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PLOUGHING BLOCK MOVEMENTS ON THE MOOR HOUSE RESERVE (ENGLAND), 1965–75

INTRODUCTORY REMARKS

Some years ago I received from Jan DYLIK a copy of his paper Dynamical geomorphology, its nature and methods (DYLIK, 1957). Characteristically, this demonstrated an unerring ability to look ahead and highlight the important problems requiring investigation. Since it was written, there has indeed been a growing awareness of the fact that dynamic geomorphology should be regarded as a major branch of the subject (*eg*. DEMEK, 1966). Greater attention is also being given to studying the interrelationships between morphological processes and man, a subject which Prof. DYLIK linked very strongly with dynamic geomorphology (DYLIK, 1957). Unfortunately, this recent progress in understanding dynamic geomorphology has been somewhat uneven, with the result that certain aspects of the subject have received comparatively little attention. One such aspect is the field measurement of the rates at which periglacial processes operate. Some idea of the nature and extent of this problem can be gained from the results of a survey sponsored by the I. G. U. Co-Ordinating Committee for Periglacial Research (FRENCH, 1974). This survey lists only 38 projects which are investigating the nature and rate of periglacial processes, though admittedly it is not entirely complete. Then again, the studies which are listed display a preference for certain parts of the globe (especially the mid-latitude mountains of Europe and North America) and also virtually ignore some periglacial processes (*eg*. wind action and ploughing block movements). Another feature of the present situation is that there are only a few studies (*eg*. PISSART, 1964, 1972; WHITE, 1971) which have recorded periglacial movements for a reasonably lengthy period. In this respect the periglacial geomorphologist would be well-advised to emulate the approach of, for example, those glaciologists who have undertaken the collection of a wealth of data on glacier fluctuations during the present century (*eg*. KASSER, 1967, 1973). The value of measuring phenomena in all kinds of scientific work has been admirably summarized by the great

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physicist Lord KELVIN who said: "When you can measure a thing you begin to know something about it; until you measure it your knowledge remains meagre and unsatisfactory".

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APPROACHES TO THE PROBLEM

Given the importance of determining rates of landscape change, the writer's survey of periglacial features in northern England has included a monitoring of ploughing block displacements on the Moor House National Nature Reserve in Cumbria. This project was begun in the summer of 1965 with the selection of five well-developed ploughing blocks from different parts of the Reserve. Their location within the area and the techniques used to measure their displacements have been described elsewhere (TUFNELL, 1972). Owing to the lack of similar projects in other areas, it was not known at first if any movements would be recorded and for this reason the blocks were visited only once a year. However, by summer 1967 it was apparent that most of the blocks were undergoing easily-detectable amounts of annual movement. In view of this, monitoring of block displacements was increased to twice a year, the idea being that winter and summer movements could then be compared. Hence, the measurements to determine annual block movements continued to be taken in early/mid-August, while those which were intended to divide the year into summer and winter seasons were made in early April—not a perfect solution, but one largely dictated by the author's other commitments. Fortunately, within a few years it was apparent that the winter component of block movement far exceeds that for summer and so after 1972 visits to the area reverted to one *per annum*. These annual visits have continued up to the present (ie. 1975), thus providing a ten-year record of ploughing block movements.

The weather in northern England during the years 1965-75 has not been very severe, for the second half of the period in particular has experienced a succession of mild winters. The data obtained should therefore be understood as representing ploughing block movements engendered by rather weak periglacial conditions. However, in view of repeated prognostications by some experts that climatic deterioration is imminent, it seems worthwhile to continue measurements beyond 1975 in the hope of seeing how ploughing block movements respond to changing conditions. The present article should therefore be regarded merely as an interim report, whose chief aim is to present the results of field measurements. Some comments will be offered on the data obtained, but any detailed analyses will have to be postponed until a future date as they will to some extent involve disturbing the environment around each block. For the moment, therefore, it is possible to determine only those aspects of a block's environment which are easily visible and it is these which are summarized in Table I.

