HUANG yong, DING jun, DAI Jie and YAN Guoqiang, 2014. Origin of the Miocene Porphyries from Zhunuo Porphyry Cu-Mo-Au Deposit, South Tibet. *Acta Geologica Sinica* (English Edition), 88(supp. 2): 526-528.

Origin of the Miocene Porphyries from Zhunuo Porphyry Cu-Mo-Au Deposit, South Tibet

HUANG yong[1], DING jun[1], DAI Jie[1] and YAN Guoqiang[2]

1 *Chengdu Center, China geological Survey, 610081, SiChuan Chengdu, China*
2 *Chengdu University of Technology, 610073, Sichuan Chengdu, China*

1 Introduction

The Zhunuo porphyry copper deposit is a newly explored deposit in Gangdese porphyry copper belt (GPCB). The GPCB is situated within the south margin of Lhasa Terrane (Fig.1). The north and south boundaries of the Lhasa Terrane are the Banggong-Nujiang and Yaluzangbu sutures, composed of Ordovician, Carboniferous and Triassic shallow-marine clastic sedimentary rocks. GPCB is one of major Metallogenic belt in the world and mainly comprises Jurassic to early Eocene volcanic and plutonic rocks. It stretches for 350km from Shigatse to Mozhugongka county. Three main tectonomagmatic events and relatively mineralization have been identified in the southern Gangdese belt: (1) a early to middle Jurassic magmatic arc due to northward subduction of The Neo-Tethys oceanic crust associated with major copper-gold porphyry deposits; (2) a late Cretaceous to Eocene Gangdese continental magmatic plates associated with Porphyry molybdenum deposit and relatively skarn deposit, . (3) A Miocene magmatism-mineralization event associated with post Gangdese extension.

2 Geological Background

Drilling programs before 2012 defined a significant resource of 402.5 M tonnes (measured and indicated) with 0.57% copper, 0.017% molybdenum, 0.13 g/t gold, and 2.5g/t silver.

Rock units in Zhunuo district includes Paleocene to Eocene Nianpo group and Pala group which comprised andesitic, dacitic, and rhyolitic volcaniclastic rock and glutenite unites and felsic tuff, mainly distributed at north and east part of the property. Multi-intrusions occur throughout the district along the northeast trending structure. These bodies have intruded the volcanic sequence, including: (1) Eocene quartz diorite porphyry; (2) Miocene biotite granodiorite porphyry; (3) Miocene biotite monzogranite porphyry; (4) Miocene quartz porphyry; (5) Miocene diorite porphyry.Six main vein types are recognized at Zhunuo. These are, from oldest to youngest: (1) early, discontinuous biotite-sulfide (pyrite + chalcopyrite) veinlets; (2) gray, sinuous quartz sulfide (pyrite ± chalcopyrite) veins with k-feldspar alteration envelop; (3) quartz molybdenite ± minor or trace sulfide (pyrite ± chalcopyrite) veins; (4) chalcopyrite-dominated sulfide veins; (5) later pyrite dominated veins; and (6) planar, white, barely quartz veins. Early biotite-sulfide veinlets and quartz sulfide veins mainly distributed within biotite granodiorite with k-feldspar alteration envelop indicating the veins and alteration assemblages and sparial association with biotite granodiorite.

3 The source and Petrogenetic model

Hou (2004) suggest that the source of Miocene adakitic porphyries may derived from partial melting of thickener lower crust. Partial melting of the subducted oceanic crust was also proposed as a source for Miocene magmatism by Qu et al. (2004). However, these models are hardly to explain the high radiogenic Pb and Sr isotope composition and higher $\varepsilon_{Hf}(T)$ value obtained in this study. Moreover previous studies about the tectonic setting of Gangdese belt suggest that Neotethyan slab have been break-off and sunk into deep mantle during Eocene time. Gao et al. (2007) suggested that the post-collision rock likely originated form an upper mantle metasomatized by slab-derived melts. It is also hard to explain the wild variable isotope composition from east and west to 88°. Moreover, low-degree hydrous melting of mantle peridotite can produce andesitic melts other than felsic melts (Mo et al., 2008).

