Executive Summary

This paper relates to Geotechnical (Mining) Engineering, being "Geomechanics associated with the surface or underground excavation of an insitu rockmass, or matters associated therewith, for the extracted commodity itself, be it hard or soft rock or even unconsolidated material, including the construction of waste dumps and stockpiles and the placement of backfill", including:

- Open Pit Geotechnical Engineers, who have responsibility for operational ground control issues in the open pit where open pit mining methods are employed. This typically includes development and implementation of a ground control management plan, tailored to the risks identified, ground conditions and operating environment.
- Similar to the above, Underground Geotechnical Engineers, who have responsibility for operational ground control issues where different underground mining methods are used.

The initiative has been one area for focus within The AusIMM Mining Society (MinSoc) due to a number of reasons, such as (detailed additionally in Section 2):

- Concerns on the depth of skills and experience for the discipline within our industry
- A limited number and type of University courses available (in Australia)
- Lack of formal on-the-job mentoring and professional development programs through industry
- Increasing depth of mine development in complex and difficult ground conditions
- Pushing the limits with pit and mine designs, and optimising support systems
- The number, scale and nature of mine site instabilities and failures
- Difficulties in filling such roles within mining companies or consultancy firms

Based on this paper and the actions proposed, MinSoc and more broadly The AusIMM may be able to help to understand and define the issue(s) and put measures in place towards lobbying, supporting and influencing change where necessary to improve on the current situation and apparent issues.

Presently there is less opportunity for robust training and development programs, with the risk of knowledge (site-specific and general) loss and reduced technical capacity in the medium to long term. If not managed carefully, this loss of knowledge and skill in turn results in increased safety and economic risks to operations.

Given company down-sizing, although there is a greater availability of Geotechnical Engineers (including those in the 5 – 15 year experience bracket, which were so difficult to attract / recruit only a few years ago), it is arguably even more important now for organisations to invest in the right training and development processes. At the present time, there is a sense of a (short-term) reduced shortage of available professionals given the industry cycle. Nevertheless a diminishing skills-base and gap remains to be addressed.

There is a need for continued government, private sector and industry association support for Geotechnical Engineering university courses. Companies (whether mining companies or consulting firms) of course have an important role in continuing to support graduate intake levels and in-house skills development, even during industry down-turns such as those being presently experienced.

A total of nine recommendations to address the issues and emerging themes identified are presented in this document (two of these have effectively been actioned), towards addressing and hopefully improving the situation and effectively closing the Geotechnical Engineering skills gap issue.

Attachments

Attachment A – AusIMM Careers Booklet (extract) and Brochure for Geotechnical Engineering
Attachment B – AusIMM CP Geotechnical (definition / requirements)
1 Introduction

This topic of the “Geotechnical Engineering Skills Gap” has been on the agenda as a special project or initiative within The AusIMM Mining Society (MinSoc) for the last couple of years. Within that period there has been quite a shift in terms of the nature of the problem (i.e., an increased availability of staff given down-sizing; but remaining concerns on the level of skills / specialisation), however it has now reached a stage considered appropriate for a discussion paper to be prepared, which will hopefully lead to specific actions that can help to address some of the key issues.

For the purpose of this discussion paper, the AusIMM careers information and discipline definitions for Geotechnical Engineering (refer Attachment A) involves the identification and solving of problems involving soil, rock and groundwater, and design structures in and below the ground, using the principles of earth science and engineering. Geotechnical (or Geological) Engineering includes a number of ground engineering specialities such as geotechnical engineering, land remediation, rock mechanics, hydrogeology and engineering geology.

Further to this, the emphasis in this case is on Geotechnical (Mining) Engineering, being "Geomechanics associated with the surface or underground excavation of an insitu rockmass, or matters associated therewith, for the extracted commodity itself, be it hard or soft rock or even unconsolidated material, including the construction of waste dumps and stockpiles and the placement of backfill", including:

- Open Pit Geotechnical Engineers, who have responsibility for operational ground control issues in the open pit where open pit mining methods are employed. This typically includes development and implementation of a ground control management plan, tailored to the risks identified, ground conditions and operating environment.
- Similar to the above, Underground Geotechnical Engineers, who have responsibility for operational ground control issues where different underground mining methods are used.

