

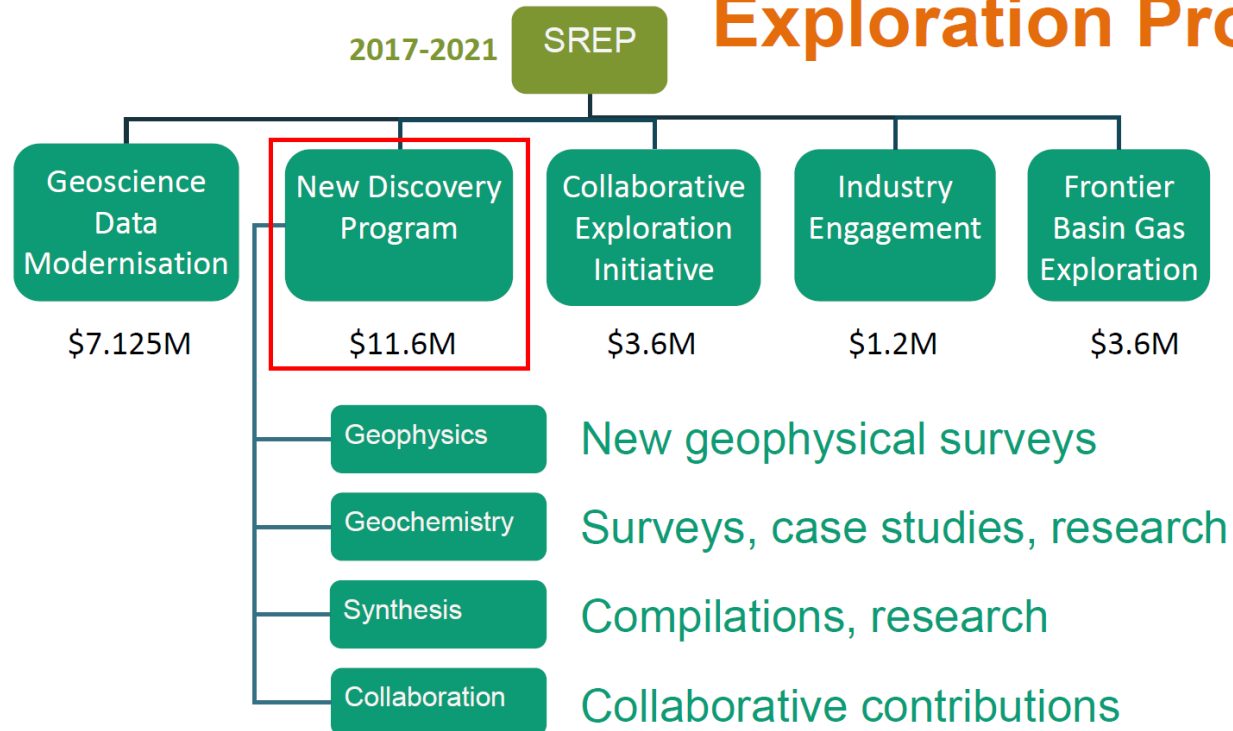


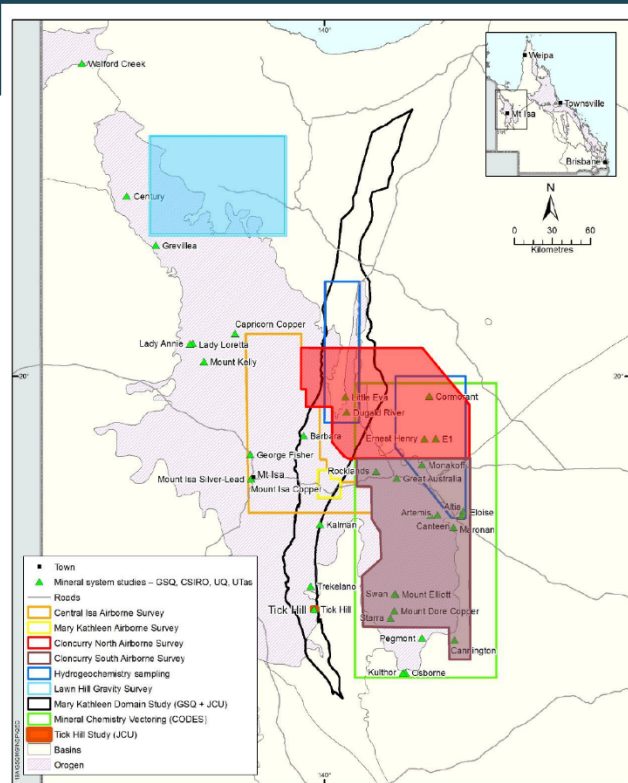
New Discovery Program

Project summaries for Advisory Panel

GSQ Projects and Funding

Strategic Resources Exploration Program

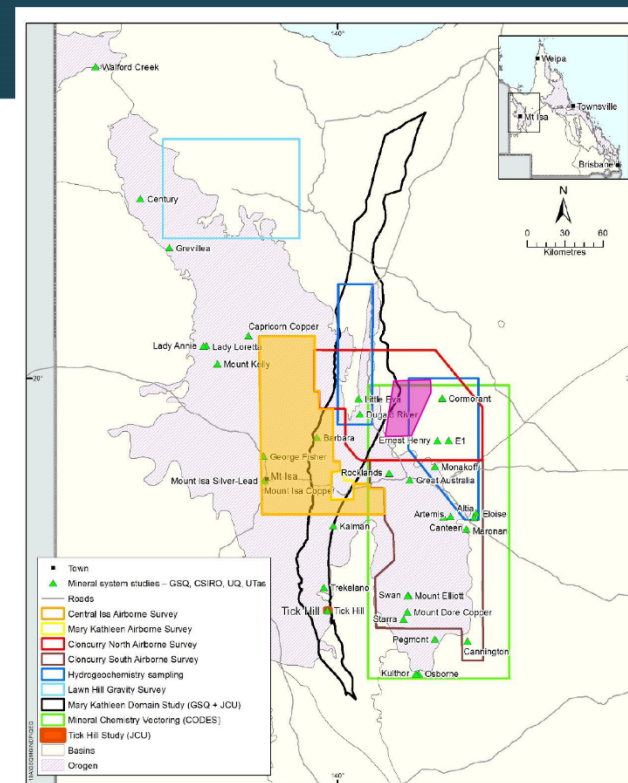




Coverage of the New Discovery Program

Completed Geophysical Surveys:

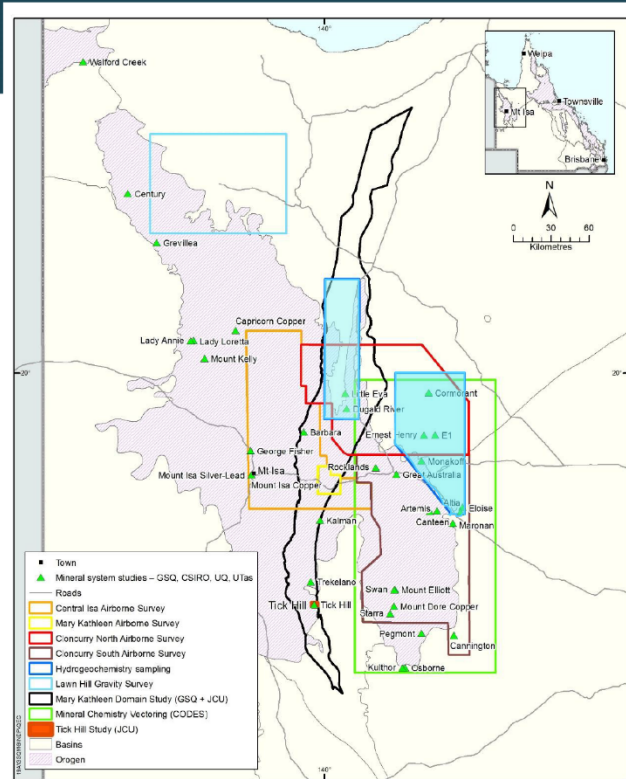
- Lawn Hill gravity
- South Cloncurry airmag + rads
- North Cloncurry airmag + rads



Coverage of the New Discovery Program

To be completed Geophysical Surveys 2019-2020:

