A Model for the Tectonic Evolution of the Tethys-Tibetan Plateau System and Implications for Continental Tectonics in China

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An integrated petrologic, geochemical and geochronological study of magmatic-tectonic-assemblages (volcanic and plutonic rocks and ophiolite suites) from the Greater Tibetan Plateau has led to a new model for the tectonic evolution of the Tethys-Tibetan Plateau system: opening of the Tethyan oceans followed by initial subduction, subduction/collision, post-collision and uplifting. The evidence for this comprehensive model comes from (1) Sm-Nd and ^{40}Ar-^{39}Ar ages of gabbros in ophiolite suites (180–204 Ma) from both Yarlung Zangpo and Bangong-Nujiang sutures reflecting the timing of the opening of the two ocean basins at J_1, probably under the influence of a super-plume. (2) Ages of subduction-related lavas: ~140–170Ma in the Bangong-Nujiang suture and ~ 65–170Ma in the Yarlung Zangpo suture. Among these lavas, boninite and boninite series, which are generally regarded as the indicating an early state of subduction initiation, have been recognized at both the northern and southern edges of the Gangdese block (Zhang, 1985; Qiu, 2004, 2007). The harzburgite-IAT-boninite association indicates that both Bangong-Nujiang and Yarlung Zangpo are SSZ ophiolites (Qiu, 2007). (3) O-type adakite rocks, among the igneous rocks next to the ophiolite belts with the ages of about 75~139Ma in Bangong-Nujiang and of about 40~110Ma in Yarlung Zangpo with low (^{87}Sr/^{86}Sr)i (0.7041~0.7064), positive ε Nd(t) (+2.5 ~ +5.7) and young T_{DM} ages (312–562Ma) show their subduction origin. (4) Collision of the continental mass with the island-arc systems in the Bangong-Nujiang ocean basin indicates its closure by the end of K_1, and the India-Asia collision at K_2/E (~65Ma; Mo, 2003; Zhou, 2004) is consistent with the closure of the Yarlung Zangpo ocean basin. These explain the large-scale magmatism at the northern (75–95Ma) and southern (65–40Ma) Gangdese. (5)With the continuous northward subduction of Indian plate, a lithospheric root was formed. C-type adakites can be regarded as the orogenic lithosphere delamination episode (Qiu, 2006). The occurrences of C-type adakite of 45–9.4Ma in the Qiangtang (Lai, 2003) and 10–18Ma in the Gangdese (Cai, 2004; Hou, 2004) suggest that the delamination happened first in the Qiangtang, before in the Gangdese. At the same period of delamination in the Gangdese, intra-continental subduction occurred in the Himalayas to form the muscovite-biotite granite belt of 20–10Ma. In brief, the above tectonic evolution model is shown in Figure 1.

