The Pleistocene History of the West Midlands*

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The Older Drifts

The 'Older Drifts,' as already pointed out, are essentially either north-western (or Welsh) or north-eastern in composition. We may now examine them to determine whether they record more than one glacial epoch. For this purpose we can divide the region into two parts along a line running roughly from Derby—Lichfield—Tamworth — Coventry — Stratford-on-Avon to Moreton-in-the-Marsh.

East of this line two distinct sets of glacial deposits can be recognized on lithological and stratigraphical grounds. The older of the two, as developed in the north, is of Pennine origin, and was carried by ice travelling from the north-west; but near Coventry and Rugby, drift occupying an analogous position contains chalk and flints, and can be described as a sort of chalky boulder clay. Its apparent southerly limit is shown in Fig. 1. In the intermediate district little is known, but near Hinckley and perhaps also at Bedworth part of the older series consists of well-bedded, probably lacustrine deposits. The oldest drifts on the Blythe-Avon watershed near Stratford-on-Avon, and the 'Campden Tunnel Drift' near Moreton appear to be Welsh in origin with a slight eastern admixture. They have both been regarded as probably older than the Great Eastern glacier (Tomlinson).

Throughout all this eastern region the upper or more recent drift has been derived from the north-east and often consists of a true chalky boulder clay. It has generally and, I think, correctly been referred to the Great Eastern glaciation of Harmer.

Between the lower and the upper boulder clays in the Hinckley-Coventry-Rugby district there is a persistent bed of gravel and sand. Somewhat similar deposits, the Jurassic gravels of Miss Tomlinson, underlie the 'Main Eastern' boulder clay of the Stratford area. The 'Ditchford' or Paxton' gravels of the Moreton district occupy an analogous position with respect to the chalky Moreton Drift' (Tomlinson and Dines). In the Jurassic gravels near Stratford a single tooth of an archaic form of *Elephas antiquus* has been found, which is suggestive of interglacial conditions. Near Coventry both cold and warm climate fossils have been recorded by Shotton. In view of the close association of these deposits with two glacial series, the presence in them of tundra and temperate fossils is not so contradictory as would at first sight appear, especially as we must allow that vast lengths of time may, in a watershed area, be represented by comparatively thin deposits.

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I consider that the facts in this eastern region support the idea of two distinct glaciations within the Older Drifts, with interglacial conditions between them (*First Interglacial*).

West of the Derby-Moreton line the area of the Older Drifts is sharply limited on the north by the southern edge of the later Main Irish Sea glacials (Fig. 1), which has already been discussed. Except in the Lower Avon valley, the older drifts are here Welsh.

The interpretation of these drifts is extremely difficult, partly because it is likely that if there have been two glaciations, they will be recorded by similar deposits which might occur each separately or both together on the same surface, and partly because of the great dissection and destruction that they have undergone. Many of the deposits, too, are gravels and sands that belonged rather to outwash fans than to the ice sheet itself. On the other hand, we have, as already pointed out, the river terraces to help us, by providing a record of the progressive deepening of the valleys and of the contemporaneous opening up and development of new lines of drainage on surfaces, each of which appear to grade with one or other of the terraces, and which for this reason may be regarded as of approximately the same age as the terrace in question.

We may consider the Lower Avon and Lower Severn vales first. Here the highest deposit, namely the Woolridge Terrace, is developed between Tewkesbury and Gloucester, and up the Leadon valley at heights between 200 and 285 O.D. I have elsewhere suggested that the Leadon valley deposits were laid down by water travelling west of the Malvern range and forced to take this course by the filling of the Severn vale by the Welsh ice, when at its maximum. At this stage, too, the ice seems to have carried Welsh boulders to the Moreton-in-the-Marsh district and to have been responsible for certain very high-level drifts in Worcestershire. For these reasons I picture it as stretching over the vales of Severn and Avon

to the Cotteswold escarpment. A slight retreat would have allowed outwash material to be laid down below Tewkesbury. Patches of this have survived at Woolridge (260 O.D.), Norton Hill (283 O.D.), and Corse Hill (250 O.D.). These and some other very high deposits seem to belong to this early stage and to be the most likely equivalents of the lower boulder clays of the Upper Avon valley and of the Pennine drifts of the Trent, Soar, and Wreak valleys.

