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FEATURES INDICATIVE OF PROLONGED AND SEVERE PERIGLACIAL ACTIVITY IN IRELAND, WITH PARTICULAR REFERENCE TO THE SOUTH-WEST

Abstract

Ice wedge casts, once thought to be largely restricted to the area south of the South Ireland End Moraine, are, in fact, widespread, both areally and within the Quaternary stratigraphic sequence. Although such features occur through the Quaternary sequence from the Courtmacsherry raised beach (6–8 m m.s.l.) upwards through the deposits of the last glaciation, this does not imply permafrost or periglacial conditions any earlier than early Vistulian times, for there is no basis for the old stratigraphic subdivision of the Quaternary deposits in Ireland, and current interpretation, relying on standard stratigraphic procedures, places all of the glacial and periglacial deposits postdating the Courtmacsherry raised beach and the Gortian interglacial sediments in the last glaciation. A consideration of the stratigraphic distribution of ice wedge casts indicates at least three major phases of permafrost activity, a prolonged period (probably extending intermittently through the whole glacial period) of periglacial conditions conducive to frost shattering and gelifraction on a large scale. Studies in south-west Ireland indicate that cryoturbation features are best developed in the zone of the end moraine of the last glaciation and outside this moraine, but do not seem to occur inside it. In areas where the end moraine zone of the Kerry-Cork (south-west Ireland) ice cap of the last glaciation can be identified the occurrence of well developed ice wedge casts both within and outside it indicates that it will be extremely difficult, if not impossible, to map the permafrost zone associated with this moraine and its correlatives unless criteria can be identified which will isolate the permafrost features of this period. An intensive programme aimed at dating the deposits in which the permafrost features occur is therefore essential to such a project.

INTRODUCTION

The object of this paper is to illustrate the difficulties that are encountered in an attempt to delineate a permafrost boundary for a particular period of Pleistocene time in Ireland (e.g., the proposed map showing the distribution of fossil periglacial phenomena as evidence for permafrost conditions at the maximum of the last glaciation (18,000 BP), under the project: "Significance of periglacial structures and forms"; coordinator prof. dr STEFAN KOZARSKI, Committee for the Coordination of Periglacial Research, International Geographical Union).

Until recently the South Ireland End Moraine (fig. 1) of CARVILL LEWIS (1894) and CHARLESWORTH (1928) was accepted as representing the southern ice limit of the last glaciation in Ireland. However, a systematic stratigraphic approach to the Irish Quaternary sedimentary sequence indicates that, unless and until some clear biostratigraphic evidence to the contrary is forthcoming, most of the tills south of the moraine must be regarded as belonging to the last (Midlandian) glaciation (BOWEN, 1973; WARREN, 1979). It has also been suggested that, failing the discovery of a stratigraphically more recent interglacial deposit, the Gortian Interglacial must be

