The power of the crowd and open data – learnings from the OZ Minerals Explorer open innovation challenge

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SUMMARY

We report on the results and lessons learned from Australia’s largest minerals exploration crowdsourcing challenge - the OZ Minerals Explorer Challenge. We discuss some of the challenges in running an international competition with a large amount of technical data at scale, and the methods used to engage innovators from outside the traditional geoscience community. We discuss specific examples of innovative approaches which have been submitted. We also examine the ways in which open innovation and crowdsourcing can provide a novel approach to rapidly evaluating tenement prospectivity and to unlock value from companies’ data assets.

Key words: exploration, data science, crowdsourcing, open innovation, open data

INTRODUCTION

Mining exploration companies around Australia and internationally are struggling with ever-increasing amounts of exploration data. Within the industry, the volume and variety of data is increasing rapidly, and the methods and models with which these datasets can be combined to map prospectivity are also growing exponentially. The mineral exploration industry is also beginning to adopt new tools which are being developed in the fields of machine learning and data science to broaden and redefine the search space. With this new and expanding set of resources, how can an exploration team source a sufficiently diverse perspective on their data to ensure that they don’t miss a viable target? Crowdsourcing offers one avenue for companies to obtain novel approaches to their problems from a large international community of innovators.

In 2019, OZ Minerals partnered with Unearthed Solutions to deliver the Explorer Challenge, a unique, incentive-based crowdsourcing minerals exploration competition. The competition called on geoscientists and data scientists from around the world to use novel approaches to generate new exploration targets at the OZ Minerals Mount Woods Project, offering an AUD$1 million prize pool. The project area comprises six exploration licenses surrounding the Prominent Hill Iron Oxide Copper Gold (IOCG) deposit in South Australia (Figure 1). Upon completion, a number of successful entries will be tested as part of a drilling campaign scheduled for the second half of 2019, which will be managed and funded by OZ Minerals exploration team.

The Mount Woods Project comprises six mineral Exploration Licenses and is located in South Australia, 600 to 700 kilometres north-northwest of Adelaide and 30 kilometres east to 160 kilometres south and southeast of Coober Pedy. The area is bounded by latitudes 29°00’S and 29°52’S and longitudes 135°04’E and 136°05’E.

Figure 1. The location of the Mount Woods tenement package (in red) in relation to the rest of South Australia.

The Project Area covers the Mount Woods Domain in the north-eastern Gawler Craton, South Australia. It is a region of shallow late Archean, Paleoproterozoic and Mesoproterozoic basement rocks which has been identified and delineated through interpretation of aeromagnetic images. Outcrop is sparse within the tenements, occurring in the Peculiar Knob Kennedy Dam area (mainly Balta Granite) and at Mount Woods (high-grade gneisses). Prospective basement is covered by ~40-500 m of flat-lying Late Paleozoic and Mesozoic glaciogenic, lacustrine and marine sedimentary sequences – Boorithana Formation, Stuart Range Formation, Mt Toondina Formation (Permian), Algebuckina Sandstone (Jurassic), Cadna-Owie Formation, and Bulldog Shale (Cretaceous).

Basement of the northern and central portions of the Mount Woods Domain consists of Paleoproterozoic supracrustal rocks that have undergone regional metamorphism to amphibolite-granulite facies (Mount Woods Metamorphics). These include granulites, quartzofeldspathic gneiss and schist, quartz-magnetite rocks, marbles, calc-silicate and BIF. These have been previously correlated with the Hutchinson Group of Eyre Peninsula and as in that case may include an Archean component. The metamorphics are intruded by the deformed, syn-orogenic Engenina Adamellite, which outcrops to the west of the Project Area in adjacent tenements. During regional north-south shortening, the Paleoproterozoic succession was thrust southward over the Archean nucleus of the central Gawler Craton (D2 folding of Betts et al., 2003).

A lower grade metamorphic package has been intersected in drillholes immediately north, east and west of the Prominent Hill deposit. This comprises upper greenschist to lower
amphibolite facies calc-silicate rocks, iron-rich impure metala-
limestones, psam mopelite, phyllite and possible meta-evaporite,
with variable metamorphic magnetite content. These rocks may
represent Paleoproterozoic Wallaroo Group equivalents on the
southern margin of the Mount Woods Inlier. This generally
lower grade metamorphic domain is referred to as the Blueduck
Sub-domain (Freeman and Tomkinson, 2010).

On the southern margin of the Mount Woods Domain, a
sequence of lower greenschist facies sedimentary and volcanic
rocks. This is the Neptune sub-domain of Freeman and
Tomkinson (2010). A sedimentary sequence hosts the majority
of mineralisation at Prominent Hill and coarsens southwards;
from dolostone, to argillite, to sandstone and greywacke. South
of the sedimentary rocks, a sequence of volcanic rocks has
dominantly basaltic to andesitic compositions, with lesser
rhodacite and rhyolite. Geochemical and geochronological
studies indicate that the volcanic rocks are equivalents of the
Gawler Range Volcanics (GRV) from further south in the
Gawler Craton. In the vicinity of Prominent Hill, the entire
sequence has been overturned, such that the GRV sit structurally
beneath the host sedimentary rocks and the
Blueduck calc-silicates to the north.