* Corresponding author. E-mail: yong.huang@hotmail.com

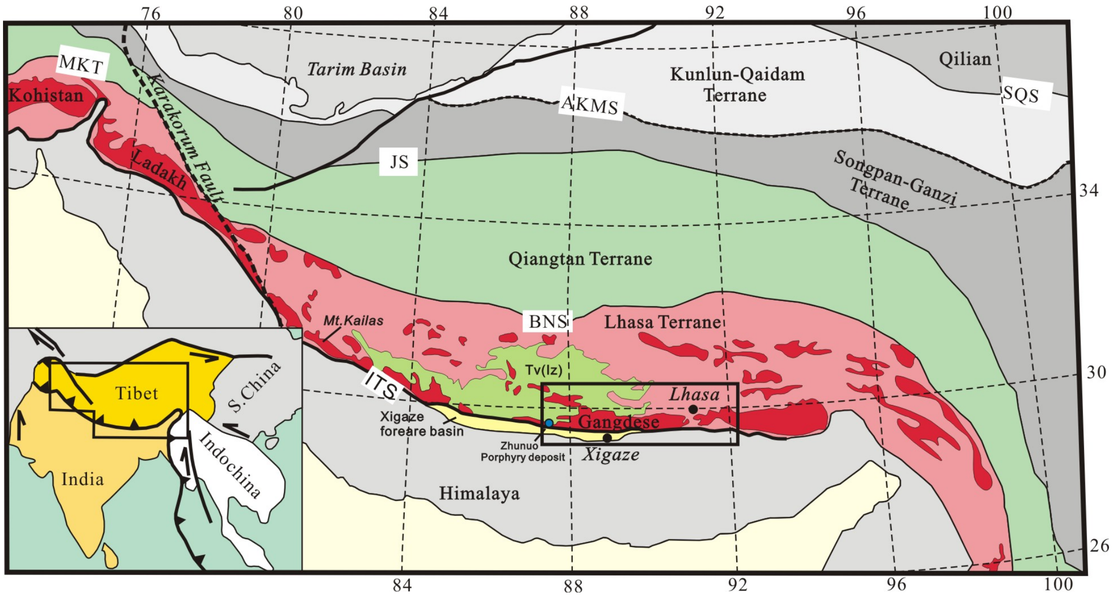

Fig. 1. Tectonic map of Tibetan Plateau showing the major terranes and suture zones (Significantly simplified from Yin and Harrison, 2000).

The initial ^{206}Pb/^{204}Pb, ^{207}Pb/^{204}Pb, and ^{208}Pb/^{204}Pb ratio fall within the ranges of 18.417-18.694, 15.609-15.737, and 38.726-39.2134, respectively, showing the higher radiogenic concentrations compared with reported Miocene units may suggest the more involvement of the ancient crustal components or an enriched mantle source for their parental magmas. Several inherited zircons cores of Miocene samples dated in this study may suggest that the old crustal material may play a significant role in the generation of magmas. Nd isotope isotope compositions of the Miocene granitoids also exhibit the obvious lower ^{143}Nd/^{144}Nd isotope compositions compared with previous studied Miocene ore-bearing porphyries in GPCB. This suggest that the Miocene porphyries of Zhunuo area with lower ^{43}Nd/^{144}Nd isotope compositions, might originate by mixing depleted mantle or juventile lower crust and ancient crust. The ancient crust may place an important role for the origination of these porphyries. Such mixing might explain the higher MgO contents and consistent with above Pb isotopic composition. Hf isotope composition shows a negative $\varepsilon_{Hf}(t)$ values (-5~0) which are different from previous studied Miocene porphyries marked by positive $\varepsilon_{Hf}(t)$ values. These data for the Zhunuo area presented here further demonstrate that the contamination of ancient crust may play a critical role for the generation of magmas. The percentage of ancient crust contribution in the melt was calculated following Mišković and Schaltegger (2009). It is estimated that ancient crust material input contributed up to 33% to the formation of the Miocene granitoids in terms of zircon Hf isotopic compositions (assumed to be objectively recorded in the crystallized/crystallizing zircons).

