



Petrogenesis of ore-bearing porphyries from the Duolong porphyry Cu–Au deposit, central Tibet: Evidence from U–Pb geochronology, petrochemistry and Sr–Nd–Hf–O isotope characteristics

Jin-Xiang Li ^{a,*}, Ke-Zhang Qin ^b, Guang-Ming Li ^b, Bo Xiao ^{b,c}, Jun-Xing Zhao ^b, Ming-Jian Cao ^b, Lei Chen ^d

^a Key Laboratory of Continental Collision and Plateau Uplift, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, 4A Datun Road, Chaoyang District, Beijing 100085, China

^b Key Laboratory of Mineral Resources, Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O. Box 9825, Beijing 100029, China

^c China Nonferrous Metal Mining (Group) Co., Ltd, Anding Road 10#, Chaoyang District, Beijing 100029, China

^d MRL Key Laboratory of Metallogeny and Mineral Assessment, Institute of Mineral Resources, Chinese Academy of Geological Sciences, 26 Baiwanzhuang Road, Beijing 100037, China

ARTICLE INFO

Article history:

Received 24 June 2012

Accepted 22 December 2012

Available online 4 January 2013

Keywords:

Duolong porphyry Cu–Au deposit

Zircon Hf–O isotope

Petrogenesis

Tibet

ABSTRACT

The Duolong porphyry Cu–Au deposit (5.4 Mt at 0.72% Cu, 41 t at 0.23 g/t Au), which is related to the granodiorite porphyry and the quartz–diorite porphyry from the Bangongco copper belt in central Tibet, formed in a continental arc setting. Here, we present the zircon U–Pb ages, geochemical whole-rock, Sr–Nd whole-rock and zircon in-situ Hf–O isotopic data for the Duolong porphyries. Secondary ion mass spectrometry (SIMS) zircon U–Pb analyses for six samples yielded consistent ages of ~118 Ma, indicating a Cretaceous formation age. The Duolong porphyries (SiO₂ of 58.81–68.81 wt.%, K₂O of 2.90–5.17 wt.%) belong to the high-K calc-alkaline series. They show light rare earth element (LREE)-enriched distribution patterns with (La/Yb)_N = 6.1–11.7, enrichment in large ion lithophile elements (e.g., Cs, Rb, and Ba) and depletion of high field strength elements (e.g., Nb), with negative Ti anomalies. All zircons from the Duolong porphyries share relatively similar Hf–O isotopic compositions ($\delta^{18}\text{O} = 5.88\text{--}7.27\text{‰}$; $\varepsilon_{\text{Hf}}(t) = 3.6\text{--}7.3$), indicating that they crystallized from a series of cogenetic melts with various degrees of fractional crystallization. This, along with the general absence of older inherited zircons, rules out significant crustal contamination during zircon growth. The zircons are mostly enriched in $\delta^{18}\text{O}$ relative to mantle values, indicating the involvement of an ^{18}O -enriched crustal source in the generation of the Duolong porphyries. Together with the presence of syn-mineralization basaltic andesite, the mixing between silicic melts derived from the lower crust and evolved H₂O-rich mafic melts derived from the metasomatized mantle wedge, followed by subsequent fractional crystallization (FC) and minor crustal contamination in the shallow crust, could well explain the petrogenesis of the Duolong porphyries. Significantly, the hybrid melts possibly inherited the arc magma characteristics of abundant F, Cl, Cu, and Au elements and high oxidation state, which contributed to the formation of the Duolong porphyry Cu–Au deposit.

© 2013 Elsevier B.V. All rights reserved.

1. Introduction

The relationship between porphyry Cu–(Mo–Au) deposit formation and subduction-related arc magmatism has been well documented (e.g., Hedenquist and Lowenstern, 1994; Richards, 2011; Sillitoe, 1972). Ore-related magmas are the main source of H₂O, S, Au, F, Cl, and Cu of the hydrothermal systems whose evolution results in the formation of these ore deposits. A general consensus suggests that arc magmas receive variable contributions from mantle, crustal and subducted reservoirs (e.g., Hildreth and Moorbath, 1988). However, the proportions and mechanisms by which these heterogeneous components are involved in arc magmatic systems remain elusive.