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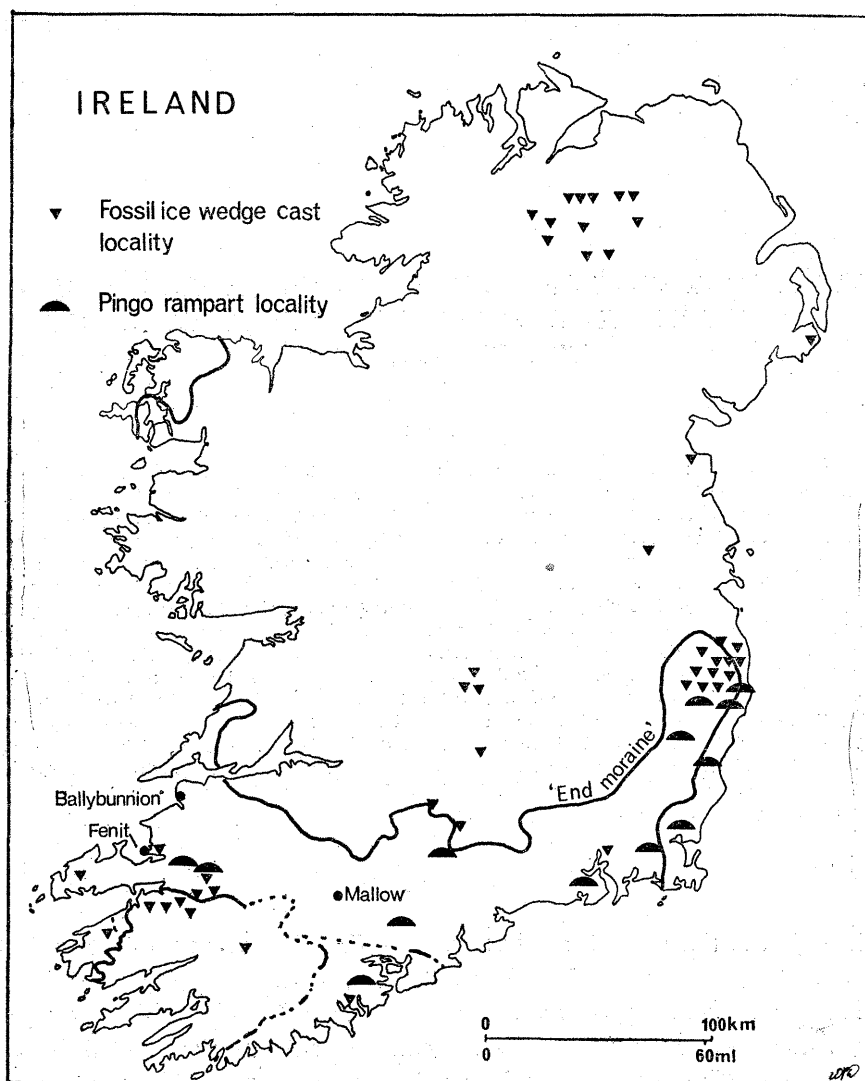


Fig. 1. Known ice wedge cast and pingo rampart localities in Ireland

regarded as last interglacial in age (WARREN, 1979). There is some evidence of a pre-Gortian glaciation at Ross Behy (WARREN, 1977) and possibly at Ballybunnion (both in County Kerry) where till deposits seem to underlie the interglacial beach deposit.

The significance of the relict periglacial structures and forms within the re-interpreted Quaternary stratigraphic sequence is illustrated and it is suggested that there is evidence for at least three periods of permafrost occurrence. Ice wedge casts are relied upon as the only relict periglacial features which are clearly diagnostic of former permafrost conditions. Other features, such as pingos and cryoturbation structures, are referred to as they are striking features of the upper litho-

logical units and indicate the former existence of prolonged and varied periglacial conditions. The widespread occurrence of these features in south-west Ireland indicates that this part of the Atlantic fringe of north-west Europe experienced climatic conditions approaching continentality during the Quaternary Period.

Along the south and south-west coasts of Ireland the sequence: 3. glacial till, 2. Main Head, 1. Courtnacsherry Raised Beach is seen as geological series (WARREN, 1978) which indicates the passage from the last interglacial (Gortian) through the last glaciation (Midlandian). The absence of the upper (till) unit from this sequence at any locality indicates the absence of glacial ice there at that time. As the complete sequence is seen intermittently along the south and south-west coast from Ross Behy, County Kerry (WARREN, 1977) to Ballymadder Point, County Wexford (WRIGHT and MUFF 1904), it seems that ice from the Irish Midlands, the Irish Sea basin and the Kerry/Cork mountains extended as far as the coast between these points (see WRIGHT and MUFF (1904) for till provenance). The upper unit is missing from sections at Fenit (MITCHELL, 1970; WARREN, 1977, 1979) and Ballybunion in north Kerry (fig. 2). This indicates that Midlandian ice did not pass over the coast between these two places. Further north of Ballybunion there is clear evidence of Midlandian tills (FINCH and SYNGE, 1966). There is no strong stratigraphic evidence, however, to support the contention (*cf.* SYNGE, 1970) that there were other significant unglaciated enclaves in Ireland during the maximum of the last glaciation. The north Kerry enclave probably extended as far as the Mallow region in north Cork as a wedge between ice from the midlands and the Kerry/Cork mountains (*cf.* WARREN, 1978).

ICE WEDGE CASTS

An examination of the occurrence of ice wedge casts in the stratigraphic sequence indicates that permafrost conditions obtained on at least three separate occasions.

