Economic Geology Research Centre

Research & Services
October 2018

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**EGRU Members**

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**South32**  
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Lantana Exploration  
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Signature Gold

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**Carpentaria Gold**  
**Chinova Resources**

Information about EGRU Membership Levels and Member Benefits is available from the EGRU web site, or contact Judy Botting, EGRU Administration Officer.

**Major Research Projects**

NW QLD Magma Fertility Project  
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Geita Gold Project, Tanzania  
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Adamantine Energy & Heritage Oil Projects  
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Rare Earths Project  
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Front & back page photos courtesy of: Top - Kaylene Camuti, EGRU JCU. Bottom - Hans Dirks, EGRU JCU
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Mineral Systems Field Trip, Cloncurry Region, July 2018

Photos this page courtesy of: Top to Bottom - 2,3,4,5 - Kaylene Camuti, EGRU JCU. 1 - Eric Zurek-Haidamous, EGRU JCU
About EGRU

The Economic Geology Research Centre (EGRU) has facilitated interaction between JCU and the global resources industry for over 35 years. EGRU (renamed the Economic Geology Research Centre in 2012) was initially developed within the Geology Department at JCU in 1982, and is now positioned within the Geoscience discipline under the College of Science and Engineering. The Centre promotes collaborative research with end-users, and offers applied research services and professional development (PD) training to the resources industry.

Through its extensive network EGRU plays a critical outreach role and has built strong connections and productive working relationships with industry and governments in Queensland, in Australia, and internationally. These collaborative relationships have fostered rapid translation of the latest research results to the exploration and development of mineral resources.

In recent years EGRU has facilitated major research projects on resources in northern Australia, central Africa and southern Asia (see pages 8 to 12). The research is carried out in partnership with the resources industry, government bodies, and other research organisations.

EGRU’s delivery of PD training for practising geoscientists has also extended and strengthened its industry and government networks. EGRU conferences, short courses, and field and laboratory workshops, attract Australian and international delegates. In the last five years EGRU has run two highly successful international conferences and delivered over 45 workshops and short courses. These conferences, workshops and short courses have reached over 2000 delegates.

EGRU’s PD training also offers JCU Geoscience students the opportunity to interact with industry professionals, and benefit from exposure to a range of professional skills that enhance their employability, and build JCU’s reputation as a world class Geoscience school.

EGRU is funded through membership subscriptions, is managed by Directors appointed from Geoscience academic staff, and is overseen by an Industry Advisory Board with representatives from member organisations. EGRU’s membership funding supports 1.4 administrative and outreach staff members, production of the biannual EGRU newsletter, annual student scholarships, and seed funding for the development of conferences, PD training, and research projects.

Members of the EGRU management and research team are active members of the international geoscience community, and are widely involved in external organisations, serving on committees of scientific and professional geoscience bodies and the editorial boards of international journals.

EGRU’s communication with industry and government is interactive and multi-faceted...

- The EGRU Advisory Board meets three times a year and provides ongoing communication between JCU researchers and EGRU’s industry partners.
- Frequent EGRU email-updates are distributed to EGRU’s Australian and international networks, providing details of staff and student seminars, upcoming conferences, and PD courses.
- The biannual EGRU Newsletter is distributed to a list of over 2000, and is also available on the EGRU web site. The Newsletter provides a forum for JCU researchers to rapidly communicate research findings to industry. The regular EGRU newsletters also provide information on analytical services and PD training opportunities.
- EGRU collaborates with geoscience professional bodies to present student-industry engagement events.
- Through its network, EGRU assists with the identification and development of student research projects within the resources industry.

The following pages provide information about EGRU’s research staff and projects, along with summaries of recent conferences, field trips and workshops, overviews of upcoming professional development courses and events, and a list of analytical equipment and capabilities.

Further information is available from the EGRU web site: http://www.jcu.edu.au/egru/
Research Staff

Prof. Paul Dirks

Structural geology, geodynamics and the tectonic history of cratonic terrains and adjacent mobile belts, and associated mineralisation patterns.

Using petrology and geochemistry, including microanalysis of minerals for trace elements and isotopes, to understand the evolution of the Earth’s crust and mantle, and the formation of metalliferous ore deposits.

A/Prof. Carl Spandler

Clastic sedimentology, sedimentary provenance, core logging, stratigraphy, U-Pb zircon geochronology, petroleum geology palaeontology, regional correlation.

A/Prof. Eric Roberts

Fluid-rock interaction processes in the lower crust and in hydrothermal mineralised systems, and thermodynamic modelling of carbon-oxygen-hydrogen systems.

Dr James Daniell

Oceanography, geomorphology, sedimentology, geophysics, remote sensing and GIS

Dr Jan Marten Huizenga

The interaction between climate, hydrology, and earth surface geochemistry, and quantifying rates and processes of weathering and erosion, using isotopic techniques, fieldwork, and numerical and climate models.

Dr Christa Placzek

Structural geology, tectonics and geochemistry, with a focus on field geology, structural controls on mineralised systems and the tectonic evolution of Proterozoic and Archean terranes.

Dr Ioan Sanislav

Economic geology, with a focus on tin and tungsten mineralisation, petrogenesis of granitic rocks, fertility of ore-related igneous rocks and genesis of “Critical Metal” ores.

Dr Yanbo Cheng

Vertebrate palaeontology; diversity, evolution and ecology of Mesozoic vertebrates.

Dr Espen Knutsen

Geochemistry and igneous petrology, supervision of geochemical/mineralogical processing laboratories and provision of specialised technical support for research projects.

