Application of Laser Ablation ICP-MS in Trace Element Analysis of Fluid Inclusions: Preliminary Study using Artificial Fluid Inclusions

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Abstract

LA-ICP-MS (Laser ablation inductively coupled plasma mass spectrometry) was utilized to evaluate the possibility of the in situ elemental analysis of fluid inclusions based on the measurement on the artificially prepared fluid inclusions. The high sensitivity of ICP-MS makes it possible to determine most elements in the periodic table at trace levels (<1 [μ]g g-1). Recent trends in the development of instrumentation have led to the possibility of analyzing method of the smaller volume (10^{-8}~10^{-11} g). Artificial fluid inclusion standards were prepared by drawing standard solution of Na, Mg, S, K, Ca, Fe, Cu, Ag, Pb, and Bi compositions into microcapillary tubes made of borosilicate glass. These data acquisition were achieved using a VG PQIII ICP-MS equipped with a Nd:YAG Merchantek EO UV laser at Korea Basic Science Institute in Taejeon and an Elan 6100 system equipped with a Q-switched Nd:YAG laser at Korea Basic Science Institute in Seoul Branch. These lasers are focused and fired on 20~30 μm pit size spots on the microcapillary tubes until the fluid was reached. The contents of the microcapillary tube are emptied and transported with argon to the torch. The average volume of fluid released, per pulse of laser, was approximately 0.2~0.3 $\mu\ell$ from 4~6 $\mu\ell$ volume glass microcapillary tubes. The main objective in analysing artificial fluid inclusions of known composition is to test the possibility of establishing a calibration curves of signal intensity (counts per second) versus concentration(ppm). Data collected from each analysis were evaluated based on the signal generated vs. time graphs and selective time intervals for the average background count rates. The successful estimation of the elemental analysis in fluid inclusions depends on the multiple variables like background, sensitivity, drift, limits of detection (spot size and laser power), matrix effects, changes in laser sampling yield, sample transport efficiency, precision and accuracy. Considering the large size of artificial inclusions used in this study, the use of laser ablation technique in the measurement of elemental concentrations in small-sized natural fluid inclusions seems to be extremely limited when using the domestic ICP-Mass Spectrometers which are routinely used for the elemental measurement in the large amount of solution.

Keywords: Laser ablation, Inductively-coupled plasma (ICP), Mass spectrometry (MS), Fluid inclusion, Trace element

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