Review of calibration method of zircon Pb/U ratio obtained by SIMS

*Kenji Horie[1,2], Mami Takehara[1]

1.National Institute of Polar Research, 2.Department of Polar Science, The Graduate University for Advanced Studies (SOKENDAI)

U-Pb zircon geochronology has been widely applied due to zircon's high durability, high closure temperature (e.g., Cherniak 2010 and references therein), high concentration of parent element uranium, and its negligible incorporation of the daughter element Pb during crystallization. In addition, the paired decay scheme of ^{238}U and ^{235}U allows us to verify the determined U-Pb zircon age, using two geochronometers. Recent technical progress of microbeam analysis using secondary ion mass spectrometry (SIMS) and laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) has allowed us to obtain highly precise U-Pb zircon age from several mm to 25 mm. A calculation of the U-Pb zircon age obtained by SIMS analysis is generally complicated by largely attributed to differences in ion yield in Pb and U sputtered from zircon. In addition, the measured ion ratios are not even necessarily constant for a target of known composition from spot to spot and from session to session, often varying during a measurement session, for example in response to pressure, surface charging, primary beam intensity, spot shape, and sample temperature. To correct this effect, a suitable reference material is required to calibrate the secondary ion ratio (Pb^+/U^+) to the atomic abundance ratio (Pb/U). An empirical relationship between Pb^+/U^+ and UO^+/U^+ (calibration curve) has traditionally been used for this correction, and this relationship has been considered to obey a power law of the form $^{206}Pb^+/^{238}U^+ = a \times (^{254}(UO)^+/^{238}U^+)^2$. The statistically more reliable calibration scheme enables us to obtain highly precise and accurate U-Pb zircon age. In this presentation, several calibration schemes were compared by using a sensitive high resolution ion microprobe (SHRIMP-IIe).
Correlation among Pb^+, U^+, UO^+, and UO_2^+ was tested using TEMORA2 zircon. The precision of Pb^+/U^+ ratios seems to be improved by using the correlation between Pb^+/UO^+ and UO_2^+/UO^+, which is probably derived from similarity of energy distribution between Pb^+ and UO_2^+ rather than between Pb^+ and U^+. Also, the correlation was assessed by several reference zircons such as FC1, OT4, OG1, and Mud Tank and the results will be reported.

Keywords: zircon, U-Pb dating, SIMS

