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NE Qld Prospectivity Project
FUTORES II Conference

EGRU
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Economic Geology Research Centre
College of Science and Engineering
James Cook University
Townsville, Queensland
Australia

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EGRU Contacts

EGRU Director
Associate Professor Zhaoshan Chang
Tel: 61 7 4781 6434
Email: zhaoshan.chang@jcu.edu.au

EGRU Manager
Judy Bottin
Tel: 61 7 4781 4726
Email: egru@jcu.edu.au

EGRU Communication
Kaylene Camuti
Tel: 61 7 4781 4726
Email: kaylene.camuti@jcu.edu.au
WEB: https://www.jcu.edu.au/egru
Economic Geology Research Centre (EGRU)
College of Science and Engineering
James Cook University
Townsville, QLD, 4814, Australia

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Professor of Geoscience
College of Science and Engineering

A/Prof. Eric Roberts
Head of Geosciences
College of Science and Engineering

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**EGRU Researchers**

Dr Gavin Clarke  
Prof. Noel White  
Prof. Lawrence Meinert  
A/Prof. Doug Kirwan  
Prof. Richard Goldfarb  
Prof Antonio Arribas  
Dr Yanbo Cheng  
Dr Cassian Pirard  
A/Prof. Carl Spandler  
Dr Jan Marten Huizenga  
A/Prof. Zhaoshan Chang  

Researchers

**GEOLOGY, GEOCHEMISTRY OF ORE DEPOSITS AND IGNEOUS SYSTEMS**

- A/Prof. Zhaoshan Chang  
- Dr Jan Marten Huizenga  
- Dr Christa Placek  
- A/Prof. Carl Spandler  
- Dr Cassian Pirard  
- Dr Yanbo Cheng  
- Dr Isaac Corral  
- Prof. Antonio Arribas  
- Prof. Richard Goldfarb  
- Prof. Jeffrey Hendenquist  
- A/Prof. Doug Kirwan  
- Prof. Lawrence Meinert  
- Prof. Noel White  
- Dr Gavin Clarke

**STRUCTURE, TECTONICS AND MODELLING OF ORE DEPOSITS AND RELATED SYSTEMS**

- Prof. Paul Dirks  
- A/Prof. Eric Roberts  
- Dr Ioan Sanislav  
- Dr Bob Holm  
- Dr Arianne Ford  
- Emeritus Prof. Bob Henderson  
- Prof. Tom Blenkinsop  
- Prof. Nick Oliver  
- Dr Mike Rubenach  
- Dr John McLellan

**Locations**

- North East Queensland  
- Mount Isa - Cloncurry, Qld  
- WA, SA, NT, NSW  
- SW Pacific  
- China  
- Papua  
- Philippines  
- Iran  
- Turkey

EGRU has been growing and we welcome Lantana Exploration, Sandfire Resources and Mantle Mining as new EGRU members this year.

During the last six months EGRU ran four short courses/workshops for students and professional geologists. Jeff Hedenquist kindly came to EGRU in February and presented a short course entitled Understanding of and Exploration for Epithermal and Porphyry Deposits: Transitions and Variations. The course attracted both students and industry geologists, and all seats were filled. EGRU also ran two Masters short courses: Business and Financial Management by Andrew White and Nick Franey, and Integrated Spatial Analysis and Remote Sensing of Exploration Targets by Arianne Ford, Carsten Laukamp and Zhaoshan Chang. In March EGRU was also involved in a workshop on Drill Core, Structure and Digital Technologies presented at JCU by Dr Julian Vearncombe, and organised and funded by the AusIMM and the AIG.

Another important event was the Cloncurry Mineral Systems workshop in March. This year the workshop was even bigger than last year, with 77 participants from 15 companies, 4 universities, 2 government agencies and 5 services companies. The presentations, core inspections and field trips involved 14 deposits, thanks to the strong support from companies. Presenters included university staff, industry geologists, CSIRO scientists, and consultants. A significant amount of the research results reported were from projects sponsored by the Geological Survey of Queensland.

This year there was also an increase in the amount of course work in the Honours programs, with four short course subjects taught by EGRU staff. These courses will also be open to professional geologists from next year. There are also developments in undergraduate teaching, with the JCU geology group currently negotiating with the China University of Geosciences, Wuhan, about introducing a collaborative 2+2 program.

EGRU also benefited from visits and seminars from experts. Arianne Ford, Managing Director of Newcrest, kindly shared his experience in successful exploration at EGRU in June. During the same period six postgraduate students completed their degrees.

EGRU is also expanding its research facilities, and is expecting delivery of a high resolution camera, with infrared capacity, for fluid inclusion work on opaque minerals. Many thanks to the EGRU board for assisting with the purchase of this instrument. A new SEM instrument will also be purchased by the university and installed at the Advanced Analytical Centre. An ARC LIEF grant proposal was submitted last year for a new laser and ICP-MS; we thank the GSQ for its support of the bid.

The organisation of the FUTORES II conference is well underway and the First Circular has been released. Confirmed speakers include world experts on the major deposit types, fundamental processes, exploration techniques and management, tectonics and metamorphism, and basins and energy. Short courses and field trips will also be organized, and there will be exhibitors’ booths. Abstract submission is now open. We appreciate the support of the SEG and the SGA, and welcome other organisations wishing to support and sponsor the conference.

EGRU has been advancing in both research and education. We thank the university and the college, and the minerals industry - particularly our members - for the strong support. We will keep working hard to contribute to our industry and society.
Prospectivity of Intrusion-Related Hydrothermal Minerals Systems in North East Queensland

In June 2014 EGRU launched a three-year $1.8m collaborative research project aimed at characterising and assessing the prospectivity of intrusion-related hydrothermal mineral systems in north-east Queensland. 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.

A summary of the first year’s work by EGRU researchers was included in the July 2015 EGRU Newsletter. This issue of the Newsletter provides an update based on the second year of work.

EGRU’s North-East Queensland Prospectivity project consists of seven subprojects:

- Magma-Related Hydrothermal Mineral Systems of the Northern Bowen Basin
- Geology of the Mt Carlton High-Sulphidation Epithermal Deposit
- Magma Fertility, Petrogenesis and Geodynamic Setting of Carboniferous and Permian Magmatic Complexes
- Metallogeny of Sn-W-Mo-Cu Mineral Systems
- Comprehensive Prospective Analysis
- Regional Alteration Mapping Using Remote Sensing Methods
- Geochemical Signatures of Intrusion-Related Mineral Systems

A related EGRU project, with separate funding, started earlier this year when PhD student, Peter Illig, began field work on his research project: Magma related hydrothermal gold and base metal deposits in the Chillagoe district, NE Queensland.

Age of Mineralisation

The preliminary findings so far include:

The mineralisation ages seem to have a north-eastward younging trend (see figure on page 8).

Mineralisation ages are all older than 325 Ma (mostly >330 Ma) in the western-most zone, 320-290 Ma (mostly 315-305 Ma) in the central zone, and <286 Ma in the eastern zone.

An exception to this north-east younging trend is the 339 Ma molybdenite Re-Os age from Ollera.

At some locations the ages varies significantly. For example, in the Chillagoe district the mineralisation close to the Palmerville fault has been dated at 335 Ma (Mungana), 327 Ma (Red Dome) and 315 Ma (Red Dome), whereas the age of the Red Cap mineralisation, approximately 10 km to the east, is only ~299 Ma (Lehrmann, 2012).

Similarly, in the southern part of the belt, Pajingo was dated at 342-330 Ma (Etminan et al., 1988; Perkins et al., 1995), whereas the Mt Leyshon deposit has a mineralisation age constrained at ~290 Ma (Allan et al., 2011). Such locations may be on or close to the zone boundary.

More dating is underway to further test the trend.

The geodynamic background causing such zonation is under investigation.

References cited:


On the 18th August several EGRU research staff and students presented updates on their projects at a north east Queensland seminar in Brisbane. The one-day seminar was jointly organised by the Queensland branches of the Australian Institute of Geoscientists (AIG) and the Geological Society of Australia (GSA). It attracted a capacity crowd, with over 120 geoscientists from around Australia gathering to hear the latest results from research in the north east.

On the following day, the Geological Survey of Queensland (GSQ) ran its annual one-day Digging Deeper seminar, comprising updates on GSQ projects and collaborations.

EGRU Director, Associate Professor Zhaoshan Chang, was invited to provide a summary on the EGRU’s north east Queensland project: Geology of Sn-W-Mo and Cu-Au-Ag deposits in northeast Queensland: Insights from the latest ICU research.

The following pages include project summaries from many of the researchers who presented at the AIG-GSA seminar.
The Bowen Basin is an elongate, north-south trending, asymmetrical basin extending from northern New South Wales through central Queensland, covering an area of approximately 200,000 km². Epithermal, porphyry and mesothermal quartz vein deposits widely occur in the northern edge of the Bowen Basin, mostly associated with the Early Permian Lizzie Creek Volcanic group. During this second year of the subproject there have been field campaigns in districts and prospects near the northern edge of the Bowen Basin, including the:

- Mt. Carlton District
- Crush Creek Prospects
- Marengo Goldfield
- Normanby Goldfield
- Mt. Hector Goldfield.

Mt. Carlton District

The Mt. Carlton district is located along the northern margin of the Permian Bowen Basin. This district includes the currently operating gold mine of Mt. Carlton (see Sahlström et al., Subproject #2, this issue), and other high- and low-sulphidation epithermal and porphyry copper prospects. All of the district prospects, including the Mt. Carlton gold mine, are hosted by the Lizzie Creek Volcanic group that overlies the older granite basement (Urannah Batholith).

In the Mt. Carlton district the stratigraphy and geochemistry of the Lizzie Creek Volcanic group is consistent with an evolving calc-alkaline sequence with volcanic arc affinity. New U-Pb zircon dating agrees with previous data for the district, however, some units must be geochronologically constrained.

Capsize Prospect

The alteration and mineralisation characteristics of the Capsize porphyry and lithocap prospects, within the Mt Carlton district, have been defined. These prospects show similar characteristics to porphyry systems, where high sulphidation and porphyry copper deposits are linked. This linkage is also supported by the new alunite Ar-Ar age from the lithocap (~282 Ma) that overlaps with a previous molybdenite Re-Os age from the Capsize porphyry (~286 Ma).

Three rhyolite porphyry intrusive rocks have been identified at Capsize: P1, P2 and P3. Crosscutting relationships indicate that P3 intrudes P2, and P2 intrudes P1. P1 is pre/syn-mineralisation and P2-P3 are late mineralisation.