The initiative has been one area for focus within MinSoc due to a number of reasons, including but not limited to the following:

- General concerns regarding the depth of skills and experience for the discipline within our industry
- The very limited number and type of University courses available in Australia to support appropriate education, training and development (including Bachelor degrees and postgraduate studies)
- The apparent lack of formal on-the-job mentoring and professional development programs through industry
- Increasing depth of mine development (open cut and underground) in complex and difficult ground conditions
- Operating cost drivers, with companies striving to push the limits with pit and mine designs, and optimise support systems - in an attempt to extract additional value
- The number, scale and nature of mine site instabilities and failures within Australia and internationally that have attracted industry attention and broader media coverage
- Periods of extreme difficulty in filling such roles within mining companies or consultancy firms (i.e., attracting and retaining suitably skilled and experienced professionals)

Considering the initial impressions above, it was considered MinSoc and more broadly The AusIMM may be able to help to understand and define the issue(s) and put measures in place towards lobbying, supporting and influencing change where necessary to improve on the current situation and apparent issues.

This document endeavours to capture key issues and themes, and suggest additional actions to help improve the situation or close the supposed gap (assuming one does exist).
2 Issue Definition

Further to the reasons for the initiative outlined in the Section 1 (Introduction), the issue has been previously defined based on research undertaken, which is presented in the following sections. The core issue sits within a broader problem associated with skills gaps and shortages, as summarised in the AMMOP (Third Edition, Volume I) piece on Skills Shortages:

“In recent years, the technical and professional skills shortage in the minerals sector has proven to be both global and persistent. The rapid growth in the demand for skilled employees presents challenges to the minerals industry and may prove a barrier to project development. Retaining employees and building their capacity, attracting new graduates, increasing the opportunities for women in the industry and seeking foreign graduates and skilled workers are among the strategies used by companies. The neglect of education of professionals by the industry over many decades, the boom and bust employment cycles in the industry, and the reluctance of many graduates to work in remote areas and in an industry that is perceived as unattractive, have contributed to this situation.”

As documented by Hebblewhite (2010) “Within the category of geoscientists and engineers, falls the category of geotechnical professionals. These people go by various names, including: engineering geologists, geotechnical engineers, strata control or ground control officers or engineers. What is clear across all the different sectors of the mining industry is that there is a chronic shortage of such geotechnical professionals at the present time…..”. Although the shortage in terms of supply is quite different now compared to a few years ago and around the time of this paper, there remains concern around the training (on the job in particular) and development processes for such professionals and the depth and breadth of experience that stems from this.

Hebblewhite’s paper also reflects on studies (including the Australian Centre for Geomechanics) investigating the issues with respect to tertiary education programs. These studies suggest there are not enough suitably skilled, trained and experienced geotechnical (mining) professionals available. An increased need for specialist skills has been identified for more difficult mining environments (and due to higher standards being expected by companies, regulators and communities), and a clear gap exists in the supply chain for education and training of geotechnical professionals (a function of the limited suitable education programs and / or lack of student intakes).

Clearly the current situation is quite different when considering the situation in the industry involving significant percentage of geotechnical professionals (along with other disciplines) from within the mining sector who are currently unemployed. This in turn impacts on and reduces corporate technical knowledge, succession planning options, and fundamental opportunities for mentoring, training and development of staff.

The stages of decision-making, when people are likely to be influenced through the early period, include the following phases, which provide an opportunity to attract further interest in the discipline:

1. Entering school
2. Entering engineering
3. Entering the workforce

Unfortunately the number of tertiary institutions providing undergraduate Geotechnical (Mining) Engineering courses is very limited, with the only options being University of Queensland and University of Tasmania, however the post graduate courses offered at UNSW and WASM in Mining Geomechanics as well as specialised study through ACG have a very good reputation (and a relatively flexible, practical and balanced format). In the early stages of employment upon entering the workforce, a considerable number of organisations do not provide adequate (both formal or on-the-job) training to less experienced staff, who subsequently learn poor habits or worse still, incorrect methods of undertaking their work.

After completing university studies, the challenge often continues because it is not necessarily clear that an individual wants to pursue geotechnical engineering, and if they do, there is the question of who will employ someone in a specialist role? Given the situation with available courses, some of those interviewed for this paper have employed a few aspirants from the engineering side who didn’t have a sufficient geology background. Of course on the other side there are many examples of geologists who don’t possess an adequate understanding of engineering principles.

Developing a well-rounded / balanced professional often requires a considerable effort and investment. Unfortunately many mine managers don’t necessarily see how geotechnical engineers can make a positive contribution to meeting production targets. Particularly in the current climate with
such a focus on cost reduction, there are financial implications associated with effective mine stability management, including the installation of more rock bolts, extensometers or piezometers for example. Consequently, what can occur is rather than geotechnical engineering being an integral part of mine planning, the geologist and engineers work together to define the orebody and plan for its extraction to meet their production goals, and then provide the plan to the geotechnical engineer to make it work. Nobody learns anything out of this approach, particularly not the junior geotechnical engineer.

