



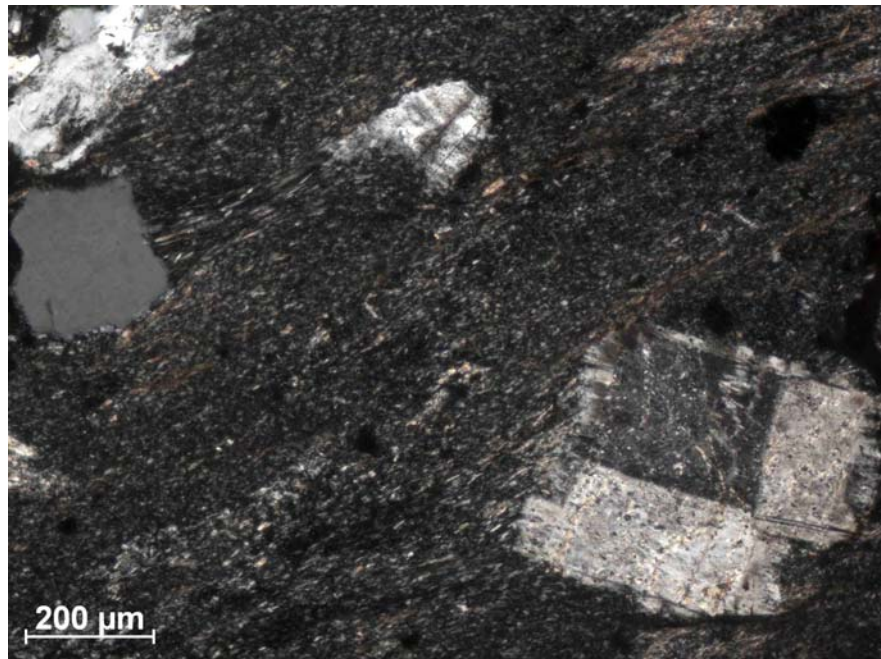
**British  
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NATURAL ENVIRONMENT RESEARCH COUNCIL

# Petrographic analysis of igneous and metamorphic rocks from the Fishguard 1:50000 sheet, south Wales

Geology and Landscape Southern Britain Programme

Internal Report IR/05/162





BRITISH GEOLOGICAL SURVEY

GEOLOGY AND LANDSCAPE SOUTHERN BRITAIN PROGRAMME

INTERNAL REPORT IR/05/162

# Petrographic analysis of igneous and metamorphic rocks from the Fishguard 1:50000 sheet, south Wales

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## *Keywords*

Petrography, Sealyham, Asaphus, Abergwilli, Abermawr.

## *Front cover*

Photomicrograph of the sample OV4, a metatuff from the Abergwilli Formation.

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J A McKervey

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# Contents

<b>Contents.....</b>	<b>i</b>
<b>1 Introduction.....</b>	<b>1</b>
<b>2 Petrographic analysis.....</b>	<b>1</b>
<b>3 Discussion.....</b>	<b>1</b>
<b>4 Other samples .....</b>	<b>5</b>
<b>5 Summary .....</b>	<b>5</b>
<b>Appendix .....</b>	<b>6</b>
Appendix 2 .....	9

## FIGURES

Figure 1: Photomicrographs of sample Fg1 (JA) .....	2
Figure 2: Comparison of the fabrics found in the Fg samples.....	3
Figure 3: Comparison of the fabrics found in the OV samples .....	4

## TABLES

Table 1: Sample details .....	1
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# 1 Introduction

This report presents the results of petrographic analysis of samples of igneous and metamorphic rocks collected as part of a mapping survey of the Fishguard 1:50000 sheet, south Wales. The objective of the report is to provide petrographic descriptions of the rocks and to discuss the origin of the fabrics present. The samples are detailed in Table 1 (submitted by JA Aspden and DI Schofield (BGS)).

**Table 1: Sample details**

	Sample	National Grid Ref.	Location/Field description	Comment
1	Fg1 (JA)	SM 19674 22805	'Upper Tongue', Sealyham Volcanic Fmn	-
2	Fg2 (JA)	SM 19656 22809	'Upper Tongue', Sealyham Volcanic Fmn	-
3	Fg3(A) (JA)	SM 19710 22822	'Upper Tongue', Sealyham Volcanic Fmn	-
4	Fg6(A) (JA)	SM 19737 22841	'Upper Tongue', Sealyham Volcanic Fmn	-
5	Fg8 (JA)	SM 19630 22765 (approx)	'Upper Tongue', Sealyham Volcanic Fmn	-
6	OV1	SN 36220 22020	Asaphus Ash Fmn	-
7	OV2	SN 36220 22020	Asaphus Ash Fmn	-
8	OV3	SN 21760 23620	Ordovician dolerite	-
9	OV4	?	Abergwilli Fmn, acid tuff	-
10	OV8	SN 22036 22979	Abermawr Fmn, acid tuff	-
11	Fg3(B) (JA)	SM 19710 22822	'Upper Tongue', Sealyham Volcanic Fmn	-
12	Fg6(B) (JA)	SM 19737 22841	'Upper Tongue', Sealyham Volcanic Fmn	-
13	OV5	SN 22300 21720	Abergwilli Fmn	-
14	OV6	SN 21760 23620	Ordovician dolerite	-
15	OV7	?	Abergwilli Fmn, acid tuff	-
16	OV9	SN 22865 22035	Asaphus Ash Fmn	-
17	OV10	SN 22300 21720	Abergwilli Fmn acid tuff	-
18	Sealy-2	SM 96562 28124	Sealyham Volcanic Unit 2	U-Pb zircon
19	Roch-R	SM 95732 25084	Great Treffarne Mountain	U-Pb zircon
20	NYC	SN 94690 25412	Nant Y Coy intrusion	U-Pb zircon
21	Ffol-R	SN 04714 38001	Carn Ffol	U-Pb zircon

