Chapter 6 Tertiary igneous rocks, Ardnamurchan, history of research

The Ardnamurchan peninsula did not offer to early workers so attractive a field for geological investigation as the other Tertiary districts of Western Scotland, and its contributions to the progress of discovery among the Tertiary igneous rocks are of much less importance than those gained, for example, in the Island of Mull. Reference may be directed to the history of research given in the Mull Memoir<ref>E. B. Bailey *in* The Tertiary and Post-Tertiary Geology of Mull.. *Mem. Geol. Surv.,* 1924, pp. 40–50.</ref> for an account of many of the advances made in our knowledge of the Scottish Tertiaries. Only such observations as concern Ardnamurchan in particular will be mentioned here.

The researches of Jameson and Macculloch in the early part of last century were devoted almost entirely to the island districts. Ardnamurchan was known to be an area of igneous rocks, but the only record of note is a drawing by Macculloch in which he illustrates cliffs of limestone (Inferior Oolite) traversed by a complexity of 'trap veins' (1819,<ref>Titles of works referred to by date in this Chapter are given in Bibliography, Appendix III, p. 380</ref> Pl. 33, (Figure 1), facing p. 55). They are without doubt the sea-cliffs west of Sròn Bheag on the south-west side of the peninsula which are so conspicuous a feature of this rock-bound coast (*see* p. 180). Ami Boue in his *Essai,* published probably in 1820, has also figured veining of limestone by basalt. His drawing shows basalt resting upon Gryphea-limestone and sending 'veins' into it, while both limestone and basalt are traversed by later basalt 'veins' (1820, Pl. 6, fig. 8). The locality is probably near Mingary Castle (*see* (Figure 25), p. 177).

Some fifty years later the next important contribution to Ardnamurchan igneous geology was made by Prof. Judd, when he formulated his conclusion that Mull, Ardnamurchan, Rum, and Skye are the basal wrecks of great central volcanoes. In Ardnamurchan he made some notable discoveries. He supplemented Macculloch's observation by recognizing that the great gabbro forming the nose of the peninsula was intrusive in the Mesozoic strata, which were inclined at high angles along the gabbro-margin (1874, p. 251). The volcanic agglomerates of Ben Hiant he also investigated, though wrongly concluded that they were superficial and not accumulated in vents (1890, p. 373). In his detailed petrographic work, dealing with the gabbros of Ardnamurchan and of other Tertiary districts, he made valuable advances (1886). On the other hand, his failure correctly to appreciate the field relations of the finer-textured basic rocks led him to misinterpret certain basic intrusions as lavas, such as the sill on which Mingary Castle is built, and the central intrusive dolerite of Ben Hiant (1874, pp. 261–264, and 1890, pp. 373–376).

Sir Archibald Geikie, on the contrary, realized that the Ben Hiant dolerite was intrusive (1888, pp. 118–119), and that the agglomerates were contained in vents (1888, pp. 105–107). His field observations were later restated more fully in his book, 'The Ancient Volcanoes of Great Britain' (1897), together with petrographical descriptions of the Ben Hiant dolerite supplied by Dr. Harker. Geikie's observations and conclusions regarding the Ben Hiant rocks mark a great advance in this area, though now emended in certain respects (*see* pp. 121 and 162–3).

In 1900 Prof. K. Busz described a granophyre dyke from near Kilchoan (exact locality not stated) which had reacted with the gabbro into which it was intruded, and produced interesting hybrids (1901).

Prior to the detailed mapping by the Geological Survey, Dr. A. Harker visited the district. In his published writings he has made brief reference to the association of an acid intrusion (the Tonalite p. 336) with the Ardnamurchan gabbro (1904, p. 170), and to the occurrence of inclined sheets (cone-sheets) (1917, p. xciv).

