*Nicholas Stephens**

Belfast

SOME PLEISTOCENE DEPOSITS IN NORTH DEVON

Abstract

The sequence of Pleistocene deposits which can be seen in the coastal sections around Barnstaple Bay will be described, together with some possible ice-marginal drainage channels, on the North Devon coast between Lynton and Hartland Quay. The deposits consist mainly of layers of solifluction debris derived by cryergic processes from the underlying bedrock, and these head deposits, as they are called in the English literature, may reach a total thickness of more than 50 feet. The head deposits consist of material which has moved down the coastal slope and spread out as a great "apron" or solifluction terrace, often of wide extent. In general, two distinct layers of head can be detected. There is an upper head (Vistulian/Würm age) which is disturbed in places by frost wedges and convolutions, and which also appears to be less weathered than the lower or main head, regaded as Saale (Riss) in age. No marine beaches transgress the surface of the solifluction terraces.

There is a deposit of calcareous, shelly boulder clay at Fremington, near Barnstaple, and near Fremington Quay and at Middleborough in Croyde Bay, cliff-sections reveal highly weathered *remanié* deposits of the same till resting upon raised beach shingle, which nearby is sealed below the lower or main head. The boulder clay is regarded as Saale (Riss) in age and to be equivalent to the Irish Sea (Eastern General) till of Southern Ireland.

The raised beach gravels contain erratic boulders, and in places "giant" erratic blocks are known to weigh more than 50 tons each. These "giant" erratics are always sealed below the raised beach or below the main head, and no boulder clay has been found in close association with them. They are regarded as ice-rafted blocks which have "floated" onto already existing wave-cut platforms in the early Pleistocene. The raised beach gravels are thought to be of Holstein (Mindel—Riss) Interglacial age being sealed by main head and boulder clay of Saale (Riss) age. The last glaciation (Vistulian/Würm) is represented by the comparatively fresh upper head.

INTRODUCTION

In this paper the results of a fresh examination of some of the Pleistocene deposits exposed in the cliff sections around Barnstaple Bay are presented. On this coast a series of well-planed wave-cut rock platforms are overlaid by giant erratic blocks, beach shingle, fossil dune sands, solifluction deposits (head) and boulder clay (Stephens 1961a)[1]. In a number of clay pits near Fremington boulder clay is revealed which is indistinguishable from the Irish Sea Older Till or Eastern General till of South-east Ireland. This Eastern General till is regarded as being of Saale age by the Irish workers, and was deposited by the Irish Sea ice at its greatest extent during the Pleistocene period (Farrington 1944; Mitchell 1960, 1962).

* Department of Geography, The Queen's University of Belfast, Northern Ireland.

[1] A general map of ice limits, glacial and periglacial deposits, and important Pleistocene sites is published in Stephens & Synge (1965).

THE ERRATICS

Near Croyde and Saunton numerous erratic boulders rest upon wave-cut rock platforms (Taylor 1956). At Croyde (Freshwater Gut) Main Head seals a large 50 ton block of granulite, and at Saunton a pink gneissose granite is buried by sandrock, which is the upper part of the raised beach sequence, and also sealed below main head. These erratics compare in size with the Porthleven erratic (Flett 1912), and there seems to be no doubt whatever that they were delivered on to pre-existing rock platforms, and were later sealed by a variety of deposits (fig. 1).

The problem as to whether these large erratics were moved into position by a regional ice sheet (Mindel/Elster or Lowestoft stage of Mitchell 1960), or by floating icebergs, has not been solved satisfactorily. Also, their true age relationship to the beach itself is not known, but it is important to note that in Devon and Cornwall the very large erratics appear to be confined to a narrow zone along the coast, below 30 feet O.D. (9 m), and within the reach of storm waves at the present time. Very large erratics have not been recorded from inland localities except at Fremington, where a boulder clay is also recorded.

In addition, many Greenstone boulders of the literature are not true erratics, but are derived from local outcrops, and flint "erratics" have a very wide distribution in a variety of deposits to all sorts of heights, and must be placed therefore in a different category to the "giant" erratics. Thus no boulder clay has been found which could be definitely associated with these giant coastal erratics, and perhaps even more important no boulder clay is known on the Irish or Welsh coasts south of a line Cahore Point to New Quay, Cardiganshire, which indicates a major Irish Sea ice-sheet older than the Saale glacial period to which the Eastern General till of East Ireland and the Fremington till could be attributed (Synge 1963, 1964). If the large erratics were moved into their present positions by pack-ice and ice-bergs, this may have taken place during the waning of an early pre-Saale glacial period when world sea-level was sufficiently high to allow the erratics to be "floated" into position (Fairbridge 1961). In this context it is interesting to note that local Irish ice responsible for depositing a pre-Saale till on the Irish coast at Clogga Head, was deflected southwards by ice moving south in the Irish Sea. But no deflection occurred south of Cahore Point, thereby suggesting that Irish Sea ice may then have been present as far south as Arklow, and able to deliver pack-ice and ice-bergs into a rising sea-level during deglaciation. Such erratics as might have been carried by the floating ice could have had a wide distribution on the Bristol Channel coasts and English Channel Coasts.