Dr Huiqing (Jeff) Huang
Adjunct Research Staff

Emeritus Prof. Bob Henderson
Prof. Zhaoshan Chang
Prof. Tom Blenkinsop
Prof. Jeffrey Hendenquist
Prof. David Leach
Prof. Noel White
Prof. Roger Taylor
Prof. Tim Bell
Prof. Nick Oliver
A/Prof. Tony Kemp
Dr John Carranza
Dr Gavin Clarke
Dr Maree Corkeron
Dr isaac Corrall
Dr Mark Doyle
Dr Hannah Hilbert-Wolf
Mr Doug Kirwin
Dr Oliver Kreuser
Dr Richard Lilly
Dr John McLellan
Mr Jim Morrison
Dr Stephanie Mrozek
Mr John Nethery
Dr Cassian Pirard
Dr Mike Rubenach
Dr Fredrik Sahlstrom
Dr Gerard Tripp
Dr Zhiming Yang

Photos courtesy of EGRU JCU students...
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This page top: Hans Dirks; bottom: Robbie Coleman
Opposite page left: Robbie Coleman; right: Hans Dirks
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Uncovering the Rare Earth metal potential of Australia

Carl Spandler (EGRU - Geoscience JCU)

Rare Earth metals (REE) are in high demand due to their use in the manufacturing of hi-tech products, but such metals are currently in a critical supply shortage across the globe. Australia is host to a large diversity of REE deposits and is uniquely placed to be one of the world’s first major REE producers outside of China, with a number of deposit now in production, or scheduled for production soon. Australia also has highly prospective geology for further REE resource discovery. These ore bodies are rich in rare metals such as dysprosium, which is an essential component of high-powered magnets used in wind turbines, motors, electric vehicles, and generators.

A team of EGRU researchers, led by Associate Professor Carl Spandler, has partnered with several companies who are exploring or developing REE deposits. The EGRU researchers are investigating a number of REE deposits in Australia, with the aim of developing a framework for understanding how these deposits form, and for improving strategies for the discovery of new resources.

Magmatic history, fertility and metallogenesis of the Mary Kathleen domain of the Mt Isa Inlier

Paul Dirks, Carl Spandler, Ioan Sanislav (EGRU - Geoscience JCU)

A New GSQ Funded Project

The North-West Queensland Mineral Province (the Mt Isa Inlier) is a major mining region in Australia, and has contributed significantly to its economic output in terms of jobs, income and regional development over the last 100 years. The province contains major ore deposits around Mt Isa, with significant new mineral deposits such as the Ernest Henry iron oxide-copper-gold deposit being discovered in the early 1990s. However, few significant discoveries have been made since that time.

This research project will involve mapping, geochronology, and geochemical and isotopic analyses of the magmatic rocks of the Mary Kathleen Domain (MKD) to provide a more comprehensive understanding of the origin, age and evolution of magmatism, as well as spatial and temporal indicators of magma fertility for gold, base metal and REE mineralisation. Knowledge and insights gained from this project have the potential to improve strategies and approaches to successful exploration for new mineral deposits in the region.

This project aims to highlight the exploration potential in the MKD by providing key mineralisation insights that can assist mining companies to plan their exploration strategy for better targeting and enhance the potential for new discoveries. To achieve this, the project has three main objectives:

1. Establish the extent, character and timing of the dominant magmatic epochs in the MKD of the Mt Isa Inlier.
2. Develop an understanding of the tectono-magmatic history of the MKD and its links to metallogenesis.
3. Explore the applicability of magma fertility concepts as a tool for exploration for a variety of deposit types.
A new PhD project investigating the origin of the Tick Hill gold deposit, south of Mt Isa, began in November 2017. Tick Hill represents a high-grade gold mineralisation style that appears to be unique in the Mt Isa Block. As part of the new initiative by the Geological Survey of Queensland (GSQ) to promote mineral exploration in the North West Minerals Province, the GSQ contracted EGRU to conduct a PhD study on the deposit. This study is being undertaken by Mr Truong Le, under the supervision of Prof. Paul Dirks, Dr. Ioan Sanislav and Dr. Jan-Marten Huizenga.

The Tick Hill gold deposit is located 110 km south-east of Mount Isa. The deposit has characteristics similar to shear zone-hosted lode gold deposits (‘orogenic’ gold), which indicates a mineralisation style in the region that has not yet been a major target for explorers. The deposit was mined in open pit and from underground workings between 1991 and 1995 by Carpentaria Gold and produced approximately 513,000 ounces of gold at an average grade of 22.5 g/t Au.

Because the deposit was mined over such a short period of time, there was little independent research done on Tick Hill, and the information available in the public domain and literature is minimal. This PhD project hopes to overcome this paucity of information, and aims to:

1. Investigate and document the geological and geochemical features of the deposit, including understanding the structural evolution, magmatic history, alteration style and mineralisation.
2. Classify the deposit.
3. Identify the factors controlling the location of the deposits such as structural architecture, controls of host rocks and intrusions.
4. Discover mineralogical, textural and geochemical zoning patterns that could be used as vectors to ore.
A new cost-effective dating method for exploration

Eric Roberts (EGRU - Geoscience JCU), Hannah Hilbert-Wolf (Geoscience JCU)

Accurate dating and correlation of rock units is necessary for weaving together the story of Earth’s evolution, and is also important for understanding natural resource development and prospectivity, such as the generation of oil or deposition of mineralised sediments.

Associate Professor Eric Roberts, adjunct research associate, Dr Hannah Hilbert-Wolf, and colleagues from the petroleum industry and Ohio University, have developed an application of detrital zircon geochronology using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) that enables dating of oil well cuttings or drill core samples. The results of this work were published in 2017 in the American Association of Petroleum Geologists Bulletin, in an article that describes this approach as a powerful tool for application in hydrocarbon exploration.

