Western Australia, 25–27 August 2010

Managing Tailings and Waste Rock Drainage – Quality and Quantity Workshop
Perth, Western Australia, 28 September 2010

First International Seminar on the Reduction of Risk in the Management of Tailings and Mine Waste
Perth, Western Australia, 29 September – 1 October 2010

Blasting for Stable Slopes Short Course
Perth, Western Australia, 17–19 November 2010

ON THE HORIZON

Fourth International Seminar on Strategic versus Tactical Approaches in Mining
Perth, Western Australia, 8-10 November 2011

Since 2005, this series of international seminars on strategic versus tactical issues in mining has been well attended by senior mining professionals and managers in Australia, South Africa and Canada. The ACG is pleased to bring this innovative and highly topical seminar back to Perth.

www.strategic2011.com

Sixth International Seminar on Deep and High Stress Mining
Perth, Western Australia, 27-29 March 2012

The ACG is delighted to bring Deep Mining 2012 back to Perth. The main objective of this seminar series is to document and disseminate the latest experiences and state-of-the-art technologies in the challenging and evolving area of deep and high stress mining.

www.deepmining2012.com

Seventh International Conference on Mine Closure
Brisbane, Queensland, 24-28 September 2012

The mine closure conference series is a well recognised international forum that puts technical excellence first. These events provide industry professionals committed to responsible and sustainable mining with a unique opportunity to interact with their counterparts from different countries.

www.mineclosure2012.com

Seventh International Symposium on Ground Support in Mining and Underground Construction
Australia, 2013

This symposium will bring together the top academics, operators and technology developers to share information about innovative ground support strategies, processes and products to help maintain a competitive advantage.

www.groundsupport2013.com

associated international events

The ACG has more than 10 years experience in hosting international mining events throughout Australia that have regularly attracted over 150 local and international mining professionals. Our dedicated team of event organisers is skilled and trained to manage and coordinate all aspects of international events including: delegate registration, marketing and promotion, abstract and paper generation, venue coordination, sponsorship, committee, programme development etc.

The ACG also has a dedicated publication team that produces peer-reviewed proceedings for our symposia and conferences. This work is undertaken in-house where we can ensure that the high standard of the publication is maintained. Our team works in close collaboration with the proceedings editors, organising committees, paper authors and reviewers, and printers.

Our team has been instrumental in initiating many highly acclaimed series of international mining conferences, symposia and seminars that are held either annually or regularly throughout the world. In close collaboration with leading mining universities such as The University of Witwatersrand, South Africa, the University of Toronto, Canada, and the Pontificia Universidad Católica, Chile, the ACG is pleased to have been the founding body and/or key collaborator for the following event series:

>> International Conference on Mine Closure

>> International Seminar on Deep and High Stress Mining

>> International Seminar on Paste and Thickened Tailings

>> International Seminar on the Reduction of Risk in the Management of Tailings and Mine Waste

>> International Seminar on Safe and Rapid Development Mining

>> International Seminar on Strategic versus Tactical Approaches in Mining

>> International Seminar on Surface Support Liners: Thin-Sprayed Liners, Shotcrete and Mesh

>> International Southern Hemisphere Rock Mechanics Symposia

For the majority of these events, the ACG has produced technical, peer-reviewed event proceedings that can assist industry personnel to maintain and develop their skills, knowledge and capabilities.

During 2009–2010, the following ACG associated events were held:

2009

>> 12th International Seminar on Paste and Thickened Tailings, Chile

2010

>> 5th International Seminar on Deep and High Stress Mining, Chile

>> 5th International Conference on Mine Closure, Chile

>> 13th International Seminar on Paste and Thickened Tailings, Canada

financial statement 2009–2010

BALANCE SHEET AS AT 31 DECEMBER 2010

	2010 A$	2009 A$	2008 A$
Cash	1,278,143	1,191,089	1,330,727
Receivables	21,440	41,700	4,036
Total current assets	1,299,583	1,232,789	1,334,763
Plant and equipment	69,971	70,357	71,435
Total non-current assets	69,971	70,357	71,435
Total assets	1,369,554	1,303,146	1,406,198
Creditors and borrowings	419	53,765	1,630
Provisions (leave liabilities)	183,692	172,649	208,723
Total current liabilities	184,111	226,414	210,353
Net assets	1,185,443	1,076,732	1,195,845
Shareholder's equity			
Partner contributions	243,980	243,980	243,980
Retained profits/acc (losses)	941,463	832,752	951,865
Total shareholder's equity	1,185,443	1,076,732	1,195,845

The balance sheet should be read in conjunction with the accompanying notes.

