12. ACID *and* INTERMEDIATE INTRUSIONS *and* ASSOCIATED ASH-NECKS *in the* NEIGHBOURHOOD *of* MELROSE (ROXBURGHSHIRE). By RACHEL WORKMAN MCROBERT, B.Sc. (Communicated by E. B. BAILEY, B.A., F.G.S. Read February 25th, 1914.)

[PLATES XLI–XLIII.]

CONTENTS.

I. INTRODUCTION.

THE igneous rocks under consideration fall within an area about 7 miles square, included in Sheet 25 of the Geological Survey's 1-inch map of Scotland.

It is generally believed that they date from a late period in the history of the 'Plateau Eruptions' of Calciferous Sandstone times, and correspond with the trachytic lavas and intrusions of the Garleton Hill district (East Lothian), and with the similar intrusions in the Campsie and Renfrewshire hills. The only new evidence obtained, bearing upon this suggestion, weakens rather than supports it: a small neck, the Little Hill, including ash and plugged by basalts of two types, has been found within the Eildon complex of felsitic and trachytic rocks, and is almost certainly of subsequent origin. But it should be borne in mind that the admittedly-late felsitic and trachytic intrusions of the Campsie Fells are in certain cases cut by still later basalts.

The restricted area over which acid rocks of this suite extend in the various districts of Scotland in which they occur is partly due to extreme denudation, and partly to the viscous character of their magma. Only in the Garleton Hills are extensive lava-flows preserved. It seems fairly certain to me that Dr. Peach is right in regarding none of the Melrose rocks as lavas, although the evidence does not altogether exclude the possibility of lavas entering into the Eildon complex.

The rocks may be grouped, according to their field-relations, as follows:—

Laccolites and sills.—White Hill; Black Hill; Bemerside; Eildon Hills; Bowden Moor Quarry; Whitelaw Hill.

Dykes mostly trending north-eastwards.—Several are strung through the country between Melrose and Selkirk; two north-west of Earlston.

Necks.—Chiefswood; Little Hill, described here, although in the main basaltic; a small neck with trachyte, in a little gorge between Bowden Moor Quarry and Rhymers Glen; Faldonside Moor; a small neck on the banks of the Tweed, not visited.

II. Relation to the Upper Old Red Sandstone.

The more easterly masses, such as White Hill, Black Hill, and Bemerside, are associated with the main outcrop of the Upper Old Red Sandstone of Roxburghshire. The more westerly, though situated in advance of this outcrop, in a region predominantly composed of Silurian greywackes, have in certain cases sheltered small outlying patches of Old Red Sandstone. Dr. Peach,[1] who mapped the district for the Geological Survey, shows a somewhat extensive outlier of Upper Old Red Sandstone forming the pedestal of the Eildon Hills, and a long strip at the side of the Chiefswood neck. Mr. J. Pringle[2] has described a minute patch at Whitelaw Hill, Fox's Cover, and Oakwood Mill; in each of these cases it is associated with the igneous intrusions, and I have recently found another under the Bowden-Moor Quarry trachyte. There is also a patch of Old Red Sandstone on the south-eastern flank of Cauldshiels Hill. Although it is not particularly well exposed, I have been led to believe that a good deal of it was got out of the quarry when first worked.

The evidence for these various outliers, except that alongside of the Chiefswood neck and the Eildon Hills, is far from easy to find. The presence of the Bowden-Moor Quarry outlier is betrayed by numerous bits of hard quartz-grit, stained deep red, lying beneath the turf on the south-eastern flank of the hill, just above the farmhouse. At Whitelaw Hill a coarse yellow grit is found at the south-east side of the cap of trachyte, and is attributed by Mr. Pringle to the Upper Old Red Sandstone. At Cauldshiels Hill, baked yellow and red sandstone and mudstone occur on the south-east side of the trachyte-dyke, below the old fort.

The main purpose of the present paper is petrographical. On account of their striking position dominating Melrose, and their curiously barren aspect, the Eildon Hills have so far attracted more attention than the other intrusions. As early as the 'forties' of last century, Prof. Forbes gathered a small collection of typical varieties from the Eildons. This material is still preserved in the Hunterian Museum, Glasgow; but no description seems to have been published. Dr. Peach, in the Geological Survey map of the district published in 1879, gives a useful classification of the igneous rocks of the Melrose district under three headings: intrusive basalt, intrusive felstone, and volcanic agglomerate—the last-named in necks of Calciferous Sandstone age. An important petrographical advance was accomplished by Mr. T. Barron[3] in 1896. He examined rocks from the Eildon Hills and the Black Hill, and demonstrated the occurrence of the rare amphibole riebeckite in the Mid Hill of the former group. He believed

[1] In Sheet 25, Geol. Surv. 1-inch map, published in 1879.

[2] 'Notes on Three Small Outliers of Old Red Sandstone in the Neighbourhood of Selkirk' Trans. Edin. Geol. Soc. vol. ix (1909) p. 351.

[3] Geol. Mag. dec. 4, vol. iii (1896) pp. 373–75.

that nepheline occurred somewhat freely in association with the riebeckite; but it seems unlikely that such is the case, for interstitial quartz is present in most instances, and I have failed to detect nepheline in the many specimens examined (both microscopically and by staining). He also drew attention to the felsitic texture characteristic of the Mid Eildon mass, and to the predominance of typical porphyritic trachytes in 'Easter' Eildon (North). He described the Black Hill, and both here and in the North Eildon suggested the original presence of riebeckite. He regarded the two masses as remnants of lava-streams of Old Red Sandstone age; but his own observations on the Black Hill are strong evidence against such an interpretation. Following this description, we find passing references to the igneous rocks of the neighbourhood in the account given by Dr. Peach & Dr. Horne of the Silurian rocks of Southern Scotland. The 'felstones' are now spoken of as trachytes, and the main features of the Chiefswood neck[1]—its probable Carboniferous age and its contents of greywacke and trachyte-blocks—are touched upon briefly. Dr. Harker[2] has more recently figured a specimen from the Mid Eildon as an example of riebeckite-orthophyre.

