GLACIAL AND ASSOCIATED FEATURES IN THE SHEAF, UPPER AND MIDDLE DON BASINS, SOUTH-WEST YORKSHIRE

By

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INTRODUCTION

In the British Isles, and in the countries of north-western Europe there are many long recognised widely and irregularly distributed. superficial deposits of clay and sand. These vary in thickness from a few to some hundreds of feet, and contain stones and pebbles foreign to the localities in which they occur. Earlier geologists believed that the deposits in question (which rest upon rocks of all ages) had been laid down during a vast deluge by what was called" waves of translation." The term "diluvium" so came into use. Gradually, as more became known about ice and its work, geologists almost without exception began to rename "diluvium" as "drift." However, they proposed conflicting suggestions on the origin of the drift. Two schools of thought could be distinguished, one holding the view that the drift is chiefly, if not wholly, due to land ice, (Dakyns 1872 and Goodchild, 1875), and the other that the more important part of deposition was played by marine ice in the form of icebergs and coast ice acting while the land was partly submerged (Tiddeman, 1868 — 1872)

Though the Ice Age is the last great episode in the geological evolution of the British Isles, and in terms of geological time took place only lately, geologists have found extraordinary difficulties in constructing the exact sequence of events during and since the time when ice-sheets overwhelmed the greater part of the British Isles. Wills (1950 P 108) referred to these difficulties by saying..

> "Though for many years, I made the study of the Midlands in the Glacial period my main object of research, I feel that the present chapter is most difficult to write."

These difficulties are partly the result of the great complexity of the subject to be presented in a few pages, to the indefinite nature of some of the conclusions, and of the scattered and incomplete nature of the actual evidence. Wooldridge (1945) stated that later advances of ice, in part destroyed the evidence of earlier periods, or buried it.

As opinion stood in the early 20th Century, most geologists leaned to the view that the glaciation was interrupted by at least one interglacial epoch, during which the climate of any particular latitude became as warm, and perhaps warmer than it is now. While others in Britain (Geikie, 1894, and W.B. Wright, 1937) in America (G.F. Wright, 1911 and Antevs, 1928) and in Germany (Penck and Brunckner, 1909), claimed that two, three, four or even five interglacial epochs, with a corresponding number of glaciation may be recognised in the glacial sequence.

In opposition to these views a smaller number of glacialists urged that there was no proof of even a single absolute interruption of the glacial conditions from the beginning to the end of the Pleistocene period. They claimed that the evidence indicated only one great glaciation, during which there were wide oscillations of the margins of the ice-sheet in different places, due probably to more or less local circumstances. This monoglacial approach was initially supported by Lamplugh (1906 P. 311). Carruthers (1947 and 1948), and Raistrick (1951 P. 1), revived this approach in studying the glacial geology of north-eastern England.

According to the orthodox view, however, the Pleistocene Glacial period embraced a number of climatic oscillations, from cold "glacial" to warm "inter-glacial". In the glacial episodes, great ice-sheets grew in the mountains of the British Isles, and in Scandinavia, and spread out into the lowlands. Beyond their limits in the extra-glacial regions tundra conditions prevailed, and yearly floods of melting snow and ice carried great volumes of gravel and sand down the valleys. The deposits so formed are collectively termed "glacial drift". The regions from which the ice travelled and the directions it took to reach a given place can be determined by tracing the "erratic blocks" and "boulders" back to the out-crops from which they were derived.

Interglacial episodes of milder climate are held to have intervened between the glaciations. They caused the melting away of the ice-sheets, completely or in part, and are recorded by valley-gravels that contain

warm-climate fossils, but are otherwise indistinguishable from those which have already been referred to as resulting from summer thaws of the glacial episodes.

Outside the limits of ice advance were formed periglacial features, including solifluction material, dellen, coombe-features, landslides (Abou el- Enin, 1962, 1964 and 1964B), cambers, gulls, ice -wedges, etc. After the withdrawal of glacier ice, and when the milder climate prevailed the short record of Postglacial time is found in peat-bogs, river deposits and alluvium, cover sands, cave earths and archeological remains.

Owing to the scantiness of these traces in the area drained by the Sheaf, Upper and Middle Don, evidence from a large adjacent area has to be utilised in an attempt to develop a tentative chronology of the Pleistocene glacial events. This area has as its boundaries a line joining Buxton, Bradford, Hull, Lincoln, and Newark-upon-Trent (Figure 1). Thus strata traversed from west to east, across this area are the Carboniferous Limestone, Millstone Grit, Coal Measures and Permian systems. Each outcrop gives a unique land surface offering varying conditions for the preservation of glacial evidence.

Drift deposits have been recorded from many parts of the above selected area, but the Sheaf, Upper and Middle Don Basins, are surprisingly free from drift. Dalton (1953 p. 40) described this area as "an oasis singularly bare of anything glacial." Consequently, discussion of the drifts can be conducted under two headings, firstly, in the adjacent area which bears reasonable evidence of former glaciation, and secondly, in the area under consideration from which firm evidence is lacking.

