Origin of Early Cretaceous high-Ti and low-Ti mafic dike swarms in the Wulong gold district, eastern North China Craton

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The North China Craton underwent a dramatic change in lithospheric architecture, with more than 100 km of ancient lithospheric mantle removed and replaced. However, the timing and mechanism of the lithospheric thinning remain controversial. This paper presents new zircon/apatite U–Pb geochronology and geochemical data of the Early Cretaceous low-Ti (TiO_2<1.2, Ti/Y<370) and high-Ti (TiO_2>1.9, Ti/Y>580) mafic dike swarms in the Wulong gold district, eastern North China Craton. The low-Ti dikes include diorite, lamprophyre, and diabase, with formation ages of 130–126 Ma. They are enriched in Pb and depleted in HFSE coupled with mantle-like signatures (e.g., high Mg-Cr-Ni). The diorites show inversely zoned phenocrysts with Mg- and Cr-rich rims, relatively radiogenic Sr ($(^{87}Sr/^{86}Sr)_i$ = 0.7133–0.7143), and less radiogenic Nd ($\varepsilon_{Nd}(t)$ = -20 to -18), indicating that they were mainly derived from ancient lower crust with subordinate contributions of enriched lithospheric mantle. The lamprophyres and diabases are similar and possess lower initial $^{87}Sr/^{86}Sr$ ratios (0.7063–0.7123) and higher $\varepsilon_{Nd}(t)$ values (-17 to -5). We suggest that they were formed by partial melting of an ancient and enriched lithospheric mantle, with different digrees of crustal assimilation and fractional crystallization during the magma ascending. In contrast, the high-Ti dikes are mainly composed of the diabases which were emplaced at ca. 115 Ma. They have OIB-like trace elements and Sr-Nd isotopic compositions (e.g., high Nb/U values (42 ± 5), depletion of Pb but rare HFSE depletion, and positive whole rock $\varepsilon_{Nd}(t)$ values (+3 to +4)), suggesting that they are derived from partial melting of a convective asthenospheric mantle. In general, the asthenosphere beneath an old craton cannot melt until the thickness of the lithosphere is markedly thinned. Therefore, we propose that a large scale lithospheric thinning of the North China Craton is occurred during 126 to 115 Ma. The Paleo-Pacific plate subduction is a favorable geodynamic mechanism to accout for this thinning event.

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