

Supplementary Material - $^{40}\text{Ar}/^{39}\text{Ar}$ constraints on the eruption history of the Christiana Volcano of the Christiana-Santorini-Kolumbo volcanic field, Greece.

S1. Sample locations

Sample	GPS coordinates		Elevation (m)
CH18-02	36°15'01.00"N	25°12'14.00"E	110
CH18-04	36°15'01.00"N	25°12'15.00"E	130
CH18-05B	36°15'01.00"N	25°12'11.00"E	160
CH18-07	36°14'59.00"N	25°12'10.00"E	180
CH18-08	36°15'00.00"N	25°12'09.00"E	210
CH18-10	36°14'57.00"N	25°12'04.00"E	250
CH18-12A	36°14'46.15"N	25°12'34.39"E	10
CH18-14A*	36°15'04.11"N	25°12'27.72"E	33
CH18-15*	36°15'05.12"N	25°12'28.00"E	20
CH18-16	36°14'46.01"N	25°12'34.35"E	2

Table S1. GPS coordinates of sample localities. Coordinates of sample localities with an * have been estimated from a topographic map.

S2. Photographs of the sample localities and the collected samples.

S2.1 Sample CH18-02

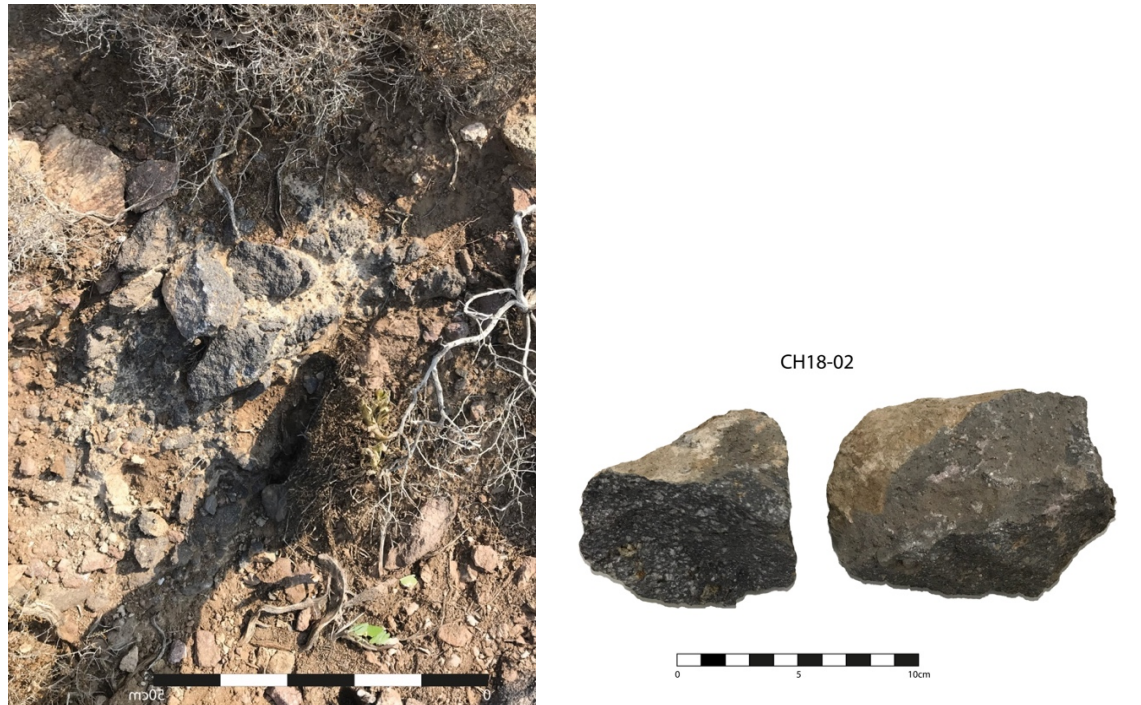


Fig. S1. Photographs of sample locality of CH18-02 (left) and collected samples (right).

S2.2 Sample CH18-04

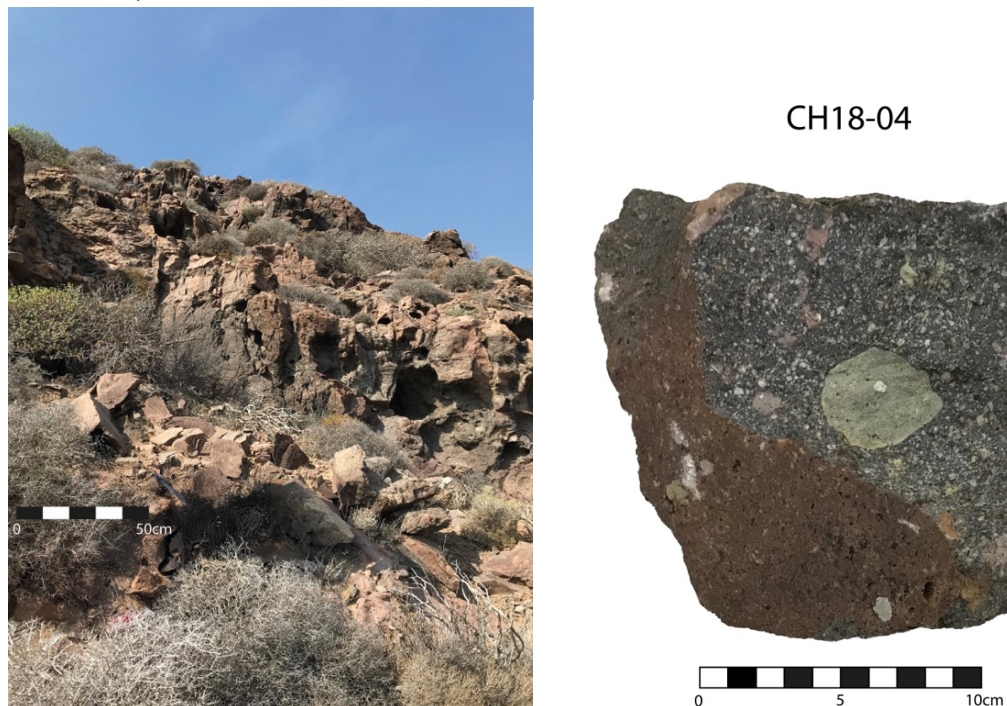


Fig. S2. Photographs of sample locality CH18-04 (left) and collected sample (right). Sample collected from the bank with the scale bar.

S2.3 Sample CH18-05B



Fig. S3. Photographs of sample locality CH18-05B (left) and collected samples (right). Sample collected from the bank with the scale bar.

