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THE LAST GLACIATION IN THE BURREN, CO. CLARE

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ABSTRACT

SOME account is given of the effects of the last glaciation in north County Clare showing that the ice moved into the area from the north-east. The deposition of the drift was irregular and there were probably drift-free areas. The destruction of the drift and the possibility of the formation of small patches of less calcareous soils is discussed.

No comprehensive survey of the glaciation of Co. Clare has been made. This study is based on observations made from time to time over the last 30 years, to which has been added the information obtained during some special visits.

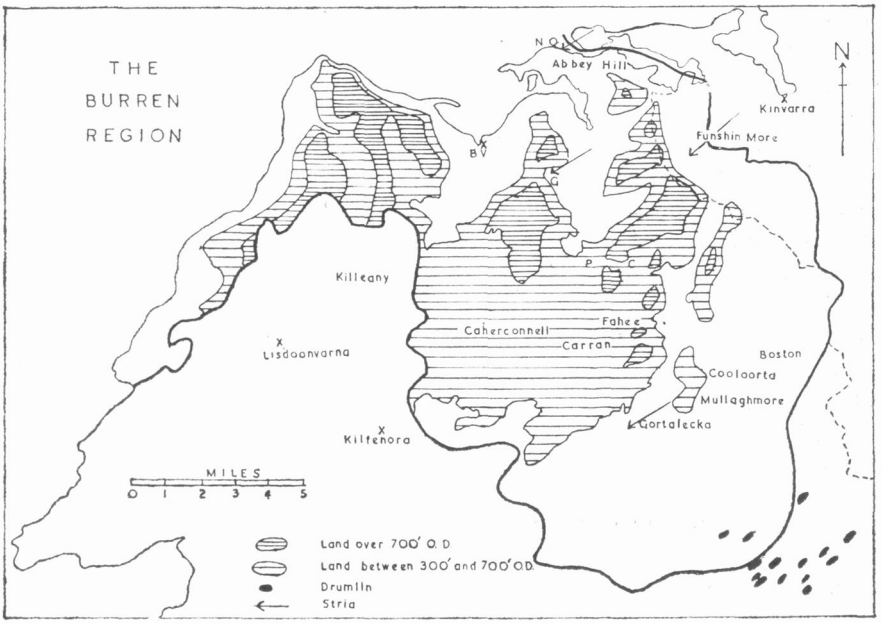

FIG. 1. — The karst area is enclosed by a heavy line. The dashed line indicates the boundary between County Clare and County Galway.

N Q (New Quay), B V (Ballyvaughan), G (Glennamanagh), P (Poulavallan), C (Glen of Clab).

(Based on the Ordnance Survey by permission of the Government.)

The last movement of ice across north County Clare came from the north-east. This is clearly shown by the direction of the glacial striae and by the direction of the long axes of the drumlins. Striae are not very common. On such a soluble rock as the limestone of the area they are very soon destroyed. It is only where there has been very recent stripping of a surface, by human activities or by sea spray or a stream, that striae can be seen at all. Records have been made as follows.

New Quay W30S [M 27 12]

Funshin More W40S [M 33 8]

Glennamanagh W30S [M 26 7]

Gortalecka W30S [R 31 94]

In Glennamanagh the somewhat rare phenomenon of "nailhead striae" confirms that the movement was to the south-west.

Striae recorded from Francis Gap [M 59 8] (S55W) and Pollboy [M 56 7] (S30W) in the Slieve Aughty hills (Farrington 1959, p. 11) show that this ice-movement was not a local phenomenon (cf. Corbel 1957, p. 334). Stone orientation counts of the upper boulder clay here (Farrington 1959, p. 10) also show a NE-SW trend

The drumlin direction is most clearly seen in the corridor between the Burren Hills and the Slieve Aughty Hills. Typical drumlins, their steep sides rising over 100 feet from the plain, the blunt ends facing north-east, are most plentiful at the southern part of the corridor. Low elongated ridges of drift also occur. All these, drumlins and ridges, have their long axes orientated in general about south-west and north-east. The axes of the drumlins on either side of Galway Bay have more westing as the ice had a free escape out to sea. The direction of movement there is confirmed by the carriage of the limestone boulders and calcareous boulder-clay westward onto the granite in the neighbourhood of Salthill.