The Capsize porphyry is hosted by the granite basement and the basalt/andesite basal unit of the Lizzie Creek Volcanic group. It is characterised by a pervasive hematite-chlorite-sericite alteration zone overprinted by local fracture- and breccia-associated sericite alteration. Porphyry mineralisation consists of several stages:

1) quartz and/or magnetite veins, cut by
2) lavender to grey quartz ± hematite veins, and
3) sulphide-rich veins and breccia (pyrite-chalcopyrite with minor molybdenite and trace galena) cutting Stage 2 veins.

In the early porphyry (P1), and surrounding host rocks, there are abundant quartz and quartz-magnetite veins where the highest Cu grades are found. The later porphyries, P2 and P3, contain only minor sulphide veins.

The Capsize lithocap is mainly hosted by rhyolites and andesites of the Lizzie Creek Volcanic group. Lithocap mineralisation consists of:

1) disseminated pyrite, cut by
2) millimetre scale pyrite-enameite veinlets, and
3) later quartz-pyrite-enameite cemented and pyrite-dickite cemented hydrothermal breccias that cut stages 1) and 2.

Geology map of the northern Bowen Basin showing the location of the ore deposits and mineral occurrences inspected during the second year of the subproject.

Modified from Donchak et al. (2013).
Hydrothermal alteration and mineralisation observed in the Capsize porphyry prospect.

A. Hematite-sericite-chlorite altered rhyolite porphyry (P1) cut by quartz and/or magnetite veins. Later pyrite veins are also observed.

B. Feldspar-hornblende phryic andesite showing overprinting of the hematite-sericite-chlorite alteration by sericite alteration.

C. Sericite halo associated with Stage 3 sulfide-rich veins.

D. Quartz-magnetite vein/breccia producing red (potassic) alteration halo in P1.

E. Mineralisation consisting of quartz-magnetite veins cut by Stage 3 pyrite veins developing a white alteration halo in the hematite-sericite-chlorite altered rhyolite porphyry (P1).

Lithocap alteration consists of an inner core of advanced argillic alteration (vuggy quartz-quartz-alunite-pyrophyllite-dickite-diaspore) grading outwards to argillic alteration (quartz-kaolinite-dickite with local illite-montmorillonite) and to propylitic alteration (chlorite-epidote-montmorillonite with local zeolite).

Whole rock geochemistry, microprobe mineral chemistry and SWIR measurements of the Capsize advanced argillic altered rocks provide consistent exploration vectoring within the Capsize lithocap. These exploration vectors point towards a specific area in the lithocap where the alunite is Ca- and Na-rich, has the longest wavelength alunite SWIR absorption feature (1487 nm), and occurs with abundant aluminium-phosphate-sulphate (APS) minerals. The work of Chang et al. (2011) at Lepanto demonstrated that the alunite absorption peak around 1480 nm moves to longer wavelengths towards the fluid source.

Crush Creek Prospects

The Crush Creek area is located within the Lizzie Creek Volcanics and comprises several low sulphidation epithermal deposits. The deposits are characterised by illite-sericite alteration associated with quartz/quartz-adularia crustiform/collomorphic textured veins. Locally, these quartz veins are brecciated and develop very fine grained pyrite (± gold) banding with adularia in the bands. Surface samples and drill chip logging data have been collected to characterise alteration and mineral assemblages, and to determine geological relationships. This work is ongoing.

Other Goldfields

Other prospect areas have been sampled for geochemistry, geochronology and fluid inclusion studies, and the work is ongoing. Results from these areas will contribute to the understanding of the metallogeny of the northern Bowen Basin.

References cited:


Subproject #2

Mt. Carlton Deposit:

#2A Geology of the Mt Carlton high sulphidation epithermal deposit
Fredrik Sahlström, Zhaoshan Chang, Isaac Corral, Paul Dirks, Antonio Arribas, Mark Stokes

The Mt Carlton high-sulphidation deposit is currently the most significant mineral occurrence in the northern Bowen Basin (NE Queensland, Australia). Open pit mining has been ongoing since 2013, with production from the silver-rich "A39" pit in the SW (largely exhausted), and the gold-rich "V2" pit in the north east.

In addition to the currently mined high-sulphidation ore, the Mt Carlton area is highly prospective for linked porphyry-style mineralisation. This project studies the geology, genesis and zonation of the Mt Carlton deposit, with the aim of providing exploration vectors for additional mineralisation in the area. Progress this year includes an improved understanding of the structural control of the deposit, as well as new data from mineral chemistry, S-O-H stable isotopes and Ar-Ar geochronology.

Mineralisation and hydrothermal alteration at Mt Carlton is controlled by NE-SW trending, subvertical structures, and the feeder zone is located in the NE parts of the ore body. The core of the hydrothermal system shows silicic alteration, with variable amounts of alunite (disseminated- and vein-type), anhydrite, pyrite, aluminium-phosphate-sulphate (APS) minerals, pyrophyllite and dickite-kaolinite. Outwards, the silicic zone progressively grades into an envelope of quartz-alunite ± pyrite-dickite-kaolinite-rutile → quartz-dickite-kaolinite ± pyrite → illite-chlorite ± pyrite alteration. Along strike from the NE to the SW, the currently known ore body (c. 800 m) shows a metal zonation of Cu+Zn+Pb+Ag → Cu+Zn+Pb+Ag → Ag+Pb+Cu → Ag.

Three distinct ore stages have been identified. All three stages carry gold and silver, occurring both in independent minerals (e.g. electrum, argyrodite) and as trace elements (e.g. in pyrite, galena, tennantite)

Stage A: High-sulphidation Au-Ag-(Cu-Ge) assemblage dominated by enargite. Subordinate minerals include luzonite, pyrite, barite, electrum, fahlores (tennantite-tetrahedrite-goldfide), argyrodite, pearceite-polybasite group minerals, a yet not fully characterized analogue to aguilarite and cervelleite (Ag,TeSe), chalcopyrite, borite, calococite, covellite, sphalerite and galena. Stage A mineralisation is associated with silicic alteration (massive silica and colloidal silica gels).

Stage B: Intermediate-sulphidation Zn-Pb-Au-(Ga-In-Ge-Ag-Cu) assemblage dominated by sphalerite, with subordinate minerals including galena, pyrite, electrum, barite, fahlores, chalcopyrite and borite.

Stage C: Intermediate-sulphidation Cu-Ag-Au assemblage dominated by tennantite, with subordinate minerals including luzonite, chalcopyrite, galena, electrum, hessite-petzite and barite.

The high-sulphidation ore contains significant enrichment in germanium (in argyrodite and up to 0.15 wt% in enargite), which is spatially associated with the distal silver-zone. Intermediate-sulphidation ore in turn contains sphalerite highly enriched in indium, gallium and germanium (locally up to 27.7 wt% In, 1.48 wt% Ga and 0.12 wt% Ge)

Both disseminated alunite and alunite veins show Na-poor compositions, suggesting low temperatures. A slight zonation towards higher Na-contents in the NE was observed.

Three alunite samples have been dated so far using the Ar-Ar technique. Two alunite vein samples show similar ages around 284 Ma. One disseminated alunite, which texturally predates the alunite veins, gave an age of c. 277 Ma. This age might represent resetting due to later magmatic events, which will be confirmed by additional dating.

Ongoing work includes:
- refining alunite dates;
- alunite fluid inclusion studies to provide information about possible depths to the causative intrusion and porphyry mineralisation.

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A high-grade vein from Mt Carlton. The vein shows evidence of multiple stages of re-opening: alunite (hydrothermal alteration stage) is followed by enargite-luzonite-pyrite (Stage A ore) and sphalerite-galena-pyrite (Stage B ore).
Magma Fertility

#3A: Magma fertility related to Sn-W mineralisation north of Paluma

Yarbo Cheng, Zhaozhan Chang, Carl Spandler, Bob Henderson, Gavin Clarke

In this subproject, we examine both volcanic rocks and granites from the Herberton Sn-W-Mo mineral field, aiming to explore magma fertility parameters more broadly with respect of magmatic activity. The results will be used to test the magma fertility of other Sn-W-Mo associated volcanic rocks in northern Queensland.

Background

Magma fertility relates to the geodynamic setting, crustal architecture, oxidation state, volatile components, volatile exsolution and reactions between magmas, hydrothermal fluids and country rocks (Cooke et al., 2005). In addition, metal and associated element concentrations, and the fractionation and water content of causative intrusions also are significant controls on generating mineral resources.

Substantial progress on magma fertility in relation to porphyry Cu-Au mineralisation has been made in recent years. The new insights have been efficiently used as exploration tools and promoted understanding of mineralisation processes. The approach has found wide application both in industry and among researchers. 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 (Sillitoe, 1972, 2010; Stemprok, 1963; Hosking, 1967; Hesp and Rigby, 1985). Through comparing geochemical data for a very large sample of subduction associated igneous rocks hosting Cu and Au ores in the circum-Pacific belt, Loucks (2014) recognized linkages between magma geochemical characteristics and ore generation.

Compared to porphyry Cu-Au deposits, research on magma fertility of the Sn-W mineralisation associated granites has an even longer history, and a series of pronounced characteristic changes have been recognized.

Sn-W associated granites are:
- rich in SiO2 and alkali (normally K2O > Na2O);
- Sn±W associated granites are:
  - granites has an even longer history, and a series of
  - compared to porphyry Cu±Au deposits, research on
  - geochemical data for a very large sample of subduction
  - alkaline magmas in arc settings (Sillitoe, 1972, 2010; Sillitoe, R.H., 1972, A plate tectonic model for the origin of porphyry Cu-Au deposits in magmatic arcs: Nature Geoscience, v. 6, p. 915–925)

Volcanic Rocks in the Herberton Area

The results from field and laboratory studies, along with the compilation of previous data, have indicated the following:
- Volcanic rocks from the Herberton area have distinctive textures, ranging from fine grained and equigranular to porphyritic with large K-feldspar phenocrysts. Some have clear flow bandings.
- Compilation of age data indicates that the granites and rhyolites in the Herberton area formed in the 346-279 Ma interval. However, given the complexity of the dating results to the end, more effort is needed to refine ages of this plutonic-volcanic rocks association; this will be done in the next phase of the project.
- Whole rock geochemistry of the volcanic rocks from the Herberton area indicate they are mainly rhyolite, with lesser dacite and local andesite. Most belong to the high K calc-alkaline series and are of peraluminous affinity.
- Volcanic rocks from the Herberton area demonstrate a clear linear trend in Harker diagrams (plots of element oxides against SiO2) consistent with pre-emplacement crystal fractionation in the parent magmas.
- Normalized trace element spider diagrams and REE patterns of the volcanic rocks demonstrate strong similarities between the element assemblages This indicates the volcanic rocks were derived from the same or similar sources, with magmas experiencing only slight differences in their evolution.
- The Slaughteryard Creek Rhyolite contains elevated concentrations of Sn, Cu and In, and a relatively high concentration of Mo, compared to volcanic rocks from other locations in the study area.
- The Slaughteryard Creek Rhyolite is the most fractionated rock in the sample set.
- The volcanic rocks are mostly distributed along the boundary of the ilmenite-series granites and magnetite-series granites, and show geochemical affinity with Sn-bearing granites and Mo-bearing porphyries and granites in SiO2 vs FeO/FeO plots.
- Comparison of the volcanic rocks from Herberton area with Sn-W associated igneous rocks from eastern Australia (Blevin, 1992) shows they have affinity with Sn and Mo associated granitic rocks (see figure below). In detail, most of the samples from the Old Featherbeds and Young Featherbeds are geochemically similar to the tin-barren granites, whereas data for Slaughteryard Creek rhyolite places it in the range of tin-bearing granites.

