Geochronology and Significance of Granites Associated with Gold Deposits in the Jidong Area, China

GUAN Kang, LUO Zhenkuan, QIU Youshou, MIAO Laicheng
Tianjin Geological Academy of China, 42 Youyi Road, Tianjin 300061,
E-mail: tggeonet@public.tpt.tj.cn
QIU Yumin, Neal MCNAUGHTON and David GROVES
Department of Geology, University of West Australia, Australia

Abstract The Jidong area is located on the north margin of the North China craton. It is a nucleus composed of the oldest rocks in China. Precambrian metamorphic rocks with various Phanerozoic granitoids invaded are widespread. Gold deposits here have close spatial relations to granitoids. Some deposits occur within them and others in the outer zone of the contact belt of the intrusion, extending thousands of metres. There have been controversial views in regard to the relations of the deposits to the intrusions although traditional techniques have been used to date the intrusions. In order to solve such a problem, the SHRIMP technique was adopted to date the U-Pb ages of zircon collected from the Yuerya intrusion which hosts the large-sized Yuerya Au deposit and Qingshankou intrusion 2 km away from the Jinchangyu (larger-sized) Au deposit. Analysis shows that the ages of 175±1 Ma and 174±3 Ma for Yuerya intrusion and the age of 199±2 Ma for Qingshankou granite indicate the Early Yanshanian stage of the Mesozoic. The Yuerya intrusion also contains inherited zircon aged at about 2500 Ma, indicating that part of its source materials are Archaean metamorphic rocks. In addition to the SHRIMP data of this study, a great deal of data related to the alteration of Au deposits indicate the formation of the deposits at the Yanshanian stage of the Mesozoic, so the ore formation of Au deposits is inferred to relate to granitic intrusion.

Key words: SHRIMP geochronology, granite, Yanshanian, East China

1 Introduction

The Jidong area is located in the Yanshan Mountains at the north margin of the North China craton. It is a nucleus composed of the oldest rocks in China and tectonically recognized as the Malanyu anticlinorium of the Yan-Liao anteclise folded belt. Precambrian metamorphic rocks with envied Phanerozoic granitoids are widely spread. Gold deposits here have a close spatial relation to the granitoids. Some occur within the intrusions, such as the Yuerya, Niuxinshan and Baizhangzi Au deposits, which are generally considered to relate genetically to and form simultaneously with the intrusions (Zou et al., 1999). Some occur in the outer zone of the contact belt of the intrusions, extending thousands of metres, such as the Jinchangyu and Sanjia Au deposits. There have been controversial views in regard to the relations of the deposits to the intrusions although traditional techniques had been used to date the intrusions (Liu et al., 1996). In order to solve the problem the author cooperated with the Department of Geology, University of West Australia. The SHRIMP technique was adopted to date the U-Pb ages of zircon collected from Yuerya intrusion, which hosts the large-size Yuerya Au deposit, and Qingshankou intrusion, 2 km away from the Jinchangyu (larger-size) Au deposit (Fig. 1). The results provide new data to explain the genetic relation of the Au deposits to the intrusions.

2 Features of the Intrusions

2.1 Yuerya intrusion

The intrusion is located in Kuancheng County, eastern Hebei Province, outcropping 0.7 km^2 and occurring as a nuclear of olive extending NE in plan and an upside-down bell in section. It intrudes in Archean metamorphic rocks and Proterozoic limestone. Lithologically it

