

THIN SECTION LABEL ID: **390C-U1556A-32X-1-W 82/86-TSB-TS6**

Thin section no.: 6

Observer: PDK, EC

Piece no.:

Thin section thickness: standard

Unit/subunit:

Thin section summary: Sparsely vesicular sparsely olivine phyric basalt: The TS billet had a thin layer of glass on a side 90 degrees to the contact with the sediment, but 90% of the glass was removed during TS preparation. The glass was a golden brown palagonite. There appears to be a concentration of small vesicles ~ 1 cm from the glass in a band parallel to the glass rind.

Plane-polarized: 62621561



Cross-polarized: 62621581



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: peperite

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt; 1) 1

Domain relative abundance (%) 80

| Phenocrysts | Original (%) | Alteration         | Size MODE (mm) | Shape    | Habit  | Comments                          |
|-------------|--------------|--------------------|----------------|----------|--------|-----------------------------------|
| Olivine     | 2            | completely altered | 0.6            | euhedral | equant | occurs in glomerocrystic clusters |

| Groundmass  | Original (%) | Comment                                                                                                                                                                                                                                                        |
|-------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Olivine     | 5            | Difficult to estimate size and percentages due to small grain size and degree of alteration. An acicular / skeletal groundmass mineral shows a similar style of alteration as the olivines, but the crystal habit is more typical of plagioclase than olivine. |
| Plagioclase | 20           | to estimate because of degree of alteration. Although unusual, I think the acicular skeletal groundmass crystals replaced by some sort of reddish brown Fe-oxyhydroxide (?) / clay is the plagioclase microlites (not olivine).                                |
| Mesostasis  | 75           | Occurs as plumose quench textures; mineralogy uncertain                                                                                                                                                                                                        |

| Vesicle | Original (%) | Size Mode (mm) | Shape | Comments                                                                                                                                                                                           |
|---------|--------------|----------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vesicle | 1            | 0.2            | round | Some vesicles are filled 100%, others show concentric zoning. Some are only partially filled, but it's not clear whether the fill was plucked during TS preparation or whether it was never there. |

## Alteration

| Domain number (if > 1) | 1 | Domain name | basalt background alteration | Domain comment | Speckled orange background alteration of pillow basalt in peperite |
|------------------------|---|-------------|------------------------------|----------------|--------------------------------------------------------------------|
|------------------------|---|-------------|------------------------------|----------------|--------------------------------------------------------------------|

| Alteration mineral | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2 | Replacing/filling 3 | Replacing/filling 4 |
|--------------------|-----------------------|---------------------|---------------------|---------------------|---------------------|
| clay minerals      | 1                     | glass               |                     |                     |                     |

## Alteration

| Domain number (if >1) | 1                     | Domain name         | basalt background alteration | Domain comment      | Speckled orange background alteration of pillow basalt in peperite |
|-----------------------|-----------------------|---------------------|------------------------------|---------------------|--------------------------------------------------------------------|
| Alteration mineral    | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2          | Replacing/filling 3 | Replacing/filling 4                                                |
| Fe oxyhydroxide       | 5                     | olivine             | groundmass                   | plagioclase         |                                                                    |

## Alteration

| Domain number (if >1) | 1                     | Domain name         | basalt background alteration | Domain comment      | Speckled orange background alteration of pillow basalt in peperite |
|-----------------------|-----------------------|---------------------|------------------------------|---------------------|--------------------------------------------------------------------|
| Alteration mineral    | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2          | Replacing/filling 3 | Replacing/filling 4                                                |
| zeolite               | 1                     | vesicle core        |                              |                     |                                                                    |

## Alteration

| Domain number (if >1) | 2                     | Domain name         | basalt halo         | Domain comment      | Light brown halo (3mm wide) in basalt along basalt-carbonate interface |
|-----------------------|-----------------------|---------------------|---------------------|---------------------|------------------------------------------------------------------------|
| Alteration mineral    | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2 | Replacing/filling 3 | Replacing/filling 4                                                    |
| Fe oxyhydroxide       | 10                    | groundmass          | olivine             | disseminated        |                                                                        |

## Alteration

| Domain number (if >1) | 2                     | Domain name         | basalt halo         | Domain comment      | Light brown halo (3mm wide) in basalt along basalt-carbonate interface |
|-----------------------|-----------------------|---------------------|---------------------|---------------------|------------------------------------------------------------------------|
| Alteration mineral    | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2 | Replacing/filling 3 | Replacing/filling 4                                                    |
| saponite              | 1                     | groundmass          |                     |                     |                                                                        |

## Alteration

| Domain number (if >1) | 3                     | Domain name         | basalt glassy margin | Domain comment      | Altered glass and chilled margin on basalt clast |
|-----------------------|-----------------------|---------------------|----------------------|---------------------|--------------------------------------------------|
| Alteration mineral    | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2  | Replacing/filling 3 | Replacing/filling 4                              |
| clay minerals         | 100                   | glass               |                      |                     |                                                  |

## Alteration

| Domain number (if >1) | 4                     | Domain name         | sediment            | Domain comment      | Altered/baked micritic carbonate sediment |
|-----------------------|-----------------------|---------------------|---------------------|---------------------|-------------------------------------------|
| Alteration mineral    | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2 | Replacing/filling 3 | Replacing/filling 4                       |
| Fe-Ti oxide           | 1                     | groundmass          |                     |                     |                                           |

THIN SECTION LABEL ID: **390C-U1556A-32X-2-W 25/28-TSB-TS5**

Thin section no.: 5

Observer: PDK, EC

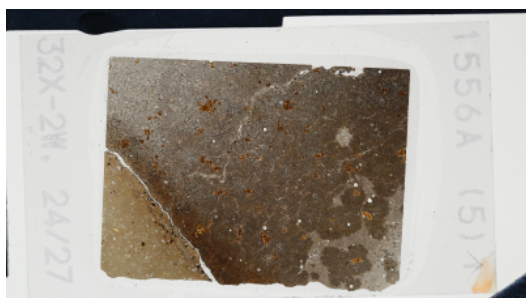
Piece no.:

Thin section thickness: standard

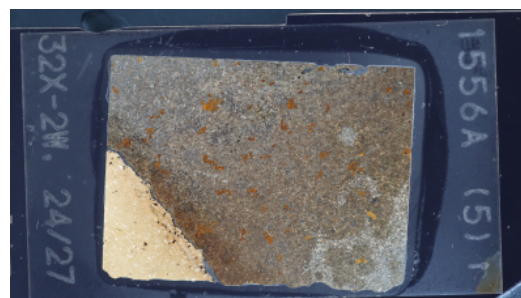
Unit/subunit:

Thin section summary: Sparsely vesicular sparsely olivine phyric basalt clast in peperite: Section is a typical altered pillow basalt, fragmented and set in pelagic carbonate sediment. Groundmass is cryptocrystalline and mostly composed of plumose clinopyroxene with plagioclase likely forming lighter areas. Fine grained acicular to dendritic quench olivines have been 100% altered to red-brown iddingsite throughout. Euhedral olivine phenocrysts are similarly altered but often include small domains of a very low birefringence, cryptocrystalline colourless mineral, likely zeolite. Groundmass is variably altered to red-brown clays + Fe oxyhydroxides and, in places, to very dark almost opaque ?oxides. The intensity of this alteration varies with distance from the sediment-basalt interface and a narrow halo of intense reddening of the groundmass rims the contact. Away from the contact, (in the lower left corner of the slide) the alteration of the groundmass is somewhat patchy without any clear cause. In the sediment along the contact opaque Fe oxides have formed an irregular rim on the basalt with blebs extending into the sediment. The sediment has abundant foraminifera microfossils attesting to its pelagic origin. Vesicles are rare and typically rimmed by brownish clay and filled by zeolite.

Plane-polarized: 62621521



Cross-polarized: 62621541



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: peperite

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 80

| Phenocrysts | Original (%) | Alteration         | Size MODE (mm) | Shape    | Habit  | Comments                         |
|-------------|--------------|--------------------|----------------|----------|--------|----------------------------------|
| Olivine     | 3            | completely altered | 0.6            | euhedral | equant | occurs in glomerocystic clusters |

| Groundmass  | Original (%) | Comment                                                                                                                                                                                                                                                        |
|-------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Olivine     | 5            | Difficult to estimate size and percentages due to small grain size and degree of alteration. An acicular / skeletal groundmass mineral shows a similar style of alteration as the olivines, but the crystal habit is more typical of plagioclase than olivine. |
| Plagioclase | 20           | to estimate because of degree of alteration. Although unusual, I think the acicular skeletal groundmass crystals replaced by some sort of reddish brown Fe-oxyhydroxide (?) / clay is the plagioclase microlites (not olivine).                                |
| Mesostasis  | 75           | Occurs as plumose quench textures; mineralogy uncertain                                                                                                                                                                                                        |

| Vesicle | Original (%) | Size Mode (mm) | Shape | Comments                                                                                                                                                                                           |
|---------|--------------|----------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vesicle | 1            | 0.3            | round | Some vesicles are filled 100%, others show concentric zoning. Some are only partially filled, but it's not clear whether the fill was plucked during TS preparation or whether it was never there. |

## Alteration

| Domain number (if>1) | 1                     | Domain name         | basalt background alteration | Domain comment      | Altered pillow basalt in peperite |
|----------------------|-----------------------|---------------------|------------------------------|---------------------|-----------------------------------|
| Alteration mineral   | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2          | Replacing/filling 3 | Replacing/filling 4               |
| clay minerals        | 5                     | groundmass          |                              |                     |                                   |

## Alteration

| Domain number (if>1) | 1                     | Domain name         | basalt background alteration | Domain comment      | Altered pillow basalt in peperite |
|----------------------|-----------------------|---------------------|------------------------------|---------------------|-----------------------------------|
| Alteration mineral   | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2          | Replacing/filling 3 | Replacing/filling 4               |
| iddingsite           | 5                     | olivine             | plagioclase                  | groundmass          |                                   |

## Alteration

| Domain number (if>1) | 1                     | Domain name         | basalt background alteration | Domain comment      | Altered pillow basalt in peperite |
|----------------------|-----------------------|---------------------|------------------------------|---------------------|-----------------------------------|
| Alteration mineral   | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2          | Replacing/filling 3 | Replacing/filling 4               |
| saponite             | 1                     | vesicle lining      | groundmass                   |                     |                                   |

## Alteration

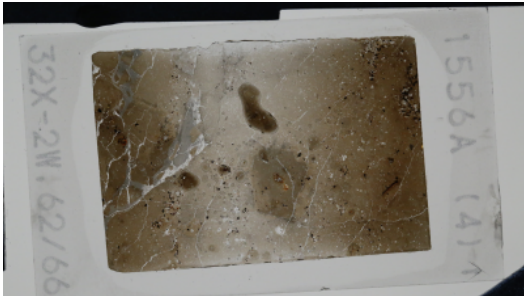
| Domain number (if>1) | 1                     | Domain name         | basalt background alteration | Domain comment      | Altered pillow basalt in peperite |
|----------------------|-----------------------|---------------------|------------------------------|---------------------|-----------------------------------|
| Alteration mineral   | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2          | Replacing/filling 3 | Replacing/filling 4               |
| zeolite              | 1                     | vesicle lining      |                              |                     |                                   |

## Alteration

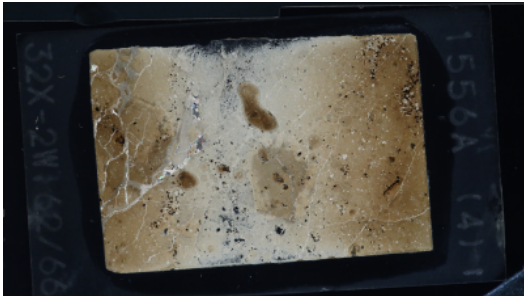
| Domain number (if>1) | 2                     | Domain name         | basalt halo         | Domain comment      | Light brown halo in edge of basalt clast along carbonate-basalt contact |
|----------------------|-----------------------|---------------------|---------------------|---------------------|-------------------------------------------------------------------------|
| Alteration mineral   | Mineral abundance (%) | Replacing/filling 1 | Replacing/filling 2 | Replacing/filling 3 | Replacing/filling 4                                                     |
| Fe oxyhydroxide      | 5                     | groundmass          |                     |                     |                                                                         |

|                         |                                                                                 |                     |
|-------------------------|---------------------------------------------------------------------------------|---------------------|
| THIN SECTION LABEL ID:  | <b>390C-U1556A-32X-2-W 62/66-TSB-TS4</b>                                        | Thin section no.: 4 |
| Observer:               | EC                                                                              | Piece no.:          |
| Thin section thickness: |                                                                                 | Unit/subunit:       |
| Thin section summary:   | Altered and partially recrystallised micritic carbonate sediment from peperite. |                     |

Plane-polarized: 62621481



Cross-polarized: 62621501



THIN SECTION LABEL ID: **390-U1556B-2R-2-W 38/41-TSB-TS9**

Thin section no.:

Observer: PDK, EC

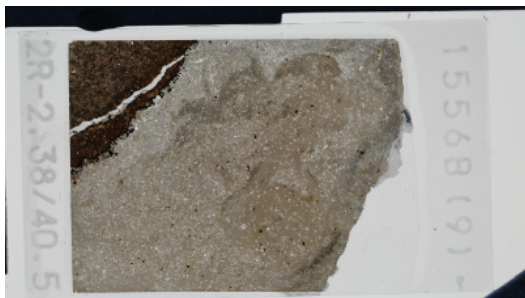
Piece no.:

Thin section thickness: standard

Unit/subunit: 1A

Thin section summary: Contact between basalt and pelagic sediment: This is a basalt clast in a sedimentary breccia of Unit 1A. The groundmass is dominated by plumose quench textures (probably cpx) and acicular to tabular crystals, now totally replaced by a dark reddish-brown Fe-oxyhydroxide (?). The alteration mineral is typical of olivine replacement, but the morphology of the acicular crystals is more typical of that of plagioclase, where observed elsewhere in the section. This dark reddish brown phase is intergrown with a colorless phase with low interference colors. It may be that these intergrowths were originally plagioclase (now the colorless phase?) and olivine, the reddish brown phase, but difficult to tell due to the complete alteration of the groundmass. [Based on subsequent samples these are interpreted as acicular quench olivine altered to iddingsite/Fe-oxyhydroxides]. Vesicles have a thin rim of a low interference colour mineral (likely zeolite). A vein cutting obliquely into the basalt was once at least partially sediment filled as it contains microfossils but is now cemented by crystalline (recrystallised?) carbonate. The abundance/density of red Fe-oxyhydroxide replacement of groundmass increases approaching the basalt-sediment contact. Further into the interior replacement of the groundmass appears to be by a greater proportion of dusty clay minerals as well as distributed blebs of yellowish mineral possibly a smectite-Fe-oxyhydroxide mixture/intergrowth. An irregular layer of opaque to very dark red-brown Fe oxyhydroxides occurs along the basalt-sediment interface, forming protruding blebs into the sediment.

Plane-polarized: 62674451



Cross-polarized: 62674471



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: breccia

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 25

| Phenocrysts | Original (%) | Alteration         | Size MODE (mm) | Shape    | Habit  | Comments                                                                                                              |
|-------------|--------------|--------------------|----------------|----------|--------|-----------------------------------------------------------------------------------------------------------------------|
| Olivine     | 100          | completely altered | 0.7            | euhedral | equant | Totally replaced by a reddish brown mineral and a colorless mineral with low interference colors, possibly a zeolite? |

| Groundmass    | Original (%) | Comment                                                                                                                                                     |
|---------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Plagioclase   | 40           | identification complicated by state of alteration. The acicular mineral, now totally replaced by a reddish brown alteration phase, forms 35% of the basalt. |
| Clinopyroxene | 60           | Estimate based on proportion of plumose quench textured phase.                                                                                              |

THIN SECTION LABEL ID: **390-U1556B-2R-2-W 80/83-TSB-TS10**

Thin section no.:

Observer: PDK, EC

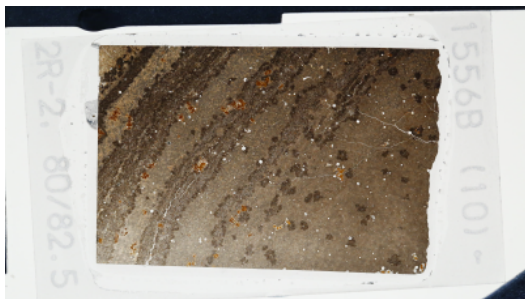
Piece no.:

Thin section thickness: standard

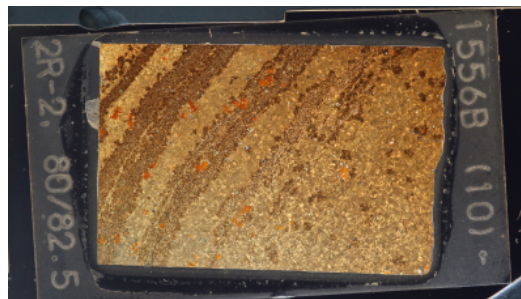
Unit/subunit: 1A

Thin section summary: Chilled margin of basalt showing laminated texture: The thin section encompasses the chilled margin of a basalt clast in a sedimentary breccia that displayed a laminated texture of ~3mm wide light and dark brown bands. The purpose of sampling this clast was to understand whether the texture was an original magmatic one due to different grain sizes or an alteration phenomenon or both. The laminations appear to be reflecting alteration on the macroscale with bands of more and less altered groundmass giving rise to dark and light bands, respectively. The least altered portions of the thin section are dominated by the plumose quench texture of clinopyroxene. On the microscale the dark bands appear to correspond to areas of slightly coarser groundmass with abundant acicular plagioclase and clinopyroxene. Within and adjacent to these coarser areas (and in circular halos around isolated clots of crystals) the groundmass is altered to a dark brown with abundant small patches of very dark almost opaque Fe oxyhydroxides. Olivine phenocrysts and elongate ?olivines (or possibly clinopyroxene) are completely altered to red-brown iddingsite. In the lighter bands radiating clusters of plagioclase are largely absent and relatively fresh plumose groundmass predominates, with only fine elongate quench olivines altered to a yellow-brown smectites + Fe oxyhydroxides. These are included by oriented plates of an opaque oxide (magnetite?) perpendicular to the elongate axis, indicating the original ferromagnesian nature of the mineral. Fresh olivine phenocrysts are present in these less altered bands with only partial or incipient alteration to iddingsite. Furthest from the dark bands (top right corner of the section) even very fine grained elongate olivines appear to retain a core of fresh material. The sample is cut by a thin zeolite + clay filled vein. Small vesicles are mostly filled by brown saponite or else rimmed by saponite and filled with zeolite. Altogether the features of this sample suggest that the banding observed arises from differential nucleation of plagioclase and olivine in separate bands, with the former giving rise to slightly coarser grained bands with abundant radiating clusters of crystals. These may have acted as nucleation sites for alteration minerals, or fluid pathways, or both. Similar features, with different geometry, are seen in the mottled, partially altered margins of many pillows with radial clusters of crystals acting as loci for alteration.

Plane-polarized: 62674491



Cross-polarized: 62674771



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: breccia

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

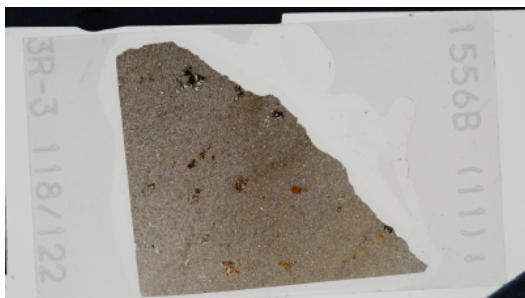
Minor groundmass Texture:

Sample domain name (if &gt; 1) 1

Domain relative abundance (%) 100

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| THIN SECTION LABEL ID:  | <b>390-U1556B-3R-3-W 118/122-TSB-TS11</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Thin section no.: |
| Observer:               | PDK, EC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Piece no.:        |
| Thin section thickness: | standard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Unit/subunit: 2   |
| Thin section summary:   | <p>Altered basalt: The thin section is an example of typical groundmass in the basalt of this section. It is dominated by an intersertal texture created by bowtie plagioclase (only partially altered) outlined by fine-grained Fe oxides. A higher birefringence mineral, pale brown in PPL, probably cpx, seems to contribute to the bowtie structures, forming elongate crystals that parallel some of the plag. The acicular mineral altered to the reddish-brown Fe-oxyhydroxide/iddingsite is interpreted as olivine. Olivine phenocrysts are 100% altered to calcite + Fe-oxyhydroxide + minor clays. Bright yellow ?clay with low birefringence (possibly a mixture of smectite and Fe oxyhydroxides) occurs in discrete patches through the groundmass. These do not appear to form around vein though could be an irregular halo to the vein bounded diagonal edge of the sample. Iddingsite after olivine varies in colour from red-brown to dark brown, almost opaque with darker colours mostly proximal to the diagonal vein bounded edge. Small vesicles filled by calcite or more rarely by a colourless low birefringence mineral (likely zeolite) and some are rimmed by the same yellow clay as occurs in the groundmass.</p> |                   |

Plane-polarized: 62674551



Cross-polarized: 62674531



## Igneous Petrology

|                                      |                                |                                      |                       |
|--------------------------------------|--------------------------------|--------------------------------------|-----------------------|
| <b>Lithology:</b>                    | sparsely olivine phyric basalt | <b>Rock texture:</b>                 | holocrystalline       |
| <b>Style of emplacement:</b>         | breccia                        | <b>Groundmass grain size (avg.):</b> | cryptocrystalline     |
| <b>Major groundmass texture:</b>     | intersertal                    | <b>Minor groundmass Texture:</b>     | dendritic or skeletal |
| <b>Sample domain name (if &gt;1)</b> | 1                              | <b>Domain relative abundance (%)</b> | 100                   |

THIN SECTION LABEL ID: **390-U1556B-4R-1-W 46/50-TSB-TS12**

Thin section no.:

Observer: PDK, EC

Piece no.:

Thin section thickness: standard

Unit/subunit: 2

Thin section summary: Altered basalt with a crosscutting vein: This thin section is of a highly altered basalt. In the alteration halo adjacent to the vein the groundmass is highly altered, in which the acicular to tabular skeletal olivine has been replaced by a dark reddish brown Fe oxyhydroxide. Away from the vein, there are areas where more of the original groundmass mineralogy and texture is retained. The cpx is surprisingly pinkish brown in color, more typical of a titanite, which I would not expect in these rocks. Plagioclase is acicular and skeletal. Small round vesicles occur throughout and are predominantly filled by carbonate or zeolite. Several large, euhedral crystals of a very low birefringence mineral (?zeolite) occur on the wall of one. A carbonate vein (mixed fill in hand specimen: white carbonate + massive orange-brown material) is partly filled by ?recrystallised sediment and includes an intact foram. The remainder of the vein is lined with zeolite and filled by crystalline carbonate. This vein has a well defined orange halo which is characterised by abundant groundmass replacement by a bright yellow ?clay (similar to prev. sections, low relief and birefringence). In parts of the halo (e.g. lower right) the yellow clay appears to form a discrete front to the halo and seems to grade into darker reds towards the vein. Green clay occurs in a small patch (towards the top right of the section) overgrown/replaced by yellow clay (remnant from overprinting/oxidation of earlier celdomite/nontronite-bearing halo?). Outside the halo, olivine (micro-phenocrysts and in groundmass) is replaced by a light brown clay (likely saponite; slightly higher biref. than the yellow clays <1st order red colours), commonly intergrown with carbonate. Within the halo, olivine is pseudomorphed by red-brown iddingsite, the colour of which grows increasingly dark with proximity to the vein. In one example an olivine, altered to saponite + carbonate, is intersected by the halo front and is partially altered to iddingsite within the halo.