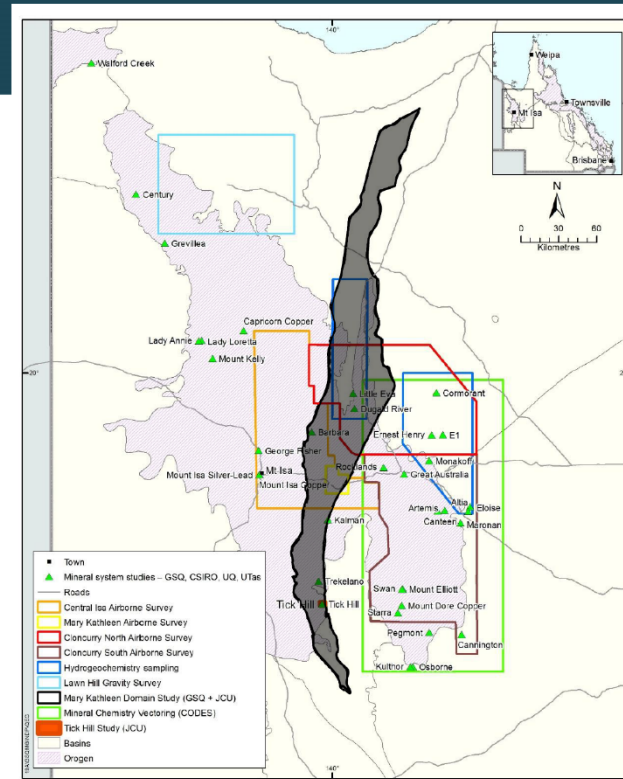
- Central Isa airmag + rads
- Cloncurry Extension MT
- AGG and AEM (areas to be determined)



Coverage of the New Discovery Program

Hydrogeochemistry (with CSIRO):

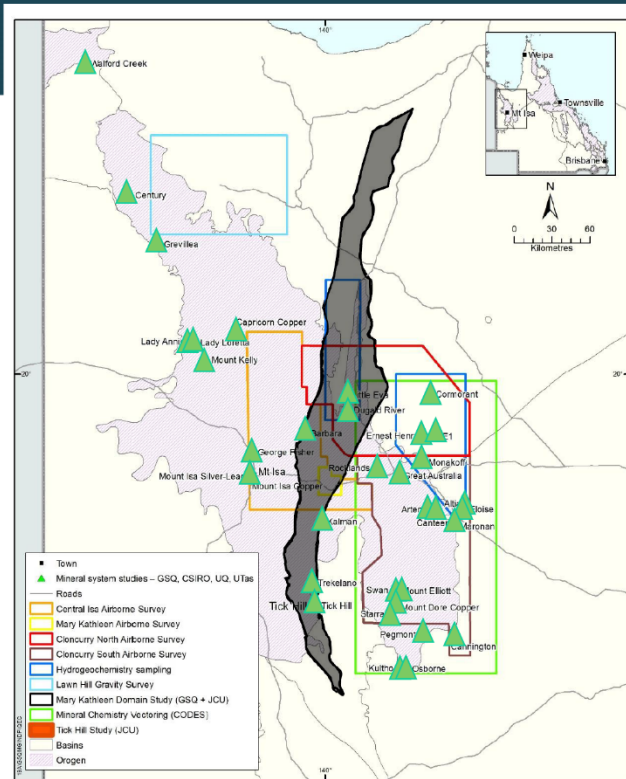
Sampling completed, awaiting analytical results



Coverage of the New Discovery Program

Mary Kathleen Domain Geology:

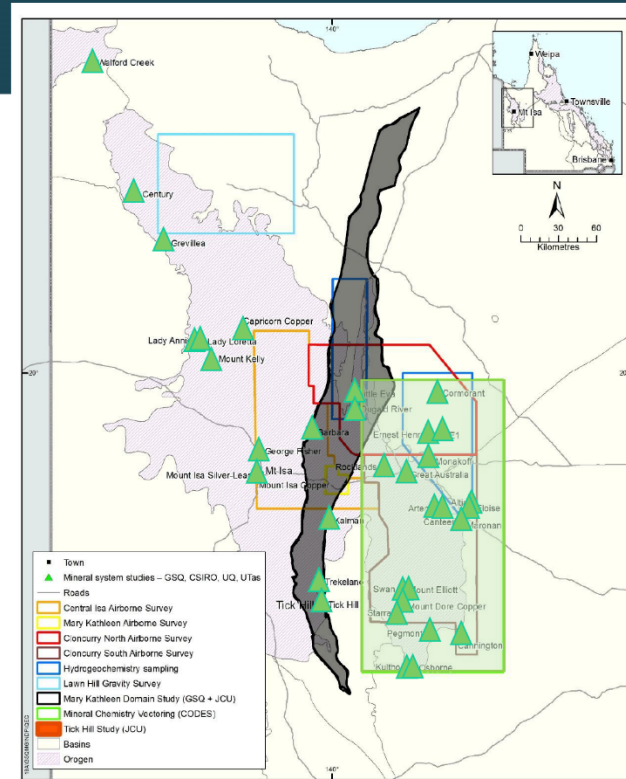
- Field work completed
- geochem and geochron underway



Coverage of the New Discovery Program

Reference Collection of Significant Deposits:

- Ernest Henry 90% complete – out in Dec 2019
- Finished scanning Mt Isa system holes



Coverage of the New Discovery Program

Collaborative Projects:

- **JCU:** Mary K tectonics and magma fertility
- **CODES:** mineral chemistry vectoring
- **UQ:** Deposit Atlas
- **CSIRO:** Deposit fingerprints

Timeline



PROJECT	PARTNERS	2017/18				2018/19				2019/20				2020/21							
		Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun				
Geochemical Toolkit	Geochem Pacific; Adelaide University; GSQ	Complete																			
Cobalt and HREE Mineral Systems in the Mount Isa Block	KDC Consulting					Complete															
NWMP Compilation	UQ-SMI	Complete																			
NWMP Predictive Modelling Pilot Project	CSIRO; GSQ		Complete																		
Magma Fertility of the Mary Kathleen Domain of the Mt Isa Inlier	JCU-EGRU; GSQ			Complete																	
Geological setting of the Tick Hill Gold Mine, Mount Isa Inlier, Queensland, Australia	JCU-EGRU		Complete																		
Mineral Geochemistry Vectoring: Uncovering Northwest Queensland's Hidden Potential	Utas-CODES			Complete																	
Northwest Mineral Province Deposit Atlas	UQ-SMI					Complete															
Cloncurry Metal	CSIRO					Complete															
Hydrogeochemistry	CSIRO;GSQ					Complete															
Queensland's Critical Metal Prospectivity	GSQ													Complete							
Cobalt in Copper Tailings	GSQ; UQ-SMI													Complete							
Mary Kathleen Domain Geology	GSQ; QUT; GA; JCU									Complete											
GSQ Reference Collection	GSQ; QUT; GA									Complete											

Complete In Progress

Geochemistry Toolkit

Summary

Since about 1950, the Mount Isa region has been covered by more than 3500 exploration tenements, most of which were explored with geochemistry as the primary means of investigation and final assessment. Yet, during the recent 25-year period of high profile geoscience initiatives and multiple post-graduate research programs, little attention, other than company confidential projects, has been given to the evaluation of surface geochemical exploration techniques suitable for the detection of buried and blind orebodies, or the challenge of chemical data optimisation for primary halo detection in drill hole samples.

The Geochemical Tool Kit (GTK) addresses these shortcomings by providing reviews, case studies, instruction, expert advice and learned opinion. Its primary aims are to guide and enhance geochemical exploration practice in northwest Queensland and encourage more companies to explore the 'greenfields' covered domain.

Collaboration & Details

The Geochemistry Toolkit is a collaboration between the Geological Survey of Queensland, GeoChem Pacific Ltd (NZ) and the University of Adelaide. Primary authorship was undertaken by Dr. Keith Hannan (Geochem Pacific). Industry contributors, by way of data or internal reports, include MIM Resource Development PL (MIMRD), Minotaur Exploration Ltd, South32 Ltd and Chinova Resources PL. The project was funded by the Queensland Government's Strategic Resources Exploration Program to increase mining activity and expedite mineral discoveries in northwest Queensland.

Project Leader: Joseph Tang - GSQ

Timing: June 2017 – June 2018

Participants: Keith Hannan, Geochem Pacific
Richard Lilly, Adelaide University
Joseph Tang, GSQ

Background & aims

The publication is primarily concerned with the chemical detection and recognition of buried targets in surficial regolith and drill hole samples. Overviews of conventional and innovative sampling and analytical methods are provided, and the relevance of each to typical exploration settings encountered in the Mount Isa region is demonstrated. Near-surface and outcropping mineralisation is also treated, but only in the context of data coverage and optimisation. The following framework links exploration setting and chemical exploration tactics as the major themes of the GTK:

- identifying locally sourced secondary dispersions at the surface (conventional surface geochemical)
- identifying deeply sourced secondary dispersions at the surface (non-conventional surface geochemical exploration)
- identifying secondary dispersions from drill hole samples within, and at the base of, transported cover (unlithified or lithified).