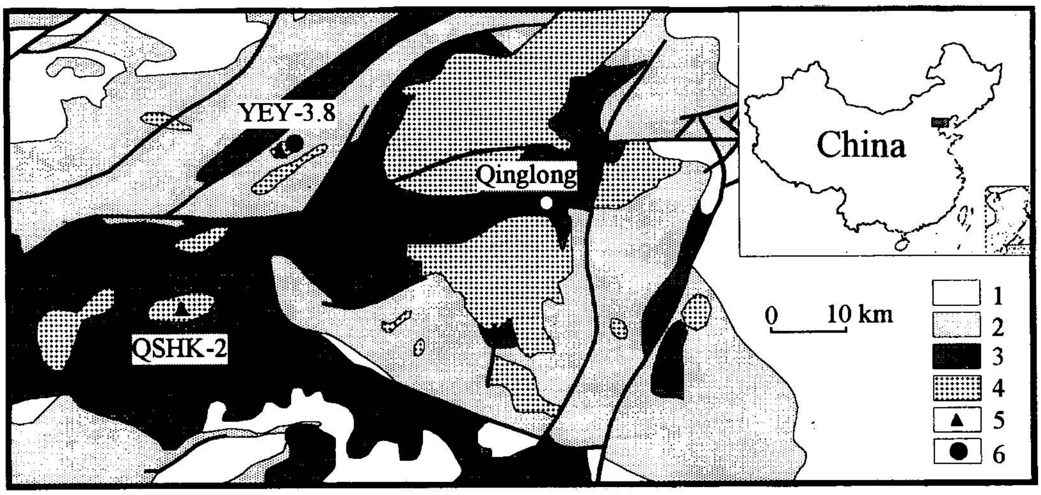

Fig. 1. Geological sketch map of the Jidong area (after the Regional Geology of Hebei Province, revised edition in 1988).
1. Cenozoic-Palaeozoic; 2. Proterozoic; 3. Archaean; 4. Phanerozoic granitoid; 5. sampling location; 6. gold deposit.

is dominated by biotite granite and divided into greyish white granite and pink granite. The pink granite is the altered greyish white granite and graded into the latter, which can be seen in the field. The latter is in medium grain texture, composed of quartz, K-feldspar (orthoclase and perthite), plagioclase (albite-oligoclase) and biotite; the former, also in medium grain texture, composed of quartz, K-feldspar (perthite) plagioclase (dominated by oligoclase) and biotite.

The large-sized Yuerya Au deposit occurs within an intrusion and the ore bodies are composed of Au-bearing sulfide-quartz lodes or Au-bearing quartz-sulfide veins and veinlets. Most researchers think that the deposit is genetically related to the intrusion. Liu et al. (1996) consider it as a porphyry Au deposit.

Some data for the isotopic age determination of the intrusion are available, such as 169 Ma by the K-Ar method (Wang, 1982), 145.0 Ma by the whole-rock Rb-Sr method (Chai, 1989), 233.8 Ma by the K-Ar dating on biotite (Sun et al., 1989). The ages are quite varied.

2.2 Qingshankou intrusion

The intrusion is located in Qianxi County, eastern Hebei Province. It is a complex intrusive body of diorite, granodiorite and granite, invading in Archaean metamorphic rocks of the Badaohe Group (Sun, 1984) and outcrops as an ellipse of an area of 28 km^2. Lithologically, it is dominated by granite, composed of quartz, plagioclase, K-feldspar and biotite in porphyry texture.

Based on spatial and geochemistry relations, Yu et al. (1989) consider the Jinchangyu Au deposit as a post-magma hydrothermal Au deposit genetically related to Qingshankou intrusion.

Previous data of isotopic age determination for the intrusion are 195.6–102 Ma (the K-Ar method) and 186.8–168.0 Ma (the Rb-Sr method).

3 SHRIMP U-Pb Dating on Zircon

The age-dating samples are crushed and washed by hand and zircon is chosen under a stereoscope. U-Pb dating of zircon is done by SHRIMP II in the University of WA.

3.1 SHRIMP age-dating of the Yuerya intrusion

Samples of YEY-3 and YEY-8 were collected from greyish white granite and pink granite of Yuerya intrusion respectively (Fig. 1).

Sample YEY-3 30 zircon grains were chosen from sample YEY-3 for SEM imaging study. The results show features of magmatic zircon with some of the grains including old cores (inherited zircon). During isotopic analysis of the 30 grains, the zircon standard (cz3) was analysed 10 times and the standard deviation in U/Pb is 0.86% (1σ). The analysis data cluster into complex populations.

The first population was obtained by analysing inherited zircon, giving a $^{207}Pb/^{206}Pb$ age of 2294±10 Ma; the second, for two points, an average $^{206}Pb/^{238}U$ age of 237±2 Ma; the third, for two points, an average $^{206}Pb/^{238}U$ age of 220±2 Ma; the fourth, 25 analytic values, the main age population, a weighted mean $^{206}Pb/^{238}U$ age of 175±1 Ma, which is considered as the formation age of the intrusion (Table 1).

Sample YEY-8 29 zircon grains were picked up for the analysis. Their SEM image scanning shows morphology features of magmatic zircon and some of them include old cores. These zircon grains were analysed 30 times and the zircon standard (cz3) 19 times with a standard deviation value being 2.5% in U/Pb. The analytic values are illustrated as complex populations in Fig. 2.

The first population includes values measured from two inherited zircon grains, giving $^{207}Pb/^{206}Pb$ ages of 2537±19 Ma and 2461±14 Ma (Fig. 2, a); the second, a $^{206}Pb/^{238}U$ age value of 215±6 Ma (Fig. 2, b) with a high common-lead correction value of 3.4%; the third, the main population of 26 points from euhedral zircons (two points, 14.1 and 21.1, were removed due to high common-lead corrections of 6.3% and 8.6%), yielding a weighted mean $^{206}Pb/^{238}U$ age of 174±3 Ma, with a chi-square of 1.8 (Fig. 2, b); the fourth, one point with a very high common-lead correction of 9.9%, i.e. evident loss of Pb, yielding a $^{206}Pb/^{238}U$ age of 45±2Ma (Fig. 2, b).