S2.4 Sample CH18-07

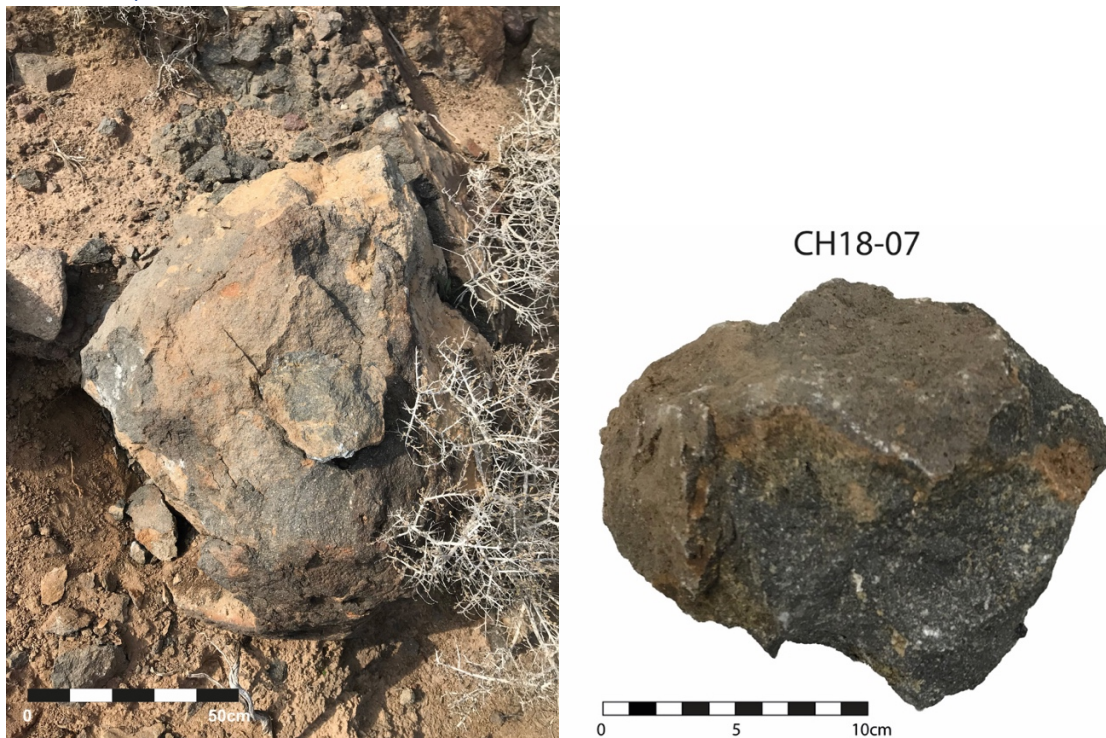


Fig. S4. Photographs of sample locality CH18-07 (left) and collected sample (right).

S2.5 Sample CH18-08



Fig. S5. Photographs of sample locality CH18-08 (left) and collected sample (right). Sample collected from the bank with the scale bar.

S2.6 Sample CH18-10



Fig. S6. Photographs of sample locality CH18-10 (left) and collected samples (right). Marker for scale has a length of 14cm.

S2.7 Sample CH18-12A



Fig. S7. Photograph of collected sample CH18-12A. No sample location photograph is available.

S2.8 Sample CH18-14A



Fig. S8. Photograph of collected sample CH18-14A. No sample location photograph is available.

S2.9 Sample CH18-15



Fig. S9. Photograph of collected sample CH18-15. No sample location photograph is available.

S2.10 Sample CH18-16



Fig. S10. Photographs of sample locality CH18-16 (left) and collected samples (right). Sample collected in the part of the outcrop near the scale bar.

S3. Petrographic descriptions of samples studied for $^{40}\text{Ar}/^{39}\text{Ar}$.

S3.1 Sample CH18-02

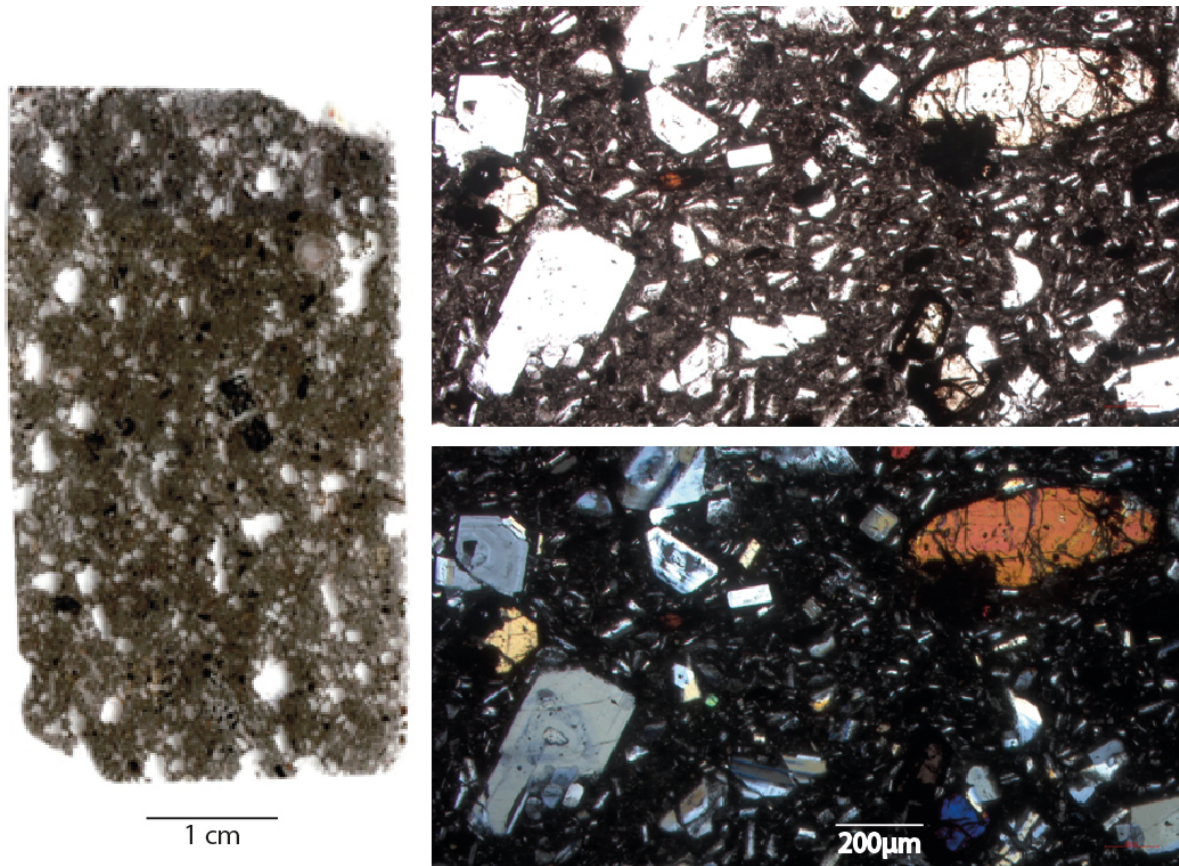


Figure S11. Petrographic thin section of sample CH18-02, left: overview, right top, photomicrograph in plane polarized light (PPL), right bottom: same photomicrograph in cross polarized light (XPL) (Magnification: 25x, Field of View (FOV): 2.0x1.1mm).

Overall description: Fine grained dark brown thin section with up to 3 mm transparent phenocrysts, does also contain small fine grained mafic inclusions

Phenocrysts:

- Plagioclase (20%): Subhedral to euhedral, short prismatic crystals of 0.3 to 3 mm in size (average 1 mm). No signs of alteration. Shows extensive polysynthetic twinning and oscillatory zoning. Crystals have few inclusions and no sieve textures.
- Amphibole (10%): Euhedral and prismatic large crystals of 2 to 4 mm, average of 3 mm. The amphibole is characterized by pleochroism from yellow to dark brown. The amphibole has inclusions of plagioclase and is sometimes resorbed.

- Olivine (2%): Some small (0.1 - 0.5 mm, average. 0.3 mm) anhedral equant minerals with 2nd order birefringence. No visible cleavage. Very fractured with dark rims. No further identifiable features.
- Opaque minerals (3%): Subhedral, size: up to 3 mm.

