Appendix A: Stratigraphic Sections

Locations of stratigraphic sections labeled with last three numbers of section name.

10JAUOK001 is 60 cm tephra not described in detail.
10JAUOK002

Location: E. Side Crater Creek

- 48 cm: Vesicular fine ash with faint wavy laminae and ash pellets. Vesicularity increases upsection.
- 44 cm: 2 cm inversely graded medium to coarse ash with subrounded to subangular fine lapilli to 3 mm. 2 cm of massive fine to medium ash. Entire 6.5 cm package is laterally discontinuous.
- 37.5 cm: 2 cm of medium to coarse ash. 1-2 cm package of fine light grey ash with faint laminae and faint mudballs.
- 3 cm of alternating layers of light grey vesicular fine ash and dark grey vesicular medium ash.
- 3 cm of dark grey non-vesicular medium ash with laminae at base.
- 29 cm: 2 cm of vesicular cohesive fine ash with 2-3 mm ash pellets.
- Top 2 cm is massive dark grey fine ash.
- 1 cm of grey fine ash with 2-3 mm ash pellets.
- 1.5 cm of massive fine ash with rare fine lapilli to 3 mm.
- 1 mm of very fine light grey ash with 2 mm lens of sorted dark grey medium ash above.
- Very poorly sorted and water-saturated fine ash to lapilli. Predominantly fine ash with many 2-3 mm lapilli.

Unit 3:

- 13 cm: Open framework coarse ash and lapilli. Fewer lapilli than below, finer mixed brown and black coarse ash. Lapilli are sub-angular to angular, vesicular, and pumiceous.

Unit 2:

- 9 cm: Lapilli and coarse ash as below but matrix full of fine and med ash. Large clasts angular, some denser clasts than below.

Unit 1B:

- 4 cm: Open framework lapilli (to 3 cm) and coarse ash. Lapilli are mostly 1 cm angular juvenile pumice. Ash is mixed black and brown glass with a mode at 1 mm. Deposit mixed with tussock grass at base.
10JAUOK003

Location: E. Side Crater Creek

39 cm
- Laminated, sorted, grey vesicular fine ash, ghosty ash pellets present. Vesiculosity increases upsection.

31.5 cm
- Well sorted dark grey medium ash, poor laminations, wavy, possible channel-fill reworking.
  - Vesicular fine ash with faint laminae becoming well developed in upper 2 cm.
  - Lower 4 cm has outlines of 2-3 mm ash pellets.

30 cm

24 cm
- Very poorly sorted water-saturated fine and medium ash to fine lapilli, matrix supported.
  - Ash is brownish grey, lapilli are black.

Unit 3

13 cm
- Open framework, clast-supported coarse ash and lapilli. Fewer lapilli than below, finer coarse ash.
  - More dense lapilli than below.

Unit 2

8 cm
- Ungraded lapilli and coarse ash as below but matrix full of fine and med ash, which coats lapilli.
  - Unit is consolidated

Unit 1B

4.5 cm
- Open framework lapilli (1-2 cm) and coarse ash mantles 5-10 cm clasts in brown scoria soil.
  - Lapilli are angular bread-crust juvenile pumice, coarse ash is mixed brown and black glass.

Unit 1A

0 cm
**10JAUOK004**

Location: E. Side Crater Creek

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>49 cm</td>
<td>5 cm of laminated fine ash. Laminations are planar at base and become wavy near the top</td>
</tr>
<tr>
<td>32 cm</td>
<td>2 cm of fine ash with ash pellets</td>
</tr>
<tr>
<td>32 cm</td>
<td>1.5 cm of laminated fine and medium ash</td>
</tr>
<tr>
<td>32 cm</td>
<td>2 cm of fine ash with ash pellets</td>
</tr>
<tr>
<td>32 cm</td>
<td>1.5 cm of laminated fine and medium ash</td>
</tr>
<tr>
<td>32 cm</td>
<td>3 cm of laminated medium ash</td>
</tr>
<tr>
<td>32 cm</td>
<td>2.5 cm of normally graded laminated medium to coarse ash</td>
</tr>
<tr>
<td>24.5 cm</td>
<td>6 cm of fine ash with ash pellets. Some medium ash present, no coarse ash or lapilli.</td>
</tr>
<tr>
<td>Unit 3B</td>
<td>Laminated and indurated vesicular fine to medium ash with scattered lapilli. No ash pellets, some fine laminitate of fine light grey ash.</td>
</tr>
<tr>
<td>Unit 3A</td>
<td>Fine lapilli and 2-3 mm ash pellets in matrix of vesicular fine to medium ash</td>
</tr>
<tr>
<td>Unit 2</td>
<td>12 cm of open framework coarse ash and lapilli. Finer lapilli than below, finer coarse ash is mixed brown and black glass and crystal rich.</td>
</tr>
<tr>
<td>Unit 1B</td>
<td>7 cm of lapilli and coarse ash as below but matrix full of fine and med ash. Unit is well consolidated.</td>
</tr>
<tr>
<td>Unit 1A</td>
<td>3.5 cm of open framework lapilli (to 2 cm) and coarse ash. Lapilli are mostly angular juvenile pumice. Ash is mixed black and brown glass.</td>
</tr>
</tbody>
</table>
Location: E. Side Crater Creek

74 cm
Very vesicular fine ash with possible weak ash pellets. Vesicles have fine-grained rims.