Further work on this subproject will include:
- Continuing evaluation of new data.
- Additional precise dating to establish the link between magmatic activities and mineralisation (data from zircon, mica and cassiterite).
- SWIR analysis to characterize alteration.
- The use the tested parameters on more samples from the region, to generate a regional magma fertility map.
- More detailed comparison of magma fertility parameters between W-Sn associated and Cu-Au associated igneous rocks.

References cited:
Blevin, P.L., Chappell, B.W., 1995, Chemistry, origin and evolution of mineralised terranes in the Lachlan Fold Belt, Australia, the metallogeny of Sn-S type granites. Econ. Geol., v. 90, p. 1604–1618.
Wilkinson, J.1., 2013. Trigger for the formation of porphyry ore deposits in magmatic arcs: Nature Geoscience, v. 6, p. 915–923
Magma Fertility

#3B: Magma fertility, petrogenesis and geodynamic setting of Carboniferous and Permian magmatic complexes south of Paluma

Helge Behnsen, Isaac Corral, Carl Spandler, Zhaoshan Chang, Robert Henderson

Background

Many hydrothermal deposits associated with Permo-Carboniferous igneous rocks have been found in northeast Queensland, mostly of small to medium size. The potential for large porphyry deposits, however, might have been underestimated. Compared to relatively young magmatic arcs and related porphyries of the Circum-Pacific region, the igneous associations of Queensland are old and the large scale exposure of plutons indicate a fair extent of erosion. However, volcanic units of similar ages are commonly present and preserved, potentially covering and protecting existing mineralisation. Advances in the understanding of magma-related hydrothermal mineral systems in recent years has shown that high- and intermediate-sulphidation epithermal deposits can be linked to porphyry deposits at depth (e.g. Hedenqust et al., 1998; Sillitoe, 2010; Chang et al., 2011). Thus the surface occurrences of high- and intermediate-sulphidation mineralisation in northeast Queensland’s Permo-Carboniferous igneous rocks could cover major porphyry deposits. This potential needs to be re-evaluated.

The application of geochemical proxies derived from whole-rock analyses to evaluate the fertility of magmas extends back to the work of Blevin et al. (1996), who introduced the Fe₂O₃/FeO vs. Rb/Sr diagram to distinguish between different granite types based on the oxidation state of the magma and degree of fractionation. A recent study by Loucks (2014) introduces a new approach. This concept involves consideration of the influence of different granite types on the Sr/Y and V/Sc ratios utilised as magma fertility indicators display differences when applied to a coherent suite of volcanic rocks proximal and distal to known mineralisation (Behnsen et al., 2016). More recent work has provided further detailed insights into geochemical differences between the sampled areas, and has provided new U-Pb zircon ages and Hf isotopic compositions.

The recent work has indicated the following:

- The new U-Pb zircon ages from the Mt. Carlton samples.
- The proposed Au fertility indicators of Loucks (2012) evolve around rifting, crustal thinning and a different source compared to Cu-ore productive magmas. The importance of rifting tectonics in the Mt. Carlton area was recently demonstrated by Dricks (2016) and has been taken into consideration when considering source, magma evolution and controls of our samples.

References cited:


Sn-W-Mo Base Metal Deposits North of Paluma

Site #7: Regional W and Sn metallogeny

Yanbo Cheng, Kaiyan Liu, Zhaoshan Chang, Robert Henderson, Gavin Clarke

The project study area is located in northeast Queensland. Tungsten and tin mineral occurrences occur mainly in the north between Herberton and Cooktown, but also in the south, in the Kangaroo Hill district (~75 km northwest of Townsville). There are several active mines in the Herberton Sn-W-Mo field, and in the Mt Carbine-Watershed W field, which located to the west of Port Douglas. Work is ongoing and the aims of the subproject are to:

1) Review and compile existing data;
2) Characterise the geochemical, geochronological and intrusive associations in relation to mineralisation and alteration;
3) Characterise the mineralogy and geochemistry of mineralisation and alteration, and determine paragenetic and zoning relationships;
4) Generate regional and prospect-scale prospectivity maps that incorporate geochemical, geochronological and mineralisation data;
5) Update regional to district scale metallogenic maps.

Mt Carbine Wolframite-Scheelite Deposit

The Mt Carbine quartz wolframite-scheelite sheeted vein deposit is located ~80 km NW of Cairns in northern Queensland. It was the largest vein type W deposit in Australia and accounted for 43% of Australia’s annual W production in 1986, prior to closure because of a international Sn-W market crash. The hard rock deposit consists of multiple deformable Devonian flysch. The formation is extensively intruded by Carboniferous to Permian granitic plutons and locally over lain by little disturbed Carboniferous to Triassic cover sequences, including the Carboniferous Featherbed Volcanics (De Keyser and Wolff, 1964; Henderson et al., 2011). The deposit area of WCM is dominated by the intrusion of the James Creek body of the Elizabethan Granite, with related greisen alteration and mineralisation. Greisen is commonly developed in the contact zone; alteration affected the granite up to 100 m away from the contact with the meta-sediments and volcanics and can be traced along strike for approximately 3km. No mineralisation has been located in the metasediments, although some hornefels formed by low grade contact metamorphism occurs within the Hodgkinson Formation within a few metres along the contact with altered granite. Mineralisation occurs mainly in quartz pipes and quartz sheets within the alteration zone, and the greisen also contains some lower grade mineralisation. The variation of epsilon Hf has a quite clear relationship with time, as distinct from a spatial relationship. References cited:

The regional geodynamic setting of the regions with Sn-W-Mo mineralisation in North Queensland has been studied employing Hf isotope datasets for the Herberton Sn-W mines, Mt Garnet Sn-Cu-Zn-Fef Field, Wolfram Camp-Banford Hill W-Mo field, and Mt Carbine-Watershed W field. Hafnium isotope data from igneous rocks in the Chillogoe Cu-Au field, and other non-mineralised rocks of the Kennedy Igneous Association in this region, have also been collected. The 600 Hf isotopic data points presently available indicate the following:

- A range of magma sources/compositions is indicated
- The variation of epsilon Hf has a quite clear relationship with time, as distinct from a spatial relationship.
- There are three groups of epsilon Hf values with three different ages.
- The ranges of the epsilon Hf values of the above three groups have significant overlap, which indicates a continuity of process, which is meaningful as spatially they are in the same region.
- All of the Sn-W-Mo mineralisation occurred during this continuity of process.

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Mineral assemblage

<table>
<thead>
<tr>
<th>Stage I</th>
<th>Stage II</th>
<th>Stage III</th>
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<tbody>
<tr>
<td>Quartz</td>
<td>Chlorite</td>
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<td>Biotite</td>
<td>Quartz</td>
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<tr>
<td>Chlorite</td>
<td>Biotite</td>
<td>Quartz</td>
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</tbody>
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Vein occurrence

<table>
<thead>
<tr>
<th>Stage I</th>
<th>Stage II</th>
<th>Stage III</th>
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<tr>
<td>Early and discontinuous</td>
<td>Late and continuous</td>
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<td>Early and discontinuous</td>
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W alteration

<table>
<thead>
<tr>
<th>Stage I</th>
<th>Stage II</th>
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<tbody>
<tr>
<td>No alteration</td>
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References cited:

The main aims of this PhD project on the Watershed deposit are to help exploration by identifying zoning patterns, field signals, and through improved understanding of the ore genesis and controlling factors on the mineralisation. In addition, the project will feed information and exploration vectors to the regional prospectivity analysis (Subproject #9).

The project also aims to understand the evolution of mineralising fluids, the genesis, mobility and precipitation mechanisms of tungsten, and the genesis of the alteration mineral assemblages, to further contribute knowledge and understanding on how Watershed was formed.

The Watershed deposit is located in far north Queensland, about 100 km northwest of Cairns. It has a combined JORC resource of 49.32 Mt @ 0.14% WO₃ totalling 70,400 tonnes of WO₃.

Watershed lies within the Mossman Orogen, which comprises a folded sequence of Ordovician-Devonian metasediments intruded by Carboniferous-Permian granites of the Kennedy Province. Mineralisation is hosted by a sequence of folded slates and, locally, calcareous psammites of the Hodgkinson Formation. Multiple felsic dykes, previously assigned to the Permian S-type Whypress Supersuite granites, cut the metasediments.

At Watershed, scheelite mineralisation occurs within, and in centimeter halos of, quartz – feldspar – scheelite – pyrrhotite and minor arsenopyrite sheeted veins. This vein set, with <50 cm wide, sinuous to planar, E-W striking veins, is generally south dipping and mostly cuts green and red skarn altered psammite breccia, striking veins, is generally south dipping and mostly cuts green and red skarn altered psammite breccia, marks a shift from the previous oxidised conditions to reduced conditions.

A new pre-mineral dyke age of ~300 Ma (LACIP-MS zircon U-Pb) in the eastern margin of Watershed has been established. This new date is approximately 35 Ma older than reported ages for intrusions of the Whypress Supersuite and may be a pre-Whypress Supersuite unrecorded magmatic event.

Further work on this project will include:
- Refining the alteration and mineralisation mineralogy and paragenesis.
- Dating to constrain the age of mineralisation.
- Fluid inclusion studies.
- O-H-S isotope studies.
- Analysis of the structural setting of the deposit.

References cited:

JCU Emeritus Professor Bob Henderson, who has retired but is as busy as ever, has been beavering away for a couple of years revising the 2nd edition of this book produced by David Johnson and firstly published in 2009. The new edition, to be published by Cambridge University Press, is expected in September.

The book retains the same general organization as the second edition and also much of its previous content, but has been comprehensively revised and updated. Two heads are always better than one, and it is surprising the extent to which new and valuable information has been generated in the passage of just seven years. Overall the book content has grown by 40 or so pages with close to a hundred new illustrations, including both line diagrams and photographs. Adella Edwards, formerly the cartographer in the School of Earth and Environmental Sciences, worked her magic in getting the new line diagrams publication-ready and revising a number that have been recycled. Many friends and colleagues, and also Geoscience Australia, were generous in making illustrations available for inclusion. A more expansive index will help readers to find specific topics more readily.

