ELSEVIER

Quaternary Science Reviews 25 (2006) 2868–2893

QSR

# A model of subaqueous sedimentation at the margin of the Late Midlandian Irish Ice Sheet, Connemara, Ireland, and its implications for regionally high isostatic sea-levels

Geoffrey S.P. Thomas*, Richard C. Chiverrell

*Department of Geography, University of Liverpool, L69 3BX, UK*

Received 25 August 2005; accepted 12 April 2006

**Abstract**

The geomorphology and sedimentology of a series of Late Midlandian glacigenic sites in Connemara, western Ireland, are described and a set of commonly occurring sedimentary assemblages identified. These form components of a simple model of ice-contact subaqueous sedimentation involving progressive down current transition from subglacial esker tunnel fill, through proximal tunnel-mouth fans, proximal and distal subaqueous fans into basin floor sediments. In two of the sites aggradation to the water-line passes into fan-delta topsets and foresets. All sites abut into inferred water bodies to their west and imply minimum water-surface heights of between 35 and 65 m Irish OD or, in the case of the two deltaic sites, shoreline heights of between 75 and 80 m. These high water levels, very close to, and facing directly into, the immediately adjacent open Atlantic Ocean are difficult to explain as ice-dammed glaciolacustrine water bodies without invoking improbable ice-sheet marginal geometries. They may, however, be explained as a set of successive 'fjord-head' grounding-line depositional systems that trace temporary still-stands in the phased retreat of the Irish Ice Sheet from its offshore maximum. This possibility, not yet confirmed by the discovery of in situ marine fauna, implies a degree of Late Midlandian isostatic depression and subsequent response unexplained by currently applied crustal response models but supported by previously constructed glacio-sedimentary models.


## 1. Introduction

Connemara is critically located at the margin of the Eastern Atlantic Glacial Sediment System (Bowen, 1991) yet little recent work has been done on the limits of successive glacial phases, their chronology, depositional environments, retreat history or associated sea-level fluctuation. This paper attempts some modest repair by examining part of the northern rim of Connemara, Co. Galway, and the adjacent part of southern Co. Mayo (Fig. 1). The aims are to describe the geomorphology and sedimentology of the glacial deposits, to devise a general model of ice-marginal sedimentation, to discuss the evidence for possible high sea-level stands during retreat from the last glaciation and, hopefully, to stimulate further research into this climatically sensitive but otherwise relatively neglected part of the far western margin of the British and Irish Ice Sheet (BIIS).

The most prominent geomorphological feature of Connemara is the series of discrete, ice-scoured mountain massifs that include the Twelve Bens and Mamturk Mountains of Co. Galway and the Mweelrea Mountains, Sheeffry Hills and Maumtrans and Partry Mountains of Co. Mayo (McManus, 1967). Each mountain massif rises almost directly from sea-level to heights of over 800 m and is fretted by short radial valleys fed by large, low-altitude cirque basins. Individual massifs are commonly separated from one another by wide, open-ended through valleys, such as Kylemore; overdeepened lake basins, such as Lough Inagh; or by fjord-like troughs, like Killary Harbour (Fig. 1). Valley floors are marked by ice-scoured bedrock and roche moutonnées, showing ice movement to the southwest, west or northwest but glacial depositional landforms occur at Kylemore, around Leenaun, in the headwaters of Joyce's River, and along the Erriff valley.

*Corresponding author. Tel.: +44 151 794 2738; fax: +44 151 794 2866.
*E-mail address:* thoma@liv.ac.uk (G.S.P. Thomas).

0277-3791/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.quascirev.2006.04.002