PROFIT AND LOSS FOR THE YEAR ENDED 31 DECEMBER 2010

	2010 A$	2009 A$	2008 A$
Income			
Affiliate membership fees	71,000	86,000	72,000
Project administration	76,779	65,445	106,409
Project income – staff time	148,835	119,400	194,623
Project income – reimbursements	125,724	6,731	13,311
Event fees and sponsorships	997,714	843,726	884,862
Publications and training materials	119,462	113,542	208,189
Publications sponsorships	55,438	27,530	0
Government grants	0	0	30,000
Interest	12,010	19,528	16,077
UWA student and research allocation	47,000	41,000	59,557
Industry funded special projects	47,985	5,849	78,605
Total income	**1,701,947**	**1,328,751**	**1,663,633**
Expenses			
Personnel	879,232	877,007	914,142
Personnel – relocation expenses	0	0	0
Provisions – personnel	183,692	172,649	208,723
Office space incl. furniture and computers	3,107	3,668	42,948
Project and contract related expenses	133,312	47,936	8,633
Events, training and royalties	455,719	355,237	448,680
Travel, conferences and MV allowances	20,996	26,380	24,960
Operating overheads incl. printing	67,288	72,428	90,390
Professional services	12,000	12,000	18,000
Depreciation	13,663	15,361	12,258
Loss on trade-in of vehicle	8,478	17,132	29,321
Printing of books	0	0	0
Student related expenses incl. special projects	1,675	71,073	19,798
Total expenses	**1,779,162**	**1,670,871**	**1,817,853**
Net profit (loss)	**-77,215**	**-342,120**	**-154,220**
Opening retained earnings	-116,566	225,554	379,774
Closing retained earnings	**-193,781**	**-116,566**	**225,554**

The profit and loss account should be read in conjunction with the accompanying notes.

financial statement 2009–2010

STATEMENT OF CASHFLOWS

Year Ended 31 December 2010

	2010 A$	2009 A$	2008 A$
Cash flow from operating activities			
Receipts from customers	1,710,197	1,309,632	1,651,420
Payments to suppliers and employees	-1,626,675	-1,451,666	-1,566,985
Government grants	0	0	0
Interest received	12,010	19,528	16,077
Net cash flows from/(used in) operating activities	95,532	-122,506	100,512
Cash flows from investing activities	0	0	0
Acquisitions of plant and equipment	-8,478	-17,132	-29,321
Net cash flows from/(used in) investing activities	-8,478	-17,132	-29,321
Cash flows from financing activities			
Partners contributions	0	0	0
Net cash flows from (used in) financing activities	0	0	0
Net increase/(decrease) in cash held	87,054	-139,638	71,191
Add: Opening cash brought forward	1,191,089	1,330,727	1,259,536
Closing cash carried forward	1,278,143	1,191,089	1,330,727

The statement of cash flows should be read in conjunction with the accompanying notes.

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS AT 31 DECEMBER 2010

1 Summary of Significant Accounting Policies

The financial statements have been prepared in accordance with the historical cost convention. Cost in relation to assets represents the cash amount paid or the fair value of the asset given in exchange.

The financial statements have been made out in accordance with applicable accounting standards.

The accounting policies adopted are consistent with those of the previous year unless otherwise specified.

(a) Depreciation

Depreciation is provided on a straight line basis on all tangible fixed assets, other than freehold land, at rates calculated to allocate their cost or valuation less estimated residual value, against the revenue derived over their estimated useful lives.

As of 2007, in line with The University of Western Australia's policies, equipment purchases of less than $5,000 in value are no longer recorded as an asset. The at cost plant and equipment value was amended accordingly in 2008.

(b) Income Tax

Tax effect accounting procedures are not applied as the Australian Centre for Geomechanics is a tax free research and education centre run on a not for profit basis.

(c) Income Recognition

Government grants are recorded as income when received.

Membership fees are recognised as income in line with the membership period covered in the subscription.

(d) Employee Entitlements

Provision is made for long service leave and annual leave estimated to be payable to employees on the basis of statutory and contractual requirements. Vested entitlements are classified as current and non-current liabilities.

The contributions made to superannuation funds by the entity are charged against profit.

financial statement 2009–2010

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS AT 31 DECEMBER 2010 (continued)

		2010 A$	2009 A$	2008 A$
2	**Operating Profit/(Loss)**			
a.	The operating profit/(loss) before income tax is arrived at after charging/(crediting) the following items			
	Depreciation – plant and equipment	13,663	15,361	12,258
	Provision for employee entitlements	183,692	172,649	208,723
b.	Included in the operating profit/(loss) are the following items of operating revenue			
	Affiliate membership fees	71,000	86,000	72,000
	Industry funding environmental position	0	0	0
	Industry funding special projects and reimbursements	173,709	12,580	78,605
	Project administration and staff time	225,614	184,845	314,343
	Course fees and sponsorships	997,714	843,726	884,862
	Publications and training materials	119,462	113,542	208,189
	Interest – other persons/corporations	12,010	19,528	16,077
	Profit on sale of vehicles	0	0	0
	Publications contracts and sponsorships	55,438	27,530	0
	UWA student and research allocation	47,000	41,000	59,557
	Government grants	0	0	30,000
	Total revenue	1,701,947	1,328,751	1,663,633
3	**Receivables**			
	Other debtors	21,440	41,700	4,036
	Partners receivables	0	0	0
	Total receivables	21,440	41,700	4,036
4	**Plant and Equipment**			
	At cost	103,905	101,106	96,839
	Provision for depreciation	-33,934	-30,749	-25,404
	Total plant and equipment	69,971	70,357	71,435

