The Petrography of the Igneous Rocks from Pouk Hill, Near Walsall

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Summary

Recently collected specimens of igneous rocks from Pouk Hill are described. Four distinct rock types, fine grained, partly tuffaceous margin, fine grained porphyritic amygdaloidal basalt, olivine dolerite/olivine teschenite, and an alkalic pegmatitic phase were encountered in the study showing the outcrop to be as alkalic as its associated igneous rocks in the West Midlands.

Introduction

The igneous rocks of Pouk Hill belong to the fairly extensive basalt and dolerite associations that outcrop within the West Midlands area. Other examples occur at Rowley Regis, Barrow Hill, Kinlet, Little Wenlock, Wednesfield, Doseley and the Clee Hills. These igneous rocks are largely confined to occurrences within sediments of Carboniferous age, although a few cut younger rocks as exemplified by the intrusion into the Keuper Marl of the Butterton Swynnerton Dyke in North Staffordshire (Gibson, in Barrow et al. 1919; Scott, in Gibson 1925).

Their age has been a matter of dispute, for they have strong petrographic similarities to some Scottish Tertiary basic alkaline rocks, especially those from Arran and the Midland Valley of Scotland. However, although most are intrusive, there is evidence of contemporaneous Carboniferous eruption of basaltic lavas and their subsequent weathering and so the rocks have generally been assigned to that age.

Petrographically all the West Midlands igneous rocks are similar, being alkali olivine basalts and dolerites, or their analcime bearing equivalents (analcime basalts and teschenites) together with minor amounts of late stage more alkalic rocks.

Previous Research

Allport (1870, 1874) was the first to recognise and describe in detail two of the major rock types from Pouk Hill, namely an ophitic olivine dolerite and a microporphyritic basalt. His descriptions were repeated by Teall (1888). Allport (1874) established the major minerology of the rocks although it was Thomas, in Barrow et al. (1919) who gave a more precise identification of the plagioclase as labradorite, the pyroxene as titanaugite and the unknown zeolite as natrolite and who first recognised the presence of a green pyroxene in association with analcime. A photomicrograph of the olivine-dolerite from Pouk Hill together with a description is given by Robertson, in Whitehead et al. (1928).

No other igneous rock types have been described (in detail) from Pouk Hill although they are known from elsewhere. Robertson, in Whitehead et al. (1928) described olivine teschenites, and sölvsbergites (sensu lato) from Wednesfield and Doseley, and Phemister, in Whitehead and Pocock (1947) described theralites from Kinlet. Whitehead, in Eastwood et al. (1925) and in Whitehead and Eastwood (1927), described the rocks of Rowley Regis including a pegmatitic phase comprising plagioclase with albite margins, augite, ilmenite plates and large oligoclase-albite perthites together with apatite and analcime. An even more extreme rock type was described occurring as late stage veinlets cutting all other rocks and composed of orthoclase or ?albite, green pyroxene, natrolite and analcime replacing nepheline.

The petrographical similarity between the West Midlands basic rocks and some Scottish Tertiary ones was first noticed by Allport (1874) and re-emphasised by Teall (1888). This petrographic similarity has also been noted by others notably by Scott, (1925).

Petrography

Six hand specimens were collected to ensure inclusion of as wide a range of igneous rock types as possible. With the exception of the fine grained contact which came from the western exposures close to sections X and Y, all were collected from the northern face of the quarry close to sections C and D (see Fig.1.).

Eight thin sections and nine polished sections were prepared for petrographical studies (Fig 2.). These were supplemented by X-ray diffraction work which assisted in the identification of the fine clay fraction and in confirming the identity of the major zeolites.

Four distinct rock types were encountered, namely

(1) a very fine grained and partly tuffaceous margin.

(2) a fine grained porphyritic amygdaloidal basalt - with olivine pseudomorphs, labradorite, titanaugite, titanmagnetite and ilmenite laths, analcime and natrolite.

(3) an olivine dolerite/olivine teschenite-with olivine pseudomorphs, labradorite, titanaugite, equant grains of titanmagnetite, analcime with minor amounts of green and brown amphiboles.