Plane-polarized: 62674571



Cross-polarized: 62674591



## Igneous Petrology

Lithology: . aphyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 90

THIN SECTION LABEL ID: **390-U1556B-5R-1-W 89/92-TSB-TS13**

Thin section no.:

Observer: PDK, EC

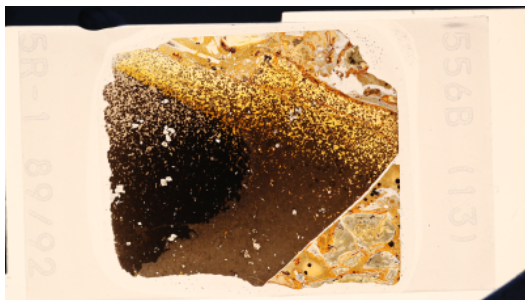
Piece no.:

Thin section thickness: standard

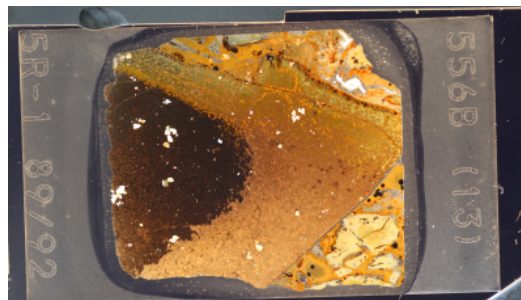
Unit/subunit: 3A

Thin section summary: Altered pillow chilled margin: This is a highly altered pillow chilled margin showing the spectrum of quench crystallization textures as well as the spectrum of alteration types that exploit those original textures. The outermost zone is now palagonite, golden yellow in color, highly fractured and disaggregated. Adjacent to that is the glass + spherulite zone. The glass is pale yellow in PPL; the spherulites are dark brown to black, and roughly 0.1 mm in size. The glass is most altered in a thin band around the spherulites, where the color is a more intense golden yellow, similar to the palagonite. The palagonite shows a concentric laminar texture the contours of which suggest alteration nucleated at relatively few sites along the boundaries of the glass and on the spherulites. Progressing inwards, the spherulites become increasingly clustered. In hand sample, this zone appears to be grey in color. In the interior of the chilled margin, the spherulites merge and develop a more plumose texture. The spherulites commonly have acicular / skeletal crystals of plagioclase (?) in their cores. The rock contains sparse, euhedral olivine microphenocrysts that commonly occur in glomerocrystic clusters. These are typically partially altered to iddingsite/Fe oxyhydroxides. The space between fragments of altered glass is lined by zeolites which show cryptocrystalline to bladed radial textures, the latter clearly having grown into void in places. These are overgrown by crystalline carbonate. Small vesicles in the cryptocrystalline basalt are filled, variously, by zeolite, carbonate and saponite. Saponite fill typically has a rim of lower birefringence, clear (PPL) mineral, possibly chalcedony.

Plane-polarized: 62674691



Cross-polarized: 62674711



## Igneous Petrology

Lithology: . aphyric basalt

Rock texture: holohyaline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): glass

Major groundmass texture: spherulitic

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-6R-3-W 63/66-TSB-TS14**

Thin section no.:

Observer: PDK, EC

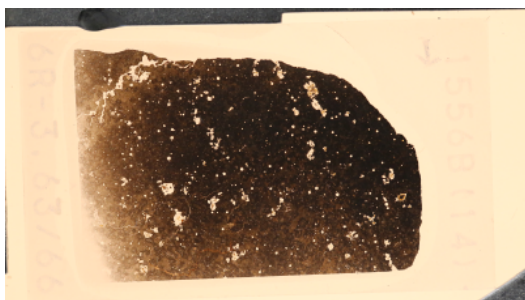
Piece no.:

Thin section thickness: standard

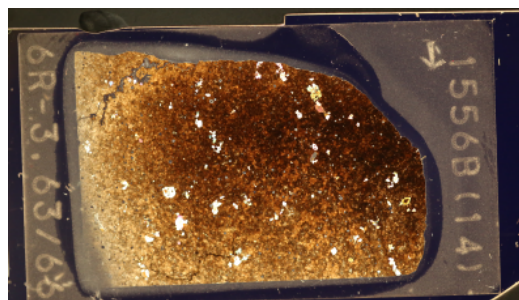
Unit/subunit: 3B

Thin section summary: Olivine basalt with crosscutting vein: Typical basalt for this interval. Groundmass is dominated by plumose quench textures, probably intergrowths of plag and cpx; alteration of the groundmass is patchy. In some areas, the cpx is replaced by dark red-brown Fe oxyhydroxides, and not in others. Some of this patchiness seems to centre on small agglomerations of slightly larger acicular plagioclase and cpx (sites for nucleation of alteration?). Yellow clay occur very sparsely replacing groundmass throughout the section. Plagioclase forms acicular bowtie structures and minute elongate opaque minerals decorate the length of the crystals Olivine phenocrysts are euhedral and remarkably unaltered. Small round vesicles are 100% filled by spherulitic zeolite or rarely, carbonate. Two veins cut the section: an Fe oxyhydroxide vein with an amorphous granular texture, and an irregular shaped vein/void completely filled by radiating fans of zeolite.

Plane-polarized: 62690921



Cross-polarized: 62690901



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 90

THIN SECTION LABEL ID: **390-U1556B-8R-2-W 84/88-TSB-TS15**

Thin section no.:

Observer: PDK, EC

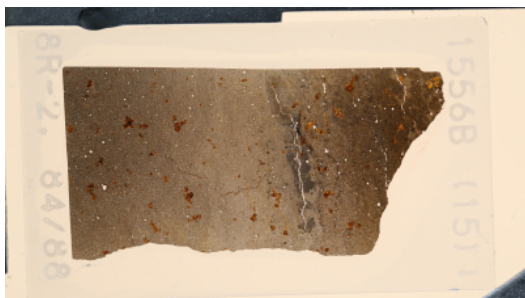
Piece no.:

Thin section thickness: standard

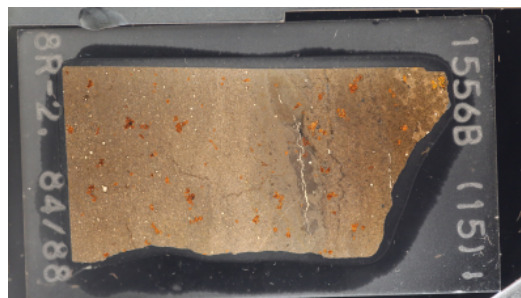
Unit/subunit: 3B

Thin section summary: Olivine basalt: The groundmass for this rock is unusual compared to other samples from cores 2R to 6R. Although very fine grained (cryptocrystalline to microcrystalline), the texture is more equigranular and less skeletal. Crystal sizes are too small to identify minerals unambiguously, but the elongate, colorless mineral is probably plagioclase. The crystals are more stubby than elsewhere and do not form bowtie structures. The groundmass is peppered by tiny equant opaque minerals. Cpx not identified unambiguously. With rare exceptions, olivine phenocrysts and olivine in groundmass are 100% altered to reddish brown Fe oxyhydroxide and carbonate. Yellow clay (likely a mixture of smectite + Fe-OH) occurs sparsely in interstitial areas, as vesicle linings, and more abundantly as an impersistent halo to a carbonate + brownish clay (?saponite) vein cutting the centre of the slide. This vein also has an inner halo of brown dusty groundmass, possibly reflecting alteration to clays. In places this inner halo is also associated with very dark nearly opaque amorphous ?oxides. Vesicles are mostly filled by carbonate, rarely by saponite or, nearer the chilled margin, by zeolite.

Plane-polarized: 62690941



Cross-polarized: 62690961



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: granular

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-9R-2-W 59/62-TSB-TS16**

Thin section no.:

Observer: PDK, EC

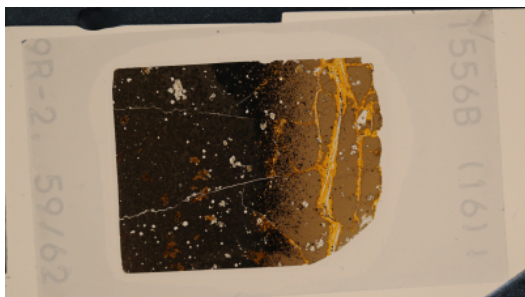
Piece no.:

Thin section thickness: standard

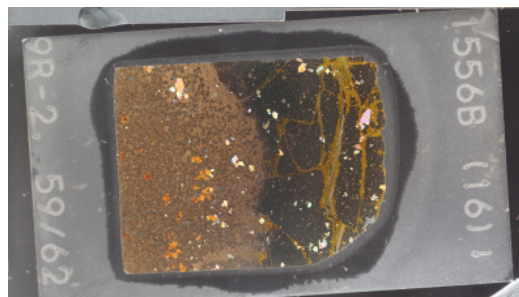
Unit/subunit: 4A

Thin section summary: Basalt chilled margin: This is an excellent example of a chilled pillow margin, including partially palagonitized glass, progressing into a variolitic zone, then a coalesced variolitic zone, and finally a cryptocrystalline zone consisting of plumose quench textures, presumably composed of intergrown plag and cpx. The rock is olivine phyric and there are unaltered olivines within the glassy and variolitic zones of the chilled margin. The olivines are euhedral and occur in glomerocrystic clusters. Some olivines contain small, equant Cr spinels (?) The rock is sparsely vesicular, with small round vesicles that are 100% filled. In the cryptocrystalline zone, olivines are partially to totally replaced by iddingsite. Vesicles are filled with carbonate or cryptocrystalline/spherulitic zeolite, the latter overgrown by pale brown clay (likely saponite) in some examples. Rare vesicles may contain chalcedony (with slightly higher interference colours <10. white). The yellow palagonite shows a laminar/spherulitic structure nucleating along cracks in the glass. At the reaction front with fresh(ish) glass the palagonite appears to grow as irregular filaments. Some of the vesicles in glass are surrounded by rims of incipient palagonitisation. Groundmass in the cryptocrystalline zone is partially replaced by golden yellow clay with low 1st order interference colours, becoming more abundant away from the glassy margin. Veins throughout the section - in both glass and crystalline basalt - are predominantly filled by massed fans of spherulitic zeolite.

Plane-polarized: 62691001



Cross-polarized: 62690981



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: sheet lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: glass

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-10R-2-W 137/139-TSB-TS17**

Thin section no.:

Observer: PDK, EC

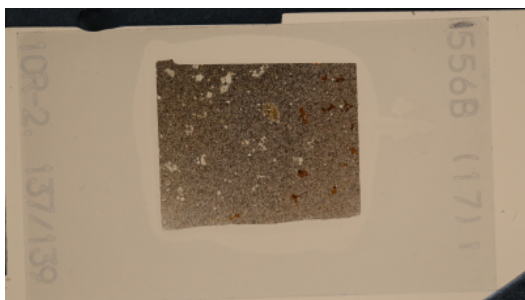
Piece no.:

Thin section thickness: standard

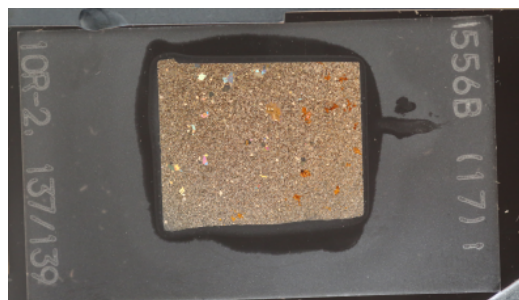
Unit/subunit: 4B

Thin section summary: Olivine basalt: This is a moderately olivine phyric basalt. Modal abundance of olivine phenocrysts is ~ 10%. They range from 100% altered to 100% fresh in the space of a single thin section. Groundmass consists of colorless tabular plagioclase and cpx. The latter is a pale pinkish brown color, not typical of augite; suggests high Ti content? The plag and cpx are relatively unaltered. Opaque minerals range from equant to elongate. Interstitial areas are golden yellow color, suggesting replacement by saponite. Olivine is replaced by red-brown iddingsite in the upper part of the section with the zone of replacement forming a halo to a vein (out of section). Olivine mostly fresh outside halo with only minor alteration to dusty clays and some incipient alteration to iddingsite. Isotropic bright orangish-yellow material (likely limonite, i.e. goethite + minor clay) is common replacing groundmass outside this halo and groundmass carbonate is abundant throughout the section. Vesicles are filled 100% by carbonate, in some cases rimmed by brownish saponite. In some examples carbonate forms a botryoidal carbonate rim on the vesicle wall, overlain by a thin layer of clay or zeolite (very pale yellow in PPL; very low interference colors in XPL), and the centre of vesicle typically filled by sparry calcite.

Plane-polarized: 62691021



Cross-polarized: 62691041



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

**THIN SECTION LABEL ID: 390-U1556B-11R-3-W 18/22-TSB-TS18**

Thin section no.:

Observer: PDK, EC

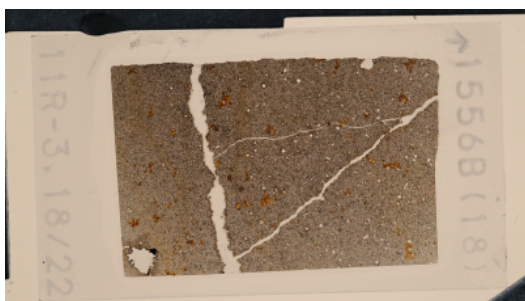
Piece no.:

Thin section thickness: standard

Unit/subunit: 4B

Thin section summary: Olivine basalt with crosscutting vein: This is a moderately olivine phyric basalt that is moderately to highly altered. Euhedral, equant olivine phenocrysts tend to occur in glomerocrystic cluster. The original groundmass consisted of cryptocrystalline to microcrystalline tabular plagioclase crystals that commonly form radiating crystal clusters. Groundmass clinopyroxene also forms acicular to tabular crystals that form radiating clusters, sometimes alongside the plagioclase. Opaque minerals are acicular and form a gridded pattern in many areas. Olivine phenocrysts are 100% altered to calcite + red-brown iddingsite throughout. In most areas, groundmass plag and cpx appear to be relatively unaltered. By contrast, groundmass olivine is 100% altered in a similar way to phenocryst phases. A thick (<2mm) carbonate vein, lined by botryoidal zeolites and filled with bladed calcite runs across the section and is associated with an alteration halo. The halo is defined by a narrow front 1-3mm from the vein in which bright yellow clay (with low 10. interference colours) is abundant, replacing interstitial groundmass and lining vesicles. Moving towards the vein, this yellow clay shows a sharp gradient towards redder colours, in some cases across a single vesicle. It is not immediately clear whether this deeper red material is equally abundant in the inner parts of the halo or whether only the outer edge is defined by an increase in the abundance of alteration minerals. Close in to the vein, an inner dark halo is defined by abundant yellowish brown clays (smectite, possibly saponite?) and a darkening in the colour of red-brown iddingsite/Fe-OH to nearly opaque. Away from the veins yellow clay groundmass is abundantly replaced by small patches of carbonate and sparse yellow clays.

Plane-polarized: 62693501



Cross-polarized: 62693521

**Igneous Petrology**

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-15R-1-W 127/130-TSB-TS19**

Thin section no.:

Observer: PDK, EC

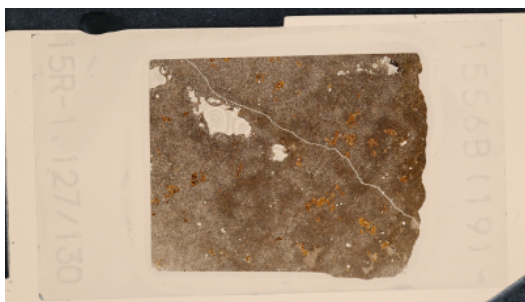
Piece no.:

Thin section thickness: standard

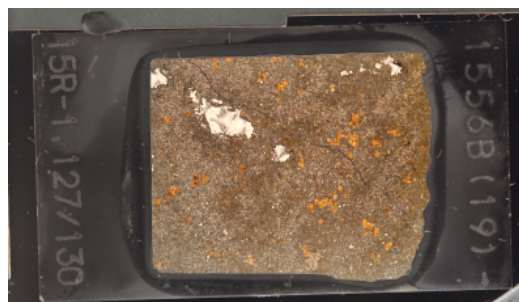
Unit/subunit: 5B

Thin section summary: Olivine basalt with large vesicle / vug filling: This is a moderately olivine phyric basalt that is moderately to highly altered. Euhedral, equant olivine phenocrysts tend to occur in glomerocrystic clusters. The original groundmass consisted of cryptocrystalline bowtie structures, presumably of intergrown acicular plagioclase and clinopyroxenes with skeletal crystal extensions. I think this slide is too thick in some parts. Olivine phenocrysts are 100% altered to calcite + iddingsite. Plumose groundmass variably and patchily altered to brownish red - likely clays + Fe oxyhydroxides but grain size too small to tell. Some of this variation appears to correspond to an alteration halo developed from the top of the slide. Interstitial areas of the groundmass are replaced by calcite and yellow clay (low 10 interference colours), the latter mostly concentrated in a halo at the top of the slide (presumably a vein bounded fracture). Several large vugs / vesicles are filled by crystalline carbonate with spectacular radial growth layers (variation in texture picking out multiphase growth?) and rimmed by yellow clay and dark red to opaque Fe oxyhydroxides. In some examples these vugs have similar halos of abundant groundmass yellow clay. Smaller vesicles are filled by carbonate or zeolite. One thin zeolite-filled vein (with very minor carbonate) crosses the section.

Plane-polarized: 62693561



Cross-polarized: 62693541



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

**THIN SECTION LABEL ID: 390-U1556B-16R-4-W 48/50-TSB-TS20**

Thin section no.:

Observer: PDK, EC

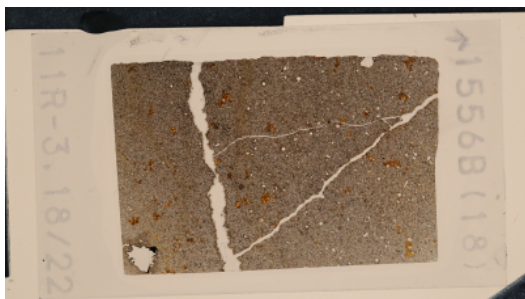
Piece no.:

Thin section thickness: standard

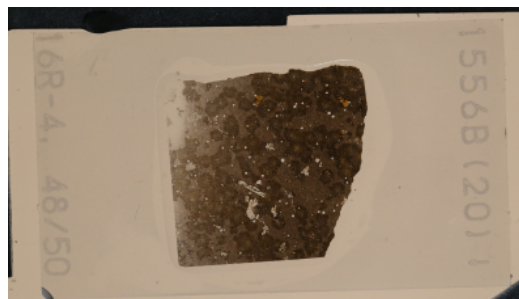
Unit/subunit: 5B

Thin section summary: Olivine basalt: This is a cryptocrystalline (plumose quench textured) zone from a pillow lava. It is moderately vesicular, with small (0.2 mm) round vesicles, most now filled by calcite. Euhedral olivine phenocrysts are present, at least one partially observed to be resorbed. Groundmass plagioclase occurs as acicular to skeletal crystals, often assembled into bowtie structures. Clinopyroxene is too fine grained to identify unambiguously, but it probably forms much of the plumose structure observed between the plagioclase crystals. Interstitial areas in the groundmass are replaced by a golden yellow secondary mineral, probably saponite, and calcite. In this thin section, the darker areas of the groundmass appear to be more altered than the lighter areas, i.e. containing more saponite. Olivine phenocrysts are slightly highly altered to iddingsite + calcite + minor cryptocrystalline ?clay, depending on proximity to patchy alteration. Skeletal quench olivines are everywhere altered, either to bright yellow clay or yellowish brown iddingsite and associated with plates or needles of opaque oxides. Similar yellow minerals are common as an interstitial alteration but in at least some occurrences appears to be isotropic (likely limonite). The abundance of interstitial yellow clay is higher in patches of darker more altered groundmass which seem to correspond to clusters of acicular plagioclase crystals (these variations are likely what is macroscopically picked out by the "mottled grey" alteration of chilled margins). Vesicles are filled by carbonate, zeolites and more rarely ?chalcedony (colourless, higher order interference colours than the zeolite <10. white), and in places rimmed by bright yellow clay. Carbonate is rare in the finer grained part of the sample but becomes more common moving down the thin section overgrowing plumose groundmass in irregular patches.