If we accept this view, it follows that the retreat of this *First Welsh Glacier* was connected with the 'first interglacial' episode for which we have discussed the evidence in the Upper Avon valley. In the Lower Severn vale the Bushley Green Terrace, containing a temperate shell fauna and lying at a considerably lower level than the Woolridge Terrace, appears to belong to this time. The Bushley Green correlates with the Avon No. 5 Terrace of Miss Tomlinson, but for several reasons I picture the latter as somewhat later in date though graded to about the same level. On this view the Bushley Green and Avon No. 5 Terraces cover the 'first interglacial' episode and the oncoming and maximum stage of the Great Eastern glacier in the Avon Vale.

What then of the rest of the region? There are certain data and several lines of reasoning* which in my opinion justify us in postulating the existence during the Great Eastern Glaciation of a Welsh ice sheet reaching across the Stour and Salwarpe valleys, and covering the Black Country, East Worcestershire and the Warwickshire Plateau (Fig. 2). There is, however, no clear-cut evidence to prove whether it was the shrunken First Welsh, or, as I think more likely, a *Second Welsh* ice-sheet which, as the first interglacial epoch passed away, grew and invaded the northern part of the same region, incorporating to some extent in its deposits the drifts of the earlier advance.

The retreat of this glacier is illustrated diagrammatically in Fig. 2.

The first position shown is indicated by a line with double offsets. This line conforms with Miss Tomlinson's maximum 're-advance' in the Blythe valley; with the considerable development on the Ridgeway of drifts with both north-eastern and north-western erratics which may have owed their origin to the combined efforts of the two glaciers; and with the gravels and sands of the Stoulton-Besford area which I have just referred to as grading to the same level as Avon No. 5 Terrace. As the two sheets withdrew, the drainage down the Avon was responsible for the formation of some parts of the same terrace. It appears necessary to imagine the Severn valley from Worcester downwards as having already been established, possibly as a marginal flow along the edge of the First Welsh Glacier.

The second stage deserves more elaboration; but this cannot yet be achieved, owing to want of data. The line indicated with three offsets must therefore be regarded as a composite representation of several that it would be necessary to draw in order to satisfy even the evidence we now possess. East of Birmingham the line represents a lobe in the Tame basin connecting near Tamworth with the Eastern ice of the Anker and Trent valleys. This disposition of the two sheets would enable us to account for the Blythe valley lake suggested

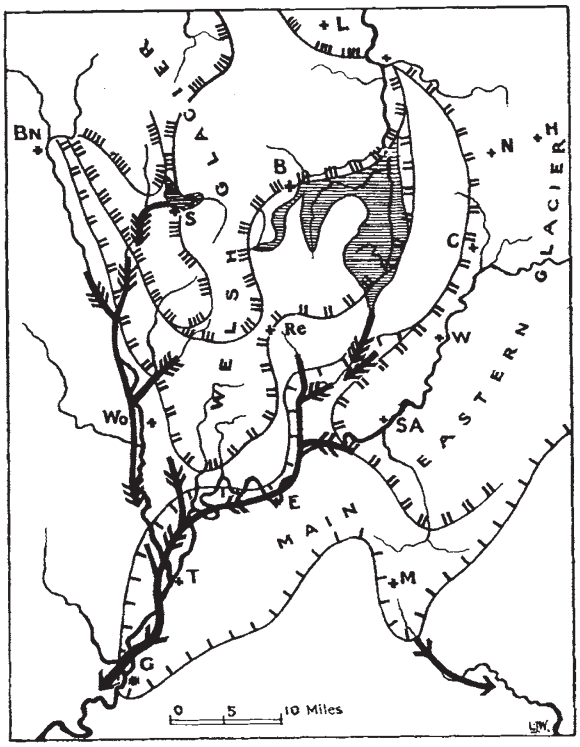

Fig. 2.

POSSIBLE SUCCESSIVE STAGES OF RETREAT OF THE SECOND WELSH AND OF THE GREAT EASTERN GLACIERS. HORIZONTAL RULING INDICATES GLACIAL LAKES; ONE-BARBED ARROW, BUSHLEY GREEN TERRACE OF SEVERN, AND WOLVERCOTE TERRACE OF EVENLODE; TWO-BARBED ARROWS, AVON NO. 5 TERRACE; THREE- AND FOUR-BARBED ARROWS APPROXIMATE TO THE KIDDERMINSTER TERRACE.

in the Birmingham Memoir and described by Miss Tomlinson. It drained southwards by the Kingswood Gap to the Alne valley during the Stratford stage of the Great Eastern Glacier (Tomlinson).