Two new chapters have been added, in exchange for a more expansive index will help readers to find specific topics more readily.

Two new chapters have been added, in exchange for two (climate change; cosmology and impacts) that were somewhat peripheral to a book on the national geology. One of the additions deals with geological time, a seminal concept and organizational structure underpinning the discipline. Stock-in-trade for most of us, in our daily work. The second deals with the Paleozoic orogenic systems of eastern Australia, a complicated topic, with good measure of conten tion. Constructing a coherent, and hopefully easy to read and understand, thumbnail in 20 or so book pages covering the Delamerian, Lachlan, Thomson, Mossman and New England systems proved to be quite a challenge. A personal research involvement with three of the five, providing a good measure of firsthand knowledge, came in handy. The final chapter summing up in a global context of how Australia evolved has been completely rewritten and is also new. In keeping with previous editions, this third edition is written for a general readership and assumes no prior knowledge of the Earth Sciences by readers, concisely explaining concepts unique to the discipline and minimising the burden of unfamiliar terminology. Its target readership is the public at large as well as students of the discipline. Hopefully it will be a vehicle of general education in the Earth Sciences for Australians.

The journey of Australia through time is the main theme of the book. It relates how the Australian cratons developed through the assembly of continental fragments, culminating in the formation of the supercontinent of Rodinia. The ongoing evolution of Australia with the development of orogenic belts and sedimentary basins following the breakup of Rodinia, and then continuing reorganisation of continental crust as the supercontinents of Gondwana, then Pangaea, is explained. The journey continued with subsequent supercontinent fragmentation which brought Australia to its present setting and resulted in development of substantial continental shelves as part of the national estate.

The features of Australian geology that shine in an international sense are highlighted, including the Pilbara banded iron formations, the Australian record of Precambrian life, the Neoproterozoic and Carboniferous-Permian glacial records, coal deposits of the Sydney-Bowen basin, the Great Artesian Basin and its relationship to the early Cretaceous drowning of most of the continent, and the spectacular late Cenozoic record of marsupials.

Although the book is not expansive on Earth resources, Australia’s main mineral deposits, and those of coal and petroleum are placed in the context of how the Australian crust was shaped over time and the Earth processes involved. Surface processes affecting the present Earth surface with consequences for Australia, such as tsunamis, cyclones, threats to coral reefs and land degradation are also covered.
Drill Core, Structure & Digital Technologies

An AusIMM - AIG sponsored short course presented by Dr Julian Vearncombe

Oriented drill core provided by Mantle Mining.

On the 9th March 18 JCU honours and postgraduate students, along with research staff and local industry geologists, attended a drill core short course given by Dr Julian Vearncombe. During the one-day workshop Julian covered several topics, including:

- Lodes and how to drill them
- Structure data collection
- Structural geology in terrains lacking outcrop
- Value from legacy data
- Effective communication and best practice

In the afternoon a hands-on session with oriented drill core gave all course participants the chance to select suitable oriented drill core and collect structural data.

At end of the day Julian asked students the question: “What have you learned from the day’s workshop?”. Responses included:

- Data quality is more important than data quantity.
- Use computer technology as a tool rather than for its own sake.
- Collect data with a purpose.
- Interpret in real time as you collect data.
- Build pictures from your data.
- Be consistent with logging and data collection.
- Apply fractal concepts.
- Drill across structures.
- Drill angled holes.
- Use structural geology as a tool.

Thank you to the AusIMM and AIG for their sponsorship of the workshop, to Geoff Phillips from the North Qld AusIMM branch for facilitating the workshop, and to Mantle Mining for providing the oriented drill core for the practical session.

This year EA2510 students visited Resolute Mining’s Carpentaria Gold operations at Ravenswood, around 95 kilometres south-west of Townsville. The current underground mining operation at Ravenswood is centred on the +million ounce Mt Wright intrusion-related breccia deposit.

The mine visit and field work were made possible through the efforts of Dr Nick Lisowiec, from Carpentaria Gold. Nick gave the students a presentation on the resource cycle - from exploration to rehabilitation, took them on a tour of an open pit, arranged a core display, and demonstrated sampling procedures. The sampling equipment for the field work was generously provided by Terra Search

EA2510 is coordinated by Dr Christa Placzek, with assistance from Dr Ioan Sanislav and A/Prof. Zhaoshan Chang.

Earth Resources, Exploration and Environment: EA2510 in the field

In April around 25 second year students, including six engineering students, had the chance to visit an operating gold mine, take a close look at drill core, and gain hands-on experience with surface geochemical sampling techniques.

The students were taking part in the field work component of JCU geology subject EA2510, Earth Resources, Exploration and Environment. This subject aims to provide students with an understanding:

- of the mechanisms by which mineral resources form;
- of basic exploration techniques for mineral deposits;
- of the nature, challenges and ways of evaluating and exploiting mineral resources, and related environmental issues;
- and informed perspective of global natural resources, Australia’s and Queensland’s resource based economics and the socio-economic impacts.

Thank you to the AusIMM and AIG for their sponsorship of the workshop, to Geoff Phillips from the North Qld AusIMM branch for facilitating the workshop, and to Mantle Mining for providing the oriented drill core for the practical session.

EGRU Honours Scholarships

Each year EGRU offers scholarships of $5000 to two Honours students who are enrolled full-time at JCU and are working on projects related to mineral or energy resources.

For further information go to:
https://www.jcu.edu.au/scholarships-at-jcu/search/egru-honours-scholarship

W.C. Lacy Scholarship

In honour of Bill Lacy - the Foundation Professor of Geology at JCU.

This scholarship of $5000 is offered on a competitive basis to students who are undertaking or have been accepted into the JCU PhD program in Earth Sciences, and have been awarded or offered a competitive postgraduate scholarship.

For further information go to:
https://www.jcu.edu.au/graduate-research-school/candidates/scholarships/wc-lacy-scholarship-for-phd-research-in-earth-sciences
2016 EGRU Short Courses & Workshops

Business and Financial Management for the Minerals Industry
8th - 19th February 2016
Course Leaders: Dr Andrew White, Dr Nick Franey
Delegates: 14

Understanding of, and Exploration for, Epithermal and Porphyry Deposits: Transitions and Variations
25th - 26th February 2016
Course Leader: Professor Jeffrey Hedenquist
Delegates: 25

IOCG and other Mineral Systems in the World-Class Cloncurry District
16th - 18th March 2016
Course Convenors: A/Prof Zhaoshan Chang, Dr Richard Lilly
Delegates: 77
Workshop report included over the page.

Integrated Spatial Analysis and Remote Sensing of Exploration Targets
18th - 29th April 2016
Course Leaders: A/Prof Zhaoshan Chang, Dr Arianne Ford, Dr Carsten Laukamp
Delegates: 12

FUTORES II
Future Understanding of Tectonics, Ores, Resources, Environment and Sustainability

4 - 7 June 2017
Townsville, Queensland, Australia

Conference Themes
- David Groves Symposium: New Insights in Mineral Deposit Understanding
- New Technologies and Approaches in Mineral Exploration
- Tectonics and Metallogenesis
- Basins and Energy
- Future Trends in the Minerals Industry

Confirmed Speakers
Richard Sillitoe
David Groves
Larry Meinert
Noel White
David Leach
David Cooke
Bruce Gemmell
Cornel de Ronde
Jingwen Mao
Jeremy Richards
Antonio Arribas
Yasushi Watanabe
Steve Cox
Steven Micklethwaite
Joel Brugger
Allan Collins
Annette George
Roric Smith

FUTORES II is supported by:

www.jcu.edu.au/futures
**FUTORES II 2017 Conference Themes**

**FUTORES II** (Future Understanding of Tectonics, Ores, Resources, Environment and Sustainability) will be held in tropical Townsville, Queensland, Australia, 4-7 June 2017. The conference will address issues related to new understanding in mineral deposits, tectonics, basins, and metallogenesis, new technologies and approaches in mineral and energy resources exploration, including the challenge of exploration in areas with cover, and future trends in the resources industry. The **FUTORES II** conference will have a similar format to the inaugural and highly successful **FUTORES** conference held in 2013. The Economic Geology Research Centre (EGRU) at James Cook University is proud to host this event and we welcome academic colleagues, industry and government geologists, and students to this inspiring and exciting conference.

**Plenary Speaker Richard Sillitoe: Exploration in and under lithocaps**

David Groves Symposium: New Insights in Mineral Deposit Understanding

Coordinator: Zhaoshan Chang

With the increasing world population and living standards the demand for mineral and energy resources continues to grow. Further exploration will need to target resources at increasing depths and in areas with cover. Such challenges require improved understanding of mineral systems and better exploration methods. This symposium, in honour of Professor David Groves, will highlight recent developments in the understanding of major types of mineral deposits, and their physical and chemical controls.

**New Technologies and Approaches in Mineral Exploration**

Coordinator: Kaylene Camuti

Technological and conceptual developments in the mid 20th century offered explorers a new framework for exploration. Affordable geochemistry and airborne geophysical techniques, combined with regional geological maps, provided tools for large scale regional surveys and led to major discoveries. Recent decades have seen continuing advances in exploration technology and new concepts applied in exploration programs, and to the challenge of exploring under cover. Developments in geophysical, geochemical, biogeochemical and drilling-related technologies, along with advances in data management and processing, offer explorers an expanding range of tools. This symposium welcomes contributions on new exploration technologies and concepts, and on modern applications of tried and true technologies and geological techniques.

**Tectonics and Metallogenesis**

Coordinator: Zhaoshan Chang

Basins and Energy

Convenor: Paul Donchak

Coordination: Eric Roberts and Maree Corkeron

This symposium will address the relationship between tectonics, basins and energy resources. The symposium will span a range of topics that include coal, conventional and unconventional hydrocarbon accumulations, as well as studies focused on basic sedimentology, stratigraphy, palaeontology and structural geology. Emphasis will be placed on Australasian basins, however case studies from around the globe are welcome. In addition, new applications and techniques for basin analysis involving geochronology, geochemistry and other fields will be highlighted.

**Future Trends in the Minerals Industry**

Coordinator: Trevor Shaw

This symposium will include contributions on trends in the minerals industry that will affect the future of exploration, discovery, and the utilisation of resources. Topics could include, but are not limited to: commodities for the future, sovereign risk, education and training, trends in research management and application, and developments in project management.

(FUTORES Photographs courtesy of: Rob Holm; Zhaoshan Chang; Auratus Minerals; Tourism and Events, Qld)
This year’s EGRU field workshop in Cloncurry continued a theme of the previous year’s workshop course: what are the genetic relationships between various major deposits in the Cloncurry region and why have we failed to find another in the past two decades? Although the primary focus of the conference was “IOCG” there were also talks on sedex and skarn deposits.