Plane-polarized: 62693501



Cross-polarized: 62693581

**Igneous Petrology**

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-19R-1-W 111/113-TSB-TS21**

Thin section no.:

Observer: PDK, EC

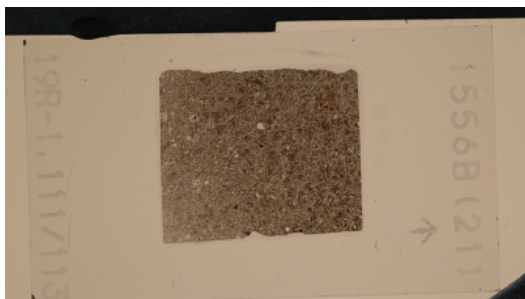
Piece no.:

Thin section thickness: standard

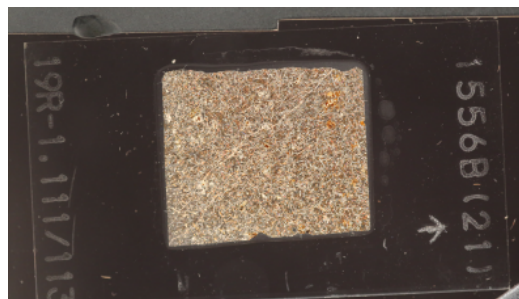
Unit/subunit: 6

Thin section summary: Olivine basalt: This is a moderately olivine phyric basalt from a pillow interior, so more coarse grained than many of the samples taken earlier in the hole. Euhedral, equant olivines are 100% replaced. Groundmass plagioclase is acicular to tabular, with skeletal extensions. Groundmass clinopyroxene is also tabular, but otherwise their crystal habit is less indicative of rapid crystallization (i.e. not skeletal). Cpx crystals are pleochroic in pale beige, to pinkish brown, to violet. Opaque minerals range from equant to acicular. When acicular, the opaque minerals often form fine grid structures. Vesicles are round and filled by calcite. In comparison with other samples, much of the alteration here is by pale brown or greenish brown clays (interference colours <10. purple; likely saponite) without as much of the bright yellow clay and red Fe oxyhydroxides as typical in many samples. This pale brown/greenish clay occurs in the groundmass, as replacement of olivine phenocrysts, and ubiquitously as a lining to vesicles. Some yellow clay occurs but usually in isolated patches. Some olivine phenocrysts are altered to iddingsite but more commonly they have been pseudomorphed by large carbonate crystals, cross-cut by veins of cross-fibrous pale brown clay. There is a broad gradient of alteration colours across the section with yellow and brown-red alteration minerals (yellow clay, iddingsite, Fe-OH etc.) more common at the top of the slide (though pale brown ?saponite still predominates as in groundmass alteration. The most abundant zone of iddingsite alteration to olivine appears to define a halo at the top of the slide. Vesicles are mostly crystalline carbonate filled, commonly rimmed by pale brown clay with a radial structure or, more rarely, larger botryoidal masses. A thin carbonate vein with cross-fibrous structure runs across the section.

Plane-polarized: 62701751



Cross-polarized: 62701771



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-20R-2-W 116/119-TSB-TS22**

Thin section no.:

Observer: PDK, EC

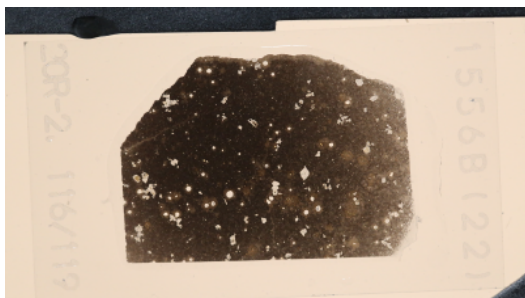
Piece no.:

Thin section thickness: standard

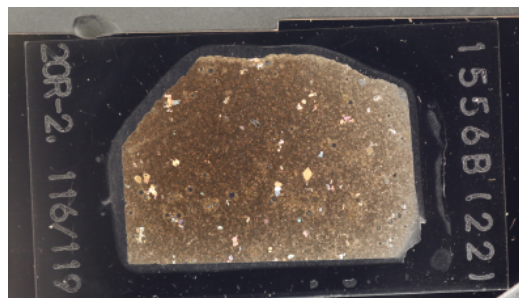
Unit/subunit: 6

Thin section summary: Olivine basalt: This is a moderately olivine phyric basalt from a pillow interior. It is also moderately vesicular, which isn't apparent from the hand sample descriptions. The vesicles are small, typically less than 0.2 mm (but very small ones < 0.03 mm are common). All vesicles are filled, predominantly with a low relief, low birefringence mineral, probably a zeolite. Euhedral, equant olivines are remarkably unaltered. About 10% of them are skeletal or partially resorbed. Some contain minute equant crystals of Cr spinel. The groundmass is cryptocrystalline, with typical plumose quench textures. Mineralogy difficult to identify and can only be inferred as an intergrowth of plagioclase and clinopyroxene. Interstitial mesostasis varies from quite fresh and grey to red-brown across the slide likely reflecting alteration to Fe oxyhydroxides in a broad halo (missing lower left corner likely bounded by a vein or fracture). Acicular quench ?olivines are altered to a yellow mineral throughout (either yellow clay or very thin Fe oxyhydroxides) and show increasingly brown-black colouration across the slide, mirroring the gradient of groundmass alteration.

Plane-polarized: 62701811



Cross-polarized: 62701791



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-20R-4-W 61/63-TSB-TS23**

Thin section no.:

Observer: PDK, EC

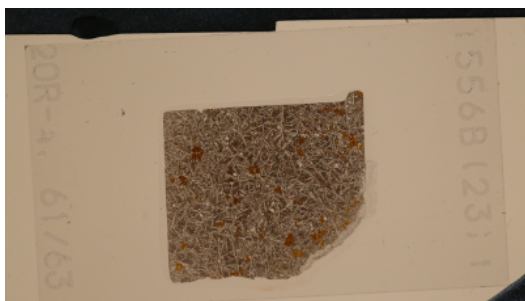
Piece no.:

Thin section thickness: standard

Unit/subunit: 6

Thin section summary: Olivine basalt: This is a moderately olivine phyric basalt from a pillow interior, so more coarse grained than many of the samples taken elsewhere in the hole. Euhedral, equant olivine phenocrysts are 100% replaced by iddingsite / Fe-oxyhydroxides / smectite plus some calcite. Groundmass olivines are also equant and altered in a manner similar to that of phenocrysts. Groundmass plagioclase is acicular to tabular, with skeletal extensions; crystals are large enough to show some polysynthetic twinning. Groundmass clinopyroxene is also tabular, with acicular extension on the ends of some crystals, similar to the skeletal plagioclase; unusual morphology for cpx in tholeiites the experience of this observer. Cpx crystals are pleochroic in pale yellowish beige, to pinkish brown, to pale blue/lavender, suggesting high Ti contents??. Opaque minerals range from equant to acicular. Interstitial areas in the groundmass are sparsely replaced by brownish green smectite and calcite. Vesicles (<1%) are round, filled by radial textured brownish saponite or else lined with saponite and filled by calcite. The top right corner of the section is formed of a carbonate vein showing interlocking crystalline and cross fibrous structures, the latter possibly a later generation of veining. A sliver of material in the centre of the vein appears to be an isolated bit of the host basalt. The margins of the vein have a thin lining of very pale brown/yellow clay and red-brown Fe oxyhydroxide. A narrow halo (1-2mm) around the vein manifests as sparse yellow clays replacing groundmass and rimming vesicles.

Plane-polarized: 62701831



Cross-polarized: 62701851



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-21R-2-W 27/30-TSB-TS24**

Thin section no.:

Observer: PDK, EC

Piece no.:

Thin section thickness: standard

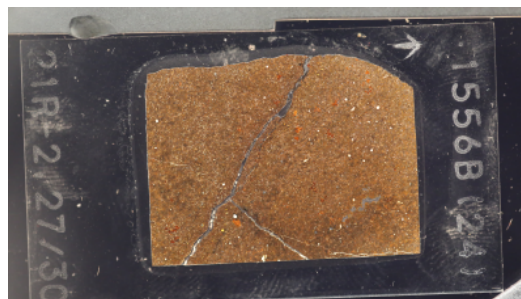
Unit/subunit: 6

Thin section summary: Highly altered olivine basalt with crosscutting veins: This is a highly altered basalt from a unit of moderately olivine phyric basalts. The area sampled for this thin section is aphyric, so presumably close to the pillow chilled margin. It is moderately vesicular, which isn't apparent from the hand sample descriptions. The vesicles are small, typically less than 0.2 mm (but very small ones < 0.02 mm are common). All vesicles are filled, mostly by crystalline carbonate, commonly lined by brown to brownish yellow ?saponite. A few vesicles and some larger, irregular vesicles/vugs are filled by radiating fans of zeolite (very low birefringence). The groundmass is cryptocrystalline, with typical plumose quench textures, that have been highlighted by the extensive alteration. Mineralogy is difficult to identify, because of the small grain size and alteration, but small, acicular plagioclase microlites can still be observed at the cores of the plumose structures. The plagioclase appears to be unaltered, but difficult to tell at this grain size. Ferromagnesian minerals, inferred to be olivine and clinopyroxene, appear to be 100% altered to very dark, reddish brown smectite + Fe oxyhydroxides (a.k.a. iddingsite). Tiny, equant opaque minerals are homogeneously distributed throughout. The thin section is crosscut by veins filled radiating bladed crystals of zeolite. Carbonate appears in the veins towards the right of the slide in patches and along the side of one of the veins. A thin carbonate vein cuts up the right hand side of the section. All three veins and the zeolite-filled vugs have narrow (1-2mm) halos defined by slighter darker groundmass alteration and the relatively abundant presence of bright yellow to orange clays (likely smectite with Fe oxyhydroxide interlayers) replacing groundmass and lining vesicles. Similar yellow clay is more sparsely present in the groundmass throughout the section.

Plane-polarized: 62715931



Cross-polarized: 62715951



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-23R-1-W 131/134-TSB-TS25**

Thin section no.:

Observer: PDK, EC

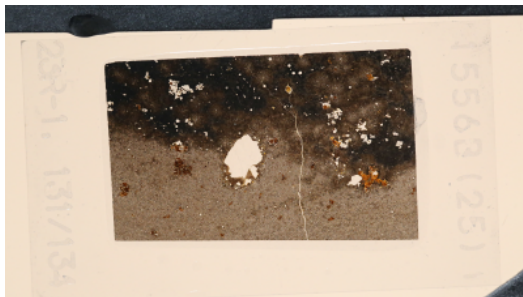
Piece no.:

Thin section thickness: standard

Unit/subunit: 7A

Thin section summary: Basalt with crystallization grain size transition and large vug: This thin section captures the transition from plumose quench texture to intergranular texture with slower cooling from pillow top to pillow interior. This description covers the more rapidly cooled plumose textured zone. The plumose quench texture area is dark brown because of the cryptocrystalline grain sizes. The basalt is moderately olivine phyric, with euhedral equant olivines, occurring in glomerocrystic clusters. The groundmass is made of plumose dendritic structures, presumably an intergrowth of quench plagioclase and clinopyroxene. The individual plumes appear to have acicular plagioclase microlite cores. There are patchy areas where plagioclase growth is greater; the crystals are larger, although still acicular, and these areas adopt bowtie structures. The rock is sparsely vesicular, with small round vesicles, some partially lined by smectite and filled by calcite. Groundmass is patchily altered to very dark brown (likely clays + Fe oxyhydroxides). These patches are generally around vesicles and thin carbonate veins as well as concentrations of olivine phenocrysts, all of which may have provided pathways for fluids. Alteration of olivine phenocrysts is variable, from incipient to complete replacement by iddingsite with minor carbonate. Vesicles are commonly lined with pale brown clay and filled by carbonate or zeolite. This description covers the less rapidly cooled intergranular portion of the slide. Olivine phenocrysts are typically equant and form glomerocrystic clusters. In contrast with the finer grained portion of the rock, they are 100% replaced by dark orange-brown iddingsite with minor carbonate. Groundmass plagioclase is acicular and much larger than in the plumose quench zone; it occurs in bowtie structures in this zone as well. Groundmass clinopyroxene is more granular here than in some thin sections from higher up in hole 1556B. Its color is in PPL is also more pale brown rather than the pinkish brown seen earlier. Groundmass mesostasis is cryptocrystalline and appears to have been largely to completely replaced by secondary minerals, including carbonate and likely brownish clays (though too fine grained to identify unambiguously). Opaque minerals in the groundmass are typically equant, often forming small clusters; some are more acicular. In the vicinity of the altered olivines, there are larger, equant crystals interpreted as Cr spinels that would have originally been included in the olivine phenocrysts. This part of the rock is sparsely vesicular, with small round vesicles, some partially lined by smectite and filled by calcite. There are also some larger, vuggy-style vesicles that are filled by bladed calcite. They are concentrated along the boundary between the two different textural areas. The thin section is crosscut by discontinuous, branching calcite veins. The transition from plumose quench texture to intergranular texture is marked by a band of abundant yellow clay simialar to that seen in the halos of many veins. The yellow clay occurs replacing groundmass and rimming vesicles/vugs and veins. This is clearest seen in a thin cross-fibrous carbonate vein along which a lining of yellow clay appears as crosses the boundary between the two domains.

Plane-polarized: 62715971



Cross-polarized: 62767161



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 50

**Igneous Petrology**

|                                     |                                  |                                      |                  |
|-------------------------------------|----------------------------------|--------------------------------------|------------------|
| <b>Lithology:</b>                   | moderately olivine phyric basalt | <b>Rock texture:</b>                 | holocrystalline  |
| <b>Style of emplacement:</b>        | pillow lava flow                 | <b>Groundmass grain size (avg.):</b> | microcrystalline |
| <b>Major groundmass texture:</b>    | intergranular                    | <b>Minor groundmass Texture:</b>     |                  |
| <b>Sample domain name (if&gt;1)</b> | 1                                | <b>Domain relative abundance (%)</b> | 50               |

**Igneous Petrology**

|                                     |                                  |                                      |                   |
|-------------------------------------|----------------------------------|--------------------------------------|-------------------|
| <b>Lithology:</b>                   | moderately olivine phyric basalt | <b>Rock texture:</b>                 | holocrystalline   |
| <b>Style of emplacement:</b>        | pillow lava flow                 | <b>Groundmass grain size (avg.):</b> | cryptocrystalline |
| <b>Major groundmass texture:</b>    | dendritic or skeletal            | <b>Minor groundmass Texture:</b>     |                   |
| <b>Sample domain name (if&gt;1)</b> | 1                                | <b>Domain relative abundance (%)</b> | 50                |

**Igneous Petrology**

|                                     |                                  |                                      |                  |
|-------------------------------------|----------------------------------|--------------------------------------|------------------|
| <b>Lithology:</b>                   | moderately olivine phyric basalt | <b>Rock texture:</b>                 | holocrystalline  |
| <b>Style of emplacement:</b>        | pillow lava flow                 | <b>Groundmass grain size (avg.):</b> | microcrystalline |
| <b>Major groundmass texture:</b>    | intergranular                    | <b>Minor groundmass Texture:</b>     |                  |
| <b>Sample domain name (if&gt;1)</b> | 1                                | <b>Domain relative abundance (%)</b> | 50               |

THIN SECTION LABEL ID: **390-U1556B-24R-1-W 100/102-TSB-TS26**

Thin section no.:

Observer: PDK, EC

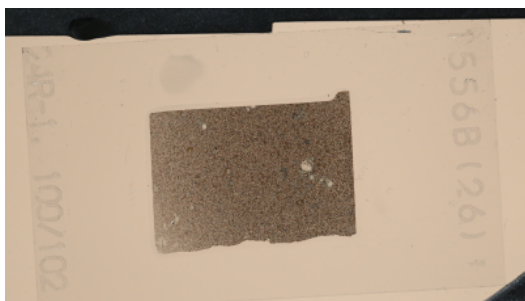
Piece no.:

Thin section thickness: standard

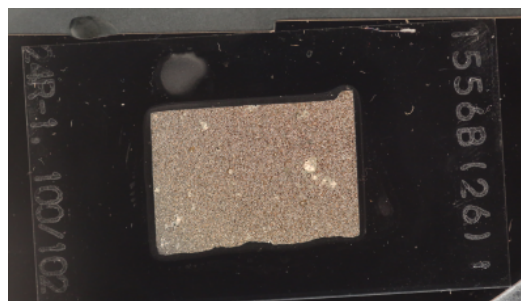
Unit/subunit: 7B

Thin section summary: Olivine basalt: This is a moderately altered moderately olivine phyric basalt. Olivine phenocrysts contain small Cr spinels. Groundmass plagioclase is tabular to acicular, exhibiting typical polysynthetic twinning. It appears to be relatively unaltered. Groundmass clinopyroxene is granular to tabular and often participates in the radiating bowtie structures common for the plagioclase; the cpx color is pale pinkish brown. Groundmass opaque minerals occupy interstitial areas. They range from equant crystals to acicular crystals that form gridded networks. The olivine phenocrysts are dominantly replaced pale brown saponite and abundant dusty looking amorphous/cryptocrystalline clays. In larger crystals the brown clays form a mesh texture-like series of rims (with radially fibrous structure) with cores replaced by crystalline carbonate. Groundmass mesostasis and smaller groundmass olivines show similar alteration with abundant clays giving a dusty, nearly opaque appearance. More ordered, pale brown-green saponite (with <10. purple interference colours) and carbonate replace groundmass in small patches, some with spherulitic textures. Some of these are slightly more orange-brown coloured but otherwise Fe oxyhydroxides appear to be (unusually) absent in this sample. The rock is sparsely vesicular, with small round vesicles totally dark cryptocrystalline clay or lined by clay and filled by calcite. A highly reflective opaque mineral, white in reflected light, occurs in association with saponite replacing olivine (marcasite?)

Plane-polarized: 62715991



Cross-polarized: 62716011



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): microcrystalline

Major groundmass texture: intergranular

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-25R-1-W 13/15-TSB-TS28**

Thin section no.:

Observer: PDK, EC

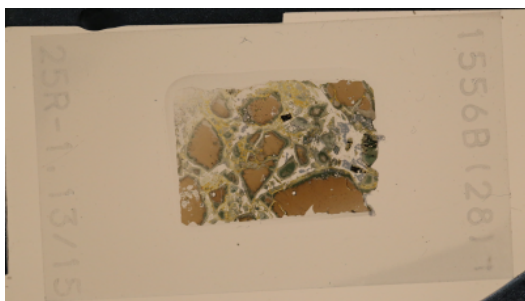
Piece no.:

Thin section thickness: standard

Unit/subunit: 7B

Thin section summary: Hyaloclastite breccia: This sample is a hyaloclastite in which the altered glass and cement is distinctly green in hand specimen. Clasts are all glass. Equant euhedral olivine phenocrysts are common within the glass and are markedly fresh, regardless of the alteration of their host. Along their margins all clasts are altered to cryptocrystalline green palagonite, with a concentric/spherulitic, nucleation-dominated texture. Smaller clasts are completely altered while larger ones have a core of moderately fresh glass with only incipient alteration visible. The reaction front of alteration is characterised by fibrous growths extending from the green palagonite into the fresher core, some almost spanning the glass. A few of the smaller clasts have been replaced by radiating fans of more ordered, green microcrystalline, minerals with blue green colour, and higher birefringence (<1st o. red), possibly celadonite. In some cases it is unclear if these represent clasts or part of the cement. The green palagonite appears to have been itself altered in a thin rim and along cracks to a bright yellow-orange more typical of the yellow palagonite seen in other samples. The clasts are rimmed and cemented principally by voluminous fans of radial, bladed or spherulitic zeolite. No carbonate is present. Lining the clasts and underlying the zeolite cement is variously a thin layer of very pale yellow-green ?clay, dusty cryptocrystalline clays, or in places a spherulitic colourless mineral, possible chalcedony. In the largest interclast openings the zeolite cement is overgrown by small spherules of dusty brown clay.

Plane-polarized: 62720001



Cross-polarized: 62719981



## Igneous Petrology

Lithology:

Rock texture:

holocrystalline

Style of emplacement: hyaloclastite

Groundmass grain size (avg.): glass

Major groundmass texture:

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-25R-2-W 138/141-TSB-TS27**

Thin section no.:

Observer: PDK, EC

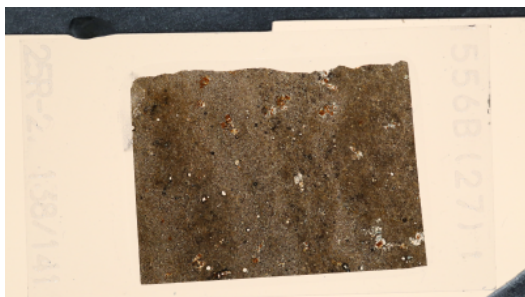
Piece no.:

Thin section thickness: standard

Unit/subunit: 7B

Thin section summary: Olivine basalt: This is a moderately olivine phyric basalt from a pillow interior. Euhedral, equant olivine phenocrysts are 100% replaced by red-brown iddingsite and carbonate. Many of these are also crosscut by thin veins of a fibrous pale green mineral, with low birefringence (<1st order purple interference colours), likely a clay. One olivine crystal is partially replaced by bright green clay, the remainder consisting of iddingsite and carbonate. Groundmass plagioclase is acicular to tabular, with skeletal extensions; crystals are too small to assess the state of their alteration robustly, but they appear to be largely unaltered. In between and around the acicular plagioclase, the groundmass is cryptocrystalline, commonly forming plumose structures that are partially (?) replaced by secondary minerals. Elongate patches of yellow to orange-red minerals (likely clay + Fe oxyhydroxides) are common in groundmass, often associated with fresher plagioclase and likely pseudomorphing acicular quench olivines which crystallised alongside the plagioclase. In places the yellow clays are more abundant and can be seen crystallising over larger areas of groundmass. These are semi continuous bands, somewhat like halos but lacking any relationship with a central vein. Opaque minerals range from equant to acicular. Larger equant crystals, believed to be Cr spinels, are common associated with the altered olivines. Vesicles (<1%) are round, lined with smectite and filled by calcite.

