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U-Pb dating of Eoarchaean zircon using a NanoSIMS

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Volatile compositions, such as hydrogen and/or sulfur which are included in the Eoarchaean igneous rock, have crucial information to reveal the evolution of interior of the early Earth. Apatite and/or glass inclusions, found in the zircon crystal, are expected to preserve a ”primitive” information of such volatile elements, though a high sensitive and high resolution analytical method are required for it. NanoSIMS is one of the most powerful tools to analyze such volatile compositions in micro-scale inclusions in zircon crystals with precise in situ U-Pb dating.

For the first step of this purpose, we performed ^{238}U-^{206}Pb and ^{207}Pb-^{206}Pb zircon dating using a NanoSIMS 50 ion microprobe, with the method developed by our group [1]. A 5 nA O^- primary beam, with 20 micrometers in diameter spot size, was used for ionization of sample surface, and secondary positive ions were collected in multicollector for mass analyses. The detector system was modified to measure $^{30}Si^+$, $^{90}Zr_2\ ^{16}O^+$, $^{204}Pb^+$, $^{206}Pb^+$, $^{238}U^{16}O^+$, and $^{238}U^{16}O_2{}^+$ ions simultaneously in ^{238}U-^{206}Pb dating session. In ^{207}Pb-^{206}Pb dating session, $^{204}Pb^+$, $^{206}Pb^+$, and $^{207}Pb^+$ ions were collected in one detector by scanning the magnetic field. A multicrystal zircon, QGNG (zircon extracted from Quartz-Gabbro-Norite-Gneiss from South Africa) with a U-Pb age of 1842 Ma, was used for standard of U-Pb dating [2].

The targeted zircons were separated from tonalite which was from Eoarchaean Nuvvuagittuq supracrustal belt, Surerior Craton, Canada. The reported U-Pb age of this tonalite is 3661+/- 4 Ma by using LA-MC-ICP-MS [3]. Euhedral to subeuhedral zircons were picked up to measure. The size distribution of zircons was from approximately 50 micrometers to 200 micrometers as the long axis of each crystal. Some of them have inclusions of glass or apatite whose size were 10 to 30 micrometers in diameter. Dating measurements were done avoiding such inclusions. Also, some of measured zircons have zonal structure. In such case, spot measurements were done by zone by zone for each zoning crystal.

Measured ^{206}Pb/^{238}U ratios range from 4.932E^{-1} to 7.644E^{-1}. These ratios get smaller toward the edge of zoning crystal. The ^{207}Pb/^{206}Pb ratios range from 3.052E^{-1} to 3.407E^{-1}. After the correction of common Pb, ^{238}U/^{206}Pb$*$ and ^{207}Pb$*$/^{206}Pb$*$ values were plotted on Terra-Wasserburg Concordia diagram. They showed a Discordia suggesting recent Pb loss. The intersection of Concordia and Discordia indicates that the age of this rock is 3633 +/- 35 Ma, which are agreed well with previous study. Now we are trying to measure the volatile compositions of inclusions in theses zircons. They could provide us primary information about the evolution of the Early Earth.

References

[1] Takahata et al., *Gondowana Res.*, 14, 587-596, 2008.
[2] Sano et al., *Geochem. J.*, 34, 135-153, 2000.
[3] David et al., *GSA Bulletin*, 121, 150-163, 2008.

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