

MASTER OF ECONOMIC GEOLOGY SHORT COURSE
via online delivery

Ore Deposit Geochemistry, Hydrology and Geochronology

Week 1: May 31—June 5, 2021

Week 2: July 5—9, 2021

(Online content will be delivered via Zoom between 9am and 6pm AEST (UTC+10))



CODES, Centre for Ore Deposit and Earth Sciences, University of Tasmania

CRICOS Provider Code 00586B

CODES' Master of Economic Geology short course on Ore Deposit Geochemistry, Hydrology and Geochronology, is presented by a range of CODES and invited experts. It provides an up-to-date review of the theory and practice of geochemistry, hydrology and geochronology as applied to studies of mineral exploration and ore deposit genesis. The first week covers basic principles of ore fluid chemistry, the use of magmatic minerals and whole rock geochemistry in exploration, geochronology, granite metallogeny, advanced geochemical exploration techniques and the uses of pyrite in mineral exploration (using samples provided by short course participants). The second week covers fluid-rock interaction and the physical hydrology of fracture-controlled hydrothermal systems, mass balance calculations from lithogeochemical data, stable isotope and fluid inclusions applications for exploration, and alteration mineral chemistry vectoring in porphyry and epithermal environments.

SHORT COURSE PRESENTERS

INVITED SPEAKERS

Shaun Barker is the Director of MDRU, at UBC. Shaun has a background of geochemistry, mineralogy and structural geology. His research focusses on the application of geochemical and isotopic tools to understand the flow of hydrothermal fluids through the Earth's crust, with a particular focus on hydrothermal ore deposits.

Phil Blevin is Leader of Mineral Systems at the Geological Survey of NSW. He has extensive expertise in the relationships between igneous geochemistry and metallogenesis in eastern Australia.

Fahrad Bouzari is a Research Associate at MDRU, University of British Columbia, with research interests and experience on porphyry copper deposits and mineralogical and geochemical techniques in exploration targeting. Farhad has expertise in establishing the anatomy and evolution of the porphyry deposits, particularly their distal and deep features, and has led MDRU's investigations to develop new exploration techniques using Porphyry Indicator Minerals (PIMS).

Stephen Cox is an Emeritus Professor at the Research School of Earth Sciences (ANU). His ongoing research addresses the coupling between seismic slip processes, fault strength, permeability enhancement and genesis of hydrothermal ore deposits in deforming rocks. In addition to his research he provides structural geology training to the minerals industry.

Rob Creaser is Professor at the University of Alberta as a Canada Research Chair in Isotope Geochemistry. He has over 30 years experience in the development and application of Re-Os geochronology, applied to topics including crustal fluid flow and ore deposit genesis using sulfide minerals. He is a Fellow of the Society of Economic Geologists, a Distinguished Member and Hutchison Medallist of the Geological Association of Canada, and a Fellow of the Royal Society of Canada.

Sarah Dare is an Assistant Professor and holder of Canada Research Chair in Geochemistry Applied to Ore Deposits at the University of Québec in Chicoutimi. Her research interests include geochemistry, igneous petrology, economic geology, mineral chemistry, and laser ablation ICP-MS.

Scott Halley is an independent consultant specializing in exploration geochemistry, and the application of multi-element ICP geochemistry and SWIR analysis to mapping alteration mineral zonation patterns around hydrothermal systems. Over the past 10 years, he has consulted to more than 130 mining and exploration companies in more than 25 countries.

Christian Ihlenfeld is Principal Geoscientist (Basin-hosted Mineral Systems) at Anglo American. He has more than 15 years of international experience in the mining industry and related research. Since joining Anglo American in 2007 Christian has worked on numerous porphyry Cu, magmatic Ni-Cu-PGE sulphide and sediment-hosted Cu exploration projects around the globe, including 6 years as Principal Geochemist. Besides a general passion for exploration one of Christian's main drivers throughout his career has been to develop new and emerging geochemical/mineralogical techniques into robust exploration tools.

Fred Jourdan is a geochronologist and geochemist at Curtin University and is the director of the Western Australia Argon Isotope Facility, part of the John de Laeter Centre for Mass Spectrometry. His research focuses on the application and development of the $^{40}\text{Ar}/^{39}\text{Ar}$ chronometer to establish temporal constraints on large igneous provinces, volcanic activity, and impact craters on Earth and throughout the solar system. His expertise in applying the $^{40}\text{Ar}/^{39}\text{Ar}$ dating technique to a range of geological problems is demonstrated by numerous collaborations in archaeology, tectonics, volcanology and planetary sciences.