Plane-polarized: 62716051



Cross-polarized: 62716031



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-26R-1-W 120/122-TSB-TS34**

Thin section no.:

Observer: PDK, EC

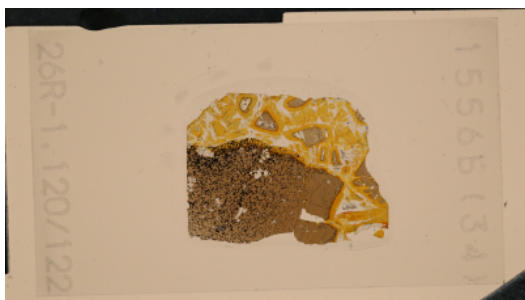
Piece no.:

Thin section thickness: standard

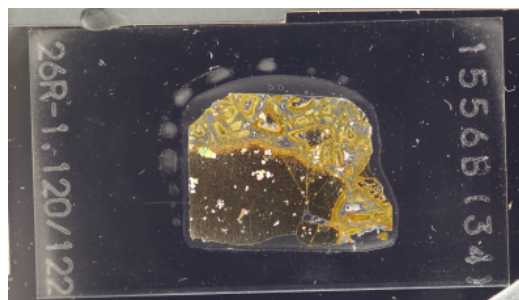
Unit/subunit: 7B

Thin section summary: Olivine basalt glassy chilled pillow margin: This is the glassy chilled margin of an olivine phyric pillow basalt. It captures the transect from the outer zone of palagonitization to the appearance of spherulites. The palagonite is golden yellow in color and cryptocrystalline. The palagonitized glass fragments are angular and set in a cement of zeolites (low interference colors, low relief) forming spherulitic structures on the palagonite, these commonly overgrown by radiating fans of bladed crystals. The zeolite fans are overgrown by pale brown radiating feathery saponite (<10. red interference colours) filling the centre of some larger interclast voids. Some of the palagonite clasts retain a core of partially altered glass. The spherulites are small, spherical, and very dark brown. Their mineralogy is uncertain, but the presence of acicular, skeletal plagioclase crystals in the cores or some larger spherulites suggests they may be plagioclase quench growth. Olivine phenocrysts are equant, euhedral and only very slightly altered. Some are partially resorbed and some contain small, equant Cr spinel crystals. Small, round vesicles are filled by bladed calcite. Some of the vesicles appear to be empty, although it's not clear whether this is the case or just that the filling has been plucked out.

Plane-polarized: 62733971



Cross-polarized: 62733951



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holohyaline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): glass

Major groundmass texture: spherulitic

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-27R-3-W 84/87-TSB-TS29**

Thin section no.:

Observer: PDK, EC

Piece no.:

Thin section thickness: standard

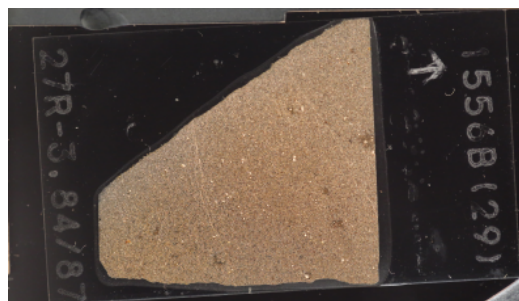
Unit/subunit: 7B

Thin section summary: Olivine basalt: This is a sparsely olivine phyric basalt from a pillow lava. Euhedral, equant olivine phenocrysts are 100% replaced, principally by calcite with subordinate iddingsite, Fe-oxyhydroxides and/or dusty smectite clays. Groundmass plagioclase is acicular and forms a felty texture overall, with some occurring in bowtie or radiating structures. The groundmass plagioclase appears to be relatively unaltered. Groundmass clinopyroxene forms elongate crystals that participate in creating the felty texture. They are pinkish brown in color and appear to be zoned from a paler brown in crystal interiors to a more intense pinkish brown on the margins. Opaque minerals range from equant to acicular. Where acicular, the opaque minerals form gridded networks. In this thin section, the equant morphology predominates over the acicular form. Larger equant opaque crystals, believed to be Cr spinels, are commonly associated with the altered olivines. Groundmass mesostasis is patchily altered to a cryptocrystalline brown material, probably clays or clay + Fe Oxyhydroxides. There may also be patchy replacement of the groundmass by zeolites (colors in PPL, very low interference colors in XPL), which also rim very small irregular voids between groundmass crystals. Vesicles (<1%) range from round to slightly irregular in outline; they are lined with yellow smectite and filled by calcite. These vesicles are associated with patches where groundmass is replaced by yellow-brown clays (+ zeolites?). Two very thin carbonate veins cross the section.

Plane-polarized: 62731141



Cross-polarized: 62731121



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): microcrystalline

Major groundmass texture: intersertal

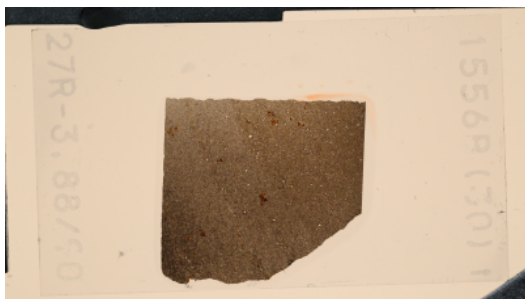
Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

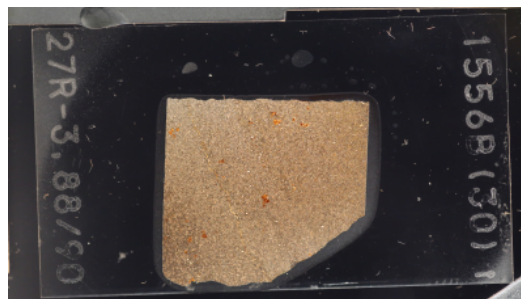
Domain relative abundance (%) 100

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                   |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| THIN SECTION LABEL ID:  | <b>390-U1556B-27R-3-W 88/90-TSB-TS30</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Thin section no.: |
| Observer:               | PDK, EC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Piece no.:        |
| Thin section thickness: | standard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Unit/subunit: 7B  |
| Thin section summary:   | <p>Olivine basalt with vein of calcite + smectite: The description of this sample is very similar to that for 390-U1556B-27R-3-W 84/87 but iddingsite more commonly replaces olivine than carbonate and several alteration halos are present. This is a sparsely olivine phyric basalt from a pillow lava. Euhedral, equant olivine phenocrysts are 100% replaced, by red brown iddingsite with small patches of carbonate. Groundmass plagioclase is acicular and forms a felty texture overall, with some occurring in bowtie or radiating structures. The groundmass plagioclase appears to be relatively unaltered. Groundmass clinopyroxene forms elongate crystals that participate in creating the felty texture. They are pinkish brown in color and appear to be zoned from a paler brown in crystal interiors to a more intense pinkish brown on the margins. Opaque minerals range from equant to acicular. Where acicular, the opaque minerals form gridded networks. In this thin section, the equant morphology predominates over the acicular form. Larger equant opaque crystals, believed to be Cr spinels, are commonly associated with the altered olivines. Groundmass mesostasis is partially replaced throughout by yellow clay, red-brown Fe oxyhydroxides and carbonate. Vesicles (&lt;1%) are lined with yellow smectite and filled by calcite. A thin vein, lined by yellow ?smectite clay (1st o. interference colours) and filled by red-brown Fe oxyhydroxides and crystalline carbonate, crosses the section. This has a somewhat patchy halo of dark dusty looking altered groundmass around it. The grain size is too small to allow identification of the mineral(s) but appearance suggests replacement by a clay mineral. The bottom right corner of the slide may appear to intersect a patch or halo of similar alteration. A similar Fe-OH + carbonate vein occurs in the lower right corner of the slide without any obvious halo. The top edge of the slide appears to be a vein-bounded surface with a different type of halo (upper = orange, middle = dark brown?) defined by an increase in the abundance of yellow clay and brown Fe-oxyhydroxides altering groundmass and elongate quench olivines.</p> |                   |

Plane-polarized: 62731161



Cross-polarized: 62731181



## Igneous Petrology

|                                      |                                |                                      |                       |
|--------------------------------------|--------------------------------|--------------------------------------|-----------------------|
| <b>Lithology:</b>                    | sparsely olivine phyric basalt | <b>Rock texture:</b>                 | holocrystalline       |
| <b>Style of emplacement:</b>         | pillow lava flow               | <b>Groundmass grain size (avg.):</b> | microcrystalline      |
| <b>Major groundmass texture:</b>     | intersertal                    | <b>Minor groundmass Texture:</b>     | dendritic or skeletal |
| <b>Sample domain name (if &gt;1)</b> | 1                              | <b>Domain relative abundance (%)</b> | 100                   |

THIN SECTION LABEL ID: **390-U1556B-28R-2-W 33/35-TSB-TS31**

Thin section no.:

Observer: PDK, EC

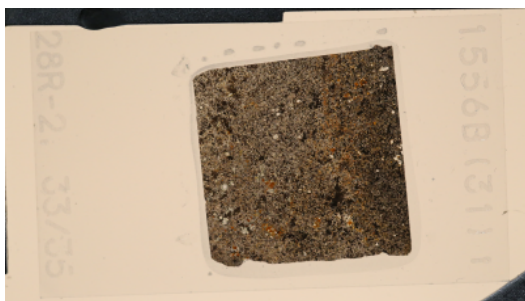
Piece no.:

Thin section thickness: standard

Unit/subunit: 7B

Thin section summary: Olivine basalt: [NOTE: the sample numbers for this sample and 390-U1556B-28R-2 42/44 are reversed on the thin sections. These are two samples from the same pillow. The sample at 33/35 cm is closer to the chilled margin than the one at 42/44 cm. This description is for the sample at 42/44 cm, i.e. closer to the pillow interior, even though the slide says 33/35]. It is an olivine basalt with euhedral, equant olivine phenocrysts that are almost 100% replaced though rare crystals of fresh olivine survive. Some olivine phenocrysts contain inclusions of small, equant Cr spinels, and a few show evidence for partial resorption. Groundmass plagioclase is acicular to tabular, some with skeletal extensions. The crystals are oriented randomly in general, but some cluster to form radiating starburst or bowtie structures. The plagioclase appears to be largely unaltered. Groundmass olivines are typically equant and euhedral; they are replaced in a style similar to that of the phenocrysts. On a thin edge, it's possible to see that groundmass clinopyroxene forms acicular crystals, similar to the plagioclase. The mesostasis in between plag and cpx is cryptocrystalline and appears 'dusty' brown. Opaque minerals occur as abundant, minute, equant crystals in the mesostasis. Vesicles (<1%) are round and filled with pale brown saponite (very pale brown in PPL, low interference colors in XPL) or else lined by saponite and filled by calcite. Two styles of alteration are apparent across the section, consisting mainly of replacement by saponite or Fe oxyhydroxide, respectively. These often are often superimposed on one another. The saponite is pale brown with fairly low interference colours (<1st order reds). It can be seen replacing olivine phenocrysts, as patches replacing mesostasis and filling or lining vesicles. It appears to occur fairly evenly across the slide. Fe oxyhydroxides are associated with (and likely form a compositional spectrum with) yellow and orange clays (typically low 1st order int. colours). These partially to completely replace olivine (i.e. forming iddingsite) across the slide and in places appear to overgrow saponite alteration. Yellow to orange-red clays are abundant as vesicle fill/linings and replacing groundmass (likely mostly groundmass olivine). This alteration is most pronounced in a broad band across the slide which appears to represent a halo front. Saponite by contrast is most abundant/least overprinted furthest from this front, along the lowermost edge of the slide. The groundmass is notably dark throughout this sample and particularly so at the topmost edge. This is likely, at least partially, to be an alteration effect, most likely reflecting clays and/or Fe oxyhydroxides replacing cryptocrystalline mesostasis.

Plane-polarized: 62731221



Cross-polarized: 62731201



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-28R-2-W 42/44-TSB-TS32**

Thin section no.:

Observer: PDK, EC

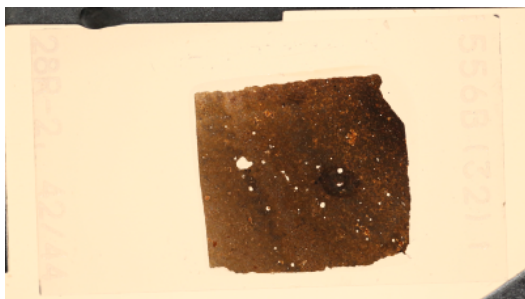
Piece no.:

Thin section thickness: standard

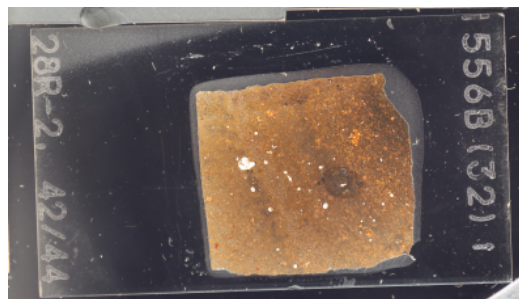
Unit/subunit: 7B

Thin section summary: Olivine basalt: [NOTE: the sample numbers for this sample and 390-U1556B-28R-2 42/44 are reversed on the thin sections. These are two samples from the same pillow. The sample at 33/35 cm is closer to the chilled margin than the one at 42/44 cm. This description is for the sample at 33/35 cm, i.e. closer to the pillow chilled margin]. It is an olivine basalt with euhedral, equant olivine phenocrysts that are 100% replaced by iddingsite and carbonate. Some olivine phenocrysts contain inclusions of small, equant Cr spinels. Groundmass plagioclase is acicular and skeletal and arranged in starburst or bowtie structures. The plagioclase appears to be largely unaltered, but it's difficult to tell at such small crystal sizes. In areas where the plagioclase crystals are smallest (i.e. the most rapid cooling), the groundmass around the plagioclase is a dark reddish / orange brown throughout, suggesting extensive replacement of any quench clinopyroxene, olivine and/or mesostasis by smectite and/or Fe oxyhydroxides. In areas where the plagioclase crystals are larger (i.e. slightly slower cooling), it appears that the orange-brown Fe oxyhydroxide replacement is targeting the olivine, which forms acicular, skeletal crystals that are intergrown with the plagioclase. The mesostasis in between is brown and cryptocrystalline (probably cpx quench growth). Locally, small interstitial patches are replaced by a golden yellow cryptocrystalline clay and, elsewhere, by a light brown mixture of carbonate and ?smectite clay. Minute opaque minerals are peppered throughout the mesostasis. Vesicles (<1%) are round and mostly lined with pale brown saponite or rarely zeolite and filled by carbonate. A few are filled by a slightly chaotic intergrowth of carbonate, dusty clays and granules of red-brown Fe oxyhydroxides. Large, vuggy style vesicles are filled with bladed calcite. Around many vesicles the groundmass is altered to a very dark nearly opaque brown colour.

Plane-polarized: 62731241



Cross-polarized: 62731261



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-28R-3-W 49/52-TSB-TS33**

Thin section no.:

Observer: PDK, EC

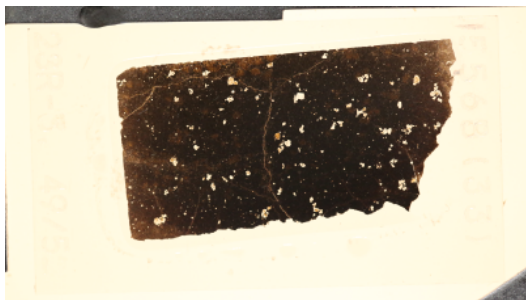
Piece no.:

Thin section thickness: standard

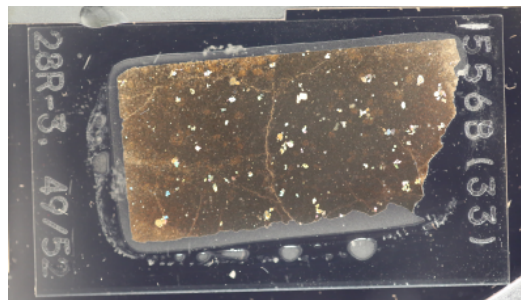
Unit/subunit: 8

Thin section summary: Olivine basalt: This is a cryptocrystalline (plumose quench textured) zone from a pillow lava. It is sparsely olivine phryic with euhedral equant olivines that are slightly altered to yellow-brown iddingsite/smectite. Some of the olivines are partially resorbed, and many contain small, equant crystals of Cr spinel. The olivines tend to form glomerocrystic clusters. Groundmass plagioclase occurs as acicular to skeletal crystals that form the cores of the plumose quench textures that dominate the groundmass. The feldspar appears to be relatively unaltered, but it is impossible to tell for such small crystal sizes. The plumose quench textures that dominate the groundmass are too fine grained to identify the mineralogy unambiguously. However, alteration of the groundmass, which is extensive, tends to target the ferromagnesian mineral(s), at least one of which forms acicular crystals similar to the plagioclase. These are 100% replaced by orange brown to dark red-brown Fe oxyhydroxides + clays. There are plumose areas that are paler brown in color, and these may be areas that are dominated by plagioclase quench crystals. Some interstitial areas are replaced by golden yellow to orange clay (low 1st o. int. colours, likely mixed smectite + minor Fe oxyhydroxides) mostly as a halo to a thin vein filled with the same mineral running along the left hand edge of the slide. The rock is moderately vesicular, with small (0.2 mm) round vesicles, most now filled by light brown saponite (commonly with a thin rim of zeolite), zeolites and/or carbonate. Some very thin veins, filled with zeolite + minor carbonate and opaque Fe oxyhydroxides cut across the section.

Plane-polarized: 62731301



Cross-polarized: 62731281



## Igneous Petrology

Lithology: sparsely olivine phryic basalt

Rock texture:

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-29R-3-W 67/69-TSB-TS35**

Thin section no.:

Observer: PDK, EC

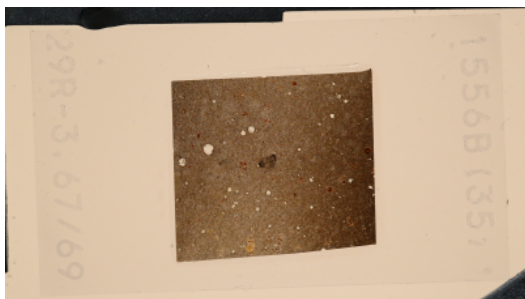
Piece no.:

Thin section thickness: standard

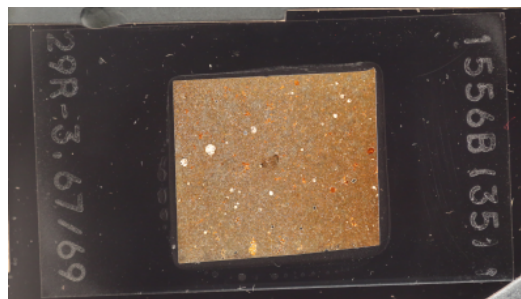
Unit/subunit: 8

Thin section summary: Olivine basalt: This is a sparsely phyric olivine basalt with euhedral, equant olivine phenocrysts that are 100% replaced by iddingsite with subordinate saponite/yellow smectite and carbonate. Phenocrysts are typically crosscut by fibrous veins of clay and the resulting domains altered to red-brown iddingsite or, more rarely, carbonate. The order of crystallisation is unclear in this slide. They tend to occur in glomerocrystic clusters and some contain inclusions of small, equant Cr spinels. Groundmass plagioclase is acicular and skeletal and commonly arranged in starburst or bowtie structures. The plagioclase appears to be largely unaltered, but it's difficult to tell at such small crystal sizes. Groundmass olivine, which also forms small equant crystals, appears to be altered in the same style as the phenocrysts. Cryptocrystalline quench growth in between plagioclase crystals is partially altered to reddish brown Fe oxyhydroxide + smectite (?). It is unclear whether this replacement is after cpx, olivine, glass or some combination of these phases. The groundmass is at least 50% altered. There is a broad gradient in the intensity of this alteration, increasing towards the top of the slide but without any obvious change in the minerals replacing or filling larger features (phenocrysts, vesicles). Minute opaque minerals are peppered throughout the mesostasis. Vesicles (<1%) are round, lined with pale brown radially fibrous saponite and filled with crystalline carbonate, sometimes brownish likely due to included clays.