A — DISTRIBUTION OF GLACIAL DEPOSITS IN THE ADJACENT REGIONS

The following account is a summary of some of the recorded glacial and associated features observed by other workers. It is convenient to discuss the glacial deposits occurring in each individual river basin within this selected area, and it is possible to formulate a chronological sequence which may throw light on Pleistocene history, which in turn, facilitates the understanding of the evolution of the surface and drainage.

1. *The Lower Trent Basin* :

This includes a great deal of the western part of Lincolnshire for the lower Trent descends northward from Newark-upon-Trent until it enters the Humber. It receives most of its tributaries on the left hand, namely the Rivers Poulter, Idle and Torne. The lower Trent Basin contains drift referred to as "Older Drift". (Jukes-Brown, 1887 p. 79; Swinnerton and Kent, 1949). Straw (1958 and 1963) has noted that the Older Drift always occupies the interfluvial crests and has been subjected to extensive dissection, whilst the Newer Drift is to be found only in the northern extremity of Lincoln-shire. (Figure 1).

The major exposures of glacial deposits are found on the interfluve of upper Torne and Idle, Around Tickhill, Bawtry, Haworth and Maltby and east of Gainsborough. The maximum height of these clays would appear to be about 225 feet, but most are much lower, about 50—100 feet O.D

2. *The Lower Don Basin* :

Unlike the Upper and Middle Don, the Lower Don Basin shows evidence of glaciation. Boulder-clay and erratics, some of Lake District origin have been recored. The main exposures are those found in and around Doncaster District. (Figure , 1).

To the south-west of Doncaster at Balby, boulder-clay was first described by Easterfield (1883 P. 212) as a tough dark blue clay, packed with boulders up to a half-a-ton in weight. Corbett and Kendall, (1896 P. 372), noted that in the unstratified boulder-clay of Balby erratics are generally well striated and composed of Magnesian Limestone, Coal-Measure Sandstones, Ironstone, Chert, Millstone Grit, Carboniferous Limestone, Lake District Andesites, and Red Granite. This deposit was re-examined later by Carter (1903), Howarth (1908, P. 180), Kendall and Wroot, (1924 P. 480), Harmer (1928 P. 134) and more recently by Dalton (1953) and Lewis (1954)

To the south of Rotherham, Green (1878 P. 776) described glacial deposits and erratics and Culpin and Grace (1906 P. 325) reported numerous Lake District and Carboniferous erratics scattered on the surface of the fields near Cusworth Park on the north side of the Don.

In view of the patchy character of these drifts, and their position on higher ground, mainly above the 100-foot contour, it may be broadly stated that the drift deposits within the lower Don Basin are Older Drift.

corresponding to the Penultimate Glaciation of Zeuner (1959). However, other patches of boulder-clay, 3 miles of Hemsworth on the west valley side of the River Went, were mapped by Lewis (1954) as remnents of the Newer Drift of the Last Glaciation.

3. *The Dearn Basin :*

The Dearn Basin, as a whole is poor in drifts but a sufficient number of patches of both boulder-clay and glacial gravel have survived denudation to show that at one time most if not all the area was covered by ice. To the west of Barnsley at Eastfield, Mitchell (1947 P. 131) noted that there are occasional boulders of Lake District rocks and transported blocks of local grits such as those at Wharncliffe Wood above the Don.

In a triangular area immediately to the north of Barnsley in the upper Dearn Basin, bounded by Royston in the north, Carlton in the east and Staincross in the west, patches of boulder-clay and erratics including Shap Granites have been described by many geologists, such as Green (1878), Carter (1905) and Harmer (1928). (Figure, 1).

4. *The Rother Basin :*

The most important deposit within the Rother Basin is that occupying the crest of a hill, south of the village of Beighton on the 200-foot contour. It consists of some 35 feet of very varied sand, gravel and boulders, the finer sands having laminae of fine coal-detritus. Green (1887 P. 59), classed these gravels as "*Drift*" and noted that he found igneous rocks in the red loamy and clayey deposit which overlies the gravels and sands on the south side and suggsts the former presence of a superimposed boulder-clay, which he related to the red boulder-clay at Kiveton, only a short distance to the east.

The exposure has been recently re-examined by Shahin (195" P. 131) who concluded that the sand and gravels may possibly be river deposits. He claimed that the false-bedding was due to the swinging of the river (probably braided) across its floor: that the erratics embedded in the sand and gravels might have been carried to the Beighton Area by the eastern tributaries of the Rother from the boulder-clay deposits on the eastern watershed; that the red loamy material can be explained as finer grade materials deposited under cold conditions and possibly in frozen-over pools. Consequently, he claimed that these deposits may, therefore be river deposits developed under periglacial conditions.