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS AT 31 DECEMBER 2010 (continued)

		2010 A$	2009 A$	2008 A$
5	**Creditors and Borrowings (current)**			
	Trade creditors and accruals	419	53,765	1,630
6	**Provisions (current)**			
	Employee entitlements	183,692	172,649	208,723
7	**Partner Contributions**			
	CSIRO opening/closing balance	60,320	60,320	60,320
	WA School of Mines opening/closing balance	60,320	60,320	60,320
	UWA Geomechanics opening/closing balance	60,320	60,520	60,520
	UWA Geology	60,320	60,320	60,320
	DMP* (previously DoIR) opening/closing balance * contribution mainly provided in-kind	2,500	2,500	2,500
	Total partner contributions	243,980	243,980	243,980
8	**Statement of Cash Flows**			
	Reconciliation of net profit/(loss) to the net cash flow from operations			
	Net profit/(loss)	-77,215	-342,120	-154,220
	Changes in assets and liabilities			
	– Other debtors	20,260	-37,664	3,864
	– Trade creditors and accruals	-53,346	52,136	566
	– Employee entitlements provision	183,692	172,649	208,723
	Depreciation	13,663	15,361	12,258
	Loss on trade-in of vehicles	8,478	17,132	29,321
	Net cash flow from operating activities	95,532	-122,506	100,512

We gratefully acknowledge the support of Mr Ian Thorson – Faculty of Engineering, Computing and Mathematics, The University of Western Australia, who provided support in the preparation of the asset register.

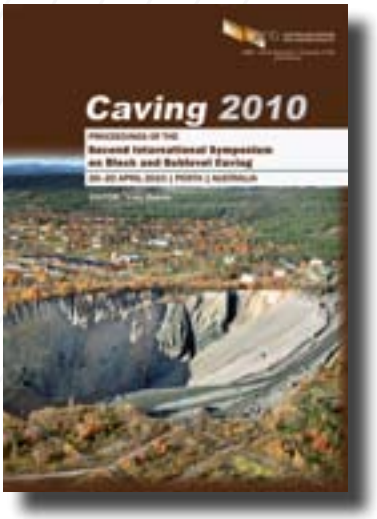
publications

The Australian Centre for Geomechanics provides industry with an excellent source of geomechanical knowledge through event proceedings, research reports and relevant industry publications. In response to industry need for high quality, comprehensive and state-of-the-art information, the ACG produces peer and technically reviewed event and seminar proceedings.

WINTHROP PROFESSOR YVES POTVIN (DIRECTOR)

Books (Editor)

Potvin, Y. (2010) Proceedings of the Second International Symposium on Block and Sublevel Caving, 20–22 April 2010, Australian Centre for Geomechanics, Perth, Australia, ISBN 978-0-9806154-1-8, 692 p.



Van Sint Jan, M. and **Potvin**, Y. (2010) Proceedings of the Fifth International Seminar on Deep and High Stress Mining, 6–8 October 2010, Santiago, Chile, Australian Centre for Geomechanics, ISBN 978-0-9806154-5-6, 562 p.

Journal papers

Potvin, Y. (2009) Strategies and Tactics to Control Seismic Risks in Mines. Journal of the Southern African Institute of Mining and Metallurgy, SAIMM, Vol. 109, No. 3, March 2009, pp. 177–186.

Hudyma, M. and **Potvin**, Y. (2009) An Engineering Approach to Seismic Risk Management in Hardrock Mines, Journal Rock Mechanics and Rock Engineering, DOI 10.1007/s00603-009-0070-0, Springer Verlag, published online: 21 November 2009.

Potvin, Y., Jarufe, J. and Wesseloo, J. (2010) Interpretation of Seismic Data and Numerical Modelling of Fault Reactivation at El Teniente, Reservas Norte Sector, re-peer reviewed and republished in Transactions of the Institution of Mining and Metallurgy, Section A, Vol. 119, No. 3, Maney Publishing, pp. 175–181. First published in Proceedings of the Second International Symposium on Block and Sublevel Caving, Y. Potvin (ed), 20–22 April 2010, Australian Centre for Geomechanics, Perth, Australia, pp. 483–493.

