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Tectonic evolution of the West Qinling Orogen from ocean spreading to IBM type subduction

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The West Qinling Orogen (WQO) is located in the middle part of the Qinling-Qilian-Kunlun orogenic belt, and plays important role in linking Qilian orogenic belt and Qinling orogenic belt. The early-Paleozoic accretionary complex in WQO consists of two lithological groups: (1) The mid-ocean ridge basalt (MORB) unit; (2) The island-arc unit (including island arc tholeiitic basaltic-andesites, and boninites).

The mid-oceanic ridge basalts in the Guanzizhen ophiolite, display N-MORB geochemical characteristics. On the Nb/Yb vs. Th/Yb diagram, they plot within the unmodified mantle array. Zircon U-Pb SIMS and LA-ICP-MS dating shows the ages of meta-gabbro are 548-503 Ma, which are coincide with the formation age (from ca. 534 Ma at least to ca. 457 Ma) of Shangdan oceanic crust [1].

The island arc rock assemblage consists of tholeiitic basalts and andesites with low Ti/V ratios (14.4~16.5), high LILE and fluid-solute elements (Cs, Rb, Ba, Th, U, Pb), and negative Nb-Ta and Zr-Hf anomalies, suggesting that they were derived from more depleted SSZ mantle wedge with the contribution of an arc-like component (enriched in fluid mobile elements and LILE). Zircon U-Pb dating results show the subduction along the Shangdan zone occurred from ca. 514 to ca. 422 Ma [1].

The boninites are magnesian (MgO = 8.00–14.42 wt %) andesitic (SiO₂ =52.98–57.62 wt %) with exceedingly low TiO₂ (0.29–0.49 wt %) and high Ni (177~469ppm) and Cr (547~2068ppm). They were formed by partial melting of a depleted, cpx-poor lherzolite source with the involvement of slab-derived hydrous fluids/melts. The evolution from high-Ca boninite (HCB) to low-Ca boninite (LCB), featured by obvious L-MREE enrichment, relatively decreased CaO/Al₂O₃ and TiO₂/Zr ratios with increased SiO₂ and Na₂O values, reflect the slab-derived enriched components transformed from LILE-rich hydrous fluid to silicate melts including Si, Na, LILE and LREE[2].

The N-MORB volcanic rocks, plus cumulate gabbro and peridotite, with the ages of 548Ma and 503Ma, compose a typical ophiolite assemblage, and are interpreted as the products of mid-oceanic ridge during the spreading of Shangdan Ocean in Cambrian. While the island-arc-type rocks are considered to represent the earliest products of infant arc magmatism by advanced degree of mantle melting influx with from slab-derived hydrous fluids to silicate melts during “late protoforearc spreading”, which is just like the third stage of “subduction initiation rule” mentioned in the modern IBM arc-trench system [3]. Therefore, the WQO is a key record of the tectonic evolution from ocean spreading to Izu-Bonin-Mariana (IBM)-type subduction.

References:

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[3] R. J. Stern, et al. (2012) *Lithosphere* 4, 469–483

