

SHORT NOTES

DIRECTIONS OF ICE MOVEMENT IN THE SOUTHERN IRISH SEA BASIN DURING THE LAST MAJOR GLACIATION: AN HYPOTHESIS

By B. S. JOHN

(Department of Geography, University of Durham, Durham, Co. Durham, England)

ABSTRACT. The movement of the Irish Sea glacier is discussed for the St George's Channel sector during the last major glaciation. It is considered that the ice was already diverging when it crossed Pembrokeshire, after passing through a constriction farther north. This constriction was probably caused by local Irish ice in the west and local Welsh ice in the east. In view of this, it is suggested that the Cardigan Bay coasts could not have been ice-free during the last glaciation.

RÉSUMÉ. *Sur les directions du mouvement des glaces dans le bassin de la Irish Sea du sud pendant la dernière grande glaciation: une hypothèse.* Le mouvement du glacier de la Irish Sea est discuté pour le secteur du St George's Channel durant la dernière grande glaciation. On considère que la glace divergeait déjà lorsqu'elle traversait le Pembrokeshire après avoir parcouru un resserrement plus au nord. Ce resserrement fut probablement dû à la glace irlandaise locale à l'ouest, et à la glace du Pays de Galles à l'est. De ces considérations il ressort l'idée que les rivages de la Cardigan Bay n'ont pu être libres de glace durant la dernière glaciation.

ZUSAMMENFASSUNG. *Richtungen der Eisbewegung in Südbecken der Irish Sea während der letzten grossen Vereisung: eine Hypothese.* Die Bewegung des Gletschers in der Irish Sea während der letzten grossen Vereisung wird für das Gebiet des St George's Channel diskutiert. Dabei wird davon ausgegangen, dass das Eis beim Überfließen von Pembrokeshire bereits wieder divergierte, nachdem es eine Enge weiter im Norden passiert hatte. Dieser Engpass wurde vermutlich durch lokale Eismassen aus Irland im Westen und aus Wales im Osten gebildet. Im Hinblick auf diese Tatsache kann nicht angenommen werden, dass die Küste der Cardigan Bay während der letzten Vereisung eisfrei gewesen ist.

RECENT expressions of opinion concerning the glaciation of west Wales have prompted this note on directions of ice movement. It has been known for many years that an extensive Irish Sea glacier was responsible for the last glaciation of the southern Irish Sea basin, having moved broadly southward across the Irish Sea from its source areas in Scotland and the Lake District of England. At the period of its maximum extent, the Irish Sea glacier swung towards the south-west on the east coast of Ireland, bounded by local Irish ice a few kilometres inland which prevented any marked westward incursion by the glacier. Most of the glacier ice was diverted along the coast to the vicinity of Wexford and thereafter the local ice appears to have been powerful enough to hold it some distance offshore (Synge and Stephens, 1960). Farther towards the west, however, the glacier encountered less resistance and was able to impinge upon the coast again in the neighbourhood of Cork Harbour. On the eastern shore of St George's Channel a similar situation prevailed, with ice movement towards the south until at some stage there was a swing eastwards into the Bristol Channel (West, 1967). Overall, therefore, the Irish Sea glacier appears to have moved within St George's Channel until it diverged as a piedmont glacier on reaching the oceanic south-western approaches of the British Isles.

Considerable difficulties are encountered when one attempts to interpret the influence of local ice on the directions of movement of the Irish Sea glacier. The presence of local ice in the Carnsore Point-Wicklow Head area in the west may have been matched by equivalent local Welsh ice in the Cardigan Bay sector. Probably the uplands of Wales acted as a centre of ice outflow during the last glaciation, and indeed the drift stratigraphy of the Cardigan Bay coast indicates a complex interplay of Irish Sea ice and Welsh ice (Williams, 1927; Mitchell, 1960). The extent to which Welsh ice was able to hold Irish Sea ice offshore at the maximum of this glaciation is unknown; it is possible, however, that in conjunction with the Irish ice to the west it was powerful enough to effect a constriction in the Irish Sea glacier prior to its divergence southwards.