Matrix (65%): It is mostly glassy (40%) with some small fibrous-prismatic plagioclase (50%) and amphibole with a maximal size of 0.1 mm and opaque minerals (2%, <0.1mm).

Texture: Porphyritic, the phenocrysts are up to 3 mm.

Degree of alteration: Matrix is fresh, plagioclase does not display sericitic alteration. Some alteration of olivine. Matrix has some areas with grey/brown colouring. Loss of ignition (LOI)=0.58 wt.%.

S3.2. Sample CH8-04

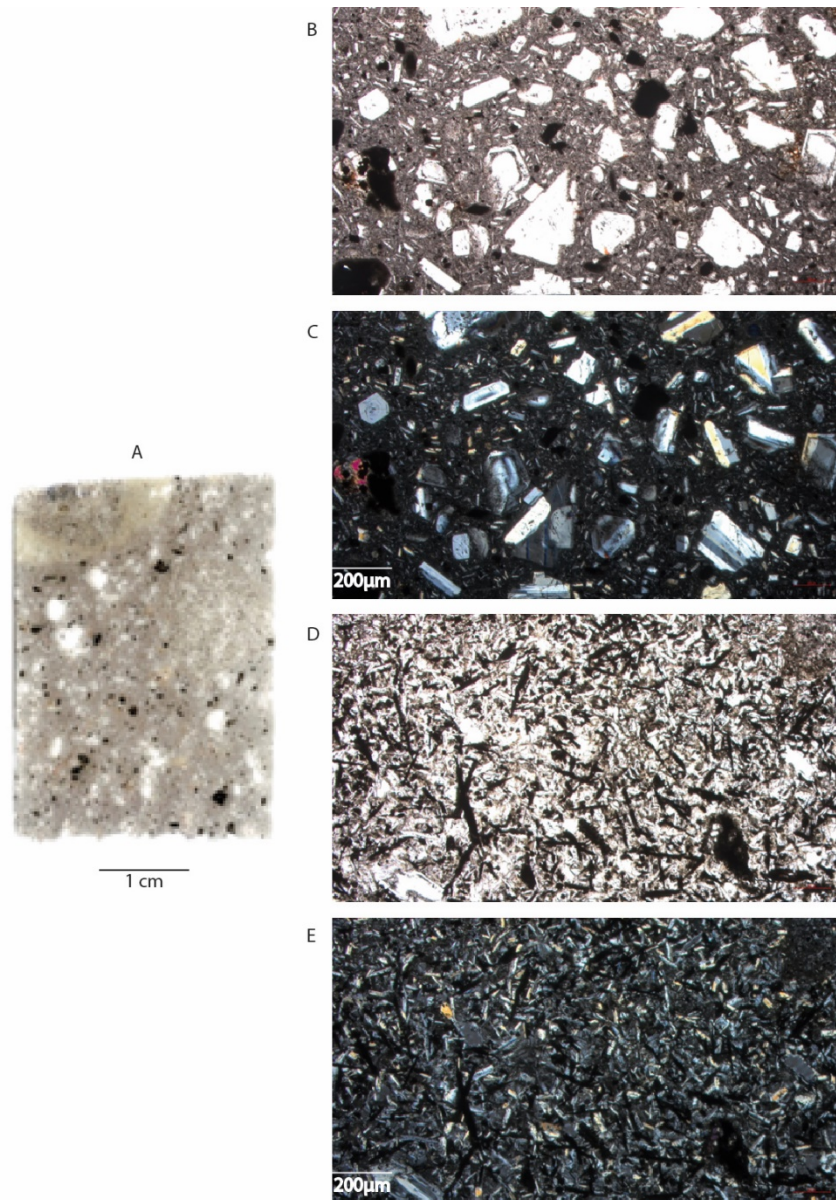


Figure S12. Petrographic thin section of sample CH18-04, (A) overview. This sample is composed of two rock types, the host and mafic inclusions (top left part in A). (B) Host rock in PPL (B) and (C) Mafic inclusion photomicrograph in PPL (D) and XPL (E) The photomicrographs are taken with a magnification of 25x, FOV: 2.0x1.1 mm).

Overall description: This thin section can be divided into three parts, the main coarse-grained part (host) and two smaller finer grained co-magmatic inclusions in the top left and right part of the thin section (inclusion 1 and 2, respectively). The host has a grey matrix with transparent (up to 3mm) and opaque (up to 2mm) phenocrysts. Round vesicles of up to 3mm do also occur. Inclusion 1 is green grey in colour and fine grained (<1mm) and has a sharp boundary with the host. Inclusion 2 is courser grained then inclusion 1 (phenocryst size 1mm) and has a diffuse boundary with the host (see Fig. S2a).

Host:

Phenocrysts:

- Plagioclase (25%): euhedral and short prismatic with sizes ranging from 0.5 to 3 mm and crystals display twinning and zoning. Some aggregates are visible. Sieve textures and bands with melt inclusions occur in some of the plagioclase phenocrysts.
- Orthopyroxene (5%): subhedral but not altered, equant with sizes from 0.5 to 1 mm. There are some opaque inclusions, and the cracks are darker than the rest of the mineral. The phenocrysts are slightly pleochroic and extinction is parallel to one cleavage direction.
- Opaque minerals (5%): Subhedral, size: up to 3 mm.

Matrix: (70%): dark brown, glassy and filled with opaque minerals and small plagioclase needles. A resorbed quartz xenocryst with undulous extinction is also found in this sample.

Texture: porphyritic.

Degree of alteration: Both the phenocrysts and matrix are fresh. (LOI=0.51 wt.%).

Inclusion 1:

Plagioclase (50%): Rock type two mainly consists of plagioclase, these are small (<0.5 mm) and long prismatic to fibrous.

Amphibole (30%), long euhedral prismatic needles, opaque.

Clinopyroxene (2%): These pyroxenes are very small and only visible due to the high birefringence colour. No cleavage is visible. No visible pleochroism.

Matrix (18%): Glassy, grey extinction in PPL.

Texture: equigranular.

Inclusion 2:

Plagioclase (50%): euhedral and long prismatic with sizes ranging from 0.5 to 2 mm.

Amphibole (30%): long opaque needles.

Olivine or clinopyroxene, maybe, too small to determine.

Matrix (20%): very little matrix, glassy, grey in colour.

Texture: equigranular.

Comment: The boundary between the two rock types is very sharp, as can be seen in Fig S2a. LOI=0.51 wt.%.

