Chapter 6 Isle of Arran

Introduction

Arran has long been known as an area of complex and diverse geology and outstanding natural beauty (Figure 6.1). It is the most accessible of the Scottish Cenozoic igneous centres and is used extensively as a training ground for geologists. Interest in the geology of Arran goes back over more than 200 years to the writings of Pennant (1774), Hutton (1795), MacCulloch (1819), Boue (1820) and others, but the first detailed survey of the island, other than that by Ramsay (1841), was not carried out until the start of the present century by Gunn (1903) and this was subsequently completed by Tyrrell (1928, reprinted 1987). The sites selected as illustrating Arran's varied igneous geology are indicated on (Figure 6.2).

The Tertiary igneous interest is concerned mainly with the varied intrusive rocks; remnants of a former lava cover now only exist as subsided blocks within the Central Igneous Complex. The largest body of intrusive rocks is formed by the granites of the scenically spectacular Northern Mountains (Figure 6.1). Two distinct biotite granites; one a coarse-grained rock forming the outermost parts and the other a younger, finer-grained rock within the first, are present (see Harker *in* Gunn, 1903; Tyrrell, 1928; Flett, 1942). These two units comprise the Northern Granite. Their significance to the British Tertiary Volcanic Province (BTVP) as a whole lies in the fact that they demonstrably pre-date the Central Ring Complex and, additionally, that emplacement of the outer granite caused updoming and faulting of the enveloping Palaeozoic sediments and Dalradian schists (Bailey, 1926; Woodcock and Underhill, 1987; England, 1988, 1990). Clear examples of the distortion of the country-rock envelope during granite emplacement are often difficult to demonstrate in the Province although predicted by Walker (1975); special significance thus attaches to the north Arran granites. The Glen Catacol site has been selected to represent both granites, their relationships to one another, to the country rocks and to later minor intrusions.

The Central Igneous Complex, between Brodick and Blackwaterfoot, is well known as an area of highly variable geology (Necker de Saussure, 1840; Ramsay, 1841; Gunn, 1900, 1903; Tyrrell, 1928). Its true complexity was realized by King (1955) who demonstrated that the varied rock types were grouped round four discrete foci, each interpreted as the eroded remains of a volcanic cone. These volcanoes built up on the floor of a caldera. Within this caldera there are large, subsided masses, the remains of Palaeocene basalt and Mesozoic sediments by which the complex is relatively dated. The complex thus preserves features of a comparatively high level of volcanicity that may be lacking, or ill exposed, in the other central complexes of the Province. The 'volcanic' part of the complex is more or less encircled by granites, sparse gabbros and some remarkable gabbro–granite hybrid rocks. The strata the complex intrudes at the present erosion level range from Devonian to Permian.

These sediments were already domed around the Northern Granites and were subsequently cut and tilted by the Central Ring Complex, which thus establishes the Northern Mountains granites as an early event in the Tertiary intrusive sequence of Arran. The site chosen to represent the features of the Central Ring Complex is the Creag an Fheidh–Beinn na h-Uaimh–Ard Bheinn area, simply denoted as the Ard Bheinn site (see below).

Despite the interest generated by these major intrusions, it is perhaps the minor intrusions of Arran which lend it most significance in the Province. The major Arran dyke swarm is magnificently exposed on the southern coast of the island, which cuts across the NNW–SSE-trending basaltic dykes from Berman Head eastwards to Kildonan and beyond. This shore section, the South Coast site, has been chosen to represent this feature of the BTVP.

