SOUTH KERRERA

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Introduction

Volcanic and volcaniclastic rocks form part of a Lower Old Red Sandstone sequence that unconformably overlies Dalradian metasedimentary rocks on the island of Kerrera. The Kerrera volcanic rocks represent part of the extensive Lorn plateau lavas, which crop out over an area of 300 km² between Glencoe and the Oban district. The Lorn lava sequence is up to 800 m thick and comprises flows of basalt, pyroxene-, hornblende-, and biotite andesite with rare acid lavas and ignimbrites (Groome and Hall, 1974). Individual flows are 5 to 30 m thick but they cannot be traced for any distance inland because of poor exposure; only on the north side of Loch Etive can individual flows be traced for several kilometres. The Kerrera lavas are geochemically distinct in being the most shoshonitic (i.e. enriched in potassium and other incompatible elements), in the Old Red Sandstone volcanic suite (Groome and Hall, 1974; Thirlwall, 1979, 1981a). The volcanic rocks typically rest directly on Dalradian rocks although locally, as on Kerrera, there are sedimentary rocks at the base of the volcanic sequence.

The Lower Old Red Sandstone volcanic rocks crop out in two principal areas on Kerrera (Figure 9.4). The main outcrop is in the SW of the island, where it is well exposed around the coast immediately south of Port Phadruig (794 280) and just west of Port Dubh (793 263). Part of the sequence is also preserved as a narrow downfaulted outcrop which extends the length of the island, but which is particularly well exposed along the coast to the north of Rubha Seanach (8062 2620–8030 2563).

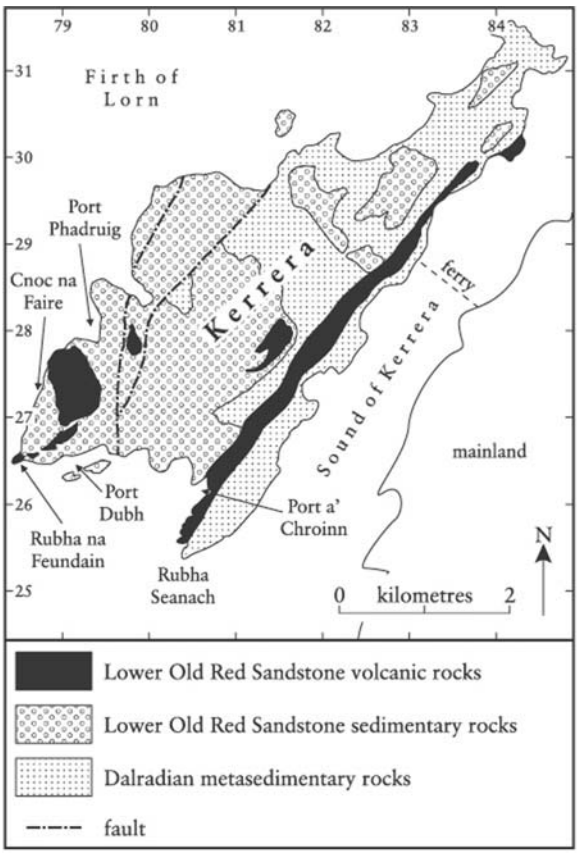

Figure 9.4: Map of Kerrera.

The sedimentary rocks underlying the lavas on Kerrera have yielded Early Devonian fish and arthropods (Kynaston and Hill, 1908; Lee and Bailey, 1925; Morton, 1979; Rolfe, 1980), but

more precise spore data indicate a latest Silurian to earliest Devonian age (Marshall, 1991). Therefore the Lorn volcanic rocks have international significance as a time marker for the Silurian–Devonian boundary, with radiometric ages currently estimated in the range 424 to 415 Ma (Thirlwall, 1988).

Description

The most complete section is that exposed along the western coast, where the volcanic rocks overlie a sequence of green conglomerates, green coarse-grained sandstones and well-laminated red fine-grained sandstones.

The base of the lava sequence is well exposed on the south side of Port Phadruig, where a 10 m-long lens of deep red jasper forms a conspicuous marker; large pillowed lobes of vesicular lava protrude into the jasper and selvages of jasper can be traced around one lobe. These relationships suggest that the jasper is silicified sediment, which was unconsolidated at the time of eruption of the basalt. A short way to the SW (7914 2788) the base is marked by a breccia characterized by blocks of vesicular basalt in a pale-pink matrix of fine-grained sandstone. The basalt fragments vary from being subrounded to angular and are up to 1 m across. Some show well-developed flow alignment of the vesicles which are now filled by calcite and quartz. The blocks are monolithological, and some have been broken *in situ*, with little movement following disaggregation of the magma. Lobes of the succeeding lava protrude into this breccia.