Table I

Characteristics of the 5 blocks and their associated features
as noted in August 1975

The block numbers correspond to those given in Fig. 1 of the present article and in Fig. 9 of TUFNELL, 1972

Block number	Comments
1	The block is of Carboniferous sandstone, angular and largely overgrown with crustaceous lichens. Immediately downslope is a type A mound (as defined in TUFNELL, 1972) which is partly vegetation-free. Upslope of the block is a depression 74 cm long. For the downslope 20 cm of its length this is nearly all bare, but the rest is totally vegetation-covered. Many gelifluction terraces occur near the block. When movement was first recorded the block was travelling down a 21° slope. It has now reached a place where the angle is almost 30°. This steepening coincides with an increased rate of block displacement. Eventually, the block should enter the head of a dry vegetation-covered gully whose long profile is in places at angles of over 40°.
2	The block is of Carboniferous sandstone, angular and about two-thirds overgrown with crustaceous lichens. It has an associated type A mound which is only partly covered with vegetation. The depression is 71 cm long and vegetation-covered. Gelifluction terraces occur nearby. The block has almost reached a part of the slope where the gradient increases from 22° to c. 30°. 45 cm below the block's 1975 position the gradient steepens further to almost 40°. Perhaps the block will start accelerating in the near future, as did block no. 1 when it encountered an increased slope angle.
3	The block is of Carboniferous sandstone, angular and heavily overgrown with crustaceous lichens. Again, it has produced a type A mound. The associated depression is c. 120 cm long and vegetation-covered (it includes some quite tall *Juncus*). The slope around and immediately downhill of the block is essentially straight.
4	Another angular block of Carboniferous sandstone overlain with crustaceous lichens. It has an associated type G mound (as defined in TUFNELL, 1972), the upper part of which is largely composed of *Polytrichum*. The depression is among the best-developed on the Reserve, being 6 m long. Upslope of this is a niche which once contained the block (Fig. 1D and Pl. 2, TUFNELL, 1972). Many well-developed gelifluction terraces occur in the area. The block has moved down an essentially straight slope and will continue to do so in the near future. However, the material which the block has gathered around itself is reducing the slope angle locally.
5	This also is an angular block of Carboniferous sandstone covered with crustaceous lichens. Its vegetation-covered mound is of the D type (as defined in TUFNELL, 1972) and it has an associated depression 66 cm long. This is wholly covered with vegetation, except where some small rock fragments protrude from its floor. The block is moving down a straight slope, much of which is covered with gelifluction terraces.

RESULTS OF THE MEASUREMENTS

Fig. 1 shows the annual rates of movement achieved by the five blocks over the period 1965—75. Although the amount of data contained in this figure is small (largely because it represents only one aspect of the writer's work in northern En-

