Exploration '17: Integrating the geosciences, the challenge of discovery

Exploration '17, the sixth decennial conference on mineral exploration technology, was organised by DMEC (Decennial Mineral Exploration Conferences) and held in Toronto, Canada from 21 to 25 October 2017 (http://www.dmec.ca). For half a century these meetings have provided a once-a-decade review of major developments in the fields of geophysics, geochemistry, remote sensing, and data management and processing as they relate to minerals exploration.

At Exploration '17, the core program consisted of 6 plenary talks, 49 invited papers, 23 technical and special talks, and 29 posters. In addition, there were 15 workshops on topics related to the conference themes prior to, and after, the conference, and a field school held in Sudbury prior to the start of the conference. There were more than 1200 registered delegates from 46 countries.

Geophysical technology

Presentations at the conference demonstrated that a number of technologies were maturing and could handle more complex earth situations. Technologies included in this category are airborne gravity gradiometry and array-style IP technology. An important new addition was airborne natural fields (AFMAG), which became commercial shortly after the last decennial meeting.

In summary:

- Versions of Airborne Gravity Gradiometry (AGG) technology were available starting in the mid-2000s, but in late 2007 the entire BHP 'fleet' of Falcon AGG systems (including HeliFalcon) was sold to Fugro Airborne (now CGG Multi Physics). This sale significantly expanded the commercial availability of AGG surveys globally. While AGG technology is recognised as the most sophisticated of any mining geophysical technology, less complex technology such as Sander Geophysics' AirGrav, has been shown to be very effective for a number of natural resource applications.
- 3D IP could be considered an outgrowth to 2D IP surveying, which emerged in the mid-late 1990s. The first survey was carried out in 2011 by a traditional 2D IP contractor, and now there are five groups offering 3D

surveys. The value of such surveys is still be established by the industry, but they appear to be able to map targets deeper than in the past. Some contractors can also concurrently provide MT data.
- AFMAG developed in the 1950s and was used mainly as an airborne technique through to the 1970s. Airborne AFMAG became commercially available as ZTEM (Geotech Ltd) in 2008. In conductive environments ZTEM does not achieve a depth of investigation much greater than standard time domain EM systems, but in resistive terrains ZTEM has been able to map conductive/resistive zones to depths approaching 2 km. The technique has been applied to a range of deposit styles, but appears best suited to large targets such as porphyry copper deposits, and structurally controlled deposits such as SEDEX-style or unconformity-style uranium similar to those found in the Athabasca Basin (Saskatchewan) Canada.

Geochemical technology

Over the past decade the quest for technology improvements on a range of fronts appears to be more common in geochemistry than geophysics, where much of the focus has been on enhancements to existing technology, with possibly some reduction in cost. Paul Agnew, the plenary speaker, touched on the major topics of interest/pursuit, and subsequent speakers expanded on these themes. In no particular order they were:

- lower analytical detection limits with ICP-MS technology
- au in natural waters for deep exploration
- portable instrumentation techniques
- automated hyperspectral core scanning
- isotopic methods
- indicator mineral chemistry using laser ablation ICP-MS
- understanding metal mobility and mechanisms for exploration under cover
- advanced geo-statistics to review legacy regional geochemistry
- application of molar element ratio litho-geochemistry
- use of AI and machine learning

One of the major exploration innovations of the past decade has been the development of a tube drilling

technology, which was discussed by Richard Hillis, Director of the DETCRC and one of the Exploration '17 luncheon speakers. A key component of this technology is a system whereby rapid turn-around geochemical analysis can be achieved; sometimes termed 'Lab-at-the-Rig'. This is potentially a 'disruptive' technology as detailed geochemistry (with mineral analysis) is available much faster than previously possible, requiring new means to process and assess the data. It is likely that the most challenging effect will be on the time frames for decision making, which may be reduced from weeks/months to hours in some situations.

Remote Sensing

The plenary paper by Dave Coulter on remote sensing captured the major changes in remote sensing over the past decade. According to Coulter, 'Over the past decade the field of exploration remote sensing has undergone a fundamental transformation from processing images to extracting spectroscopic mineralogical information resulting in the broader field of Spectral Geology and Remote Sensing (SGRS), which encompasses technologies that contribute to the definition, confirmation, and characterisation of mineral deposits. SGRS technologies provide information on the mineralogical and alteration characteristics of a mineral orebody by assisting with the identification of features on the surface, in field samples, and in the subsurface through core spectroscopic measurements and imaging.'