According to le Roux (2006) “a successful geotechnical engineer has to have a good understanding of almost all technical aspects of mining. Even more important are good communications skills and the ability to problem solve on the fly. None of these skills are taught at tertiary institutions and therefore need to be learnt in the workplace. However, the shortage of geotechnical professionals means that young engineers do not always receive the mentorship and training they need to develop confidence and technical effectiveness.”

The larger and more complex sites often possess more substantial geotechnical teams, which obviously provides an opportunity for development and implementation of more formal and structured training and mentoring program. This isn’t necessarily always the case though and in the current mining cycle with so much emphasis on cutting costs (including staff) there is clear evidence of a reduced ability to train and mentor junior to mid-level staff, and a focus on lean teams and core mining operational geotechnical support. Many larger companies that used to have formal and comprehensive graduate programs don’t exist now (at least in a form resembling past systems).

In this environment there is less opportunity for robust training and development programs, with the risk of knowledge (site-specific and general) loss and reduced technical capacity in the medium to long term. If not managed carefully, this loss of knowledge and skill in turn results in increased safety and economic risks to operations.

Given company down-sizing, although there is a greater availability of Geotechnical Engineers (including those in the 5 – 15 year experience bracket, which were so difficult to attract / recruit only a few years ago), it is arguably even more important now for organisations to invest in the right training and development processes. At the present time, there is a sense of a (short-term) reduced shortage of available professionals given the industry cycle. Nevertheless a diminishing skills-base and gap remains to be addressed. “Career hopping”, either as a function of the previous environment with Geotechnical Engineers in such high-demand (with attractive salaries and incentives to move), or in the current climate of “right-sizing” leading to high staff turn-over, does not help the situation in developing well-rounded individuals. The Geotechnical Engineer should be similarly valued and considered to be as critical to the mine planning and technical services processes as the Mine Geologist, Mine Planning Engineer and Scheduling Engineer (towards an integrated approach of achieving optimal resource extraction).

3 Information Sourcing

The following people are acknowledged as an initial pool of key people who contributed during discussions on the topic. The fact they were each willing to draw upon their own impressions and experiences, and share their ideas is greatly appreciated and important towards achieving a healthy cross section of opinions and ideas, and I / we thank these people for their contributions.

- Bruce Hebblewhite (UNSW)
- John Player (MineGeoTech)
- Kim Chan (GHD)
- Lesley Munsamy (formerly GHD, now Anglo American)
- Mike Sandy (AMC)
- Peter Hills (Pitt & Sherry)
- Peter Knight (Newcrest)
- Rob Botha (BHP Billiton)
- Roger Johnson (Anglo American)
- Tim Sullivan (PSM)

In particular Peter Hills’ inputs, relevant experiences and advice have been highly valued. Separate discussions on an ad-hoc basis with others, and initial / preliminary research was also undertaken towards additionally understanding the issue and opportunities. The limited research included consideration of select papers as referenced in Section 7.
4 Geotechnical (Mining) Engineering Attributes

According to The AusIMM's Guidelines for Chartered Professional (Geotechnical Engineering), "a geotechnical engineering (mining) professional Investigates, plans, designs and monitors the process of creating fit-for-purpose excavations for the extraction of ore, or creating infrastructure in mining operations." Further to this, Attachment B details the type and level of experience and competence generally required for registration as a Chartered Professional (Geotechnical Engineering), which is not intended to be exhaustive but provides information on all of the areas of competency necessary to achieve additional recognition of one's professional standing. The groups of practice are summarised below:

- Site characterisation
- Geotechnical analysis and design
- Monitoring
- Mining systems
- Safety, health and risk

What contributes to well-rounded, highly professional Geotechnical Engineer?

- A balance between specialisation and variety in the type of work (including stability monitoring and management, as well as design experience).
- Education – appropriate graduate and post-graduate courses in Geotechnical Engineering.
- Substantial experience on site, including day-day operational, projects, studies and design.
- Mentoring and professional development opportunities.
- Communication skills – an ability to interact with a broad cross section of professionals and operational personnel as part of ground control management activities (including special projects and studies, and design functions).

The Senior Site Geotechnical Engineer must have sufficient experience to work with all technical disciplines to ensure that geomechanics is seen as an integral step in the production chain. He / she must work with the Geologist and the Design and Production Engineers to ensure that geomechanics is the foundation step in optimising extraction of the ore. No longer is it good enough to concentrate on optimising the schedule and leaving the Geotechnical Engineer to "make it work".

5 Emerging Themes

At a senior level, it is considerably easier to source professionals with site operational geotechnical experience (stability monitoring activities and other elements from within a typical ground control management plan) than those well-credentialled in project investigation and design work.