The potential of this dating approach was demonstrated in a case study of hydrocarbon prospective Miocene-Recent volcaniclastic sediments in the Rukwa Rift Basin of the East African Rift System in Tanzania. The results demonstrate for the first time that sedimentation in the basin began by 8.7 Ma, which is critical for burial and thermal history modelling and therefore for establishing the probability of a working hydrocarbon system in this portion of the rift.

This radio-isotopic approach to dating and correlating wells is an inexpensive, relatively quick way to establish age control, particularly of subsurface units, within prospective basins. This new application of LA-ICP-MS detrital zircon geochronology to well cuttings and core samples will be useful for both researchers and industry professionals, providing a low cost, efficient and accurate technique for the often difficult task of dating small samples of subsurface sediments.
Gold in the Geita Greenstone Belt, Tanzania

Ioan Sanislav, Paul Dirks (EGRU - Geoscience JCU)

The Geita Greenstone Belt in north-west Tanzania is host to a large number of gold deposits. Most of the deposits are mined by Geita Gold Mine, which is owned by AngloGold Ashanti Limited - the third largest gold mining company in the world.

The Geita Gold Mine produces around half a million ounces of gold annually and recently commenced underground mining for some of the operations.

Since 2011, EGRU has been involved with the GGM exploration team on developing a thorough understanding of the gold mineralisation from deposit to regional scale. This project has involved detailed studies on the geological setting, structure, alteration and genesis of individual deposits, as well as regional studies on the structural and tectonic controls of gold mineralisation. These studies are led by Dr. Ioan Sanislav and Professor Paul Dirks from EGRU, working in collaboration with Professor Tom Blenkinsop from Cardiff University.

A part of the great East African Rift Valley (overlooking the Rukwa Rift Basin) in southwestern Tanzania. Photo by Eric Roberts.
High quality graphite deposits - a new technology mineral
Jan Huizenga (EGRU - Geoscience JCU)

Graphite is pure carbon with a simple layered structure. However, despite its simple composition and structure, graphite has unique physical properties that make it a critical industrial mineral. Graphite has both metallic and non-metallic properties, and is used in many applications, including new and developing technologies such as batteries, nuclear, wind and solar power, fuel cells, and semi-conductors. Because of the growing demand for graphite, natural graphite is now considered a supply-critical mineral by the USA and the European Union.

EGRU researcher Jan Huizenga, in collaboration with researchers from Spain, France and Japan, is working to improve the understanding of high grade graphite deposits around the world. The study involves integrating the geological settings of the deposits and the factors controlling mineralising processes, and relating the mineralogical characteristics with potential industrial applications.

As part of the research project the vein-hosted graphite deposits of Sri Lanka have been investigated. Sri Lanka has been one of the major graphite producers in the world since the 19th century, and the graphite veins in Sri Lanka are very large and produce high quality graphite. Recently published results from the project have characterised the Sri Lankan graphite vein deposits and identified the factors controlling the mineralisation, providing valuable input to future exploration for high grade deposits.

Prospectivity of intrusion-related hydrothermal mineral systems in North-East Queensland
Zhaoshan Chang, Carl Spandler, Paul Dirks, Yanbo Cheng, Jan Huizenga, (EGRU - Geoscience JCU)

EGRU’s $1.8m collaborative research project, characterising and assessing the prospectivity of intrusion-related hydrothermal mineral systems in north-east Queensland, is nearing completion. The project is a collaboration between EGRU researchers, the Geological Survey of Queensland (GSQ), and industry geoscientists. The research project is funded by the GSQ (Department of Natural Resources and Mines, Queensland) under the Future Resources Program, and by a generous cash contribution from Evolution Mining.

EGRU researchers presented a major report to the GSQ in late 2017 and a number of papers have been published or are in press. Updates during the project were circulated to the resources community via regular progress reports in the EGRU Newsletter, and during one-day project seminars held in Townsville and Brisbane.
EGRU’s flagship FUTORES conference was held in Townsville in June this year. FUTORES II built on the success of the inaugural FUTORES conference in 2013, and brought together researchers, explorers and government agencies to address issues related to the sustainable supply and utilisation of mineral and energy resources. The conference was opened by Professor Iain Gordon, JCU Deputy Vice Chancellor, Tropical Environments and Societies, and welcomed the Honourable Dr Anthony Lynham, Queensland Minister for State Development and Minister for Natural Resources and Mines.

FUTORES II attracted 280 delegates from 16 countries, including global leaders in the fields of economic geology research and resource exploration. The delegates gathered to present papers and contribute to discussions about recent developments in the exploration and understanding of major types of mineral deposits, and the key issues and techniques critical to future minerals and energy exploration.

Over 130 conference presentations, during three days of three concurrent sessions, covered a wide range of resource types, geological settings, and exploration technologies. Presentations by plenary speakers, Richard Sillitoe and Dan Wood, tackled some of the major technical and management issues that face explorers targeting world class deposits. A keynote presentation by legendary explorer, Doug Kirwin, traced the changing world of exploration and highlighted the frustrations and challenges of exploring in the 21st century. The warm sunny days and balmy evenings, typical of Townsville in winter, encouraged informal (and vigorous) discussions during breaks and social sessions to spread from the conference rooms to the verandahs.

The conference was preceded by several short courses and followed by field trips to deposits in north-east Queensland.

EGRU would like to acknowledge and thank speakers and poster presenters, short course presenters, and field trip leaders for their contributions. We are also grateful for the support of our conference sponsors: Mount Isa Mines (a Glencore company), South32, Newmont, HiSeis, and Geoscience Australia. The generous assistance of our industry and professional association supporters is also gratefully acknowledged: SEG, SGA, Aranz Geo, AusIMM, Evolution Mining, Carpentaria Gold / Resolute Mining, Minjar Gold, Consolidated Tin Mines, Auctus Minerals, Lantana Exploration and Wolfram Camp Mining. Special thanks to all the students who provided invaluable help before and during the conference.
Mt Carlton - Ravenswood - Pajingo Field Trip
Fredrik Sahlström (EGRU - Geoscience JCU)

After the successful completion of the FUTORES II conference, EGRU organised a three-day field trip to some of the major gold deposits south of Townsville. The field trip was led by Paul Dirks, Zhaoshan Chang, Isaac Corral and Fredrik Sahlström from EGRU, and attracted 12 industry and academic geologists, hailing from Australia, Asia and Europe.

