

CORRESPONDENCE

Ardnamurchan, Centre 1—new radiometric evidence

SIR, — Four years ago we wrote a short letter to this Magazine questioning the generally accepted thesis that there are 3 clearly defined centres of Tertiary volcanic and intrusive activity on the Ardnamurchan peninsula. In particular we questioned the identification of Ben Hiant volcano as part of the oldest centre (Green & Wright, 1969). It has been suggested (R. R. Skelhorn, pers. comm.) that the answer lies in faulting, i.e. that Ben Hiant is a downfaulted block, a volcanic remnant preserved among plutonic intrusions.

The only evidence for differential movements on Ardnamurchan, however, is provided by Skelhorn & Elwell (1970), who propose that there has been cauldron subsidence along ring fractures of some Units in Centre 2. Moreover, Le Bas (1971) made specific reference to Ben Hiant in a discussion of cone sheet emplacement as a mechanism of uplift. His point is that the Ben Hiant centre is actually topographically higher than it would be without the associated cone sheet complex. This geological evidence appears to strengthen our original case: the supposedly *older* volcano may have been *elevated*, while some of the supposedly *younger* plutonic rocks show signs of having *subsided*. In other words, any differential movements seem to have been in an unexpected direction.

At the time of our original enquiry, we obtained for radiometric dating a dolerite sample from the cone sheet which forms a northward projection on the main Ben Hiant complex and which terminates at the southern end of Loch Mudle, as shown on the geological map of Ardnamurchan. The samples were collected above and a short distance to the W of the main road, about 1 km S of the southern end of Loch Mudle. In hand specimen the dolerite is quite fresh, and there is no sign of alteration in thin section. The age determinations were made by Isotopes Inc., and the results are presented in Table 1 (sample collected by J. Green and J. B. Wright).

Table 1. K/Ar age determination on Ben Hiant Dolerite

Isotopes' sample number	Rad. Ar/total Ar	K (%)	Isotopic age (millions of years)
KA 70-16	0.88	1.97	61.2
	0.85	1.99	59.4
			60.3 ± 3.0

The constants used for the age calculations are

$$\lambda_B = 4.72 \times 10^{-10} Y^{-1}, \quad \lambda_e = 0.585 \times 10^{-10} Y^{-1},$$

and $^{40}\text{K} = 1.19 \times 10^{-4}$ atom % of natural potassium (where $\lambda =$ decay constant and $Y =$ year). The error indicated for the reported ages takes into account all sources of analytical error. Isotopes Inc. uses an RMS summation of errors method similar to that discussed by Cox & Dalrymple (1967, pp. 2603–14). The average age of 60 ± 3 million years is older than the figure of 55 ± 6 million years for the quartz-monzonite of Centre 3 (Sabine & Watson, 1965) which is the youngest member of the Ardnamurchan complex as a whole, according to classical ring intrusion complex theory.

Since the error limits of the age determinations overlap (55 ± 6 and 60 ± 3), the real age difference could well be less than that suggested by the mean values. A smaller difference of a million years or two could then be explained on the basis that we are comparing *intrusive* ages from one centre with *extrusive* ages from another.

Centre 3 units have dimensions measurable in thousands of metres, while the cone Geol. Mag. 111 (2), 1974, pp. 163–164. Printed in Great Britain.

sheets are only a few tens of metres thick. Moreover, the former were emplaced at an estimated minimum depth of 1000 m and therefore well insulated with consequent reduction of the cooling rate – while the cone sheets were more rapidly cooled near-surface bodies. Is it possible that the Ben Hiant rocks are truly younger than the ‘hearth’ of Centre 3, which simply cooled down at a much slower rate and reached its argon-blocking temperature 1–2 million years later? We ask the question, because it still remains to be explained how *older* volcanic rocks can be exposed at the same erosion level as *younger* plutonic rocks, without evidence of intervening faults.

References

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[*Note added in proof.*]

Recent age determinations by Mitchell & Reen (1973) give average ages of:

58.9 ± 2 m.y. for Centre 1

59.1 ± 2.2 m.y. for Centre 2

59.0 ± 1.8 m.y. for Centre 3

These closely similar ages for all 3 centres are based upon determinations from both hypabyssal and plutonic rocks, and lead the authors to suggest that evolution of all 3 centres must have taken place within at most 2 m.y. The volcanic and plutonic rocks thus appear to be virtually contemporaneous. Was the Ardnamurchan peninsula a volcanic dome, the upper parts of which have been removed to unroof the plutonic rocks, leaving the Ben Hiant volcano as a remnant on the lower-lying flanks of the dome? This seems the only way in which the paradox outlined above can be resolved.

Reference

- Mitchell, J. G. & Reen, K. P. 1973. Potassium–argon ages from the Tertiary Ring Complexes of the Ardnamurchan Peninsula, Western Scotland. *Geol. Mag.* **110**, 331–40.

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