Robert Lee is a Research Associate at MDRU, University of British Columbia, who specialises in porphyry copper deposits, their genesis and techniques to explore for them. He is actively researching mineral chemical compositions related to economic ore deposits and how this can be related to fertility and exploration, with a focus on, but not limited to, zircon.

Christopher Leslie is an economic geologist specialized in district- to project-scale targeting in porphyry to epithermal environments. He is currently consulting for multiple exploration companies focused on gold and copper exploration in Canada, United States and

Australia. He is also finishing his PhD at CODES, UTAS focused on the metallogeny of the Cowal District, New South Wales.

Matt Loader is a Postdoctoral Researcher at the Natural History Museum in London. His work focusses on the chemistry and petrogenesis of igneous rocks and minerals, especially in porphyry Cu deposits. He is currently a collaborator on the BHP-funded High Grade Hypogene Porphyry project; using accessory mineral chemistry to develop effective tools to discriminate high grade ore domains.

Bob Loucks joined the Centre for Exploration Targeting, University of Western Australia in 2009, continuing research into developing new methods of geochemical exploration for magmatic-hydrothermal Cu and Au ore deposits, including development of zircon-trace-element indicators of magmatic Cu and Au metallogenic fertility. Bob is also a consultant to major mining companies worldwide.

Yongjun Lu is Senior Geochronologist and Isotope Geologist at the Geological Survey of Western Australia. He was awarded the Society of Economic Geologists 2018 Waldemar Lindgren Award for his work on isotopic mapping and zircon fertility.

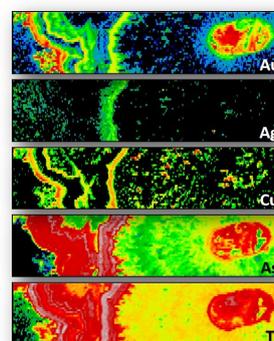
Nick Oliver is Principal and Consultant HCOV Global. He specializes in combining structural and geochemical approaches to understanding ore deposits and their associated hydrothermal systems. Nick was previously director of EGRU and Professor of Economic Geology at JCU.

Dave Rhys is a Consulting Structural Geologist and Principal of Panterra Geoservices. While having worked on ore deposits of a variety of commodities, he has extensive experience in gold deposits, having worked globally in numerous gold districts for both major and junior companies providing technical support in the optimization of mining and exploration projects.

Lesley Wyborn is an Honorary Professor the Research School of Earth Sciences and the National Computational Infrastructure Facility at ANU. She is a specialist in Proterozoic granite geochemistry and in detecting regional footprints of granite-related mineral systems using online information systems and processing, including HPC.

CODES PRESENTERS

Mike Baker, David Cooke, Matthew Cracknell, Leonid Danyushevsky, Sebastien Meffre, Robert Scott, Jeff Steadman, Lejun Zhang



Ore Deposit Geochemistry, Hydrology and Geochronology
is offered as a unit in the national Minerals Geoscience Masters program.

MASTER OF ECONOMIC GEOLOGY

THE MOST COMPREHENSIVE MASTER DEGREE IN MINERAL EXPLORATION AND MINING GEOLOGY ANYWHERE IN THE WORLD

This course work-based Masters program is aimed at geoscientists who want to gain a thorough up-date on advances across the spectrum of economic geology applied to mineral exploration. The Master of Economic Geology at UTAS is part of the national Minerals Geoscience Masters program, jointly offered by the University of Tasmania and the University of Western Australia, in conjunction with Curtin Business School at Curtin University.

Course structure

The Masters course can be completed in either of two ways:

Option 1: requires the completion of six coursework units and a minor research thesis. Four of the units must be completed at CODES, while the remainder may be completed at other participating universities. Duration: 18–24 months full-time; up to 30 months part-time (flexible in recognition of industry participants).

Option 2: requires the completion of eight units of coursework, at least four of which must be undertaken at CODES. Duration: up to 30 months part-time (flexible in recognition of industry participants).

Participating universities offer up to six units annually or in rotation over a two-year period. Most units are of two weeks duration.

Fees

UTAS tuition fees are approximately \$1,987 per unit (8 in total) for domestic students (2021 rate for Commonwealth Supported Places) and \$8,636 (AUD) per unit for full-fee paying overseas students (FFPOS) (2021 rate). Field-based courses have additional costs. Costs will vary for units taught by other MGM partner institutions.

Entry Requirements

BSc (Hons), or a BSc (majoring in geoscience) with at least two years industry experience. International students should also refer to <http://www.international.utas.edu.au>. English language proficiency requirements also apply.

