Small-Volume U–Pb Zircon Geochronology by Laser Ablation–Multicollector–ICP–MS
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Abstract
U-Pb geochronology is beset by problems acquiring meaningful geologic ages on round grains that remain invisible from multiple ground or thermal events. We present case studies at the Arizona Laser Center using laser ablation–multicollector-inductively coupled plasma mass spectrometry (LA-MC-ICP-MS) to resolve complications associated with internally zoned crystals through high-resolution sampling of zircon volumes as small as 12-14 μm in diameter by >5 μm in depth of focus. Using Channeltron multipliers to monitor Pb isotopes in coincidence with a total counting system, and errors calculated as a function of the number of counts, the small-volume technique reported published ages on eight Mesozoic-Eocene zircon secondary-precision standards and a zircon within ~1 μm of age zero—1 Ma younger than a Variscan age. Two initial applications of the small-volume technique—the diurnal zircon provenance of the northern Colorado Front Range and the course of 12 Pb ages from zircons—highlight the detail and temporal resolution of U-Pb age maps in resolving the diurnal and seasonal variation in the field of U-Pb geochronology.

Results: secondary zircon standards

<table>
<thead>
<tr>
<th>Sample</th>
<th>Age (Ma)</th>
<th>Error (Ma)</th>
<th>Concentration (ppm)</th>
<th>Precision</th>
<th>Distance (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FC1</td>
<td>1099.9</td>
<td>±4</td>
<td>12</td>
<td>0.5</td>
<td>12</td>
</tr>
<tr>
<td>FC2</td>
<td>1099.9</td>
<td>±4</td>
<td>12</td>
<td>0.5</td>
<td>12</td>
</tr>
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<td>FC3</td>
<td>1099.9</td>
<td>±4</td>
<td>12</td>
<td>0.5</td>
<td>12</td>
</tr>
</tbody>
</table>

Applications

1. Detrital zircon geochronology of shales

2. U-Pb age mapping of high-grade palaeo-

Conclusions
The small-volume U–Pb geochronology technique at the Arizona Laser Center microsample and data zircon volumes as small as 12-14 μm in diameter by >5 μm in depth, comparable to sample volumes for U-Pb geochronology by secondary ion mass spectrometry. Low Pb yields produced by the small laser spot diameter and a slow laser pulse rate require using Channeltron detectors to monitor all Pb peaks coupled with a total counting system to resolve Pb isotopes. Measurement errors are calculated as a function of the number of counts. Zeolitic and alkali feldspar zircons from a granulite-grade pelite were analyzed, and Pb yields for 12 Pb ages on 1 μm of age zero. The ability of this method to resolve the complex systems associated with sampling numerous U-Pb ages on a small sample is demonstrated by the total count for the small-volume U–Pb zircon geochronology.

Acknowledgments
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