

NEW SEDIMENTOLOGICAL INVESTIGATIONS HELP UNRAVEL COMPLEXITIES IN THE DEGLACIATION OF NORTHEAST IRELAND

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Background and Rationale

Northeast Ireland lay under a major ice divide at the confluence of the Malin Sea and Irish Sea ice streams in the centre of the last British-Irish Ice Sheet (BIIS). During deglaciation (Fig. 1d), British and Irish sectors unzipped over this region c. 20-19 ka BP (Benetti et al., 2021; Clark, et al., 2022), isolating separate ice centres over Scotland and Donegal (Wilson et al., 2019; Ely et al., 2024). During this process, the Armoy Moraine – a c. 50 km wide complex ridge (Shaw and Carter, 1980) – was formed along the north Antrim coast by a major outlet, allowing ice-dammed lakes in the Lower Bann valley and north Antrim Hills to form contemporaneously (Creighton, 1974; Warren, 1990; Knight, 2004). Little is known about the nature and drivers of retreat of this outlet and the subsequent separation of the BIIS down the North Channel.

However, recent digital mapping and scouting of the region (Clark et al., 2024) sheds light on a previously unexamined complex style of retreat. Further investigations into this behaviour may therefore uncover hitherto unexplored drivers and impacts of the BIIS unzipping over northeast Ireland. Towards achieving this aim, we employed sedimentological methods on exposures along the north Antrim Coast to complement a new high-resolution geomorphological map.

Methodology and Results

Runkerry Beach is situated 16.5 km north of the central Armoy Moraine ridge and 3.2 km north of a previously unidentified series of recessional moraines (Fig. 1a). From a single exposure, Dardis (1990b) previously described ice-distal till deposited in a glaciomarine setting overlain by beach cobbles, similar in age to the deposits at Portballintrae <1 km to the west (Dardis, 1990a; McCabe et al., 1994). Upon

examining a c. 760 m long transect of the exposed short cliff sequences at Runkerry, we uncovered a much more varied suite of sediments, and 14 key exposures were logged in detail.

Crudely stratified and planar bedded gravels from the southeastern section of Runkerry (Fig. 1b points 1-4) are interpreted as hyperconcentrated flow deposits (Fig. 2a) found in sub-aqueous ice-proximal settings (see Todd, 1989; Mulder and Alexander, 2001). At the northwest and central sections of Runkerry (Fig. 1b points 4-14), the short exposures tell a story of subglacial till formation (Fig. 2b) and deformation under high stress during retreat with occasional supra-/ extra-glacial inputs (Fig. 2c). Two contrasting till facies are identified, implying a shift in ice-bed interface dynamics. Glaciofluvial sand and gravel outwash deposition then followed over much of Runkerry.

In the northeast of Co. Antrim, Watertop Farm lies near the head of the Carey Valley (Fig. 1a) which hosts a series of Gilbert-type glaciolacustrine deltas formed in an ice-dammed lake (Warren, 1990), as well as glaciofluvial terraces that formed after its disappearance (McCabe and Eyles, 1988). The nature of ice withdrawal from this region has been staunchly debated (e.g. Derryhouse, 1923; Charlesworth, 1938; Hill and Prior, 1968; McCabe and Eyles, 1988; Warren, 1990), but the upper reaches of the valley above c. 130 m OD (metres above Ordnance Datum, Belfast) have always evaded further study. We hypothesised newly mapped subdued morainic and glaciofluvial deposits in the region of Watertop Farm (Fig. 1c) could provide vital context for understanding the morphostratigraphy of the Carey Valley landforms, as well as the nature of ice withdrawal from the Antrim Hills into the North Channel.

At Watertop Farm 1 (Fig. 1c) located behind a subtle moraine crest, matrix-supported, edge-rounded

