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P-type ophiolite in the Lajishan, Qilian orogenic belt, NW China: mantle-plume activity in Cambrian ocean basin

Zhang, Y.Q.[1], Song, S.G.[1]

[1] School of Earth and Space Sciences, Peking University, Beijing 100871, China. yqzhang@pku.edu.cn

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Ophiolites represent fragments of upper mantle and oceanic crust that were incorporated into continental margins during interplate collisions. The spatial association of pillow basalts, sheeted dykes, and other ultramafic intrusions represent preserved cross-sections through oceanic crust and upper mantle. So one of the most successful paradigms in attempting to decipher the origin of mafic igneous rocks in the geological record has been the ophiolite model [1].

The Qilian orogenic belt at the northern margin of the Qinghai-Tibetan Plateau recorded a complete history of a Wilson circle during the Neoproterozoic to the Paleozoic. Ophiolite is ubiquitous from the southeastern to northwestern of the belt, representing the oceanic lithosphere of the ancient Qilian Ocean. The Southern Ophiolite Belt represent the oceanic crust generated at an ocean ridge, while the Northern Ophiolite Belt are consistent with formation in a back arc spreading center (supra-subduction zone (SSZ) type ophiolite) [2].

The Lajishan ophiolite is composed of voluminous mafic vocanic rocks (pillow and massive lavas and mafic dikes) associated with minor pelagic sedimentary rocks (chert). Three groups can be subdivided according to the Lajishan basalts' geochemical features. Group 1 sub-alkaline basalts with E-MORB affinity, Group 2 alkaline basalts with OIB features that were derived from the partial melting of a deep and enriched mantle source. Group 3 high-Mg basalts with MgO contents of 19-20 wt. %. The calculated potential temperature of mantle (T_p) is 1582-1642°C by using PRIMELT2 software [3], which is obviously higher than that of the modern mid-ocean ridge basalts and close to that of the Hawaii picrites [4]. The higher T_p demonstrates an anomalously hot mantle source. Based on series of evidence (geological, geochemical and isotopic data), we propose that the basalts from Lajishan ophiolite complex formed in an intra-oceanic setting, so the Lajishan ophiolite conform to the definition of Plume-type ophiolite which related to the plume activity [5]. One gabbro sample was selected for LA-ICP-MS zircon U-Pb dating, yielding a Concordia age of 525 $\pm$ 3Ma, which represent the ophiolite formed in the Early Cambrian age.

"Trench jam" can explain the emplacement of the Lajishan P-type ophiolite complex [6]. The 525Ma plume activity in Qilian Ocean formed an oceanic plateau. This plateau moved with the oceanic crust while the crust subducted until finally collided with the continental margin. Because the oceanic plateau was too buoyant to subduct, the sizable buoyant mass would jam the trench so the oceanic plateau can preserve as Lajishan ophiolite complex distributed in south Qilian orogenic belt.

We conclude that the Lajishan P-type ophiolite is the remnant of an oceanic plateau and records a mantle plume activity in the Early Cambrian, similar to present-day Hawaii hotspot.

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