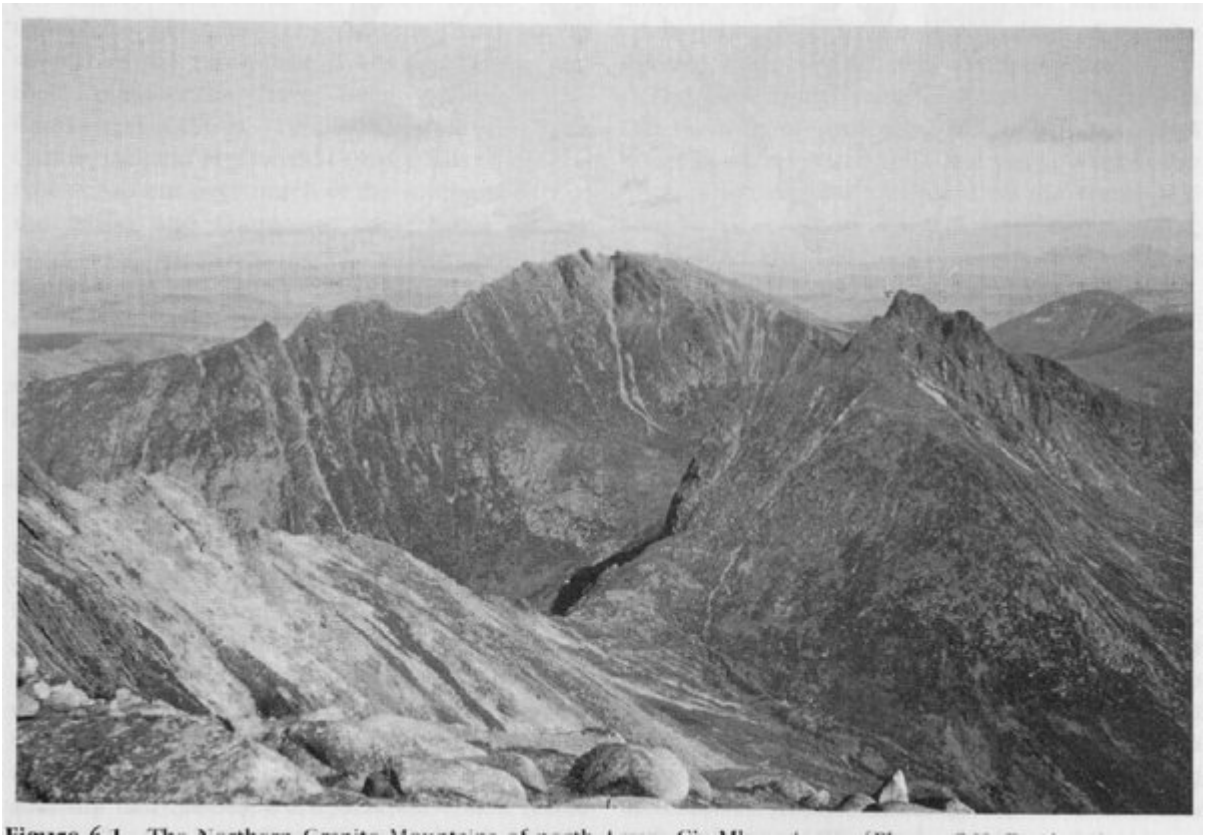
Dykes also figure prominently in the west coast site at Drumadoon and Tormore. These dykes are composite (dolerite + felsite + pitchstone) intrusions which, although present elsewhere in the Province, are especially prevalent and well exposed in Arran; having been described in the classic works of Judd (for example, 1893), they are usually referred to as Judd's Dykes' as a tribute to his acute observations. Analyses of several of the pitchstone dykes and sheets and their phenocrysts have been published by Carmichael (1960a, 1960b, 1962, 1963) and Carmichael and McDonald (1961). Sills of various types crop out over much of the southern part of the island and composite (dolerite + quartz porphyry) examples occur within both the Drumadoon and South Coast sites. These sills encompass a wide range of the

compositions and structures associated with such bodies (for example, Tyrrell, 1928; Rao, 1958, 1959; Rogers and Gibson, 1977; Kanaris-Sotiriou and Gibb, 1985) and greatly enhance the significance of these sites. Basic sills are also a prominent feature and are either olivine-analcite dolerites (crinanites) or quartz dolerites. They form important members of the Dippin Head and Corrygills Shore sites. Recent studies on the Dippin Head sill (Henderson and Gibb, 1977; Gibb and Henderson, 1978a, 1978b) have added valuable information on the petrogenesis of the mildly alkaline basalt magma type which characterizes much of the Province. The Corrygills Shore site, in addition to exposing a crinanite sill which forms part of a possible cone-sheet system around Lamlash Bay (Tomkeieff, 1961), contains numerous other minor intrusions including the well-known Corrygills Pitchstone. The Tertiary igneous succession on the Isle of Arran is summarized in (Table 6.1).