Approximately 30 kilometres to the east of Prominent Hill a
greenschist facies, bimodal volcanic suite has a late Archean
age of ca. 2550 Ma (Cathers, 2010).

A second, post-orogenic suite of intrusive rocks includes
granite, granodiorite, diorite and gabbro of the Balta Suite occur
both in outcrop and in historical drill core. U-Pb SHRIMP
zircon ages of 1590-1580 Ma obtained from diamond drill core
samples in the Project Area suggests that these are equivalents
of the Hiltaba Suite, well documented in the southern and
central Gawler Craton.

While the OZ Minerals geological team have largely focused
their efforts on exploring the Mount Woods tenements for
IOCG style mineralisation, they recognise there is also potential
for other mineralisation styles within the tenement package.
Exploration drilling has been conducted in the area targeting
shear hosted copper gold systems, intrusion-related copper gold
and copper nickel sulphide systems, BHT lead zinc systems and
VHMS mineralisation with varying degrees of success. The
Government of South Australia Department for Energy and
Mining also considers the Gawler Craton prospective for
IOCG style mineralisation, they recognise there is also potential
for mineralisation within the Mount Woods Domain. Participants were welcome to process,
analyse, model, or otherwise work with the data in any way they
saw fit, including bringing in data from Australia’s public data
holdings. To support participants, OZ Minerals made publicly
available all of their internally generated exploration data for
participants to examine. Data released as part of the challenge
including a comprehensive exploration drilling database
containing over 120,000 multi-element assays, geological
maps, and regional and prospect-scale magnetic, gravity,
seismic and IP survey data.

In total, between 4 and 5 terabytes of data were made available,
which by ‘big data’ standards would be considered a modest
volume. However, distributing this volume of data to
participants who may not necessarily have access to high speed
internet created a unique challenge. In order to encourage more
people to participate in the Explorer Challenge, Unearthed took
steps to create a user experience which simultaneously allowed
participants to download the data that was relevant to their
particular interest, while minimising the risk of participants
feeling overwhelmed and lost in a vast and unfamiliar dataset.

Thus, Unearthed took a multi-pronged approach to provide a
good participant experience:

1. A semi-automated indexing of the data was performed to
extract metadata such as text content, keywords, locations
and file types.
2. A semi-automated process converted most proprietary
binary file formats into open formats in order to improve
accessibility and ease of use.
3. To serve the data to participants DKAN (http://demo.getdkan.com), an open source data portal
developed by US federal agencies built on Drupal) was
deployed in order to make the data searchable and
downloadable (Figure 2). DKAN also provided online
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COMPETITION APPROACH AND OUTCOMES

The primary aim of the competition design was to incentivise
people from many different backgrounds to rapidly analyse and
interpret OZ Minerals’ exploration and mining data and to
submit their ideas for mineral exploration targets within the
Mount Woods Project. To be successful the competition also
needed to enable people to demonstrate how their particular
skill set was applicable to solving this problem, and the
technical merit behind their approach, regardless of the discipline or background. In particular we wanted to:

1. Make it easy for participants to gain access to, and to easily
understand both OZ Minerals’ internal data and the
Government of South Australia’s pre-competitive publicly
available data.
2. Provide a way for non-geoscience participants to
contribute (particularly from the data science community)
and provide a learning experience for the community.

To achieve these outcomes, we ran a multi-streamed challenge
with several prize categories for innovators to submit solutions to. The main challenge (and the bulk of the prize categories)
were focused around the Mt Woods tenements. However, in
recognition of the fact that exploration data can be confusing to
non-geologists, we also ran a separate data science stream to encourage the innovator community to come up with new
predictive models for mineralization, based on publicly
available data, which could then be used as a base for
submissions to the main challenge.

Main Explorer Challenge

The main aim of the main explorer challenge was to generate
the drill targets for a wide range of mineralisation styles within the
Mt Woods tenements. Participants were welcome to process,
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what was in the data before they downloaded it. This was hosted using a range of managed services from Amazon Web Services. Having a central portal had the added benefit of providing a way to get updated or missing data to participants in a central location as the competition continued.

4. To help participants get started, Unearthed also provided ongoing support through several online platforms (a forum on the Unearthed website, the Unearthed Community Slack channel and social media), as well as in-person events in Cape Town, Toronto, Brisbane and Perth.

Initial feedback from the participants has been positive, in comparison to similar events where a single large dump of data has been provided. Taking some of the pain away from data preparation and processing enabled the competitors to spend more time working on the actual challenge. Standardised formats also made things simpler for those not as familiar with geosciences. This helped to raise participation and engagement.

