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Journal of Asian Earth Sciences 33 (2008) 252–266

Journal of Asian Earth Sciences

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The Shanggong gold deposit, Eastern Qinling Orogen, China: Isotope geochemistry and implications for ore genesis

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Received 10 June 2007; received in revised form 22 October 2007; accepted 31 December 2007

Abstract

The Shanggong Au deposit in the Xiong'er Terrane, East Qinling, China, has resources of about 30 ton Au, making it one of the largest orogenic-mesothermal Au deposits hosted in volcanic rocks of the Mesoproterozoic Xiong'er Group. Three stages of hydrothermal activity are recognized (early, middle and late), of which two (early and middle) were ore producing and characterized by quartz–pyrite and polymetallic sulfides, respectively. The third and late stage is represented by a carbonate–quartz assemblage. Hydrogen, oxygen and carbon isotope systematics of the Shanggong deposit from a previous work suggest that the early stage fluids were derived from magmatic and/or metamorphic devolatilization of sedimentary rocks at depth. This is supported by new C, S and published Sr and Pb isotopic data, presented in this paper. These new data, $\delta^{13}C$ values ranging from 1.5 ‰ for early stage ankerite to −2.2 ‰ for late stage ankerite, negative $\delta^{34}S$ values for sulfides from the middle stage (–19.2 to –6.3 ‰), suggest a contribution from organic matter and that the ore fluid evolved from deeply sourced to shallowly sourced, with those of the middle stage representing a mixture of these two fluid systems. The comparison of the hydrogen–oxygen–carbon–sulfur–lead–strontium isotope systematics between the Shanggong deposit and the main lithologies in the Xiong'er Terrane, shows that neither these nor the underlying lower crust and mantle, or combinations thereof, could be considered as the source of ore fluids for the Shanggong Au deposit. A likely source was a carbonaceous carbonate, sandstone, shale, chert sequence in the underthrusted Guandaokou and Luanchuan Groups, exposed south of the Xiong'er Terrane.

Ar–Ar and Rb–Sr isochron ages for mineral phases of the early, middle and late stages, together with geological field data, constrain the timing of the hydrothermal activity and Au metallogenesis at 242 ± 10, 167 ± 7 and 112 ± 7 Ma, respectively. This metallogenesis and associated granitic magmatism, can be related to the continental collision between the Yangtze and North China Cratons that resulted in the formation of the Qinling Orogen, led to the different hydrothermal systems that were responsible for the three stages that formed the Shanggong Au deposit, over a period of about 130 Myrs.
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Keywords: Qinling Orogen; Orogenic lode; Shanggong; Isotope geochemistry; Ore genesis

1. Introduction

The Shanggong Au deposit, Henan Province (central China), discovered in 1982 by the No. 1 Geological Team of the Henan Bureau of Geology and Mineral Resources (unpublished report, 1988), has a resource of about 30 ton of Au metal with ore grades averaging 6.9 g/ton Au. Since its discovery, more than 10 large (>20 ton) and medium (10–20 ton) Au deposits and one large Ag deposit (>1000 ton Ag) have been found in the region. These deposits are mainly hosted in volcanic rocks of Paleo-Mesoproterozoic age, with a few hosted in high-grade metamorphic rocks of Archean-Paleoproterozoic age. Recent studies (Mao et al., 2002; Chen et al., 2004, 2005a) show that these Au and Ag deposits belong to the orogenic class

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doi:10.1016/j.jseaes.2007.12.002

(Groves et al., 1998; Hagemann and Cassidy, 2000; Kerrich et al., 2000; Goldfarb et al., 2001). More specifically, the Shanggong Au deposit is comparable to the orogenic disseminated Au deposits as defined in Bierlein and Maher (2001). In this paper, we report the results of new C, S data and published Pb and Sr isotopic studies of the Shanggong Au deposit, which we integrated with D–O systematics and fluid inclusion studies presented in a previous study (Chen et al., 2006). The integrated isotopic data enable us to propose a model of ore genesis in the context of regional geodynamics and associated magmatism.

2. Geological setting

The Shanggong Au deposit is hosted in volcanic rocks of the ~1.8 Ga Xiong'er Group, in the Xiong'er terrane (Xiong'er Shan region; shan means mountains), Henan Province, China (Fig. 1). The Xiong'er terrane is one of the Precambrian terranes at the southern margin of the North China craton and is the result of a complex tectonic evolution related to the Mesozoic continental collision between the North China and the Yangtze Cratons (Hu et al., 1988; Zhang et al., 2001; Chen et al., 2004 and references therein). This collision produced the Qinling Orogen of central China (inset in Fig. 1), which extends for more than 2000 km, separating the North China Craton from the Yangtze Craton. The suture is marked by the Shang–Dan (Shangnan–Danfeng) fault and defines the southern boundary of the northern Qinling Orogen (Fig. 1). The tectonic evolution of the Qinling Orogen is discussed in detail by Zhang et al. (2001) and Ratschbacher et al. (2003).

