Zircon U-Pb age, Hf and O isotope insight into origin of Neoproterozoic granitoids in South China

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The genetic links between rift magmatism, crustal growth and reworking, and granitoid petrogenesis are an important issue with respect to supercontinent breakup. A combined study of U-Pb age, Hf and O isotopes in zircons from Neoproterozoic granitoids in South China, including the Jiangnan orogen between the Yangtze and Cathaysia Cratons, the Kangdian rift along the western margin of the Yangtze Craton, and the Dabie-Sulu orogen along the northern margin of the Yangtze Craton. Two generations of magma crystallization are discerned for the granitoids, with double-bimodal features in their zircon Hf and O isotope compositions. Despite consistently high $\delta^{18}O$ values of 8.1 to 10.4‰ for zircons, ~825 Ma S-type granitoids in the Jiangnan orogen show not only positive $\varepsilon_{Hf}(t)$ values of 3.4 to 5.4 with young Hf model ages of 1.17 to 1.25 Ga, but also negative $\varepsilon_{Hf}(t)$ values of −3.4 to −1.6 with old model Hf ages of 1.81 to 1.92 Ga. In contrast, 760~750 Ma bimodal I-type intrusives in the Kangdian rift are characterized by positive $\varepsilon_{Hf}(t)$ values of 3.5 to 9.9 with young model Hf ages of 0.94 to 1.18 Ga, and by both low and high $\delta^{18}O$ values of 4.2 to 6.2‰ relative to 5.3±0.3‰ for normal mantle zircons. Bimodal protoliths of 780~750 Ma ages for metaigneous rocks in the Dabie-Sulu orogen have consistently low $\delta^{18}O$ values of −4.3 to 4.4‰ for igneous zircons, but their Hf isotopes are subdivided into two groups: one has positive $\varepsilon_{Hf}(t)$ values of 5.9 to 12.9 and young Hf model ages of 0.82 to 1.24 Ga, and the other has neutral $\varepsilon_{Hf}(t)$ values of −2.7 to 2.3 and old Hf model ages of 1.68 to 1.92 Ga.

The zircon Hf-O isotope systematics provides a link of granitoid petrogenesis to orogenic collapse, rift magmatism, water-rock interaction, and the Rodinia breakup. Growth and reworking of juvenile and ancient crusts are dated by means of zircon $\varepsilon_{Hf}(t)$ values and model Hf ages in combination with U-Pb ages. While a change in magma source from arc-derived crust to asthenospheric mantle keeps pace with the tectonic advance from supercontinental rifting to breakup, reworking of pre-existing arc-continent collision orogen in either successful or failed rifts plays a basic role on their composition. As a result, the granitoids have principally inherited their source features in element and isotope geochemistry, with additional changes due to partial melting, fractional crystallization or crustal contamination. A plate-rift model is thus proposed to resolve paradoxical interpretations concerning trace element and isotope patterns of both arc-like and rift-like sources in given suites. It also provides a resolution to the controversy between arc-derived and plume-related magmatism for the Neoproterozoic igneous rocks in South China.

Re-Os systematics of lithospheric peridotites from Nushan, east China: Implications for multiple modifications of SCLM

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The Nushan Quaternary volcanic cone in northeast Anhui province, carries abundant mantle xenoliths which including spinel and garnet phase peridotites with or without volatile-bearing minerals such as amphibole, phlogopite and apatite. 12 representative xenoliths were selected for determination of Re and Os concentrations and Os isotope compositions.

Os and Re abundances range from 0.876 to 2.417 ppb and from 0.019 to 0.306 ppb respectively, while $^{187}Os/^{188}Os$ and $^{187}Re/^{188}Os$ ratios vary from 0.1149 to 0.1310 and from 0.037 to 0.805 respectively in this sample set. 4 of 12 samples have Os concentrations of <1.0ppb. Such low Os concentrations have usually been attributed to S-undersaturated melt percolation that remove Os-bearing sulfides. 2 of 3 fertile garnet lherzolites with high equilibration temperatures (~1100°C) have the highest $^{187}Os/^{188}Os$ ratios, similar to the present value of PUM (~0.1296). All spinel lherzolites from fertile to refractory in major chemical compositions, with or without amphibole and/or phlogopite have unradiogenic $^{187}Os/^{188}Os$ ratios. 6 of 12 samples have $^{187}Re/^{188}Os$ ratios higher than the PUM ratio of 0.435 that indicating recent Re addition. Nushan mantle xenoliths define a well-correlated linear trand between $^{187}Os/^{188}Os$ and both Al_2O_3 and Yb, through the PUM composition and give the model age of primitive melt extraction event (~2.0Ga).

Previous data indicate that $^{143}Nd/^{144}Nd$ and $^{87}Sr/^{86}Sr$ isotope ratios of clinopyroxenes separted from the sample set fall on the mantle array in the depleted quadrant. It is interesting that $^{187}Os/^{188}Os$ and $^{143}Nd/^{144}Nd$ ratios have a linear positive correlation for the sample set. The sample with the most depleted $^{187}Os/^{188}Os$ ratio has the richest $^{143}Nd/^{144}Nd$ ratio and 2 garnet lherzolites with the highest $^{187}Os/^{188}Os$ ratio have rather depleted $^{143}Nd/^{144}Nd$ ratios. The decoupling of Os and Nd isotope compositions of the Nushan mantle xenoliths indicate that SCLM experienced complex multiple modification via modal and/or cryptical mantle metasomatism after primitive melt extraction.

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