
Chapter 5 Rhyolitic and trachytic lavas and tuffs.

Lavas of acid and sub-acid composition — rhyolites, dacites, trachytes, etc. — play but a very subordinate part among the British Tertiary volcanic rocks. The "felstone-lavas", to which Prof. Judd in his first account (1874) assigned a prominent place, have since been relegated by that author (1889, 1890) mainly to the family of augite-andesites. Some of the rocks he still retains as rhyolites, dacites, and sanidine-trachytes; but from his generalised treatment it is not possible to be sure whether true lava-flows of acid and sub-acid composition are intended. Rhyolites, including obsidians, are recognised in the Antrim area, <ref>See especially Cole, *Sci. Trans. Roy. Dubl. Soc.* (2), vol. vi., pp. 77–114: 1896.</ref> even after excluding such intrusive types as the quartz-porphry of Tardree; and it appears that they were poured out, though only sparingly, about the middle of the volcanic period, *i.e.* between the lower and upper groups into which the basalts of the Irish district divide. <ref>McHenry, *Geol. Mag.*, 1895, pp. 261–264.</ref> The pitchstone of the Sgùrr of Eigg and Oighsgeir, regarded as a glassy lava of trachytic or perhaps dacitic composition, is referred, on the other hand, to a much later epoch <ref>Geikie, *Quart. Journ. Geol. Soc.*, vol. xxvii., pp. 303–309: 1871; and vol. lii., p. 371: 1896.</ref> and perhaps some of the rocks of Ardnamurchan, described by Prof. Judd, <ref>*Quart. Journ. Geol. Soc.*, vol. xlvi., p. 378: 1890.</ref> also belong here. Sir A. Geikie's "pale group" of Beinn Mòr in Mull, <ref>*Trans. Roy. Soc. Edin.*, vol. xxxv., p. 93: 1888.</ref> which is underlain by a great thickness of basalts, is described as highly felspathic, and may prove on closer examination to include trachytic or even rhyolitic lavas; while the existence of an older group of trachytes is proved by their occurrence as pebbles in the gravel at Ardtun Head in the same island. <ref>Cole, *Quart. Journ. Geol. Soc.*, vol. xliii., p. 277: 1887.</ref>

This is but a scanty record in comparison with the vast outpouring of basic lavas belonging to the same great suite of eruptions, and our investigations in Skye serve further to emphasise this enormous preponderance of basic over acid material among the British Tertiary volcanic rocks. In one small area only, situated on the northern border of the Cuillins, has a group of rhyolitic and trachytic rocks been discovered. These rocks form much of the ground below Fionn Choire, and extend for some little distance up Bruach na Frithe at its northern end. The area which they occupy has a length of a mile in a W.S.W.–E.N.E. direction and a maximum width of about ■ mile. It is very conspicuous as seen from the Sligachan and Glen Brittle foot-path, owing to the bare surface of the rocks and their pale colour, often with a tint of lilac or lavender. No further extension of this group of rocks has been detected, excepting at one or two places about 1½ to 1¾ mile to the south-west, and within the gabbro tract. Here a few relics of laminated rhyolite and acid breccia are preserved. Associated with these are some strips of a biotite-bearing felsite (not a lava) to be referred to again below. The locality is on the slopes of Sgùrr Thuilm.

Three divisions of the group may be recognised for convenience of description; the first and lowest consisting chiefly of trachytic lavas, the second of rhyolitic tuffs and breccias, and the third of rhyolitic lavas. The strike is on the whole east and west, being more E.S.E.–W.N.W. at the eastern end and E.N.E.–W.S.W. at the western; and the general dip is southerly, though variable in direction as well as in amount. Most of the northern, or rather N.N.W., border of the area is a fault, throwing down to the south, against which the lower members of the group are obliquely cut off; and in some parts, especially to the north of Tobar nan Uaislean, the rocks are invaded by numerous tongues of gabbro. These accidents partly obscure, but do not conceal, the real extent of the group and its relations to the basalts, which are of a remarkable kind.