Outcomes

The outcomes of the project were delivered in the form of a report and appendices. The first half of the document comprises four chapters in which conventional sampling and chemical analytical methods are discussed. The subject matter includes: the quality and effectiveness of compiled surface geochemical data (DNRME, openfile), the optimisation of future surface and drill hole sample geochemical data, and the applicability of isotopic and mineral-based technologies. The second half, Chapters 5 to 8, concerns sampling and chemical analytical methods designed, or intended for, the measurement of chemically introduced secondary dispersions. Topics covered include: chemical transport mechanisms in transported cover, sample media and sampling procedures, nature of the data and the identification of anomalies..



[Link to Domain Map NWQ](#)



Deliverables & links

(ctrl click icons for links)



[Link to QDEX report and appendices](#)



[Presentation September 2018](#)



[Webinar 30 April 2020 – Joseph Tang](#)



[Webinar 30 April 2020 – Dominic Brown](#)



[Webinar 23 July 2020 – Joseph Tang](#)

Cobalt and HREE Mineral Systems in the Mount Isa Block

Summary

Significant opportunities exist in the Mount Isa Block for HREE mineralisation associated with igneous systems responsible for the IOCG deposits in the Cloncurry area. The element association in these IOCG systems is similar to the element suite, viz., Co-Ni-Cu-Au-Pt-Pd-F in the Idaho cobalt belt, where high concentrations of HREEs have been discovered. As Idaho was located adjacent to the north east margin of Precambrian Australia during the Mesoproterozoic ~1600 - 1400 Ga years ago, the hypothesis that Co systems in the Mount Isa Block could contain similar elevated HREE concentrations was tested.

Collaboration & Details

This study was undertaken under the auspices of the GSQ New Discovery Program with two objectives. (1) to improve understanding of Mesoproterozoic cobalt mineralization in the Eastern Succession of the Mount Isa Block, reviewed by Munro-Smith (2007). (2) to determine if any northwest Queensland cobalt mineralisation contained the high-levels of heavy rare earth elements and yttrium reported from Mesoproterozoic hydrothermal deposits in the Idaho Cobalt Belt (Bookstrom et al., 2007; Slack, 2010; 2012).

Project Leader: Ken Collerson – KDC Consulting

Timing: June 2018 – December 2018

Participants: Ken Collerson – KDC Consulting

Background & aims

China is the leading supplier of high-value heavy rare earth elements (e.g., Dysprosium Dy). These elements are considered to be "critical rare metals" because their supply from China, is being threatened by increased Chinese domestic consumption and environmental concerns regarding their extraction from ionic clay deposits by artisanal operated mines. This has stimulated a global search to secure alternative sources of HREEs. However, unlike the light rare earth elements Neodymium (Nd) and Praseodymium (Pr) which occur in abundance in carbonatites, deposits that are enriched in HREEs are significantly less common.

As this possibility had not previously been investigated, a litho-geochemical study of cobalt ores from deposits in the Eastern Succession was undertaken to improve understanding of cobalt mineral systems with the potential to stimulate exploration for the rare heavy rare earth elements, yttrium and scandium in addition to other battery metals like Co and Cu and associated precious metals gold and the platinum group elements.

Outcomes

- REE and other trace element data presented in this report shows a clear genetic link between cobalt-bearing IOCGs in the Eastern Succession with multi-element (Co- HREE-Au-PGE-Ni) mineralisation in the Idaho Cobalt Belt, where a number of the Co deposits are in reality HREE, Au and PGE resources.
- Earlier studies of this mineral system suggested that Cu, Au, F, U, P and REEs as well as S were derived from the Williams Naraku Granite via a magmatic-hydrothermal fluid (Williams et al., 2015). However given the element association (Co, Ni, Sc as well as PGE's), a more plausible explanation is that metals in the system were derived from an ultramafic to mafic alkaline igneous source, like the Sc, HREE, Cu, Ni, Au and PGE rich olivine websterites discovered in this study, at Mount Cobalt.
- There is high potential for discovery of other HREE, Sc, PGE, Au, Ni, Co-enriched, alkaline ultramafic bodies that are similar to the Mount Cobalt (intrusion?), possibly associated with carbonatites, a hypothesis originally proposed by Groves and Vielreicher (2000).
- Thus the Cloncurry District has significant and as yet untested prospectivity for discovery of a new source of high-value heavy rare earth mineralisation.



Deliverables & links

(ctrl click icons for links)



[Link to QDEX report and appendices](#)



[Presentation September 2018](#)



[Seminar July 26 2019](#)

NW Mineral Province Compilation

Summary

The objective of this project is to carry out a compilation of precompetitive geoscientific studies for the Northwest Mineral Province

There is a wealth of information available arising from exploration, mapping and research by GA and the GSQ, Universities, research organisations and exploration companies, but much of that information is buried in reports and theses, spread around the internet, not geographically referenced, hidden in proprietary datasets, and not placed into the context of previous and subsequent studies. Most exploration companies do not have the time, resources and background knowledge to bring this information into a form in which its usefulness to industry is maximised. Key questions relating to compilation of previous geoscientific data include:

- What information is available?
- What is the priority order of information to be compiled based on its perceived usefulness to exploration companies?
- What forms should the data compilation be delivered in?
- What needs to be done to ensure that compiled data is understood and used by explorers

Collaboration & Details

The project aims to assemble information relating to all relevant geoscientific studies of the region and to extract information on the geographic extent, key focus, outcomes and a range of other parameters relating to each study.

Project Leader:	Rick Valenta – SMIBRC - UQ
Timing	June 2017 – June 2018
Participants:	Rick Valenta, UQ Mark Hinman, UQ Dominic Brown, GSQ Courtney Dhnaram, GSQ

Background & aims

The Mount Isa region is one of the world's best endowed belts of Zinc, Lead, Silver, Copper and Gold. It hosts several world class deposits and has been intensely explored for the last 50 years or more. Over that time, there have been many geoscience initiatives aimed at studying the characteristics and geoscientific expressions of the major deposit types in the region, and a large proportion of the region's exploration data has been compiled in multiple phases, resulting in a large resource of open file geoscientific data. Whilst the existing precompetitive datasets have been very valuable to exploration in the region, there is abundant remaining potential to realise value from these datasets through additional analysis and delivery in a form in which it can be most effectively used by the region's explorers.

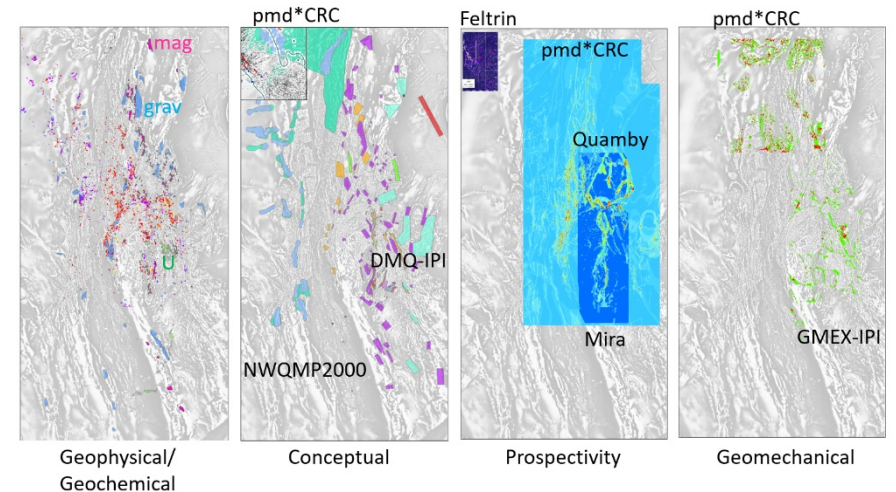
The objective of this project is to carry out a compilation of precompetitive geoscientific studies for the Northwest Mineral Province

Outcomes

Data compiled to date includes:
















- a prototype for an Atlas of Northwest Mineral Province ore deposits containing Ernest Henry and Mount Isa
- Updated event stratigraphy chart
- Timesliced stratigraphy, structure and igneous events
- Compilation of polygon outlines/isopachs/isodepths from existing 3D models
- Draft structure of final GIS project outputs
- Compilation of exploration targets from previous prospectivity studies
- Compilation of miscellaneous legacy GIS datasets (Metamorphic map, NABRE sections, CRC LEME regolith)
- A draft Spatial Data Index (SDI) prototype
- Secure set of drillcore and accompanying materials from Mount Isa, George Fisher and Ernest Henry for storage and study at DNRM Core facility
- An update of existing solid geology interpretations

A Gap Analysis of Industry Priorities and Compilation results has allowed the definition of a Gap Analysis and Action Plan which can form a basis for future precompetitive research activities aiding exploration in the NW Mineral Province.