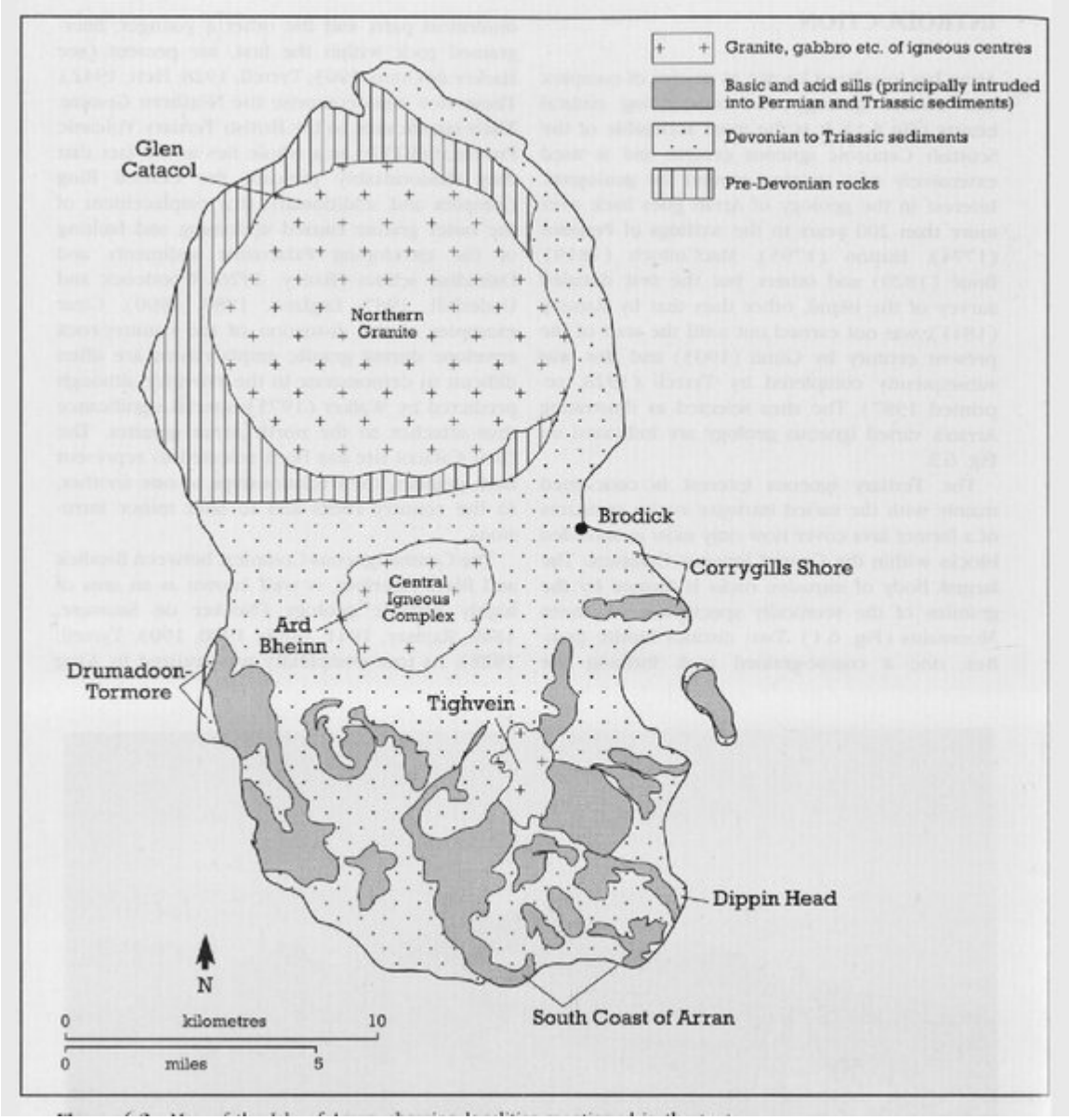
The Tertiary igneous rocks of the island have been the subject of geophysical studies and radiometric age determinations. The Northern Granite and Central Igneous Complex are the site of a positive Bouguer gravity anomaly, indicating that both centres are probably underlain by a considerable body of dense, mafic rock (McQuillin and Tuson, 1963). Palaeomagnetism investigations of the Arran dykes by Dagley *et al.* (1978) showed the majority to have reversed magnetization, although a substantial number of the dykes on the north-east coast showed normal magnetization; some of the sills and the Northern Granite sites also yielded normal magnetization. Age determinations on the Northern Granite range from *c.* 60 Ma (Dickin *et al.,* 1981) to *c.* 58 Ma (Evans *et al.,* 1973); a Palaeocene age (*c.* 58 Ma) was also obtained from the Central Igneous Complex (Evans *et al.,* 1973). Geochemical investigations by Dickin *et al.* (1981) included isotopic determinations on a variety of the Tertiary igneous rocks. From these the authors concluded that the isotopic variation is attributable to crustal contamination of mantle-derived, basic magma after differentiation.

