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Geology and ore genesis of the Yu'erya gold deposit, eastern Hebei Province, China

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ABSTRACT

The large Yu'erya gold deposit (65 t of contained gold averaging 2.3 g/t Au) in the eastern part of the Hebei Province of China is spatially associated with the Yu'erya Granite, and a group of NE- and NNE-trending faults. The alteration associated with mineralization is characterized by the assemblage pyrite, quartz, sericite, albite, and carbonate. Four stages of mineralization, in chronological order, are (1) quartz and medium- to coarse-grained pyrite; (2) quartz, fine-grained pyrite, and gold; (3) quartz, polymetallic sulfide, tellurobismuthite, and gold; and (4) quartz, pyrite, and carbonate. Most of the gold was deposited during the second and third stages of alteration from mesothermal fluids. These fluids were relatively rich in H_2O, CO_2, K^+, Ca^{2+}, Cl, and S, and low salinity. The H–O and sulfur isotope ratios determined for the mineralized samples indicate a magmatic source, and the Pb isotope data indicate that the Au mineralization originated from the mantle and lower crustal materials. Geochronological data indicate that the gold mineralization event was restricted to 200–163 Ma whereas the associated magmatism occurred between 200 and 150 Ma. This Mesozoic gold mineralization is related to the subduction of the Mongolia–Okhotsk and Paleo-Pacific oceans along the edges of the North China Craton.

1. Introduction

The North China Craton (NCC) is a major metallogenic terrane that records secular changes in tectonics and metallogeny (Yang et al., 2014); numbers of gold deposits in the craton are distributed in the Xiaoqinling, Jiao–Liao, and Yan–Liao gold fields (Nie, 1997a,b; Hart et al., 2002; Zhou et al., 2002; Yang et al., 2003; Nie et al., 2004; Zhang et al., 2005; Jia et al., 2011) (Fig. 1a, b). The Jiaodong Peninsula is the most important source of gold in China with resources totally over of 1300 t of contained Au accounting for about a quarter of the country's gold production (X. C. Li et al., 2013; Zhai et al., 2001). The Xiaoqinling gold field is the second largest gold producing center in China with an estimated unmined resource of 800 t Au (Nie, 1994; Chen et al., 2008, 2009; Li et al., 2011; Zhao et al., 2012).

Late Jurassic to Early Cretaceous granites host the majority of gold deposits in the NCC, although some are located in the country rocks adjacent to the granites (Miao et al., 2002; Yang et al., 2003; Zhang et al., 2005; Goldfarb et al., 2014). Based on these associations, there has been a general concensus that the deposits are magmatic in origin and related to the granites (e.g., Hart et al., 2002). The intrusion-related gold deposits in the craton can be classified based on geological associations into three groups: (1) Those hosted by, or related to, felsic intrusions, including calc-alkaline granitic intrusions (e.g. the Yu'erya, Anjiayingzi, Linglong, and Jiaojia deposits), and cryptoexplosion breccia pipes (e.g. the Chenjiazhangzi and Qiyugou deposits); (2) those related to ultramafic intrusions (e.g. the Jinjiazhuang gold deposit); and (3) those hosted by or related to alkaline intrusions (e.g. the Wulashan, Donghuofang, Dongping, Hougou, and Guilaizhuang gold deposits) (Nie, 1998; Nie et al., 2004). The gold in these three types is present in quartz veins or as bodies of disseminated gold and stockwork-type veins along altered shear zones between granites and metamorphosed Precambrian basement rocks (Yang et al., 2003; Goldfarb et al., 2014).

Many papers have been published on the gold deposits in the NCC and related igneous rocks, and they have focused on the geology, mineralogy, petrochemistry, geochronology, fluids, and isotopic characteristics of mineralization (e.g. Mao et al., 2005a; Zhang et al., 2007; L. S. Zhang et al., 2013). Although there are several reviews on Mesozoic magmatic rocks and the ore deposits in the craton, there is as no consensus on the geodynamic processes related to the large volume of magmatism and mineralization generated (Li and Santosh, 2014; Mao et al., 2003, 2005b; Nie, 1997a; Nie et al., 2004; Ouyang et al., 2013; Wang, 1989; Yang et al., 2003; Zhou et al., 2002; Zhu et al., 2011). Various hypotheses have been proposed to account for the Phanerozoic tectonic reactivation of the craton, and to explain the driving forces responsible or magmatism. These include: (1) a far-field effect of the motion of the Pacific Plate (Hu et al., 1994; Zhang et al., 2014); (2) plume-upwelling, lithospheric delamination, and mantle plume activity (Lin et al., 1998; Pirajno et al., 2009); (3) the interaction of the Tethyan, paleo-Asian, and Pacific plates (Hart et al., 2002); and (4) the