Masters units offered by CODES

- February–April 2021 (22–27 March- intensive Module 2):
KEA713 Geodata Analytics
- 31 May–5 June & 5–9 July 2021:
KEA709 Ore Deposit Geochemistry, Hydrology and Geochronology
- 30 August – 10 September 2021:
KEA716 Fundamentals of Economic Geology
- 18–29 October 2021:
KEA711 Geometallurgy
- 26 November – 8 December 2021:
KEA707 Ores in Magmatic Arcs (NSW & Qld)
- February 2022:
KEA718 Advanced Field Skills in Economic Geology
- March 2022:
KEA708 Volcanology and Mineralisation in Volcanic Terrains (New Zealand, western Tasmania)
- June 2022:
KEA712 Ore Deposit Models and Exploration Strategies
- October 2022:
KEA710 Exploration in Brownfield Terrains
- September–November 2022:
KEA713 Geodata Analytics

We want your pyrite!

Masters students and fee-paying participants for Day 6 (Application of pyrite trace element chemistry to studies of ore deposit genesis and mineral exploration) are invited to provide a small pyritic rock sample for study during the short course. The trace element composition of pyrite in the sample will be mapped by LA-ICPMS in CODES' analytical facility prior to the short course. During the short course, participants will analyse the data from their sample, and make predictions about deposit type, proximity and fluid chemistry based on the observed patterns of trace element enrichment.

Pyritic samples from any deposit type will do, but general guidelines are:

- Pyrite formed below ~350°C is generally most informative. Pyrite from deposits with protracted mineralization histories is ideal.
- Pyrite from deposits formed at temperatures >400 degrees C (e.g. porphyry Cu deposits) or from highly metamorphosed deposits generally contains fewer trace elements and is less suitable for this exercise. If used, choose fresh samples from shallower areas or the fringes of porphyry deposits.
- Diagenetic pyrite can also be enriched in a variety of trace elements. Although in most cases these will not be ore-related, diagenetic pyrite

can preserve complex growth histories and may be suitable for this exercise.

- Ideally, samples should be between 50 and 500 g, and contain pyrite grains 0.05–2 mm in size. Please avoid samples containing very coarse grained or abundant arsenopyrite (or other arsenic-rich minerals).

Samples should be delivered CODES as soon as possible, and no later than 4 weeks before to the start of the short course.

Send pyrite samples to:

Dr Robert Scott
CODES, University of Tasmania
Clark Rd, Sandy Bay, Tasmania, Australia 7005

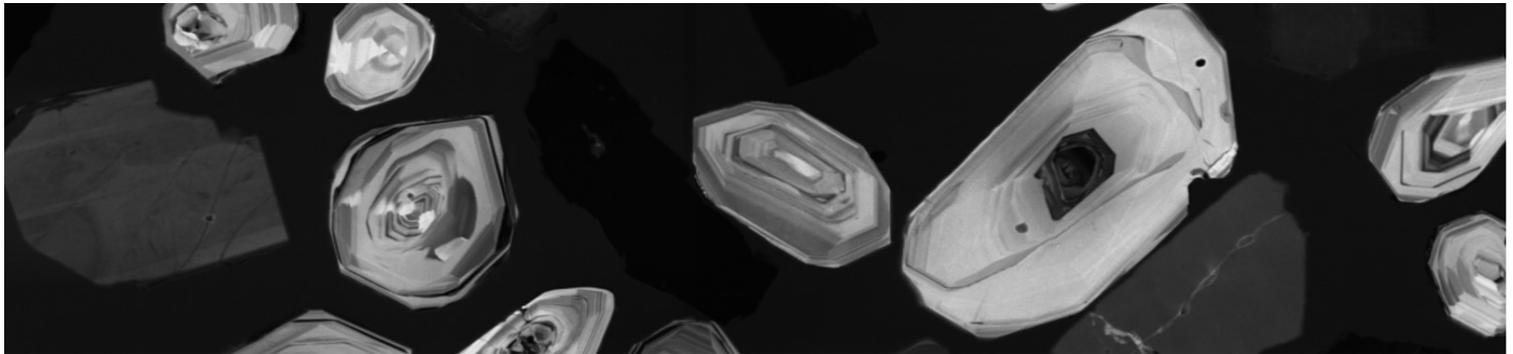
For further coursework Masters information contact:

Dr Robert Scott
Masters Coordinator, CODES
Private Bag 79, Hobart 7001, Australia
Tel: +61 3 6226 2786
Email: CODES.info@utas.edu.au
Robert.Scott@utas.edu.au
Website: <http://www.utas.edu.au/codes/masters-short-courses>

