

ASPECTS OF THE GLACIATION  
AND SUPERFICIAL DEPOSITS  
OF PEMBROKESHIRE

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Oxford.

**VOLUME II.**

**ILLUSTRATIONS**

**(PLATES, FIGURES, MAPS, AND  
APPENDICES).**

IT IS INTENDED THAT THE  
ILLUSTRATIONS IN THIS VOLUME  
SHOULD BE CONSULTED CLOSELY  
IN CONJUNCTION WITH THE  
TEXT IN VOLUME I

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**VOLUME II**

**PLATES**

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Plate 1. Carnllidi and Carn Trelwyd monadnocks standing above the flat platform surface of Western Dewisland. View to the north-west from the southern end of Dowrog Common.



Plate 2. Esgyrn Bottom, one of the deep melt-water channels of the Gwaun-Jordanston system, south of Fishguard. In the foreground the channel is c. 150 ft deep. View to the west from near Gelli.



Plate 3. The undulating upland ridge of Mynydd Prescelly. Note that the only rock outcrops are tors on the mountain flanks in the middle distance.

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Plate 4. The Dewisland erosion surface, with an altitude of c. 200 ft. O.D. View to the south from the summit of Penbiri monadnock. Note the patches of moorland in gentle depressions in the middle distance.



Plate 5. Head Type 1.

The stratified flaky gravels, with interbedded quartzite boulders, at Aber-mawr North. Assuming continuous deposition with an annual cycle represented by each flaky layer, the thickness of head shown in this photograph (c. 4 ft) may have taken c. 130 years to accumulate.



Plate 6. Head Type 2.

A moderately blocky head of quartzite fragments at the north end of Newgale Beach. Note the fine head matrix and the way in which the head fragments project from the cliff face.



**Plate 7. Head Type 3.**

An angular blocky head at Pen Dal-aderyn.  
Note the large size of many of the blocks,  
and the complete lack of pseudo-stratification.

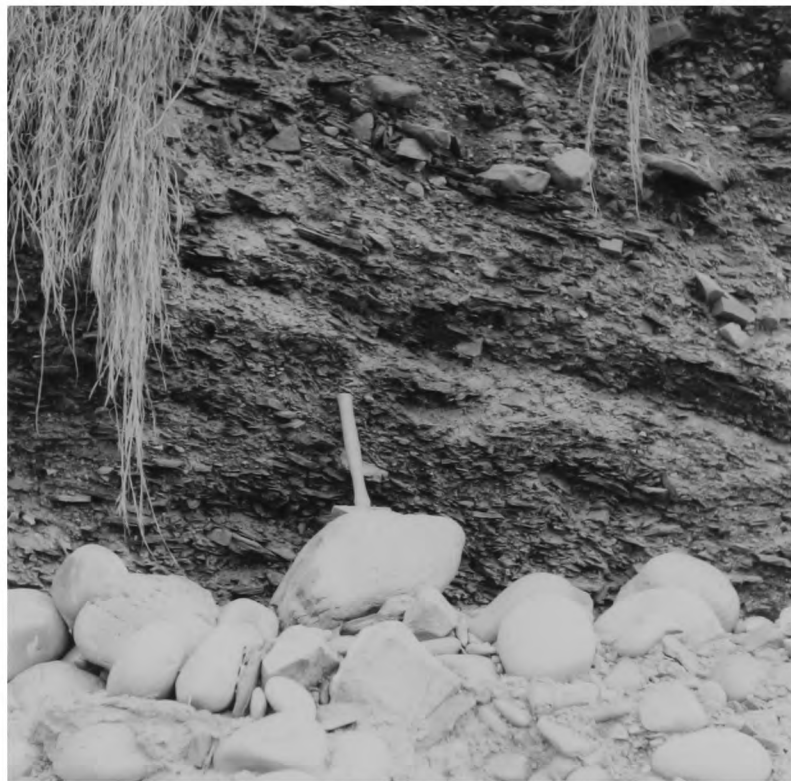


Plate 8. A typical coastal drift cliff exposure used as a preferred stone orientation sampling-site. The face of the exposure is fresh, and few of the pebbles in the till are disturbed.

Cwm Mawr (Grid ref. 844227)



A



B

Plate 9. Drift exposures at Aber-mawr North.

- A. The drift succession at the northern part of the section. From bottom to top may be seen the lower heads, the thick flaky head, the calcareous till, and the rubble-drift.
- B. The weathering break between the lowest shale head (2) and the Lower Blocky Head (3). The break is c. 6" above the top of the hammer handle.



Plate 10. The contact between weathered Irish Sea till and the sandy middle head at Aber-mawr North. Note the irregular contact, with masses of sandy head caught up into the till. The decalcified layer of till has a reddish colour.



Plate 11.

A slump feature in fluvio-glacial sands and gravels at Aber-mawr North. This feature, like many others exposed in the cliff, has resulted from deposition in a dead-ice environment.



Plate 12.

Ice-contact sands beneath the Upper Shale Head at Aber-mawr South. Note the severe contortions in the bedding of the sands.



**Plate 13.**

The rubble-drift capping the cliff  
between Aber-mawr and Pen Deudraeth.  
The Aber-mawr North Drift-cliff is immed-  
iately to the right of the photograph.  
Note the apparent pseudo-stratification  
in the drift and the smoothed appearance  
of the quartzite bedrock.



**Plate 14.**

The polished and striated rock platform near the Lifeboat Station, Parrog. The altitude is c. 23 ft. O.D. This is probably a marine-cut platform modified by ice-action.



Plate 15.

Aerial photograph of the Afon Nevern Estuary View from above Newport towards the north-west. Note the gentle valley-slopes in the foreground, suggesting that the valley was cut sub-aerially. Note that the cliff-line extends up the estuary; the drowning of the estuary occurred before the last major phase of cliff erosion. (Copyright, Aerofilms and Aero Pictorial Ltd.)



**Plate 16. Striated bedrock slabs at Whitesands North**

**A. A smoothed slab near the corner-pole.**

**B. Striated bedrock slab passing beneath the Lowest Head at the northern end of the main drift cliff.**



Plate 17. Two drift exposures at Whitesands South.

A. The stained basal deposit with rounded boulders resting on the rock platform.

B. The fine flaky head with erratics.



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Plate 18.

St. David's Head, the Porthmelgan channel, and Carnllidi monadnock, seen from the west.

Note that the Porthmelgan channel is a "through" channel which passes from the inlet at Porthmelgan to the coast at the left of the photograph. The course of the channel can be recognised by the strip of white vegetation.



**Plate 19.**

**The drift-filled Porthmelgan Channel.**

**Note the sharp break of slope between the marshy valley-floor and the side of the channel.**

**In the right background is Carnllidi.**



Plate 20. The laminated silt beneath calcareous till at Porthmelgan. Note that the silt is in contact with smoothed bedrock.



**Plate 21.**

The veins of silt and clay in the Irish Sea till at Porthmelgan. These veins may indicate that the till was laid down by the dumping of a series of independent till masses during ice wastage.



A



B

**Plate 22**

A. The Pen Dal-aderyn raised beach platform capped by head deposits. Note the head pillar on the lowest part of the platform, and the angular rock fragments in the foreground.

B. The southern part of the Pen Dal-aderyn rock platform, showing the loose angular surface boulders and the lichen-covered rock.



**Plate 23.**

One of the head pillars at Pen Daladeryn. Note the chaotic and unsorted character of the deposit and the faceted boulder surface to the right of the auger.



A



B

**Plate 24**

- A. The Ogof Golchfa (Porth-clais) raised beach platform and drift terrace. Seen from the west.
- B. The eastern part of the Ogof Golchfa platform. Note the extension of the platform on the stacks to the east; the loose bedrock boulders on the platform surface; the shingle patches in bedrock hollows; and the till exposure in the drift cliff.



Plate 25.

The western (lower) part of the Ogof Golchfa raised beach platform. Overlying deposits which are visible include raised beach shingle and erratic boulders, lower head, and non-calcareous till. Note the large white erratic embedded in beach shingle.



**Plate 26.**

The colourful upper local head at Ogof Golchfa. The path from the cliff top is seen at left centre. The head is underlain by non-calcareous till and overlain by sandy loam with head fragments.



**Plate 27.**

The stained gravel layer truncated by slump features in the new gravel cutting at Caerbwdy . The gravels are stained black by manganese oxide.



A



B

**Plate 28** Drift exposures at Caerbwdy.

- A. The stony non-calcareous till in the main drift cliff.
- B. The local head of purple sandstone fragments at the top of the drift cliff.

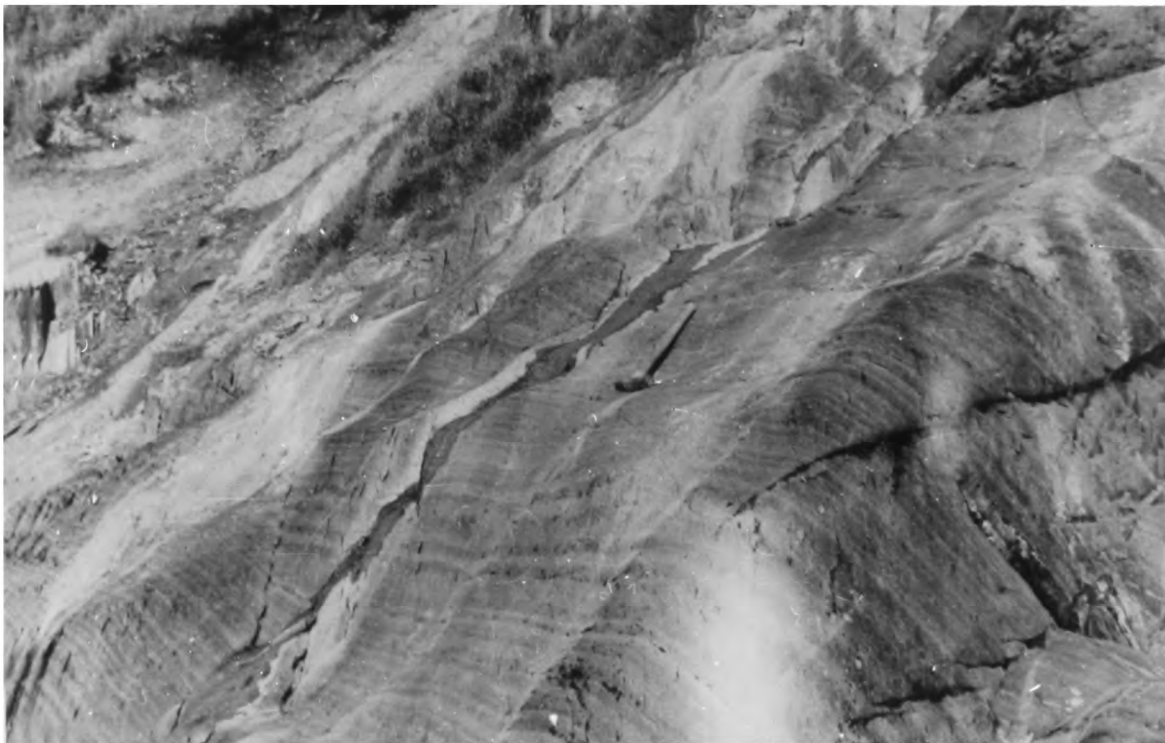


Plate 29. The terrace of drift and the drift cliff at Druidston Haven, seen from the clifftop to the north. In the middle distance are the two stream valleys which enter the sea at the southern end of the section.

The bulk of the drift exposed in the cliff face is Irish Sea till.



A



B

**Plate 30.** Pleistocene features at Gwbert, in the Teifi estuary.

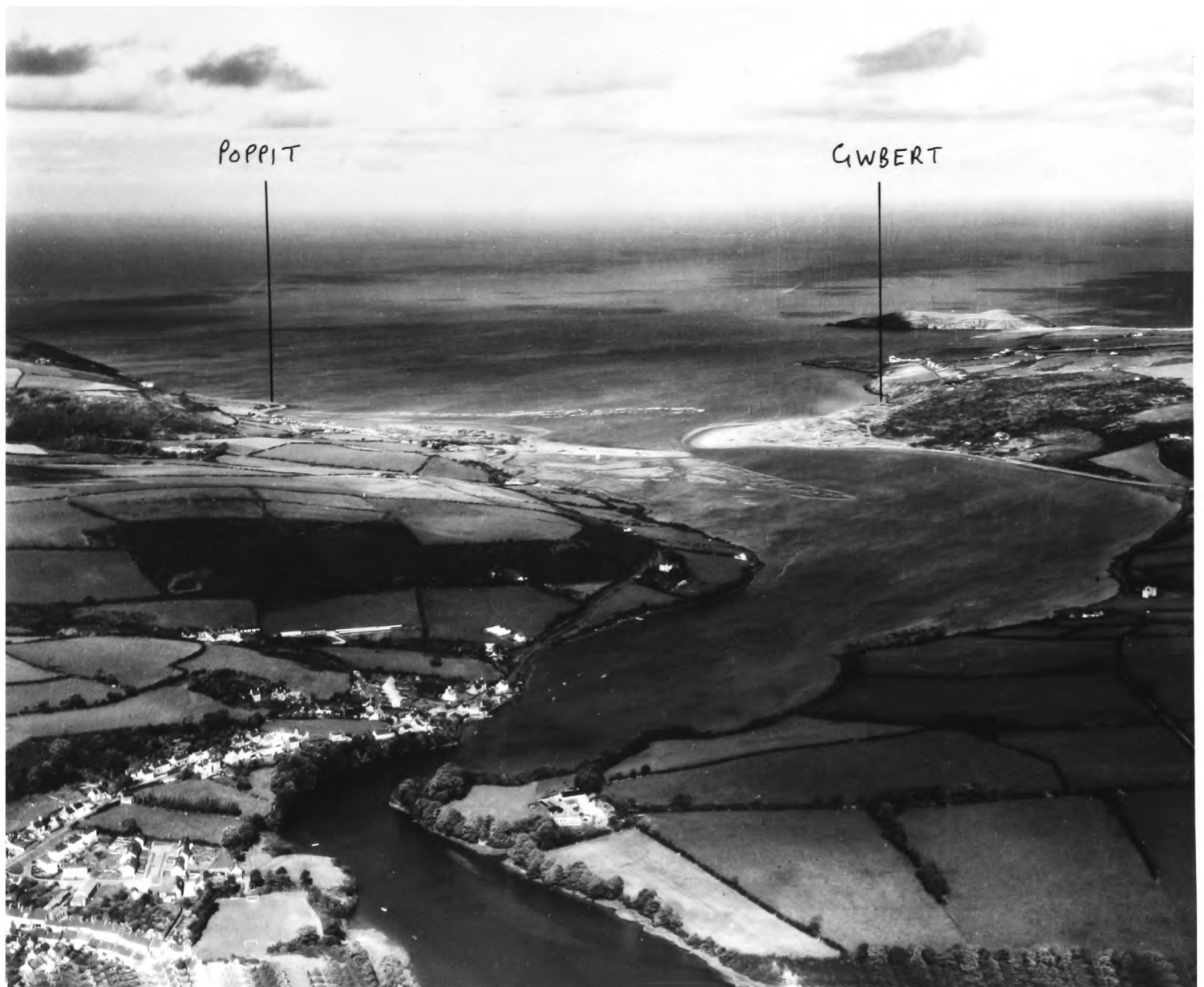
A. The raised beach platform, with the old cliffline on the left (partly masked by drift). In the background is the main exposure of Irish Sea till.

B. The smoothed and striated rock surface at the northern end of the platform.



**Plate 31.**

The laminated silts overlying contorted  
head and smoothed bedrock on the raised  
beach platform at Gwbert.



**Plate 32.**

Aerial photograph of the Teifi Estuary, looking north from St. Dogmaels. Note that the Poppit and Gwbert exposures are within the sides of the estuary. The presence of raised beach platforms at each locality means that the estuary must have been in existence prior to the platform-cutting phase.

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A



B

Plate 33. Raised beach exposures at Poppit, on the west side of the Teifi estuary.

- A. A raised storm beach with large embedded boulders at the base. The deposit is stained red with iron oxide. It is overlain by thick local head.
- B. The stained beach deposit near the small headland. It is stained by iron oxide at the base and by manganese oxide above.



Plate 34.

The exposure of raised beach gravels near the boathouse at Cei Bach, Poppit. The beach rests upon a planed rock surface and is overlain by blocky head.



Plate 35.

The rubble-drift on top of the drift cliff at Aber-mawr North. The deposit consists largely of angular quartzite blocks (bed-rock) set in a reddish sandy matrix.

The rubble-drift is considered by some workers to be a local Welsh Till; however, fabric analyses indicate that it is a mixed solifluxion rubble of head, patches of outwash sand and gravel, and till remnants.



**Plate 36.**

The top of the Irish Sea till at Abermawr North.

Note the reddish colour of the weathered and decalcified layer, which extends to a depth of 12 - 18 inches. Note also the very sharp contact between the till and the overlying outwash sands and gravels.



Plate 37.

The drainage reservoir on Treleddyfawr Moor; one of the few inland exposures of till in Western Dewisland. The till is stony and non-calcareous, but is gleyed in the waterlogged part of the moor.

In the background are the igneous masses of Carnllidi and Carn Trelwyd.



Plate 38.

The exposure of non-calcareous stony and sandy till at Emlych. The till is less than 3 ft thick, and has been disturbed by cryoturbation. Note the erratic pebbles, some of which are rounded.



Plate 39.

The location of the till patches on Penbiri monadnock, beneath a steep cliff and above the quarry. The till occurs above 425 ft. O.D. View from the south.



A



B

Plate 40. Exposures in Tre-lllys Gravel-pit.

- A. Calcareous shelly gravels overlain by bedded silts and sands. These gravels occur about four feet beneath the ground surface.
- B. Slump features in bedded sands and gravels in the lower part of the pit. Note the erosional contact in the upper part of the photograph, overlain by more torrential gravels.



Plate 41.

Bedding structures in the gravels in Mathry Road pit.

Note that the lower layers of outwash are gently dipping, but that above a sharp contact there is well-marked foreset bedding. At the top of the section is coarse torrenial outwash. This sequence of deposits may indicate that an outwash plain advanced into a pro-glacial lake at this point.



Plate 42.

A small fossil ice-wedge in the gravels at Mathry Road. Note that at the bottom of the photograph two generations of cracking appear to be represented.

The wedge is overlain by undisturbed gravels, and indicates that very cold periglacial conditions prevailed at times during deglaciation.



Plate 43.

The Gwaun Channel; view towards the north-east from the rock divide at Llanerch. Note the steep channel sides, the flat drift-filled floor, and the rock knob above the valley floor at Parc-y-Dyffryn (just visible to the left of the house at the far end of the channel). This channel was cut subglacially, probably during the Early Glaciation.



Plate 44.

The rock knob at Allt Pengegin Isaf,  
near Pontfaen in the Gwaun Channel.

To the right of the rock there is a small  
humped arcuate channel connected to steep  
chutes on the valley side.

The features at Allt Pengegin  
Isaf are diagnostic sub-glacial  
features; they are typical of many such  
features in the channel.



A.



B

Plate 45. The location and character of Cwm Mawr arcuate channel, on the face of the Dinas Cliff.

- A. View to the south-west from the summit of Castell, an isolated rock knob. Cwm Mawr is clearly seen cutting across the spur in the middle distance. Beyond the end of the spur is Rhos Isaf, where Jehu recorded 15 ft of Irish Sea till.
- B. View towards the south-west from the col on the floor of Cwm Mawr channel.



Plate 46.

The northern intake of the Escalwen East channel, seen from Pant-y-wrach Farm. In the foreground the channel is a negligible feature as it grades from the Gelli marginal channels; however, within a distance of 200 yards it assumes sizeable proportions as it plunges obliquely down the spur.



Plate 47.

The Escalwen West Channel, looking west from the channel floor. It is possible that this channel was cut sub-glacially, although its position on the side of a spur may indicate that it was cut marginally or sub-marginally.

Above the valley side to the right of the photograph striated boulders may be found.



Plate 48.

The large meltwater channel at Cwm-mawr.  
The intake point is at Pen-y-cwm, visible in  
the distance.

Note the steep channel sides  
cut into the flat platform surface of Dew-  
island. The channel carries only a minute  
stream today, and was probably cut sub-  
glacially during the Early Glaciation.



A



B

**Plate 49.**

**Characteristics of the Solfach Valley.**

- A. The narrow Solfach Valley to the north of Middle Mill. Note the steep, rocky channel sides and the flat floor.
- B. The lower channel just north of the point at which it is joined by the Trecadwgan channel. Note the marked rock bench on the channel side; this may be a remnant of an old valley floor.



A



B

**Plate 50.**

**Views of Merry Vale channel, near Porth-clais.**

- A. The steep-sided channel; view towards the south-west from Ffordd Porth-clais.
- B. A bad photograph of the arcuate channel cut across the spur to the north of the quarry. The channel floor is used for agriculture, and is visible as a white patch; it stands well above the floor of Merry Vale, which passes to the left of the spur. This arcuate channel is a sub-glacial feature.



**Plate 51.**

Part of the Patella raised beach platform at Caswell Bay, Gower.

In the foreground is a cemented block of angular limestone head. Other cemented patches can be seen on the cliff above the platform.



**Plate 52.**

Close-up of a patch of cemented Patella beach at Caswell Bay, Gower. Note that there are many erratic pebbles in the beach, but that they are seldom well-rounded.



**Plate 53.**

Part of the extensive rock platform in Croyde Bay, North Devon. It is cut across steeply-dipping Devonian slates and is overlain by sandrock and head.

Altitude - up to 40 ft O.D.



A



B

Plate 54. Erratic boulders resting upon the raised beach platforms at Whitesands South, Pembrokeshire (A), and at Freshwater Gut Devon (B). In each case the erratics lie beneath lower ("main") head, and appear to date from the Early Glaciation.

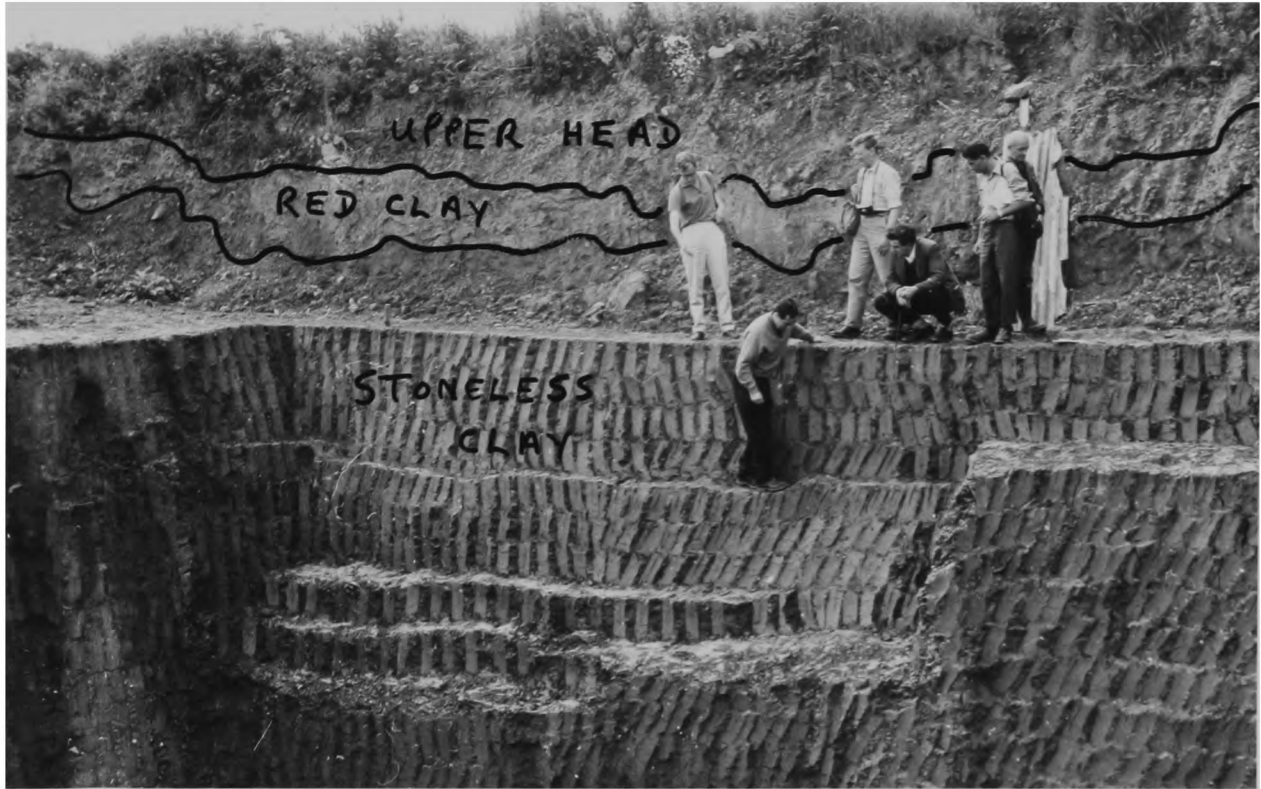


**Plate 55.**

**Thick sandrock overlying a dissected rock platform at Bloody Basin (Saunton, North Devon).**

**It is probably an aeolian deposit, and is found in association with raised beach and main head deposits.**

**It may have accumulated during the Poppit Interglacial.**



**Plate 56.**

The exposure of Fremington Clay at Brannan's Clay-pit. This clay is probably a till, although it may be in part lacustrine; it is thought to be a product of Irish Sea Ice. Note the decalcified upper horizon and the overlying upper head.



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Plate 57. Milford Haven, an ancient river valley which was probably drowned prior to the Early Glaciation. Note that the cliffs on the Haven shores extend at least as far as Pembroke Dock, left-centre in the distance, and almost ten miles from the open sea. View to the east from above Musselwick, on the north shore.

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**Plate 58.**

Marine cliffs within the drowned lower portion of the Solfach Channel, suggesting that the last phase of marine erosion post-dated the cutting of the channel.

**VOLUME II**

**FIGURES**

**Nos. 1 - 128**

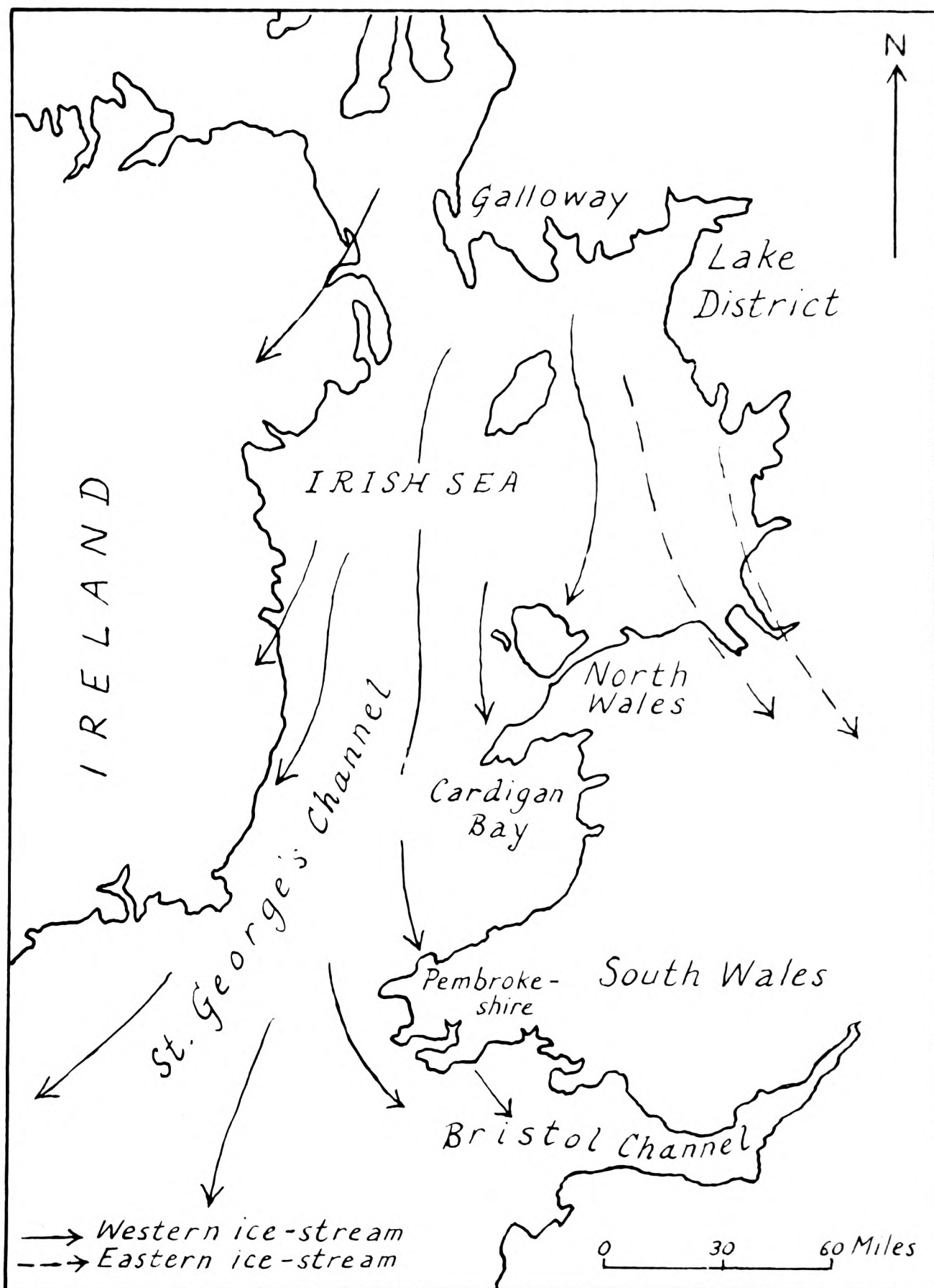


Fig.1 The theatre of action of the Irish Sea Ice-sheet (after Charlesworth, 1957)

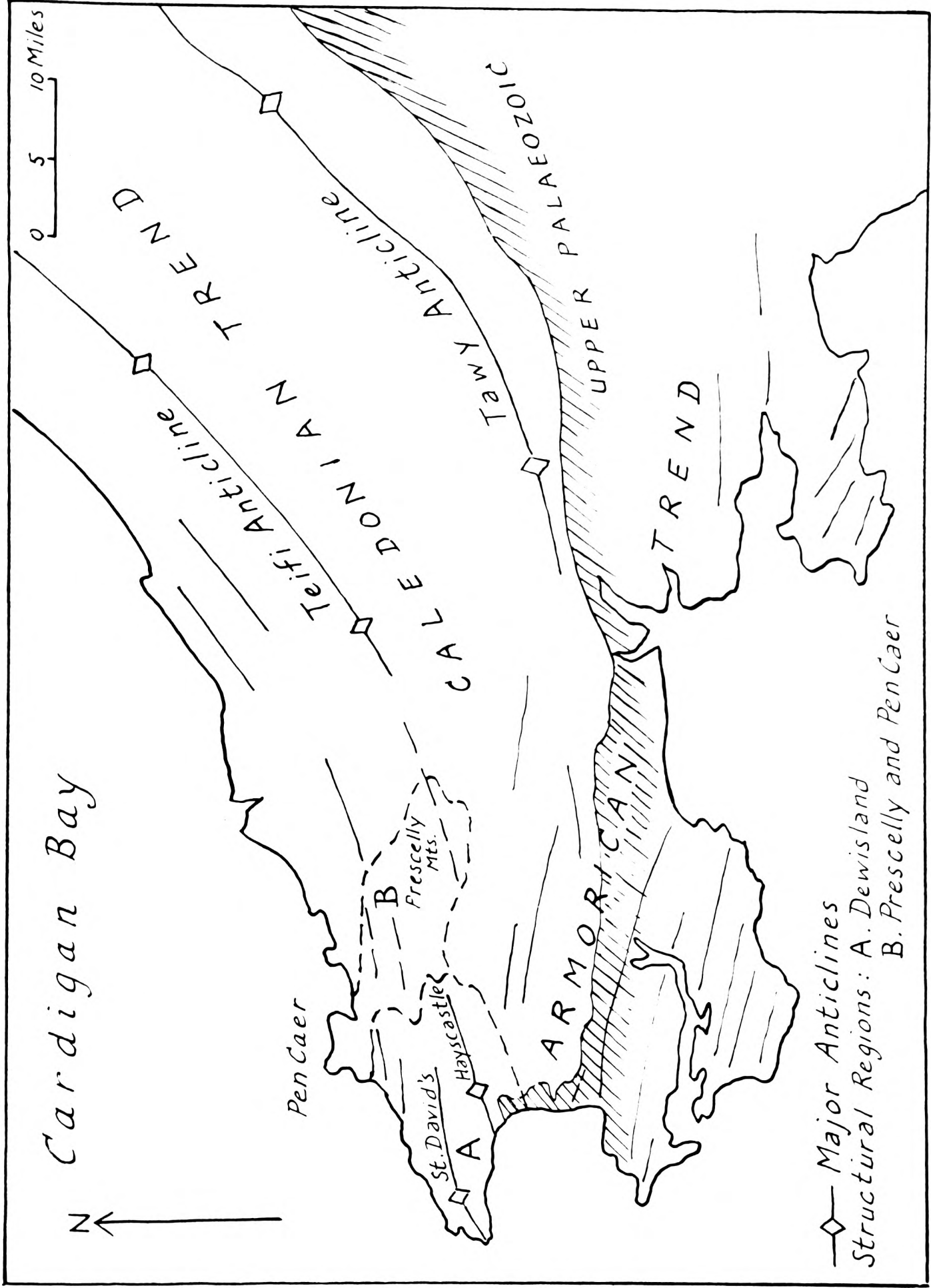
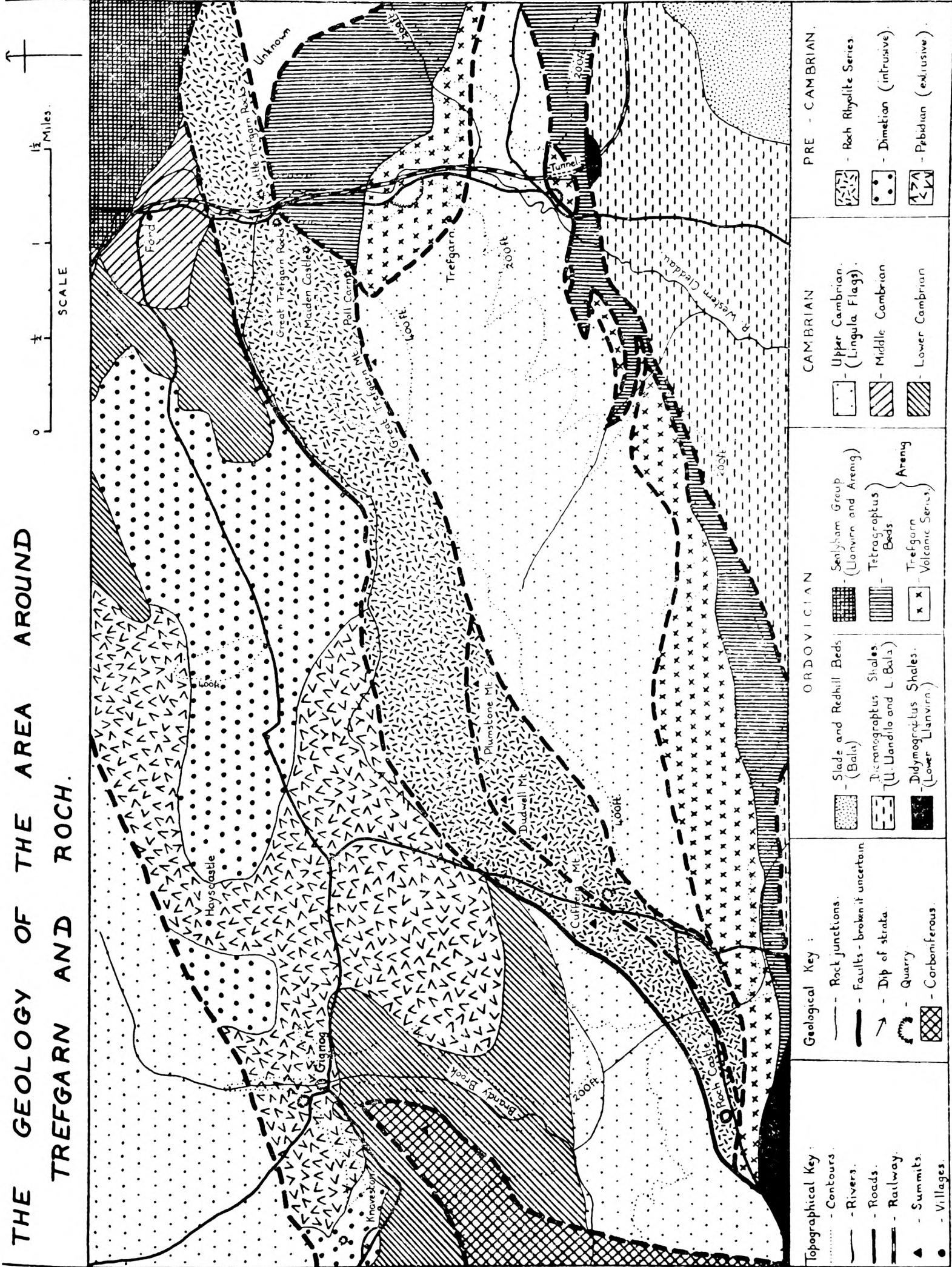


Fig.2 Main structural trends in South-West Wales



# THE GEOLOGY OF THE AREA AROUND TREFGARN AND ROCH.



**Topographical Key:**  
 - Contours.  
 - Rivers.  
 - Roads.  
 - Railway.  
 - Summits.  
 - Villages.

**Geological Key:**  
 - Rock junctions.  
 - Faults - broken if uncertain.  
 - Dip of strata.  
 - Quarry.  
 - Carboniferous.

**ORDOVICIAN**  
 - Slade and Redhill Beds (Bala).  
 - Trecroptus Shales (U. Uandilo and L. Bala).  
 - Didymogroptus Shales (Lower Llanvirn).  
 - Searlyham Group (Llanvirn and Arenig).  
 - Tetragnostus Beds.  
 - Trefgarn Volcanic Series.

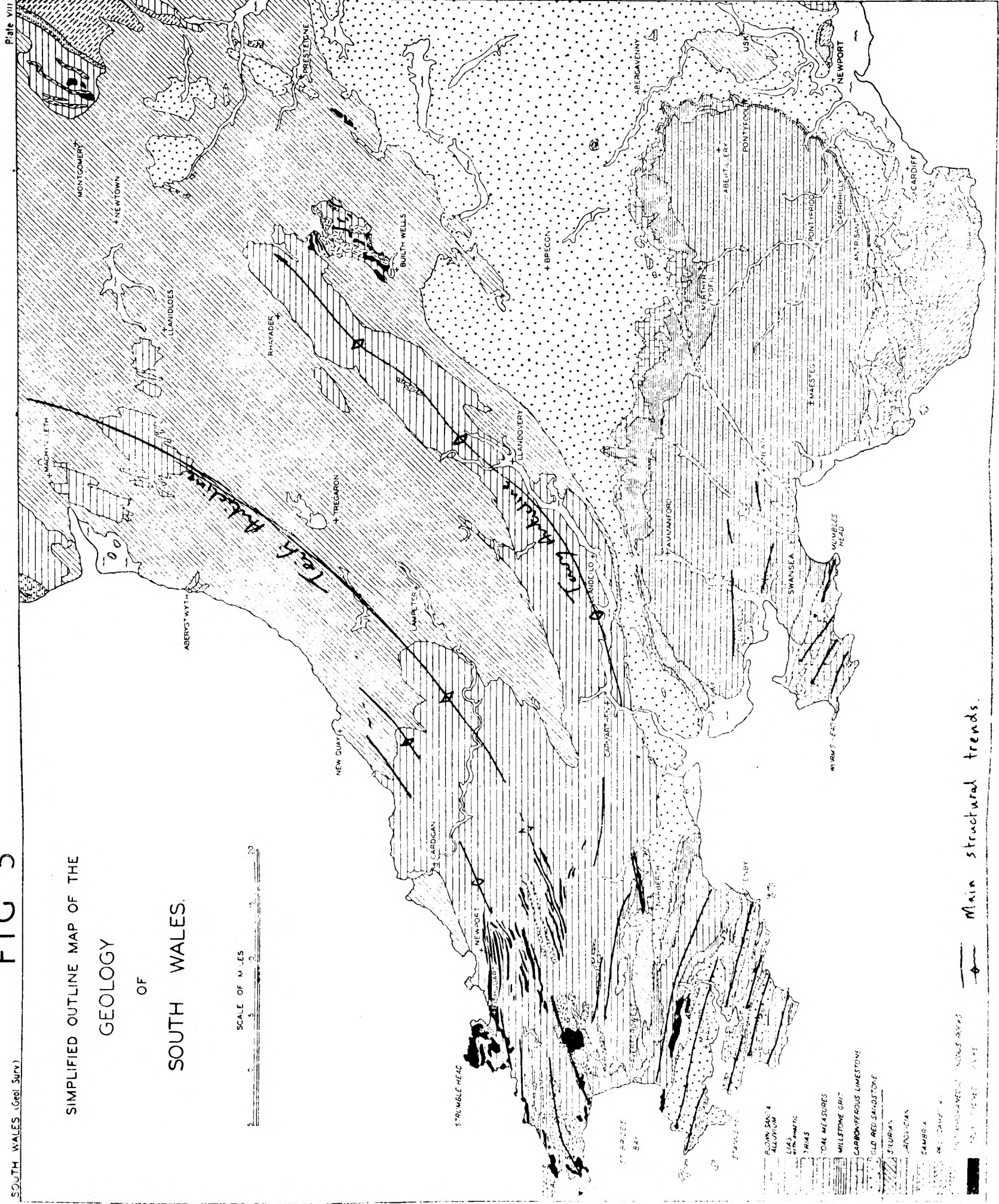
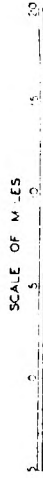
**CAMBRIAN**  
 - Upper Cambrian (Lingula Flags).  
 - Middle Cambrian.  
 - Lower Cambrian.

**PRE - CAMBRIAN**  
 - Rock Rhyolite Series.  
 - Dimetian (intrusive).  
 - Pabidian (extrusive).

Fig. 4.

