Chapter 35 Camptonites, etc., of doubtful age

Introduction

True camptonites were first distinguished in Britain by Dr. Flett,<ref>J. S. Flett, The Trap Dykes of the Orkneys, Trans. Roy. Soc. Edin., vol. xxxix., 1900, p. 865.</ref> when he described the camptonite-monchiquite dyke-assemblage of Orkney. The name was previously used in Scottish petrological literature for rocks of the spessartite class. The camptonites of Orkney have an east-north-east trend. When Dr. Flett described these dykes, he pointed out that they had been generally assumed to be of Tertiary age; and he added that they might well be of this date, although further research in the northeast of Scotland was required before it would " be possible to arrive at any definite conclusion." Later, after describing a few examples from Caithness, belonging to the Orcadian field of dyke-intrusion, he summed up as follows: "The whole question of the age of these rocks is still very obscure, and the possibility that they are really Tertiary cannot be definitely excluded."<ref>J. S. Flett in The Geology of Caithness, Mem. Geol. Surv., 1914, p. 117.</ref>

Dr. Flett<ref>J. S. Flett in The Geology of Central Ross-shire, Mem. Geol. Surv., 1913, p. 79.</ref> has also described a few east-north-east dykes of Orcadian facies and direction from the Glen Strath Farrar district of Ross; and has pointed out that others are known in Eastern Sutherland and the neighbourhood of Glenelg. As regards the Glenelg examples, the most definite reference that can be given is due to Dr. Clough,<ref>C. T. Clough in The Geology of Glenelg, Lochalsh, and. the South-east part of Skye, Mem. Geol. Surv., 1913, p. 79,</ref> who under the heading Pre-Triassic Igneous Rocks, refers to an east-north-east dyke of teschenitic affinity occurring towards the north end of the Sleat peninsula of Skye (south of Rudha na Caillich). This particular dyke has well-developed ocelli; and Dr. Clough has taught the geologists working in the Mull district that ocellar structure is of the utmost service in the field for distinguishing camptonites from other thoroughly basic types. It is true that one may be misled in applying this criterion, for felspathic segregations of ocellar type are found in some of the Mull basalt-lavas (p. 114), and also commonly among quartz-dolerite intrusions; but, in practice, it is comparatively seldom that one mistakes a camptonite. A further characteristic is the proneness of camptonites to a pustular or nodular weathering, so as to be covered on the surface by protruding spheres half an inch or less in diameter. Dr. Peach<ref>B. N. Peach in The Geology of the Seaboard of Mid Argyll, Mem. Geol. Surv., 1909, p. 90.</ref> and Dr. Flett<ref>J. S. Flett in The Geology of Caithness, Mem. Geol. Surv, 1914, p. 115.</ref> seem to have been the first to draw attention to this feature in particular cases in Scarba and Caithness. It is an exaggeration of the pimply type of weathering characteristic of many of the Mull Plateau lavas (p. 138).

Dr. Flett's discussion of the age of the Scottish camptonites, as given in the Caithness Memoir, may be turned to by anyone wishing for an introduction to this difficult subject. Further assistance is afforded by (Figure 60) (p. 357), where localities for camptonite (or its allies, monchiquite, ouachitite, nepheline-basalt, etc) are marked with a C. For descriptions of these occurrences the reader may turn to the Geological Survey ' Explanations ' of the various one-inch Sheets indicated by numbers on (Figure 60). Explanations have not yet appeared in the case of Sheets 43, 51, and 52, but accounts of camptonites are given in Prof. Jehu's<ref>T. J. Jehu, The Archean and Torridonian Formations and the Late Intrusive igneous Rocks of Iona, Trans. Roy. Soc. Alin., vol. liii, 1922, p. 186.</ref> description of Iona, and also in the *Summaries of Progress of the Geological Survey* for the years 1920 (p. 34), 1921 (pp. 96, 104), and 1922 (p. 94).

The camptonitic assemblage, recognized at several places in the West Highlands, agrees very closely in petrological type with what is characteristic of the Orkney-Glenelg country farther north. On the other hand, the predominant direction for camptonite-dykes in the West Highlands is north-west, and not east-north-east as it is farther north.