As an alternative hypothesis it might be suggested that during the waning of the Saale glacial period isostatic depression of the land allowed the sea to move ice-bergs against these coasts even though world sea-level was below that of the present day. However, while this would have allowed the erratics to have a wide distribution, without the need for a regional ice-sheet advancing to Porthleven (as postulated by Mitchell 1960), it does not explain why the Saunton erratic is buried by the main head and by the underlying fossil dune sands (sandrock) associated with the raised beach shingle. Nor does it explain why the large Croyde erratic is also buried by main head, for as will be explained later this deposit is regarded as being a product of the Saale glacial period. The main head accumulated as the Irish Sea ice advanced to a limit near Cork, to Fremington, and perhaps to some distance south of Hartland Quay, the limit of the lowest marginal drainage channels on this coast. Furthermore, at Fremington Quay and Fremington clay-pits a well-rounded gravel, identical to the raised beach on the outer coast, passes below the Fremington till. The hypothesis is further discredited because quantities of erratic boulders, including the large erratics, were deposited on this coast so as to be incorporated in the raised beach, which is covered by the main head and the Fremington boulder clay. No erratics occur deep within the main head, but only upon its surface.

Thus the Irish Sea (Saale) ice is considered to have pressed against the coast, cleared some of the north-facing slopes of main head, as at Baggy Point, but was unable to remove the head on the lee slopes (south-facing slopes) of Baggy Point and Saunton Down. Similar circumstances prevailed at Garryvoe, Co. Cork, where Eastern General till can be seen to rest upon considerable thicknesses of main head, in a situation where the Irish Sea ice was shearing along the coast in a west-south-west direction, i.e. all the south-facing slopes were not lee slopes.

THE RAISED BEACH, THE SANDROCK AND THE MAIN HEAD DEPOSITS

The inter-relationship of these deposits was shown at a number of sections. At Saunton the main head thickened to 30 feet (9 m) or more and effectively covered the 6 or 7 feet (2.1 m) of beach deposits, all of which overlaid a rock platform.

Near the Bloody Basin a section shows the beach shingle and overlying sandrock series of cemented shelly sands (with a temperate fauna) resting upon a rock platform clearly awash at spring tides. The sandrock may be up to 30 feet (9 m) thick and is always capped by main head.

At Middleborough the rock platform is elevated some 20—25 feet

(6.1—7.6m) above present high watermark at 45 feet O. D. (13.7 m), and is perfectly planed across steeply dipping rock strata — comparable in every way to the rock platform in South-east Ireland, and the old cliff notch is very near at about 50 feet O. D. (15.1 m.) Resting upon the platform are the shingle and sand of the raised beach sequence and the overlying main head.

At Pencil Rock, the platform and beach lie at 45 feet O. D. (13.7m), with the raised beach shingle and sandrock extending up to 60 feet O.D. (18.3 m). Here, as at some other sections in Cornwall (e.g. Prah Sands, Porthleven and Pendower), and in Southern Ireland, the raised beach overlaid and contained many angular blocks, which may be described tentatively as an old head deposit. This ancient head may be contemporaneous with the ice-advance responsible for the distribution of the large erratics. The main head is a frost rubble deposit of great thickness, which is regarded as having been formed during the period of severe peri-glacial climate — the Saale glacial period. This is suggested because in South-east Ireland and West Wales there is no such great deposit of head which can be associated with the advance of the last glaciation ice to the Southern Ireland End-Moraine, and its continuation in the Lleyn Peninsula of North Wales (Synge 1964). Outside this end-moraine the head deposits, or disturbance of the older tills rarely exceeds 6 feet. While the age of the Southern Ireland end-moraine depends on some measure upon the somewhat unsatisfactory Ardcavan site (Mitchell 1960), it cannot be denied that in Ireland, as in North Wales, this moraine marks the outermost limit of fresh, relatively unweathered drift. The main head is always associated with the purple, shelly, calcareous Irish Sea (Eastern General) till in South-east Ireland (Farrington 1944), deposited by Irish Sea ice moving across the eastern and southern coastlands. At Garryvoe this till rests upon main head, which in turn caps raised beach shingle containing erratics and resting on a rock platform, and providing a close analogy with North Devon. Where the Irish Sea (Eastern General) till has been subjected to weathering it is decalcified to depths of from 8 to 12 feet, in complete contrast to the tills north of the Southern Ireland End-Moraine. Furthermore, at the Kilbeg and Newtown Great Interglacial sites (Watts 1955), the till resting upon the peats was derived from the north (Munster General Glaciation) and was almost certainly responsible for excluding the Irish Sea (Eastern General) ice from these sites (Mitchell 1960, 1962). If this contemporaneity is accepted, allied to the highly contrasting depth of weathering of the "older" and "younger" tills, and if the difference of degree of head formation is considered, then a Saale age for the main head seems not unreasonable.

