

# Integrated Spatial Analysis and Remote Sensing of Exploration Targets

18<sup>th</sup> - 29<sup>th</sup> April 2016

Presented by  
Economic Geology Research Centre



Location  
James Cook University  
Townsville QLD

Course Co-ordinator  
A/Prof. Zhaoshan Chang

Course Leaders  
A/Prof. Zhaoshan Chang (JCU), Dr Arianne Ford (JCU), Dr Carsten Laukamp (CSIRO)

## Course Fees\*

	Module 1	Module 2	Both Modules
EGRU member	\$1600.00	\$2400.00	\$4000.00
AIG member	\$1800.00	\$2700.00	\$4500.00
Non-EGRU member	\$2000.00	\$3000.00	\$5000.00

*GST inclusive and Au\$*

Registration – register at <https://alumni.jcu.edu.au/EGRU>

## Subject Description

This course has two modules:

Date	Topic	Presenter
<b>Module 1: Spectral Remote Sensing for Mineral Exploration</b>		
Mon 18 April	Spectral remote sensing & image enhancement	Carsten Laukamp
Tue 19 April	Remote sensing image integration techniques	Carsten Laukamp
Wed 20 April	SWIR (Short Wave Infra-Red) spectral analysis – 1	Zhaoshan Chang
Thu 21 April	SWIR (Short Wave Infra-Red) spectral analysis – 2	Zhaoshan Chang
<b>Module 2: Exploration Geochemistry and GIS-based prospectivity analysis</b>		
Fri 22 April	Geochemistry in mineral exploration	Arianne Ford
Sat 23 April	Statistical analysis of geochemical anomalies	Arianne Ford
Sun 24 April	Basics of mineral prospectivity modelling	Arianne Ford
Mon 25 April	ANZAC Day – no teaching	
Tue 26 April	Weights-of-evidence modelling of mineral prospectivity	Arianne Ford
Wed 27 April	Alternative methods of modelling mineral prospectivity	Arianne Ford
Thu 28 April	Mineral prospectivity practical assessment	Arianne Ford
Fri 29 April	Review and Exam – optional for industry	

Enquiries:

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## Course Content

### ***Module 1 Spectral Remote Sensing for Mineral Exploration***

The first part of this module aims for the participants to be able to take measurements using SWIR instruments including specTERRA and PIMA, interpret the spectra, and use the results in exploration. The second part of this module will cover applications of spaceborne multispectral and airborne radiometric images for recognition of indications of mineralised land.

#### **1.1 Spectral remote sensing with spaceborne/airborne images**

- The electromagnetic spectrum and remote sensing targets
- Hyper- and multispectral remote sensing technologies
- Radiometric sensors
- Methods of processing spectral and radiometric images
- Ground validation of remote sensing data and comparison with other geoscience data
- Regolith characterization
- Mapping mine-scale to regional mineral footprints

#### **1.2 SWIR (short wavelength Infra-Red) spectral techniques and applications**

- Basic principles of the SWIR spectral techniques
- Taking measurements using a specTERRA or a PIMA instrument
- Interpret SWIR spectra manually
- Interpret SWIR spectra with the assistance of a software, TSG (The Spectral Geologist)
- Major spectral features of common minerals detectable by the technique
- Extract numerical features from SWIR spectra using TSG
- Applications of the SWIR spectral techniques in mineral exploration

### ***Module 2 Exploration Geochemistry and GIS-based prospectivity analysis***

The first part of this module will cover principles of mineral exploration geochemistry as well as applications of statistical analyses to mapping of geochemical anomalies. The second part of this module will cover various methods for analysis and integration of various layers of spatial geo-exploration datasets for predictive mapping of mineral prospectivity.

#### **2.1 Geochemistry in Mineral Exploration**

- Conceptual models of geochemical anomalies in the rock and weathering environment: geochemical dispersion
- Recognition of primary and secondary geochemical dispersion patterns
- Geochemical sampling and field methods for mineral exploration
- Element mobility, pathfinder elements, lithologic indicator elements
- Understanding analytical methods

#### **2.2 Univariate analysis of exploration geochemical data**

- Notions of background, threshold and anomaly
- Traditional methods of threshold selection to define/map anomalies
- Analysis of uni-element data distributions
- Analysis of uni-element threshold values and anomalies

### 2.3 Basics of Mineral Prospectivity Modelling

- Concept of spatial data analysis
- Mineral systems analysis
- Concept of mineral prospectivity modelling
- Tools for mineral prospectivity mapping, including GIS tools

### 2.4. Weights-of-evidence Modelling of Mineral Prospectivity

- Quantifying spatial association between mineral deposits and geological features
- Combining layers of spatial evidence in weights of evidence modelling to map prospective areas

### 2.5. Alternative Methods of Modelling Mineral Prospectivity

- GIS-based conceptual fuzzy logic
- GIS-based data-driven neural networks
- GIS-based evidential belief functions

## Presenters



**Arianne Ford** is post-doctoral researcher at JCU. Her research focuses on the application of spatial statistics and computational techniques to mineral exploration targeting and resource classification. She is currently working on a state government funded project utilizing existing geological and mineral deposit data to develop GIS-based prospectivity maps to improve the availability of pre-competitive data in north-east Queensland.