The weighted mean age of 174±3 Ma evaluated from 24 analytic values of sample YEY-8 represents the formation age of Yuerya intrusion.

U-Pb ages of 174±3 Ma and 175±1 Ma of sample YEY-3 and YEY-8 are slightly varied, thus representing the emplacement age of Yuerya intrusion and simultaneous emplacement of the greyish white and pink granites. U-Pb age of 2537±19–2461±14 Ma for xenocryst zircon imply that the intrusion originated partly from Archaean metamorphic rocks.

3.2 SHRIMP age-dating of the Qingshankou intrusion

From Qingshankou intrusion was collected an age-dating sample QSHK-2 (Fig. 1), from which 20 zircon grains were picked up for detail SEM study. They are characterized by magmatic zircon. Isotopic analysis was performed on the 20 zircon grains 20 times and on the cz3 zircon standard 14 times, which yielded a standard deviation of 1.07% in U/Pb. All the data form a tight cluster in the concordia diagram. Of the 20 analytic values, 6 have high common-lead corrections (f 206>2%), which were removed from the statistic analysis. The weighted mean $^{206}Pb/^{238}U$ age of the other 14 values is 199±2 Ma, representing the formation age of Qingshankou intrusion.

4 Conclusions

(1) 175±1 Ma and 174±3 Ma were obtained for the greyish white and pink granites of Yuerya intrusion by the SHRIMP U-Pb analysis. The age value identity indicates that they are products of the same emplacement and the lower age limit of the Yuerya Au deposit was determined. The colour difference resulted from alteration. Therefore, inference of Early Yanshanian tectono-magmatic product was made in regard to the intrusions and Au deposits.

(2) Age values of 2537±19 Ma and 2461±14 Ma gained from two inherited zircon grains indicate that part of the substances in Yuerya intrusion came from Archaean metamorphic rocks—greenstone. The Yuerya Au deposit was formed by reactivation and rework of the Archaean green stone during the Early Yanshanian.

(3) An age value of 199±2 Ma for Qingshankou intrusion gained from the SHRIMP U-Pb analysis is slightly older than that of Yuerya intrusion belonging to the Early Yanshanian of the Middle Mesozoic. The

Table 1 SHRIMP U-Pb zircon age of granites in the Jidong area

Name of intrusion	Lithology	Sample	Mean age (Ma)	Number	Age of inherited zircon (Ma)
Yuerya intrusion	Greyish white granite	YEY-3	175±1	30	2294±10
Yuerya intrusion	Pink granite	YEY-8	174±3	29	2537±19 and 2461±14
Qingshankou intrusion	Granite	QSHK-2	199±2	20	

