Report of the (U-Th)/He dating system at Tono Geoscientific Research Unit, Japan Atomic Energy Agency

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Though the (U-Th)/He dating method that regards helium-4 nuclei (alpha particles) as the daughter products from radioactive decays of uranium and thorium has been already recognized since the beginning of the twentieth century, the idea was considered to be impracticable except for some particular cases by reason that helium was not completely retained in rocks. In 1987, it was revealed that the (U-Th)/He ages of apatites might be cooling ages with very low temperature cooling. Because of the suggested useful possibility in geo- and thermochronology, the (U-Th)/He method has been quickly developed since 1990's. The excellent points for applications are such as below: (1) Closure temperatures are very low, e.g. ~70 ^{o}C for apatite and ~180 ^{o}C for zircon. (2) Uranium bearing minerals are often weathering- and alteration-resistant. (3) It is possible to date using single grain. (4) Non-radiogenic helium including blank is generally rare. (5) The rates of helium ingrowth are large. (6) It does not require a reactor or a large-scale exclusive mass spectrometer. The (U-Th)/He method mainly applies to investigate the last event on a cooling history of present rapid orogen and a thermal anomaly through an active fault at the present because of merit (1). This method is suitable for dating young ages from merit (4) and (5). It also works good for the investigation for the last event.

Japan Atomic Energy Agency have jointly set up the lab of the (U-Th)/He dating in cooperation with Kyoto University. At the present stage, samples are apatite and zircon separated from the Fish Canyon Tuff, that is the international age standard, and the Tanzawa Tonalite Complex, that was dated in my PhD thesis, as a working standard. Infrared laser heating in vacuum chamber extracts helium.

The helium is quantified using the MM5400 rare gas mass spectrometer and the sensitivity method since an activated charcoal trap cooled by liquid nitrogen and a non-evaporate getter pump purify the extracted gases. The sensitivity of the mass spectrometer is calibrated using standard air, a volume-known pipette, and a capacitance manometer. The ICP quadrupole mass spectrometer quantifies uranium and thorium using standard addition method after dissolution of the gas-extracted sample. Apatite is dissolved using HNO3 and zircon is decomposed by the alkali-fusion method using XRF bead sampler and LiBO3. Quantifications of uranium-238 and thorium-232 are only need for parent isotopes to date samples because they are expected that the state of secular equilibrium becomes established and samarium does not compose the samples.

We are performing the calibration of MM5400 and testing dissolution procedures for ICP at present, and will report detailed views of dating systems in addition to them.