Plane-polarized: 62733991



Cross-polarized: 62734011



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-30R-2-W 73/75-TSB-TS36**

Thin section no.:

Observer: PDK, EC

Piece no.:

Thin section thickness: standard

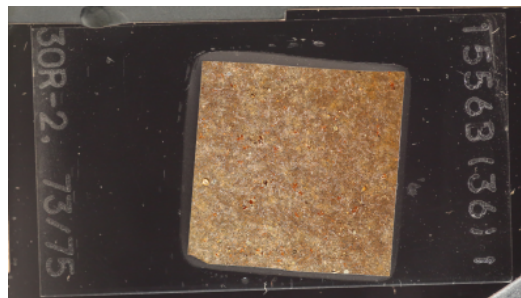
Unit/subunit: 8

Thin section summary: Olivine basalt: This is a sparsely phyric olivine basalt with euhedral, equant olivine phenocrysts that are 100% replaced by iddingsite / Fe-oxyhydroxides / smectite, plus some calcite. Groundmass plagioclase is acicular and skeletal, some with elongate skeletal extension on the ends of already acicular crystals, elsewhere forming box structures. The acicular crystals are commonly arranged in bowtie or sheaf structures. The plagioclase appears to be largely unaltered, but it's difficult to tell at such small crystal sizes. A ferromagnesian mineral also forms acicular, skeletal crystals in the groundmass; these are 100% replaced by Fe-oxyhydroxides, so presumably the phase is olivine. Cryptocrystalline quench growth in between plagioclase crystals is brown in color and too fine grained to identify. The groundmass is more than 50% altered to smectite clays and Fe oxyhydroxides. Minute opaque minerals are peppered throughout the mesostasis. Vesicles (<1%) are round, mostly filled with pale brown saponite or else lined with saponite/yellow clay and filled by bladed carbonate which appears to contain inclusions of the clay. There are broad variations in the alteration seen across the slide. In areas with the largest radiating sheaves of plagioclase crystals elongate quench olivines are typically altered to deep red-brown iddingsite and the groundmass mesostasis appears quite dark. Between these patches the elongate olivines are altered mainly to orange-yellow clay (perhaps a more smectite rich variant of a similar mixture of minerals to iddingsite). Very pale brown to yellow ?saponite appears to be present in the groundmass replacing mesostasis across the section and in the least altered parts of the section appears to be the phase replacing groundmass olivine. There is some evidence that brighter yellow-orange clays may result from oxidation/further alteration of these pale brown ?saponite clays. They occur in very similar settings (replacing olivine and groundmass; rimming vesicles) often in adjacent patches but rarely as coexisting minerals. The relationships seen may have arisen via pervasive saponite alteration followed by a more oxidative overprint radiating out from more coarsely crystalline domains (zones of nucleation or fluid ingress or both?). However the relative order is quite poorly constrained and could be the other way around.

Plane-polarized: 62734051



Cross-polarized: 62734031



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: massive lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-31R-4-W 71/73-TSB-TS37**

Thin section no.:

Observer: PDK, EC

Piece no.:

Thin section thickness: standard

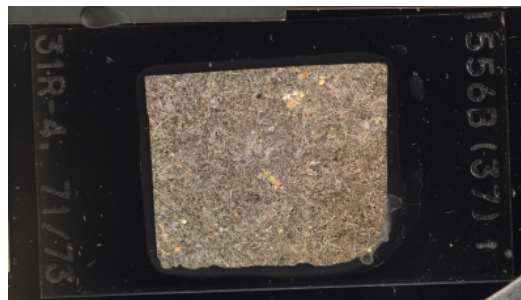
Unit/subunit: 8

Thin section summary: Olivine basalt: This is a sparsely olivine phyric basalt from a thick pillow interior. The macroscopic appearance of the core, i.e. dark gray and homogeneous, lacking the obvious oxidation of the olivine phenocrysts observed in most other samples higher in the hole, suggested a relatively fresh rock. Compared to some of the basalts higher up, this rock is, indeed, less altered. Euhedral, equant olivine phenocrysts are ~30% replaced by a pale brown mineral along cracks and fractures, with a texture similar to that of serpentine mesh texture. This pale brown mineral has optical properties mostly consistent with minerals described as saponite in other samples (i.e. low relief, typically cryptocrystalline or fibrous/radial habit, <1st o. red int. colours). However, in places this mineral or a very similar associated mineral has significantly higher interference colors (<2nd. order green). There is no obvious change in refractive index or colour so this is likely to be a closely related mineral (or even the same mineral growing in a different orientation) - possibly a mix of saponite with an illite or talc component? The olivine phenocrysts contain equant Cr spinels. Groundmass plagioclase is acicular to tabular, with skeletal extensions and box structures. They appear to be largely unaltered. Pinkish brown clinopyroxene forms fine acicular crystals and needles intergrown with the plagioclase. Groundmass olivines and mesostasis are replaced by the same pale brown ?saponite. Minute equant opaque minerals are peppered throughout the groundmass. Vesicles (<1%) are round and filled by light brown saponite (with more typical birefringence) or carbonate.

Plane-polarized: 62734071



Cross-polarized: 62734091



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

**THIN SECTION LABEL ID: 390-U1556B-32R-1-W 32/34-TSB-TS38**

Thin section no.:

Observer: PDK, EC

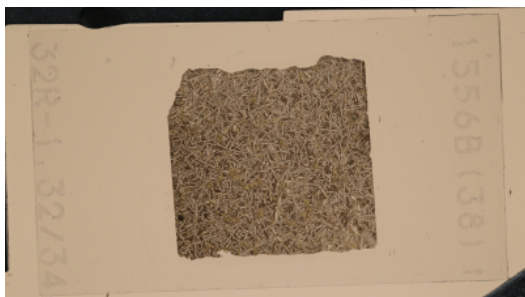
Piece no.:

Thin section thickness: standard

Unit/subunit: 8

Thin section summary: Olivine basalt: This is a moderately olivine phyric basalt from a thick pillow interior. The macroscopic appearance of the core, i.e. dark gray and homogeneous, lacking the obvious oxidation of the olivine phenocrysts observed in most other samples higher in the hole, suggested a relatively fresh rock. Compared to some of the basalts higher up, this rock is, indeed, less altered and has very similar alteration features to 31R4 (TS37). Euhedral, equant olivine phenocrysts are 100% replaced by a pale greenish brown mineral very similar in appearance to saponite but with higher birefringence (<2nd o. red/pink;  $d < 0.035$ ) than most examples seen in these rock - possibly a mix of saponite and talc or a higher birefringence illite. The olivine phenocrysts contain equant Cr spinels. Groundmass plagioclase is acicular to tabular, with skeletal extensions and box structures. They appear to be largely unaltered. Clinopyroxene forms elongate crystals intergrown with the plagioclase. They are pleochroic in shades of pinkish brown, to pale brown to violet. The clinopyroxenes appear to be largely unaltered. Groundmass olivines and mesostasis are replaced by the pale brown mineral that replaces the olivine. Minute equant opaque minerals are peppered throughout the groundmass. Vesicles (<1%) are round and filled by the same mineral replacing the olivine. Adjacent to some vesicles are circular areas of groundmass that have radiating acicular opaque minerals; origin and significance unknown.

Plane-polarized: 62748691



Cross-polarized: 62748671

**Igneous Petrology**

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): microcrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-33R-3-W 91/94-TSB-TS39**

Thin section no.:

Observer: PDK, EC

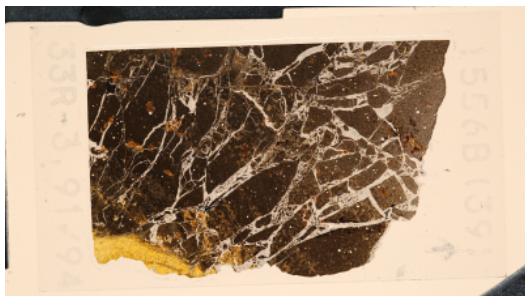
Piece no.:

Thin section thickness: standard

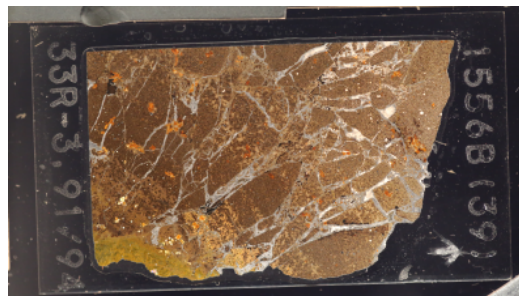
Unit/subunit: 9

Thin section summary: Olivine basalt crosscut by veins: This is an example of a chilled pillow margin that has been heavily dissected by crosscutting veins filled predominantly by zeolites. The textures range from partially palagonitized glass, to variolitic, then coalesced varioles, to finally cryptocrystalline plumose quench textures, presumably composed of intergrown plag and cpx. The rock is olivine phyric and there are unaltered to slightly altered olivines within the glassy and variolitic zones of the chilled margin. Alteration of olivine increases significantly toward the pillow interior, with those in the cryptocrystalline quench textured areas being 100% altered to red brown iddingsite with minor carbonate. The olivines are euhedral and occur in glomerocrystic clusters. Some olivines contain small, equant Cr spinels (?). Plagioclase microlites form the cores of most plumose quench structures. Interstitial areas between the 'plumes' in the cryptocrystalline zone are replaced by a dark reddish brown Fe oxyhydroxides + clays. The veins are filled by spherulitic clusters or bladed radial fans of zeolite in the glassy margin, but in the cryptocrystalline interior, the cores of the veins are discontinuously filled by a dusty calcite, which overgrows the zeolite fans lining the vein walls. This transition from zeolite to carbonate fill, at or near the edge of the cryptocrystalline margin, has been observed in numerous veins during logging. Clear cross-cutting relationship between the veins and alteration features in the basalt were not observed. The rock is sparsely vesicular, with small round vesicles that are filled, predominantly by zeolites, clays and possibly chalcedony in the glassy margin, while a proportion remain unfilled with just a thin rim of zeolite or clay.

Plane-polarized: 62749691



Cross-polarized: 62749711



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture:

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: spherulitic

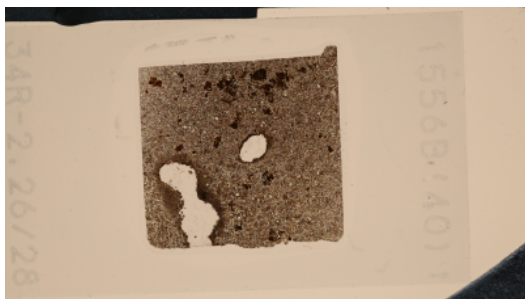
Minor groundmass Texture: glass

Sample domain name (if &gt; 1) 1

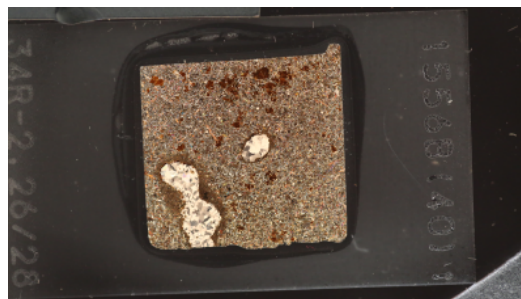
Domain relative abundance (%) 80

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| THIN SECTION LABEL ID:  | <b>390-U1556B-34R-2-W 26/28-TSB-TS40</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Thin section no.: |
| Observer:               | PDK, EC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Piece no.:        |
| Thin section thickness: | standard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Unit/subunit: 10  |
| Thin section summary:   | <p>Olivine basalt with large calcite-filled vug: This is a moderately altered moderately olivine phyric basalt. Euhedral, equant olivine phenocrysts are 100% replaced by dark reddish brown iddingsite. This can be seen in several examples to overgrow and earlier phase of thin pale green-brown saponite alteration forming sets of polygonal veins across olivine. Groundmass plagioclase is tabular to acicular, exhibiting typical polysynthetic twinning when large enough, but many are 'hollow' as a result of skeletal growth. The plagioclase appears to be relatively unaltered. Groundmass clinopyroxene is elongate to tabular and intensely colored. It is pleochroic in a rosy brown to pale pinkish brown to violet. It is largely unaltered. Groundmass opaque minerals occupy interstitial areas. They range from equant to acicular. Adjacent to the large vug, the opaque minerals are predominantly acicular, suggesting there may be a connection between this morphology and the local abundance of volatiles. Pale green to yellowish brown saponite is abundant replacing groundmass olivine and mesostasis, commonly associated with carbonate and undergoing the same replacement by iddingsite/Fe oxyhydroxides as seen in phenocrysts. Yellow-brown Fe oxyhydroxides are also common replacing mesostasis in irregular patches. The rock is sparsely vesicular, with small round vesicles totally filled by dusty to sparry calcite. The thin section captures a large vuggy vesicle, commonly observed in this lithologic unit. The vug is partially lined by feathery radial/botryoidal intergrowths of carbonate, red Fe oxyhydroxides and dusty clays. These are overgrown by a thin layer of dark reddish brown Fe oxyhydroxide and the vug is then filled by sparry carbonate. Around this vug a thin halo has developed in which groundmass is abundantly altered to darker red- to yellow-brown Fe oxyhydroxides, likely with smectite clays.</p> |                   |

Plane-polarized: 62775401



Cross-polarized: 62775381



## Igneous Petrology

|                                      |                                  |                                      |                       |
|--------------------------------------|----------------------------------|--------------------------------------|-----------------------|
| <b>Lithology:</b>                    | moderately olivine phyric basalt | <b>Rock texture:</b>                 | holocrystalline       |
| <b>Style of emplacement:</b>         | pillow lava flow                 | <b>Groundmass grain size (avg.):</b> | microcrystalline      |
| <b>Major groundmass texture:</b>     | intergranular                    | <b>Minor groundmass Texture:</b>     | dendritic or skeletal |
| <b>Sample domain name (if &gt;1)</b> | 1                                | <b>Domain relative abundance (%)</b> | 90                    |

THIN SECTION LABEL ID: **390-U1556B-35R-3-W 123/125-TSB-TS41**

Thin section no.:

Observer: PDK, EC

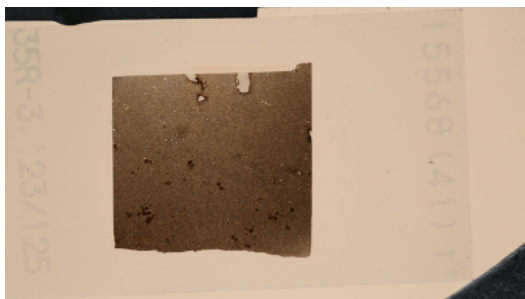
Piece no.:

Thin section thickness: standard

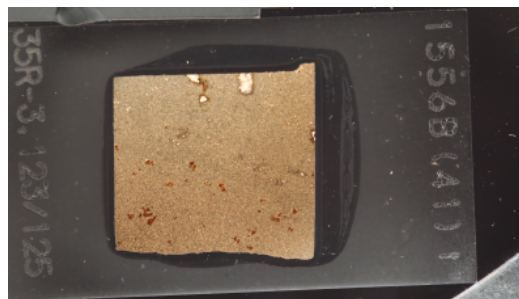
Unit/subunit: 11A

Thin section summary: Olivine basalt: This is a moderately phyric olivine basalt. Euhedral, equant olivine phenocrysts are 100% altered to a dark orange-brown iddingsite +/- calcite. There is a gradient or halo of alteration across the slide with calcite replacement of olivine phenocrysts restricted to the left hand side and complete replacement by iddingsite on the right. Groundmass plagioclase forms small, elongate / tabular crystals and appears to be relatively unaltered. Groundmass clinopyroxene is elongate to tabular, commonly crystallizing in radiating starburst structures. These are pale pinkish brown in color and appear to be largely unaltered. Groundmass opaque minerals occupy interstitial areas. They range from equant to acicular, the latter forming gridded networks. Groundmass olivine and mesostasis are pervasively replaced by yellowish brown clay + Fe oxyhydroxides and rare patches of carbonate. The thin section contains several large vuggy-style vesicles that are common in these rocks. The vuggy vesicles are lined by dark orange brown to opaque Fe-oxyhydroxide and filled by inclusion-filled sparry calcite. There are thin alteration halos around many of the vesicles in the section, characterised by relatively intense groundmass replacement by orange-brown Fe oxyhydroxides. Smaller vesicles, irregular in shape, are also filled by the inclusions-filled calcite. Smaller, round vesicles are lined by clay (?) and unfilled.

Plane-polarized: 62775421



Cross-polarized: 62775441



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: intersertal

Minor groundmass Texture: dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-37R-2-W 26/28-TSB-TS42**

Thin section no.:

Observer: PDK, EC

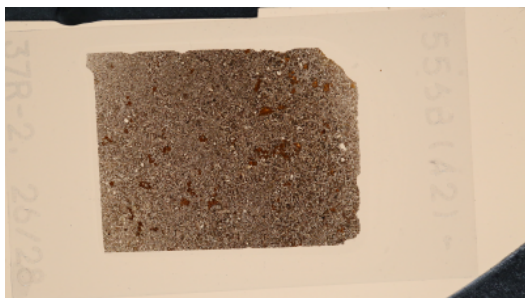
Piece no.:

Thin section thickness: standard

Unit/subunit: 11A

Thin section summary: Olivine basalt: This is a highly altered moderately olivine phyric basalt. Euhedral, equant olivine phenocrysts are 100% replaced by a dark reddish brown iddingsite; some also replaced partially by calcite. Groundmass plagioclase is acicular, exhibiting typical polysynthetic twinning when large enough, but many are 'hollow' as a result of skeletal growth. The plagioclase appears to be relatively unaltered. Groundmass clinopyroxene forms stubby tabular to elongate crystals that are intensely colored. It is pleochroic in a rosy brown to pale pinkish brown. It is largely unaltered. Groundmass opaque minerals occupy interstitial areas and occur as small equant to acicular crystals. Groundmass olivines are pervasively replaced by red-brown iddingsite and/or Fe-oxyhydroxides similar to the phenocrysts. Plumose quench textures are still discernably in some intersitital areas, suggesting that it is only partially altered, but much of the mesostasis is replaced by yellow-brown Fe-oxyhydroxide + clay, (similar to that replacing olivine), as well as abundant dark dusty greenish brown clays and small patches of carbonate. The rock is sparsely vesicular, with small round vesicles totally filled by calcite.

Plane-polarized: 62775501



Cross-polarized: 62775521



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture: holocrystalline

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): microcrystalline

Major groundmass texture: intergranular

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-38R-3-W 37/39-TSB-TS43**

Thin section no.:

Observer: PDK, EC

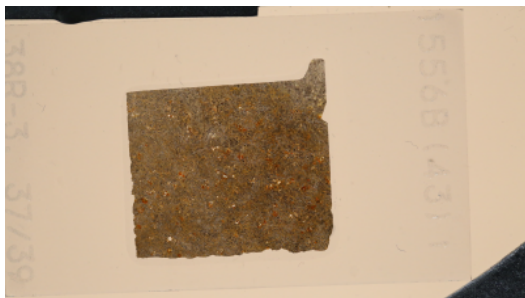
Piece no.:

Thin section thickness: standard

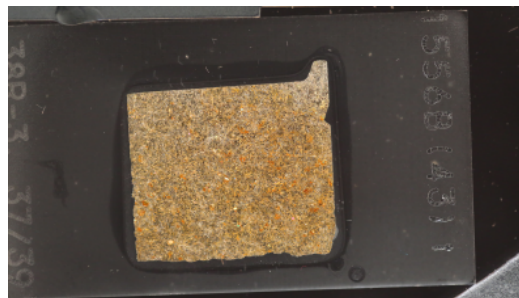
Unit/subunit: 12A

Thin section summary: (olivine) basalt: This is a very sparsely microphyric olivine basalt. The olivine microphenocrysts are euhedral, equant and only ~50% replaced by orange-brown smectite + some Fe-oxyhydroxides, the colour of which is paler and yellow than typical of iddingsite (lower Fe oxyhydroxide content?). In one area of the sample, olivine is partially replaced by what appears to be yellow-brown saponite together with (intergrown with?) a similar looking mineral with moderate interference colors (<2nd o. green) - possibly a mixture of saponite and talc or illite (as seen in TS37 and 38). This saponite/talc(?) appears to be partially overgrown and altered to iddingsite in most of its occurrences. Elongate groundmass quench olivine and mesostasis are altered to orange- to red-brown in the same style as most of the olivine phenocrysts. There is a broad halo or gradient of alteration across the slide with deep red colouration of altered olivines and overall abundance of Fe oxyhydroxide replacement increasing towards the top edge of the section. Groundmass plagioclase is acicular and skeletal and commonly arranged in fanning, starburst or bowtie structures. The plagioclase appears to be largely unaltered, but it's difficult to tell at such small crystal sizes. Groundmass clinopyroxene is too small to identify unambiguously, but small, stubby, pinkish brown crystals in between the plagioclase are assumed to be this mineral. Minute equant opaque minerals are peppered throughout the mesostasis. Very sparse vesicles (<<1%) are round, filled with smectite (?) (very pale yellow-brown in PPL, low interference colors in XPL).