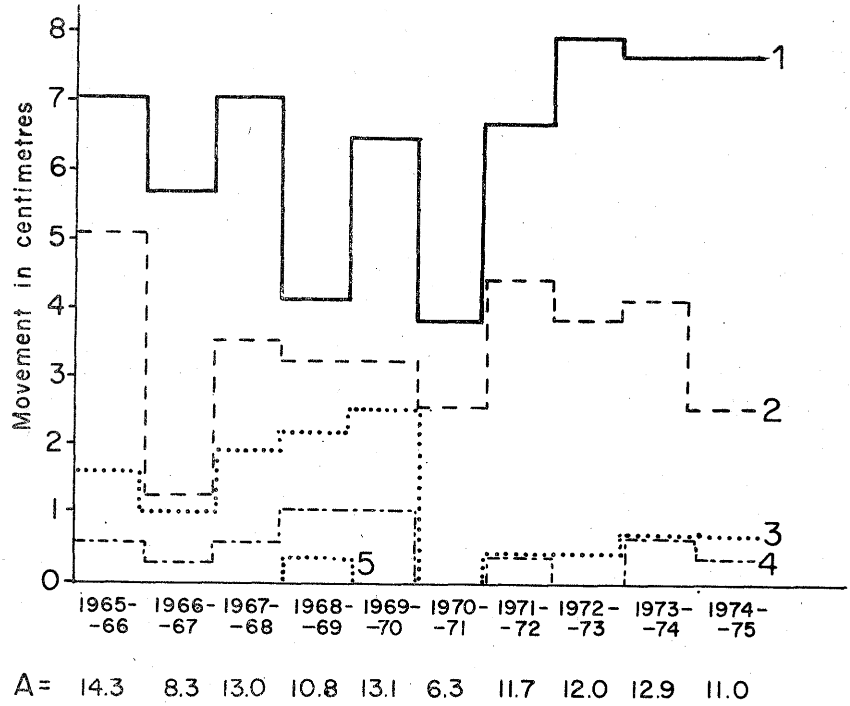

Fig. 1. The annual rates of movement of the five ploughing blocks on the Moor House Reserve between 1965 and 1975

Figures in column "A" represent the total amount of movement in each year for all five blocks combined

gland) and despite the restrictions just mentioned when investigating the environment surrounding each block, there are nevertheless several valid observations which can be made at this stage.

One is that the total amount of yearly movement for all five blocks combined has remained fairly constant, usually falling within the range 10.8—14.3 cm. Only two exceptions were recorded. The first was in 1966—7 when all blocks displayed low amounts of movement, so that their combined displacements totalled only 8.3 cm: the other was in 1970—1 when only blocks 1 and 2 moved and then at reduced speeds, with the result that the total movement achieved by all five was a mere 6.3 cm.

Fig. 1 also shows that the amounts of movement recorded by individual blocks within a 12-month period have ranged from nothing to almost 8 cm (*cf.* PISSART, 1964; p. 306—307; 1972; p. 264). Interestingly, none of the five blocks has experienced a displacement even remotely approaching the shift of 1.5 m in 12 months which was noted by JOHNSON and DUNHAM (1963). Therefore, as the present survey has recorded a total of 50 annual rates of block movement every one of which was below 8 cm, it would appear that large shifts are rare, at least in areas such as the northern Pennines. The changes necessary to induce a substantial acceleration of block movements in this area would probably involve such things as an exceptionally severe winter (like that of 1962—3), a period of generally harsher climate (as occurred during the Little Ice Age) or, in the case of individual blocks, a change of terrain conditions (*eg*. a marked increase in the angle of the slope down which a block is moving). As some blocks on the Moor House Reserve are associated with depressions whose lengths exceed 5 m (TUFNELL, 1972, p. 247), it would indeed appear that such accelerations of movement have occurred in the past. The point may be illustrated by block no. 4 of the present survey. During the years 1965—75 it moved only 4.7 cm and yet it is associated with a depression 6 m long. This may have formed during one particularly harsh winter or, more likely, it is the result of a protracted period of severe conditions. Also important may be the fact that the slope on which the block occurs tends to attract a long-lying snow patch which suggests that any changes in the efficiency of nivational processes may have helped to cause variations in the speed of block movement. On the other hand, terrain factors appear to have been less influential in this respect, particularly as