## 2 Petrographic analysis

Appendix 1 contains sample-by-sample petrographic descriptions of the 10 samples submitted for full petrographic analysis (samples 1 to 10 in Table 1). In addition, Appendix 2 contains brief descriptions of another 7 samples submitted so that they could be quickly compared to the 10 samples above (samples 11 to 17 in Table 1), and petrographic descriptions of 4 samples submitted for U-Pb zircon geochronology.

## 3 Discussion

The Fg rocks (1 to 5 in Table 1) are trachytic in the main. Modal estimates for some rocks allow more specific names to be assigned (quartz-alkali-feldspar-trachyte; quartz-trachyte) whereas for some the broader name trachytic-rock is assigned (Appendix 1 for details). One

sample (Fg8 (JA)) is substantially different from the remainder; it is a banded, mylonitic, metafelsite. The Fg rocks are moderately altered (to  $\pm 2^{\text{nd}}$  quartz  $\pm$  sericite  $\pm$  carbonate  $\pm$  chlorite) but in some samples the alteration is more widespread and includes patchy alteration to amphibole + epidote and/or substantial development of  $2^{\text{nd}}$  quartz (up to 10%).

All the trachytic rocks display a pilotaxitic texture (A term now used for what previously might have been termed a trachytic texture) formed during the cooling of the magma (Figure 1)

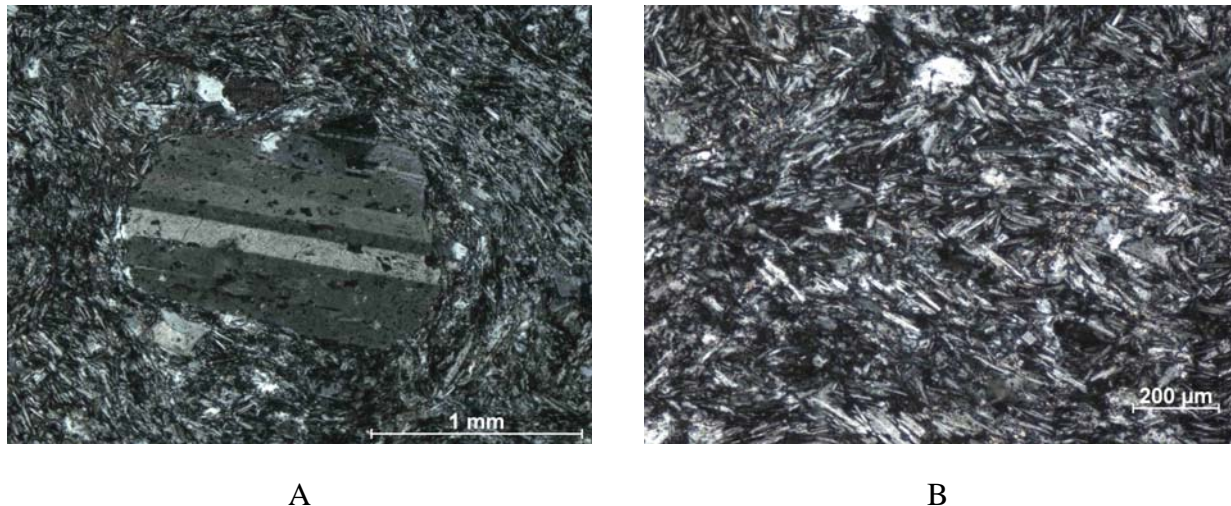


Figure 1: Photomicrographs of sample Fg1 (JA) illustrating the pilotaxitic texture of this trachytic rock. In (A) the groundmass feldspar encircles the feldspar phenocryst and in (B) the groundmass has a sub-parallel alignment of feldspar in which a number of different orientations are present rather than one single preferred orientation.

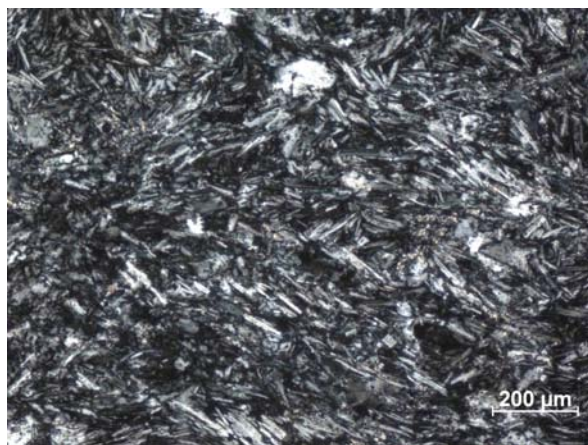
In the samples Fg1, Fg2 and Fg3 it is suggested that this texture is undeformed, whereas in sample Fg6(A) there is suggestion of a poorly-defined realignment of the groundmass feldspar along a single, preferred orientation (Figure 2 A to D).

