In-situ U-Pb isotope geochronology by a high lateral resolution ion microprobe (NanoSIMS)

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To determine the absolute ages using radiogenic isotopes is important for reconstruction of paleo-environments, estimate of secular changes and define the timing of geological events. U-Pb isotope geochronology for monazite, zircon and apatite which concentrate uranium has been carried out from the Hadean to Phanerozoic samples. The U-Pb dating were divided into two types: solution (TIMS) and *in-situ* (SIMS/SHRIMP/LA-ICP-MS) analyses. *In-situ* analyses provide isotope ages from several tens of micrometers in spot diameter. Recently, high lateral resolution SIMS (NanoSIMS) has been developed by Cameca, which provides nano-scale analysis spots. This powerful feature is advantage for analyzing the samples which have tiny mineral inclusions, zonings or micro-cracks.

We report that method and results of U-Pb dating by Cameca NanoSIMS 50 installed at Ocean Research Institute (ORI), The University of Tokyo. U-Pb dating at ORI is using O^- primary beam and measurements are separate 2 sessions ($^{238}U/^{206}Pb$ and $^{207}Pb/^{206}Pb$). At first, we analyze $^{204}Pb^+$, $^{206}Pb^+$, $^{238}U^{16}O^+$, $^{238}U^{16}O_2{}^+$ by multi-collection, static mode for estimating $^{238}U/^{206}Pb$ with Pb^+/UO^+-$U\ O_2{}^+/UO^+$ calibration, then $^{204}Pb^+$, $^{206}Pb^+$, $^{207}Pb^+$ are measured by magnetic switching mode with single collector for $^{207}Pb/^{206}Pb$.

In this study, we analysed three types of minerals (monazite, zircon and apatite) which reference values were determined by other method (SHRIMP/EMPA/TIMS), to evaluate U-Pb dating by NanoSIMS.

Monazite is easy to determine U-Pb ages because of high uranium concentration. Sano et al. (2006) analyzed with a ˜4 nA primary beam, and obtained 5-7 micrometers-diameter crater. A mass resolution fo 4100 at 1% peak height was attained with a flat peak top. Three age groups (230 Ma, 440 Ma and 1850 Ma) are obtained from concordant samples. These ages are consistent with U-Th-Pb chemical ages by EMPA.

Zircon is the most popular mineral for U-Pb dating, because zircon has a high hardness and high closure temperature. Takahata et al. (in press) measured three standard zircons (QGNG, 91500, SL13) which already analyzed by SHRIMP. A 7-9 nA primary beam was used to sputter a 15 micrometers-diameter crater. A mass resolution of about 4000 at 10 % peak height was attained with flat peak top. Obtained U-Pb ages of standard zircons by NanoSIMS agreed with published ages within experimental error. Then Observed ages of zircon grains in a metamorphic rock have high corretation (R: more than 0.99) with SHRIMP U-Pb ages.

Apatite is lower uranium concentration mineral than other two minerals. The dating of apatite, however, is useful because of direct dating of (micro-) fossils which were occurred as phosphate. 15-20 nA primary beams focused onto 15-20 mirometers spots. We analyzed three apatite samples (PRAP, POAP and BNCF) which were measured by SHRIMP. Obtained ^{207}Pb-^{206}Pb isochron ages of PRAP, POAP and BNCF are 1256+/-56 Ma (SHRIMP: 1156+/-45 Ma), 2790+/-550 Ma (2701+/-86 Ma) and 1224+/-140 Ma (918+/-45 Ma), respectively.

These results suggest that NanoSIMS is a powerful tool for micrometer-scale (less than 20 micrometers) U-Pb isotope dating and provides new insight to *in-situ* geochronology.