The main head consists of blocks of all sizes of local slate, sandstone and quartz, set in a sandy matrix. Where it has not been disturbed by later frost action the rock fragments have a preferred orientation downslope, often lying at low angles to the horizonatal (0—10°) and projecting out of the face of the cliff. Carboniferous limestone erratics have been recovered from the surface of the main head, but no foreign material has been found deep down within the head. The material has moved downslope as a kind of sludge and spread out as a great apron or solifluction terrace at the foot of the coastal slope (e.g. Saunton Down, Baggy Point). It must be emphasised that there is no evidence to suggest that the "terrace-like" surfaces of the solifluction deposits owe their from to wave action, for no marine deposits have been found to cap the main head in south-west England South Wales and Southern Ireland (Arber 1960; Stephens 1961b).

The main head is the thickest of the solifluction deposits, and at certain points in Devon and Cornwall (e. g. Croyde Bay, Godrevy) it can be seen to be highly weathered. At many places the top of the main head is disturbed by cryoturbation, frost cracks, wedges and convolutions which extend down 5 or 6 feet (1.6 m) below the surface. This is interpretated as meaning that the head had ceased movement when renewed peri-glacial activity churned the surface of the deposit. This could have taken place, during one of the late phases of the Saale cold period, or during the Würm (Vistulian) cold period.

But capping the main head at many points is a fresh upper head (multiple layers in places) of slate, sandstone and quartz blocks which are separated from the main head by sand layers. At Middleborough this upper head is also disurbed by frost wedges some two to three feet deep. Above this disturbed layer of upper head is a stony-sandy wash, perhaps representing another head in places, and then a layer of sandy soil from which Mesolithic flint flakes have been recovered. It is suggested that the main head accumulated, and the disturbance of its upper surface occurred in the Saale glacial period. The fresh upper head, and the frost wedges in it, which must necessarily have formed after the upper head had ceased to flow seawards from the exposed rock faces of the coastal slope, may be placed in the Vistulian glacial period. The upper wash may be late- to post-glacial in age.

THE BOULDER CLAYS AT FREMINGTON AND CROYDE BAY

A calcareous, shelly boulder clay, indistinguishable from the Irish Sea (Eastern General) till of South-east Ireland is present at Fremington (Maw 1864). The till is sometimes deeply weathered but a preferred

Table I

1—11 Characteristics of the deposits Sites	1 Calcareous (when unweathered) Depth of weathering recorded	2 Tough clay: Purple or Chocolate colour	3 Sandy clay: sandy-brown colour	4 Shell fragments	5 Striated stones	6 Variety of erratics	7 Abundant rounded stones 1/10" to 1/4" grade	8 Greater than 85% of sample is less than 1/10" grade	9 Abundant angular and subangular stones	10 Clay matrix and/or stones deeply weathered	11 Other remarks
Fremington Boulder ("Horseflesh") clay at Brannam's Clay pit)	**6—8′	**		**	**	**	**	**			
Fremington till at Fremington Quay			**		**	**	**	**		**	
Fremington Solifluction "Earth" at Brannam's clay pit			**		**	**			**	**	Frost cracks and weathering pipes
Fremington Lake Clay at Brannam's clay pit	**	**			**	**		**			Occasional erratic boulders: some large
Till at Middleborough Croyde Bay			**		**	**	**	**		**	
Main head at Croyde Bay			**						**	**	Rare Quartzite and Flint
Irish Sea (Eastern General) till at Garryvoe, Co. Cork	**6—8′	**		**	**	**	**	**			
Irish Sea (Eastern General) till at Killiney, near Dublin, Co. Dublin	**6—10′	**		**	**	**	**	**			
Irish Sea till at Gwbert, Cardiganshire	**	**		**	**	**	**	**			

pebble orientation has been obtained from unweathered till at Brannam's clay pit. The till (known locally as "Horseflesh") overlies a variable thickness of lake clays (worked for pottery clay), another till layer, and a gravel deposit which has been traced inland along stream sections from the cliffs near Fremington Quay and Penhill where it forms a raised beach. This raised beach reaches precisely the same height as the raised beach on the outer coast, and it rests upon a wave-cut platform in places (fig. 2).

