New 40Ar/39Ar sanidine dates for the Green Canyon Flow, Yellowstone Volcanic Field, and implications for a revised volcanic stratigraphy

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Introduction

In the Yellowstone Volcanic Field, the Green Canyon Flow is one of several effusive lavas comprising the Big Bend Ridge Rhyolites that erupted between two caldera-forming eruptions: the Huckleberry Ridge and Mesa Falls Tuffs. The flow straddles the rim of Henry’s Fork Caldera, which was generated from the eruption of the Mesa Falls Tuff\textsuperscript{(1)}.

Objectives:

1) Determine a more accurate and precise 40Ar/39Ar age for the Green Canyon Flow.
2) Establish the stratigraphic relationship of the Green Canyon Flow relative to the Mesa Falls Tuff.
3) Refine the volcanic stratigraphy of the flow in relation to the Big Bend Ridge Rhyolites.

Location & Geologic Background

Two Conflicting Hypotheses:

1) Green Canyon Flow erupted concurrently with the Mesa Falls Tuff and flowed into the newly formed caldera\textsuperscript{(2)}.
2) Green Canyon Flow erupted prior to the Mesa Falls Tuff and faulted during caldera collapse\textsuperscript{(3)}.

Volcanic stratigraphy

<table>
<thead>
<tr>
<th>1.30 Ma Mesa Falls Tuff caldera-forming eruption\textsuperscript{(4)}</th>
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<tbody>
<tr>
<td>K/Ar ages\textsuperscript{(4)}</td>
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<tr>
<td>Unit</td>
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<tr>
<td>1.16 ± 0.03</td>
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<tr>
<td>Bishop Mountain Flow (BB)</td>
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<tr>
<td>1.17 ± 0.03</td>
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<tr>
<td>Green Canyon Flow (BG)</td>
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<tr>
<td>1.19 ± 0.03</td>
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<td>Tuff of Lyle Spring (BT)</td>
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<td>1.25 ± 0.03</td>
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<td>Moonshine Mountain Flow</td>
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<td>1.77 ± 0.05</td>
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<tr>
<td>Blue Creek Flow</td>
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<tr>
<td>1.81 ± 0.03</td>
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<tr>
<td>Headquarters Flow</td>
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Big Bend Ridge Rhyolites

2.08 Ma Huckleberry Ridge Tuff caldera-forming eruption\textsuperscript{(5,6)}

Hand Sample & Thin Sections

The hand sample is white with a porphyritic texture. The individual phenocrysts within the rock are largely composed of sanidine, plagioclase, and quartz. There are additional phenocrysts of biotite, which is overall quite rare in the Yellowstone Volcanic Field. The groundmass is devitrified, with a spherulitic texture in thin section.

40Ar/39Ar Dating Methods

Sanidine crystals ranging from 1-3 mm were separated from a bulk rock sample and irradiated with the Alder Creek Rhyolite standard\textsuperscript{(7)}. Single crystals were incrementally heated in order to assess trapped excess argon within the crystal. 40Ar/39Ar analyses were conducted at the WiscAr Geochronology Lab using a Nu Instruments Noblesse multi-collector mass spectrometer and 60W CO\textsubscript{2} laser.

40Ar/39Ar Sanidine Results

All six incremental heating experiments produced a plateau with ages ranging from 1.298 to 1.300 ± 0.002 Ma (including uncertainty on \(J\)). A weighted mean of the six experiments yields an age of 1.2989 ± 0.0009 Ma. (MSWD = 1.13)

Interpretations

- As determined by \(40Ar/39Ar\) dating, the Green Canyon Flow erupted at 1.2989 ± 0.0009 Ma.
- This places the flow in close temporal proximity to the Mesa Falls Tuff caldera formation eruption with an \(40Ar/39Ar\) age of 1.3001 ± 0.0006 Ma\textsuperscript{(3)}.
- This age also suggests the flow erupted ~150 ka after the Bishop Mountain Flow\textsuperscript{(6)} and Lyle Spring Tuff\textsuperscript{(9)}, making it the youngest of the Big Bend Ridge Rhyolites.

Conclusions

- The Green Canyon Flow is the youngest of the Big Bend Ridge Rhyolites, but is indistinguishable from the eruption age of the caldera-forming Mesa Falls Tuff.
- Additional field mapping will assist in resolving the sequence of eruption events at this time.
- To better constrain the connection between small volume rhyolite flows and caldera-forming eruptions, future work on the Green Canyon Flow will examine zircon grain morphology and zoning patterns, trace element geochemistry, and U-Pb dating.

References


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