5. *The Wye Basin* :

Though glacial deposits within the Wye Basin are not widely distributed they are of great significance. They are mainly found around Bakewell and Buxton at heights of 800 and 1200 feet O.D. respecively, and are generally composed of Peak District materials. In view of their location on high ground, and their patchy relict character, they are believed to corresppnd with the "Older Drift" of the Ante-Penultimate of Zeuner (Table 1)

However, Straw and Lewis (1962 P. 78) have claimed that the drifts around Bakewell may be classed as Older Drift, probalby having been emplaced during the Penultimate Glaciation, for the fact that till has been preseved fairly extensively around Bakewell suggests its emplacement in later rether than earlier Older Drift times. The degree of dissection of the drift is also no greater than that which affects the Chalky boulder-clays of Penultimate age in parts of Lincolnshire, Northamptonshire and Rutland.

6 *The Upper Derwent Basin* :

Unlike the Wye, the upper Derwent does not possess positive evidence of glaciation. However, erratics were found, here and there, to reveal parts of the story of an earlier glaciation, which probaly corresponds with Zeuner's Ante-Penultimate Glaciation. These erratics were noted and recorded in different places by Jowett and Charlesworth (1929), Gibson (1913 P. 102) Wedd (1913) and Harmer (1928), and their sites and location are indicated in Figure 1.

7 *The Aire-Calder Basin* :

The drift deposits in Aire-Calder Valleys are wide spread and of a diverse character, but may be referred, on the basis of physical features and disposition in relation to topography, to two main groups, the deposition of which appears to have been separated by a long time interval. The first group, the earlier drifts, includes pathces of boulder-clay and gravel which lie on hill tops throughout the greater part of the area. The second group, the later drifts includes river deposits in the valley bottoms, strand-line gravels along the west side of the Vale of York, and the bedded sands, silts and clays which cover much of the vale of York below the level of about 25 feet. O.D.

Because the Older Drifts occur on high ground, and not on the sides or in the bottom of the main valleys, it is inferred that an interval of denudation and valley-cutting followed their deposition. Further, because glacial deposits, fresher in appearance than the Older Drift, lie in the bottoms of the main valleys, it is inferred that this interval lay between the two periods of glaciation. Such an interval is recognised in the southern parts of England as succeeding the "Great Eastern Stage" or the Penultimate Glaication, of the Older Drift, and preceding the Newer Drifts of the Last Glaciation. It is called the "Great Interglacial" by Wills, (1938; P. 232), the "Ipswichian Interglacial" by West, (1961), and is considered to be of Riss-wurn age by Zeuner, (1937, P. 139 and 1959).

B — DISTRIBUTION OF GLACIAL DEPOSITS IN THE SHEAF, UPPER AND MIDDLE DON BASINS

The area under consideration is well-dissected by river erosion, but to what extent glacial conditions have affected the valleys is difficult to assess. The effect, too, of recent erosion and fluvial conditions is problematic, though it may be assumed that these account for much of the scarcity of glacial evidence. Reviewing the evidence in south Yorkshire, Kendall (1907) points to difficulties of interpretation, fairly because of its extremely fragmentary character, secondaly because of remarkable mixture of erratics in the drifts from so many widely-separated localities, travelling by very different routes.

For the Sheffield Area, Dalton (1953 P. 40), claimed that, though surrounded by a variety of glacial evidence it appears to be "an oasis singularly bare of anything glacial". He also considered it to be remarkable that such important valleys as the Don and Rivelin in the east of the Pennines and the upper reaches of the Derwent and Noe in the west, are singularly bare of glacial evidence, though a few erratics are recorded in them.

The present writer considers therefore, on the basis of this evidence, that the south-eastern part of the Pennines south of the River Calder, and particularly the area under consideration, appears never to have been invaded by an ice-sheet: and its general aspect is that of a typically

unglaciated area. But at several localities there exist patches of a material resembling boulder-clay, a sandy and gravelly clay which might be full of boulders and fragments of sandstone and grit. All the consituents are of local drivation but in some cases they show by their composition that they must have been transported some distance from their source. Most of these deposits lie at the bottom of long gentle slopes where they probably accumulated under periglacial mass-movement processes. This may also account for the distribution of scattered boulders of grit which have travelled some distance from their present outcrop.

It is convenient, therefore, to discuss some of the deposits which may be of glacial origin within the area under consideration, and to their nature and sites, with some reference to previous descriptions when possible.

Near Well House, on an erosion surface relic to the east of Penistone Lewis (1954 P. 58) found pebbles of Lake District and Yorkshire Dales origin between 800 and 830 feet O.D. Similar pebbles were also found by him at approximately 650 O.D. at Jordanthorpe and Greenhill and he considered both of them to be associated with the Older Drift of the Penultimate Glaciation of Zeuner.

