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Combined O-Nd-Sr-Pb isotopic constraints on the diverse origin of A-type granites in eastern China

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Debate continues on the origin of A-type granites, which usually occur in extensional tectonic settings, and which have alkaline and anhydrous imprints. In order to constrain the potential source(s) of A-type granites, a combined study of zircon $\delta^{18}O$ values, whole-rock Nd and Sr isotopes, and feldspar Pb isotopes was conducted for five well-characterized late Mesozoic A-type granite plutons in eastern China. From north to south, they are Nianzishan, Shanhaiguan, Laoshan, Suzhou, and Kuiqi plutons, respectively.

Compared to the "mantle zircon" $\delta^{18}O$ value of 5.3±0.3‰, uniformly low zircon $\delta^{18}O$ values and high-T equilibrium fractionations were observed for A-type granites in eastern China. These are best ascribed to derivation from low $\delta^{18}O$ magmas, whose protoliths with igneous affinity experienced surface fluid alteration under subsolidus conditions. In other words, A-type granites in eastern China originated from reworking and/or recycling of crust, and not directly from primitive mantle.

Three subgroups can be clearly identified from Nd-Sr-Pb isotopic compositions. (1) $\varepsilon_{Nd}(t)$ ranges from +0.86 to +4.27, T_{DM1} is younger than 1.0 Ga, and feldspar $^{206}Pb/^{204}Pb$ ratio is greater than 18.0 for the Nianzishan pluton. Since juvenile oceanic crust (gabbro), which was subjected to high-T seawater alteration has similar values to those of the Nianzishan pluton, it is genetically linked to partial melting of oceanic crust. (2) In contrast, negative $\varepsilon_{Nd}(t)$ values (from -18.20 to -5.88), older T_{DM1} ages (>1.5 Ga), and less radiogenic feldspar $^{206}Pb/^{204}Pb$ ratio (<17.5) were measured for Shanhaiguan, Laoshan, and Suzhou plutons. These values suggest that these three plutons were probably generated by remelting of the lower continental crust. (3) Our modeling of O-Nd-Pb isotopes show that binary mixing can account for the intermediate values for Kuiqi pluton.

In summary, the petrogenetic diversity of A-type granites in eastern China is related to partial melting of either intracontinental or interoceanic crust. And the latter process geodynamically contributes to the net growth of continental crust in eastern China during the late Mesozoic.

5.5.43

Petrogenesis of Qianlishan granitic pluton, Southeast China: Implications for an extension setting

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The Qianlishan granitic pluton in Hunan Province, southeast China hosts the world-class Shizhuyuan W-Sn-Mo-Bi-polymetallic deposit. The pluton is composed of pseudoporphyritic granite (152 Ma) and equigranular granite (146 Ma) and was intruded by late dykes such as granite-porphyry (144 Ma) and diabase-porphyrite dykes (142 Ma). The granites consist mainly of K-feldspar, albite, quartz, Fe-rich biotite and minor muscovite. Both pseudoporphyritic granite (SiO_2 75.18%-75.90%) and equigranular granite (SiO_2 76.10%-76.93%) are peraluminous (A/CNK>1.1) and are enriched in alkali, REE, HFSE, and Ga with high Ga/Al and FeO*/MgO ratios, but depleted in Ba, Sr and transition metals. Detailed trace element and Sr-Nd isotope studies suggest that the Qianlishan pseudoporphyritic granite was most likely derived by partial melting of the lower crust, composed of Early Proterozoic metamorphic rocks. These metamorphic rocks include both orthometamorphic and parametamorphic rocks that had been dehydrated but not melt-depleted during the earlier thermal event. The pseudoporphyritic granitic magma underwent fractionation, forming the equigranular granite that show a 'seagull' REE pattern with an enhanced negative Eu anomaly. These features suggest that the Qianlishan granite may belong to the A-type, rather than S-type as proposed by earlier workers. The geochemical characteristics of granite-porphyry dykes (SiO_2 72.93%-74.87%) indicate that these dykes were likely generated by mixing of the Qianlishan granitic magma with a small portion of diabase-porphyritic magma. Geochemistry of diabase-porphyrite dykes suggests that they were derived from an EMII-like mantle source contaminated by an OIB component, implying an enriched lithospheric mantle heated by ascending asthenosphere.

The detailed petrologic and geochemical data of the Qianlishan granite and late dykes of granite-porphyry and diabase-porphyrite suggest that they were likely generated in an extensional setting.

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