By contrast, sample Fg8 (JA) is substantially different in terms of its fabric. This sample originated as a banded and porphyritic felsic rock but is now strongly mylonitised with a single, parallel alignment of feldspar in the groundmass (Figure 2E). In addition, in some bands in this rock the sericitic foliation wraps around porphyroclasts of amphibole + quartz (Figure 2F). Thus sample Fg8 (JA) originated as a banded, felsic igneous rock, which was subsequently altered, to develop amphibole + sericitic mica in parts, and then strongly mylonitised throughout with the further development of foliated ?metamorphic white mica.

In summary, the Fg rocks are characterised as porphyritic trachytic magmas (?lava flows) with a pilotaxitic igneous fabric and where one sample is banded and could be of pyroclastic origin (Fg8). These rocks were altered to sericite + carbonate + quartz with the local development of amphibole + epidote in some rocks (Fg3 and Fg8). One sample (Fg8) shows intense subsequent deformation, involving mylonitisation of any original igneous fabric, whereas the other samples show little (Fg6(A)) or no evidence of deformation (the remainder) of the pre-existing igneous fabric.

The OV rocks are a more heterogeneous group and consist of metafelsite, metatuff, opaque-carbonate-chlorite-sericite hydrothermal rock and a silicic tuff (Appendix 2 for details). The samples are moderately to strongly altered, with sample OV3, now classified as a hydrothermal rock, probably originating from an undeformed, medium-grained, mafic igneous rock. Samples OV1 and OV2 are compositionally similar to each other, however OV2 has a more clearly defined fabric of aligned quartz and sericitic mica (Figure 3A and B). In addition sample OV2





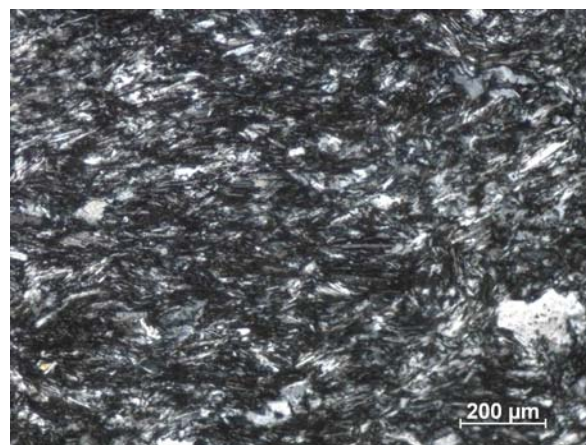
A: Fg1 (JA)



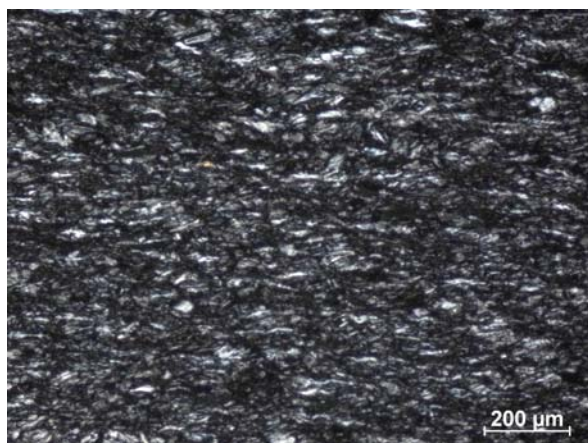
B: Fg2 (JA)



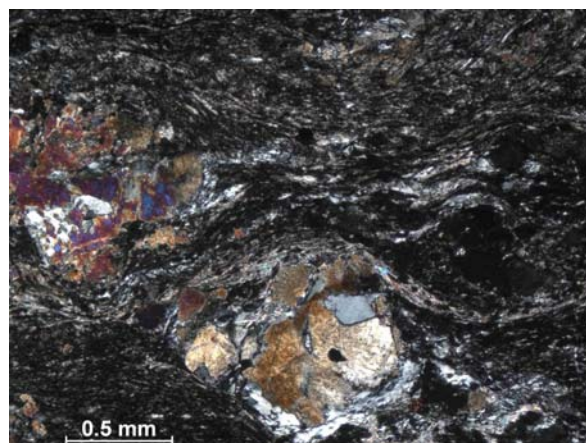
C: Fg3 (JA)



D: Fg6(A) (JA)



E: Fg8 (JA)



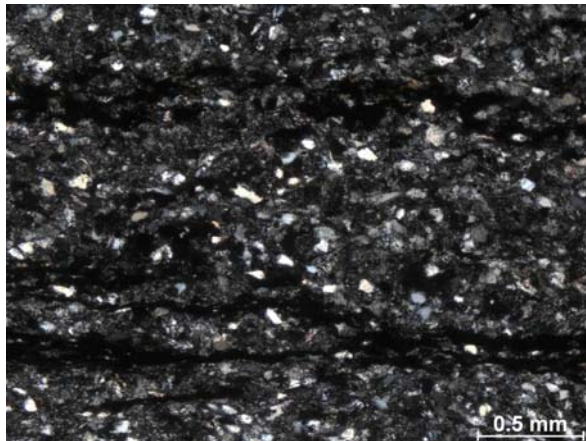
F: Fg8 (JA)

Figure 2: Comparison of the fabrics found in the Fg samples. Fg1, 2 and 3 (A, B and C above) are characterised by a pilotaxitic texture of sub-parallel alignment of groundmass feldspar. The texture of Fg6 is of a similar origin, however it may also have a superimposed, poorly-defined tectonic fabric resulting in the preferred orientation of the groundmass feldspar predominantly in one direction (D). By contrast, Fg8 has a distinct tectonic foliation defined by the groundmass feldspar in some bands (E) and sericitic mica + opaque minerals in other bands in which the foliation wraps around porphyroclasts of amphibole + quartz (F).

