Multi-element isotope dilution by HR-ICP-MS

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Introduction

Isotope dilution (ID) is the most precise and accurate technique for trace-element analysis. Therefore, multi-element ID combined with High-Resolution ICP-MS will provide data of high accuracy and high sensitivity for many elements with a small amount of sample preparation.

Analytical technique

We added a multi-element isotopic spike solution to the sample powder prior to preparation. The spike solution was calibrated by ID-TIMS against standards made from 1 g chunks of high-purity rare-earth metals or highly pure salts (Raczek et al., 2001). The high-resolution mode of a ThermoFinnigan Element2 ICP-MS ($m/\Delta m$ = 11,000) was used to acquire mass lines of interest that are interfered by molecule lines. Abundances of elements with more than two isotopes were determined by ID. Using these values as internal standards, concentrations of all other elements (e.g., mono-isotopic elements, like Pr, or elements that have only one measurable isotope because of interference of isobars, like Ce) were obtained by external calibration.

Results and discussion

We have applied this multi-element ID technique to the analysis of international reference materials. Repeated measurements of REE in BHVO-2 (Table 1) yielded a reproducibility of the data of about 1-2%. Our results of this reference material agree within 2-3% with high-precision ID-TIMS and MIC-SSMS values (Raczek et al., 2001).

Table1: Multi-element ID ICP-MS data of REE in BHVO-2 (concentrations in ppm). Abundances determined by external calibration are marked by (*).

La*	14.8	Sm	5.91	Dy	5.23	Yb	2.00
Ce*	37.2	Eu	1.99	Ho*	0.97	Lu*	0.3
Pr*	5.17	Gd	6.1	Er	1.7		
Nd	23.9	Tb*	0.9	Tm*	0.34		

Reference

Raczek, I., Stoll, B., Hofmann, A.W. and Jochum, K.P., (2001), *Geostandards Newsletter* **25**, 77-86

Galileo spacecraft observations of active ultramafic eruptions on Jupiter's moon Io

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NASA's Galileo spacecraft has just completed 12 years of remote sensing observations, which included study of 17 different objects in our solar system and 6 years of intensive study of Jupiter's four large moons. One of the most surprising results to come from Galileo observations of Jupiter's volcanic moon Io is evidence that a few of its active eruptive centers produce high-temperature silicate eruptions (~1300-1700˚C: McEwen et al., 1998; Geissler et al., 1999; Williams et al., 2001; Davies et al., 2001; Lopes et al., 2001). These temperatures are consistent with terrestrial Precambrian komatiitic eruptions. This talk will discuss the Galileo spacecraft data that suggest that active ultramafic eruptions are occurring on Io.

The best studied eruption thusfar occurred at Pillan Patera in the summer of 1997. This eruption included a high-temperature (>1600˚C) hotspot, a 140-km-high eruption plume that deposited dark, presumably silicate-rich pyroclastic material over >125,000 km^2, and emplacement of ~8-10 m thick dark flows over >3100 km^2. The eruption had a duration of 52-167 days, and volumetric flow rates are estimated to have been ~2-7 x 10^3 m^3 s^{-1}, comparable to the (1783) Laki eruption and the inferred flow rates of flows in the Columbia River flood basalts. The Pillan flow field shows a rough, pitted surface that is thought to have resulted from rapid, low-viscosity lava surging, which produced a fractured lava crust.

Other high-temperature eruptions have occurred at Pele and Tvashtar, with eruptive styles that include lava lakes, lava fountains, and large S-rich plumes. The differences in ultramafic eruption styles on Earth and Io are a function of the different eruption environments, and possibly the different compositions and volatile contents of the magmas.

References

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