Thus the camptonites of the West Highlands agree in trend with the undoubtedly Tertiary dykes of the same region. More over, when a large collection of slides is examined, it becomes evident that the camptonites are petrologically united with basalts of a type such as undoubtedly figures largely among Tertiary lavas and intrusions of Mull. On these two grounds, it has been thought, with varying. degrees of confidence, that the camptonites of the West Highlands may be of Tertiary age.<ref>J. S. Flett in The Geology of the Country near Oban and Dalmally, (Sheet 45), Mem. Geol. Surv., 1908, p. 124; C. T. Clough, W. B. Wright, and E. B. Bailey in The Geology of Colonsay and Oronsay with parts of the Ross of Mull

(Sheet 35),Mem. Geol. Surv., 1911, pp. 41–88.</ref>

At the same time, the fact remains that, while typical camptonites, monchiquites, etc., occur round about Mull, and even in Mull itself, they have not yet been found cutting Mesozoic sediments or Tertiary lavas. Furthermore, wherever camptonite-dykes are seen in contact with undoubted Tertiary intrusions in the West Highlands, the rule seems to be that the camptonite dyke is cut by its companion. Dr. Harker,<ref>Presidential Address, Quart. Jour. Geol. Soc., vol. lxxxii., 1918 for 1917, p. lxxxxvi.</ref> with these two circumstances in view, has suggested a Permian age for the West Highland and Orkney camptonites. It will be seen that no one favours a Pre-Permian date; and, indeed, such a view would he difficult to maintain, for straggling examples of the north-west camptonites are known cutting coal-measures in Ayrshire and Lanarkshire.

The evidence, as outlined above, does not permit of any certain conclusion. At the present time, however, the writer is inclined to adopt the Tertiary hypothesis, with the proviso that most of the West Highland camptonites are amongst the earliest manifestations of the Tertiary magma. Before elaborating these suggestions, it is well to give an account of the Ross of Mull and Morven occurrences, which seem, at first sight, to point in the opposite direction.

R.B.B.

- **Ross of Mull** – It has been shown in the Explanation of Sheet 35 that most of the north-west dykes met with on the south coast of Mull beyond the Loch Assapol (Sheet 43) boundary-fault of the Tertiary lavas are of the camptonitic suite. Out of ten sliced specimens, four have been determined by Dr. Flett as camptonites, one as fourchite, two as monchiquites, and three as dolerites or basalts. One of the dolerites (S14445) [NM 4324 1814] is certainly cut by the Tertiary xenolithic sill of Tràigh Bhàn na Sgurra (p. 266), and the same is in all probability true of the fourchite (S14446) [NM 4327 1814]; in addition, the latter is crossed by a number of small faults. The rest of the Ross of Mull evidence can be left to the 'Explanation' of Sheet 43. Here, it is enough to say that the camptonitic dykes are fairly well represented westwards right out into iona. (C.T.C) The Loch Assapol boundary-fault runs roughly parallel with the dykes of its neighbourhood. The Tertiary lavaa on its north-eastern side, are, at first, markedly deficient in dykes of any sort. Even where, after some miles, dykes occur in profusion, typical eamptonites, fourchites, or monchiquites are absent; or, at least, they have not been found in spite of free collection and slicing from all parts of the island. E.B.B.
- **Loch Aline, Morven** –The same absence of camptonites seems to characterize the Tertiary lava-area of Loch Aline. But, across the boundary-fault of Inninmore, (p. 181), camptonites are fairly well-represented on the mainland, and also, as Mr. Maufe found, in Lismore. The reappearance of camptonites is certainly striking, considering their absence throughout many intervening miles; but none of them is found, in the Loch Aline district, within 1½ miles of the lava-boundary, nor indeed aiming straight at it. Almost all the occurrences noted have been inserted on the one-inch Map and lettered C. Two of these are of particular interest, since, in them, camptonite is cut by normal Tertiary basaltic types.: one shows an east-and-west camptonite (S15844) [NM 8198 4579], on the coast south of Camas Lèim an Taghain, cut by a north-and-south basalt, similar in type to a Plateau Lava (S15843) [NM 8198 4579]; the other, a north-west camptonite (S15785) [NM 7667 4572], in a stream north-east of Allt Dubh Dhoire Theàrnait, cut by a north-and-south tholeiite of Salen Type (S15784) [NM 7667 4572]. It will be noticed, from the above, that the camptonites of the Loch Aline district vary considerably in direction; but their prevalent trend is roughly north-west. In Lismore, Mr. Maufe has found that they share with their companion basalts a tendency to run west-north-west. G.W.L.