The base of the lava sequence is also exposed in a raised sea stack beneath the main cliff NW of Cnoc na Faire (7884 2743). Here, the northerly dipping top surface of the underlying conglomerates and sandstones forms the wave-cut platform at the south end of the bay. In the sea stack, the lobate base of the lowest lava cuts down through a pale-green coarse-grained sandstone and a conglomerate into well-laminated red sandstone. Well-rounded pebbles from what was clearly an unconsolidated gravel have been caught up and are now included within the lava. The green sandstone includes fragments of vesicular basalt, the largest being 50 cm, and rip-up clasts of laminated red sandstone. The conglomerate contains well-rounded pebbles of volcanic rock and quartzite.

A breccia with angular to subrounded fragments of vesicular basalt in a limestone matrix forms a striking rock, particularly in the wave-polished boulders beneath the main cliff and on the beach. The basalt fragments, generally up to 10 cm but larger in some of the beach boulders, are supported within, and fairly evenly distributed through, the calcareous matrix. A second type of breccia has highly angular fragments of basalt in a white calcite matrix. The basalt fragments show little displacement during fragmentation and can easily be matched up to adjacent fragments. This type of breccia crops out on the wave-cut rock platform and is visible beneath and between the huge boulders. Basalt boulders on the beach contain amygdales and irregular cavities filled by quartz, calcite and agate.

In the main cliff itself (7892 2745), both columnar-jointed and more massive flows are present. Well-developed 20–30 cm-wide columns can be examined close to sea level in a down-faulted block of pale-grey compact basalt, which forms a marked ‘whale-backed' outcrop, and also a short distance to the south (Figure 9.5). This flow is overlain by a massive extremely vesicular basalt, which is patchily autobrecciated and cut through by irregular curving joints, well seen close to a conspicuous gully formed by erosion of a Palaeogene dyke (7890 2772). Elsewhere, hexagonal columns up to 1 m across occur with selvages of sediment preserved locally within the joints.

