Series E, Set 1a, ROCK SECTIONS.

ROOMS OF THE ROYAL SOCIETY
PICCADILLY, W.1.

2 & 4 TUDOR STREET : LONDON : EC4

SERIES E
MISCELLANEOUS. SET 1.A Rock Sections.

N O T E S
on some of the Petrological Slides in the cabinets of the Quekett Microscopical Club.

I only propose dealing with the Igneous Rocks, and as far as the Cabinets will allow I have taken an example of each of the types into which these rocks are divided.

I have photographed a portion of each slide showing the essential minerals and structure, and have lettered the same for reference. The photographs were taken with a 2in. objective, and the magnification is about 15. It is advisable to use a 2in. objective when searching the slide for the portion photographed.

I have not attempted to give any particulars respecting the structure, &c., of the various types of rocks, but have simply described the slides. Any member desiring to go further into the study is referred to the list of books at the end.

C. H. Goldsmith

Igneous Rocks.

The Igneous Rocks are generally split up into three great division.

The Plutonic are considered as having consolidated at a great depth under high pressure, the Hypabyssal have been intruded as dykes and sheet nearer the surface, and the Volcanic have been extruded at the surface.

These groups are not wholly distinct, as some of the Volcanic rocks can be traced back to the Hypabyssal ones, and the Hypabyssal can in some cases be traced back to the Plutonic.

Each of the above divisions contains several types of rocks, as set out below.

Plutonic.
- Granites.
- Syenites.
- Diorites.
- Gabbros.
- Peridotites, &c.

Hypabyssal.
- Granite Porphyries, &c.
- Porphyries & Porphyrites.
- Diabases.
- Lamprophyres.

Volcanic.
- Rhyolites.
- Trachytes, &c.
- Andesites.
- Basalts.
- Leucite basalts.

This classification will be followed in these notes.

Plutonic Rocks.

The plutonic rocks are without exception holocrystalline, that is, they consist entirely of crystalline minerals without any unindividualised residue.

In the typical structure of these rocks only a few of the minor minerals have developed their external crystal forms, while the majority have interfered with each other, and take whatever shape they can get room for.

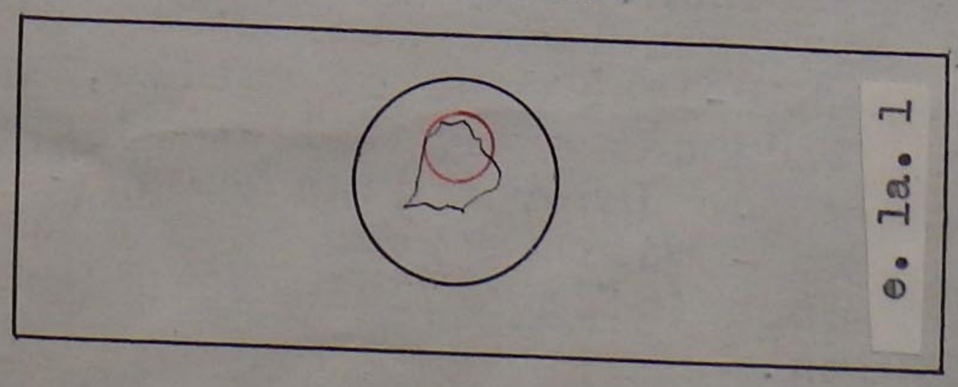
This structure is called "granitoid", as it is essentially that of ordinary granite.

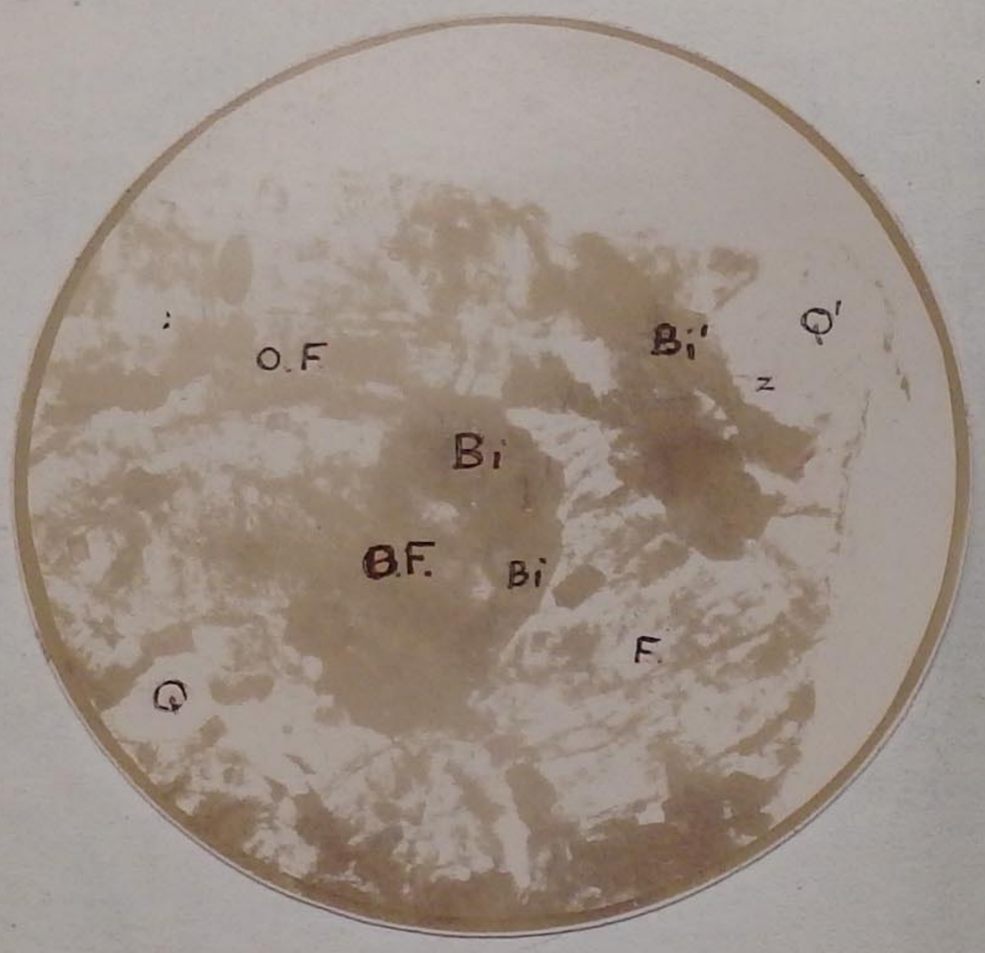
Granite.

Slide E. 1a. 1 Granite, Aberdeen.

The essential minerals in a granite are quartz, orthoclase felspar, and one or more kinds of mica. Hornblende sometimes occurs in place of or accompanying the mica.

The position of the portion of the slide photographed is shown in the rough sketch below.





Granite. x 15.

This is a biotite-granite, consisting of quartz, felspar, and biotite mica.

The quartz is the clear glassy portion, marked Q on photo. The felspar is the portion clouded with dull grey, marked O.F., and is the variety called orthoclase. The biotite mica, marked Bi, is yellowish brown in most positions, but when the longest diameter of the crystal is parallel with the long axis of the polarizer it is nearly black.

The quartz crystal Q' is crowded with hair-like rods of rutile, and also includes a crystal of zircon, marked Z. Under a high power - $\frac{1}{4}$in. or more - will be seen rows of cavities containing a fluid with moving bubbles.

The cloudiness of the felspar is due to chemical alteration with the development of kaolin, &c. This is called kaolinization, and is characteristic of most felspars. It is very seldom that this mineral is found unaltered.

The piece of biotite mica marked Bi' is somewhat decomposed and shows patches of green.

The mica in this slide is a typical biotite, and there is seldom any difficulty in identifying this mineral in other slides, especially when it is borne in mind that biotite is darkest when the length of the crystal is parallel to the long diameter of a single nicol, and is quite dark when parallel to either of crossed nicols.

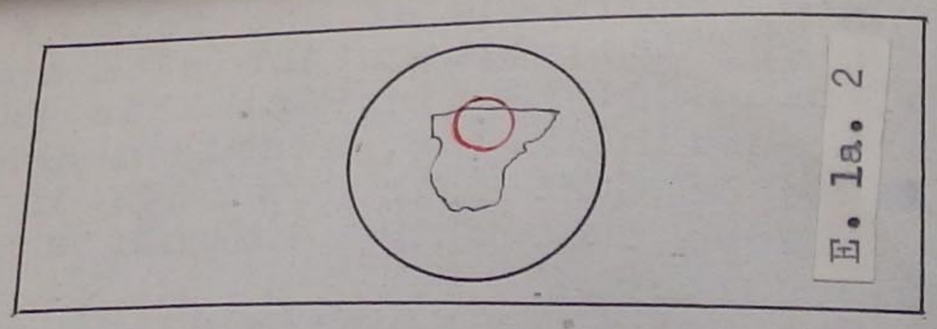
S y e n i t e.

