# Late Cretaceous adakitic intrusions in the Gangdese batholith, southern Tibet: Evidence for re-melting of thickening lower crust and flat subduction

Da-Ren Wen [a], Biao Song [b], Jianqing Ji [c], Yoshiyuki Iizuka [d], Sun-Lin Chung [a], Dunyi Liu [b], Huai-Jen Yang [e], Qi Zhang [f]

a. Department of Geosciences, National Taiwan University, Taipei, Taiwan
b. Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China
c. School of Earth and Space Sciences, Peking University, Beijing, China
d. Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan
e. Department of Earth Sciences, National Cheng Kung University, Tainan, Taiwan
f. Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China

## Abstract

The Gangdese batholith in southern Tibet has been conventionally recognized as part of an Andean-type arc resulted from northward subduction of the Neo-Tethyan slab beneath Eurasia. Beneath the batholithic root, re-melting of hydrous, newly underplated mafic lower crust can produce voluminous silicic magmas for crust growth. As partial melts of the base of continental crust equilibrate with different pressure-sensitive residual minerals in each different magmatic episode, relative crustal thickness can be "monitored" from the chemical variation of the magma source. Following this idea, we examine the epidote-bearing granitoids in the eastern Gangdese batholith to reveal different development of the continental arc during the Late Cretaceous. SHRIMP zircon U-Pb dating of two such samples yields weighted $^{206}Pb/^{238}U$ ages of 80.4 ± 1.1 and 82.7 ± 1.6 (2σ) Ma, but with plenty of major ~100 Ma and minor ancient inherited ages. Various independent geothermobarometric calculations indicate that the emplacement P-T conditions are around 730–765 ˚C and 8.5 ± 1.8 (2σ) kb, corresponding to mid-lower crust level of 26–40 km. Moreover, the notable resorption texture of magmatic epidote and muscovite further reveals that the intrusions have formed not only at high pressure but also in a rapid ascent/unroofing setting. These deep-seated tonalitic–granodioritic plutons are sodium-rich, peraluminous, and low Mg# in composition. Especially the adakitic geochemical characteristics, such as apparently high La/Yb ratios and low Y and HREE concentrations, suggest an origin from partial melting of garnet-bearing amphibolite at even higher pressure (≥ 1.2 GPa). Their isotopic compositions of the higher $^{87}Sr/^{86}Sr_i$

= 0.7044–0.7048 and the lower $\varepsilon_{Nd}(T)$ = 0.2–3.0, are also distinct from those of previous Gangdese arc magmas. Our systematic data point to the origin that the intrusions were generated from partial melting of thickened, juvenile lower crust formed by ~100 Ma magma underplating, with some assimilation by ancient continental material. Analogous to the flat-slab segments of the modern Andean or the contemporaneous Laramide orogen, the adakitic intrusions and the consequent dormancy of arc magamatism suggest a thickened crust by tectonic contraction due to flattening of the Neo-Tethyan subduction, indicating that southern Tibet was situated in an accretionary margin where orogenic processes involving magmatic accretion, crustal thickening and rapid tectonic uplift had been operating actively during the early Late Cretaceous.