Positive Zr anomaly in Archean-Paleoproterozoic sandstones and its significance in continental growth

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Growth history of continental crust has been discussed by many studies; however, forms and sizes of individual continental masses during the Archean to early Paleoproterozoic are still unknown. Chemical composition of sandstones from each continent may reflect its size, which was lost afterwards. Sandstones composed of ill-sorted grains tend to have similar composition to that of provenance rocks, whereas well-matured sandstones have dominantly silica-enriched composition (e.g., quartz arenite). The origin of Archean quartzose (meta-)sandstone commonly found in the greenstone belts is still ambgious because whole-rock major element compositions of them were usually affected by later metasomatism. The pattern of trace elements in sandstone is likely useful in monitoring sedimentary maturity of terrigenous clastics, which potentially reflected the size of provenance continent. In particular, this study focused for the first time on positive Zr anomaly (=Zr/(Nd*Sm)^0.5) in the primitive mantle-normalized pattern of trace elements to evaluate degree of sedimentary sorting because zircon is concentarted in sandstone through sedimentary sorting more than softer allanite and sphene which are main carriers of REEs in granitoids. We measured whole-rock composition of major, minor and trace elements of 50 Archean-Paleoproterozoic sandstones from southern Africa, North America, and western Australia, by using a sector magnetic field type inductively coupled plasma-mass spectrometer (ICP-SFMS). In order to achieve complete digestion, we prepared sample solution from fused-glass bead (sample powder + lithium tetraborate). Results demonstrate that approximately 80 % of the analyzed samples recorded the positive Zr anomaly. Quarthose sandstones tend to show larger magnitude of Zr anomaly than less quarthoze ones. Among the quartzose sandstones, the largest positive Zr anomaly in the middle Archean (3.5-3.0 Ga) and Paleoproterozoic (2.5-2.0 Ga) sandstonees are about 4 times larger than those in the late Archean (3.0-2.5 Ga) ones. This infers that the general size of late Archean continents had been much smaller than that in the middle Archean (3.5-3.0 Ga), and that the general size of continent likely re-increased after 2.5 Ga. This change in overall trend may have been related to active rifting of continents during the late Archean and subsequent amalgamation in the early Proterozoic.