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Genesis of Mesozoic high-Mg dioritic rocks from the eastern North China Craton: Implications for the evolution of continental lithosphere

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Abstract

Pre-Cenozoic high-Mg andesites (HMAs) are mostly present in continental interiors, but their genetic relationship with continental lithosphere evolution remains unclear because of uncertainties of their mantle source, magmatic processes, and physicochemical conditions of formation. Early Cretaceous high-Mg dioritic rocks (HMDs, analogs of HMAs) of the Jinling complex in the Luxi area are typical intra-plate intrusions of the eastern North China Craton (NCC) and can be subdivided into two groups (Group-I and -II) on the basis of their petrographic and geochemical features. Group-I HMDs show low SiO_2 contents (52.47–56.10 wt%) and Sr/Y (34.5–39.6) and $(La/Yb)_N$ (10.3–13.6) ratios but high contents of MgO (7.86–9.13 wt%), Y (18.3–20.3 ppm), Yb (1.43–1.47 ppm), and compatible elements (Cr = 407–585 ppm; Ni = 117–216 ppm), classifying as sanukitic rocks. Group-II HMDs are characterized by high SiO_2 contents (63.81–64.87 wt%) and Sr/Y (47.1–63.4) and $(La/Yb)_N$ (16.1–17.5) ratios with low MgO (2.90–3.08 wt%), Y (0.88–1.04 ppm), Yb (0.88–1.04 ppm), and compatible elements (Cr = 201–213 ppm; Ni = 55–57 ppm) contents, belonging to adakitic rocks. Group-I and Group-II HMDs of the Jinling complex are closely related in spatial and temporal distribution, and all have enriched Sr-Nd isotopic compositions and arc-like trace element patterns with abundant hydrous minerals. Therefore, the Jinling HMDs should share a common source of ancient sub-continental lithospheric mantle that was metasomatized by aqueous fluids derived from the subducted Paleo-Pacific slab. The Jinling HMDs were not formed from interaction between slab-derived melts and mantle-wedge peridotites but were instead derived from partial melting of hydrous mantle peridotites in the continental interior of the eastern NCC. The distinctly different petrography, geochemistry, and mineralogy of the two groups of rocks resulted mainly from differing magmatic processes at crustal depths. Thus, Pre-Cenozoic intra-plate HMAs/HMDs are genetically distinct from Cenozoic HMAs that were mostly present in arc settings and generally represent juvenile crust growth. In a way, Archean tonalitic-trondhjemitic-granodioritic rocks (TTG) and sanukitoids, geochemically similar to HMAs/HMDs, could also be derived from interaction between slab-derived melts and mantle-wedge peridotites in arc settings or partial melting of hydrous mantle peridotites in continental interiors, and thus might not always be related with continental crustal growth and the onset of plate subduction.

Keywords: High-Mg dioritic rocks, magmatic processes, fluid metasomatism, sub-continental lithospheric mantle, North China Craton