It was evidently desirable to obtain a more comprehensive knowledge of the petrology of the district, and with this end in view the various exposures have been carefully examined, and a large number of specimens collected and sliced. In the following pages the intrusions are considered in the order in which they are cited on p. 303.

The chief rock-types represented are:—

(1) Quartz-trachytes.
  (*a*) Non-porphyritic: for instance, Bemerside.
  (*b*) Porphyritic, Black Hill.
(2) Sanidine-trachytes.
  (*a*) Non-porphyritic, Cauldshiels Hill, Whitelaw Hill, etc.
  (*b*) Porphyritic, { with fresh riebeckite, Mid Eildon. / with ægirine-augite and olivine, Mid Eildon. / without fresh ferromagnesian mineral, North Eildon.
(3) Felsites, with fresh riebeckite, Eildon West and Mid Hill.
(4) Quartz-porphyry.
(5) Sanidine-porphyry.
(6) Basalt, Little Hill.
(7) Volcanic agglomerate, ash, etc.

III. Laccolites and Sills.

The White Hill is covered with ploughed fields, and bounded on the north-east and south-east by Upper Old Red Sandstone and on the west by Silurian rocks, but actual contacts are not seen.

[1] Mem. Geol. Surv. 'The Silurian Rocks of Britain' 1899, vol. i (Scotland) p. 190.
[2] 'Petrology for Students' 4th ed. (1908) pp. 128 & 129, fig. 33 B.

It is composed of a fine-grained, pink, orthophyric trachyte rich in soda. The phenocrysts are chiefly orthoclase, or twinned albite with a vein of orthoclase, and some soda-orthoclase. The ground-mass is mainly of orthophyric orthoclase embedded in limonite, which replaces the original ferromagnesian mineral, possibly riebeckite.

The Black Hill, with its steep southern slopes of platy screes, is an intrusive sheet of porphyritic quartz-riebeckite-trachyte, this expression being used to denote a porphyritic trachyte which contains a fair proportion of interstitial quartz. This quartz occurs most freely on the upper part of the sheet.

On the south side of the hill the lower contact of the trachyte with Upper Old Red Sandstone containing scales of *Holoptychius* is well seen in a disused quarry. It runs nearly parallel with the bedding of the sandstone, but cuts across it in places. At the back of the hill the Old Red Sandstone overlies the trachyte, thus forming the roof of the sheet. The rock is sometimes beautifully banded parallel to its floor, which dips gently northwards. In the quarry the trachyte is compact and non-porphyritic at its base; but within a foot above the junction it shows scattered phenocrysts of white sanidine, which increase in number towards the more massive centre of the sheet. The rock is characterized by a platy, crinkly fluxion-cleavage. The best-marked joints are parallel to the dip. When struck with a hammer it emits a peculiar sulphurous smell. The mineral constituents are:—

Sanidine, as fresh phenocrysts, and laths showing Carlsbad twinning in the ground-mass.

Quartz, abundant interstitially.

Limonite, filling spaces among the felspars; in one slide are bluish-green pleochroic needles among the secondary limonite, and these have the habit of the Eildon riebeckite.

The structure is trachytic.

There is a lower sheet in the wood above the road.

Bemerside Hill has been cut into by the Tweed so as to form a steep cliff of non-porphyritic quartz-trachyte (see Pl. XLI, fig. 5). The contacts of the trachyte are everywhere much covered with grass, but the appearances rather suggest a dome-shaped massive intrusion. In the quarry near the turn in the road a well-jointed face is exposed, with one set of joints arching roughly parallel to the outline of the hill, which looks as though its present surface approximately corresponds with the original form of the intrusion. The other set of joints are about 15° from the vertical near the edge, and become vertical near the centre. The rock is purplish and compact, with pinkish-white spots and a few scattered felspar-phenocrysts. It weathers yellow, showing a considerable development of white talc (or kaolin) and pyrolusite along the cracks. Under the microscope it is seen to be a mass of trachytic sanidine-needles, with interstitial quartz and much limonite.

The Eildon Hills are probably the denuded remains of a composite laccolite. The North Hill is petrographically distinguishable, as Mr. Barron has pointed out, from the Mid and Wester Hills, and was probably a subsidiary dome. As the laccolite lies far above the plane of local erosion, its entire sedimentary cover and a good part of the igneous core have been removed. At the present time some 300 or 400 feet of the latter remain. There is no representative of the roof except, perhaps, the narrow band of Old Red Sandstone which is exposed in the quarry between Mid and North Hills. Probably only the eastern half of the laccolite is preserved, as is indicated by the outward dip of the rocks in the north-eastern and south-eastern quadrants. The present western boundary and its three feeders represent the central part of the original laccolite; and the small outlier of Bowden-Moor Quarry, with its strip of underlying Old Red Grit, is probably the sole remnant of the western half.

That the igneous rocks are in the form of thick sheets or a laccolite, rather than a plug, is inferred from the general appearance of the mass; but clear exposures, showing that it has a base, are nowhere available. That portions, at least, of the complex are intrusive is clear from the following considerations:—

A narrow strip of igneous rock connects the North and Mid Hills, and it is seen that this strip, in part at least, has dyke-like relations, for the igneous rock cuts steeply through Old Red mudstone exposed at the brink of a small quarry. The chilled edge against the mudstone is remarkable for its spherulitic structure.

The dyke-like offshoots which break the even western boundary of the Mid and Wester Hills must be transgressive in their relations. The middle one, as exposed in a quarry south of some targets, cuts right across the bedding of the vertical Silurian, and then runs along parallel to the bedding.