The day before the workshop Ernest Henry Mine hosted an introduction to their mine geology and allowed viewing of core from their ore body. Attendees were able to view the open pit and discuss at length the genesis of the sulphide-bearing breccias which host the ore. On the morning of the 16th Dr. Zhaoshan Chang (JCU EGRU Director) opened the workshop. He was followed by Nick Oliver (HCOV Global) and Mike Rubenach (JCU) who provided the attendees with a detailed description of the Cloncurry region geology and a synthesis of the current understanding of minerals systems contained within. The first day’s program consisted of deposit scale geology talks including Cannington, Dugald River, Rocklands, Elaine, Mt Watson, Mt Cuthbert, Kalman and Overlander. These presentations highlighted the variety of ore deposit types (IOCG, sedex, skarn) and the successful modern exploration and development history which defined the Cloncurry region. Of notable interest was the talk on CuDECO’s Rocklands project which is now in operation. Michael Hawthin, geologist with CuDECO, described the chalcopyrite, magnetite and amphibole-bearing ore of the Rocklands project and provided the attendees with an update on infrastructure and mining progress. He also explained that the genesis and age of the deposit remain unknown and that CuDECO would be available for further work to help constrain these major questions.

Wrapping up the day were two talks: one by Dr. Zhaoshan Chang on distinguishing hydrothermal from sedimentary magnetite in the Cloncurry district, and its significance in identifying mineral systems. The final talk of the day was by Richard Lilly’s (MIM/Univ Adelaide) on “IOCG” mineral systems within the Cloncurry district. Richard provided an abundance of data which demonstrated that the IOCGmodel, if applied to Cloncurry, has many flavours and variations, with no single genetic model broad enough to cover the district’s variation in metallogeny or host rock characteristics.

After the first day of talks the group met for BBQ, beer, core viewing and cricket at the MIM barracks in Cloncurry. On table was beautiful core from Cannington, Eloise and seven other deposits. The core provided the geologists (especially those who are new to the region, like me) with a better understanding of the metamorphic host rocks of the region and an idea of the ore controlling features. On the 17th talks continued with the direction changing from mine and prospect geology to broader scale geology, exploration under cover, and an end of workshop wrap-up. CSIRO made preliminary presentations on their Cloncurry based geophysical, geochemical and structural research funded by the Geological Survey of Queensland (GSQ). This includes work on interpreting magnetic remanence in the Cloncurry district and how this applies to mineral exploration and exploring for magnetic targets under cover. Dr. John Walsh (CSIRO) gave a talk on redox gradients in mineral systems, including Archean gold systems in Western Australia, mid-Proterozoic mineral systems of varying metallogeny in Queensland and Southern Australia, and how to use these gradients as vectors to mineralisation. Dr. Walsh stated that what Cloncurry is missing is a synthesized geochemical understanding of metal accumulation and deposition. Dr. James Austin finished the CSIRO talks with presentation on quantifying structural controls on mineralisation. Ernest Henry, Monakoff, E1, Canteen, Maroran, Cameron River, Swan, Starra, Kultbor and Osborne were used as case studies. The CSIRO work is due to be reported for public dissemination this year.

The remaining talks covered a variety of topics such as Dr. Zhaoshan Chang’s research on the genesis of the enigmatic Corella breccias, which appear visually similar to deposit hosts in the region, Emma Beattie, with FMR Investments, gave an energetic talk on the history of the previous 20 years of production at the Eloise copper gold deposit. Dr. Richard Lilly finished the day with a talk about his GSQ funded work on exploring through cover and gave insight into new techniques that could be used to find deposits not exposed at surface.

The workshop ended with a discussion about what explorers in the Cloncurry region can do moving into the future. Glen Little, from Minotaur Exploration, pointed out that no major economic deposits had been found in the Cloncurry region for over 20 years. There was a lack of consensus amongst workshop delegates as to whether a misunderstanding of ore deposit genesis of the region was misdirecting exploration efforts or whether it was a lack of data that prevented efficient exploration under cover. Many deposits in the region were first detected due to their magnetic signatures (e.g. Cannington by BHP) and others had surface outcrop. The IOCG model followed these discoveries in an attempt to understand their genesis and allow for future major discoveries. Ever since the easy deposits (exposed at surface and magnetite bearing deposits) were drilled no major discoveries have occurred. The IOCG model has not been credited with aiding the discovery of any new mines in the Cloncurry region. Major questions were raised but remained unresolved, including:

- What geophysical datasets would best aid exploration under cover?
- Should the broad IOCG model be abandoned?

Exploring under cover is a challenge presenting itself in mature mineral districts globally. Although no broad consensus was found on pathways forward, the EGRU IOCG workshop served as a forum for industry and research geoscientists from around the region to convene and begin working on these challenges.

On the day after the workshop presentations many attendees visited the Rocklands and Dugald River mines. Dugald River was a brief but welcome departure from IOCG and provided another window into the base metal geological story in the Cloncurry region.

We would like to thank all attendees, including the many industry participants, geoscientists from GSQ and CSIRO and academia. We would also like to thank Dr. Zhaoshan Chang and Dr. Richard Lilly and the other support staff required to make this meeting a reality.
Goldschmidt 2016 -
A Postgraduate’s Experience

Paul Slezak
PhD Candidate, EGRU

The 2016 Goldschmidt conference, held in Yokohama, Japan from June 26th - July 1st, covered topics ranging from cosmochemistry to mantle geochemistry. I attended the conference as a student delegate and presented a talk entitled, “Yangibana LREE deposit and associated ferrocarbonatites, Gascoyne Province, Western Australia” in the presentation theme, “REE/HFSE Deposits: Characteristics, Ore Genesis and Exploration”. The conference was an excellent place to catch up on the latest geochemical research, present my own project, and to meet current and future colleagues.

Goldschmidt Mentoring Program

This year, the Goldschmidt conference created a mentor program for students and early career researchers. The premise is that a more experienced academic researcher who has previously attended a Goldschmidt conference would provide advice to a mentee. My mentor was Dr. Katsuhiko (Katz) Suzuki from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). Katz was an excellent mentor making himself easily reachable at all times. We met at the regularly scheduled lunches established by Goldschmidt to talk about our research and the conference. In addition, Katz invited me on a tour of the JAMSTEC facilities where I was able to see their new isotope lab facilities, clean lab, and deep-sea exploration vehicles.

Short Course: High Pressure Geochemistry

Nu Instruments Japan and JAMSTEC sponsored student short courses at the Yokohama Institute for Earth Sciences. I participated in the “High Pressure Geochemistry” course taught by Marc Hirschmann from the University of Minnesota. The course discussed H2O and CO2 flux in the Earth’s mantle. It was an excellent introduction to how H2O and CO2 are stored in the mantle; how they are brought to surface; and the geochemical evidence scientists have for the presence of these compounds in the different parts of the mantle. The course also opened up many questions such as the residence time and initial sources for H2O and CO2 in the mantle.

JAMSTEC underwater research station circa 1960s. The station was used to study the effects of water pressure on the human body to depths of 300 m.

EGRU presentations at AESC 2016:

Cheng, Yanbo; Chang, Zhaoshan; Poblete, Jaime.
Geology and Mineralization of the Mt Carbine Deposit, Northern QLD, Australia.

Poblete, Jaime; Chang, Zhaoshan; Cheng, Yambo. The Watershed tungsten deposit (NE Qld, Australia): Scheelite vein mineralization, alteration and mineral chemistry.

EGRU presentations at Goldschmidt 2016:

Spandler, Carl. Trace element and Nd isotope evolution of subducted sediments; insights from HP and UHP rocks. (Keynote)

Corral, Isaac; Chang, Zhaoshan; Behnsen, Helge; Sahlin, Fredrik; Spandler, Carl; Povock, Michael; Hewitt, David. The Capsize porphyry prospect, NE Queensland, Australia: A Paleozoic linked porphyry-lithocap system.

Nazari Dehkordi, Teimoor. The unique wolframine HREE deposit, Browses Range area, Western Australia.

Sadeghi, Benham; Carranza, John; Wang, Haicheng; Yilmaz, Huseyin; Ford, Arianne. Weight bulk leach extractable gold with catchment area.

Sahlin Stores, Corral Ist, Chang Z, Arribas A, Dirks P & Stokes M. Hydrothermal Alteration and Mineralisation at the Mt. Carlton High-Sulphidation Au-Ag-Cu Epithermal Deposit (NE Queensand, Australia).

Slezak, Paul; Spandler, Carl. Age and origin of the Yangibana LREE deposit and associated ferrocarbonatites, Gascoyne Province, Western Australia.

Spandler, Carl. Geology and genesis of the Toongi rare metal (Zr, Hf, Nb, Ta, Y) REE deposit, New South Wales, Australia.

EGRU @ AESC 2016

26 June - 1 July, Yokohama, Japan

A number of EGRU staff and students attended and presented at this year’s Goldschmidt conference, held in Yokohama Japan, from the 26th June to 1st July. The Goldschmidt conference is the world’s premier geochemistry conference and this year was attended by more than 3700 delegates from across the globe. EGRU had a strong showing in the “Mineral Resources” theme, with Isaac Corral and Frederik Sahlin giving talks in the “Hydrothermal Systems: Geochemistry of Porphyry and Epithermal Deposits” session, and Helge Behnsen presenting in the “Geochemical Mineral Exploration” session. Paul Slezak, Carl Spandler and Teimoor Nazari-Dekhordi all presented in the “REE/HFSE deposits: Characteristics, Ore genesis and Exploration” session. Carl also gave a keynote talk in the “Slab Processes and Slab mantle interaction” session and participated in a BBC World Service radio edition of “The Forum” on geological hazards and plate tectonics, which can be heard at: http://www.bbc.co.uk/programmes/p041svq3.

JCU honours student John Wardell also attended and worked as an official Student Helper for the duration of the conference.

The Goldschmidt Conference™ is named in honour of Victor Goldschmidt (1888-1947), a Norwegian mineralogist considered to be the founder of modern geochemistry. The annual conferences are organised by the Geochemical Society and the European Association of Geochemistry, in collaboration with other learned mineralogical and geochemical societies.

Photo at left: EGRU staff and students at Goldschmidt 2016 in Yokohama. From LtoR: Helge Behnsen, Teimoor Nazari Dehkordi, Isaac Corral, Carl Spandler, John Wardell, Paul Slezak

EGRU @ Goldschmidt 2016

26 June - 1 July, Yokohama, Japan

A number of EGRU staff and students attended and presented at this year’s Goldschmidt conference, held in Yokohama Japan, from the 26th June to 1st July. The Goldschmidt conference is the world’s premier geochemistry conference and this year was attended by more than 3700 delegates from across the globe. EGRU had a strong showing in the “Mineral Resources” theme, with Isaac Corral and Frederik Sahlin giving talks in the “Hydrothermal Systems: Geochemistry of Porphyry and Epithermal Deposits” session, and Helge Behnsen presenting in the “Geochemical Mineral Exploration” session. Paul Slezak, Carl Spandler and Teimoor Nazari-Dekhordi all presented in the “REE/HFSE deposits: Characteristics, Ore genesis and Exploration” session. Carl also gave a keynote talk in the “Slab Processes and Slab mantle interaction” session and participated in a BBC World Service radio edition of “The Forum” on geological hazards and plate tectonics, which can be heard at: http://www.bbc.co.uk/programmes/p041svq3.