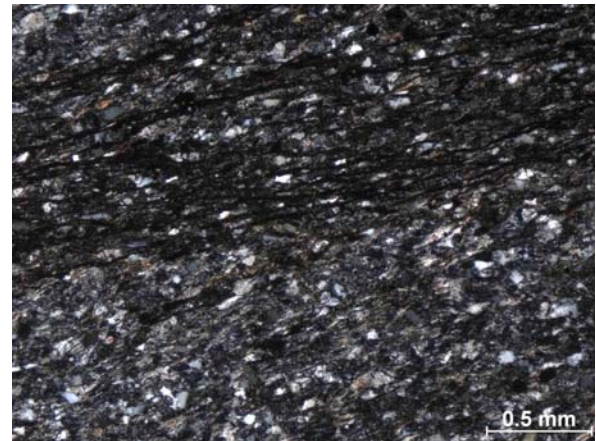


contains lapilli-grade rock fragments indicating a pyroclastic origin. Sample OV4 is even more strongly deformed (mylonitic) than OV2 and contains porphyroclasts of quartz + feldspar + rock fragments set in a fine-grained, banded, foliated sericitic matrix (Figure 3 C). Sample OV8 is not foliated but is substantially modified by alteration and probably originated as a porphyritic, felsic tuff (Figure 3D). In the OV rocks some late pyrite is present.

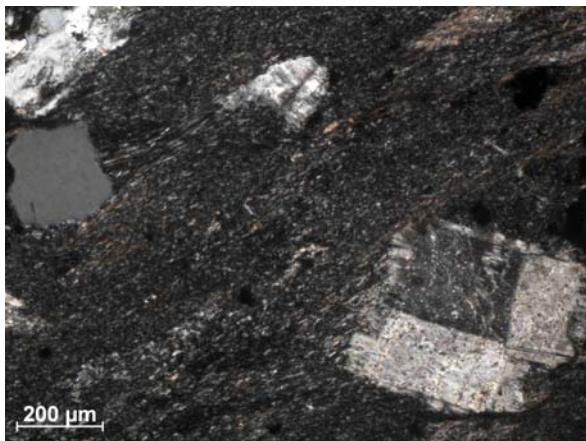
In summary, the OV rocks are often substantially altered, however they do show evidence for medium-grained mafic (OV3) and pyroclastic felsic magmatism (the remainder). No igneous fabrics have been identified but original volcanoclastic banding is present. Intense mylonitic deformation is present in some samples, with the intensity of deformation in OV4 > OV2 > OV1 and is associated with the development of foliated, sericitic mica. However, other samples show considerable alteration but no deformation (OV3 and OV8).



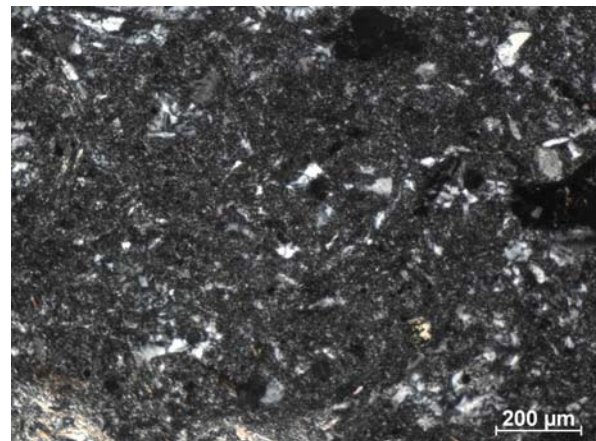
A: OV1



B: OV2



C: OV4



D: OV8

Figure 3: Comparison of the fabrics found in the OV samples. OV1 is sub-foliated with alignment of fine-grained sericite in the groundmass but little or no alignment of the predominant mineral, quartz (A); whereas, in sample OV2, a more obvious foliation exists defined by fine-grained sericitic mica and quartz (B). In both OV1 and OV2 the fabrics are parallel to locally pervasive, thin (<0.1mm), irregular, brown-stained veins giving both rocks a banded texture (A and B). A strong mylonitic fabric characterises sample OV4 and is defined by fine-grained sericitic mica in the groundmass forming pressure-shadows adjacent to porphyroclasts (C). Sample OV8 displays no fabric (D).

## 4 Other samples

A second set of samples was more briefly examined and includes two further Fg samples and 5 OV samples (Appendix 2). In the case of the Fg samples further evidence of intense mylonitisation is present in Fg6(B). This rock has a well-developed texture of quartz porphyroclasts set in a foliated, sericitic matrix and is more similar, in terms of the degree of deformation at least, to sample Fg8 rather than sample Fg6(A). The additional OV samples confirm the suggestion from the heavily altered sample OV3 described above that mafic magma does occur in these rocks. Sample OV6 is a sub-ophitic microgabbro with intersertal glass (now altered) and is undeformed; sample OV7 is another rock of this type but it is more heavily altered, similar to sample OV3. Samples OV9 and OV10 are undeformed or little deformed pyroclastic rocks (sericitic, felsic (?meta)tuff) predominantly of ash-grade but rare lapilli-grade rock fragments are also present.