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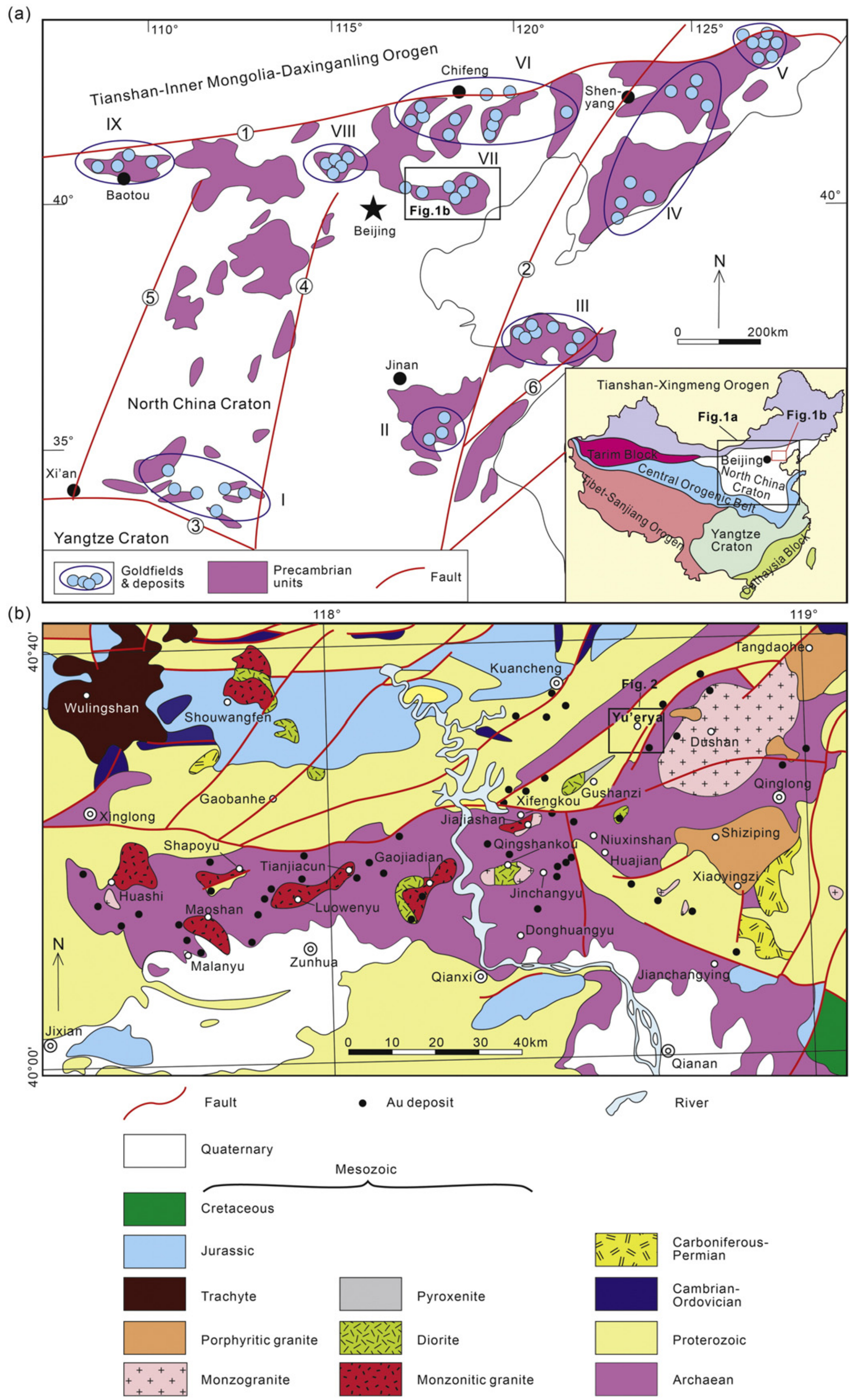

Fig. 1. Simplified geological maps showing: (a) distribution of gold deposits in the North China Craton (modified from Miao et al., 2005; Wang, 1989; Yang et al., 2003) of the Xiaoqinling (I), western Shandong (II), Jiaodong Peninsula (III), eastern Liaoning (IV), southern Jilin (V), Chifeng–Chaoyang (VI), eastern Hebei–western Liaoning (VII), Zhang–Xuan (VIII), and Daqingshan (IX) gold fields; and (b) the location of major gold deposits in the eastern Hebei district (modified from Guo et al., 2009). Numbers: ① = Chifeng–Kaiyuan Fault; ② = Tan–Lu Fault; ③ = Xiaotian–Mozitan Fault; ④ = Xingyang–Kaifeng–Shijiazhuang–Jianping Fault; ⑤ = Huashan–Lishi–Datong–Duolun Fault; and ⑥ = Wulian–Mishan Fault.