70 cm
Moderately vesicular laminated fine ash.

66 cm
5 mm cap of medium ash.

61 cm
Vesicular fine ash with 1 mm ash pellets.

58 cm
Poorly vesicular fine ash with weak laminae, no ash pellets.

53 cm
Vesicular fine ash with 1-3 mm ash pellets and possible faint laminae.

47 cm
Laminated vesicular fine ash with possible weak ash pellets in upper 3 cm.

43.5 cm
Alternating laminae of sorted, nonvesicular fine and medium ash. No ash pellets

41.5 cm
5 mm of laminated vesicular medium ash with 1.5 cm of vesicular fine ash with ash pellets above.
Top 1 cm is 1-2 mm fine ash pellets. Basal 1 cm is laminated fine-medium ash.
Ash pellet size is decreasing upsection

39 cm
Fine ash with rare medium and coarse ash. Abundant 1-3 mm ash pellets

31 cm
Basal 1 cm is indurated laminae of vesicular fine ash.

30 cm
Laminated and indurated fine to medium ash with scattered lapilli to 5 mm. No ash pellets.

25 cm
Matrix supported fine ash to lapilli to 5 mm, many 3 mm ash pellets, and zones of cored lapilli (1 mm core, 3 mm total diameter).

14 cm
Open framework medium to coarse ash and lapilli. Lapilli are finer than below, subround to angular, and most are vesicular.

10 cm
Lapilli and coarse ash as below but matrix full of fine and medium ash. Unit is well consolidated, clast supported. Many lapilli are subrounded.

6 cm
Open framework lapilli (to 2 cm) and coarse ash. Lapilli are angular juvenile pumice and dense lava fragments. Ash is mixed black and brown glass and more abundant than in other locations.

0 cm
10JAUOK006

Location: E. Side Crater Creek

23 cm. Very vesicular fine ash with possible ghosty mudballs. Vesicularity increases upsection.

20.5 cm. 2-3 mm layer of medium ash at base. Much is dense and black.

19 cm. Laminated fine ash.

18 cm. Vesicular fine ash with possible ghosty ash pellets.

17 cm. Laminated fine ash.

Unit 3B Fine ash with coarse ash to fine lapilli. Lapilli are smaller but more abundant than below. Matrix of fine ash is coarser than below. Better sorted than Unit 3A below.

13 cm. Fine lapilli and 2-3 mm ash pellets in matrix of fine ash.

Unit 3A

8 cm. Open framework coarse ash and lapilli to 8 mm. Finer lapilli than below, some are subround. Coarse ash is mixed brown and black glass with black glass more prevalent.

6 cm. Lapilli (some rounded) and coarse ash as below but matrix full of fine and med ash. Cored lapilli and ash pellets are present.

Unit 1B

3 cm. Open framework lapilli (to 2 cm) and coarse ash. Lapilli are mostly finely vesicular brown pumice. Some lapilli resemble ribbon bombs. Ash is mixed black and brown glass. Tussock grass extends up into next unit.

Unit 1A

0 cm.
Location: E. Side Crater Creek

**Unit 3B**

- **30 cm**: Vesicular fine ash with planar laminations becoming wavy in upper 2-3 cm.

**Unit 3A**

- **24 cm**: Fine to coarse ash with fine lapilli and few ash pellets. Lapilli are smaller but more abundant than in Unit 3A. Matrix of fine ash is coarser and sorting is better overall than in Unit 3A.
- **19 cm**: Fine lapilli, ash pellets, and cored lapilli in matrix of fine to coarse ash.

**Unit 2**

- **13.5 cm**: Open framework coarse ash with few lapilli, Lapilli are finer than below and some are subrounded. Coarse ash is mixed brown and black glass.
- **10.5 cm**: Lapilli (some rounded) to 1 cm and coarse ash as below but matrix full of fine and med ash with some ash pellets.

**Unit 1B**

- **7 cm**: Open framework lapilli and coarse ash. Lapilli are mostly finely vesicular brown pumice. Lapilli of plagioclase-rich dense lava are also present. Ash is mixed black and brown glass with a mode of dense black lava at 1 mm. Tussock grass extends up into next unit.

**Unit 1A**

- **0 cm**:
Section 10JAUOK010 was described within a few meters of 10JAUOK009. Section 10JAUOK009 was determined to be more representative of deposits in this area.
64 cm
Medium to coarse ash, top with thin fine light grey cap.
Ash pellets (2-4 mm) with fine ash in matrix.
Medium to coarse ash layer.
Fine ash, mostly ash pellets with few 5 mm massive fine ash layers.

51 cm
Couplet of sorted medium to coarse ash with 1 cm fine massive ash in center. Coarse layers contain red coarse ash particles.

48 cm
Clast-supported and sorted ash pellets with four 2-5 mm thick layers of sorted medium to coarse ash.

