

U-Pb dating of Eoarchaeon zircon using a NanoSIMS -implication for the measurement of volatile in the inclusions

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Volatiles, such as hydrogen or sulfur, trapped in the Eoarchaeon igneous rocks, are one of the most important tracers of the evolution of the interior of the early Earth. Apatite or glass inclusions found in the zircon crystal, are expected to preserve such volatiles. However, because of their scarceness, high-sensitive, high-resolution analytical methods are required for quantify them and reveal their isotopic compositions. Furthermore, discriminating between pristine compositions and later alteration is problematic. We are trying to approach these issues carrying out analyses by NanoSIMS50.

Euhedral to subhedral zircons were separated from a tonalite which was from the Eoarchaeon Nuvvuagittuq supracrustal belt, Superior Craton, Canada. The reported U-Pb age of this tonalite is 3661 ± 4 Ma by using LA-MC-ICP-MS [1]. The size distribution of zircons was from approximately 50 micrometers to 200 micrometers. Some of them have inclusions of apatite and glass whose size were 10 to 30 micrometers in diameter. Dating measurements were done avoiding such inclusions.

We performed ^{238}U - ^{206}Pb and ^{207}Pb - ^{206}Pb dating in the same analytical spot of zircon crystals. A 5 nA O^- primary beam, with spot size of approximately 10 micrometers in diameter, was used for ionizing the sample surface, and secondary positive ions were collected in a multicollector. The detector system was modified to measure $^{30}\text{Si}^+$, $^{90}\text{Zr}_2^{16}\text{O}^+$, $^{204}\text{Pb}^+$, $^{206}\text{Pb}^+$, $^{238}\text{U}^{16}\text{O}^+$, and $^{238}\text{U}^{16}\text{O}_2^+$ ions simultaneously in ^{238}U - ^{206}Pb dating session. In ^{207}Pb - ^{206}Pb dating session, $^{204}\text{Pb}^+$, $^{206}\text{Pb}^+$, and $^{207}\text{Pb}^+$ ions were collected in the same detector by changing the magnetic field. Detailed analytical procedure and standard calibration is described in Takahata et al.(2008) [2].

Measured $^{206}\text{Pb}/^{238}\text{U}$ ratios range from 0.4932 to 0.7993, and the $^{207}\text{Pb}/^{206}\text{Pb}$ ratios range from 0.3052 to 0.3443. After the correction of common Pb, those values were plotted on Tera-Wasserburg Concordia diagram, giving a corrected age of 3633 ± 35 Ma, consistent with the previous value obtained by [1]. On the other hand, some samples showed a discordant age. Since such crystals are thought to have suffered metamorphism with subsequent loss of Pb, volatiles in the inclusions might have lost their initial information as well. Now we are proceeding to measure the volatile compositions of inclusions based on the results of U-Pb dating.

[1] David et al., GSA Bulletin, 121, 150-163, 2008.

[2] Takahata et al., Gondwana Res., 14, 587-596, 2008.

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