**Zhaoshan Chang** is an Associate Professor and the director of EGRU at JCU. He has worked extensively on skarns, epithermal, porphyry, IOCG, Sn-W and sediment-hosted Au deposits, plus SWIR (Short Wavelength Infra-Red) and LA-ICP-MS U-Pb dating / mineral trace element analysis methodologies. He works closely with the mineral industry on exploration-oriented research projects, looking for indicators, discriminators and zoning patterns in mineralogy, texture and geochemistry that can be directly used in exploration. His research mainly involves the investigation of the spatial and temporal distribution of alteration and mineralization, and understanding the genesis of ore systems.



**Carsten Laukamp** is a senior research geoscientist at CSIRO Mineral Resources, based in Perth, Australia. In 2007, Carsten obtained his Doctorate of Science (Dr. rer. Nat.) from the Ruprecht Karls University in Heidelberg, Germany, based on his study of the structural and fluid system evolution in the Otavi Mountain Land (Namibia) and its significance for the genesis of sulphide and nonsulphide mineralisation. Before joining CSIRO, Carsten was a postdoctoral research fellow at James Cook University in Townsville, where he worked in the pmd\*<sup>2</sup>CRC on the evaluation of hyperspectral remote sensing data for mapping hydrothermal alteration footprints in the Mount Isa Inlier. In Carsten's current position with CSIRO and his involvement in the Western Australian Centre of Excellence for 3D Mineral Mapping, he aims to unravel the physicochemistry of minerals using lab, field and remote visible and infrared reflectance spectroscopy, working with microscopic to continent-scale data.

## Location

EGRU

034-127 - Building 034, Room 127

[Map](#)

**NOTE:** Please arrive at 08.15 on April 18th.

## Daily Routine

Each day will be divided into four sessions:

Session 1 08.30 – 10.00

Session 2 10.30 – 12.30

Session 3 13.30 – 15.00

Session 4 15.30 – 17.00

Additional work outside course hours will be required (reading and presentation preparation for the masters students). Participants should not be planning significant extracurricular activities or large quantities of other work while doing the course.

## Course Notes, Computers and Software

Course notes will be provided in the form of pdfs of the PowerPoint slides, which will be posted on LearnJCU.

Some additional papers will be provided.

*Access to LearnJCU* (link is on the JCU Homepage)

Students once enrolled in the subject: automatically have access to LearnJCU using jc# and password

Industry: Before the course commences you will receive an email detailing how to access LearnJCU

Participants will require laptop computers with Microsoft Excel for practical exercises. Participants will need to download ILWIS version 3.08 from <http://www.52north.org/> and familiarize themselves with this software from the manuals ([http://www.ilwis.org/user\\_friendly\\_gis\\_teach\\_yourself.htm](http://www.ilwis.org/user_friendly_gis_teach_yourself.htm)). Please note that if participants wish to use their personal version of ArcGIS on their laptops for practical exercises, they should contact Arianne Ford ([Arianne.Ford@jcu.edu.au](mailto:Arianne.Ford@jcu.edu.au)) prior to starting the course to discuss the licenses required. The software packages will also be available on desktop computers in a JCU computer lab.

## Catering

Fully catered for industry participants.

Advise any dietary details to [mgm@jcu.edu.au](mailto:mgm@jcu.edu.au)

## Transport and Parking

[Sunbus](#) – Route 201 - one stop on the University near building 134 – follow pathway in front of the Library to 034

Parking – free parking is available beside the ring road opposite buildings 017/034 – parking tickets for the permit areas are available at the bookshop

## Accommodation Options

Cedar Lodge – [www.cedarlodge.com.au](http://www.cedarlodge.com.au)

JCU Short Stays - <https://www.jcu.edu.au/jcu-halls/short-stays>

General Townsville Accommodation -

[http://www.queenslandholidays.com.au/destinations/townsville/accommodation/accommodation\\_home.cfm](http://www.queenslandholidays.com.au/destinations/townsville/accommodation/accommodation_home.cfm)