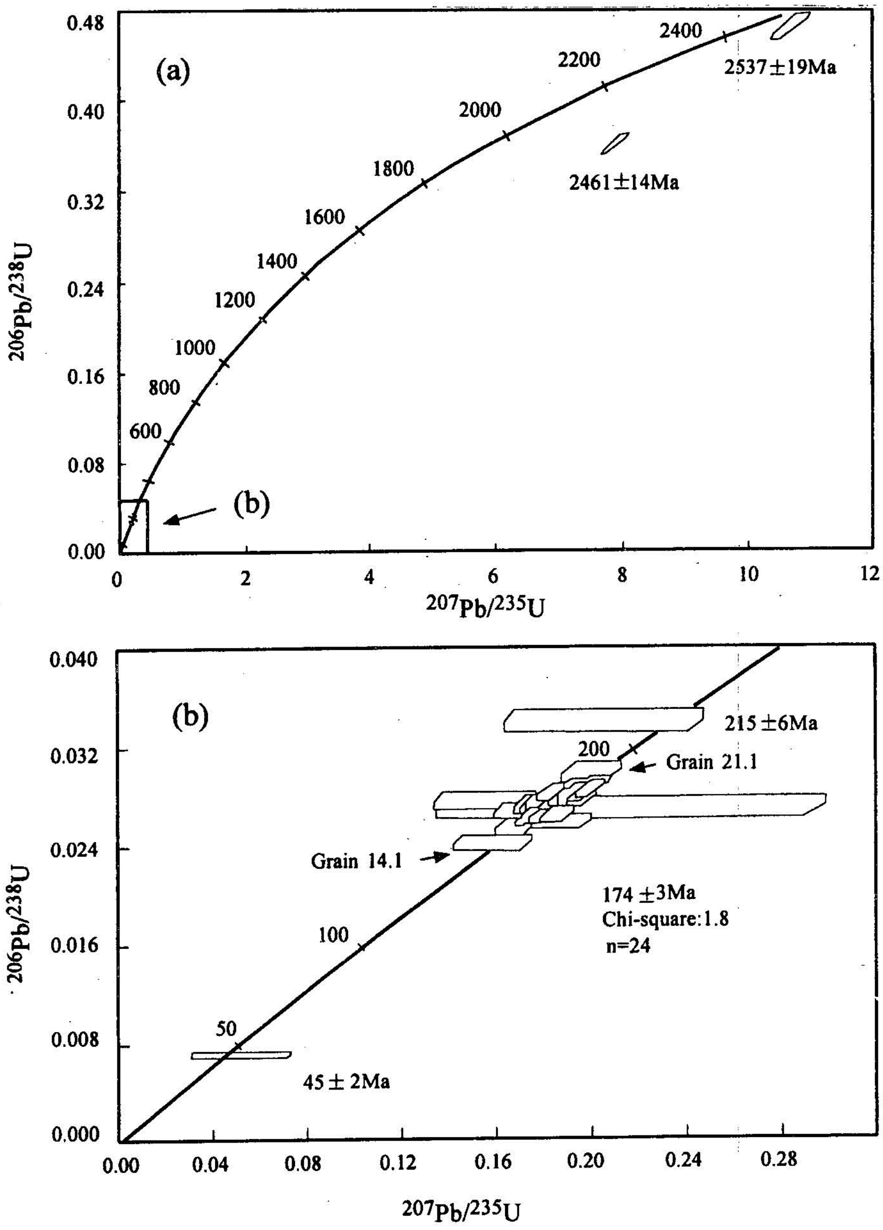

Fig. 2. Concordia diagram of zircon U-Pb for sample YEY-8.

K-Ar age of sericite and altered-rock of the Jinchangyu Au deposit is 197.1–155±2.94 Ma (Zhang et al., 1991), approximate to the SHRIMP U-Pb age of Qingshankou intrusion. Therefore, the authors infer that Au-bearing molybdenite quartz lode mineralization in the Jinchangyu Au deposit may be genetically related to Qingshankou intrusion.

Manuscript received Jan. 2000
edited by Liu Xinzhu and Hao Ziguo

References

Chai Sheli 1989. Geology and geochemistry of Yuerya gold deposit. *Journal of Changchun University of Earth Science*, (19): 271–272 (in Chinese with English abstract).

Liu Shaobo and Wang Liankui, 1996. The time gap between rock and gold ore formation. *Geological Review*. 42(2): 154–165 (in Chinese with English abstract).

Sun Dazgong, Wang Kuiyuan, Wang Junlian, Yang Chunliang and Zhao Fuming, 1989. Studies on auriferous rock series of Archaean in Eastern Hebei. *Contributions to the Project of Regional Metallogenetic Conditions of main gold deposit types in China (II: Eastern Hebei Province)*, Beijing:

Geological Publishing House, 55–56 (in Chinese with English abstract).

Sun Dahong, 1984. *The early Precambrian geology of the Eastern Hebei.* Tianjin: Science and Technology Press, 273p (in Chinese with English abstract).

Wang Yiwen, 1982. The isotopic study of major types of gold deposits of China. *Geological Review*, 28(2): 115–116 (in Chinese with English abstract).

Yu Changtao and Jia Bin, 1989. Study on the Genesis of Major Types of Gold deposits and Its Mechanism of Formation in Eastern Hebei. *Contributions to the Project of Regional Metallogenetic Conditions of main gold deposit types in China (II: Eastern Hebei Province)*, Beijing: Geological Publishing House, 33–37 (in Chinese with English abstract).

Zhang Yixia, Cun Gui, Liu Liandeng, 1996. *Gold deposits in China: Advances and considerations.* Beijing: Geological Publishing House, 205p (in Chinese with English abstract).

Zhang Qiusheng, Yang Zhensheng, Gao Deyu, Ren Hongmao, 1991. The Archaean high-grade Metamorphic Geology and Gold Deposits in Jinchangyu Area of Eastern Hebei. Beijing: Geological Publishing House, 445p (in Chinese with English abstract).

Zou Jixing, Li Fuping, Zhang Shuanghe, Zhao Zhenchun and Chen Shuqiang, 1999. Geological characteristics and gold deposits in Niuxinshan granite, Kuancheng, Hebei provice. *Geological Review,* 45(sup): 528–533 (in Chinese with English abstract).

About the first author

Guan Kang Born in 1953; graduated from Guilin Institute of Technology; senior geologist. He has long been engaged in the study of regional metallogenic patterns of gold deposits.