The Duolong porphyry Cu–Au deposit (5.4 Mt at 0.72% Cu, 41 t at 0.23 g/t Au; Li et al., 2012b) is one of the largest known deposits in

Tibet, China (Fig. 1a). It belongs to the east–west trending Cretaceous Bangongco copper belt (Fig. 1b), which shows a Cu–Au mineralization assemblage and was formed in a magmatic active arc setting (Li et al., 2007a, 2008, 2011a,c, 2012a,b), in contrast to those of the Yulong and Gangdese copper belt (Fig. 1b). The porphyry deposits of the Yulong and Gangdese copper belt were formed in the Eocene and Miocene, respectively, and both of them belong to the Cu–Mo mineralization assemblage and formed in a post-collision geotectonic setting (Hou et al., 2004, 2009; Jiang et al., 2006; Li et al., 2007b, 2011b, 2012c; Liang et al., 2006; Qin et al., 2005; Qu et al., 2009; Xiao et al., 2012). The Duolong mineralization is closely related to the granodiorite porphyry and the quartz–diorite porphyry; however, the petrogenesis of the ore-bearing porphyries remains unclear.

Zircon in-situ Hf–O isotopes, in contrast to the traditional whole rock Sr–Nd isotopes, are insensitive to post-magmatic hydrothermal alteration and, therefore, can better trace the nature and evolution of the host magma (Be'eri-Shlevin et al., 2009; Lackey et al., 2005;

* Corresponding author. Tel.: +86 10 82998187; fax: +86 10 62010846.
E-mail address: ljx@mail.iggcas.ac.cn (J.-X. Li).

