PhD project at EGRU, JCU

Geological characteristics and genesis of Mt Carlton high-sulfidation epithermal deposit, and the implications for exploration of more ores and its linked porphyry mineralisation

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Background

Mt Carlton is a high-sulfidation epithermal (HS) deposit 150km south of Townsville, Queensland, Australia. It has a resource of 38 Mt averaging 1.8 g/t Au, 38 g/t Ag and 0.24% Cu at 31 December 2012 (http://www.evolutionmining.com.au/projectsMtCarlton.html). The open pit mining of this deposit commenced in July 2013. In this area there are also prospects of porphyry-style and intermediate- / low-sulfidation epithermal (IS/LS) styles.

The project will be based on the new understanding of magma-related hydrothermal system in which HS deposits are genetically linked to porphyry deposits below them (Arribas et al., 1995; Hedenquist et al., 1998; Sillitoe, 2010; Chang et al., 2011). In other words, HS deposits such as Mt Carlton are the most direct indication of porphyry deposits at lower elevations.

Aims

The project aims to A) document the geological characteristics, particularly the zoning patterns of Mt Carlton, and understand the ore formation processes and factors controlling the positions of orebodies, to help the exploration for similar deposits, and b) to estimate the position of the porphyry deposit related to the Mt Carton HS deposit, by first estimating the surface projection of the porphyry deposit at depth, and then estimating the depth of the deposit.

Research plan

To constrain the surface projection of the porphyry, we will use the vectors in lithocaps recently developed by Chang et al. (2011), coupled with the understanding of structural and stratigraphical controls. To estimate the depth, we will use the vertical zonation pattern, and the uplift history. The following research method will be applied:

1. To understand the ore-forming processes and the factors controlling the position of orebodies:
b. Establish the structural framework and history by mapping, core logging, and dating.

c. Determine the alteration and mineralisation paragenesis through mapping, core logging, textural study using BSE-EDS (Back Scattered Electron imaging – Energy Dispersive Spectrometry analysis), cathodoluminescence (CL) imaging, dating of alteration minerals (Ar-Ar dating) and ore minerals (Re-Os dating).

d. Constrain formation temperature and pressure using fluid inclusion microthermometric measurements, and oxygen and sulfur isotope pairs

e. Estimate the fluid compositions and evolution by determining fluid compositions of single inclusions in minerals formed at various depths and paragenesis stages.

f. Constrain fluid evolution by examining trace elements (composition and zoning pattern) in key minerals, using PIXE (Proton-Induced X-ray Emission) methods.

2. Document the zoning patterns in the following parameters, through mapping, core logging other methods detailed below:

a. Alteration and mineralisation mineralogy, based on microscopy, SWIR (Short Wavelength Infra-Red) spectral analysis, XRD, and electron microprobe analysis

b. SWIR spectral features of minerals, by SWIR analysis

c. Oxygen, hydrogen and sulphur isotopes, by conventional and SHRIMP-SI (Sensitive High Resolution Ion Micro-Probe – Stable Isotopes) methods

d. Metal content, by analysing company whole rock and soil geochemistry database

3. To locate the potential positions of deposits: use zoning patterns in mineralogy, texture, mineral chemistry, soil geochemistry, whole rock trace elements, and SWIR (Short Wavelength Infra-Red) spectral features to identify fluid channels and sources, thereby identifying the positions of causative intrusions.

a. For lithocaps (HS environments), alunite 1480 nm absorption peak position, trace elements in alunite by LA-ICP-MS, and the trace elements of altered rocks containing alunite could be used as vectors towards the surface projection of a causative intrusion (Chang et al., 2011).

b. Illite crystallinity of sericite and secritic Al-OH absorption peak position may also change regularly as in some deposits (Chang and Yang, 2012), determined by XRD and SWIR techniques

c. In the propylitic zone of porphyry deposits, use trace elements in epidote and chlorite, analysed using LA-ICP-MS.

d. Metal zonation patterns and trends in soil geochemistry, using company database.

4. To estimate the deposit depth:

a. Using the vertical zoning pattern from shallow HS epithermal deposits to deeper porphyry deposits.

b. Establish the regional exhumation history by estimate the formation depth of individual deposits via 1) pressure estimation from fluid inclusion studies,
coupled with dating; and 2) Thermochronologic analysis of samples from various elevations, using zircon, titanite and apatite (U-Th)/He methods.

c. Document the distribution and nature of structural overprints related to Hunter-Bowen orogenesis, the only episode of compressional tectonism that post-dates formation of the Kennedy Igneous Association, to estimate post-mineralisation exhumation/removal of potential deposits.

5. A GIS database will be constructed to help with data synthesis.

Scholarship:

The PhD student will receive a stipend scholarship of A$25,500 per annum for 3 years with a possibility to extend for half a year. For an international student, an international fee-waiver may be granted to exceptional students, who will be selected on a competitive basis.

Starting date:

The PhD student is expected to start in late July – early August.

Application

International students whose native language is not English need to meet the JCU English requirements (http://www.jcu.edu.au/international/apply/entry/JCUSO_073732.html) to be eligible to apply.

Please send CV, informal transcripts, statement of research interests and career goals, English test results, and publications or thesis to Zhaoshan.chang@jcu.edu.au for initial evaluation before submitting scholarship applications.

Main References: