Ore Geology Reviews 81 (2017) 342–357

Contents lists available at ScienceDirect

Ore Geology Reviews

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

# A possible genetic relationship between orogenic gold mineralization and post-collisional magmatism in the eastern Kunlun Orogen, western China

Jinyang Zhang [a,*], Changqian Ma [b,c], Jianwei Li [a,b], Yuanming Pan [d]

[a] Faculty of Earth Resources, China University of Geosciences, Wuhan 430074, China
[b] State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan 430074, China
[c] Faculty of Earth Sciences, China University of Geosciences, Wuhan 430074, China
[d] Department of Geological Sciences, University of Saskatchewan, Saskatoon, SK S7N 5E2, Canada

ARTICLE INFO

*Article history:*
Received 8 July 2016
Received in revised form 4 November 2016
Accepted 7 November 2016
Available online 10 November 2016

*Keywords:*
Late Triassic
Post-collisional
Wulonggou
Orogenic gold
Kunlun Orogen

ABSTRACT

Controversies in orogenic gold deposits remain, especially regarding the relative contribution of magmatic fluids to the mineralization. The Shuizhadonggou-Huanglonggou gold deposit in the Wulonggou gold field of the eastern Kunlun Orogen, western China consists mainly of sulfide disseminations in hydrothermally altered rocks with minor amounts of quartz-sulfide veins coeval to or overprinting the disseminated ores. Gold mineralization is hosted in diverse lithologies (i.e., Early Palaeozoic metamorphic rocks, Late Silurian syenogranite and Late Triassic porphyritic granodiorite and quartz diorite) and is structurally controlled by a second-order NW-trending sinistral-normal ductile shear zone and its subsidiary structures along the first-order Central Kunlun Fault. Gold-related hydrothermal alteration formed chlorite, sericite, quartz and calcite, with associated sulfide minerals dominated by pyrite, arsenopyrite, löllingite and pyrrhotite. Two types of hydrothermal sericite separates from a gold mineralized syenogranite yielded two $^{40}Ar/^{39}Ar$ ages of 237.0 ± 2.0 Ma and 230.8 ± 1.7 Ma, respectively, which postdated the Early Triassic regional metamorphism and ductile deformation by ~13 m.y. Field relationships suggest that gold mineralization also overprinted ~220 Ma porphyritic granodiorites and quartz diorites. These data indicate three gold mineralization events in the Late Triassic overlapped with post-collisional magmatism in the orogen. Gold-bearing sulfides have $\delta^{34}S$ values mostly in the range of 2.0–5.5‰, consistent with a magmatic source of sulfur. Quartz from quartz-pyrite-sericite veins has calculated $\delta^{18}O_{H2O}$ values of 1.8–6.1‰ and $\delta D_{H2O}$ of −63 to −107‰. The stable isotopic and geochronological data suggest a magmatic origin for the ore-forming fluids. Therefore, the Shuizhadonggou-Huanglonggou and other gold deposits in the eastern Kunlun Orogen share many features of orogenic gold deposits (e.g., multiple-order ore-controlling structures, hydrothermal alteration, mineralization styles, close association between mineralization and magmatism, and H-O-S stable isotope compositions) and are genetically related to Late Triassic post-collisional magmatism.
© 2016 Elsevier B.V. All rights reserved.

## 1. Introduction

Orogenic gold deposits are typically hosted in metamorphic terranes and structurally controlled by compressional to transpressional tectonics associated with accretionary and/or collisional orogenesis (Goldfarb et al., 2001; Groves et al., 1998). Many studies have shown that orogenic gold and ore-forming fluids are mostly sourced from metamorphic devolatilization of volcano-sedimentary rocks, but whether gold veining is genetically related to contemporaneous magmatism has long been debated (Goldfarb et al., 2005; Goldfarb and Groves, 2015; Groves et al., 2003; Phillips and Powell, 2010). While most orogenic gold deposits formed by metamorphic dewatering (Tomkins, 2013), others have been demonstrated to be genetically associated with magmatism (Li et al., 2012; Xue et al., 2013). For example, multiple sulfur isotopes of sulfide with mass-dependent fractionation have provided supportive evidence for a magmatic origin of the Archean gold deposit in the Eastern Gold field superterrane of the Yilgarn Craton (Xue et al., 2013). In most cases, however, contrasting genetic models exist for individual deposits because fluid inclusions and geochemical and isotopic data are not definitive in identifying the source of ore fluids and other components. For example, Mueller et al. (2007) proposed that the Wallaby gold deposit in the Yilgarn Craton was formed from a magmatic-hydrothermal fluid based on detailed geochronological studies about relationships between magmatism, structure and mineralization, but conventional S-C-O isotopes and dating results argued against a magmatic model (Salier et al., 2005).

* Corresponding author.
*E-mail address:* zhangjinyang@cug.edu.cn (J. Zhang).

http://dx.doi.org/10.1016/j.oregeorev.2016.11.003
0169-1368/© 2016 Elsevier B.V. All rights reserved.

The eastern Kunlun Orogen in western China hosts numerous gold deposits, as best represented by those in the Wulonggou and Gouli gold fields (Fig. 1, Li et al., 2013; Tian, 2012). Previous studies have concluded that these deposits can be considered as orogenic gold deposits on the basis of geological and geochemical data (Ding et al., 2013; Feng et al., 2003, 2004; Li et al., 2001; Li et al., 2013; Zhang et al., 2007a; Zhao, 2008; Zou et al., 2011). However, the source of the ore-forming fluids responsible for gold mineralization in the orogen remains controversial and has been interpreted to originate from magmatic water (Li et al., 2001), deep circulation of meteoric water (Feng et al., 2003, 2004), or mixing of metamorphic and magmatic waters with a late-stage input of meteoric components (Ding et al., 2013; Zou et al., 2011), partly because the relationships between the gold mineralization and the widespread magmatism over the orogen are not clear.

The Wulonggou gold field contains the largest gold deposits in the eastern Kunlun Orogen (Figs. 1, 2). Recent explorations have led to discovery of a few tens of gold deposits, of which the Shuizhadonggou-Huanglonggou gold deposit (Fig. 3) is the largest, with proven reserves of 45 t Au at an average grade of 4.5 g/t (Zhang et al., 2011). In this paper, we present geological, geochronological, and geochemical data to better understand the timing and genesis of gold mineralization at Shuizhadonggou-Huanglonggou and discuss possible genetic relationships between gold mineralization and magmatism, metamorphism and orogenic deformation. Results from this study, when combined with regional geological and geochronological evidence, also provide new insights into the tectonic setting under which the Shuizhadonggou-Huanglonggou deposit formed.

## 2. Geological setting

The Kunlun Orogen is the western segment of the Central China Orogenic Belt that separates the Tarim and North China cratons to the north from the Tibet plateau and the South China Block to the south (Fig. 1a). It is divided into western and eastern parts by the multistage Altyn Fault. The eastern Kunlun Orogen is underlain by a Mesoarchean-Mesoproterozoic basement (Chen et al., 2011; Wang et al., 2004, 2007; Wei et al., 2007; Zhang et al., 2012a), and has witnessed multistage subduction and collision from Neoproterozoic to Early Mesozoic (Bian et al., 2004; Meng et al., 2013; Yang et al., 1996, 2009; Zhu et al., 2006).

The eastern Kunlun Orogen consists of three tectonic units: the Northern, Middle, and Southern zones (Fig. 1b, Jiang et al., 1992). The Northern Zone, principally exposed in the western part of eastern Kunlun Orogen, is an Early Palaeozoic fold belt mainly comprising Ordovician marine sediments and low-grade metamorphic rocks with igneous rocks ranging in ages from Early Ordovician to Late Triassic (e.g., Chen et al., 2006; Gao et al., 2014; Meng et al., 2015; Wang et al., 2012a). The Middle Zone, which is separated by the North Kunlun Fault from the Northern Zone and by the Central Kunlun Fault from the Southern Zone, consists of the Archean-Paleoproterozoic Baishahe Complex, Mesoproterozoic Xiaomiao Formation and Neoproterozoic Binggou Group (Chen et al., 2011; Wang et al., 2007). The Middle zone is characterized by widespread Early Cambrian-Early Devonian and Early Permian-Late Triassic igneous rocks (e.g., Ni, 2010; Zhang et al., 2012b). Minor Devonian terrestrial sandstone and conglomerate and Carboniferous marine limestone and clastic sedimentary rocks also occur in the Middle Zone. The Southern Zone, between the Central and Southern Kunlun faults, includes the Mesoproterozoic Kuhai and Wanbaogou volcanic-sedimentary complexes that are unconformably overlain by thick Triassic flysch successions (Liu et al., 2005; Wang et al., 2007). Minor Early Palaeozoic and Late Triassic granitoid intrusions also occur in the Southern Zone (Chen et al., 2013; Li et al., 2015a; Wang et al., 2012b).

