Lessons From The Explorer Challenge
Journey to discovery with Data

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All figures are expressed in Australian dollars unless stated otherwise.

Exploration Results as referred to on Page 15

1 Information extracted from OZ Minerals Quarterly Report for the three months ended 30 September 2014, dated 14 October 2014 and is available at https://www.ozminerals.com/uploads/media/ASX-2014-Sep-Quarterly-Report-b7eed6fb-ed79-4514-9aec-13dc2c3af87b-0.pdf

2 Information extracted from OZ Minerals ASX Release entitled ‘Significant copper mineralisation returned from Khamsin prospect’ dated 6 May 2013 and is available at https://www.ozminerals.com/uploads/media/ASX-20130506-Khamsin-Results-505cf178-fc34-44ad-91e9-ed98004518af-0.pdf

3 Information extracted from OZ Minerals ASX Release entitled ‘First production from Prominent Hill copper-gold operation’ dated 26 February 2009 and is available at https://www.ozminerals.com/uploads/media/ASX_20090226a_PH_first_production-5dc67ae1-acf1-46cd-9c5a-079f7ba1ea5a-0.pdf

OZ Minerals confirms that it is not aware of any new information or data that materially affects the information included in the original market announcements and, in the case of estimates of Mineral Resources or Ore Reserves, that all material assumptions and technical parameters underpinning the estimates in the relevant market announcement continue to apply and have not materially changed. OZ Minerals confirms that the form and context in which the Competent Person’s findings are presented have not been materially modified from the original market announcement.
A modern mining company
The exploration process is iterative and takes time. More money doesn’t necessarily help.

We collect and generate vast amounts of data that does not always result in discovery.

The low hanging fruit in the best jurisdictions appears to have been picked.
Gawler IOCG Research

We learned a lot about Prominent Hill

Breccia Characterisation
Tom Blenkinsop, James Cook University

How extensive is hydrothermal brecciation?
What are the host rock controls on breccia formation?

Sedimentary facies mapping and Petrography
Stuart Bull and Sebastien Meffre, CODES
We learned a lot about Prominent Hill

What is the regional crustal-scale architecture?

a) ca. 1600 - 1592 Ma

b) ca. 1592 - 1582 Ma

c) ca. 1582 - 1560 Ma

d) ca. 1560 - 1540 Ma

Tectonothermal evolution of the Inlier

Mitchell Neumann, OZ Minerals
Gawler IOCG Research

We learned a lot about Prominent Hill

We drew lots of cross sections!

2000 square kilometres of cross sections at 200m spacing

Ian Anderson, Paul Hehuwat, OZ Minerals
We know a lot about Gawler IOCGs … and that’s a fantastic competitive advantage!

/ Fremantle Doctor¹
  – 44.5m @ 2.0% Cu, 1.3g/t Au,
    51.0m @ 1.8% Cu, 1.2g/t Au

/ Khamsin²
  – 334.0m @ 0.8% Cu, 0.2g/t Au
    (including 108.0m @ 0.9% Cu, 0.4g/t Au)

/ Ankata³
  – 129.3m @ 2.6% Cu, 0.6g/t Au
    (including 59.0m @ 3.9% Cu, 0.3g/t Au)
Gawler IOCG Research

We know a lot about Gawler IOCG’s … but maybe we are a little too smart!

/ Increasingly model-driven exploration.

/ Increasingly difficult to identify and rationalise targets which don’t fit the OZ Minerals IOCG model.

/ Bias pulls our attention to well-known prospects – we avoid new frontiers.

/ By searching for the exact features of our detailed exploration model, are we making a new discovery more difficult?

/ It’s not just us – the industry does it too!
Why the crowd?

- Terabytes of collected data isn’t valuable if it isn’t being put to work.
- Tapping into a global ideas market ensures diversity of thought.
- Insight and ideas from outside the mining industry empowers a shared, sustainable future.
- Human-centred approach creates opportunities for unusual partnerships and genuinely unique exploration methodology.
Explorer Challenge
Harnessing Data Driven Discovery

Geologist

Data Scientist
Often the signal is not the obvious trend!

‘Normal geology’

Economic Mineral Deposits
(what we are looking for)
Explorer Challenge - Data Science Stream

13 Mar - 18 Apr

Generate new knowledge by predicting all Australian mineral deposits

Description

This challenge is a data science stream for the main Explorer Challenge, using Australia-wide data, with a prize pool of A$50,000.

This challenge provides a far greater number of training points for your model, compared to the main Explorer Challenge stream, however the data is sparser.

You are welcome to use your findings and work from this challenge for the main Explorer Challenge stream.

A leaderboard will be provided for benchmarking and feedback purposes but won’t be used in the final judging.

We’re looking for data science teams who can master geological uncertainty, predictive accuracy, and tell an awesome story with data.
Explorer Challenge

Getting data scientists involved

/ Separate Data Science competition specifically tailored to encourage experts in machine learning, programming, mathematics, etc. to get involved.

/ Competition tailored to provide real time feedback to entrants on how well their models were predicting mineralisation across different geologic terranes.

/ Data scientists were able to adapt their trade to the geologic problem surprisingly quickly.