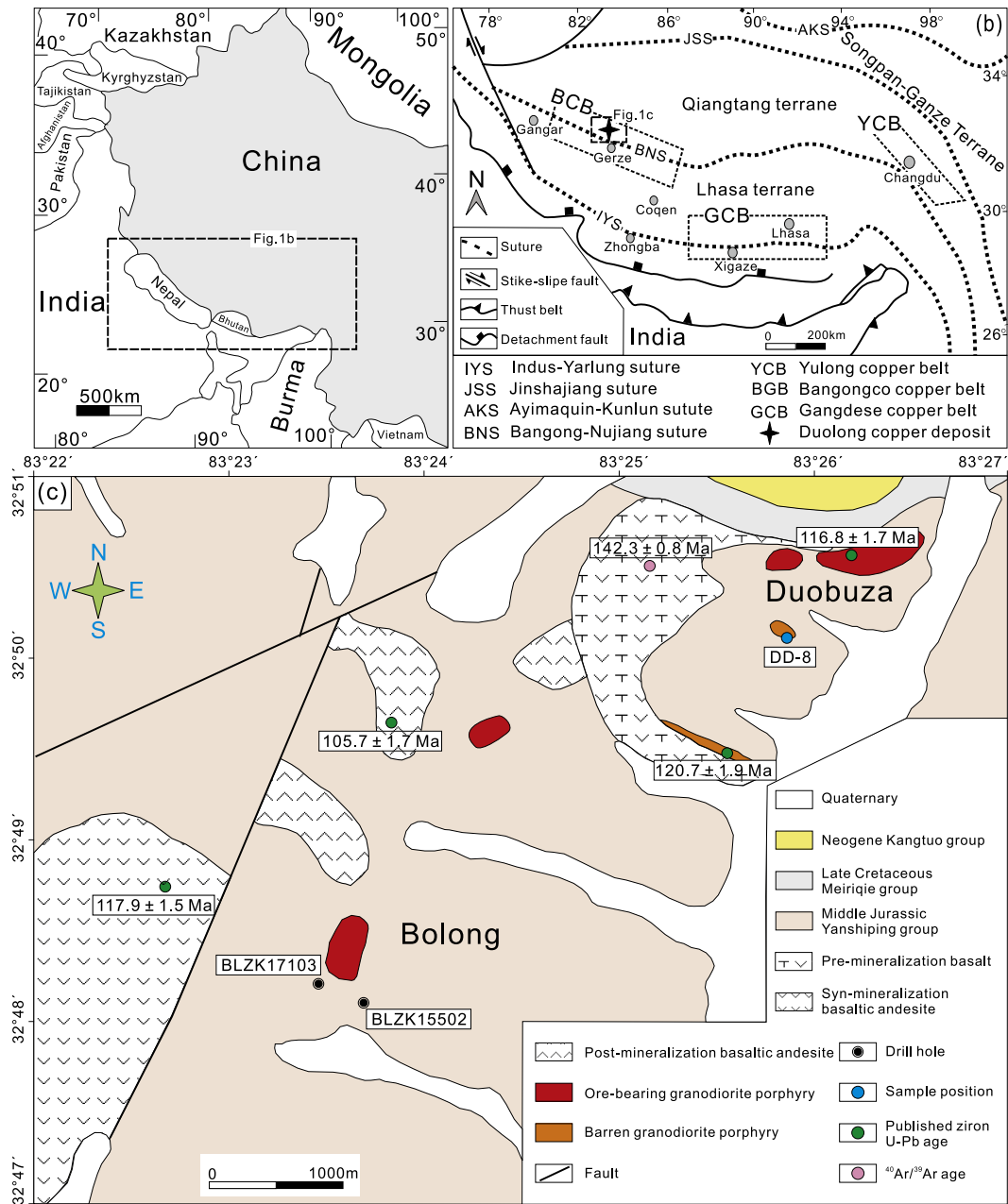


Fig. 1. (a) Geographic map, (b) sketch tectonic map (Hou et al., 2004) and generalized geologic map (b) of the Duolong porphyry Cu–Au deposit (Li et al., 2011a). The published zircon U–Pb ages are from Li et al. (2011c). The $^{40}\text{Ar}/^{39}\text{Ar}$ age for pre-mineralization basalt is unpublished by the author (Li JX).

Muñoz et al., 2012; Peytcheva et al., 2009; Valley, 2003; van Dongen et al., 2010). Moreover, zircons in equilibrium with mantle-derived magma have average $\delta^{18}\text{O}$ values of $5.3 \pm 0.3\%$ (Valley et al., 1998). The zircon $\delta^{18}\text{O}$ value is insensitive to modification by differentiation because the whole rock $\delta^{18}\text{O}$ and Δ (melt–Zrc) increase in parallel with differentiation and the accompanying increase of SiO_2 (Valley, 2003). Thus, the zircon $\delta^{18}\text{O}$ value can effectively trace the contribution of supracrustal materials (^{18}O -enriched) to mantle-derived magma (Appleby et al., 2008; Bolhar et al., 2008; Gagnevin et al., 2011; Kemp et al., 2007; Valley, 2003). In this study, new SIMS zircon U–Pb ages, geochemical data, and Sr–Nd whole-rock and zircon in-situ Hf–O isotopic analyses data of the ore-bearing and barren porphyries are presented to track the petrogenetic evolution of Duolong related magmas that gave rise to magmatic-hydrothermal ore formation. We propose that Duolong mineralization-related fertile magmas are a mixture of melt components that were derived from dehydration melting in the lower

crust and from primary basalt differentiation and then experienced a process of minor crustal assimilation and fractional crystallization (FC) at the upper crust level.

2. Geological setting of the Duolong deposit

The Duolong porphyry Cu–Au deposit (5.4 Mt at 0.72% Cu, 41 t at 0.23 g/t Au; Li et al., 2012b) is located approximately at 100 km northwest of Gerze City and to the north of the Bangongco–Nujiang suture zone (BNS; Fig. 1b). It formed in a Mesozoic continental arc that resulted from the Neo-Tethys Ocean subduction (Li et al., 2008). The stratigraphy was mainly made of the Middle Jurassic Yanshiping and the Late Cretaceous Meirique groups (Fig. 1c) which contact tectonically. The Middle Jurassic Yanshiping group is a clastic-interbedded volcanic sequence of littoral facies with an EW strike and WNW dip of $50\text{--}80^\circ$. It is composed of arkosic sandstone, siltstone-interbedded

Download English Version:

<https://daneshyari.com/en/article/4716334>

Download Persian Version:

<https://daneshyari.com/article/4716334>

[Daneshyari.com](https://daneshyari.com)