Deliverables & links

(ctrl click icons for links)

	Prototype Spatial Data Index		Report (unreleased)
			
			NWMP Target Compilations
			Timesliced stratigraphy, isopachs, structure and igneous events
	3D Model Compilation		Seismic Interpretations
	Workshop June 2019		Southern EFB Solid Geology
	Workshop September 2019		Presentation September 2018

NWMP Data-Driven Mineral Exploration and Geological Mapping

Summary

We have conducted several experiments to assess the utility of different machine learning algorithms applied to freely available data covering the North West Minerals Province (NWMP) in Queensland. The first experiment focused on accessing the copper and gold mineral prospectivity of the Quamby area. The second suite of experiments aimed at the digital geological mapping of the Eastern Succession in the Mount Isa Inlier. Finally, we attempted to predict the concentration of Cu, Au, Pb, Zn indicating possible mineralisation in bedrock as if no cover existed, using in situ soil samples

The process of exploring for mineral resources consists of several interconnected steps, where the probability of finding a deposit or target is evaluated based on the geological, geochemical and geophysical surveys conducted in an area. All of the acquired data form the foundation of an integrated approach to geological mapping and exploration targeting.

Collaboration & Details

The project will leverage a multidisciplinary team from CSIRO Mineral Resources and Data61 and will include project management and expertise in minerals exploration and data analytics. Others with complementary expertise may be brought in by CSIRO as required. Participants from GSQ included Vladimir Lisitsin and Matthew Greenwood

Project Leader: Vladimir Lisitsin- GSQ

Timing: October 2017 – December 2018

Participants: David Cole, Lachlan McCalman, Vasek Metelka, Alexander Otto, Jess Robertson, Andrew Rodger, and Daniel Steinberg, CSIRO
Vladimir Lisitsin, Matthew Greenwood, GSQ

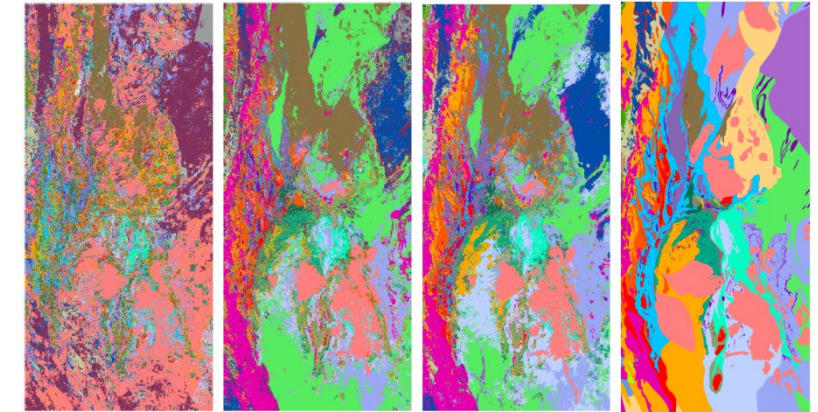
Background & aims

The overall aim of the project was to investigate how aspects of machine learning can support geologists in order to make quicker and more informed interpretations. We have conducted several experiments to assess the utility of different machine learning algorithms applied to freely available data for the North West Minerals Province in Queensland. The first experiment focused on the comparison of the traditional weights of evidence (WoE) method to logistic regression in the Quamby area in assessing copper and gold mineral prospectivity of the Quamby area. In the second experiment, we attempted to predict concentrations of Cu, Au, Pb, and Zn using in situ soil element concentrations as training and geophysical data as explanatory variables in order to find anomalous regions suitable for exploration targeting. The third suite of experiments evaluated several approaches to the automated geological mapping of the Eastern Succession in the Mount Isa Inlier. We tried to provide an insight on how we could enhance the abilities of a geologist by a data-driven interpretation as an aid in the mapping process. We attempted to classify lithological units, discover undetected granite outcrops, and find anomalous regions in the interpreted geological maps based on a multivariate dataset.

Outcomes

While limited to a single region of study, this project has demonstrated the value of information obtained within large, freely available datasets and the potential of machine learning to extract that information in an automated way to improve existing processes. The geochemical element predictions successfully uncovered links between deep geophysical and surface geochemical signatures which can be utilised as an alternative to traditional prospectivity mapping while the anomaly detection and geological classifications provide a more objective assessment for mapping efforts both historical, in production, or planned.

The development and use of new data integration and analysis techniques will not only allow for easier, faster, and more repeatable interpretation of multi-source data but can also improve future data collection practices, all to maximise the value of information gathered for a region of interest.



(a) Model prediction – 2 points per class. (b) Model prediction – 20 points per class. (c) Model prediction – 200 points per class. (d) Solid geology interpretation.

Figure 6.9.: Sparse geology classification – *Random forest* with *all* covariates. The model prediction is shown for varying number of training points (a maximum of 2, 20, and 200) per class. Figure 6.9d shows the existing solid geology interpretation for comparison.

Deliverables & links

(ctrl click icons for links)



[Link to QDEX report and appendices](#)



[Presentation June 2019 – Vasek Metelka](#)



[Presentation October 2019 – Matthew Greenwood](#)

Magma Fertility of the Mary Kathleen Domain of the Mt Isa Inlier

Summary

Four different groups of intrusive rocks from the Cu-Au and U-REE mineralised Mary Kathleen Domain, Mt Isa Inlier are studied to examine their magma fertilities. LA-ICP-MS zircon U-Pb dating results reveal these extrusive rocks formed in the time period between ca 1450 and ~1800 Ma. Bulk rock geochemistry demonstrates that these intrusive rocks experienced extensive magma fractionation and possible magma mixing. The oldest, one of the petrographic phases from the Wonga Granitoids, does not show a close connection with the regional Cu-Au and U-REE mineralisation. Pegmatite from Mt Godkin may be the youngest phases, and contains most obvious mantle components in the Mary Kathleen Domain. Ore elements Cu and Au are most enriched in the Lunch Creek gabbro. Uranium and REE concentrations are elevated in certain phases of the Burstall and Wonga granitoids.

Collaboration & Details

The project is being carried out by staff and students of JCU, with collaboration involving the spatially-overlapping Mary Kathleen Domain Geology Project being carried out by the GSQ

Project Leader: Paul Dirks, Ioan Sanislav - JCU

Timing: January 2018 – March 2021

Participants: Ioan Sanislav, Paul Dirks, Joshua Spence, Alexander Edgar, Truong Le, Grace Manestar, Pieter Creus, Travis Mackay, Jan Huizenga, Carl Spandler

Background & aims

Substantial progress on understanding magma fertility has been achieved in porphyry Cu±Au field in recent years, leading to the development of effective exploration tools. It has been recognized that porphyry Cu±Au deposits are most commonly formed by hydrothermal fluids exsolved from water-rich oxidized calc-alkaline magmas in arc settings (Hedenquist and Lowenstern, 1994). Several parameters have been recognized to address magma fertility in porphyry Cu±Au deposits. By contrast, there has been very little work on understanding magma fertility in relation to IOCG mineral systems, probably because connections between magmatism and mineralization remains vague.

In this study, we examine the magmatic rocks from the Mary Kathleen IOCG Cu-Au and skarn U-REE mineral field including the Mt Godkin Complex, the Burstall and Wonga Suites, and the Lunch Creek gabbroic rocks, aiming to explore the magma fertility parameters from intrusive rocks through establishing the connection between magmatic activities and mineralization in this region. The results will be used to test the magma fertility of other IOCG associated magmatic rocks in the northwestern Queensland.

Outcomes to date

- Bulk rock geochemical analysis of 51 samples of various igneous phases of the Burstall, Wonga and Mount Godkin Granitoid complexes have been obtained and analysed. These results point to an intraplate, A-type classification for these igneous rocks.
- LA-ICP-MS U-Pb dating of igneous zircons indicate that the Mount Godkin granite and granitic rocks associated with the Little Eva Cu deposit formed at ca. 1750 Ma.
- New mapping in the Mary Kathleen Syncline and LA-ICP-MS U-Pb dating of igneous zircons indicate that:
 - deformation related to the Mary Kathleen Syncline largely predates ~1740-1730 Ma. This may re-define the relationship between plutonism and deformation in the region.
 - the stratigraphy and deformation in the area predates ~1770 Ma. Together with age results from the Mary Kathleen syncline this suggests that: a) there may be an early (pre-1740) compressional stage affecting rocks of the Mary Kathleen Domain; b) the current stratigraphic correlations in the Mary Kathleen Domain do not hold.
- Analysis of various stages of scapolite formation around the Elaine Dorothy Cu-REE deposit show systematic variations in Cl/Br ratios and sulphur contents with distance from the orebody. These results demonstrate the potential for scapolite to be used as a vectoring tool in mineral exploration.