The only evidence suggesting the presence of lavas is the rather stratiform appearance of the hills. This is most probably due to the intrusion of the mass sheet by sheet.

The steeper slopes of the Mid and Wester Hills are covered by scree, while the North Hill is much overgrown with grass: continuous zoning of the intrusions is, therefore, fraught with considerable difficulty.

The North Hill has a particularly stratiform appearance. The lowest portion consists of porphyritic sanidine-trachyte, with a spongy aggregate of secondary limonite which recalls the habit of riebeckite. This rock is found next to the Old Red Sandstone in many portions of the complex. Above this, pink non-porphyritic sanidine-trachyte with much quartz is sometimes found; it is composed of sanidine-laths, abundant mossy limonite, probably after riebeckite, and a fair proportion of interstitial quartz. Specimens from below the prominent crags on the north-west side of the hill, and from a corresponding point farther east, show quartz-phenocrysts quite clearly. Under the microscope the quartz-phenocrysts exhibit sharp idiomorphic

boundaries, with very few inclusions; felspar-phenocrysts are entirely chalcedonized, and lie in a microcrystalline ground-mass containing much spongy limonite. It is possible that this quartz-porphyry occurs as a sheet running parallel to the contours, but the nature of the exposure is such that it is impossible to speak with certainty. The topmost rock of the hill, usually ending in an abrupt escarpment, is a highly porphyritic sanidine-trachyte with much quartz. It consists of numerous fresh sanidine phenocrysts in a fine red ground-mass: the latter consists of sanidine-laths, interstitial quartz, and limonite.

No unaltered ferromagnesian mineral has been found in the North Hill, but the habit and distribution of the limonite suggests pseudomorphs after riebeckite.

About 100 feet below the base of the laccolite on the west side is a dyke of the same porphyritic trachyte. It seems to turn into a sheet in the Old Red Sandstone, rising slightly eastwards, and to crop out again in this form on the north and east sides of the hill.

The igneous rock exposed on the col between the North and Mid Hills is a porphyritic trachyte like that of the lower part of the North Hill.

In the Mid Hill similar porphyritic trachyte can be recognized in the lower part of the northern scree-covered slopes adjoining the col just mentioned. It may even extend continuously, perhaps as a basement sheet, to the more northerly of the dykes jutting from the margin of the Mid Hill. This dyke, as also its neighbour on the south, consists of sanidine-porphyry. So far as one can judge on the scree-slope, the more southerly porphyritic dyke extends for some little distance vertically into the overlying felsite. There is, at the same time, the suggestion that the porphyritic rock furnishes a bottom layer to the complex, and reaches across the col between the Mid and Wester Hills.

The porphyritic trachyte of these exposures is red and much stained with limonite. It is rough to the touch, and porous. Amygdales are sometimes abundant, and the jointing is platy. Phenocrysts of fresh sanidine are found, but they are more often pseudomorphosed in kaolinite or chalcedony. They lie in a trachytic ground-mass of small fresh sanidine-laths, spongy limonite, and much secondary quartz filling vesicles and pores. The quartz is sometimes idiomorphic, and is accompanied by chalcedony.

Closely similar porphyries, with a microcrystalline and felsitic ground-mass, also occur.

Much the greater part of the Mid and Wester Hills is formed of riebeckite-felsite (see map, Pl. XLII). The featuring of the two hills suggests that this rock occurs in two layers. The upper layer shows magnificent columnar structure, with very perfect hexagonal columns, on the south-western slopes of the Wester Hill.

The felsite (Pl. XLI, fig. 2) is very hard and compact, and

has yielded a profusion of platy screes. In the lower layer the rock is pink, with small dark patches of riebeckite. Under the microscope the riebeckite-growths are minute, and largely altered to limonite. In the upper layers the rock is purplish grey, weathering pale pink or white, with conchoidal fracture. Fresh riebeckite is abundant in nests and irregular aggregates: it is pleochroic, from deep blue to lemon-yellow. The ground-mass is felsitic, with much secondary quartz in large plates. The higher parts of the upper layer become coarser, and show microporphyritic sanidine-crystals; a brownish-green biotite also occurs in one slide from the summit of the Wester Hill.

This rock, as indicated later, is the only one containing fresh riebeckite that is found in any of the necks. In these higher horizons there is an increasing proportion of soda, and phenocrysts of soda-orthoclase have been found in the corresponding rocks of the Mid Hill. These rocks closely approach keratophyres.

Two interesting rocks occur towards the top of the Mid Hill. The actual summit consists of orthophyric riebeckite-trachyte, while to the west of this occurs augite-olivine-trachyte. Hand-specimens from the junction can be selected showing the two types intimately mixed.

The orthophyric riebeckite-trachyte (Pl. XLI, fig. 4) is a very hard, compact, brown rock with a contorted fluxion-cleavage, recalling in appearance corrugated iron. Riebeckite is conspicuous in blue mossy aggregates. Under the microscope, large and fairly abundant phenocrysts of anorthoclase lie in an orthophyric ground-mass of sanidine-prisms, embedded in deep-blue pleochroic riebeckite, and a small quantity of interstitial primary quartz. It is this summit-rock which, as already mentioned (p. 305), has been figured by Dr. Harker.

The augite-olivine-trachyte (Pl. XLI, fig. 3) is a very hard, compact, grey-green rock, with good felspar-phenocrysts. It weathers to a buff colour, and has an irregular fracture. Its small, fresh ground-mass felspars impart to it a saccharoidal lustre. The phenocrysts are orthoclase, with probably some anorthoclase, and ægirine-augite in long thin crystals showing transverse sections with (100) and (110) developed almost to the exclusion of (010). The extinction-angle of this ægirine-augite is 5° to 9°. The ground-mass in which the phenocrysts lie consists of trachytic sanidine, with fluidal arrangement, and abundant, fresh, bright-green ægirine-augite microlites. The olivine is represented by occasional yellow or reddish-brown pseudomorphs of characteristic shape.