There is no sandrock and no main head in contact with the raised beach or the Fremington till, but the beach gravels are frequently disturbed and severely contorted to a depth of 8 feet. In the cliff sections west of Fremington Quay the contorted beach gravels are overlaid by a weathered, stony clay (Dewey 1913) containing erratics and striated pebbles, and which upon analysis has been identified as part of the Fremington boulder clay. Thus, the contortions in the beach gravels can be attributed mainly to over-thrusting by the Irish Sea ice responsible for depositing the Fremington till.

In the Fremington clay pits the boulder clay can also be seen to be weathered to a depth of 6—10 feet, and it is capped by a solifluction "earth" or stony clay. This "earth" appears to represent a frost-churned layer composed partly of weathered till, and partly of local material which has sludged into position from the slopes above.

On the north shore of Croyde Bay, at Middleborough, similar deposits of highly weathered till rest upon the raised beach shingle. Analysis of this till shows it to be almost idential to the Fremingon till in terms of the stone content, ratio of pebbles to "fines" (less than Grade 8 on British Standard Scale), and erratic content; also, there was a complete contrast with the analysis of the main head from Croyde Bay (table I).

The stratigraphical position of this till showed that it had displaced the main head in order to be in contact with the raised beach, which nearby was covered by a considerable thickness of the same head. But the till did not rest upon a wave-cut rock platform and was not associated with any of the "giant" erratic blocks.

Erratics and striated pebbles have also been recovered from Braunton Great Field and from Crock Point, near Lee Bay, where there may have been once an old clay pit.

It is considered that the Fremington boulder clay is Saâle in age, because it is equated with the Irish Sea (Eastern General) till, which for reasons stated above is regarded by the Irish workers as Saale in age; and because recent investigations by Synge (1963, 1964) in Wales and South-east Ireland established beyond reasonable doubt that the Irish Sea Ice failed to reach as far south as North Devon by at least 100 miles (160 kms)

in the Vistulian period. Both the Fremington boulder clay and the main head are capped by solifluction deposits. The latter can be assigned, at least in part, to the Vistulian glacial period. Outside the Vistulian limit in Southern Ireland and West Wales peri-glacial deposits of this age seldom exceed 6 feet in thickness and are generally little weathered, in complete contrast to the main head and the till deposits at Fremington and Croyde (Synge 1963).

MARGINAL CHANNELS IN NORTH DEVON

The presence of boulder clay identical to the Irish Sea (Eastern General) till at Fremington (extending to over 200 feet O.D.) and Croyde, together with the finding of erratics at Crock Point (at 150—200 feet O.D.) suggests that a large volume of ice occupied the Bristol Channel and extended to Cork at the maximum of the ice advance. This is supported by the presence of the same calcareous, shelly till on the south coast of Ireland (the Ballycroneen till of Mitchell 1962), in Pembrokeshire (Synge 1963), and the direction of ice movement shown by striae trending north-west to south-east in south-west Wales (Mitchell 1960). The pebbles in the Fremington till have a preferred orientation west-north-west to east-south-east (fig. 2), which is consistent with the known records of striae directions and carriage of erratics in the Southern Irish Sea and Bristol Channel.

An ice-sheet capable of depositing the same till in Ireland, Wales and North Devon must have pressed against the high cliffed coast between Lynton and Hartland Point. Such an ice-sheet may be expected to have produced temporary diversions of drainage and given rise to conditions where marginal drainage channels could have formed. The following have been indentified as possible marginal channels:

(1) The Valley of the Rocks, west of Lynton (intake at about 460 feet O.D., but perhaps higher; Grid Reference: 720495)

(2) Sloo Farm—Worthygate channels, near Horns Cross (intake at about 550 feet O.D.; Grid Reference: 373236).

(3) Clovelly Court channels, near Clovelly (intakes at about 250 feet O.D.; Grid Reference: 310255).

(4) Damehole Point channel, immediately south of Hartland Point (intake at about 100 feet O.D.; Grid Reference: 226264)

(5) Hartland Quay and St. Catharine's Tor Channels (intake at about 100 feet O.D.; Grid Reference: 225242).

