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Pervasive melting of thickened crust from Lhasa terrane to Himalaya constrained by Miocene dykes in southern Tibet

Wei-Qiang Ji
Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China (jiweiqiang@mail.iggcas.ac.cn)

The southern Tibet show obviously regional variation in the Oligocene-Miocene magmatism along different sides of the Yarlung Tsangpo suture zone (YTSZ), although the Lhasa terrane to the north and the Himalayas to the south have been unified since the Indo-Asian continental collision in the early Tertiary. The ultrapotassic rocks and calcalkaline adakites in the Lhasa terrane reflect partial melting of lithosphere mantle and thickened lower crust, respectively, while the coeval Himalayan leucogranites are considered to be pure crustal melts derived from metasediments without mantle component. Why do the adjacent and united two geologic units contrast with each other so much in magma nature revealing different dynamic processes in depth?

We conducted detailed studies on a special magma type—dyke which is widespread in southern Tibet pervading from the Lhasa terrane through the YTSZ to the Tethyan Himalaya. Most volcanic eruptions and pluton emplacements are initiated by dyke intrusions, which nucleate when the pressure inside an inflating magma reservoir exceeds a threshold value. Dykes and magma bodies are different magma types in the middle to upper crust to image the melt generated in the middle to lower crust in active orogens. Thus southern Tibet dykes provide a unique chance for studying and comparing the dynamic processes among different regions. The dykes can be classified into various lithologies including minette, aplite, granodiorite porphyry and granite porphyry. All the minette dykes and some aplite dykes trend along north-south direction and show high dip angles even vertically, while granodiorite porphyry dykes and most aplite dykes trend along east-west direction. In the Tethyan Himalaya, the granite porphyry dykes mainly show concordant emplacement into the Mesozoic strata.

Radiometric dating by SIMS and/or LA-ICP-MS methods for zircon, monazite and titanite from these dykes indicates that they were all generated in middle Miocene (15-10 Ma). The granite porphyry dykes from Tethyan Himalaya show adakitic characteristics and depleted isotopic compositions [e.g., positive εHf(t) values] which are in sharp contrast with that of the Himalayan leucogranites but resemble that of the aplite and granodiorite porphyry dykes from the YTSZ and the Lhasa terrane. The identification of juvenile components in the granite porphyry dykes from the Tethyan Himalaya indicates the potential contribution of depleted mantle because the Himalaya is underlain by ancient basement. The minette dykes from the YTSZ and the Lhasa terrane were generated by partial melting of metasomatized lithospheric mantle. Together with literature and our unpublished data, it is implied that there was pervasive melting of thickened lower crust in southern Tibet in middle Miocene ascribed to mantle contribution.