coalfields also suggests that major sandstones, apparently traceable over wide areas, may have accumulated in a number of depositional environments.

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HASZELDINE AND ANDERTON REPLY—Heward and Fielding have highlighted some of the difficulties encountered when attempting to develop a model for the English Westphalian. Our model[1] was not intended as a definitive explanation for the details of the north-east coalfield succession, but as an alternative stratigraphic and sedimentological framework to the 'large delta' model. We proposed a low relief 'coastal plain' depositional environment crossed by many rivers. Heward and Fielding do not disagree with this general idea, but dispute some of the detailed evidence.

Deductions from measured palaeocurrents of the major fluvial facies must be made cautiously, as a wide spread of cross-bedding orientations is expected from any type of fluvial system[2–4]. Only the highest stage indicators, formed when currents are not influenced by lower stage component flows and channel-floor relief, give an accurate measure of the overall river direction[3,4]. Even these high stage current directions, fossilized by bar platform or supraplatform stratification, depend on the type of bar in the river and the method of its accretion to the floodplain[2–4]. Consequently, even from the deposits of one migrating low-sinuosity river, high stage palaeocurrents may easily vary by ±60° from the mean river orientation. These palaeocurrents will still, however, show a vector mean roughly downriver, unless accretion to one bank is dominant[4]. Coal Measures washout directions show good agreement with measured high stage palaeocurrent means, have consistent trends over large areas and have different trends from cycle to cycle. Subsidence resulting from compaction or local faulting may well have produced local palaeolopes, but these were superimposed on the regional drainage pattern. We would expect the sandstones of the coal facies to show a very great palaeocurrent variability, as lakes were probably filled from many directions (ref. 1, Fig. 1).

The sandstones examined by us contain many direct examples of recycled grains. Obviously not all recycled grains will preserve such direct evidence[5]. The apparent lack of extraformational sediment clasts is common in many modern recycled sands[5]. Note also that large quantities of fresh feldspar can survive more than one sediment cycle, and long transport distances in rapidly eroded tropical climates[6,7].

As Heward and Fielding suggest, the differences in sandstone mineralogy are not compelling in isolation, but we think that a greater degree of uniformity would be expected of sands derived from one source. Until a large-scale petrographic examination, combined with an appreciation of the relationships between petrography, the sub-environments within a river and the overall depositional environment shows otherwise, mineralogical differences and grain-size differences between sandstones (such as the anomalous coarse-grained sandstone above the Bensham seam in Northumberland) must suggest heterogeneous sediment sources.

We do not imply that all this sediment was supplied from adjacent areas, and would consider such areas as Ireland, the present North Sea and the Caledonides also contributed significantly. Any other more distant source would not account for the increasing marine influence, decrease in sediment grain size and change in river type from Northumberland towards the thickest Coal Measures in the Southern Pennine coalfields. Palaeocurrent trends of major sandstones from the east, west, south-west and north are thus in accord with our model and the overall palaeogeographical context[8].

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High sediment yields from major rivers of the western Southern Alps, New Zealand

GRIFFITHS has recently estimated[1] erosion rates in the Southern Alps of New Zealand. His presentation, however, takes too little heed of published data, and has under-reported the suspended load data available.

(1) Griffiths reports suspended sediment yields from four east-coast and 10 west-coast rivers. In contrast, I have given yields[2,3] for 28 east-coast and 18 west-coast rivers, Thompson and Adams[4] have given yields from 23 of the same east-coast rivers and discussed their calculation and results in detail, and I have given yields[5] from 40 North Island rivers that have comparably high yields.

(2) Griffiths applies a traditional approach to his calculation of suspended loads. The water flow records presently available are generally good, and are quite adequate for suspended load calculations. However, I have expressed some reservations about the suspended load concentration data[4,5]. For flows less than the mean, the data are numerous (see Fig. 2 of ref. 1), but inconsequential as their contribution to the long-term mean load is slight. It is unfortunate that the sampling of flood flows is inadequate. Taking the Haast River data[1] as an example, there are 16 samples taken at less than mean flow, but only six at flows greater than the mean.

For many South Island rivers, half the suspended load is carried at flows greater than 3–8 times mean flow[4]. Because the highest flow sampled for the Haast River is only about twice the mean, considerable extrapolation of any concentration–flow relationship is required to calculate loads. Griffiths seems to have used linear regression for the relation, an approach Thompson and I rejected because of the nature of the data. Our reasons and an alternative method are given elsewhere[4,5]. This method gave the "earlier crude estimates" mentioned by Griffiths[1].

For all rivers except the Cleddau (see below) estimates by our method average 70% higher than Griffiths'. As there are no independent measurements of load in these rivers (note that both Griffiths and I used essentially the same data), and because estimates of load from point concentration samples may be in error by +100% and −50% (ref. 6), the importance of the difference is uncertain.

(3) I do not know on what additional data Griffiths' estimate of 13,000 tonnes $km^{-2} yr^{-1}$ for the Cleddau is based, as I[2,3] estimated 275 tonnes $km^{-2} yr^{-1}$ from concentration and flow data available up to 1977, and showed that the rate of sedimentation in adjacent Milford Sound represented erosion of about 200 tonnes $km^{-2} yr^{-1}$. This discrepancy of a factor of 50 is remarkable and needs to be resolved.

(4) Griffiths comments briefly on the

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