Traces of earlier ice movements are found only in the occasional occurrence of erratic rocks from Connemara which occur all round the northern slopes of the Burren Hills and, more rarely, on the upper plateau. It is probable that all these are in a secondary position having been incorporated in the later drift and involved in the later movement. This earlier movement is also shown by the orientation count of the lower clay in the Boleyneendorrish Valley (Farrington 1959, p. 10).

The manner in which the drift, usually a very stony boulder-clay, occurs on the plateau, on the hill-slopes and on the low-lying karst areas, poses the question of its deposition. Is the patchy distribution original or is it due to erosion of a more or less uniform sheet of drift, the existing patches being residual?

The irregular deposition of drift is a well-known phenomenon, particularly well seen in the drumlins west of Murvey in Connemara or those of the Ardara district of Co Donegal Here, isolated drumlins, up to 150 feet in

height, may be found surrounded by driftless areas. The occurrence of drumlins at all, implies an irregular deposition of the drift.

In Burren the drift occurs characteristically in isolated mounds and ridges, although there are some areas covered by a thin spread of boulder-clay. Typical low ridges are to be seen in the country around Lough Bunny. The larger drumlins are better developed to the south of the Burren. On the east slope of Mullaghmore [R 33 96] and on the side of the escarpment to the north, eliptical, drumlin-like patches are plastered on the side of the hill. Similar occurrences are found elsewhere along the escarpment. Near Cooloorta, [R 34 97] two miles west of Lough Bunny [R 37 97], one of the spreads of boulder-clay may be seen. A thick mass of boulder-clay, banked against the escarpment thins out to the north-east gradually disappearing to reveal clean karstland.

There are some patches of boulder-clay on the plateau, the most extensive being in the two large depressions of Carran [R 28 99] and Caherconnell [R 23 99]. North-east of Lisdoonvarna [R 14 98] and south [R 17 99] of the col leading to the Caher valley, low ridges of drift lie with their axes west-south-west. It is particularly noticeable here that far-travelled erratics are found almost exclusively on such drift ridges. This is a general phenomenon of the Burren but is more noticeable north-east of Lisdoonvarna because far-travelled erratics are more common there than elsewhere. On any of the drift patches one may be sure of finding some specimens of Connemara rocks, or at least some Carboniferous sandstone, whereas a prolonged search of a karst area often yields nothing but the local limestone. This, surely, is strong evidence in favour of the suggestion that the drift was absent or at least very thin over the areas that are now bare.

In addition to the far-travelled erratics there are also numerous loose, rounded blocks of limestone. In certain special cases it may be argued that these are remnants of beds of limestone that have been almost completely washed away, but for the most part they are indisputably glacial erratics. In such an area as the low-lying karst east of Mullaghmore [R 33 96], where these boulders are very numerous, it would be difficult to maintain that there was not once a continuous spread of drift. There are, however, many areas where there is no such spread of erratics and in these it is unlikely that there was ever a cover of drift. Good examples of this type of ground may be seen south-west of Poulavallan [M 29 2], and half a mile east of Carran [R 28 99]. These boulderless areas are common on the plateau but not on the low-lying karst.

Gravel is found at various places on the lower ground on the north, north-east and east of the mountains. None of these gravel patches is very extensive and all are obviously products of the retreat of the ice. With the exception of a small deposit in Glennamanagh [M 26 7] at about 200 feet, all the gravel lies close to the 100 foot contour. Typical occurrences are those on the western spur of Abbey Hill [M 29 11], at Funshin More [M 33 8], north of the mountains, and at Derreenatloughtan [M 37 1], south of Tulla [M 37 3]. Corbel (1957, p. 374) attributes the disturbance of the beds in a section

of the gravels at the last named site to the ploughing action of an iceberg. No other evidence of a high sea-level at this period has been brought forward and there is much evidence against it.

The area of the originally bare karst has been increased by late- and post-glacial erosion. The Burren drift is easily eroded as both the clay and the contained stones are calcareous, so that solution is added to the washing away of the clay as a destructive agent.