THE COURTNACSHERRY RAISED BEACH

FARRINGTON (1966) described an ice wedge cast and cryoturbation structures in the gravels of the Courtnacsherry Raised Beach at Courtparteen, County Cork (fig. 2). The Main Head rests undisturbed on the beach, indicating that permafrost conditions most likely obtained before the head began to develop. At Fenit in north Kerry (fig. 2) sandy peat muds interbedded with the basal silts of the main head are greater than 42,000 radiocarbon years old (MITCHELL, 1970). The formation of the head seems therefore to have begun at least 42,000 radiocarbon years ago, and the ice wedge cast in raised beach at Courtparteen is probably at least this old. The absence of a syngenetic growth of the wedge into the head seems to indicate that permafrost did not persist as the head developed.

THE MAIN HEAD

G. F. MITCHELL (1970) recorded ice wedge casts about midway up the section in the Quaternary sediments between Fenit and Spa in north Kerry (Fig. 2). He saw

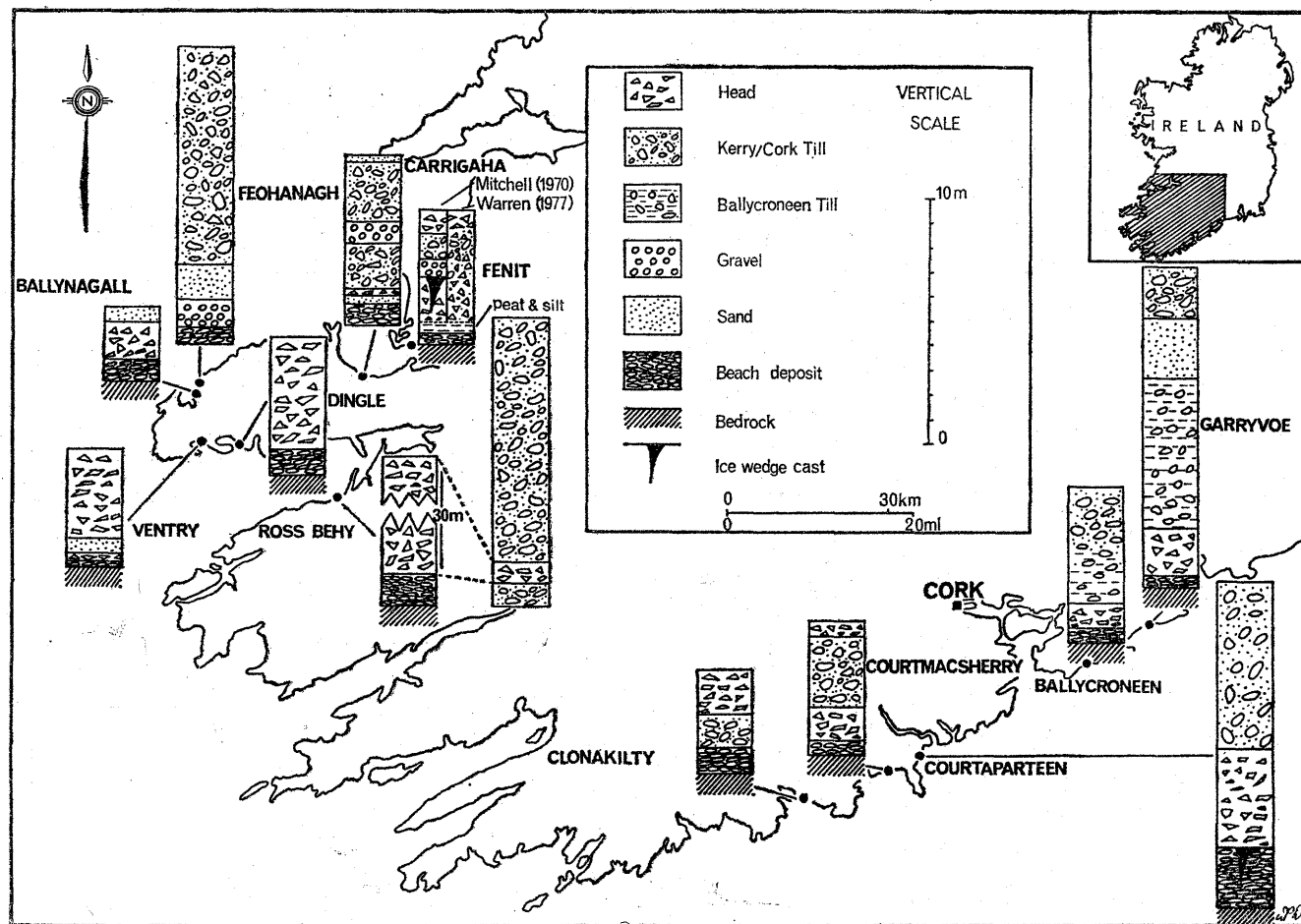


Fig. 2. Stratigraphic positions of sub-surface ice wedge casts in correlative sequences in south-west Ireland

these as lying at the top of a lower head deposit over which he identified a glacio-fluvial gravel, a till and an upper head. He now, however, accepts WARREN'S (1977) interpretation, that the deposits superjacent to the peats between Fenit and Spa form a continuous head unit which contains varying amounts of erratic material (MITCHELL, 1979, pers. comm.).

The significance of ice wedge casts which do not appear to have developed syngenetically with the head overlying them (MITCHELL, 1970, p. 144) is that they indicate a cessation of the gelifluction process for a period long enough for the wedges to form. The wedge casts occur just below the level at which the erratic content of the head begins to concentrate to form a distinct horizontal facies which passes eastwards into a distinct line of erratic Devonian sandstone boulders which are often striated. This boulder concentration suggests either a change or a halt in the dominant gelifluction slope process. They may represent a lag layer relating to a change in the mass movement process. At any rate, there seems to have been a significant change in slope process at precisely the level at which there was ice wedge development and it is reasonable to suppose that the two are related to climatic change which was ultimately favourable to the development of permafrost and changed the nature of the surface mass movement. It is unlikely that the ice wedge casts relate to any of those occurring at the surface, either in periglacial or glacial debris, for there is no evidence of any significant postglacial gelifluction aside from the upper head of WRIGHT and MUFF (1904), which is rarely more than 1 m thick.

THE UPPER TILL AND OTHER IMMEDIATELY SURFICIAL DEPOSITS