JCU honours student John Wardell also attended and worked as an official Student Helper for the duration of the conference.

The Goldschmidt Conference™ is named in honour of Victor Goldschmidt (1888-1947), a Norwegian mineralogist considered to be the founder of modern geochemistry. The annual conferences are organised by the Geochemical Society and the European Association of Geochemistry, in collaboration with other learned mineralogical and geochemical societies.

Photo at left: EGRU staff and students at Goldschmidt 2016 in Yokohama. From LtoR: Helge Behnsen, Teimoor Nazari Dehkordi, Isaac Corral, Carl Spandler, John Wardell, Paul Slezak
Andy White has been a long-serving member of the EGRU team, and when he hung up powerpoint slides to move on to other things early this year, it marked the end of an era for the JCU-EGRU Masters course.

Andy has taught that Business and Financial Management postgraduate course at EGRU for nearly two decades. This year’s course in February was his final JCU course, but he ensured its continuation by jointly presenting the course with Nick Franey, prior to handing it over to Nick for future years.

Andy’s long and successful career, which is still continuing, encompasses a wide range of commodities and extensive management experience. To mark his retirement from teaching at EGRU he looked back over his career and noted the highlights, the turning points, and the roles of family, colleagues, and mentors.

Andy grew up in Sydney and majored in economic geology at Sydney University. He worked as a driller’s offsider and then as a (very unskilled) diamond driller in and around Sydney until a PhD scholarship sent him off to study at UNE under the supervision of Allan Voisey. While at UNE he met and married Elizabeth, his wife, companion and mother of their two children.

Andy is the first to say that being mentored, and then having the opportunity to mentor, are of prime importance in any professional’s career. Andy says he got lucky as his first mentor was the legendary Ken Glasson, who Andy describes as the worst lecturer but the best geological mentor and friend any younggeo could wish to have. The second was Allan Voisey, whose gifts were enthusiasm, patience, kindness, and an ability to surround himself with a stellar cast of academic staff. The peer group of PhD and Masters students at the time included Max Richards, Barrie McKelvey, Stirling Hopwood, consultant. Bruce Webb, then MD of Poseidon Ltd, and Tim Andrew White & Associates. Enter the next mentors, Andy says he cannot remember much about the first course, probably because of the nerves and worry of getting it right, but it must have gone well because some of the participants still keep in touch. Except in severe downturns, the course was held each year at the AMF, and occasionally at overseas locations. In 1997 the expanded course notes were published by the AMF as “Management of Mineral Exploration”. The Brisbane years (28 to date) have involved management courses about annually, firstly at CODES then at JCU, a series of management training programmes for BHP Discovery based around the course, and consulting to China National Nonferrous Corporation on their process of privatisation.

The second edition of the book was published in 2008 as EGRU Contribution 66. There are very few editing errors, the layout is a bit tidy, but Andy and EGRU were happy with the result (this really is a collector’s item, so get your copy now).

Heading into his 75th year, Andy figured that it was time to ease back a bit. As luck would have it, in correspondence with Nick Franey who is writing his own book, he determined that there was a geologist who could take over the course. Nick and Andy jointly conducted the 2016 course and, satisfied that he had found the right person to continue the work, Andy has hung up his powerpoints and gone back to some prospecting, some consulting, and company direction. He leaves with very fond memories of the people at EGRU, starting with that legendary duo, Bill Lacy and Roger Taylor, but including all those at EGRU who took an interest since, especially the post grads. He is particularly grateful to Judy Botting for all the administrative support she gave him during the “EGRU years”. He hopes that EGRU is a lastingly successful institution and is very glad to have had the chance to contribute. Andy White Retires From EGRU MS Course

Lunch with Tim one day led to the discovery of the Skardon River kaolin deposit. Further consulting work led to the position of Manager, Minerals for Poseidon. In the Poseidon years, Andy became involved in the Kalgoorie JV between Homestake, WMC and Poseidon. During one of his Kalgoorie trips, Bill Hill, a leading WMC mine geologist, took him aside and put the proposition that instead of remnant mining narrow veins underground, the consortium should consider developing a very large, nay, super pit and process the lot. After juggling some numbers based on Bill’s estimate of a grade of 2.2 g/t gold, Andy promoted the idea to the Poseidon Board. Soon after, Rob de Crespigny took over Poseidon to form Normandy Mining Ltd and, after some corporate wheeling and dealing, the Super Pit became a reality, with a grade a bit north of 2.2 g/t. Although working for Rob was exhilarating, Andy had other goals and headed back to Queensland with the family.

A year after returning to Queensland, Andy was co-opted into the job as foundation director of the WH Bryan Mining Geology Research Center at the University of Queensland, with the goal of getting Geology and Mining Engineering back to a close working relationship. He says this job was the second toughest he ever had, but working with Alban Lynch, Head of Mining Engineering and Director of the Julius Kruttschnitt Mining Research Center for the five years at UQ was a joy, a challenge and a privilege.

In 2006 John Bishop, Andy and Steve Bartrop worked together to float Icon Resources Ltd (now Carbine Tungsten Ltd) and learn the trials, tribulations and occasional triumphs of directing a junior company. This was hands-on learning that Andy could feed occasional triumphs of directing a junior company.

A week after being appointed Exploration Manager for Comalco in 1980, Andy attended the Exploration Management course conducted by Professor Rex Davis of London University College at the Australian Mineral Foundation (AMF). At the end of the course the participants were asked to come up with proposals for other courses at the AMF. Andy suggested that rather than wait for a geologist to become an exploration manager, it would good to have an intermediate course for senior geologists who might one day be exploration managers. Dean Crowe, AMF director, asked Andy if he knew anyone who could run the course and Andy suggested Bill Lacy, Professor of Economic Geology at JCU, would be ideal. Bill was talked into it and ran three courses before illness and overwork led him to declare the AMF course was something he had to give up. Dean came to see Andy with this news and popped the question: would Andy do it? After getting over the initial surprise Andy agreed and, while in Cape York exploring for kaolin, wrote the first set of course notes. Liz, the ever loyal wife and partner in life, typed out the hand written notes in camp on her portable typewriter, and so it began.

The Management Course

A week after being appointed Exploration Manager for Comalco in 1980, Andy attended the Exploration Management course conducted by Professor Rex Davis of London University College at the Australian Mineral Foundation (AMF). At the end of the course the participants were asked to come up with proposals for other courses at the AMF. Andy suggested that rather than wait for a geologist to become an exploration manager, it would good to have an intermediate course for senior geologists who might one day be exploration managers. Dean Crowe, AMF director, asked Andy if he knew anyone who could run the course and Andy suggested Bill Lacy, Professor of Economic Geology at JCU, would be ideal. Bill was talked into it and ran three courses before illness and overwork led him to declare the AMF course was something he had to give up. Dean came to see Andy with this news and popped the question: would Andy do it? After getting over the initial surprise Andy agreed and, while in Cape York exploring for kaolin, wrote the first set of course notes. Liz, the ever loyal wife and partner in life, typed out the hand written notes in camp on her portable typewriter, and so it began.
People

New Students & Staff

Robbie Coleman

Robert is a Far North Queensland local, born in Cairns. He was awarded his BSc in Computer Science at James Cook University where he received the academic medal and Laing exploration mapping prize. After a short hiatus he returned to JCU to conduct honours research. His thesis was titled "Magnetite geochemistry and its implication on the genesis of magnetite in lminated rocks in the E1 Group deposits, Cloncurry District, Queensland, Australia." This research focused on the development of analytical methods for magnetite trace element analysis. This method was subsequently applied to magnetite from the E1 Group Deposits to better understand local magnetite genesis.

Robert joined EGRU as an M.Phil student in late February 2016. He is conducting research on the Tommy Creek Block (Mount Isa Inlier) with Carl Spandler. This project will aim to improve the understanding of the Tommy Creek Block’s Precambrian evolution through geophysical interpretation, field work, and geochronology. Multiple REE mineral occurrences in the block will also be investigated in order to better understand magnetite genesis.

Kelly Heilbron

Kelly completed undergraduate studies in 2015 at JCU with a Bachelor of Geology (Honours). For her honours year she worked for Kely Genetics as a technical analyst and generated a 3D model of the Gulf of Papua in Leafpfrog and used GPPlates to test out various opening scenarios of the Trough and the Pocklington Sea, an ancient ocean that once existed north of the Coral Sea. Kelly returned in February 2016 to undertake a MPhil under the supervision of Rob Holm, Eric Roberts and Carl Spandler. Kelly will investigate sedimentary and volcanic rocks from IODP core from the Queensland Plateau and Lord Howe Rise. Outcomes from the analysis of the IODP samples will assist in modelling the lithosphere dynamics offshore of eastern Australia. This research will contribute towards closing the gap in the understanding the evolution of the eastern Australian continent during the Jurassic and Cretaceous.

New Students & Staff

Hannah Hilbert-Wolf

Hannah Wolf recently finished her PhD at JCU, during which she studied the geodynamics of the East African Rift System in Tanzania via sedimentologic, geochronologic, and paleoseismic investigations under the supervision of Dr. Eric Roberts and Prof. Paul Dirks. Hannah is now a Postdoctoral Researcher at JCU studying the geologic context of the new hominin species recently discovered in South Africa, Homo naledi. In collaboration with a multidisciplinary team from around the world, which includes other researchers from JCU as well, she is helping to accurately date the assemblage containing Homo naledi and generally better understand formation and depositional processes in caves in the Cradle of Humankind in South Africa. Hannah will also be assisting with the sedimentology courses in the second semester of this year.

Jess Robbins

Jess began her geology studies at Victoria University in Wellington, and her honours research focused on the Wellington Fault. Following this, Jess went on to study paleomagnetism at the University of Otago in NZ. Her masters project involved analysis of paleomagnetic records in marine sediments from the Waiaoa Basin. Jess spent the subsequent seven years working as an exploration geologist, initially with epithermal gold deposits in remote parts of Suriname, and later copper in Zambia. She also worked for the National Oil Company in Suriname, where her role focused on seismic interpretation of plays in the offshore blocks.

