Research report on long-term stability of geological environments and LA-ICP-MS-based age dating

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In recent years, it has become possible to carry out high-precision microscale age dating of geological samples (with a spatial resolution of less than several tens of micrometers) using developed micro-analytical techniques such as secondary ion mass spectrometry (SIMS), laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), etc. Application of LA-ICP-MS-based microscale U-Pb dating is extending from U-rich heavy minerals such as zircon, apatite and monazite to U-depleted minerals such as calcite. This kind of method enables age determination of several types of mineral grains (and their internal zoning structures) occurring within rock bodies, and thereby reveals chronological changes in chemical composition of source materials from which the minerals were crystallized, with some cases in which thermal history of the crystal formation system can be reconstructed.

For research and development of geological disposal techniques for high-level radioactive wastes, we develop and facilitate geochronological dating techniques for evaluation of long-term stability in geological environments, at Tono Geoscience Center, Japan Atomic Energy Agency. Elucidating past long-term variations of geological environments leads to predicting the future of the environments and is essential for the geological disposal, because the radioactive wastes need to be buried in deep underground and isolated far from the human living sphere for more than tens of thousands of years. Geochronological dating techniques are necessary for this purpose. LA-ICP-MS U-Pb dating of zircon provides reliable information about igneous activities such as magmatic differentiation and is also useful for provenance analysis if the mineral is found in sediments. Additionally, dating techniques using ^{10}Be and ^{26}Al, which are generated by cosmic rays reaching the ground, can be applied to quantitative estimation of the amount of uplift and erosion. Combining these various dating methods has great potential to elucidate past long-term variations of geological environments.

In our presentation, we introduce the current status of our development for research on long-term stability of geological environments, U-Pb dating of calcite, U-Pb dating of young zircon and trace element analysis by using LA-ICP-MS.

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Keywords: long-term stability in geological environments, LA-ICP Mass Spectrometry, U-Pb dating