Ice wedge casts are widely recognised at surface in the uppermost Pleistocene deposits in Ireland. Widespread occurrence of ice wedge casts at the surface has been reported in particular from Counties Kerry (BRYANT, 1968; QUINN, 1974; WARREN, 1977), Wicklow (LEWIS, 1977), Derry and Tyrone (COLHOUN, 1971), but they also achieve widespread distribution in the south midlands, Cork and along the east coast (Fig. 1). They occur both outside and well within even the most conservative estimate of the limit of the last glaciation, and as LEWIS (1978) has pointed out, their pattern of distribution bears a close relationship to that of detailed analyses of Quaternary deposits. In other words the sample is biased against the stratigraphically less interesting areas in the midlands and north midlands, where little work has been done.

It is clear from the occurrence of ice wedge casts in the deglacial deposits of the main Midlandian ice sheet (LEWIS, 1978) and local ice caps of the Midlandian Glaciation (LEWIS, 1977; WARREN, 1977) that many were formed in the late Midlandian and possibly during the Nahanagan Interstadial (Pollen Zone III of the Late Glacial). However, there is no reason why many of these features in the immediately surficial deposits of the late Midlandian should not be either individually diachronous, or diachronous in relation to one another.

OTHER FEATURES

Pingos, which are probably also indicative of permafrost, abound in southern and south-western Ireland (MITCHELL, 1971, 1973). They occur both within and outside the probable limit of Midlandian glaciation in the south-west and entirely within that limit in the south and south-east (Fig. 1). Other features which do not necessitate permafrost, proliferate in the Irish countryside indicating that periglacial processes played an active part in shaping the Irish landscape (BRYANT, 1968; COLHOUN, 1971; FARRINGTON and STEPHENS, 1964; LEWIS, 1978; MITCHELL, 1971, 1973, 1976, 1977; QUINN, 1975; WARREN, 1978). These are not included in the map in Figure 1. Periglacial involutions and vertical stones, insofar as they have been observed north of the MacGillycuddy's Reeks in south-west Ireland, occur only in the sediments of the end moraine of the last local glaciation or outside its limit; these never occur inside the moraine. This does not apply to the deposits of the general ice sheet, and may not even apply universally to the south-west. Nevertheless, until they are found within this moraine their distribution remains an intriguing anomaly and suggests that periglacial climatic conditions, which were not subsequently repeated, obtained in this area when the local ice sheet approximated to its maximum extent. This was not simply the occurrence of permafrost, for ice wedge casts occur well within the moraine, and permafrost is not a prerequisite for the formation of involutions and vertical stones (BLACK, 1969).