As the olivine increases, the pyroxene changes from ægirine-augite to grey-green augite with an extinction-angle of 43°, and is confined to the ground-mass, which latter becomes orthophyric. Soda-felspars preponderate: both twinned and untwinned albite occur, the latter with a rim of orthoclase. Zircons of large size occur, both in this and in the riebeckite-trachyte.

This augite-olivine-trachyte closely resembles specimens from Traprain Law and the Bass Rock (East Lothian). It is more

likely that nepheline will be found in this type than in any of the others met with in the Eildon Hills, but as yet neither microscopic examination nor staining has revealed any.

Bowden Moor Quarry.—Near Bowden Moor, half a mile due west of Eildon Wester, is an oval, grass-covered mound, of which almost the whole interior has been quarried away. The quarry yields a fine-grained, pink, compact trachyte, showing scattered small sanidine-phenocrysts, generally decomposed. These lie in a trachytic ground-mass of sanidine-laths, with a certain amount of primary interstitial quartz, sometimes enclosing the laths ophitically. Secondary quartz is abundant in small vesicles. Limonite, in spongy aggregates and large masses, possibly represents original riebeckite. The rock, as a whole, resembles the trachyte of the spur extending westwards from Eildon Wester Hill.

The Whitelaw Hill Sill lies about a mile and a quarter south-west of the above, and is petrologically so similar that it does not require description. It forms the oval cap of the hill, its longest diameter being about 10 yards. It is in contact with Silurian shales and greywackes, except on its south-east side, where a coarse yellow grit is found, which Mr. Pringle attributes to the Upper Old Red Sandstone. The north-western boundary is a black-banded flinty rock with conchoidal fracture, which extends for some distance beyond the present position of the trachyte. It would seem to be a fine-grained shale, intensely indurated by silicification subsequent to the intrusion. The mass appears to be in connexion with a dyke which runs south-eastwards from the hill-top.

IV. Dykes.

The dykes of the district nearly all run in a general north-easterly direction; it is certain that many of them belong to the same suite of intrusions as the laccolites and sills just described, but it is possible that some may date from the Lower Old Red Sandstone period of igneous activity.

The field-evidence bearing upon the point is as follows:—Two trachyte-dykes of rather irregular form cut the Upper Old Red Sandstone north-west of Earlston. Two others are met with in the narrow strip of the same formation bordering the Chiefswood neck, while a quartz-porphyry dyke is found actually within this neck. A large trachyte-dyke forming Cauldshiels Hill, though in the main traversing Silurian strata, cuts across a small outlier of the Upper Old Red Sandstone immediately south-east of the old fort.

The group of three dykes, half a mile south-west of Cauldshiels Hill, has been found to consist of riebeckite-trachytes, wherefore their connexion with the Eildon suite of intrusions may be taken for granted.

The various dykes of the district will now be dealt with briefly under the respective headings trachyte, porphyry, felsite, and quartz-porphyry.

Trachyte.—Two purplish-pink trachytic dykes cross the main road north-west of Earlston. They contain phenocrysts of albite, surrounded by orthoclase, in a trachytic ground-mass. They resemble the White Hill sill very closely.

The Cauldshiels Hill dyke is a trachyte, composed of sanidine-laths with beautiful trachytic structure, and an occasional sanidine-phenocryst. Limonite replaces some of the felspar-laths, and is also present in grains. There can have been very little, if any, ferromagnesian mineral present originally.

The riebeckite-trachytes, half a mile south-west of Cauldshiels Hill, contain large kaolinized felspar-phenocrysts in a mottled, fine-grained, purplish, trachytic ground-mass of sanidine-laths, numerous tiny fresh riebeckite-prisms, and interstitial quartz. Towards the centre of the largest dyke the structure approaches the orthophyric.

Porphyries.—On the shores of Cauldshiels Loch are three porphyry-dykes which strongly resemble the trachytes just described. They are greatly altered, and contain only kaolinized felspars and limonite-pseudomorphs, possibly after riebeckite.

Felsites.—A beautifully-banded felsite occurs as a dyke at the top of Rhymers Glen, close to the Birkhill Shales. The margin which abuts against Silurian greywacke is fine-grained and spherulitic. Then follow alternate pale and dark-brown bands, the latter opaque under the microscope. Towards the centre the dyke is coarser, and presents an irregular fracture. Occasional microphenocrysts of altered felspar occur in the fine-grained felsitic base, which, under crossed nicols, shows patchy devitrification. Numerous quartz-veins traverse the dyke.

Quartz-porphyries.—The dyke intruded in the Chiefswood neck consists of small quartz and orthoclase-phenocrysts in a compact pinkish-brown matrix. The quartz-phenocrysts give rounded or square sections, and are subordinate to those of orthoclase. The latter are altered rectangular aggregates of muscovite, calcite, and a little quartz. The ground-mass is a microcrystalline aggregate of quartz, orthoclase, and some limonite.

A long quartz-porphyry dyke, lying north-west of Whitelaw Hill, contains large phenocrysts of deep-green pleochroic soda-pyroxene, kaolinized felspars, and idiomorphic quartz, in rectangular and hexagonal sections.

A 4-foot dyke, branching like a tuning-fork on the northern shore of Cauldshiels Loch, carries phenocrysts of kaolinized felspar and corroded quartz, the latter containing numerous inclusions of ground-mass. Irregular patches of limonite probably represent some decomposed ferromagnesian mineral.

A large dyke extending across the Cauldshiels Loch is very similar, and shows large, columnar, idiomorphic phenocrysts of sanidine which can be picked out intact. These are carried in a red ground-mass.

