Three new offset $\delta^{11}$B isotope reference materials for environmental boron isotope studies

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Introduction

The isotopic composition of boron is a well established tool in various areas of science and industries. Especially in environmental and geo sciences boron isotopes have been proven as a suitable analytical tool to unravel a variety of processes.

Boron isotopic compositions are typically reported as $\delta^{11}$B values which indicate the isotopic difference of a sample relative to the isotope reference material.

However, a significant drawback of the available boron isotope reference materials is that none of them covers a natural boron isotopic composition apart from NIST SRM 951.

The high demand for such offset $\delta$-reference materials is demonstrated by two offset isotope intercomparison studies$^{1,2}$ which published highly scattering data for $\delta^{11}$B values.

Objectives

Preparation and certification of offset $\delta$-reference materials for geochemical and environmental boron isotope studies.

Improving validation of procedures for the determination of $\delta^{11}$B values.

Enabling a straightforward quality control of $\delta^{11}$B data across the whole natural range of boron isotopic compositions.

Production of $\delta^{11}$B reference materials

The target $\delta^{11}$B values of -20, +20 and +40 ‰ have been chosen such that most of the natural boron isotope variation is covered in equidistant intervals.

The new boron $\delta$-reference materials were prepared under full gravimetric control by mixing boron mother solutions with natural isotopic composition with two mother solutions highly enriched either in $^{10}$B and $^{11}$B.

The three stock solutions with 100 mg kg$^{-1}$ B were finally filled in pre-cleaned 20 mL PFA bottles.

Sufficient homogeneity has been confirmed by analysing randomly selected bottles. The stability has been proven by testing the evaporation through the bottle as well as by long term monitoring of a preceding boron isotope reference material.

New intercomparison study

Based on the poor results of former boron isotope intercomparisons and the promising results of the (MC) ICP-MS technique a new intercomparison study is advisable.

As no dissolution and boron matrix separation is necessary our new boric acid $\delta$-reference materials are suitable samples for a new boron isotope intercomparison study.

Boron isotope reference and quality control materials

<table>
<thead>
<tr>
<th>Isotope reference materials</th>
<th>B3</th>
<th>B5</th>
<th>B8</th>
<th>B2</th>
<th>B1</th>
<th>NASS5</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERM-AE120</td>
<td>![b3]</td>
<td>![b5]</td>
<td>![b8]</td>
<td>![b2]</td>
<td>![b1]</td>
<td>![nass5]</td>
</tr>
<tr>
<td>ERM-AE121</td>
<td>![b3]</td>
<td>![b5]</td>
<td>![b8]</td>
<td>![b2]</td>
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<tr>
<td>ERM-AE122</td>
<td>![b3]</td>
<td>![b5]</td>
<td>![b8]</td>
<td>![b2]</td>
<td>![b1]</td>
<td>![nass5]</td>
</tr>
</tbody>
</table>

$\delta^{11}$B and B isotope reference materials from BAM

<table>
<thead>
<tr>
<th>B mass fraction</th>
<th>$\delta^{11}$B</th>
<th>Isotope abundance ratio</th>
<th>Isotope abundance</th>
<th>Molar mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nc in mg·kg$^{-1}$ in %</td>
<td>$^{11}$B/$^{10}$B</td>
<td>$^{11}$B/$^{11}$B</td>
<td>$^{11}$B</td>
<td>in g mol$^{-1}$</td>
</tr>
<tr>
<td>AE120</td>
<td>100.0 (2.0)</td>
<td>-26.2 (6)</td>
<td>0.23526 (33)</td>
<td>5.961 (6)</td>
</tr>
<tr>
<td>AE121</td>
<td>100.0 (2.0)</td>
<td>19.9 (6)</td>
<td>0.24237 (32)</td>
<td>4.127 (6)</td>
</tr>
<tr>
<td>AE122</td>
<td>100.0 (2.0)</td>
<td>39.7 (6)</td>
<td>0.23702 (31)</td>
<td>4.205 (6)</td>
</tr>
</tbody>
</table>

Boron mass fractions of 100 mg kg$^{-1}$ are informative values only.

Certification and uncertainty

The expanded uncertainty of 0.6 ‰ has been calculated from the individual techniques (gravimetry, Na$_2$BO$_3$, Cs$_2$BO$_3$) TIMS techniques.

Availability and price

The presented boron isotope reference materials are commercially available through European Reference Materials$^3$ (http://www.erm-crm.org) or the webshop of the BAM Federal Institute of Materials Research and Testing (http://www.webshop.bam.de).

The $\delta$-reference materials ERM$^4$-AE 121, AE 122, AE 123 (100 mg kg$^{-1}$; 20 mL PFA bottle) are offered at 95 €.

The isotope reference materials ERM$^4$-AE 101, AE 102, AE 103, AE 104 (1000 mg kg$^{-1}$; 30 mL PFA bottle) are offered at 353 €.

Acknowledgement

We kindly acknowledge excellent laboratory work of Dorit Becker and Maren Koenig during the preparation.

Literature