The sites at Well House and Norton were re-examined in the field in 1963 (Figures 3 and 4). The fragments are largely of well-rounded and sub-rounded sandstones, and located on the resistant sandstone outcrops. At Well House, they stand at a height of 830 feet O.D. and at Whitethorns they are at a height of 570 feet O.D.

The present writer believes (1962 and 196) that these deposits can alternatively be interpreted as river deposits for the following reasons

a) The deposits at both of these localities occur in the floor of possible wind-gaps between the Don and Little Don, and the Moss and the Drone, respectively.

b) Examination of these pebbles, revealed that they are composed of local sandstone rock, that they are not faceted, and they do not possess cracks, striations nor sharp edges

c) The present writer failed to find erratics or foreign rocks amongst them.

One mile to the south-east of Wortley at Booth Wood (Figure 5), several rounded fragments were also observed in 1963, occupying the interfluvial area though mainly situated in the floor of a possible wind-gap between the upper Black-burn Brook and the Little Don. The fragments were composed of the local sandstone and stand at a height of 775 feet O.D. They were generally well -rounded and brown to deep-brownish in colour. Their origin is still doubtful, but they are perhaps more likely to be river deposits than glacial drifts.

Westby (1883 P. 137), observed a patch of boulder-clay containing Millstone Grit, Coal Measure and New Red sandstone erratics, sandstones with casts of brachiopods and pieces of Magnesian Limestone, at Crosspool (altitude 730 feet O.D.), 1 1/2 miles west of Sheffield. Similar materials were found in the same location, later by C. Johns (1905 P. 245) who claimed a Lake District origin for some of the rocks, and that the general character of the series rather suggested the Vale of York glacier. This locality was re-examined in 1963, and it was found to be much built over. However, several rounded fragments mainly of sandstone and gritstone were observed, lying on a bench-like feature at a hight of 730 feet O.D. (Figure 2). The fragments do not occur on the higher surrounding ground, and their location downslope may refer to their movement by erosional processes. Due to the fact that glacial deposits only found in this locality and that such variety of deposits has not been seen by the present writer, their positive origin and age are still doubtful.

It is of some interest to mention that Carter (1905 P. 411) traced the passage of the Stainmore Glacier and Pennine Glacier until it blocks the Don at the Conisbrough gorge, thus impounding the water of the Don and Rother into a glacial lake to a height of 300 feet. (Figure 1). Recent evidence (i.e. the distribution of drifts) does not favour the former existence of such a lake, and Carter's hypothesis has rejected by many writers (e.g. Lamplough, 1913, Dalton, 1953, and Shahin, 1957).

It is obvious that efforts to reconstruct the history of the area under consideration during the Pleistocene are hampered by the fragmentary nature of unreliable evidence. However, Eden (1957 P. 152), adapted a recently compiled table (Edwards and Trotter, 1954 P. 68), to the special conditions of the Sheffield area, and it is summarised as follows :—

Pleistocene or Glacial.	*Newer Drift*, probably equivalent to Warthe-Weichsel Stage of North Germany.	In two main stages, represented in the Vale of York by glacier-advance, Periglacial condition in Sheffield area.
	Interglacial Period.	Valley cutting and dissection of Older Drift.
	Older Drift, probably equivalent to Saal and earlier stages of North Germany.	Extension of northern glaciation across the Sheffield area and into the Midland in "Catuvelaunian" time.

No details of earlier sequence of events.

A CORRELATION AND TENTATIVE CHRONOLOGY OF THE DRIFTS AND GLACIAL EVENTS IN SOUTHWEST YORKSHIRE, AND IN SOME OTHER PARTS OF ENGLAND