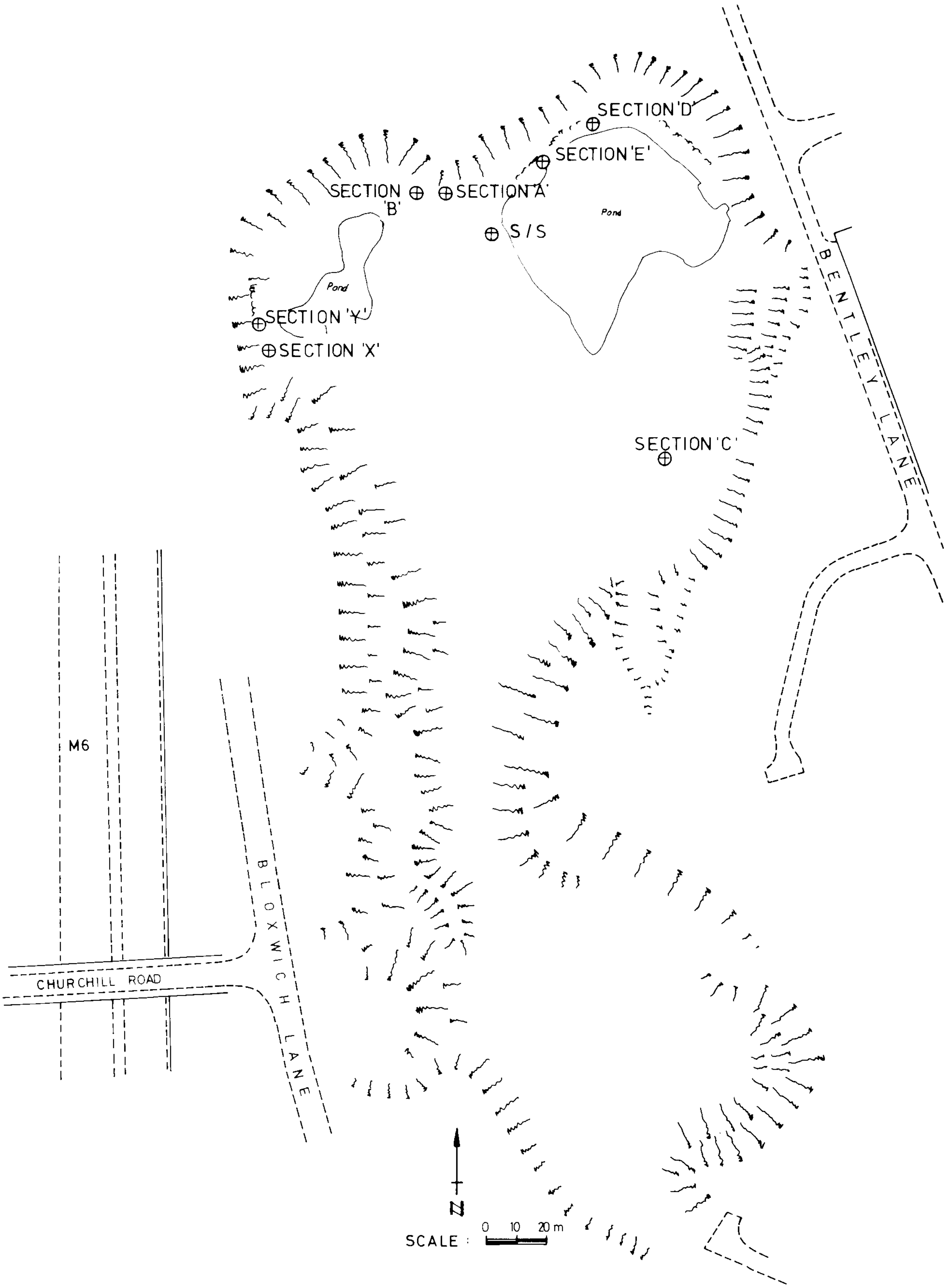
(4) an alkalic pegmatitic phase - with an oligoclase/albite plagioclase, green and brown amphiboles, green pyroxene, apatite and analcime.

Alteration is variable but is often extensive and includes veining of all the rock types by calcite, chalcedony, chloritic minerals and natrolite.

Tuffaceous Margin

The margin is a fine grained grey-green massive rock having both rounded and angular basalt fragments. Texturally these basalts range from amygdaloidal aphanitic basalts to holocrystalline ones. Other rock types are rare but may include some quartz mosaic sediment. Although much of the brecciation of this rock is later, the variability of the basalts and roundness of some fragments suggests that it is in part tuffaceous.