The Valley of the Rocks channel and the much smaller Sloo Farm—Worthygate channels are the highest known on this coast between Lynton

and Hartland Point, and may represent conditions of marginal drainage at the maximum of the ice advance, their height being not inconsistent with the recorded presence of boulder clay at 200 feet O.D. near Fremington (Maw 1864). The explanations provided by various authors (including Arber 1911; Steers 1946; Simpson 1953) to account for the presence of the Valley of the Rocks and other dry coastal valleys, solely by invoking rapid marine erosion resulting in the dismemberment of former drainage lines, may have to be reconsidered now that it can be proved that Irish Sea ice pressed against this coast. The magnificant hogs-backed cliffs found between Lynton and Hartland Point, and the extensive Pleistocene sections around Barnstaple Bay, Croyde Bay and Lee Bay, would seem to preclude there having been rapid and severe marine erosion for considerable distances and for long periods. Furthermore, the use by Simpson (1953) of extrapolated stream profiles to reconstruct the former drainage system of the East Lyn River through the Valley of the Rocks is open to many objections. The rock floor of the Valley of the Rocks is hidden beneath thick head (some 50 feet thick at the western end) making extrapolation to the original rock floor almost impossible. Likewise, an ice marginal drainage channel must have had its floor below the present one which consists of head for much of its length. The height of the intake of the channel near Lynton is thus not known accurately, but estimated at 460 feet O.D. Thus, while the Valley may be a composite feature it is believed that it may have acted as a marginal drainage channel, subsequently to be sealed by head of Saale and Vistulian age. The tors and buttresses forming part of the narrow northern (seaward) side of the Valley are periglacial landforms and probably indicate that ice nowhere crossed this coast above 500—600 feet, during even the maximum extension of the Irish Sea (Saale period) ice.

The Sloo Farm—Worthygate channels are small, and do not exceed 30 feet in depth. The Clovelly Court channels lead from the present cliffs into an existing stream valley running parallel with the modern coast, 1—2 miles north-west of Clovelly. The dry valleys at Damehole Point and near Hartland Quay may be connected to a col at Hartland Point (at about 100 feet O.D.). These channels have trench-like cross-sections quite unlike the normal valley cross-sections of the small coastal streams, some of which make a discordant junction with the dry channels. The impression gained is that the existing small coastal streams are quite incapable of cutting such large flat-bottomed channels, even if the explanations of drainage diversions favoured by Arber (1911) are accepted. Up to 6 feet of head has been recorded in places on the floors of these channels, some of it where the original surface which supplied the head has since been

Correlation table — Table II

	SOUTH AND SOUTH-EAST IRELAND (after Farrington, Mitchell & Synge)	SOUTH AND WEST WALES (after Mitchell & Synge)		SOUTH-WEST ENGLAND NORTH DEVON	
		Fishguard-New Quay	Gower Pencoed	Barnstaple Bay Saunton and Middleborough	Fremington
Post-Glacial	Post-Glacial deposits			Post-Glacial soils, alluvium, submerged peats and blown sand	
Würm/Vistulian Glaciation	Southern Ireland End-Moraine	Thin head	head Cardiff-Llandaff Moraine	Stony wash Frost wedges Upper head + sand	Frost disturbances Solifluction "Earth"
Eem Interglacial	Ardcavan deposit No marine deposits known	Llansantffraid fossil soil No marine deposits known		Weathering Sand layer No marine deposits known	Weathering and erosion
Riss/Saale Glaciation	Munster Gt. Cork-Kerry General Glac. {Eastern General, Irish Sea, Ballycroneen till: Main Head at Garryvoe and other sites	New Quay (local tills) New Quay (Shelly, cal. tills) New Quay (local till) Main head	Pencoed Pencoed Gower till & Lower head	Weathered Irish Sea Till Lower/Main head	Hele-Ellerslie sands and gravels Fremington Boulder Clay
Holstein Interglacial	Kilbeg Newtown peats and silts Raised shingle beach at Courtmacsherry Bay and other sites	New Quay Raised beach shingle which includes	Sand Gower Beach shingle {Patella Heatherslade Neitoides beaches	Sandrock (partly dune sand) Raised beach shingle, with erratics	Raised beach shingle
Mindel/Elster Glaciation	Erratics reach south coast of Ireland (Regional ice? Ice-bergs?) Enniskerry-Clogga drift	Lowest drift at Aberarth	erratics reach coast (local ice?)	Many erratics reach old shoreline, including: — Saunton Gneissose Granite (50 tons)	
Early Pleistocene	Wave-cut rock platforms below 50—60 feet O. D.	Wave-cut rock platforms below 50 feet O. D.		Wave-cut rock platforms below 50 feet O. D.	