The rocks collected for U-Pb zircon geochronology (n=4) are described in Appendix 3. They comprise a mylonitic, metatrachytic-rock (Sealy – 2) that is very similar to the Fg rocks in composition with a lesser amount of deformation than Fg8 and Fg6(A). U-Pb zircon dating of this rock should therefore provide the age of the trachytic magmatism and a maximum age for the mylonitic deformation. The sample NYC (Nant Y Coy granite) is an undeformed, porphyritic microgranodiorite distinct from the magmatism recorded in the Fg and OV samples. The sample Ffol-R is a silicified, plagioclase-phyric felsite which, broadly speaking, appears more similar to the NYC type of magmatism than that found in either the Fg and OV samples. A fourth sample is a very-fine-grained (?devitrified) felsite with no distinguishing petrographic features relative to all other samples.

All the igneous rocks show alteration, however some samples are sufficiently fresh to make geochemical analysis a possibility. The only felsic rocks suitable would be Fg 1, Fg 2, Fg 3(B) and Fg 6(A); whereas for the mafic rocks only OV6 would be suitable although elements of particular interest for rock classification and petrogenesis (e.g. Na and K) would need to be interpreted as minima due to the degree of alteration present in this sample.

## 5 Summary

The petrographic analysis of the Fg and OV samples suggests that a series of bimodal magmatic rocks (microgabbro - trachytic-rock), including rocks of pyroclastic origin, were formed and resulted in some rocks with a pilotaxitic texture. All of these magmatic rocks have been altered to include, in some samples, the development of amphibole  $\pm$  epidote, in addition to the more widespread development of quartz  $\pm$  sericite  $\pm$  chlorite  $\pm$  opaque minerals. Subsequent deformation (mylonitisation) has strongly affected some samples from both the Fg (Fg6(B) (JA); Fg8 (JA); and ?Fg6(A) (JA)) and OV rocks (OV2 and OV4). Deformation in these samples involved the further development of foliated, sericitic (?metamorphic) mica. All other rocks from both groups, including some of those with a pre-existing magmatic fabric, show little or no evidence of deformation. Rocks submitted for U-Pb zircon dating should provide constraints on the age of the trachytic magmatism, mylonitic deformation and a undeformed, granodioritic magmatic event.



# Appendix 1

**Fg1 (JA)** is moderately altered and composed of ~10-15% phenocrysts set in a fine-grained groundmass. The phenocrysts are plagioclase (~7%;  $An_{10-15}$ ) and kfs (2-3%) and also includes sub-rounded to elongate-irregular rock fragments (1-2%) that are now entirely replaced by fine-grained secondary minerals. The phenocrysts are subhedral-to-euhedral and glomeroporphyritic in places. The groundmass is dominated by pilotaxitic, subhedral kfs (70-75%) and anhedral quartz (~10%) with rare opaque minerals. Carbonate, chlorite and sericite are all present as secondary replacement of feldspar with carbonate (5%) predominant.

A kfs-pl-phyric quartz-alkali-feldspar-trachyte  $\Rightarrow$



**Fg2 (JA)** is moderately altered and composed of phenocrysts (~10%) set in a fine-grained groundmass. The phenocrysts are plagioclase (5-6%;  $An_{10-12}$ ; sieve-textured), kfs (2-3%) and sub-rounded, irregular-to-lenticular rock fragments now entirely altered to fine-grained secondary minerals (2-3%; with feldspar phenocrysts within the rock fragments). The rock is pilotaxitic in texture, mostly defined by the groundmass with a less-pronounced alignment of the phenocrysts. The groundmass is dominated by kfs (60-65%) with minor pl (?10%), anhedral quartz (5-10%) and rare opaque minerals. Sericitisation of the feldspar phenocrysts is common and, in parts, pervasive; rare chlorite also occurs.

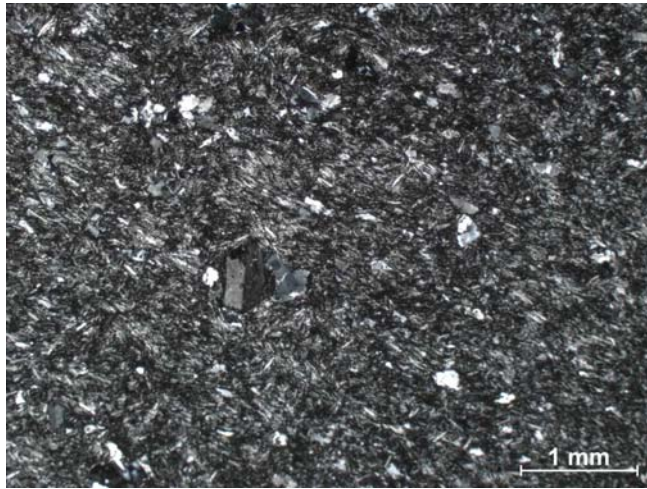
$\Rightarrow$  A rock fragments-kfs-pl-phyric quartz-trachyte

**Fg3(A) (JA)** is substantially altered and ~20% of the present mineralogy is composed of secondary minerals. The rock is porphyritic (5-10%) with a fine-grained, poorly-pilotaxitic groundmass with a banded appearance due to alteration. Phenocrysts are of pl (~5%;  $An_{12-13}$ ) and kfs (1-2%) and are in places glomeroporphyritic. The groundmass is composed predominantly of kfs, with minor pl + qtz + opaque minerals. Alteration is widespread with abundant sericitisation of phenocrysts and groundmass and clots/patches of  $\pm$ amph  $\pm$  ep  $\pm$  qtz  $\pm$  chl present. Due to the degree of alteration and the fine grain size of the groundmass the modal estimates are imprecise and a level 7 rock classification is therefore preferred.