31 cm
Sorted medium ash.

30 cm
Clast supported 2-5 mm ash pellets, none cored, all fine to medium ash.
Couplet of medium-coarse ash with center 5 mm of fine ash.

26 cm
Clast-supported ash pellets, accretionary lapilli, and cored lapilli. Ash aggregates are moderately well sorted by pellet size. Aggregate size ranges from 2 to 8 mm and unit is crudely reversely graded.

Unit 3A
Open framework medium to coarse ash and lapilli. Lapilli are finer than below and brown.

9.5 cm
Matrix supported lapilli and coarse ash with fine to medium ash. Middle 2 cm is better sorted and fines poor. Lapilli make up less than 10% of unit and contain some angular lava clasts.
Open framework lapilli and coarse ash. Lapilli are angular brown bread-crust ed friable pumice with a mode at 5-10 mm. Ash is mixed black and brown glass and makes up about half of the unit. Base lies on moss and grass.
10JAUOK012
Lower 154 cm

Location: In caldera, Cone B bench.

154 cm
- Ash pellets in distinguishable horizontal beds.
- 5-10 mm thick layer of medium to coarse ash with rare lapilli.
- Ash pellets in distinguishable horizontal beds.

120 cm
- Couplet: upper and lower 2 cm are coarse ash, middle 2 cm is fine ash with ash pellets.

114 cm
- 11 cm of ash pellets.
- 3 cm of coarse ash with rare fine lapilli with undulose upper surface.

100 cm
- 6 cm of ash pellets with some horizontal layering.
- 2 cm layer of medium ash.
- 6 cm of ash pellets supported by matrix of fine ash with some horizontal layering.
- 6 cm couplet: lower 2 cm is medium to coarse ash laminated with fine ash. Middle 2 cm is very fine wet ash. Upper 2 cm is medium ash with some fine ash.

80 cm
- 7 cm of ash pellets.
- 3 cm of poorly sorted fine to coarse ash with few lapilli and no ash pellets.
- 5 cm of clast-supported 3-6 mm ash pellets with rare coated lapilli.
- 5 cm of coarse ash and 3-8 mm lapilli (30%) with fine ash in matrix.
- 6 cm of fine ash in 2-6 mm ash pellets.

54 cm
- Unit is capped by a light grey layer of coarse ash and lapilli with a matrix of fine ash.
- Matrix-supported lapilli and coarse ash with matrix of fine to medium ash. Lapilli are mostly subrounded brown pumice.

36 cm
- Open framework lapilli (to 2 cm) and coarse ash in equal amounts. Large lapilli are brown pumice.
- Matrix-supported lapilli and coarse ash with matrix of fine to medium ash. Lapilli are mostly subangular, most subangular.

Unit 2
24 cm
- Clast-supported, normally-graded lapilli (mode at 2-3 cm) with a matrix of medium to coarse ash.
- Lapilli are mostly subangular juvenile pumice. Large dense lithic lapilli present at top. Large juvenile lapilli and bombs (to 40 cm) present at base.

Unit 1B
3 cm
- Moderately well sorted medium to coarse mixed brown and black vitric ash with rare brown lapilli.

Unit 1A
0 cm
10JAUOK012
Upper 128 cm

Location: In caldera, Cone B bench.

- **282 cm**: Upper packages is mixed layers of ash pellets, laminated fine and medium ash, and alternating layers of medium to coarse ash and fine ash.
- **240 cm**: 8 cm couplet; lower 2 cm is coarse ash, middle 4 cm is laminated fine ash, and upper 2 cm is coarse ash.
- **232 cm**: Package of ash pellet layers and weakly laminated fine and medium ash.
- **196 cm**: Package of laminated fine ash, alternating laminae of medium and fine ash, laminated medium ash, and ash pellet layers. Most of this unit is fine to medium ash in laminations, ash pellets account for less than 30% of total.
- **168 cm**: Weakly laminated medium ash with some fine ash. Possible ash pellets at base.
- **158 cm**: Couplet of upper and lower coarse ash with ash pellets in middle.
10JAUOK013

Location: On plain north of Idak

1-4 cm of reworked ash.

Unit 3

Poorly sorted fine to coarse ash with rare very fine lapilli. Most of the unit is medium to coarse ash. Weak ash pellets are present.

Unit 2

Moderately well sorted coarse ash with very fine lapilli.

Unit 1B

Lapilli and coarse ash as in unit below, but with matrix full of fine to medium ash.

Unit 1A

Open framework lapilli and coarse ash. Lapilli are brown pumice up to 1 cm. Ash is mixed black and brown glass.

10JAUOK014

Location: East side Tulik, below Station OKTU

Top 1 cm is vesicular fine ash with weak laminations and possible weak 1 mm ash pellets

5 mm coarse ash below fine top
Fine, medium, and coarse ash in weak 5-10 mm layers

Unit 3B

1.5 cm of laminated fine and medium ash with rare fine lapilli.

