Ore Geology Reviews 74 (2016) 196–210

Contents lists available at ScienceDirect

Ore Geology Reviews

journal homepage: www.elsevier.com/locate/oregeorev

Fluid inclusion geochemistry and Ar–Ar geochronology of the Cenozoic Bangbu orogenic gold deposit, southern Tibet, China

Xiaoming Sun [a,b,c,d,*], Huixiao Wei [a], Wei Zhai [b,c,**], Guiyong Shi [b,c,d], Yeheng Liang [b,c,d], Ruwei Mo [a], Moxiang Han [a,b], Jianzhou Yi [e], Xiangguo Zhang [e]

[a] School of Earth Science and Geological Engineering, Sun Yat-sen University, Guangzhou 510275, China
[b] School of Marine Sciences, Sun Yat-sen University, Guangzhou 510006, China
[c] Guangdong Provincial Key Laboratory of Marine Resources and Coastal Engineering, Guangzhou 510006, China
[d] South China Sea Bio-Resource Exploitation and Utilization Collaborative Innovation Center, Guangzhou 510006, China
[e] Geological Survey of Tibet Bureau of Geology and Mineral Exploration and Development, Lhasa 851400, China

ARTICLE INFO

Article history:
Received 3 August 2013
Received in revised form 13 November 2015
Accepted 15 November 2015
Available online 30 November 2015

Keywords:
Fluid inclusions
Ar–Ar dating
Cenozoic orogenic gold deposit
Continental collision
Bangbu gold deposit
Tibet

ABSTRACT

Located along the southern part of the Yarlung Zangbo suture zone in southern Tibet, Bangbu is one of the largest gold deposits in Tibet. Auriferous sulfide-bearing quartz veins are controlled by second- or third-order brittle fractures associated with the regional Qusong–Cuogu–Zhemulang brittle-ductile shear zone. Fluid inclusion studies show that the auriferous quartz contains aqueous inclusions, two-phase and three-phase CO_2-bearing inclusions, and pure gaseous hydrocarbon inclusions. The CO_2-bearing inclusions have salinities of 2.2–9.5% $NaCl_{eq}$, and homogenization temperatures (Th) of 167–336 °C. The δD, $\delta^{18}O$, and $\delta^{13}C$ compositions of the Bangbu ore-forming fluids are −105.5 to −44.4‰, 4.7 to 9.0‰ and −5.1 to −2.2‰, respectively, indicating that the ore-forming fluid is mainly of metamorphic origin, with also a mantle-derived contribution. The $^3He/^4He$ ratio of the ore-forming fluids is 0.174 to 1.010 R_a, and $^{40}Ar/^{36}Ar$ ranges from 311.9 to 1724.9. Calculations indicate that the percentage of mantle-derived He in fluid inclusions from Bangbu is 2.7–16.7%. These geochemical features are similar to those of most orogenic gold deposits. Dating by $^{40}Ar/^{39}Ar$ of hydrothermal sericite collected from auriferous quartz veins at Bangbu yielded a plateau age of 44.8 ± 1.0 Ma, with normal and inverse isochronal ages of 43.6 ± 3.2 Ma and 44 ± 3 Ma, respectively. This indicates that the gold mineralization was contemporaneous with the main collisional stage between India and Eurasia along the Yarlung Zangbo suture, which resulted in the development of near-vertical lithospheric shear zones. A deep metamorphic fluid was channeled upward along the shear zone, mixing with a mantle fluid. The mixed fluids migrated into the brittle structures along the shear zone and precipitated gold, sulfides, and quartz because of declining temperature and pressure or fluid immiscibility. The Bangbu is a large-scale Cenozoic syn-collisional orogenic gold deposit