Considering the limited courses available in Australia; we are experiencing a real trend towards postgraduate versus undergraduate studies. Feedback received suggested there is a need to strengthen key universities (and perhaps add another - don’t dilute though) through integrated courses across different universities.

Some examples include consulting firms such as PSM, which has a very strong focus on mentoring. In addition, it is mandatory for staff to undertake the UNSW masters course in Mining Geomechanics (including generous support for fees and time). PSM have also been active in working closely with UNSW to shape the course and lectures. The University of Tasmania has also received very good support from Coffey in their undergraduate geotechnical program through support and lecturing.

Notwithstanding some of the challenges outlined in Section 2, it is pleasing to acknowledge some of the current initiatives through the likes of the BHP Billiton groups, Rio Tinto and Newcrest by way of initial examples. In the Iron Ore division of BHP Billiton, this includes a more structured graduate program over a two-year period on site, including a log-book, mentor and supervisory sign-off. In addition, BMA have an arrangement with the University of Queensland involving a tailored course for training of Geotechnical Engineers. Such initiatives and those being applied by other companies are encouraging, however we are a long way off the systems in place at Mt Isa previously for example, where there was a large on-site geotechnical group providing comprehensive training and mentoring for backfill, blasting and rock mechanics.
At the present time it is likely an increasing number of graduates and postgraduate students will experience difficulties in sourcing Geotechnical Engineering employment positions. As a result in the latter stages of these studies and beyond, there may be opportunities to coordinate mentoring and practical training by established practitioners (and for formal recognition of continuing professional development activities).

6 Next Steps / Recommendations (and Ideas)

1. Published the Executive Summary of this draft Discussion Paper in the MinSoc November 2013 Newsletter towards promotion and feedback (received some inputs / feedback).
2. Distribute draft version to the MinSoc committee, as well as the selection of people who were engaged through the process for their views, and also other interested individuals.
3. Distribute final version of this paper more broadly within AusIMM and beyond as appropriate.
4. Identify priorities in supporting the strengthening of Universities through additional contributions around courses or subjects that could be led by specialists from industry (either mining companies or consulting groups; which The AusIMM may be able to facilitate).
5. Identify, recognise and support existing and new courses – such as those discussed in Section 2, which in several cases are receiving good industry support currently. Tie this in with Masters program revisions aligned to the national Australian Quality Framework (AQF).
6. Investigate trends in AusIMM CP (geotechnical) take-up, lessons and explore opportunities to additionally encourage (e.g., membership fee subsidy incentives).
7. Understanding and promoting supplementary courses available (post graduate studies, ACG short-courses, the Large Open Pit (LOP) online training package using the guidelines for open pit slope design as a foundation).
8. Better understand international models such as South Africa’s Chamber of Mines CEO’s committee funding development of self-learning material and tuition in this field. Further to this is the South African Institute of Rock Engineering – mentoring, coaching, assessing and examining (as part of the Rock Mechanics certificate). Develop and implement similarly.
9. Identify co-authors to build on this document and jointly publish / promote a paper towards action and change. Seek to raise the profile of Geotechnical Engineering, which will enhance the desire from students and demand for such courses, and strengthen an appreciation of the role within the context of successful mine planning and operations.

7 References

- AMMOP (Third Edition, Volume I) piece on Skills Shortages

Dave Clark
Principal Geotechnical (Mining) Engineer
BE (Geological) Hons, MEngSci (Mining Geomechanics), FAusIMM(CP), MIEAust
Geotechnical/Geological Engineering

**WHAT DOES A GEOTECHNICAL/GEOTECHNICAL ENGINEER DO?**

Geological engineers identify and try to solve problems involving soil, rock and groundwater, and design structures in and below the ground, using the principles of earth science and engineering. Geological engineering includes a number of ground engineering specialties such as geotechnical engineering, land remediation, rock mechanics, groundwater hydrology and engineering geology.

Geological engineers may perform the following tasks:

- Investigate the engineering feasibility of planned new developments involving soil, rock and groundwater
- Plan and undertake site investigations for proposed major engineering works such as bridges, dams and tunnels
- Design measures to correct land contamination and salination
- Design major structures in rock such as tunnels, basements and shafts
- Supervise construction and performance of major engineering works involving the ground
- Work out strategies to control landslides and areas of potential instability
- Coordinate of multi-disciplinary study teams
- Perform computer analyses, use computer databases and generate computer-aided designs.

Geological engineers may work with other professionals including environmental scientists, geologists and hydrologists on solving land degradation, groundwater and salination problems; with civil engineers in the design and construction of better transportation links; or with mining engineers in designing open-cut and underground mines, and on rehabilitation works on completion of mining. Geological engineers typically spend up to half of their working hours on field investigations and supervising construction of their designs. Responsibilities of the role typically include ensuring geotechnical activities are conducted safely in order to provide a safe working environment for employees and contractors in accordance with company standards and government legislation.