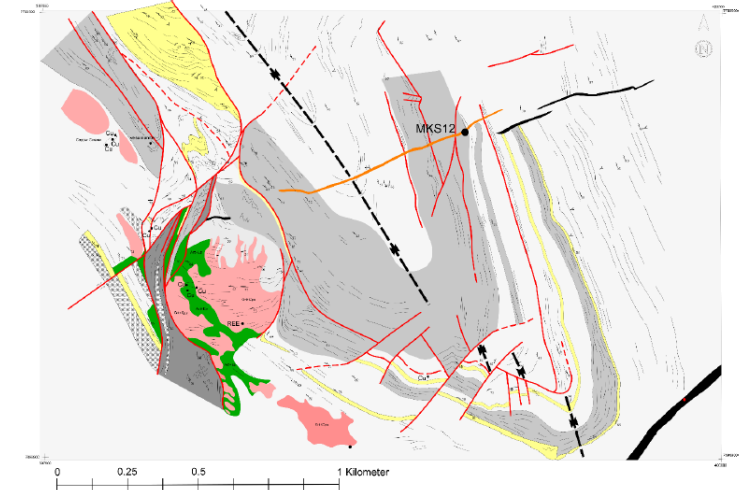


Fig. 8. Map showing ENE trending monzodiorite dyke intruding across the core of the Mary Kathleen Syncline. The Elaine Dorothy Prospect is shown to the left hosted in skarn.

Deliverables & links

(ctrl click icons for links)



Presentation March 2019



Presentation June 2019



Presentation September 2019



Webinar 14 May 2020

Geological setting of the Tick Hill Gold Mine

Summary

The Tick Hill Au deposit is located in the Mary Kathleen Domain, 110 km southeast of Mount Isa in NW Queensland. The deposit was discovered by MIM Exploration in September 1989 during Cu-Au exploration, and was mined by Carpentaria Gold between 1991-1994, in both open pit and underground workings. The deposit produced approximately 511,000 ounces (~15.9 tons) of gold at an average grade of 22.52 g/t Au. The ore body was about 140m long, 1 to 30m wide, and extended 320m down dip (240m below surface). The high-grade of the deposit, the lack of sulphides and the presence of almost exclusively free gold within upper-amphibolite facies, quartz-feldspar mylonite units, makes Tick Hill a unique gold-rich deposit in the Mount Isa Inlier, of interest to mineral exploration.

Collaboration & Details

The project is being carried out by PhD student Truong Le under the supervision of Prof. Paul Dirks, Dr. Ioan Sanislav, Dr. Jan Huizenga. Glencore, Carnaby Resources and Superior resources have each provided assistance to the project.

Project Leader:	Paul Dirks – JCU/EGRU
Timing	April 2018 – June 2021
Participants:	Truong Le under the supervision of Prof. Paul Dirks, Dr. Ioan Sanislav, Dr. Jan Huizenga, JCU

Background & aims

The Tick Hill Au deposit is located in the Mary Kathleen Domain, 110 km southeast of Mount Isa in NW Queensland. The deposit was discovered by MIM Exploration in September 1989 during Cu-Au exploration, and was mined by Carpentaria Gold between 1991-1994, in both open pit and underground workings. The deposit produced approximately 511,000 ounces (~15.9 tons) of gold at an average grade of 22.52 g/t Au. The ore body was about 140m long, 1 to 30m wide, and extended 320m down dip (240m below surface). The high-grade of the deposit, the lack of sulphides and the presence of almost exclusively free gold within upper-amphibolite facies, quartz-feldspar mylonite units, makes Tick Hill a unique gold-rich deposit in the Mount Isa Inlier, of interest to mineral exploration.

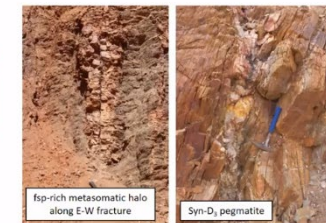
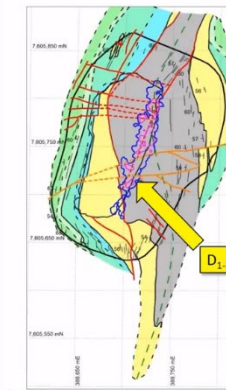
Available research data and the interpretations derived from that are at times contradictory, which suggests that the Tick Hill deposit could be more complex and the result of more than one control. At this point, there is too little information on the deposit available in the public domain. The study conducted by JCU and funded by GSQ is intended to correct this and aims to: (1) characterize the geological setting of the deposit; (2) clarify the mineralization style for the deposit; and (3) constrain the timing of mineralization.

Outcomes to Date

- Gold is mostly syn-D3 (~1525Ma)
- Gold associated with
 - Magnetite-low
 - Few sulphides
 - Intense qtz-ab-chl-ep alteration
 - Sheeted veins // S_{1-2} and along E-W normal fractures
- Gold is partly hosted in leucogranite which probably originated as migmatite @ ~1775Ma
- Au and Cu-Co display an antithetic relationship at 1m scale
- Fluids appear to be hyper-saline, aqueous fluids with no CO₂ and abundant hematite inclusions with evidence for boiling (preliminary only!!)
- Geophysics hints at underlying intrusion
- Oxygen isotopes are all the same

Structural setting

Deformation: D₃ @ ~1525Ma



- D₃:
- Normal faulting
 - Pegmatite emplacement
 - Alteration
 - Au mineralisation

D_{1,2} foliation truncation plane reactivated as D₃ normal-sinistral fault

Ore envelope parallels foliation truncation plane

Deliverables & links

(ctrl click icons for links)



Presentation March 2019



Webinar 14 May 2020



Mineral Geochemistry Vectoring: Uncovering Northwest Queensland's Hidden Potential

Summary

The Mount Isa district contains numerous base and precious metal systems which have suites of sulfide, silicate, and carbonate minerals that are ideal for trace element geochemical analysis. Furthermore, many of the mines in the Mount Isa district are approaching end-of-life scenarios, which could have a significant negative socio-economic impact on the region. Finding new resources and re-vitalizing the Northwest Queensland Mineral Province is therefore of paramount importance.

The LA-ICP-MS facilities at CODES, University of Tasmania, are at the forefront of mineral geochemistry research, both nationally and internationally. Over the last decade, our laser labs have enabled us to produce cutting-edge results in pyrite, chlorite, and epidote vectoring and paragenetic studies, leading to high-profile publications in major peer-reviewed scientific journals. We therefore have the expertise and capacity to adequately manage high sample throughput and data analysis in a timely manner.

Collaboration & Details

The trace element geochemistry research program will be carried out over a 3-year period by a team of CODES researchers using existing sample material in storage at CODES, as well as new samples collected in the field in the Mount Isa region. The raw data collected via LA-ICP-MS analyses will then be screened and processed at CODES before delivery to the Department for further analysis and application. Sample collection and analysis is being carried out in collaboration with complementary programs by the GSQ and CSIRO.

Project Leader:	David Cooke, Shaun Barker - CODES
Timing	March 2018 – June 2021
Participants:	David Cooke, Shaun Barker, Jonathan Cloutier, Jeff Steadman, Max Hohl CODES

Background & aims

UTAS objectives will be to provide the Department with new geochemical information on known systems in the Mount Isa district, which will then be applied to greenfields targets elsewhere in the province, with the ultimate objective of providing new pre-competitive regional geochemical datasets that can aid in the exploration for, and discovery of, new base- and/or precious-metal resources to revitalize the Mount Isa region. The objectives of UTAS are more specifically to:

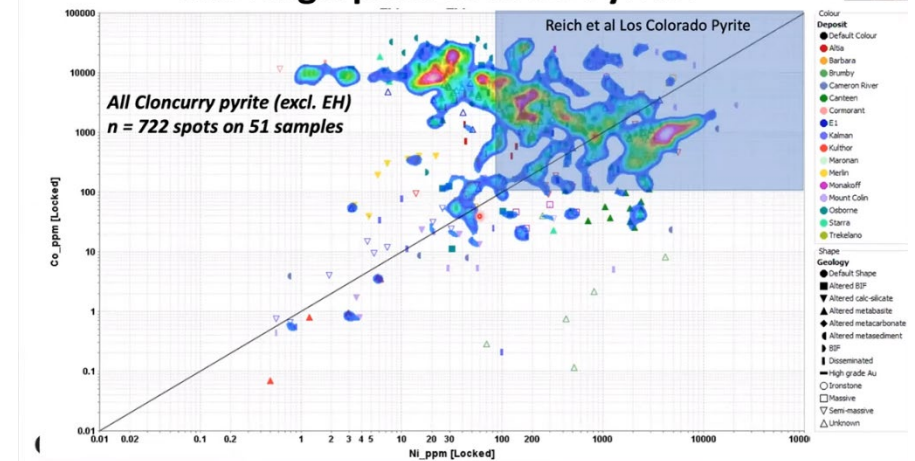
- Provide the Department with a pre-competitive mineral geochemistry database on known deposits in the Mount Isa region that can be used by exploration and mining companies to inform decision making regarding their exploration activities in the region.
- Explore the patterns of mineral geochemical zoning in common sulphide, carbonate and silicate components of sediment-hosted base metal and iron oxide copper-gold deposits in the region.
- Develop new mineral vectoring tools which can be easily applied by researchers and explorers working in the Mt Isa region.
- Use these data to interpret how the ore deposits and their alteration halos formed, leading to high-impact publications in international journals and presentations at conferences.

