QI Qi, WANG Yonghe, FENG Minxuan, YANG Jianguo, YU Jiyuan, WANG Lei and WANG Xiaohong, 2016. Geochronology, Geochemistry and Tectonic Significance of Dike Swarms in Beishan, Gansu. *Acta Geologica Sinica* (English Edition), 90(supp. 1): 114-115.

Geochronology, Geochemistry and Tectonic Significance of Dike Swarms in Beishan, Gansu

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Study area is located at Beishan, Gansu province. Beishan area located at conjunction site among Tarim plate, Sino-Korean plate and Kazakhstan plate, this special tectonic position has a very complex geological tectonic. During long historic geological evolution, it formed a multi-level, multi-cycle, multi-eras, multi-institution and multi-scale tectonic association（Zuo et al.，1990； He et al.，2002；Gong et al.，2003）, which tectonic forms are complex and diverse, tectonic transpositions are strongly, it is a multicycle composite orogenic belt. Therefore, this research is a very popular direction that is concerned by many geologists.

Dike swarms are the product of extensional tectonic, especially the basic dike swarms originated from deep earth (mantle or lower crust), emplaced at different crustal levels, are the product of shallow emplacement of deep magma. The research of dike swarms can be used to analyze the magma formation such as the nature of the magma source, crust - mantle interaction, crustal contamination, magma mixing, liquid immiscible to obtain the important information about properties of deep mantle, crust-mantle evolution. Magma, emplaced way, spatial-temporal distribution and tectonic style of dike swarms are always closely related to magmatic activity, regional tectonic stress field and crustal evolution, which have important geological significance. In Beishan, Niuquanzi area develops a lot of quartz diorite dikes and diabase dikes which provide good materials for the study of dike swarms.

Field research suggests that intermediate-basic dike swarms mainly strike NS or NWW, and acidic dike swarms major strike NW or EW. Through hand specimen identification and thin section identification, intermediate-basic dike swarms are diabase (porphyry) rock, acidr dike swarms are quartz diorite.

Through LA-ICP-MS zircon U-Pb dating, we measured intermediate-basic dike swarm emplacement age, which zircon oscillatory zoning is clean, Th/U ratio is between 0.42 to 0.71, greater than 0.4, indicating that they are magmatic zircons. The age of diabase is concentrated, so diabase dike swarms formed in 313.6 ± 3.3Ma, the Late Carboniferous. Through LA-ICP-MS to measure acidic dike emplacement age, which zircon oscillatory zoning is clear, obtaining zircon Th/U ratios are between 0.06 to 1.11, except two points that Th/U ratio is less than 0.4, the rest are larger than 0.4, show they are magmatic zircons. Acidic dikes have two phases of zircon ages, the older age of 377.3 ± 5.0Ma (MSWD=2.2), the younger one of 260.2 ± 4.5Ma (MSWD=3.1), the older age is consistent with surrounding rock age of 365 ± 13Ma within the error range, it is considered that dike captured surrounding rock zircon during emplacement. The younger zircon age is dikes formation age that is the acidic dike swarms formed at 260.2 ± 4.5Ma, the Late Permian.

The geochemistry analysis of diabase dikes show that major elements SiO_2 = 48.34% ~ 53.7%, with high MgO, poor K, P_2O_5, TiO_2 and Na_2O> K_2O, belong to sub-alkaline tholeiitic. Most samples display LREE enrichment characteristics, REE curves are shown as a rightist type with a weak negative Eu anomaly. Relatively enriched in incompatible elements, losses compatible elements, with positive anomalies in LILE elements (Rb, K)of , strongly low anomaly in Ta, Nb, most samples showed a weak low anomaly in Ba, significantly high anomalies in Pb, weak secondary anomalies in Ce, Ti. Significant loss in Nb, Ta may indicate dikes contaminated by crust materials. Geochemical analysis of acidic dike swarms show that SiO_2=66.48%~71.14%; TiO_2 with average of 0.44%; Al_2O_3 with an average of 15.07%; K_2O with an average of 3.18%; Na2O with an average of 4.26% , showing Na_2O> K_2O,

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CaO with average of 2.44%; P_2O_5 with an average of 0.24; A/CNK = 0.96 ~ 1.08, are peraluminous or aluminous. And they also have low MgO and CaO, high TiO_2, $K_2O$and Na_2O. Acidic dike swarms belong to high-K calc-alkaline I -type granites. REE curves show LREE enrichment and flat HREE distribution patterns. The samples have overall enrichment of incompatible elements and loss of compatible elements. Some samples have a weak negative anomaly in Eu, with poor Y, Yb and high Sr. The comprehensive analysis about acidic dikes consider they are adakite.

Diabase dike swarms tectonic discrimination diagrams show that they formed in continental-rift environment, formation age of 313.6 ± 3.3Ma are the same with occur time of the widely distributed large igneous province of Carboniferous-Early Permian in Tarim at northwest China . The comparison of main and trace elements as well as REE geochemistry, confirmed they are an integral part of large igneous province which are the surface response for mantle plume acting in the Beishan area. Combined K calc-alkaline I-type granites and adakites characteristics of quartz diorite dike swarms, we think they formed in extensional environment of thickened crust, speculated they formed through that rift closing lead to crustal thickening and lower crust partial melting, with the crustal rheological delamination, thermal extention and magma emplacement into the shallow crust. To confirm that Beishan area occurred extensional events at 257.8 ± 2.4Ma of the Late Permian. This new discovery provides evidence for correct the understanding tectonic evolution of Beishan area at Late Paleozoic, as well as provides a new constraint for rift closure time of Beishan.

Acknowledgements:

This study was financially supported by Geological survey project of China Geological Survey（Grant：12120113046400 and 12120119046700）。

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