Plane-polarized: 62775561



Cross-polarized: 62775541



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture:

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

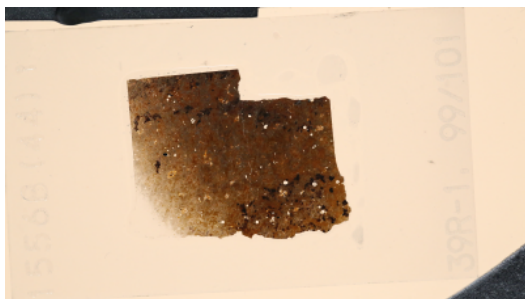
Minor groundmass Texture:

Sample domain name (if &gt;1) 1

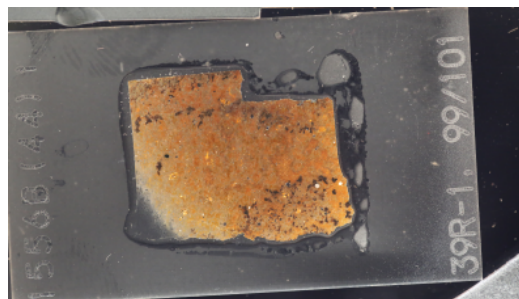
Domain relative abundance (%) 100

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                   |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| THIN SECTION LABEL ID:  | <b>390-U1556B-39R-1-W 99/101-TSB-TS44</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Thin section no.: |
| Observer:               | PDK, EC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Piece no.:        |
| Thin section thickness: | standard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Unit/subunit: 12A |
| Thin section summary:   | <p>(olivine) basalt: This is a highly to completed altered, very sparsely (&lt;&lt;1%) phyric olivine basalt with euhedral, equant olivine phenocrysts that are 100% replaced by iddingsite, plus some calcite. Groundmass plagioclase is acicular and skeletal. The acicular crystals are commonly arranged in bowtie or sheaf structures. The plagioclase appears to be totally altered, but it's difficult to tell at these small crystal sizes. A ferromagnesian mineral also forms acicular, skeletal crystals in the groundmass; these are 100% replaced by Fe-oxyhydroxides, so presumably the phase is olivine. On a thin edge, the olivine pseudomorphs adopt a skeletal habit that is reminiscent of spinifex textures. Cryptocrystalline quench growth in between plagioclase crystals is brown in color and too fine grained to identify. It appears to be highly, if not complete, altered to smectite / Fe oxyhydroxides. Minute opaque minerals are peppered throughout the mesostasis. The rock is sparsely vesicular (~1%). Vesicles have various fillings. Some of lined by zeolites (?) and unfilled. Some are filled by a dusty calcite (i.e. they are riddled with inclusions). At least one is filled by the very dark brown Fe mineral that forms the patchy replacement of groundmass. The groundmass is pervasively altered to orange brown Fe oxyhydroxide + smectite (?). Two thin veins filled with bright yellow clays and Fe oxyhydroxides cut the section. In irregular patches, mostly along these veins the groundmass alteration is overprinted by blotchy growths of a very dark brown to opaque Fe mineral, likely an Fe oxyhydroxide as well. This appears to form preferentially along acicular quench olivines, from which it radiates out to form irregular dendritic or ink blot-like forms. These appear to be the fuzzy dark halos seen along many thin veins during logging.</p> |                   |

Plane-polarized: 62775601



Cross-polarized: 62775581



## Igneous Petrology

|                                     |                                |                                      |                   |
|-------------------------------------|--------------------------------|--------------------------------------|-------------------|
| <b>Lithology:</b>                   | sparsely olivine phyric basalt | <b>Rock texture:</b>                 |                   |
| <b>Style of emplacement:</b>        | pillow lava flow               | <b>Groundmass grain size (avg.):</b> | cryptocrystalline |
| <b>Major groundmass texture:</b>    | dendritic or skeletal          | <b>Minor groundmass Texture:</b>     |                   |
| <b>Sample domain name (if&gt;1)</b> | 1                              | <b>Domain relative abundance (%)</b> | 100               |

THIN SECTION LABEL ID: **390-U1556B-41R-1-W 41/43-TSB-TS45**

Thin section no.:

Observer: PDK, EC

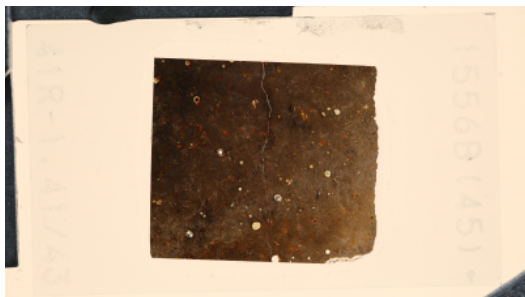
Piece no.:

Thin section thickness: standard

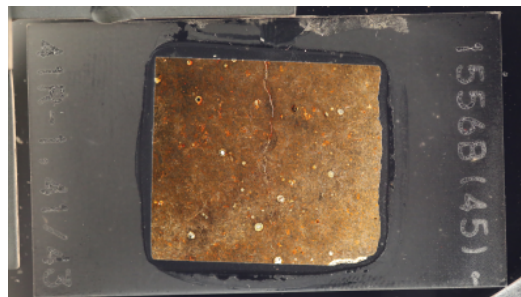
Unit/subunit: 12A

Thin section summary: (olivine) basalt: This is a highly to completely altered, very sparsely (<<1%) phyrlic olivine basalt pervasively altered to orange brown Fe oxyhydroxide +/- smectites. Euhedral, equant olivine microphenocrysts are 100% replaced by red-brown iddingsite. Groundmass plagioclase is acicular and skeletal. The acicular crystals are commonly arranged in bowtie or sheaf structures. The plagioclase appears to be partially altered (?), but it's difficult to tell at these small crystal sizes. A ferromagnesian mineral also forms acicular, skeletal crystals in the groundmass; these are 100% replaced by very dark red Fe-oxyhydroxides/smectite, so presumably the phase is olivine. Cryptocrystalline quench growth in between plagioclase crystals is more brown in color (less red) and too fine grained to identify. It appears to be at least partially, if not complete, altered as well. The alteration of the groundmass varies across the slide with grain size and grows both redder and darker as grain size decreases (presumably towards a chilled margin) with more pervasive replacement by what appears from the colour change to be principally be red to very dark brown Fe oxyhydroxides. Minute opaque minerals are peppered throughout the mesostasis. The rock is sparsely vesicular (~1%). Vesicles have various fillings. Some are filled by a pale brown to yellowish brown saponite, or lined by saponite and filled by carbonate; still others are filled by carbonate only. Most distinctive, however, are the vesicles filled by deep red - likely predominantly Fe oxyhydroxide + smectite - which appears to give the 'old red' pillow lavas their red color. These are more common in areas of more intense red-brown groundmass alteration and can in some examples be seen to partially overprint an earlier light brown saponite fill. A thin carbonate vein lined by yellow smectite + dark red Fe oxyhydroxides cuts the sample and has a dark halo characterised by blotchy replacement of groundmass olivine by opaque Fe oxyhydroxides.

Plane-polarized: 62779001



Cross-polarized: 62778981



## Igneous Petrology

Lithology: . aphyric basalt

Rock texture:

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-44R-3-W 92/94-TSB-TS46**

Thin section no.:

Observer: PDK, EC

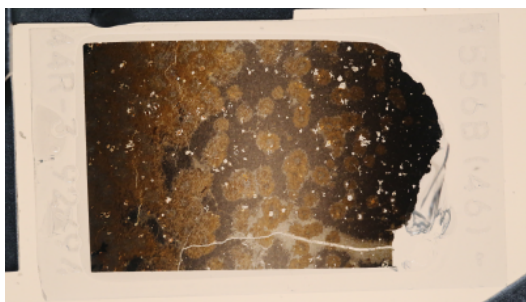
Piece no.:

Thin section thickness: standard

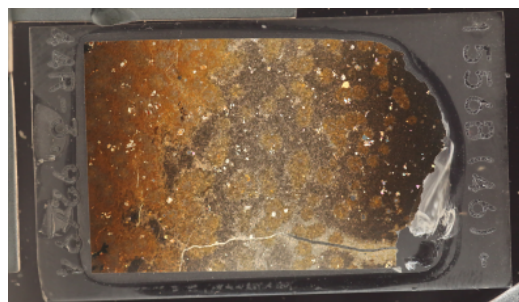
Unit/subunit: 12A

Thin section summary: (olivine) basalt: This is a moderately altered, moderately phyric olivine basalt across a mottled and reddened chilled margin showing "bulls-eye" patches of alteration. In altered areas (bulls-eye patches and lower part of slide), euhedral, equant olivine microphenocrysts are partially to totally replaced by pale brown saponite, red-brown iddingsite and carbonate. Outside of these areas, generally nearest to the glassy margin, the olivines are largely unaltered. The order of alteration is not clear from the textural relationship of saponite, carbonate and Fe oxyhydroxides where they co-exist with each generally restricted to discrete domains within the pseudomorphed olivine rather than overgrowing one another. The groundmass highly dendritic and the minerals are too fine grained to identify from thin section. Minute opaque minerals are peppered throughout the mesostasis. Far from the glassy margin, alteration of the dendritic mesostasis to orange brown Fe oxyhydroxide +/- smectite (?) occurs in circular patches with a concentric zonation of colours from greyish brown to deep red brown to orange-brown outwards. It is not possible to discern what minerals cause this variation. Moving away from the glassy margin (top of section) these circular patches become more numerous and appear to coalesce. Their occurrence alteration does not appear to be correlated with proximity to veins. Instead the patches appear to nucleate semi randomly typically with some heterogeneity such as a cluster of olivine quench crystals, phenocrysts or a vesicle at their centre. Between the patches the groundmass is markedly dark grey, possibly indicating some alteration to clays. Generally it is fairly fresh nearest the cryptocrystalline margin. At the bottom of the slide (furthest from the pillow margin) the groundmass is pervasively and intensely altered to red brown Fe oxyhydroxides and clays and much of the texture has been obliterated. The rock is sparsely vesicular (~1%). Vesicles have various fillings including zeolite, carbonate, pale brown to yellow saponite/yellow clay and red brown Fe oxyhydroxides. Zeolite only occurs in the chilled margin and carbonate is generally restricted to the interior (lower part of section), yellowish clays possibly representing a different mineral from the brownish saponite, are common into the transitional zone where bulls eyes are most common. Where successive layers fill a single vesicle the order is typically saponite/yellow clay -> Fe oxyhydroxides +/- carbonate -> carbonate/zeolite. Carbonate and zeolite never co-exist. There is a hybrid vein cutting the section which is filled by zeolite in the cryptocrystalline margin and transitions abruptly to carbonate fill as it crosses out of the chilled margin into the more pervasively altered interior. There are also several thin veins filled by a mixture of smectites, carbonate and opaque Fe oxyhydroxides.

Plane-polarized: 62779101



Cross-polarized: 62779121



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture:

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-45R-2-W 26/28-TSB-TS47**

Thin section no.:

Observer: PDK, EC

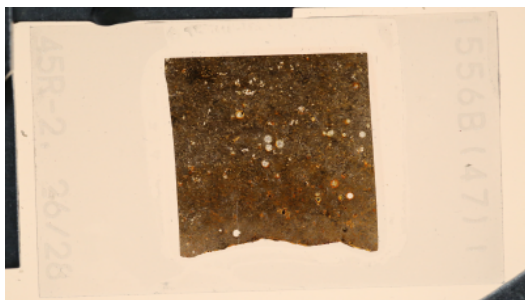
Piece no.:

Thin section thickness: standard

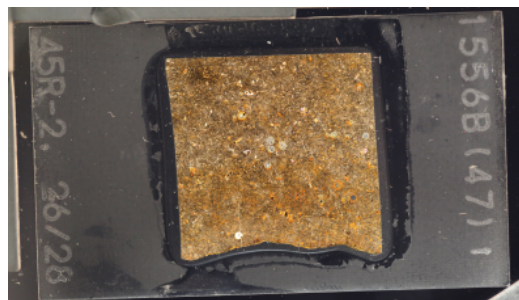
Unit/subunit: 12A

Thin section summary: Olivine basalt: This is a moderately altered, moderately phyric olivine basalt. Alteration is variable in character but fairly pervasive across the slide with replacement by both saponite and Fe oxyhydroxides abundant. Alteration appears to be zoned within the halo of an orange clay (likely smectite + Fe oxyhydroxide) vein which forms the left hand edge of the section. Surprisingly, given the level of overall alteration, there are euhedral, equant olivine microphenocrysts that are only partially altered and even unaltered. More altered olivine occurs nearest to the vein and is replaced by iddingsite, bright yellow clays, some opaque Fe oxyhydroxides and minor carbonate. Groundmass plagioclase is acicular and skeletal. The acicular crystals are commonly arranged in bowtie or sheaf structures. The plagioclase appears to be unaltered, but it's difficult to tell at these small crystal sizes. A ferromagnesian mineral also forms acicular, skeletal crystals in the groundmass; these are 100% replaced by very dark red Fe-oxyhydroxides/smectite, indicating the phase is likely olivine. The abundance (and size?) of these acicular quench olivines decreases from left to right across the slide, implying some variation in cooling rate (chilled margin out of section to left?) The replacement mineralogy/colour also varies from left to right from deep red-brown to yellower colours, possibly indicating lower relative Fe oxyhydroxide content and a greater proportion of clays. Cryptocrystalline quench growth in between plagioclase crystals ranges from a greyish brown colour to a orange/red-brown where alteration is highest. The dark greyish colour of the alteration in many areas suggests replacement by saponite or another clay. The alternation of these greyer areas with redder groundmass alteration varies as a function of position within the overall vein halos, as well as likely reflecting variations in the proportion of groundmass quench phases. Minute opaque minerals are peppered throughout the mesostasis. The rock is sparsely vesicular (~1%). The vesicle fills most clearly reflect zonation of alteration in the halo from left to right. Close to the vein they are typically rimmed by orange to red Fe oxyhydroxides-rich clay mixtures and mostly filled by bright yellow cryptocrystalline clay +/- opaque oxyhydroxides or, less commonly, carbonate. A few vesicles have grains of a highly reflective opaque mineral (grey/white in reflect light: magnetite, marcasite?) Further away from the vein pale brown (slightly yellow) saponite is the predominant vesicle fill, mostly overgrowing a partial rim of the same orange-red Fe oxyhydroxides-rich clay.

Plane-polarized: 62779081



Cross-polarized: 62779061



## Igneous Petrology

Lithology: moderately olivine phyric basalt

Rock texture:

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-46R-1-W 7/9-TSB-TS48**

Thin section no.:

Observer: PDK, EC

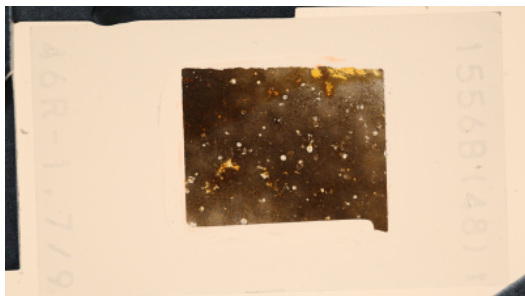
Piece no.:

Thin section thickness: standard

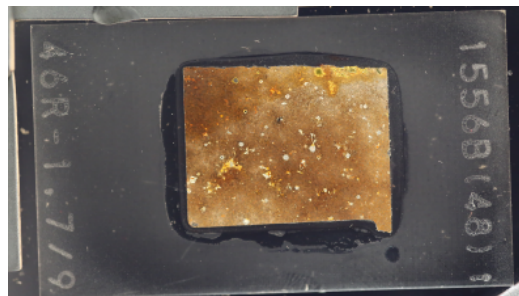
Unit/subunit: 12B

Thin section summary: Olivine basalt: This is a highly altered, very sparsely olivine (micro)phyric basalt. Alteration of the rock to orange brown Fe oxyhydroxide and pale brown saponite is pervasive with patches of more intense alteration and an orange halo at one edge of the slide. Euhedral, equant olivine microphenocrysts are totally altered to a pale brown saponite as well as yellow-orange clays and iddingsite, the latter often defining a skeletal framework of the pseudomorphed grain. Groundmass plagioclase is acicular and skeletal. The acicular crystals are commonly arranged in bowtie or sheaf structures. The plagioclase appears to be unaltered, but it's difficult to tell at these small crystal sizes. A ferromagnesian mineral also forms acicular, skeletal crystals in the groundmass; these are 100% replaced by very dark red Fe-oxyhydroxides/smectite, so presumably the phase is olivine. Cryptocrystalline quench growth in between plagioclase crystals ranges from dark grey brown in color in areas where less altered to a orange / red brown where alteration is highest. These colours likely correspond, respectively, to greater proportions of saponite and Fe oxyhydroxide, however, they are too fine grained to identify the mineralogy definitively. Minute opaque minerals are peppered throughout the mesostasis. There is a marked orange halo developed along the left edge of the slide, with abundant bright yellow clay filling vesicles and possibly replacing olivine (/replacing another secondary mineral?) in one patch. Separately, irregular, semi-connected patches of dark grey background alteration occur across the slide. These mostly occur around and connect clusters of vesicles (pathways for fluid flow?) and show more intense alteration of groundmass mesostasis by dark grey ?saponite clay and Fe oxyhydroxides, obliterating much of the detail of the plumose quench texture. Like the orange halo, they also contain and appear to be associated with similar yellow-orange clay, though this is less clear than in the halo and usually occurs as a partial replacement of saponite in vesicles and pseudomorphed olivine (zones of fluid flow reused by saponitic and oxidizing alteration?). The rock is sparsely vesicular (~1%). Outside the orange halo, most vesicles and some irregular vugs are filled by pale brown saponite without linings, some with a core of carbonate nearer the orange halo (left hand side). Within the dark patches this saponite often shows partial oxidation/addition of Fe oxyhydroxides resulting in a gradient in colour towards more yellow/orange colours (often across a single vesicle). In the orange halo, vesicles are filled or rimmed by yellow clay (possibly an alteration product of saponite), opaque oxyhydroxides and dusty-looking inclusion-rich carbonate, with carbonate the latest forming phase. Rare examples are unfilled.

Plane-polarized: 62793641



Cross-polarized: 62793621



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture:

Style of emplacement: massive lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt; 1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-46R-1-W 80/82-TSB-TS51**

Thin section no.:

Observer: PDK, EC

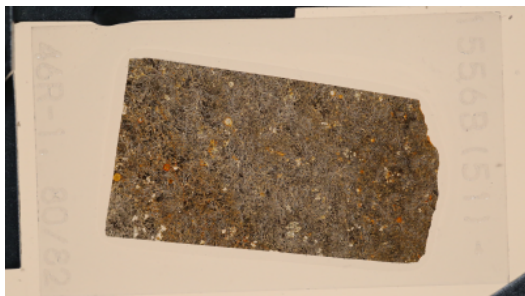
Piece no.:

Thin section thickness: standard

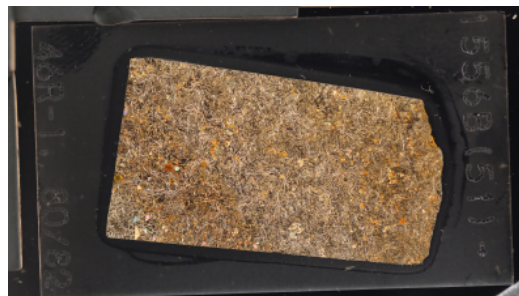
Unit/subunit: 12B

Thin section summary: Olivine basalt: This is a moderately altered, sparsely phyric olivine basalt. In general, alteration is relatively pervasive but patchy with (apparently independent) patches of both orange Fe oxyhydroxide (+/- clay) and pale yellowish saponite alteration. Overall extent of alteration which begs the question of how olivine has survived unaltered. Euhedral, equant olivine phenocrysts and microphenocrysts range from totally altered to entirely fresh. Larger olivine crystals contain Cr spinel inclusions. Olivine is replaced by pale yellowish saponite and a mineral of very similar appearance but with higher interference colours (possibly saponite - talc intergrowth?) This is variably overprinted by bright orange Fe oxyhydroxide + clay mixtures, which occur in irregular patches, possibly defining a broad halo at the top of the slide where there are remnant of a moderately thick orange Fe oxyhydroxide + clay vein. There appear to be spatially independent patches of the occurrence of both saponite and orange clay + Fe-OH (fresh + saponite, saponite only, saponite + orange, fresh + orange, all occur). Groundmass plagioclase is acicular and skeletal, forming some bowtie structures, but also more random orientations. Some are skeletal, forming open box structures. The acicular crystals are commonly arranged in bowtie or sheaf structures. The plagioclase appears to be unaltered, and some is large enough to discern polysynthetic twinning. Groundmass olivine and mesostasis are replaced similarly to the phenocrysts by saponite/?talc or golden yellow to brown smectite/ Fe oxyhydroxide following the overall patchiness in oxidative alteration in the samples as a whole. Plumose quench cpx seems to be unaltered, but difficult to tell at these small grain sizes. Minute equant opaque minerals are peppered throughout the mesostasis. The rock is sparsely vesicular (~1%). These are filled by a spectrum of clays ranging in colour from pale yellow saponite to deep red Fe-OH rich material following the same spatial pattern as olivine alteration. The colour often varies across a single vesicle suggesting later alteration of an original paler saponite-like fill. Some vesicles have cores of carbonate overgrowing the clays.

Plane-polarized: 62793741



Cross-polarized: 62793761



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture:

Style of emplacement: massive lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt; 1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-46R-3-W 53/55-TSB-TS50**

Thin section no.:

Observer: PDK, EC

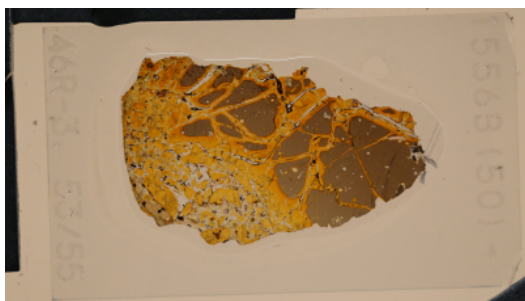
Piece no.:

Thin section thickness: standard

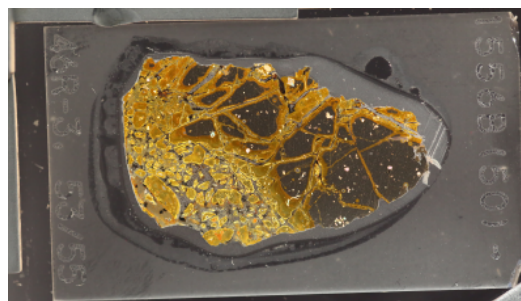
Unit/subunit: 12C

Thin section summary: Basaltic glass and palagonite: This is the glassy chilled margin of a basaltic pillow lava. It is partially palagonitized along cracks and fractures. The glass is a pale brown and the palagonite is a rich golden yellow-brown, mostly lined by a thin reddish brown to opaque layer of Fe oxyhydroxide on the edges of the palagonite. There are incipient spherulites in the glass (and palagonite) in part of the thin section. The glass contains euhedral microphenocrysts of olivine that range from unaltered to completely replaced by red-brown iddingsite. The glass is sparsely vesicular. The vesicles are either unfilled or lined by a thin coating of zeolite and unfilled. Where a zeolite coating is present there is incipient palagonitization of the glass surrounding the vesicles (suggesting the two may be coupled). There is a micritic sediment incursion in one area. The micrite has a 'dirty' / 'dusty' appearance to it, suggesting it is full of tiny clay (or palagonite) inclusions. Zeolites (low interference colors, radial growth habit) for a cement filling most of the areas between palagonite clasts.