An amphibole-epidote-bearing, sericitic trachytic-rock  $\Rightarrow$





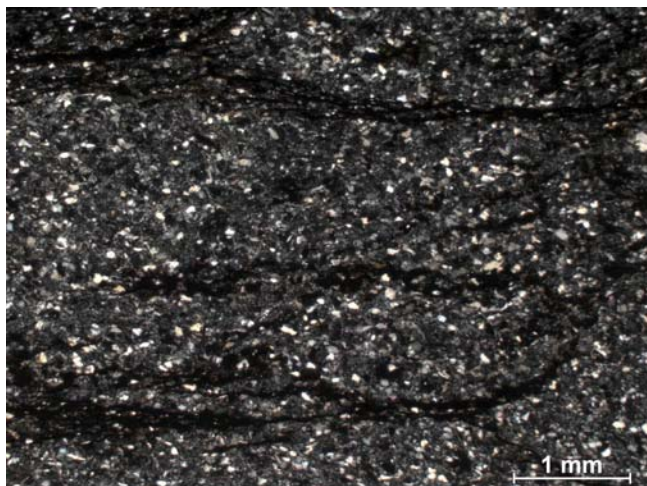
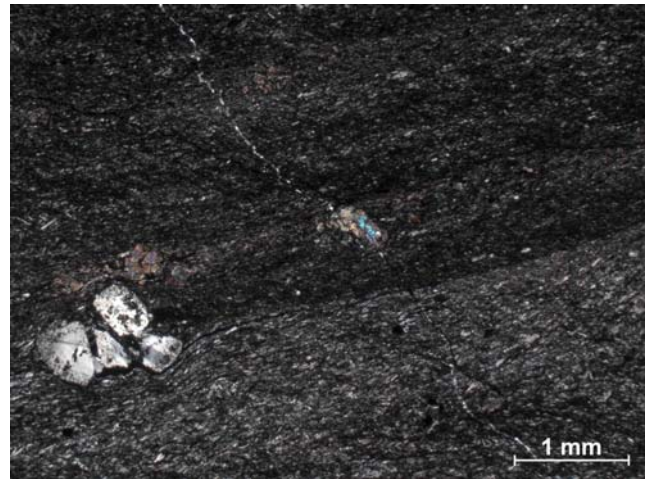


**F 6(A) (JA)** is moderately altered, phenocrystic (5%) with a fine-grained, poorly-foliated groundmass. The phenocrysts are of kfs (3-4%) and ?plagioclase. The groundmass is dominated by kfs with minor qtz + opaques + ?pl. The groundmass defines a poor foliation which is magmatic in origin (pilotaxitic) but may also have been subsequently tectonically deformed; weathered surfaces of the hand specimen suggest the presence of a through-going foliation. Due to the fine grain size modal estimates are rough estimates and level 7 rock classification is assigned. A patchy, vuggy development of late quartz constitutes 5-10% of the rock and minor alteration of feldspar to chlorite ± sericite is present.

⇒ A foliated, vuggy (quartz-rich) trachytic-rock

**Fg8 (JA)** is moderately altered, banded and mylonitic. The banding consists of ~50:50% of either feldspar-dominated, fine-grained bands with ~10% porphyroclasts of feld + qtz + amph, or, more texturally-heterogeneous bands dominated by strongly foliated fine-grained feldspar + white mica + quartz with porphyroclasts of amph + qtz, interbanded with discontinuous strongly foliated bands rich in fine-grained opaque minerals. Overall the rock is dominated by feldspar (50-60%) and white mica (10-15%) with lesser quartz, amphibole, opaques and chlorite.