The evidence for directions of ice movement across Pembrokeshire is valuable in this context, although it appears to have escaped previous comment. Geikie (1894) suggested that Pembrokeshire was over-ridden by ice from north-east to south-west. This was a logical hypothesis, assuming that there was no local Welsh ice in Cardigan Bay strong enough to cause any diversion of the Irish Sea glacier (Fig. 1). Geikie has been followed by many authors (e.g. Pringle and George, 1948, p. 91-99; Mitchell,

1960) in showing an unimpeded passage of Irish Sea ice southwards across Cardigan Bay at the maximum stage of the area's last glaciation. This ice impinged upon the coast of south Cardiganshire, but is not thought by these authors to have been diverted south-westwards by the orientation of the upland slope or by Welsh ice flowing off the uplands. Presumably, the forward movement of the glacier must have been balanced by ablation at its margin.

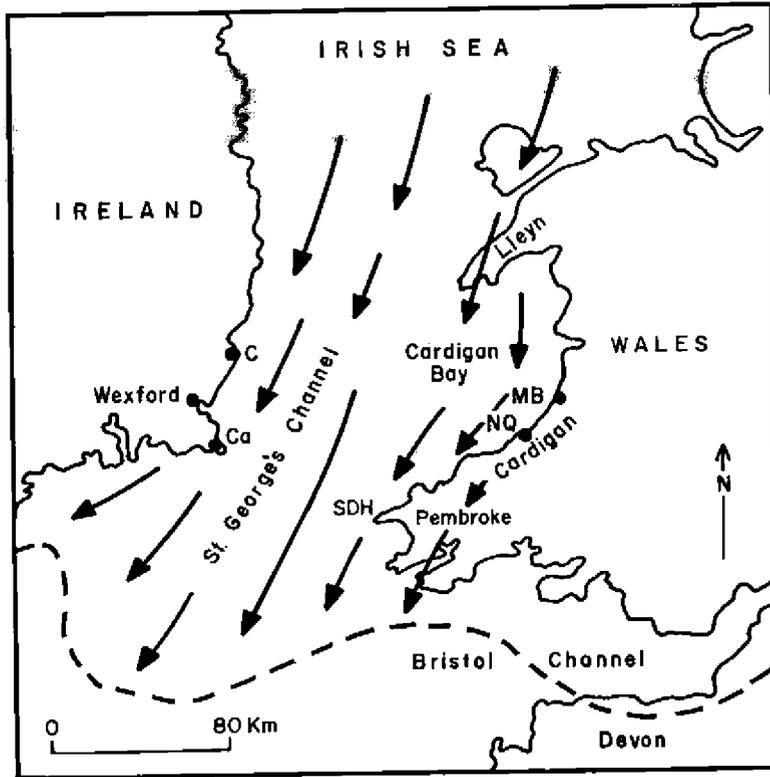


Fig. 1. Hypothetical directions of ice movement through St George's Channel, assuming the absence of local Welsh ice from Cardigan Bay (in part after Geikie, 1894).
C Cahore Point, Ca Carnsore Point, MB Morfa Bychan, NQ New Quay, SDH St David's Head. Also marked is the glacial limit as recorded by Geikie (1894).

On the other hand, Hicks (1885) and Jehu (1904) suggested from the evidence of striations and transport of erratics that the Irish Sea glacier over-rode Pembrokeshire from north-west to south-east. Subsequent work has confirmed this and Griffiths (unpublished) has shown that at one stage ice movement was almost west-east. It appears, therefore, that the glacier ice was *already diverging* when it crossed the Pembrokeshire peninsula. The greatest constriction in the glacier must have been located, not between St David's Head and Carnsore Point in Ireland, but farther to the north, possibly between Cardigan Bay and Cahore Point. In the east this constriction could have been caused by either:

- (a) a mass of impeded Irish Sea ice in the embayment, separated by a zone of shearing from the unimpeded glacier ice farther west, or
- (b) a mass of Welsh ice flowing from an ice cap over central Wales and Snowdonia.