1. Introduction

Since Groves et al. (1998) and Goldfarb et al. (2001) formerly proposed the model of "orogenic type gold deposit", numerous papers on the geological and geochemical features and genesis of the orogenic gold deposits in various metamorphic terranes around the world have been published (Goldfarb et al., 2001, 2004, 2005; Groves et al., 1998, 2003; Bierlein et al., 2004). Some researchers, such as Groves et al. (1998) and Kerrich et al. (2000), argued that the orogenic gold deposits are mainly present in accretionary orogens, whereas collisional orogens, such as the Alpine–Himalayan orogen, are not as favorable for preservation of orogenic gold deposits. In recent years, however, some large orogenic gold deposits have been discovered in the Qinghai–Tibet Plateau and in the collisional Ailaoshan gold belt in Yunnan Province (Sun et al., 2006, 2007a, 2007b, 2009; Xiong et al., 2007a, 2007b; Shi et al., 2012), the Longmenshan–Jinpingshan gold belt in western Sichuan Province (Luo and Yu, 2001; Wang et al., 2001; Yan et al., 2002; Li et al., 2005), the Xiaoqinling–Xiongershan gold province in the Qinling orogen (Chen et al., 1998, 2008; Zhou et al., 2014, 2015), the Tanjianshan deposit in the eastern Kunlun orogen, the Sawayaerdun deposit in the southwestern Tianshan (Chen et al., 2012a, 2012b), and the Erqis gold belt in the southern Altay (Chen et al., 2001). In addition, orogenic gold and gold–antimony deposits, such as Mayum, Zhemulang, and Mazhala, were discovered in southern Tibet along the Yarlung Zangbo suture zone. Geological and geochemical features suggest that the deposits are typical Cenozoic orogenic gold deposits formed during the early stage of India–Eurasia continental collision (Jiang

* Correspondence to: X. Sun, School of Earth Science and Geological Engineering, Sun Yat-sen University, Guangzhou 510275, China.
** Corresponding author.

http://dx.doi.org/10.1016/j.oregeorev.2015.11.021
0169-1368/

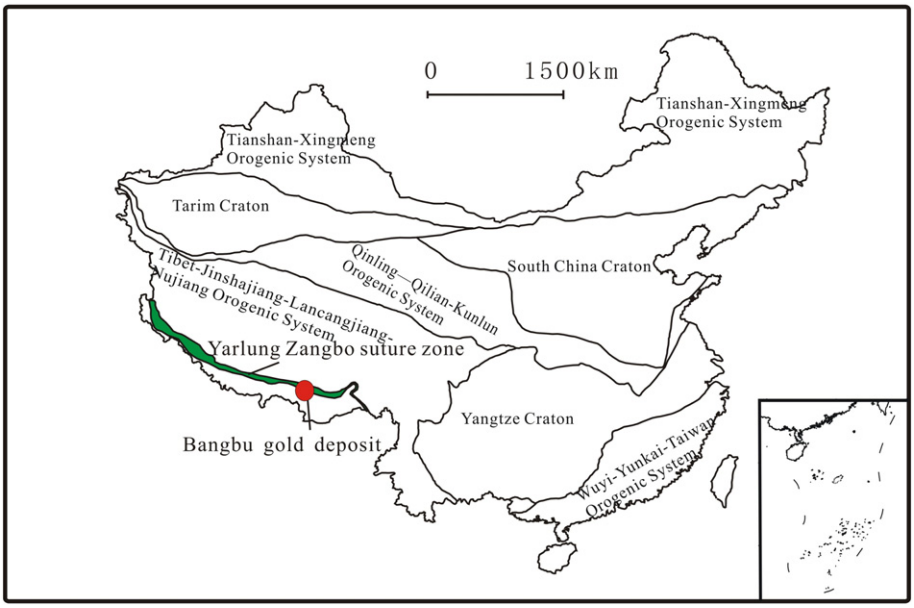

Fig. 1. Tectonic setting of Bangbu gold deposit (after Pan et al., 2009).

et al., 2008, 2009; Duoji and Wen, 2009; Zhai et al., 2014). Hence, the genesis and exploration potentials of orogenic-type gold deposits are now a very important issue to discuss.