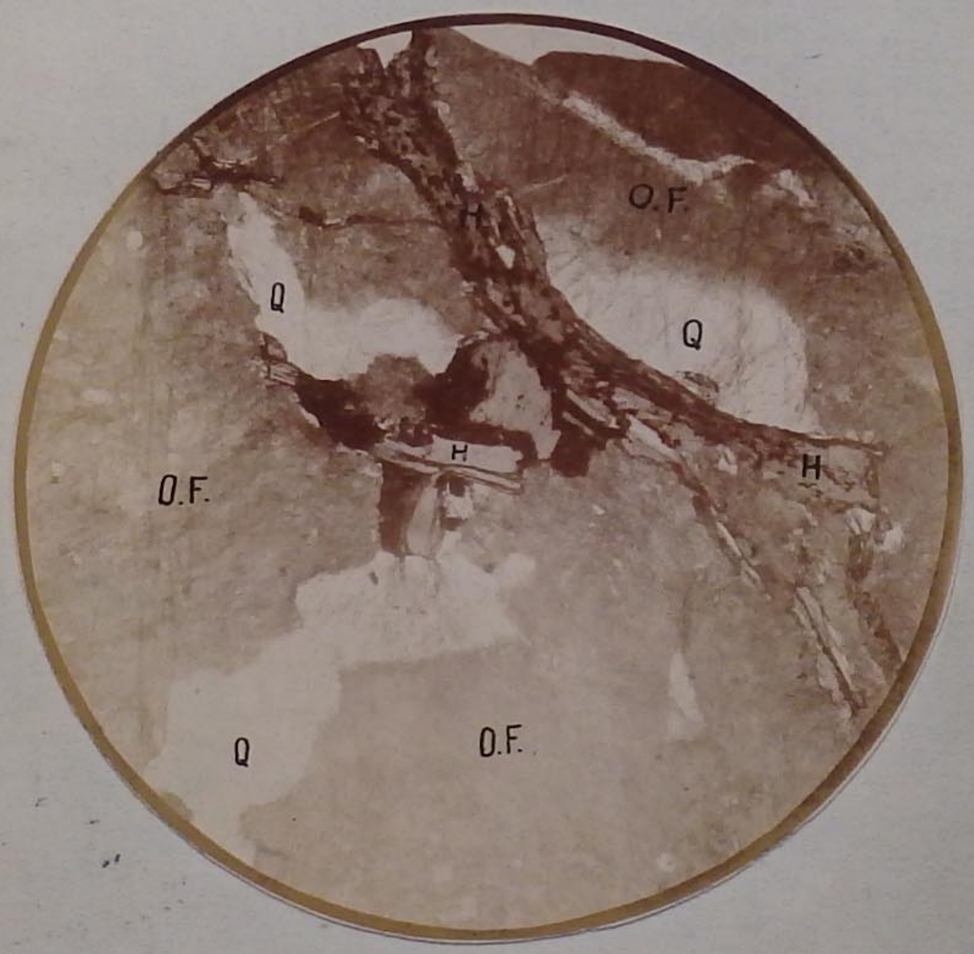
Slide E. 1a. 2 Syenite, Ord Hill.

The essential minerals in syenite are orthoclase felspar and one of the ferro-magnesian group (mica, hornblende, or augite). The felspar is much in excess of the other minerals.

Quartz sometimes occurs, and nepheline (a mineral allied to felspar) sometimes takes the place of or is in addition to the felspar.

The example is a quartz-syenite from Ord Hill, Scotland.





Syenite. x 15.

The orthoclase felspar, O.F., is of a pale reddish tint, being in an advanced stage of kaolinization (alteration into kaolin, &c.) and is stained with iron oxide.

The quartz, Q, is of the usual clear glassy type, and is crowded with strings of cavities.

The greenish crystals, H, are hornblende, and if looked at with only one nicol the mineral is green when the longer diameter of the crystal is parallel to the long diameter of the nicol, but is yellow when the crystal or nicol is turned at right angles. This property is called dichroism, and is useful in distinguishing certain minerals from others.

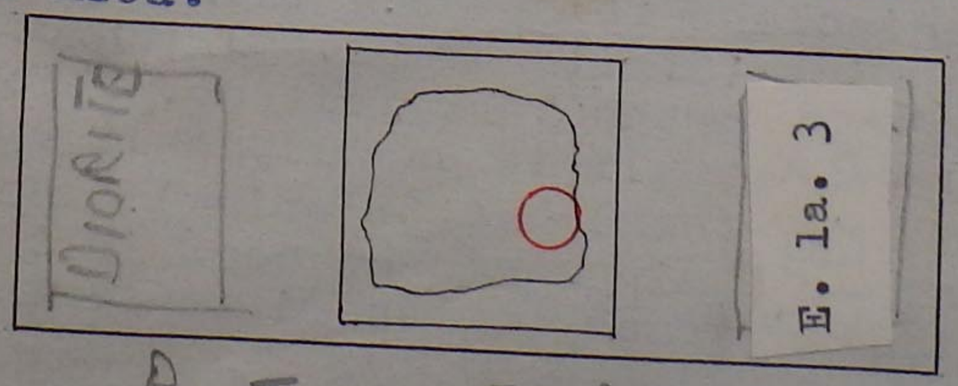
Some hornblende is brown instead of green, and then appears somewhat like biotite, but the dichroism will generally distinguish them. The main distinction between brown hornblende and biotite mica is that with crossed nicols no light passes the biotite when parallel with either nicol, while hornblende does not get dark (extinguish) in this position.

The hornblende in this slide is somewhat altered, and the black specks are magnetic iron ore (magnetite), probably the result of the partial decomposition.

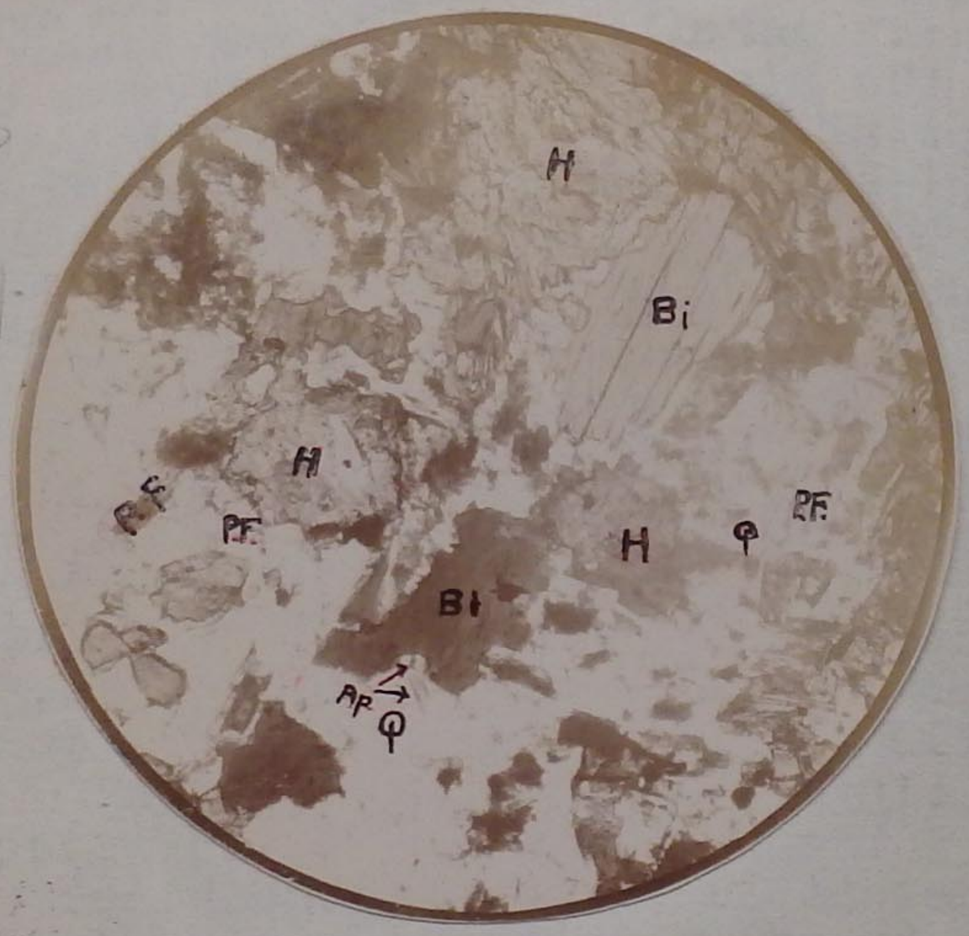
D i o r i t e.

