FAST MEASUREMENT METHOD OF LEAD ISOTOPIC RATIO IN METEORITIC MATERIAL USING QUADRUPOLE ICP-MS

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ABSTRACT

Isotopic ratio measurement is a very important tool for geologists and analytical chemist, as it can be used for dating meteorite samples and also trace a particular pollution agent, since no common chemical or physical processes can tamper with isotopic ratios of a certain element, while natural processes that affects this ratio are well understood and can be very well predicted. ICP-MS instruments offers fast analysis time and relatively simple sample preparation and it also has good isotopic ratio capabilities, although performance of TIMS or SF-ICP-MS cannot be met. Lead isotopic ratio of meteoritic sample was measured in this work using a fast measurement method, with NIST 981 standard reference material used for calibration and control.

Keywords: isotopic ratio, lead, meteorite

INTRODUCTION

Mocs meteorite, classified as L5-6 chondrite fell on 3rd February 1882, in Transylvania region over an area of several dozen squared kilometers, near Mocs village (now Mociu). Since its fall, scientific investigation was performed on the meteorite, since fragments from it was distributed in museums all over the world. However, no Pb isotopic data was reported in literature for this specific meteorite. Pb isotopic data is important for determining the age and possibly the origin of the meteoritic fragment. Meteoritic control samples material from an undocumented fall was also considered for this study.

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MATERIALS AND METHODS

Only ultrapure acids were used for all sample preparation. Ultrapure water produced in laboratory, using a Millipore Milli-Q system, was used for sample initial washing and dilutions. For all measurements, Perkin Elmer Elan DRC II ICP-MS model was used. Dynamic Reaction Cell was used in rf-only mode (vented, no reaction gas). Detector dead-time value was set to 55 ns. Instrument check was performed every working day with a solution containing 1 ppb In, 1 ppb Ce, 10 ppb Ba and 1 ppb. Oxides levels and double ionized levels were kept under 3%, background for both low and high mass was under 1 cps and all the other parameters were chosen considering the best signal/noise ratio. Pulse mode eas chosen for the detector, since it offers higher sensitivity.

The meteorite samples were weighted and each sample was grinded and turned into fine powder. The dissociation was done in a Teflon cup on a sand box. The Teflon was cleaned with *aqua regia*. The temperature of the sand box was kept constant (T = 90ºC). A modified method of four steps was used. Every step consists of combination of strong acids. HNO_3 was used in the first step. The vaporizing should continue until approximately 2ml of sample remains in an opened Teflon cup. Strong acids have been used next (HCl and HNO_3) with combination of ultrapure water. The last step is the most significant one, using a combination of HNO_3, HF, HCl and H_2SO_4 acids. Following the dissociation, the solution was filtered into flask of 25ml.

RESULTS AND DISCUSSION

Calibration with NIST 981 standard reference material was done every 5 samples. The Mocs meteoritic fragment, received from the collection of Mineralogical Museum of Cluj-Napoca, had the crust removed and was split in three parts that were digested separately. The same procedure was applied for some possible meteorite control samples (not classified or registered). Quantitative analysis revealed 0.888 mg/kg concentration of Pb in Mocs samples and 0.574 mg/kg in control samples. The obtained solutions for Mocs sample, NIST 981 SRM and control sample were read in three consecutive days.

Only ^{206}Pb, ^{207}Pb and ^{208}Pb isotopes were considered for this study. ^{204}Pb was not considered, due to its low abundance and ^{204}Hg traces found in the sample (isobaric interference) that would introduce a significant error source in the measurement. The measured isotopic ratios averages for NIST SRM, Mocs meteorite and control samples are reported in Table I. The proposed method was tested using a NIST 981 standard reference material and offers good results for lead determination. Some built-ins limitation would not yield performance figures as the traditional TIMS or MC-SF-ICP-MS would, but considering instrument's high availability, fast sample preparation and analysis time, and low costs (when compared with MC-SF-ICP-MS for instance), single collector, quadrupole based ICP-MS offers decent performance in elemental isotopic determinations.

Table I. Measured averages (± SD)

	NIST 981		Mocs fragment	Control sample
	Measured	Certified		
$^{207}Pb/^{206}Pb$	0.9142±0.0005	0.9146±0.0003	0.8656±0.0084	0.8463±0.0031
$^{208}Pb/^{206}Pb$	2.1683±0.0015	2.1681±0.0008	2.1011±0.0156	2.0630±0.0112

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