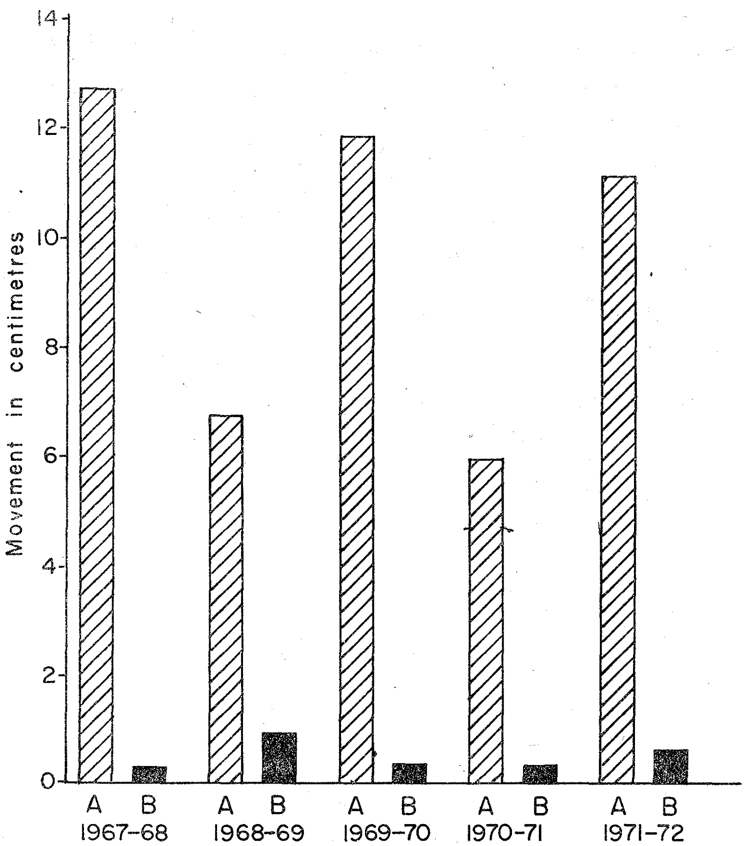

Fig. 2. Ploughing block movements at different times of the year

"A" columns show movement from early/mid-August to early April, while "B" columns indicate movement from early April to early/mid-August. All columns give the total amount of movement achieved by the five blocks, except those for 1968-69 and 1969-70. In these years a seasonal breakdown of the annual movement was possible for only four of the blocks, as a fifth was under deep snow in early April and could not therefore have its winter movement recorded the angle of the slope down which the block has travelled is fairly constant. Some importance should, however, be attached to the fact that the block has pushed up a great deal of material in front of it and this is no doubt contributing to a retardation of its speed.

Among the most interesting findings of the present survey has been that each of the five blocks must be regarded as an individual with its own particular rates of movement, though this individuality is expressed in a very orderly fashion. As a result, block no. 1 has in each of the ten years achieved the highest rate of movement, while block no. 2 has consistently recorded the second highest amount and so on down to block no. 5, which has always been the slowest mover. Such an orderly pattern could hardly have been forecast when the survey began.

As already mentioned, a twice-yearly examination of the ploughing blocks was undertaken in the period 1967—72. This showed conclusively that movement in the colder months of the year is far greater than during summer (Fig. 2). In fact, of the total movement recorded from 1967 to 1972, over 95% occurred in the early/mid-August to early April period[1]. Consequently, it seems likely that most ploughing block displacements are the result of periglacial activity.

The present survey has also confirmed certain aspects of PISSART's (1964) work at Chambeyron in the Alps. For example, the displacements of blocks 1—3 at Moor House show quite marked differences, even though for most of the time they have been moving down virtually identical gradients[2] (*cf.* PISSART, 1964, p. 308). Then again, fragment size appears to have a bearing on the rate of displacement. Hence, in the present survey, as at Chambeyron, the smaller blocks have tended to move fastest. Significantly, the combined effect of fragment size and a low slope angle has meant that ploughing blocks 4 and 5 are travelling more slowly than nos. 1—3, despite their being at higher altitudes (data illustrating these various points are given in Fig. 1 and Table I of the present article, and in Fig. 9 of TUFNELL, 1972).

CONCLUDING REMARKS

Measuring the rates of ploughing block displacements is fairly easy, though it does require persistence, patience and care if it is to be worthwhile. Persistence is necessary because it is only after several years of measurements that one can begin to draw meaningful conclusions and to wait this length of time for results demands patience. Equally, great care is needed when setting up the equipment required and when carrying out the measurements, especially as the amounts of movement can be very small. On the other hand, this type of field work need occupy only

[1] Unfortunately, on two occasions in early April one of the blocks could not be examined as it was under deep snow. Hence, records of twice-yearly movements by the five blocks for the 1967—72 period are not entirely complete (see Fig. 2).

[2] The exception is block no. 1 after it entered an area of steeper gradients in c. 1972.

one or two days each year and is so worthwhile in view of the current dearth of information on rates of landscape change under periglacial conditions. It is therefore suggested that anyone who is working in an area where ploughing blocks occur might like to devote a small proportion of his field work to installing the necessary equipment and to measuring the rates at which such blocks are being displaced. Indeed, our understanding of periglacial phenomena generally would be vastly improved if everyone working in areas where cryergic processes are active undertook to investigate the movements of at least one type of frost feature.

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