On the first day we visited the Mt Carlton high-sulphidation Au-Ag-Cu epithermal deposit in the northern Bowen Basin, operated by Evolution Mining. The participants first enjoyed a tour of the open pits, where they got a chance to observe the spectacular extensional deformation features which have overprinted the Mt Carlton deposit. This was followed by lunch and interesting presentations about Mt Carlton and the nearby prospects in the district. The day was finished off by a visit to the core shed where we inspected and discussed a variety of interesting ore textures from the Mt Carlton deposit.

On the second day we drove to the historical mining town of Ravenswood to visit the Carpentaria Gold mining operation. The day started with presentations where about the different breccia hosted gold deposits in the Ravenswood area. These were followed by visits to one of the open pits and to the core shed, and all participants got to collect a few samples to bring home. The day finished with a hill climb where we observed some of the different host rocks for the Ravenswood deposits.

After spending the night in Charters Towers, we drove to the Pajingo gold mine operated by Minjar Gold. After presentations introducing the local geology we visited the core shed to see some of the spectacular features of the Pajingo deposit which, amongst others, include sinter horizons with fossilised algae. We finished the day by visiting one of the mineralised outcrops where participants could collect samples. After a drive back to Townsville the group parted ways for the time being, with everyone happy after a successful field trip.
Mt Garnet - Wolfram Camp - Chillagoe Field Trip

Ian Morrison (Lantana Exploration)

The FUTORES II post-conference field trip to Mt Garnet, Wolfram Camp and Chillagoe, over four days from 8th to 11th June, was enjoyed by 14 participants and included geologists from industry, PhD students and Post Doctoral Fellows with strong representations from China and CODES (UTAS). Tour leaders were: Ian Morrison from Lantana Exploration, who led the Mt Garnet sector of the tour, and Kairan Liu and Peter Illig, PhD students from JCU who took over responsibilities, respectively, for Wolfram Camp and Chillagoe.

Day 1 we headed to Mt Garnet, with stops along the way to view major structures and contacts. Brief presentations by Ian and Col Abbot, on key features of the deposit and the regional setting, were followed by an inspection of drill core and a trip down the open pit to inspect skarn relationships. The day finished at Innot Hot Springs.

Day 2 (for some) started with a reviving dip in the hot spring pools, then on to Wolfram Camp via Atherton. Darcy Milburn and Kairan led us to the open pit workings and waste dumps where critical geological contacts were inspected and specimens of coarse-grained molybdenite and wolframite were collected. From Wolfram Camp it was on to Chillagoe for the night, with presentations by Peter and local geologist, John Nethery.

Day 3 started with a trip along the mine corridor led by Joel Cullen and Peter, from the Mungana Mill to the old Red Dome pit, followed by a trip to the core yard and a ferret around the ROM pad. The day ended with a trip out to the Redcap prospect and a wander over outcropping mineralised skarn-altered limestone.

Day 4 we returned to Townsville, where the group parted ways after a most enjoyable and rewarding four days.

We thank Consolidated Tin Mines Ltd, Almonty Industries and Auctus Resources Pty Ltd for access to the Mt Garnet, Wolfram Camp and Chillagoe sites, respectively. Our particular thanks to the people at each site who prepared presentations, core displays and site tours under the guidance of geologists Colin Abbott (Mt Garnet), Darcy Milburn (Wolfram Camp) and Joel Cullen (Chillagoe).
Mineral Systems of the Mt Isa Inlier Workshop, Cloncurry

Eric Zurek-Haidamous (Honours Student, EGRU - Geoscience JCU)

The 2018 EGRU workshop on mineral systems of the Mt Isa Inlier was held in Cloncurry in March. The workshop included presentations from academic and industry geologists that addressed new concepts related to the regional geology and mineralisation. The forum covered practical and theoretical problems while suggesting solutions using the latest innovative technology to help discover the next major deposit in the district.

During the week preceding this workshop north western Queensland received a welcome once-in-10-year rain event that disrupted the drought. The rain resulted in wide-spread flooding that cut access to many of the mine sites in the Cloncurry area. This flooding unfortunately forced EGRU to postpone the field trip through the Selwyn mineral field to the Osborne Mine that had been scheduled to follow the workshop, and was to be generously hosted by Chinova. Nevertheless, the technical presentations and drill core components of the workshop went ahead and participants were greeted with an unusually green Cloncurry.

The first day’s program consisted mainly of academic presentations, talking about the latest research and ideas in the region. EGRU co-directors Assoc. Prof. Carl Spandler and Prof. Paul Dirks opened the workshop and welcomed delegates. They were followed by a presentation by Paul Donchak from the GSQ. Paul summarised the Proterozoic tectonic evolution of the Mount Isa region and the associated mineralised systems. This summary of the current regional understanding gave an appropriate backdrop to the workshop and was a great prelude for the talks that followed.

Steve Micklethwaite from Monash University presented an insightful talk about drones and their current and prospective use as a field and research tool. Steve highlighted the versatility and cost efficient aspect of drones, with their ability to conduct exploration and monitor areas that are not safe for employees in mine sites. He stated that this could be achieved by a variety of attachments that can acquire many different data sets such as gravity and hyperspectral imagery at a high resolution. Steve also mentioned the prospect of neural network software to autonomously process data.

