CORRESPONDENCE

Metamorphic zones and fault displacement in the Scottish Highlands

SIR –

> 'I don't see no p'ints about that frog thats any better'n any other frog.' Mark Twain, *The Notorious Jumping Frog of Calaveras County*

My attempted emasculation of Dr Winchester's Moine zones (Chinner, 1978) was arguably intemperate and excessive; I am rightly rebuked. Nonetheless, better men than I (Soper & Brown, 1971) have judged the Strathnaver inversions to be of prograde origin, so I think that the question posed at the foot of page 40 of my paper still stands to be answered.

The nature of the Moine zones was not, however, central to my main theme; I am content to leave the field with Dr Winchester (Winchester, this issue, pp. 453–60), and to retire behind the lines of the Great Glen. Here the acceptance of the proposed complex isograd outcrop depends very much on one's attitude to the calc-silicate reactions on which they are based. One must always be suspicious when on a small scale zonal patterns mimic lithological patterns (e.g. by Loch Spean on fig. 2 of the above discussion). The Moray 'low' still seems dubious to me, occupying as it does a region of monotonous Moine bounded to the E by the Dalradian boundary and to the W by the more pelitic formations running in northerly trend past Aviemore and Grantown – note how on Figure 3 of Winchester (1974) the kyanite-bearing pelitic 'fish' of Grantown becomes a high-grade protrusion into the low grade area! The original evidence for this low (biotite-bearing calc-silicate rocks and *the absence of kyanite* – Winchester, 1974, p. 516), if positive, was only weakly so, and is barely strengthened by the new asseverations. The supposed high-grade area to the E seems to have been based (Winchester, 1974, p. 512) on Survey Memoir reports of sillimanite around the Ben Rinnes granite. In my experience this sillimanite is confined to the polymetamorphic hornfelses which surround the 'newer' Caledonian Ben Rinnes and Rothes intrusions. The only certain thing about the Banff 'high' is thus its dubiety; for my money the region stays firmly within the kyanite zone.

I do not wish, however, to become bogged down in the parade of particular prejudices masquerading as 'field evidence'. Even if the 'highs' and 'lows' on the Winchester maps were correct in every detail, and if there were as many more again of them to hand, the matching across the fault to give the 160 km displacement would involve *only one critical correlation* – the correlation of the low-grade zones of Sutherland and Inverness with those of Argyll to the SE of the Great Glen. And since metamorphic zones cannot, like stratigraphic units, be identified uniquely by objective parameters such as fossil assemblages, this correlation presupposes some unique thermal structure which makes the two zones matchable with themselves *and with no others*. Professor Kennedy, doubtless recognizing this, called the structure a 'thermal anticline'. Dr Winchester disowns the anticline, but is rather coy in identifying his alternative, and in stating why his match is any better than any other other matchings permissible within the available constraints. My essay was intended to suggest that in our present state of relative ignorance, quite radically different interpretations are possible; it may be dismissed as over-simplification or even simplemindedness. The main point, however, surely cannot be confuted. Metamorphic zones are by their nature inspecific. Unless some other parameter can be specified, their use to reconstruct a fault such as that of the Great Glen cannot be given great weight.

References

Chinner, G. A. 1978. Metamorphic zones and fault displacement in the Scottish Highlands. *Geol. Mag.* **115**, 37–45.

Soper, N. J. & Brown, P. E. 1971. Relationship between metamorphism and migmatisation in the northern part of the Moine Nappe. *Scott. J. Geol.* **7**, 305–25.

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Department of Mineralogy and Petrology
Downing Place
Cambridge

G. A. CHINNER

1 *June* 1978

Geol. Mag. **115** (*6*), *1978, pp. 461–462. Printed in Great Britain.*

SIR – Dr Chinner's letter above emphasizes one particular point about current research into metamorphic grade variations in the Scottish Highlands, and that is the continuing scarcity of detailed information on the subject.

I concur with his suspicions of zonal patterns which mimic lithological patterns, especially where the presence or absence of aluminium silicates has been used as the sole criterion by which metamorphic grade may be (dubiously) judged. Nevertheless I was unaware of any correlation between zonal distribution and lithological patterns by Loch Spean, where the grade variations were deduced solely from the mineral assemblages in calc-silicate of known chemical composition, occurring in typical monotonous Moinian psammites and semipsammites.

I am in broad agreement that the Strathnaver–Ben Klibreck inversion are of prograde origin, but whereas Soper & Brown (1971) stated that 'the [metamorphic] inversion must be interpreted as an original feature, as no major post-D2 structures, apart from the Assynt antiform, are known to exist', more recent mapping by officers of the IGS has indicated the presence of several tectonic discontinuities in the area. Therefore I have interpreted the Strathnaver inversions as a product of tectonic movements, rather than a result of a metamorphic interference pattern like that seen in the Fannich–Freevater area to the SW. A later metamorphic climax may have 'blurred' any pre-existing isograds and produced the appearance of a smoothly inverted morphic gradient. Confirmation of lower-grade rocks in Morayshire must clearly await further evidence. In my paper (pp. 453–60, this issue) I stated my reasons for believing that an area of lower-grade rocks exists; clearly they have not convinced Dr Chinner. However, I defer to his greater field knowledge of NE Scotland in accepting his contention that sillimanite recorded near Ben Rinnes may be confined to thermal aureoles.

In spite of any doubts thereby cast on the validity of the Banff 'high' and the Morayshire 'low', my reconstruction of the 160 km sinistral shift of the Great Glen Fault is based principally on the match of the axes of the phanerozoic metamorphic 'high' in Ardgour with that of the Monadhliaths. (Dr Chinner does not appear to dispute the existence of the latter.) If there is a 'thermal anticline' it is here, rather than centrally situated in the Central Highlands. Attempts to match the Monadhliaths 'high' with that of Sutherland are less convincing, because there is then no correlation of the Ardgour 'high' with a corresponding thermal structure in SW Argyll and Jura, as no such structure exists – even allowing for the effect of dip-slip movement on the Great Glen Fault. Let me finally stress that my match across the Great Glen was not so much a correlation of *zones*, but of *axes of metamorphic grade maxima and minima.*

Nevertheless I do agree with Dr Chinner that metamorphic zones tend, by their nature, to be unspecific, although I believe that zones based on chemical criteria as well as mineral assemblages are more reliable. However, because structural/lithological means of correlation across the Great Glen are currently lacking, zonal correlation appears to remain the least unreliable means of assessing movement on the Great Glen Fault since Ordovician.

Reference

Soper, N. J. & Brown, P. E. 1971. Relationship between metamorphism and migmatisation in the northern part of the Moine Nappe. *Scott. J. Geol.* **7**, 305–25.

Department of Geology
University of Keele
Keele
Staffs. ST5 5BG
30 *June* 1978

J. A. WINCHESTER