A reconstruction of the paleo-ice thickness at Bláhnúkur, Torfajökull, Iceland, using volatile degassing

Jacqueline Owen

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What role do volatiles have in determining the explosivity of subglacial rhyolitic volcanoes in Iceland?
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Pre-eruptive Water & CO$_2$

Post-eruptive Water & CO$_2$

Reconstruct palaeo-ice thicknesses
Bláhnúkur

Pre-existing topography
Assume:
- equilibrium degassing
- 0 ppm CO$_2$
- 850°C
The End

... I wish
Altitude (m)

Glass water content wt %

- 1050m ice elevation
- Green circle: Graenagil
- Yellow triangle: A ridge
- Red line: Feeder dyke
- Blue diamond: No man's land
- Yellow plus: Top ridge
Possible explanations for A ridge being water-poor

- 1) Meltwater drainage
- 2) Low initial water content
- 3) Re-mobilisation
1) Meltwater drainage
2) Low initial water content

![Graph showing the relationship between altitude and glass water content with different bubble concentrations.](image)

- **1050m ice elevation**
- 0% bubbles
- 1% bubbles
- 5% bubbles
- 10% bubbles
- 20% bubbles
2) Low initial water content

![Graph showing altitude (m) vs. glass water content wt % with various markers for different locations such as Graenagil, A ridge, feeder dyke, No man's land, and Top ridge. The graph also highlights the 1050m ice elevation.](image-url)
3) Remobilisation
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Possible explanations for a ridge being water-poor:

1) Meltwater drainage

2) Low initial water content

3) Re-mobilisation
Altitude (m) vs. Glass water content wt %

- Green circles: Graenagil
- Orange triangles: A ridge
- Red line: Feeder dyke
- Blue diamond: No man's land
- Yellow plus sign: Top ridge

1050m ice elevation curve is shown.

Legend:
- Green circles: Graenagil
- Orange triangles: A ridge
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Possible explanation for Brandsgill being water-rich

Lava flow or sill?
Altitude (m)

Glass water content wt %

- 1050m ice elevation
- Graenagil
- A ridge
- feeder dyke
- No man's land
- Brandsgill
- Top ridge
Possible explanations for the lobe slope being water-rich

1) The lobes formed intrusively
2) Thicker ice
3) Endogenous growth
4) Hydration
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1) The lobes formed intrusively
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2) Thicker ice

600 m
2) Thicker ice
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1325 m

600 m
2) Thicker ice

![Graph showing the relationship between altitude (m) and glass water content wt % for different locations.

- Green dots represent Graenagil.
- Orange triangles represent A ridge.
- Purple squares represent lobe slope.
- Red diamonds represent feeder dyke.
- Blue diamonds represent No man's land.
- Purple crosses represent Brandsgill.
- Yellow crosses represent Top ridge.

Legend:
- Green line labeled 1325 m ice elevation (0 ppm CO2).
- Blue line labeled 1325 m ice elevation (18 ppm CO2).

The graph illustrates the data for ice thickness at 1325 m elevation with and without 18 ppm CO2, showing variations in glass water content at different altitudes.]
3) Endogenous growth
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- Altitude (m)
- Glass water content wt %

- 1050m ice elevation
- Green circle: Graenagil
- Orange triangle: A ridge
- Purple square: lobe slope
- Red line: feeder dyke
- Blue diamond: No man's land
- Blue cross: Brandsgill
- Yellow plus: Top ridge
3) Endogenous growth

[Diagram showing altitude vs. glass water content with various markers and lines indicating different features such as Graenagil, A ridge, lobe slope, feeder dyke, No man's land, Brandsgill, Top ridge, below 115 m of rhyolite, and below 170 m of hyaloclastite.]
4) Hydration

(Nowak & Behrens, 2001)
4) Hydration

(Nowak & Behrens, 2001)
Possible explanations for the lobe slope being water-rich

1) The lobes formed intrusively

2) Thicker ice
   - A two stage eruption
   - CO$_2$ present

3) Endogenous growth

4) Hydration

5) A combination of the above
Conclusion

The thickness of ice was...

450 m
Putting it into context...

- Bláhnúkur is ~95 thousand years old (P. Clay), therefore we can reconstruct the ice thickness for this part of Iceland for this specific time period.
Putting it into context...

- Tuyas in the same region show ice contact features up to 1150 m (Tuffen et al., 2002)

- This is only 100m more ice than Bláhnúkur which is reasonable considering that Rauðfossafjöll erupted about 80,000 years ago (McGarvie, 1984), nearer the glacial max.
But it’s told us more than that...

- It’s told us things about the way in which Bláhnúkur erupted
  - Meltwater drainage (A ridge)
  - Intrusive formations with endogenous growth (lobe slope)
  - The lava body in Brandsgill is a sill rather than a lava flow and therefore was probably one of the last things to be erupted
Take home points

- It’s relatively easy (mine was a by product of the main project)
- Don’t rely on a just a few points
  - Feeder dyke = 1042 m
  - A ridge = 810 m
  - Lobe slope = 1402 m
- Colour is a wonderful thing
# Thank you

Special thanks to...

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<tr>
<th>Supervisors</th>
<th>Lab support</th>
<th>Discussion</th>
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<tbody>
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<td>Hugh Tuffen</td>
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<td>All sauna members</td>
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<td>Dave McGarvie</td>
<td>Steph Flude</td>
<td>Esp. Jo Denton</td>
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<td>Harry Pinkerton</td>
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<td>Panel people</td>
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<td>Anabelle de Chazal</td>
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<td>Mike James</td>
<td>The wardens at Landmannalaugur</td>
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