Rick Valenta from the Sustainable Minerals Institute at the University of Queensland presented a talk on deposit discovery in the North West Mineral Province, and highlighted the lack of success in finding a major deposit during the last 15-20 years. Rick discussed a program to compile deposit data sets from across industry, government and academic sectors, into an atlas to assist explorers. Vladimir Lisitsin from the GSQ also referred to the lack of major deposit discoveries and outlined the plan the GSQ and Geoscience Australia have in regards to acquiring data sets. Vladimir opened the table for industry feedback on prioritising tasks and collaboration in acquiring data.

Gordon Lister from the Australian National University spoke about the Elzeverian landscape of Mount Isa showing his preliminary results from Argon dating. These results shed new light on the possible mineralisation ages in the region that drew some enthusiastic discussion from the audience. John Walshe from CSIRO discussed the value of mapping chemical gradients as vectors to mineralisation, and
demonstrated the use of a range of chemical parameters. Ioan Sanislav from EGRU presented a talk on the use of Short Wave Infrared (SWIR) spectroscopy to explore for structurally controlled deposits. He used a case study from a structurally controlled gold deposit in Tanzania to show that SWIR can be used to fingerprint gold related alteration from as far as 200 m from the ore zone. The procedure is cost effective and can be automated so results are interpreted in real time.

Richard Lilly from the University of Adelaide proposed a zoned carbonate replacement model for mineralisation at Mount Isa, and presented evidence from ore textures and paragenetic relationships in the sediment hosted system. Peter Rea, from Mount Isa Mines Exploration, finished off the day’s talks with an economic focus. Peter spoke about exploration efforts in Mount Isa that have defined more copper resources. He identified paucity in drill core profiles, drilled the gaps, and discovered significant copper grades in the upper halo areas that will potentially extend the life of Black Rock Pit.

Core viewing was next on the agenda and the workshop moved to the MIM Barracks in Cloncurry where core was on display. Due to the floods transportation of some core had been hindered, but beautiful core from MIM’s exploration efforts and the Ernest Henry Mine were on display, along with drill core from other deposits. Core was made available by MIM/Glencore, MMG, Capricorn Copper, Altona Mining and Malaco Leichardt. The core viewing sparked conversation between the participants, and was followed by a classic game of backyard cricket, a BBQ and beers, which helped promote further discussion about the day’s talks. Presentations resumed the next day with an economic focus, with company geologists talking about recent exploration and current understanding of existing deposits. George Ross from Altona Mining opened the day, speaking about Altona’s Cloncurry Copper project in the Roseby field. George spoke about the Little Eva and Turkey Creek deposits’ resource potential, and mentioned geobotanical vegetation anomalies being used as an exploration tool. Malaco Leichardt’s representative, Bruce Godsmark, presented a talk on the Crusader Copper Mine - including current resources, exploration, and the unusual colloform chalcopyrite.

David A-Izzeddin from Capricorn Copper gave an overview of the company’s assets and different deposit styles, with a focus on the Esperanza South deposit. Mark Whittle from Hammer Metals talked about the different mineralisation styles along the Prince of Wales - Scalper Trend, and Carolyn Deacon (MMG) gave an update on logging and fault modelling at the Dugald River Pb-Zn-Ag mine. Damian Jungmann presented evidence for the new structural and timing model for the Osborne Cu-Au deposit, and Jennifer Gunter (Virga Pty Ltd) outlined new modelling of Chinova’s Kuthor Cu-Au deposit. Ava Stephens, a recent JCU honours graduate, presented the findings from her project on the Artemis deposit and gave a concise description of this unusual deposit. The talks finished with a thank you to Judy Botting for her critical role in organising the workshop, and organising (and then cancelling) the arrangements for the field trip.

The Cloncurry district has a complex mineralisation history that presents challenges in exploration. Solid geological models and a better understanding of the diverse IOCG classification criteria will help in meeting these challenges. The workshop highlighted the value of cooperating and communicating across the various sectors in the search for new deposits - a message reinforced by many of the workshop speakers and delegates.

The main questions taken away from the workshop were:

- “Why haven’t we discovered a new major deposit?”
- “What new methods and technologies can we use to find the next major deposit or extend existing deposits?”

Thank you to all the companies who contributed to the workshop, who provided drill core, and who were involved in the planning of the field trip. The use of the Barracks for drill core viewing, and to Altona Mining for providing beverages.
Recent Courses & Workshops

Advanced Field Training
Course Leaders: Prof. Paul Dirks, Dr Ioan Sanislav (EGRU - Geoscience JCU)

In June 2017 Professor Paul Dirks and Dr Ioan Sanislav led the Advanced Field Training course in Cloncurry, NW Queensland. The Cloncurry region contains a high number of world class IOCG and skarn related Cu, U and REE deposits hosted within well-exposed mid-Proterozoic multiply deformed and metamorphosed rocks. This makes the area ideal for training in geological mapping with a focus on mineral exploration techniques.

The field trip started with two days of mapping along the Cloncurry Fault where different types of breccias associated with widespread hematite alteration are beautifully exposed. A one day visit to the now closed U-REE Mary Kathleen mine introduced participants to the skarn hosted mineralisation styles typical of the Mary Kathleen belt. The distinction between metamorphic and hydrothermal skarn mineralisation was emphasised with a focus on the strong structural controls on the distribution of the mineralisation.

The next five days included mapping of the Eloise Doherty prospect, near the Mt Colin copper mine, which contains outcropping Cu mineralisation in close spatial relationship to intense skarn alteration. The next Advanced Field Training course is scheduled for June 2019.