Geologists and Engineers (usually civil or mining) can do postgraduate study to specialise and work as geological/geotechnical engineers. Postgraduate study is often more flexible than undergraduate study to fit in with full-time work.

**Geotechnical Engineer - Open Pit**

Open Pit Geotechnical Engineers have responsibility for operational ground control issues in the open pit where open pit mining methods are used. They collect geotechnical data on the rock mass; monitoring of the performance of the excavation slopes and installed support systems. They are responsible for the design, installation, maintenance and use of geotechnical instrumentation to assess the response of the rock mass to the mining activities; and for the interpretation and reporting of data collected. Typically they will deal with slope stability issues, erosion and the effects of weather conditions on the pit stability.

**Geotechnical Engineer - Underground**

Underground Geotechnical Engineers have responsibility for operational ground control issues underground where different underground mining methods are used. Underground geotechnical engineers collect geotechnical data on the rock mass; monitor the performance of the excavations and installed support systems; design, install, maintain and use of geotechnical instrumentation to assess the response of the rock mass to the mining activities; and interpretation and reporting of data collected. Underground geotechnical engineers spend time underground in the mine investigating and designing against rock bursts and failing of the development’s walls.

**Geotechnical Engineer - Civil**

Civil geotechnical engineers often inspect proposed construction sites to work out soil and foundation conditions by conducting drilling and sampling programs. They oversee and participate in field and laboratory testing of soils, making sure that test equipment and machinery is properly set up, prepare reports of test results and make recommendations for the solution of engineering problems identified in test reports. They can also prepare specifications of soil mixtures for use in roads, embankments and other construction, calculate and advise on the required slope at cuttings and the thickness of soil dams and retaining walls.

**Geotechnical Engineer - Consulting**

Consulting geotechnical engineers will often be exposed to both underground and open pit projects depending on the company they work for and their area of expertise. Consulting geotechnical engineers will often be based in coastal capital cities and fly to their projects as necessary. Depending on the company they work for they may also be involved in civil engineering and/or construction projects.

**Geotechnical Engineer - Computing/Modelling**

Geotechnical Engineers who specialise in computing and modelling often design and apply computer programs and models to characterise and predict rock and ground behaviour. The models often look at stress regimes and rock strength by looking at the rock properties and then varying the situation parameters whether they be geometrical, material etc., to see how the model responds to the changes.

**Geotechnical Engineer - Academic/Research**

Academic and research geotechnical engineers investigate why and how things behave the way they do or are the way they are rather than looking primarily at the economic issues of how to mine most economically and locating the boundaries of ore deposits for this reason. Academic and Research geotechnical engineers often work in universities or CRC’s (cooperative research centres).
MARNIE PASCOE
BSc Geology (Hons) and working on finishing MEngSc Workplace Trainer / Assessor MAssIM (CP)

Why did you choose your particular career?
At the time WMC Kambalda were looking for a geologist with a structural geology background who wanted to learn new things. I worked with an experienced rock mechanics engineer and did a lot of learning on the job. Since then I’ve found the job very interesting and rewarding with good advancement opportunities and diversity.

What have you done so far in your career?
I worked for 3 years at Kambalda as the “sorcerer’s apprentice” providing a geotechnical service to the 15 or so Nickel and Gold Mines in the region. I then joined BHP Minerals Cannington Project as part of the AMC Consultants team and helped set up the Cannington Mine. I was there for 4 years and saw the mine go from feasibility project to producing mine. I moved to AMC Consultants in Melbourne and worked there for 5 years doing all sorts of project work on existing mines and working on scoping and feasibility studies as well as training courses for miners and technical staff. RMIT University engaged AMC to teach their 4th yr rock mechanics unit which I did for 4 years. I rejoined WMC at Olympic Dam as the Geotechnical Superintendent and was there for 3 years as part of the team that stabilised mine production and improved mine design and technical practices. Following the BHP Billion takeover of WMC I now work for Exploration and Mining Technology as a technical expert providing support to mining operations and identifying and implementing new technologies to mining operations.

What have you enjoyed most about your profession(s)?
Working with a wide variety of people across the operation. Being involved in more than one discipline. The job requires that you have a sound working knowledge of all aspects of the mining operation to be able to contribute effectively. Being part of the group that often leads change in the workplace.