Outcomes to Date

Significant progress has been made toward the overall objectives of the program, in the areas of:





1. Deposit “fingerprinting” – trace element characterisation of hydrothermal alteration minerals proximal to known deposits (e.g. pyrite, magnetite, chlorite, calcite) – answering the question – are we in a mineral system?
2. Deposit “footprints” – delineating mineral chemistry alteration footprints for IOCG and sediment-hosted deposits to provide an idea of proximity to a deposit.
3. Dating of non-traditional minerals (i.e., calcite, epidote, etc.)

The Fingerprint of IOCG Pyrite?



Deliverables & links

(ctrl click icons for links)

-  Presentation September 2018
-  Presentation March 2019
-  Presentation September 2019
-  Webinar 14 May 2020

Northwest Mineral Province Deposit Atlas

Summary

A key component of the NW Mineral Province Compilation project was the preparation of prototype Mineral Deposit Atlas entries for Mount Isa and for Ernest Henry. The Mineral Deposit Atlas research component was ranked second by Industry feedback out of 26 proposed areas of research for the Northwest Mineral Province New Discovery Program.

The aim of the atlas is not to extensively revisit and update the well-studied and long-debated process models for each deposit type (summarised for example, in the NWQMEP 2011 report). As noted by McCuaig et al (2010), as exploration progresses to more detailed scales there is a decrease in the effectiveness of model-based conceptual targeting and an increasing reliance on direct detection, with its associated high risk of “false positives”. The best way to maximise the effectiveness of exploration at this scale is to ensure that exploration is being carried out with the most comprehensive knowledge possible of the expression of the outer and inner haloes of the deposit style in question.

Collaboration & Details

The Project is being carried out by staff of the WH Bryan Mining and Geology Research Centre, part of the Sustainable Minerals Institute at the University of Queensland. Many companies have provided data to help with the compilation, including, Glencore, Chinova, South32, Red Metal, FMR, Capricorn Copper, Carnaby Resources, Hammer Metals, MMG, and Aeon Metals. GSQ and CSIRO have also provided data which have been included in the atlases

Project Leader:	Paul Gow, Rick Valenta – UQ BRC
Timing	July 2018 – June 2020
Participants:	Paul Gow, Rick Valenta, Nathan Fox, Mark Hinman, Ali Parchegani, Sasha Aivazpourporgou, UQ BRC

Background & aims

The Mount Isa region is host to many large deposits of Cu, Pb, Zn, Ag and Au, and there is significant variation between the deposits. Knowledge relating to the geology, mineralogy and geochemistry of each deposit and its associated inner and outer haloes as they are expressed in common exploration datasets can provide important information for assessment of exploration projects in a number of ways including:

- Provision of a basis for assessment of mineral system affinity of a new early stage exploration target
- Provision of assistance in the vectoring of exploration drillholes on the basis of geochemical, geological, and/or mineralogical gradients found to exist in known deposits of similar type.

The objective of this project is to complete an atlas of all significant mineral deposits in the Northwest Mineral Province as an aid to future exploration in the region.

Outcomes

The deposit atlas entries have been progressively released as they have been completed, and each atlas has been delivered in the form of a pdf document as well as a 3D Compilation of data in Geoscience Analyst (along with common file format copies of the constituent datasets for use in other programs. To date 17 chapters have been completed covering 20 deposits, and when complete the project will cover 24 deposits.

Feedback to date from NW Mineral Province explorers has been positive, and a survey is currently in circulation aimed at identifying potential improvements and next steps.



Link NWMP Atlas on GSQ Data Portal

Chapter 6 - Osborne and Kullthor	Chapter 7 - Eloise	Chapter 8 - Lady Loretta/Annie	Chapter 9 - Gunpowder	Chapter 10 - Century-Grevillea
Osborne-Kullthor 3D Atlas	Eloise 3D Atlas	Lady Loretta/Annie 3D Atlas	Gunpowder 3D Atlas	Century-Grevillea 3D Atlas
Chapter 11 - George Fisher	Chapter 12 - E1	Chapter 13 - Rocklands	Chapter 14 - Tick Hill	Chapter 15 - Kalman
George Fisher 3D Atlas	E1 3D Atlas	Rocklands 3D Atlas	Tick Hill 3D Atlas	Kalman 3D Atlas

Deliverables & links

(ctrl click icons for links)



Link to SMI-BRC page with all downloadable atlases



Presentations December 2018



Presentations June 2019



Webinar 23 April 2020



Webinar 10 April 2020



Paul Gow Ore Deposits Hub Presentation October 2020

Cloncurry Metal

Summary

The objectives of the project are to collect a consistent mineralogical-geochemical-petrophysical data-base on identical samples from major deposits of the Cloncurry district. The Outcomes will be used to:

1. Provide an up-to-date consistent understanding of the Cloncurry mineral system, which will be expressed as an Atlas of alteration types and petrophysical responses.
2. Develop a toolkit consisting of techniques developed in order to identify critical mineral system indicators using relatively inexpensive tools, i.e., tools that can be made available in the core shed.

The toolkit which can be used in conjunction with an Atlas, to identify where samples extracted might sit relative to known mineral occurrences.

Collaboration & Details

CSIRO will be responsible for the management of the project, the sampling of materials, which will be coordinated separately with third parties, and the preparation of all samples, other than the generation of rocks powders for geochemistry. CSIRO will provide materials to GSQ, for the generation of rock powders, but GSQ will be responsible for the generation of rock powders.

CSIRO will be responsible for the acquisition of the majority of the data collected, including TIMA imagery and analysis, and all petrophysical datasets including: AMS, Magnetic Susceptibility, Remanence (NRM), Density, Radiometrics and Conductivity, as outlined in the table below.

Project Leader:	Jim Austin - CSIRO
Timing	July 2018 – June 2020
Participants:	Jim Austin, Andreas Bjork, Ben Patterson (CSIRO, North Ryde, NSW) Jess Stromberg, Renee Birchall, Mark Pearce and John Walshe (CSIRO, Kensington, WA)

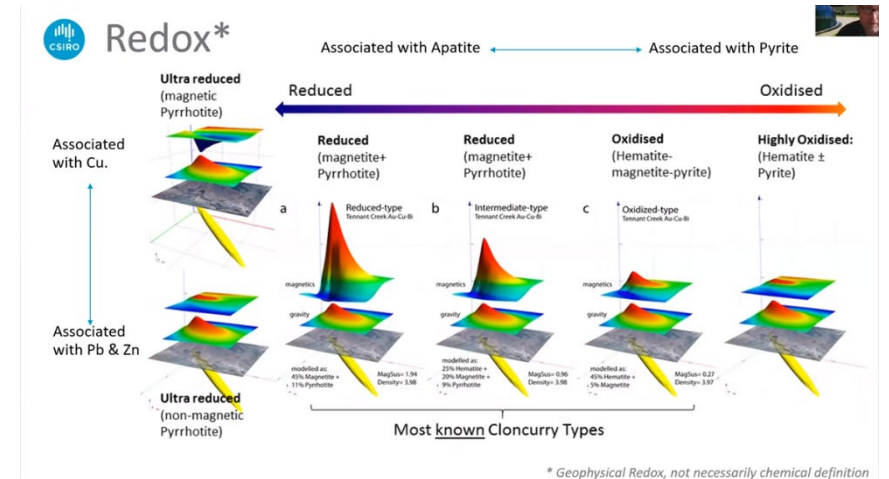
Background & aims

The Uncover Cloncurry project introduced a new way of looking at mineral exploration, based on generating mineralogical, structural and petrophysical information at the hand sample scale, which could be used to understand the metasomatic history, structural controls and geophysical expression of different deposit styles. One of the main outcomes of the Uncover Cloncurry Project was that it developed a methodology to evaluate a vast suite of deposit types consistently, using the same five techniques, and most importantly at the same scale.