Survey mapping was begun in the autumn of 1920 and was continued during the three succeeding summers. The progress of the work is recorded in the annual reports for the years 1920–1923 and 1925, and the chief advances made are stated below. Reference is directed to (Plate 2) (p. 71) for an explanation of many of the rock-groups mentioned in this account. The plate illustrates the grouping of the various intrusions about three successive centres, 1, 2, and 3. The recognition of these centres was not completed until 1923.

In a preliminary reconnaissance by Mr. Richey in 1920, Dr. Harker's observation of the occurrence of cone-sheets was confirmed. It was found that they formed an extensive group around the visible margins of the great gabbro mass, and. were of earlier date than the latter. It was noted that these sheets (the Outer Set) inclined towards what is now called

Centre 2 on (Plate 2).

In 1921 progress was chiefly made in the investigation of the vents and of the gabbro mass. Several contacts between the agglomerates of Ben Hiant and vent-walls composed of the plateau basalt lavas were determined by Mr. Richey, and detailed mapping showed that on Ben Hiant there were no more than perhaps two large contiguous vents. The agglomerates were found to be interstratified with beds of tuff and sheets of pitchstone, and the latter were interpreted as lava-flows within an extensive crater. Farther north the mapping of a wide area of agglomerates (forming the Northern Vents), traversed by a group of more massive cone-sheets than those immediately around the great gabbro mass, was begun by Mr. Bailey. These sheets, as was realized later, would seem to belong to Centre 1.

The gabbro was found by Mr. Richey to be an intrusive complex of various types, and the disposition of curving outcrops of gabbro and dolerite intrusions around a more acid mass (Tonalite and Quartz-monzonite at Centre 3) first suggested the presence of ring-dykes in Ardnamurchan.

In 1922, the gabbro-complex was mapped out in detail, and the existence of two centres of ring-intrusion was established. The occurrence of a ring-dyke complex around Centre 3 was confirmed, and it was shown that an earlier suite of ring-dykes was developed around Centre 2, around which the Outer Set of Cone-sheets had previously been recognized. It was also proved that the Outer Cone-sheets of Centre 2 are of earlier date than the outermost and perhaps earliest of the associated ring-dykes (the Hypersthene- gabbro). Further, a later Inner Set of Cone-sheets was identified cutting certain of the ring-dykes of Centre 2, but cut off by the outermost and earliest of the ring-dykes of Centre 3. Among other points of interest, an elongate volcanic vent east of Kilchoan Bay (Glas Eilean Vent) was found to be later than the Outer Cone-sheets of Centre 2, and thus of later date than the Ben Hiant and Northern Vents. Also, Prof. Judd's observation of tilted Mesozoic strata at the margin of the gabbro-complex was extended, and it was recognized that these rocks had been domed up around Centre 2 previous to the intrusion of the ring-dykes.

In 1923, advances were chiefly made in establishing a time sequence in the two ring-dyke complexes, in which work assistance was given to Mr. Richey by Dr. Thomas and Mr. Bailey.

The shape of the great Ben Hiant Intrusion was finally determined, and prolongations from it simulating cone-sheets, which Geikie had pieviously noted, were investigated by Mr. Bailey. The mapping of several other major intrusions, cut by the Outer Cone-sheets and evidently of early date, was concluded in the area outside the gabbro-complex, around its eastern side.

When the six-inch field-maps were reduced in the office to the one-inch scale, it was realized that the Ben Hiant and Northern Vents, together with the associated major intrusions and the easterly series of massive cone-sheets (mapped by Messrs. Bailey, Richey, and Simpson), must belong to an early complex, to be referred to a centre (1) in the eastern part of the Ardnamurchan igneous district. The early date of this centre was determined by the fact above stated that the major intrusions concerned were profusely cut by the Outer Cone-sheets belonging to the earlier ring-dyke centre (2). Thus it became evident that there were three successive complexes, each of which had reference to a centre of its own.

In 1924, the 'Memoir on the Tertiary and Post-Tertiary Geology of Mull, Loch Mine, and Oban' was published. In it some brief references were made to Ardnamurchan, while detailed descriptions were given of North-west Mull, which was included in the area dealt with (1924, pp. 115–117, 156, 157, 160, 161, 357, 358).