V. The Necks.

The Chiefswood neck is oval. Its larger diameter is a mile and three-quarters long, and ranges north-east; the smaller measures three-quarters of a mile.

It extends from Melrose well up into the moorland country, about 700 feet above sea-level. It is in contact with Silurian strata, except along its south-eastern boundary, where, as already stated, Upper Old Red Sandstone still remains.

The materials of the vent are exposed in Huntly Burn and in its three tributaries coming from the high ground on the south. They consist here of decomposed yellow clay, well bedded near the margin of the neck, and dipping inwards at about 30°. The junction with the Silurian greywacke is clearly visible in Rhymers Glen, about 20 yards below the lowest waterfall.

There are plenty of quarries in the neck where fresh agglomerate can be examined. The largest lies close to the railway-station, and provides building-stone for Melrose. The agglomerate seen in these quarries is a coarse accumulation of angular fragments up to 6 and 9 inches in diameter, with finer débris furnishing a matrix. The fragments recognized were :—

Greenish and grey micaceous shales.	Silurian.
Grits and greywackes.	
Dark red sandstone.	Old Red Sandstone.
Flesh-coloured quartz-porphyry.	
Hard purple porphyry.	
Pink trachytes, similar to the Eildon trachytes.	
Amygdaloidal greenish basic glass.	
Olivine-basalt.	

The Little Hill neck is dealt with in this paper, on account of its occurrence within the Eildon complex, otherwise its basic constitution would exclude it from consideration here. The main rock is a plug of fine-grained non-porphyritic basalt stained by limonite, and often brecciated. This basalt consists of basic plagioclase, with fluxional arrangement and zoned with a fair proportion of orthoclase and abundant olivine in small granules.

An associated rock at the western end of the hill is closely allied to the Markle type of basalt. Phenocrysts of basic labradorite (60 to 70 per cent. anorthite) and decomposed olivine lie in a ground-mass of labradorite-laths associated with much limonite. On the two sides of a wall at the western end of this composite plug an ash occurs, containing small fragments of basalt, trachyte, greywacke, and shale. Small dykes are seen penetrating the ash from the adjoining plug.

The Little Hill neck is bounded on the west by sedimentary rocks of Silurian age, but on the north is in contact with a narrow band

of trachytic rock, fine-grained at its margin, although it becomes coarser away from the junction.

The contact of the trachyte with the Silurian rocks is exposed near the path; but, owing to the striking similarity of the rocks in colour and texture, is most difficult to locate. The Silurian rocks consist of much-indurated coarse and fine bands, greatly contorted and crumpled, which seem to have been pushed aside and diverted from their normal strike.

A small neck occurs in a ravine between the 800- and 900-foot contours, south-east of Rhymers Glen. The country rock in its immediate neighbourhood consists of much-shattered red shale and greywacke. The neck is filled, partly by a bright pink non-porphyritic vesicular felsite saturated with limonite, and partly by a breccia of angular fragments of a pink igneous rock and some bits of sediment in an igneous matrix.

There are but few exposures in the Faldonside Moor neck. Hillocks of medium-grained ash exist, which in their easterly extension contain numerous fragments of red honeycombed sandstone. The microscope shows a little sedimentary material in the main ash, with pumiceous and glassy igneous rocks, porphyritic and non-porphyritic trachytes, and, most interesting of all, a fresh piece of riebeckite-felsite, containing green-brown biotite, exactly like the felsites of the upper part of Eildon Wester.

VI. Summary.

The following are the main results of my recent study of the district:—

(1) The recognition of the Little Hill basaltic neck within the Eildon Hill complex, the acid rocks of which it almost certainly pierces.

(2) The extension of Mr. Barron's record of riebeckite. He found this mineral in the Eildon Hills, and suspected its former presence in the Black Hill. It has now been found fresh in the latter, as also in three trachytic dykes half a mile south-west of Cauldshiels Hill, and in a block in the Faldonside Moor neck.

(3) The recognition of a quartz-porphyry sill in the Eildon complex and a quartz-porphyry dyke in the Chiefswood neck; also the realization that quartz is an important mineral in the Eildon complex as a whole, and that the main rock-type occurring there is felsite.

(4) The proof that, if nepheline occurs in the Eildon complex, it must be very rare.

(5) The fact that these rocks may be regarded as a link between the phonolites and trachytes of the same age south-east of Hawick[1] and those of East Lothian,[2] already so well known. They cannot

[1] H. J. Seymour, 'Summary of Progress for 1900' Mem. Geol. Surv. 1901, p. 164.

[2] 'The Geology of East Lothian' Mem. Geol. Surv. Scot. 2nd ed. (1910) p. 127.

lay claim to being phonolites themselves, as has been hitherto thought, but are closely allied. Their content of alkali is high. Soda-bearing minerals, such as riebeckite, ægirine-augite, primary albite, and soda-orthoclase, are well developed and play an important part. Only a felspathoid is wanting to complete the analogy.

I wish to take this opportunity of expressing my thanks to Dr. Peach, Dr. Flett, and Mr. E. B. Bailey for much valuable advice and assistance during the progress of the work, and also to Mr. G. W. Tyrrell for the loan of rock-sections.

EXPLANATION OF PLATES XLI–XLIII.

PLATE XLI.

[Except in one case, the slides belong to the Author's collection.]

Fig. 1. Porphyritic sanidine-trachyte from the sheet below North Hill. Ordinary light, × 32 diams. (Slide No. 21*b*.) The figure shows porphyritic sanidine-crystals in a ground-mass of orthoclase-laths and limonite. (See p. 307.)

2. Fine-grained riebeckite-felsite from the southern slope of Wester Hill, 100 feet below the summit. Ordinary light, × 37 diams. (Slide No. 14.) The figure shows dark patches of riebeckite in a fine felsitic ground-mass. (See p. 308.)

