

Geology, Petrology and Geochemistry of Neoproterozoic Granitoids of the Qinling Orogen, Central China, and its Geological Significance

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Introduction

Intensive research carried out during the last several decades has significantly advanced our understanding of the geological and tectonic processes, especially in Phanerozoic times (Zhang et al., 2001), related to the formation of the Qinling orogen. This paper will present some new geological, geochronological and geochemical data and provides some constraints on the geological and tectonic processes took place in the Qinling orogen during Neoproterozoic.

Regional Geological Background of the Qinling Orogen

The Qinling orogen, part of the "Central Mountain Ridge" (Jiang, 1993), lies across the central region of China, stretching in an approximately east – west direction. Geologically and tectonically, this has been subdivided into three major tectonic units (Zhang et al., 2001). These are, from north to south (1) the North China Block (North China platform), (2) the Qinling orogen, and (3) the South China Block (South China platform). The Qinling orogen is sandwiched between the North China Block and the South China Block. The North China Block is separated from the Kuanping Group by the large-scale Luonan–Ruanchuan–Fangcheng fault zone. The boundary between the South China Block and the Qinling orogen is defined by the Mianxian–Chengkou– Xiangfan fault zone. The assembly between the North China Block and the South China Block occurred along the Shangnan–Danfeng suture zone during Early Phanerozoic and led to the formation of the present-day Qinling orogen (Zhang et al., 2001). This orogen has a complex geological evolutionary history and has been divided into two parts as North Qinling and South Qinling by the Shangnan–Danfeng suture zone. Apart from intensive Phanerozoic magmatic activities, a large amount of Neoproterozoic granitoids have been observed within the Qinling orogen, especially in the eastern part of North Qinling.

Geological Setting of the Neoproterozoic Granitoids

All the Neoproterozoic granitoids observed in this region are closely associated with and intruded into Palaeoproterozoic to Mesoproterozoic metamorphic rock sequences such as the Qinling Group, the Douling Group and the Fuping Group. These granitoids show different degrees of deformation, sizes and shapes. Some granitoid bodies are long

and narrow, and some of the granitoids only occupy several square kilometers. The Neoproterozoic granitoids occurring in this region are two-mica granite, biotite-granite, K-feldspar granite, granodiorite and diorite. Most of the granitoids in the area (see QL15T01, T24, T01, DQ14 and DQ100 in Table 1) are strongly deformed, showing distinct foliations (gneissic structure) and/or lineations, which have been subsequently folded. The Songshugou biotite-granite has intruded as veins, with thickness >2 m, into older granitic gneiss. The granodiorite (DQ07) is found to be cogenetic with minor amphibole cumulate and show a weak gneissic structure, while the K-feldspar granite (DQ05) is a typically massive. The above two granitoid types are observed in South Qinling. It should be mentioned that both the Qinling orogen and the South China Block have been affected by the Neoproterozoic magmatism (Li et al., 2002). However, no Neoproterozoic magmatic event has been reported from the adjacent North China Block.

U – Pb Zircon Dating of Granitoids

SHRIMP and TIMS U–Pb geochronological studies of zircon from granitoids mentioned above were carried out. The presence of euhedral zircon crystals, with typical fine magmatic zoning, in all granitoids and their high Th/U ratios indicate syngenetic character of zircons with corresponding magmatic activity. A minor proportion of inherited zircon and zircon with metamorphic rims are also found in these granitoids. Magmatic zircons from the rock samples QL15T01, T24, T01, DQ14, DQ100, DQ07 and DQ05 yielded ages of 911 ± 18 Ma (SHRIMP), 959 ± 3.6 Ma (TIMS), 901 ± 18 Ma (SHRIMP), 914 ± 10 Ma (SHRIMP), 830 ± 19 Ma (TIMS), 717 ± 10 Ma (SHRIMP) and 711 ± 11 Ma (SHRIMP) (2σ error), respectively (Table 1). These U–Pb zircon data represent the ages of emplacement of the above Neoproterozoic granitoids.

Table 1. U–Pb ages of some granitoids from the Qinling orogen and their tectonic settings.

Sample No.	Rock Type	Tectonic Environment	Age
DQ14	Gneissic biotite-granite	VAG	981.1 ± 4.6 Ma
QL15T01	Gneissic two-mica granite	VAG	959 ± 3.6 Ma
T24	Mylonitized biotite-granite	VAG	914 ± 10 Ma
T01	Gneissic two-mica granite	VAG	911 ± 18 Ma
DQ100	Gneissic biotite-granite	VAG	843.6 ± 4.4 Ma
DQ07	Granodiorite	VAG (?)	731.6 ± 0.47 Ma
DQ05	K-feldspar granite	WPG	711 ± 11 Ma

Petrographical, Petrological and Geochemical Features of the Neoproterozoic Granitoids

The mineral assemblages and textures of the early Neoproterozoic granitoids (QL15T01, T24, T01, DQ14 and DQ100) are different from each other. However, they all exhibit relatively simple mineral association. Biotite-granites consist almost exclusively of plagioclase, quartz, K-feldspar, biotite, muscovite and garnet. Two-mica

granites have equal amount of biotite and muscovite. Petrochemical studies and trace elements geochemistry of the above granitoids indicate that they have been formed in a volcanic arc tectonic environment (VAG granitoids). The late Neoproterozoic granitoids, e.g. the granodiorites (DQ07), are characterized by the presence of plagioclase, K-feldspar, quartz and amphibole and display geochemical characteristics similar to those of volcanic arc granitoids. However, all the other criteria such as weak gneissic structure in the granodiorite, its bimodal character, nearly identical crystallization ages (731.6 ± 0.47 Ma) and tectonic position with the K-feldspar granite (DQ05) do not agree with a such a model. K-feldspar granites (e.g. DQ05) mainly comprise K-feldspar and quartz, show characteristic features of A-type granites (Lu et al., 1999). Trace element geochemical study shows that K-feldspar granites have been formed as within plate granitoids (WPG type). The above granodiorite (DQ07) may have been formed in the same tectonic environment as the K-feldspar granite, and its apparent VAG geochemical character may be the result of its source rock composition.....

Summary

- (1) Geochronological data of this study suggest that three different Neoproterozoic magmatic activities occurred in the Qinling orogen at ~900 Ma, ~840 Ma and ~710 Ma ago. These magmatic events are somewhat younger than the worldwide Grenville-age events related to the formation of Rodinia supercontinent.
- (2) The early Neoproterozoic granitoids such as two-mica granites and biotite-granites are of VAG-type and are related to syn- to late-orogenic magmatic activities (compressive tectonic environment). Bimodal magmatic character of the granodiorite (DQ07) may indicate that it has been originated in an extensional tectonic setting.
- (3) Neoproterozoic magmatic events in the Qinling orogen represent only geological-tectonic processes of the north margin of the South China block . The available data are insufficient to establish the geological relationship between the Qinling orogen and the south margin of the North China Block during Neoproterozoic.

References

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