Proceedings of conferences, symposia and seminars

Potvin, Y. (2009) Surface Support in Extreme Ground Conditions – HEA Mesh, Proceedings of the First International Seminar on Safe and Rapid Development Mining, P.M. Dight (ed), Perth, Australia, 6–7 May 2009, pp. 111–119.

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Potvin, Y. and Heal, D. (2010) Dynamic Testing of High Energy Absorption (HEA) Mesh, Proceedings of the Fifth International Seminar on Deep and High Stress Mining, M. Van Sint Jan and Y. Potvin (eds), 6–8 October 2010, Santiago, Chile, Australian Centre for Geomechanics, pp. 283–300.

Potvin, Y., Jarufe, J. and Wesseloo, J. (2010) Interpretation of Seismic Data and Numerical Modelling of Fault Reactivation at El Teniente, Reservas Norte Sector, Proceedings of the Second International Symposium on Block and Sublevel Caving, Y. Potvin (ed), 20–22 April 2010, Australian Centre for Geomechanics, Perth, Australia, pp. 483–493.

WINTHROP PROFESSOR PHIL DIGHT (PROFESSOR OF GEOTECHNICAL ENGINEERING)

Books (Editor)

Dight, P.M. (2009) Proceedings of the First International Seminar on Safe and Rapid Development Mining, 6–7 May 2009, Australian Centre for Geomechanics, Perth, Australia, ISBN 978-0-9804185-7-6, 239 p.

Proceedings of conferences, symposia and seminars

Dight, P.M. and Hulls, I.H. (2009) Maturity and Shotcrete Strength for Early Re-entry, Proceedings of the First International Seminar on Safe and Rapid Development Mining, P.M. Dight (ed), Perth, Australia, 6–7 May 2009, pp. 81–100.

Wesseloo, J. and **Dight**, P.M. (2009) Rock Mass Damage in Hard Rock Open Pit Mine Slopes, Proceedings of the 2009 International Symposium on Rock Slope Stability in Open Pit Mining and Civil Engineering, 9–11 November 2009, Santiago, Chile, on CD Rom only.

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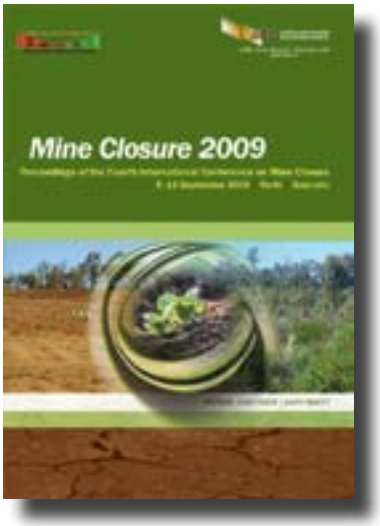
Dight, P.M. and Synman, L. (2010) Stress Measurement for St Barbara Mines Gwalia Deeps Project — One of the World's Deepest Underground Haulage Mines, Proceedings of the Fifth International Seminar on Deep and High Stress Mining, M. Van Sint Jan and Y. Potvin (eds), 6–8 October 2010, Santiago, Chile, Australian Centre for Geomechanics, pp. 105–116.

WINTHROP PROFESSOR ANDY FOURIE

Books (Editor)

Jewell, R.J., **Fourie**, A.B., Barrera, S. and Wiertz, J. (2009) Proceedings of the Twelfth International Seminar on Paste and Thickened Tailings, 21–24 April 2009, Viña del Mar, Chile, Australian Centre for Geomechanics, Perth, Australia, 404 p.

Fourie, A.B. and Tibbett, M. (2009) Proceedings of the Fourth International Conference on Mine Closure, 9–11 September 2009, Australian Centre for Geomechanics, Perth, Australia, 622 p.



Jewell, R.J. and **Fourie**, A.B. (2010) Proceedings of the 13th International Seminar on Paste and Thickened Tailings, 3–6 May 2010, Toronto, Canada, Australian Centre for Geomechanics, Perth, Australia, 548 p.

Jewell, R.J. and **Fourie**, A.B. (2010) Proceedings of the First International Seminar on the Reduction of Risk in the Management of Tailings and Mine Waste, 29 September – 1 October 2010, Australian Centre for Geomechanics, Perth, Australia, 532 p.

publications

Fourie, A.B., Tibbett, M. and Wiertz, J. (2010) Proceedings of the Fifth International Conference on Mine Closure, 23–26 November 2010, Viña del Mar, Chile, Australian Centre for Geomechanics, Perth, Australia, 740 p.

Proceedings of conferences, symposia and seminars

Belem, T., **Fourie**, A.B. and Fahey, M. (2010) Time-dependent Failure Criterion for Cemented Paste Backfills, Proceedings of the 13th International Seminar on Paste and Thickened Tailings, R.J. Jewell and A.B. Fourie (eds), 3–6 May 2010, Toronto, Canada, Australian Centre for Geomechanics, Perth, Australia, 548 p.