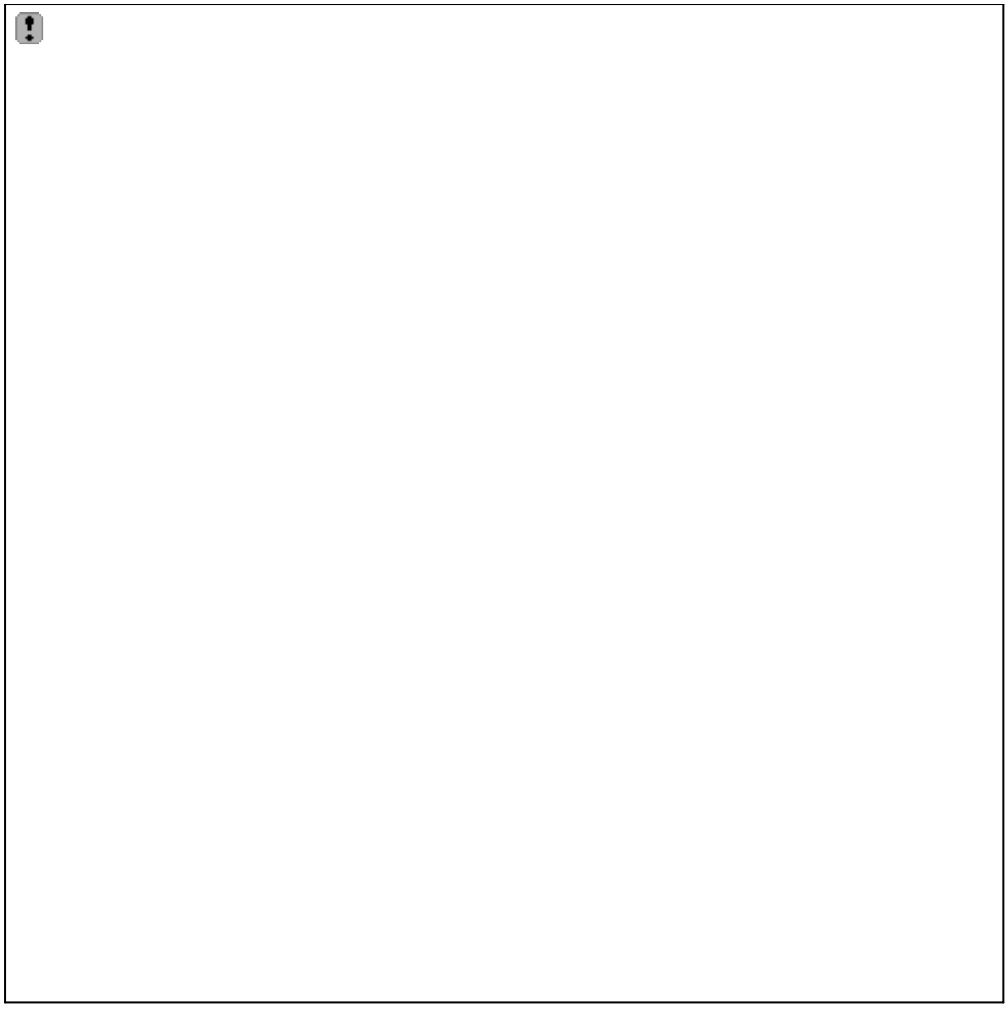

Figure 9.5: Columnar jointing in andesite flow, south of Port Phadruig, Kerrera (NS 7888 2767). (Photo: BGS no. C 2647.)

In the extreme SW of the island the base of the lava sequence is exposed in the low cliffs to the west of Port Dubh (7875 2668). Here the pillowed base of a vesicular basalt flow overlies sandstone and a coarse conglomerate. Enclaves of laminated sandstone occur between pillowed masses of basalt, which cut down through the bedding laminations of a pinkish-red sandstone to rest directly on top of the conglomerate. Individual pillowed lobes are flattened and are up to 2 m across. A short distance from Rubha na Feundain, just to the east of a conspicuous gully formed by the erosion of a Palaeogene dyke (7866 2671), the surface of a thin basalt flow shows distinctive pahoehoe texture, which indicates that this subaerial lava was locally flowing in what is now a south-westerly direction.

The hill forming Rubha na Feundain is made up of columnar-jointed orange-weathering biotite andesite. A steeply dipping contact can be traced around the base of the outcrop, defining an oval vent-like feature. The age of this plug is uncertain. It may be coeval with the Lower Old Red Sandstone lavas but it could be younger. A biotite-augite andesite cropping out on the nearby Bach Island (7780 2690) has been assigned to the Lower Old Red Sandstone volcanic sequence (Lee and Bailey, 1925).

In the down-faulted south-eastern inlier, the lavas vary from compact to rubbly and are much fractured due to the proximity of the faults. The tops and bases of individual flows are commonly brecciated, as is well seen in wave-polished exposures in the small bays at the NE and E sides of Port a'Chroinn.

The bay immediately north of Rubha Seanach has formed along the line of the NE–SW fault that separates Dalradian pelites and limestones from the down-faulted lavas. The lowest exposed part of the lava sequence, a breccia of volcanic rock fragments in a red sandstone matrix, is seen on the north side of the bay. This breccia is overlain by a sliver of red laminated

sandstone and a lens of purplish coarse-grained sandstone which dip steeply to the west. The purplish sandstone is cut out by the lobate base of the overlying blocky lava which has a reddened top. The succeeding flow, a pale-grey weathering compact basalt, permeates the rubbly top of the underlying flow, forming irregular enclaves (8027 2566). A much reddened rubbly lava forms the small headland north of Rubha Seanach (8028 2577) and a short distance NE of this, a breccia composed of volcanic rock fragments in a green coarse-grained sandstone matrix crops out adjacent to a conspicuous Palaeogene dyke (8035 2589).