Owing partly to the arrangement described, the lowest or trachytic division is found only in the eastern part of the area. Here it is clearly underlain by amygdaloidal basalts. Further, the several members of the division die out eastward, dove-tailing with flows of amygdaloidal basalt which die out westward; thus making it clear that the trachytic and associated rocks are contemporaneous with that portion of the basaltic group exposed immediately to the east (Figure 9). Again, they are surmounted in Meall Odhar by more massive basaltic rocks, much invaded and metamorphosed by gabbro above, these basalts being apparently on the same horizon as the rhyolitic rocks seen farther west. The trachytes, etc., either die out westward before reaching the boundary fault, or are cut off by a parallel fault a little north of the main one, for in this place we find rhyolitic tuffs on the line of strike of the trachytic lavas. On the former alternative, which seems the more probable on the ground, it would appear that, although the acid fragmental rocks are in the main newer than the lavas mentioned, they are in part contemporaneous and this supposition is perhaps strengthened by the

occurrence of two or three thin bands of rhyolitic breccia and tuff interstratified with the trachytes. It is possible that a similar relation holds between the middle (fragmental) division and the upper (rhyolitic lavas), but the irregularities of dip and strike and the want of exposures in critical places leave this point in doubt. It is at least certain that both the lower and the middle division die out rapidly towards the west, for beyond Allt Mòr an Fhinn Choire the rhyolitic lavas rest with unbroken junction upon amygdaloidal basalts. The rhyolites themselves, with certain agglomeratic beds mainly of acid material which form the summit of the group, die out on the western face of Bruach na Frithe, dovetailing, as before described for the trachytes, with amygdaloidal basalts (Figure 9); while metamorphosed basalts like those of Meall Odhar overlie the group again about Tobar nan Uais-lean and upward.

It thus appears that the stratigraphical position of all these rocks is *in the midst of the basalt series*, a considerable thickness of the basic lavas occurring both below and above. In this we seem to trace both an analogy and a contrast with the corresponding succession in the Irish area. We have already remarked that in Antrim the basalts fall into two divisions, which must have been separated by a very considerable interval of time; and, according to Mr McHenry, the acid lavas and breccias belong to this interval between the Lower and the Upper Basalts. In Skye the basic lavas present practically an unbroken succession, and there is no direct proof to show that they represent both divisions of the Antrim basalts. If, however, we may correlate the acid volcanic rocks of Skye with those of Antrim, we obtain the missing evidence on this question. It then appears that our basaltic lavas are the equivalents of both the Lower and the Upper Basalts of Ireland; but in our area there was no pause between the two, and they cannot be separated except in the very limited district where the trachytic and rhyolitic rocks interpose to mark the division.

The field-relations, as described above and illustrated diagrammatically in (Figure 9), prove firstly that this group of rocks is of *extremely local* distribution, and is contemporary with a part of the basaltic lavas; and secondly that *the centre of eruption gradually shifted westward or south-westward*, so that the successive divisions of the group overlap one another in that direction, and are in turn overlapped by the massive basalts of Meall Odhar and Bruach na Frithe. Incidentally the manner of occurrence of these trachytic and rhyolitic rocks throws light upon the nature of the great accumulation of basaltic lavas, which is here revealed as an aggregate of comparatively thin flows, each of small extent and rapidly wedging out.

The fact that the volcanic rocks of acid and sub-acid composition consist to the extent of fully one-half of tuffs and breccias suggests that, unlike the basalts, they were ejected from a true volcanic vent, or from vents belonging to a definite volcanic centre; and the limited distribution of the rocks is quite in accord with this supposition. It is also worthy of note in this connection that there are no acid or sub-acid dykes in the vicinity, and indeed none in the district which can be referred to this early epoch. Activity must have been prolonged at this centre for a considerable time, for the total thickness of rocks seen is not less than 2000 feet.

Turning to the *petrographical characters* of the rocks, we take first the *trachyte*, which forms the bulk of the lowest division of the group, and is seen in the eastern part of the area, viz. N. and N.W. of Meall Odhar. It is a rock of uniform appearance, light grey in colour, and of very fine texture, presenting little of a crystalline aspect to the eye. It contains flattened green and greenish yellow amygdules (chloritic and epidotic) and some smaller ones of quartz, and has evidently suffered somewhat from secondary changes. A fairly fresh specimen gave the specific gravity 2.53. A slice [\(S9260\)](#) [NG 466 271] shows this rock to consist essentially of minute crystals of orthoclase, mostly less than 1/1000 inch in length, closely packed with a fluxional arrangement. Minute octahedra of magnetite are also found in subordinate quantity. In this ground-mass are enclosed, quite sparingly, decayed flakes of biotite and other pseudomorphs which by their form suggest augite. The secondary products, in addition to the quartz in the vesicles, are disseminated chloritic matter and granular epidote. Another specimen, taken at a rather higher horizon, has rather more of the mica, though this is still a very subordinate element. It appears, to the eye, as little black specks with a parallel disposition; and a slice [\(S7839\)](#) [NG 45 26] shows that these are flakes of biotite which have been altered by the so-called "resorption" and subsequently chloritised. There are also in this specimen a few scattered alkali-felspars, up to 1/10 inch in diameter, embedded in the fine-textured trachytic ground-mass.