S3.3. Sample CH18-05B

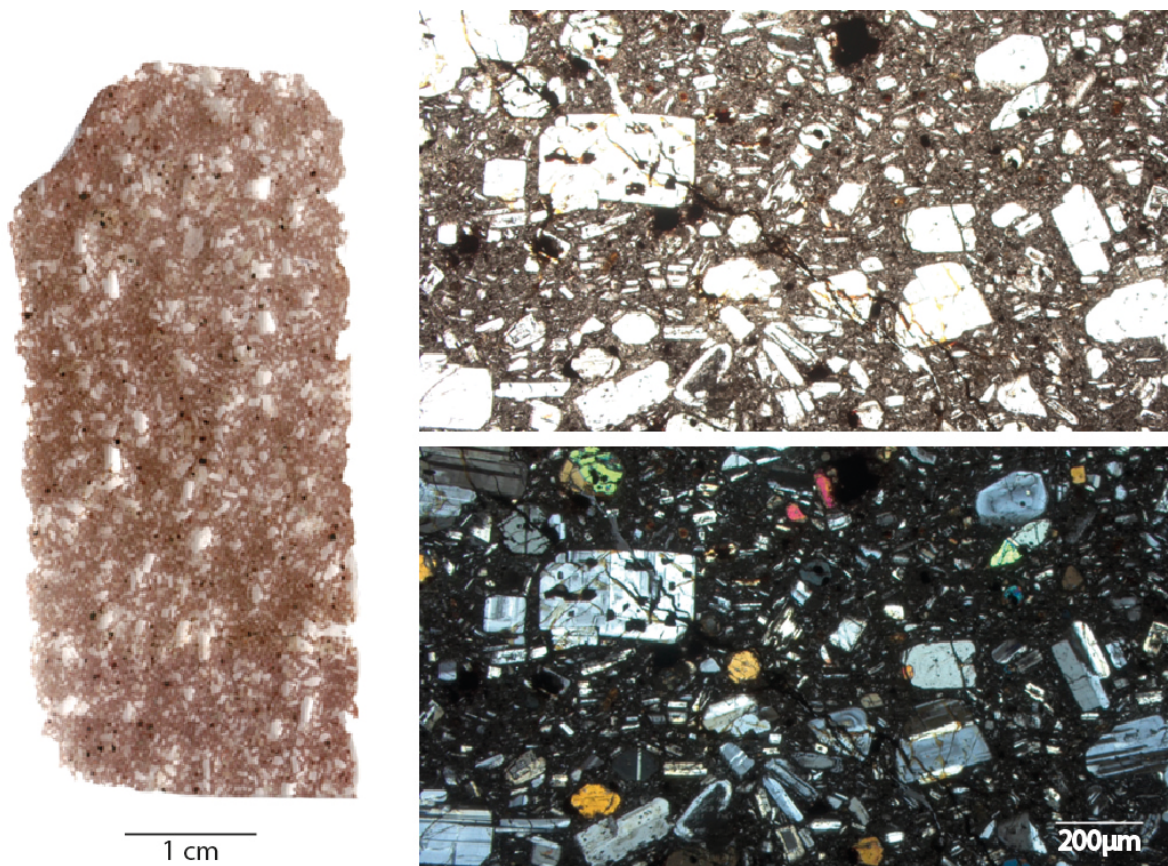


Figure S13. Petrographic thin section of sample CH18-05B, left: overview, right top, photomicrograph in PPL, right bottom: same photomicrograph in XPL (Mag. 25x, FOV: 2.0x1.1 mm).

Overall description: Brownish, porphyritic sample with up to 2mm transparent phenocrysts.

Phenocrysts:

- Plagioclase (25%): Subhedral large phenocrysts (1-2 mm) which are equant to short-prismatic. Some show polysynthetic twinning and oscillatory zoning with melt inclusions rich growth zones and cores (sieve textures). Some plagioclase phenocrysts are nearly completely resorbed. A couple of larger plagioclase phenocrysts have cracks filled with brown material. Bimodal size distribution of plagioclase phenocrysts.
- Olivine (5%): Anhedral crystals of higher birefringence. Small (<0.2 mm) and these have dark, alteration rims. Most show a brown birefringence but are clear in PPL. A select few olivine crystals show higher birefringence.
- Clinopyroxene (<2%), anhedral, small phenocrysts (<0.2mm).
- Orthopyroxene (<<1%), anhedral, small phenocrysts (<0.2mm). Straight extinction in PPL and first order interference colours.

- Opaque minerals (2%): Subhedral, size: up to 1 mm.

Matrix (65%): Brown in PPL, brownish black in XPL, contains small prismatic plagioclase and opaque minerals. Glassy.

Texture: Porphyritic with large plagioclase phenocrysts.

Degree of alteration: The alteration seems to be mostly contained in the matrix and the olivine. Some plagioclases crystals do also show signs of alteration. (LOI=1.08 wt.%).

S3.4. Sample CH18-07

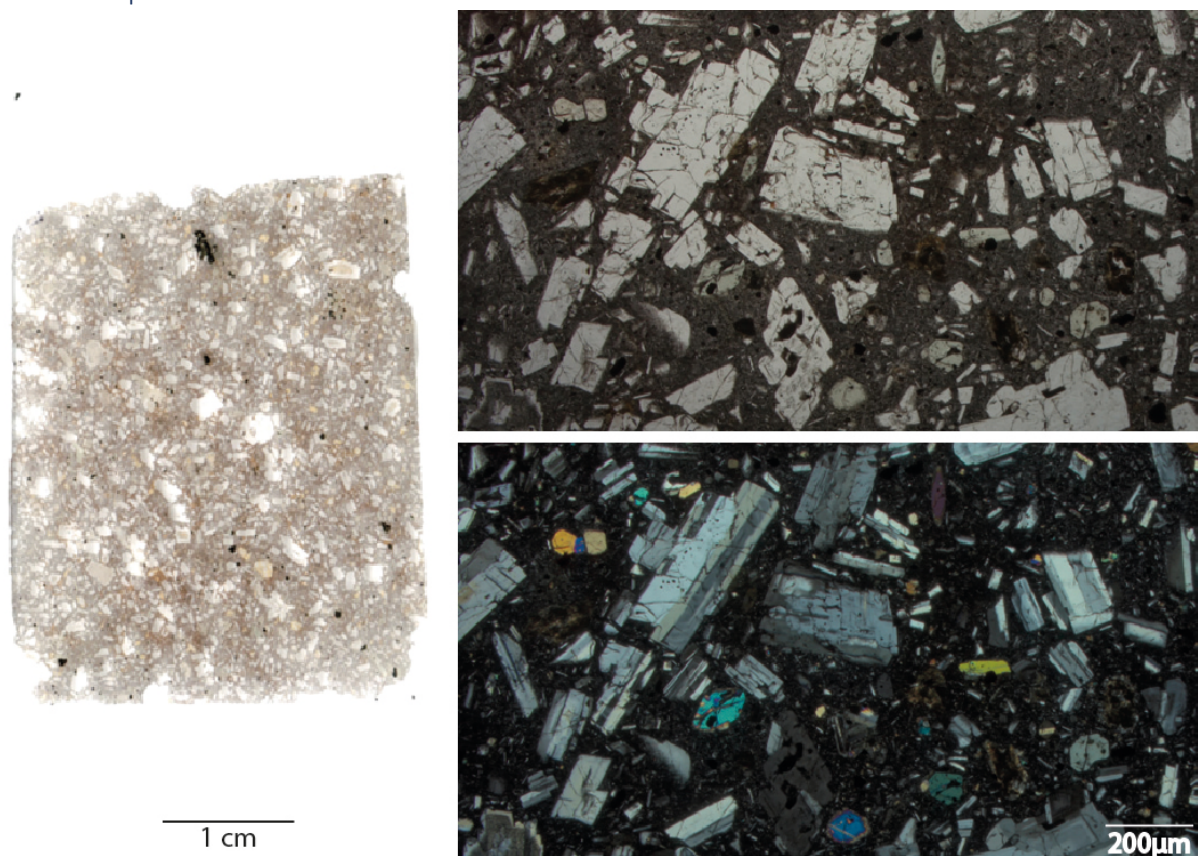


Figure S14. Petrographic thin section of sample CH18-07, left: overview, right top, photomicrograph in PPL, right bottom: same photomicrograph in XPL (Mag. 25x, FOV: 2.0x1.1 mm).

