GEOLOGY

Age of the Caledonian Orogeny and Metamorphism in Britain

Recently a hypothesis on the age of the main orogenic deformation of the Dalradian rocks of Britain proposed by Fitch, Miller and Brown[1] was criticized on stratigraphic grounds by T. G. Miller[2]. I find myself in agreement with the essentials (though not the whole) of Miller's argument against a Pre-Cambrian age for the main orogenic deformation of the Dalradian rocks, and feel that some further points should be made on this aspect of the 'working hypothesis' of Fitch, Miller and Brown. A fuller account of my views on the geographical and time relationships of the 'early Caledonian' and 'late Caledonian' orogenies of Britain is being prepared to amplify the conclusions briefly indicated in the introduction of an earlier work[3], but it would appear pertinent to raise briefly some of the relevant points now.

In their original article and in their later reply[4] to T. G. Miller the three authors reject the only published accounts[5,6] of detailed investigations of the Leny Limestone of Callander since the discovery by Pringle of Middle Cambrian trilobites there[7]. The interpretation of isotopic data by Fitch, Miller and Brown does not appear to be sufficiently unequivocal to allow the rejection of Stone's conclusion that the Leny Limestone forms an integral part of the Dalradian succession without re-mapping of the Callander area to find another structural hypothesis in agreement with the field evidence. At present the evidence of stratigraphic and structural relationships as they appear in the Callander area must be given more weight than isotopic data which are manifestly open to more than one interpretation[1,8,9]. Moreover, although fossils have so far been found only at this one locality, it seems to me (as it did to Anderson[5] and Shackleton[10]) highly suggestive that the Leny Grits of Arran are divided by a thin group of slates with a limestone in their middle, giving a stratigraphic succession closely similar to that advocated for the Callander area. In Arran these strata occur only a little lower in the exposed succession than the 'Arenig' rocks of the North Glen Sannox area. The advocated Arenig age of these rocks now seems uncertain in view of the evidence suggestive of Pre-Arenig folding and metamorphism in north-west Ireland and since their assignment to the Arenig was based on a lithological comparison of common rock-types and the presence of two poor specimens of a brachiopod genus which can be found in both Cambrian and Ordovician rocks. Nevertheless, whether these rocks be of Cambrian or Arenig age, it would seem relevant that they appear to have shared completely in the folding and metamorphism of the Dalradian rocks, from which they are separated by only a possible slight disconformity[11]; it would appear that here, as in the Callander area, the highest strata involved in the orogenic deformation contain Lower Palaeozoic fossils.

The suggestion by Fitch, Miller and Brown that the F_3 phase of the Highlands may be equivalent to the F_1 of Wales, Isle of Man, Lake District, etc., appears, in the present state of knowledge, attractive, but their brief quotation, without any details, of Pre-Devonian fold amplitudes of 10,000–15,000 ft. in the Midland Valley of Scotland[12] as supporting this link tends to obscure the true geographical relationships. It may be mentioned in passing that the concept of fold-amplitudes as defining orogeny is itself open to criticism, since the essential characteristic of orogeny is horizontal crustal shortening rather than differential vertical movement, though in the cases quoted orogenic deformation is not disputed. The main point here is that both the localities mentioned as examples of end-Silurian folding are right against the southern margin of the Midland Valley. A little farther north in the Lesmahagow district, the Hagshaw Hills and the Tinto area, and much farther north at Stonehaven, the Silurian rocks remained horizontal and undisturbed until Middle Devonian times. It appears probable that the major part of the Midland Valley remained a stable block separating fold movements in the country to the south from possibly synchronous events in parts, in any event, of the mobile belt to the north.

The sudden nature of the boundary of this block to the south of the Hagshaw Hills and Tinto may be in part due to differences in the stratigraphic/structural level of the deformed and undeformed rocks, the marginal folds of the orogeny fading out upwards as well as laterally. Making allowance for this, however, the edge of the end-Silurian orogenic belt in southern Scotland (also apparently in eastern Wales between Welshpool and Long Mountain) was far more sudden than the available exposures would require for the southern limit of an early Palaeozoic orogeny of the Dalradian rocks of the British Isles. On this basis, and also on account of other examples of knife-edged orogenic belts in other parts of the world (as in Algeria and parts of the eastern Rockies), there appears no validity in Fitch, Miller and Brown's contention that an early Palaeozoic age for the main deformation of the Dalradian rocks is unlikely due to the absence of movements at these times in areas farther south.

In summary, while it is agreed that there is room for more work on the rocks of the southern strip of the Highlands, at present there appears reasonable evidence that strata containing Palaeozoic fossils were involved in the main phases of deformation of the Dalradian. There seems no reason to refute this evidence because the age-dates of the main orogenic movements have been largely obscured by later events, when all the ages found in the Dalradian rocks could as well result from modification of an early Palaeozoic orogeny as from partial changes of original Pre-Cambrian dates.

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Coesite from Lake Mien, Southern Sweden

Lake Mien (lat. 56° 25′ N, long. 14° 52′ E.) is situated about 30 km north of Karlshamn, or almost on the border between the provinces of Smaland and Blekinge. The depression in which the lake is located is to a large extent filled by glacifluvial deposits from the last glaciation. No outcrops have been found around the lake, except a few on the northern shore, which consist of granite.

During the regional mapping of Sweden, Holst[1] discovered that boulders of peculiar rocks, regarded by him as volcanic, occurred within an area south of the lake. Such boulders are common both in the till and in the glacifluvial sediments. It is evident that they derive from the bottom of the lake. This geological structure is regarded in all books on the regional geology of Sweden, even the most recent ones[2,3], as the remnants of a young rhyolitic volcano, probably Tertiary.

A survey of the literature shows that another interpretation has also been considered. This is already evident from the original paper by Holst. He sent some rock samples from Lake Mien to the petrographer Prof. F. Zirkel for microscopical studies. In a letter to Holst,