FIG 5

# SIMPLIFIED OUTLINE MAP OF THE GEOLOGY OF SOUTH WALES.



- BOURN SAND & ALLUVIUM
- GLACIAL DEPOSITS WITH FLINTS
- TRIAS
- TOTAL MEASURES
- MILSTONE GRIT
- CARBONIFEROUS LIMESTONE
- OLD RED SANDSTONE
- STURIA
- LAPOUCHE
- SAMBRAY
- ORISKANY
- NEWCASTLE
- WYNN'S HEAD
- SWANSEA
- AVONFORD
- CARMARTHEN
- GLYNNEATH
- EBBW VALE
- STUMBLE HEAD
- NEWPORT
- LLANIDLOES
- RHAYADER
- BRECON
- BWLTH WELLS
- USK
- ABERCAVENNY
- NEWPORT
- CARDIFF

Main structural trends

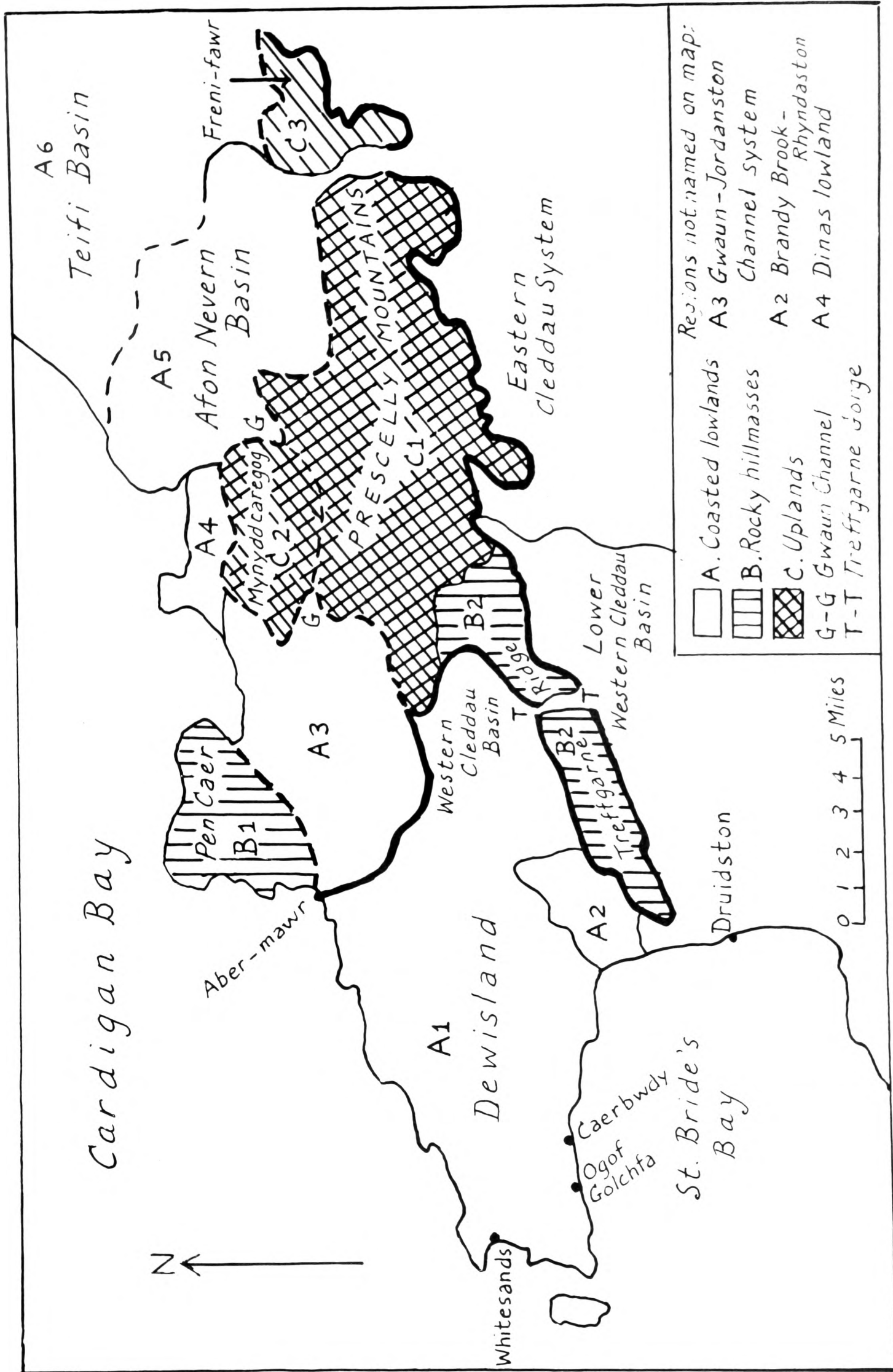


Fig.6 North Pembrokeshire — Landscape Regions

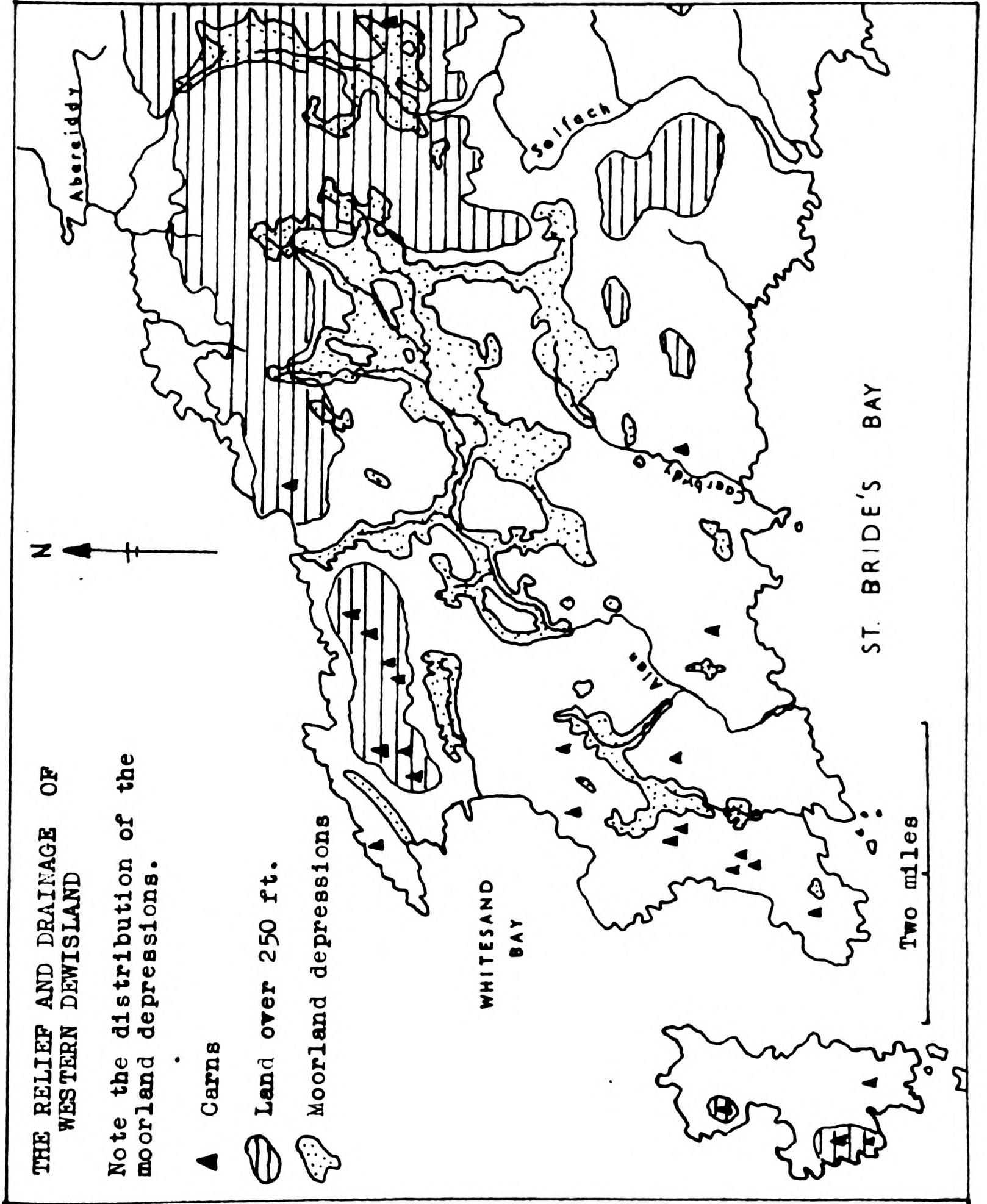


Fig. 7

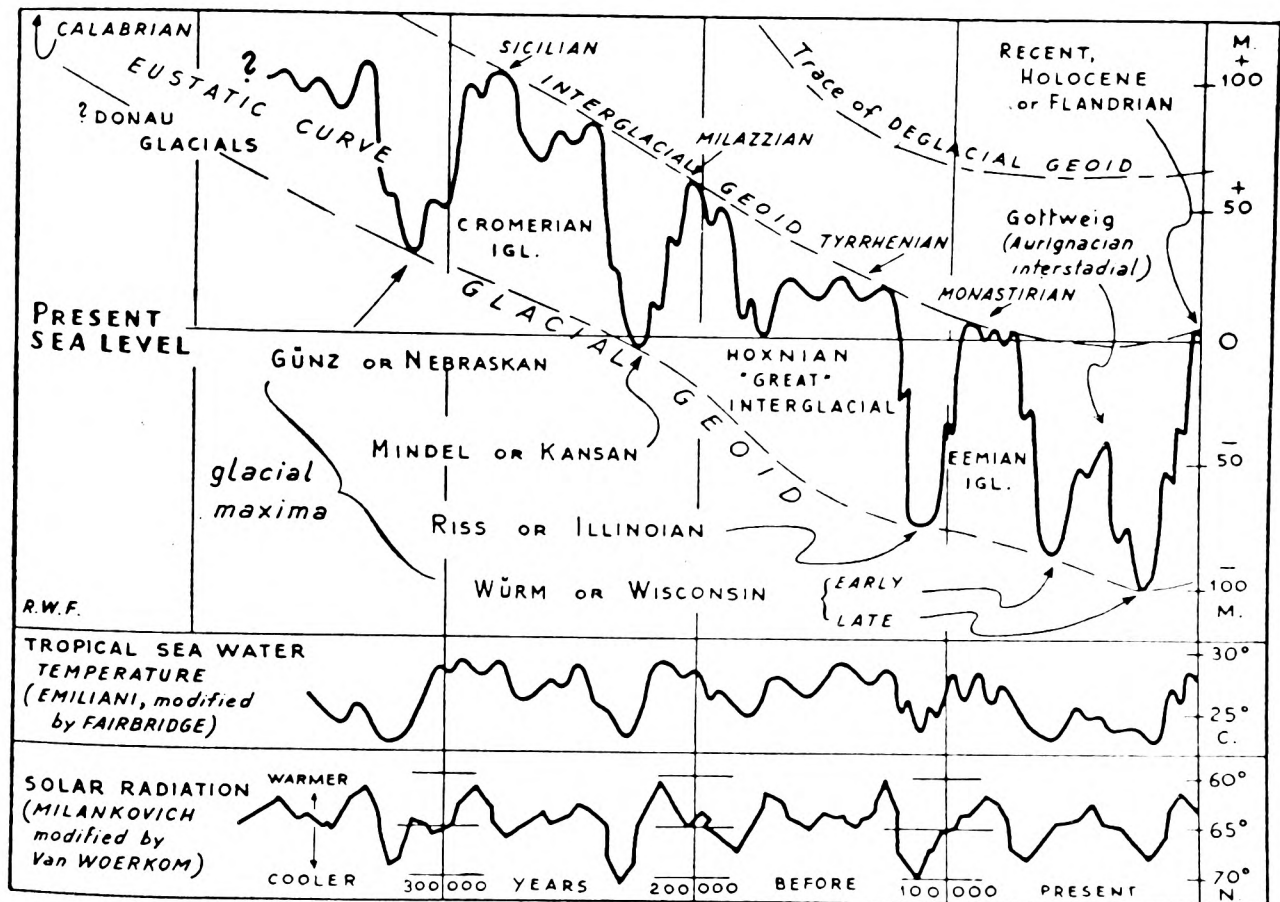


Fig. 8.

Proposed Quaternary eustatic oscillations, being Fig. 10 in Fairbridge, 1962.

Note that low sea-levels are thought only to have occurred during the Riss and Würm Glaciations. The proposed gradual fall of sea-level during the Pleistocene is well shown.

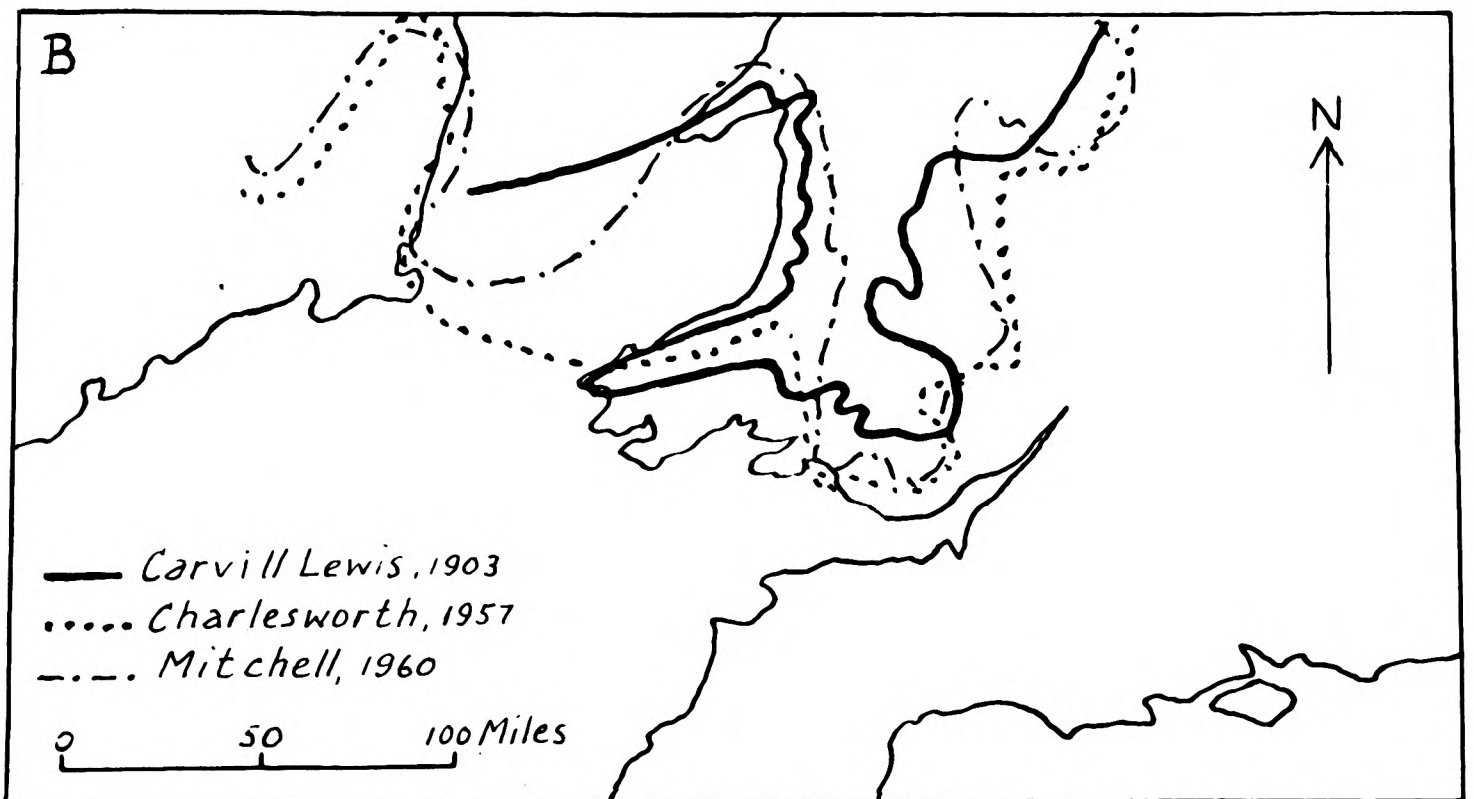
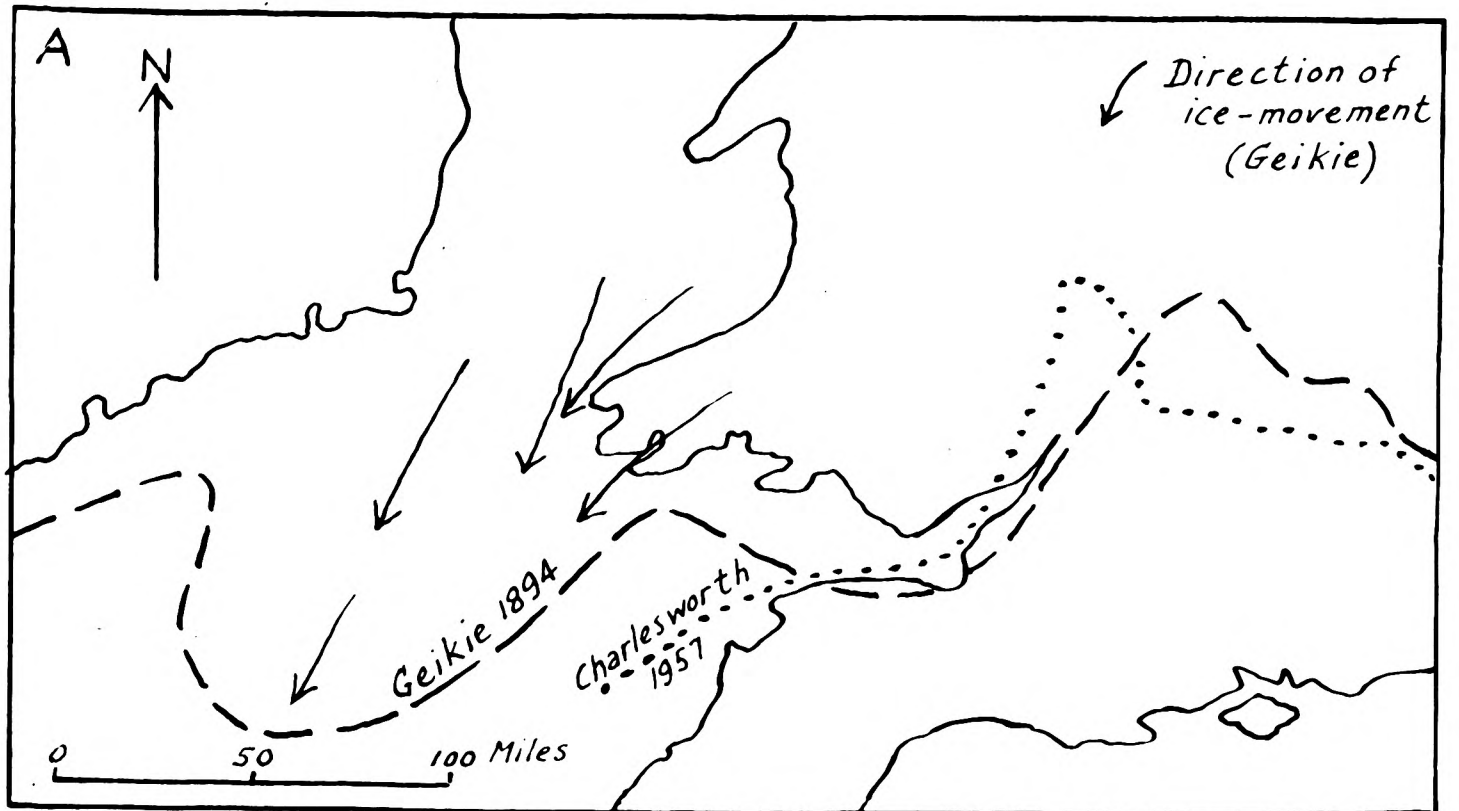


Fig.9 Proposed glaciation limits in Western Britain

A. Geikie's Line (1894) and Charlesworth's Limit of Older Drifts (1957)

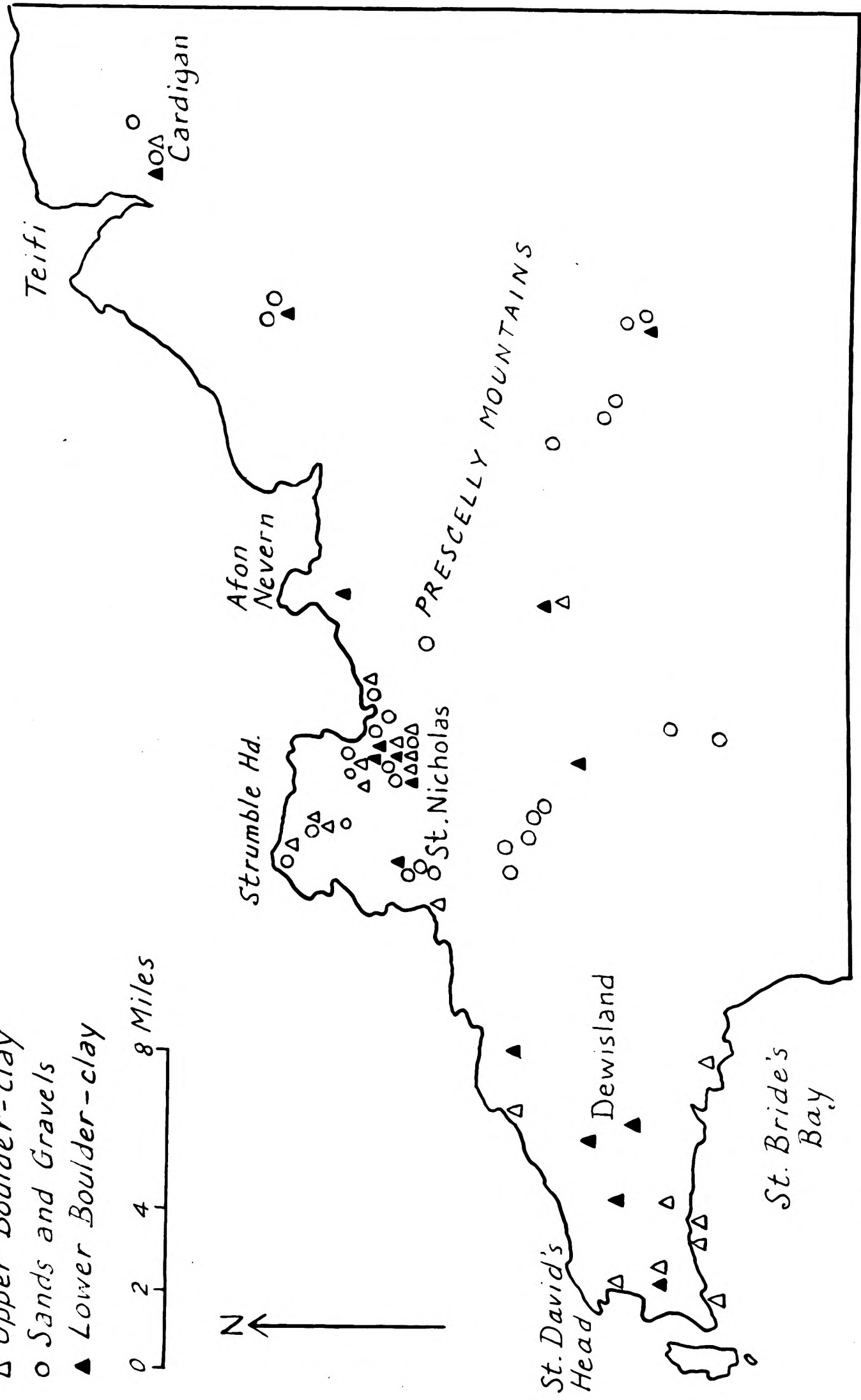
B. Carvill Lewis' "edge of the Ice-sheet" compared with the Newer Drift Limits of Charlesworth 1957 and Mitchell 1960

Fig.10 Localities mentioned by Jehu, 1904

△ Upper Boulder-clay

○ Sands and Gravels

▲ Lower Boulder-clay



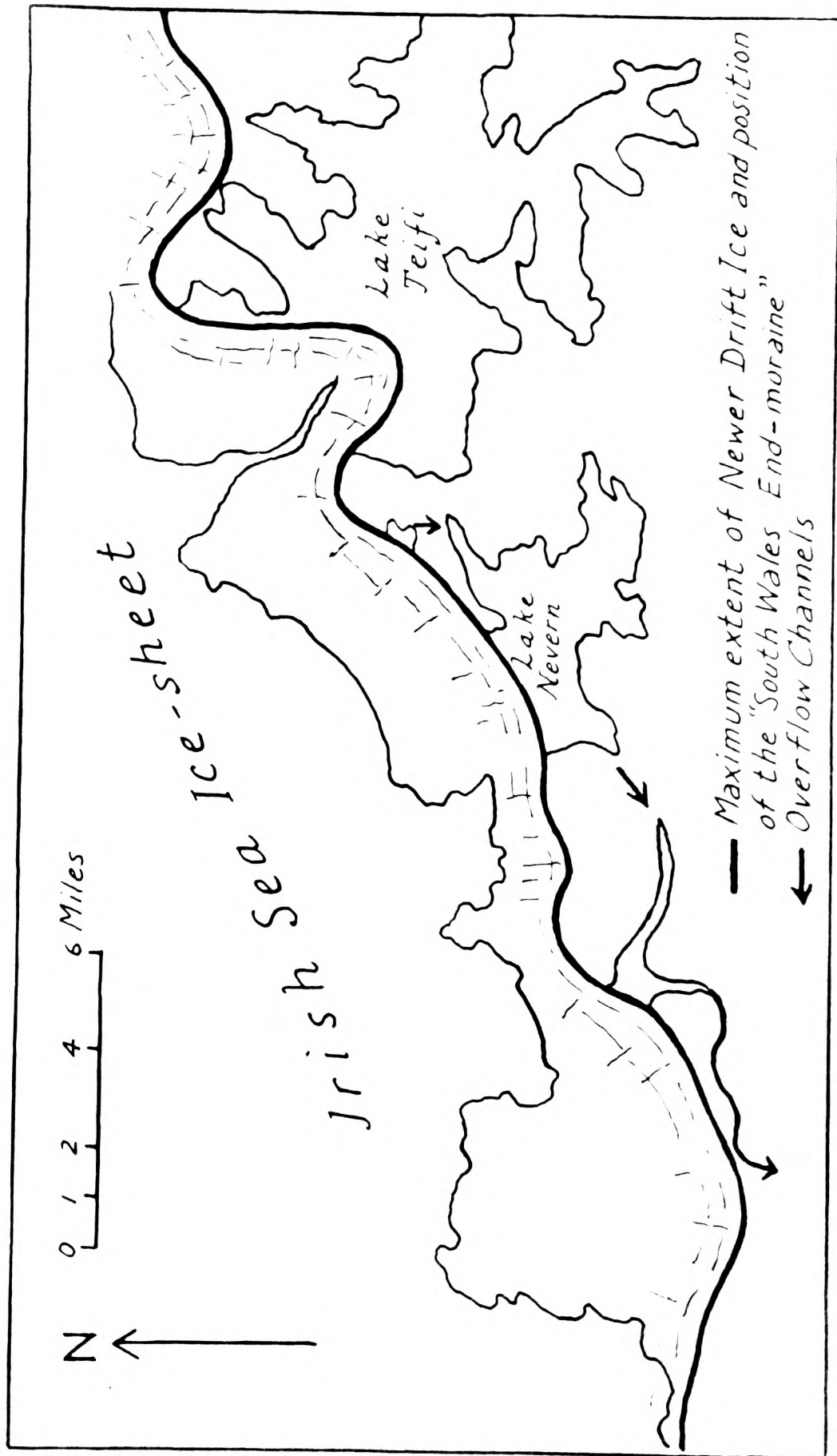


Fig. II THE SOUTH WALES END-MORaine AND THE MAIN GLACIAL LAKES OF NORTH PEMBROKESHIRE DURING THE NEWER DRIFT GLACIATION, ACCORDING TO CHARLESWORTH.

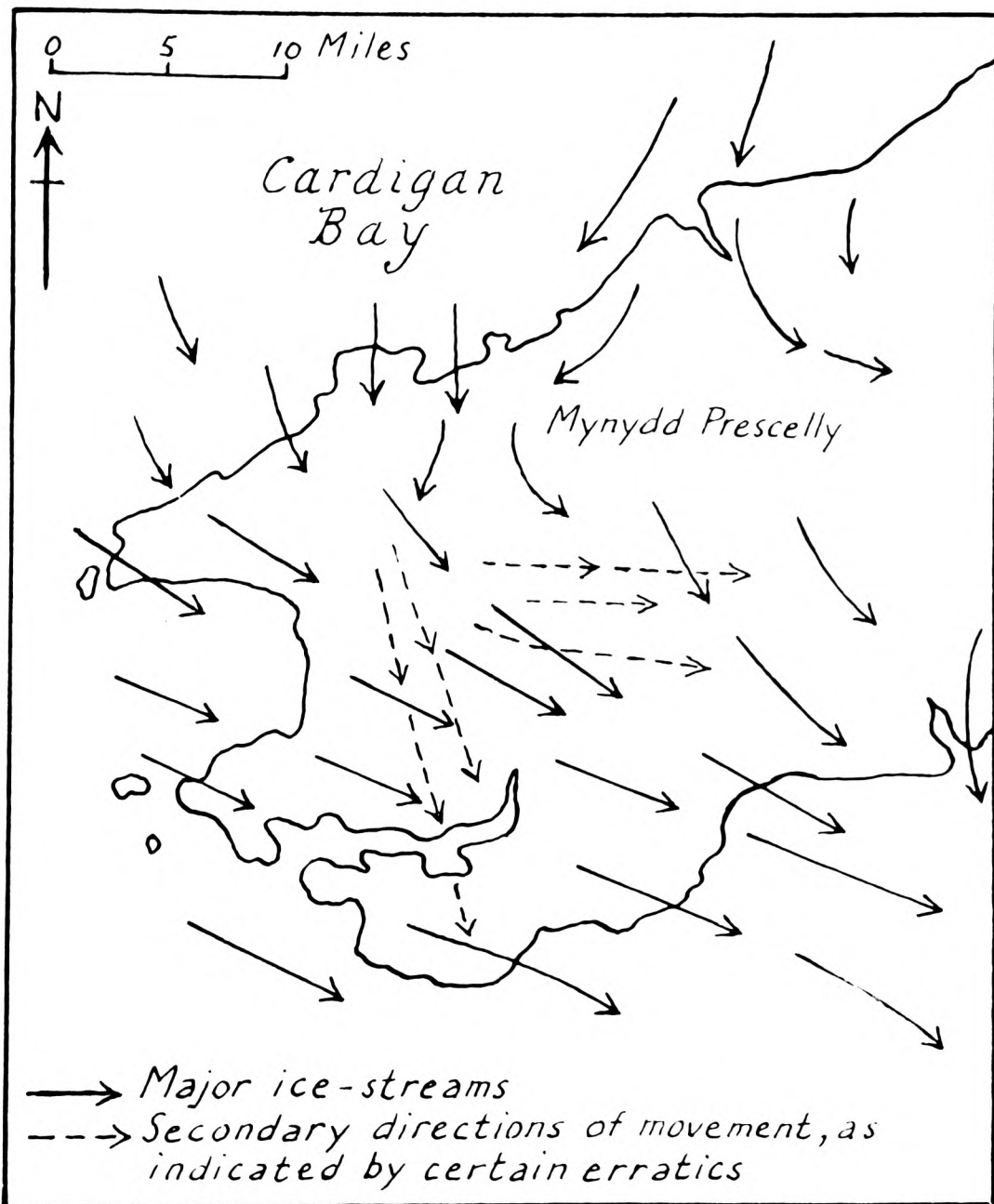


Fig.12 The movement of the Irish Sea Ice across Pembrokeshire, after J.C.Griffith, 1940, (based upon erratic trains)

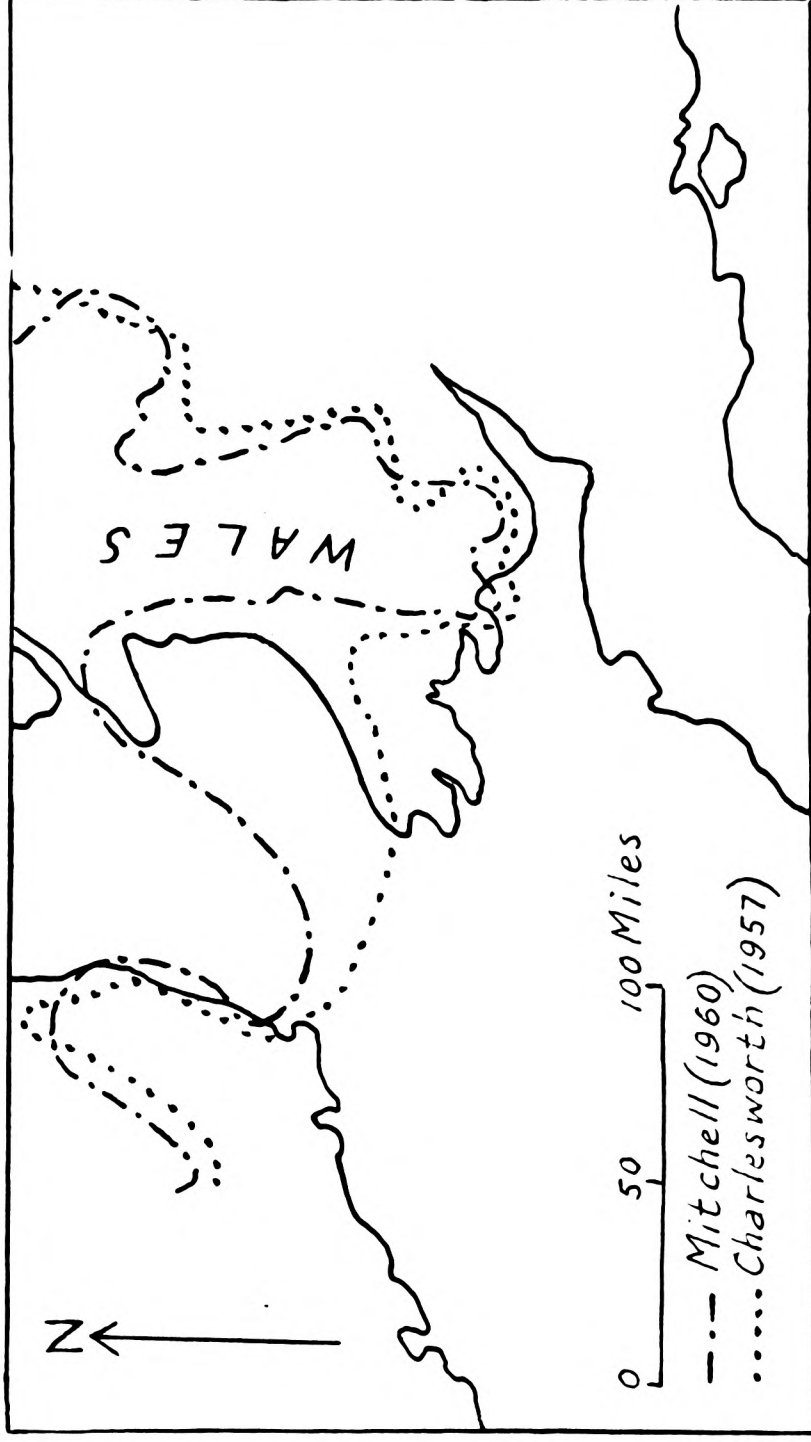
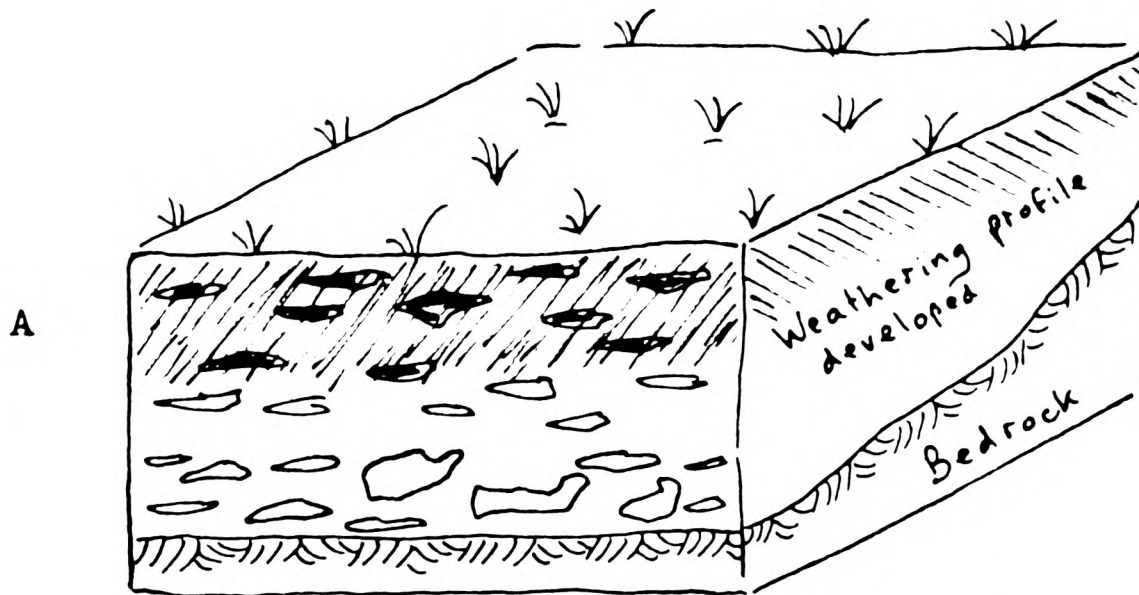


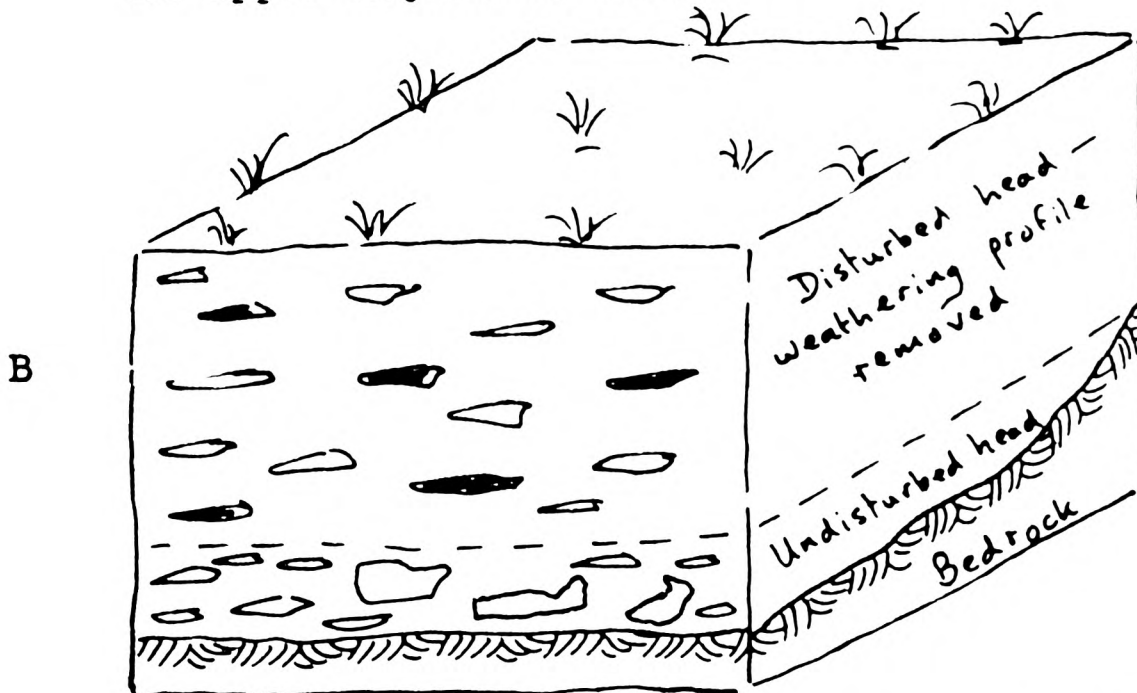
Fig.13 The suggested "Midland General" ice-limit in the southern Irish Sea Basin and Wales, according to Charlesworth and Mitchell.

Charlesworth's limit incorporates the South Wales End-moraine, but Mitchell proposes a Welsh limit on the north side of the Lleyrn Peninsula





Warm phase after head development. Weathering profile in upper layers of head



Return of periglacial conditions. The weathered layer is removed by the new phase of solifluxion.

Fig. 15. A hypothetical sequence of events in which all trace of an interglacial or interstadial weathering period is removed by solifluxion

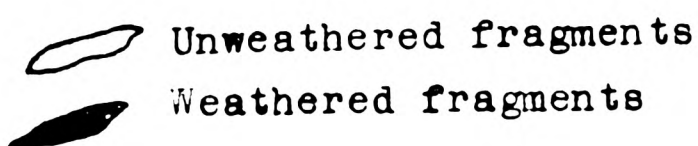
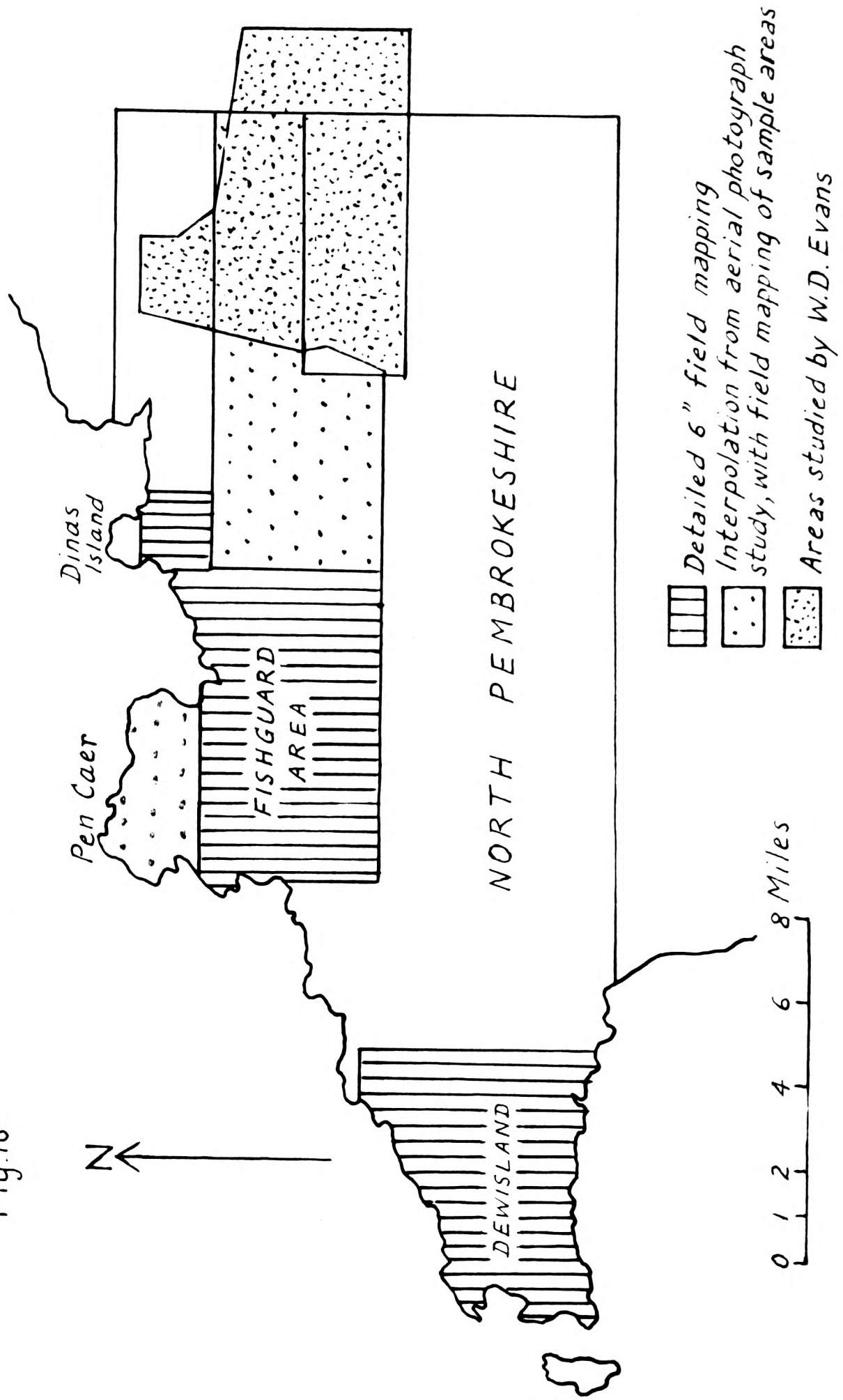


Fig.16



RELIABILITY DIAGRAM, SHOWING THE AREAS STUDIED IN  
DETAIL IN NORTH PEMBROKESHIRE.