Fourie, A.B. and Gawu, S.K.Y. (2010) The Validity of Laboratory Flume Data for Predicting Beach Slopes of Thickened Tailings Deposits, Proceedings of the 13th International Seminar on Paste and Thickened Tailings, R.J. Jewell and A.B. Fourie (eds), 3–6 May 2010, Toronto, Canada, Australian Centre for Geomechanics, Perth, Australia, 548 p.

Lamont-Black, J., Jones, C.J.F.P., **Fourie**, A.B. and Krüger, L. (2010) Electrokinetic Belt Press Dewatering of Kimberlite Tailings — Case Study of a Full-scale Field Trial, Proceedings of the 13th International Seminar on Paste and Thickened Tailings, R.J. Jewell and A.B. Fourie (eds), 3–6 May 2010, Toronto, Canada, Australian Centre for Geomechanics, Perth, Australia, 548 p.

Belem, T., **Fourie**, A.B. and Fahey, M. (2010) Proceedings of the First International Seminar on the Reduction of Risk in the Management of Tailings and Mine Waste, R.J. Jewell and A.B. Fourie (eds), 29 September – 1 October 2010, Australian Centre for Geomechanics, Perth, Australia, 532 p.

Sun, J., **Fourie**, A.B. and Yuen, S.T.S. (2010) Instrumentation for use in Field Cover Trials — An Illustration of the Importance of Soil Specific Calibration, Proceedings of the Fifth International Conference on Mine Closure, A.B. Fourie, M. Tibbett and J. Wiertz (eds), 23–26 November 2010, Viña del Mar, Chile, Australian Centre for Geomechanics, Perth, Australia, 740 p.

DR DANIEL HEAL (PROJECT LEADER)

Proceedings of conferences, symposia and seminars

Lessard, J.F. and **Heal**, D. (2009) Evolution of Ground Support Practices within the Development Cycle at Perseverance Mine, Proceedings of the First International Seminar on Safe and Rapid Development Mining, P.M. Dight (editor), 6–7 May, Perth, Australian Centre for Geomechanics, pp. 181–197.

Potvin, Y., Wesseloo, J. and **Heal**, D. (2010) An Interpretation of Ground Support Capacity Submitted to Dynamic Loading, Proceedings of the Fifth International Seminar on Deep and High Stress Mining, M. Van Sint Jan and Y. Potvin (eds), 6–8 October 2010, Santiago, Chile, Australian Centre for Geomechanics, pp. 251–272.

DR MATTHEW HELINSKI (RESEARCH FELLOW)

Proceedings of conferences, symposia and seminars

Helinski, M., Fourie, A.B. and Fahey, M. (2009) In Situ Monitoring and Back Analysis of Two Different Paste Backfill Types, Proceedings of Mines and the Environment, 3–5 November 2008, Quebec City, Canada, published on CD by CIM Canada.

ASSOCIATE PROFESSOR RICHARD JEWELL

Books (Editor)

Jewell, R.J., Fourie, A.B., Barrera, S. and Wiertz, J. (2009) Proceedings of the Twelfth International Seminar on Paste and Thickened Tailings, 21–24 April 2009, Vina del Mar, Chile, Australian Centre for Geomechanics, Perth, Australia, 404 p.

Jewell, R.J. and Fourie, A.B. (2010) Proceedings of the 13th International Seminar on Paste and Thickened Tailings, 3–6 May 2010, Toronto, Canada, Australian Centre for Geomechanics, Perth, Australia, 548 p.

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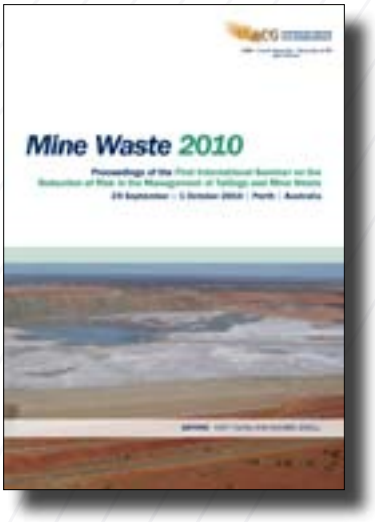
Proceedings of conferences, symposia and seminars

Jewell, R.J. (2010) Ensuring the Credibility of Thickening Technology, Proceedings of the 13th International Seminar on Paste and Thickened Tailings, 3–6 May 2010, Toronto, Canada, Australian Centre for Geomechanics, Perth, Australia, 548 p.



DR JOHAN WESSELOO (PROJECT LEADER)

Book chapters

Wesseloo, J. and Read, J. (2009) Acceptance Criteria, Guidelines for Open Pit Slope Design, J. Read and P. Stacey (eds), CRC Press/Balkema, ISBN 9780415874410, Chapter 9, pp. 221–236.