PROVISIONAL PROGRAM

WEEK 1: May 31—June 5

Monday May 31	Transport and deposition of metals from hydrothermal fluids—implications for ore formation and exploration PANEL DISCUSSION: How understanding metal transport can influence exploration models	PRESENTERS: David Cooke PANELISTS: David Cooke, Scott Halley, TBA
Tuesday June 1	SYMPOSIUM: Magmatic indicator minerals—exploration and research applications for magmatic and hydrothermal ore deposits PANEL DISCUSSION 1: Indicator minerals for magmatic and hydrothermal ore deposits: zircon, apatite and magnetite PANEL DISCUSSION 2: Porphyry indicator minerals: zircon, monazite and titanite	PRESENTERS: Mike Baker, Farhad Bouzari, Sarah Dare, Christian Ihlenfeld, Robert Lee, Christopher Leslie, Matt Loader, Yongjun Lu, Sebastien Meffre PANELISTS (AM): Farhad Bouzari, Sarah Dare, Robert Lee, Christopher Leslie PANELISTS (PM): Christian Ihlenfeld, Yongjun Lu, Matt Loader
Wednesday June 2	Radiometric dating and igneous geochemistry for exploration	PRESENTERS: Mike Baker, Rob Creaser, Fred Jourdan, Bob Loucks, Sebastien Meffre
Thursday June 3	Granites and granite metallogeny	PRESENTERS: Phil Blevin, Lesley Wyborn
Friday June 4	Enhanced geochemical exploration	PRESENTER: Scott Halley
Saturday June 5	Application of pyrite trace element chemistry to studies of ore deposit genesis and mineral exploration	PRESENTERS: Robert Scott, Leonid Danyushevsky, Jeff Steadman



WEEK 2: July 5—9

Monday July 5	Fluid-rock interaction and the physical hydrology of fracture-controlled hydrothermal systems	PRESENTERS: Nick Oliver, Stephen Cox
Tuesday July 6	AM: Structural controls on precious metal deposit types in different tectonic settings: comparative case studies PANEL DISCUSSION: Structural controls on fluid flow in hydrothermal systems PM: Mass balance calculations from whole rock geochemical data	PRESENTER (AM): Dave Rhys PANELISTS (AM): Stephen Cox, Nick Oliver, Dave Rhys PRESENTER (PM): Robert Scott
Wednesday July 7	Stable isotopes and fluid inclusions—applications for mineral exploration and ore genesis	PRESENTERS: Shaun Barker, David Cooke
Thursday July 8	Mineral chemistry vectoring in porphyry and epithermal environments	PRESENTERS: David Cooke, Matthew Cracknell, Lejun Zhang
Friday July 9	Minerals Geoscience Masters (MGM) Student presentations and wrap-up	PRESENTERS: Students

REGISTRATION FORM

Ore Deposit Geochemistry, Hydrology and Geochronology

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Week 2: 5–9 July, 2021

Please complete and return to:

CODES

University of Tasmania, Private Bag 79

Hobart, Tasmania, Australia 7001

Ph: +61 3 6226 2472

Email: CODES.Info@utas.edu.au

PERSONAL DETAILS

Title—Please highlight (Prof / Dr / Mr / Mrs / Ms / Miss)

First Name: Last Name: (surname / family name):

Preferred Name:

Position:

Company / University / Affiliation:.....

Address:

City: State: Postcode: Country:

Email: Phone (mobile / cell):

Dial-in Location (ie City):Dial-in Timezone (e.g. UTC +10):

REGISTRATION FEES

All fees are in Australian dollars (AUD) and include GST.

Please indicate

Minerals Geoscience Masters Program (MGM) Students:

(Excludes UTAS tuition fee)

- Full course (free) - University of Tasmania enrolled
- Full course (free) - University of Western Australia enrolled

Industry Participants:

- Full course (\$3,300)
- __ days at \$550/day (maximum charge 6 days)
- Magmatic Indicator Minerals Symposium only (\$550)

CODES Staff/Students:

- Short course classes (free, indicate days below)

Other Full-time Students:

- Full course (\$550)
- Magmatic Indicator Minerals Symposium only (\$90)

PLEASE NOTE: Participants *NOT* attending entire course, please circle selected days

Week 1: 31 1 2 3 4 5 May-June

Week 2: 5 6 7 8 9 July

PAYMENT

Registrations are due by 21st of May, 2021. Full payment must be received by 27th of May, 2021.

Preferred payment method. Please indicate

- Credit Card

Upon receipt of your registration form you will be provided with a payment reference number and web address for online payments. Please note: Credit card details cannot be accepted by email.

- Cheque or Bank Draft

Please make cheques and bank drafts payable to "The University of Tasmania". Bank drafts must be made out in Australian currency (AUD).

- Invoice

Name, address and email address for person responsible for payment of invoice:

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Please retain a copy of this form for your records and email to CODES.Info@utas.edu.au.