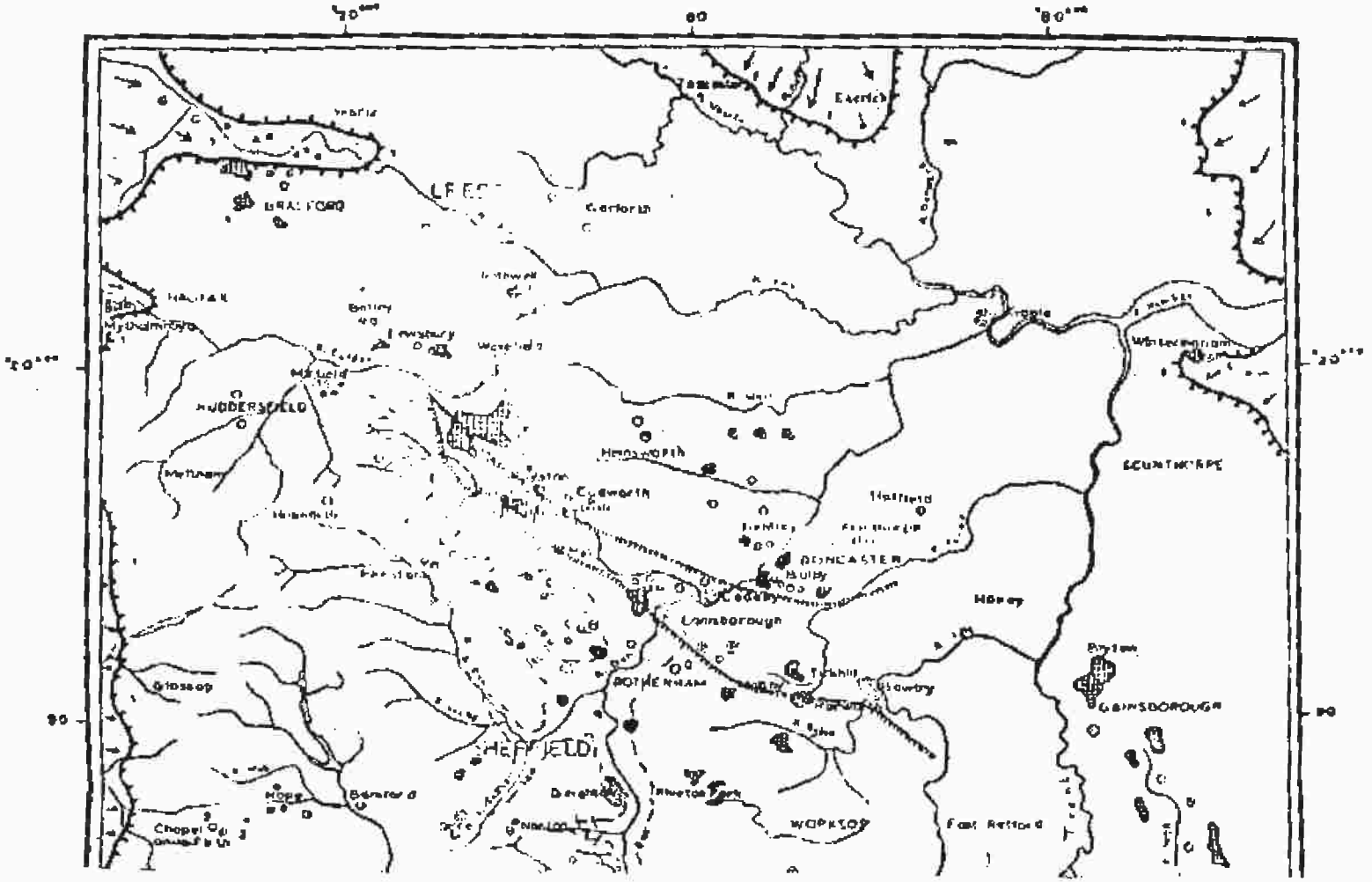
The complexity of the drifts, the absence of sections showing superposition of different age, are some of the difficulties attending classification and correlation, while to these must be added the problem that the Quaternary sequence not only in England but also in Western Europe is itself still imperfectly understood. However, it is now generally accepted that the British glacial deposits can be distinguished into Older and Newer Drift, the former associated with Ante-Penultimate and "mainly" Penultimate Glaciations of Zeuner (1957), and the later with his Last Glaciation.

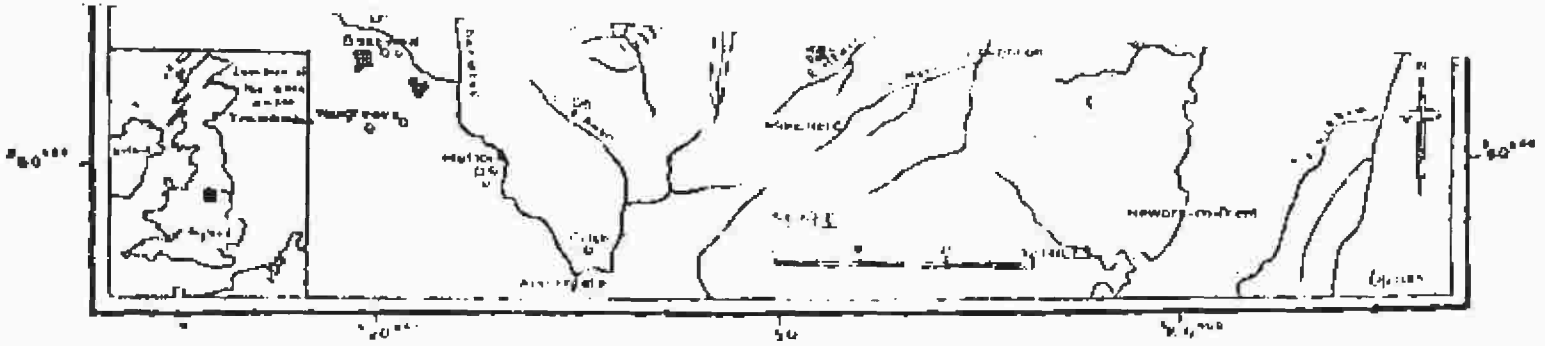
Table 1 is an attempt to correlate the Pleistocene chronology of the British Isles suggested by Zeuner (1957), with the Pleistocene events of Norfolk, the Leeds District, the Don Basin, the Rother Basin and the research area under consideration, as proposed by West (1961), Edwards (1950), Lewis (1954), Shahin (1957), and the present writer, respectively.