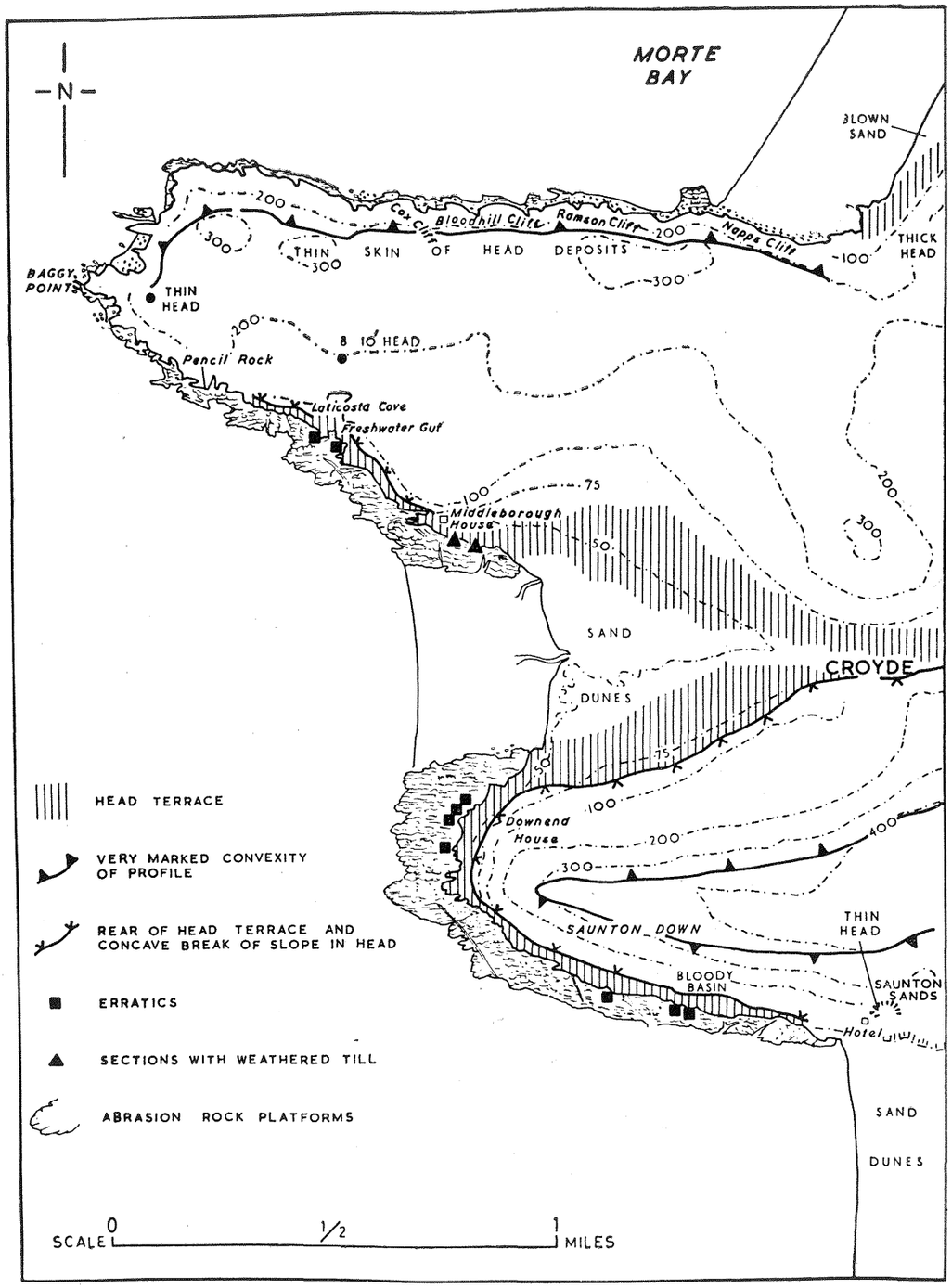

Fig. 1. Pleistocene deposits and coastal features near Croyde and Saunton, North Devon.