Major points of development include:

- spectral geology has been used at all stages of exploration
- technical advances such as Core Scan enabled more effective, multi-scale, integrated applications
- multi-disciplinary integrated approaches should be applied from data collection, to data processing (information extraction), to synthesis analysis and integrated interpretation.
- Core Scan hyperspectral imaging provides alteration mineralogy for exploration, geometallurgy and mine planning
- recent development on thermal infrared hyperspectral imaging broadens mineral detection capability for exploration and beyond.
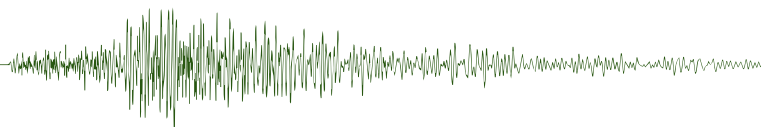
Data processing and visualisation

The various disciplines featured at Exploration '17 dealt with processing issues. The catalyst for new processing approaches seems to be driven by new acquisition systems that challenge the current processing approaches and overall data processing capacity. An example of this is now unfolding with 3D IP surveys, where traditional inversion approaches (even 3D) are showing they lack the performance required to handle data sets an order of magnitude larger than for which they were first designed. The expectation is that the industry will respond and address these issues in fairly short order. However, the value proposition of conducting such surveys has yet to be established, as very often the service industry acts to provide new technology because it can, rather than because of a defined, client-driven need.

There is the emergence of a new class of processing termed AI and 'Big Data'. This was not a topic of specific focus at Exploration '17, but one paper by Desharnais and his colleagues looked at the subject. DMEC supported two workshops in early 2018 on AI/Big Data; these proceedings are available on the DMEC website (www.DMEC.ca) under Resources. At Exploration '17 there was probably not enough long term experience with AI/Big Data to build a meaningful understanding of the technology. It is expected that the application of these approaches will be far greater in the coming decade.

Data visualisation technology appears to have reached a mature level, and little new was discussed at Exploration '17. While some efforts have made in the past to blend sensory inputs to extract subtle levels of information, it is possible that difficulties in interacting with complex spatial environments, i.e. 3D visualisation, remains a barrier to the greater use of this technology or, more importantly, the recognition that these approaches can significantly enhance pattern recognition leading to discovery.

Geological modelling is an important field but one that has a limited user base. Mark Jessell and his colleagues ran a workshop at the conference that focused on modelling and inversion of geology, suggesting this field is more advanced than the pure geophysically orientated 3D modelling.

Case studies

A block of 12 case studies were organised and nine deposits were discussed. Together they highlighted the application of current geological model building, state-of-the-art geophysics, geochemistry and remote sensing. Of the deposit types, there were three gold, one IOCG (Cu-Au), one VMS, one a combination of layered UM (chrome) and magmatic Ni-Cu, and one a UM layered complex PGE. Geophysics played a major role in guiding drilling for all the non-gold deposits, including the first deposit attributed to discovery by a Falcon AGG survey (Santo Domingo, Chile). Geophysics was also used in the three gold discoveries, but in more of a secondary role. Several other excellent case studies were presented in the 'Integrated Interpretation' and 'Targeting' sessions.

While not technically a case study, some of the late-stage results from the Canada Mining Innovation Council (CMIC) Footprints program (ends in 2018) were presented as technical talks and workshops. The Canadian exploration industry invested heavily in this program over the past five years, and many will be watching to see how the outcomes are taken up by the sponsors and the industry as a whole.

Frank Arnott Award

The Frank Arnott Award was created to honour Frank Arnott, a geoscientist who pioneered the value of data integration and visualisation well in advance of the rest of the industry. The contest was created by friends of Arnott, and was designed to help the industry build skills in innovation and collaboration. Two categories of entrants were defined;

novice and expert. The contest ran for several years prior to Exploration '17. The competition winners were selected mid-2017 and their presentations and awards were incorporated into Exploration '17. The top two presentations in each category are available on the DMEC website (http://www.dmec.ca/Resources/Exploration-17.aspx).

