Apatite rare earth element abundances as a tool to recognize the granite petrogenesis: Applications to Mesozoic granitic rocks in S China

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ABSTRACT

The systematic and distinctive differences in rare earth element (REE) abundances, distribution patterns, and ratios have been successfully used to discriminate source-different S-type granites and I-type granites of the Lachlan Fold Belt in Australia. On this basis, REE abundances of apatites from typical S-type and I-type granites of Cathaysia Block in S China are used to compare with Early Yanshanian granitic rocks from Huashan, Kuidong, Jiufeng and Fogang batholiths using the method of LA-ICP-MS. Apatites from Indosinain S-types (Darongshan) show convex-upward REE distribution patterns, with significant depletions of LREE ($(La/Sm)_N$ = 0.57-0.69, $(La/Yb)_N$ = 0.94-1.22) and Eu (Eu/Eu* = 0.01) and slight Nd anomaly. In contrast, apatites from Late Yanshanian I-types (Zudi and Yanqian) are characterized by right-inclined REE distribution patterns, with LREE enrichment ($(La/Sm)_N$ = 1.49-10.7, $(La/Yb)_N$ = 5.80-34.7), small Eu anomaly (Eu/Eu* = 0.12-0.40) but no Nd depletion. Besides, in apatites from S-types the most abundant element of the REE group is Y, while in apatites from I-types the most abundant one is Ce. As a result, apatites from Huashan, Kuidong and Jiufeng have right-inclined REE distribution patterns, LREE enrichment ($(La/Sm)_N$ = 0.97-1.44, $(La/Yb)_N$ = 1.39-5.85), slight Eu anomaly (Eu/Eu* = 0.12-0.36) and no Nd depletion, whereas those from Fogang have convex-upward REE distribution patterns ($(La/Sm)_N$ = 0.58-1.01, $(La/Yb)_N$ = 1.3-2.5), distinct depletion of Eu (Eu/Eu* = 0.02-0.05) and no Nd depletion. When Sr and Nd isotopic compositions of these batholiths are concerned, Early Yanshanian granitic rocks (I_{Sr} = 0.71121 to 0.72260 and $\varepsilon Nd_{(T)}$ = -9.2 to -12.2) fall between the Indosinian S-types (I_{Sr} = 0.7219 to 0.7300 and $\varepsilon Nd_{(T)}$ = -9.4 to -12.1) and Late Yanshanian I-types (I_{Sr} = 0.7045 to 0.7077 and $\varepsilon Nd_{(T)}$ = -4.8 to –5.6). All these observations suggest that Early Yanshanian granitic rocks are intermediate between I-types and S-types, and granitic magmas of different stages progressively evolved with mantle involvement. Furthermore, there is clear evidence of strong relationships between granitoid types and geodynamic environments. Therefore, characteristic REE abundances, distribution patterns, and ratios of apatites are able to identify different sources of granitic rocks in S China, applied to granite petrogenesis and potentially used as geodynamic tracers.

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