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Tectonic Evolution of the Early Paleozoic Tianshui － Wushan Tectonic Zone in the Northern Margin of West Qinling

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The Central Orogenic Belt is an important huge tectonic belt that was formed by the collision between the southern blocks and northern blocks. The conjunction of West Qinling and North Qilian orogens, situated in the central segment of Central Orogenic Belt and the northern margin of Qinghai-Tibet Plateau, is divided by the Carboniferous Xinyang-Yuanlong ductile shear belt into Qinling in the south and Qilian in the north, and extends across the longitudinal structural belt in central China. The conjunction of West Qinling and North Qilian orogens, influenced by Paleo-Asian, Tethyan and Pacific tectonic domain, is an important region to study the compound transformation of the three tectonic domains and the evolution and geodynamics of the multiple blocks' convergence (Zhang et al., 2004). Based on the Meso-Neoproterozoic tectonic history, the conjunction experienced an evolution of ocean formation, subduction and continent-continent collision in the Early Paleozoic, and the final aggregation in Late Paleozoic-Triassic (Zhang et al., 2004; Pei et al., 2009; Dong et al., 2011), and established its principal tectonic framework. The Tianshui－Wushan tectonic zone at the conjunction of West Qinling and North Qilian orogens is a critical zone to study its tectonic intersection relationship and evolution. Being the westward extension of the Shangnan－Danfeng ocean, the formation and evolution of Tianshui－Wushan ocean is an approach to analyze the Early Paleozoic tectonic framework.

The formation of Tianshui－Wushan ocean is related to the opening of Proto-Tethys ocean. The collision between the North Qinling micro-block and Longshan block in the Early Neoproterozoic (980 ~ 910Ma)is a response to the assembly of Rodinia (Pei et al., 2007a). Relevant blocks split from Rodinia in Late Neoproterozoic and reassembly converged to form the Gondwana during 600 ~ 550Ma. The formation and evolution of the Proto-Tethys in northern margin of Gondwana developed the Caledonian orogenic belt including most of the principal blocks of China (Lu., 2003). The breakup along Shangnan－Danfeng－Tianshui－Wushan at the southern margin of North China craton marked an archipelagic ocean-arc systemic branch of Proto-Tethys ocean beginning to open up. And the Early Paleozoic evolution of Tianshui－Wushan tectonic zone just is the continuation and development of Proto-Tethys ocean.

Guanzi and Wushan ophiolites are formation and spreading records of Tianshui－Wushan ocean. Guanzi ophiolite in Tianshui area contained basic volcanic rocks with N-type MORB features (Pei et al., 2004) is the early result of Tianshui－Wushan ocean in the Cambrian (534 ~ 489Ma, Pei et al., 2007b). And Wushan ophiolite mélange is composed of meta-peridotite, meta-pyroxenite, meta-gabbro and E-type MORB (Dong et al., 2007). Li (2008) reported two SHRIMP U-Pb zircon ages of 440±6Ma and 456±3Ma that indirectly restrict Wushan ophiolite mélange formed before 456Ma, probably in the early-middle of Early Paleozoic. The present geochronologies suggest that the formation and spreading of the Tianshui－Wushan oceanic crust should be at 534 ~ 456Ma (Fig.1).

In the northern margin of West Qinling, the northward subduction of the paleo-ocean represented by Guanzi and Wushan ophiolite occurred in the Early Ordovician, at the north side of which appeared the initial island-arc and fore-arc basin represented by Liziyuan Group that consisted of a suite of sedimentary-volcanic rock series containing typical Boninite. With the continuous subduction of the oceanic crust, there formed the island-arc type sedimentary-volcanic rock series represented by Caotangou Group in the Middle-Late Ordovician (Yan et al., 2007). Wang et al. (2007) reported a LA-ICP-MS U-Pb zircon age of 456.4 ± 1.8Ma for the basalt from