If one had no more evidence in regard to the distribution of camptonites round about Mull, their occurrences in the schist and granite parts of Morven and the Ross of Mull, and their absence from the intervening lava-fields, would seem to point almost conclusively to a Pre-Tertiary date of intrusion. As a matter of fact, this evidence stands for nothing, since camptonite s are unknown in the Mull Swarm from Oban to the Clyde. To supplement earlier enquiries, Mr. Tait collected a suite of forty-eight specimens across the swarm from Sloc nan Uan on the west coast of Sell (near southern edge of Sheet 44), northwards to near Barrnacarry Bay (S18993) [NM 7460 1852]–(S19041) [NM 8018 2267]; and these showed no greater camptonitic tendencies than the dykes across the water in Mull itself.

Barrnacarry Bay (see above) (S18993) [NM 7460 1852], (S18994) [NM 7470 1873], (S18995) [NM 7478 1883], (S18996) [NM 7480 1892], (S18997) [NM 7486 1893], (S18998) [NM 7491 1899], (S18999) [NM 7492 1906], (S19000) [NM 7496

1918], (S19001) [NM 7500 1923], (S19002) [NM 7505 1928], (S19003) [NM 7506 1930], (S19004) [NM 7508 1933], (S19005) [NM 7508 1933], (S19006) [NM 7512 1937], (S19007) [NM 7513 1938], (S19008) [NM 7519 1937], (S19009) [NM 7525 1941], (S19010) [NM 7525 1941], (S19011) [NM 7526 1942], (S19012) [NM 7527 1943], (S19013) [NM 7537 1954], (S19014) [NM 7549 1960], (S19015) [NM 7549 1961], (S19016) [NM 7553 1964], (S19017) [NM 7558 1972], (S19018) [NM 7560 1973], (S19019) [NM 7560 1973], (S19020) [NM 7560 1973], (S19021) [NM 7561 1973], (S19022) [NM 7867 2028], (S19023) [NM 7874 2045], (S19024) [NM 7874 2045], (S19025) [NM 7874 2046], (S19026) [NM 7874 2047], (S19027) [NM 7885 2101], (S19028) [NM 7886 2103], (S19029) [NM 7887 2104], (S19030) [NM 7890 2122], (S19031) [NM 7892 2130], (S19032) [NM 7913 2159], (S19033) [NM 7925 2169], (S19034) [NM 7942 2180], (S19035) [NM 7963 2206], (S19036) [NM 7963 2206], (S19037) [NM 7990 2239], (S19038) [NM 7990 2239], (S19039) [NM 7991 2245], (S19040) [NM 8012 2263], (S19041) [NM 8018 2267]

Accordingly, the absence of camptonites in the greater part of Mull is not due to their concealment under Mesozoic and Tertiary cover.

Other evidence which has been collected bearing on the question is as follows:

1. Camptonites are unrepresented among the few dykes which cut the Moine Gneiss, exposed beneath Tertiary lavas for four miles in a north-easterly direction along the shores of Gribun and Inch Kenneth (Sheet 43). Visitors must be warned against a very deceptive appearance afforded by a 2 ft. west-north-west basalt-dyke on the West shore of Inch Kenneth. At a point noted on the one-inch Map, this dyke traverses the gneiss of the foreshore, but ends in the cliff 10 ft. below the base of the Trias. One has to climb up the cliff-face to realize that the dyke ends below the base of the Trias, and is not cut off by the same.

2. The absence of camptonite-dykes from the Mull Swarm and its immediate neighbourhood no longer holds good in Coll, where Mr. V. A. Eyles and the writer have found north-west camptonites striking at the lava-field of Mull.

3. On the other hand, camptonite-dykes do seem to be absent from the western half of the Aramurchan peninsula. Messrs. Eyles, Simpson, and the writer have found them well-represented in the eastern half of the peninsula, where they continue the camptonitic belt of south-east Morven, Lismore, and Arnamucknish.