3. Augite-olivine-trachyte from near the summit of Eildon Mid Hill. Ordinary light, × 18 diams. (Slide No. 14, Forbes Collection, Hunterian Museum, Glasgow.) The figure shows subidiomorphic crystals of ægirine-augite and small granular olivines in a mass of alkali-felspar. (See p. 309.) From a slide kindly lent by Mr. G. W. Tyrrell.

4. Orthophyric riebeckite-trachyte from the northern slope of Mid Hill. Ordinary light. × 37 diams. (Slide No. 73.) The slide shows stumpy crystals of alkali-felspar in interstitial plates of riebeckite. (See p. 309.)

5. Quartz-trachyte from Bemerside Quarry. Crossed nicols, × 37 diams. (Slide No. 49.) The figure shows orthoclase-laths arranged in marked parallelism with interstitial patches of quartz. (See p. 306.)

PLATE XLII.

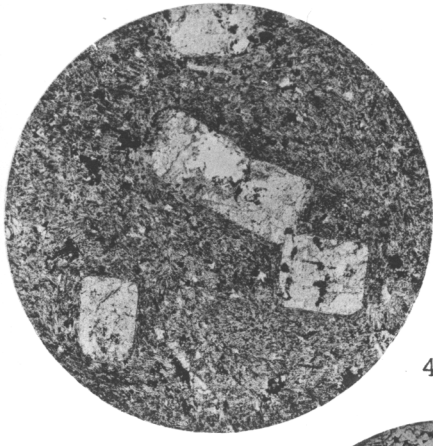
Fig. 1. Sketch-map of the Eildon Hills, on the scale of 6 inches to the mile, or 1 : 10,560. The broken lines drawn between the main rock-types do not represent definite geological boundaries, but have been inserted merely in order to give a general idea of the distribution of the types and the probable structure of the ground.

2. Section, on a horizontal and vertical scale of 6 inches to the mile, drawn across the above map, along the line AA.

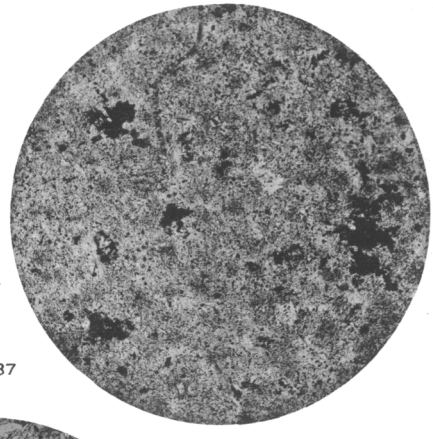
PLATE XLIII.

General map, on the scale of 1·5 inches to the mile, or 1 : 42,240, showing the position of the various sills, dykes, and necks described in the paper, and their relations to the Upper Old Red Sandstone.

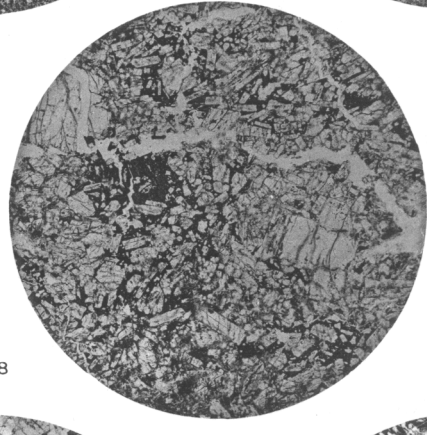
1. × 32



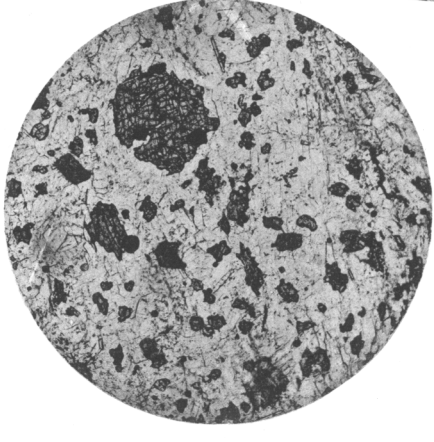
2. × 37



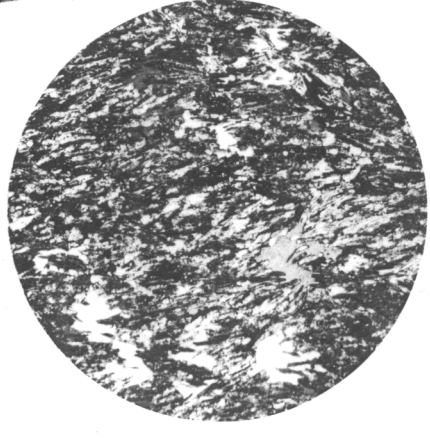
4. × 37



3. × 18



5. × 37



R.W.Mc R., Photomicro. Bemrose, Collo., Derby.

TRACHYTES AND FELSITES FROM THE EILDON HILLS.