Overall description: Very porphyritic, light-coloured, petrographic thin section with transparent and some green-grey phenocrysts with some large (1-3mm) opaque minerals.

Phenocrysts:

- Plagioclase (30%): large (up to 2 mm) euhedral and short prismatic phenocrysts. Oscillatory zoning and polysynthetic twinning. Some seem to form clusters with twinning. Figure S4 shows an example of the sieve textures that have formed in 20% of the plagioclase phenocrysts. Cracks filled with brown material do occur.
- Clinopyroxene (5%), euhedral prismatic crystals of up to 2mm, high interference colours, extinction angle. Pleochroism: light green
- Olivine (5%), small anhedral crystals, no cleavage, have a fresh appearance
- Orthopyroxene (2%): euhedral-subhedral with sizes ranging from 0.1-3 mm. they are equant and show clear sets of cleavage with a straight extinction angle, low birefringence and some pale pink green pleochroism.

- Opaque minerals (<1%): Subhedral, size: up to 3 mm.

Matrix: (60%): light brown with light coloured small plagioclase crystals and some opaque crystals
Glass between plagioclase/opaque crystals. Crystal clots.

Texture: Porphyritic with large phenocrysts of plagioclase.

Degree of alteration: Sample has a fresh appearance. (LOI=0.47 wt.%).

S3.5. Sample CH18-08

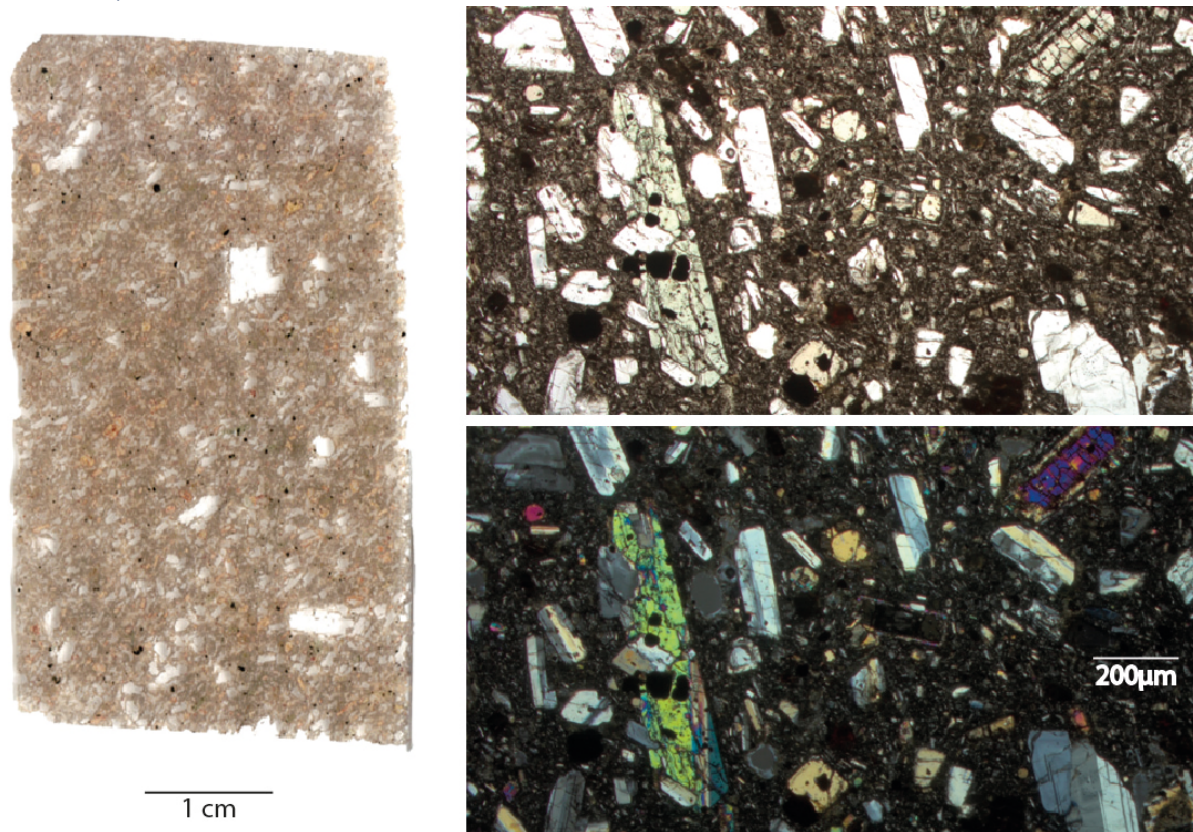


Figure S15. Petrographic thin section of sample CH18-08, left: overview, right top, photomicrograph in PPL, right bottom: same photomicrograph in XPL (Mag. 25x, FOV: 2.0x1.1 mm).

Overall description: A light-brown coloured petrographic thin section with a porphyritic texture with three very large (>4 mm) transparent phenocrysts. Smaller phenocrysts with a brown-green colour of 1-5mm are also visible. A few opaque crystals (<1mm) can also be observed.

Phenocrysts:

- Plagioclase (20%): euhedral, short-prismatic and up to 4 mm in size. The plagioclase shows extensive polysynthetic twinning, oscillatory zoning, sieve textures, growth zones with melt inclusions and sometimes they are part of glomerocrysts. The glomerocrysts of plagioclases are the largest of all the thin sections of this study and appear to have enveloped some of the clinopyroxene.
- clinopyroxene (5%): subhedral prismatic phenocrysts with size range of 0.1-1 mm. These show medium birefringence colours and an inclined extinction to the one clear set of cleavage. Inclusions of opaque and plagioclase. Pleochroism from light green to pale light green. There are some completely brown altered needle shaped crystals in the matrix, probably cpx.
- Orthopyroxene (5%) subhedral long crystals (0.1-0.5mm).

- Opaque minerals (<1%): Subhedral, size: up to 0.5 mm.

Matrix: (70%), brown matrix with small plagioclase needles and clinopyroxene. Most vesicles are clean and spherical, some contain brown (PPL) material.

Texture: Porphyritic with large phenocrysts of plagioclases and clinopyroxene phenocrysts.

Degree of alteration: Sample appears fresh (including vesicles, however, LOI is quite high (LOI=1.36 wt.%).