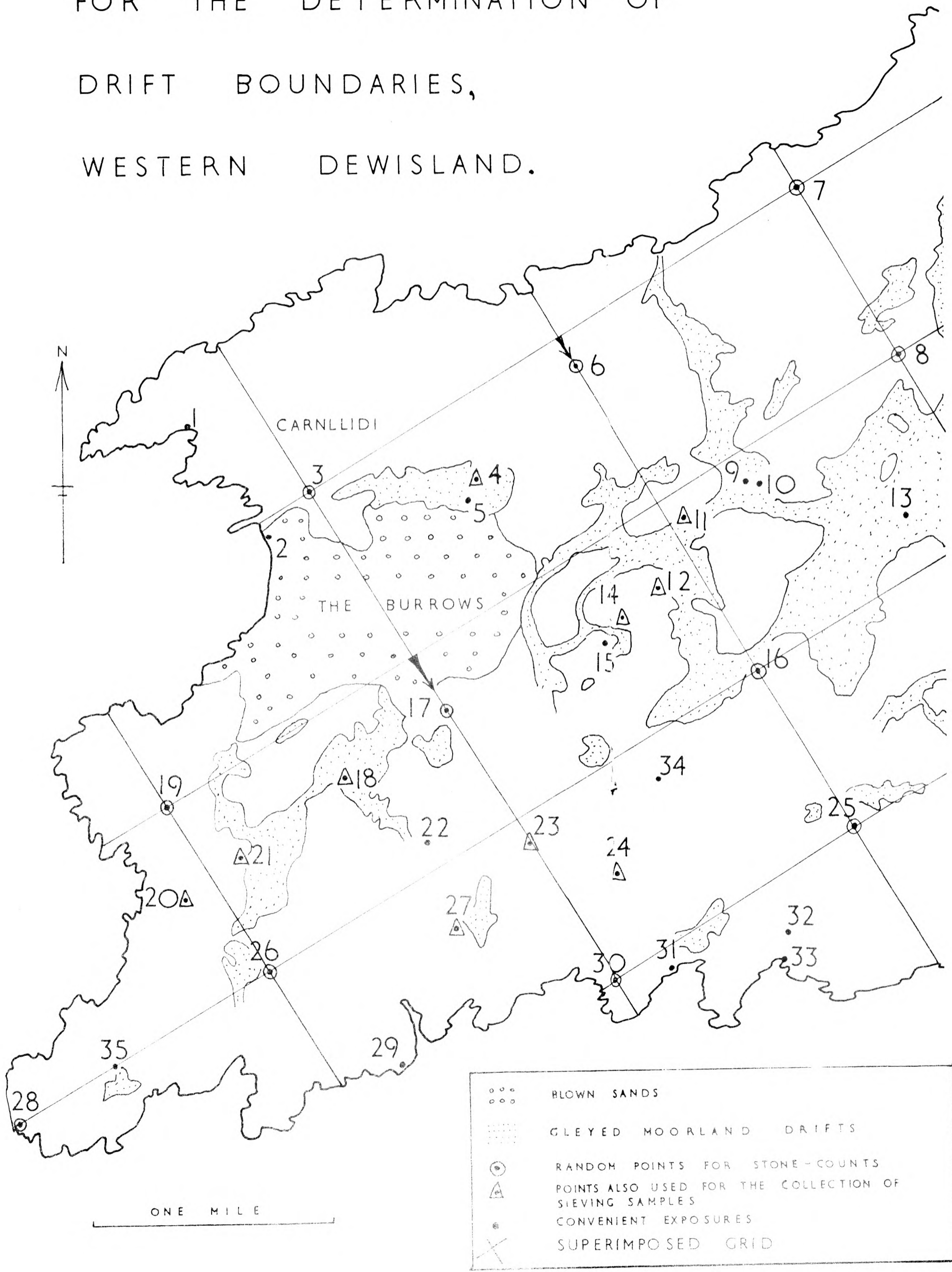
FIG. 17

POINTS USED FOR STONE-COUNTS

FOR THE DETERMINATION OF

DRIFT BOUNDARIES,

WESTERN DEWISLAND.



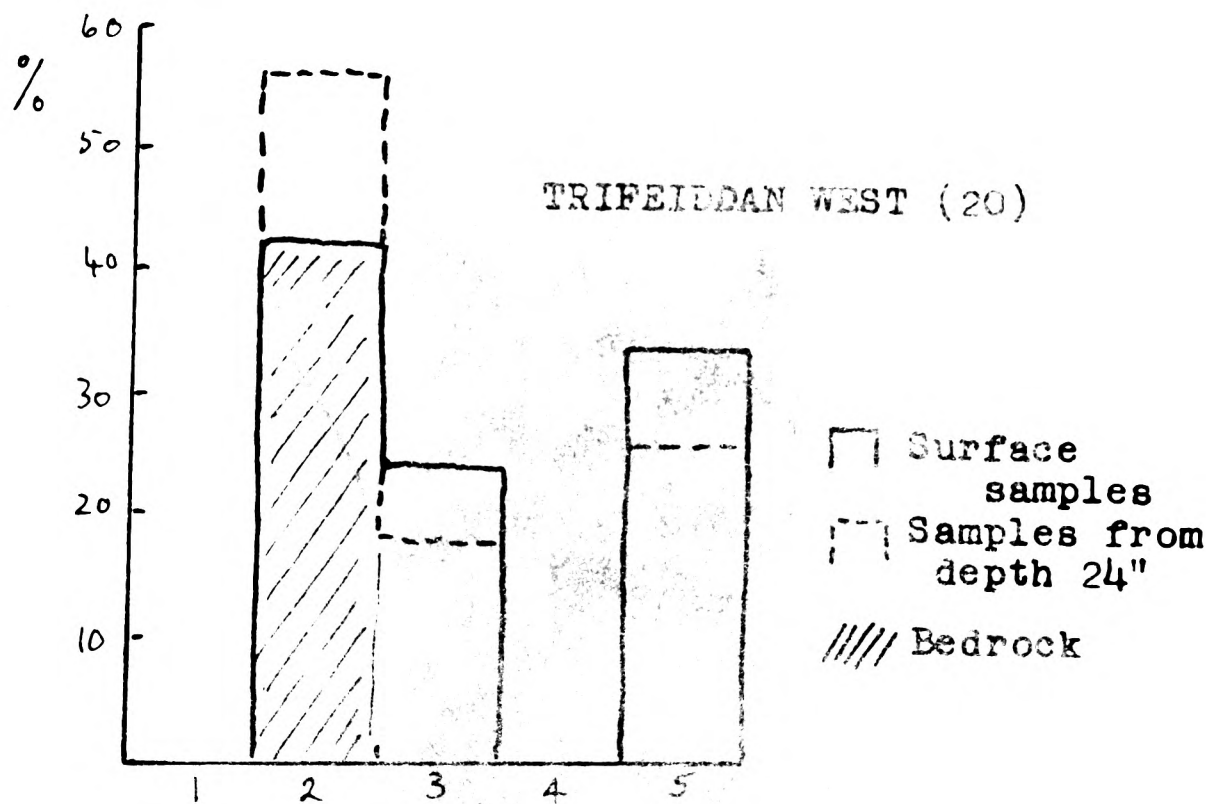
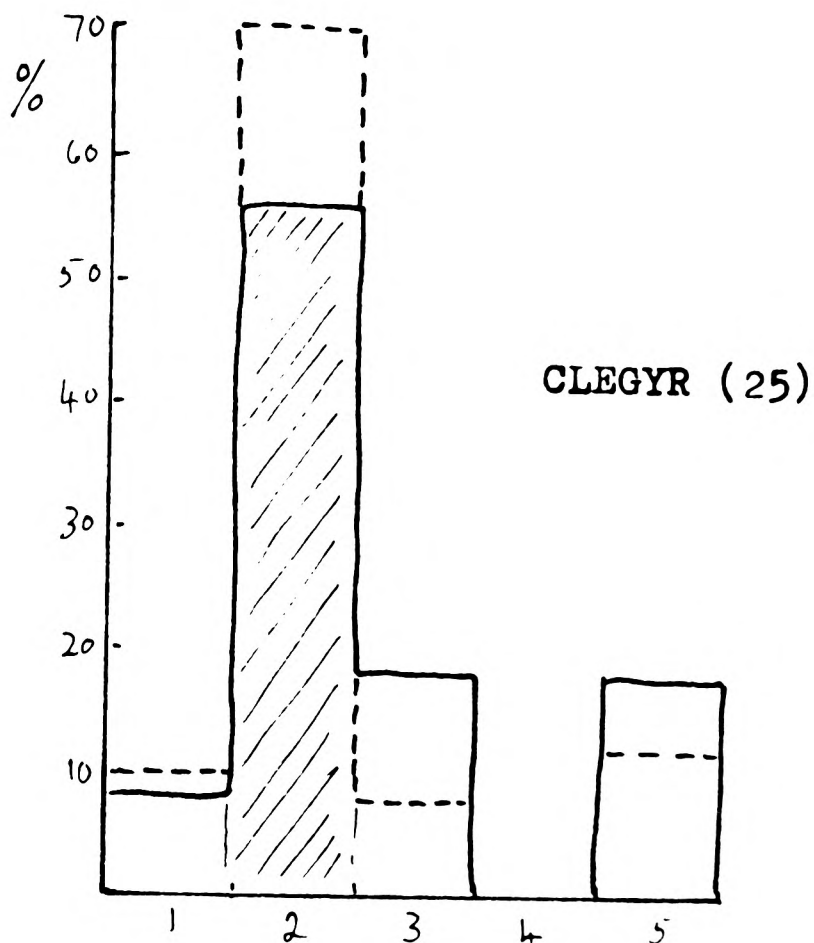


Fig. 18

Histograms showing the pebble composition of drift at two sampling points. Each histogram shows one sample from the surface and another from a depth of 24".

(stone-type categories as indicated on P. 68 of text)

Note the increase in the percentage of bedrock at a depth of 24"; however, there is no basic change in the form of the histogram.

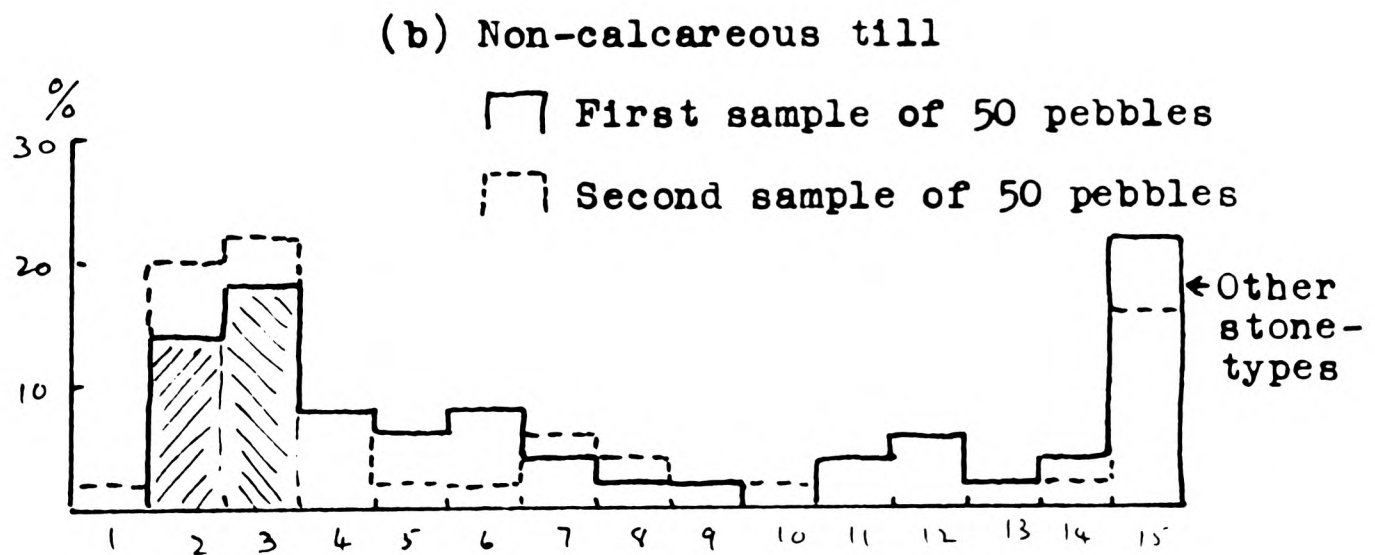
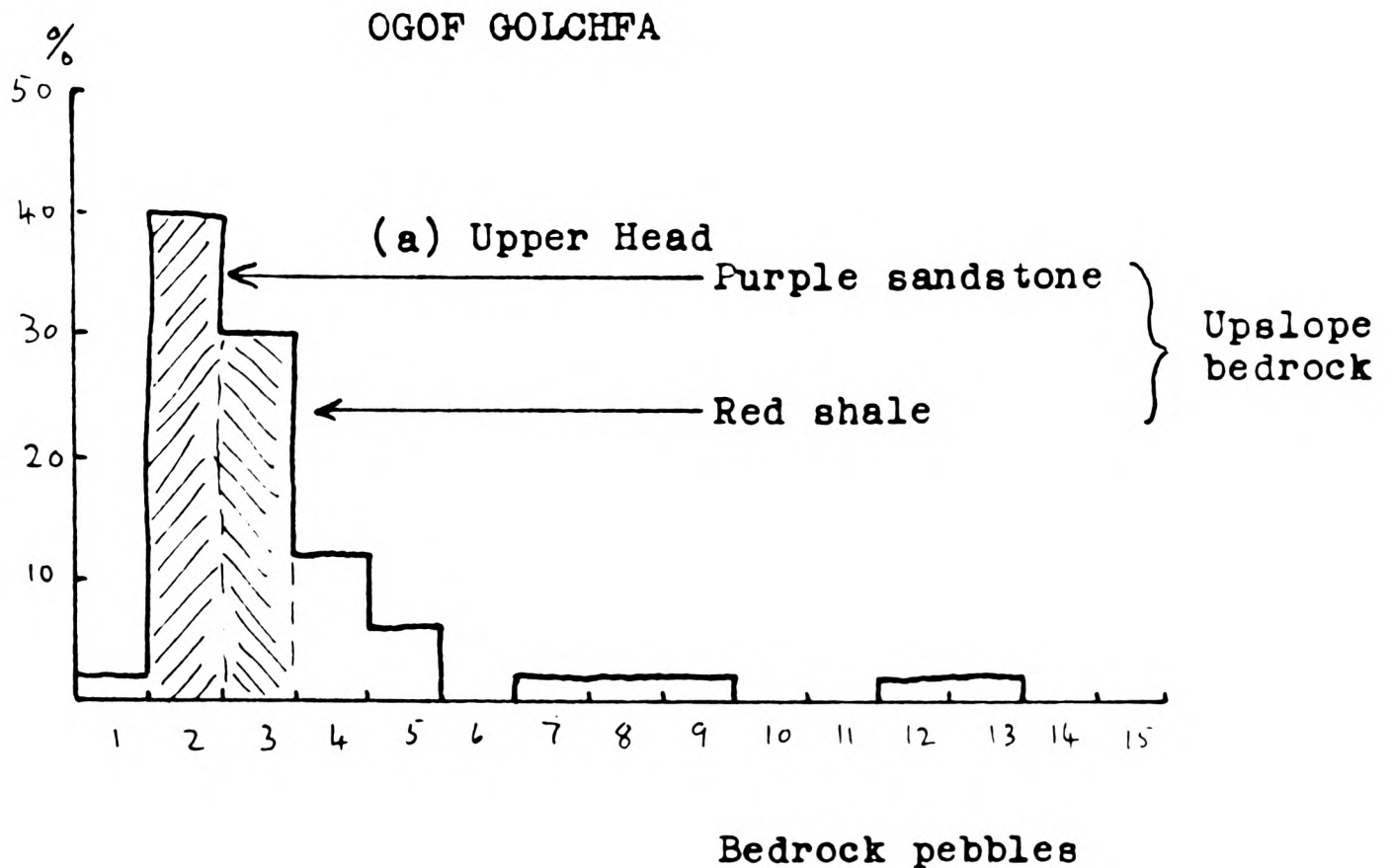


Fig. 19.

Comparative histograms showing the stone-types in two drift deposits exposed in the same cliff.

- Note: 1. The larger percentage of bedrock in the head.  
 2. The greater range of stone-types in till.  
 3. The close correspondence between the histograms for the two independent samples of 50 stones from the till.

THE SYMBOLS USED IN THESE HISTOGRAMS (E.G. FOR BEDROCK PEBBLES) ARE USED IN ALL SUBSEQUENT HISTOGRAMS FOR STONE TYPES IN THIS THESIS.

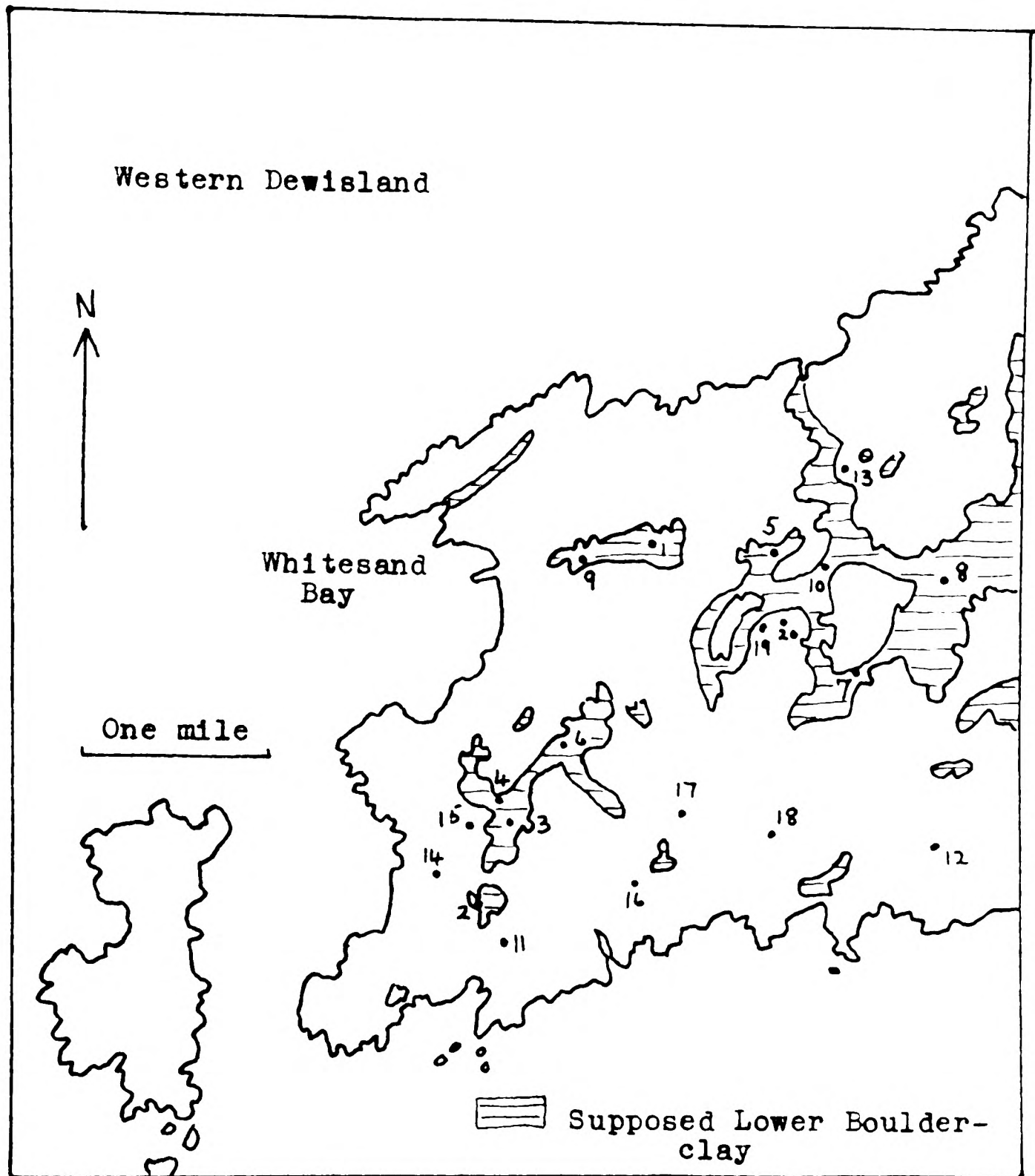


Fig. 20. The hypothetical distribution of Lower Boulder-clay in Western Dewisland, and the plotted random sampling-points.

Nos. 1 - 10 on "Lower Boulder-clay"  
 Nos. 11 - 20 on "Upper Boulder-clay"

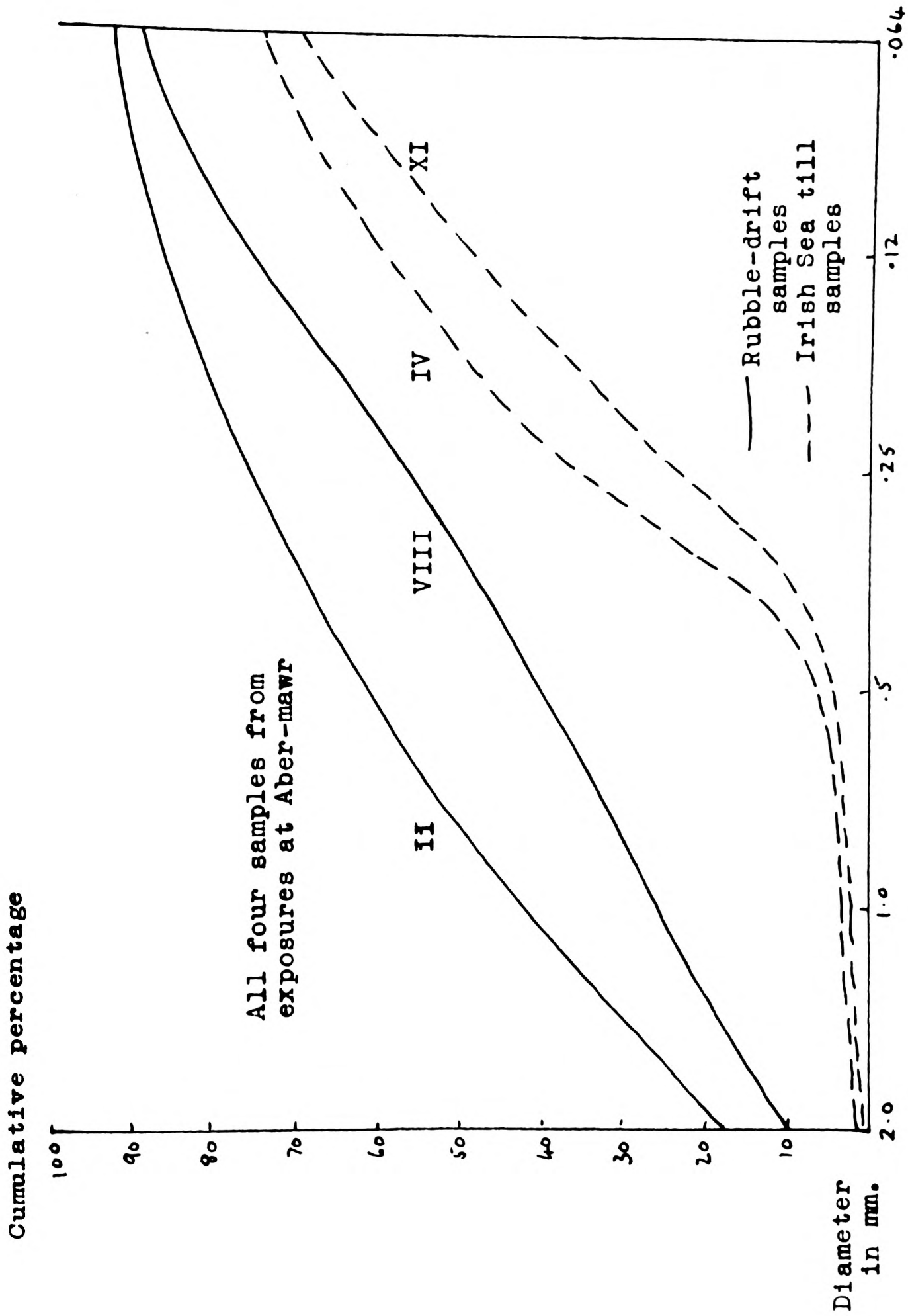


Fig. 21. Grain-size curves for spot samples of Aber-mawr drifts, showing that reasonably consistent curves are obtained for each type of deposit.

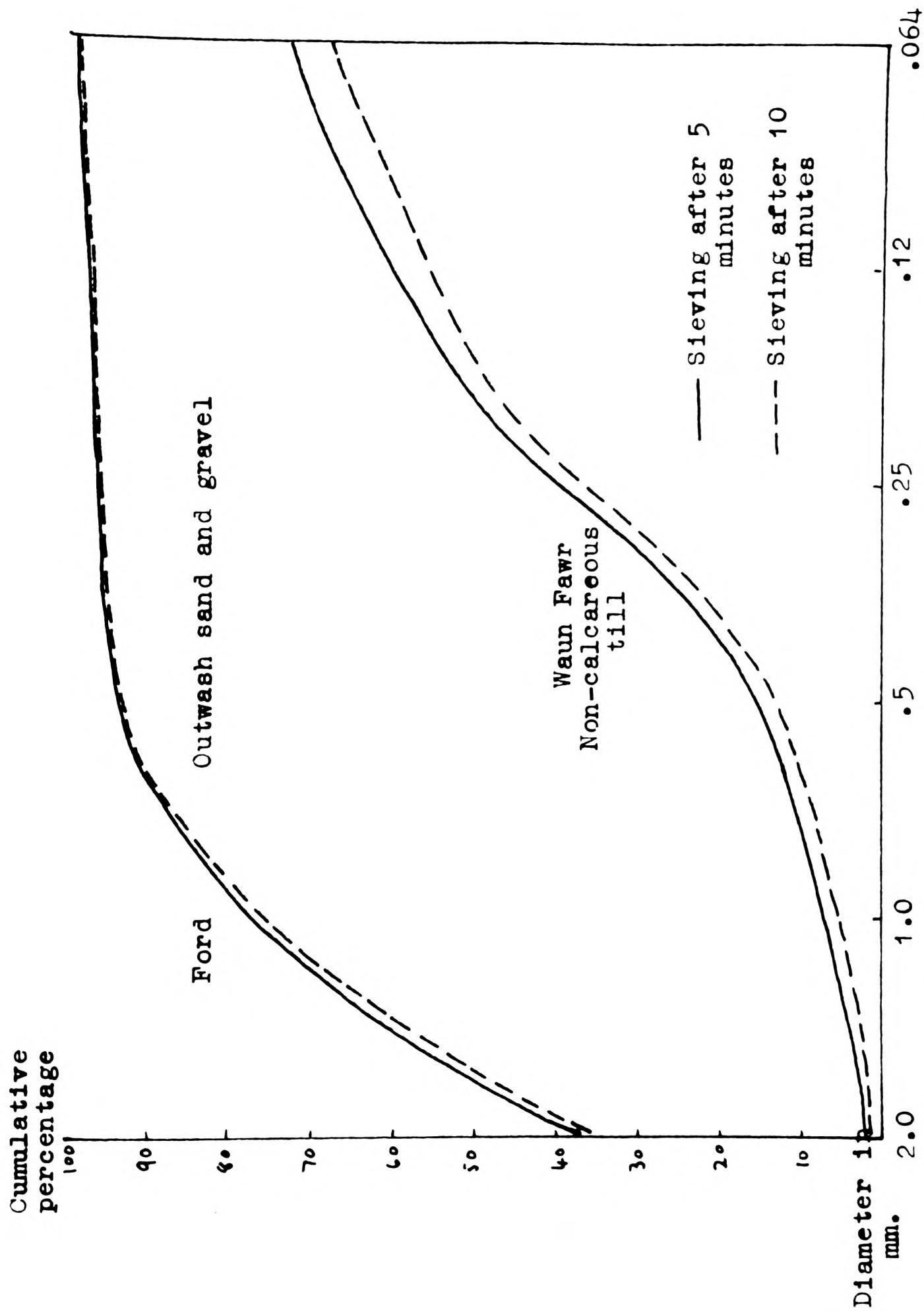


Fig. 22. Two tests to determine the time required for sieving of different deposits. The curves after 5 and 10 minutes are almost identical for sand and gravel, but differ for the fine-grained till.

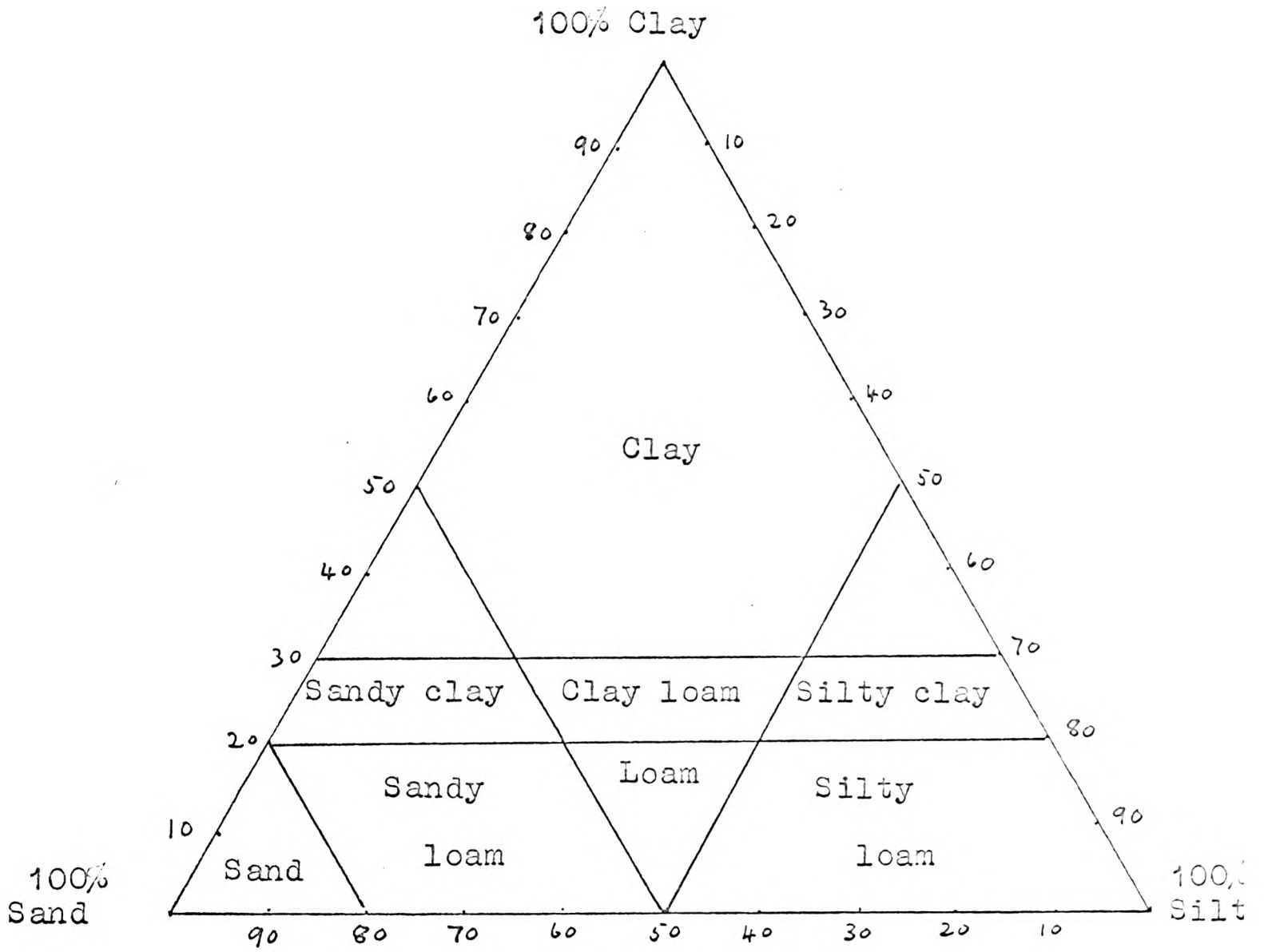
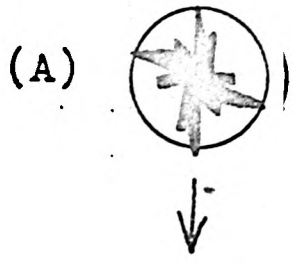
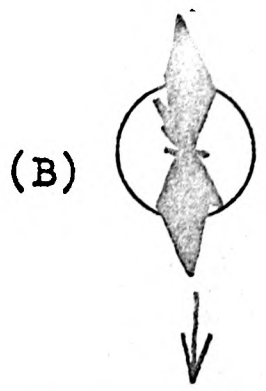


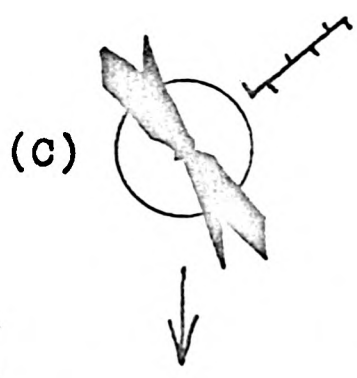
Fig. 23. A classification of soils on the basis of their grain-size distributions. After Lakin and Shaw (in Krumbein and Pettijohn, 1938, P. 203).



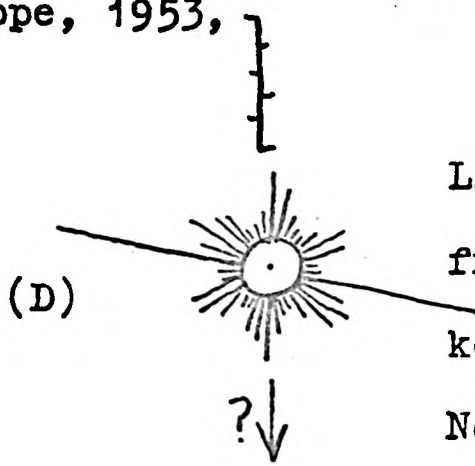
(A) Moraine plateau,  
Veiki, Norrbotten.  
(Hoppe, 1962, Fig. 2)



(B) Ground-moraine from  
Skaftafellsjokull,  
Iceland (Hoppe, 1953,  
Fig. 12)



(C) Hummocky moraine slope,  
Purnu, Norrbotten  
(Hoppe, 1953, Fig. 22)



(D) Lateral block-moraine  
from Litle Jiek'  
kevarribre, North  
Norway (Galloway,  
1956, Fig. 3)

↓ Direction of regional ice-movement  
f Ridge crest.

Fig. 24. Sample diagrams to show the variations in preferred stone orientation with relation to the direction of regional ice-movement.

STONE ORIENTATION

Fig. 25. Sample field form for the measurement of preferred stone orientation.  
 NUMBER OF STONES TAKEN = 50

Y  
 WHITESANDS  
 NORTH  
 GRID REF.  
 SM 733273

O.  
 (3)  
 DATE  
 20.5.64

APPROX. SLUDGE SECTOR = 180° - 210°

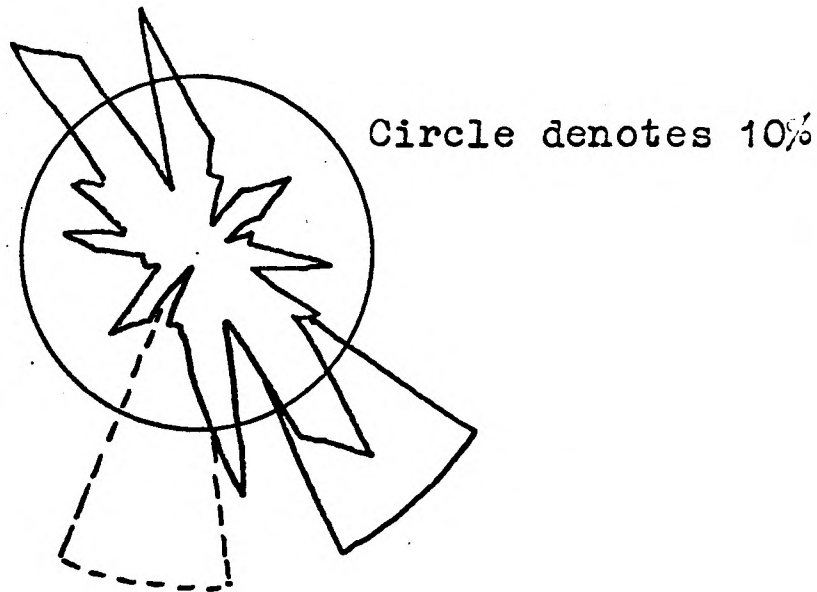
STRATIGRAPHIC NAME		SECTOR	SECTOR	PLOTTED ON	%	
ay - ill calcareous shales + ratics BEDROCK Cambrian Shale	CALCAREOUS SHELLY TILL	1-10	181-190	11	5-185	8
	STONE SIZE	11-20	191-200	11	15-195	4
	1" - 3"	21-30	201-210	11	25-205	4
		31-40	211-220		35-215	
		41-50	221-230	11	45-225	4
		51-60	231-240	111	55-235	6
		61-70	241-250		65-245	2
		71-80	251-260		75-255	
		81-90	261-270	1	85-265	2
		91-100	271-280	1	95-275	2
DESCRIPTION OF SITE		101-110	281-290	11	105-285	8
Wedge of calc. till above head. 1 sq. ft. of face at site (1) 4.7.63.		111-120	291-300	1	115-295	2
FULL DRIFT SECTION		121-130	301-310	111	125-305	8
	131-140	311-320	11	135-315	6	
	Blown Sand	141-150	321-330	111 111	145-325	16
	Rubble-drift	151-160	331-340	111 111	155-335	12
		161-170	341-350	1	165-345	2
		171-180	351-360	111 111	175-355	14

% STONES IN SLUDGE SECTOR = 16%

% STONES IN DOMINANT 30° SECTOR = 34%  
 (i.e. 130° - 160°)

Magnetic north  
 1964  
 (approx.  
 7 20' deviat-  
 ion)

Grid north



WHITESANDS NORTH (3). CALCAREOUS SHELLY  
 IRISH SEA TILL.



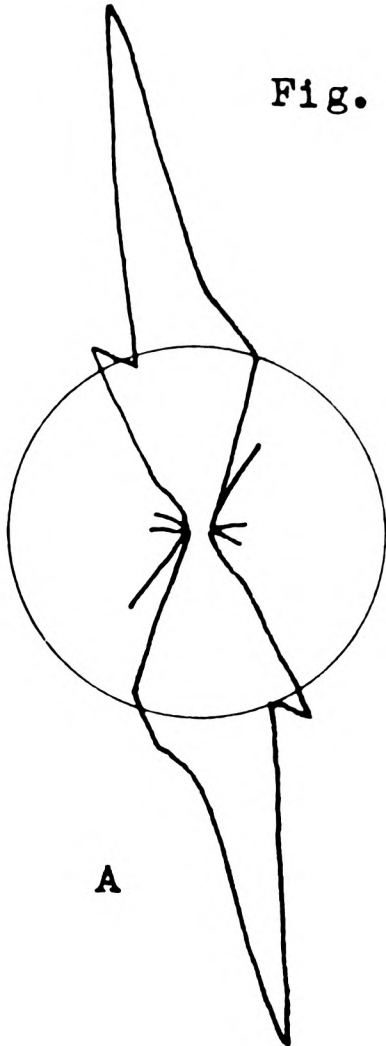
-  Sludge sector : mag. 180 - 210  
(16%)
-  Dominant 30 Sector: mag. 130 - 160  
(34%)

Fig. 26.

A sample preferred orientation diagram for one of the drift exposures in North Pembrokehire.

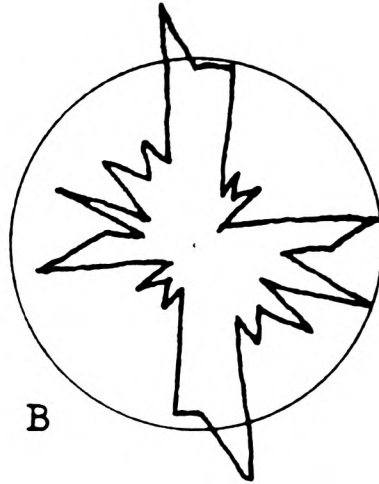
The symbols used here are used in subsequent diagrams in the thesis.

Fig. 27. Some types of preferred orientation diagram.