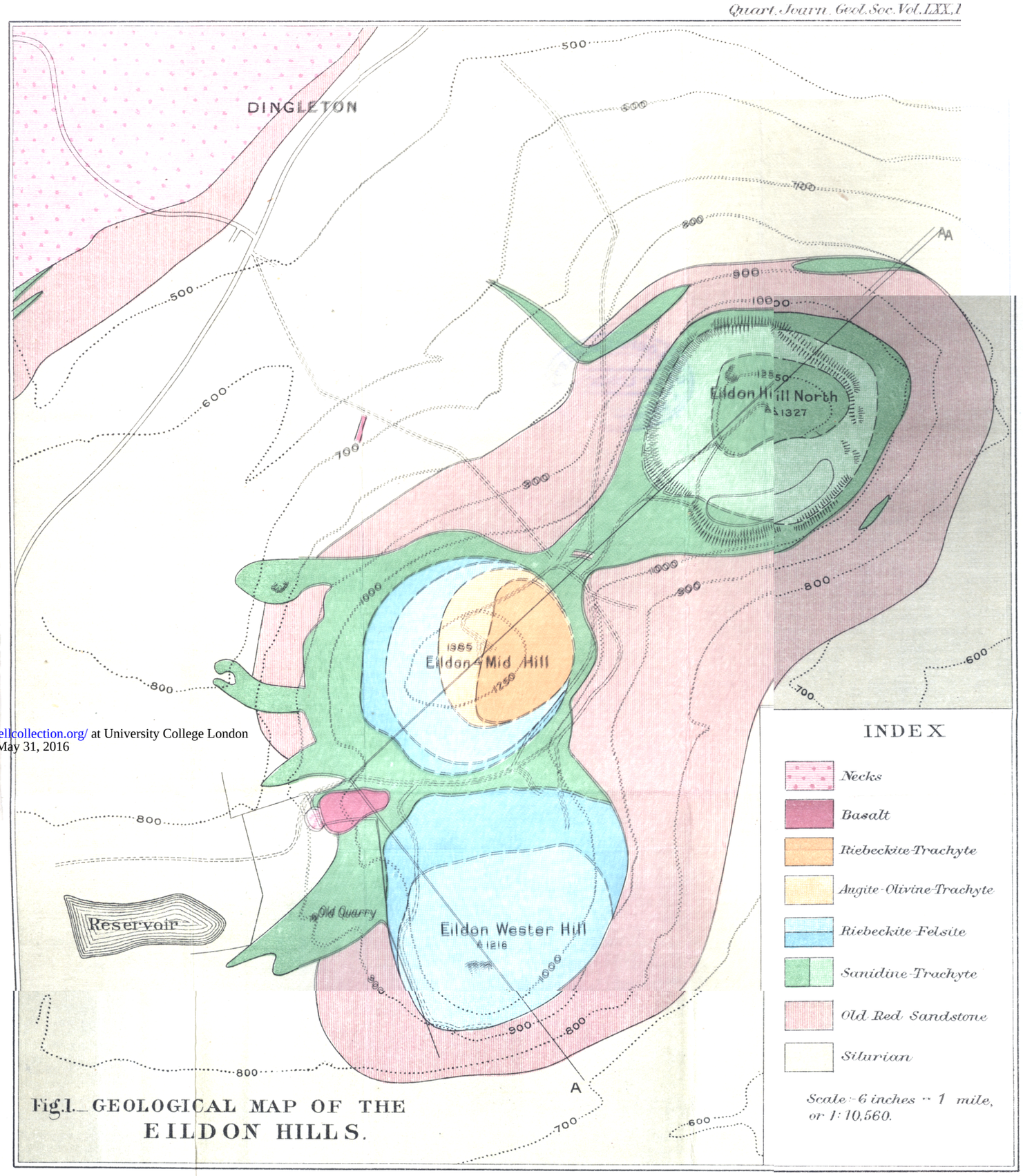
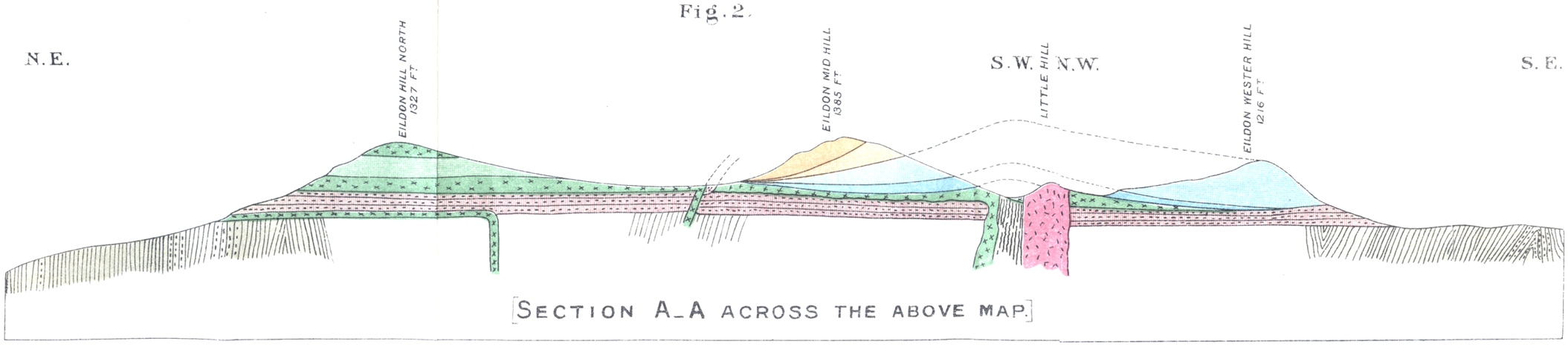