The main prize categories (first, second, third and student prizes) were awarded based on the overall quality of the submission, with judging criteria based on technical merit, data use, creativity, feasibility and presentation. Teams were asked to submit a five-minute video pitch outlining their approach, including how they validated their methodology, and how they arrived at the targets they selected. The top video submissions proceeded to the next stage for detailed proposal review. For the detailed review teams submitted:

- A proposal document outlining methodology and approach in more detail than the video pitch.
- The team’s top predicted mineralization locations, including location (i.e. longitude, latitude and depth) and a resource description (including commodity, tonnage and grade), submitted as a csv.
- A digital model (a prospectivity map in GeoTIFF format)

This submission format also allowed OZ Minerals to examine crowd-determined targets - if multiple teams suggested a target by different methodologies then this improved the confidence in that target.

An additional aim was to reward innovative approaches to the data even if those didn’t lead directly to a winning submission (i.e. incidental innovation). To enable this, Unearthed and OZ Minerals designed several side categories targeting aspects of the exploration process which are current pain points. Criteria for these side categories included: most unique approach, best use of public and private data, best generation of novel insights and best data fusion approach. These categories provide an interesting insight into potential future exploration tools for industry.

Data science stream

The aim of the data science stream was to enable non-geologists to engage with geological data and exploration prediction problems. Unearthed hypothesised that data scientists and machine learning practitioners have a lot to offer the exploration process, particularly around developing quantitative approaches to dimensionality reduction and feedback loops for constant improvement. However, we found through community engagements that the technical nature of geological data and degree of uncertainty common in exploration made it difficult for non-geoscientists to engage. Additionally, machine learning approaches generally require a large training set – while there was a significant volume of data over the Mt Woods domain there were only a handful of known deposits, all of which were a single style mineralisation. A different dataset was needed to help international participants build their models.

Figure 2. A page from the data portal available to competition participants including metadata, extents and download links.

While participants were allowed to use any public data to build models, it is difficult for an international participant to know where to start. To make this process easier we built a demonstration dataset based on the continent-wide geological mapping, geophysics (gravity, magnetics, radiometrics and remote sensing data) held at Geoscience Australia and NCI. This consisted of over 2000 25 x 25 km squares (‘stamps’) cut out of the continent-wide datasets, some of which had deposits within and some of which were empty (Figure 3). We re-projected and re-gridded all the data so that it was easily used in modern machine learning approaches, while allowing some obfuscation of the original data by removing some location information (Figure 4). Participants were asked to start by creating predictive models for likely commodity types (e.g. Au vs Cu vs PGE vs Pb-Zn) and also the location within the stamp area, and we provided a benchmarking facility and scoring metrics for doing this as a starter for teams. We also released an open-source Python module (Robertson, 2019) for participants to connect to public data services (including the OGC Web Coverage and Web Feature services hosted at the NCI) and generate their own datasets for model building.

The judging criteria were designed to cover the real issues with applying data science in exploration. Given the variability of quality and quantity of data in exploration settings, the value of a data-driven approach is not just in its accuracy. The ability to handle uncertainty and communicate complex relationships to geologists led us to ask for a more open-ended video and technical submission (e.g. Jupyter notebooks). The teams could then detail their approaches using the example datasets. Judges assessed teams against technical implementation: model choice, training validation process, uncertainty quantification and then their communication of the results.
We then encouraged participants in the data science stream to use similar datasets (regional geophysics, publicly available remote sensing etc.) to make predictions over the Mount Woods tenement areas as a submission to the main competition. This provided a further opportunity for cross-disciplinary team building, since data scientists could now start having conversations with geology experts to validate their model outputs based on other datasets not used in the data-driven approach.

Looking to the future—what next for crowdsourcing exploration?

Crowdsourcing can significantly reduce the amount of time and therefore cost to a business in processing large amounts of exploration data. Businesses looking to make quicker decisions on where to focus their exploration efforts and which ground to hold, acquire or release, can benefit from this approach. There is however still lot of hesitancy within industry about releasing data into the public domain. More education is required to properly understand the risk and reward balance for both industry and the innovator community in order to achieve broader approval of crowdsourcing.

Running a successful crowdsourcing competition is dependent on access to a market of skilled and talented individuals who can take part. In general, the best outcomes arise by engaging people from a variety of industries and disciplines, so consideration needs to be taken in how to communicate and promote the opportunity. Utilising organisations that have prior experience in digital community engagement will be a key to future success.

CONCLUSIONS

The Explorer Challenge represents a fundamental change in approach to solving exploration problems. It enabled OZ Minerals to explore with a much larger range of tools and approaches than is possible with a small internal team of geologists. In particular, it also highlights novel data science techniques which should be developed further to improve exploration efficiency through quantitative feedback loops. The competition was a very real example of the future application of data science within the mining and exploration industry.

Finally, the Challenge clearly illustrates how companies can directly benefit from moving away from the business-as-usual approach and instead building teams with diverse, non-traditional skills sets and perspectives to develop unique solutions to meet business needs.

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