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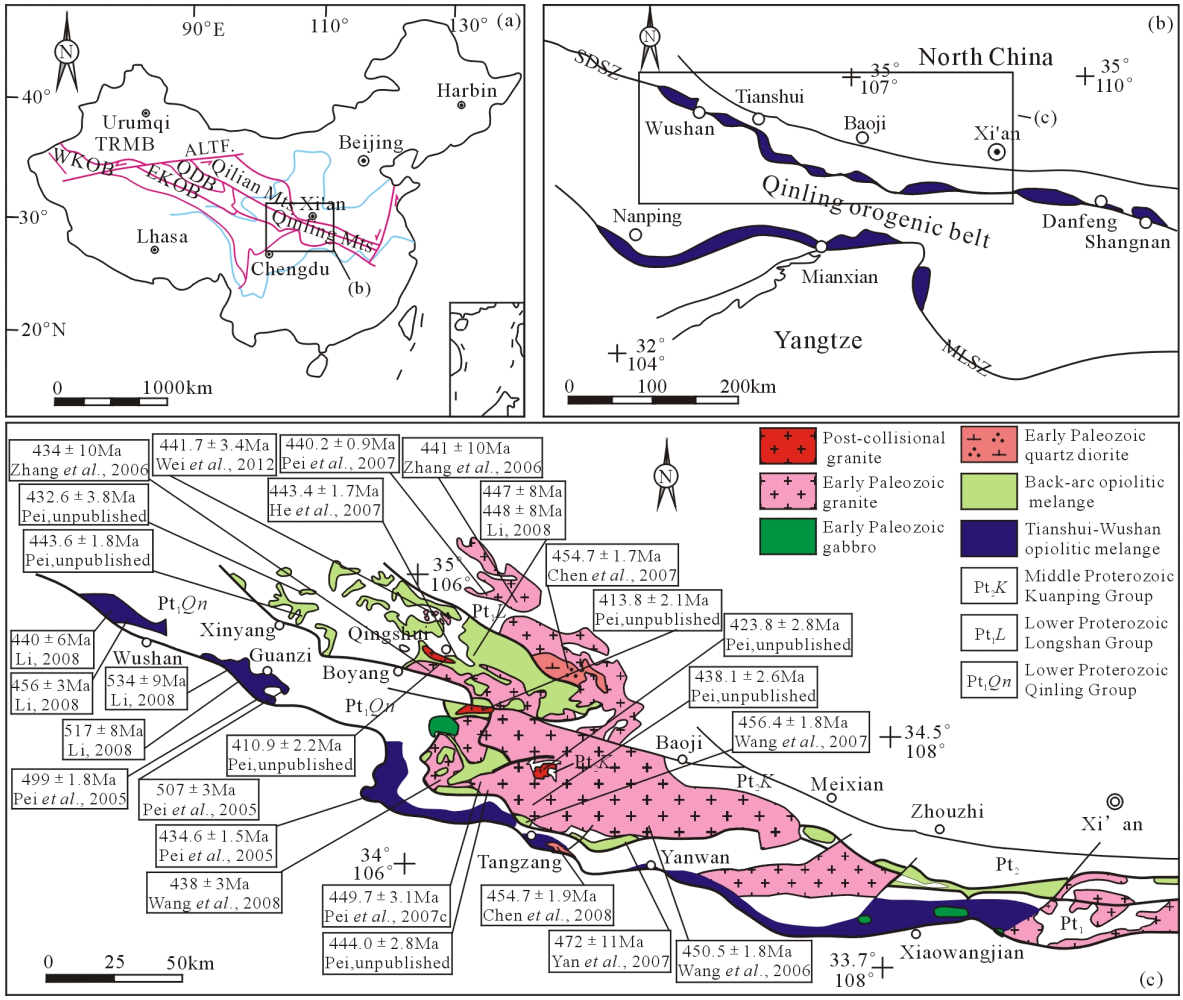

Fig.1 (a)Map showing macroscopic tectonic framework of the Central Orogenic Belt, China; (b)Showing the main tectonic divisions of the Qinling orogenic belt; (c)Simplified map with the principal tectono-stratigraphic units within the North Qinling belt and eastern section of North Qilian belt (modified after Dong et al., 2011).

Caotangou Group. The available information indicates that there are still many subduction-related magmatic rocks in West Qinling, taking into account all the available accurate ages in West Qinling, we propose that the timing of northward subduction of the Tianshui—Wushan ocean is during 472 ~ 440Ma, with peak timings of 456 ~ 440Ma, belonging to Late Ordovician-Early Silurian.

In the eastern section of North Qilian, the northward subduction of Tianshui—Wushan oceanic crust made a great number of intrusions intruded into active continental margin represented by Longshan Group. And the arc-crust began to rift with records of Chenjiahe-Hongtubao bimodal volcanic rocks, and developed into the back-arc basin represented by Hongtubao meta-basalt and Moshigou meta-basalt. Hongtubao meta-basalt resulted from the initial back-arc basin, and Moshigou meta-basalt with E-type MORB features resulted from mature back-arc basin. Additionally, according to the geochemical and geochronological information, we suggest that Huangmenchuan granite and Yanjiadian Quartz-diorite should be the results of the northward subduction of the back-arc basin. Taking into account all the available accurate ages in the eastern section of North Qilian, we propose that the magmatic response to the northward subduction of the Tianshui—Wushan ocean is during 454 ~ 440Ma, roughly similar to the intruding peak timings of West Qinling. The Early Paleozoic magmatic rocks in West Qinling and east section of North Qilian mentioned above were all the results of the northward subduction of Tianshui—Wushan ocean during 472 ~ 440Ma.

Large-scale subduction of Tianshui—Wushan oceanic crust had basically finished in the Early Silurian, then shifted to the arc-continent or continent-continent collision stage, in which the paleo-ocean and back-arc basin had closed but the marine residual basin still received deposition. The formation ages of those representative syn-collisional granites were at 438~434Ma. The low-grade metamorphic Taiyangsi Formation in West Qinling deposited in a foreland basin of the Ludlow-Pridoli of Silurian. And the low-grade metamorphic Huluhe Group

of North Qilian deposited in the Early Silurian semi-foreland basin. Both of Taiyangsi Formation and Huluhe Group were sedimentary responses to the syn-collision stage.

The differences of magmatic rocks in formation age, rock assemblage and rocks series systematically indicate that the regional tectonic stress regime at the conjunction of West Qinling and North Qilian experienced a major transformation from compression to extension in the Early Devonian. And the post-collisional Xianping, Putaoyuan and Nantouhe granites with emplacement ages of 423.8±2.8Ma, 413.8±2.1Ma, and 410.9±2.2Ma, respectively (Pei, unpublished), recorded the tectonic transformation process.

The Middle Devonian Shujiaba Group is a slope facies turbidite deposition in the marine residual basin. However, the Upper Dacaotan Group is a suit of continental facies coarse detrital rocks, which indicate a full-scale uplift of West Qinling and North Qilian. Hereto, the Proto-Tethys tectonic cycle represented by Tianshui－Wushan ocean at the southern margin of North China was over.

Key words: Early Paleozoic, Tectonic evolution, Western Qinling, Conjunction of the Qinling – Qilian orogens

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