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Education matters

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Clean energy transition will increase demand for minerals: World Bank

Students today are understandably cautious about employment prospects in the future, with the move away from fossil fuels in the western world, and the increasing levels of environmental restrictions which limit exploration and development in both the hydrocarbon and mineral industries. I was glad to read a note of optimism this month in a report from the World Bank ('The Growing Role of Minerals and Metals for a Low-Carbon Future' http://documents.worldbank.org/curated/en/207371500386458722/The-Growing-Role-of-Minerals-and-Metals-for-a-Low-Carbon-Future).

The report highlights the potential impacts that the expected continuing boom in low-carbon energy technologies will have on demand for many minerals and metals; far from anticipating a reduction in demand for mineral commodities under the scenario of a low-carbon future, it predicts growing demand for selected minerals and metals as the world works towards commitments to keep the global average temperature rise at or below 2°C.

Minerals and metals expected to see heightened demand include: aluminium, copper, lead, lithium, manganese, nickel, silver, steel, and zinc, and rare earth minerals such as indium, molybdenum, and neodymium. The most significant example is electric storage batteries, where the rise in relevant metals – aluminium, cobalt, iron, lead, lithium, manganese, and nickel – grow in demand from a relatively modest level under 4°C to more than 1000 percent under 2°C.

The report shows that a shift to a low-carbon future could result in opportunities for mineral-rich countries, but also points to the need for these countries to ensure they have long-term strategies in place that enable them to make smart investment decisions. In readiness for growth in demand, countries will need to have appropriate policy mechanisms in place to safeguard local communities and the environment.

'With better planning, resource-rich countries can take advantage of the increased demand to foster growth and development,' said Riccardo Puliti, Senior Director and Head of the Energy and Extractive Industries Global Practice at the World Bank. 'Countries with capacity and infrastructure to supply the minerals and metals required for cleaner technologies have a unique opportunity to grow their economies if they develop their mining sectors in a sustainable way.'

Demand for individual metals and minerals will reflect the component mix of low-carbon technologies, corresponding with economic changes and technical developments. To position themselves well, countries will need reliable sources of economic data and market intelligence, as well as the capacity to turn that information into plans, investments, and sustainable operations.

Based on current trends, it is expected that Chile, Peru, and (potentially) Bolivia, will play a key role in supplying copper and lithium; Brazil is a key bauxite and iron ore supplier; while southern Africa and Guinea will be vital in the effort to meet growing demand for platinum, manganese, bauxite, and chromium. China will continue to play a leading role in production and reserve levels in practically every key metal required under low-carbon scenarios. India is dominant in iron, steel, and titanium, while Indonesia, Malaysia, and Philippines have opportunities with bauxite and nickel.

A 'green' technology future has the potential to be materially intensive, the report states. Increased extraction and production activities could also have significant impacts on local water systems, ecosystems, and communities. As countries develop their natural resource endowments, it will be critical that sustainability, environmental protection, and options to recycle materials be integrated into new operations, policies and investments.

While the report strikes a welcome note of optimism for the mineral industry, I find it curious (even alarming) that Australia is not rated more highly as a major player by the World Bank; tables of production and reserves by commodity show Australia leading other countries in its reserves of lithium and nickel and it follows that exploration and mining technology for these commodities should be a major focus for us.

The World Bank report looks 30–50 years ahead into the global future. It is undoubtedly useful in that it reflects the assumptions and projections of economists and policy makers based on an uncritical acceptance of climate science and intergovernmental policies of this decade. Students who like to think outside the box will notice two missing features. First, nuclear energy (uranium/thorium) is excluded, and second, the risk to the conclusions in the event that the consensus science of anthropogenic CO_2 and global warming is found in error, does not gain a mention.

A brief reference to history will inspire the curious student on both of these caveats. While nuclear energy today is meeting progressively increasing opposition in the western world, it wasn't always so; in 1973 a local war in the Middle East prompted an oil embargo against the western world, and France, after being brought to its knees by lack of energy supplies, made a dramatic move to nuclear energy, which now accounts for 77% of its electricity supplies. Could a local conflict elsewhere in the world during the next 50 years produce a similar result in other countries?