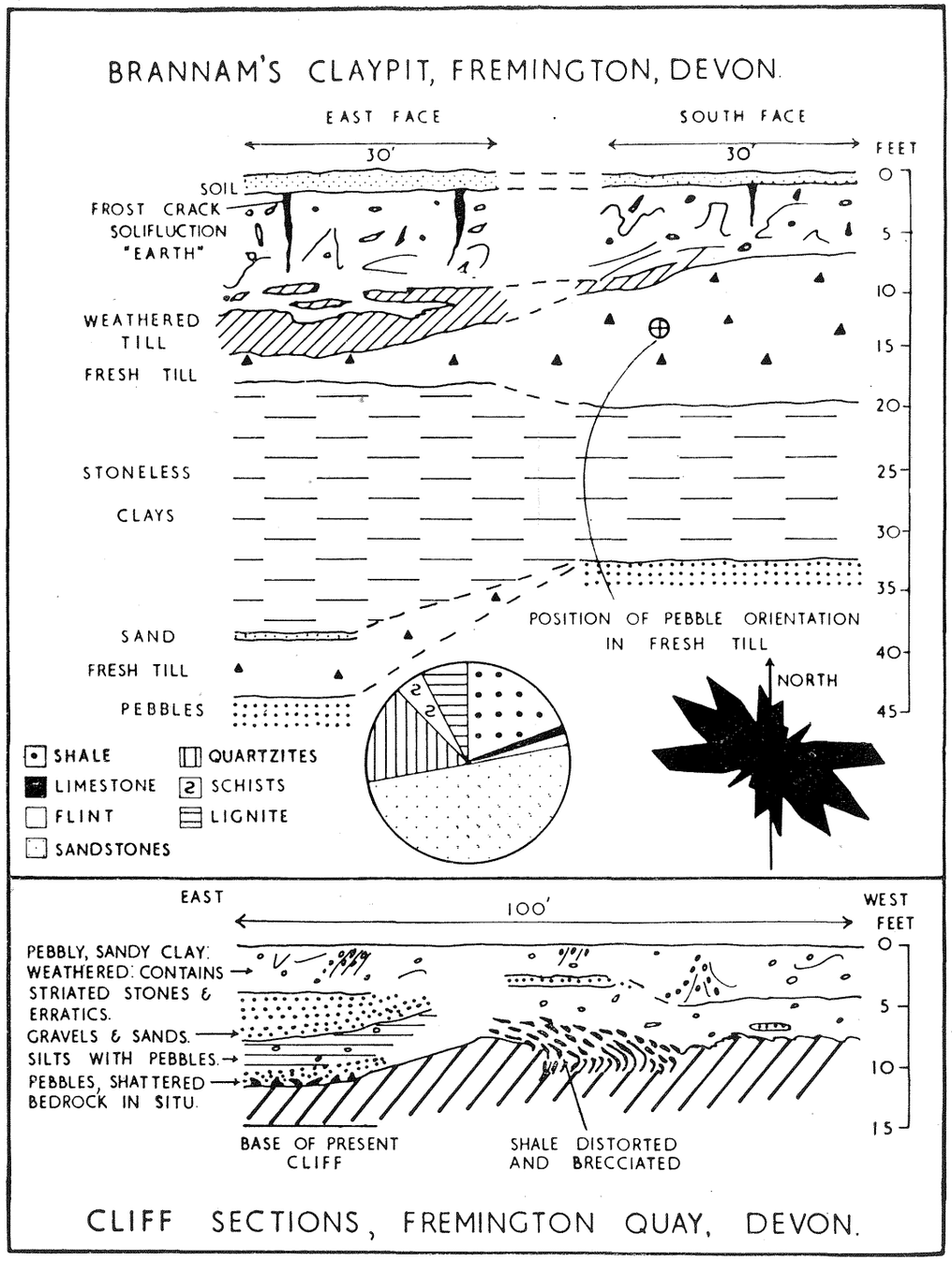

Fig. 2. Pleistocene deposits near Fremington and Fremington Quay, North Devon.

removed by marine erosion by the cliffs. Thus, while there has been and still is, severe coast erosion near Hartland Quay, resulting in the truncation of stream valleys and cliff recession, this is regarded as insufficient to explain the "In and Out" channels at Damehole Point and St. Catharine's Tor. These channels are regarded as forming a series falling southwards from Hartland Point, but no similar dry channels are known along the coast to the south. A full description and analysis of these channels will be made in another paper.

CONCLUSIONS

Wave-cut rock platforms occur at several levels in North Devon, and some parts of them may not be of the same age as the beach gravels (which contain erratics) resting upon them. No boulder clay has been recorded in close association with the large erratic boulders at Saunton and Middleborough, which are thought to have been moved into position by floating ice during the early Pleistocene and to pre-date the raised beach, the main head and Fremington till. The relationship of the wave-cut platforms and the erratics contained in the raised beach to the buried rock channels of the Taw-Torridge estuary is unknown at present (McFarlane 1955).