DISCUSSION

The most striking and continuous lithostratigraphic unit exposed along the south and south-west coasts of Ireland is without question the Main Head of WRIGHT and MUFF (1904), which is the Stookaniller Head member of the Iveragh Formation (WARREN, 1978). This is clearly a geliflucted deposit (see WRIGHT and MUFF, 1904; WARREN, 1977), and includes geliflucted till facies in several localities. It reaches considerable thickness, often in excess of 30 m, as at Ross Behy (WARREN, 1977). Where Quaternary deposits are exposed on this coast line the head unit is missing only where it has been removed by glacial erosion and replaced by till. Invariably, the Courtmacsherry Raised Beach of the last interglacial is overlain by this unit. At Fenit, in north Kerry, it is clear that the head unit began to develop soon after the formation of the raised beach, for there are clear palynological and macrofossil indications of salt marsh conditions (*Chenopodiaceae* ?*Salsola* sp. and *Triglochin maritima*) associated with the accumulation of the basal silt-mud of the silt-with-interbedded-peat unit, which in turn interdigitates with the head proper (MITCHELL, 1970). This deposit, therefore, indicates a prolonged period of gelifluction activity, but as indicated by the ice wedge casts, and the boulder concentration midway up the section at Fenit, the process may have been arrested from time to time, and permafrost conditions may have obtained during such intervals.

The interglacial raised beach is an isochronous unit which, if it can be precisely dated, will give an indication as to the date of the onset of periglacial, and perhaps permafrost, conditions.

The till that in most places overlies the Main Head is Midlandian, but of uncertain age within that period. MITCHELL (1977) indicated that there is evidence for an early Midlandian (pre 40,000 BP) glacial advance in the north midlands. This is of unknown extent, for its deposits are seen in two neighbouring localities in County Fermanagh (Hollymount and Derryvree) only, where they are overlain by organic interstadial deposits, dated 41,500 and 30,500 radiocarbon years BP respectively. This glacial event may be represented in the south by the tills south of the so called South Ireland End Moraine. If this were so it might account for some of the morphological differences in the surface expression of the tills on either side of that moraine, which lead some writers to regard it as the end moraine of the last glaciation and the tills south of it as a product of the previous glaciation (*cf.* FARRINGTON, 1959). The South Ireland End Moraine might then represent the post 30,500 BP glacial event, which might also be represented by the upper head, sometimes seen overlying the upper till unit south of the moraine. This head is rarely more than 1 m thick (WRIGHT and MUFF, 1904).

There is no indication as to when the gelifluction process that gave rise to the Main Head ceased, but, aside from the rare occurrence of the upper head unit on the south coast, there is no indication that it continued to any extent after deglaciation had set in.

CONCLUSION

The onset of the Midlandian (last glaciation) cold period was marked in southern Ireland by the initiation of the accumulation of a massive geliflucted deposit. It is probable that this was either preceded by, or accompanied by, the occurrence of permafrost. The process of gelifluction was halted locally long enough for ice wedges to form in permafrost at Fenit in north Kerry. After the ice of this glaciation had reached its maximum extent and had retreated some distance permafrost conditions again returned on at least one occasion.

As yet we can but speculate as to the extent of glacial ice at any given period in the last glaciation. There may have been an early Midlandian advance, but its extent is unknown. There are, as yet, no means by which the features indicative of permafrost can be dated. And, as the maximum extent of the Midlandian ice seems to be somewhere off the south coast (with the exception of a small area in north Kerry and Cork) there is little possibility of delimiting accurately the southern limit of the ice sheet, let alone the permafrost limit at this time.

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