Slide E. 1a. 3. Quartz-mica-diorite. Redritz Lichselgebirge, Germany.

Typical diorite consists of a plagioclase felspar and hornblende. Some varieties also contain quartz and mica.



POSITION OF SLIDE ON STAGE



Diorite. x 15.

The quartz, Q, is of the usual type, and should be easily recognizable.

The felspar, P.F., is the variety called plagioclase and is somewhat difficult to distinguish without polarized light, as it is not so much kaolinized as in the other slides. Between crossed nicols, however, it will be noticed that it is banded dark and light.

This is owing to the crystals being twinned, and is usually seen in plagioclase felspars. This repeated twinning (albite twinning) is not found in orthoclase felspar, which if twinned at all is usually only twinned once (carlsbad twinning). Both these twinnings can be seen in the slide of trachyte described further on.

The large brownish crystals, Bi, are biotite mica. They are very dark brown or black when parallel to the long nicol and yellowish brown in other positions.

The green crystals, H, are hornblende, and change to yellow according to their position with regard to the single nicol.

The small black specks are magnetic iron ore (magnetite), and the two crystals marked Ap are apatite.

G a b b r o.

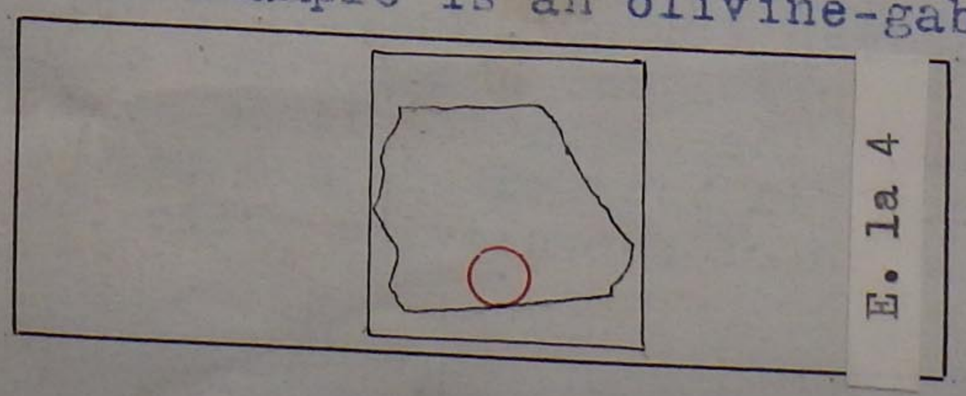
Slide E. 1a. 4 Gabbro, Silesia.

Typical gabbro consists of a plagioclase felspar and augite, and only differs from diorite in the nature of the ferro-magnesian constituent (mica, hornblende, or augite).

Diorite is felspar and hornblende, while gabbro is felspar and augite.

If olivine occurs in addition to the felspar and augite, the rock is an olivine-gabbro.

The example is an olivine-gabbro.



Olivine-gabbro. x 15.

The large crystal shown on the right hand side of photograph full of irregular greenish cracks is olivine altering to serpentine. The clear patches marked Ol are the unaltered olivine, and the serpentine is the pale greenish mineral which has developed along the irregular network of cracks usually found in olivine.

This serpentine is heavily charged with specks of magnetic iron ore.

The clear mineral, P.F., is plagioclase felspar, and under polarized light shows the banding due to twinning. The radiating lines at ϕ are cracks in the felspar due to the expansion of the olivine while turning into serpentine.

The augite, Au, is the variety known as diallage, and shows the fine cleavage lines parallel to the base of the crystal. These are crossed by irregular cracks.

The dark specks here and there are magnetite.

This slide under polarized light shows good examples of albite twinning in plagioclase felspar, and should be studied carefully so that it will be possible to recognize similar minerals in other rocks.

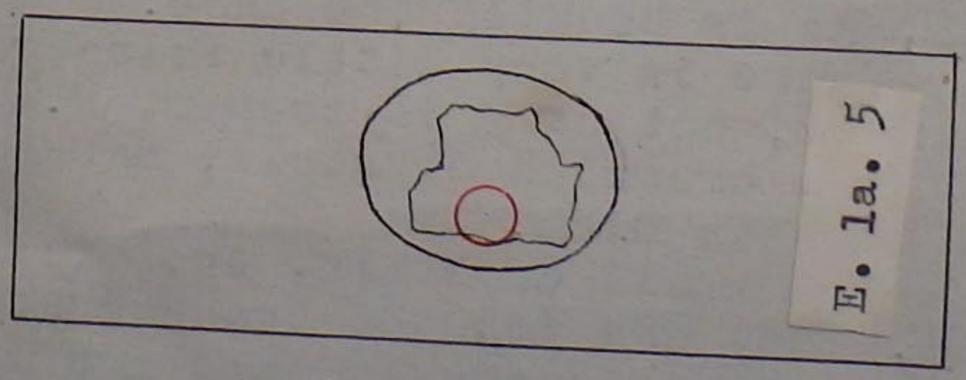
Peridotites and Picrites.

Slide E. 1a. 5 Picrite, Inchcolm.

The essential minerals of peridotite are olivine and augite, with olivine in excess.

Picrite consists of olivine, augite, hornblende and a little felspar.

~~There are no slides of peridotite in the Club cabinets.~~ The example is an augite-picrite from Inchcolm, Scotland.



Augite-picrite. x 15.

The pale purplish brown crystals marked Au, are augite.

The olivine, Ol, is nearly all serpentinized, but there is still a good deal of the unaltered mineral left. The serpentine is nearly all deep honey-yellow coloured, and not green as was seen in the gabbro slide It is heavily charged with magnetite dust, as is usually the case.

There is very little felspar in the rock, but some is seen at P.F.

The brownish crystals, marked Bi are biotite mica.

The small crystals, Ap, are apatite. They are jointed transversely at irregular intervals, and are dull grey under polarized light. They extinguish (become entirely dark) when the length is parallel to either of the crossed nicols.

Serpentine Rocks.

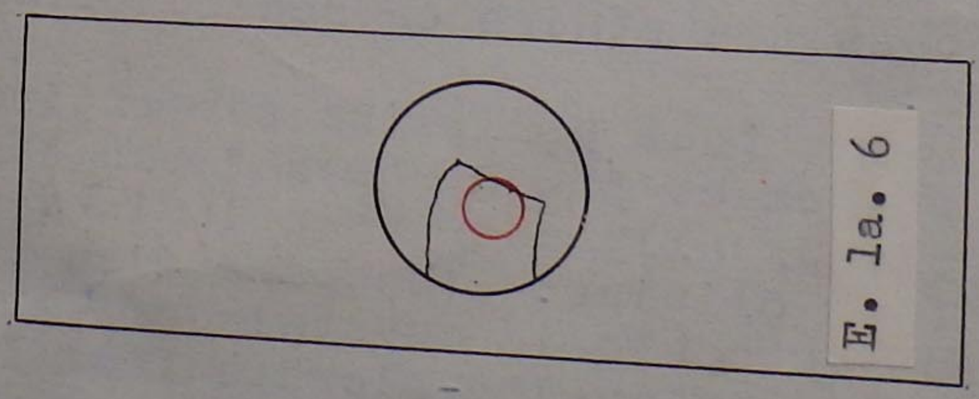
Slide E. 1a. 6 Serpentine, Cornwall.

The serpentine rocks are usually included with the previous type, as they have been formed by the chemical alteration of other rocks, chiefly peridotites and picrites.

These rocks are largely developed in the Lizard district of Cornwall and can be seen in great variety in Kynance Cove.

In most of these rocks relics of the original minerals can be traced.

It is possible to distinguish serpentine derived from one mineral from that derived from another, and in this way a good idea can be obtained of the original rock.



Serpentine. x 15.

The crystal at top of photo is composed of the variety of serpentin called bastite, and the original cry tal was probably enstatite, which is a mineral allied to augite and is found in some varieties of peridotit

Under crossed nicols it will be seen to be made up of parallel fibre which do not cross the irregular cracks in the crystal. The reddish patches are stains caused by oxide o iron.

The pale yellowish serpentine at bottom of photo shows "mesh struc ture", usually seen when it is deriv ed from olivine. (Compare with the same structure in crystals of olivin in slide of augite-picrite from Inch colm). The usual specks of magnetite accentuates the structure.