The sequence of head deposits can be correlated with similar Pleistocene sections in Cornwall, south Wales and Southern Ireland, where Irish Sea (Eastern General/Ballycroneen Till) drift is extensively displayed as the counterpart of the till at Fremington and Croyde. Marginal drainage channels have been recorded where the Irish Sea ice pressed against the North Devon coast during the Saale glacial period, and gravel deposits at Hele and Ellerslie, near Fremington, are now interpreted as outwash deposits from the receding Irish Sea ice.

No raised beach gravels have been found capping the Fremington till, nor the head deposits on the coast. Thus, it seems that there is no raised beach of Last Interglacial age (Eemian) present on this coast, a suggestion which would seem to apply in Southern Ireland and South Wales if the tentative correlation table (tab. II) is accepted (see also Correlation Table in Stephens a Synge 1965).

ACKNOWLEDGEMENT

The author acknowledges the help and encouragement received from Professor E. E. Evans, G. F. Mitchell, A. W. Smith, F. M. Synge and C. W. Taylor during this work; and thanks are expressed to the Queen's University of Belfast for research grants which contributed to the cost of the investigations.

References

Arber, E. A. N. 1911 — The Coastal Scenery of North Devon. London.

Arber, M. A. 1960 — Pleistocene sea-levels in North Devon. *Proc. Geol. Assoc.*, vol. 71; pp. 169—176.

Dewey, H. 1913 — The raised beach of North Devon: its relation to others and to Palaeolithic Man. *Geol. Magazine,* vol. 10; pp. 154—163.

Fairbridge, R. W. 1961 — Eustatic changes in Sea-level. *Physics and Chemistry of Earth,* 4; pp. 99—185.

Farrington, A. 1944 — The glacial drifts of the district around Enniskerry. *Proc. Roy. Irrish Acad.*, 50B; pp. 133—157.

Flett, J. S. & Hill, J. B. 1912 — Geology of the Lizard and Meneage. *Mem. Geol. Survey.*

Green, J. F. N. 1943 — The age of the raised beaches of South Britain. *Proc. Geol. Assoc.*, vol. 54; pp. 129—140.

Guilcher, A. 1949 — Aspects et problèmes morphologiques du massif de Devon—Cornwall comparés à ceux d'Armorique. *Rev. Géogr. Alpine,* vol. 37; pp. 689—717.

Maw, G. 1864 — On a Supposed Deposit of Boulder Clay in North Devon. *Quart. Jour. Geol. Soc. London,* vol. 20; pp. 445—451.

McFarlane, P. B. 1955 — Survey of two drowned river valleys in Devon. *Geol. Magazine,* vol. 92; pp. 419—429.

Mitchell, G. F. 1960 — The Pleistocene history of the Irish Sea. *Adv. of Science,* vol. 17; pp. 313—325.

Mitchell, G. F. 1962 — Summer Field Meeting in Wales and Ireland. *Proc. Geol. Assoc.*, vol. 73; pp. 197—213.

Simpson, S. 1953 — The development of the Lyn drainage system and its relation to the origin of the coast between Combe Martin and Porlock. *Proc. Geol. Assoc.*, vol. 64; pp. 14—23.

Steers, J. A. 1946 — The Coastline of England and Wales. Cambridge.

Stephens, N. 1961a — Re-examination of some Pleistocene sections in Cornwall and Devon. Abstracts Proc. 4th Conf. Geol. Geomorph. S. W. England: *Roy. Geol. Soc. Cornwall*; pp. 21—23.

Stephens, N. 1961 b — Pleistocene events in North Devon. *Proc. Geol. Assoc.*, vol. 72; pp. 469—472.

Stephens, N. & Synge, F. M. 1965 — Pleistocene Shorelines. Essays in Geomorphology. Edited by G. H. Dury Heinemann, London.

Synge, F. M. 1963 — A correlation between the Drifts of S. E. Ireland with those of N. Wales. *Irish Geog.*, no 4; pp. 360—366.

Synge, F. M. 1964 — The glacial sequence in West Caernarvonshire. *Proc. Geol. Assoc.*, vol. 75; pp. 431—444.

Taylor, C. W. 1956 — Erratics of the Saunton and Fremington Areas. *Rep. Devon Assoc. Adv. Sci.*, 88; pp. 52—64.

Watts, W. A. 1959 — The Interglacial deposits at Kilberg and Newton, Co. Waterford. *Proc. Roy. Irish Acad.*, 60B; pp. 79—134.