Plane-polarized: 62793721



Cross-polarized: 62793701



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture:

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): glass

Major groundmass texture: glass

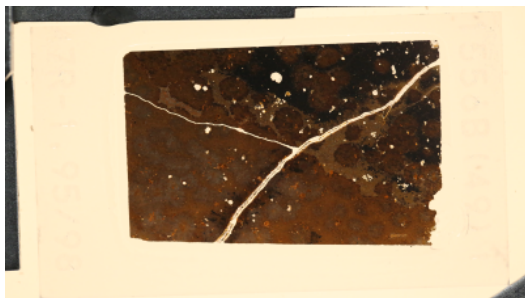
Minor groundmass Texture:

Sample domain name (if &gt;1) 1

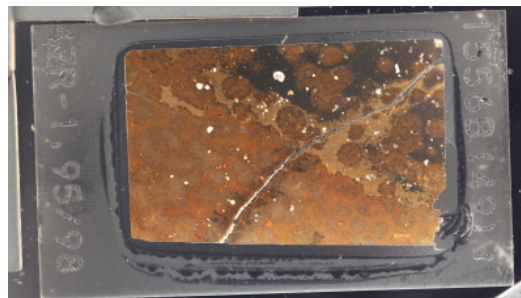
Domain relative abundance (%) 100

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                   |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| THIN SECTION LABEL ID:  | <b>390-U1556B-47R-1-W 95/98-TSB-TS49</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Thin section no.: |
| Observer:               | PDK, EC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Piece no.:        |
| Thin section thickness: | standard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Unit/subunit: 12C |
| Thin section summary:   | <p>Olivine basalt crosscut by vein: This is a highly to completed altered, very sparsely (&lt;&lt;1%) phyric olivine basalt which cuts the transition from blotchy grey chilled margin (with red "bulls eye" alteration) to the pervasively reddened interior of a pillow. Euhedral, equant olivine microphenocrysts range from 100% altered to iddingsite (+ opaque Fe oxyhydroxides + minor carbonate) to only slightly altered. The groundmass consists of cryptocrystalline quench textures and is too fine grained to identify primary mineralogy. The rock is sparsely vesicular (~1%) and the vesicles are filled by a variety of minerals. Most are lined by bright yellow-orange smectite +/- discontinuous splotches or granular accumulations of Fe oxyhydroxides, and filled by sparry calcite (often dusty looking with abundant opaque inclusions). A few are filled by low birefringence zeolites or by clear ?chalcedony (&lt;1st order white int. cols., colourless and clean looking). A hybrid vein cuts through the cryptocrystalline margin and transitions from zeolite to carbonate + yellow clay over about 5mm at the transition from blotchy cryptocrystalline margin to reddened interior (NB: piece split along vein during sawing of thin section billet and was epoxied back together). The bulls eye texture is defined by concentric layers of slightly different groundmass alteration. These are all broadly red-brown and seems to nucleate round sheaves of slightly coarse acicular plagioclase (+olivine?) quench crystals. The surrounding groundmass is altered to a much dark colour, possibly a result of more clay/saponite alteration or possibly reflecting opaque oxyhydroxides - unclear due fine grain size. Overall colour variations could be controlled by variation in quench mineralogy or simply sites of nucleation for alteration and degree/timing of alteration. The patchy alteration of the groundmass doesn't seem to correlate with the alteration of the olivine microphenocrysts which are pervasively replaced by red Fe oxyhydroxides/iddingsite. There is a light grey halo round the vein the cryptocrystalline portion of the slide but all that is visible is a change in colour and it is unclear what controls this mineralogically. In the pervasively reddened interior there is instead a blotchy/fuzzy dark brown halo consisting of opaque oxyhydroxides growing along elongate quench crystals.</p> |                   |

Plane-polarized: 62793661



Cross-polarized: 62793681



## Igneous Petrology

**Lithology:** sparsely olivine phyric basalt

**Style of emplacement:** pillow lava flow

**Major groundmass texture:** dendritic or skeletal

**Sample domain name (if >1)** 1

**Rock texture:**

**Groundmass grain size (avg.):** cryptocrystalline

**Minor groundmass Texture:**

**Domain relative abundance (%)** 85

THIN SECTION LABEL ID: **390-U1556B-50R-2-W 55/57-TSB-TS52**

Thin section no.:

Observer: PDK, EC

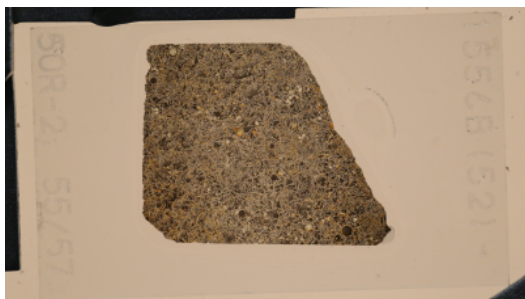
Piece no.:

Thin section thickness: standard

Unit/subunit: 12C

Thin section summary: Olivine basalt: This is a moderately altered, sparsely phyric olivine basalt. Euhedral, equant olivine phenocrysts and microphenocrysts range from totally altered to entirely fresh. Larger olivine crystals contain Cr spinel inclusions. Olivine altered to pale yellow ?saponite +/- minor carbonate and the saponite variably overprinted by oxidation/addition of red-brown Fe oxyhydroxides resulting in a spectrum of colours from pale yellow to deep orange-brown. The orange colouration does not seem to result from growth of a new mineral as textures such as radial fibres or growth laminae are unaffected by the change in colour, implying it is caused by only minor changes or results from staining of the original minerals by an amorphous Fe oxyhydroxide phase. The spatial pattern of the occurrence/intensity of orange/brown appears to define two halos paralleling the top and bottom edges of the section. Groundmass plagioclase is acicular and skeletal, forming some bowtie structures, but also occurring in more random orientations. Some are skeletal, forming open box structures. The plagioclase appears to be unaltered, and some crystals are large enough to discern polysynthetic twinning. Groundmass olivine and mesostasis are replaced by a spectrum of orange smectite to pale yellow saponite much like the phenocrysts and with a similar abundance within the halos. Plumose quench cpx seems to be unaltered, but difficult to tell at these small grain sizes. Minute equant opaque minerals are peppered throughout the mesostasis. The orange halos seem to coincide with darker grey plumose groundmass implying they may also have been zones of more intense clay (saponite?) alteration. The rock is sparsely vesicular (~1%). Vesicles are lined and filled by the same range of pale yellow to dark red smectite + clay mixtures seen throughout the slide. In some, clays are overgrown by carbonate. One rare vesicles has both a rim and core of carbonate with an intervening layer of orange clay. In general, alteration of the rock by an orange brown Fe oxyhydroxide +/- smectite is moderately pervasive--which begs the question of how olivine has survived unaltered.

Plane-polarized: 62793801



Cross-polarized: 62793781



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture:

Style of emplacement: pillow lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-51R-1-W 36/38-TSB-TS53**

Thin section no.:

Observer: PDK, EC

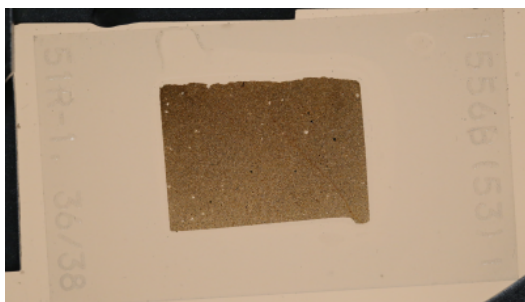
Piece no.:

Thin section thickness: standard

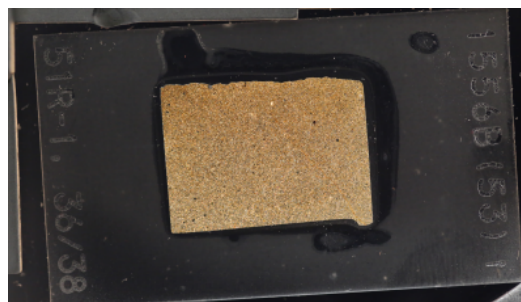
Unit/subunit: 12D

Thin section summary: Aphyric basalt: This is a moderately altered aphyric basalt. The groundmass consists of stubby, rectangular cpx and plagioclase, with cpx > plag in abundance. Interstitial mesostasis has been replaced by yellow-brown clays (likely smectite) + Fe oxyhydroxide. I assume that olivine was present in the groundmass, but obvious olivine pseudomorphs are not apparent, which would make the composition of this rock a bit odd. In detail the groundmass alteration can be divided into yellower patches and browner domains, the latter of which appear pseudomorphous after stubby equant crystals - these likely represent the altered olivine. Groundmass opaque minerals are abundant and occupy interstitial areas. Equant crystals predominate, but to acicular crystals that form gridded networks. The rock is sparsely vesicular, and the vesicles range from round to slightly irregular in outline. They are uniformly lined by a thin layer of the same yellow-brown clay + Fe oxyhydroxide which replaces much of the groundmass mesostasis, and are unfilled or filled by crystalline carbonate and/or, rarely, opaques. A thin yellow-brown smectite + Fe oxyhydroxide vein cuts the rock, eventually petering out around the middle of the slide. Overall the alteration is very homogeneous in this sample and lacks any obvious halos or patches.

Plane-polarized: 62793821



Cross-polarized: 62793841



## Igneous Petrology

Lithology: . aphyric basalt

Rock texture:

Style of emplacement: massive lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: felty

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-54R-1-W 63/66-TSB-TS54**

Thin section no.:

Observer: PDK, EC

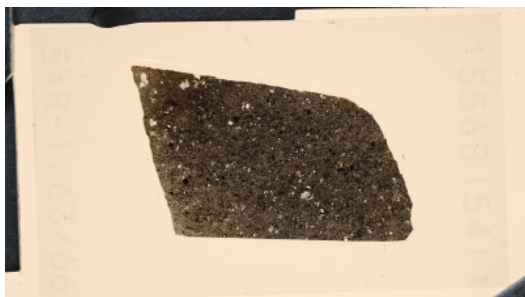
Piece no.:

Thin section thickness: standard

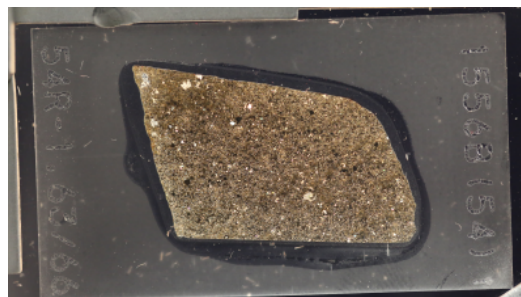
Unit/subunit: 12F

Thin section summary: Olivine basalt: This is a sparsely olivine microphyric basalt. The small euhedral equant olivines are relatively unaltered (i.e. ~50% altered throughout; some are entirely fresh). They occur in small glomerocystic clusters. They are replaced by pale brown saponite, possible intergrown with a higher birefringence mineral in some examples. One larger crystal is partly replaced by a green micaceous mineral with intermediate interference colors (celadonite/nontronite?). Groundmass plagioclase occurs as small, acicular crystals that form radiating clusters. The plagioclase is 'coated' or surrounded by a fibrous, brownish mineral, too fine grained to identify unambiguously but likely to be quench olivine (these have a similar appearance to low temperature actinolite). The mesostasis in between the plagioclase clusters is cryptocrystalline and too fine grained to identify any minerals. This mesostasis is markedly dark throughout the section (could be fresh and very fine grained or might reflect clay alteration). Opaque minerals occur as minute, equant crystals peppered throughout the groundmass. Irregularly shaped vesicles are commonly filled by calcite or by a succession of clay minerals. In the latter case a consistent sequence of very pale greenish-brown rim (much paler than rare bright green mineral replacing olivine) overgrown by brown ?saponite (or possibly saponite + Fe oxyhydroxides) grading to paler brown saponite cores.

Plane-polarized: 62798091



Cross-polarized: 62798071



## Igneous Petrology

Lithology: sparsely olivine phyric basalt

Rock texture:

Style of emplacement: massive lava flow

Groundmass grain size (avg.): cryptocrystalline

Major groundmass texture: dendritic or skeletal

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-55R-1-W 5/9-TSB-TS55**

Thin section no.:

Observer: PDK, EC

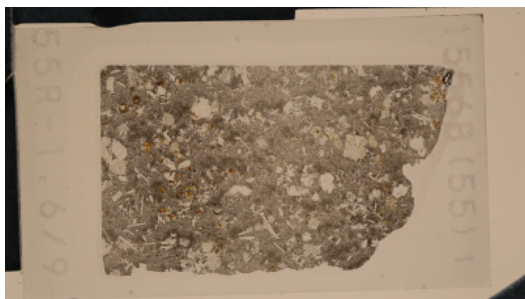
Piece no.:

Thin section thickness: standard

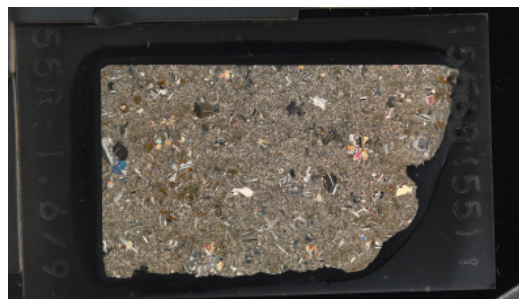
Unit/subunit: 13

Thin section summary: Plagioclase olivine pyroxene basalt: This is a highly plagioclase-olivine-pyroxene phyric basalt. The plagioclase ranges from large subequant crystals to much smaller tabular - elongate ones that show ubiquitous polysynthetic twinning. Larger plagioclase crystals commonly have sieve textures. Most crystals appear unzoned, but at least one large macrocryst shows subtle oscillatory zoning on the rims. Plagioclase is mostly fresh but commonly exhibits very thin veins of yellow-brown Fe oxyhydroxide along fractures. Euhedral olivine phenocrysts are 100% replaced, predominantly by pale brown saponite with subordinate reddish brown iddingsite, and calcite. Rarely, an apple green clay (int. cols. <1st o. red) occurs in association with saponite replacement of olivine. Clinopyroxene is present as large, pale brown to colorless crystals, but always in association with feldspar or feldspar plus olivine pseudomorphs in crystal clots. The textures suggests that these clusters are cognate inclusions. The groundmass exhibits a wide range of crystal habits from plumose quench textures to subophitic relationships between cpx and plagioclase. Groundmass opaque minerals are clustered in the interstitial areas between cpx plumose quench crystals. There is patchy replacement of groundmass by carbonate and saponite and of groundmass olivine by iddingsite, as well as small rare patches of a very pale green mineral generally associated with saponite. Vesicles typically rimmed or filled by pale brown clay (similar to the saponite elsewhere in the samples but cryptocrystalline and typically very low interference colours), commonly overgrown by carbonate with botryoidal habit and spherulitic growth textures. This is commonly patchily altered to brown Fe oxyhydroxides. There is a thin vein Fe oxyhydroxide lined carbonate vein cutting one corner of the sample.

Plane-polarized: 62798121



Cross-polarized: 62798141



## Igneous Petrology

Lithology:

highly plagioclase-olivine-augite  
phyric basalt

Rock texture:

Style of emplacement:

massive lava flow

Groundmass grain size (avg.):

microcrystalline

Major groundmass texture:

intergranular

Minor groundmass Texture:

dendritic or skeletal

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-55R-3-W 69/72-TSB-TS56**

Thin section no.:

Observer: PDK, EC

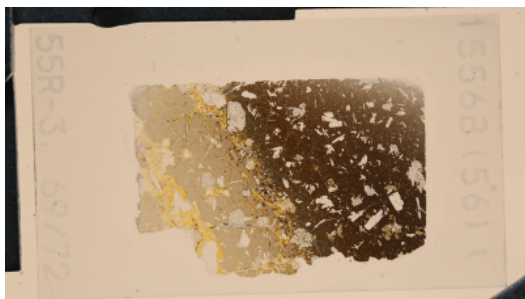
Piece no.:

Thin section thickness: standard

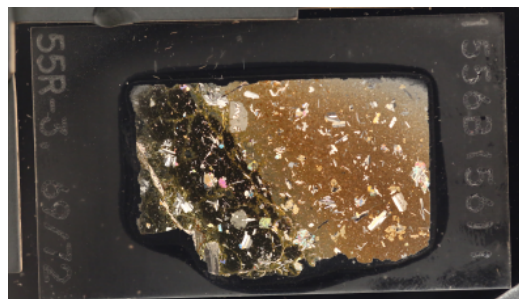
Unit/subunit: 13

Thin section summary: Plagioclase olivine pyroxene basalt: This is the chilled margin of the highly plagioclase-olivine-pyroxene basalts. The glass is pale brown and contains abundant phenocrysts. The glass is partially altered along cracks and fractures to a golden yellow palagonite and there is a calcite vein running across the top. The zone of spherulites + glass is abbreviated relative to the pillow basalts seen in earlier sections, and the spherulites are quite small. The zone of coalesced spherulites is also abbreviated and the texture rapidly turns into plumose quench structures. The groundmass in this zone is brown and the plumes are outlined by small equant oxide minerals. Plagioclase microlites with acicular skeletal extensions occur throughout. The phenocrysts consist of plagioclase, which predominantly forms large tabular crystals. Clinopyroxene occurs in autoliths / microgabbros along with plagioclase. One large euhedral cpx is observed to optically enclose small plagioclase laths. Euhedral olivines, now 100% altered, tend to occur separately from the plag + cpx crystal clots, but forms glomerocrystic clusters of its own. The olivine phenocrysts are 100% altered to radially fibrous clusters of pale brown saponite +/- red brown iddingsite which may form small patches or a skeletal outline of the pseudomorphed crystal. In the centre of the former olivines the saponite is quite dark. Small subequant patches of very similar saponite in the groundmass are likely olivine pseudomorphs. Irregularly shaped patches of calcite are presumably vesicle fillings. Sparse small round vesicles are filled with brown saponite showing, from rim to centre, a similar progression of colours, from pale to darker brown, as to the olivine pseudomorphs. Irregular vesicles are also filled by carbonate. Sparse voids in the palagonite and glassy margin are filled by radially bladed zeolites.

Plane-polarized: 62798181



Cross-polarized: 62798161



## Igneous Petrology

**Lithology:** highly plagioclase-olivine-augite  
phyric basalt

**Rock texture:**

**Style of emplacement:** massive lava flow

**Groundmass grain size (avg.):** cryptocrystalline

**Major groundmass texture:** glass

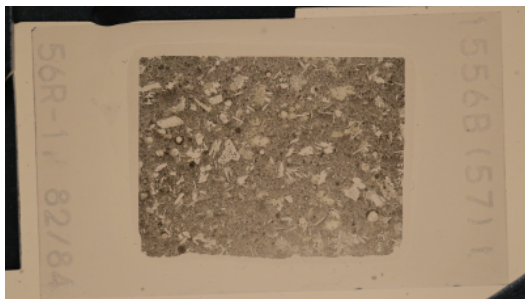
**Minor groundmass Texture:** dendritic or skeletal

**Sample domain name (if >1)** 1

**Domain relative abundance (%)** 100

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| THIN SECTION LABEL ID:  | <b>390-U1556B-56R-1-W 82/84-TSB-TS57</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Thin section no.: |
| Observer:               | PDK, EC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Piece no.:        |
| Thin section thickness: | standard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Unit/subunit: 13  |
| Thin section summary:   | <p>Plagioclase olivine pyroxene basalt: This is a highly plagioclase-olivine-pyroxene phyric basalt. The plagioclase ranges from large subequant crystals to much smaller tabular - elongate ones and shows ubiquitous polysynthetic twinning. Some larger plagioclase crystals have sieve textures. Most smaller tabular crystals appear unzoned, but larger, more equant crystals exhibit more complex histories, including subtle concentric or oscillatory zoning on the rims. Euhedral olivine phenocrysts are 100% altered. Some show evidence for resorption / embayments. They are predominantly replaced by pale brown saponite with a fibrous/radial habit and interference cols. &lt;1st order red. Between domains of saponite are thin very pale green veinlets. Less commonly seen replacing the olivine is an olive green clay (similar to bright green clays seen in other samples, clear in PPL, cryptocrystalline, low 1st order interference colours - celadonite/nonttronite?). There are also small patches of carbonate within the saponite. Clinopyroxene is present as large, unzoned pale brown to colorless crystals in association with feldspar or feldspar in crystal clots (i.e. microgabbros). The textures suggest that these clusters are cognate inclusions. Olivine typically occurs independently from the plag + cpx clots. The groundmass exhibits a wide range of crystal habits from plumose quench textures to subophitic relationships between cpx and plagioclase. Groundmass opaque minerals are clustered in the interstitial areas between cpx plumose quench crystals. There is patchy replacement of groundmass by carbonate, pale brown saponite and olive green clay (and in one example, blue-green clay). These constitute the largest and most abundant occurrences of this mineral. Vesicles are filled by the same combination of minerals as seen replacing olivine and groundmass. Pale green clays are the earliest phase (partially) lining vesicles. These are overgrown by brown saponite and carbonate. The latter two phases appear to mutually overgrow one another in several examples and lack a consistent sense of relative order of formation (co-precipitation or multiple phases of resurgent growth/recrystallisation?) The vesicles commonly have a brown halo around them; the darker brown color appears to be due to brown oxyhydroxide replacement of glass / mesostasis in this area relative to adjacent groundmass.</p> |                   |

Plane-polarized: 62798201



Cross-polarized: 62798221



## Igneous Petrology

|                                      |                                                    |                                      |                  |
|--------------------------------------|----------------------------------------------------|--------------------------------------|------------------|
| <b>Lithology:</b>                    | highly plagioclase-olivine-augite<br>phyric basalt | <b>Rock texture:</b>                 |                  |
| <b>Style of emplacement:</b>         | massive lava flow                                  | <b>Groundmass grain size (avg.):</b> | microcrystalline |
| <b>Major groundmass texture:</b>     | intergranular                                      | <b>Minor groundmass Texture:</b>     | intersertal      |
| <b>Sample domain name (if &gt;1)</b> | 1                                                  | <b>Domain relative abundance (%)</b> | 100              |

THIN SECTION LABEL ID: **390-U1556B-56R-2-W 35/38-TSB-TS58**

Thin section no.:

Observer: PDK, EC

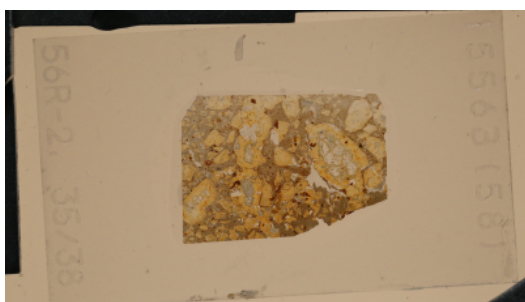
Piece no.:

Thin section thickness: standard

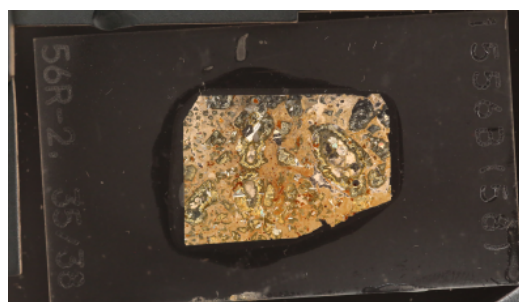
Unit/subunit: 13

Thin section summary: Hyaloclastite: This is a hyaloclastite breccia composed of palagonitized glass fragments of highly plagioclase-olivine-pyroxene phyric basalt. The breccia is matrix supported and the matrix is at least in part a pelagic sediment, as there are fossils present. The matrix also contains silt size clasts of igneous derivation. The breccia is partially cemented by sparry calcite and the micritic matrix has been partially recrystallized / neomorphism. In some areas the interclast space is lined by small "teeth" of carbonate, overgrown by coarse radial blades of zeolite themselves overgrown and cemented by coarse crystalline carbonate. The phenocryst assemblage in the glass fragments is consistent with that of the highly plagioclase-olivine-pyroxene phyric basalt observed elsewhere in this unit. The core of the largest glass clast consists of large domains of carbonate or zeolite. The latter appear to consist of single very large crystals with sector twinning (likely phillipsite).

