

is full of unconformities whereas it is in fact only full of bedding planes each of which of course marks a break of sequence. True angular unconformities should persistently cut out major lithostratigraphic units over significant areas. We believe that, despite undoubted local inconsistencies and difficulties of interpretation, the five formations we have defined can indeed be mapped from available evidence over the greater part of the Craven Basin. We eagerly look forward to the refinements which will certainly materialise when the remapping by the I.G.S. of the bulk of the Basin is undertaken.

Reference additional to the above

Moseley, F. 1962. The structure of the south-western part of the Sykes Anticline, Bowland, West Yorkshire. *Proc. Yorks. geol. Soc.* **33**, 287–314, pl. 19.

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Chloritoid-staurolite assemblages in central Perthshire

SIR – My interest in the recent paper by Atherton & Smith (1979) concerning metamorphic mineral assemblages in central Perthshire was naturally tinged with apprehension when I read in the first sentence that the existence of these mineral assemblages “questions the concept of the ‘Stonehavian’ metamorphism of Harte (1975) and its corollary that pressure increased from NE to SW along the metamorphic belt”. Being reasonably certain that Harte (1975) had not attempted to assess pressure variation for the whole Dalradian metamorphic belt, I read on rapidly in order to discover how mineral assemblages from central Perthshire could possibly affect the mineral assemblages reported from the E coast near Stonehaven. Unfortunately I was not enlightened further on this point and it thus seems that some clarification is essential.

Harte (1975) noted that the pelitic mineral assemblages, as given in the literature, for the metamorphic zones near Stonehaven (Kincardineshire) showed certain differences from those known for the zones in and immediately adjacent to Barrow’s (1893) original area (essentially between Perthshire and Kincardineshire in county Angus). In particular, near Stonehaven the occurrence of chloritoid + biotite assemblages had been recorded (Chinner, 1967) along a narrow zone on the low-grade side of the staurolite zone (with staurolite + biotite assemblages). Such chloritoid + biotite assemblages have not been noted in the literature, as far as I am aware, for the original area mapped by Barrow (1893, plate xv). Partly on this basis Harte (1975) suggested a distinction between a Barrovian (*sensu stricto*) facies series (in which garnet + chlorite assemblages gave way directly to staurolite + biotite assemblages) and a Stonehavian facies series (in which chloritoid + biotite assemblages are interposed between garnet + chlorite and staurolite + biotite assemblages). The Barrovian facies series was placed on the high-pressure side, and the Stonehavian on the low-pressure side, of the [A C] invariant point in a pelite petrogenetic grid. This increase in pressure from Stonehaven to the type area of Barrow’s zones was supported by the independent evidence of the occurrence of andalusite and sillimanite at higher grades just N of Stonehaven instead of the kyanite and sillimanite of Barrow’s zones (Harte, 1975).

Since Atherton & Smith (1979) did not present data on mineral assemblages from the region considered by Harte (1975), they can hardly question both Harte’s distinction of Barrovian and Stonehavian facies series and the work of others who reported the mineral assemblages which Harte listed as being representative of Stonehavian metamorphism. The mineral assemblages from central Perthshire described by Atherton & Smith (1979) include both chloritoid + biotite and kyanite bearing assemblages. From this viewpoint they appear to belong to a facies series of intermediate pressure between Harte’s Barrovian and Stonehavian, and referred to as facies series B by Harte (1975).

Atherton & Smith (1979) appear to believe that similarities in certain mineral assemblages at two widely separated localities imply the existence of the same mineral assemblages in the intervening

ground, irrespective of any indication to the contrary. Perhaps Atherton & Smith also believe that, because the term Barrovian (or showing Barrow's Zones) has long been used for wide tracts of the Dalradian, it should continue to be so used, irrespective of any differences in detailed mineral assemblages. However one views this question of semantics, it must surely be desirable to define the sequences of mineral assemblages (or metamorphic zones) in all areas as accurately as possible.

It should perhaps be noted, *à propos* of Atherton & Smith's (1979) concluding remarks, that Harte (1975) did not suggest that the abundance of chloritoid near Stonehaven was solely due to the facies series concerned; indeed he concurred (1975, p. 441) with the contention of Atherton & Brotherton (1974) that rock bulk compositions influenced the overall development of chloritoid.

Contrary to Atherton & Smith's implication, Harte (1975) did not suggest that the increase of pressure from NE to SW, proposed for the Stonehaven to county Angus area, applied to areas further W or the Dalradian in general. There is relatively little information concerning local and regional pressure variations in both space and time for large areas of the Dalradian metamorphic belt. Harte (1975) used pelite facies series as one way of gaining such information, and Atherton & Smith's new data are a valuable contribution to the delineation of such facies series in central Perthshire. It appears possible that quite extensive tracts of the Scottish Dalradian may be characterized by pelite facies series involving chloritoid + biotite assemblages. Furthermore, as noted by Harte (1975, Table 9), the type Barrovian sequence given by him is not immutable. The transition from garnet to staurolite zones is notoriously badly exposed in Barrow's type area; chloritoid + biotite assemblages may yet be chanced upon, and the area from which they are supposedly absent gradually eliminated. In such an eventuality the detailed facies series referred to as Barrovian by Harte (1975) would need to be renamed, and might become entirely theoretical as far as the Dalradian is concerned.

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