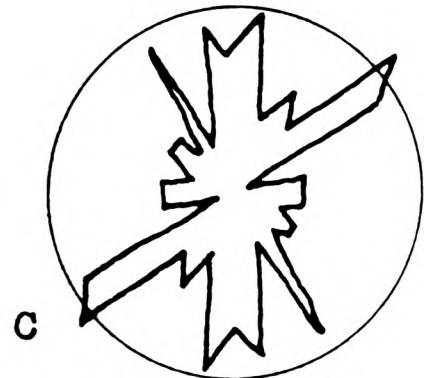


Ogof Golchfa  
(1)

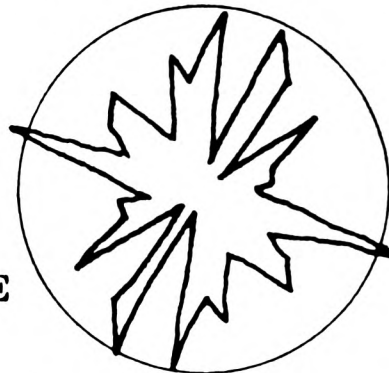
"SIMPLE TYPE"



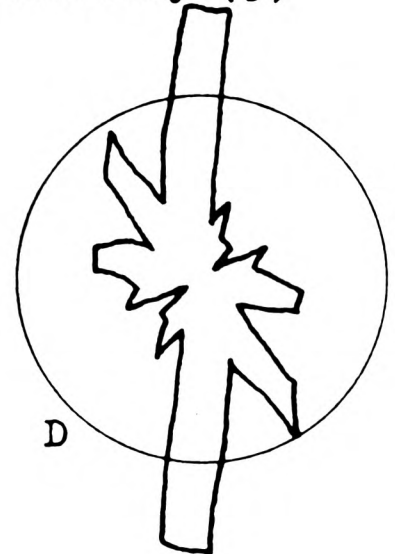
Porth-y-Rhaw (2)



Caerbwdy (5)



Trefeiddan West  
R.P. 14 UBC



Sibbernock Point  
(1)

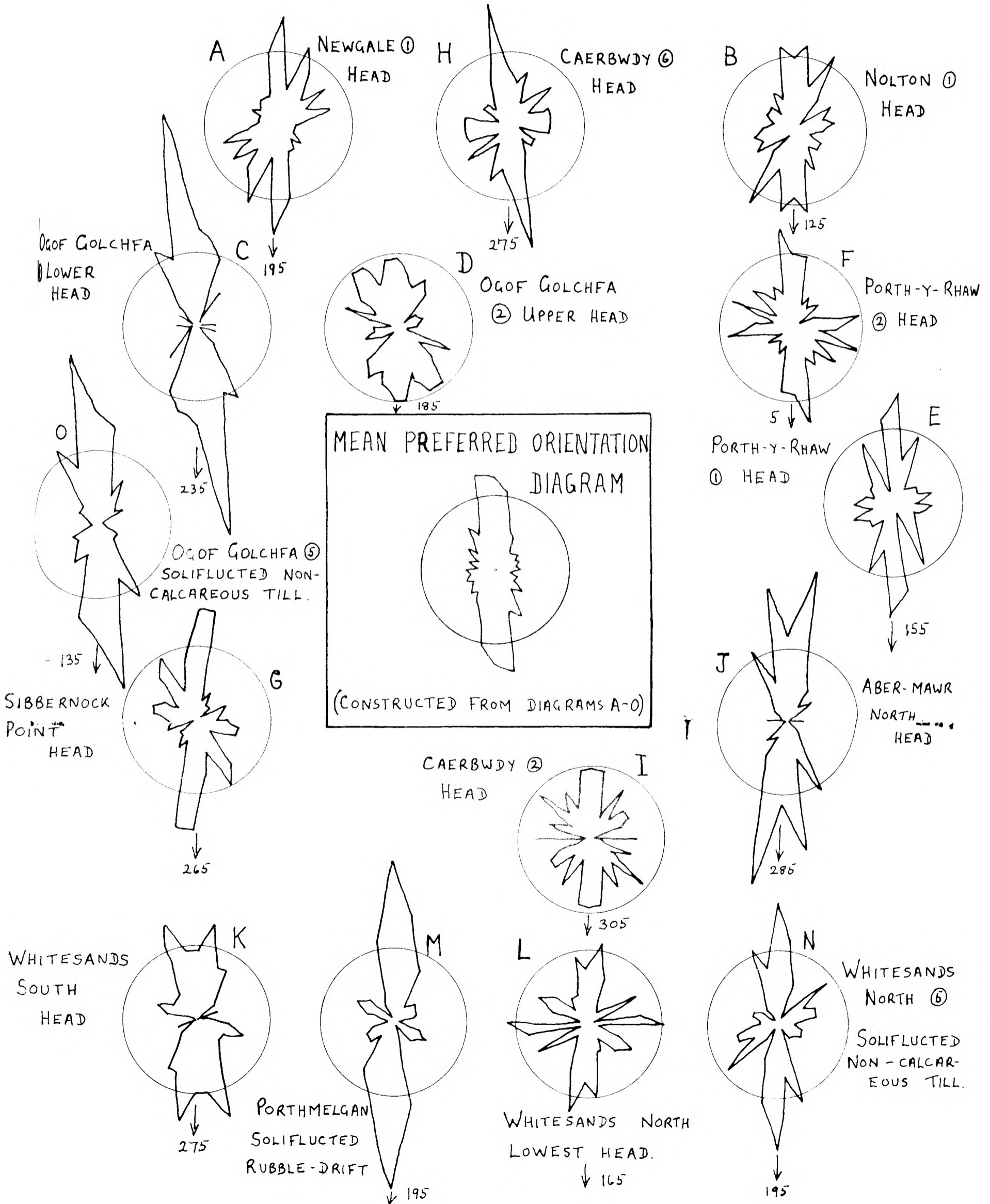
"COMPOUND TYPES"

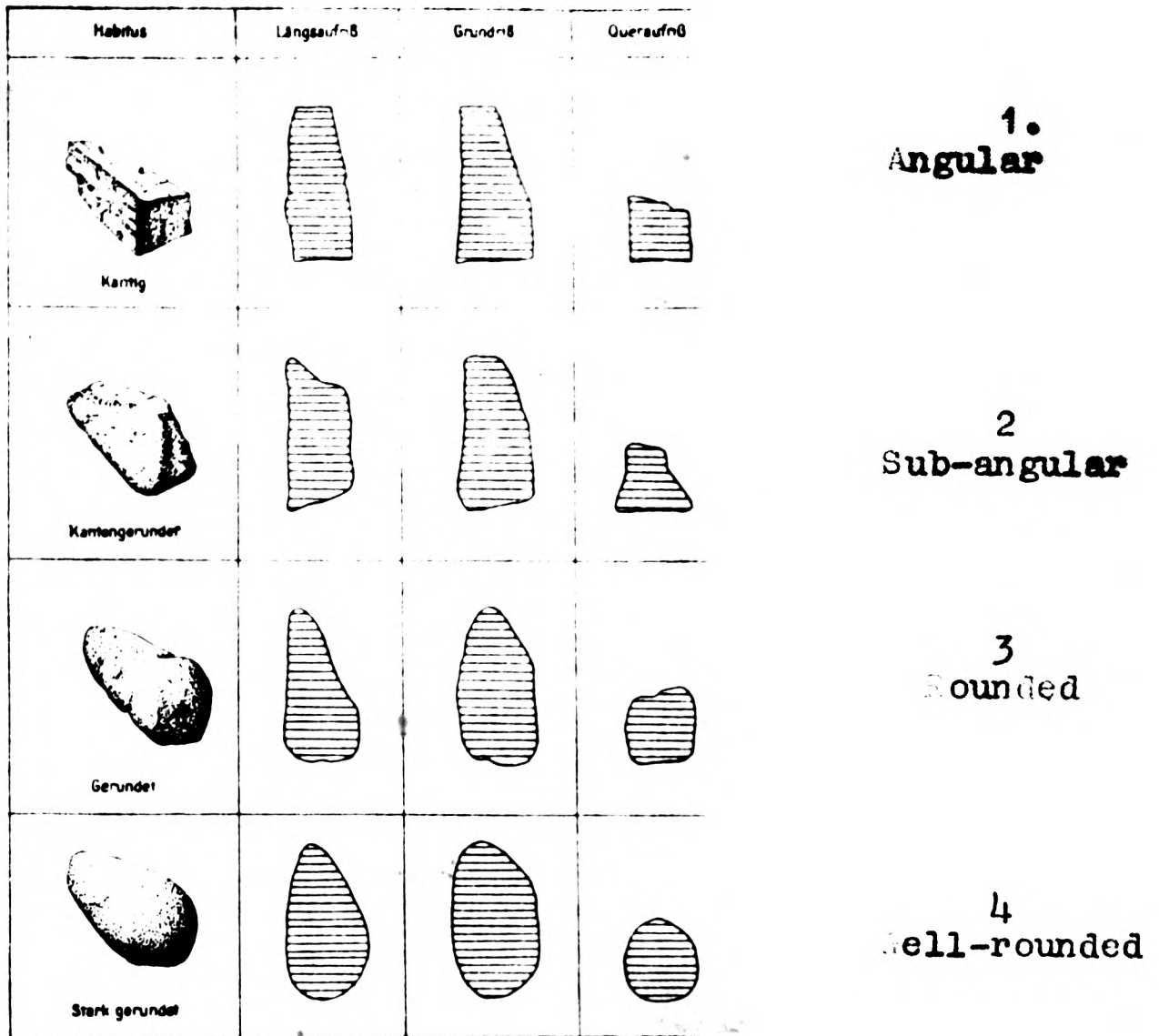
- A. A strong diagram (56%) with a minor oblique peak and no transverse peak.
- B. A rather weak diagram (34%) with a strong transverse peak and minor oblique peaks.
- C. A weak diagram (28%) with strong oblique peaks.
- D. A moderately strong diagram (40%) with strong oblique and transverse peaks.
- E. A very weak diagram (14%).

# PREFERRED ORIENTATION DIAGRAMS FOR SOLIFLUXION DEPOSITS

FIG. 28

ORIENTATIONS STANDARDISED BY DEPICTING CENTRE OF DOMINANT 30° SECTOR AS DUE SOUTH.  
FOR CONSTRUCTION DETAILS SEE APPENDIX V.

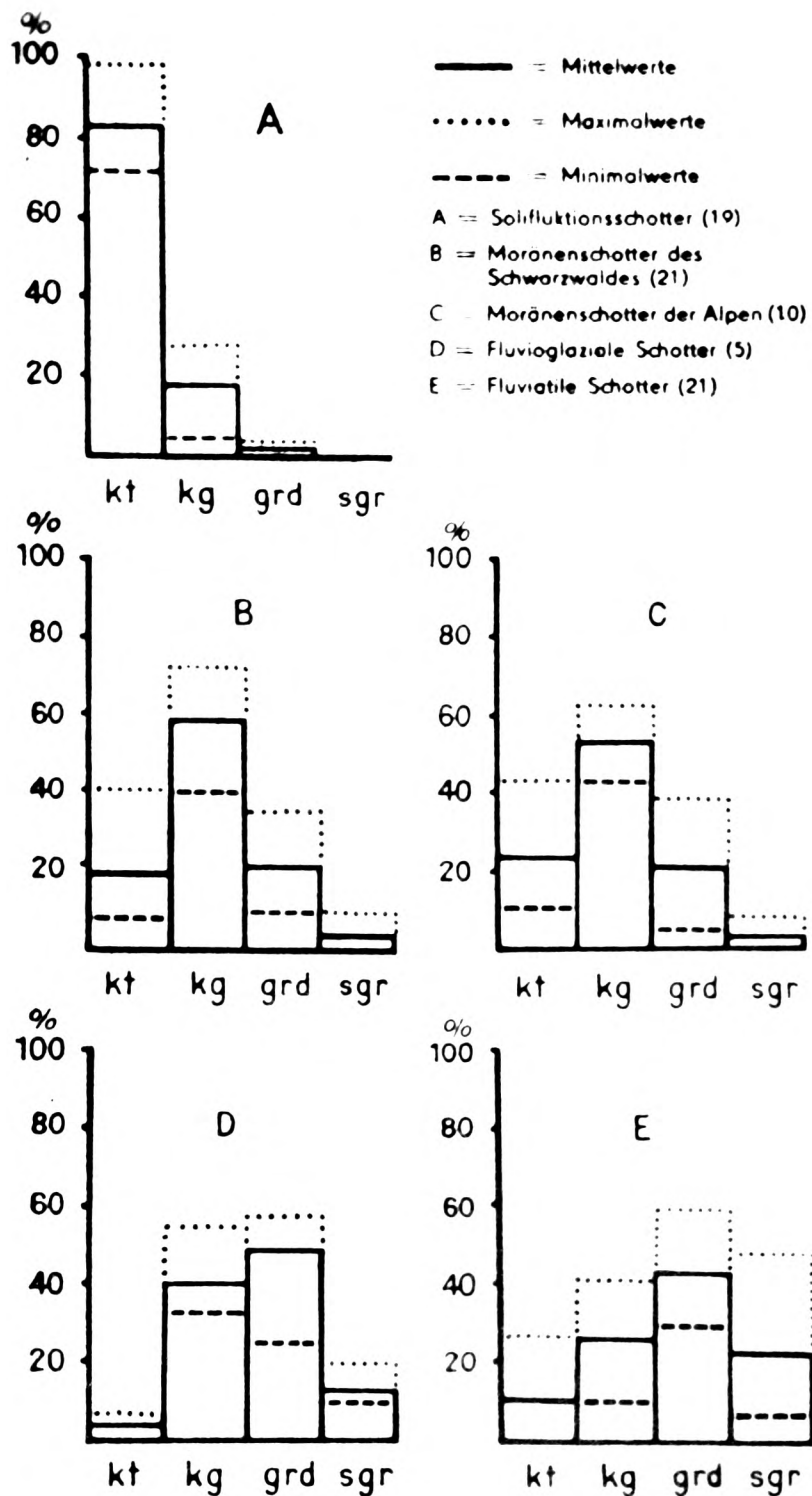




**Fig. 29.**

The pebble roundness categories proposed by Reichelt, 1961. These categories were used during the analysis of pebble-roundness in North Pembroke-shire.

In subsequent histograms the roundness categories are identified by number only.

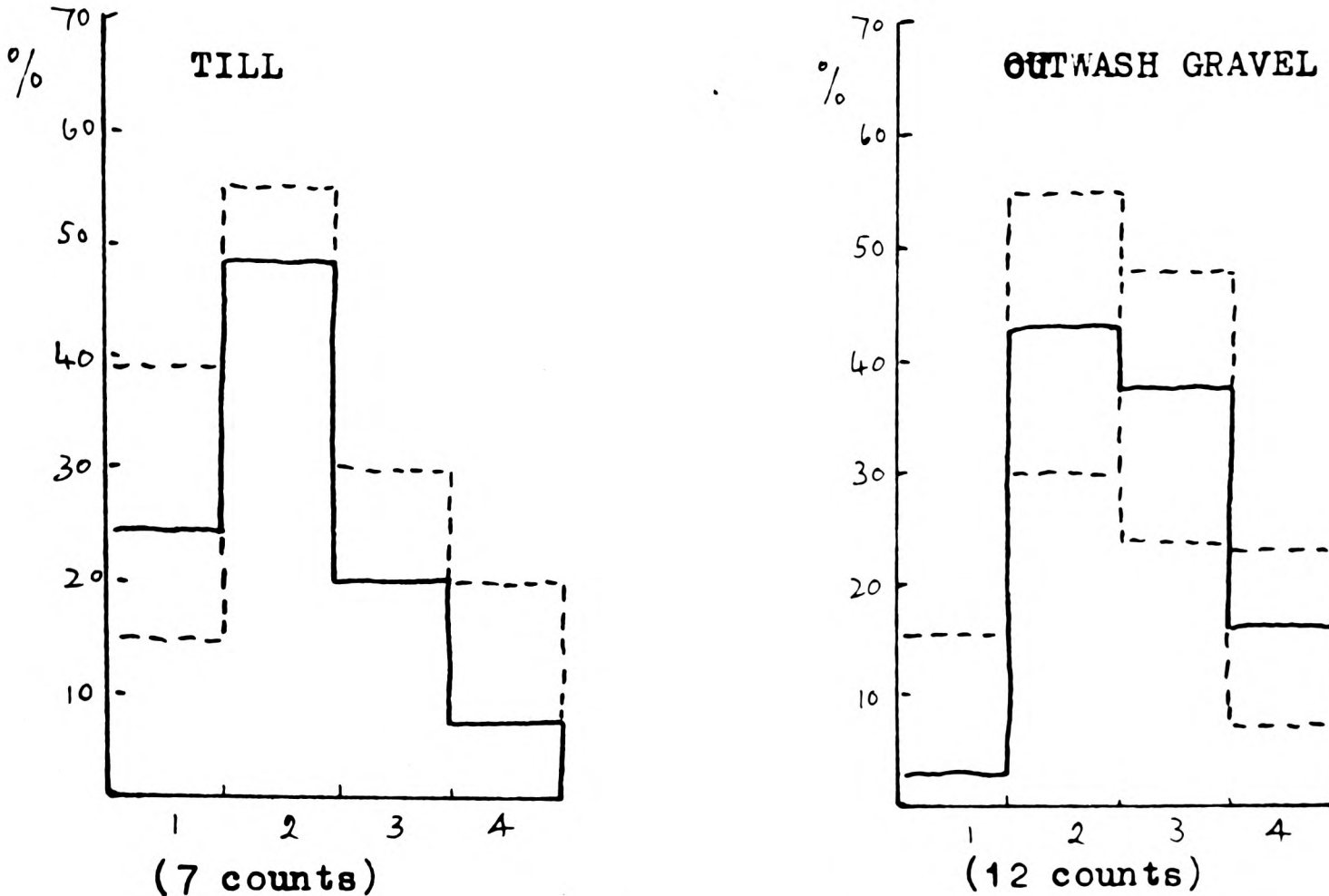


**Fig. 30. Histograms from Reichelt, 1961, showing the roundness of pebbles in different deposits.**

**kt= angular, kg= sub-angular, grd= rounded, sgr= well-rounded.**

**Histogram A is for head, B and C for till, D for fluvioglacial material, and E for fluvial pebbles.**

CASEMENT GLACIER, ALASKA



(Stone-roundness categories as shown in Fig. 29)

Fig. 31.

Histograms showing the degree of roundness on pebbles in till and outwash sands and gravels beyond Casement Glacier, Alaska (constructed from R.J. Price, 1964, Table I, P. 6)

--- Maximum and Minimum      □ Mean

Note that the till has a higher percentage of angular and sub-angular pebbles, while the outwash has a higher percentage of rounded pebbles.

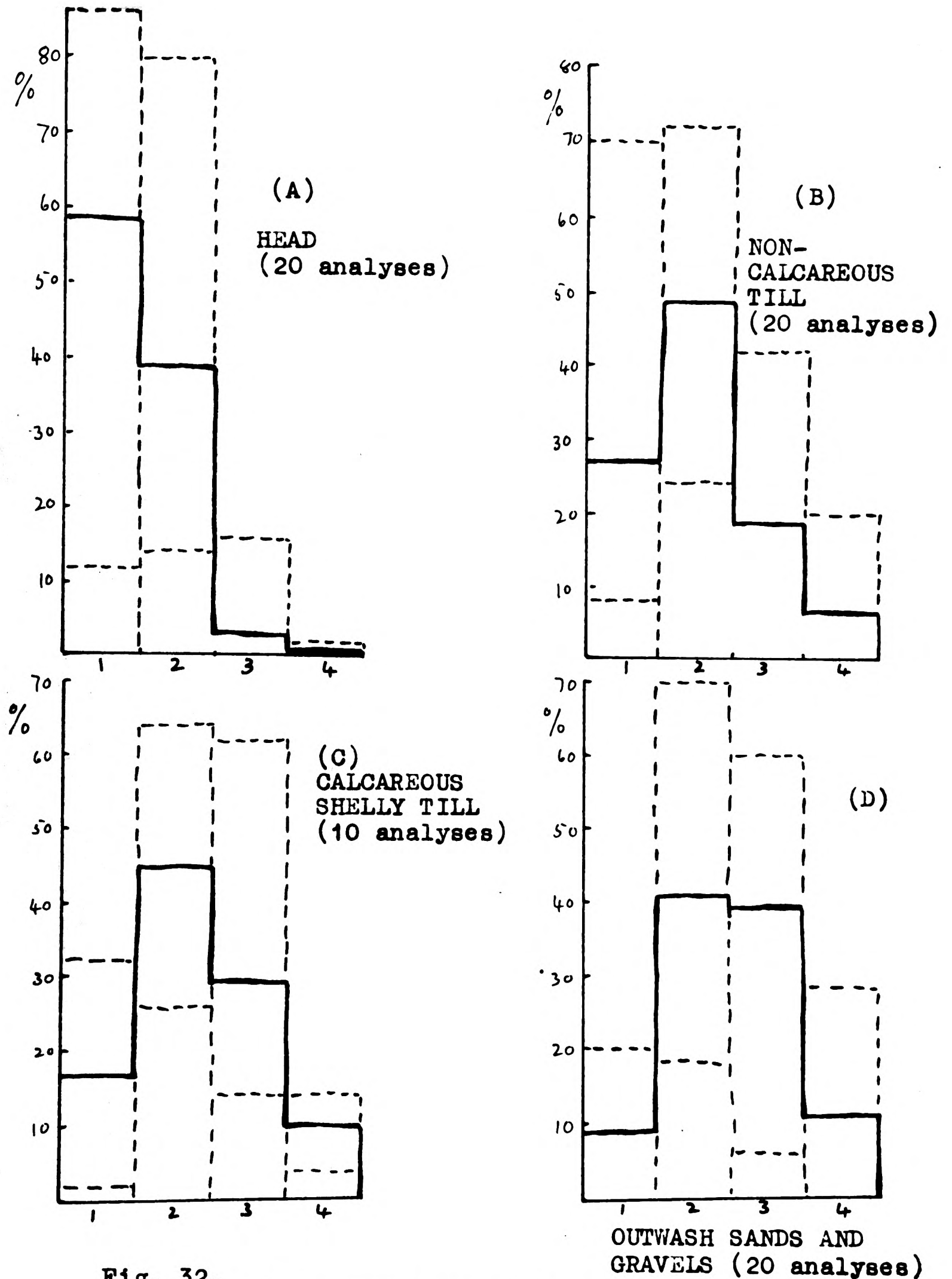
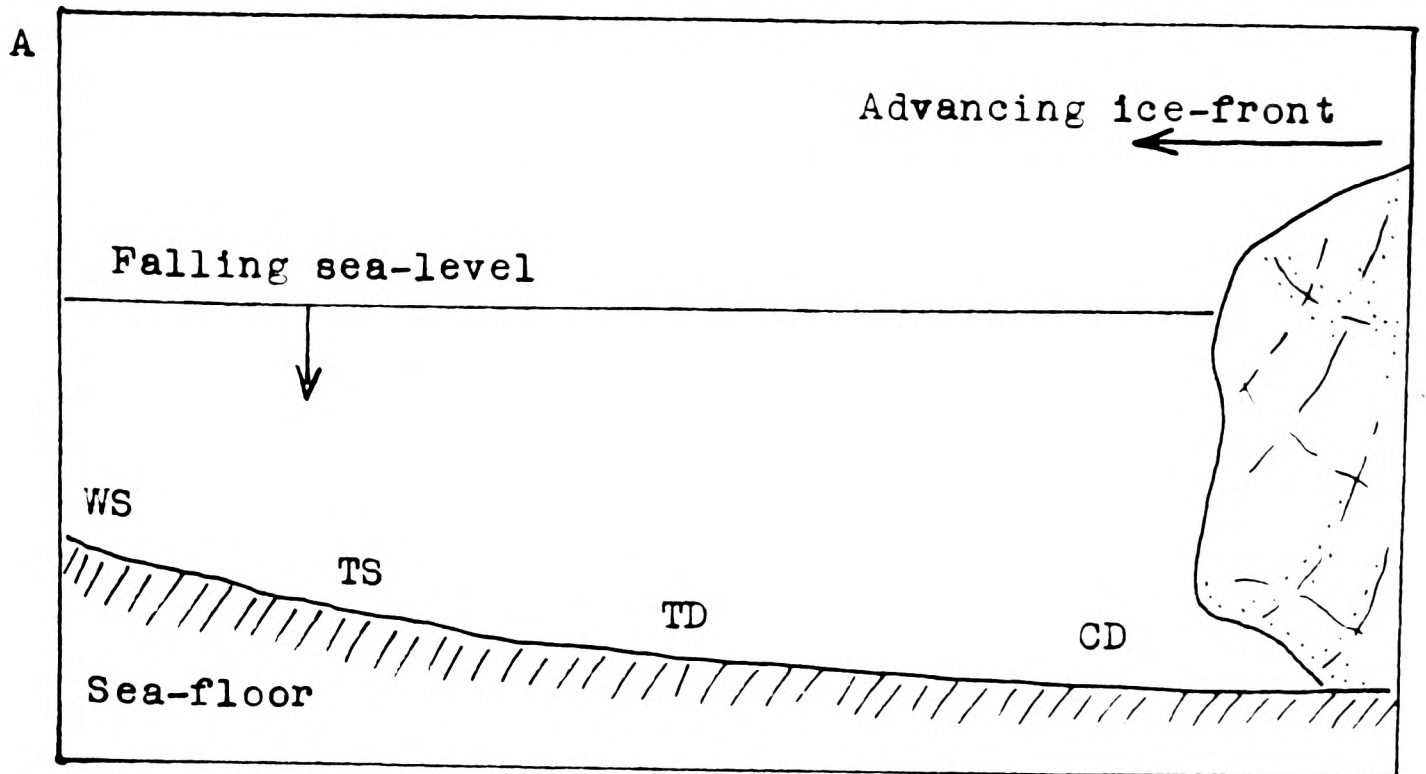


Fig. 32.

Stone roundness analyses: type diagrams for various Pembrokeshire drifts (using the stone roundness categories and methods of Reichelt)

--- MAXIMUM AND MINIMUM.     MEAN.



Key to mollusc communities: WS = warm shallow-water  
 TS = temperate shallow water. TD = temperate deep water  
 CD = cold deep water CS = Cold shallow water.

( ) = fauna killed by changing conditions

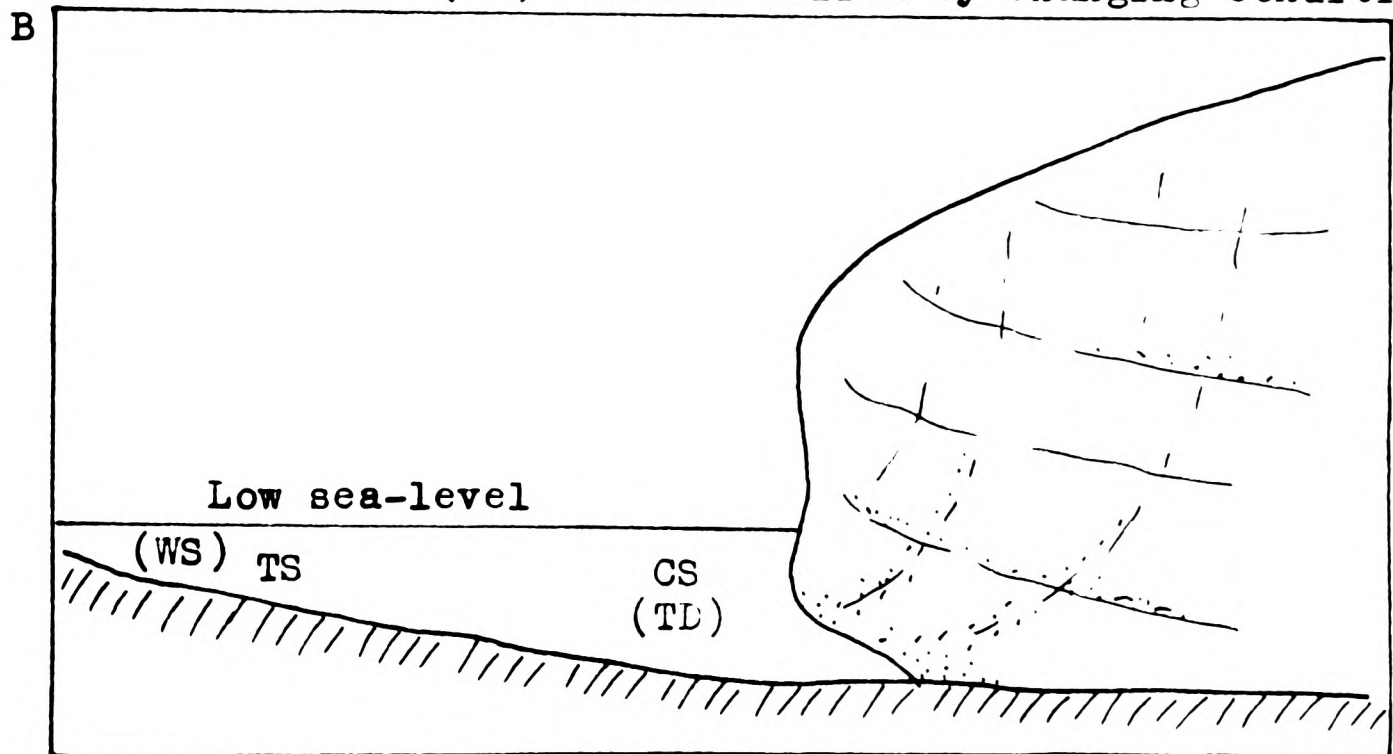


Fig. 33. Idealised diagram showing a possible succession of marine mollusc communities as an ice-front advances and as climatic conditions deteriorate. Sea-level falls as a glaciation reaches its maximum (omitting the complication of isostatic depression of the sea-floor). (After information in Ockelmann, 1958; Spärck, 1933; Thorson, 1933).

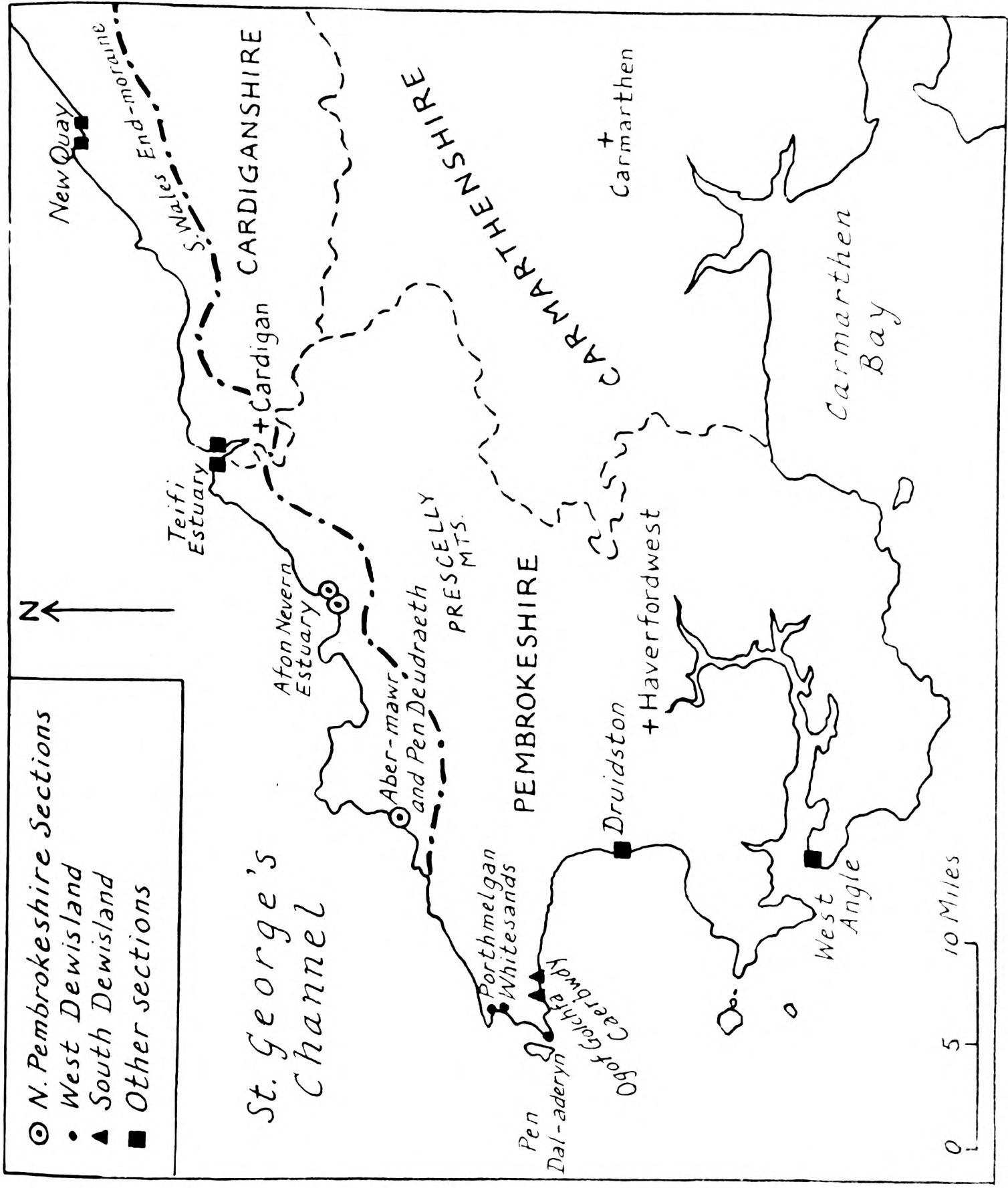


Fig. 34 The Location of Sections analysed in Part III.

**Fig 35.**

**For convenience Fig. 35 is folded into the back of the thesis where it can be consulted alongside individual sections.**

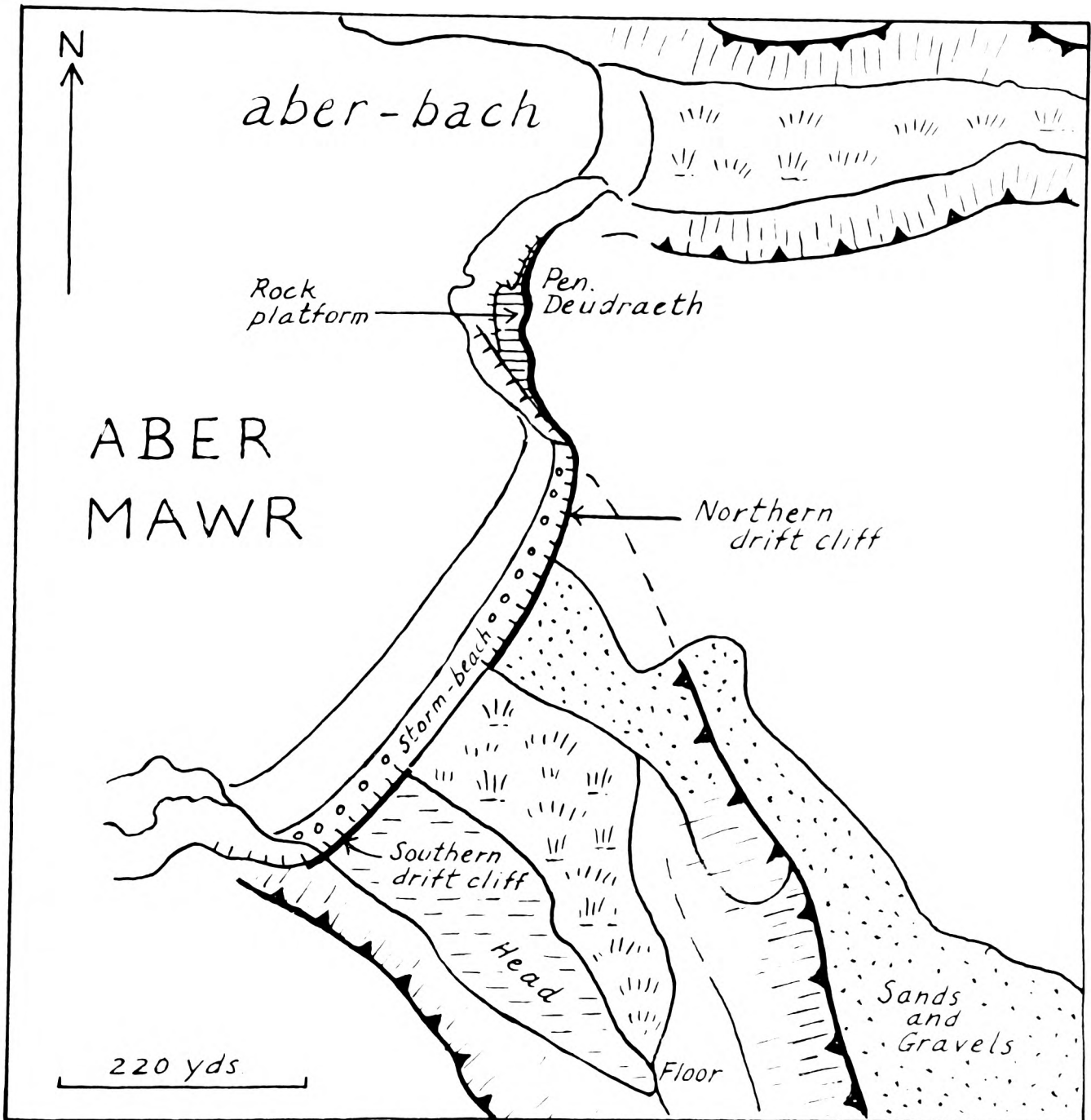
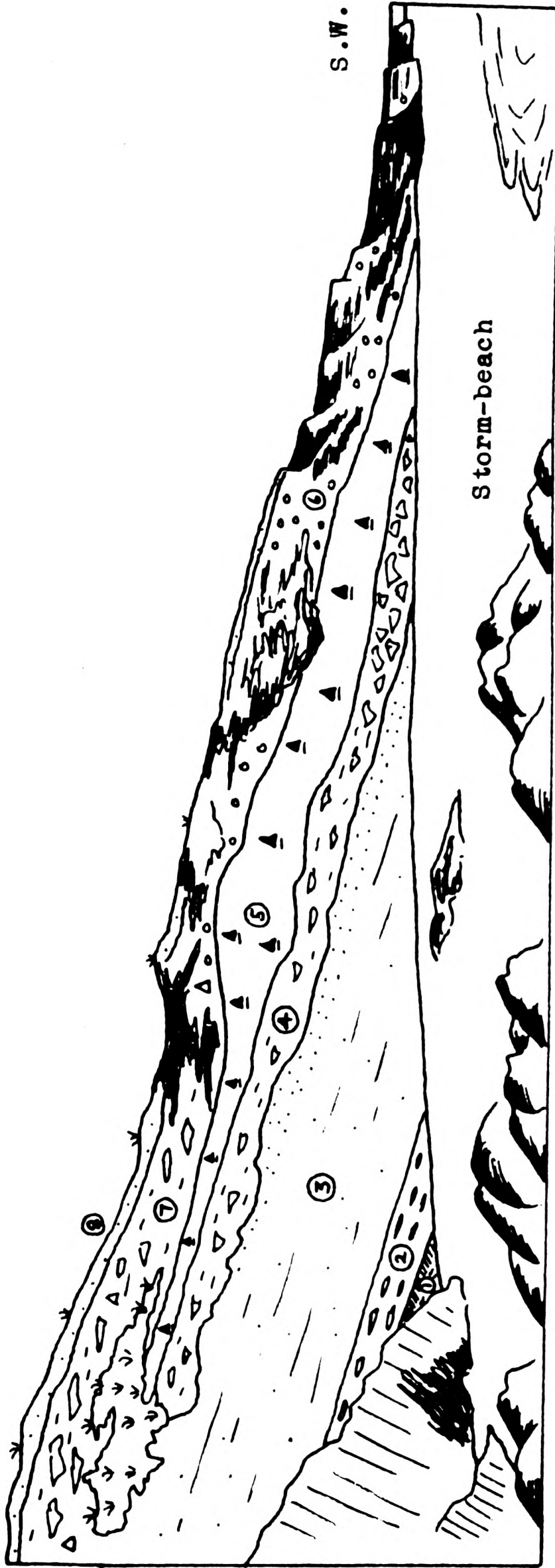


Fig.36 Aber Mawr: Location of Sections

N.E.



Not to scale

Fig. 37. A perspective view of the Northern Drift Cliff at Aber-mawr. Seen from beneath the cliff close to Pen Deudraeth.