Plane-polarized: 62798261



Cross-polarized: 62798241



## Igneous Petrology

Lithology: .. breccia

Rock texture:

Style of emplacement: breccia

Groundmass grain size (avg.): glass

Major groundmass texture: glass

Minor groundmass Texture:

Sample domain name (if &gt;1) 1

Domain relative abundance (%) 100

THIN SECTION LABEL ID: **390-U1556B-57R-3-W 42/44-TSB-TS59**

Thin section no.:

Observer: PDK, EC

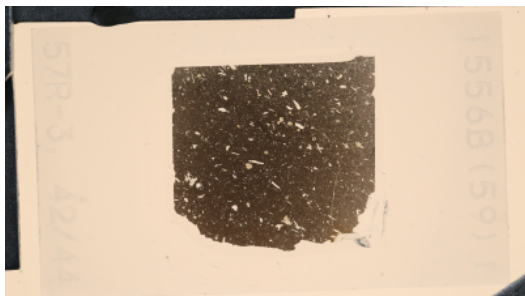
Piece no.:

Thin section thickness: standard

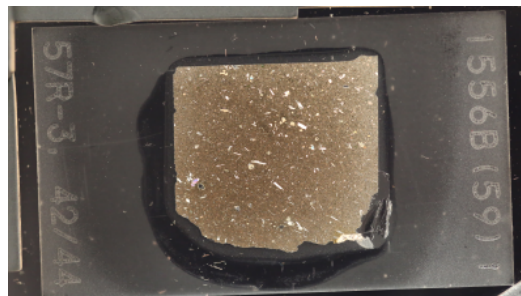
Unit/subunit: 13

Thin section summary: Plagioclase olivine pyroxene basalt: This is the plumose quench textured zone from a highly plagioclase-olivine-pyroxene phyric basalt. Plagioclase is the most abundant phenocryst phase and it ranges from subedral tabular phenocryst phases to acicular / skeletal microlites in the groundmass. It shows ubiquitous polysynthetic twinning. Some larger crystals show evidence for resorption. Euhedral equant olivines are the second most abundant phase, and they are completely replaced by pale brown clay saponite apart from one grain, partially replaced by green clay in a vein halo. Anhedra clinopyroxene crystals occur almost exclusively in subophitic relationships with plagioclase. The groundmass is brown and consists of plumose quench textures that are outlined by small equant opaque minerals. Patches of lime green clay mineral (celadonite/nonttronite?) replace interstitial areas in a halo to a thin vein filled with the same green mineral, and yellow-red-brown clays + Fe oxyhydroxides. This vein continues across the slide where it is wider, and lacks green clay fill and halo. Other than this green halo, the groundmass appears to be relatively unaltered. The slide includes a calcite vein on one side. The vein is lined by neomorphic calcite microspar that is mixed with silty clasts of igneous derivation. The carbonate material may have been sedimentary in origin, as there appears to be a fossil in part of this boundary. The center of the vein is sparry calcite. Vesicles are common and are filled by saponite, Fe oxyhydroxides or green clays. Where a filling order is clear, green clays are the earliest phase and are overgrown by brown Fe oxyhydroxides and lastly, by pale brown saponite. Some filled only by saponite show a slightly darker rim and slightly paler core.

Plane-polarized: 62798281



Cross-polarized: 62798301



## Igneous Petrology

**Lithology:** highly plagioclase-olivine-augite  
phyric basalt

**Rock texture:**

**Style of emplacement:** massive lava flow

**Groundmass grain size (avg.):** cryptocrystalline

**Major groundmass texture:** dendritic or skeletal

**Minor groundmass Texture:**

**Sample domain name (if > 1)** 1

**Domain relative abundance (%)** 100

THIN SECTION LABEL ID: **390-U1556B-58R-1-W 97/99-TSB-TS60**

Thin section no.:

Observer: PDK, EC

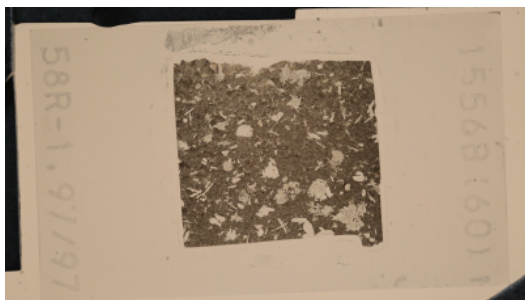
Piece no.:

Thin section thickness: standard

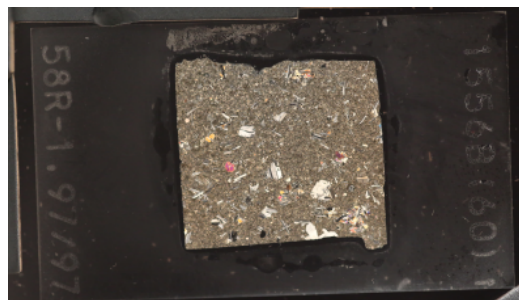
Unit/subunit: 13

Thin section summary: Plagioclase olivine pyroxene basalt: This is a highly plagioclase-olivine-pyroxene phyric basalt. Plagioclase is the most abundant phenocryst phase and it ranges from subeudritic tabular phenocryst phases to acicular / skeletal microlites in the groundmass. It shows ubiquitous polysynthetic twinning. Some larger crystals show evidence for resorption and subtle concentric or oscillatory zoning. Smaller, more tabular crystals appear unzoned. Euhedral equant olivines are the second most abundant phase, and they are completely replaced by very pale (greenish?) brown saponite. Anhedral clinopyroxene crystals occur almost exclusively in subophitic relationships with plagioclase; they are unzoned. The groundmass is brown and consists of plumose quench textures. The plumes are probably dominated by cpx growth, given the moderate interference colors where crystals are large enough to see this characteristic. Plagioclase occurs as small acicular microlites in the groundmass. Masses of small, equant opaque minerals are concentrated in the mesostasis in between quench plumes. These areas appear to be relatively unaltered, aside from distinct patches of pale brown saponite. Some of these are likely smaller olivines but others appear to represent replacement groundmass. In addition there are two areas in which groundmass is replaced by green clays. The smaller of these is related to an impersistent vein of the same green clay. The second is more extensive an irregular halo or patch along the left hand side of the slide possibly related to thin veins through and impersistently joining large clots of (fresh) plagioclase and clinopyroxene. In this patch bright green clays form irregular patches replacing groundmass and filling/lining vesicles. paler green clay (more saponitic in composition) partially replaces olivine in association with pale brown saponite. Green clays are overgrown by red-brown Fe oxyhydroxides in this patch and the thin veins present are mostly filled by yellow brown Fe oxyhydroxides + clays (the only place these occur in the slide). Where the order of overgrowing is clear (mostly in vesicles), yellow to red-brown Fe oxyhydroxides overgrow green clays and are overgrown by saponite. Vesicles show variable fillings. Some are lined with a mineral very similar in appearance to the saponite (and int cols. <1st order red) but exhibiting a marked radial growth habit more similar to a zeolite (fibrous form of clay mineral??) and/or filled by sparry calcite. Others are filled by pale brown saponite with more consistent properties to what replaces olivine and groundmass.

Plane-polarized: 62801131



Cross-polarized: 62801091



## Igneous Petrology

**Lithology:** highly plagioclase-olivine-augite  
phyric basalt

**Rock texture:**

**Style of emplacement:** massive lava flow

**Groundmass grain size (avg.):** cryptocrystalline

**Major groundmass texture:** dendritic or skeletal

**Minor groundmass Texture:**

**Sample domain name (if >1)** 1

**Domain relative abundance (%)** 100

THIN SECTION LABEL ID: **390-U1556B-59R-1-W 9/10-TSB-TS61**

Thin section no.:

Observer: PDK, EC

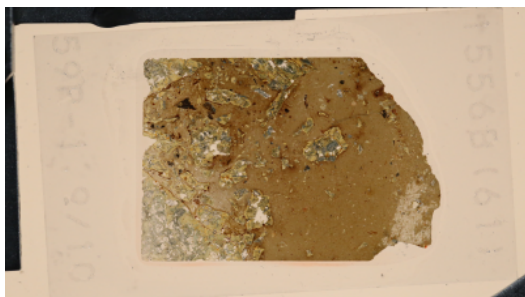
Piece no.:

Thin section thickness: standard

Unit/subunit: 13

Thin section summary: Hyaloclastite: This is a hyaloclastite breccia composed of palagonitized glass fragments, most of which are without phenocryst cargo, but at least one contains a crystal clot of plag + cpx, indicating this is derived from the highly phyric plag-ol-cpx basalts. The palagonite ranges from golden yellow to pale green in color and exhibits concentric lamination/zoning in XPL. In some examples such growth layers are truncated by the edge of clasts suggesting brecciation at least partly postdates alteration. There are some spherulite-like textures in one part of the thin section in the palagonite, suggesting alteration to zeolites and/or clays? The cores of some larger clasts contain a range of minerals including radiating fibrous/spherulitic pale brown to slightly opaque clay (similar in appearance to saponite with slightly higher int. cols. <2nd order blue) - often poorly preserved. Several have cores composed of pale to bright green clay typically divided from the yellower palagonite by a thin layer of yellow-brown Fe oxyhydroxides (oxidation front?). This green mineral occurs with saponite or with radiating bundles of bladed zeolites (likely phillipsite). The breccia is matrix supported and the matrix is at least partially derived from pelagic sediment, as there are fossils present. It also contains silt size clasts of igneous derivation, e.g. small palagonite fragments. The carbonate sediment has partially recrystallized to calcite microspar. Small patches of a very low birefringence cementing carbonate microspar are likely zeolite.

Plane-polarized: 62801151



Cross-polarized: 62801171



## Igneous Petrology

Lithology: .. breccia

Rock texture:

Style of emplacement: breccia

Groundmass grain size (avg.): glass

Major groundmass texture: glass

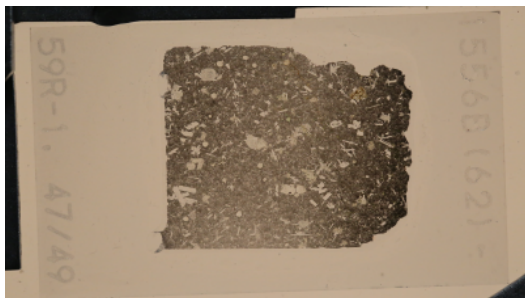
Minor groundmass Texture:

Sample domain name (if &gt;1) 1

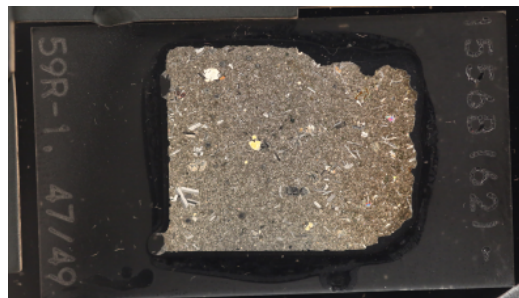
Domain relative abundance (%) 100

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                   |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| THIN SECTION LABEL ID:  | <b>390-U1556B-59R-1-W 47/49-TSB-TS62</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Thin section no.: |
| Observer:               | PDK, EC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Piece no.:        |
| Thin section thickness: | standard                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Unit/subunit: 13  |
| Thin section summary:   | <p>Plagioclase olivine pyroxene basalt: This is a highly plagioclase-olivine-pyroxene phyric basalt. Plagioclase is the most abundant phenocryst phase and it ranges from subhedral tabular phenocryst phases to acicular / skeletal microlites in the groundmass. It shows ubiquitous polysynthetic twinning. Some larger crystals show subtle concentric or oscillatory zoning. Smaller, more tabular crystals appear unzoned. Some large, subhedral tabular plagioclase occur together in glomerocrystic clusters. Euhedral equant olivines are the second most abundant phase, and they are completely replaced by pale brown saponite with minor green clays and red brown iddingsite in halos/patches. Large equant opaque minerals occur in one large olivine pseudomorph; these may have originally been Cr spinel, but now look like that may be magnetite. Anhedral clinopyroxene crystals occur almost exclusively in subophitic relationships with plagioclase; most are unzoned, but some show sieve textures and complex extinction patterns, suggesting development of subgrain boundaries. The groundmass is brown and consists of plumose quench textures. The plumes are probably dominated by cpx growth, given the moderate interference colors where crystals are large enough to see this characteristic. Plagioclase occurs as small acicular microlites in the groundmass. Masses of small, equant opaque minerals are concentrated in the mesostasis in between quench plumes. Groundmass is mostly relatively unaltered but does show replacement in small patches by pale brown saponite. In addition there are several distinct patches/halos with slightly more intense alteration. Two of these in the middle of the slide occur as halos around thin green clay-filled veins. Within the (slightly irregular) halo of these veins groundmass, olivine and vesicles are partially replaced or filled by pale green clays (NB: slide cut slightly thin =&gt; colour more muted than at top of slide where thicker) which are overgrown by saponite where the two co-exist. There is variable later oxidative alteration along both veins resulting in a brown Fe oxyhydroxides overgrowing a green lining in veins and some vesicles and patchy oxidation of green clays to yellower colours in the halo. At the top of the slide is a broader more well developed halo in which green clays are abundant and groundmass mesostasis has been altered to markedly dark greys and lost some of its textural definition. In this zone brown Fe oxyhydroxides/iddingsite is common overgrowing the green clays in vesicles and as a minor component replacing olivine. Outside these halos where they are variously filled by green clay, pale brown saponite and brown Fe oxyhydroxides, vesicles are filled by saponite, some with a slight zonation from darker to paler colours from rim to core.</p> |                   |

Plane-polarized: 62801211



Cross-polarized: 62801191

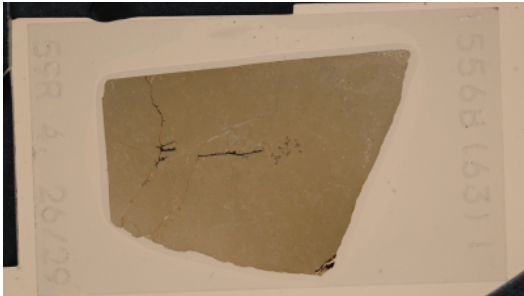


## Igneous Petrology

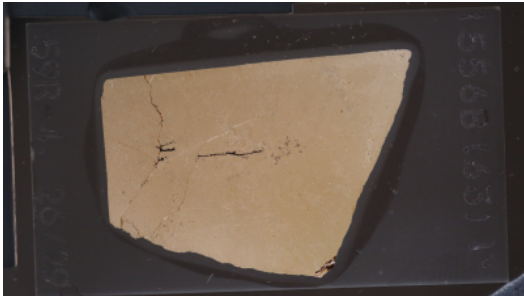
|                            |                                                 |                                                 |
|----------------------------|-------------------------------------------------|-------------------------------------------------|
| Lithology:                 | highly plagioclase-olivine-augite phyric basalt | Rock texture:                                   |
| Style of emplacement:      | massive lava flow                               | Groundmass grain size (avg.): cryptocrystalline |
| Major groundmass texture:  | dendritic or skeletal                           | Minor groundmass Texture:                       |
| Sample domain name (if >1) | 1                                               | Domain relative abundance (%) 100               |

|                         |                                   |                   |    |
|-------------------------|-----------------------------------|-------------------|----|
| THIN SECTION LABEL ID:  | 390-U1556B-59R-4-W 26/29-TSB-TS63 | Thin section no.: |    |
| Observer:               |                                   | Piece no.:        |    |
| Thin section thickness: | standard                          | Unit/subunit:     | 13 |
| Thin section summary:   | pelagic sediment                  |                   |    |

Plane-polarized: 62801251



Cross-polarized: 62801231



THIN SECTION LABEL ID: **390-U1556B-59R-4-W 65/67-TSB-TS64**

Thin section no.:

Observer: PDK

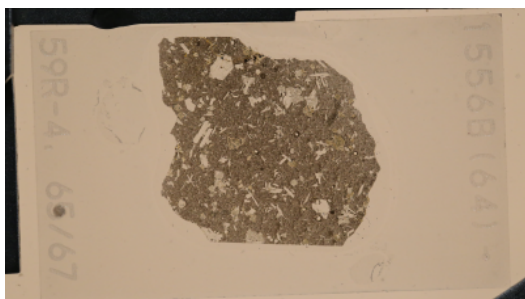
Piece no.:

Thin section thickness: standard

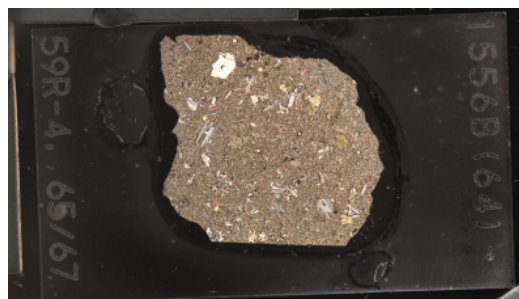
Unit/subunit: 13

Thin section summary: Plagioclase olivine pyroxene basalt: This is a highly plagioclase-olivine-pyroxene phyric basalt. Plagioclase is the most abundant phenocryst phase and it ranges from subhedral tabular to equant (some euhedral) phenocryst phases. It shows ubiquitous polysynthetic twinning. Some larger crystals show subtle concentric or oscillatory zoning. Smaller, more tabular crystals appear unzoned. Some large, subhedral tabular plagioclase occur together in glomerocrystic clusters. Plagioclase is largely unaltered. Euhedral equant olivines are the second most abundant phase, and they are completely replaced by pale brown saponite with radial fibrous habit (some of it quite dusty/grey, amorphous and opaque looking) plus very minor brown Fe oxyhydroxides. Some of the largest of these have apparently crystallographically elongate patches of more amorphous clay replacement which look like they might pick out the morphology some early stage of alteration/chemical attack. Large equant opaque minerals occur in one large olivine pseudomorph; these may have originally been Cr spinel, but now look like that may be magnetite. Anhedra clinopyroxene crystals occur almost exclusively in subophitic relationships with plagioclase; most are unzoned, but some show complex extinction patterns, suggesting development of subgrain boundaries. Cpx is unaltered. The groundmass is brown and consists of plumose quench textures. The plumes are probably dominated by cpx growth, given the moderate interference colors where crystals are large enough to see this characteristic. Plagioclase occurs as small acicular microlites in the groundmass. Masses of small, equant opaque minerals are concentrated in the mesostasis in between quench plumes. Groundmass is relatively unaltered, although there is a patchiness of darker and lighter areas which might be due to variable clay alteration. There are small patches of pale brown saponite replacement throughout the slide. There is a halo around a few thin green clay/Fe oxyhydroxide-lined, saponite filled veins. These cut between and through large plagioclase phenocrysts (plag contributing chemically or just a convenient zone of fracturing?). The halo is characterised by replacement of groundmass and olivine and filling of vesicles by green to yellow clays, the later apparently an oxidised product of the former. Saponite overgrows the green/yellow clays and Fe oxyhydroxides. Vesicles show variable fillings. Some, near the vein, are lined by green clay (or its oxidised yellow equivalent) overgrown and filled by brown saponite; others in the rest of the section are just filled by saponite. Still others are lined by saponite and filled by calcite. Calcite and green clay never occur together. The vesicles commonly have a darker halo around them possibly indicating more intense background alteration to clays. There are the remains of a saponite-filled vein at the top of the section.

Plane-polarized: 62801271



Cross-polarized: 62801291



## Igneous Petrology

**Lithology:** highly plagioclase-olivine-augite  
phyric basalt

**Rock texture:**

**Style of emplacement:** massive lava flow

**Groundmass grain size (avg.):** cryptocrystalline

**Major groundmass texture:** dendritic or skeletal

**Minor groundmass Texture:**

**Sample domain name (if >1)** 1

**Domain relative abundance (%)** 100