Towards high-precision Pb-Pb dating of extra-terrestrial materials by MC-ICPMS

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Knowledge of the timescales of condensation of the first solids from the solar nebula, accretion, differentiation and metamorphism of asteroids is essential to decode the early evolution of our solar system. Considering the possible overall time spans from molecular cloud to planetary systems of ~10 Ma, and much shorter timescales of individual events, a high-precision age determination (error ±0.1 Ma) is required. The U-Pb system offers such high-precision chronometer because of having two decay chains. In this study, we have evaluated the precision and accuracy of Pb isotope analysis by multiple collector-inductively coupled plasma mass spectrometry (MC-ICPMS). The MC-ICPMS has advantages in simple usage and high analytical throughput compared with TIMS which is the conventional method to measure Pb isotope ratio. We applied two independent mass-bias correction methods for Pb isotope ratio measurements of synthetic Pb solution: external-normalization by doping Tl standard and internal-normalization by adding ^{202}Pb-^{205}Pb double spike. We found that there is no remarkable difference in the analytical accuracy between the two methods. We also found that a precision of 0.01% can be achieved for isotope analysis of ~100 pg of Pb.
Taking another view of high precision and accuracy Pb dating, removal of non-radiogenic Pb is important before isotopic analysis and this can be achieved by acid leaching. For establishing a robust leaching method, it is important to understand what minerals and elements are eluted in multiple leaching steps. This has been investigated by combining SEM imaging of acid-washed samples and chemical analysis of leachates.

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