For someone considering a career in your profession, are there any words of wisdom to pass on to them?
Move around every 3 yrs or so (you need about this length of time to become really familiar with most aspects of the ground behaviour at a site) to broaden your experience of mining methods and conditions. Be prepared to sometimes be last in line for promotion or sometimes letting people “claim” your improvements as a way of getting them to change. Try not to say “I told you so” too many times. Learn to communicate your ideas effectively, the engineering profession is an easy bit, getting someone to do something they may not want to do is the hard bit. Be open to review of your ideas and find a mentor that will give you this input “without fear or favour”.

STEVE WEBBER
Geotechnical Engineer, Consolidated Minerals, Beta Hunt Mine

What formal qualifications do you have?
B.Sc. (Physics), B.Sc. (hons), M.Sc. Both Geophysics all from Victoria University of Wellington, New Zealand, M.Sc. (dist) Mining Geophysics from University of the Witwatersrand, South Africa, Ph.D. (Geological Engineering) University of Oklahoma, U.S.A.

What have you enjoyed most about your profession(s)?
Being exposed to things relatively few people get to see. Not having to dress formally to go to work. Being exposed to different conditions and problems every day – the job/profession is never the same on any two consecutive days.

What are the negatives and low points in your career?
I suppose being retrenched twice would normally be considered to be career low points. However, each time I was retrenched my career changed direction and life got a lot more interesting so getting retrenched was brilliant.

For someone considering a career in your profession are there any words of wisdom to pass on to them?
Do what you enjoy doing. Chase the fun not the dollar. Just be aware of the consequences of your decisions. Choosing a niche field is great but it can limit your career options at times. Don’t be scared to change career directions and start at the bottom again. Take advantage of any opportunities to go on courses, go to conferences, receive training or to broaden your knowledge. Ask questions all the time.

BRUCE HEBBLEWHITE
BEngining, Hons 1) PhD (AICdE) MAusIM
Head of School & Research Director, Professor of Rock Mechanics – School of Mining Engineering, The University of NSW.

What formal qualifications do you have?
I did my first degree in Mining Engineering at UNSW, graduating in 1974. I travelled to England to do a PhD in rock mechanics at the University of Newcastle upon Tyne, whilst working for Cleveland Potash Ltd. After returning to Australia, I undertook a Diploma offered by the University of New England, run by the Australian Institute of Company Directors.

Why did you choose your particular career(s)?
Having completed my undergraduate degree, I chose to pursue a PhD in rock mechanics, my interest in the field having been captured by the topic itself, but also by a very capable and inspiring lecturer. I did not want to just sit and contemplate theoretical concepts, but was taken by the practical applications of rock mechanics in mining. The opportunity arose to study for my PhD at the internationally famous centre of mining geomechanics at the University of Newcastle-upon-Tyne in the UK. There was the added bonus of working for Cleveland Potash Limited at their Boulby Mine, on a range of geotechnical issues associated with mining potash at 1,100m deep, under the North Sea – the deepest mine in Europe at the time. This time spent in the UK was an extremely rewarding experience – not just academically, but as a life experience, studying and living in a different part of the world.

What have you done?
During my undergraduate degree, I had three periods of industry industrial training – all very different - spent in WA at Mt Newman, at Broken Hill, working in the old South Mine, and in Tasmania with Aberfoyle Ltd, working in the north-east, and also at Cleveland Tin on the west coast at Lunra. After completing my PhD in 1977, I returned to Australia and joined the Australian Coal Industry research Laboratories Ltd (ACIRL) in Sydney. I spent 17 years with ACIRL, during which I saw many changes across the coal industry. For the last 10 years I headed ACIRL’s Mining Division and had the opportunity to work on a large range of mining projects – both applied research and consulting – in many parts of Australia and around the world. In 1995 the opportunity arose to join academia at UNSW as a Professor of Rock Mechanics and Research Director. This was an industry-funded position which ensured I would be able to maintain my close involvement with the industry, as well as entering the new field of teaching and university research. I took over at UNSW as Head of School in 2003, moving back into a management role, but still active in teaching, research and industry consulting.

Do you have any regrets about how your career has developed?
None whatsoever. I would never have contemplated the move to academia, but having done it at the stage of my career that I did, I have absolutely no regrets.

What have you enjoyed most about your profession(s)?
The exposure to so many different parts of the industry and the people in them in all parts of the world. It is a big industry, but in many ways it is very small and close, in terms of people and the contacts you make. I have also really enjoyed being able to make a difference – both through technical project work, and now education.
MINERALS INDUSTRY CAREERS.
RICH IN DISCOVERY.

Geotechnical/Geological Engineering

WHAT DOES A GEOTECHNICAL/ GEOLOGICAL ENGINEER DO?