4. Though typical camptonites are unknown from the lava-held of Mull, at least one camptonitic basalt (or dolerite) has been met with (p. 369), which might possibly be classed as camptonite. Then, too, one cannot lose sight of the somewhat camptonitic affinities of many of the Mull dykes and lavas—more especially in the case of lavas with ocellar segregations (Chapter 10). Not only so, but the occasional mugearites (Chapter 10), trachytes, bostonites, and syenite (Chapter 14), are just such associates as one expects to meet with camptonites.

5. Though rocks of camptonitic affinity recur in the Mull petrological timetable, it is almost certain that the West Highland camptonites, if Tertiary at all, are of relatively early date; for they have often been seen cut by other Tertiary intrusions. Perhaps an early date in some small measure accounts for their not being found exposed in the region of depression occupied by the lava-field; but it is difficult to press this suggestion in view of the apparently continuous absence of camptonites along the track of the Mull Swarm south-eastwards to the Clyde. E.B.B.

Petrology

For the most part the dykes of the present chapter are fairly uniform in their microscopic characters, but vary amongst themselves to some extent in the relative abundance of their constituent minerals, among which first one bisilicate and then another gains preponderance. They are holocrystalline rocks with the typical panidiomorphic structure of the lamphrophyre-group; and are composed essentially of olivine, purple augite, deep-brown hornblende, soda-lime and alkali-felspars, and magnetite, with generally some analcite as the ultimate residual product. The felspar appears to be dominantly plagioclase; but orthoclase is usually, though not universally, present. The residual analcite occurs alike in the base, in vesicular cavities, and in ocelli. Quartz has not been detected.

Dr. Flett, whose writings have been quoted freely in the earlier part of this chapter, was the first to claim that Scottish dyke-rocks with the characters outlined above are true camptonites; and, at the same time, he pointed out that the name had previously been misapplied in Scottish literature. Dr. Flett's determination of the camptonites was largely based upon the colour of the augite and hornblende, and the presence of analcite, instead of quartz, as a residuum. He arrived at his conclusions after comparison of Scottish material with slides from continental areas; and his results have been accepted by Sir Jethro Teall and Rosenbusch.<ref>H. Rosenbuch, Mik. Phys. d. Min. and Gesteine, 1907, Bd. ii., 1, p. 170, also E. B. Bailey The Geology of Ben Nevis and Glen Coe, Mem Geol. Surv, 1916, p. 157.</ref>

The figured Lismore dyke (S13744) [NM 8468 4270], (Figure 63)A) contains moderately large crystals of augite and olivine in a matrix of well-formed elongated crystal of rich-brown hornblende, lath-shaped crystals of acid labradorite, and fairly abundant magnetite, in a base of what appears to be turbid orthoclase and analcite. In some cases (S13748) [NM 8442 3979], olivine, as large crystals, is the dominant micro-porphyritic constituent, and the place of hornblende in the matrix is wholly taken by augite. In other cases, olivine is practically wanting (S13746) [NM 8480 4023], and hornblende almost unrepresented., Augite occurs in two generations, the one as larger somewhat-coloured individuals, frequently zoned towards the margin and showing hour-glass structure, and the other as hypidiomorphic prisms occurring in a matrix of plagioclase, orthoclase, and analcite.

The approach of certain dykes to the composition of vogesites is shown by the occasional increase in the amount of alkali-felspar (S13751) [NM 8558 4191].

In Morven, the hornblende-rich rocks constitute the dominant variety, and the figured example (S15788) [NM 7843 4466] may be regarded as characteristic. As before, olivine forms well-shaped phenocrysts (S13744) [NM 8468 4270], (S15834) [NM 7547 4684], and augite and hornblende figure prominently in the matrix. The felspar is largely a moderately acid plagioclase, but some alkali-felspar and analcite appear as ultimate products of consolidation. Occasionally, the crystals of olivine reach large dimensions. The hornblende is the usual deep red-brown variety, and occurs as elongated crystals showing strong pleochroism. Augite may occur as phenocrysts of considerable size (S13744) [NM 8468 4270], (S15842) [NM 8251 4686], but frequently it is more or less restricted to the matrix, and is comparable as regards dimensions with the hornblende. The amount of alkali-felspar and analcite in the base is a variable quantity. It seldom, if ever, reaches a value sufficient to cause the rocks to be classed: as vogesites, but is readily detected (S15790) [NM 7831 4271], (S15812) [NM 7411 4694].

