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# CORRESPONDENCE AND NOTES

## 'Lamprophyre' minor intrusions of Colonsay – a comment

SIRS – Borradaile's (1986) paper is extremely welcome, as the first published study of the Colonsay 'lamprophyres' since Cunningham-Craig, Bailey & Wright (1911). This comment in no way questions the great value of Borradaile's careful and detailed field descriptions, but rather emphasises the urgent need for structural geologists to collaborate with igneous petrologists (all too rare phenomenon!) in studying such rocks, if the many problems identified by Borradaile himself (e.g. p. 670) are to be solved, and the larger-scale ideas he raises are to be substantiated.

Borradaile relies on incomplete, largely outdated literature citation – for example, Watson's (1964) account of the 'appinites' is greatly modified by Watson (1984). Berger's (1971) study of *felsic* dykes is less relevant than numerous, partly structural, papers on *mafic* dykes equivalent to those of Colonsay (e.g. Reynolds, 1931; Blyth, 1949; Rust, 1965; French, 1978; Smith, 1979; Leake & Cooper, 1983), or indeed than the one published study on the Colonsay plugs themselves (Reynolds, 1936). Borradaile's omission of all this work has broader implications, notably the question of how many igneous suites (i.e. discrete events, *sensu* Rock, 1981) are represented on Colonsay.

Borradaile (p. 666) correctly records *three* structurally distinct intrusions: (1) undeformed, discordant, subvertical dykes; (2) undeformed, discordant syenitic.appinitic plugs (Scalasaig, Kiloran and Balnahard); (3) deformed, concordant to discordant bodies, which I term sheets (Smith, 1979), to avoid confusion with the other two types. However, based on petrographical examination of my own collection of over 80 Colonsay 'lamprophyres' (British Geological Survey registered rocks S71163–71247), type (1) dykes probably belong to Smith's (1979) post-tectonic (395–410 Ma) *Minette Suite*. Type (2) plugs have long been linked (e.g. Bailey, 1960) with the ≈ 400 Ma *Appinite Suite* of the Appin-Ballachulish area (Wright & Bowes, 1979). Type (3) sheets, by contrast, most probably belong to Smith's (1979) syn-tectonic *Microdiorite Suite*, emplaced around 424 ± 13 Ma (unpubl. BGS K-Ar data). In the Ross of Mull (the nearest area to Colonsay documented recently), type (1) dykes at *c.* 405 Ma postdate the *c.* 415 Ma granite, whereas type (3) sheets are metamorphosed by this pluton (Rock & Hunter, 1987).

In short, the Colonsay dykes almost certainly include representatives of *at least three* minor intrusive suites, differing by 20 Ma or more in age, and Borradaile's (p. 665) statement that they 'belong to the Appinite suite recognized throughout the British Caledonides' perpetuates two misconceptions from the 1960s: (*a*) it ignores the modern separation of 'appinites' into the *Microdiorite Suite* (formerly the *West Highland Appinite Suite* of MacGregor & Kennedy, 1931), represented by the Colonsay mafic dykes, and the unrelated, Appin-Ballachulish *Appinite suite*, represented by the Colonsay plugs; (*b*) it copies from Johnson and Dalziel (1966) the incorrect assumption (Smith, 1979) that the foliated Colonsay dykes (*Microdiorite Suite*) actually represent foliated variants of the unfoliated dykes (when the latter in fact represent a third, unrelated, *Minette Suite*).

In his larger-scale interpretation of the western Caledonides (pp. 669–70), Borradaile does not consider the problem of the Colonsay Group metasediments forming Colonsay and the Islay Rhinns; three views as to their age are extant:

(*a*) They are *Torridonian*, as indicated on all British Geological Survey memoirs and maps so far published.

(*b*) They are *Dalradian* (Stewart, 1962, 1975); possibly, Colonsay Limestone ≡ Ballachulish Limestone (Rock, 1986).

(*c*) They belong to a new, hitherto unrecognized stratigraphical grouping (e.g. Bentley, Fitches & Maltman, 1986).