Intercalated in the trachytic division are four flows of a *porphyritic andesite*, a rock of very striking appearance owing to the presence of abundant large feldspars, sometimes as much as two inches long. The specific gravity of the rock is 2.72. The ande-sites stand out a little in relief from the trachytic lavas, and the second and thickest flow makes a conspicuous

small escarpment at the foot of Meall Odhar. Immediately beneath it is a thin band of a curious *volcanic agglomerate*, mainly of gabbro material. This has in the field the appearance of a crystalline rock, but is seen to enclose fragments of gabbro up to several inches in diameter. In a slice ([S7840](#)) [NG 45 26] the principal elements are seen to be shattered crystals of labradorite, doubtless derived from a gabbro, with a few alkali-feldspars, probably from a granite: there are also chloritic and serpentinous substances replacing destroyed augite.

The acid fragmental accumulations, which occur principally in the middle division of the group, consist essentially of rhyolitic material. They are in general *rhyolite-tuffs* of fine texture enclosing scattered larger fragments, though in some beds the coarser material is in such quantity as to warrant the term *rhyolite-breccia*. The breccias are well seen along a strip adjoining the northern border of the area, between Allt an Fhionn-choire and the next burn to the west. There are also two lenticular accumulations of breccia in the upper part of the succeeding division of rhyolitic lavas: one of these is on the spur of Bruach na Frithe marked by an Ordnance Survey cairn (1681.5 ft.), and the other occurs a little higher up, running for some distance along the western flank of the mountain. It is to be noticed that the rhyolitic tuffs and breccias, as well as the rhyolitic lavas, are, to a much greater extent than the lower division of the group, invaded by offshoots from the gabbro of the Cuillins, chiefly in the form of tongues and wedges which tend to follow the bedding of the volcanic rocks. If these latter have suffered in consequence any considerable thermal metamorphism, the effects of this are masked by other secondary changes. What is seen in other regions would lead us to anticipate much less mineralogical transformation from the influence of heat in these acid rocks than in the basalts. The whole group is traversed too by the same N.N.W. basic dykes which intersect also the basalts and the gabbro, and there are inclined intrusive sheets (not sills) of basic rocks in addition.

The acid pyroclastic rocks show little variety except as regards the varying proportion of larger fragments which they contain. The finely-divided matrix is always of pale colour, either white or light greenish from disseminated chloritic matter. In it are little chips and broken crystals of feldspar, besides rock-fragments. These latter are angular, sub-angular, or rounded, and mostly less than an inch in diameter, though larger in some beds. The majority are of rhyolite; some seem to be of trachyte; while darker fragments, more conspicuous though less abundant, are of a microlitic andesite and a vesicular basalt, stained a deep brown colour and recalling palagonite ([S7837](#)) [NG 45 26], ([S7838](#)) [NG 450 262].

The *rhyolites* constitute, as has been said, the uppermost of the three divisions of the group, and make up about a half of the total thickness. The breccias towards the summit, already mentioned, indicate some recurrence of explosive eruptions towards the close of the rhyolitic phase. The most extensive exposures of the acid lavas occur in the neighbourhood of Allt Mòr an Fhinn-choire, the burn coming down from the fine group of springs named Tobar nan Uaislean; but here, and generally throughout the area, these rocks are greatly altered by secondary changes. Better specimens, which may be taken as representing fairly closely the unaltered condition of the rocks, are to be found in the little isolated patches associated with the biotite-feldspar and gabbro on the south-western slope of Sgùrr Thuilm.