S2.6. Sample CH18-10

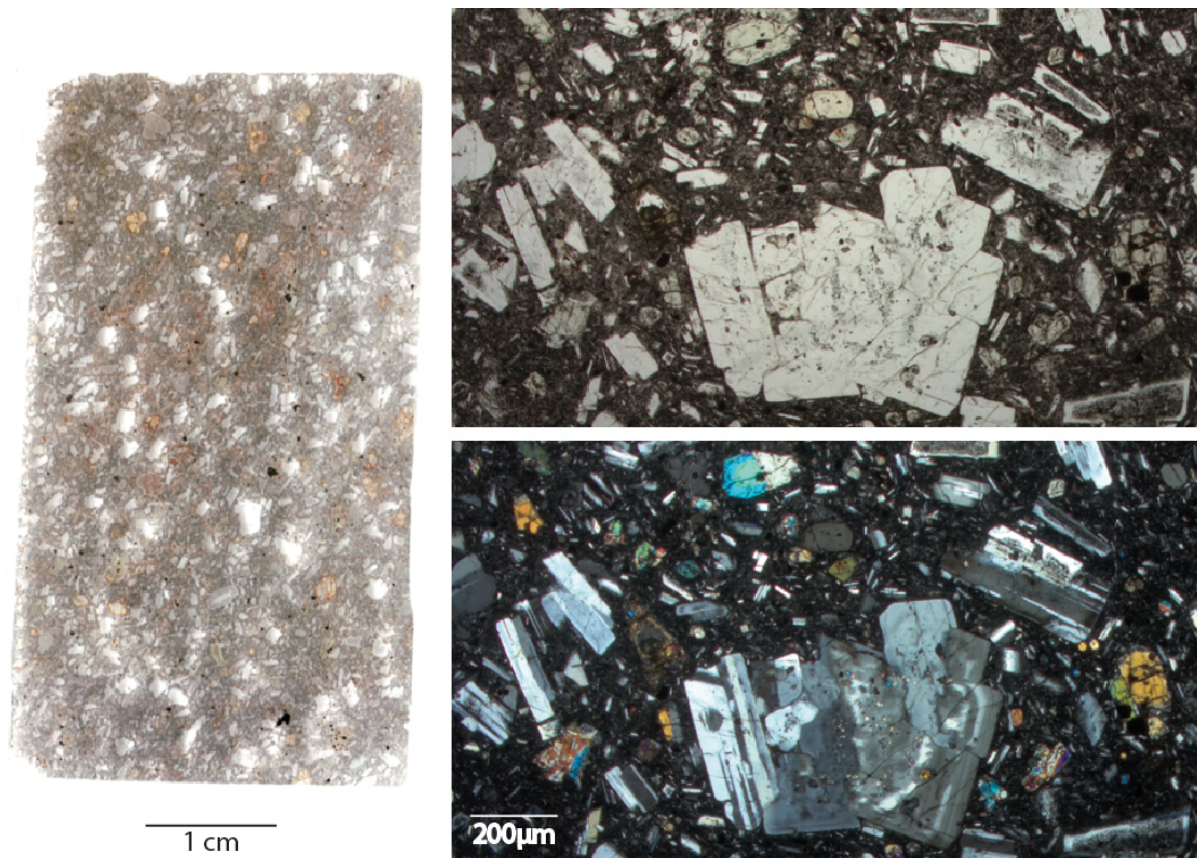


Figure S16. Petrographic thin section of sample CH18-10, left: overview, right top, photomicrograph in PPL, right bottom: same photomicrograph in XPL (Mag. 25x, FOV: 2.0x1.1 mm).

Overall description: Dark grey petrographic thin section with transparent phenocrysts of up to 3 mm. Light brown-coloured phenocrysts of 1-2mm. opaque minerals < 1mm. Porphyritic texture.

Phenocrysts:

- Plagioclase (25%): Euhedral, short-prismatic phenocrysts with sizes of 0.5-3 mm. Many show polysynthetic twinning, sieve textures, bands of melt inclusions and oscillatory zoning.
- Clinopyroxene, phenocrysts (2-3%) ranging from euhedral to anhedral, size 0.1-2 mm. The phenocrysts are slightly altered on the rims, the unaltered phenocrysts show a pleochroism from pale pink to pale green.
- Orthopyroxene (1%): sub to anhedral phenocrysts with size range of 0.2-1 mm. They show a clear set of cleavage and have parallel extinction. Inclusions of opaque minerals.
- Olivine (<1%), small (0.1 mm) anhedral crystals, no cleavage, second order interference colours in XPL.
- Opaque minerals (<1%): Subhedral, size: up to 1 mm.

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Matrix: (70%): Brownish matrix with small plagioclase needles.

Texture: Porphyritic.

Degree of alteration: Fresh matrix, some resorption on clinopyroxene rims. (LOI=0.46 wt.%).

S2.7. Sample CH18-12A

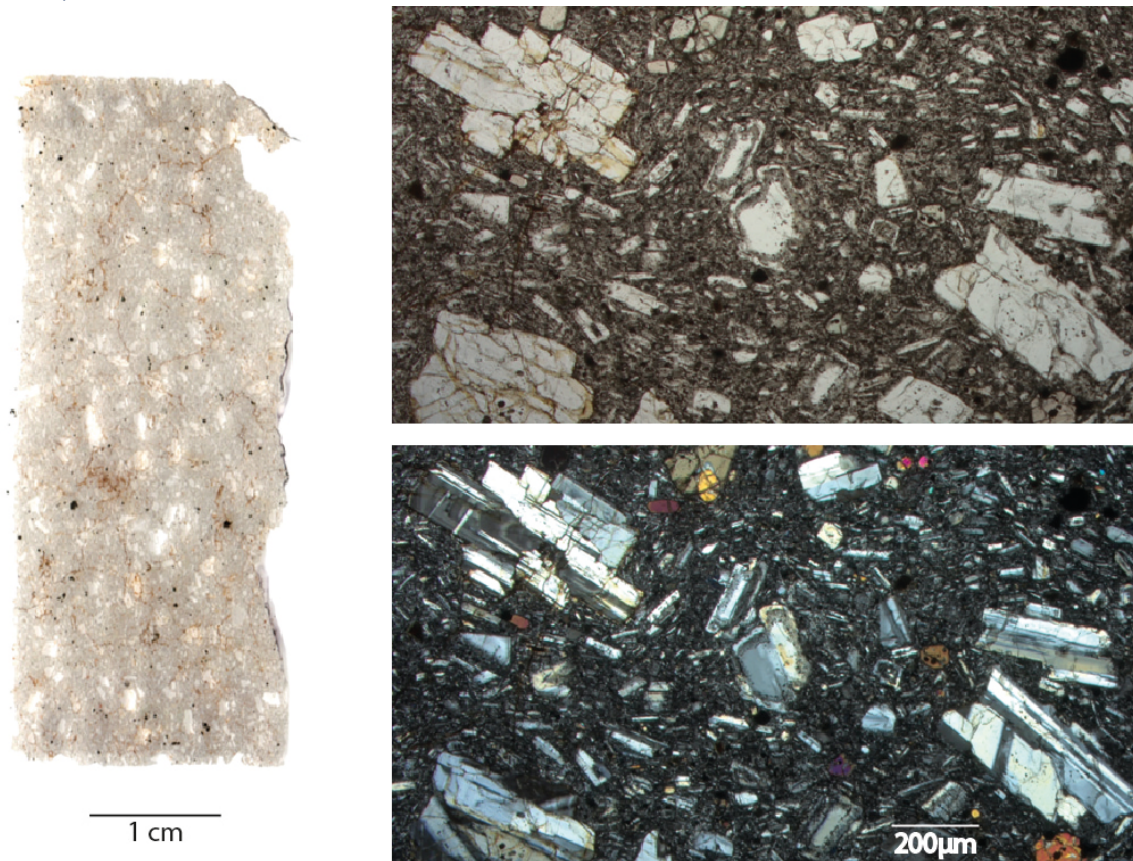


Figure S17. Petrographic thin section of sample CH18-12A, left: overview, right top, photomicrograph in PPL, right bottom: same photomicrograph in XPL (Mag. 25x, FOV: 2.0x1.1 mm).

Overall description: a light grey and porphyritic petrographic thin section with large clusters of transparent phenocrysts and some opaque minerals (<2%). The matrix is not homogeneous and shows brownish spots.

