

CORRESPONDENCE

CROSS-FOLDS

SIR,—In a recent paper on “Fold Structures in the Dalradian Rocks of Knapdale, Argyllshire” (Roberts, 1959), I stated that King and Rast (1956) attributed the development of cross-folds in the Dalradian rocks of south-east Cowal to the action of a subsidiary axis of shortening. This was incorrect. They consider that “the cross-folds correspond to the general direction of elongation or transport, whereas the Caledonoid folds are more especially related to an axis of rotation” (p. 195). The relevant section of my own paper (p. 221) should have read as follows:—“These authors recognize the existence of one dominant Caledonoid axis of folding while folds of the second set are considered to be cross-folds. Weiss (1958), however, considers that the axial planes of cross-folds, typically developed by a subsidiary axis of shortening, should be perpendicular to the axial planes of the main folds.”

I deeply regret this unfortunate mistake, and should like to apologize to the two authors concerned.

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CULM MEASURES STRATIGRAPHY

SIR,—A close examination of Dr. Simpson's (1959) paper on “Culm Stratigraphy . . .” shows that it contains no indisputable facts to support the idea of a major unconformity within the Carboniferous strata of Devon and Cornwall. Moreover, the main points of his paper—(1) the apparent absence of cleavage in his Ugbrooke Group, (2) the post-orogenic and probable post-granite age of this group—were clearly stated by Somervail (1898).

The present balance of evidence is definitely against this coarser-grained Ugbrooke Group being post-orogenic in age. Detailed field work shows that both to the east and west of Dartmoor this group of sediments possesses a fold pattern similar to that seen in the other Carboniferous rocks. Dr. Simpson has been misled in that he has evidently only visited exposures in the relatively long flat-lying fold limbs where the strata are the right way up and virtually undeformed. This could have been avoided by a careful reading of the excellent detailed descriptions in the relevant Geological Survey memoirs. These make it clear that the Ugbrooke Group must be fully involved in the orogenic movements (e.g. Reid and others, 1911, pp. 42–47).

The most convincing field evidence so far available of the orogenic and pre-granite character of this group is to be seen at Tavistock (Dearman and Butcher, 1959, pp. 61–62 and 66–67). Here the strata, locally referred to as the Whitchurch Down Greywacke Group, are mostly inverted and tightly folded. The outcrop can be traced eastwards as a narrow band until it is cut off, and the sediments contact metamorphosed, by the Dartmoor granite (Fig. 14).

Certainly the presence or absence of cleavage cannot be relied upon in dating the strata; only fossils can be used, as these provide indisputable facts. Fortunately the Culm Measures are slowly yielding determinable goniatites

so that the Carboniferous goniatite zonal scheme can be used in Devon to establish the succession and hence the structure. It is a fact worth emphasizing that so far this coarser-grained group has nowhere yielded goniatites, so that all correlations of the different outcrops of this group are as yet purely on a lithological basis. However, I have recently collected *Homoceras* in shales near the River Inny north of Stoke Climsland—that is, in an area of Dr. Simpson's Ugbrooke Group (p. 204).

The author remarks in conclusion (p. 207) on the fact that in the Tavistock Sheet (337) of the Geological Survey unmetamorphosed Culm Measures are shown *well within* the metamorphic aureole of the Bodmin Moor granite near Altarnun. From this he argues the probable post-granite age of the Ugbrooke Group. Surely the answer is more likely to be that this is a draughtsman's error, especially as there appears to be no mention of the matter anywhere in the accompanying memoir (Reid and others, 1911). That such errors can occur is seen from the 1913 edition of the Newton Abbot Sheet (339) in which a small patch of metamorphosed Permian is shown adjacent to the Dartmoor granite at Woolley near Bovey Tracey. One could argue from this the post-Permian age of the Dartmoor granite!

In any case, Dr. Coles Phillips showed in 1928 (Fig. 1) that the strip of Culm Measures near Altarnun definitely occurs *outside* the outer limit of the thermal aureole of the Bodmin Moor granite.

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THE SUPPOSED EVOLUTION OF *GRYPHAEA*

SIR,—I regret that Professor Swinnerton chose to word his criticisms of my work in such intemperate language; I shall nevertheless endeavour to reply briefly to the relevant points he raises.

There is surely a *non sequitur* in his opening argument for he states, referring to gryphaeid coiling, that "If such coiling be indeed a function of size then some of the giant forms which lived later in the Jurassic should be as closely coiled as an ammonite." I fail to see that there is anything in my argument that implies this. In regard to my choice of an index of size, the work of MacLennan and Trueman shows that the length of the right valve is satisfactory in this respect and that no substantially different result is to be expected if width is measured. I did incidentally measure width as well and my findings confirmed this. Depth cannot reliably be used as a size index as it is too intimately bound up with coiling.

Professor Swinnerton goes on to suggest that as my work on *Liostrea* is not supported by statistics there is a marked hiatus in my argument. Though I did a laborious analysis on *Gryphaea* I followed in the case of *Liostrea* the principle that no statistics are better than weak statistics, because rejection