In the Sheaf, Upper and Middle Don Basin, no conclusive evidence regarding the date of the glacial drifts has been formed, but they are broadly considered to be Older Drift. However, much evidence of periglaciation has been observed, and it is considered that the research area was subjected to extensive periods of periglaciation during the Last Glaciation.

FIG. 1.

LIMIT OF THE LAST GLACIATION AND DISTRIBUTION OF GLACIAL DRIFT AS RECORDED BY DIFFERENT AUTHORS IN THE SHEFFIELD AND ADJACENT AREAS.





SAND AND GRAVEL

TILL OR BOULDER-CLAY

ABUNDANT PEBBLES OF GLACIAL ORIGIN.

ERRATIC BLOCKS OR PEBBLES

LOCAL TRANSPORTED ROCK-FRAGMENTS

ICE-FRONT OF THE LAST GLACIATION

ICE-FRONT OF STAINMOOR [illegible] OF CARTER, 1905.

DON-ROTHER LAKE OF CARTER, 1905.

STREAMS.

POSSIBLE CHRONOLOGY

1 LAST GLACIATION

PENULTIMATE GLACIATION.

2 ANTE-PENULTIMATE GLACIATION

FIG. 2

DISTRIBUTION OF ROUNDED ROCK-FRAGMENTS AT CROSSPOOL

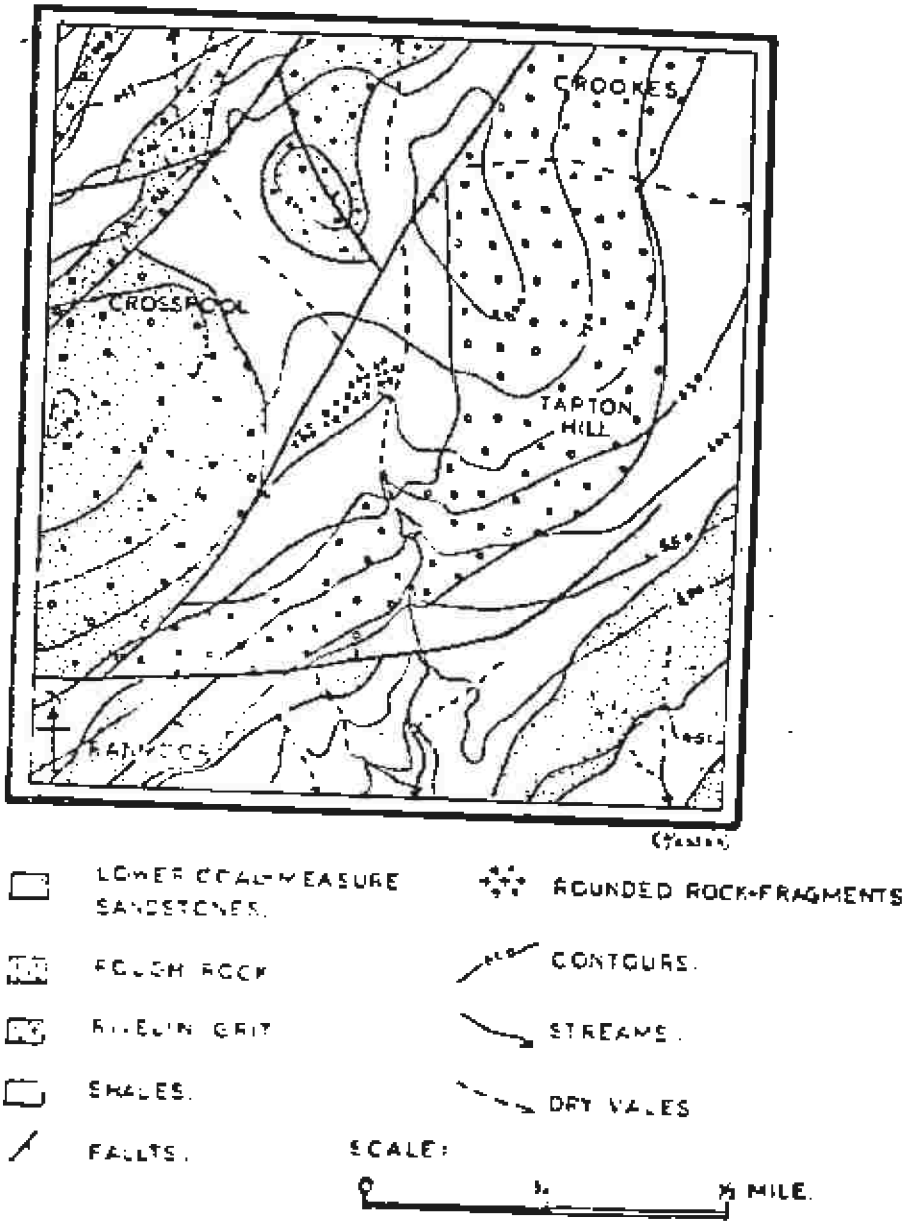
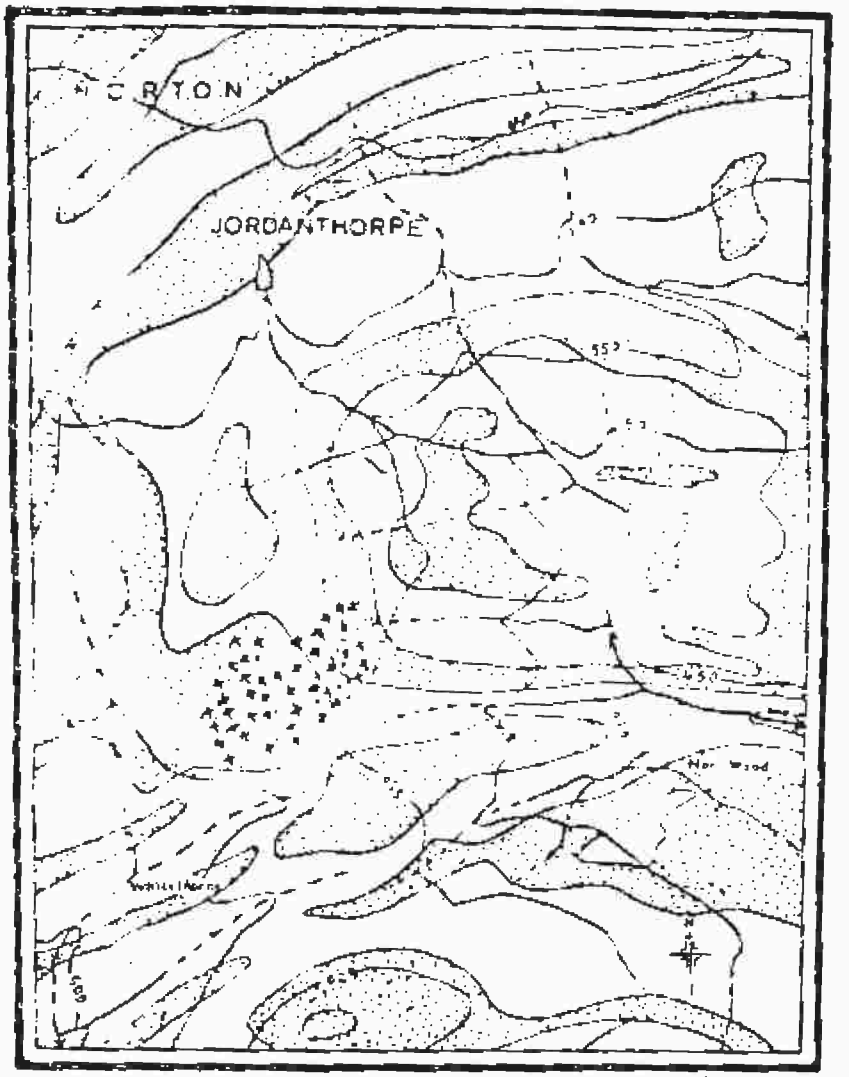


FIG. 3

DISTRIBUTION OF ROUNDED ROCK-FRAGMENTS
TO THE SOUTH OF NORTON



LOWER COAL-MEASURE SANDSTONES

SHALES.

ROUNDED FRAGMENTS OF LOCAL ROCKS.

CONTOURS

STREAMS.