A banded, mylonitic, qtz-feld-amph-porphyroclastic metafelsite ⇒

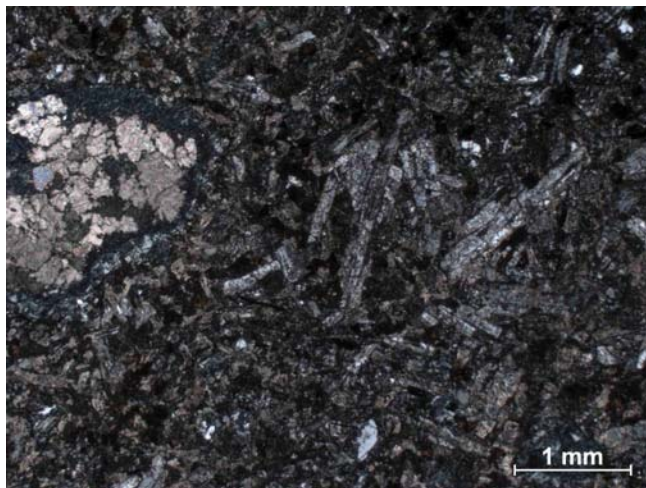
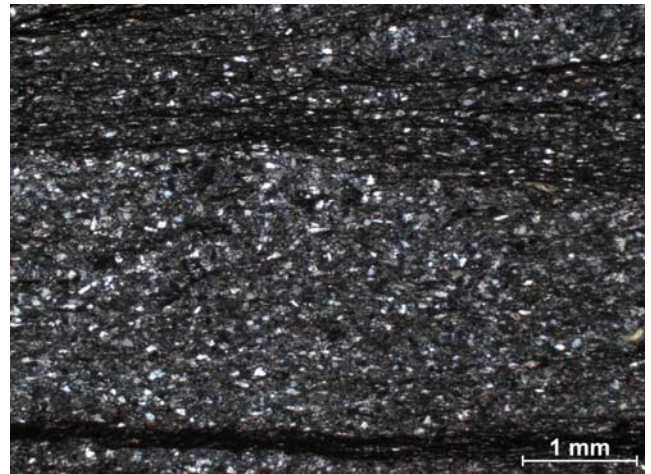


**OV1** is moderately altered, banded and composed of very-fine- to fine-grained qtz + sericite + feldspar + opaques + zircon(acc.). The rock is sub-foliated but the fabric is only obviously displayed by the sericitic mica. The foliation is in parallel with thin (<0.1mm), irregular, brown-stained veins (10-15% of the rock, but locally pervasive). As the rock is very similar to OV2, where there is better evidence of a pyroclastic origin, and the hand specimen looks and feels fragmental rather than crystalline the rock is probably of pyroclastic origin.

⇒ A sericitic, banded metafelsite

**OV2** is very similar to OV1. It is moderately altered, banded and composed predominantly of very-fine- to fine-grained quartz+sericite with minor ?feldspar + opaques + chlorite. Relatively rare (<10%) lapilli-grade rock fragments (rounded, porphyritic, with an isotropic groundmass) also occur and indicate a pyroclastic origin. The rock is foliated (defined by quartz+sericitic mica) and the fabric wraps-around the lapilli-grade fragments. The foliation is in parallel with thin (<0.1mm), irregular, brown-stained veins (~20% of the rock, but locally pervasive).

A sericitic, banded metatuff ⇒



**OV3** is heavily altered with at least 40% of the rock composed of secondary minerals. Relicts of equigranular, medium-grained, subhedral plagioclase are present and are associated with pervasive alteration to secondary opaques + carbonate + chlorite + sericite + quartz. Alteration also occurs infilling vugs (carbonate + chlorite). The original rock was probably a medium-grained, equigranular basic-to-intermediate igneous rock.

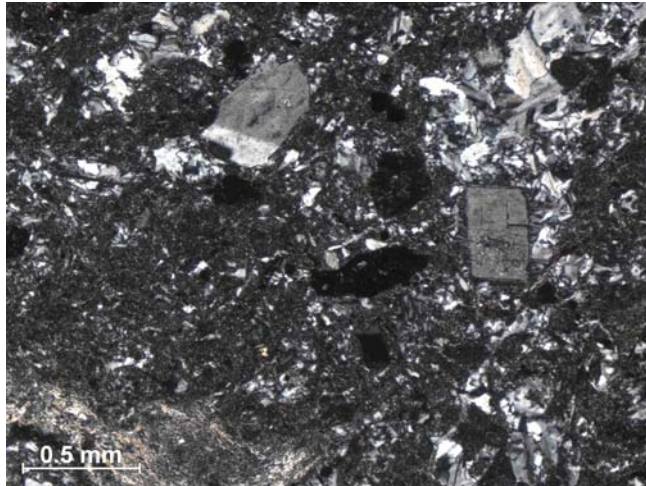
⇒ An opaques-carbonate-chlorite hydrothermal-rock

**OV4** is moderately altered, banded and composed of ~50-60% of a very-fine-grained, sericitic, foliated groundmass, associated with thin opaque-rich foliated bands, in which are set ~40% coarse-ash grade, sub-angular to sub-rounded (some elongate, irregular), porphyroclasts of quartz < feldspar < altered rock fragments. The foliation is defined primarily by sericitic (metamorphic) mica. Also present is one rounded, altered lapilli-grade fragment (originally glassy?). 5% of late, euhedral to subhedral pyrite also occurs.

A sericitic, mylonitic, qtz-feld-rock fragments-porphyroclastic metatuff ⇒







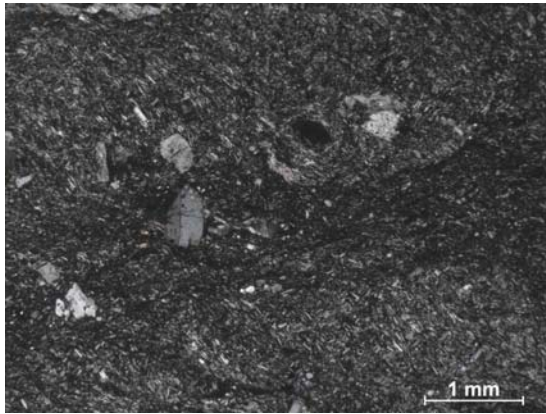
**OV8** is a moderately to heavily altered, porphyritic (15-20%) rock with a very-fine-grained, irregularly banded, felsic groundmass. The phenocrysts are predominantly pl ( $An_{12-18}$ ), with possible qtz + kfs, and irregular, sub-rounded rock fragments heavily altered to opaque minerals and sericite. The rock fragments contain phenocrysts of qtz + ?feld. The rock is also composed of ~20% of secondary quartz in the form of vuggy replacement and later cross-cutting veins. The phenocrysts and groundmass are probably of pyroclastic origin and are predominantly ash-grade.