Fluid Inclusion Research Collaboration & Training
Dr Jan Huizenga (EGRU - Geoscience JCU)

Jan Huizenga visited the China University of Geoscience (Beijing) in June to discuss fluid inclusion research collaboration with Professor Shengrong-Li and Dr Sida Niu. During his visit he presented a fluid inclusion short course that was attended by 35 economic geology postgraduate students. The course content included fluid inclusions associated with metamorphism and with mineralisation. Future cooperative activities will include the development of a collaborative fluid inclusion website to enhance fluid inclusion research collaboration, focussing on economic geology.
EGRU Professional Geologist Short Course Series

EGRU offers a range of professional development short courses and workshops presented by JCU Geoscience staff or by specialist geoscientists from industry.

The preliminary 2019 program of short courses includes:

- Ore Textures & Breccias Recognition Techniques
- Core Logging Techniques
- QAQC for Mineral Exploration & Beyond
- Integrating Geochemistry & Mineralogy for Exploration
- Management in Mineral Exploration (5 x 1-day modules)
- QGIS for Geologists
- Introduction to the JORC Code
- A JORC Code Refresher Course
- Geological Uncertainty and Risk
- Advanced Field Training

Course dates and overviews are included on the following pages.

Following the success of field workshops in 2015, 2016 and 2018, EGRU will hold the next

- Mineral Systems of the Mt Isa Inlier Workshop

in the Cloncurry - Mt Isa region in early 2020.
Ore Textures and Breccias Recognition Techniques

28 - 30 January 2019

Course Leader: Dr Gavin Clarke, EGRU JCU

This three-day course covers the fundamentals of textural observation and interpretation in mineralised hydrothermal systems. The techniques used are simple, highly effective and require no specialised equipment for their implementation. The techniques are also extremely practical in that they generate numerous questions concerning the mineralisation being studied and commonly provide vectors toward mineralisation for drill testing. Critical evaluation factors considered during the course include:

- Infill: Recognition Criteria
- Alteration: Recognition & Evaluation
- Channelways: Recognition Criteria
- Overprinting and Paragenesis: Recognition & Sequencing Criteria
- Breccia: Recognition Criteria
- Breccia: Rudimentary Classification system
- Tectonic Breccia Systems
- Intrusive Breccia Systems
- Paragenetic Core Logging

Core Logging Techniques

31 January - 1 February 2019

Course Leader: Prof. Paul Dirks, EGRU JCU

This two-day course introduces the basic skills and methodology required to review and log geological core. Emphasis is placed on the recognition, description and acquisition of oriented data (bedding planes, faults, fractures, shear zones), and how this data relates to field observations. The course aims to familiarise participants with the key requirements of core logging, and how to interpret and integrate drill logs with geological models.

The course will comprise short morning lectures introducing the principles of core logging on day one and the integration of core logs into structural sections and geological models on day two, with substantive time each day spent undertaking practical group exercises.

Day 1 - Logging at suitable scales to capture the required degree of information for a successful interpretation, and, importantly, present that data and interpretation to their peers.

Day 2 - Construct cross sections from existing core logs, orientation data and geological maps. This will require careful consideration of how to connect critical markers to best reflect the geology of the area. Results will be discussed within the group at the end of the practical sessions.
QAQC for Mineral Exploration & Beyond

2 February 2019

Course Leader: Dr Dennis Arne, CSA Global

This one-day short course is designed to present a clear and practical approach to designing, implementing and assessing QAQC protocols for exploration and drilling programs. It will involve a series of practical exercises that will allow the participants to develop confidence in plotting and assessing quality control data using real-world data. Emphasis will be placed on using quality control data to reduce ambiguities associated with the interpretation of exploration results and to help minimise errors in resource estimates. Topics covered will include:

- Meeting the requirements of reporting codes & regulators
- Implications for exploration and resource estimation
- Representative sampling and data precision from field to instrument
- Selection of certified reference materials (CRM)
- Check Assays and Blanks – when, where and how
- In-house laboratory quality control data
- Quality control for additional data sets: e.g. bulk density, collar and down-hole surveys
- Reference material control plots
- Estimates of data precision
- Acceptable carry-over vs cross contamination
- Quality control failure
- Tracking issues, actions and outcomes
- Database structure
- Data verification
- Integration of quality control data

Dennis Arne has over 35 years’ experience as a geologist and geochemist, working in a wide range of commodities and environments. In recent years he has consulted to exploration programs for precious and base metals exploration in Australia, North America, South America and the Middle East. This has included the design and implementation of geochemical surveys, the interpretation of geochemical data, the design of QAQC programs, reviews of geochemical data quality, and training of personnel. He has published extensively in the areas of applied geochemistry and economic geology.

Integrating Geochemistry & Mineralogy for Exploration

3 February 2019

Course Leader: Dr Dennis Arne, CSA Global

(Delegate numbers are limited.)

Geochemical and mineralogical data are now routinely collected on the same sample material, but the interpretation of these data sets is often done separately. Geochemical data may include assays or multi-element data collected from crushed rock or from surficial material. Mineralogical data may include hyperspectral analyses, semi-quantitative XRD or heavy mineral separates. Integration of complementary data sets such as these on a single interpretive platform allows for a better understanding of geochemical and mineralogical processes associated with hydrothermal mineralisation and secondary dispersion.

The short course will be a full day of lectures, discussions, and practical interpretive exercises. Participants will need to bring a laptop computer and download a demonstration copy of ioGAS software. Lectures on geochemical and mineralogical responses from some common hydrothermal deposit types will be integrated with exercises involving data interpretation. Topics covered will include:

- Introduction to the integration of geochemical and mineralogical data
- Introduction to exploration data analysis (exercise)
- Review of hydrothermal alteration systems
- Defining hydrothermal alteration using geochemical data (exercise)
- Introduction to mineralogical data in mineral exploration
- Case studies illustrating data integration
- Data integration exercises
EGRU Professional Geologist Short Courses in 2019

Management in Mineral Exploration

February 2019
Course Leader: Dr Nick Franey, NJF Consulting

Five one day modules are offered as individual courses.