The prevalent type<ref>A preliminary account of these rocks was published in the *Summary of Progress* for 1897, pp. 131–135, and is here reproduced with some modifications and additions.</ref> appears in hand-specimens as a compact looking rock of light grey to pale lavender colour. A specific gravity determination on an average specimen gave 2.596. Though there is no conspicuous porphyritic structure, a few small scattered crystals of feldspar are visible, which are found to be orthoclase, turbid from incipient decomposition. A strongly marked flow-structure, exaggerated by secondary mineralogical changes, imparts a laminated appearance and often a highly fissile structure. This lamination is shown by alternating narrow bands of lighter and darker grey, with fine lines of a dark green colour and slender strings of quartz. In thin slices ([S7830](#)) [NG 45 26], ([S7831](#)) [NG 45 26], ([S7832](#)) [NG 45 26], ([S7833](#)) [NG 45 26], ([S7834](#)) [NG 45 26], ([S7835](#)) [NG 45 26], ([S7836](#)) [NG 45 26] it is seen that these bands correspond with slight differences in the nature of the general ground-mass of the rock; differences partly original, but partly due to, or accentuated by, secondary changes. The texture is in general very fine; in some bands of rather confused appearance, though evidently a feldspar-quartz aggregate; in others more definite, with many minute feldspars set parallel to the direction of flow. The ferro-magnesian element of the rock has been quite subordinate, and is in no case preserved unaltered. The least changed specimens show under the microscope small yellow-green chloritised prisms, representing destroyed augite, and more rarely a flake of altered biotite. Of iron-ore minerals there are minute cubes of pyrites, usually converted to limonite, and sometimes grains of magnetite. In many specimens both augite and iron-ore have disappeared, and there is only chloritic or ferruginous matter disseminated through the rock or tending to collect in cloudy patches. It is interesting to note that, in

those specimens which contain most of the pseudomorphs after augite, there are rather abundant little prisms of apatite, associated with the ferro-magnesian mineral and the magnetite.

Specimens from different horizons on the hill-side east of Allt Mòr an Fhinn-choire show no noticeable variations excepting such as are due to the varying advance of secondary changes, indicated especially by the development of quartz. In slices of the less altered examples the lighter bands are seen to be rich in this mineral, which tends to form a mosaic, and in this kind of occurrence is doubtless of secondary origin. The distinct strings of quartz, already mentioned as visible in hand specimens, are not essentially different. They sometimes swell into little lenticles, and it is clear that they are not merely veins filling fissures, but replace portions of the ground-mass. The little pseudomorphs supposed to represent augite, as well as the small crystals of pyrites, are sometimes embedded in the clear quartz-mosaic. Other specimens illustrate what may be regarded as a further stage, the little strings of quartz passing in places into knots up to half an inch in diameter, while locally there occur nodules of quartz up to an inch or more. In the examples which have suffered most alteration we find not only these knots or nodules of quartz but also druses, often an inch or two inches in diameter, and of irregular shape. These are lined with quartz crystals in the form of the hexagonal prism with pyramidal termination, coated with a yellow ferruginous skin. The flow-lines of the rhyolite tend to wind round these drusy cavities, but are sometimes cut off by the larger ones, the appearances indicating that there has been an original cavity, but that it has been in some degree extended in connection with the process by which the new quartz was produced. The rocks in some places give evidence of a certain amount of crushing, and are indeed locally brecciated, this mechanical modification being clearly posterior to the chemical alteration which gave rise to the fine strings, knots, and druses of quartz.

The degree to which these lavas have been altered by replacement by secondary quartz — for which we must postulate in part an extraneous origin — leaves the true nature of the rocks, taken by themselves, a question of some obscurity. Having regard, however, to their general characters, and especially to the paucity of porphyritic elements, the strongly marked fluxion-structure, and certain peculiarities in some bands which suggest a denitrified glass, the affinities of these lavas seem to be very decidedly with the rhyolites. This conclusion is placed beyond doubt by an examination of the fresh examples preserved under exceptional conditions.

Like the Icelandic rhyolites, which they resemble in many respects, these Skye rocks show in general no tendency to spherulitic structures. If microspherulitic varieties are represented, their distinctive characters have been obliterated by secondary processes. At one place, however, quite at the base, or more accurately in the highest part of the underlying pyroclastic division, there is a thin flow of rhyolite composed in great part of large spherulites. This is exposed in the little ravine of Allt an Fhionn-choirs. As is usual in these coarsely spherulitic rocks, the structure is obscured by later changes, and there is indeed a close resemblance to certain "nodular" rhyolites of Lower Paleozoic age in North Wales and Westmorland. Again, at a place a little east of Allt Mòr an Fhinn-choire the rhyolite at the base of the division shows what is possibly a spherulitic structure on a smaller scale; but this is too much affected by secondary changes to be made out clearly under the microscope.