Certain of the dykes have, in the main, distinct doleritic affinities (S15795) [NM 8106 4475], (S15844) [NM 8198 4579], but present an ocellar structure of which the ocelli are lamprophyric both in composition and in the arrangement of the constituent minerals. H.H.T.

Fig. 60.—Tertiary Dykes of the South-West Highlands.
Only about one dyke in every ten or fifteen is shown. The mainland portion of Sheet 52 of the one-inch Map of Scotland has still to be surveyed.

(Figure 60) Tertiary Dykes of the South-West Highlands.

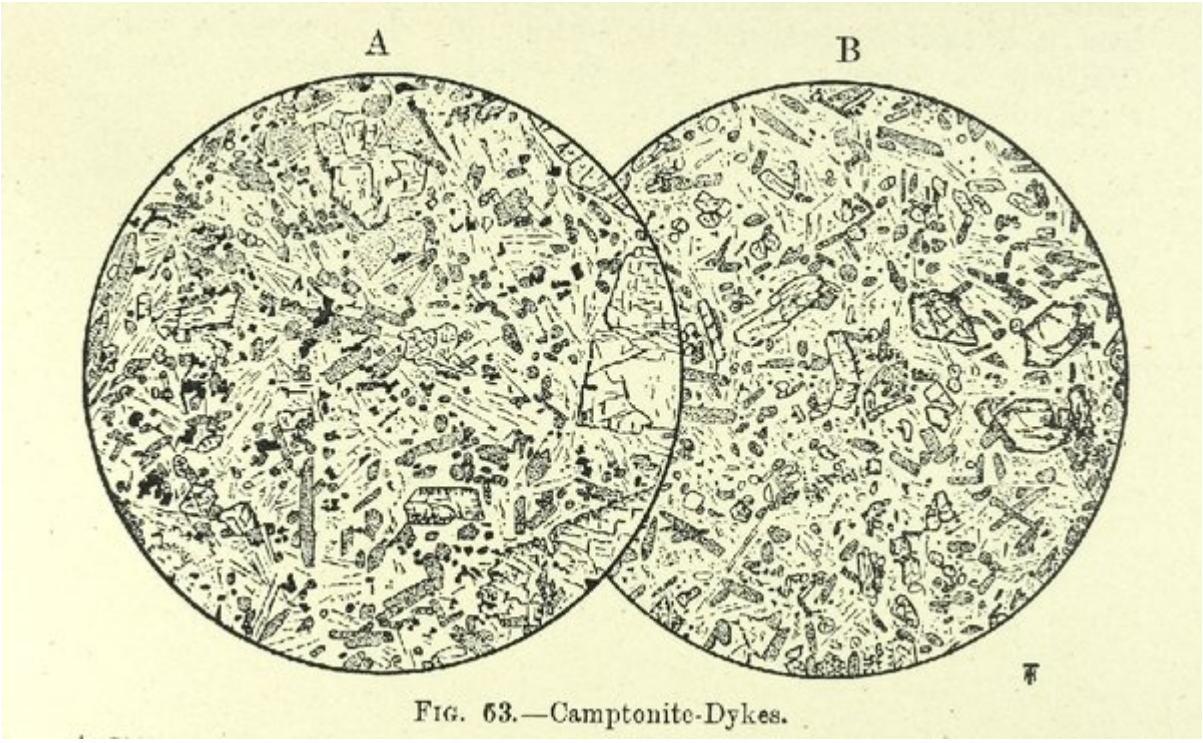

Fig. 63.—Camptonite-Dykes.

(Figure 63) Camptonite-Dykes. A. [(S13744) [NM 8468 4270]] ×17. Camptonite from Lismore, showing moderately large crystals of augite and olivine in a matrix of well-formed elongated, crystals of hornblende, labradorite, and magnetite, in a base of turbid orthoclase and analcite. B. [(S15788) [NM 7843 4466] ×17. Camptonite from Morven. The phenocrysts are mainly olivine. Augite is a less prominent constituent than in A; otherwise the rocks are similar.