There is apparently no unaltered olivine left in this slide, but in some of my own slides of similar rocks from the same locality there are small pieces here and there.

There is no doubt that this rock was originally a variety of peridot- ite, composed of a ground mass of ol- ivine in which were embedded large crystals of enstatite.

-

H y p a b y s s a l R o c k s.

This group contains the inter- mediate rocks which cannot convenient ly be classed with either the Pluton- ic or the Volcanic.

It is not a well defined divis- ion, as the rocks contained in it gradate into the other two groups, but there are sufficient grounds for separating them.

A c i d I n t r u s i v e s.
(Pitchstones, felsites, granite- porphyries, quartz-porphyries).

Slide E. 1a. 7. Felsite, Mt. Sorrell.

This type includes a considerable range of varieties, connecting the granites with their volcanic equivalents, the rhyolites.

The rocks as a whole are porphyritic, that is, have large crystals of one or more minerals embedded in a finer ground mass. This ground mass varies from entirely crystalline to entirely glassy. The rocks, however, agree in having the same constituent minerals so far as they are developed.

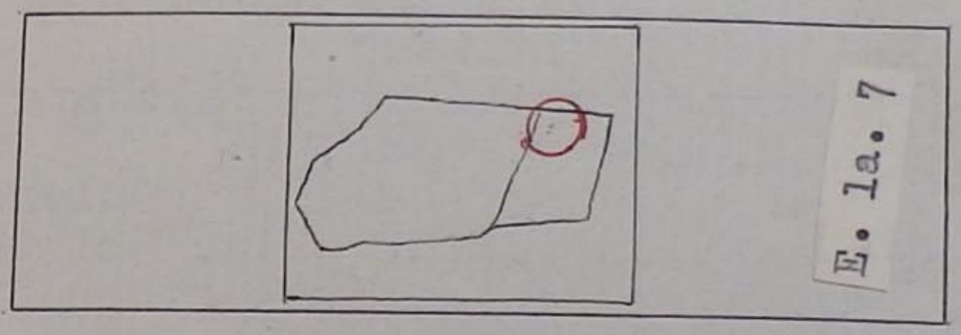
Felspar is the main porphyritic constituent, with usually some quartz These minerals also form the ground mass. There is very little of the ferro magnesian minerals.

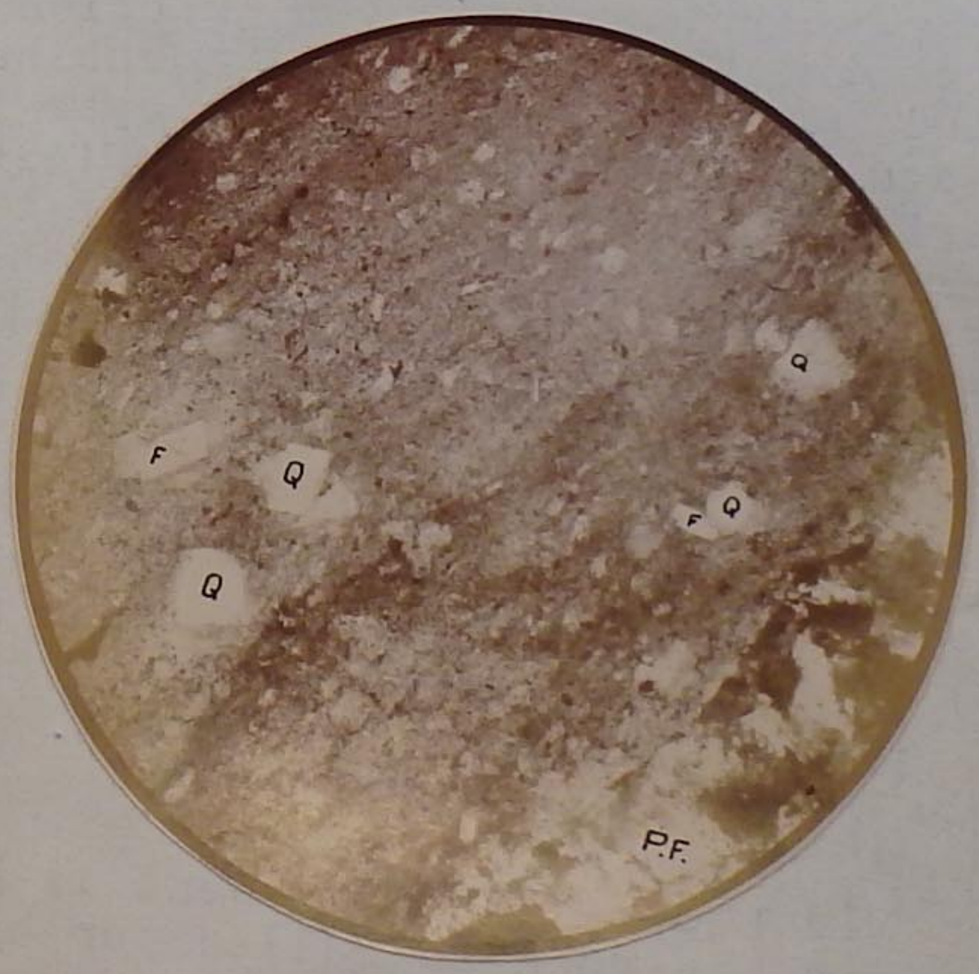
The groundmass of the pitchstones is glassy, in which are generally great numbers of small imperfectly developed crystal growths.

The groundmass of the porphyries is usually a finely crystalline aggregate of irregular grains of felspar and quartz.

If these constituents are plainly resolvable under the microscope this type of base is called "microgranitic", but when the base is so fine that the constituent minerals cannot be resolved properly it is called "cryptocrystalline" or "microfelsitic". The power used has little to do with this resolving, and with slides of ordinary thinness it is a question of whether the grains are smaller in diameter than the thickness of the section.

Rocks of this group are not well represented in the cabinets, but I have selected a felsite from Mount Sorrell, to illustrate the felsitic type.





Felsite. x 15.

This rock consists of a fine grained groundmass, in which are imbedded a few clear glassy crystals.

Under crossed nicols the section shows a general dappled appearance, due to the grains being in layers one over the other. This is typical of the microfelsitic groundmass. It is

impossible even under a high power to distinguish the different particles owing to their being one over the other, but there is no doubt they are quartz and felspar.

The porphyritic crystals are quartz, Q, and felspar, F.

There is a piece of hornblende in one portion of the slide between two quartz crystals, (not shown in photo).

The photo shows the junction between the felsite and the hornblende granite. This felsite is a dyke intruded into the granite. The felspar, quartz, mica, and hornblende in the granite can easily be distinguished by the particulars given respecting previous slides.

Porphyries and Porphyrites.

If the main constituent is orth felspar the rock is called porphyry and if plagioclase felspar predominates the rock is a porphyrite.

The structure of these rocks is typically porphyritic, with crystals of felspar embedded in a groundmass of small felspars, with a little mi and augite, and sometimes hornblend

There are no slides of this ty in the cabinets of the Club.

D i a b a s e.

Slide E. 1a. 8 Diabase, Edinburgh.

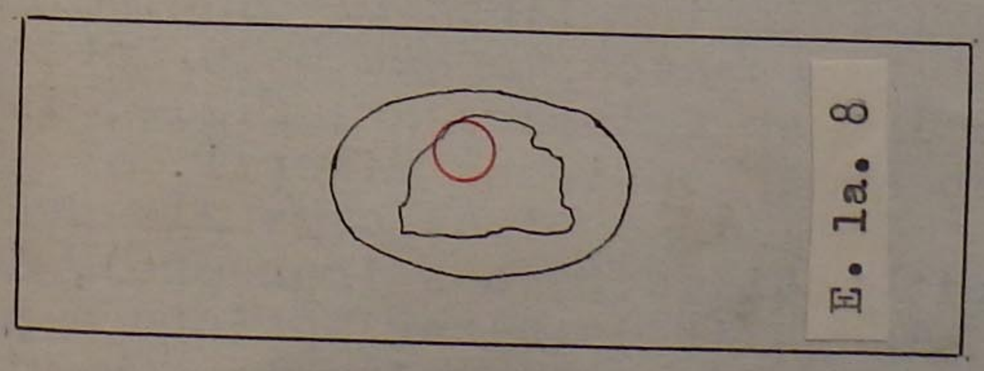
The essential minerals are plagioclase felspar and augite. If olivine is present in addition, the rock is called olivine-diabase.

