Reworking of newly added mafic crust: Geochemical evidence from Late Cretaceous monzogranites of the Gangdese batholith, southern Tibet

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A combined study of zircon U-Pb ages and Lu-Hf isotopes, whole-rock major-trace elements and Sr-Nd-Pb isotopes was carried out for the late stage of Late Cretaceous monzogranites from the Gangdese batholith in southern Tibet. The results place constraints on the origin of these monzogranites and provide new insights into the effect of source composition and fractional crystallization on their geochemical variations. LA-ICPMS zircon U-Pb dating suggests that they were generated at 77 to 80 Ma. Relict zircon cores give three groups of U-Pb ages, which are Late Cretaceous, Early Permian and Late Devonian to Early Carboniferous, respectively. They have depleted whole-rock Sr-Nd isotope compositions with initial $^{87}Sr/^{86}Sr$ ratios and $\varepsilon_{Nd}(t)$ values similar to those of the early stage of Late Cretaceous mafic rocks in the Gangdese batholith, their Pb isotopes are consistent with the Gangdese intrusive rocks of 60 to 100 Ma. Relict zircons exhibit $\varepsilon_{Hf}(t)$ values similar to those of the Gangdese mafic rocks with the corresponding U-Pb ages. These results indicate their derivation from partial melting of the mafic lower crust of south Tibet, which predominantly consists of the early stage of Late Cretaceous mafic rocks with minor Late Paleozoic mafic rocks. The monzogranites show adakite-like geochemical features with high Sr/Y and La/Yb ratios. As SiO_2 increases, their Sr/Y and La/Yb ratios rise and peak at ~68 to 70 wt.% SiO_2, followed by decrease with further increase in SiO_2. The less fractionated samples have Sr/Y ratios comparable to the early stage of Late Cretaceous mafic rocks. These results indicate that both source composition and fractional crystallization can contribute to their high Sr/Y ratios. Therefore, the monzogranites were derived from partial melting of newly added mafic crust at normal crustal pressures rather than thickened lower crust due to the northward subduction of the Neo-Tethyan oceanic lithosphere under Asia before the India-Asia collision.