

LI Yang, David SELBY, Martin FEELY, Alessandra COSTANZO and LI Jianwei, 2014. Ore-forming Fluid Characterization of Tibet's Largest Porphyry Cu-Mo Deposit, Qulong: Insights into the Super Accumulation of Cu and Mo. *Acta Geologica Sinica* (English Edition), 88(supp. 2): 1122-1123.

Ore-forming Fluid Characterization of Tibet's Largest Porphyry Cu-Mo Deposit, Qulong: Insights into the Super Accumulation of Cu and Mo

LI Yang^{1,†}, David SELBY¹, Martin FEELY², Alessandra COSTANZO² and LI Jianwei³

¹ Department of Earth Sciences, Durham University, Durham DH1 3LE, UK;

² Earth and Ocean Sciences, National University of Ireland, Galway, Ireland;

³ Faculty of Earth Resources, China University of Geosciences, Wuhan, 430074, China

1 Introduction

The Gangdese Porphyry Copper Belt (GPCB) hosts a series of world class Miocene porphyry Cu deposits (Fig.1), which are directly linked with Indo-Asian continent collision (Yang et al., 2009). Porphyry deposits are major resources of Cu, Mo, Re and provide significant amounts of other precious metals (e.g. Au and Ag), and represent one of the most studied class of hydrothermal ore deposit (Sillitoe, 2010). However, the process of ore deposition, still remains poorly understood.

The Qulong porphyry deposit, located in the eastern part of GPCB, is the largest porphyry Cu-Mo system in China and hosts 10.4 Mt Cu with an average grade of 0.5 % and about 0.5 Mt of Mo with an average grade of 0.03 %. A study of the ore-forming fluids of the Qulong Porphyry Cu-Mo deposit is presented here based on vein and alteration mineral content, vein cutting relations, and

fluid inclusion distribution and analysis to understand the processes of super accumulation of Cu and Mo and the temporal evolution of the exsolving fluids.

2 Geological Background

Barren Jurassic volcanic rocks and porphyry are products of northward subduction of the Neo-Tethys. Rongmucuala granodiorite pluton (~17 Ma) is the largest porphyry and hosts most of the Cu and Mo resources. The slightly younger P porphyry intrudes the Rongmucuala pluton and is closely associated with the formation of the Qulong Cu-Mo system. Both intrusions are crosscut by the X porphyry (Fig. 2), and the post ore diorite marks the end of the Miocene magmatism and mineralization (Yang et al., 2009). Our preliminary molybdenite Re-Os dating indicate the mineralization formed within a short interval (100 ka) at ~16 Ma.