The whole-rock two-stage Nd model ages and single zircon two-stage Hf modes (T_{DM2}) range from 1.15 to 1.43 Ga and 1.08 to 1.45 Ga, respectively. This suggests that a Mesoproterozoic crust could be the source for the studied magmas. Although, the nature and history of crustal remain at Lhasa Terrane remains unknown where lithospheric structure similar to that of Archaean and Proterozoic cratons is inferred to exist relying on geophysical and Hf isotopic interpretations (McKenzie and Priestley, 2008). As Zhu, et al (2011) suggested, the negative εHf(t) for the reworked crust is like overestimated due to the inevitable of crust-mantle interaction during mantle melting and melt emplacement (e.g., crustal assimilation). If it is ture, the crustal model age should be even older (Paleoproterozoic, or even older). This finding offer evidence for the presence of Paleoproterozoic and Archean basement also beneath the south Lhasa subterrane.

4 Conclusion

The following conclusions are drawn from this study: Miocene granites exhibits the geochemical characteristics of high-K, calc-alkaline, and I-type granite. Geochemical and Sr-Nd-Pb-Hf isotopic compositions suggest that they were derived from the mixing melting of depleted mantle crust or juvenile mafic lower crust with Paleoproterozoic or Archean crust during the magma ascent upward. Combination of previous study, we suppose that Paleoproterozoic to Archean basement crust not only exist at the middle part of Lhasa terrane, but also preserve at south part of Lhasa terrane.

Acknowledgements

We are grateful for construction reviews by professor Tang Juxing. This research was financially supported by the Chinese geological project (No. 1212011221073). We also thank Hou Kejun and Guo Yongcun for LA-ICP-MS U-Pb dating and *in-situ* Hf isotopic analyses.

Reference

Gao Yongfeng, Hou Zengqian, Kamber, B.S., Wei Ruihua, Meng Xiangjin, Zhao Rongsheng. 2007. Adakite-like porphyries from the southern Tibetan continental collision zones: evidence for slab melt metasomatism. Contributions to Mineralogy and Petrology 153 (1), 105–120.

Hou Zengqian, Gao Yongfen, Qu Xiaoming, Rui Zongyao, Mo Xuanxue. 2004. Origin of adakitic intrusives generated during mid-Miocene east-west extension in southern Tibet. Earth Planet Sci Lett, 220: 139~155.

McKenzie, D., Priestley, K., 2008. The influence of lithospheric thickness variation on continental evolution. Lithos 102, 1–11.

Mišković, A., Schaltegger, U., 2009. Crustal growth along a non-collisional cratonic margin: a Lu-Hf isotopic survey of the Eastern Cordilleran granitoids of Peru. Earth Planet. Sci. Lett. 279, 303–315.

Mo Xuanxue, Hou Zengqian, Niu Yaoling, Dong Guochen, Qu Xiaoming, Zhao Zhidan, Yang Zhiming. 2007. Mantle contributions to crustal thickening during continental collision: evidence from Cenozoic igneous rocks in southern Tibet. Lithos 96 (1-2), 225-242.

Qu Xiaoming, Hou Zengqian, Li Youguo. 2004. Melt components derived from a subducted slab in late orogenic ore-bearing porphyries in the Gangdese copper belt, southern Tibetan plateau. Lithos 74, 131–148.

Yin Jixiang, Xu Juntan, Liu Chengjie, Li Huan. 1988. The Tibetan plateau: regional stratigraphic context and previous work. Philosophical Transactions of the Royal Society of London. Series A, Containing Papers of a Mathematical or Physical Character 327, 5-52.

Zhu Dicheng, Zhao Zhidan., Niu Yaoling, Mo Xuanxue., Chung Sunlin, Hou, Zengqian, Wang Liquan, Wu Fuyuan. 2011. The Lhasa Terrane: Record of a microcontinent and its histories of drift and growth. Earth and Planetary Science Letters, 301: 241-255.