There are numerous places where the erosion of the drift and, indeed, of the bed rock may be noted. For example, at the head of Glennamanagh a drift slope faces the limestone escarpment: the drift is retreating from the escarpment down a rock slope leaving exposed a smooth, striated surface. A few feet from the drift the striations are already weathered away and after a few yards the surface of the bed rock is fretted and shattered by solution and weathering. Oversteepened slopes, denoting rapid retreat, may be seen on many of the drift banks, for instance on the hill west of Cooloorta [R 34 97] or at Cappagh [M 32 2], two miles north of Columcille House. The runnels on the steep slope of drift at Fahee [R 30 99] in the Carran depression are also evidence of rapid erosion. On the road between Boston [R 38 98] and Tulla [M 37 3] a fringe of large limestone boulders may be seen lying on the bare pavement at the edge of a drift slope, indicating how far the slope has retreated.

The gravels at the northern end of the Glencolumcille valley [M 35 5] (now completely dry) and those at Funshin More [M 33 8], were laid down by drainage off the hills as the ice melted back. Balls of various sizes of the local boulder-clay are frequent in the gravel, showing that the destruction of the drift began vigorously immediately it was uncovered by the retreating ice. Another observation points to the erosion of the drift by washing down into the subterranean drainage of the dolines. The most likely places to find erratics of sandstone in the bare karst areas is at the bottom of the dolines. This suggests that a thick plug of drift lying in a doline would lead to a concentration of the very rare foreign rocks at the bottom when the limestone drift was dissolved and washed away.

Two estimates of the present rate of erosion of the limestone have been made in recent years (Corbel 1957, pp. 370–371; Williams 1963, p. 440). It is, of course, impossible to assess how much of the dissolved material in the waters analysed came from the rock surface, from underground or from the drift. Williams estimates that an amount equivalent to a layer of limestone ·05 mm. thick is removed in solution each year. Corbel's estimate is about double this figure. These estimates refer to present conditions when most of the area is bare karst and can have little relation to a period when the drift cover was much more extensive. At such a time, even when the waters were saturated with carbonates, the streams could carry vast quantities of drift as mud in suspension. Corbel's estimate depends on a very few samples. Williams samples covered five summer months but no record was published for the winter. The results, therefore, cannot carry much weight.

It is clear from the way in which the ice drove straight at the escarpment that the sheet was capable of surmounting it. The strong striae at Glennamanagh [M 26 7] at a level of 500 feet, directed towards the escarpment are an earnest of this. The occurrence of thick drift in the Carran [R 28 99] and Caherconnell [R 23 99] depressions show that thick ice must have moved across the plateau. But the deposition of the drift on the plateau was very irregular, and there were great stretches, distinguished by the absence of boulders, where no drift was ever laid down. That there were extensive bare patches in the lowland of the Burren is much less likely. The limestone boulders seem to be scattered everywhere. The few patches seen where boulders were few may have been caused by the removal of the boulders to build boundary walls.

The Constituents of the Drift.

From the direction from which the ice came it is clear that over the area of the Burren any erratics from Connemara are secondary, having been picked up from earlier drift sheets. There is no evidence that ice from Connemara was present in the Burren at this period. Furthermore, ice moving from the north-east to the Burren region would pass over no rock other than limestone. The sandstones and slates of the Slieve Aughty Hills lie too far to the south. It is not unexpected, then, that samples of boulder clay from various sites should consist almost completely of material derived from limestone. For example; a sample (2 lbs.) of boulder-clay from Carran yielded no pebbles except limestone, although occasional small fragments of sandstone were found in the loose material fallen from the section. The clay fraction of this sample was 42% by weight. A sample (2½ lbs.) from a section in Caherconnell yielded 181 stones of limestone and 2 of sandstone. This sample was almost a limestone rubble. The clay fraction was only 9%. A search of a large pit near Kilfenora [R 18 94], an exposure of the order of 100 yards long by 10–12 feet in height, did not reveal anything other than limestone. The same results were shown in most of the other places examined. In fact, although occasional fragments of sandstone can be found in many sections they are too rare to have any effect on the constitution of the boulder-clay or on any soil derived from it. On the other hand both in the fine sand recovered from washings and also in the fine clay recovered from suspension by filtering there was always a considerable residue of material insoluble in concentrated hydrochloric acid.