Unit 3A

Fine to medium ash with coarse ash and lapilli to 8mm. Unit is matrix supported and lies atop a pavement of 5-10 cm dense clasts.
Location: West Side of Tulik

18 cm

Fine to medium ash in wavy 1-1.5 cm layers.

9 cm

Light grey layer of fine ash.

0 cm

Laminated dark medium and coarse ash with some fine ash. Unit is ungraded, moderately sorted and lies on a base of 2-3 cm brown oxidized scoria.
Location: East of Jag Peak

19 cm
Laminated fine ash with a few light grey layers of very fine ash.

11.5 cm
11 cm
Sorted medium to coarse ash.
Laminated fine ash.

6.5 cm
6 cm
Well sorted medium to coarse ash.
Massive fine ash.

5 cm
Pinching and swelling layer and pods of coarse and medium ash.

4 cm
Massive fine ash. Some clasts from underlying surface are mixed in (red oxidized clasts).

3 cm
Moderately well sorted medium ash with occasional subrounded pumice lapilli (to 6 mm).
Unit overlies red oxidized scoria.

0 cm
Unit overlies red oxidized scoria.
10JAUOK017

Location: Flanks East of Tulik

- **22 cm**: Vesicular sorted fine ash with 1 mm ash pellets.
- **21 cm**: Two packages of medium to coarse ash with fine ash tops.
- **20 cm**: Weakly laminated fine ash with some medium ash.
- **17 cm**: Coarse ash base, moderately poor sorting, contains fine and medium ash. Layered (3-5 mm) of fine, medium, and coarse ash with wavy laminations. Possible syneruptive wind reworking.
- **10.5 cm**: Moderately sorted medium ash with some fine and coarse ash.
- **10 cm**: Laminated fine ash with occasional coarse ash, some slightly wavy laminations.
- **6.5 cm**: Moderately sorted medium ash with some coarse ash, faint layering on few mm scale. Contains few juvenile black pumice lapilli around 1.5 cm.
- **1.5 cm**: Thin layer medium to coarse ash with 5-10% 2-5 mm lapilli. Structureless fine to medium ash with some very coarse ash to lapilli. Lies atop large clast pavement and upper contact is undulose.
- **0 cm**: Structureless fine to medium ash with some very coarse ash to lapilli. Lies atop large clast pavement and upper contact is undulose.
10JAUOK018

Location: Upper East Flanks

44 cm
- Vesicular fine ash laminations in middle 1 cm

40 cm
- Normally graded fine to medium ash with slightly wavy laminations

30 cm
- Thin layer of fine to medium ash
- Moderately well sorted coarse ash, mostly vesicular brown juvenile clasts
- Laminated fine ash, possibly all reworked from thin layer up

28 cm
- Medium to coarse ash with 1 cm of fine ash in 1 mm ash pellets
- Clast-supported 3-5 mm pellets of fine ash
- Laminated medium and fine ash

24 cm
- Medium ash with some fine ash, coarse ash, and subangular juvenile pumice lapilli. Very well consolidated (Unit 3B)

19 cm
- Ash pellets and cored lapilli (30%) and juvenile lapilli to 2 cm (10%) supported by a matrix of fine, medium, and coarse ash. Lower 10 cm (Unit 3A) less indurated than top 5 cm.

8.5 cm
- Coarse ash with some medium ash and rare lapilli, marked loss of fines from below.

6.5 cm
- Unit 2

4 cm
- Unit 1B

0 cm
- Unit 1A

- Open framework coarse ash and lapilli. Many angular brown pumice lapilli around 1 cm. Coarse ash is subequal brown pumice and black dense clasts. Unit lies on pavement of large clasts.
Location: Upper East Flanks

Cap of vesicular fine ash with few small ash pellets.

Wavy layers of moderately well sorted coarse ash, fine ash laminations, and medium ash.

Clast supported ash pellets (2 mm). Unit is entirely fine ash.

Two 1 cm layers of fine to medium ash with coarser dark lenses between.

Upward fining laminations of medium and fine ash. Lapilli and ash pellets absent.

Moderately well sorted coarse ash with a light grey fine ash top.

Laminated medium and fine ash, well consolidated.

Fine to medium ash with 1-2 mm ash pellets.

Two 1 cm packages of medium to coarse ash with fine ash pellets (1-2 mm) in between. Occasional lapilli to 1 cm.

Medium ash with fine ash, coarse ash, and lapilli to 3 mm. Intermittent horizontal structure and laminations present.

Ash pellets to 6 mm, fine, medium, and coarse ash with occasional juvenile lapilli to 15 mm.

Coarse ash with 15% lapilli, fine and medium ash rare at base and increase upwards. Rare cored lapilli are present to 6 mm.

Moderately well sorted coarse ash with juvenile lapilli to 3 mm.

As above, with fine and medium ash filling matrix, lapilli possibly larger, still clast supported.

Coarse ash (subequal black and brown clasts) and subangular to angular brown lapilli.