On the second caveat, we as geoscientists are used to testing models against observational data sets, and we are used to looking back in geological time in order to understand the present. I have in recent years had cause to re-examine evidence for past natural climate cycles with periods in the range 60 to 6000 years – a recent commentary article in

The Australian gives a brief overview ('A cold climate for science', http://www.theaustralian.com.au/opinion/a-cold-climate-for-science/news-story/f82f4126477b029feb76dbff2fdf467d). I find the evidence in peer-reviewed journal articles for the existence of these centennial-millennial natural cycles to be compelling, and their magnitude is such as to modify the underlying assumptions of studies such as that of the World Bank reviewed here. It is unlikely that I will see a definitive yea or nay in my professional lifetime, but many students with a 40+ year career in geosciences ahead of them will discover the truth on one side, the other side, or in a direction nobody has thought of yet.

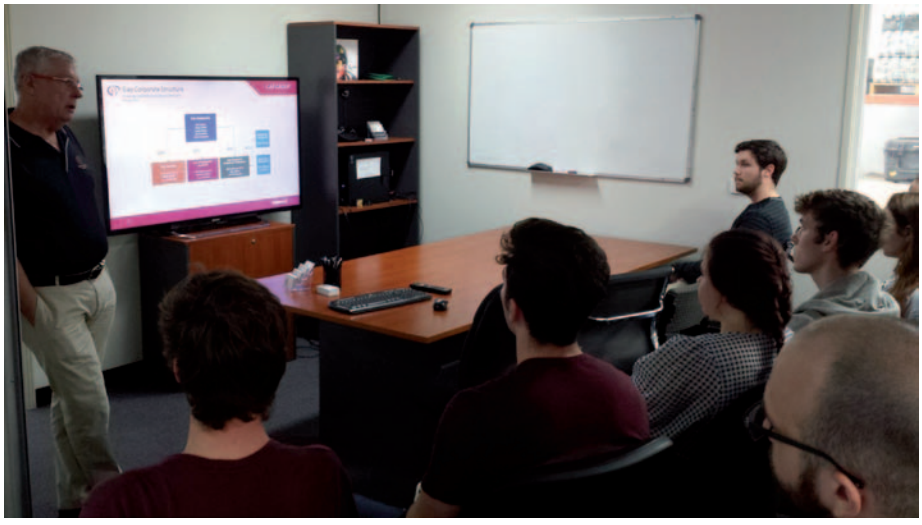
Brisbane students meet industry in field demonstration at Gap Geophysics

The ASEG student group at Gap Geophysics. From right, Nick Josephs (ASEG Qld Branch organiser of the tour), Stephen Griffin (Gap), Mal Cattach (Gap), and geosciences students from QUT and UQ. Will Rowlands (Gap) is 2nd from the left.

In mid-May, students from Queensland University of Technology (QUT) and the University of Queensland (UQ) went on a field trip to the head office of the Gap Geophysics Group (Gap) in West End, Brisbane with the support of the ASEG Queensland Branch and its Members Ron Palmer and Nick Josephs.

A group of 19 students of geophysics, geology and other geosciences who were keen to learn about geophysics arrived at Gap and were greeted by Mal Cattach, Chairman and Chief Geophysicist of Gap Geophysics. Mal gathered the students in the boardroom and presented a history of the company, highlighting the importance of research in its longevity and success. Gap Geophysics has been a pioneer for decades in the development of total-field and three-component EM electromagnetic methods for both mineral exploration and environmental applications such as unexploded ordnance detection.

Mal continued by explaining the wide range of applications for geophysics across the broad spectrum of exploration, environmental and engineering industries, as well as the global reach of the company and the demand for their specific expertise. The case studies in a variety of countries and the variability of the applications of the EM geophysical techniques certainly piqued the students' curiosity.



Mal Cattach of Gap Geophysics addresses QUT & UQ students.

Trent Retallick, the General Manager, then directed the students to a nearby park where an EM survey was set up by the GapEOD team for demonstration. The students gathered around and were shown a demonstration survey with a fixed loop pulsed electromagnetic source together with real-time feedback on a SAMSON digital logging magnetometer receiver. Students were able to see, and hear, the influence of replica unexploded ordnance (UXO) that was brought near and into the loop.

Stephen Griffin, Head of Technical Services for Gap, and Will Rowlands, UXO Technician, then provided a detailed explanation of the techniques being used in detection of UXO and hazardous metal fragments on mine-sites, incorporated in Gap's UltraTEM2 cart – a moving-loop time-domain EM system combined with an array of three-component sensors that gives maximum directional sensitivity in detection of such objects.

It was great to see curious students focused on a screen depicting the potential field and TEM responses, and asking pertinent questions about the techniques being used.

Stephen Griffin of Gap Geophysics explains the features of the UltraTEM2 precision UXO and metal-detection cart.

Following the return to headquarters, the staff at Gap provided some food and drinks for the hungry university students. This social setting allowed the students to engage one-on-one with the staff and afforded them great networking opportunities that will inevitably lead to employment prospects and further studies into geophysics.

From the student feedback, it became apparent that most were especially captivated by the global opportunities that a career in geophysics involves and were happy to see geophysics in action. From this response and success, the Branch will probably organise another outing later in the year.

This is the third year that student field trips have been organised and conducted by the Queensland Branch of the ASEG. They originally started from the Perth ASEG-PESA 2015 conference where students, who were awarded bursaries to attend the conference, struck up conversations with companies at booths and floated the idea of students getting some industry exposure. Special thanks to Ron Palmer, the student representatives and Gap for giving their time to open the eyes of budding geophysicists and geologists as to the capabilities of geophysics.

Australian School of Petroleum Oman Study Tour

The gang at the Nizwa Fort, one of the oldest fortresses of Oman (photo taken by Hugo Burgin).

On 8 April 2017 petroleum geoscience honours and masters students at the Australian School of Petroleum (University of Adelaide) embarked on a two week study tour to Oman, a country located on the Arabian Peninsula, one of the most significant petroleum passages of the world. Due to its prime location, Oman, like various other nations in the Middle East, depends on its oil and gas industry, making it the ideal setting for a petroleum geoscience field trip.

Mandatory lectures were held four days per week from 9 am until 2 pm at the Sultan Qaboos University in Muscat, with Professor Khalid Amrouch (the Study Tour organiser and leader) covering aspects of structural geology and geomechanics. As the city of Muscat is surrounded by great outcrops, all less than a few hours' drive away, the remainder of the days were spent tying in-class learnings to practical exercises in the field.

Students were also required to give an oral presentation on the stress field of a particular area of the world by applying the knowledge learned both in class and in the field to the world stress map. This was a great way for students to not only develop presentation and speaking skills, but also to sharpen their critical thinking about the multiscale effects of stress and stress regimes through time and space.

Another fascinating and geologically significant part of the trip was the chance to see a completely intact section of the oceanic crust obducted and perfectly preserved on the continental crust, only a short drive away from the University. Professor Andreas Scharf (from SQU) presented a short lecture followed by a tour of the Semail Ophiolite, an amazing cross-section of a textbook ophiolite, from pillow basalts to layered gabbros and harzbugite all the way down to the Moho, a depth that has not been achieved in even the deepest ocean drilling projects.

Aside from the technical education, another highlight of this Study Tour for many students was the exposure to a very different culture and the geotourism associated with the trip. Afternoons and evenings were spent wandering through the busy Souk Matrah (local markets), touring mosques and learning about the Omani culture and history at the Bait Zubair Museum. It was great for students to immerse themselves in a foreign culture, an experience that is relevant for almost all professionals working in the minerals and energy resources industries.

The Hajar Mountain Range overlooking the Indian Ocean was a spectacular sight from the Jabal Akhdar peak, which reaches 3000 m. And of course, after so much trekking and field work in 40°C+ weather, the refreshing swims at Wadishap and the Bimmah Sinkhole followed by fine dining at traditional restaurants in Seeb were the cherry on top.

As a hopeful future exploration geophysicist, it was a highlight to see the structural geology firsthand, such as faults, folds and other kinds of structural elements that are commonly sought out in seismic data in petroleum exploration. Stress regimes, sources of stress, geomechanical concepts and fault seal analysis are all also integral parts of a career in petroleum geoscience and it was

Anna Manka (the author) sitting on the Moho.

Examining fractures to determine stress regimes in the field (photo taken by Hugo Burgin).

very enjoyable to learn about these topics without being constrained by the walls of a classroom.

The two-week study tour was not only a great opportunity to visit the largest non-OPEC oil producer in the Middle East, but also an educational milestone for future geoscientists, with the chance to stand on the Moho and examine the Semail Ophiolite. It was a fantastic occasion to get to know fellow classmates and network with professional geoscientists, while learning important skills in structural geology and geomechanics and admiring the beautiful scenery of Oman.

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Happy geoscientists relaxing in the crystal clear waters of the Bimmah Sinkhole after a packed day.