Phenocrysts:

- Plagioclase (25%): The plagioclase is short prismatic, euhedral and 0.5-1 mm long, characterized by polysynthetic twinning, oscillatory zoning and growth zones with melt inclusions. Plagioclase crystals are aligned.
- Orthopyroxene (5%): The orthopyroxene is 0.1-0.5 mm in size, subhedral and equant. There is a slight pleochroism from pale pink to green.
- Clinopyroxene (euhedral-subhedral crystals (<2%)), light green to pale pink pleochroism, high interference colours. Opaque and plagioclase inclusions.

- Olivine (<1%) forms small (<1%) anhedral crystals in the groundmass. Clear with no cleavage.
- Opaque minerals (<1%): Subhedral, size: up to 1 mm.

Matrix: (65%), The matrix is unaltered and grey with some small plagioclase needles and opaque minerals.

Texture: The sample is porphyritic with large plagioclase and some smaller orthopyroxene. While it looks like the plagioclase phenocrysts display a preferred direction, this is not the case for the whole sample.

Degree of alteration: Sample has a fresh appearance. Some of the clinopyroxene crystals have a brownish zone around them (LOI=0.59 wt.%).

S2.8. Sample CH18-14A

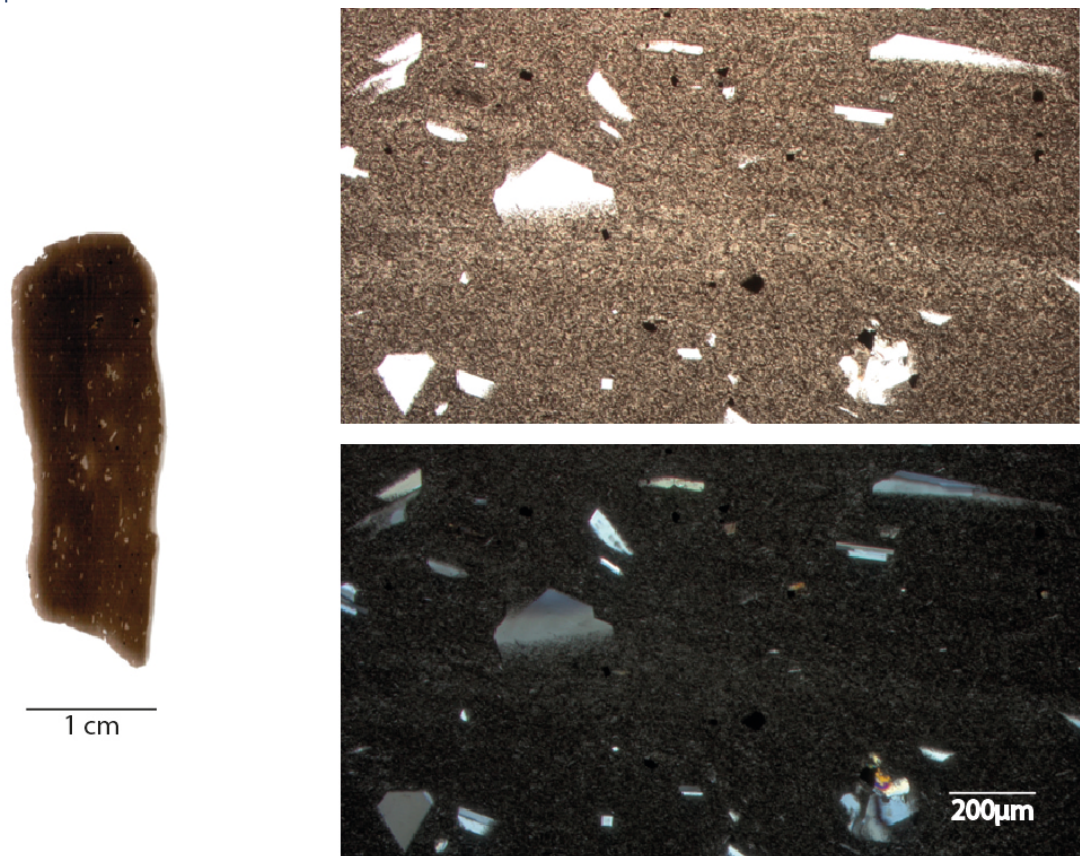


Figure S18. Petrographic thin section of sample CH18-14A, left: overview, right top, photomicrograph in PPL, right bottom: same photomicrograph in XPL (Mag. 25x, FOV: 2.0x1.1 mm).

Overall description: Homogenous dark brown coloured thin section with some just visible brownish-transparent phenocrysts (<1 mm).

Phenocrysts:

- Plagioclase (<5%): The anhedral plagioclase phenocrysts are smaller than 0.5 mm and shows no discernible properties.
- Clinopyroxene (2%): anhedral and a high birefringence colour phenocrysts which are smaller than 0.2 mm.
- Orthopyroxene (<1%), small subhedral crystals with straight extinction in XPL and 1st order interference colours.
- Quartz <5% small anhedral crystals, with low birefringence 1st order colours. Very difficult to distinguish from plagioclase.
- Opaque minerals (<1%): Subhedral, size: up to 0.1 mm.

Matrix: (93%) The matrix is brown and hyaline in XPL. There are many small transparent crystals which could be plagioclase/quartz. There are lighter and darker coloured areas in the matrix. Crustal clots also occur.

Texture: Porphyritic with phenocrysts of plagioclase/quartz.

Degree of alteration: This is the sample, which is the most hyaline, obsidian, but has a fresh appearance (LOI=0.51 wt.%).