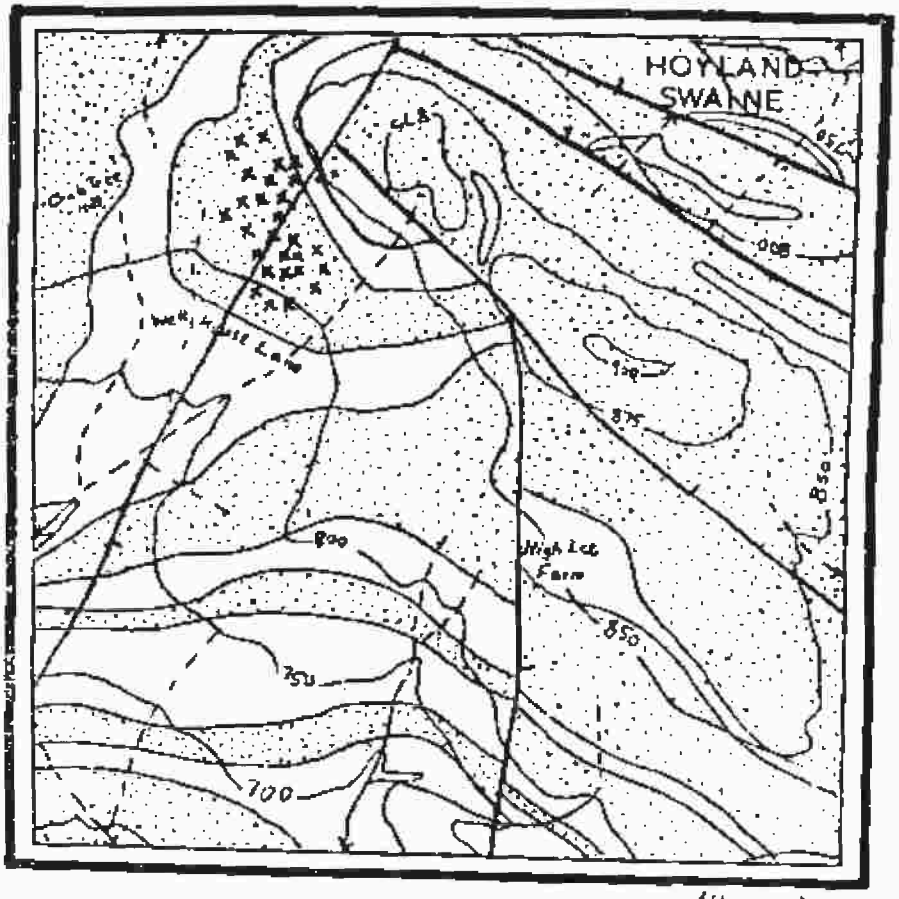
DRY VALES.

SCALE.

0 ¼ ½ MILE.

FIG. 4

DISTRIBUTION OF ROUNDED ROCK-FRAGMENTS
AT WELL HOUSE LANE

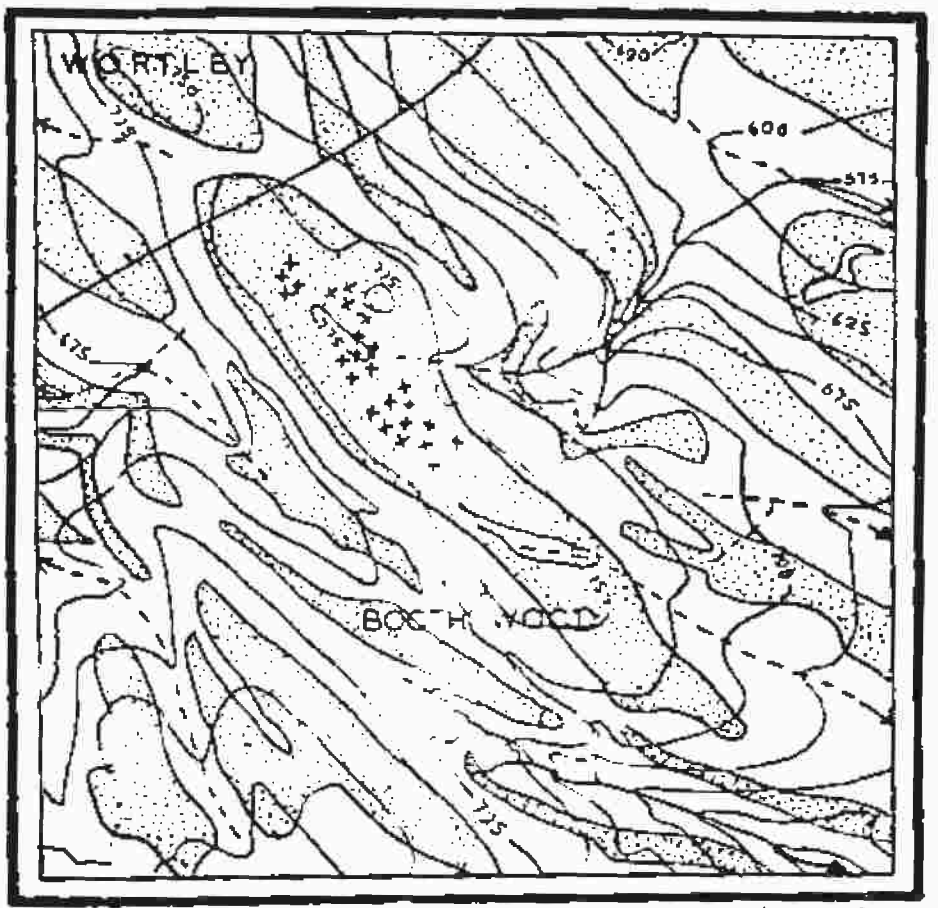


(Hassan).

KEY AS IN FIG. 3

FIG. 5

DISTRIBUTION OF ROUNDED ROCK-FRAGMENTS
AT WORTLEY



(Hesser)

KEY AS IN FIG. 3

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