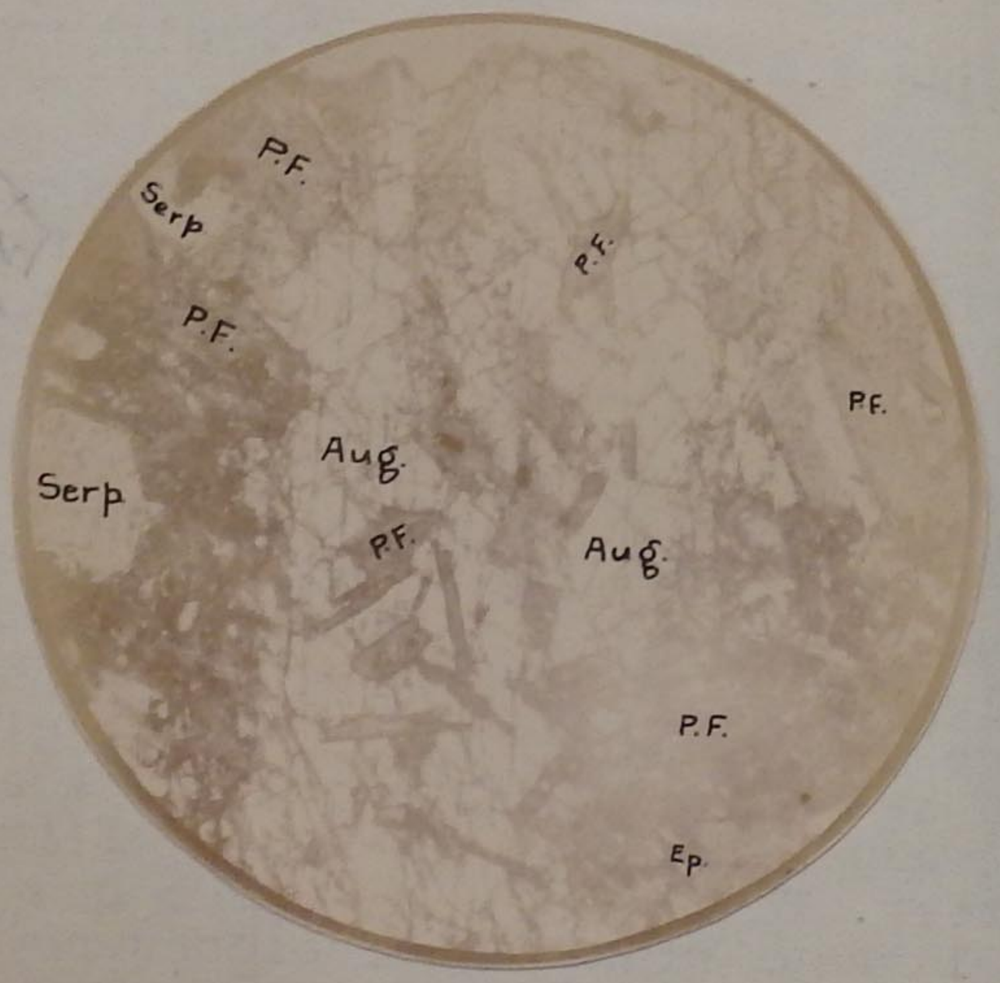
It will be noticed that the constituent minerals are the same as in gabbro.

The structure of these rocks, however, is different to that of normal plutonic rocks, as the felspars have crystallized before the augite, and several crystals of the former are usually included in one of the latter. This structure where one mineral wraps round and encloses crystals of another mineral is called the "ophitic".

This structure is typical of the diabases, and distinguishes them from the gabbros, which are composed of the same minerals.

It is well shown in the slide selected to illustrate the type.





Diabase. x 15.

The large crystal, marked Au., is augite enclosing lath shaped crystals of felspar. This is the typical "ophitic" structure.

The felspar is much decomposed, and therefore shows very poorly the usual twinning lines of plagioclase.

The spaces, marked Serp, between the larger felspars are filled in with a serpentinous mineral.

The large black crystals are ilmenite (titaniferous iron ore), and at places it is altering into a pale brownish mineral, which is a variety of sphene called leucoxene.

The yellow crystals, marked Ep. are epidote.

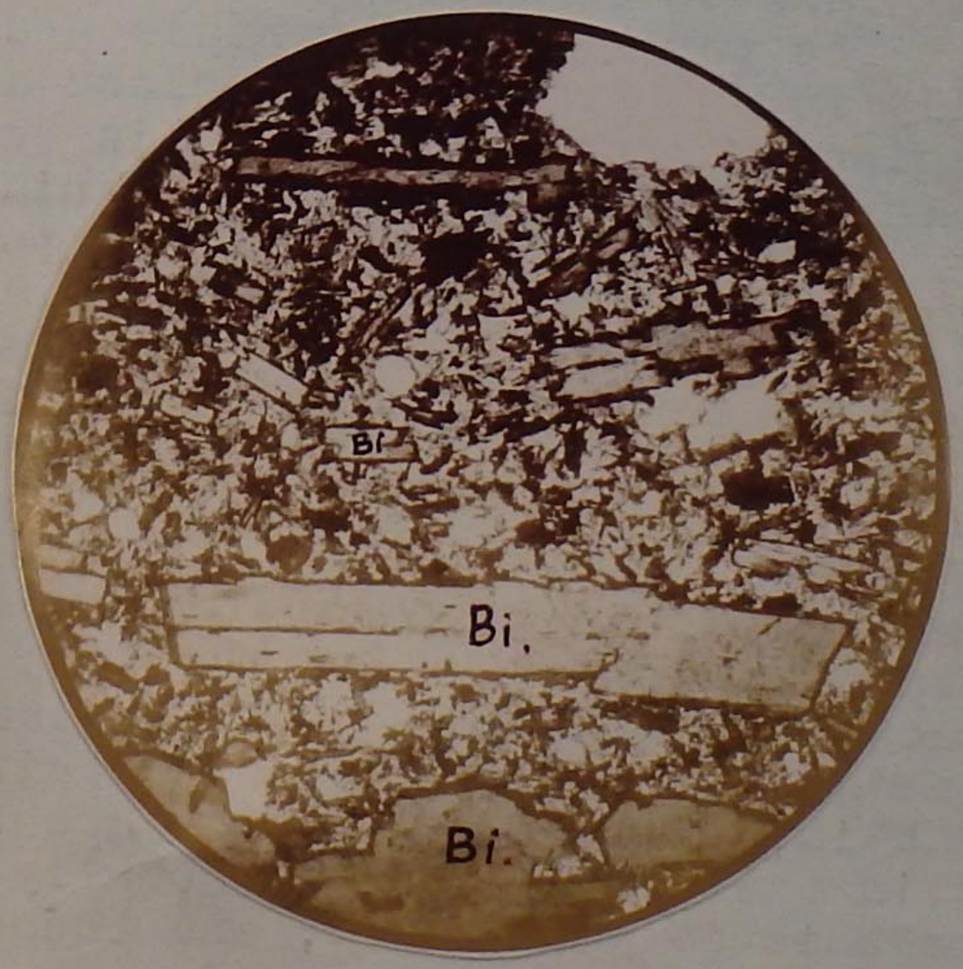
L a m p r o p h y r e s.

Minette, Kersantite, Vogesite, and Camptonite.

These are porphyritic rocks, but differ from the other types already described because it is the ferromagnesian constituent (mica, augite, or hornblende) that forms the large crystals embedded in a groundmass of small felspars.

There is no slide in the Club cabinets illustrating this type, so I have shown a photograph of one of my own slides. (Sec 4 B 80 + 34)

This is a minette, consisting of porphyritic crystals of biotite mica embedded in a ground mass of small orthoclase felspars and mica.



Minette. x 15.

Volcanic Rocks.

This group includes the rocks that have been extruded at the surface as molten lava, and they have characters sharply in contrast with the rocks of the Plutonic group.

Most of these Volcanic rocks ar porphyritic, and there is usually more or less glassy residue in the ground mass.

Rhyolites.

The rocks of this type vary fr all glass to completely crystalline

The porphyritic crystals are u ually felspars, both orthoclase and plagioclase. The orthoclase is usua ly the clear variety called sanidin

Quartz is also found as a porphyritic constituent.