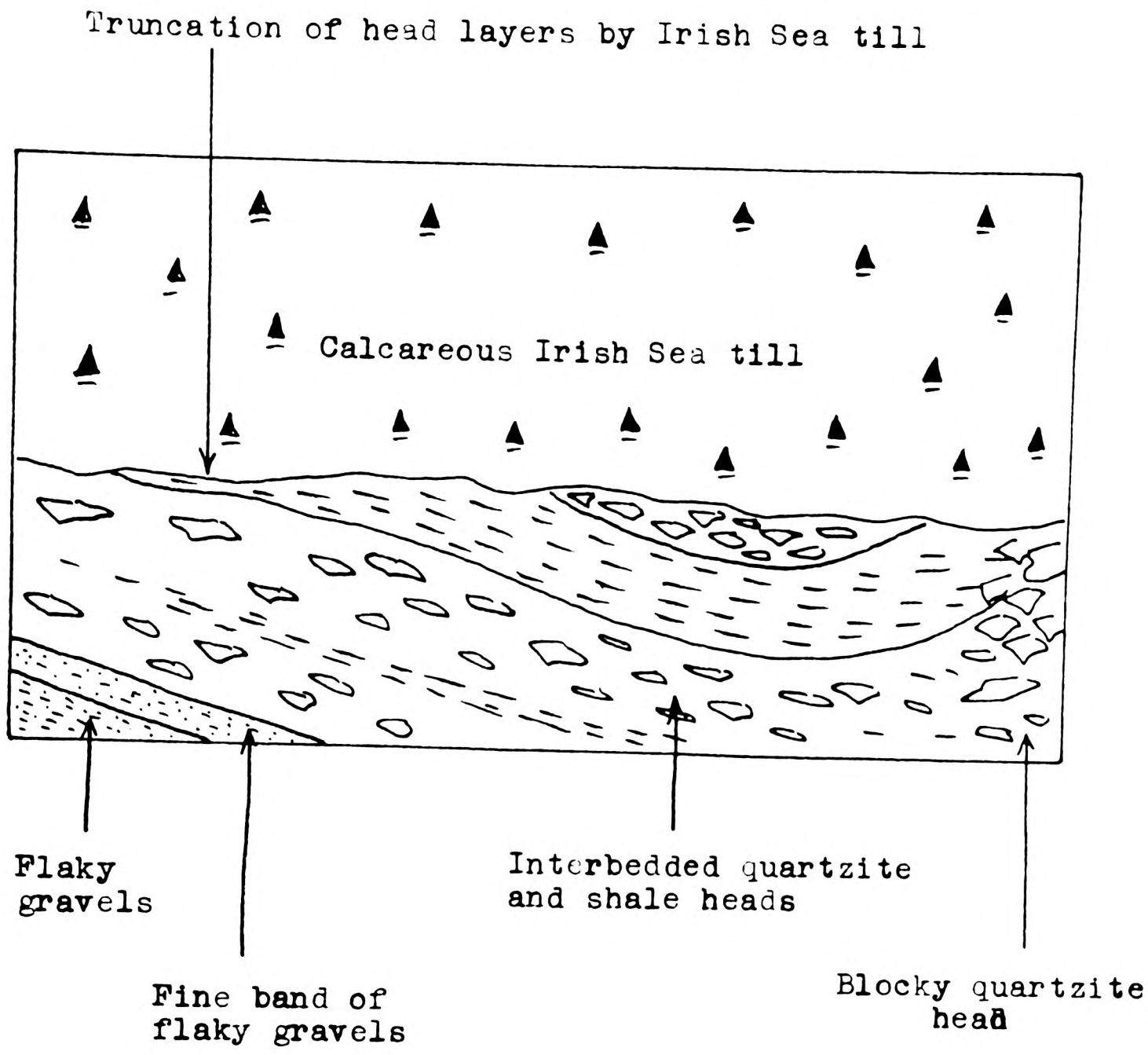
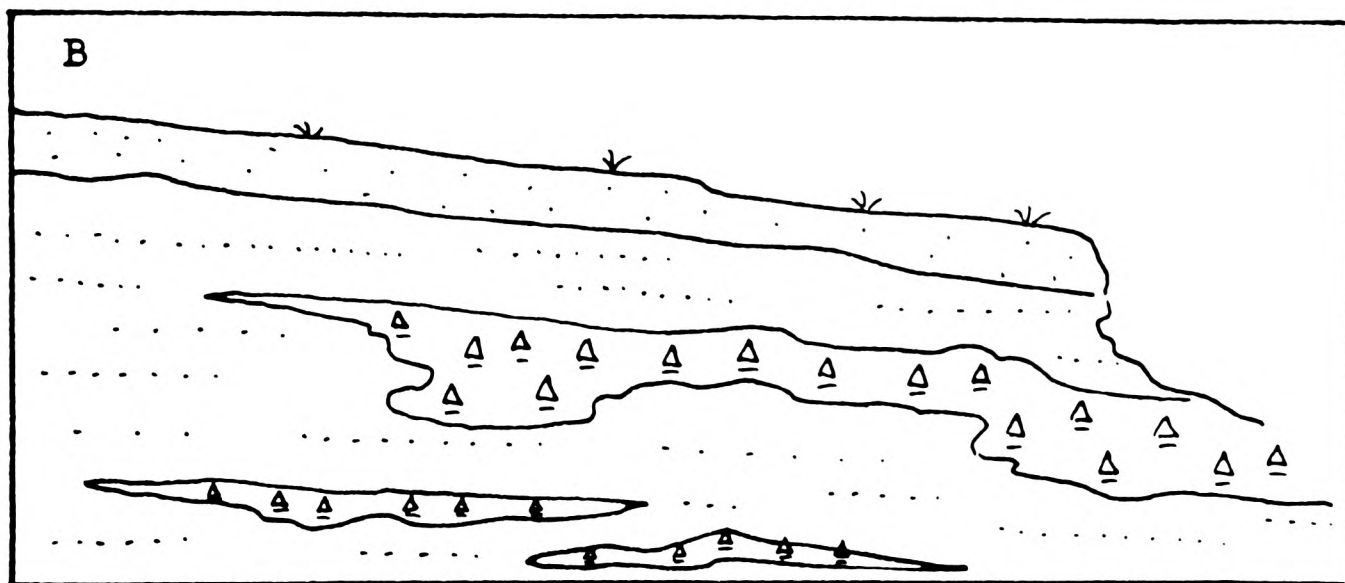
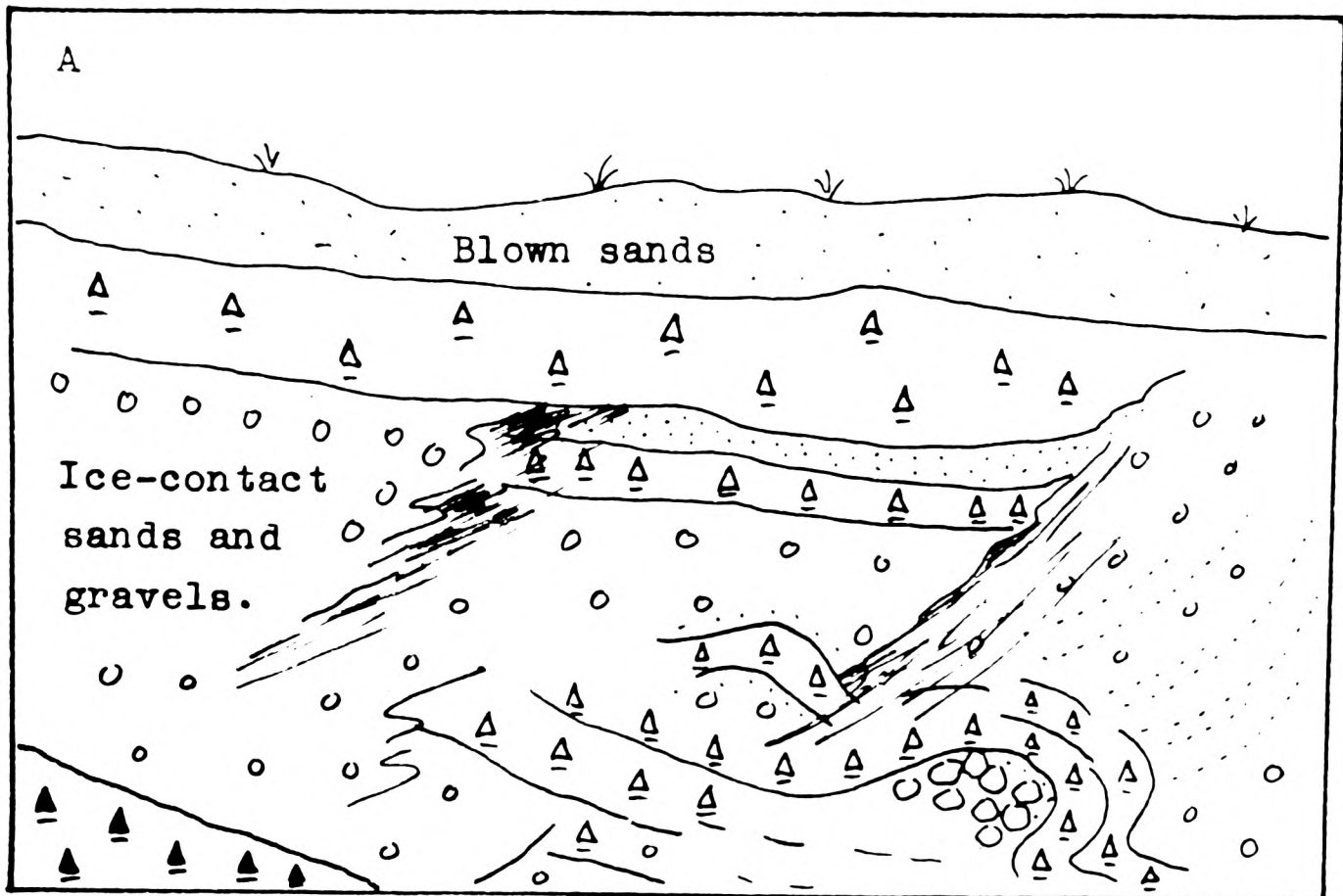


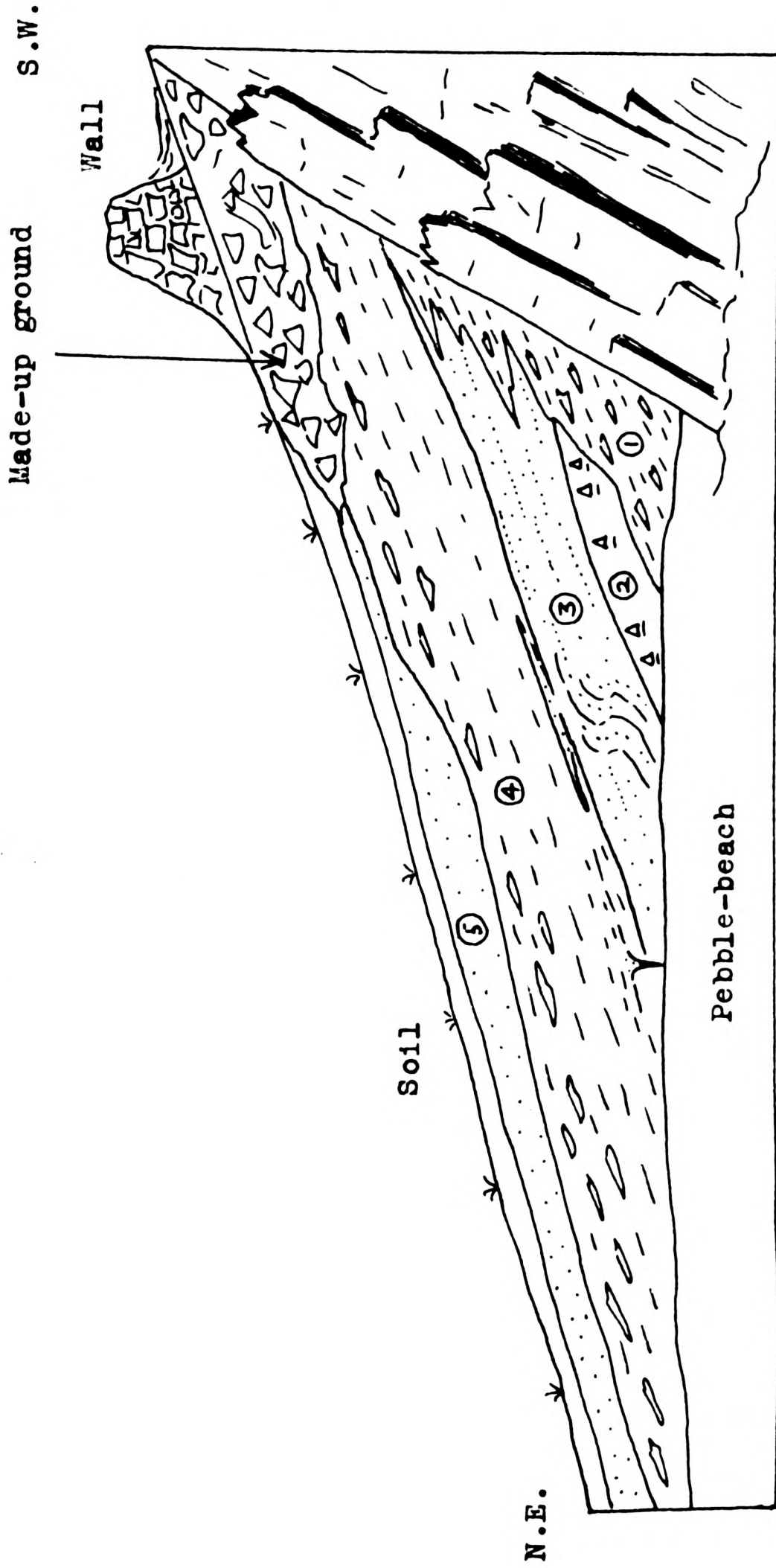
Fig. 38. The junction between Irish Sea till and the underlying blocky heads at Aber-mawr North.



Not to scale.

Fig. 39. Two sections near the footpath at the southern end of the main drift cliff, Aber-mawr North. Note the interbedding of decalcified Irish Sea till and ice-contact sands and gravels.

Section A is c. 10 ft high.  
Section B is c. 6 ft high.



Not to scale.

Fig. 40. The Southern Drift-cliff at Aber-mawr.

Cumulative percentage

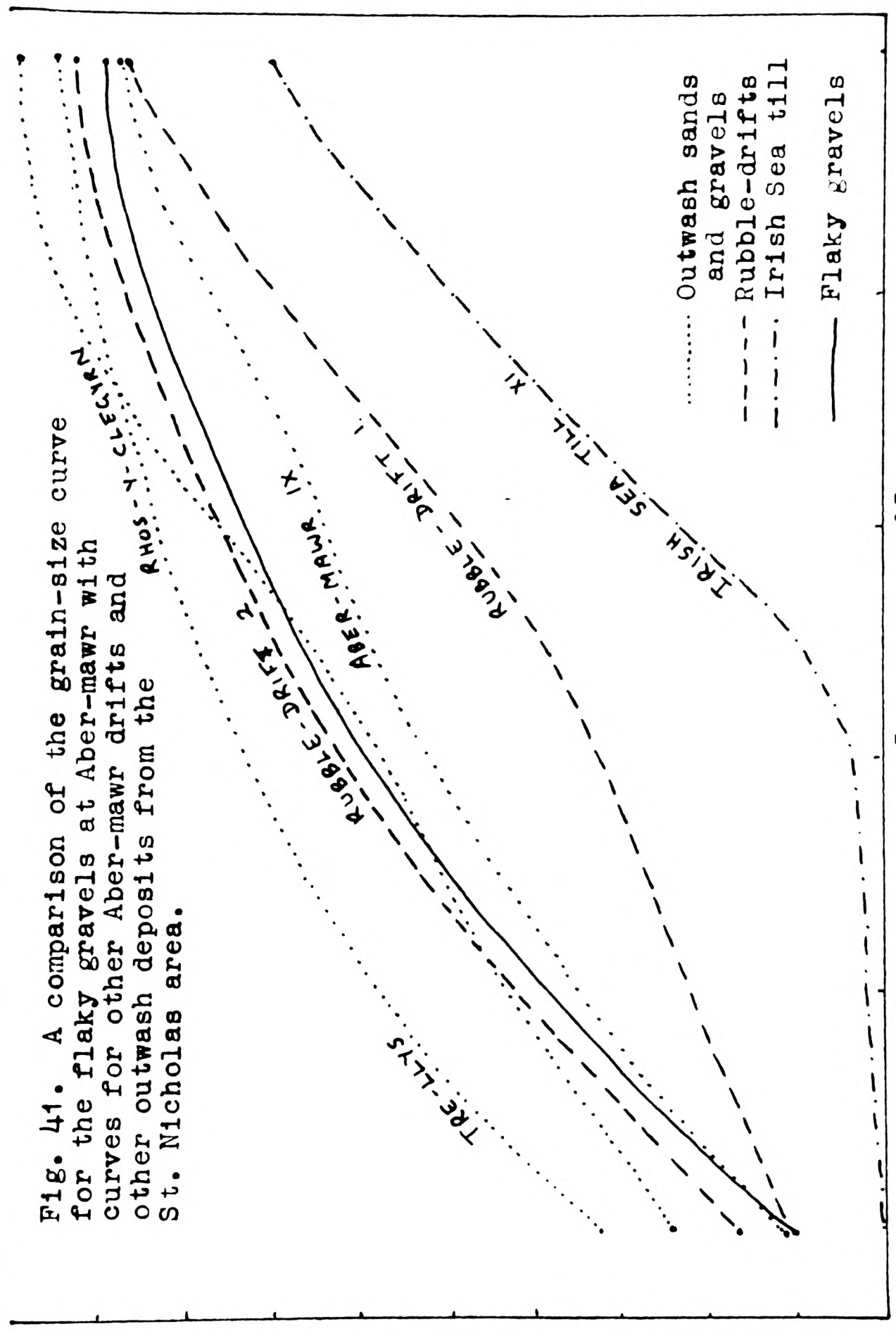
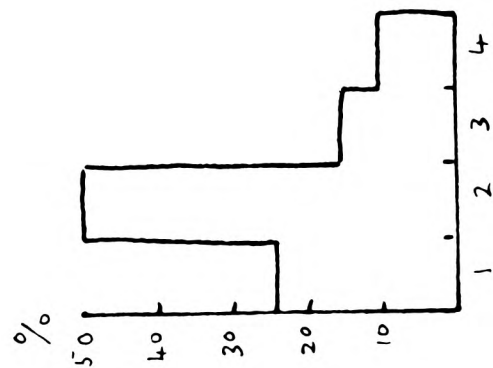


Fig. 41. A comparison of the grain-size curve for the flaky gravels at Aber-mawr with curves for other Aber-mawr drifts and other outwash deposits from the St. Nicholas area.

..... Outwash sands and gravels  
 --- Rubble-drifts  
 - - - - Irish Sea till  
 — Flaky gravels

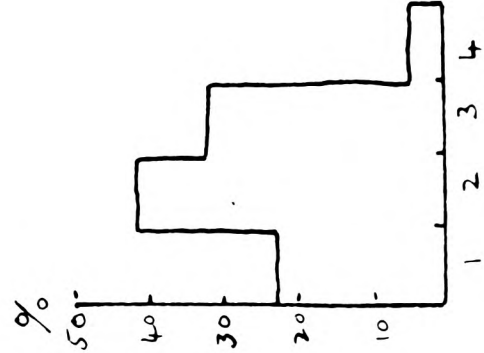
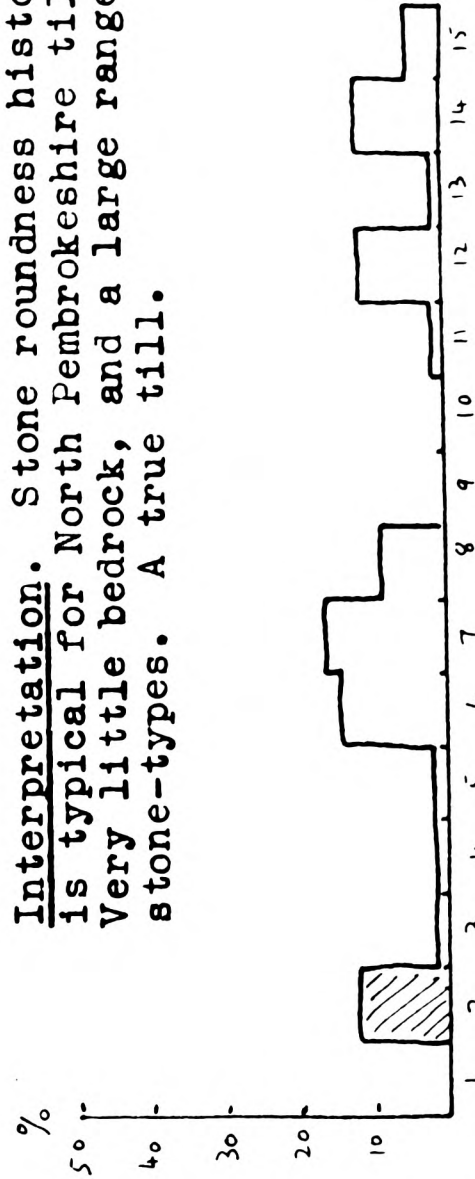
Roundness analyses

Stone-type analyses



Interpretation. Stone roundness histogram is typical for North Pembrokehire till. Very little bedrock, and a large range of stone-types. A true till.

(5) Aber-mawr Irish Sea till



(3) The flaky gravels at Aber-mawr

Interpretation. A high percentage of bedrock fragments; it is not a glacial deposit. However, more rounded pebbles than is normal for head. A solifluxion deposit containing bedrock fragments and derived erratic pebbles.

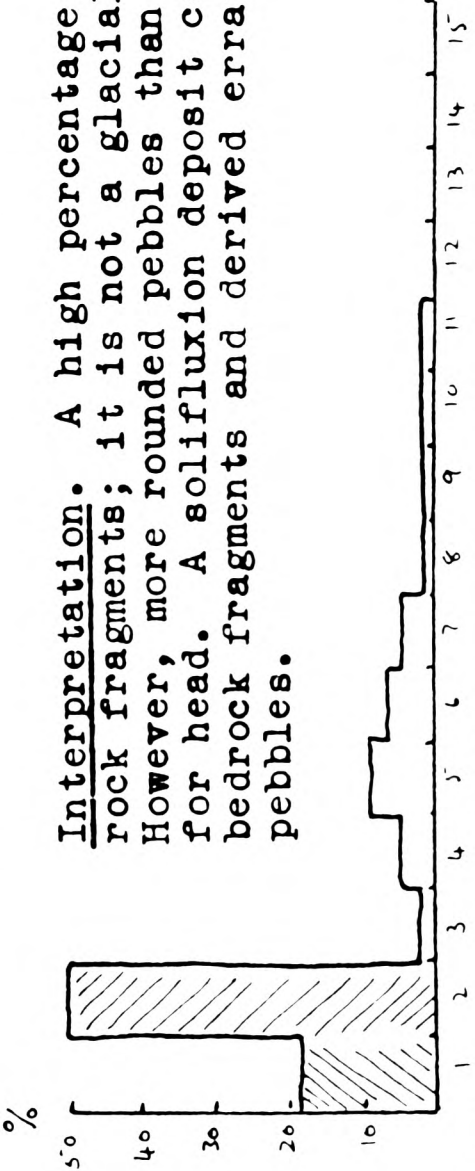


Fig. 42. Pebble analyses from the Irish Sea till and the flaky gravels at Aber-mawr North.

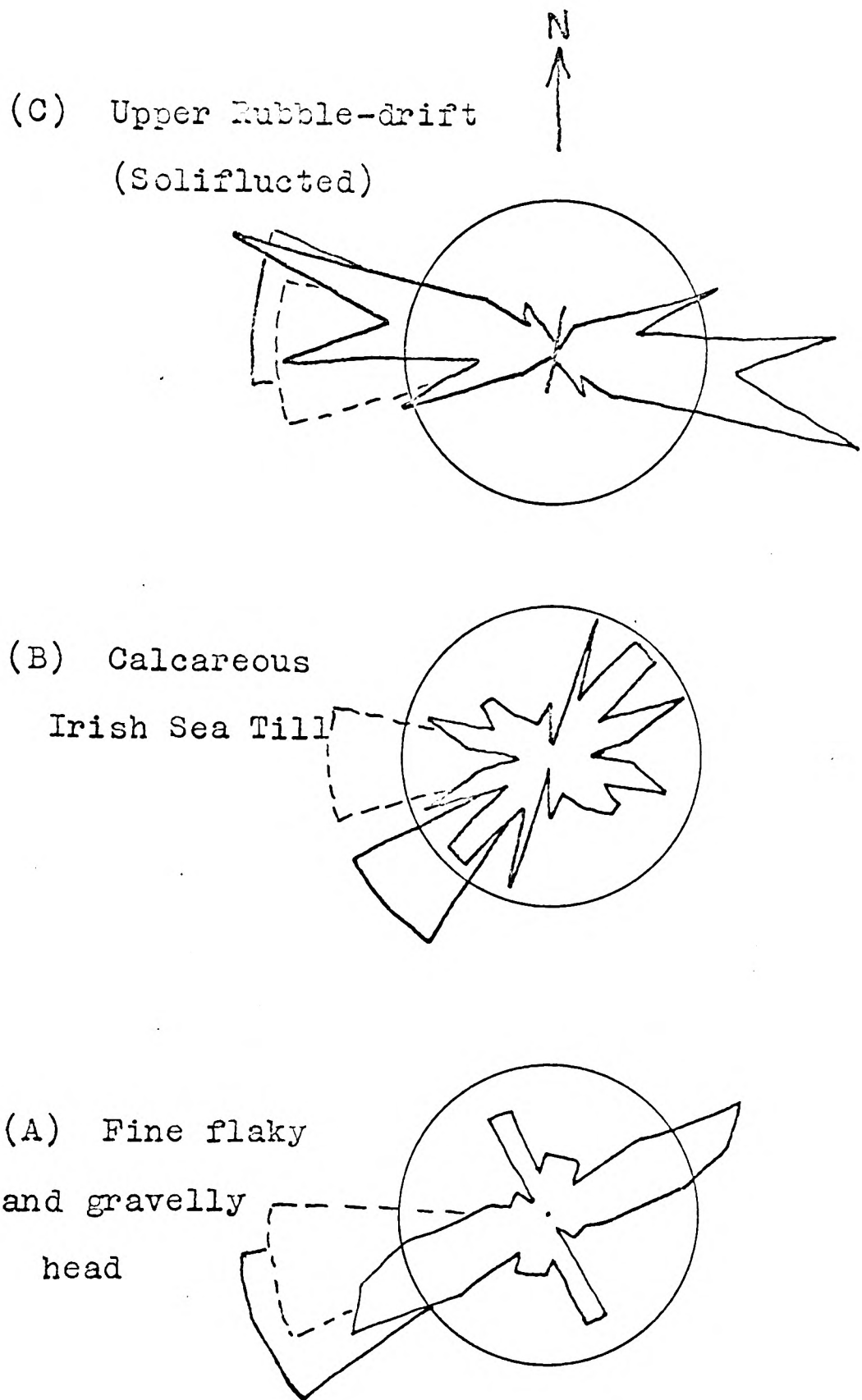
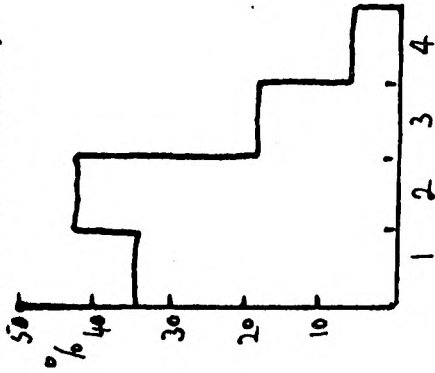


Fig. 43. Preferred orientation diagrams for drifts at Aber-mawr.

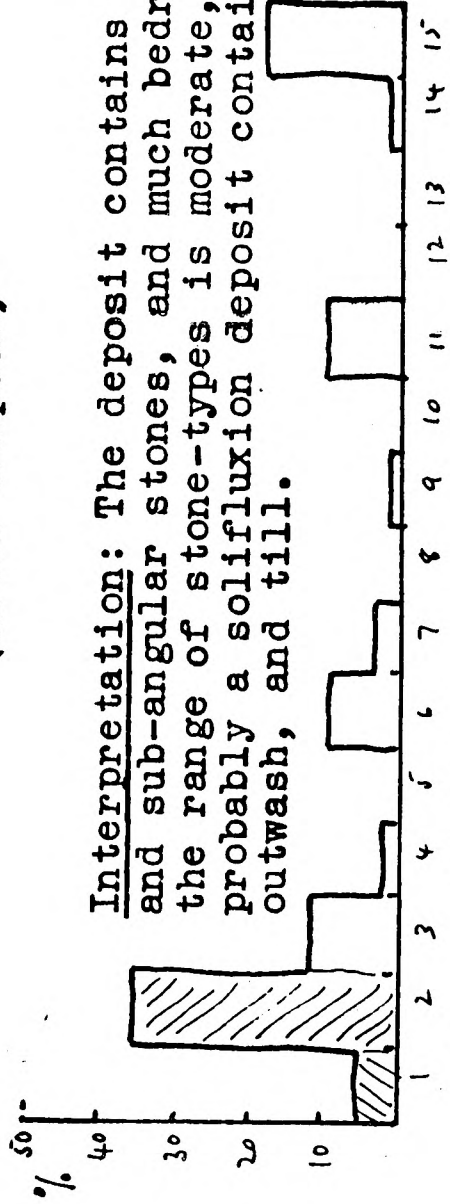
Note that (A) and (C) are clearly soliflucted, with strong peaks in close agreement with the sludge sector. The Irish Sea till has no marked preferred orientation.

**Roundness Analysis  
(after Reichelt)**

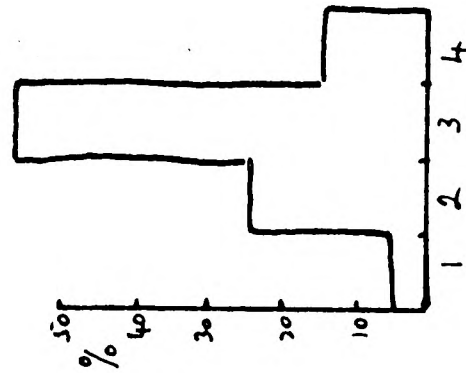


**Stone-type Analysis  
(after Simpson)**

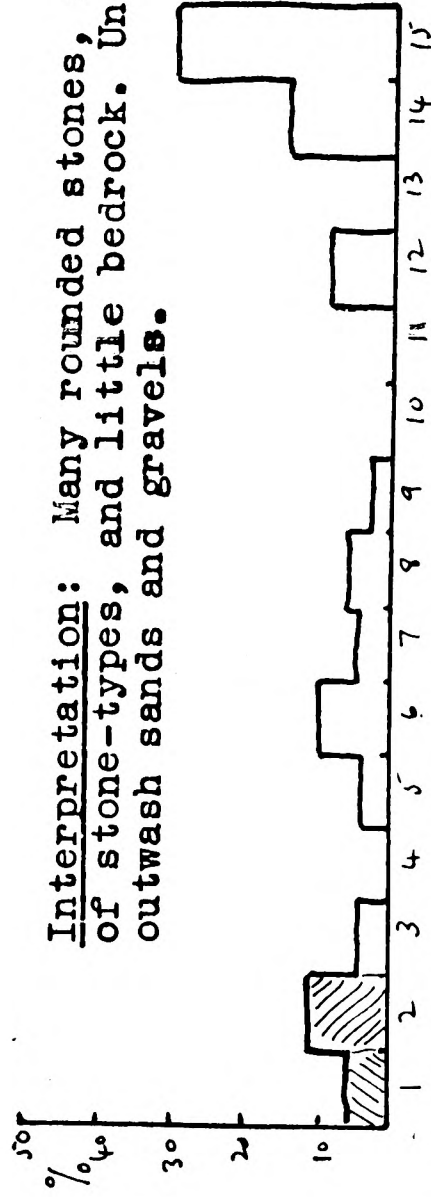
Interpretation: The deposit contains many angular and sub-angular stones, and much bedrock. However, the range of stone-types is moderate, so it is probably a solifluxion deposit containing head, outwash, and till.



**Aber-mawr North (7) Rubble-drift**



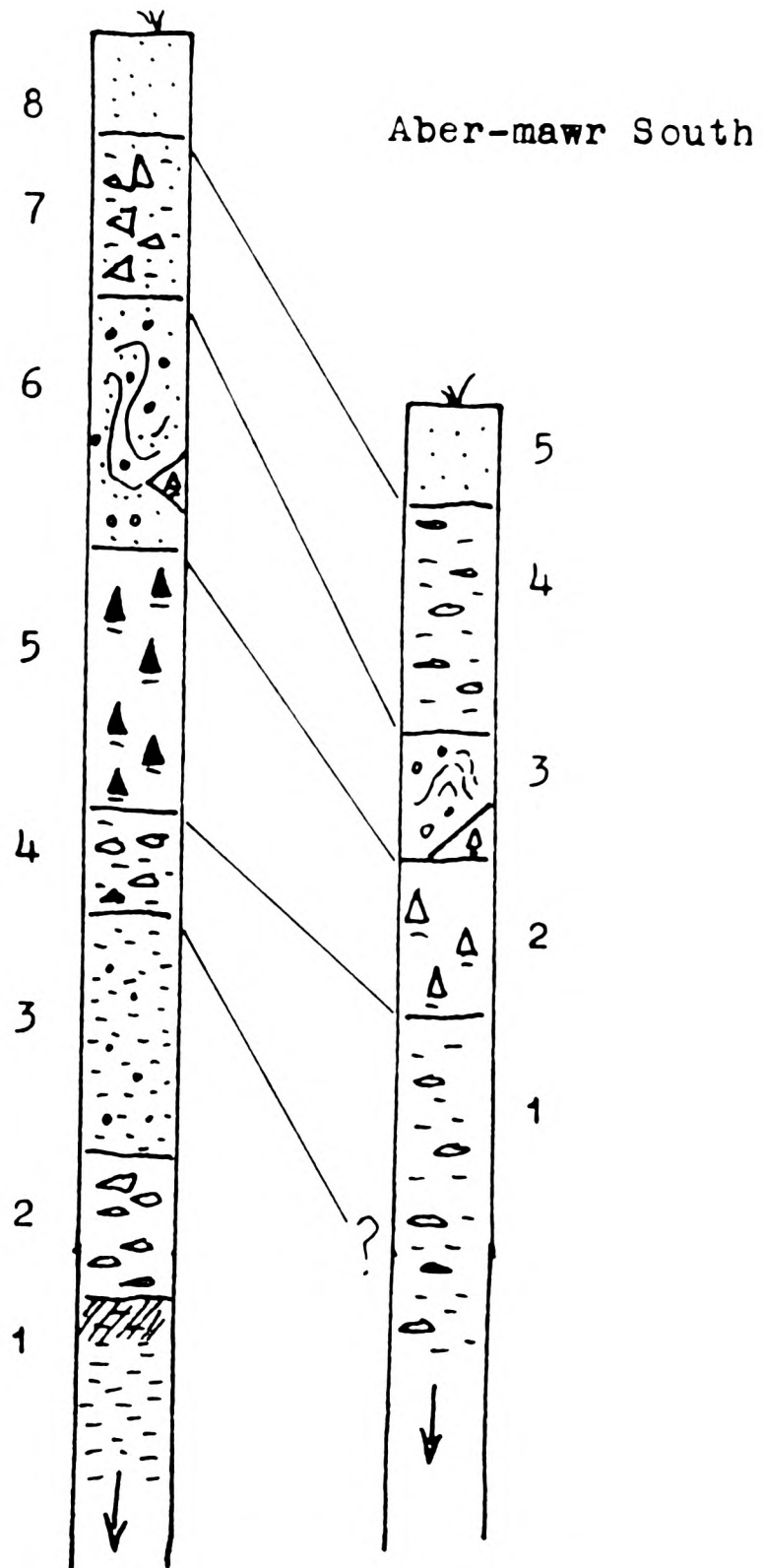
Interpretation: Many rounded stones, a good range of stone-types, and little bedrock. Undoubtedly outwash sands and gravels.



**Aber-mawr (6) Fluvio-glacial sand and gravel**

**Fig. 44. Pebble analyses of drift deposits from Aber-mawr North.**

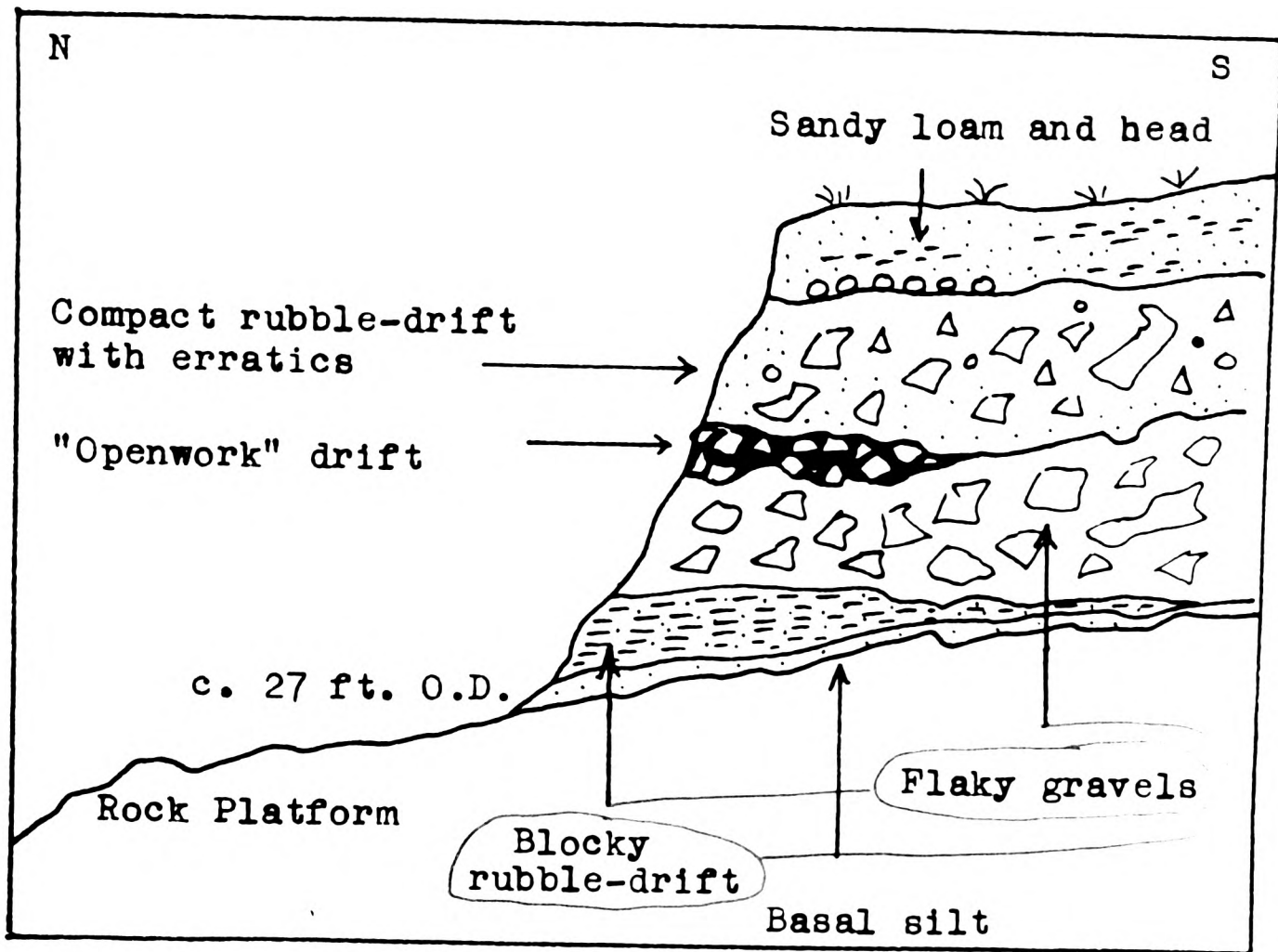
Aber-mawr North



Not to scale  
For key see Fig. 35

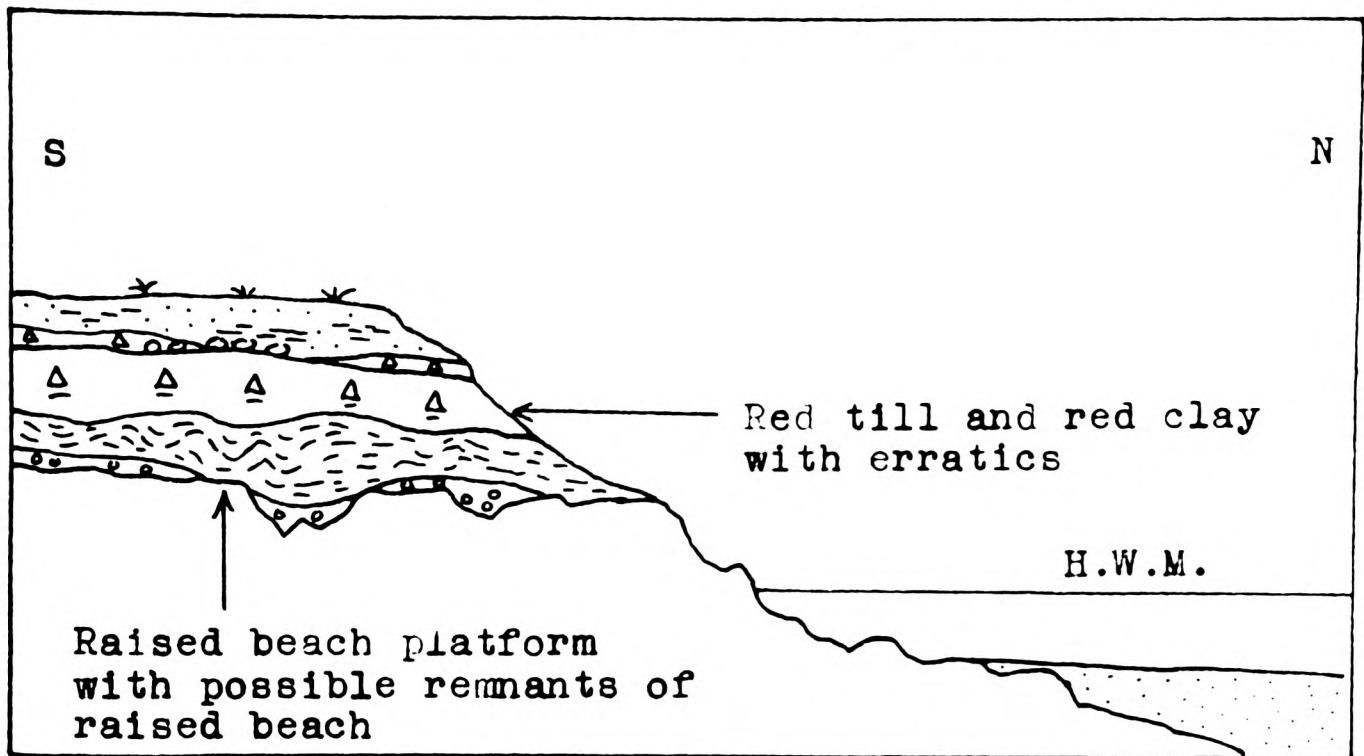
Fig. 45.

A suggested correlation of the drifts exposed in the northern and southern drift-cliffs at Aber-mawr.



Not to scale  
 Height of section c. 10 ft.

Fig. 46. A composite idealised drift section for Pen Deudraeth Headland.



Vertical scale exaggerated

Fig. 47. Idealised composite section at Parrog, on the south side of the Afon Nevern Estuary.

S.W.  
SN 042386

N.E.  
SN 064415

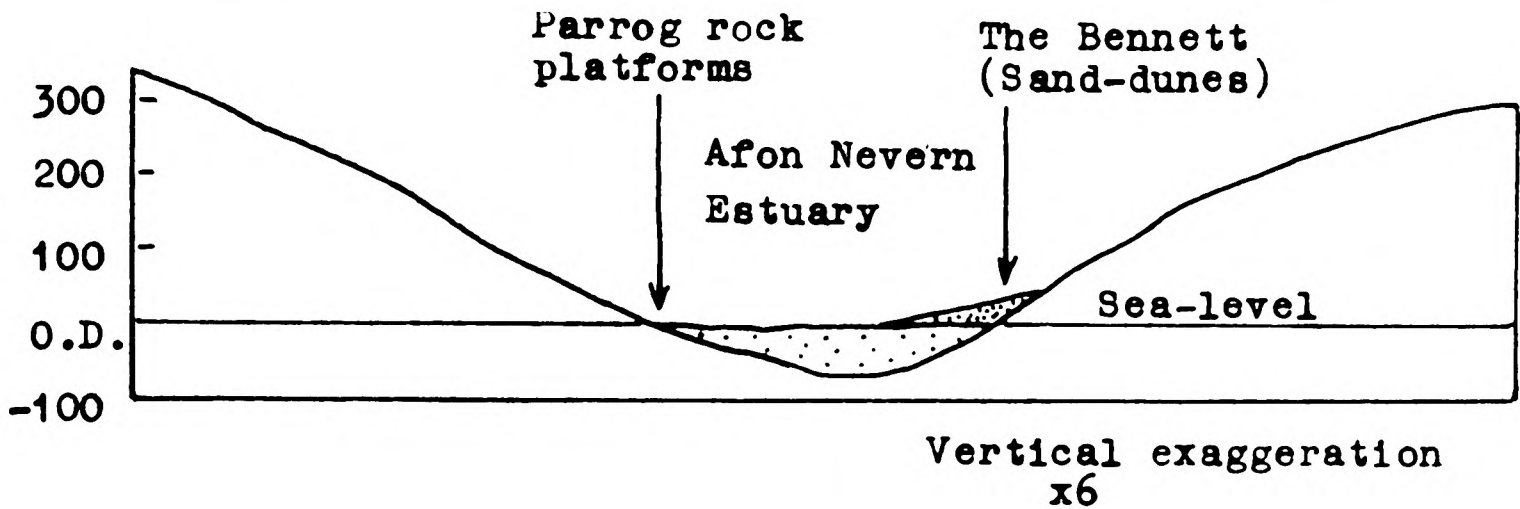


Fig. 48. A reconstruction of the cross-profile of the Afon Nevern Estuary. Note the gently-sloping valley-sides, the submerged channel, and the presence of raised marine platforms within the estuary. The estuary is an ancient feature cut to beneath sea-level before the platform-cutting episode.