Geological engineers identify and try to solve problems involving soil, rock and groundwater, and design structures in and below the ground, using the principles of earth science and engineering. Geological engineering includes a number of ground engineering specialties such as geotechnical engineering, land remediation, rock mechanics, groundwater hydrology and engineering geology.

Geological engineers may perform the following tasks:

- Investigate the engineering feasibility of planned new developments involving soil, rock and groundwater
- Plan and undertake site investigations for proposed major engineering works such as bridges, dams and tunnels
- Design measures to correct land contamination and salination
- Design major structures in rock such as tunnels, basements and shafts
- Supervise construction and performance of major engineering works involving the ground
- Work out strategies to control landslides and areas of potential instability
- Act as consultants or researchers in managerial positions and be responsible for coordination of multi-disciplinary study teams, staff recruitment and matters of work organisation
- Perform computer analyses, use computer databases and generate computer-aided designs.

Geological engineers may work with other professionals pooling their expertise to solve particular problems. For example, they may work with environmental scientists, geologists and hydrologists on solving land degradation, groundwater and salination problems; with civil engineers in the design and construction of better transportation links; or with mining engineers in designing open-cut and underground mines, and on rehabilitation works on completion of mining. Outdoor work is an essential aspect of geological engineering investigations.

Geological engineers typically spend up to half of their working hours on field investigations and supervising construction of their designs.
GEOTECHNICAL AND GEOLOGICAL CAREERS

- Geotechnical Engineer – Open Pit
- Geotechnical Engineer - Underground
- Geotechnical Engineer - Civil
- Geotechnical Engineer - Consulting
- Geotechnical Engineer - Computing/modelling
- Geotechnical Engineer - Academic/research

Responsibilities of the role typically include ensuring geotechnical activities are conducted safely in order to provide a safe working environment for employees and contractors in accordance with company standards and government legislation.

WHAT ARE THE CAREER OPPORTUNITIES?

Most geological/geotechnical engineers are based in coastal capital cities, and are employed by a range of companies, from large multinationals to small, local consultants, as well as by all levels of government.

Geologists and Engineers (usually civil or mining) can do postgraduate study to specialise and work as geological/geotechnical engineers. Postgraduate study is often more flexible than undergraduate study to fit in with full time work.

MARNIE PASCOE
BSc Geology (Hons) Completing MEngSc
Workplace Trainer / Assessor MAusIMM (CP)

Why did you choose your particular career?
At the time WMC Kambalda were looking for a geologist with a structural geology background who wanted to learn new things. I worked with an experienced rock mechanics engineer and did a lot of learning on the job. Since then I’ve found the job very interesting and rewarding with good advancement opportunities and diversity.

What have you done so far in your career?
I worked for 3 years at Kambalda providing a geotechnical service to the 15 or so Nickel and Gold Mines in the region.

I then joined BHP Minerals’ Cannington Project as part of the feasibility team and helped set up the Cannington Mine. I moved to AMC Consultants in Melbourne and worked there for 5 years doing all sorts of project work on existing mines and working on scouting and feasibility studies as well as training courses for miners and technical staff. I rejoined WMC at Olympic Dam as the Geotechnical Superintendent and was there for 3 years as part of the team that stabilised mine production and improved mine design and technical practices. Following the BHPBilliton takeover of WMC I now work for Exploration and Mining Technology as a technical expert providing support to mining operations and identifying and implementing new technologies to mining operations.

What have you enjoyed most about your profession(s)?
Working with a wide variety of people across the operation. Being involved in more than one discipline. The job requires that you have a sound working knowledge of all aspects of the mining operation to be able to contribute effectively. Being part of the group that often leads change in the workplace.

FOR MORE INFORMATION ON A CAREER IN GEOTECHNICAL/ GEOLOGICAL ENGINEERING GO TO AUSIMM.COM/CAREERS
1 Introduction
This document provides the criteria that will be used for assessing applicants for Chartered Professional status conferred by The Australasian Institute of Mining and Metallurgy in the general area of Geotechnical Engineering (Mining) practice within the minerals industry.

A geotechnical engineering (mining) professional investigates plans, designs and monitors the process of creating fit-for-purpose excavations for the extraction of ore, or creating infrastructure in mining operations.

2 Criteria for Eligibility for Registration as a Chartered Professional in the Geotechnical Engineering Discipline

- Geotechnical engineering must be the applicant’s main technical discipline and only in exceptional circumstances would the applicant not have qualifications in geotechnical engineering, which are, were or would be sufficient to allow admission to Corporate Membership of The AusIMM. For the avoidance of doubt, geotechnical engineering qualifications include a Bachelor’s degree in science or engineering relevant to the geotechnical field, or a Master’s degree in geotechnical engineering (rock mechanics, etc) combined with a geology degree or engineering degree, or a geology/engineering degree followed by course work and experience under geotechnical supervision.

