Continental growth history deduced from zircon U-Pb and Lu-Hf isotope systematics of river sands

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Knowledge of the growth history of continental crust is essential to understanding the evolution of the Earth. A major issue in the study of continental growth is how to estimate the difference of its "actual" growth rate from the growth rate based on the present age distribution of continental crust. The difference can be caused by three main recycling processes: (1) the erosion of crustal materials and subsequent deposition and diagenesis (intra-crustal recycling), (2) formation of granitoids from remelting of older crustal materials (crustal reworking), and (3) subduction of crustal materials into the mantle (crust-mantle recycling).

The combination of U-Pb and Lu-Hf isotope systematics on detrital zircons from large rivers is a powerful tool for understanding crustal reworking and continental growth rates (i.e., growth rate corrected for the effect of recycling (1) and (2)), because U-Pb and Lu-Hf isotope systems of zircon, which are resistant to intra-crustal recycling, reflect the timing and mode (juvenile vs. reworking) of crust formation [1,2]. In this study, we carried out in-situ U-Pb and Lu-Hf isotope analyses of ~ 1000 detrital zircons from the Mississippi, Amazon, Congo, and Yangtze Rivers. The total size of the drainage basins of the four rivers is equivalent to 11% of the present-day continent surface area. The obtained results demonstrates that only 13% of the analyzed zircons have $\varepsilon_{Hf(T)DM}$ values less negative than –5. These data correspond to a crustal residence time of <240 m.y. This finding indicates that crustal reworking was a very important process in continental crust formation. The $\varepsilon_{Hf(T)DM}$ population demonstrates that reworking was relatively predominant after 0.9 Ga. We calculated the mantle-extraction model ages for each zircon to estimate formation ages of the reworked juvenile continental crust. The continental-growth rate calculated from model age population of the zircons and the size of drainage basins of the rivers suggests that 43% and 95% crust in the source region was formed by 2.5 Ga and 0.9 Ga, respectively.

References

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