The amygdaloidal basalt fragments consist of replaced olivine phenocrysts set in a very fine matrix of altered plagioclase microliths, chalcedony, calcite and clay minerals, amongst which montmorillonite and kaolinite were identified by X-ray diffraction. The olivine is pseudomorphed by calcite and to a lesser extent by serpentine minerals although relict 10 - 20μm brown spinels (probably chromite), which are inclusions within the olivine, are unoxidized. Flett, in Gibson (1905) noted their presence in altered olivines from the Butterton Dyke, together with green octahedral spinels. In extremely altered basalts the presence of these octahedral spinels may be the only indication of the former presence of olivine.



POUK HILL - RECORDING & SAMPLING - SUMMER 1976

(B. C. G. S.)

Location of Sections at Pouk Hill

Fig. 1.

1. MAIN OLIVINE TESCHENITE

Equant grains of titanmagnetite (white) are intergrown with titanaugite (light grey) and plagioclase laths (top centre). Analcime and olivine pseudomorphs (soft and grey) are also present. Reflected Light, air, x 40

2. OLIVINE TESCHENITE CLOSE TO THE OLIVINE BASALT JUNCTION

Equant grains of titanmagnetite (white) within a finer matrix of titanaugite, plagioclase and clays. The groundmass is more feldspathic than in photomicrograph 1. Fibrous natrolite (N) contains a euhedral crystal of analcime (A). Reflected Light, air, x 40

3. BASALTIC LAVA

Sub-parallel laths of titanmagnetite (M) and ilmenite (I) in a very altered matrix of clays and carbonate. A small calcite (C) amygdale is present. Reflected Light, air, x 40

4. OLIVINE TESCHENITE

A euhedral titanmagnetite showing alteration to haematite and rutile along edges and cleavage, especially at the bottom and top left of the grain. Reflected Light, air, x 160

5. PEGMATITIC PHASE

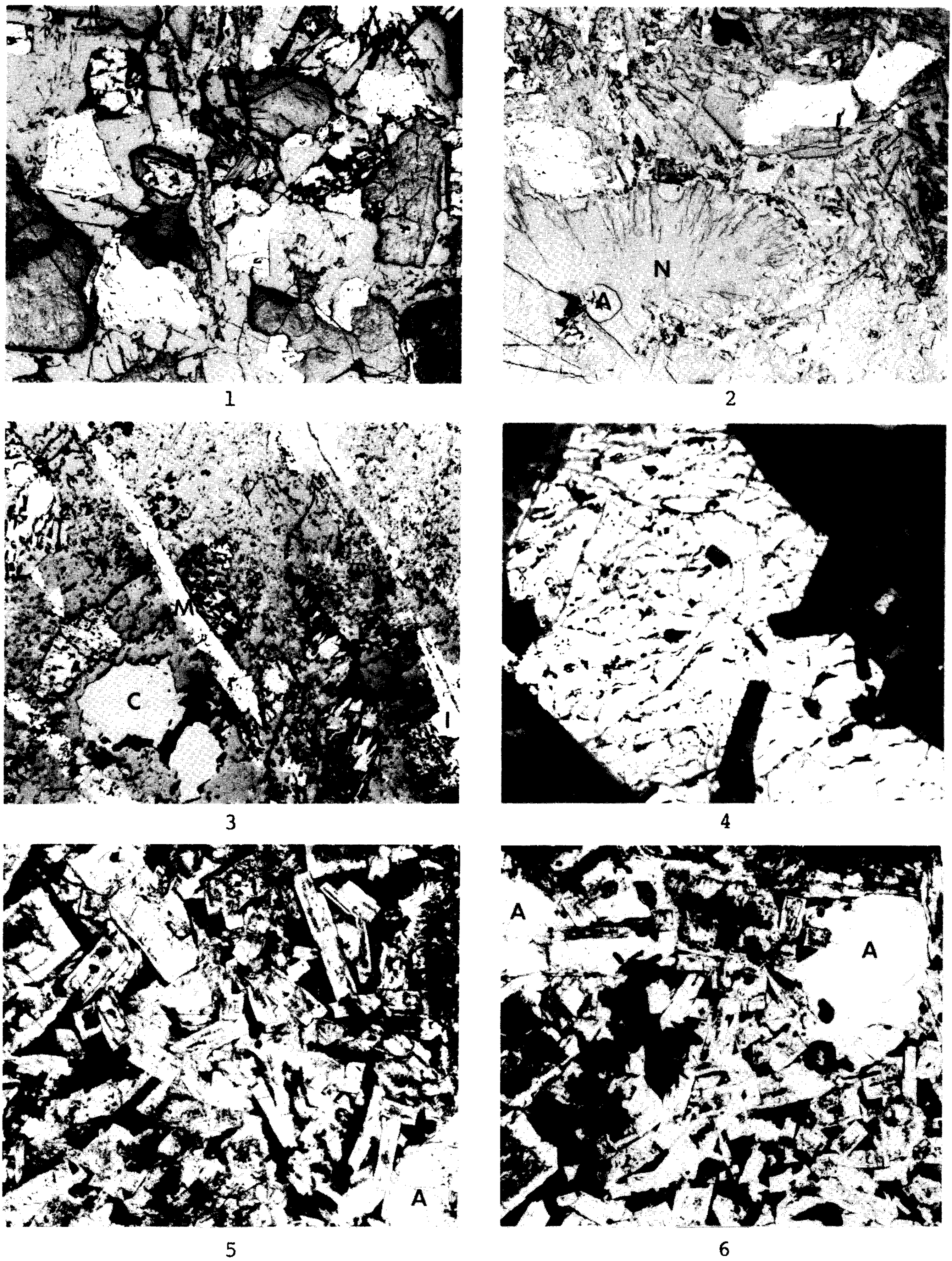
Stout acid plagioclase crystals, many showing alteration of their cores to clay minerals but with clear margins, are intergrown with dark amphibole and pyroxenes. Transmitted Light P.P.L. x 40