Jess joined EGRU in February 2016 as a student of Eric Roberts and Paul Dirks. She is working on the paleoethems within the Rising Star cave system and conducting both paleomagnetic and stable isotope analyses. A primary objective is to obtain a record of paleoclimatic and vegetation that potentially spans the period of time represented by the hominin fossils discovered here. The record of magnetic excursions preserved in the speleothems will be matched against the Geomagnetic Instability Timescale (GITS), providing chronology that is complimentary to U/Th dating.

New Students & Staff

Jelle Wiersma

Jelle began his PhD studies at JCU in May 2016 under the supervision of A/Prof. Eric Roberts and Prof. Paul Dirks. His project involves the sedimentological history of the Rising Star Cave system in the Cradle of Humankind, South Africa, and includes the lithological characteristics and facies associations of speleothem chambers in the cave system, in addition to detrital zircon-based provenance studies, geochronologic and geochemical analyses. This extraordinary cave system has recently enjoyed a lot of scientific and media attention due to the 2013 discovery of the largest concentration of hominin fossils ever recorded in a single location in Africa, belonging to the new species Homo naledi.

Prior to moving to Australia, Jelle completed a MSc. in geology at the University of Utah, USA. For this project, he described two new armored (ankylosaurid) dinosaur taxa from the Late Cretaceous Kaiparowits Formation of southern Utah. Subsequently, he revised the evolutionary relationships for the clade Ankylosauridae by implementing both new taxa, and modeled the timing of Late Cretaceous biogeographic dispersal from Asia to western North America for ankylosaurid dinosaurs. Jelle has been taking part in dinosaur palaeontology excavations for nearly 14 years, including hotspot localities such as the Kaiparowits Formation of Utah, and historical localities in the USA, including Dinosaur National Monument, Utah, the Ghost Ranch quarries in New Mexico; Bridger Basin, and Bone Cabin Quarry, Wyoming, and the Mygatt Moore Quarry in Colorado. His research interests include, but are not limited to: sedimentology, stratigraphy, cave geology, geochemistry, hydrology, vertebrate palaeontology and taphonomy, palaeobiogeography, taxonomy, and cladistics.

Student Awards

Behnam Sadeghi

International Association for Mathematical Sciences: Travel Grant Award

Michael Calder

SEG Student Research Grant: Hugh McKinstrey Fund US$4,500

Ashish Mishra

1st Prize: College of Science, Technology and Engineering Seminar Day Poster
Postgraduate Student Research Projects

Helge Behnser (PhD)
Magma fertility related to Au-Cu mineralization in north Queensland, Australia - evaluating the potential for linked porphyry Cu±Au (±Mo) deposits at depths.
Supervisors: A/Prof. Carl Spandler, Prof. Paul Dirks

Michael Calder (PhD)
Zonation, paragenesis and fluid evolution from the root to top of the Far Southeast Lepanto porphyry epithermal system, Mankayan district, Philippines.
Supervisors: A/Prof. Zhaoshan Chang, A/Prof. Carl Spandler, Dr Jeffrey Hedenquist, Dr Antonio Arribas

George Case (PhD)
Ore genesis and alteration paragenesis of the E1 group and Monakoff IOCG deposits, Cloncurry region, north west Queensland.
Supervisors: Prof. Tom Blenkinsop, Prof. Paul Dirks, A/Prof. Zhaoshan Chang, Dr Jan Martin Huizenga

Robert Coleman (MPhil)
Geology and REE mineralisation of the Tommy Creek Block, Mount isa inlier.
Supervisors: A/Prof. Carl Spandler, A/Prof. Zhaoshan Chang

Vicky Darlington (PhD)
Lawn Hill impact structure
Supervisors: Prof. Paul Dirks, Dr David Holmes

Kelly Heilbron (PhD)
Establishing a tectonic framework for the eastern margin of Australia during the Jurassic.
Supervisors: Dr Rob Holm, A/Prof. Eric Roberts

Peter Illig (PhD)
Magma related hydrothermal gold and base metal deposits in the Chillagoe district, NE Queensland, Australia: relationships, transitions and controls.
Supervisors: A/Prof. Zhaoshan Chang, A/Prof Carl Spandler, Dr Jeffrey Hedenquist, Dr Antonio Arribas

Quaid Jadoon (PhD)
Kinematics of tectonic fracture development during regional folding in sandstones of the Kamlil formation, Khushalgarh northern Pakistan.
Supervisors: A/Prof. Eric Roberts, Prof. Paul Dirks, Dr Raphael Wust

Shimba Kwelwa (PhD)
Gold Mineralization in the Kukuluma Domain in Getia Greenstone Belt.
Supervisors: Prof. Paul Dirks, Prof. Tom Blenkinsop, Dr Yvonne Cook, Dr Ioan Sanislav

Xuan Truong Le (PhD)
Geological setting and mineralisation characteristics of the Pac lang Au-W deposits, Bac Kan Province, north eastern Vietnam.
Supervisors: A/Prof. Zhaoshan Chang, Dr Jan Martin Huizenga

Karian Liu (MPhil)
Geochronology and formation conditions of the Wolfram Camp W-Mo-Bi deposit, Queensland.
Supervisors: A/Prof. Zhaoshan Chang, Dr Yanbo Cheng

Asish Mishra (PhD)
Rates of Erosion and Weathering in the Tropics.
Supervisor: Dr Christo Placeczek, Prof. Michael Bird

Stephanie Mrozek (PhD)
Uplift History, Intrusive Sequence, and Skarn Mineralisation at the Giant Antamina Deposit, Peru.
Supervisors: A/Prof. Zhaoshan Chang, A/Prof Carl Spandler, Prof. Lawrence Meinert

Jesse Robbins (PhD)
Understanding the genesis and patterns of cave fill across the Cradle of Humankind, South Africa
Supervisors: A/Prof. Eric Roberts, Prof. Paul Dirks, Dr Jan Martin Huizenga

Behnam Sadeghi (PhD)
Delineation of mineral exploration targets through integration of informative layers, with multi-fractal modelling and multivariate data analysis in 3D block models.
Supervisors: Dr Arianne Ford, Dr Jan Martin Huizenga, Dr John Carranza

Teimoor Nazari Dehkordi (PhD)
Rare earths unearthed: Resolving the mystery of how rare earth elements are mobilized and concentrated in continental crust.
Supervisors: A/Prof. Carl Spandler, Prof. Paul Dirks

Michael Nugus (PhD)
Mechanisms of mineralization in Amphibolite Facies, RIF-hosted gold deposits, using the example of the Golden Pig deposit, SGGB.
Supervisors: Prof. Tom Blenkinsop, Prof. Paul Dirks

Prince Owusu Agymang (PhD)
Mesozoic detrital zircon provenance of Central Africa: implications for Jurassic-Cretaceous tectonics, paleogeography and landscape evolution.
Supervisors: A/Prof. Eric Roberts, A/Prof. Carl Spandler, Dr Rob Holm

Alexander Parker (MPhil)
Fluids in the lower crust: storage and mobilization
Supervisors: Dr Jan Martin Huizenga, Dr Ioan Sanislav

Jaime Poblete Alvarado (PhD)
Geological Characteristics and Origin of the Watershed W Deposit, North Queensland, Australia.
Supervisors: A/Prof. Zhaoshan Chang, Prof. Paul Dirks, Dr Jan Martin Huizenga

Fredrik Sahlström (PhD)
Mt Carlton high-sulphidation epithermal deposit, Queensland Australia: Geological character, genesis and implications for exploration.
Supervisors: A/Prof. Zhaoshan Chang, Prof. Paul Dirks

Paul Sleek (PhD)
Understanding the hydrothermal mobility of rare earth elements in the continental crust.
Supervisors: A/Prof. Carl Spandler

Mark Stokes (MPhil)
Structural characteristics and evolution of Mt Carlton high-sulphidation epithermal deposit, and the implications for exploration.
Supervisors: Prof. Paul Dirks, A/Prof. Zhaoshan Chang

Erin Stormont (MPhil)
Hydrothermal Breccia Zones in the Proterozoic Cloncurry District (Mt Isa Inlier, Australia): Implications for Fe-Oxide-Cu-Au Mineralisation.
Supervisor: Dr Jan Marten Huizenga

Christopher Todd (PhD)
Sedimentary History of the Porcupine Gorge National Park and Application of U Pb Detrital Zircon Geochronology for Correlation of Cretaceous and Jurassic Strata in Northern Queensland.
Supervisor: A/Prof. Eric Roberts, A/Prof. Carl Spandler

Jella Wiersma (PhD)
Cave sedimentation processes, geochronology, and the distribution of hominins at Rising Star Cave, Cradle of Humankind, South Africa
Supervisors: A/Prof. Eric Roberts, Prof. Paul Dirks

Matthew Van Ryt (PhD)
Geochemical characterisation of gold mineralisation in Geita Hill (Geita Greenstone Belt, Tanzania).
Supervisors: Dr Ioan Sanislav, Dr Jan Martin Huizenga
EGRU facilities/equipment

- ICP-MS: 2 quadrupole ICP-MS units.
- LA (Laser Ablation): GeoLas 200 Excimer Laser Ablation System (193nm)
- MC-ICP-MS (Multi-collector Inductively Coupled Plasma-Mass Spectrometer)
- Clean Lab: class 350 clean lab
- Microprobe: Jeol JXA8200 “Superprobe” – SWDS, EDS, BSE, SE, CL
- SEM: with cathodoluminescence imaging capacity: Jeol JSM5400LV
- XRD: Siemens D5000 Diffractometer (XRD)
- ICP-AES: Varian Liberty Series II
- SWIR spectral instrument PIMA-SP
- SWIR spectral instrument spectTERRA
- Fluid inclusion stage: Linkam MD500 freezing/heating stage
- Melt inclusion / fluid inclusion stage: Linkam TS550 heating stage
- Lapidary/Mineral Separation Laboratory Equipment available includes - RockLabs crusher and splitter, Terner and Disc mills, Franz magnetic separator, Wilfley table, and dental drill for micro-sampling. Magnetometer: GeoMetrics G-650/G6EA
- 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 C & O isotope analysis
- 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 Membership 2015

Level 1
Evolution Mining
Mount Isa Mines (Formerly Glencore Xstrata)
South 32, Cannington (BHP Billiton)

Level 2
MMG
Newmont Asia Pacific

Level 3
Anglo American
Carpentaria Gold Pty Ltd
Chinova Resources
FMN Investments Pty Ltd (Eloise Copper Mine)
Map to Mine Pty Ltd
Minerals Resources Authority PNG Terra Search Pty Ltd

Level 4
CSA Global
Gnomic Exploration Services
Teck Australia Pty Ltd

Level 5
15 Individual members

Staffing Update

Arrivals
Ioan Sanislaw - lecturer

Awards
Eric Roberts: JCU Award for Research Excellence
Christa Placzek: winner JCU My Research in 3 Minutes
Isaac Corral: High Distinction Doctoral Degree – Autonomous University of Barcelona, Spain