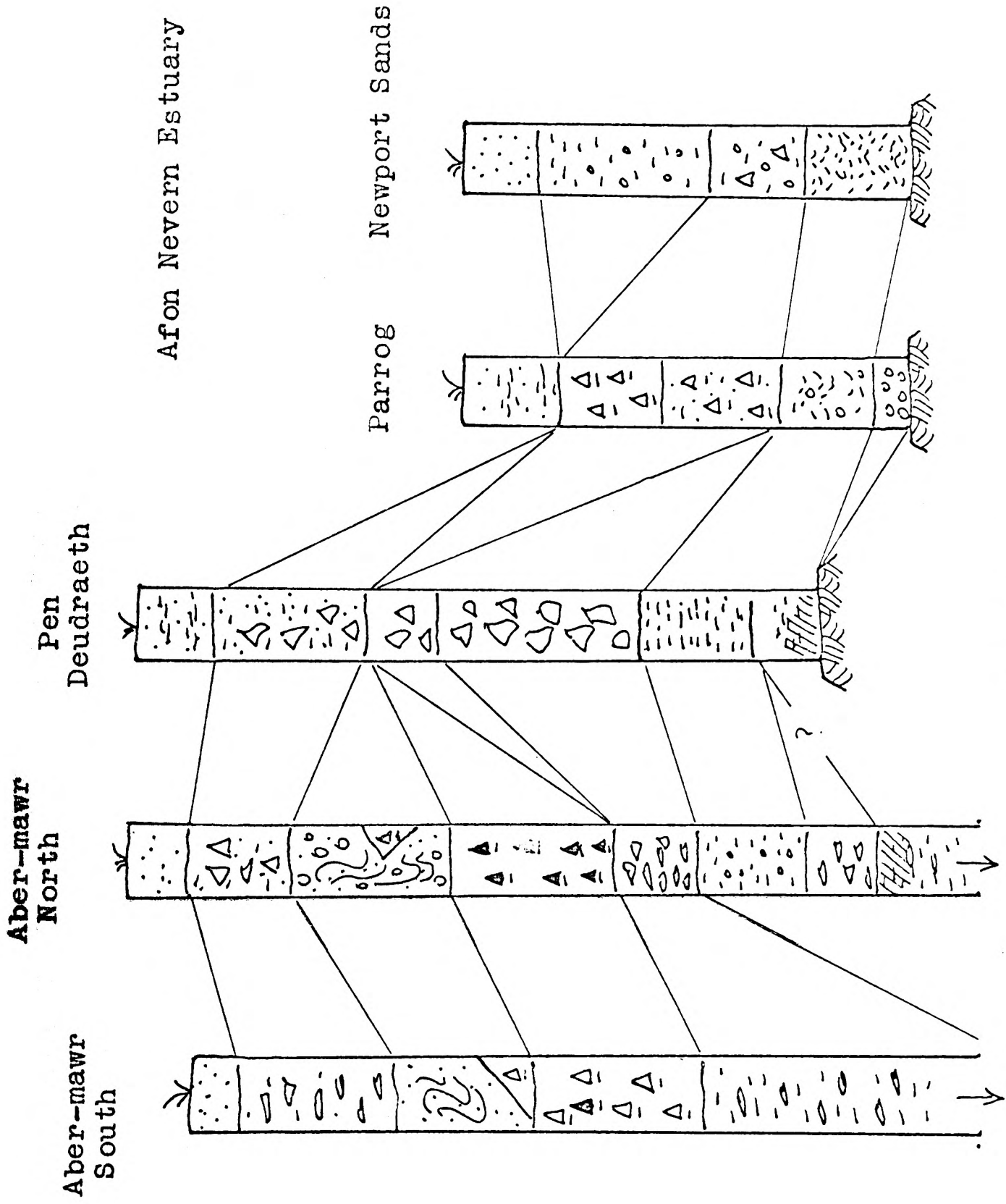
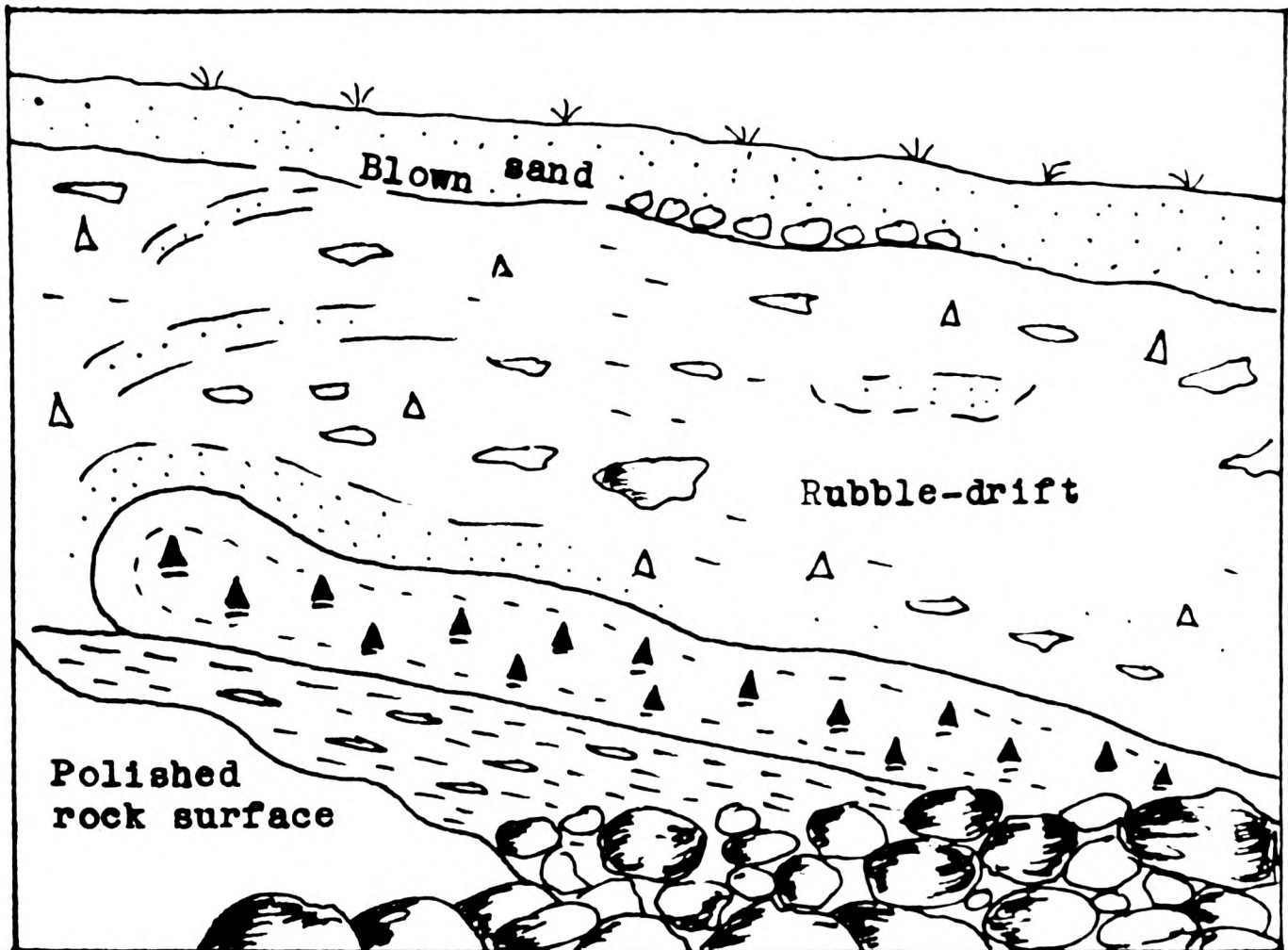


Fig. 49.

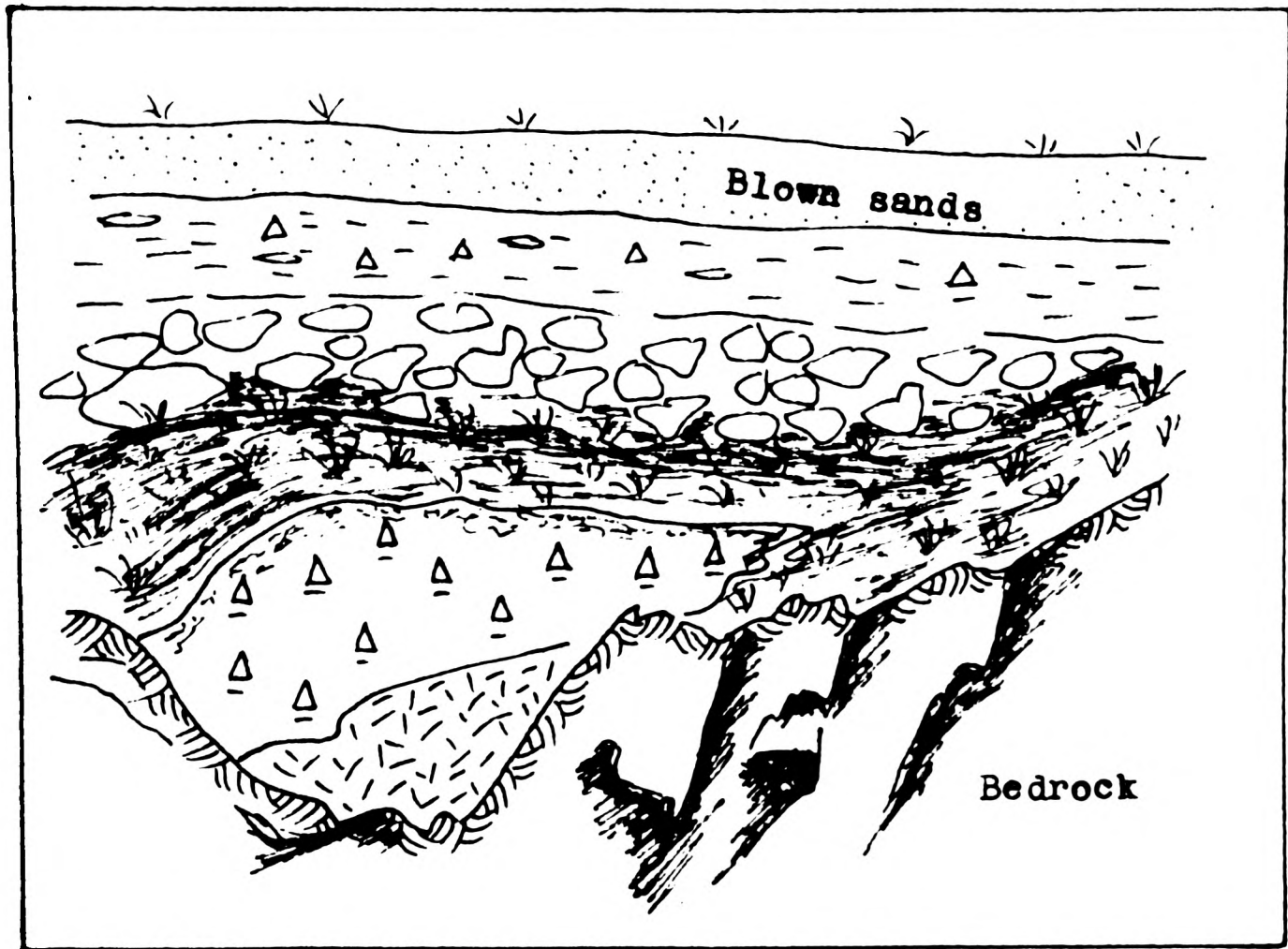
A correlation of the drift successions on the north coast of Pembrokeshire.



Height c. 18 ft.

Not to scale.

Fig. 50. The main drift cliff at Whitesands North. At the base of the section is the present-day boulder-beach.



Section is c. 12 ft. high.

Not to scale.

Fig. 51. The drift-filled gully at Whitesands North. Contorted head and decalcified till are overlain by variable rubble-drift.

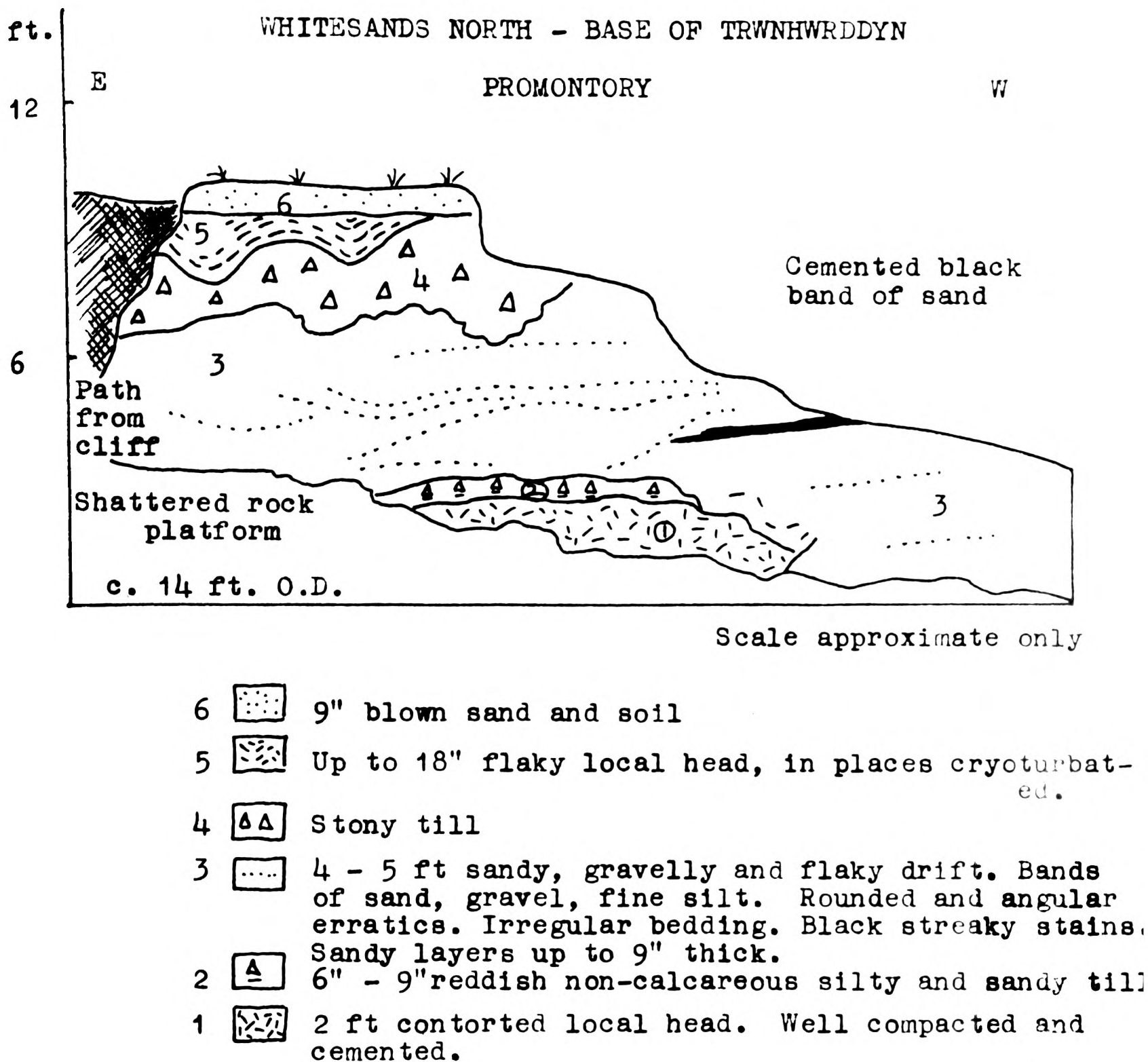
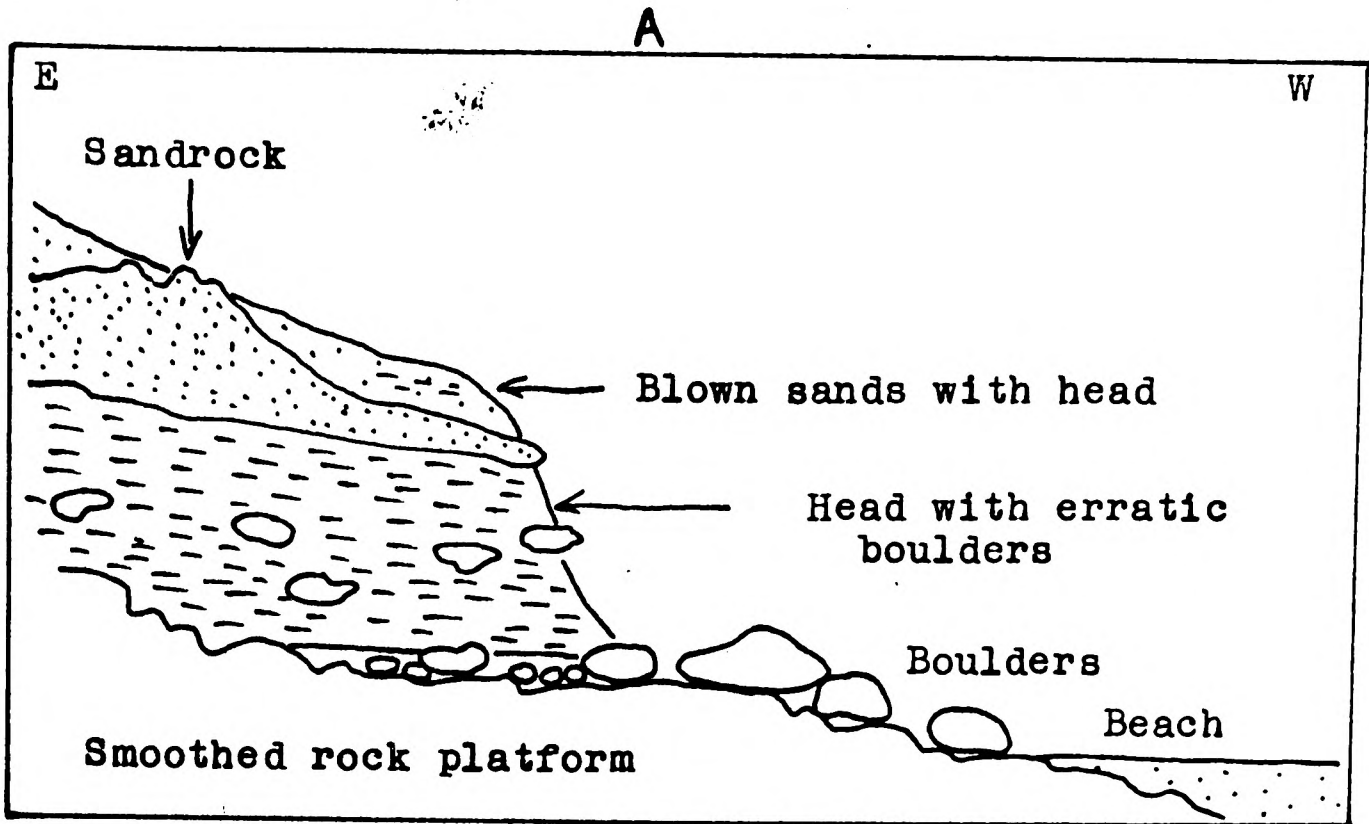
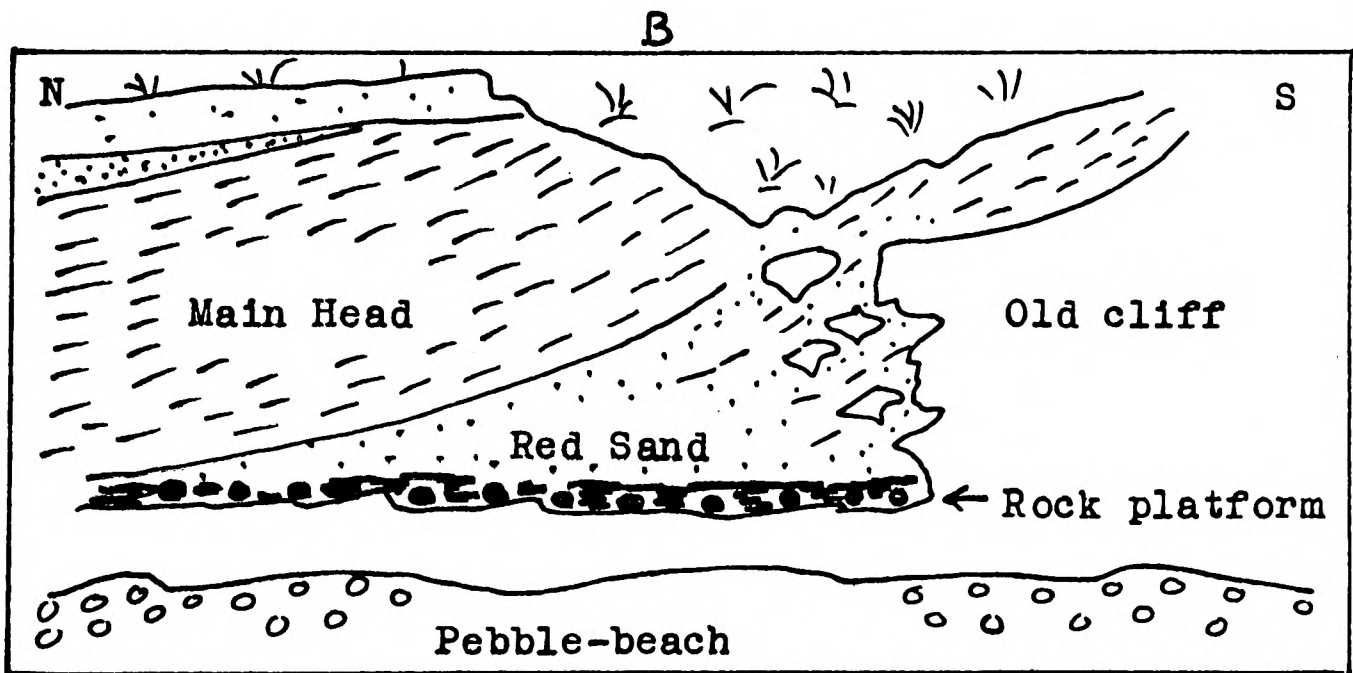


Fig. 52. The drift exposure on Trwnhwrddyn Promontory, Whitesands North.

Note the two layers of till separated by gravelly flaky drift.



Height of face c. 8 ft

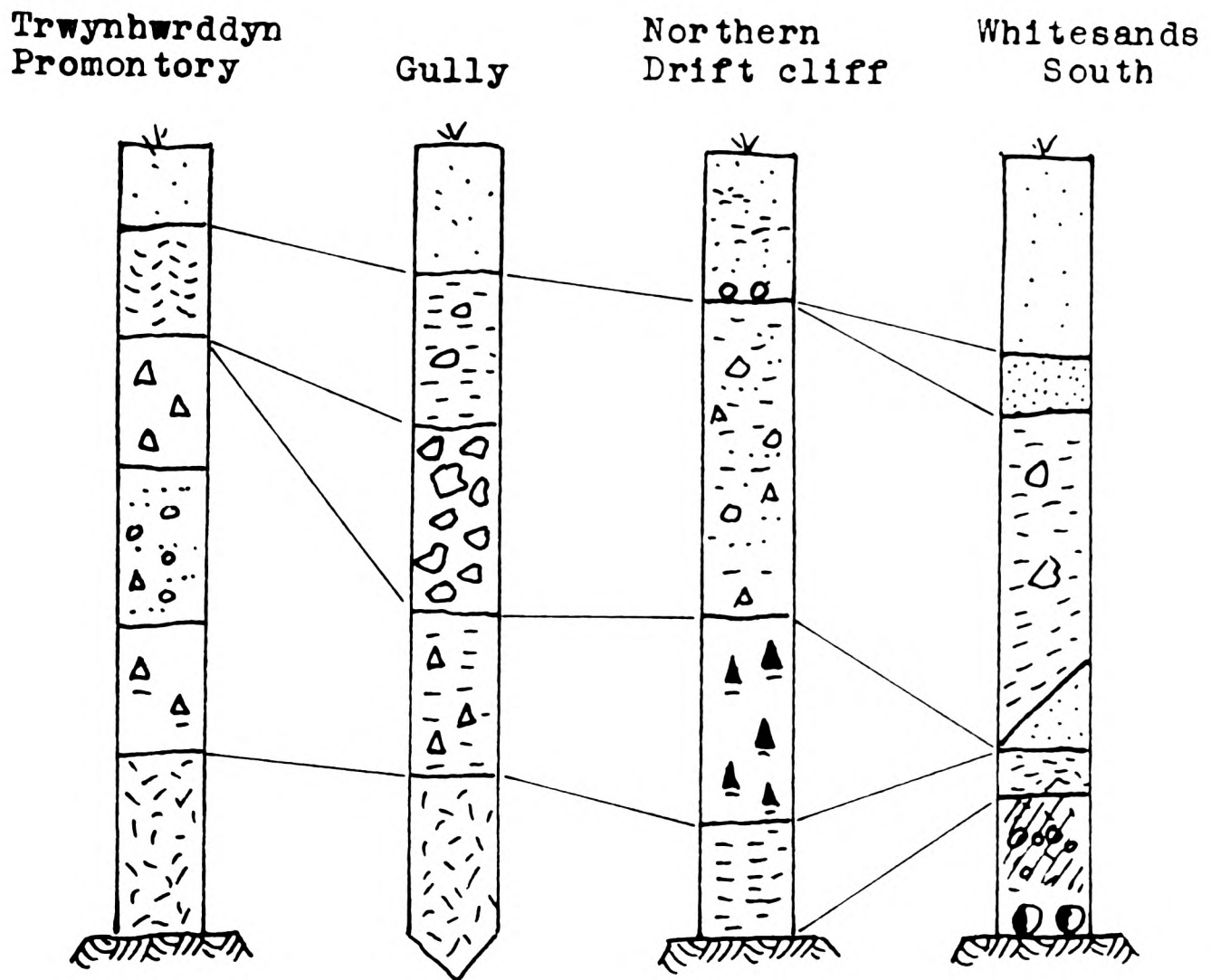


Boulders on rock platform embedded in rich red sand, sandrock, and black cemented head

Fig. 53.

The drift sections at Whitesands South (Not to scale).

Fig. 54. A suggested correlation of the sections at Whitesands.



Cumulative percentage

100

90

80

70

60

50

40

30

20

10

Diameter in mm.

2.0 mm

1.0

.5

.25

.12

.064

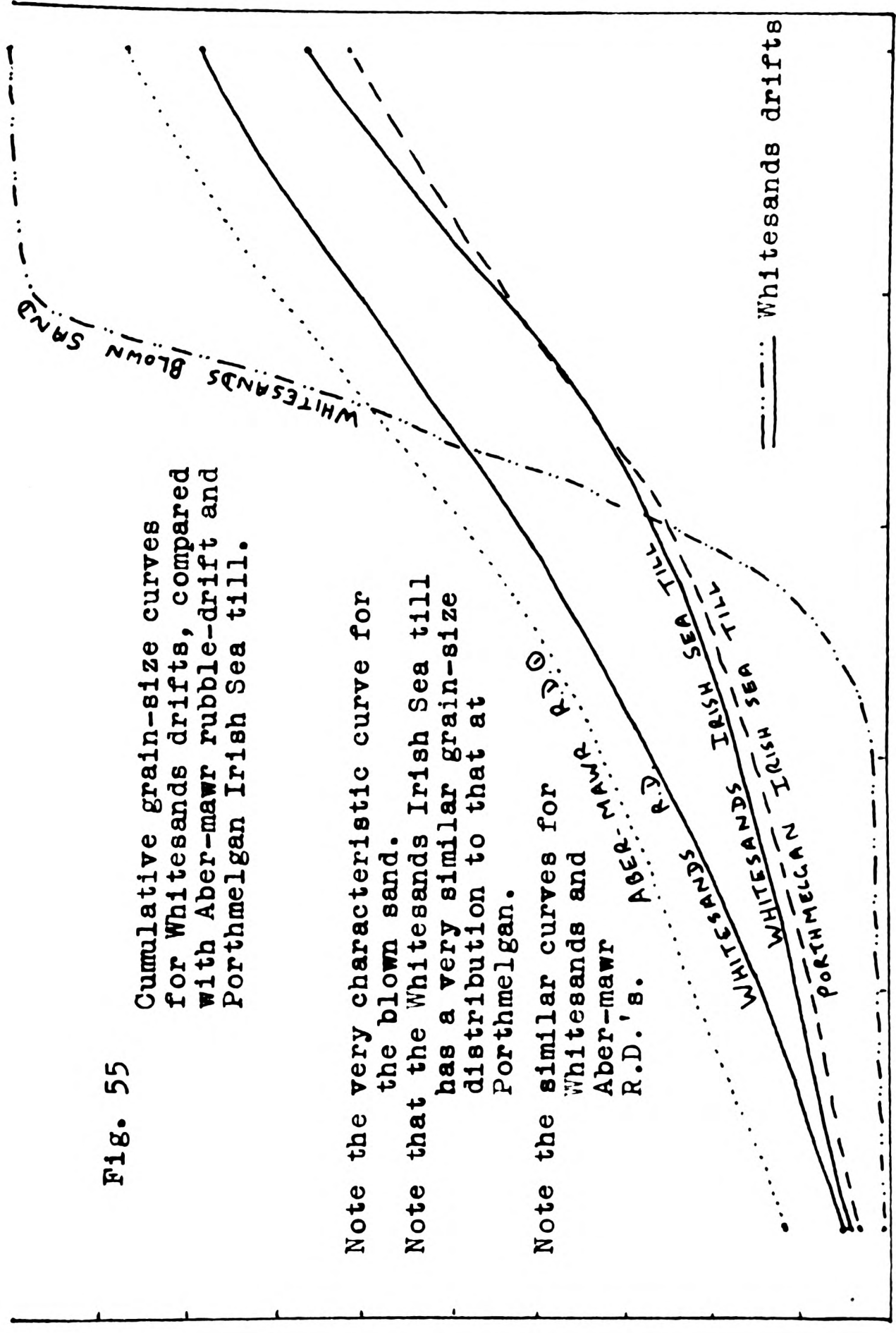
Fig. 55

Cumulative grain-size curves for Whitesands drifts, compared with Aber-mawr rubble-drift and Porthmelgan Irish Sea till.

Note the very characteristic curve for the blown sand.

Note that the Whitesands Irish Sea till has a very similar grain-size distribution to that at Porthmelgan.

Note the similar curves for Whitesands and Aber-mawr R.D.'s.



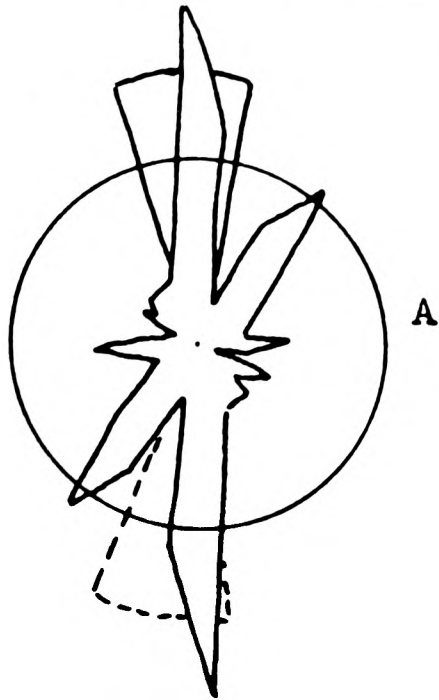
--- Whitesands drifts

WHITESANDS BLOWN SAND

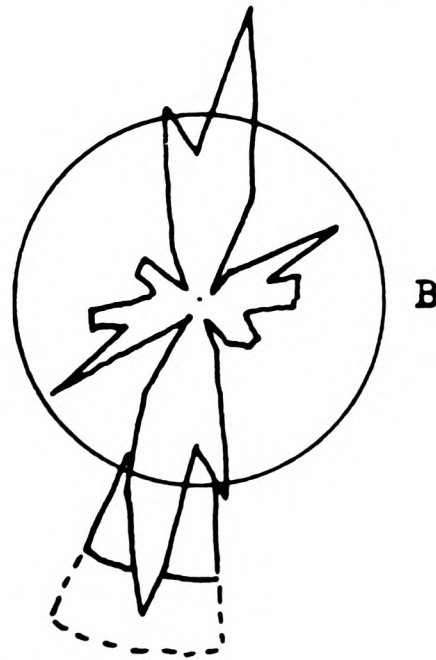
WHITESANDS IRISH SEA TILL  
WHITESANDS IRISH SEA TILL  
PORTHMELGAN IRISH SEA TILL

WHITESANDS  
ABER-MAWR R.D.  
PORTHMELGAN IRISH SEA TILL

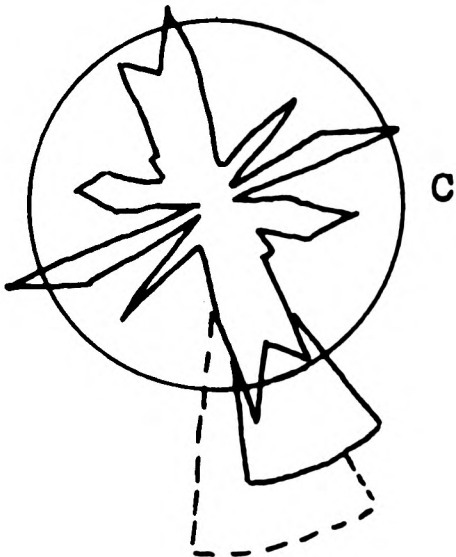
Whitesands North (4)  
Upper Rubble-drift



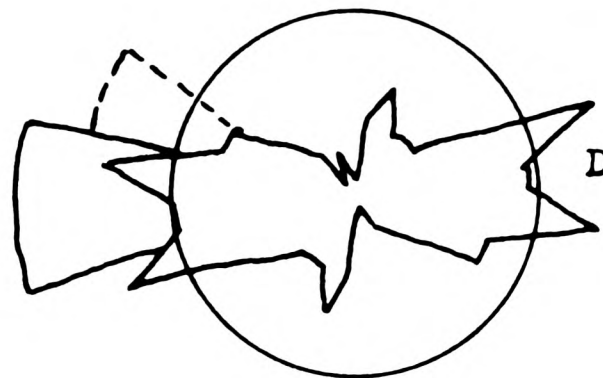
Whitesands North (5)  
Upper Rubble-drift



Whitesands North (6)  
Lowest Head



Whitesands South (7)  
Head with erratics



WHITESANDS SOUTH

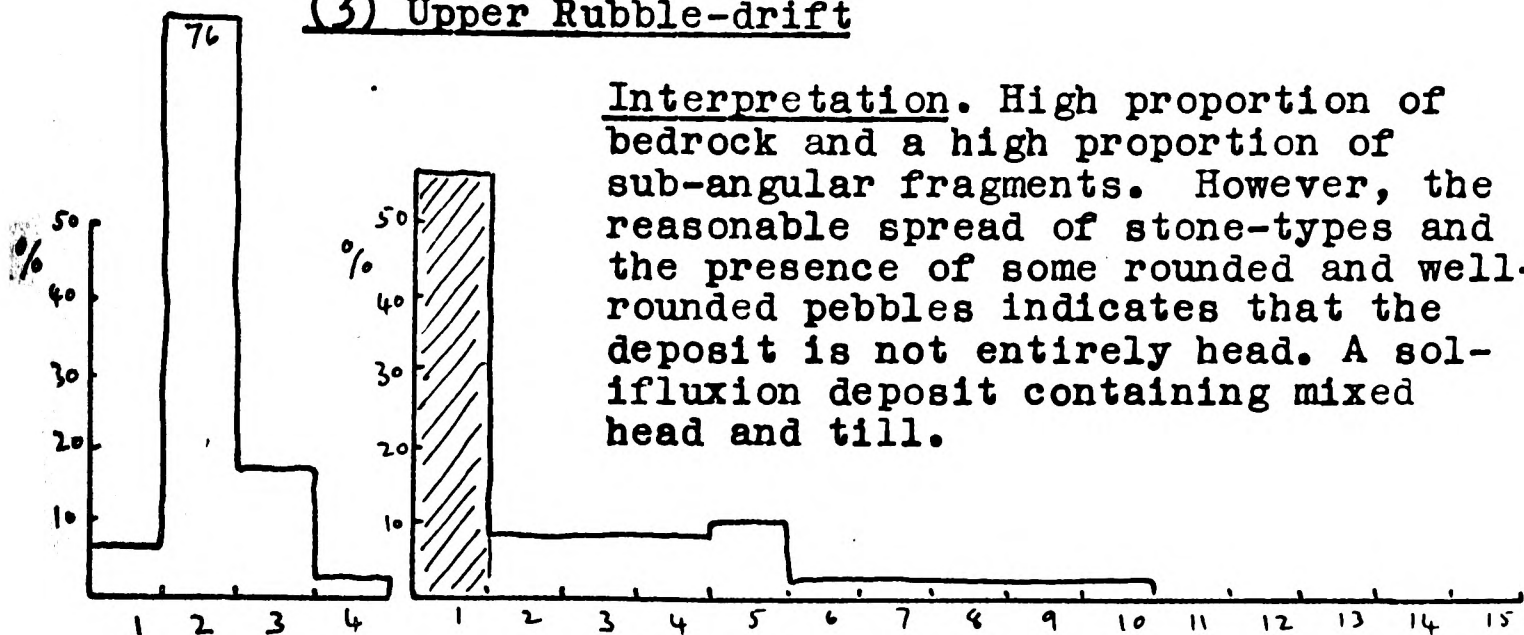
Fig. 56. Preferred orientation diagrams for drift deposits at Whitesands.

Fig. 57. Analysis of pebbles from the drift at Whitesands North.

**Roundness Analysis**

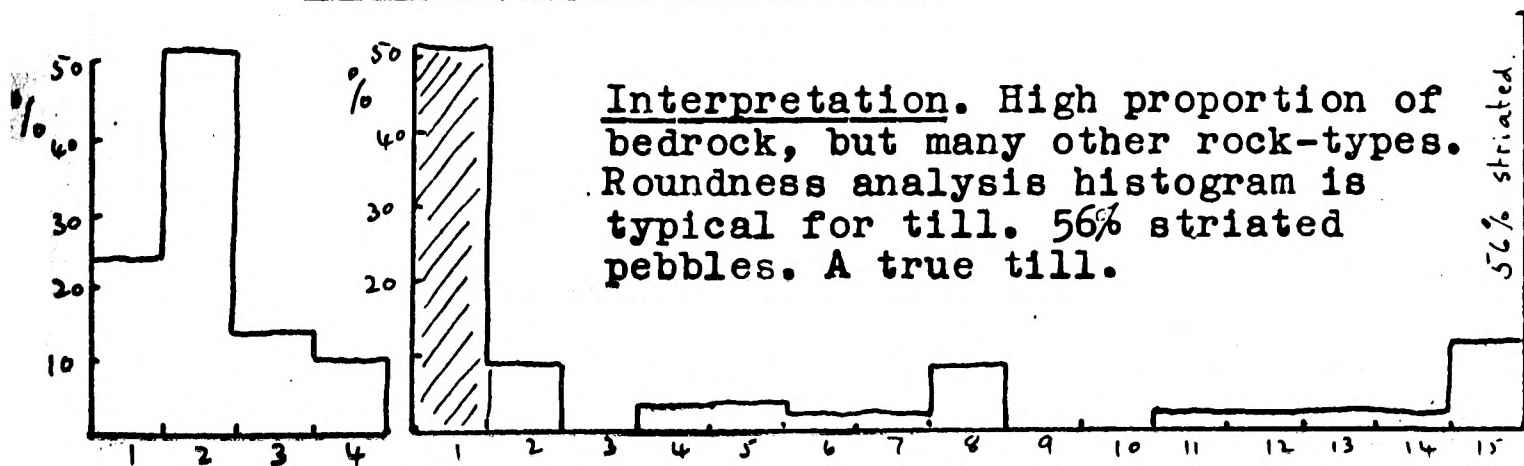
**Stone-type Analysis**

(3) Upper Rubble-drift



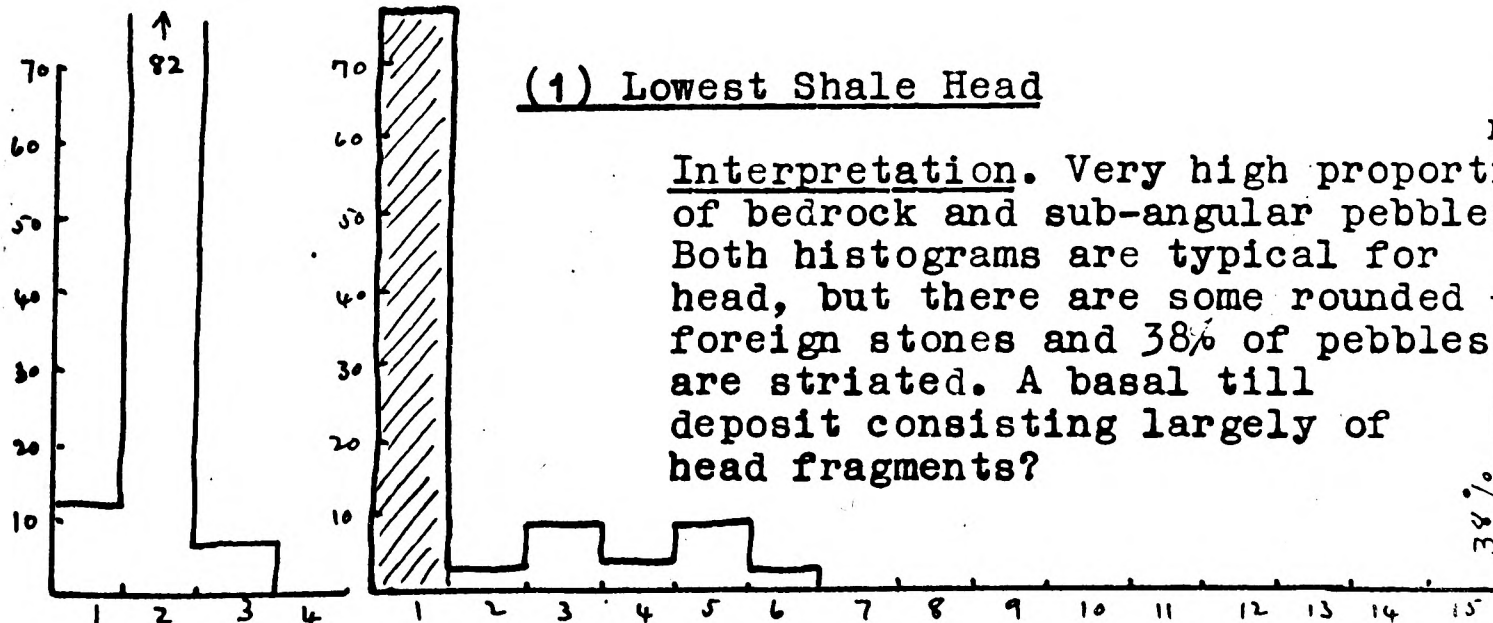
Interpretation. High proportion of bedrock and a high proportion of sub-angular fragments. However, the reasonable spread of stone-types and the presence of some rounded and well-rounded pebbles indicates that the deposit is not entirely head. A solifluction deposit containing mixed head and till.

