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U–Pb zircon geochronology and fluid inclusion studies in the Cerro Colorado porphyry copper deposit, northern Chile, suggest shallow syn-volcanic mineralisation

Presented by Debbie Tsang
PhD researcher at Nagoya University

Date:	13 June, 2017 (Tuesday)
Time:	6:30 pm to 7:30 pm
Venue:	JL104, James Lee Building, The University of Hong Kong
Fee:	Free of charge
Registration:	Prior registration is not required.
	For enquiry, please contact Miss Trudy Kwong at tkwong@bmintelligence.com

Synopsis:

Porphyry Copper Deposits (PCDs) dominantly form in convergent plate margins associated with volcanic arcs. However, their genetic relationships with active volcanism are less clear. A major eruption or substantial sulphur-rich degassing may vent any metal-rich fluids and gases that have formed in the volcanic edifice dispersing the available metals into the atmosphere [1,2]. This process is often considered to suppress the formation of PCDs and many workers have concluded that PCD formation must take place at times of volcanic quiescence [3]. In contrast, several studies have documented evidence suggesting syn-eruption PCD formation [4,5]. A combination of radiometric dating, fluid inclusions studies and observations of rock cores from the Compañia Minera Cerro Colorado (CMCC) PCD, a BHP Billiton property located in N. Chile, provides clear evidence for syn-volcanic PCD formation at relatively shallow depths within a volcanic edifice.

We carried out U–Pb dating of zircons from all the main intrusive units in the CMCC by LA-ICP-MS analysis. These ages show that the host rocks for the CMCC dominated by the Cerro Empexa Formation (CEF) range in age from 80–57 Ma. The youngest unit is a dacitic tuff breccia unit with an age of 53.9 ± 4.4 Ma, which overlies the CEF. Field and microstructural observations combined with geochemical data suggest that the subvolcanic porphyritic intrusions can be divided into an early tonalite unit and a later monzonite–quartz unit. U–Pb zircon dating yields weighted mean ages for these two units of 53.51 ± 0.80 Ma and 51.38 ± 0.58 Ma. There is also evidence of a significant phase of earlier magmatism with ages of 64.4 ± 6.1 to 57.6 ± 4.1 Ma although a distinct

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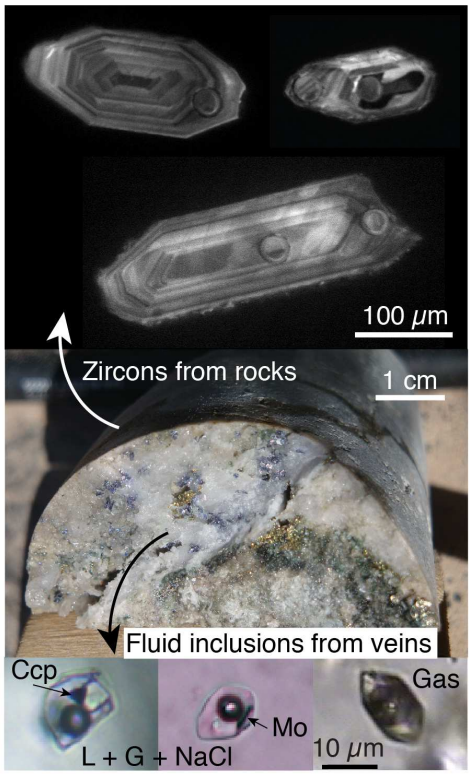
intrusive body was not recognized. The overlap in ages of the tuff and subvolcanic units suggests syn-volcanic intrusion.



Mineralized veins consisting dominantly of quartz, chalcopyrite and molybdenite are closely associated with the porphyry intrusions and contain abundant brine- and gas-rich fluid inclusions. A combination of observations using reflected light microscopy and cathodoluminescence (CL) reveals four distinct microstructural domains in the quartz: early amorphous (Q1), well-formed euhedral (Q2), late irrelgular pore-space filling (Q3) and latest dissolution and splatter (Q4). Copper and molybdenum minerals commonly grow along grain boundaries of Q2, locally cross-cutting Q1 and Q2 and occupy the same microstructural domain as Q3. Micro-thermometry reveals quartz growth at temperatures of 200–600 °C, locally reaching 700 °C. The high temperature group corresponds to magmatic temperatures and demonstrates the close relationship between mineralization and magmatic activity. In addition, the pressures derived from the fluid inclusions are highly variable, corresponding to a variation from sub-hydrostatic to supra-lithostatic at depths of 1.6–3 km and densities of 1–2.8 g/cm3. The low pressures are best explained as representing localized and short-lived connectivity to the surface implying either degassing, brecciation or eruption. This was followed by fracture healing and a return to lithostatic pressures.