Outcomes

The decade-long assessment afforded the decennial conferences is unique, and offers the geoscience community a more in-depth vista on the recent past, but also allows for some speculation on the future. Much of what was 'early days' in 2007 is now common practice 10 years later. An anecdotal remark in 2007 was that there were 25 exploration geochemists working in the industry, and the sense is that there is less than that now. The Frank Arnott Award was designed as a one-off event to end at Exploration '17, but given this contest's strong support at Exploration '17, especially amongst students, the Arnott Committee has worked since Exploration '17 to build an on-going collaborative contest modelled after the oil industries Imperial Barrel award. Updates on what is being called FAA 2.0 can be found on the website www.FrankArnottAward.com.

A second outcome on the non-technical, sociological front related to the lack of gender balance in the make-up of the Exploration '17 conference. While the mining industry as a whole appears to be making efforts to address this, it is much harder to see progress in applied geoscience in general. A small group of younger women were sufficiently concerned that they formed Women Geoscientists in Canada (WGC) www.WGCanada.org. They believe it is important to advocate for change and their hope is to see a more gender representative group who build and attend Exploration 2027 in 10 years time.

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Upcoming conference: AGGC 2018 – Big issues and ideas in geoscience

AGGC 2018 will highlight the fundamental role that geoscience has as a major field of science throughout the Asia Pacific Region. The conference will be the largest geoscience event to be held in Australasia since 2012. AGCC 2018 is supported by all eight member organisations of the Australian Geoscience Council, and is sponsored by Geoscience Australia, as Patron Sponsor, and Santos Ltd as Major Sponsor.

The AGCC 2018 third circular has been released and includes information about:

• the updated program with additional sessions
• new initiatives for young geoscientists
• the announcement of confirmed plenary and keynote speakers
• more details on the Big Issues and Ideas in Geoscience Day
• an expanded list of field trips and professional workshops, with information on costs and deadlines.

The deadline for abstract submission was midnight on Saturday 16 June. Formal notification of acceptance of abstracts will be by Saturday 28 July; presenters of accepted abstracts must pay for their full delegate registration by Saturday 18 August.

The deadline to register at the lower cost, early bird registration rate, is Saturday 7 July. After this date, registrations will increase by approximately $200 ($1000 to $1200 for Members). The cost of registration will increase again on 7 October ($1200 to $1400 for Members). If you are an Early Career Geoscientist, you may be able to take up AGCC 2018 special offer and pay $765 for a full delegate registration, saving up to $235 on the early bird Member rate. Be quick, the offer closes on Thursday 30 August!

The AGC want to make AGCC 2018 as accessible as possible to all geoscientists, including those with young children and who may need assistance with their care. The Steering Committee is investigating the possibility of having a child-minding facility set up at the Adelaide Convention Centre for the duration of AGCC 2018. The facility would be operated and managed by a licensed contractor and all arrangements would be made by parents with the contractor directly. It is intended to provide this facility on a cost-recovery basis.

If you are interested in this service, please complete the Expression of Interest form on the AEGC 2018 website or before Tuesday 14 August. The decision on whether or not to provide this facility will be based on the demand received via the Expression of Interest form by this date.

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Upcoming conference: AEGC 2019 – Data to discovery

Planning is well underway for next years' AEGC Conference, AEGC 2019.

ASEG, AIG and PESA will join together again in September 2019 to host a four-day program. AEGC 2019 will be held at the wonderful Crown Perth, and feature technical sessions of the highest calibre. The conference has a focus on geology, geophysics and geochemistry, and how these sciences are applied to exploration in both petroleum and mineral systems in Australasia and the wider Asia Pacific region. As Perth is a hub for Australia's mining and petroleum sectors, AEGC 2019 is expected to attract over 1000 geoscience professionals involved in the exploration for energy resources, metals and industrial minerals, as well as near surface and ground water exploration. Representation from international and local companies, government and academia is anticipated.

AEGC 2019 will be held at the recently upgraded Crown Perth, located on the Swan River, only minutes from the city centre. Accommodation is available right at the conference venue and delegates will be spoiled for choice. They will be able to entertain clients and, in spare

moments, check out the new Optus Stadium, which located a few minutes' walk from the venue. In addition to Perth's unique natural attractions, delegates will have the opportunity to join field trips and social functions which will be exceptional opportunities to network with peers and make new contacts.

With the theme 'Data to Discovery', the technical program has a large focus of

geology, geophysics and geochemistry and how these are applied in exploration for both petroleum and mineral systems in Australasia and the wider Asia Pacific region.

To register your interest visit www.aegc.com.au.

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AEGC2019
Data to Discovery
Australasian Exploration Geoscience Conference
2-5 September 2019 • Perth, Western Australia
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