S2.9. Sample CH18-15

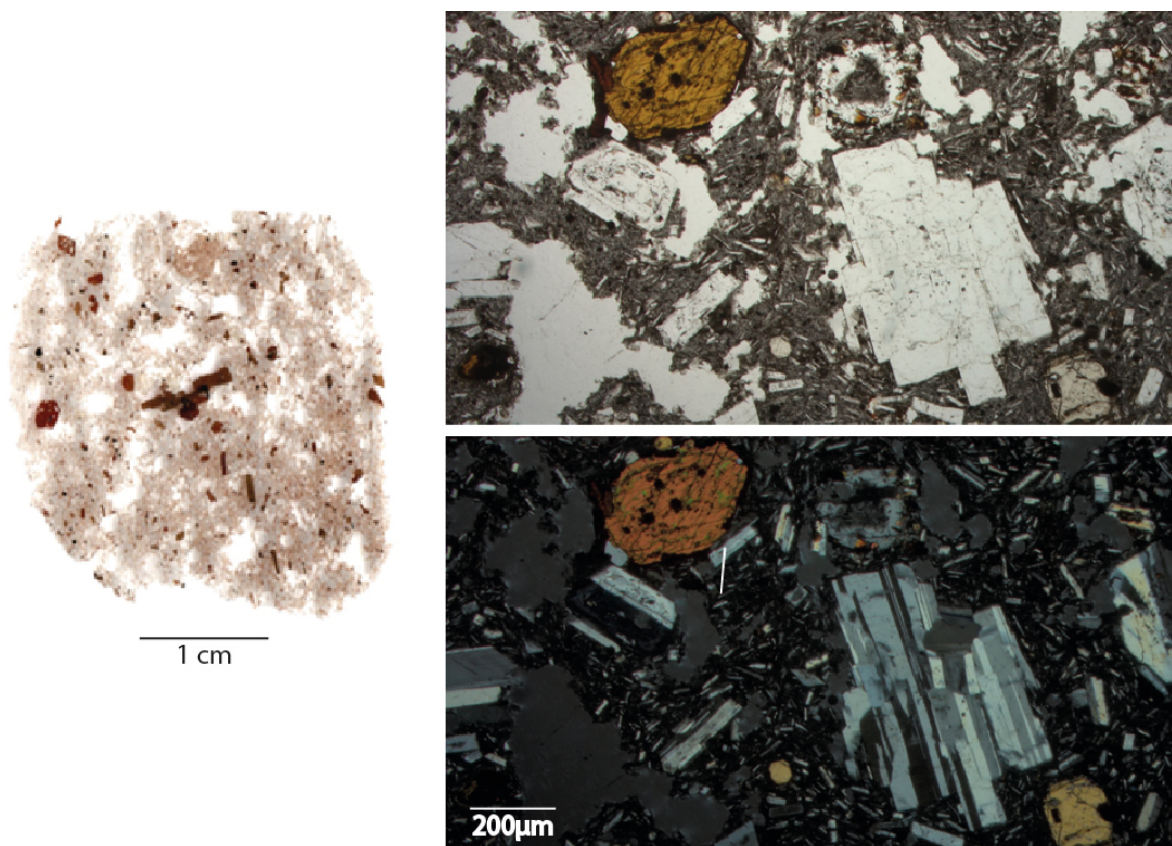


Figure S19. Petrographic thin section of sample CH18-15, left: overview, right top, photomicrograph in PPL, right bottom: same photomicrograph in XPL (Mag. 25x, FOV: 2.0x1.1 mm).

Overall description: A light grey/greenish-brown thin section with large transparent and dark coloured phenocrysts that sometimes have a long prismatic shape.

Phenocrysts:

- Plagioclase (25%): subhedral short-prismatic transparent phenocrysts that range in size from 0.5 to 2 mm. They form sometimes glomerocrysts and show polysynthetic twinning, oscillatory zoning and ~20% have dark inclusions and/or sieve textures.
- Hornblende (10%): Very large (>2 mm) euhedral prismatic phenocrysts which display pleochroism from light to dark brown. They show two very clear sets of cleavage with a 120-degree angle and high birefringence colours. Opaque mineral inclusions are common.
- Orthopyroxene (5%): Subhedral-anhedral and 0.5-1 mm in size. They show a low to order birefringence colour and are slightly pleochroic from pale pink to green.
- Opaque minerals (5%): Subhedral, size: up to 3 mm.

Matrix: (55%): The matrix is very fine grained with some small plagioclase needles. Vesicles (20%) are up to 3 mm, spherical, not connected to each other and homogenously distributed through this thin section.

Texture: The sample is porphyritic with a 6 mm wide glomerocrysts of amphibole and plagioclase.

Degree of alteration: The sample appears completely fresh without alteration of the plagioclase and glass matrix. sample with amphibole. (LOI=1.47 wt.%).

S2.10. Sample CH18-16

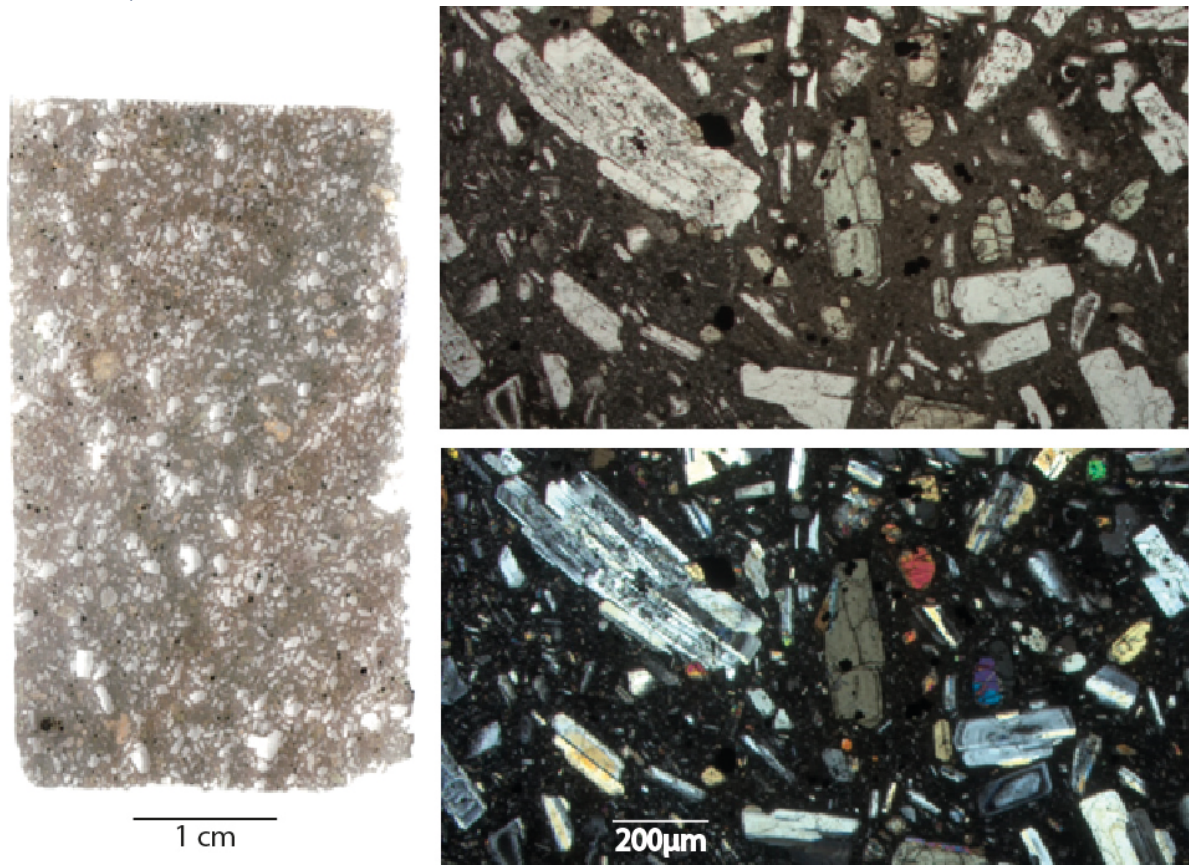


Figure S20. Petrographic thin section of sample CH18-16, left: overview, right top, photomicrograph in PPL, right bottom: same photomicrograph in XPL (Mag. 25x, FOV: 2.0x1.1 mm).

Overall description: a banded light grey-brown coloured and porphyritic thin section with transparent and smaller dark coloured phenocrysts.

Phenocrysts:

- Plagioclase (30%): The plagioclase is euhedral, up to 1.5 mm long and equant to short-prismatic. They show polysynthetic twinning and oscillatory zoning. Some (~20%) have zones of melt inclusions and/or sieve textures.
- Orthopyroxene (3%): The orthopyroxene phenocrysts are 0.1-1 mm in size, equant and euhedral to subhedral. They show one clear set of cleavage with another at 90 degrees that is visible in some crystals. The birefringence colours are 1st order and they show parallel extinction. They are slightly pleochroic from pale pink to green.
- Olivine (2%): anhedral crystals, resorbed.
- Opaque minerals (<<1%): Subhedral, size: up to 0.1 mm.

Matrix: (65%): The matrix is dark brown and hyaline. There are some small plagioclase needles.

Texture: The thin section is porphyritic with plagioclase and clinopyroxene phenocrysts.

Degree of alteration: Fresh phenocrysts and matrix. (LOI=0.59 wt.%).