EGRU Short Courses/Workshops:

Conferees/Meetings attended by staff and students

PacRim, Hong Kong
Zhaoshan Chang
Carlo Spandler
Bob Hofm
Stephanie Mrozick
Fredrik Sahlstrom

ICG: The Concurrancy Experience Zhaoshan Chang
Isaac Corral
Michael Calder
George Case
Michael Fuss

Emma Beattie
Robbie Coleman
Ross Christie
Mark Ayres

SEG Conference Hobart, Tasmania
Zhaoshan Chang
Paul Dirks

Yanbo Cheng
Isaac Corral
Fredrik Sahlstrom
Jaime Pohlete
Michael Calder
George Case

Queensland Exploration Council - New Initiatives in Exploration Zhaoshan Chang, Paul Dirks
University of Wollongong Guest Speaker Christa Placzek
State-of-the-arc, Australian National University/Bristol University Carl Spandler

Industry & Academic Liaison

Chinese University of Geosciences: three person delegation - Introduction to JCU and EGRU

Visiting Speakers

Prof. Neil Williams: SEG Thayer Lindsay Lecture Tour
John Walsh: Chief Geoscientist CSIRO Perth
Doug Kärnén: special guest SEG Student Chapter
Prof. Suzanne Miller: CEO Qd Museums
Andy Tomkins: AusIMM Julius Kruttuntsch Technical Session

Conferences/Meetings:

Intrusion Related Mineral Systems and Deposits and Skarns: Anglo American: Zhaoshan Chang
Deposits and Skarns: Geoscience Australia: Zhaoshan Chang
Advanced Techniques in Mining and Exploration Geology: John Carranza, Zhaoshan Chang, John McLellan, Arianne Ford, George Case

Visiting Scholars

Antonio Arrihas
Guoxiong Zhong: PhD candidate, School of Resources and Environmental Engineering, Hefei University of Technology (HFUT)
Haicheng Wang: PhD candidate of Mineral Resource Prospecting and Exploration, China University of Geosciences
Sida Niu: China University of Geosciences
Youqiang Qi: Chinese Academy of Geological Sciences
Hongrui Zhang: Chinese Academy of Geological Sciences
Pablo Ferreyra: IAEA supported short term training
Youqiang Qi: Institute of Geochemistry, Guiyang, China Academy of Science

Alumni

EGRU Short Courses/Workshops:

Skarn short course – Anglo American: Zhaoshan Chang

Gnomic Exploration Services
CSA Global
Level 4
Terra Search Pty Ltd
Minerals Resources Authority PNG Map to Mine Pty Ltd
FMR Investments Pty Ltd (Eloise Copper Mine)

Level 3
Anglo American
Carpentaria Gold Pty Ltd
Chinova Resources
FMN Investments Pty Ltd (Eloise Copper Mine)
Map to Mine Pty Ltd
Minerals Resources Authority PNG Terra Search Pty Ltd

Level 2
MMG
Newmont Asia Pacific

Level 1
Anglo American
Carpentaria Gold Pty Ltd
Chinova Resources
FMN Investments Pty Ltd (Eloise Copper Mine)
Map to Mine Pty Ltd
Minerals Resources Authority PNG Terra Search Pty Ltd

2015 EGRU Annual Report
Short Courses/Workshops by external organisations held at JCU

Leapfrog training for post graduate students

Core logging using Hyilogger data

Research Grants

Continuing Grants

Grantee: Paul Dirks, Tom Blenkinsop, Ioan Sanidad
Source: AngloGold Ashanti Geita Gold Mine Ltd, Contract Research
Title: Geological Services Geita Gold Mine
Commencing year: 2011
Completing Year: 2016
Amount: $1,818,729.00

Grantee: Carl Spandler
Source: Australian Research Council: Discovery - Future Fellowships
Title: Rare earths unearthed: resolving the mystery of how rare earth elements are mobilised and concentrated in continental crust
Commencing year: 2012
Completing Year: 2016
Amount: $711,098.00

Grantee: Eric Roberts
Source: Heritage Ol Rukwa (TZ) Ltd
Title: Discovery - Future Fellowships
Commencing Year: 2015
Amount: $220,847.00

Postgraduate and Honours Courses

MGMT Postgraduate Courses
EA5027 Advanced Field Training: Tom Blenkinsop
EA5028 Advanced Techniques in Mining and Exploration Geology
Johannes Hammerli:
Tom Blenkinsop
Stephanie Mrozek:
EA5027 Advanced Field Training
EA5028 Advanced Techniques in Mining and Exploration Geology
Johannes Hammerli:
Tom Blenkinsop
Stephanie Mrozek:

Student Awards

PhD Candidates
Michael Calder: SEG - Student Research Grant
Newmont Mining Corp Fund
Stefanie Morzsek: SEG Student Research Grant
Hugo Dummett Mineral Discovery Fund
Fredrik Sahlstrom: SEG Student Research Grant
McKinstry Fund
Johannes Hammerli: JCU Dean's Award for research higher Degree Excellence
Honours Candidates
Roa Christie: EGRU Honours Scholarship
Emma Beattie: GSA AU Medal
Cheng Pang: Davis-AIG Geoscience Honours Bursary
Natalie Melver: AIG Geoscience Honours Bursary

Student Field Trips
SEG Student Chapter - North Island New Zealand

New PhD Students
Benham Sadeghi
Ashish Mishra
Jaime Poblete Alvarado
Paul Sleat
Christopher Todd

PhD Completions
Julie Graham Ruzicka
Clement Fay

Honours Completions
Todd Kane
Emma Beattie
Rosa Christie
Robert Coleman
Michael Doube

Professional Development Training, Honours & Masters Courses

MTEC Honours & Minerals Geoscience Masters Courses - Student Enrolments
EA3502 Discovery Geology
EA3503 Exploration Targets
EA3504 Integrated Spatial Analysis & Remote Sensing of Geology
EA3505 Ore Textures & Breccias in Mineralised Systems
EA3506 IOCG Deposits: The Cloncurry Experience

Undergraduate Courses

Student Enrolments
EA1110 Evolution of the Earth
EA2006 Hydrology
EA2007 Applied Soil Science
EA2010 Introductory Geology
EA2110 Introduction to Sedimentology
EA2220 Minerals & Magmas
EA2300 Introductory Structural & Metamorphic Geology
EA2404 From Icehouse to Greenhouse

2015 2014
221 275
67 79
30 35
3 1
48 49
70 64
61 60
21 35
203 278
52 55
53 51
14 15
25 33

Student Enrolments
EA3008 Advanced Hydrology
EA3100 Igneous Petrology and Processes
EA3200 Advanced Structural & Metamorphic Geology
EA3400 Ore Genesis
EA3502 Advanced Geographic Information Systems
EV3506 Remote Sensing
EA3510 Geological Mapping
EA3511 Field Techniques in Geology
EA3640 Advanced Environmental & Marine Geoscience Technologies & Applications
EA3650 Sedimentary Environments & Energy Resources
EA3800 Earth & Environmental Geochemistry
EA5016 Hydrology
EA5017 Applied Soil Science

2015 2014
23 37
40 56
37 49
41 39
42 43
7 29
34 47
32 49
21 28
41 46
47 67
5 10
1 7

New Grants
Grantee: Zhaoshan Chang, Paul Dirks, Carl Spandler, John Carranza, Jian Huizenga, Bob Henderson
Source: Qld Dept of Natural Resources and Mines, Future Resources Program
Title: Characteristics and assessing prospectivity of intrusion-related hydrothermal mineral systems in north-east Queensland
Commencing year: 2014
Completing Year: 2017
Amount: $1,779,736.00

Grantee: Paul Dirks, Eric Roberts, Carl Spandler, Tom Blenkinsop
Source: Australian Research Council – Discovery Grants Project
Title: Life and death of Australopithecus sediba: how a potential ancestor ended up dead in a cave in world heritage site in South Africa
Commencing year: 2014
Completing Year: 2017
Amount: $256,000.00

Grantee: Ian Martin Huizenga, Paul Dirks
Source: Stichting Dr Schuurmannfonds - Research Grant
Title: Hydrothermal breccia zones in the Proterozoic Cloncurry District (Mt Isa Inlier, Australia): implications for Fe-oxide-Au-Cu mineralisation
Commencing year: 2014
Completing Year: 2015
Amount: $13,321.00

Grantee: Zhaoshan Chang, Paul Dirks, Christa Placzek
Source: Evolution Mining Contract Research
Title: Geological Characteristics and Genesis of Mt Carlton High-Sulphidation Epithermal Deposit, and the Implications for Exploration
Commencing year: 2014
Completing Year: 2017
Amount: $150,000.00

Grantee: James Daniell
Source: Australian Research Council - Linkage - Infrastructure (LIEF)
Title: Membership of the IODP
Commencing year: 2015
Completing Year: 2015
Amount: $3,600,000.00

New Grants
Grantee: Eric Roberts, Carl Spandler, Robert Holm
Source: Australia-New Zealand Quaternary Dating Methods - Cairns: Christa Placzek

Student Enrolments
EA1110 Evolution of the Earth
EA2006 Hydrology
EA2007 Applied Soil Science
EA2010 Introductory Geology
EA2110 Introduction to Sedimentology
EA2220 Minerals & Magmas
EA2300 Introductory Structural & Metamorphic Geology
EA2404 From Icehouse to Greenhouse

2015 2014
221 275
67 79
30 35
3 1
48 49
70 64
61 60
21 35
203 278
52 55
53 51
14 15
25 33

Student Enrolments
EA3008 Advanced Hydrology
EA3100 Igneous Petrology and Processes
EA3200 Advanced Structural & Metamorphic Geology
EA3400 Ore Genesis
EA3502 Advanced Geographic Information Systems
EV3506 Remote Sensing
EA3510 Geological Mapping
EA3511 Field Techniques in Geology
EA3640 Advanced Environmental & Marine Geoscience Technologies & Applications
EA3650 Sedimentary Environments & Energy Resources
EA3800 Earth & Environmental Geochemistry
EA5016 Hydrology
EA5017 Applied Soil Science

2015 2014
23 37
40 56
37 49
41 39
42 43
7 29
34 47
32 49
21 28
41 46
47 67
5 10
1 7

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**Undergraduate Courses (cont’d)**

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<th>Course Code</th>
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<td>EA5046</td>
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<td>Advanced Structural &amp; Metamorphic Geology</td>
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<td>EA5041</td>
<td>Field Studies in Tropical Water &amp; Soil Science</td>
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<td>EA5018</td>
<td>Introductory Structural &amp; Metamorphic Geology</td>
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**Closing Balance December 2015**

$332,247.86


Case


Chang


Diers


Ford


Henderson


Hibbert-Wolf


Holm


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robert.holm@jcu.edu.au

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(Further details page 25)

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