6. PEGMATITIC PHASE

Clear analcimes (A) are surrounded by stout acid plagioclase crystals and dark coloured amphiboles and pyroxenes. The feldspar cores show much alteration to clay minerals. Transmitted Light P.P.L. x 40

Photomicrographs of Igneous Rock from Pouk Hill

Fig. 2



Photomicrographs of the Igneous Rock from Pouk Hill

Late stage calcite as amygdales and as veinlets, often accompanied by poorly crystalline 'spongy' pyrite or euhedral pyrite cubes, is very common. This basalt appears to be similar to the microporphyritic basalt of Allport (1874) but is far more extensively altered.

The non-porphyritic basalt fragments have equigranular olivine, pyroxene and plagioclase in a finer matrix. Alteration has caused calcite pseudomorphs after pyroxene and olivine, and calcite with chalcedony pseudomorphs after plagioclase cores. Very fine acicular haematite (5µm)) and anatase (20µm) representing material from the altered iron-titanium opaque minerals, and green and brown clays representing the alteration of original ?glass and fine grained silicates make up the matrix.

The basalt fragments are themselves set in a matrix of calcite and clays.

Amygdaloidal Basalt

The uppermost specimen collected from the northern face of the quarry is a 4cms thick amygdaloidal basalt overlying the main dolerite facies and separated from it by a 1cm thick intermediate zone.

Within the basalt the amygdales exhibit some variation. At the base and throughout most of the basalt, the amygdales are small (3 - 4mm in width) and white or colourless whereas at the top they are larger (up to 2cms in width), pink and fibrous. Mineralogically the white amygdales are of twinned and often euhedral analcime with lesser amounts of calcite, green vermicular chloritic minerals, chalcedony, pyrite and secondary chalcopyrite. The larger pink amygdales are of radiating fibrous natrolite with very fine haematite, associated with minor amounts of euhedral analcime, calcite and chlorite.

The basalt is very altered, with original olivine, titanaugite, labradorite, and laths and skeletal crystals of titanmagnetite, ilmenite or mixed crystals of the two, set within a fine groundmass of clays, haematite and anatase. The laths of the iron-titanium oxides are commonly in sub-parallel domains. Extensive alteration has produced calcite pseudomorphs after titanaugite, serpentine minerals after olivine, green clay minerals after the plagioclase and haematite with rutile/anatase after the opaque minerals.

The degree of alteration, the presence of amygdales, the habit of the iron - titanium oxides and their occurrence in domains has been useful in discriminating between basaltic lava flows (which have these features) and fine grained margins of sills (which do not), within the igneous rocks of the Derbyshire Dome (Ixer, 1972).