Base lies atop pavement of large clasts sitting on soil developed in scoria.
10JAUOK020

Location: Upper East Flanks

- 51.5 cm: Vesicular fine ash top with 2-4 mm ash pellets.
- 50 cm: Couplet of medium to coarse ash with fine ash pellets in the middle, contacts are wavy.
- 48 cm: Fine to medium ash with ash pellets. Ash pellets are weaker and some layering present in top 1 cm.
- 45 cm: Medium and coarse ash with thin layer of sorted coarse ash below.
- 39.5 cm: Layered (2-5 mm) medium ash with some fine ash layers.
- 34 cm: Clast supported ash pellets. Unit is entirely fine ash.
- 24 cm: Normally graded alternating layers of fine and medium ash, top 4 cm is vesicular.
- 16.5 cm: Couplet of coarse ash with fine ash laminations in middle.
- 9 cm: Normally graded and alternating layers of fine and medium ash.
- Unit 3B: Layer of coarse ash. Laminated fine ash.
- Unit 3A: Strongly laminated medium ash with coarse ash and more lapilli than below. Reverse grading.
- Unit 2: Fine to medium ash with rare very fine lapilli and weak layering.
- Unit 1B: Medium and coarse ash and lapilli with some fine ash. Contains ash pellets, 3-4 mm cored lapilli, and juvenile lapilli to 1 cm with a mode at 5 mm.
- Unit 1A: Coarse ash (mixed black and brown clasts) with 10% juvenile lapilli to 8 mm.
- Unit 1B: Clast-supported coarse ash and lapilli with matrix of medium ash.
- Unit 1A: Coarse ash and lapilli (mostly angular juvenile to 1.5 cm). Overlies brown soil developed in scoria.
10JAUOK021

Location: North of Idak

- Normally graded coarse and medium ash, fine lapilli present throughout. Fine ash ribbons present near top.

- Open framework mixed black and brown coarse ash and brown pumice lapilli to 1.5 cm. Fine and medium ash absent. Unit lies atop brown soil.

10JAUOK022

Location: North of Idak

- Loose medium and coarse ash with some very fine lapilli to 2 mm.

- Open framework coarse ash and lapilli to 1 cm. Unit lies atop brown soil.
10JAUOK026 is 2 cm medium to coarse ash with fine lapilli.
10JAUOK027 is 3 cm ash.
10JAUOK028 is 4 cm upward-fining coarse ash with lapilli and medium ash at top.
10JAUOK029 is 1 cm or less medium and fine ash in vegetation.
10JAUOK030 is 2 cm fine ash in roots.
10JAUOK031 has no detectable ash
10JAUOK032 has no detectable ash.

10JAUOK034 is 1.5 cm gray fine ash in moss.

10JAUOK036 is 1 cm gray fine ash.
10JAUOK037 is 0.5 cm fine ash.
10JAUOK039 is 3 cm fine to medium ash with coarse ash and lapilli at base.

10JAUOK040

10JAUOK041 is 2 cm fine to medium ash with some coarse clasts.
10JAUOK042 is 1 cm fine ash in moss with few coarse ash clasts.
10JAUOK043 is 0.5 cm fine ash.
10JAUOK046 is 1 cm fine ash.
10JAUOK047 is 2 cm fine to medium ash.
10JAUOK050 is 0.3 – 0.5 cm fine ash.
10JAUOK051 is 1 cm fine ash with some medium ash.
10JAUOK052 is 1.5-2.0 cm with 0.7 cm fine ash at base and 0.8 cm med ash at top.
10JAUOK053 is 3 cm ash, bottom 1.5 cm is fine ash, upper 1.5 cm is medium ash.
10JAUOK054 is 3.5 cm fine to medium ash.
10JAUOK055 is 8 cm with 4 cm coarse ash and lapilli at base, 3 cm medium ash, and 1 cm fine ash at top.
10JAUOK056

Location: Near Reindeer camp southwest of Idak

10JAUOK057 is 10 cm, 4 cm coarse ash and lapilli at base, 3 cm medium ash, and 3 cm fine ash at top.

10JAUOK058

Location: Around north side of Idak

10JAUOK059 is 5 cm 2 cm coarse ash and lapilli at base and 3 cm medium ash at top. 10JAUOK060 is 6 cm coarse ash and lapilli with medium ash at top. 10JAUOK061 is 5.5 cm ash, bottom 2 cm is open-framework coarse ash and lapilli, middle 2 cm is medium ash with fine ash and coarse ash with few fine lapilli, top 1.5 cm is medium to coarse ash.
10JAUOK062 is 10 cm tephra, bottom 4 cm is open-framework coarse ash and lapilli, next 3 cm is medium ash with lapilli, next 2 cm is fine ash, top 1 cm is coarse ash. 10JAUOK063 is 7 cm tephra, bottom 4 cm is coarse ash with lapilli, middle 2 cm is medium ash with coarse ash and lapilli, and top 1 cm vesicular fine ash with weak laminations.
10JAUOK066