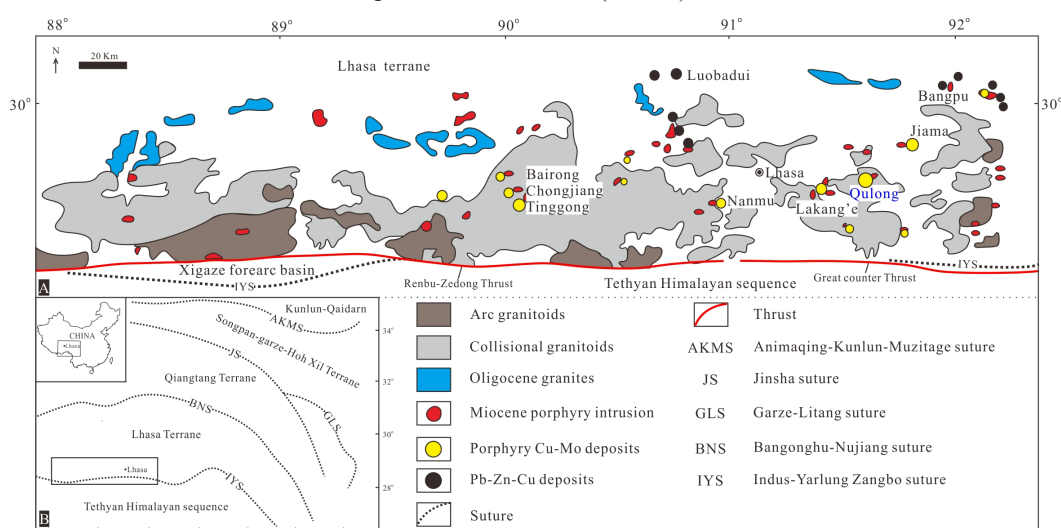


Fig.1 Location and geological setting of Gangdese Porphyry Copper Belt

* Corresponding author. E-mail: li.yang@durham.ac.uk

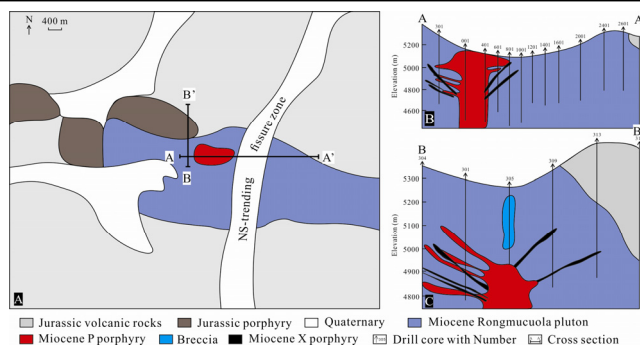


Fig. 2 Geological map and cross sections for Qulong

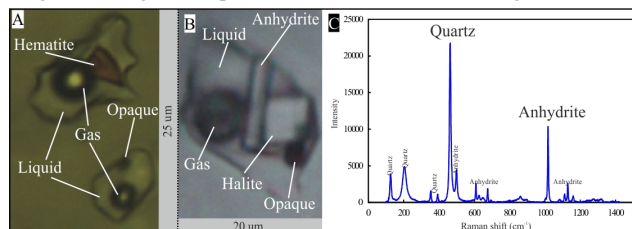


Fig. 3 Representative fluid inclusions and Raman spectra of quartz and anhydrite

3 Fluid Inclusion Petrography

Fluid inclusion petrography, microthermometry and Laser Raman Microscopy were conducted at the National University of Ireland, Galway. As for many other porphyry deposits, it's difficult or even impossible to classify fluid inclusions based on growth zone due to the anhedral quartz crystal as well as multiple stages of fluids trapped in one quartz vein. On the basis of phases present at room temperature, five types of fluid inclusion have been distinguished and classified as LV25 (L= liquid, V=vapor, the number stands for the volume % of vapor less than 25, same as below), LV60 (25<V<60), LV90 (60<V<90), LV+OP (OP=opaque minerals) and LVH/OP (Halite bearing fluid inclusion with or without opaque minerals).

In general, the earliest barren A vein hosts abundant LV25 fluid inclusions; LV60, LV+OP and LVH/OP are more common in Cu-Mo bearing A and B veins; LV90 fluid inclusions are recognized in high-grade Mo-Cu A veins, and rare in other veins; latest low Cu-Mo grade D veins are dominated by LV60 and LV25 fluid inclusions with rare LVH/OP fluid inclusions. Hematite and anhydrite are recognized by Laser Raman from Cu-Mo rich A and B veins (Fig. 3). Due to the size of the opaque minerals (~1 μ m), no information has been obtained.

4 Results and Conclusion

As summarized in Figure 4, the LV25 fluid inclusions yield the lowest homogenous temperatures (250-320°C), LV60 and LV90 fluid inclusions have much more limited

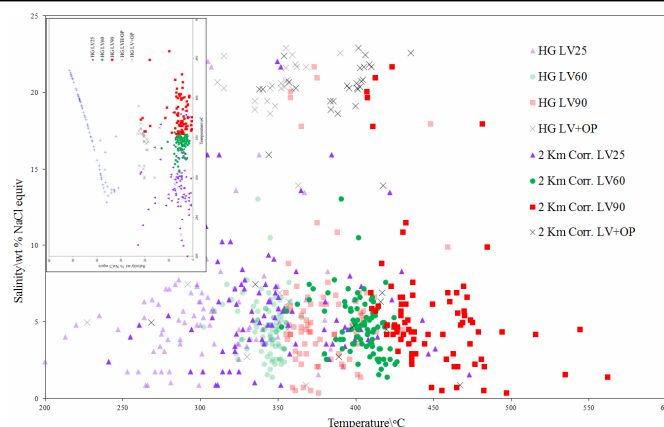


Fig. 4 Fluid inclusion data [the inserted figure shows Th-Salinity plot for all fluid inclusions, all FI except halite bearing ones are plotted (dark color) together with 2 km pressure correction (bright color)].

distribution of homogenous temperature with the later much higher (320-350°C and 350-400°C). All LV25, 60, and 90 fluid inclusions have similar salinity abundance ranges from 0 to 10 wt % NaCl equiv. LV+OP fluid inclusions yield T_h (°C) between 300 to 410°C and posse much higher salinity (18-24 wt % NaCl equiv). All of the halite bearing fluid inclusions homogenize by halite disappearance (many of the opaque minerals do not melt, T_h varies from 270 to 435°C) and define a halite saturation curve which marks the upper limit of the salinity (30-52 wt % NaCl equiv). Based on a 27.5 MPa (2 km which is typical depth for porphyry Cu) pressure correction, the majority of the fluid inclusions yield a trapping temperature which is 50°C higher than the homgenisation temperature. The corrected temperature agrees with the temperature of formation of the mineral alteration phases.

Our fluid inclusion data show no appreciable drop in salinity, and in addition lack any evidence of boiling. As such the control(s) of Cu and Mo deposition for Qulong were driven by other processes; e.g., a) huge excess of sulfur flushing triggered disproportionation and b) external H_2S mixing or water-rock interaction.

Acknowledgements

The first author thanks Prof. Hou Zengqian and others from his group for their help to get access for field work; Special thanks given to Prof. Ronald Bakker and Dr. Jamie Wilkinson for their kind suggestions and help for the interpretation of the data.

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