The latter possibility has more to commend it, for there is every reason to suppose that the last glaciation of the Welsh uplands was contemporaneous with the Irish Sea glaciation. Indeed, evidence for an outflow of local Welsh ice before the incursion of Irish Sea ice at New Quay (Mitchell, 1960) and at the close of the Irish Sea glaciation in Lleyn (Syngé, 1964) indicates that Welsh ice must have been

active in this area over a greater length of time than the Irish Sea ice itself. The contemporaneity of Welsh and Irish Sea ice in Cardigan Bay has not been doubted since the work of Williams (1927), and has again been stressed by Brown and others (1967). In view of this evidence, the hypothesis of an ice-bounded constriction in the Irish Sea glacier seems entirely reasonable (Fig. 2).

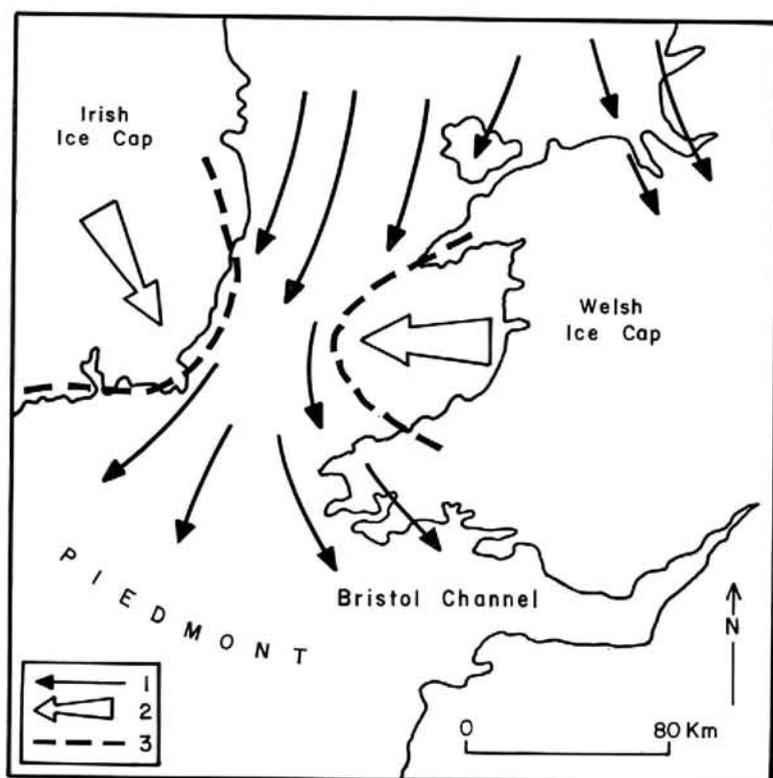


Fig. 2. The position of the hypothetical constriction in the Irish Sea glacier during the last major glaciation of St George's Channel.
 1. Directions of movement of the Irish Sea glacier.
 2. Directions of movement of local ice masses.
 3. Zone of contact between Irish Sea glacier and local ice.

The age of this Irish Sea glaciation is still open to doubt. While it is just possible that the directions of ice movement referred to above date from different glaciations, most authors have referred them to one glaciation: this is the "Eastern General" glaciation of Syngé and Stephens (1960) and the "Gipping" glaciation of Mitchell (1960). These authors have considered that this glaciation was the equivalent of the continental Riss glaciation. Together with Watson and Watson (1967), Bowen (1966) and Lewis (1966), they have considered that Irish Sea ice of the Würm glaciation did not impinge upon the southern coast of Cardigan Bay, with the possible exception of a small area around the Teifi estuary.

Alternatively, the Irish Sea glaciation referred to above is here thought to be the equivalent of the European Main Würm glaciation. This is based upon stratigraphic evidence from Pembrokeshire and south Cardiganshire, and on a comprehensive series of radiocarbon dates for organic materials contained in fluvio-glacial deposits of the Irish Sea glacier. These dates indicate that the last glaciation of St George's Channel probably occurred within the last 30 000 years (John, 1965; Brown and others, 1967).