Mica and augite are sometimes present, but are not very plentiful

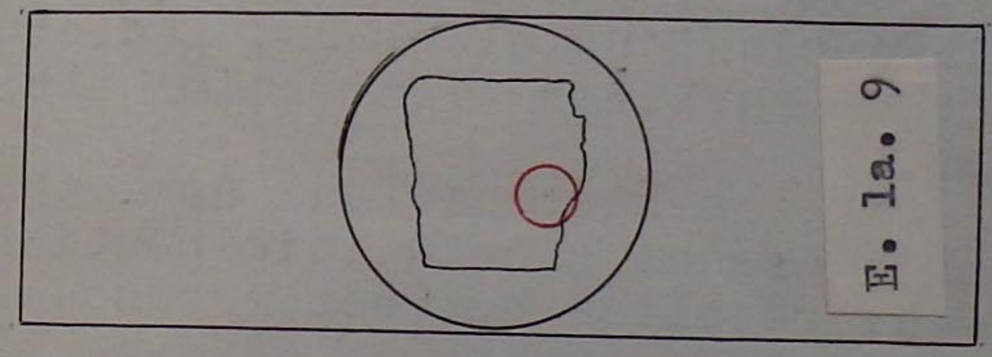
The entirely glassy type is ca led obsidian, and looks very much like ordinary bottle glass. These glassy rocks often show a series of concentric cracks due to unequal co traction when cooling. They also have a great tendency to devitrify, that is, incipient crystals are for ed in the glass until eventually there is no glass left, and the roc has a microfelsitic ground mass.

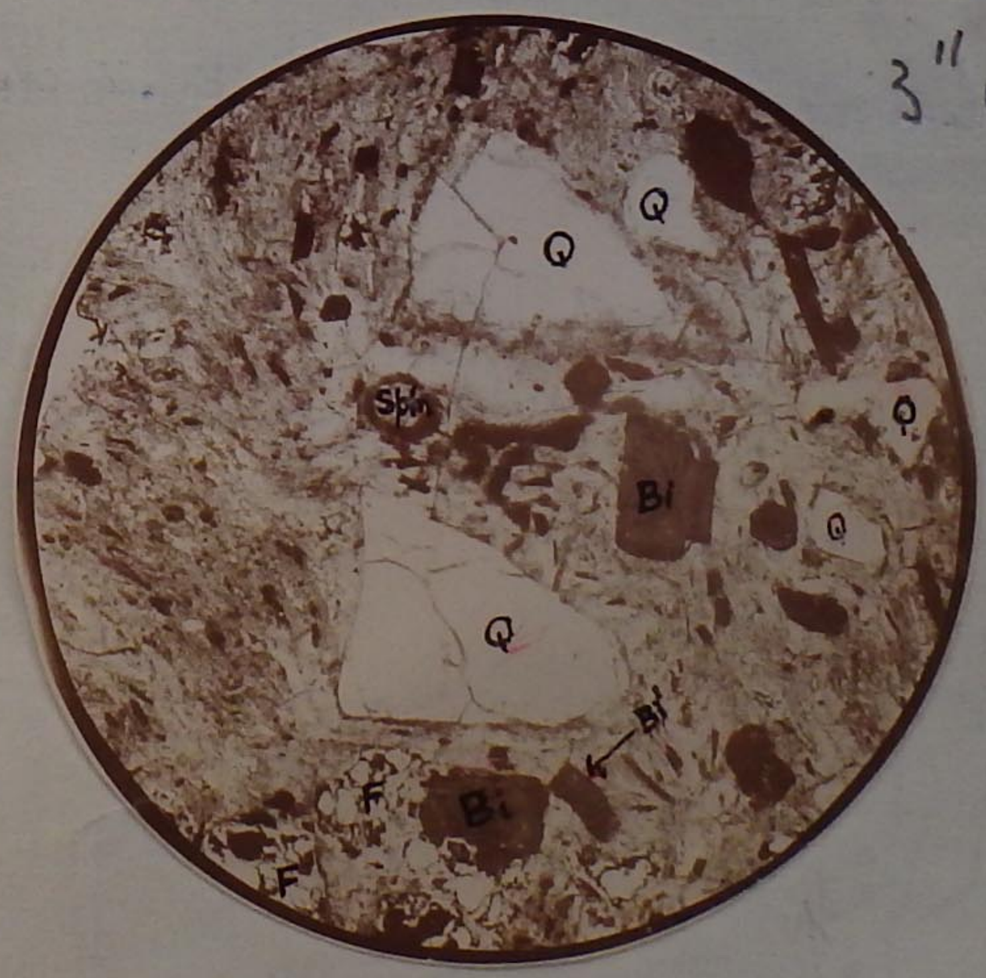
This process generally begins around the concentric cracks and other lines of fracture, and is beautifully shown in the glassy rhyolites (pitchstones) from Meissen. See the slide E. la. 10

I have chosen two slides to illustrate this type.

E. la. 9 illustrates the porphyritic type with microfelsitic ground mass, and E. la. 10 the glassy type with perlitic cracks and incipient devitrification.

Slide E. la. 9. Rhyolite, Hungary.





Rhyolite. x 15.

The porphyritic crystals, Q, ar quartz, and are cracked in various places.

The brown crystals, Bi., are bi tite mica, and the large spongy look ing crystals are felspar.

The ground mass is microfelsit and shows the typical flow structure from which the rock takes its name.

The small microlites in the ground mass curve round the larger crystals, and then run on straight again.

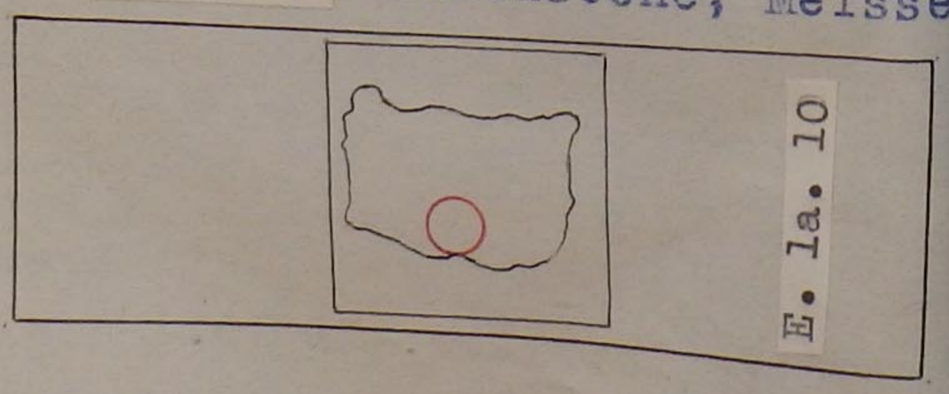
The crystal of biotite mica, marked Bi', is curved.

Some of the quartz crystals co tain inclusions of glass, and others contain cavities with fluids and bub bles.

At the spot marked Sph. there is a somewhat spherulitic portion, and if revolved between crossed nic ols it shows a roughly defined blac cross. This tendency of the micro- lites to form radiating masses is a common feature in some of the rhyol ites.

This slide is a typical rhyoli with a microfelsitic base, but whet er this base is original or a produ of devitrification is not determin- able from the slide.

Slide E. 1a. 10. Pitchstone, Meissen



Pitchstone. x 15.

The porphyritic crystals, Q, are quartz, and are traversed by irregular cracks. These crystals can be best seen under crossed nicols.

The top one has been corroded by the ground mass at x.

The ground mass is a clear yellowish glass, and is perfectly dark in all directions under crossed nicols. This glass is intersected by concentric cracks, giving what is called "perlitic" structure.

Along these cracks devitrification has commenced, so that under crossed nicols they are marked out by lines of light.

The flow structure in the rock is shown by the sinuous bands of darkish dust, marked F.S. The spherical cracks cut across these flow lines

without interfering with their course which proves that the perlitic structure is later than the flow structure.

The cracks in some places are heavily stained with oxide of iron.

There are one of two pieces of biotite mica in this slide, marked Bi.

At places the devitrification has a tendency to form spherulitic aggregates.

T r a c h y t e s,
Phonolites, and leucitophyres.

The trachytes are lavas with less quartz than the rhyolites.

The porphyritic constituents are orthoclase felspar (usually the variety sanadine) and plagioclase, embedded in a fine grained ground mass of felspar crystals.

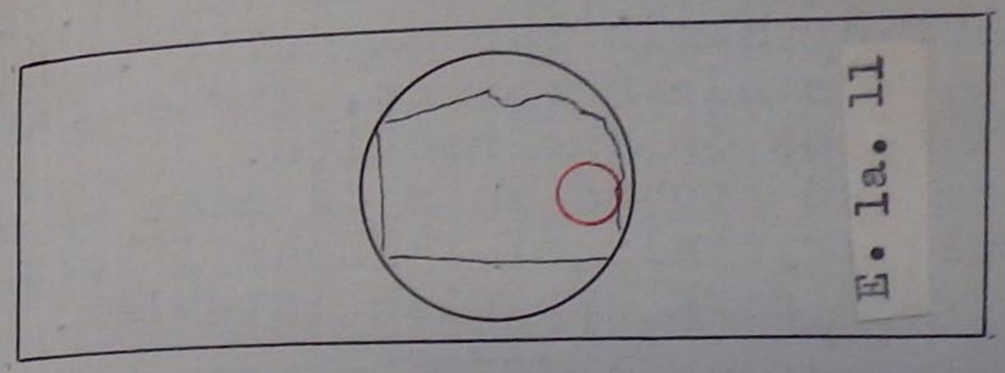
Other usual minerals present are biotite mica and augite.