Our results suggest that PCD formation is, at least in some cases, associated with active volcanism at relatively shallow levels.

References

[1] Wilkinson (2013) Nature Geosci. 6, 917–925. [2] Simon et. al (2006) Geochim Cosmochim Ac. 70, 5583–5600. [3] Cooke et. al. (2005) Econ. Geol. 100, 801–818. [4] Hattori & Keith (2001) Miner. Deposita. 36, 799–806. [5] Nadeau et. al. (2010) Nature Geosci. 3, 501–505.

About the Speaker:

Debbie Tsang is a PhD candidate in the Department of Earth & Planetary Sciences of Nagoya University, Japan. She received her BSc and MPhil in Earth Sciences at the University of Hong Kong, and has work experiences in mineral exploration in NW China and in mining consultation industry. Debbie's research interest mainly lies in shallow crustal level mineralization processes. Her PhD project focuses on the timescale of magmatism and the evidences of syn-volcanic mineralization at Cerro Colorado porphyry copper mine in northern Chile.

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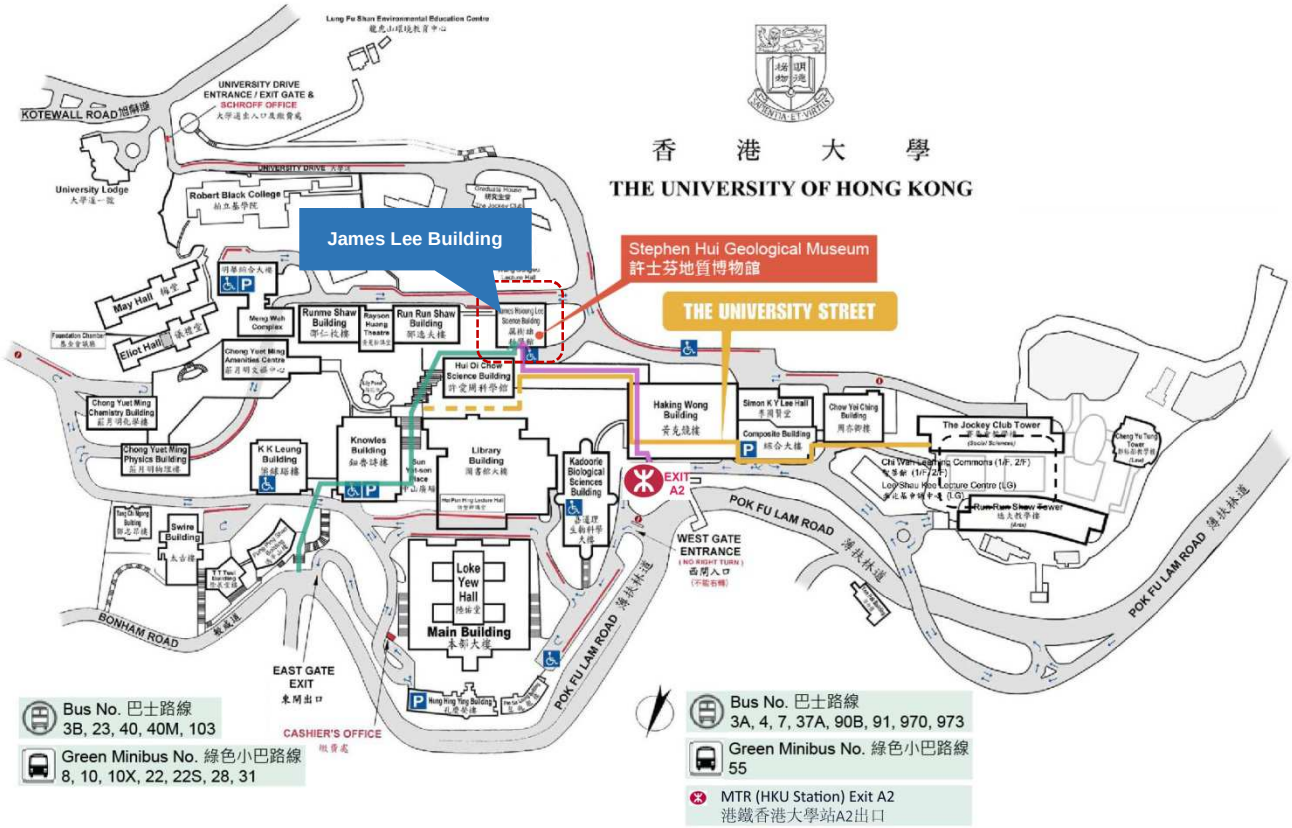

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