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Wesseloo, J., Visser, A.T. and Rust, E. (2009) The Stress–Strain Behaviour of Multiple Cell Geocell Packs, Journal Geotextiles and Geomembranes 27 (2009), Elsevier, pp. 31–38.

Potvin, Y., Jarufe, J. and **Wesseloo**, J. (2010) Interpretation of Seismic Data and Numerical Modelling of Fault Reactivation at El Teniente, Reservas Norte Sector, re-peer reviewed and republished in Transactions of the Institution of Mining and Metallurgy, Section A, Vol. 119, No. 3, Maney Publishing, pp. 175–181. First published in Proceedings of the Second International Symposium on Block and Sublevel Caving, Y. Potvin (ed), 20–22 April 2010, Australian Centre for Geomechanics, Perth, Australia, pp. 483–493.

Proceedings of conferences, symposia and seminars

Wesseloo, J. and Dight, P.M. (2009) Rock Mass Damage in Hard Rock Open Pit Mine Slopes, Proceedings of the 2009 International Symposium on Rock Slope Stability in Open Pit Mining and Civil Engineering, 9–11 November 2009, Santiago Chile, on CD Rom only.

Wesseloo, J. (2010) Empirical Methods for the Assessment of Seismic System Sensitivity, Proceedings of the Fifth International Seminar on Deep and High Stress Mining, M. Van Sint Jan and Y. Potvin (eds), 6–8 October 2010, Santiago, Chile, Australian Centre for Geomechanics, pp. 239–248.

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Potvin, Y., Jarufe, J. and **Wesseloo**, J. (2010) Interpretation of Seismic Data and Numerical Modelling of Fault Reactivation at El Teniente, Reservas Norte Sector, Proceedings of the Second International Symposium on Block and Sublevel Caving, Y. Potvin (ed), 20–22 April 2010, Australian Centre for Geomechanics, Perth, Australia, pp. 483–493.

geomechanics training products

COLLABORATING WITH INDUSTRY TO DEVELOP STATE-OF-THE-ART TRAINING AND AWARENESS MATERIAL **FOR MINE WORKERS**

Mining is carried out in an environment that undergoes frequent and varied changes. The factors that affect the safety and productivity of a mine must be considered at a number of different levels prior to and during the extraction process. Workers are required to readily identify and avoid potential hazards. As these skills are likely to arise without prior experience, they must be imparted through state-of-the-art training.

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A geotechnical hazard awareness training DVD for underground mine workers.

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A safety training DVD for underground metalliferous mine workers.

All underground mine workers are exposed to drilling and blasting processes. The aim of this new DVD is to provide workers with the critical knowledge on drilling and blasting to aid appreciation of the importance of these mining processes and their related hazards. The DVD will feature an introduction to the rock breaking process in mining, and how to handle, store and transport explosive products. The third part of the DVD will cover development drilling and blasting practices; and the fourth part will discuss production drilling and blasting.

Target audience

- Underground mine workers with the need to identify the potential hazards of working near or with explosives, and the protocols of re-entering a working area after blasting.

- Workers responsible for development and production drilling and blasting activities. This DVD will review drilling and blasting fundamental concepts that are critical to achieving optimal rock breaking outcomes.
- All industry stakeholders – those keen to learn more about drilling and blasting in underground mines.

Project Sponsors

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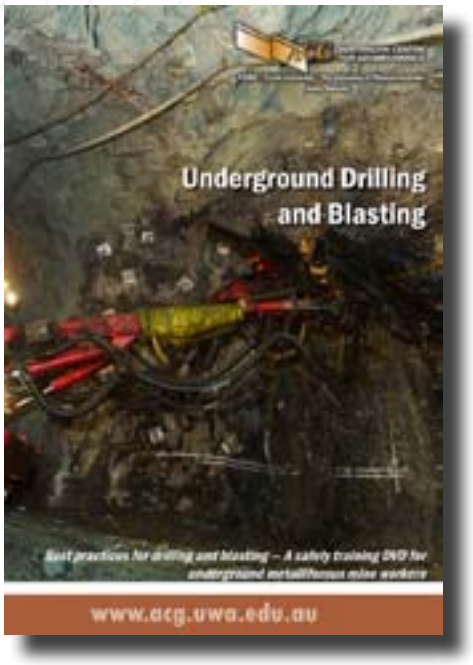