Recently, a large gold deposit hosted in Late Triassic metamorphic rocks, Bangbu, was discovered in Jiacha County of southern Tibet. It is one of the largest lode gold deposits in Tibet and is located to the east part of the Yarlung Zangbo terrane suture zone. Preliminarily investigations have focused on the local geology and a tentative genetic model (Lu, 2005; Lv et al., 2005; Geological Survey of Tibet Bureau of Geology and Mineral Exploration and Development, 2006; Sun et al., 2010; Wei et al., 2010), and stressed that Bangbu may be an epithermal gold deposit. However, a systematic study of geochemical features and geochronology, critical for understanding the genesis, was lacking. In this study, microthermometric, Laser Raman, and stable isotope analyses of fluid inclusions, and Ar–Ar dating of hydrothermal sericite were performed on auriferous sulfide-bearing quartz veins from the Bangbu gold deposit. Our results suggest that it is a typical Cenozoic orogenic gold deposit formed during continental syn-collision.

2. Geological setting and geology of the Bangbu gold deposit

2.1. Regional geological setting

Tectonically, the Bangbu gold deposit is located on the southern side of the eastern Yarlung Zangbo suture zone in southern Tibet (Fig. 1), which marks the boundary between once widely separated continental masses of Eurasia and India (Allégre et al., 1984). The suture also marks the site where the Indus–Yarlung Zangbo Tethyan Ocean lithosphere

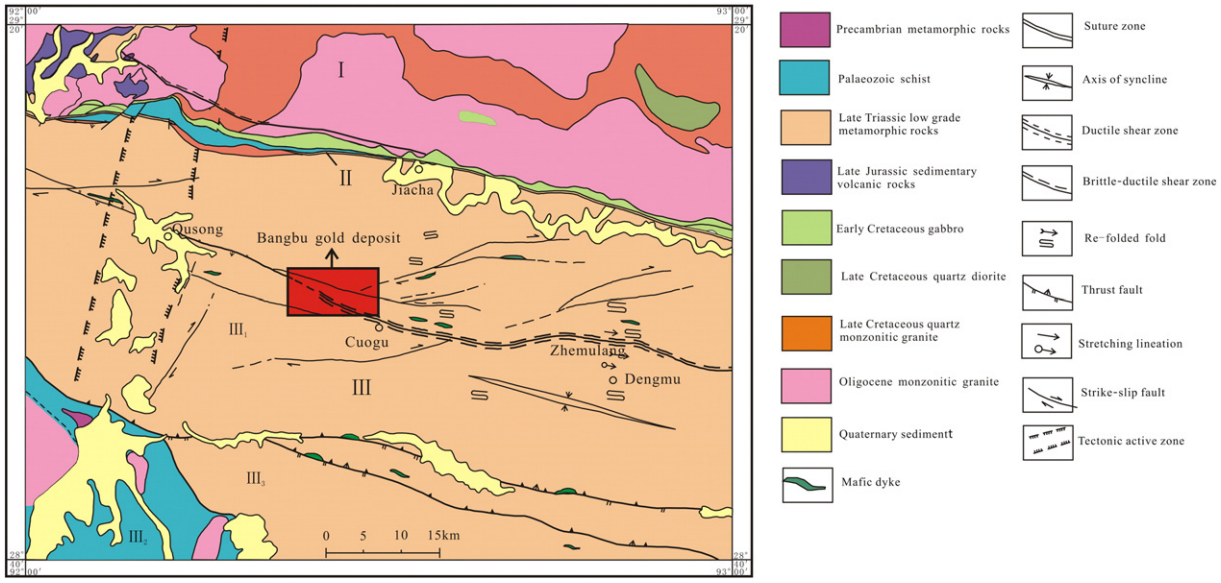

Fig. 2. Regional geological map of Bangbu gold deposit (modified after Geological Survey of Tibet Bureau of Geology and Mineral Exploration and Development, 2006). I — Gangdese block; II — Yarlung Zangbo tectonic suture zone; III — Himalayan block; III1 — Qusong–Dengmu slab; III2 — Qiongduojiang crystalline slab; III3 — Zongxu–Kala slab.