Location: Upper East Flanks

- 31 cm: Vesicular fine ash top. Clast supported 2-4 mm ash pellets.
- 25.5 cm: Clast of coarse ash. Bottom 6 mm is sorted coarse ash. Middle 2 cm is fine to medium ash with ash pellets in lower cm and laminations in upper cm. Top 4 mm is coarse to medium ash.
- 22 cm: Laminated ash grades from coarse ash at base to fine ash with scatter coarse ash at top.
- 15 cm: Clast of coarse ash with middle of vesicular fine to medium ash and thin cap of light grey fine ash.
- 13.5 cm: Laminated reversely graded fine to medium ash with no outsized clasts.
- 9 cm: Laminated medium to fine ash with more coarse ash and lapilli than unit below. Ash pellets absent.
- Unit 3A: Massive fine to medium ash with coarse ash, lapilli, and ash pellets to 6 mm.
- Unit 2: Clast supported mud-coated lapilli. Could be base of Unit 3.
- Unit 1B: Open coarse ash with few lapilli, ash is finer than below.
- Unit 1A: As below, with the addition of medium ash.
- Open framework 50-50 coarse ash and pumice lapilli with some mixed lithics.
10JAUOK067
Location: East Caldera Rim

85 cm
- Laminated medium and fine ash. Thin coarse ash at base.
- Laminated fine to medium ash.

70 cm
- Thin coarse ash.
- Prominent 7 mm coarse ash layer.

67 cm
- Laminated medium and fine ash.

60 cm
- Laminated medium ash with fine ash, well indurated and normally graded.
- Well sorted coarse ash at base.

58 cm
- Normally graded coarse to fine sorted laminated ash.
- Clast-supported fine ash pellets with layers of medium ash.

50 cm
- Coarse ash layer at top.
- 2-4 mm ash pellets in fine ash matrix.
- Laminated medium ash.
- 2-4 mm ash pellets.

44 cm
- Well indurated medium ash with coarse ash and lapilli. Unit is hard, and forms a shell in outcrop. Contains some fine ash, looks similar to unit below, but is better indurated.

Unit 3B
- Abrupt transition.

30 cm
- Fine ash with ash pellets and cored lapilli up to 1 cm and pumice lapilli to 1 cm.
- Fairly well consolidated, unit had very well preserved ash pellets and is clast supported ash aggregates and lapilli.

Unit 3A

17 cm
- 70% coarse to medium ash, 30% lapilli. Ash is clean and appears crystal rich. Lapilli are predominately pumice, but also include lithics. Lapilli seem more rounded than below.

Unit 2

10 cm
- Lapilli and coarse ash with a matrix of fine and medium ash. Lapilli are subangular pumice with some plagioclase-rich lava clasts.

6 cm
- Open framework lapilli and coarse ash.

Unit 1

3 cm
- Very poorly sorted lapilli and fine to coarse ash. Lapilli are mostly subangular pumice with some lithics.

0 cm
10JAUOK069 is 3 cm medium ash with fine ash, coarse ash, and lapilli to 7 mm.
10JAUOK070 is 3 cm ash.
10JAUOK071 is 3 cm ash, bottom 1 cm is coarse ash, top 2 cm is medium to fine ash.
10JAUOK072 is 3 cm ash, bottom 1 cm is coarse ash, top 2 cm is medium to fine ash.
10JAUOK073 is 4.5 cm, bottom 2 cm is open-framework coarse ash and few very fine lapilli, top 2.5 cm is medium to fine ash.
10JAUOK075 is 93 cm tephra and was not described in detail.
Location: Southeast caldera rim

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>37 cm</td>
<td>Vesicular laminated fine and medium ash with packets of normal grading. Thin basal open framework coarse ash.</td>
</tr>
<tr>
<td>33 cm</td>
<td>Laminated fine to medium ash with some vesicular fine ash layers with ash pellets.</td>
</tr>
<tr>
<td>27 cm</td>
<td>2-3 mm layer of open framework sorted very coarse ash.</td>
</tr>
<tr>
<td>19 cm</td>
<td>Massive fine and medium ash with 2-4 mm ash pellets.</td>
</tr>
<tr>
<td>13 cm</td>
<td>Medium and fine ash with wavy and pinch-and-swell laminations. Moderate sorting, alternating layers of fine and medium ash, fairly well indurated. Possible surge deposit.</td>
</tr>
<tr>
<td>3 cm</td>
<td>Poorly sorted ash with abundant ash pellets to 7 mm. Ash pellets include fine ash, some large pellets contain medium and coarse ash.</td>
</tr>
<tr>
<td>0 cm</td>
<td>Medium ash with coarse ash and lapilli. Very well indurated and poorly sorted. Pumice lapilli to 1 cm. Lies atop a brown soil with dense rock pavement.</td>
</tr>
<tr>
<td>Depth</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>70 cm</td>
<td>Open framework coarse ash with medium ash. Light fine ash layer at top.</td>
</tr>
<tr>
<td></td>
<td>Vesicular fine to medium ash with small weak ash pellets.</td>
</tr>
<tr>
<td>63.5 cm</td>
<td>Open framework coarse ash with some medium ash.</td>
</tr>
<tr>
<td>57 cm</td>
<td>Laminated fine ash with medium ash, lighter and finer than below.</td>
</tr>
<tr>
<td>55 cm</td>
<td>Laminated fine ash with medium ash.</td>
</tr>
<tr>
<td></td>
<td>Massive medium to coarse ash, moderately sorted with faint layering at top.</td>
</tr>
<tr>
<td>48 cm</td>
<td>Alternating laminae of medium to coarse ash and fine to medium ash building up to coarse layer above.</td>
</tr>
<tr>
<td>44 cm</td>
<td>Structureless finely vesicular fine ash with thin lenses of medium to coarse ash.</td>
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<tr>
<td>37 cm</td>
<td>Light grey fine ash cap. Fine to medium ash, structureless at base and laminated at top. Well sorted coarse ash with slight normal grading.</td>
</tr>
<tr>
<td>32 cm</td>
<td>Laminated medium and fine ash.</td>
</tr>
<tr>
<td>30 cm</td>
<td>Alternating ash pellets and laminated medium ash. 3-5 mm ash pellets common.</td>
</tr>
<tr>
<td>21 cm</td>
<td>Laminated medium ash with rare coarse ash and lapilli.</td>
</tr>
<tr>
<td>14 cm</td>
<td>Color change at base of unit.</td>
</tr>
<tr>
<td>11 cm</td>
<td>Laminated medium ash with coarse ash and lapilli. Basal 1 cm is laminated fine to medium ash with coarse ash, lapilli, and ash pellets.</td>
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<tr>
<td>6 cm</td>
<td>Very poorly sorted ash and lapilli. Fine ash content increases upward, but top is nearly clast-supported lapilli. Base is coarse ash with lapilli.</td>
</tr>
<tr>
<td>0 cm</td>
<td>Open framework 50% coarse ash 50% lapilli. Ungraded and undifferentiated. Lapilli are juvenile pumice and lithic lava clasts.</td>
</tr>
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</table>
Location: Bench north of Cone B