⇒ silicified, rock fragments-feldspar-phyric tuff

## APPENDIX 2

Additional Fg and OV samples:

Sample	Description
Fg3(B) (JA)	A pilotaxitic, porphyritic trachytic-rock. This sample is fresher than Fg3(A) (JA) and it does not display the clots of amphibole+epidote alteration found in that sample.
Fg6(B) (JA)	A mylonitic, quartzose metafelsite. Substantially different to Fg6(A) (JA) but more similar to Fg8 (JA) due to the degree of mylonitisation which post-dates partial silicification.
OV6	A (meta)microgabbro, partially altered to chlorite + sericite. Metamorphic amphibole and/or ?pumpellyite present. It has a sub-ophitic texture and intersertal glass (altered). Similar to OV3, but substantially less altered. No foliation.
OV5	Very-fine-grained, banded, quartz-veined, sericitic felsite. Very poorly foliated, if at all (?).
OV7	Very heavily altered. A plagioclase-rich, chlorite+sericite+opaques hydrothermal rock. Similar to OV3 but more altered. No foliation.
OV9	A quartz-feldspar-rich coarse-tuff. Sericitic. No foliation
OV10	A vuggy, brown-stained fine-(?meta)tuff. Brown-stained veining is aligned and the rock may be foliated. Very-fine-grained.

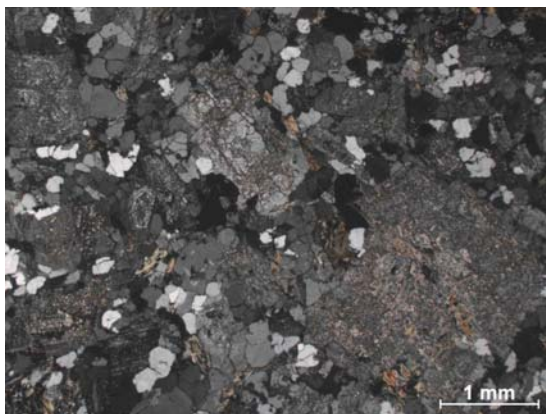
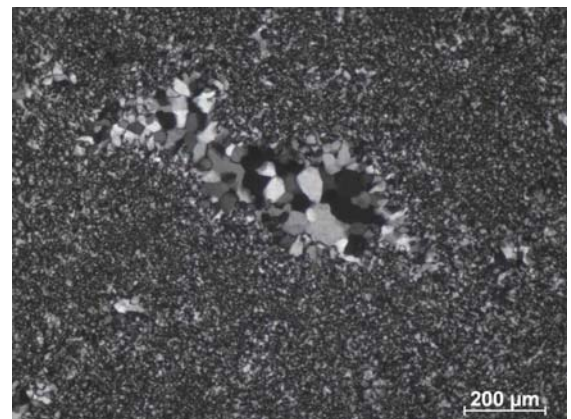
U-Pb zircon geochronology samples:

**Sealy – 2** is a moderately altered, banded rock composed predominantly of feldspar (60-70%) now present as a fine-grained groundmass, fine- to coarse-grained porphyroclasts and remnant phenocrysts. Also present is 10-15% banded sericitic mica, 2-3% banded opaques, quartz (5-10%), and irregularly-shaped, porphyritic, felsic rock fragments (5-10%). A pilotaxitic fabric has been locally overprinted by a mylonitic fabric (centre of the field-of-view opposite) which is defined predominantly by the mica but also in places by groundmass feldspar.

⇒ mylonitic, metatrachytic-rock

**Roch-R** is a very-fine-grained rock composed of felsic minerals (?predominantly quartz) and rare zircon. The rock is cross-cut by vuggy and vein quartz. The texture is anhedral crystalline with poorly-developed grain boundaries. The rocks may have been glassy in origin and subsequently devitrified. No foliation is present.

⇒ veined, very-fine-grained, ?devitrified felsite



**NYC** is a moderately altered, medium-grained rock composed of plagioclase (40-45%), K-feldspar (25%), quartz (25%) with <1% of opaque minerals and rare zircon. An original biotite mica (5%) is now partially-to-completely altered to chlorite, and sericitisation of feldspar is widespread. The rock has a medium-grained, porphyritic texture with subhedral phenocrysts of plagioclase (~An<sub>30</sub>). The rock is classified as a granodiorite but adjacent to the (monzo)granite field.

⇒ porphyritic microgranodiorite

**Ffol-R** is an altered rock composed predominantly of feldspar and secondary quartz. Overall it is fine-grained with partially resorbed, sometimes skeletal, phenocrysts of plagioclase (3%; ~An<sub>35</sub>) set in a fine-grained felsic groundmass substantially altered to ovoid secondary quartz. Also present are <1% opaque minerals, <1% chlorite and rare zircon.

⇒ silicified, plagioclase-phyric felsite