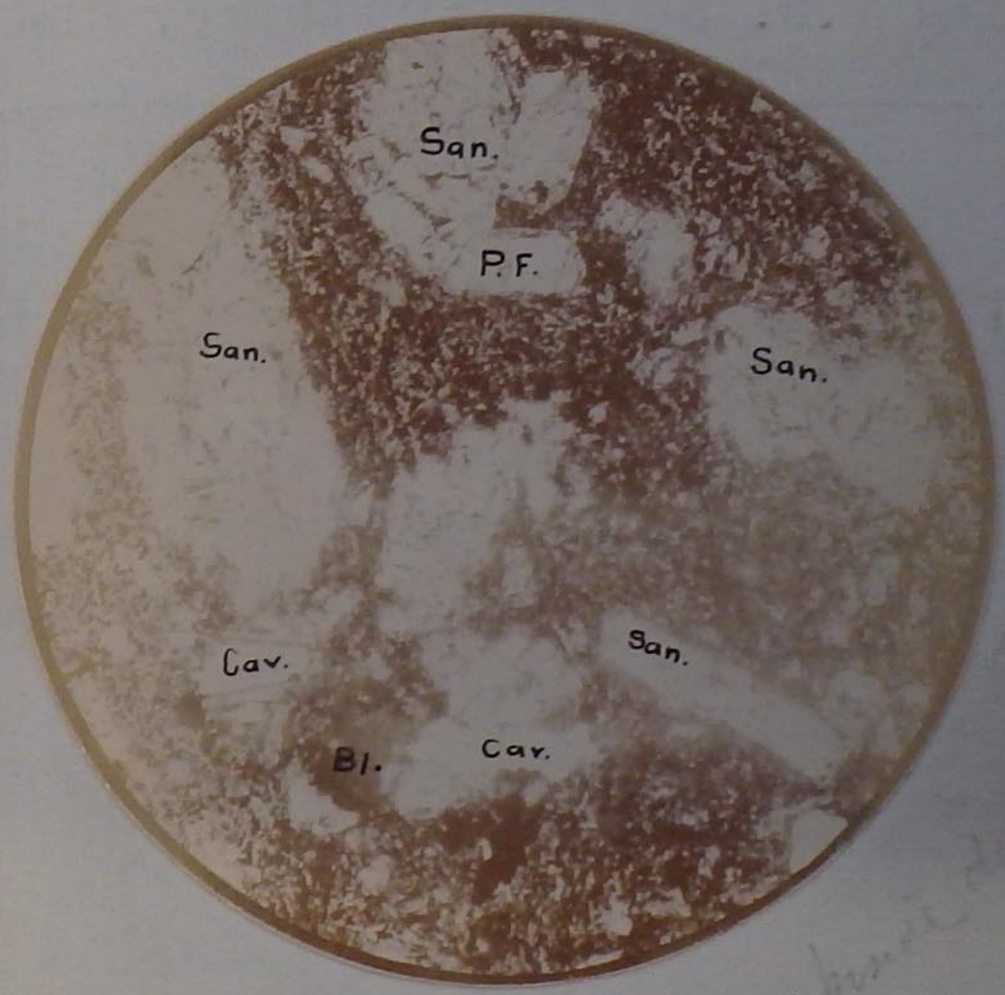
The Phonolites contain nepheline and nosean in addition to the minerals present in trachyte.

There are no slides of phonolite in the Club collection.

In the Leucitophyres the porphyritic constituents are leucite (a mineral allied to felspar) and nosean embedded in a fine ground mass of felspar, aegerine augite, and nosean

Slide E. 1a. 11. Trachyte, Rhine.





Trachyte. x 15.

The large crystals, marked San, are sanidine - the glassy variety of orthoclase felspar - and in polarized light show banding parallel to the edges of the crystal. This is called zoning, and is due to inclusion of foreign matter during the growth of the crystal.

The crystal of plagioclase fels-

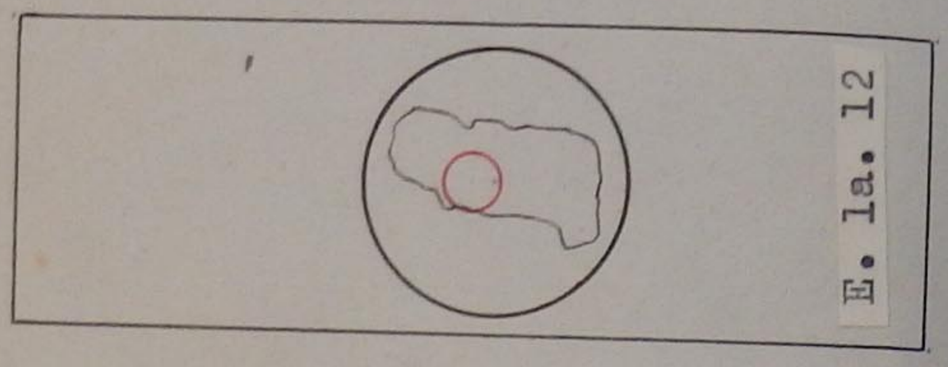
par, marked P.F., shows albite and carlsbad twinning at the same time.

Biotite mica is marked Bi. The black crystals are magnetite.

The clear spaces, marked Cav., are holes in the section.

The ground mass is made up of small crystals of felspar interspersed with dark brownish material.

Slide E. 1a. 12. Leucitophyre, Rieden.



Leucitophyre. x 15.

The clear glassy crystal, Leu., is leucite, a mineral closely allied to felspar, and under crossed nicols shows the typical twinning which cannot be mistaken. The polarization colours are never above blackish gray.

The crystal, lettered Nos., is nosean, which has a dark border and contains rows of cavities containing glass. These can be well seen under a $\frac{1}{2}$in. objective. This mineral is dark in all positions between crossed nicols. Most of this nosean is stained with oxide of iron.

The long greenish yellow crystals, marked Ac., is a variety of augite called acmite.

The crystals, Ap., are apatite, and are dark when parallel to either nicol.

The large crystal, marked, San, is sanidine, which is found very sparingly in this rock.

The ground mass is made up of small greenish crystals of aegerine (another variety of augite), small white laths of nepheline, small leucites, and nosean.

A n d e s i t e s.

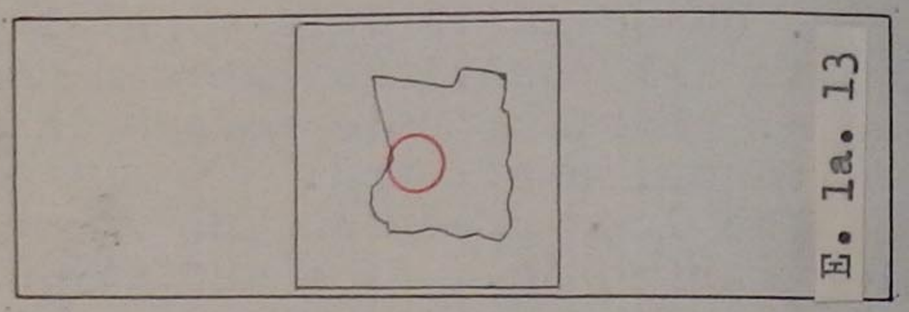
Slide E. 1a. 13. Andesite, Rhine.