/ A large number of teams with no geologic background achieved high accuracy predictions well above random chance!
Explorer Challenge

Data Science competition

/ 6 week competition
/ Global reach
/ 241 different models generated
/ Additional assessment criteria applied
  not just final leader board scores
  - Technical capability and Accuracy
  - Uncertainty
  - Communication
Explorer Challenge

Incentive to participate

/ Grand Prize $500,000
/ 2nd $200,000
/ 3rd $100,000
/ Student prize $50,000

/ Selected Targets will be drill tested in 2019

/ Data Science Stream $50,000

All values in Australian dollars
Explorer Challenge

Making it accessible

- Unearthed provided the bridge to the non-geologic community.
- Data was made easy to understand and painless to access through a custom-built online portal.
- Records were cleaned and accompanied by metadata, and comprehensive explanations.
- Kickoff presentations at PDAC in Toronto and a webinar with OZ Minerals domain experts.
- “Geoscience 101”
Explorer Challenge

Main Challenge - Data Access portal

7 results

Search

geology (3)
geochemistry (2)
assay (1)
drilling (1)
geospatial (1)
lithology (1)
regional (1)
reports (1)
survey (1)

Regional geological and structural data

Mt Woods Geology - Freemen-oxide related mineralisation in Australia

Drilling database

Introduction to drilling database for Mt Woods and Prominent Hill

This is a dump of drill holes from Mt Woods and Prominent Hill. Of these holes there are:

- 878 holes with located collars (in collar.csv or collar.gps
- 658 with logged lithology information - these are in lithology.csv
- 594 with survey information (so you can transform the distance down hole into x, y, z) - these are in survey.csv
- 585 holes with multi-element assays, for a total of 11,6596 assayed samples
- 342 holes with logged alteration data
- 324 holes with magnetic susceptibility measurements
- 259 holes with specific gravity measurements
- 228 holes with structural geology measurements
- 41 holes with rock quality indicators

The site identifier is consistent across tables so you can cross-reference the data to each hole.
Explorer Challenge

Main challenge - results

/ 3 months produced 37 models, 400+ targets.

/ A faster way to iterate and have multiple hypothesis presented.

/ Exciting new ideas, perspectives, models and methodologies – not just impacting exploration but raising questions throughout the business.

/ Consensus targets are independent, multidisciplinary, diverse and valid.

/ Biggest challenge now is keeping an open mind and not letting our detailed domain knowledge bias our thinking!
Explorer Challenge

Statistics

/ 1000+ individual registrations
/ 60+ plus countries represented
/ 10,000 data sets downloaded
/ Over 1 Million files
/ 20 Teams applied Machine Learning
/ >400 targets identified
Explorer Challenge

Winners

1st Prize (A$500,000): Team Guru - Michael Rodda, Jesse Ober, and Glen Willis.

Background: Michael was the data scientist for the team, Jesse has a background in environmental science and GIS, and Glen has a background in process engineering in the field of oil and gas and has a keen interest in data science.

Approach: Interpretable machine learning models for mineral exploration using geochemistry, geophysics and surface geology.

"Winning first prize gives our team the confidence in our data science abilities and cements our passion to shake up mineral exploration. We definitely plan to keep chipping away at this problem - we’ve barely scratched the surface of the value we could potentially get out of the data."
Explorer Challenge

Winners


Background: The DeepSightX team exploited multi-disciplinary skills at the intersection of artificial intelligence and geoscience. Researchers from the Australian Institute for Machine Learning (AIML) and the Institute of Minerals and Energy Resources (IMER) - both hosted by the University of Adelaide – collaborated with industry experts in minerals exploration (Austrike Resources) and geoscientific modelling (Gondwana Geoscience).

Approach: DeepSightX used a multidisciplinary approach to generate an AI model, DeepSight, which provides promising exploration targets in the Prominent Hill Region (PHR) supported by best practice geoscience.

The next step is to seek supports from all levels of the university, build capability, and start commercialisation process. We have a few ideas. We will consider all options and develop a holistic strategic plan for the future. The competition is a prelude for DeepSightX, and we look forward to the exciting journey ahead.
Explorer Challenge

Winners

3rd Prize (A$100,000): Cyency - Hugh Sanderson, Derek Carter, and Chris Green.

Background: Cyency has a strong data science and geoscience background. Hugh has been practising deep learning for several years. Derek has been involved with the technical and software side of mining for over 10 years, and Chris is an experienced geologist who is always looking for innovative ways of doing things.

Approach: "With so much data, it was difficult to know where to start, so we started with what we knew - the results from the Data Science Stream. We had a set of models that we knew were pretty good at predicting mineralisation across Australia, so we ran them over the tenement...we applied several data science techniques to estimate a set of candidate points, and then selected the 10 best of these."

"Prize money will be put straight towards developing a business in the mining/geology/artificial intelligence/machine learning space. There are so many interesting problems and the technology has opened up a greenfield, and Australia looks well placed to take advantage of it."
Explorer Challenge

Learnings

/ What we think is impossible probably isn’t.
/ Data-driven predictions of geology, mineralisation, alteration, etc. are achievable.
/ Other industries have tools, techniques and methodologies that can be applied to mineral exploration - we just don’t know each other’s challenges well enough yet.
/ Opening your data is less scary than you think.
/ Multidisciplinary teams see things differently.
/ With a combination of many models, we can build confidence through consensus.
Explorer Challenge

Going forward

/ More open data will yield better models in a much shorter time frame

/ Sharing our hard problems will produce better solutions.

/ Growing a distributed and diverse expert community in exploration will build better relationships between industry, communities and government.

/ We will gain more confidence in our targets before we drill them.

/ We will strive to increase the speed and success rates of economic discoveries.
Explorer Challenge

2019 Drilling program commencing

// Drilling of consensus targets starting this week.
// Initial program of 6 holes are planned.
// Testing live streaming of XRF assay data to a select group.
// Objectives:
  – Drill hole predictions.
  – Near real time decision support.
The future of mineral exploration