- Completing work on Major Deposits (e.g., Eloise, Cannington, Great Australia, Dugald River, etc)
- Incorporating additional techniques e.g., conductivity, radiometrics and hyperspectral core mapping.
- Utilising the existing reference library to locate dateable minerals for geochronology
- Expanding the workflow out to regional scales, on the surface and undercover.
- Conducting more comprehensive principal component analyses of the datasets to identify indicators of mineralisation that may not be apparent using more qualitative approaches.
- Generating a comprehensive reference library and condensed Atlas of deposit types, the association between geochemistry, mineralogy, alteration minerals, alterations types, structural controls and various petrophysical parameters (e.g., density, conductivity radiometrics, MagSus, NRM).
- Adapting the workflow, such that industry can incorporate the outcomes into their exploration programs, including using handheld petrophysical tools and also developing a method to convert geochemistry to alteration using hyperspectral scanning.

Outcomes to date

The comprehensive program of sampling and analysis is now well-advanced, with petrophysics, mineral characterisation and geochemistry collected for a majority of the targeted deposits. Reporting is taking place on a six-monthly basis and work is proceeding according to schedule.



Deliverables & links

(ctrl click icons for links)



Presentation September 2018



Presentation March 2019



Webinar 14 May 2020

Cobalt in Copper Tailings

Summary

The project seeks to undertake first-pass characterisation assessments in terms of critical metal abundances and their modes of occurrence in tailings and other mine wastes in north Queensland.

The mine waste features at 9 sites in Queensland (Lady Annie, Capricorn Copper, Century, Osborne, Selwyn, Baal Gammon, Wolfram Camp, Mt Oxide, Pindora) have been sampled for new economy metal exploration funded by the GSQ. Preliminary assay data for these samples has been collected (NB. some samples require additional analysis) so only limited interpretations are presented in this interim report. Samples were collected from 6 sites in January-February 2020, with tailings samples also provided from the New Century, Osborne and Chinova sample stores).

Mineralogy (XRD and MLA) and mineral chemistry (LA-ICPMS) data is outstanding. A UQ honours student, Ruby Fritz, has joined this project and is working on identifying indigenous bacteria at Capricorn Copper.

Collaboration & Details

Site-based sample collection for the project is being undertaken as a cooperative effort involving both BRC and GSQ staff. Support has been provided by several NWMP Companies including Glencore, Capricorn Copper, New Century, Chinova and Lady Annie

Project Leader:	Anita Parbhakar-Fox – UQ SMI BRC
Timing	November 2019– June 2020
Participants:	Anita Parbhakar-Fox, Nathan Fox, Ruby Fritz, Rick Valenta, BRC Dominic Brown, Friedrich von Gnielinski, GSQ

Background & aims

Australia is well endowed in base and precious metals, but to date critical metals (e.g., Co, In, W, Ga, Ge) have not been the focus of the Australian mining industry, and are instead by-products of mining for other commodities (i.e., Cu, Pb, Zn). The 2019 Critical Metal Strategy commissioned by the Australian Government identified that out of 30 critical metals, Australia was the top global producer for just one, lithium. With increasing global pressure to utilise low-carbon technologies there is greater demand for critical metals to support this development with mine waste materials representing a potential resource to help supplement the supply of these sought after metals and minimising potential environmental impacts they may have on the surrounding environment, such as the release of acid and metalliferous drainage (AMD). However, determining their contents and mode of occurrence in mine waste is vital in assessing if a potential economic deposit exists and indeed, the most appropriate metallurgical processing pathways suited to their extraction. The Queensland State Government recognise there is great potential to explore for these critical or 'new economy' metals in mine waste materials produced by mines across the state and is the focus of this project.

Outcomes

Field-based sampling activities for the project are now complete and preliminary analyses have been received. An interim report has been delivered to the GSQ, and final reporting will be complete by the end of June

In the next two months, collection of the outstanding MLA, XRD and LA-ICPMS data is the priority activity. In addition, micro-XRF images are being collected on slabbed waste rock samples collected from the sampled sites. It is anticipated that this will provide some context with regards to new economy metal deportment in-situ, in these materials



Deliverables & links

(ctrl click icons for links)



Presentation December 2019



Webinar 14 May 2020

GSQ Reference Collection

Summary

The GSQ Reference Collection project aims to understand the geoscientific signatures of known mineralised systems in the NW Mineral Province in order to better understand and interpret results from sparse datasets collected as part of exploration in unknown targets. The intended use of the data is to help in the early understanding of greenfields exploration targets, and to aid in application of the mineral systems approach to exploration under cover.

Data collected as part of the project will help explorers to answer questions such as:

- Have I intersected the halo of a potential orebody
- How far might I be away from economic mineralisation
- What geochemical factors could be used to vector towards mineralisation

The GSQ has been collecting suites of samples from many of the important mineral systems in the region, and this new data will be incorporated into compilations and interpretations from other concurrent projects in order to improve the understanding of system footprints in the region

Collaboration & Details

The Geochemistry Toolkit is a collaboration between the Geological Survey of Queensland, GeoChem Pacific Ltd (NZ) and the University of Adelaide. Primary authorship was undertaken by Dr. Keith Hannan (Geochem Pacific). Industry contributors, by way of data or internal reports, include MIM Resource Development PL (MIMRD), Minotaur Exploration Ltd, South32 Ltd and Chinova Resources PL. The project was funded by the Queensland Government's Strategic Resources Exploration Program to increase mining activity and expedite mineral discoveries in northwest Queensland.

Project Leader: Vladimir Lisitsin - GSQ

Timing: July 2019– June 2021

Participants: Vladimir Lisitsin, Courteney Dhnaram, Matthew Valetich, Jacques Batumike, GSQ

Background & aims

It is now widely acknowledged that discovery rates are decreasing, and that new approaches are necessary in order to make discoveries in the new and challenging environments which are the focus of modern exploration. One of the approaches which has been increasingly applied in recent times is one which attempts to expand the footprint of mineral systems by documenting the far-field expressions of systems, rather than simply focusing in on the ore-grade parts of the system. The aim of this approach is to increase the odds of recognising the significance of exploration "near-misses".

In more detail the aims are:

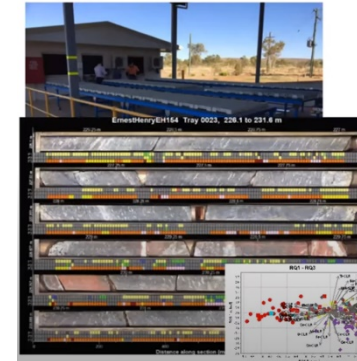
- To collect systematic baseline geochemical information on known mineral systems, both from existing data and, where necessary, from new sampling
- To collect, analyse and interpret a suite of samples from these systems, in order to provide a new dataset based on currently applied techniques, but also to retain a suite of appropriate samples for future testing of new ideas and methods.
- To assemble representative drillcore from as many NWMP deposits as possible

Outcomes to date

Sampling and analysis have now been carried out for a large number of mineral systems in the region. These results have so far been communicated in the form of internal 6-monthly reports, and the aim is to publicly report the geochemical results.

Under this project, a large number of drillholes have been measured with Hylogger, XRF scanning, geochemistry, mineralogy, mineral chemistry, and geochronology for selected samples. Hylogged holes have been progressively released, and some of the other data have been incorporated into the NW Mineral Province Deposit Atlas releases.

GSQ Reference Collection of mineral systems



- Acquisition of representative samples and geological information, to characterise key mineral systems at different scales
- Both **physical** and **virtual** reference models of deposits and their footprints
- HyLogger, XRF scanning, geochemistry, mineralogy, mineral chemistry, geochronology...
- Not a static compilation – but a driver of further research

Deliverables & links

(ctrl click icons for links)



Presentation September 2018



Presentation December 2018



Presentation June 2019



Hylogger Workshop September 2019



Webinar 14 May 2020

Hydrogeochemistry

Summary

The GSQ has finished a program in the eastern part of the Mount Isa region which involved taking borehole water samples from both static and flowing boreholes. These samples have been analysed for cation and anion concentrations, alkalinity, Au/PGE and stable isotopes. Suites of over 60 elements have been collected in order to develop and apply chemical indices to enable the identification and fingerprinting of different mineralisation styles. With an understanding of the water table and regional fluid flow patterns, this can be used to develop and understanding of hydrogeological dispersion patterns which could allow vectoring towards deposits.

This dataset is a powerful tool in the increasingly prevalent challenge of exploration through cover. The project will aid in filling a hole in the data in a very prospective part of the region, and will add data for mineral types not currently available to the Australian hydrogeochemical atlas. It may also open up new areas for exploration based on the results of the new analyses.