- 8 cm: Very vesicular fine ash top.
- 6 cm: Laminated medium and fine ash.
- 4.5 cm: Vesicular fine to medium ash with coarse ash and ash pellets, rare fine lapilli.
- 0.7 cm: Thin coarse ash layer at base.
- 0 cm: Massive fine to coarse ash with ash-coated pumice clasts at base atop brown scoria soil.
Location: Southeast caldera rim

- 68 cm: Vesicular massive fine ash top.
  Couplet of laminated coarse and medium ash with coarse ash base and top.

- 63 cm: Fine to medium ash with clast-supported 3-4 mm ash pellets.

- 55 cm: Laminated medium ash.

- 49 cm: 5 mm very coarse ash with lapilli.
  Laminated medium and coarse ash with rare lapilli. Coarsens upward.

- 40 cm: Laminated medium ash with some fine and coarse ash. Includes a few better sorted coarse ash layers near top.

- 32 cm: Coarse and medium ash with fine ash laminae and lenses. Duneforms and pinch and swell laminations. Possible surge deposit.

- 28 cm: Laminated medium ash with beds of fine ash and ash pellets. Better indurated above 24 cm. Coarse ash fall (1 mm) at base.

- 21 cm: Fine ash with 2-4 mm ash pellets.

- 18 cm: Laminated medium and coarse ash with some very coarse ash and fine lapilli.

- 15 cm: Structureless medium ash with some fine ash and lapilli to 8 mm.

- 12 cm: Laminated indurated medium to coarse ash with very coarse ash and rare lapilli.

- 6 cm: Massive vesicular fine to medium ash with coarse ash and rare lapilli.

- 3 cm: Laminated medium ash with abundant coarse ash and lapilli to 1 cm. Crude normal coarse-tail grading.
Location: Near Cone F

- **60 cm**: Vesicular fine to medium ash top.
- **58 cm**: Laminated fine and medium ash.
- **56 cm**: Fine to medium ash with 2-4 mm ash pellets.
- **50 cm**: Coarse ash layer.
- **43 cm**: Laminated medium and fine ash with some layers of small ash pellets.
- **38 cm**: Open framework coarse and very coarse ash with light grey fine ash cap.
- **36 cm**: Laminated medium and fine ash.
- **31 cm**: Open framework sorted coarse ash.
- **30 cm**: Laminated medium and fine ash with thin sorted very coarse ash layer.
- **28 cm**: Weakly layered fine to medium ash with weak ash pellets.
- **20 cm**: Fine ash with 5 mm open framework coarse ash bed.
- **18 cm**: Fine to medium ash with ash pellets. Massive medium ash with some fine layers and 3-5 mm ash pellets.
- **10 cm**: Weak couplet of medium ash with fine center.
- **8 cm**: Massive fine to medium ash.
- **8 cm**: Indurated medium ash with fine ash and some coarse ash.
- **0 cm**: Finer ash at base.

- **0 cm**: Medium ash with coarse ash through fine lapilli to 4 mm and ash pellets to 5 mm.
10JAUOK081

Location: Lower flanks traverse

22 cm
Vesicular laminated fine to medium ash.

18 cm
Sorted medium to coarse ash with salt and pepper appearance.

15 cm
Weakly laminated medium and fine ash.

Unit 3 12 cm
Medium and coarse ash with lapilli and fine ash.