During the course of the field-work in Ardnamurchan it was found that the rock-types were for the most part similar to those already investigated from Central Mull. The Interior Complex of ring-dykes, typified by containing biotite, supplied the chief departures from Mull types. In the 'Summary of Progress' for 1925 (pp. 125–127), Dr. Thomas emphasized the prevalence in Ardnamurchan of rocks rich in alumina, lime, and magnesia as compared with the 'Normal Mull Magma-Series',<ref>The terms, Plateau Magma-Type and Central Magma-Type of the Mull Magma-Series, as employed in the ` Tertiary Mull Memoir, carried a strictly geographical significance, in that 'Plateau' and 'Central' bore reference to the distribution of two important groups of basalt lavas developed in that island. The Plateau Magma-Type is thus characteristic of the olivine-rich basalt lavas that constitute the greater part of the extensive lava-plateau of Mull. The Central Magma-Type is exemplified by younger, olivine-poor basalt lavas preserved by folding and faulting in the central

part of the island. The terms are used in the present Memoir in order to facilitate comparisons with Mull. It should perhaps be stated explicitly that the two terms do not imply any particular modes of origin. Lavas of Central Magma-Type are not necessarily to be regarded as products of central volcanoes, nor are those of Plateau Magma-Type necessarily connected with fissure eruption or scattered vents.</ref> correlating this feature with the concentration of basic plagioclase and olivine. More recently, in his Presidential Address to Section C at the British Association meeting at Leeds (1927), he dealt with many aspects of Tertiary igneous activity in Britain. In the same year, it may be mentioned, Dr. Burri of Zurich gave a critical review of post-Mesozoic differentiation-types, and compared the British Tertiary Province with other regions (Madagascar, Reunion, Mauritius, Rodriquez). J.E.R.