The Central Kunlun Fault represents an Early Palaeozoic suture zone marked by well exposed ophiolites distributed discontinuously between Nuomuhong and Qingshuiquan, with zircon U-Pb ages of 518–509 Ma (Feng et al., 2010; Yang et al., 1996). It is characterized by ductile thrust deformation during Late Ordovician to Early Devonian (Wang et al., 2003) and subsequent dextral ductile strike-slip shearing in the Late Permian (Wang et al., 1999). The Southern Kunlun Fault is considered to represent a composite suture zone, in which ophiolitic bodies are exposed along Buqingshan-Dur'ngoi and have zircon U-Pb ages of 516–467 Ma and 345–333 Ma (Bian et al., 2004; Chen et al., 2001a; Liu et al., 2011). It underwent ductile sinistral strike-slip transpression at about 220–200 Ma (Xu et al., 2001; Zhang et al., 2010a), followed by brittle sinistral strike-slip shearing.

Early Palaeozoic subduction-related intrusive rocks in the eastern part of the eastern Kunlun Orogen (Fig. 1b) are dominated by gabbros, diorites, quartz diorites and granodiorites with zircon U-Pb ages ranging from 515 to 438 Ma (Chen et al., 2001b; Liu et al., 2013; Zhang et al., 2010b). High-Mg diorites and granodiorites were emplaced at ~430 Ma, likely indicating the beginning of the collision (Zhang et al., 2014). More voluminous monzogranites and syenogranites (~420 Ma, Lu et al., 2013), and granodiorites, monzogranites, cordierite-bearing syenogranites and gabbros (413–393 Ma, Liu et al., 2012a; Xiong et al., 2014a) in large areas of Jinshuikou-Wulonggou suggest a post-collisional setting.

Early Permian-Late Triassic igneous rocks are widespread in the eastern part of the eastern Kunlun Orogen (Fig. 1b). Extensive Late Permian-Middle Triassic intrusive rocks consist of gabbros, diorites,

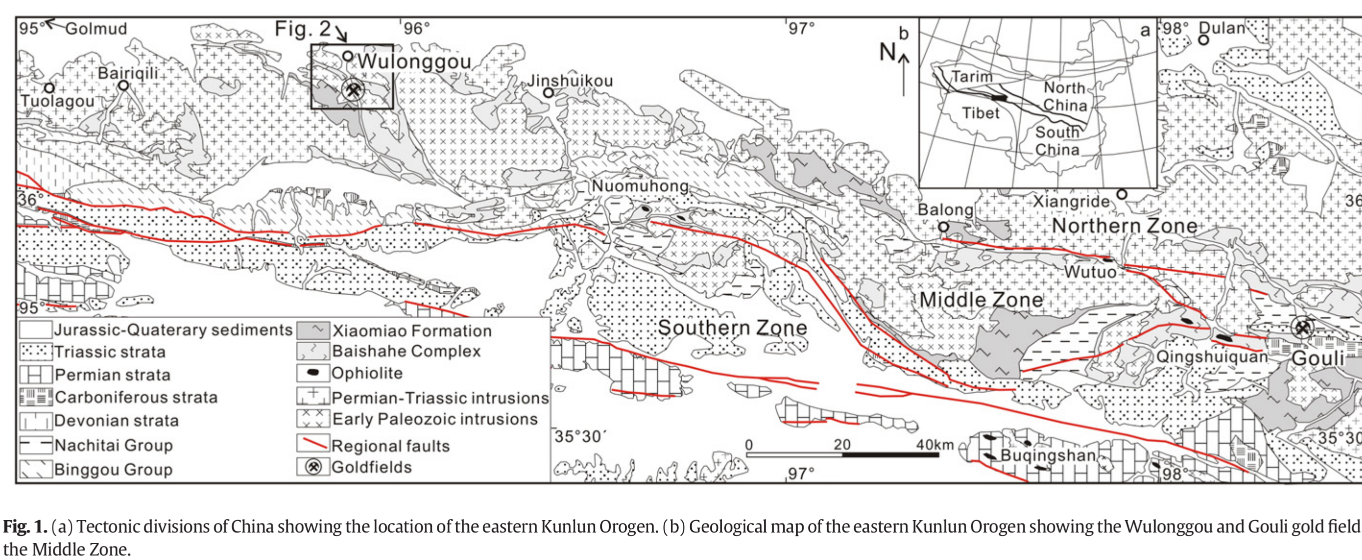


**Fig. 1.** (a) Tectonic divisions of China showing the location of the eastern Kunlun Orogen. (b) Geological map of the eastern Kunlun Orogen showing the Wulonggou and Gouli gold fields in the Middle Zone.

Download English Version:

https://daneshyari.com/en/article/6482030

Download Persian Version:

https://daneshyari.com/article/6482030

Daneshyari.com