Unit 2 10 cm
70% coarse ash and 30% lapilli. Ash finer than below, lapilli slightly rounded.

Unit 1B 6 cm
Coarse ash and lapilli with matrix full of fine and medium ash. Some cored lapilli and dense lava lapilli.

Unit 1A 0 cm
Open framework coarse ash and lapilli to 1 cm. Lapilli subangular to angular pumice.
Unit lies atop brown soil.

10JAUOK082

Location: Lower flanks traverse

20 cm
Vesicular fine and medium ash. Laminated medium and fine ash at base.

16 cm
Prominent black coarse ash with laminated medium to coarse ash below.

13 cm
Laminated medium ash with coarse ash and lapilli.

Unit 3 8 cm
60% coarse ash and 40% lapilli (most <8 mm).

Unit 2 5.5 cm
Lapilli and coarse ash as below with matrix full of medium ash.

Unit 18 3.5 cm
Open framework 60% lapilli and 40% coarse ash. Many lapilli around 7 mm.

Unit 1A 0 cm
Unit lies atop brown soil.
10JAUOK085 is 4.5 cm tephra, 0.5 cm coarse ash base and 4 cm medium ash with fine ash near top.
## Appendix B: SEM images and glass geochemistry

### Glass Geochemistry from Energy Dispersive Spectroscopy

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### Glass Geochemistry from EDS for sample 10JAUOK011B 2-phi

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Glass Geochemistry from EDS for sample 10JAUOK011E 4-phi with error of analysis shown

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### Glass Geochemistry from EDS for samples 10JAUOK011D-E 4-phi

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### Glass Geochemistry from EDS for samples 10JAUOK011F and 10JAUOK074B 4-phi

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Glass Geochemistry for samples 10JAUOK011F and 10JAUOK074B 4-phi
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**Sample Glass Geochemistry from EDS for samples 10JAUOK005F-G 4-phi**

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## Mineral Geochemistry from Energy Dispersive Spectroscopy

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Selected SEM images

Multi-fractal particles

$y = -0.0985x + 3.3387$
$R^2 = 0.9625$

$y = -0.5447x + 4.2551$
$R^2 = 0.803$

$D_1 = 1.10$
$R_1 = 0.98$

$D_2 = 1.54$
$R_2 = 0.90$

$R^2 = 0.803$
$y = -0.1056x + 3.2796$

$R^2 = 0.9544$

$y = -1.0311x + 5.2461$

$R^2 = 0.7884$

$D1 = 1.09$

$R1 = 0.94$

$D2 = 2.03$

$R2 = 0.89$
$y = -0.0371x + 3.1412$

$R^2 = 0.5504$

$y = -0.1808x + 3.4345$

$R^2 = 0.4334$
10JAUOK011D 4-phi: Glass Particle 10

\[ y = -0.0758x + 3.1683 \quad R^2 = 0.7571 \]

\[ y = -0.6731x + 4.3883 \quad R^2 = 0.3648 \]

\[ D_1 = 1.08 \quad R_1 = 0.87 \]

\[ D_2 = 1.67 \quad y = -0.6731x + 4.3883 \quad R^2 = 0.3648 \]
y = -0.0947x + 3.3156
\( R^2 = 0.957 \)

y = -0.5041x + 4.146
\( R^2 = 0.7874 \)

D1 = 1.09
R1 = 0.98

D2 = 1.50
R2 = 0.89
\( R^2 = 0.7874 \)
Monofractal particles with low fractal dimension (D<1.06)

10JAUOK011D 4-phi: Glass Particle 12

LOG perimeter (pixels)

LOG steplengt (pixels)

\[ y = -0.0403x + 3.186 \]

\[ R^2 = 0.7559 \]

D=1.04
R=0.87
$y = -0.038x + 3.0696$

$R^2 = 0.4728$

$D = 1.04$

$R = 0.69$
Monofractal particles with intermediate fractal dimension (1.06<D<1.09)

10JAUOK011C 4-phi: Glass Particle 3

\[ y = -0.0798x + 3.2071 \]

\[ R^2 = 0.9427 \]

\[ D=1.08 \]

\[ R=0.97 \]
$y = -0.0727x + 3.2596$

$R^2 = 0.8115$

$D = 1.07$

$R = 0.90$
10JAUOK011F 4-phi: Glass Particle 3

\[ y = -0.0752x + 3.161 \]

\[ R^2 = 0.7424 \]

\[ D = 1.08 \]

\[ R = 0.86 \]
Monofractal particles with high fractal dimension (D>1.09)
10JAUOK011B 4-phi: Glass Particle 4

\[ y = -0.1185x + 3.2622 \]

\[ R^2 = 0.889 \]

\[ D=1.12 \]

\[ R=0.94 \]
$y = -0.1265x + 3.3612$  
$R^2 = 0.9693$

$D=1.13$  
$R=0.98$
Appendix C: Digital appendices

The included disc contains the following files:

- SFT data sorted by unit
- Raw grain-size data
- Raw componentry data
- Okmok GIS files
- SEM images of all imaged particles