(2) Calcareous Shelly till



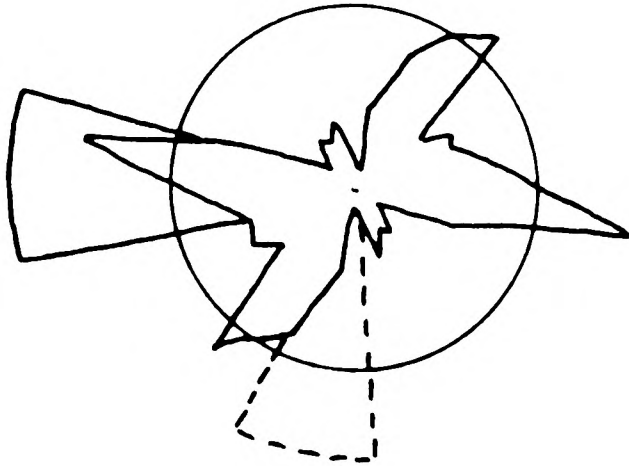
Interpretation. High proportion of bedrock, but many other rock-types. Roundness analysis histogram is typical for till. 56% striated pebbles. A true till.

(1) Lowest Shale Head

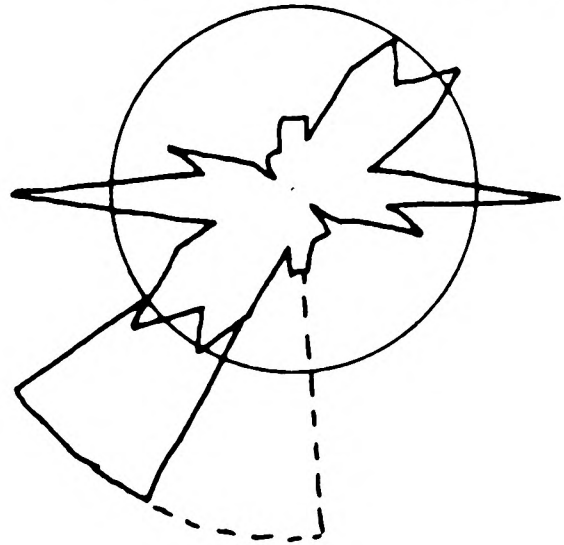


Interpretation. Very high proportion of bedrock and sub-angular pebbles. Both histograms are typical for head, but there are some rounded foreign stones and 38% of pebbles are striated. A basal till deposit consisting largely of head fragments?

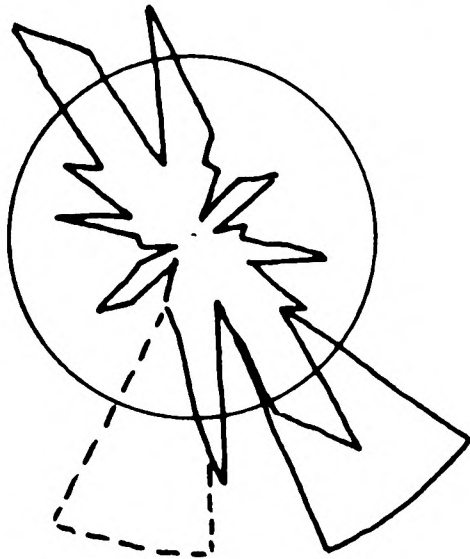
Whitesands North (1)



Whitesands North (2)

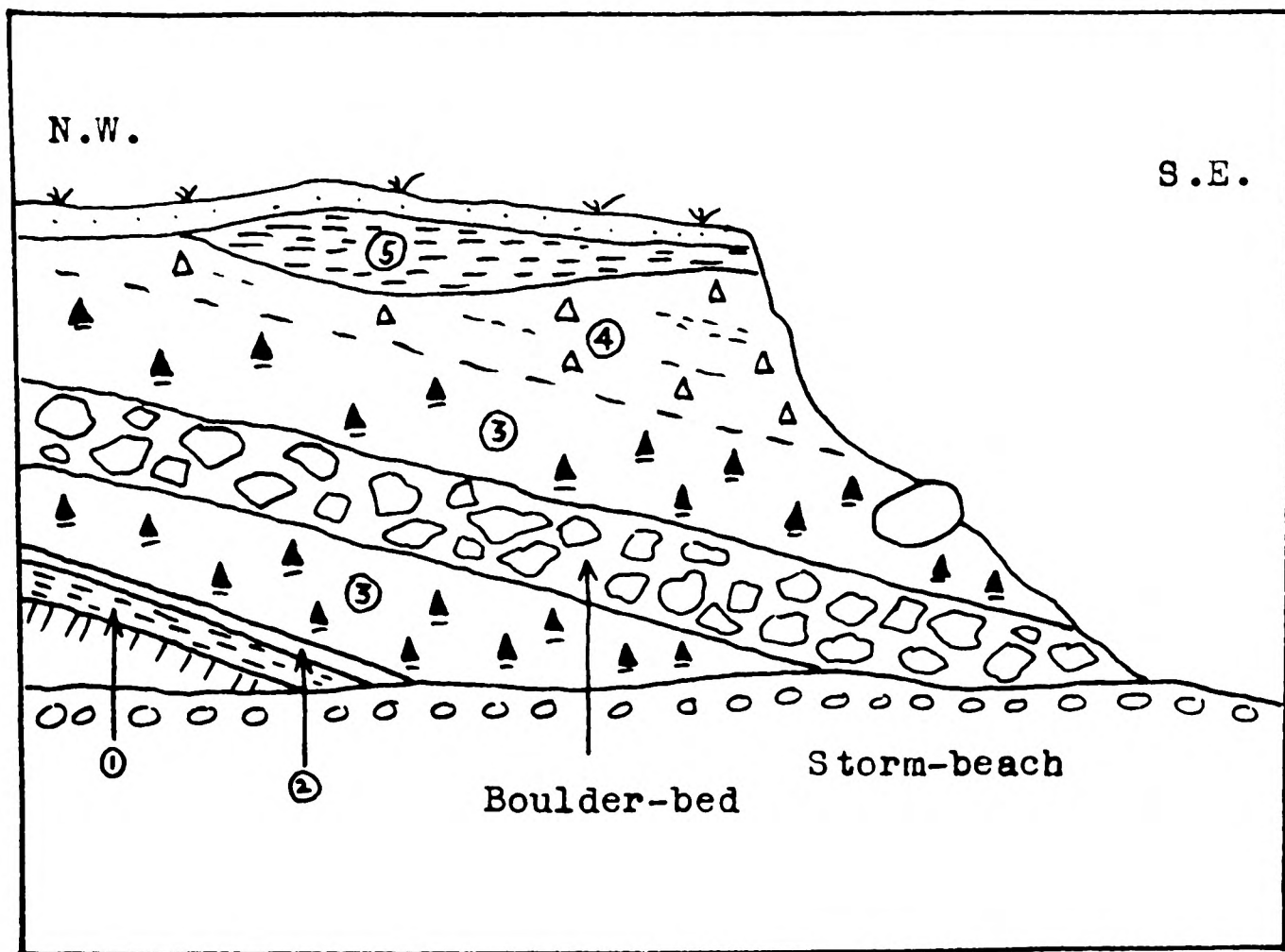


Whitesands North (3)



Direction of ice-  
movement as indicated  
by striations

Fig. 58. Three preferred orientation diagrams from the same exposure of calcareous shelly Irish Sea till, Whitesands North. Not one of the diagrams has an "ideal" preferred orientation.



Height of section c. 20 ft.  
 Not to scale.

Fig. 59. An idealised composite section of the drift cliff at Porthmelgan.

Direction of ice-movement  
indicated by striations

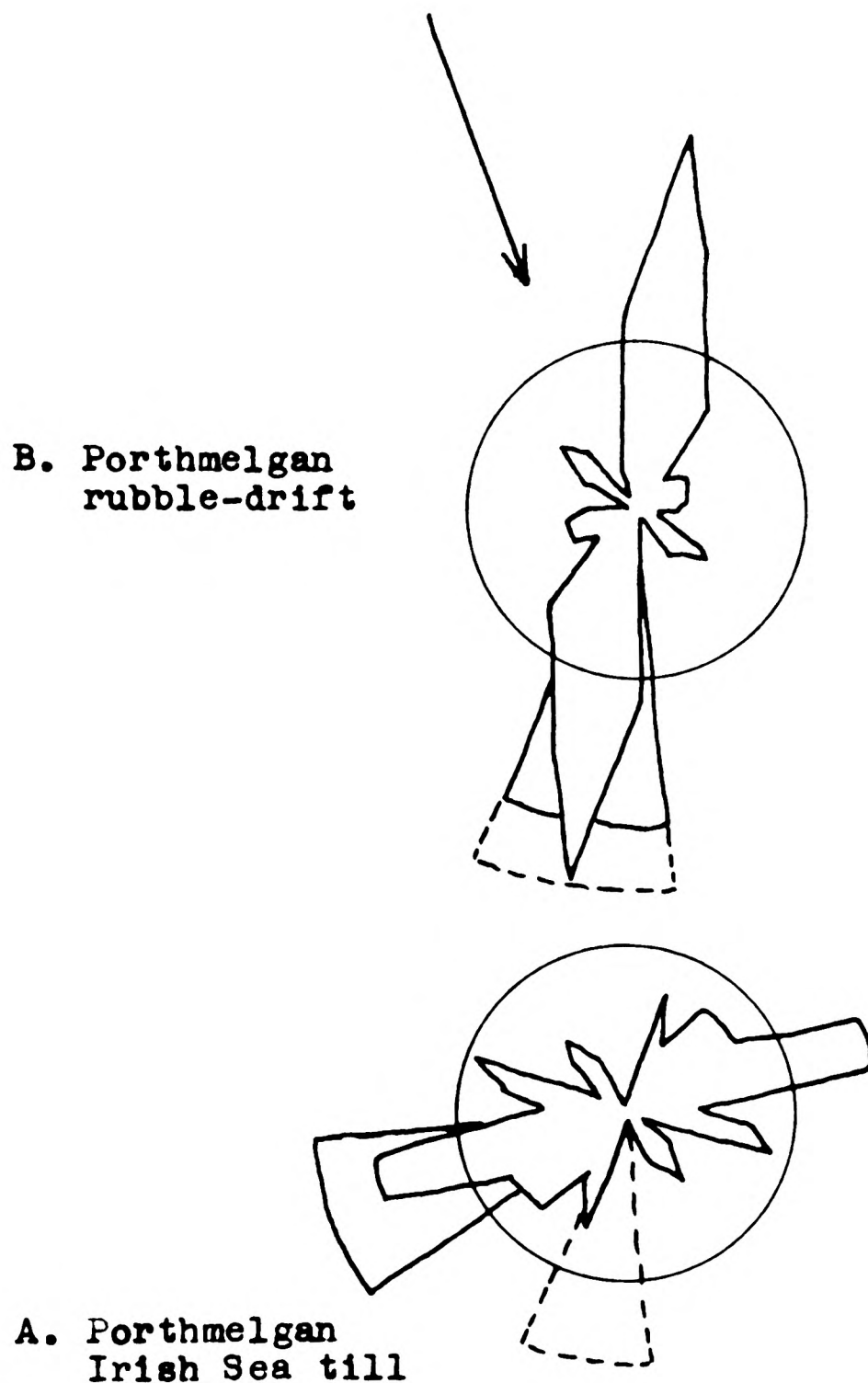
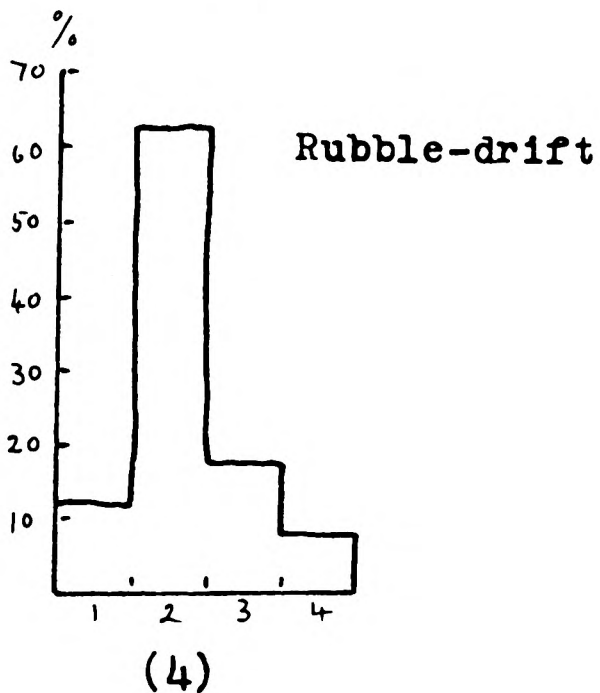
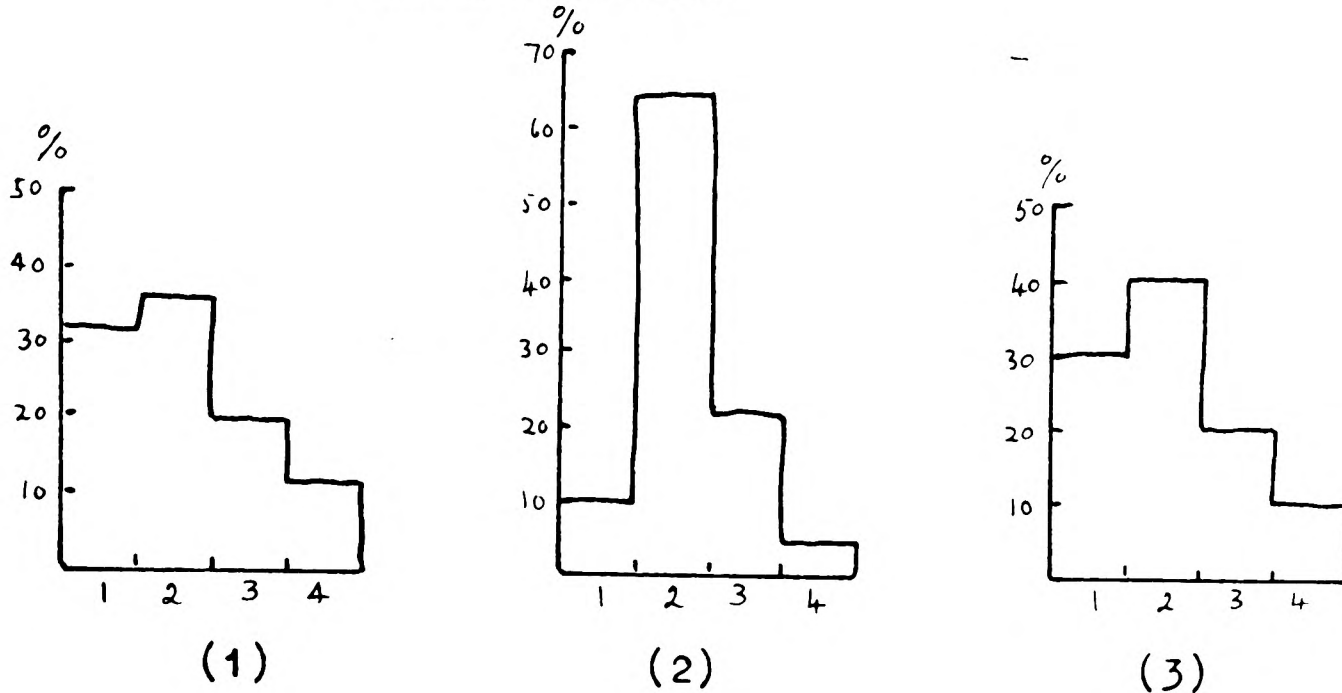


Fig. 60. Preferred orientation diagrams for drifts at Porthmelgan; the Irish Sea till has hardly any pebbles orientated in the direction of ice-movement, and was probably dumped in a dead-ice environment, while the rubble-drift is clearly soliflucted.

Calcareous till



Sample (1) had 48% striated pebbles

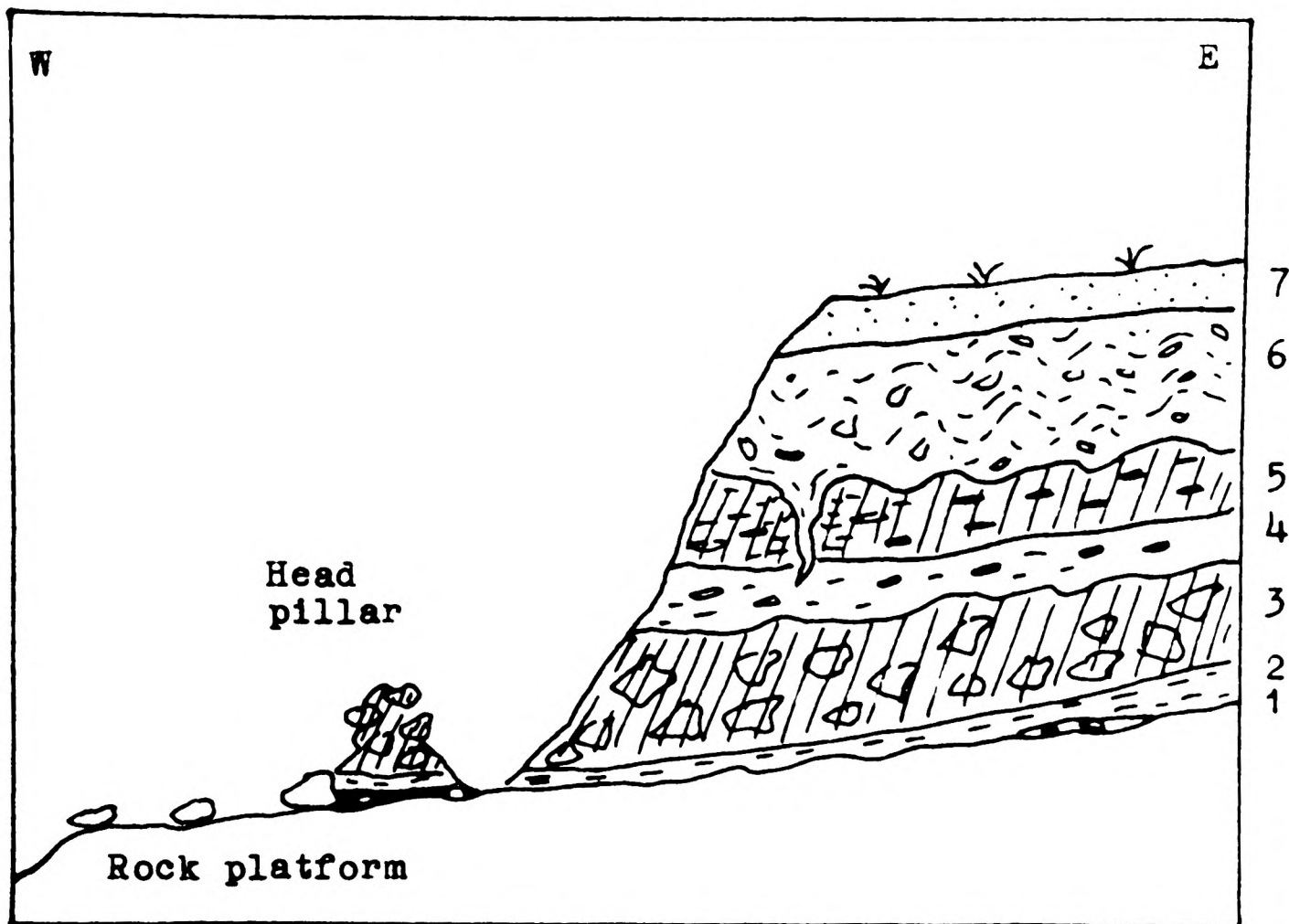
Sample (4) had 36% striated pebbles

Fig. 61. Roundness analyses of Porthmelgan drifts.

Nos. 1, 2, and 3 are for Irish Sea till

No. 4 is for rubble-drift

The rubble-drift has slightly fewer rounded pebbles than the calcareous till; however, all the histograms approximate to the North Pembrokeshire mean histogram for till.



Not to scale



Purple heads

7. Sandy loam
6. Purple-buff finer head
5. Purple-green blocky head
4. Buff blocky head with erratics
3. Purple blocky head
2. Lowest head with erratics
1. Blocky green-buff head

Fig. 62. The drift section on Pen Dal-aderyn Headland. No raised beach deposits or coherent till have been found on the rock platform, but it is possible that all the heads have formed post-glacially.

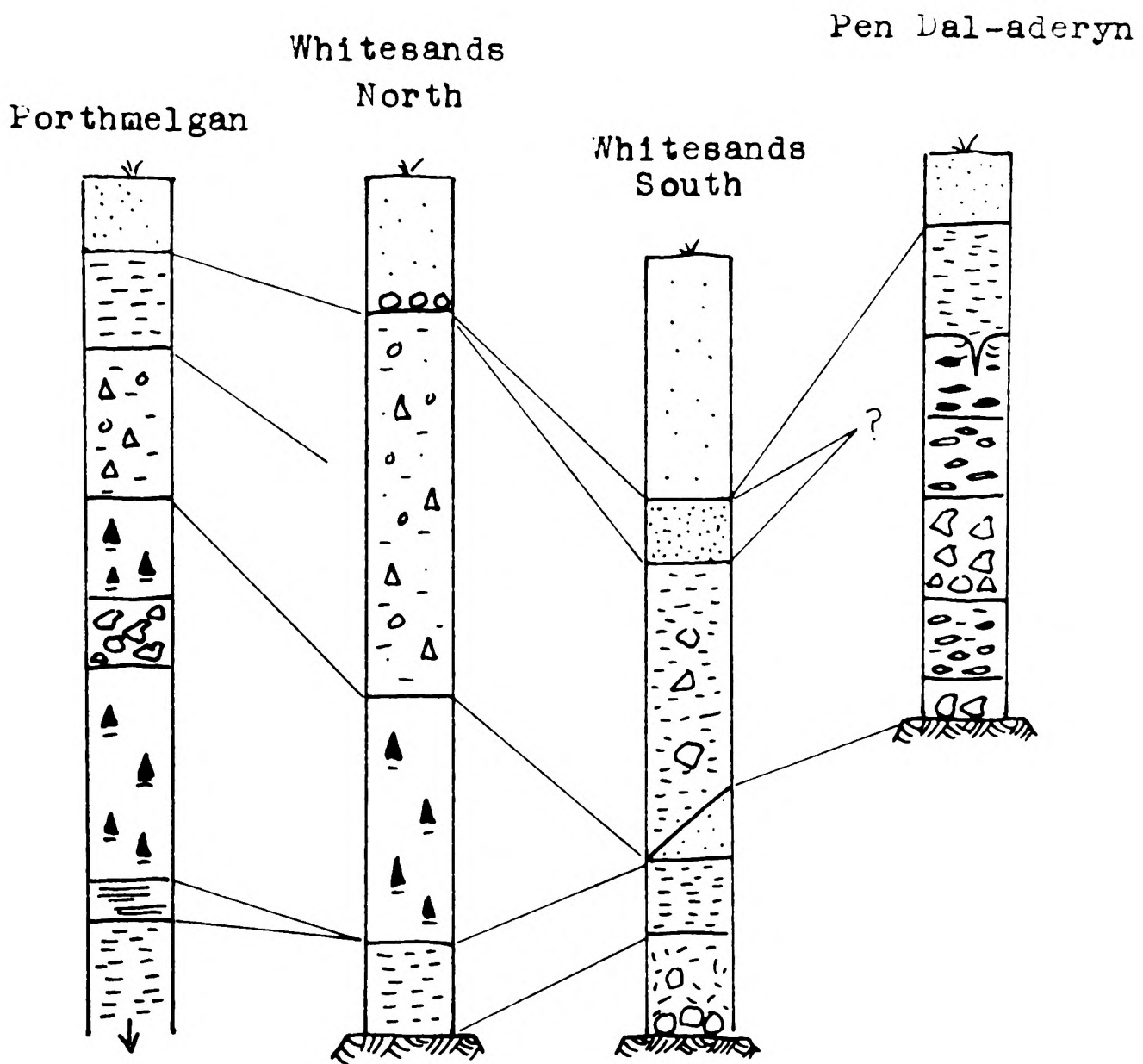
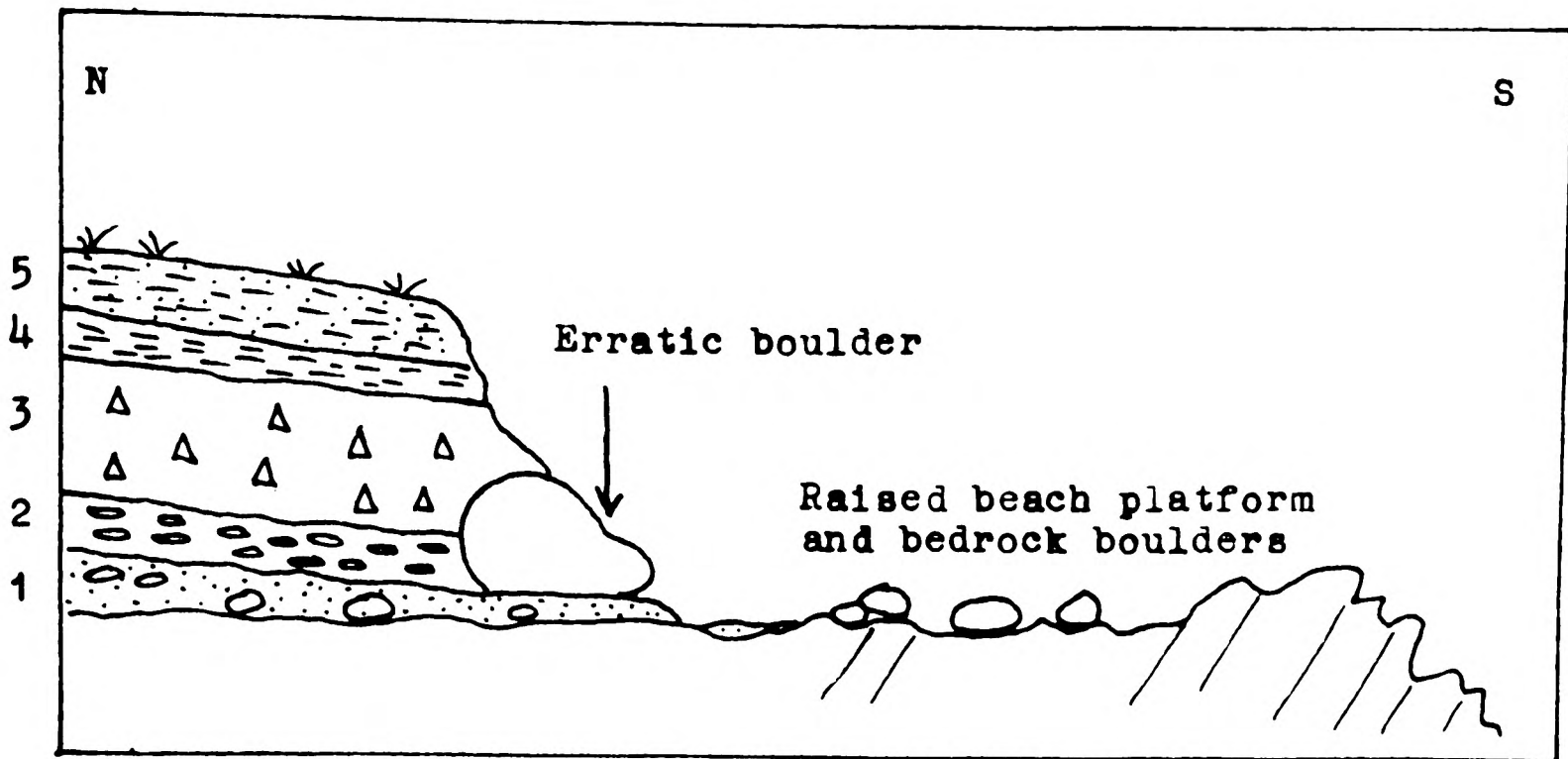


Fig. 63. Correlation of idealised stratigraphic columns for sections on the west coast of Dewisland.

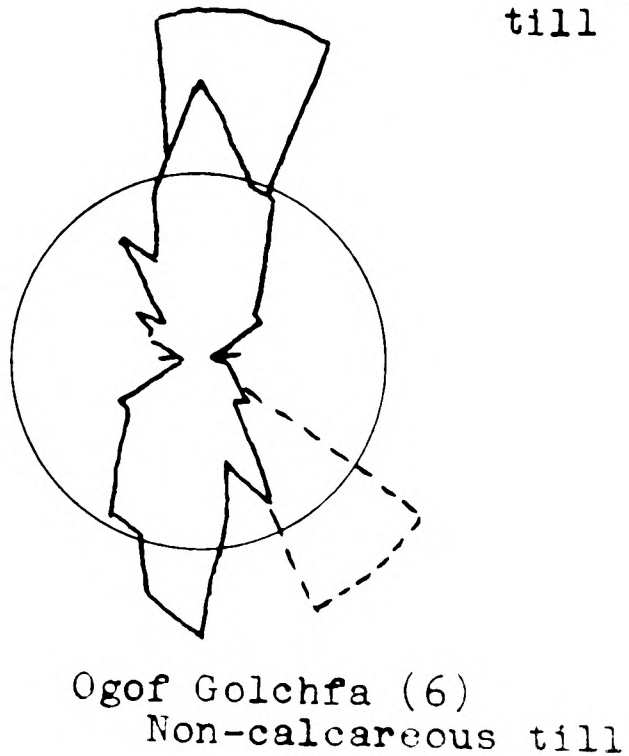
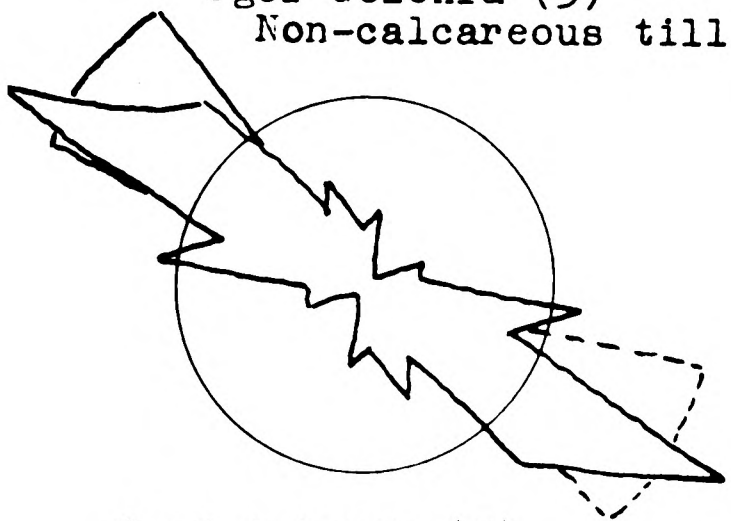
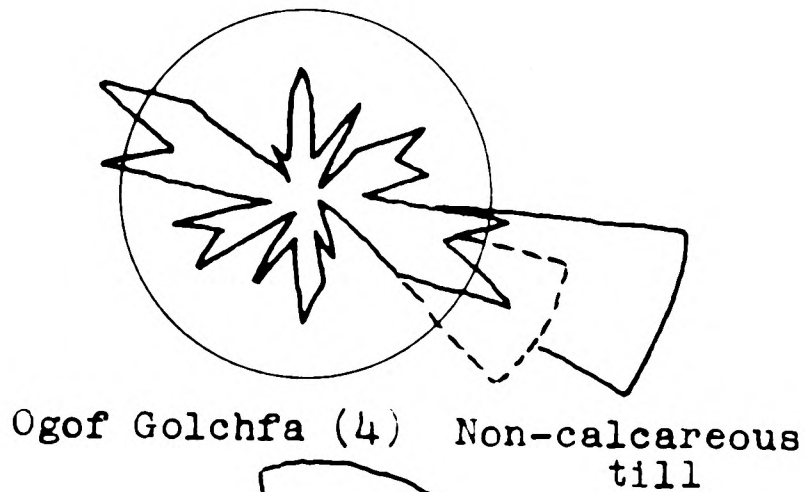
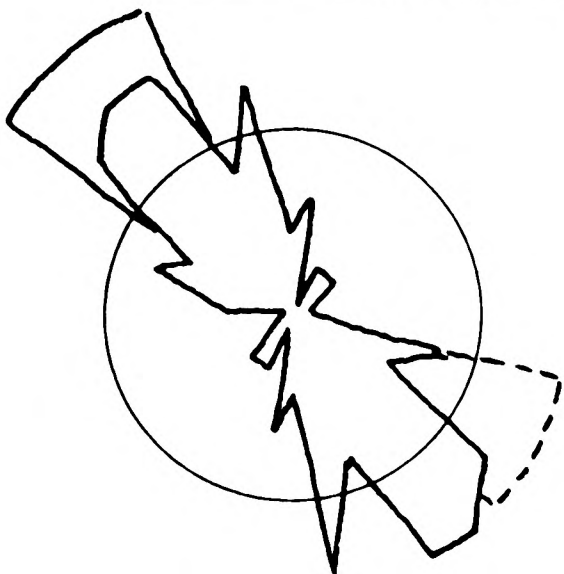
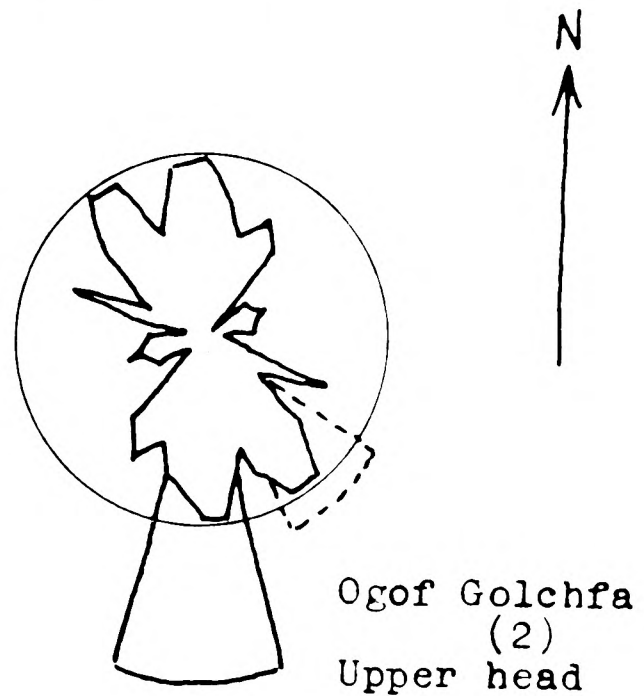
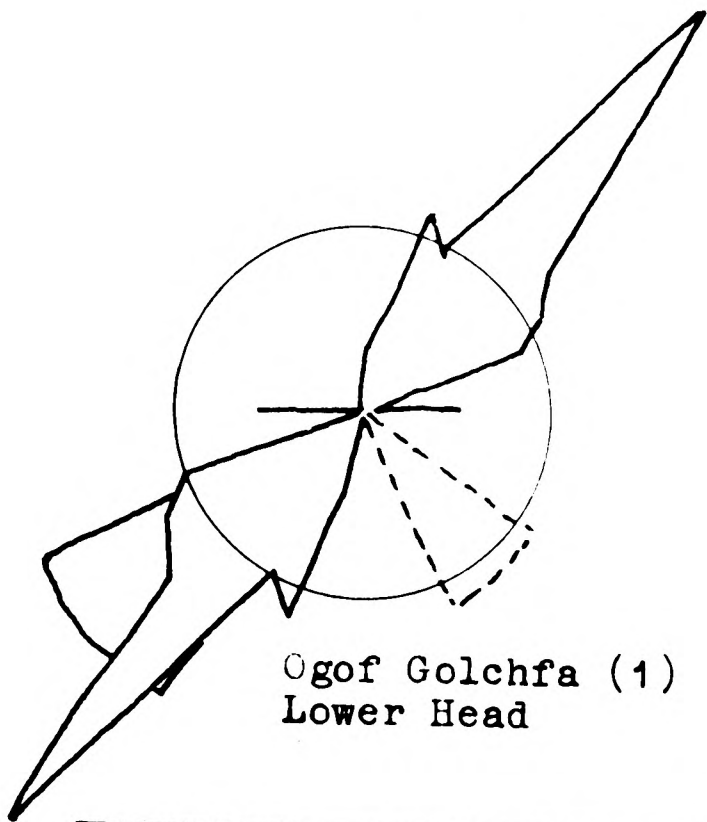


Not to scale  
 The drift section is  
 c. 8 ft high.

5. Sandy loam
4. Upper local head
3. Non-calcareous till
2. Lower head of beach pebbles
1. Raised beach shingle and erratic boulders

Fig. 64. The raised beach platform and drift cliff at Ogof Golchfa (Porth Clais). Except for the omission of sandrock, the succession is almost identical to that of Gower.

Fig. 65. Preferred orientation diagrams for  
Ogof Golchfa drifts.



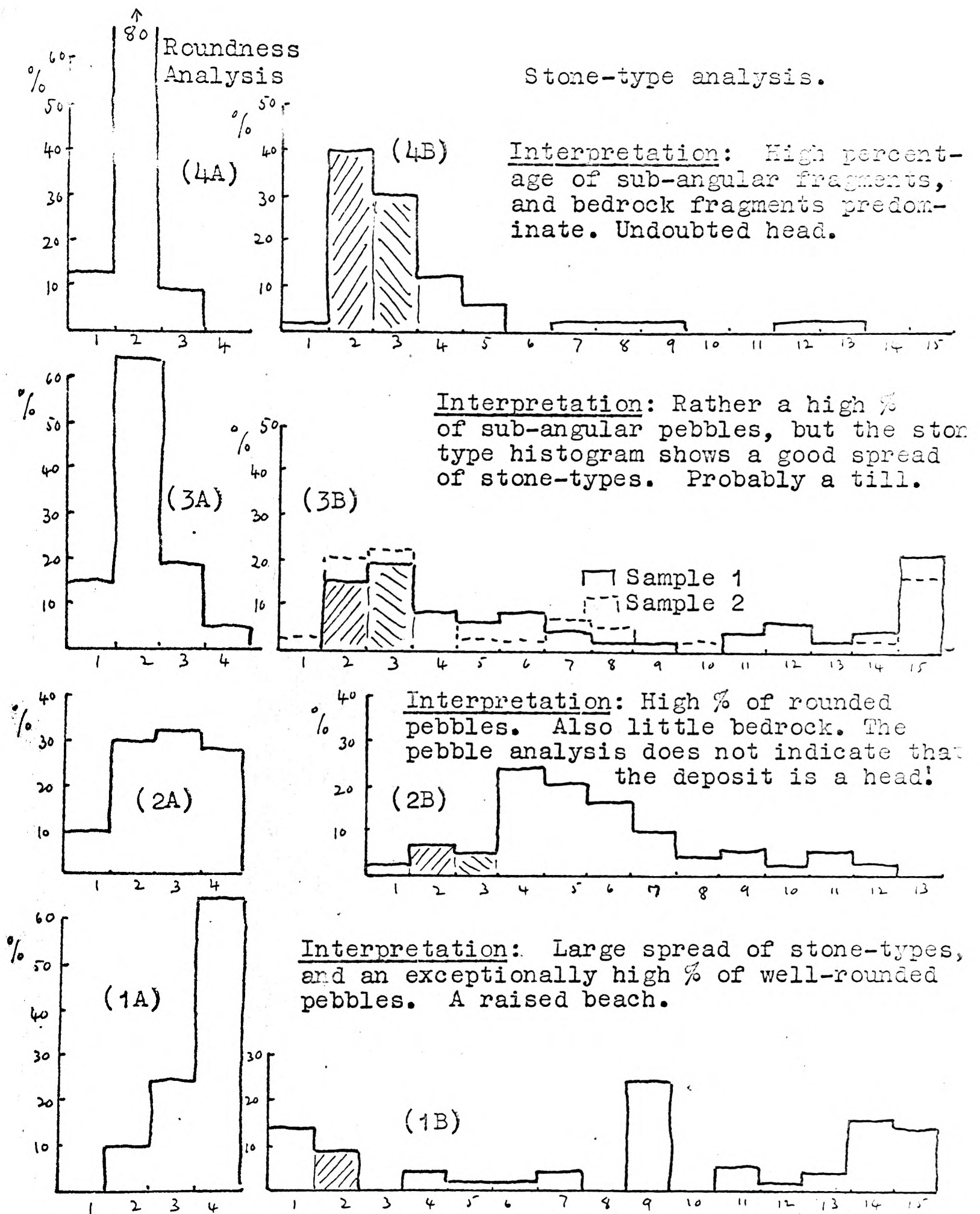


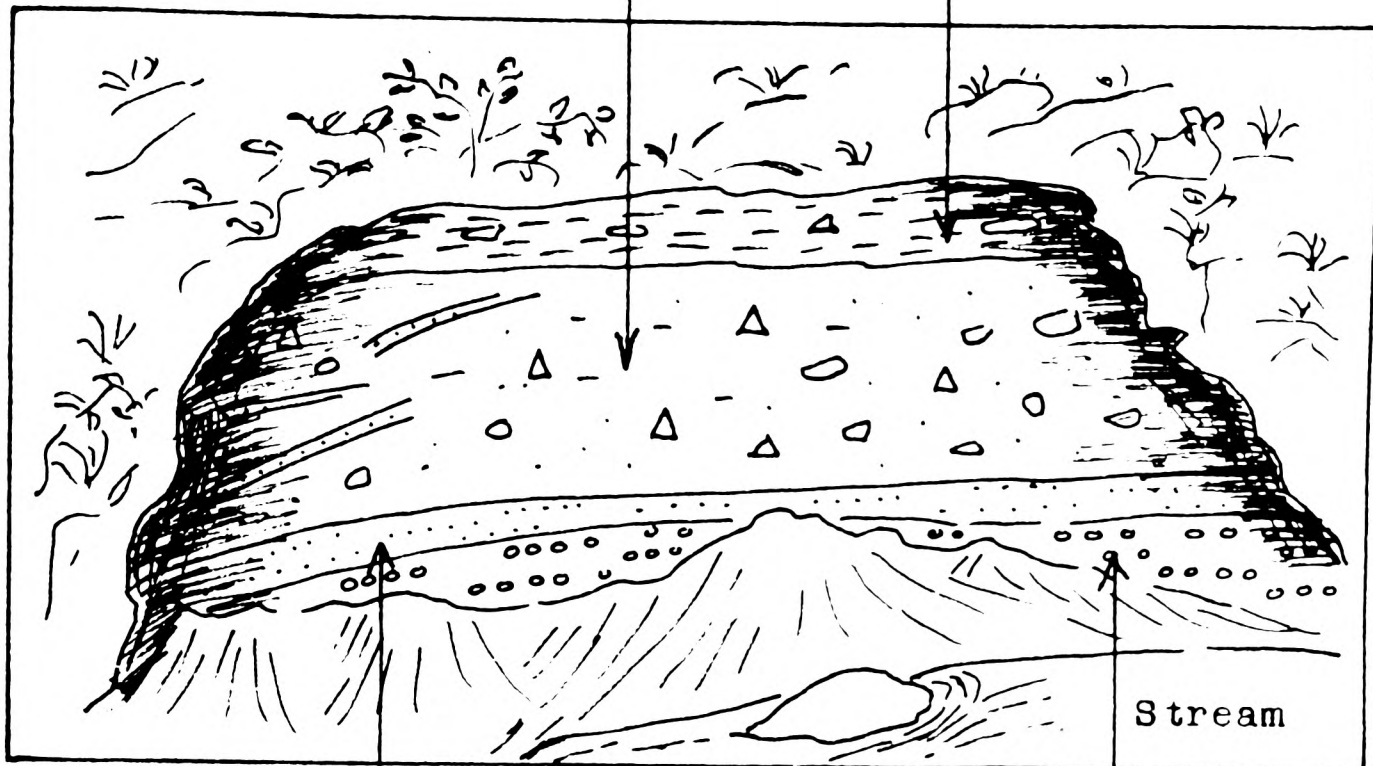
Fig. 66.