Some of the ridges south of the Caher col are composed of a black boulder-clay. The material must have been derived from the Clare shales which overlie the limestone in parts of N.W. Clare. This could have been caught up by ice moving from the north-east. A section in one of these ridges, on the road a mile north of Lisdoonvarna, exposed a blackish clay with well-striated stones. A sample (1 lb. 2 oz.) gave 70 pieces of limestone and three pieces of sandstone. The sand fraction, consisted very largely of tiny fragments of sandstone and shale. This contrasts markedly with the sand fraction of the grey limestone boulder-clays where the insoluble material was almost

completely grains of clear quartz. This black boulder-clay is of a type in which the materials have not travelled very far. The large stones, although striated, were angular and showed very little rounding. The clay fraction was 47%. Another sample (1 lb. 4 oz.) taken from a ridge south of Killeany, three miles north-east of Lisdoonvarna [R 14 98] was almost entirely black clay. There were no pebbles and the sand fraction weighed only $\frac{1}{4}$ oz. When washed and cleaned with hydrochloric acid the insoluble residue was similar to that from the last sample mentioned. At the sides of this ridge the down-washed clay was leached and showed no effervescence with hydrochloric acid although the unweathered material was highly calcareous. These sections lie just west of the boundary of the Burren Region as shown in the map (Webb 1962) but they are quoted to show the great contrast between clay deposited by ice which has passed over a small area of sandstone and shale and the purely limestone clay of the rest of the Burren Region.

If the destruction of the boulder-clay were capable of producing a reasonable amount of insoluble material why is this not found deposited somewhere in the lower parts of the drainage system, forming silts and clays in the lakes? Probably the answer is to be found in the fact that the drainage of the area is almost wholly subterranean. It has been suggested that the destruction of the drift began immediately on the retreat of the ice. It may be that a large proportion of the erosion took place then, before there was a cover of vegetation. This was probably a period of low sea-level and if deposits were formed somewhere it is likely to have been in a position not now accessible. The very consistent levels of the lakes, Bunny [R 37 97], Muckanagh [R 37 93], Balleighter [R 35 93], Cullaun [R 32 91] etc. shows that their surfaces are controlled by the general ground water level, related to present sea level. The lakes are probably not very old. They are all fed by springs, having no normal feeding streams, The formation of deposits of sand, silt or clay under these circumstances is very unlikely. Corbel (1957, p. 373) considers that it is the impermeable substratum of Old Red Sandstone that holds up the water table. It is not likely that this substratum is above sea level in the karst area

The Occurrence of Sandstone in Poulavallan [M 29 2] and the Glen of Clab [M 30 2]

In the Glen of Clab there are two concentrations of fragments of a thin-bedded sandstone. There is possibly a third at the eastern end of the glen but this may be due to road building as the sandstone occurs in the roadway. In no case did a search of the rocky slopes above the accumulations of sandstone fragments, which all occur near the valley bottom, reveal any outcrop of rock *in situ* On one side of Poulavallan doline loose boulders of sandstone are found The slopes there are very overgrown and difficult to examine but no rock *in situ* was found At the top of Poulavallan, above the sandstone boulders, there is a continuous exposure of limestone. It is extremely unlikely that an outcrop of solid sandstone could occur. Hodson (1952) states that

there has been very little disturbance of the strata in this area. As much denuded remnants of the overlying rocks, the Clare shales, are found over considerable areas in N.W. Clare, it is very likely that these rocks were present not far above the surfaces into which Poulavallan and the Glen of Clab are sunk. The most likely reason for the preservation of these accumulations of sandstone fragments is their involvement in the collapse of the roof of an underground drainage system now represented by the Glen of Clab and the Poulavallan doline. Such remnants of the overlying cover may have contributed to the drift the very small proportion of sandstone found in it and lying about as erratics.

Conclusions

The karst of the Burren Region was overswept by ice coming from the north-east and a cover of drift of variable thickness was laid down. On the plateau considerable areas do not seem ever to have had any significant cover of drift. The drift, except in a few places where it had passed over residual patches of the shales and sandstones overlying the limestone, was pure limestone drift, the amount of non-calcareous erratic stones being negligible. There has been considerable erosion of the drift and of the underlying rock since the end of the glacial period. Much of this erosion occurred immediately on the retreat of the ice, so that bare patches caused by erosion were added to bare patches where drift was never deposited, before there could have been any colonisation by vegetation. The drift contains a noticeable proportion of insoluble material in its finer fractions. Its destruction would leave a residue much less calcareous than the drift itself, which could accumulate under favourable circumstances to form the basis of a soil.

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