If the Irish Sea ice which over-rode Pembrokeshire from north-west to south-east was Main Würm in age, then it follows that the hypothetical lobe of Welsh ice in Cardigan Bay must have been contemporaneous. The coast of Cardiganshire could not have remained ice-free in these circumstances, and it seems possible that the problematical pseudo-stratified deposits at Morfa Bychan and New Quay may

be the products of local Welsh ice which was at its most powerful during the Main Würm maximum. (For an alternative interpretation of the Morfa Bychan deposits see Watson and Watson (1967).) Again, the presence of Irish Sea till above the local till at New Quay may indicate that the Irish Sea glacier achieved its greatest incursion of the south Cardiganshire coast towards the end of the glaciation.

There are many problems to be solved before the full story of ice movements on the shores of the southern Irish Sea basin can be told. Possibly glaciological criteria could be applied to the reconstruction of both the form and dimensions of Britain's largest Pleistocene glacier. Concerning the age of the Irish Sea glaciation, the two viewpoints outlined above are clearly incompatible. However, it is hoped that the hypothesis of a lobe of Welsh ice in Cardigan Bay during the Main Würm will prompt some discussion during subsequent studies of glaciation in this area.

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REFERENCES

- Bowen, D. Q. 1966. Dating Pleistocene events in south-west Wales. *Nature*, Vol. 211, No. 5048, p. 475-76.
- Brown, M. J. F., and others. 1967. A new radio-carbon date for Wales, by M. J. F. Brown, I. D. Ellis-Gruffydd, H. D. Foster and D. J. Unwin. *Nature*, Vol. 213, No. 5082, p. 1220-21.
- Geikie, J. 1894. *The great Ice Age and its relation to the antiquity of man. Third edition.* London, Edward Stanford.
- Griffiths, J. C. Unpublished. The glacial deposits west of the Taff, South Wales. [Ph.D. thesis, University of London, 1940.]
- Hicks, H. 1885. (In Bonney, T. G. On the so-called diorite of Little Knott (Cumberland), with further remarks on the occurrence of picrites in Wales. *Quarterly Journal of the Geological Society of London*, Vol. 41, No. 164, p. 511-22.)
- Jehu, T. J. 1904. The glacial deposits of northern Pembrokeshire. *Transactions of the Royal Society of Edinburgh*, Vol. 41, Pt. 1, No. 4, p. 53-87.
- John, B. S. 1965. A possible Main Würm glaciation in west Pembrokeshire. *Nature*, Vol. 207, No. 4997, p. 622-23.
- Lewis, C. A. 1966. The Breconshire end-moraine. *Nature*, Vol. 212, No. 5070, p. 1559-61.
- Mitchell, G. F. 1960. The Pleistocene history of the Irish Sea. *Advancement of Science*, Vol. 17, p. 313-25.
- Pringle, J., and George, T. N. 1948. *South Wales. Second edition.* London, H.M.S.O. (British Regional Geology.)
- Synge, F. M. 1964. The glacial succession in west Caernarvonshire. *Proceedings of the Geologists' Association*, Vol. 75, Pt. 4, p. 431-44.
- Synge, F. M., and Stephens, N. 1960. The Quaternary period in Ireland, an assessment. *Irish Geography*, Vol. 4, No. 2, p. 121-30.
- Watson, E., and Watson, S. 1967. The periglacial origin of the drifts at Morfa-Bychan, near Aberystwyth. *Geological Journal* (Liverpool), Vol. 5, Pt. 2, p. 419-40.
- West, R. G. 1967. The Quaternary of the British Isles. (In Rankama, K., ed. *The Quaternary*. New York, London, etc., Interscience Publishers, Vol. 2, p. 1-87.)
- Williams, K. E. 1927. The glacial drifts of western Cardiganshire. *Geological Magazine*, Vol. 64, No. 5, p. 205-27.