The development of the Xiong'er terrane (Fig. 2) involved three main events (Chen and Fu, 1992): (1) formation of the early Precambrian crystalline basement before 1850 Ma, (2) Mesoproterozoic-to-Paleozoic accretion, and (3) Mesozoic intracontinental shortening and extension related to the collision between the North China and Yangtze Cratons. In the east and west the terrane is covered by Cretaceous to Quaternary sedimentary rocks deposited in structural depressions. The northern part of the terrane is overthrust onto the ~1300 Ma Ruyang Group (Yin et al., 2005) along the San–Bao (Sanmenxia–Baofeng) fault (Chen and Fu, 1992). Its southern part is delimited by the Machaoying fault.

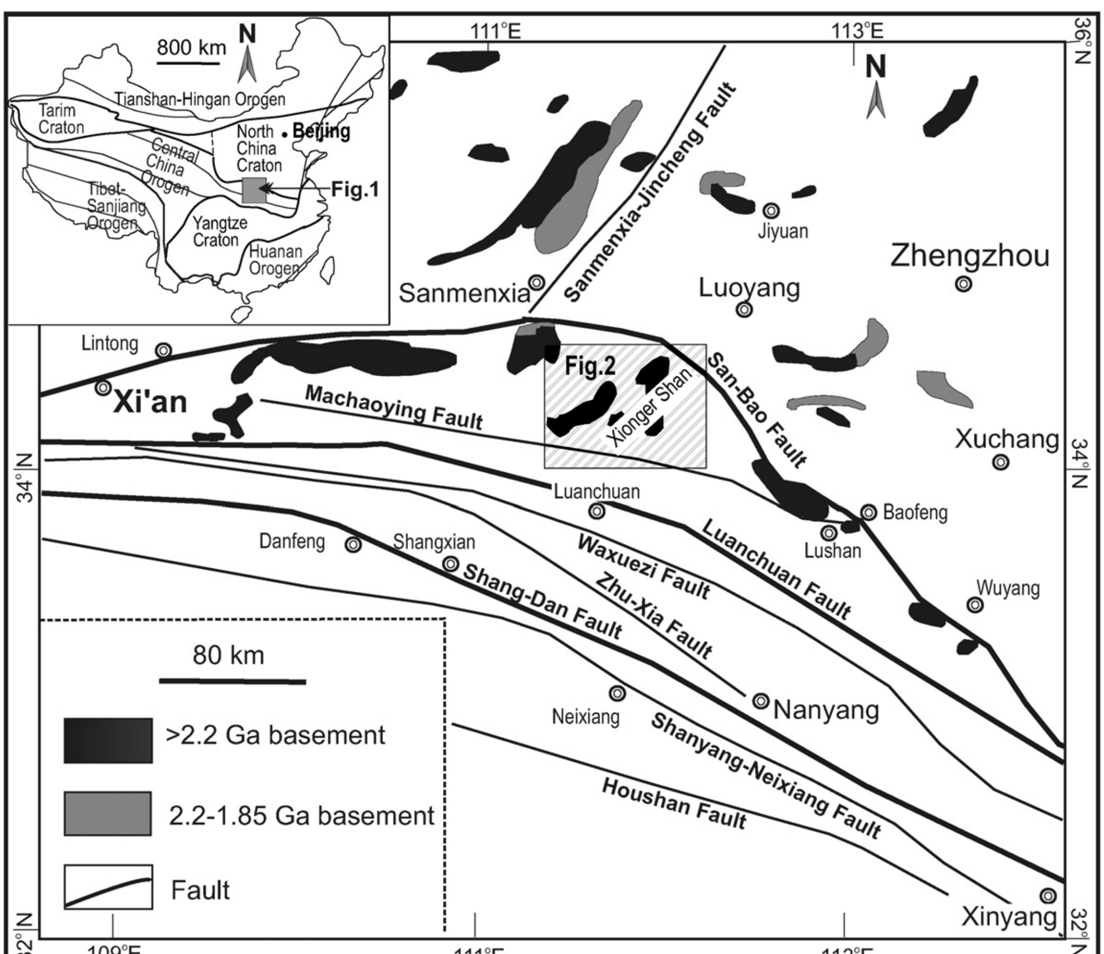

Fig. 1. Schematic tectonic map of the eastern Qinling Orogen showing the general area of study. The major tectonic domains of China are shown in the inset; note that the eastern part of the Central China Orogen is also known as Qinling Orogen.

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