Most of these courses are suited to both technical and non-technical professionals involved in managing exploration programs.

Monday 4 February
The Principles and Key Success Criteria of Mineral Exploration Management

Tuesday 5 February
Day-to-Day Management for Mineral Exploration

Wednesday 6 February
Data Management for Mineral Exploration and Feasibility Studies

Thursday 7 February
The Non-Technical Aspects of Mineral Exploration Management (e.g. HR, Administration, Logistics, HSEC)

Friday 8 February
Financial Aspects of Mineral Exploration and Project Evaluation (for experienced geologists)

Nick Franey has taught the Business and Financial Management module of the JCU Masters of Mineral Geoscience since 2016, working with Andy White until Andy retired (see EGRU Newsletter April 2018 for Nick’s profile). In response to feedback from industry, Nick has now developed a series of one-day courses based on the MGM course, to provide a flexible option for time-poor explorers who are looking to enhance their management skills.

QGIS for Geologists

9 February 2019
Course Leader: Mr Grant Boxer, Consultant Geologist

(Delegate numbers are limited. The course will also be offered on 10 February if there is sufficient demand.)

QGIS is a free open-source GIS program that runs on the PC, Mac and Linux. Although QGIS is not specifically built for geological applications, the program is very capable and can do the majority of data import, data display and map production required by today’s geologists. A wide variety of geological symbols and patterns are available for decorating geological maps.

This workshop is designed for both new and experienced users of Geographic Information Systems. The workshop includes an introduction to the various features of QGIS and extensive hands-on sessions using QGIS to create maps, and to explain and demonstrate how to import and display various types of data (vector, raster, geological, geochemical, geophysical, and satellite imagery).

Registrants will use their own laptops during the course and will be requested to download and install the latest version of QGIS, together with a number of free plug-ins, before the workshop. GIS data will be provided for the hands-on workshop together with documentation on using QGIS in mineral exploration.

Grant Boxer, a consultant geologist with over 40 years’ experience in exploration and mining, has presented more than 10 QGIS workshops in Perth.
Assessing and Communicating Geological Uncertainty and Risk to Non-Geologists

12 February 2019
Course Leader: Mr Mark Berry, Derisk Geomining

This workshop is aimed at geologists and other mining industry professionals. No prior knowledge is assumed.

Geologists provide essential technical information during all stages of exploration, feasibility, development and mine operations. Much of this information is used by mining engineers, metallurgists, environmental staff, operations staff and mine management for planning and operations management. But, almost everything geologists deliver to these staff are estimates and interpretations rather than FACTS, so how do geologists identify, document and convey the fundamental uncertainties associated with their estimates and interpretations to non-geologists?

This workshop will review the sources of geological uncertainty that feed into exploration, mineral resource and ore reserve estimates, mine planning, scheduling, optimisation and operations – with implications from pit to port. Workshop modules include:

- Risks and opportunities linked to the provision of geological information
- Conventional risk assessment and management systems
- Contributions to geological uncertainty
- Approaches for identifying, documenting and communicating geological uncertainty to non-geologists

Case studies emphasising the importance of assessing geological uncertainty linked to mineral resource and ore reserve estimates (including mining, processing, waste disposal and transport) are used to emphasise the importance of effectively managing geological risk. Group interaction and exercises are also used to illustrate and reinforce workshop concepts.

Mark Berry is a geologist with over 38 years’ experience, spanning exploration, feasibility and development, mine operations, management, research and development, consulting, and professional development.

Introduction to the JORC Code

For technical and non-technical professionals

This half-day course is designed for anyone new to the JORC Code, including early career geoscientists, and geoscience and engineering students considering a career in the resources industry. Other technical and non-technical professionals who wish to develop an understanding of the Code are also welcome to attend.

The course will provide an overview of the Code and illustrate how Table 1 can be used to guide day-to-day work flows and procedures in exploration and mining. It will also introduce the concept of the Competent Person.

A JORC Code Refresher for Existing and Aspiring Competent Persons

Technical staff signing off on public reports presenting Exploration Results, Mineral Resources and Ore Reserves are accepting significant personal responsibility for these reports. This course is designed as a refresher for technical staff who are currently taking Competent Person responsibility for public reporting of Exploration Results, Mineral Resources and Ore Reserves; or those that may be in a position to do so now or in the near future.

The course will provide an overview of the key elements of the Code and how it is monitored, focusing on the issues most relevant to Competent Person responsibility. Case studies will be used to illustrate good reporting practices.
Advanced Field Training

29 June - 6 July 2019

Course Leaders: Prof. Paul Dirks, Dr Ioan Sanislav
Location: Cloncurry-Mt Isa area, NW Queensland

This intensive 8-day field course is designed to provide geoscientists with essential exploration-related field skills in complexly deformed and altered rocks. Real field mapping is a dying art and this course does not encourage wandering around with a GPS making random observations. Genuine ‘form surface’ mapping of contacts, alteration zones and structures will be integrated with paragenesis, geophysical interpretation and the use of alternate knowledge-based and data-based exploration models. The course will also include an introduction to the simple and useful application of semi-quantitative prospectivity tools.