Interpretation

The basalt lavas of Kerrera are of a more uniform composition than those of similar age elsewhere in the Lorn Plateau where a greater thickness is preserved. The lavas commonly have slaggy tops and bases that are much brecciated due to eruption onto or into wet sediment. In considering the general inter-relationship of lava and sediment within the Lower Old Red Sandstone province, Geikie (1897) noted that ‘a more striking proof of the subaqueous character of the eruptions could hardly be conceived'. Lee and Bailey (1925) noted that ‘there is good reason to believe that the lavas from time to time, must have encountered expanses of water in their path' and that there must have been ‘frequent recurrence of aqueous conditions during the accumulation of the volcanic rocks'. The re-interpretation of Lower Old Red Sandstone lavas as sills elsewhere in the province (Kokelaar, 1982; and see the Port Schuchan to Dunure, Culzean Harbour and Turnberry Lighthouse to Port Murray GCR site reports) has important bearing on the nature of the Kerrera lavas and some at least could be sills intruded in to wet sediment. However, the pahoehoe flow near Rubha na Feundain and the reddened tops of flows near Rubha Seanach argue for a subaerial origin for others. There can be no doubt that the lavas or sills encountered wet sediment in their path producing the breccias and that some of the sediment has been removed in the process. Rare veins of sandstone within columnar-jointed lavas could have originated in the manner suggested by Kokelaar for similar features in the Ayrshire coast Lower Old Red Sandstone sequence. The erosion of sediment at the base of lavas is demonstrated at a number of localities, particularly the raised sea stack below the cliffs NNW of Cnoc na Faire. However it is doubtful whether a flow could remove 20 m of sediment and hence the suggestion of Lee and Bailey (1925) that the lavas were erupted onto an eroded surface of sandstone and conglomerate with at least 20 m of relief requires further examination. It is clear that an adjacent volcanic area was being eroded prior to eruption of the main Kerrera lava sequence to provide the source of andesite, olivine basalt and highly vesicular basalt for the conglomerates that underly the main volcanic sequence on the island.

Conclusions

The Kerrera GCR site is of regional and national importance as a representative of the extensive Lorn Plateau volcanic sequence. These rocks are some of the most enriched in potassium and other ‘incompatible' elements in the whole late Caledonian calc-alkaline volcanic suite and hence are believed to have originated in the deepest levels of a postulated subduction zone beneath the Laurentian continental margin (Thirlwall, 1981a).

Coarse conglomerates rich in volcanic debris are a significant component of the lower part of the sequence demonstrating that an adjacent volcanic landscape was being eroded before the eruptions of basalt that form the upper part of the sequence. Some of these lavas are characterized by columnar jointing and autobrecciation and some have pillowed bases demonstrating that they were erupted onto or into wet sediment. Other flows have reddened surfaces and one shows a pahoehoe-textured surface indicating subaerial eruption.

When taken in conjunction with the other geological features on Kerrera, particularly the spectacular unconformity at the base of the Lower Old Red Sandstone sequence, a visit to the south and west of Kerrera must rank as one of the finest excursions in Scottish geology.

Reference list

Geikie, A. (1897) *The Ancient Volcanoes of Great Britain*, Macmillan, London.
Groome, D. R. and Hall, A. (1974) The geochemistry of the Devonian lavas of the northern

Lorne Plateau, Scotland. *Mineralogical Magazine*, **39**, 621–40.

Kokelaar, B. P. (1982) Fluidization of wet sediments during the emplacement and cooling of various igneous bodies. *Journal of the Geological Society of London*, **139**, 21–34.

Kynaston, H. and Hill, J. B. (1908) The geology of the country near Oban and Dalmally. *Memoir of the Geological Survey of Great Britain*, Sheet 45 (Scotland).

Lee, G. W. and Bailey, E. B. (1925) The pre-Tertiary geology of Mull, Loch Aline and Oban. *Memoir of the Geological Survey of Great Britain*, Sheet 44 (Scotland).

Marshall, J. E. A. (1991) Palynology of the Stonehaven Group, Scotland: evidence for a mid Silurian age and its geological implications. *Geological Magazine*, **128**, 283–6.

Morton, D. J. (1979) Palaeogeographical evolution of the Lower Old Red Sandstone basin in the western Midland Valley. *Scottish Journal of Geology*, **15**, 97–116.

Rolfe, W. D. I. (1980) Early invertebrate terrestrial faunas. In *Terrestrial Environment and the Origin of the Invertebrates* (ed. A. L. Panchen), Academic Press, London and New York, pp. 117–157.

Thirlwall, M. F. (1979) The petrochemistry of the British Old Red Sandstone volcanic province. Unpublished PhD thesis, University of Edinburgh.

Thirlwall, M. F. (1981a) Implications for Caledonian plate tectonic models of chemical data from volcanic rocks of the British Old Red Sandstone. *Journal of the Geological Society of London*, **138**, 123–38.

Thirlwall, M. F. (1988) Geochronology of Late Caledonian magmatism in northern Britain. *Journal of the Geological Society of London*, **145**, 951–67.