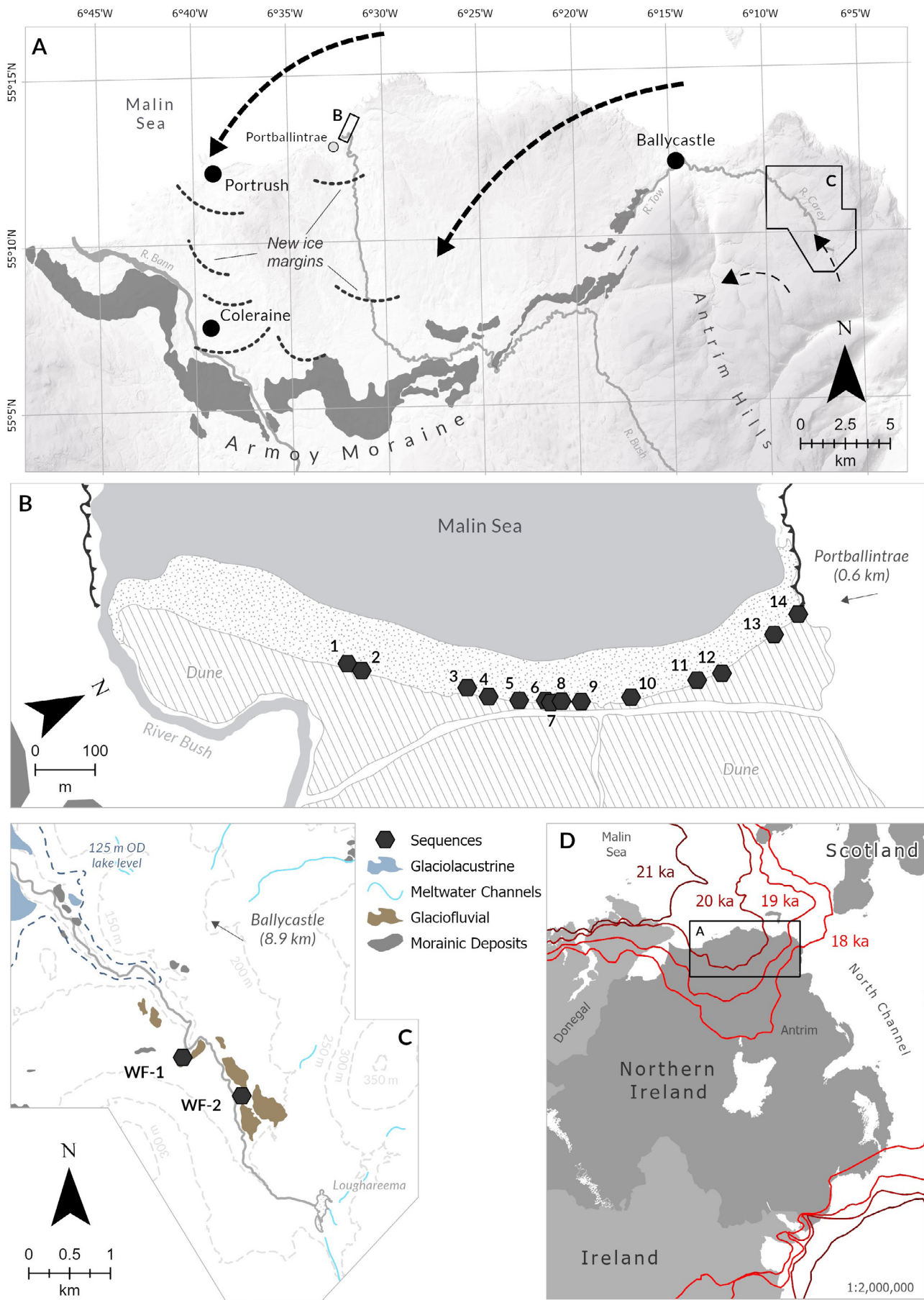


Figure 1. **a)** Map of the study region along the north coast of Northern Ireland with generalised ice flow directions indicated by dashed arrows; **b)** Runkerry Beach and the location of 14 exposures identified and logged; **c)** the upper reaches of the Carey Valley with the locations of the sections at Watertop Farm, including key digitally mapped glacial landforms; **d)** optimum empirical BIIS reconstruction limits from 21-18 ka BP from Clark et al. (2022) and location of panel A.

gravels of mostly weathered basalt (52%) and schist (28%) with lenses of coarse gravels overlying medium sands are suggestive of a low- to intermediate-energy ice-distal braided (glacio-)fluvial system. Stratified sandy gravels and poorly-sorted gravels overlying greyish brown clast-rich glacial till at Watertop Farm 2, by contrast, likely represent a more ice-proximal glaciofluvial system with a more ephemeral meltwater discharge regime.

Significance

These results will have important implications for characterising and unravelling the complex nature of deglaciation in northeast Ireland. At Runkerry Beach, our results point to an active and dynamic retreat after the formation of the Armoy Moraine, likely punctuated by standstill events even as ice recedes from the present coastline. This interpretation expands upon and potentially challenges the proposed surge-like (re)advance theory resulting in a down wasting ice lobe (Knight, 2004).

Finally, evidence from Watertop Farm suggests a valley glacier experienced an active retreat in the upper reaches of the Carey Valley c. 170 m OD. At this elevation and with this style of retreat, it is most plausible that the glacier was attached to thick ice in the North Channel rather than a small local centre in the Antrim Hills. Our results therefore help demonstrate that the survival and decay of ice in northeast Antrim was predominantly influenced by the thinning and detachment of North Channel ice during the unzipping of the BIIS.

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Figure 2. a) Runkerry Beach sequence 14: dark reddish-brown subglacial till (Dmm) overlain by glaciofluvial sands (Sm) and gravels (Gcm, Gms); b) Runkerry Beach sequence 4: large oversized basalt boulder deforming sub-aqueous gravels (Gh) with fine-grained rip-up clasts (Fm) overlying dark greyish-brown chalky till (Dmm); c) Runkerry Beach sequence 1: hyperconcentrated flow (Gcm, Sm, Gp), glaciofluvial (Gmm, Gms), and sand dune (Sm) sequence.

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