- The applicant will have accumulated five years of technical experience in any one of, or a combination of, the first four specialist areas of mining practice as those listed in Section 3 below; or

- For holders of diplomas or equivalent only, there will be a need to demonstrate significant additional levels of experience and mentoring by recognised geotechnical engineers or engineering geologists over and above the five year minimum.

- Applicants will be required to certify that on gaining CP accreditation, they will maintain a satisfactory level of relevant professional development (PD). Except in specific extraordinary circumstances, they will be required to certify also that they have maintained a satisfactory level of relevant PD during the three years prior to their application for CP.

3 Areas of Practice and Experience

The following lists are examples of the type and level of experience and competence generally required for registration as a Chartered Professional (Geotechnical Engineering). The list is representative rather than exhaustive or comprehensive and applications will be considered for areas of practice outside those listed below.

Site characterisation
- Enhanced proficiency in mine mapping skills with the ability to identify and focus on important aspects of the geotechnical regime
- Ability to finalise sectional interpretations
- Ability to integrate geotechnical data into a field work component, eg sections, plans, etc

- Plan and supervise data acquisition, interpret the data and report
- Ability to recognise and interpret the significance of lithological units, alteration and structural domains in the field
- Ability to review, identify and design drill hole programs
- Ability to manage daily drilling activities and daily supervision of contractors
- Compile databases and reports on rock mass parameters
- Ability to plan, implement and manage field projects.

Geotechnical analysis and design
- Develop a model of the major geologic structures and geotechnical features of the mine
- Determine the geotechnical domains in the mine
- Assess rock mass quality within geotechnical domains
- Familiarity with empirical, analytical and numerical design methods
- Carry out numerical modelling of stress and displacement and recommend actions resulting from investigation
- Understand limitations of modelling tools
- Interpret data from instrumentation, eg ground movements from displacement monitoring equipment.

Monitoring
- Ensure rock mass parameters and ground movements are captured in the mine database and in a timely manner
- Ensure information from rock mass assessments and ground movement monitoring is interpreted in a timely manner
- Analyse and report trends in monitoring data
- Analyse and report data from ground support quality testing programs eg grout, groundwater, shotcrete, etc
- Analyse and report on testing of mine fill
- Design and specify instrumentation programs
- Supervise installation and maintenance of monitoring equipment
- Implement instrument reading and data collation programs
- Monitor ground performance and make recommendations accordingly
- Ensure systems are in place to determine the effect stress changes are having and will have on the mine environment
- Ensure systems are in place to monitor and assess mine seismicity in a timely manner
- Ensure collection of groundwater from mine environment, grout and fill samples for testing
- Monitor ground vibrations resulting from development and stope blasting.
Mining systems
- Sound practical understanding of mining methods, mining equipment capability and their interaction with the mine environment
- Provide information to mine management on the effect current mining practices are having on localised and mine wide ground stability issues in a timely manner
- Communicate to workforce on geotechnical awareness.

Safety, health and risk
Implementation of workplace health and safety systems that provide for:
- Hazard identification
- Risk assessment
- Implementation of controls
- Effective monitoring
- Comprehensive review.
This should be undertaken with reference to appropriate codes and guidelines. Samples of these are provided in Appendix 1.

4 The Application and Assessment Process
4.1 Required documents
To apply for accreditation as a Chartered Professional (Geotechnical), you must submit all of the following:
- The prescribed application form
- A detailed curriculum vitae (CV) providing clear evidence that you have worked competently in the general area of practice and in the Index Category or Categories applied for, and showing that you meet the requirements described in this Guideline
- Evidence that over the last three years you have fulfilled the PD requirements, as detailed in the PD Guideline
- The names of three Chartered Professional sponsors, or professionals of comparable standing in accordance with By-law 7.3, who are familiar with your qualifications and experience (at least one of whom should be a Chartered Professional [Geotechnical Engineering]) and can substantiate your CV, only one of which can be from your current employer
- And you must:
  - Sign a declaration that all the information you submit is a true and fair representation of your recent responsibilities
  - Furnish any other information the Board may request from you
  - Sign a declaration that all the information you submit is a true and fair representation of your qualifications and experience
  - Sign a declaration of adherence to the AusIMM Code of Ethics
  - Sign a declaration that you will adhere to the PD program
  - Pay the required application fee, if applicable.

4.2 Assessment
Your CV and PD records will be analysed for evidence that you meet the requirements for this accreditation. Each of your sponsors will be required to submit a confidential report to the Board of Chartered Professionals. You may be invited by the Board to attend an interview in support of your application.