Ice approximately in the position shown for this stage could also account for the Cole valley lake, the Moseley gravels, and the barrier of sands which turn the Cole eastwards near Castle Bromwich. Fig. 2 also indicates a lake in the upper Rea

* These are outlined in the printed address.

valley, south-west of Birmingham. This expresses the hypothesis that certain clays, such as the 'india-rubber clay' of California and the similar deposits at Parson's Hill, King's Norton, may have originated as lake clays when the Rea valley was obstructed by ice that impounded water up to about 550 O.D.

The line further coincides to the south-west of Birmingham with the gravel deposits of Rowney Green near Alvechurch, which may be regarded as marginal in origin. The lobe stretching southwards complies with the necessity for an extension into the lowlands of an ice-sheet that was mighty enough to overspread the high ground of the Black Country and the Lickey Hills. Drainage from this was carried away along the Salwarpe into the Severn, and was responsible for part of the erosion of these valleys before the Kidderminster Terrace came to be formed. It will be noted that the overflow from the Blythe lake coupled with drainage from the retreating Eastern glacier produced similar erosion-effects in the Avon valley before Avon No. 4 Terrace was laid down.

Returning to the melting glacier, the next event seems to have been the splitting of the ice on the high ground of the Black Country. The lobe on the west I picture as occupying the low ground west of the coalfield and of the Clent-Lickey range as far south as the Salwarpe valley. It was this ice that held up the lake or lakes near Wildmoor and Barnt Green which have left their record in the horizontally bedded high-level sands and gravels of that district.

As the ice shrank back the thick mounds of sand and gravel in the Stour vale and near the Churchill brook were deposited. These clearly antedate the Kidderminster Terrace and so fall into their correct position in the scheme.

The final stage, indicated on Fig. 2 by a line with five offsets, was suggested to me by Mr. T. H. Whitehead. There is much evidence to justify the assumption that in pre-Glacial times the Stour flowed northwards as far as Hinksford, where it rounded the end of the then unbroken Bunter Pebble Bed escarpment. Ice in the position shown on the map would, as already suggested, have impounded a lake in the upper Stour valley, the overflow from which might have initiated the present gorge of the Stour through the Bells Mill Gap. The sands of the so-called Kingswinford Esker can be regarded as having originated in this lake.

All the records of the further retreat of the Welsh ice sheet have been obliterated by the invasion of the later Main Irish Sea glacier.

The evidence relating to the Older Drifts that we have been considering is scattered, difficult to interpret and usually ambiguous; but nevertheless I feel some confidence in the correctness of the main features of its interpretation, namely, that there were two glaciations involved. In the first the ice movement was from North Wales and the Pennines towards the south-east: in the second there was a similar, but less powerful North-Welsh dispersion with some slight intermingling of Irish Sea material. Simultaneous with this, however, in the east and in the Avon valley was the Great Eastern glacier.

By the end of the First Glacial epoch the general trend of the lowest parts of the Severn seem to have been established as marginal channels bordering the ice which lay thickest in the Salwarpe-Piddle Brook depression. The first and the second glaciations were probably separated by truly interglacial conditions (First Interglacial).

The Second Glaciation came to an end in the *Second* or *Great Interglacial* epoch which intervened between the deposition of the Older and Newer Drifts. In the area under review we find at this stage that the present directions of the rivers had been determined, and that the valleys of those days can be recognized and their depths defined by the Kidderminster-Avon No. 4 Terrace, and perhaps by the 'High Terrace' with *Hippopotamus* in the Trent valley. There is, however, one exception to this statement. I refer to the Iron Bridge gorge. This section of the present river was non-existent at this time, and in its place was a high watershed. The diversion of the Upper Severn across this waterparting belongs to the story of the Newer Drifts.

Newer Drifts

(*a*) *The Main Irish Sea Glaciation.* I can only refer in the very briefest way to the events that have occurred since the 'Great Interglacial.' I have already mentioned that the Newer Drifts in the Midlands were the product of the *Main Irish Sea Glacier*, and I have attempted to define its maximum extent on Fig. 1. This glacier belonged to the *Third Glaciation.*

The oncoming of this glacier seems to have coincided with the deepening of the Severn valley below the Kidderminster Terrace level, in preparation, as it were, for the great floods of sand and gravel that were fed into it as soon as the ice crossed the old watershed near Iron Bridge and at the head of the Worfe and Smestow valleys. These deposits are now the Main Terrace, correlatives of which are the Second Terrace of the Avon and probably the low terraces of the Trent and Tame.