In conclusion we have to notice the *intrusive biotite-felsite*, already mentioned, on the slopes of Sgùrr Thuilm. It occurs in several detached but neighbouring outcrops along a strip about 1½ mile long, which are surrounded by gabbro. The exposures are not good enough to show clearly whether the gabbro has broken up and enveloped an earlier mass of felsite, or has been penetrated by intrusions of a later felsite; but the shape of the outcrops, so far as it can be determined, rather suggests the former interpretation. It is also worthy of remark that the gabbro is not traversed by any dykes or veins of acid rock, which might be apophyses from a later intrusion. It is therefore possible, and not improbable, that we have here the relics of an intrusive mass of acid rock older than the gabbro of the Cuillins, and so belonging to some part of the stage of volcanic eruptions. This suggests a possible connection between the felsite and the rhyolitic rocks of Fionn Choire and Bruach na Frithe, only about a mile distant. Such suggestion is strengthened by the occurrence, at one or two places among the felsite, of volcanic rocks allied to those described from Fionn Choire. At one spot is found a laminated rhyolite and at another spot a small patch of rhyolitic breccia. Their relations to the felsite are not clearly exhibited, but they are presumably enveloped in it.

The petrographical characters of the felsite of Sgùrr Thuilm are consistent with the idea that it is genetically related to the rhyolites. It is a dull, compact, light grey rock, enclosing numerous little yellowish feldspars and some bronzy flakes of

mica, sometimes as much as ¼ inch in diameter. The porphyritic feldspars, which embrace orthoclase and oligoclase, have more or less rounded outlines, and are usually very turbid. The mica is considerably altered, sometimes completely bleached, sometimes ehloritised. There are also grains of magnetite and prisms of apatite, the latter penetrating both mica and iron-ore. These various minerals tend to occur in groups or patches. The ground-mass is of a common "felsitic" type, very fine-textured, but not cryptocrystalline: the felspathic element is partly in the form of minute prisms (S8195) [NG 432 248], (S8196) [NG 432 248].

It is possible, and perhaps probable, that this rock represents a volcanic plug or "neck" connected with the acid lavas and tuffs, its form and relations obscured by a subsequent invasion of gabbro; but the evidence does not warrant us in insisting strongly upon this view. Apart from this, the very limited distribution of this highly interesting group of volcanic rocks, and the largely fragmental character of the rocks themselves, sufficiently prove them to be the products of central volcanic eruptions. That these were demonstrably contemporaneous with fissure-eruptions of widely different petrographical nature in the immediate vicinity, clearly indicates that there was no immediate relationship between the two groups. During the volcanic phase of activity at least, the "regional" and the "local" events followed independent lines, and must have been provoked by two different sets of causes. (See Chapter 25).

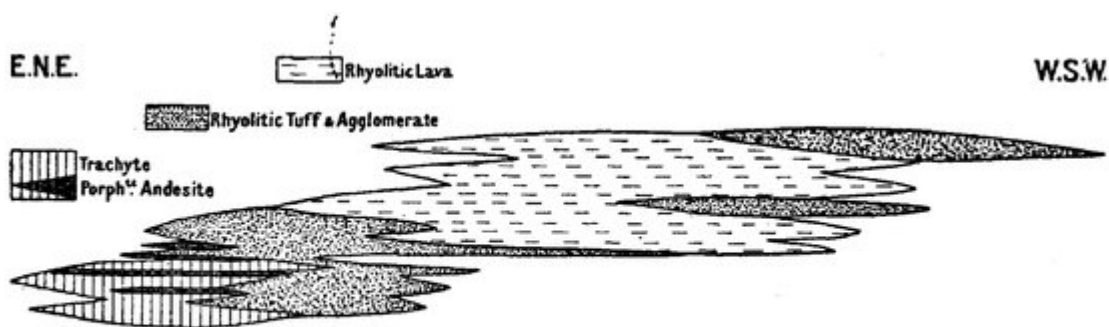


FIG. 9.—Diagrammatic representation of the relations of the trachytic and rhyolitic rocks to one another and to the basalts. The figure is an ideal general section of the group, not drawn to true scale.

(Figure 9) Diagrammatic representation of the relations of the trachytic and rhyolitic rocks to one another and to the basalts. The figure is an ideal general section of the group, not drawn to true scale.