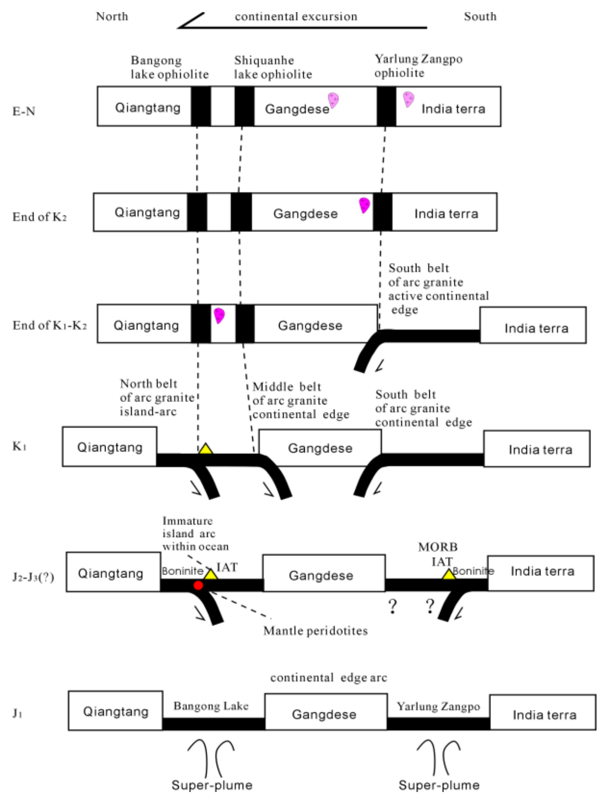

Figure 1. Tectonic evolution of the Greater Tibetan Plateau

Figure 2 (after Qiu, 2006) shows the five types of lithosphere in continental China, whose characteristics are consistent with being produced by processes described above for the Tethyan-Tibetan Plateau system.

Since the Triassic, the dominantly N-S compressional regime in continental China changed to an E-W dominated compressional regime. In western China, the Tethys Ocean opened in the Mesozoic and underwent compressional orogenies in the Cenozoic, forming the Tethys-Himalaya orogenic-type lithosphere. In the Cenozoic, due to bi-directional (north- and south-directed) compression in western China and extension in eastern China, the Qinghai-Tibet Plateau expanded and evolved into the western segment (Qilian and Kunlun) of the Qinling-Qilian-Kunlun orogenic belt, thus forming the Cenozoic orogenic-type lithosphere with “old material and new structure”, while in Xinjiang the Paleozoic orogenic belts, such as Tianshan and Altay, “rose again” and became the Cenozoic orogenic-type lithosphere with “old material and new structure”, with only the Paleozoic Central Asian orogenic-type lithosphere represented by that of Ejin Qi remaining. The east part of continental China underwent compressional orogenies in the Mesozoic and extensional rifting in the Cenozoic. The Cenozoic rifting gave rise to the rift-type lithosphere in the Songliao plain, North China plain and sea areas off Fujian and Guangdong and only in Northeast China, North China and North China did the Yanshanian lithospheres represented by those in the Da Hinggan and Yanshan-Taihang mountains and central segment of the Nanling Mountains remain. In the Late Cenozoic, the oceanic type lithospheres represented by the Central basin of the South China Sea formed with further expansion of the rift-type lithosphere in eastern China. After undergoing rifting in the Cenozoic, the pre-Cenozoic continental margins in eastern China were separated and interacted with the Pacific plate, thus forming the island arc-type lithosphere represented by that of Taiwan.

The above observations and interpretations suggest that the evolutional process of the Tethyan system in Qinghai-Tibetan Plateau is one of the most importance factors for the dynamic process of continental China and for the formation of different lithosphere types. The coexistence and formation of the different types of lithosphere in continental China also indicate that Qinghai-Tibetan Plateau is one of the best sites to study continental dynamics in China, and is perhaps of global significance.

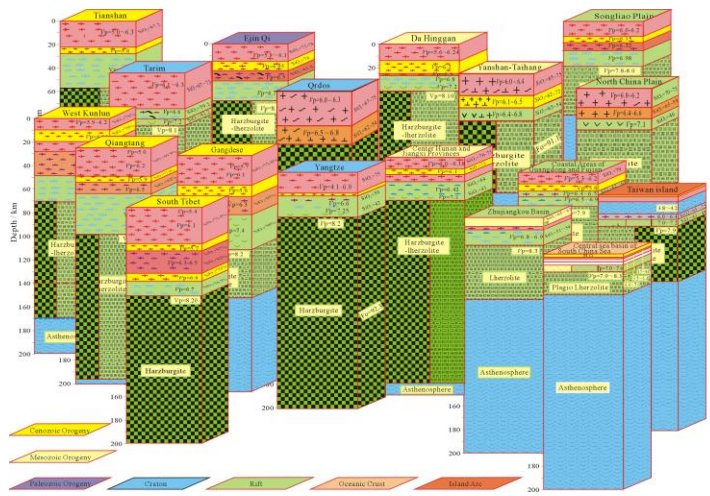

Figure 2. Present lithosphere types in continental China.

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