As the ice had been moving upstream in its invasion of the Dee and Mersey basins, it must

have impounded the drainage during the advance, as we know it did later during the retreat; but there seems to be no record of an overflow into the Severn catchment during this growth stage. As the ice melted back from the maximum position shown on Fig. 1, a series of important drainage changes took place. First, at an early stage when the ice still covered the watershed at Iron Bridge and at the head of the Worfe, but had melted back enough to expose the upper Penk valley, a small lake was impounded just north of Wolverhampton which flowed out south-westwards over the watershed near Tettenhall, forming the Tettenhall Gap. This overflow was responsible for the great train of gravels full of Irish Sea erratics that follows the Smestow Brook down into the Stour.

Dixon has traced various ice fronts trending in a general north-easterly direction across the country between the Penk and Newport, Salop. These are marked by terminal kames and by beaded åsar.

The Worfe valley was an important line of drainage from the ice front until the latter came to lie on the north side of the watershed. In this position a lake was impounded near Newport, and Dixon has shown that this drained across the watershed at Gnosall into the Church Eaton brook and so into the Trent. He named it Lake Newport.

I have elsewhere described the detailed evidence relating to the way in which the waters of the Upper Severn came to be diverted through the Iron Bridge gorge into the drainage basin of the present Middle and Lower Severn. This diversion was brought about during the melting back of the Main Irish Sea Glacier on the watershed region near the Wrekin, through the development of a system of marginal channels and glacial lakes. The detailed evidence substantiates a hypothesis suggested independently by both Lapworth and Harmer, the main feature of which was that a lake was held up by the ice sheet on the north-west side of the pre-Glacial watershed at Iron Bridge; and that this lake drained away across the divide, and thus initiated a gorge that became so deep that it has permanently retained the Upper Severn drainage which formerly went out to sea either by the Dee or by the Mersey. This lake I named Lake Buildwas.

At this stage then there were two lakes, Buildwas and Newport, on the north-west side of the watershed, one draining to the Trent and one to the Middle Severn. They were separated by the ice where it impinged on the Wrekin. When the glacier melted back farther and allowed the lakes to join and form 'Lake Lapworth,' so nearly at the same level were the outlets that it was a mere matter of chance that the Upper Severn went permanently to the Bristol Channel and not to the Humber. As it happened, the Iron Bridge outlet was, or at any rate soon became, the lower. It took all the discharge and has retained it ever since.

These glacial accidents have been the factors that have determined much of the geography of the Midlands; for they diverted into the relatively small pre-Glacial catchment basin of the Lower and Middle Severn great volumes of water which have rejuvenated the river, especially in its middle reaches, on a stupendous scale. The rejuvenation is still operative, and can be seen to-day in the erosive activity of every tributary of the Middle Severn.

Climatic conditions during the Main Irish Sea glaciation were extremely severe. Solifluxion and melt-water floods were on a correspondingly grand scale in the periglacial region. There are vast spreads of local, often angular, detritus at the foot of the Cotteswold and Malvern Hills, and in the valleys draining the high ground of Enville and the Clent-Lickey range, which resulted from these conditions. Most of these grade down to the Main Terrace level in the adjacent valley, and may be correlated with that terrace and thus with the third glaciation; though some seem to be still younger and to correlate with the Worcester Terrace and the Welsh Re-advance.

(*b*) *The Welsh Re-advance* or Little Welsh Glaciation.* The fourth and last glacier to reach our area was an extension of the Upper Severn valley-glacier down as far as Shrewsbury, to which Whitehead has given the name *Welsh Re-advance.* There is strong evidence that the lowest of the important Severn Terraces, the Worcester Terrace, was being formed during this re-advance.

The problem of the Welsh re-advance is one among many relating to our glaciations that await solution, and yet can never be solved by work in one restricted area. The cry is always for accurate data in neighbouring areas. I close this address, as I began it, by an appeal for amateurs who are willing to undertake conscientiously and scientifically the recording and co-ordinating of every scrap of evidence in the district in which they live, whether it be a glacial or a periglacial one. If this were done so carefully that no temporary exposure escaped record, data would gradually, but I think quickly, accumulate by which some at least of the many outstanding problems of glacial correlation and interpretation would reach solution.

* The map, Fig. 1, does not attempt to show the limits of this along the Welsh borderland, as worked out by Dwerryhouse and Miller and by Charlesworth, since they lie wholly outside the Midlands.