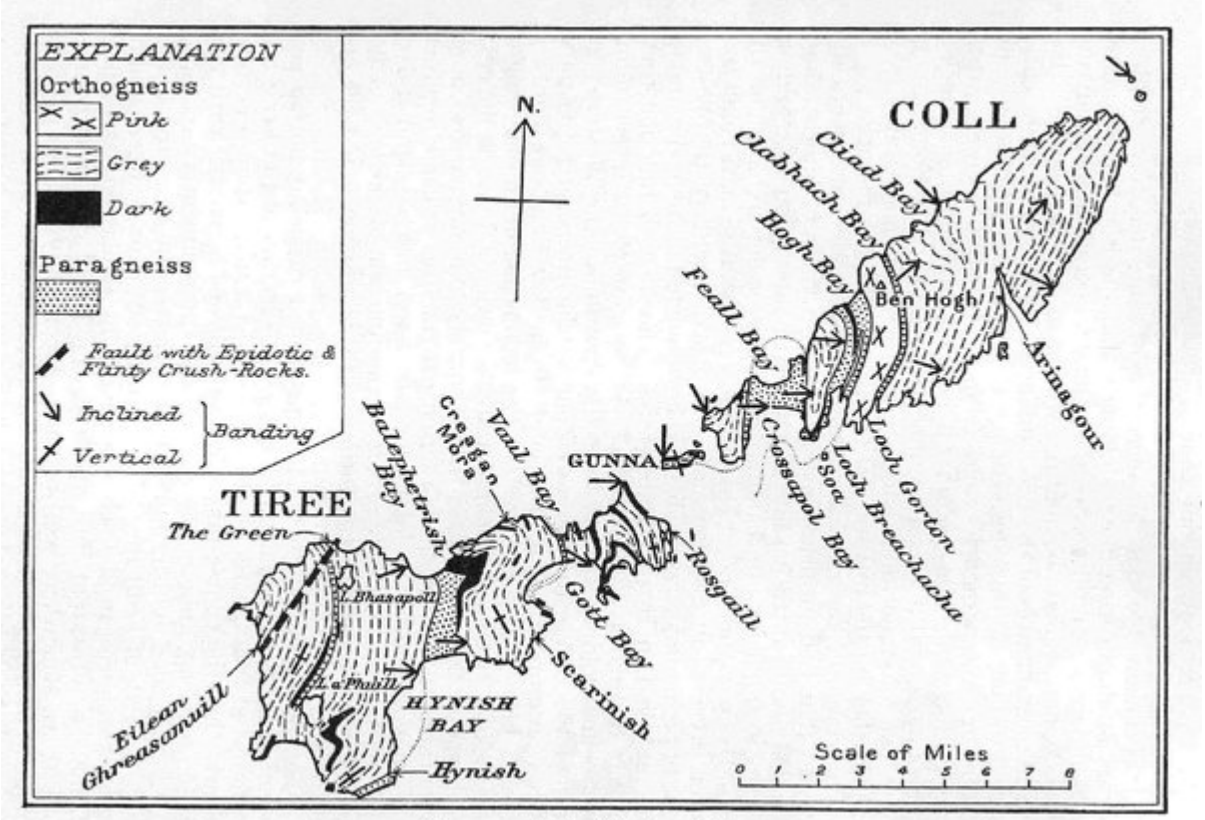

FIG. 1.—*Map of Coll and Tiree.*

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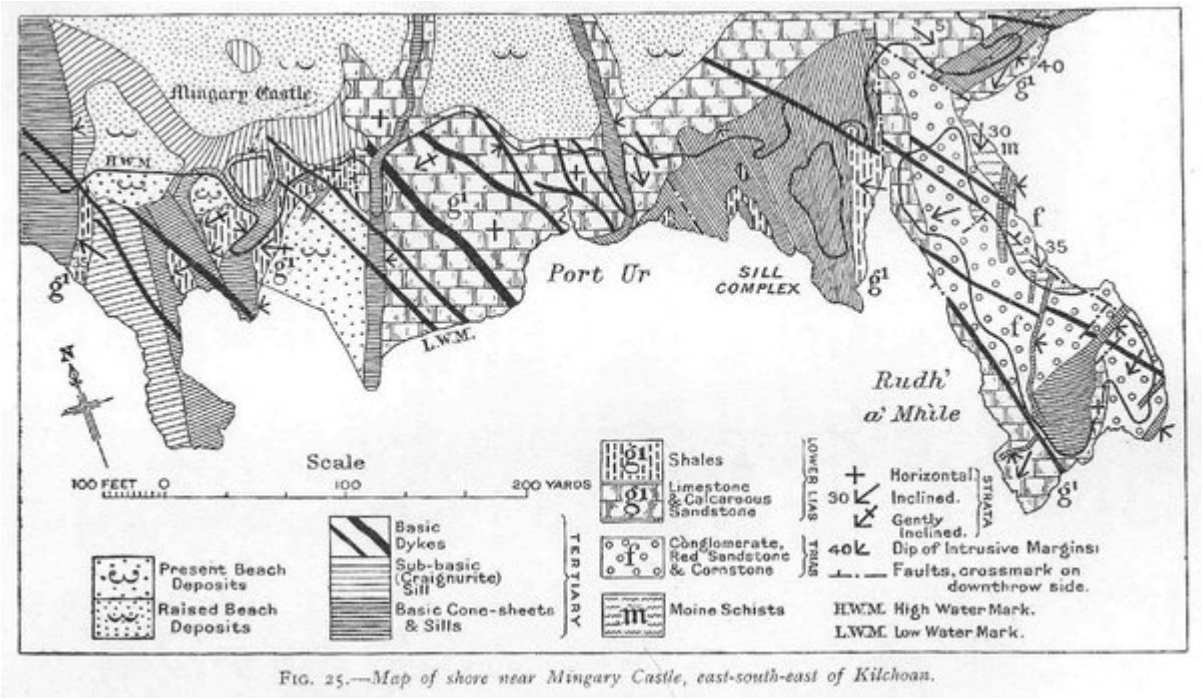