THE ACG'S TRAINING AND FURTHER EDUCATION TOOLS WOULD NOT HAVE BEEN DEVELOPED IF IT WERE NOT FOR THE SUPPORT AND ENCOURAGEMENT OF VARIOUS MINING COMPANIES, RESEARCH ORGANISATIONS AND INDUSTRY SUPPLIERS. IT IS THIS COLLABORATIVE APPROACH THAT BOTH CONSOLIDATES AND VALIDATES ACG'S ROLE IN THE DEVELOPMENT OF SAFETY TRAINING TOOLS AND TECHNIQUES. THROUGH THIS SPIRIT OF COOPERATION, THE ACG CONTINUES TO WORK WITH MINING STAKEHOLDERS AND RESEARCH ORGANISATIONS TOWARDS THE COMMON VISION OF CREATING A SAFER WORKING ENVIRONMENT WITHIN THE AUSTRALIAN AND OVERSEAS MINERALS INDUSTRIES.

acg membership

During 2009–2010, the majority of the Australian Centre for Geomechanics' Corporate Affiliate Members remained on board. Corporate and technical affiliate members assist the ACG to provide research excellence, training and education in the geomechanics disciplines. These memberships are fundamental in alerting funding bodies of the need to support the Centre. Contributions by affiliates are used by the Centre to promote research excellence, education and training in geomechanics areas.

The ACG was delighted to have the following Corporate and Technical Affiliate Members for 2009–2010.

CORPORATE AFFILIATES

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BHP Billiton Cannington Pty Ltd

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Gold Fields Australasia

Kalgoorlie Consolidated Gold Mines Pty Ltd

Newmont Asia Pacific

Rio Tinto Iron Ore

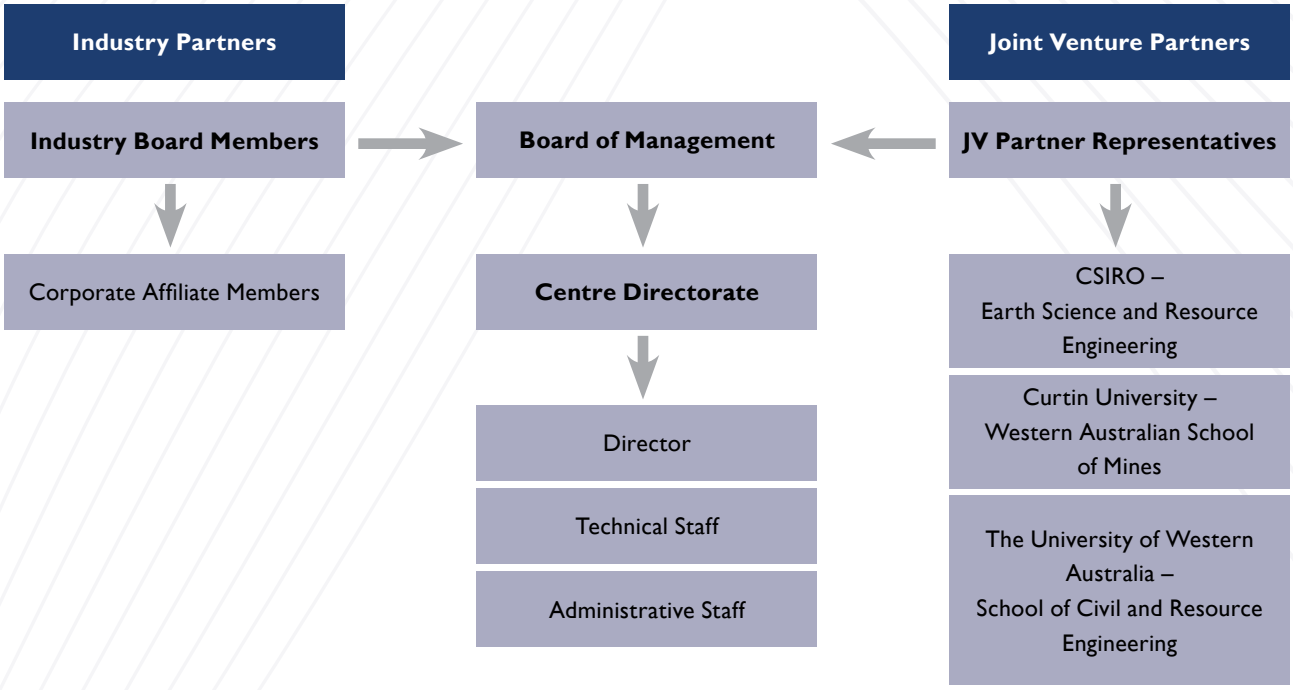
Snowden Mining Industry Consultants

SRK Consulting

TECHNICAL AFFILIATE

M. Sandy (AMC Consultants Pty Ltd)

management structure



AUSTRALIAN CENTRE FOR GEOMECHANICS
BOARD OF MANAGEMENT

The Australian Centre for Geomechanics Board of Management comprises of an independent chairman, director of the Centre and industry and joint venture partner representatives. The Board meets up to four times a year to present strategic direction for the Centre, review and approve activities and operations and to provide counsel.