On view (*a*), 'Torridonian' (Colonsay Group) unconformably overlies uncontested Lewisian (in northeast Colonsay and the Rhinns of Islay), and is tectonically separated from the Islay Dalradian by the Loch Gruinart Fault. On view (*b*), by contrast, Dalradian is juxtaposed *directly* on Lewisian in Colonsay and Islay, and extends northwest of the Great Glen Fault system. On view (*c*), Colonsay and Islay constitute a 'suspect terrane' (Bentley, Fitches & Maltman, 1986), tectonically separate from the mainland Caledonides. Borradaile's regional extrapolations (fig. 9) and his use of the Colonsay fabrics as 'regional palaeostress indicators' are both premature, given these radically different alternatives.

Finally, Borradaile appreciates (pp. 669–70) that his 'pan-metamorphic' interpretation of the Colonsay intrusion fabrics poses major problems. I do not deny a metamorphic origin for fabrics such as those actually seen to crenulate earlier flow foliations (p. 665). However, given that the fabrics are 'confined to the igneous rock over most of the area' (p. 665), and 'do not pass into the country rocks' (p. 670), the *prima facie* conclusion must surely be that *some* of them have an igneous component. Borradaile's statement that they are 'clearly of secondary nature' (p. 665) is not adequately justified by petrographical description (pp. 666–7). Borradaile assumes (p. 666) that a chlorite-carbonate-mica mineralogy automatically implies metamorphism, but in lamprophyres such assemblages are commonly autometasomatic, generated by exceptionally high $H_2O$ and $CO_2$ in the parent magma (Rock, 1987). Lamprophyes can contain very abundant biotite (30–60 modal %); efficient flow foliation of such abundant mica can produce a 'pseudo-schistosity' *in an unmetamorphosed rock*. Among > 2000 Caledonian 'lamprophyres' I have examined, flow foliated, 'schistose' examples include many from the *paratectonic* Caledonides (e.g. Barnes, Rock & Gaskarth 1986, p. 107; Rock, Cooper & Gaskarth 1986, fig. 3). Borradaile himself only uses 'schistosity' 'for want of a better term' (p. 666). His differences with Wilkinson (1907, p. 61) over the interpretation of one Colonsay intrusion, where the fabric in a 'folded' (terminated) body is not only discordant with that in the country-rocks, but also unrelated to an apparent fold closure, provide yet another example where an alternative (igneous) interpretation could usefully have been considered. Overall, Borradaile's assumption (p.



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669) that 'all the schistose dykes reflect broadly the same deformation event' cannot be justified from the information in his paper.

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### Reply

This discussion focuses on two items. Is the fabric described from the intrusions of tectonic or magmatic origin? And, were the host rocks in their present location with respect to the Dalradian rocks at the time the fabric developed?

Rock clarifies that these variably schistose 'lamprophyre' rocks belong to a microdiorite group, possibly pre-415 Ma, as part of an Appinite suite. In my opinion, these modifications from Watson (1964) are not substantial with regard to the present arguments. Moreover, Watson (1984) expresses caution with regard to the radiometric work (see table 5).

(1) *Is the fabric tectonic or magmatic*? For the purposes of this discussion I shall term a fabric magmatic when some non-hydrostatic stress system is induced by flowing magma or some other unspecified *internal* source of differential stress in the magma. In contrast a tectonic fabric is induced by some state of stress that exists in the country rock, *external* to the body of magma. The latter could occur at any stage in the consolidation of the magma.

I believe that the S-fabric described is tectonic for the following reasons.

(*a*) Different bodies of different shapes, dimensions and orientations have the same orientation of their internal secondary fabric. This is shown in Figure 1, in which a lower hemisphere projection illustrates mean poles to the internal fabric from 14 different, variably oriented bodies spread over several $km^2$.

(*b*) The fabric has constant orientations in each body and each orientation is unaffected by the varying directions of the walls of the body (my paper, figs 4, 5). This is unlikely if the source of stress was internal.

At the end of his discussion, Rock incorrectly cites an example from Colonsay that is in fact from Islay. He suggests that the origin of this fabric is magmatic. Below, (fig. 2), I present a field sketch of this intrusion.

(*c*) The fabric transects internal contacts between different phases of the intrusions (my paper, fig. 8). This is improbable for a magmatic fabric.

(*d*) The fabric transects and crenulates a pre-existing magmatic flow fabric that *is* parallel to the walls of some

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