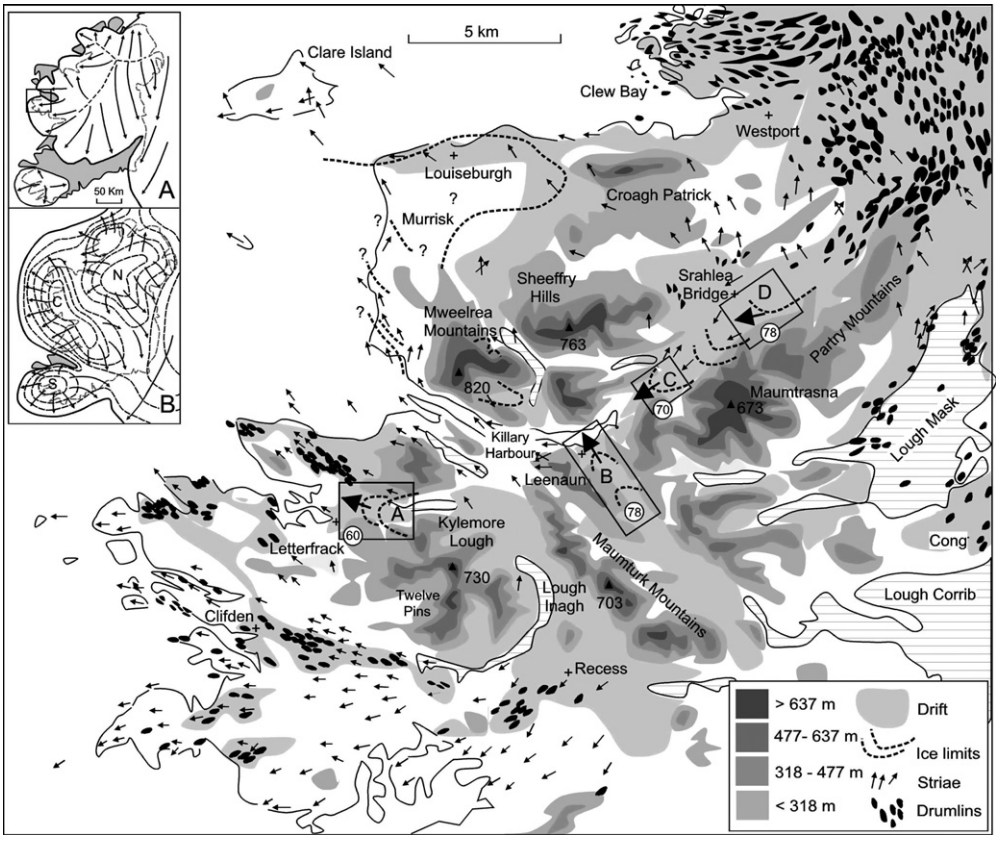


Fig. 1. Map of the geomorphology and glacial geology of northern Co. Galway and southern Co. Mayo, Western Ireland, showing areas investigated (Areas A–D), distribution of drift, drumlins and striae and identified ice limits. Large arrows show direction of sediment transport in areas investigated and numbers in circles show minimum water surface height, in metres. For explanation of these figures see text. Map based on Synge (1968) and Orme (1967). Inset A shows location in Ireland and the maximum limits of the Irish portion of the British–Irish Ice Sheet during the last glaciation, based on the traditional 'Great Central Snowfield' single-dome model of Hull (1878) and succeeding literature (Re-drawn from Clark and Meehan, 2001). Inset B shows maximum limits according to the multiple ice-dome model of Warren (1992) and Warren and Ashley (1994).

Outside the mountain massifs much of the surrounding lowland is heavily rock-scoured, especially in southern and western Co. Galway and is indicative of lowland ice moving offshore to the southwest. Localised drumlin swarms, also running southwest, are superimposed upon this erosional terrain and to the north more extensive drumlin fields run north and west from central Ireland towards the sea at Clew Bay, Co. Mayo.

Ireland was affected by at least two major glaciations: the earliest probably in OIS6 (the Munsterian) and the latest in OIS2 (the Late Midlandian) (Mitchell, 1976; McCabe, 1985, 1987, 1999; Warren, 1985; Coxon and Browne, 1991; Coxon, 2001; Farrell et al., 2005). Traditionally, two Late Midlandian glacial expansion phases have been recognised: the 'Last Glacial Maximum' (LGM), at around 24 ka and extending to the South Irish End Moraine (Charlesworth, 1929, 1963, 1973), and the subsequent 'Drumlin Readvance Phase' (Synge, 1968, 1969; McCabe, 1985, 1987, 1993; McCabe et al., 1986). Bowen et al. (2002), however, have recently revised the BIIS chronology and suggest that it probably existed throughout most of the Midlandian as a highly dynamic ice sheet that responded to Heinrich events. In an Irish context this work suggests that the most extensive glacial expansion, when the whole of Ireland was glaciated and the western limit was well offshore (McCabe and Clark, 2003), occurred around c 40 ka. Between c 40 and 20 ka the BIIS fluctuated several times with readvance to the traditional LGM at the South Irish End Moraine, occurring at c 22 ka. A subsequent readvance, the "Drumlin Readvance Phase", occurred at c 16.5 ka (McCabe and Clark, 1998; McCabe et al., 1998, 2005). The very limited chronostratigraphic data available in western Ireland makes it impossible to verify the application of this chronology to the region. The traditional limits of the LGM were defined by Charlesworth (1929) but owe their origin to the long-held 'Great Central Snowfield' model of Hull (1878) in which ice radiated outwards from a single ice-dome located in the centre and north of Ireland (inset A, Fig. 1). Warren (1992) and Warren and Ashley (1994) have latterly produced a radically different, multiple-domed model based on the flow directions of the extensive Irish esker systems (inset B, Fig. 1).

Although a very considerable body of early literature on the glacial geology of Connemara exists much is concerned with regional flow patterns or regional stratigraphy