Joint Venture Partner Representatives (3)

Dr Steve Harvey
(CSIRO – Earth Science and Resource Engineering)

Professor Paul Dunn/
Professor Stephen Hall
(Curtin University – WA School of Mines)

Winthrop Professor John Dell
(The University of Western Australia – Faculty of Engineering, Computing and Mathematics)

Chair (from industry)
Mr Ian Suckling
Newmont Mining Corporation

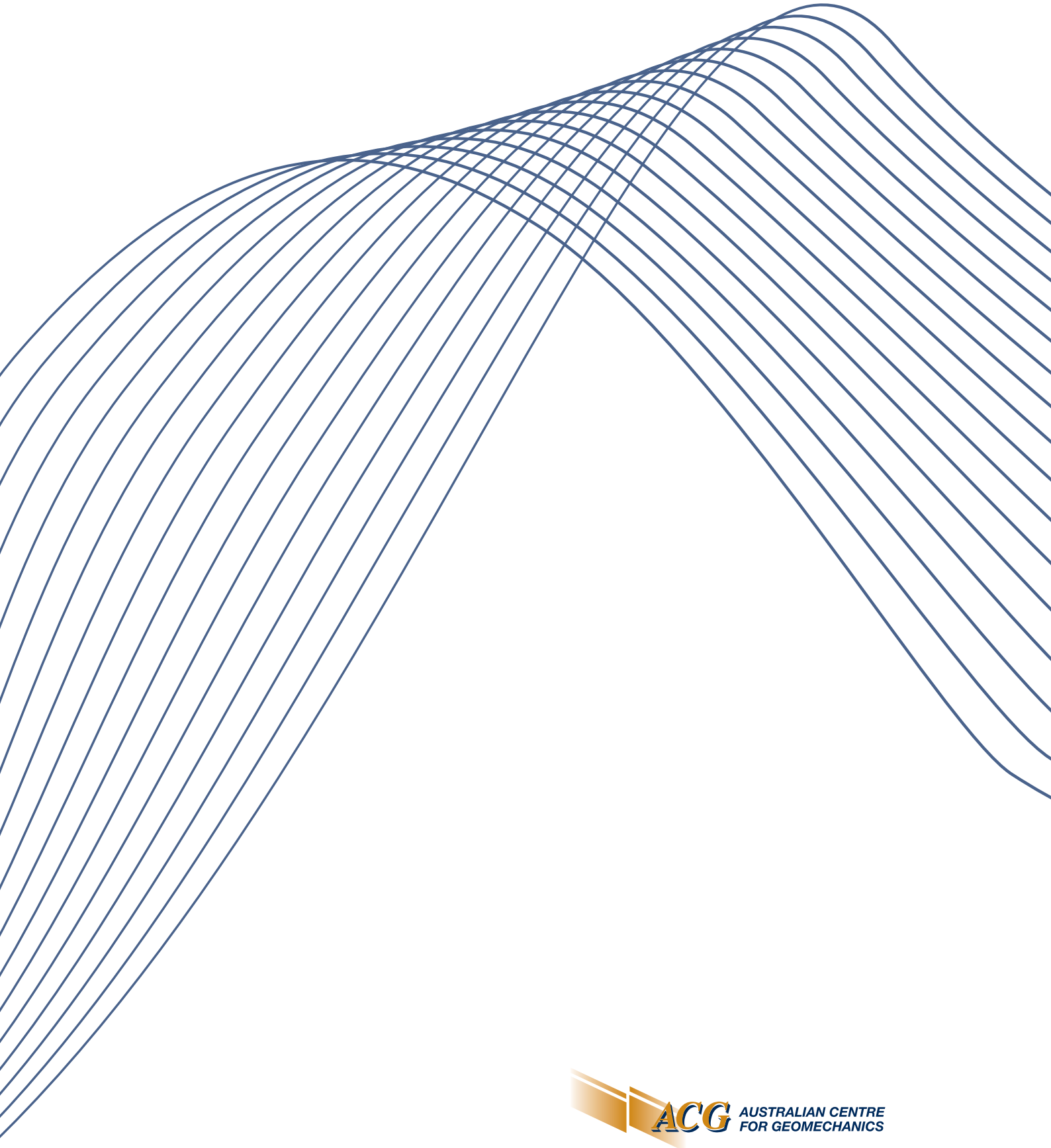
Centre Director (non-voting)
Winthrop Professor Yves Potvin
(Australian Centre for Geomechanics – The University of Western Australia)

Industry Representatives (up to 4)

Mr Mark Adams
(Barminco Pty Ltd)

Mr Richard Butcher
(Barrick Gold of Australia Ltd)

Mr Christopher Stone
(BHP Billiton Nickel West Pty Ltd)



ACG AUSTRALIAN CENTRE FOR GEOMECHANICS

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