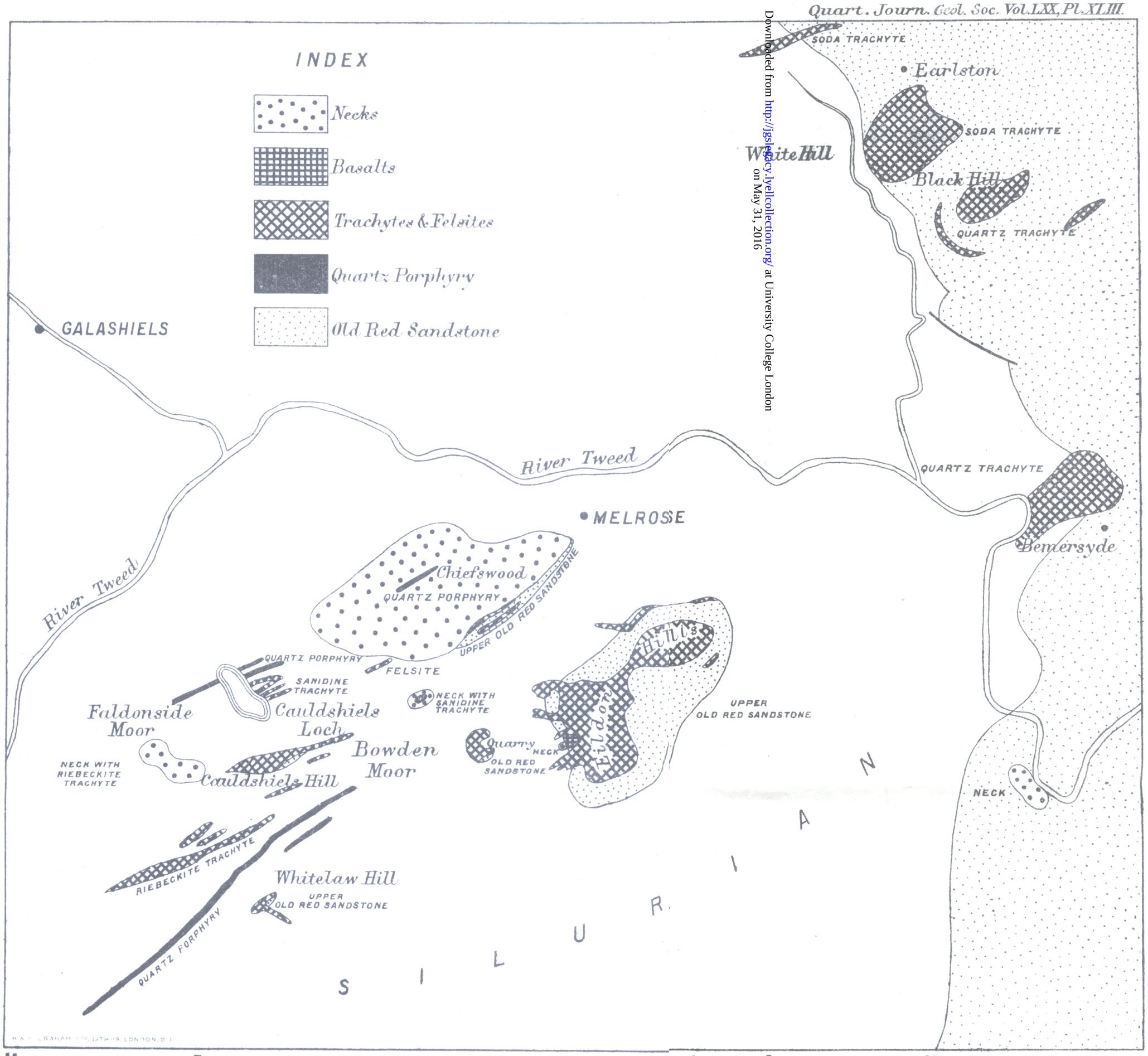
Fig. 1. GEOLOGICAL MAP OF THE EILDON HILLS.

Fig. 2.



SECTION A_A ACROSS THE ABOVE MAP.

H. & C. GRAHAM LTD, LITHOS, LONDON, S.E.



MAP SHOWING THE DISTRIBUTION OF THE IGNEOUS ROCKS AND THEE OLD RED SANDSTONE IN THE NEIGHBOURHOOD OF MELROSE.

[SCALE: 1 MILE = 1·5 INCHES, OR 1:42,240.]

Discussion.

Prof. W. W. Watts remarked on the peculiarity of the soda-bearing rocks described by the Author, in that they carried riebeckite and ægirine, but apparently no nepheline. He asked how far the connexion shown in the section between dykes and sills was supported by field observations.

Mr. W. Campbell Smith commented on the very wide sense in which the term 'trachyte' was used in the paper. He thought that many of the rocks mentioned were equivalent to those described by Dr. Prior as 'phonolitic trachytes,' while others containing more ægirine-augite and olivine might be acid members of the 'trachydolerite' group. Dr. Prior had described closely similar rocks from British East Africa and from the Antarctic.

He asked whether it was possible to determine the exact nature of the olivine in these rocks. The presence of fayalite in relatively-acid rocks, rich in iron-oxides and poor in magnesia, had been recorded recently, and further records of this mineral would be interesting.

Dr. J. V. Elsden said that particular interest attached to the rock described by the Author as olivine-trachyte, which appeared to be a highly specialized type and one that, if consolidated under plutonic conditions, might have been expected to produce a rock something like kentallenite. He regretted the necessity for applying the term 'trachyte' to these rocks, all of them being intrusives. He congratulated the Author upon her careful and detailed work in this area, which in some respects recalled certain features of the Christiania district.

Dr. J. W. Evans referred to the different use of the term 'trachyte' in Germany and in the United Kingdom. In Germany the essential difference between a trachyte and an orthoclase-porphyry or orthophyre was formerly one of geological age and was now one of degree of alteration, and there was no objection to applying the former term to an intrusive rock. On the other hand, although a few British authors made the structure the criterion, as the Author had done, the great majority undoubtedly restricted its use to volcanic rocks. He was, however, doubtful whether such a restriction could be logically defended.

The Author, in reply, indicated on the sections those portions of the area that could be mapped with accuracy, and those that were largely covered with screes. She had detected a mineral resembling fayalite in some of the acid trachytes: it forms small spherulitic growths with glass as interstitial matter. She added that petrographical nomenclature was always a most difficult matter, and presented ample scope for differences of opinion; but she had tried to do the best that she could with existing rock-names. In conclusion, she thanked the Fellows present for the kind reception given to her paper.