The field course will cover:

- Veins, breccias, shear zones, paragenesis, overprinting, geometry
- Advanced structural geology and structural controls
- Developing exploration strategies from field observations

*Photos, top to bottom, courtesy of: Yanbo Cheng, Robbie Coleman (x2), Yanbo Cheng, Robbie Coleman, EGRU JCU.*

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**EGRU Professional Geologist Short Courses in 2019**

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**EGRU Research & Services October 2018**
Sn-W-Critical Metals & Associated Magmatic Systems

A geological conference with a session in honour of Dr Roger Taylor

The Economic Geology Research Centre (EGRU) at James Cook University is proud to announce a conference on “Sn-W-Critical Metals & Associated Magmatic Systems” to be held in the historic Herberton tin field in north-eastern Australia, 24-28 June 2019. The conference will include a session in honour of former EGRU Director, Dr Roger Taylor, in recognition of his contribution to the understanding of Sn magmatic systems in Australia, and globally.

The conference will address advances and breakthroughs in understanding the setting, genesis and characteristics of magmatic systems related to Sn-W-Critical Metal mineralisation, including Rare Metal Pegmatites. The conference program will feature presentations from world-class researchers in the field, including:

- Prof. Rolf Romer (GFZ, Potsdam, Germany)
- Prof. Jingwen Mao (Chinese Academy of Geological Sciences, Beijing, China)
- Prof. Shao-Yong Jiang (China University of Geosciences, Wuhan, China)
- Dr Phillip Blevin (Mineral Systems, Geological Survey of NSW, Maitland, Australia)
- Prof. Zhaoshan Chang (Colorado School of Mines, Denver, USA)
- Prof. David Cooke (CODES, University of Tasmania, Hobart, Australia)
- Dr Peter Pollard (Pollard Geological Services, Brisbane, Australia)
- Dr Yanbo Cheng (EGRU, James Cook University, Townsville, Australia)

EGRU warmly welcomes academic, industry and government colleagues, including students and young professionals, to join us at the conference and take part in discussions while enjoying the glorious setting of the Atherton Tablelands in tropical far north Queensland.

Abstract submission will open later this year.

Preliminary Conference Timetable
(subject to change)

24 June:    Monday evening welcome function
25-27 June:  Technical Presentations (includes half-day field trip to the historic Herberton township and tin field)
28 June:  Optional 1 to 1.5 day Field Trip

For further information please contact the conference conveners:

Carl Spandler  Carl.Spandler@jcu.edu.au  Yanbo Cheng  Yanbo.Cheng1@jcu.edu.au
Kaylene Camuti  Kaylene.Camuti@jcu.edu.au  Jan Huizenga  Jan.Huizenga@jcu.edu.au
or contact the EGRU Administration Officer

Judy Bottig  Judith.Bottig@jcu.edu.au

www.jcu.edu.au/economic-geology-research-centre-egru/conferences/
Asian Current Research on Fluid Inclusions
ACROFI VIII Conference
June 2020
Townsville, Queensland
Australia

A biennial international conference for the exchange of the latest research and new ideas on the study of fluid and melt inclusions.
ACROFI VIII welcomes geoscientists from academia, government and industry from Asian countries and around the world.

Hosted by
EGRU
Economic Geology Research Centre
Geoscience, James Cook University

2021

Future Understanding of Tectonics, Ores, Resources, Environment and Sustainability
June 2021
Townsville, Queensland, Australia
Analytical Facilities/Equipment

- ICP-MS: 2 quadrupole ICP-MS units.
- LA (Laser Ablation) System (193nm)
- MC-ICP-MS (Multi-collector-Inductively Coupled Plasma-Mass Spectrometer)
- Clean Lab: class 350 clean lab
- Microprobe: Jeol JXA8200 “Superprobe“ – 5WDS, EDS, BSE, SE, CL
- SEM: with cathodoluminescence imaging capacity
- XRD: Siemens D5000 Diffractometer
- ICP-AES: Varian Liberty Series II
- SWIR spectral instruments: PIMA-SP and specTERRA
- Raman microspectrometry facility
- Fluid inclusion stage: Linkam MDS600 freezing/heating stage
- Melt inclusion / fluid inclusion stage: Linkam TS1500 heating stage
- Lapidary/Mineral Separation Laboratory Equipment available includes - RockLabs crusher and splitter, Temer and Disc mills, Franz magnetic separator, Wilfley table, and dental drill for micro-sampling. Magnetometer: GeoMetrics G 816/826A
- Photomicrography set 1: Leica DM2500P microscope + Leica DFC420 C Camera
- Photomicrography set 2: Leica DM RXP microscope + Leica DC 300 v2.0 Camera
- Magnetic susceptibility meter: Fugro GMS-2 (Serial No: 1942)
- Microscopes: Transmitted light + reflected light optical microscopes, including a Nikon Eclipse E400 POL, a Nikon Labophot2 POL, and ~45 Leica microscopes
- Gigapan robotic camera
- 3D visualisation laboratory

EGRU Analytical Capabilities

- SWIR (Short Wavelength Infra-Red) spectral analysis
- Thermometric measurements of fluid inclusions and melt inclusions
- Composition of individual fluid/melt inclusions
- Mineral major element compositions by EDS and/or WDS on a Jeol ‘Superprobe’ electron microprobe
- Cathodoluminescence (CL), Back-Scattered Electron (BSE) and Secondary Electron (SE) imaging, using SEM and electron microprobe
- Full CL wavelength spectra analysis by electron microprobe equipped with a CL spectrometer (XCLent)
- Mineral trace element composition
- Mineral elemental mapping
- Stable isotope analysis (C, O, Cu)
- Geochronology (U-Pb on zircon, titanite, monazite, xenotime)
- Radiogenic isotope analysis
- In situ Lu-Hf and Sm-Nd isotope analyses
- High pressure / temperature experiments

For information on EGRU analytical services contact A/Prof. Carl Spandler: carl.spandler@jcu.edu.au
EGRU Members receive discounted registration for EGRU conferences, short courses and workshops.

Membership information is available at http://www.jcu.edu.au/egru/

Delegates attending EGRU conferences, short courses and workshops may earn Professional Development points from their professional bodies.