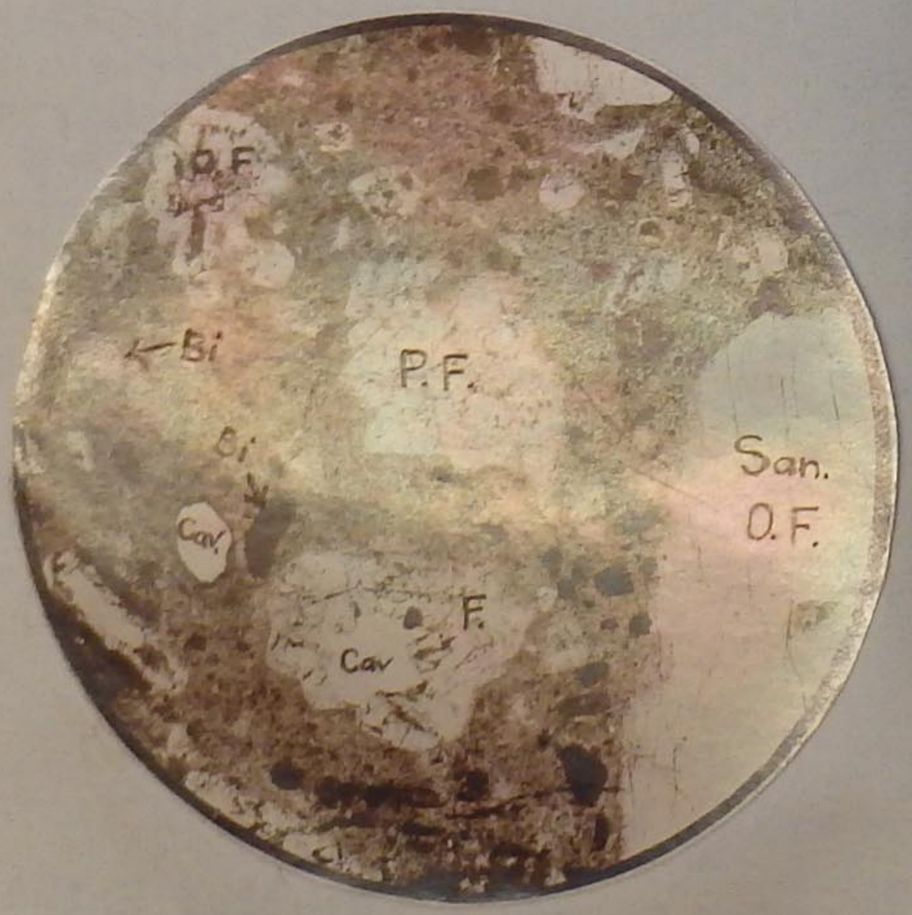
These rocks are of intermediate composition, and their old name of

"trachy-dolerite" indicates their position between the trachytes and the dolerites.

The essential minerals are plagioclase felspar and one or more of either mica, hornblende, or augite, embedded in a mass of small felspars.

Quartz is sometimes present, but is not common.





Andesite. x 15.

This is a typical mica-andesite showing the fine grained ground mass in which are embedded porphyritic crystals of felspar and biotite mica.

The crystal, marked O.F. is orthoclase felspar showing carlsbad twinning. P. F. is plagioclase felspar showing typical albite twinning.

The biotite mica is marked Bi. The ground mass in this slide is somewhat felsitic, but in most andesites the ground mass is made up of a felted mass of little laths of felspar.

D o l e r i t e s
a n d B a s a l t s .

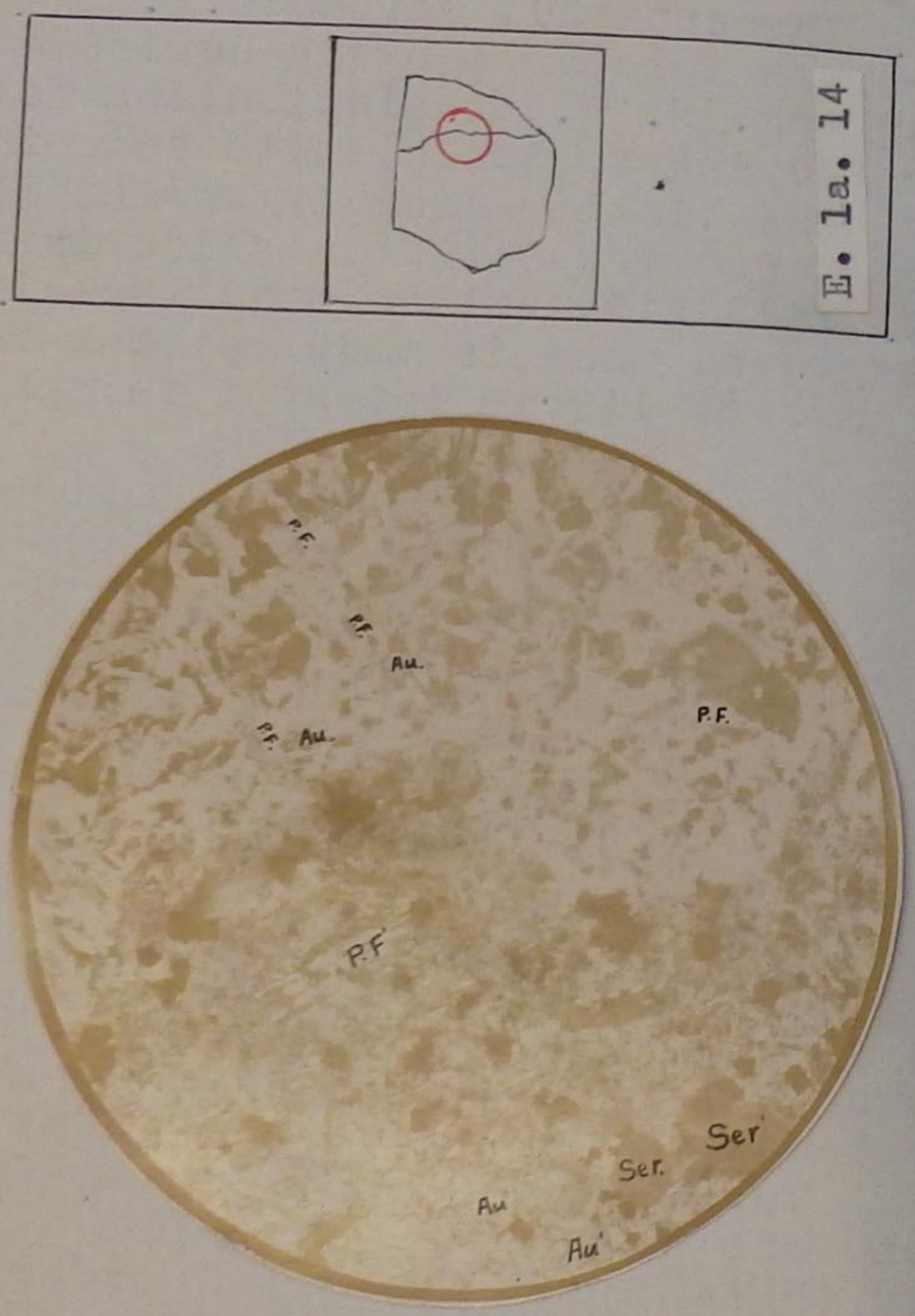
Slide E. 1a. 14. Basalt, Rowley Regis.

This type includes all the basic lavas with the exception of those containing leucite and nepheline.

The essential minerals are plagioclase felspar, augite, and olivine, and these usually occur as large crystals in a finer ground mass. This ground mass usually consists of small felspars, with grains or crystals of augite and some iron ore.

The dolerites are somewhat coarse grained, and seldom have any porphyritic constituents.

Some of the basalts also have no porphyritic structure, but these are then very fine grained compact rocks. A good example of this non-porphyritic type is the rock of the Giant's Causeway.



Basalt. x 15.

The photo shows the junction between the fine grained basalt and the coarser dolerite.

The coarse portion is composed of laths of felspar, marked P.F., between which are a few grains of augite, marked Au.

The black crystals are magnetite and the brownish stains are oxide of iron.

The ground mass of the basalt is crowded with small granules of augite (recognised by their high polarization colour) and comparatively few laths of felspar.

P.F'. is a large crystal of plagioclase felspar, Au' is augite, and the green crystals, marked Ser., are olivine altered to serpentine.

There is no unaltered olivine in this slide, but in some of my sections from the same locality original olivine can be seen.

Some of the magnetite shows crystal form.

There is some glassy residue in the ground mass which is dark in all directions between crossed nicols.

Leucite and Nepheline Basalts.

These rocks are very basic lavas containing one or more of the felspar like minerals (leucite, nepheline, &c.) with or without the addition of plagioclase felspar.

The other minerals present are olivine, augite, magnetite, &c., and the rocks are of interest because it appears that only modern volcanoes (comparatively speaking) emit lava of this description.

The lava from the last eruption of Vesuvius is a leucite-tephrite belonging to this type.

There ~~are no slides in the Club cabinets illustrating this type, and the~~ rocks do not lend themselves well to photographic representation.

ooooo
ooo
o

The Club library contains two books on Petrology,

The Study of Rocks, by Rutley.
British Petrography, by Teall.

A good book for a beginner is the Text-book of Petrology, by Hatch, price ~~4/6~~ 7/6. This gives information respecting the rock-forming minerals. New edition.

The best book on the subject, however, is undoubtedly "Petrology for Students", by Harker. This is one of the Cambridge Science Manuals, and is published at 7/6. There is a new and improved edition just published.