The educational value of Arran is reflected in the number of geological guides to the island which have appeared over the years. Those now in common use are published by the Geological Society of Glasgow (MacDonald and Herriot, 1983) and the Geologists' Association (McKerrow and Atkins, 1985).

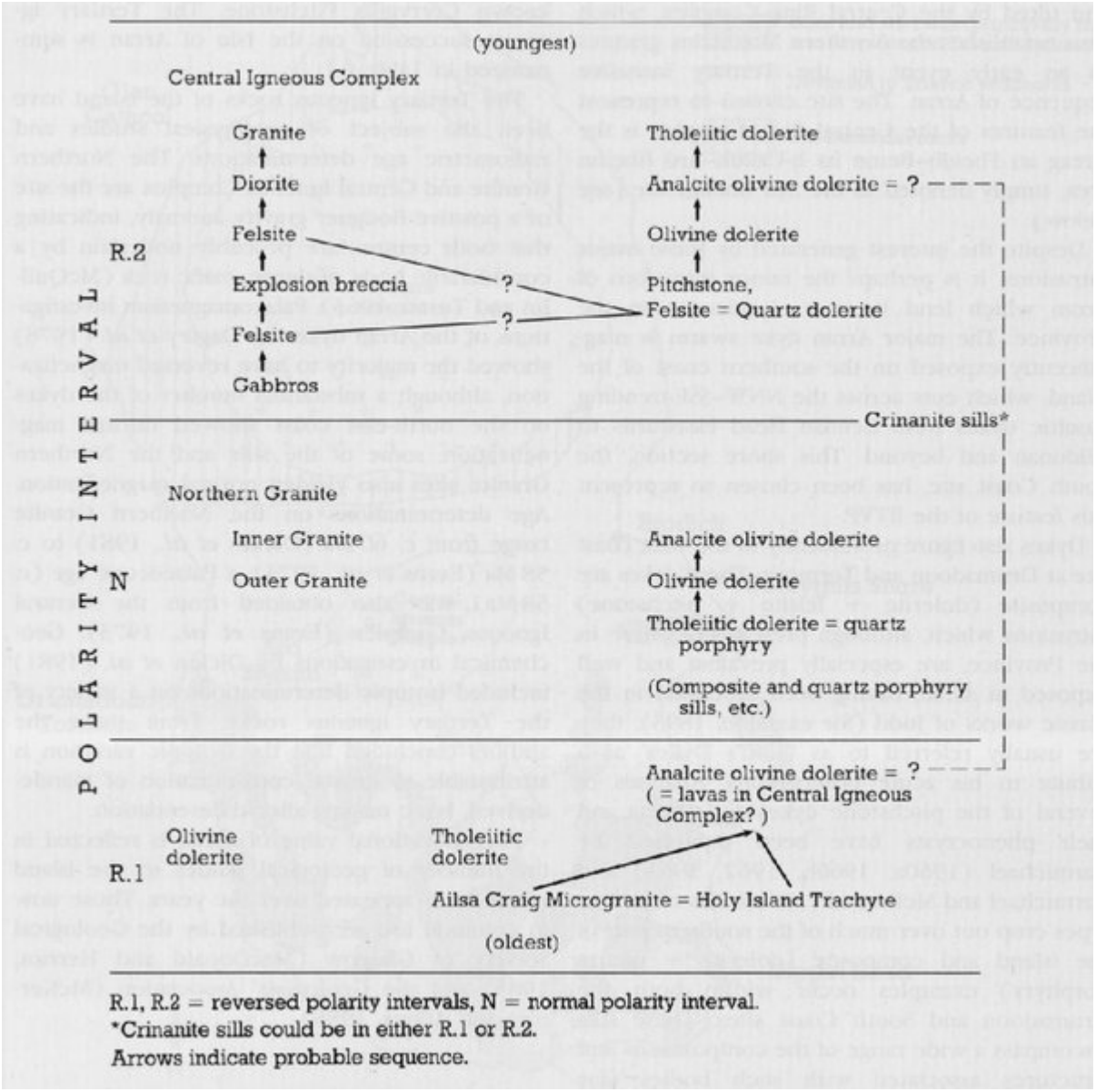
References



(Figure 6.1) The Northern Granite Mountains of north Arran. Cir Mhor, Arran. (Photo: C.H. Emeleus.) (Figure 6.2) Map of the Isle of Arran, showing localities mentioned in the text.



(Figure 6.2) Map of the Isle of Arran, showing localities mentioned in the text.



(Table 6.1) Tertiary igneous succession in the Isle of Arran (after Hodgson et al., 1990, figure 8)