Collaboration & Details

The Geochemistry Toolkit is a collaboration between the Geological Survey of Queensland and CSIRO. CSIRO is contributing assistance in the areas of survey planning, purchasing of equipment and consumables, and training of staff in sampling and analysis procedures. CSIRO is also arranging for samples to be analysed for low level Au, Ag and PGEs as well as a range of other measures.

Project Leader: Joseph Tang - GSQ

Timing: September 2018 – June 2021

Participants: Joseph Tang, Dominic Brown, Dave Purdy, Derek Hoy, GSQ
Nathan Reid, Patrice deCaritat, David Gray, Robert Thorne, Ryan Noble, CSIRO

Background & aims

The aim of the project is to bring together hydrogeochemical data from the Mount Isa Region into a unified dataset. This has involved training GSQ staff in hydrogeochemical sampling procedures and methods, planning of field sampling campaigns, and analysis of newly collected samples

The project will develop and apply indices for exploration in the region allowing for the hydrogeochemical signature of differing mineralisation styles to be identified. Understanding the hydrogeochemical dispersion patterns will also allow vectoring towards deposits in the region. The anomalies generated can be compared to those seen in other regions across Australia with similar groundwater properties to determine the relative size and importance of these anomalies.

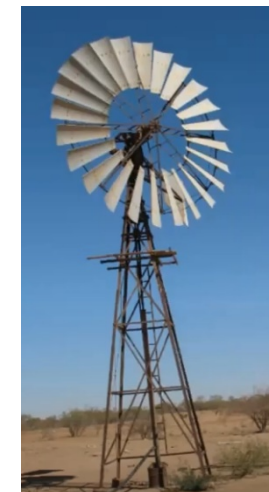
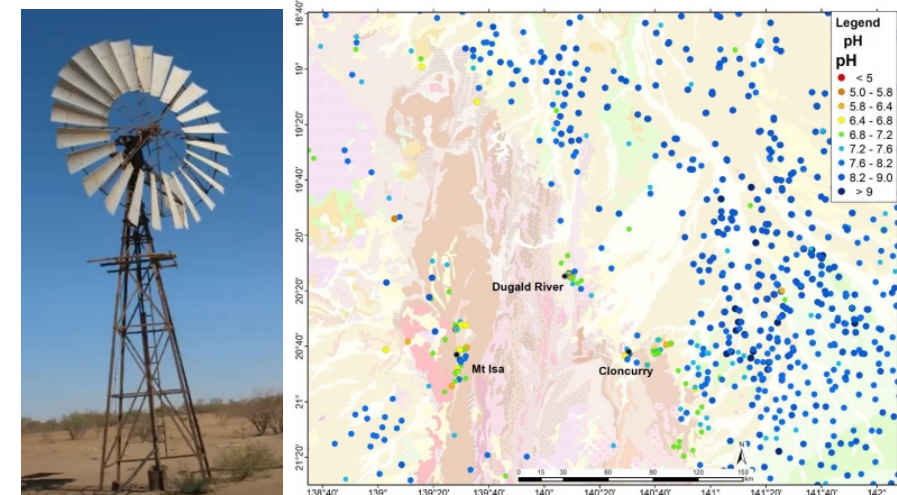
Processing of previous data and additional sampling from recognised bore or drilling can be integrated to produce mappable hydrogeochemistry. Recording of QA/QC and metadata will allow the results to be interpreted robustly.

Outcomes

The intended outcomes of the project are to deliver:

- Metals and pathfinders concentration to define geochemical anomalies, environmental baselines and water quality assessment
- Specific Mineralisation Indices to define mineralisation potentials (IOCG, VHMS, MIM and Century mine systematics)
- Mineral Saturation Indices for exploration e.g. carnotite saturation for uranium exploration
- Derived indices (SO₄ anomaly, FeS, Acids, NO₃ depletion) to identify weathering of rock sulphides
- Produce a Hydrogeochemical Atlas for project area
- A levelled hydrogeochemistry database

The project is currently in a phase of data processing, in which results from the sample collection and analysis are levelled based on variations in water chemistry so that results across the region can be compared on an equal basis.



Deliverables & links

(ctrl click icons for links)



Presentation September 2018



Presentation September 2019



Webinar 30 April 2020

Mary Kathleen Domain Geology

Summary

- Defining the magmatic history of the southern portion of the Mary Kathleen domain, incorporating the Argylla Suite and Wonga Belt
- Asses the geochronology of the southern part of the Corella Formation including
- the Mount Philp Breccia
- Assessing the extent and effect of Williams Supersuite magmatism
- Provision of a framework for the understanding of the relationship between
- magmatism and mineralisation

Collaboration & Details

Thanks to South32, Red Metal, Hammer Metals, Copper Mountain and Round Oak Minerals for providing access to core and information

Thanks to our collaborators JCU, QUT and Geoscience Australia.

Project Leader:	Dave Purdy - GSQ
Timing	April 2019– June 2021
Participants:	Dave Purdy, Dominic Brown, Courteney Dhnaram, Derek Hoy, Bob Bultitude, GSQ, Charlotte Allen, QUT

Background & aims

Mineralisation in the Mary Kathleen Domain (MKD) is variably suggested to be associated with felsic magmatism and mafic magmatism. Certsain ages appear to be favoured (eg 1540-1500 Ma), but overall the timing of mineralisation is poorly constrained. In addition, there are a number of unreslved mapping and stratigraphic inconsistencies in the areas which require resolution. In more detail, the objectives are to:

- Provide an updated regional framework of magmatism in collaboration with JCU
- Define magmatic groups (age, geochemistry, spatial distribution)
- Investigate comagmatic felsic igneous rocks in the Corella Formation
- Establish a U-Pb, O and Lu-Hf isotopic framework for magmatic rocks
- Place undercover geology into the updated regional framework
- Support other projects (hydrogeochemistry, geophysics acquisition)

Outputs and Future Work

- Descriptive GSQ record of magmatic rocks
- LA-ICPMS dating campaign at QUT
- O-Hf transect
- Corella Geochronology
- Undercover area
- Strucutral interpretation in northern part of belt



Deliverables & links

(ctrl click icons for links)



Presentation March 2019 – Dave Purdy



Presentation September 2019 – Dominic Brown



Presentation September 2019 – Derek Hoy

Industry Engagement

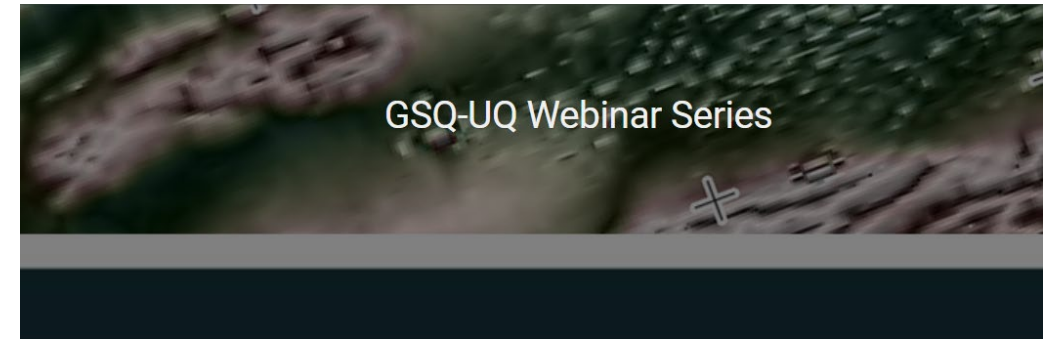
Workshop Series – 2018 to 2019



One of the key aims of the SMI is to ensure that its work has an impact on Industry outcomes. This means that Knowledge Transfer through formal and informal avenues is a key component of our programs. At the BRC, we are working as hard as we can to ensure that the outcomes and workflows associated with our research are communicated in a way that maximises Industry takeup and impact.



Webinar Series – 2020



Introduction to the Webinar Series

Dr Helen Degeling - Director Minerals Geoscience - GSQ

9 April, 2020

In early 2020, in response to travel restrictions, the Geological Survey of Queensland and UQ's SMI inaugurated a webinar series to help continue to support Queensland's explorers. The series has attracted a large amount of interest from explorers and other interested attendees from all over the world, and has also attracted a very strong group of presenters, including global representation. Curated by Dr Helen Degeling, the Director of Minerals Geoscience for the Geological Survey of Queensland, the main goal of the series is to find new ways to support the minerals industry in Queensland during this unprecedented time. With most explorers deskbound and probably at home, there is a great opportunity to think about new techniques that can remotely, and the hope of the webinar series is to be able to trigger some lightbulb moments, and to possibly introduce to the exploration community something that will help to define new and exciting targets that can be tested when field activities resume. Each webinar is also followed by an online networking session for those that want to stay around for a digital drink!