FIG. 25.—*Map of shore near Mingary Castle, east-south-east of Kilchoan.*

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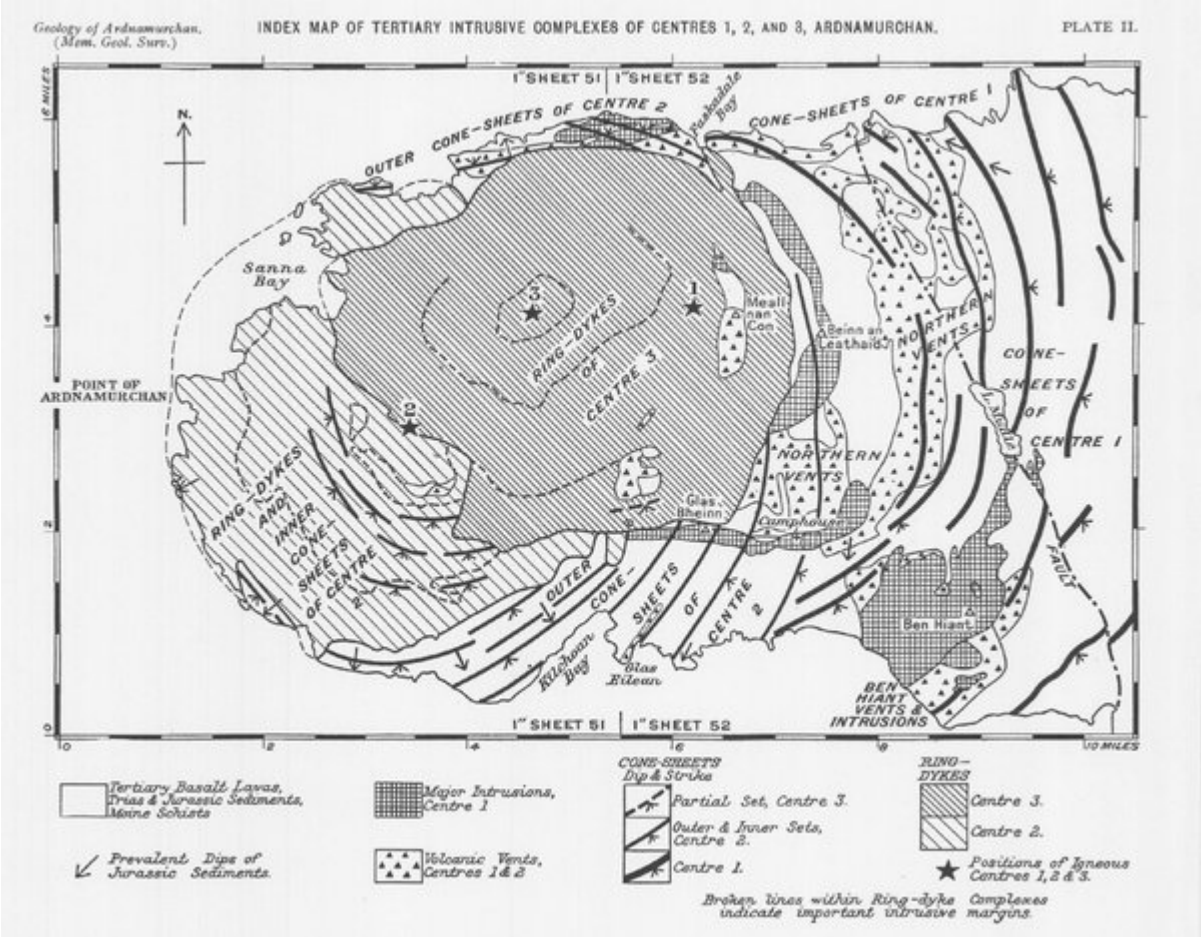

(Plate 2) Index map of Teriary intrusive complexes of Centre 1, 2, and 3 Ardnamurchan.