Lying directly beneath the basalt is an intermediate zone of very large ophitic titanaugite, together with very 'chloritized' plagioclase and equant grains of titanmagnetite.

Main Olivine Teschenite

This is the ophitic olivine dolerite of previous workers. The main doleritic phase is an equigranular black rock which in hand specimen can be seen to have sharp contacts with both the basalt and pegmatite facies. It comprises olivine, equant grains of titanmagnetite, subophitic titanaugite and zoned plagioclase (An_{54} core - An_{34} margin), with fibrous natrolite and minor amounts of analcime within the interstices. The titanaugite is intensely zoned and often displays deep lilac-brown cores and green margins. Primary accessory minerals include ilmenite intergrown with anhedral chalcopyrite in a fingerprint texture; brown and green subhedral amphiboles occurring on the margins of titanaugite or olivine; acicular apatite and brown octahedral spinels within the olivine pseudomorphs. Secondary minerals include calcite, chloritic minerals, kaolinite, montmorillonite, mixed illite-montmorillonite, haematite, anatase, pyrite and marcasite.

Alteration of the teschenite has produced pseudomorphs after olivine, these are of green serpentine minerals, brown iddingsite or of chalcopyrite either as thin fibres following the cleavage of the serpentine, or as small anhedra growing into the pseudomorph from its margin. The titanaugite has largely escaped alteration but some replacement by calcite is present. However, the labradorite laths often show extensive alteration to green clay minerals within the cores but retain a clear, unaltered margin of oligoclase. Both the titanmagnetite and ilmenite have oxidized, firstly to haematite and then to fine grained mixtures of haematite, rutile and anatase. The alteration is also responsible for the introduction of coarse grained euhedral to anhedral pyrite and marcasite, and for the abundant fine grained anatase, haematite, calcite and clay minerals that occurs between much of the primary silicates.

Weathering of the specimen can be seen by the oxidation of the pyrite, chalcopyrite and some haematite to limonite.

Pegmatite

Intergrown with the main olivine teschenite phase is a more alkalic pegmatitic phase comprising analcime surrounded by plagioclase feldspars, zoned amphiboles, green pyroxene and apatite. The occurrence of titanaugite, olivine and the iron-titanium minerals is rare. The analcime is very twinned and shows a number of generations some of which are euhedral. The feldspar is of two types: large polysynthetically twinned calcic plagioclase which is much altered to chalcedony but with clear sodic margins; and small, stout crystals. These have one simple twin and refractive indices between 1.53 and 1.55, and are optically positive. This suggests albite or oligoclase rather than a potassium feldspar. Although, elsewhere alkali feldspars have been reported, for example potassium-oligoclase from Kinlet (Phemister, in Whitehead and Pocock, 1947) and orthoclase or ?albite from Rowley Regis (Whitehead and Eastwood, 1927), the present study did not unambiguously show any from Pouk Hill. Amphibole is abundant usually as well-cleaved euhedral crystals, between the feldspars, that show intense zoning with red-brown cores and green margins or, more rarely, a deep indigo-blue margin. A positive indentification of the amphibole has not been accomplished but the amphibole is probably a barkevikite or possibily Kaersutite with a more sodic margin and, in extreme cases, a riebeckitic margin. A sodic green pyroxene of aegerine-type is associated with the amphibole but is far less common. Both barkevikite and aegerine were described from Kinlet (Phemister, in Whitehead and Pocock, 1947), whilst riebeckitic amphiboles have been described from the pegmatitic phase of the Dippin Sill teschenite (Gibb and Henderson, 1978). Abundant acicular apatite is common.

Conclusions

Although most of the petrography of the Pouk Hill rocks is consistent with their being part of an intrusive body, there are a few discordant features suggestive of an extrusive origin. These are the tuffaceous nature of the fine grained contact, the amygdaloidal basalt containing lava-like textures, and the occasional intimate mixing of fine basalt and normal dolerite

The wider range of rock types now described from Pouk Hill shows it to be as alkalic as its associated igneous rocks in the West Midlands.

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Footnote

It is important to mention that during 1976 and 1977 The Black Country Geological Society undertook sampling and recording at Pouk Hill. This exercise preceded the infilling of the large quarry where exposures are now completely lost. The Society was instrumental in cutting a new section in the smaller southern quarry.

(Editor)