Analysis of pebbles from drifts at Ogof Golchr

- (4) = Upper local head
- (3) = Non-calcareous till
- (2) = Lower head of beach pebbles
- (1) = Raised beach

Up to 5 ft of rubble-drift  
with interbedded lenses of  
sand and gravel.

Head and sandy loam.



Up to 3 ft of  
stratified sand.

Up to 2 ft. of fine  
stratified gravel.

Fig. 67. The stream cutting in Caerbwly Valley,  
exposing sands and gravels beneath  
local till and rubble-drift.

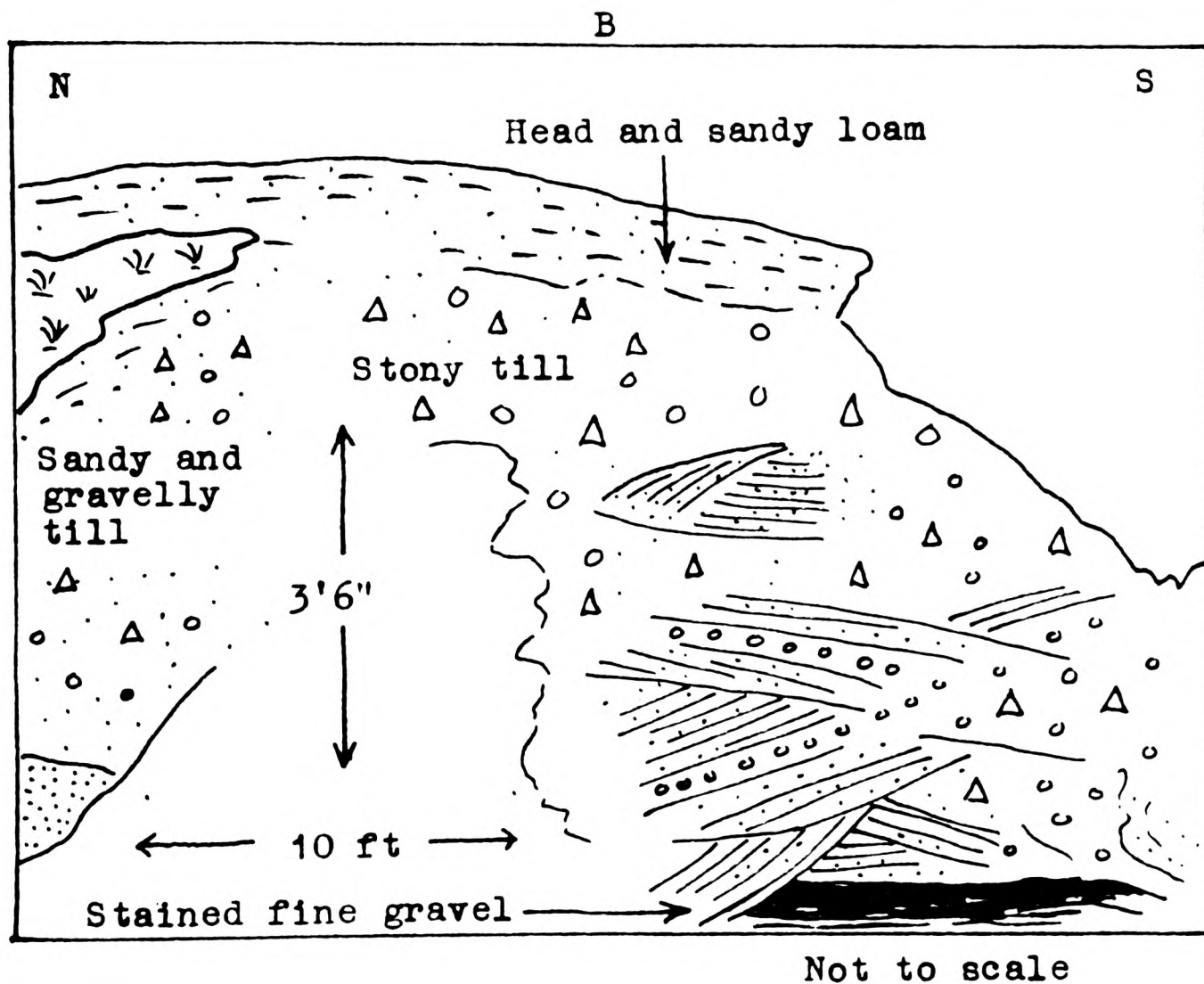
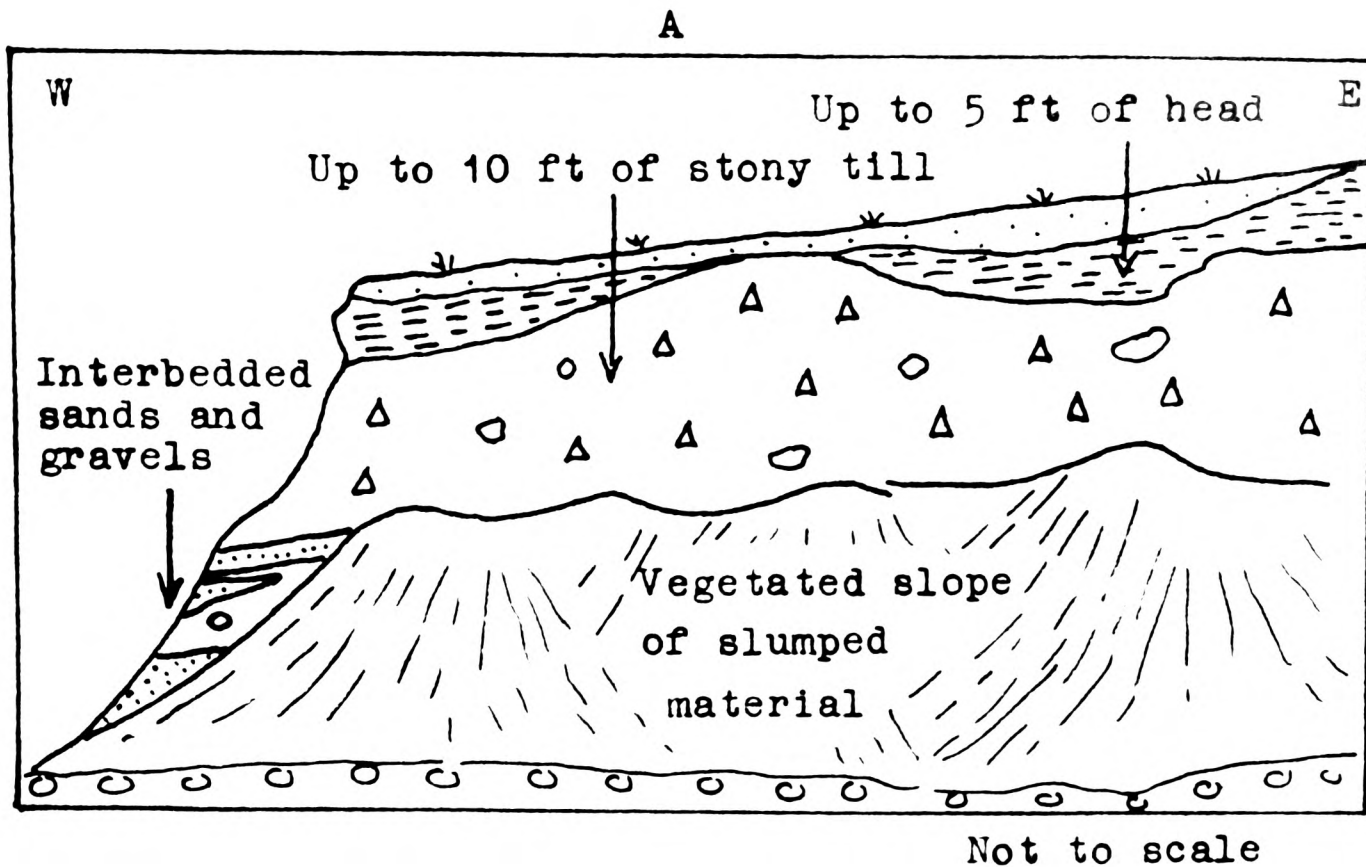


Fig. 68 A. The main drift cliff at Caerbwdy.

B. Generalised section in the new gravel-cutting on the flank of the Caerbwdy drift cliff.

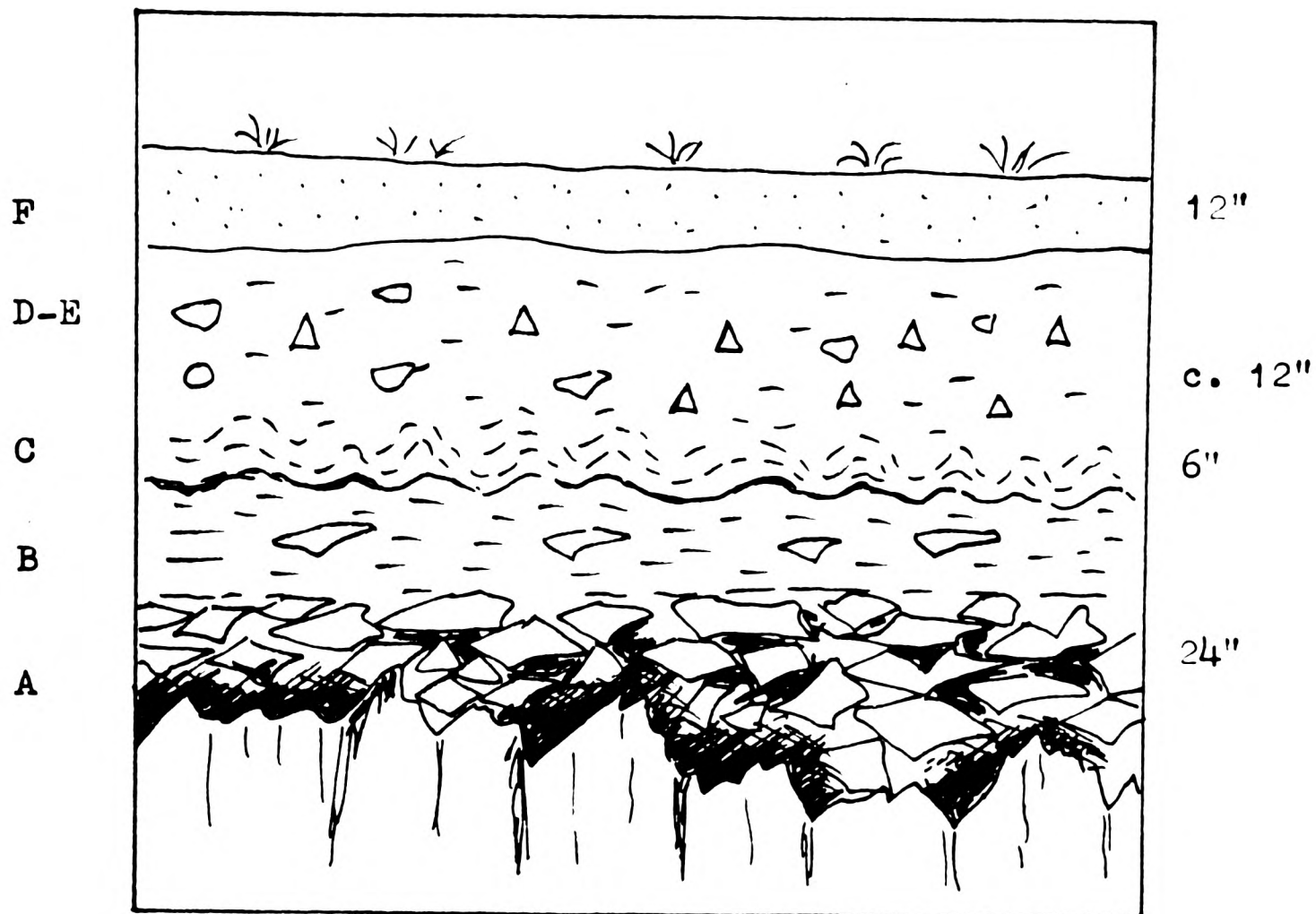


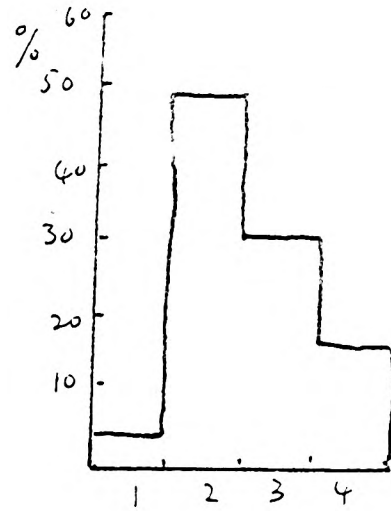
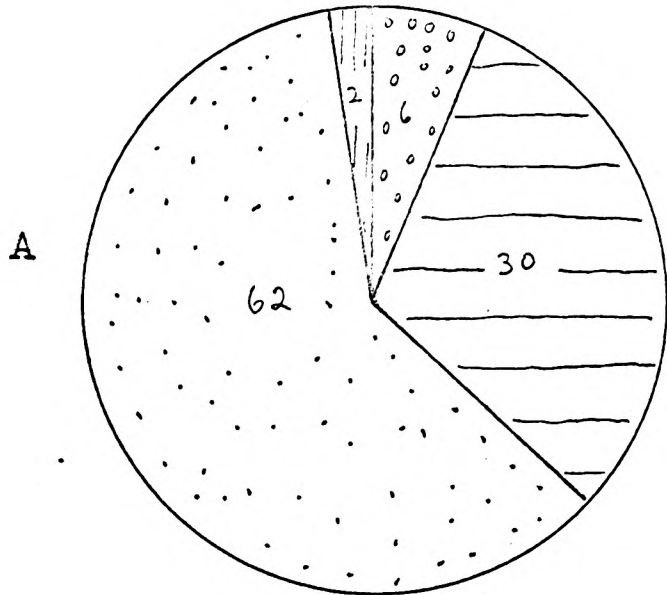
Fig. 69. The drift sequence on the clifftop  
on the east side of Caerbwdy Bay.

Note the "ideal" drift sequence. Suggested  
chronology:

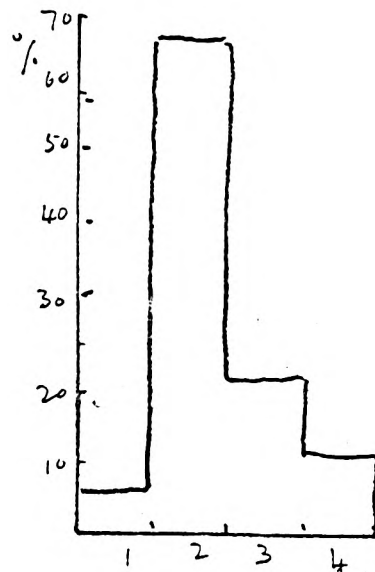
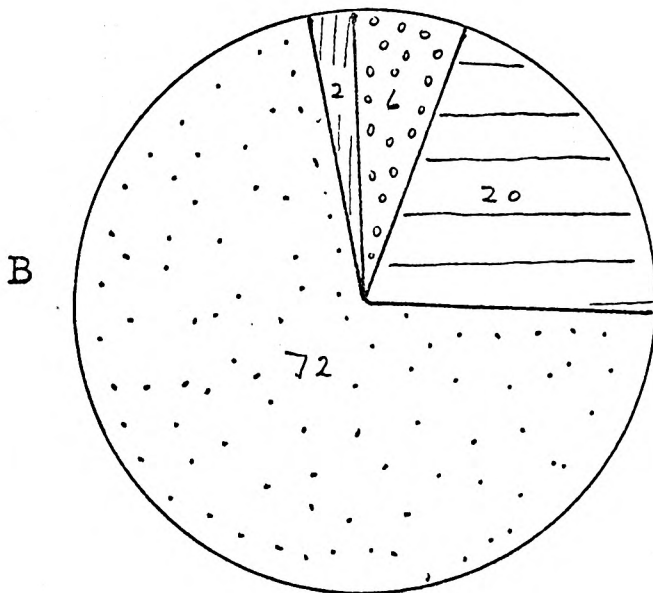
- F Waning periglacial conditions; hillwash and sandy loam.
- E Periglacial phase; solifluxion of till.
- D Glaciation; till.
- C Severe periglacial conditions; cryoturbation of head flakes.
- B Increasing cold and aridity; flaky head with blocks.
- A Onset of periglacial conditions; blocky head.

Pebble composition

Roundness Analysis



Gravels 12" above the stained band



Gravels in the stained band

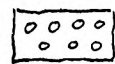
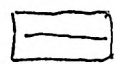
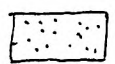

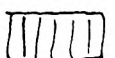
-  Pre-Cambrian intrusive rocks
-  Pre-Cambrian extrusive rocks
-  Cambrian sedimentaries
-  Ordovician sedimentaries
-  Ordovician intrusives.

Fig. 70. Comparative stone-counts and roundness analyses for the stained and non-stained fluvio-glacial gravels in the Caerbwŷ drift cliff.

Roundness analysis

Stone-type analysis

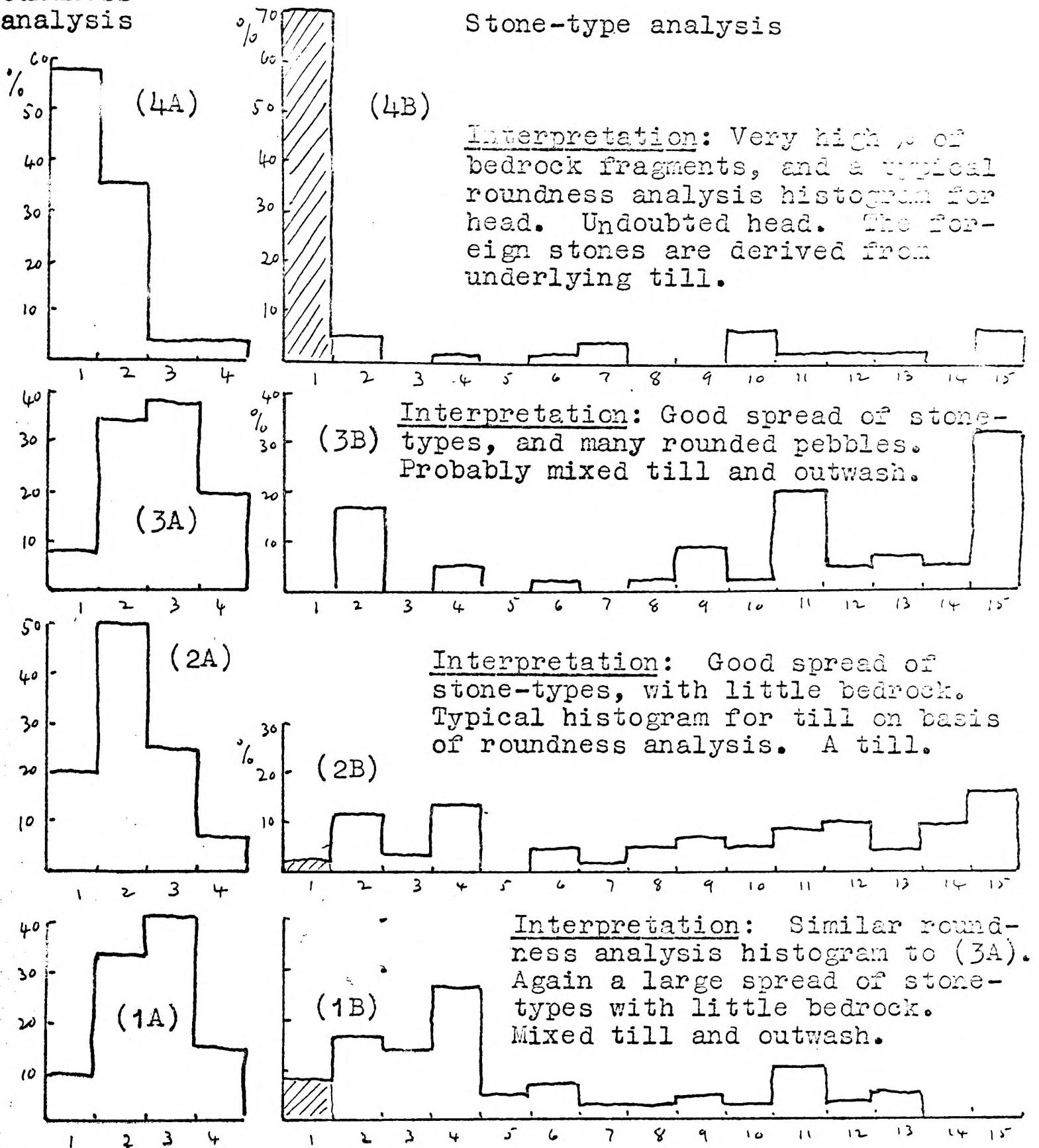


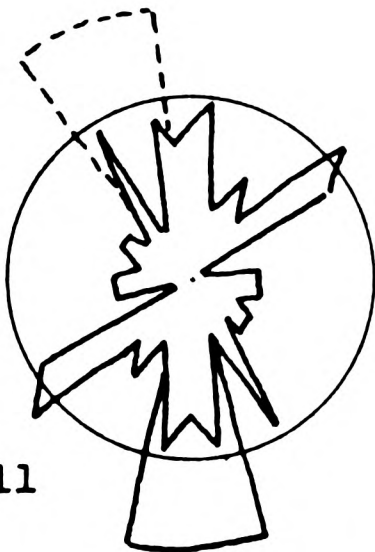
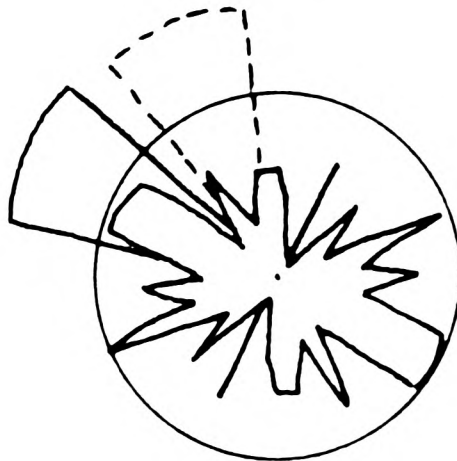
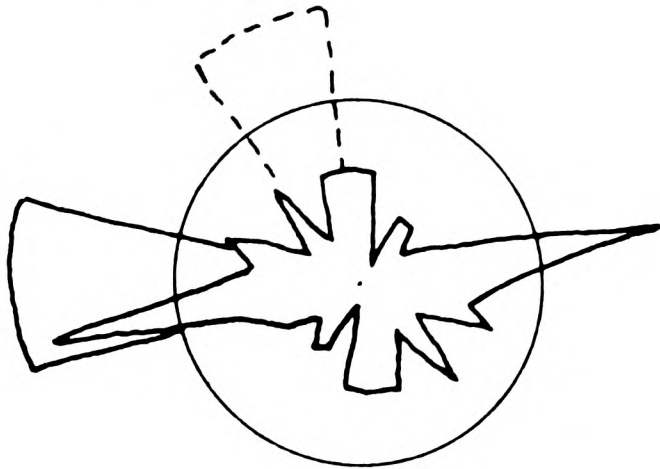
Fig. 71.

Pebble analyses from Caerbwdy drifts.

- (4) = Upper purple head
- (3) = Basal till from stream cutting
- (2) = Till from near clifftop
- (1) = Till from base of main drift cliff.

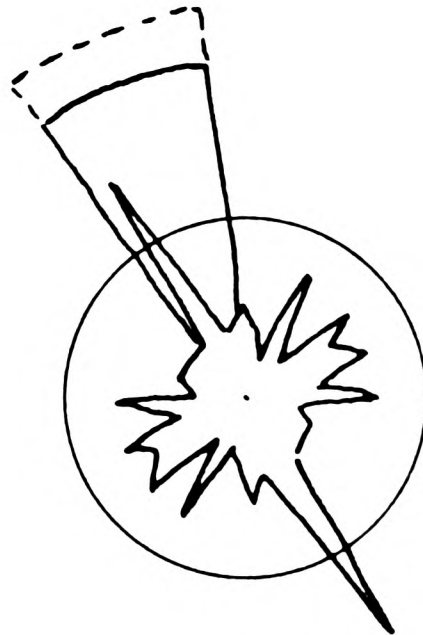
(6) Head

(2) Head

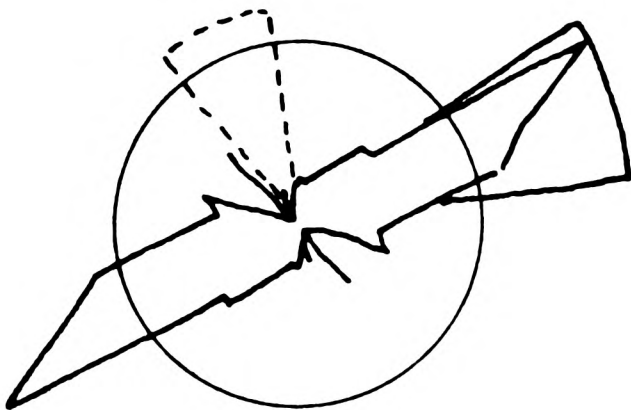


(1) Cliff-top till

(5) Cliff-top till



(3) Middle till



(4) Basal till

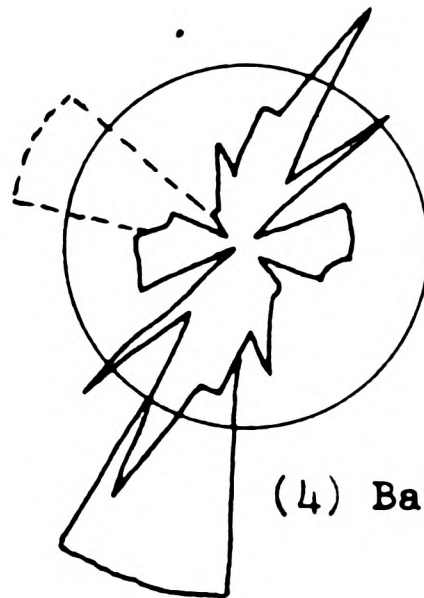
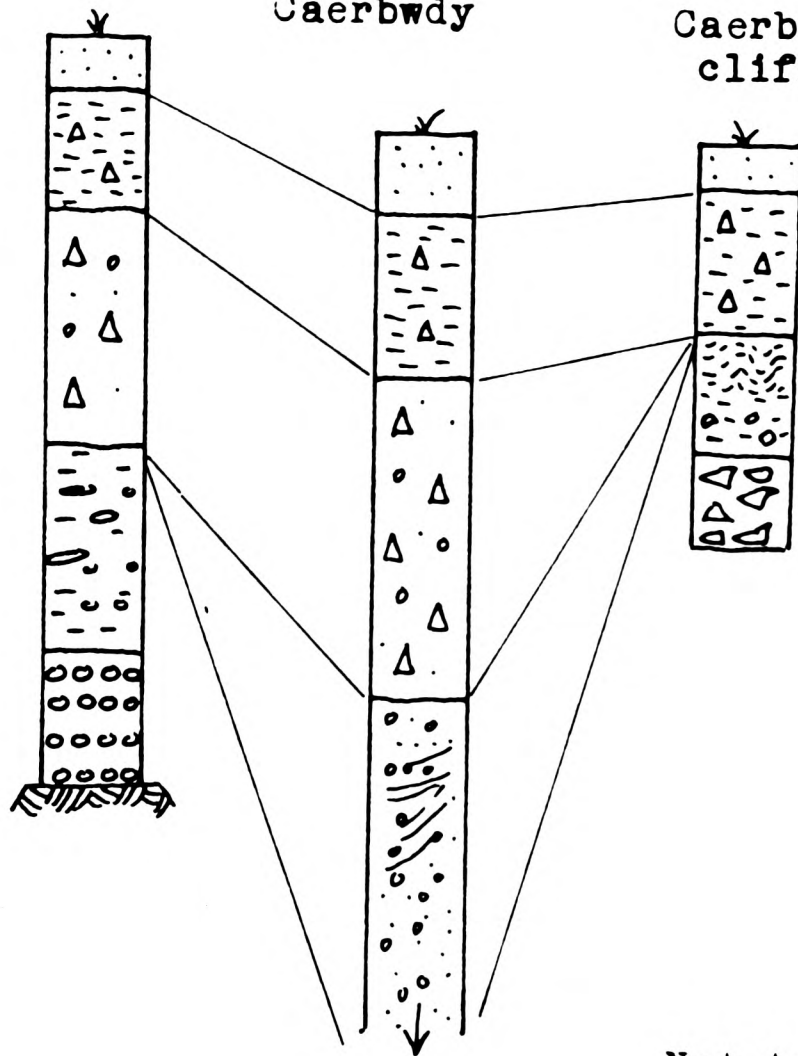


Fig. 72. Preferred orientation diagrams for Caerbwdy till and head.

Ogof  
Golchfa

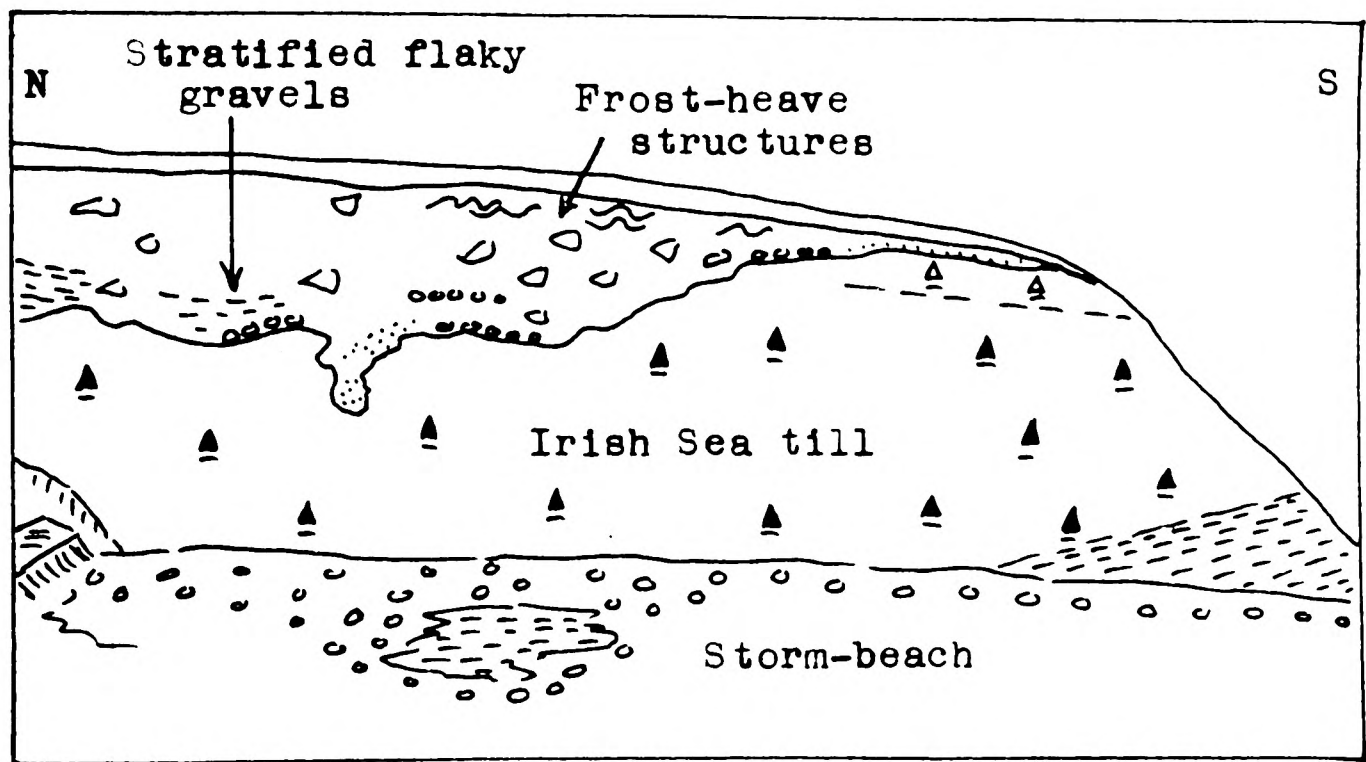
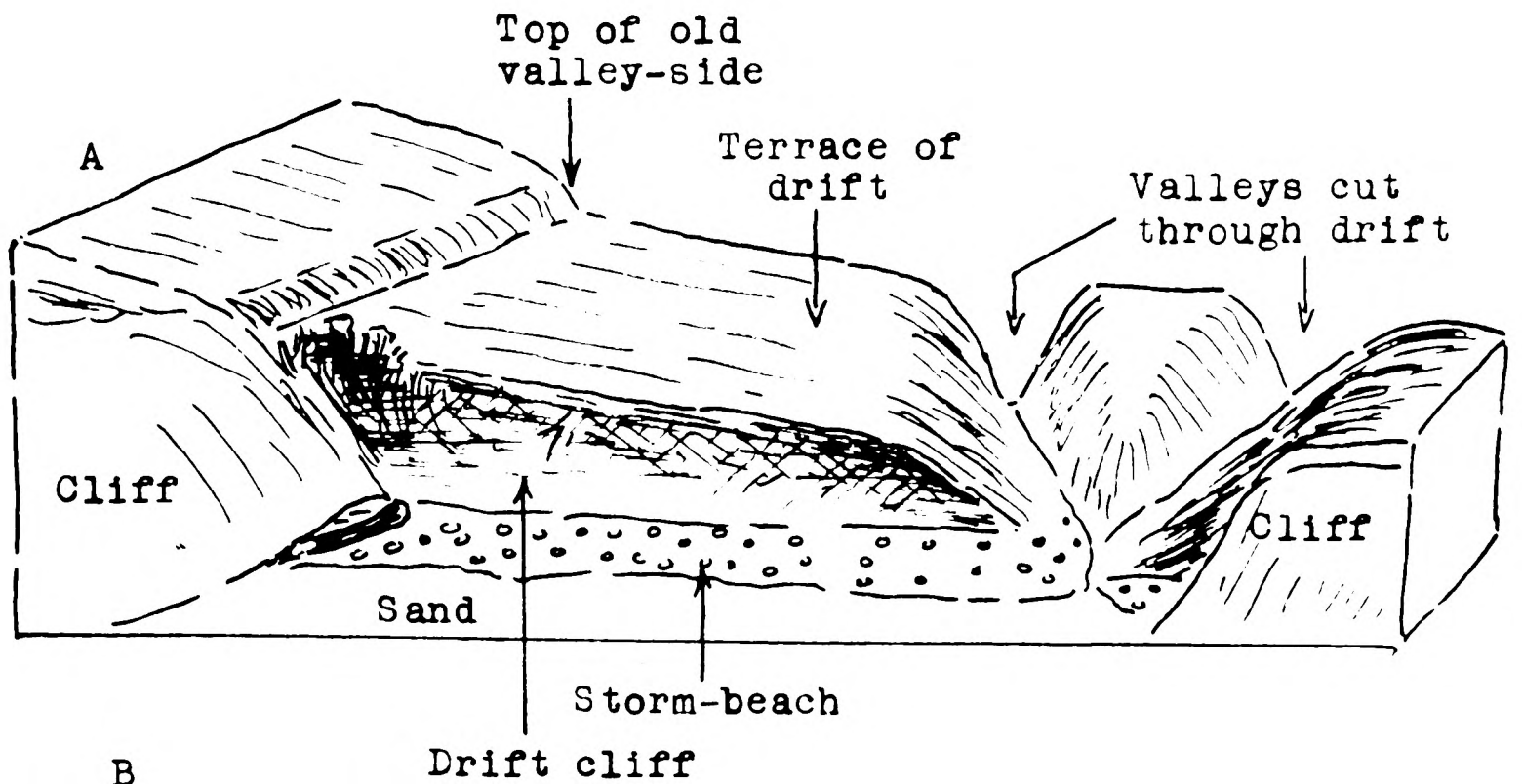
Caerbwdy

Caerbwdy  
clifftop



Not to scale  
For key see Fig. 35

Fig. 73. Idealised stratigraphic columns showing the correlation of drifts for sections on the south coast of Dewisland.



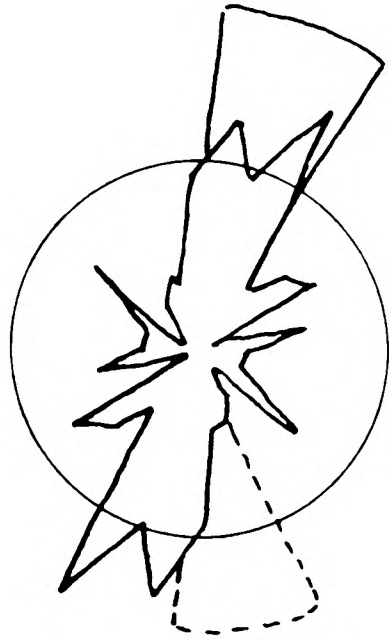
Not to scale

Fig. 74.

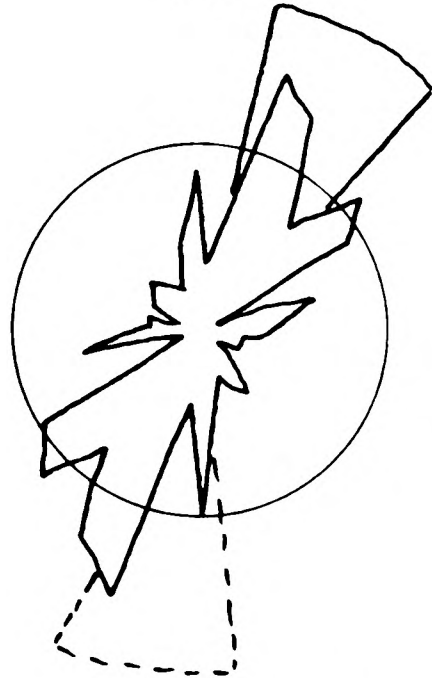
The Druidston Haven drift cliff.

A A sketched block diagram showing how the drift plugs an old valley.

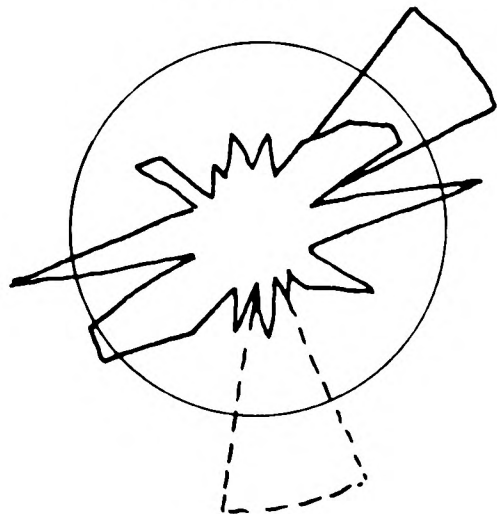
B Simplified stratigraphy of the drift cliff



Druidston C  
Rubble-drift



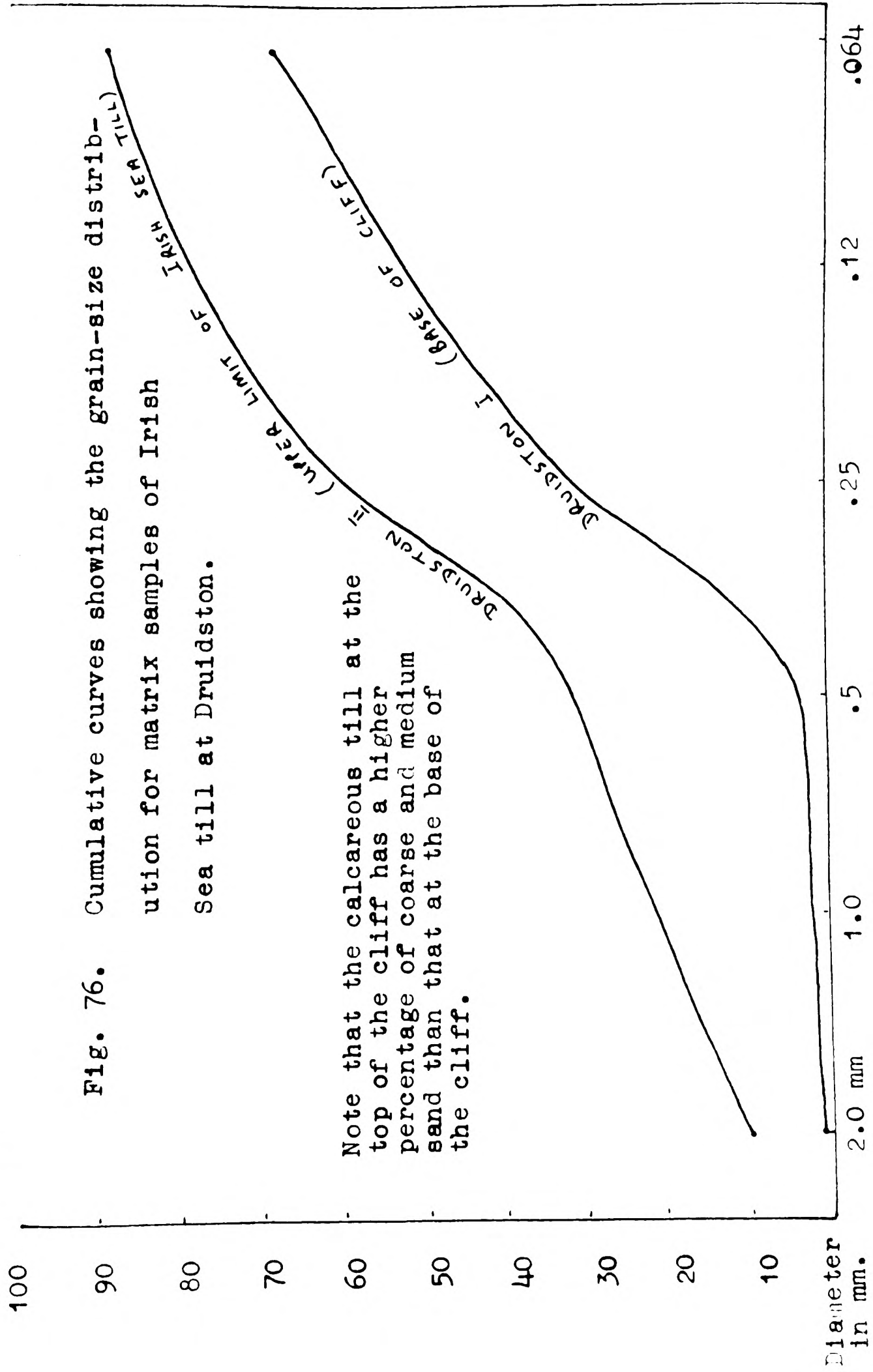
Druidston B  
Calcareous Irish Sea till



Druidston A  
Lower Head

Fig. 75. Preferred orientation diagrams for drift deposits at Druidston. Note that the Irish Sea <sup>till</sup> diagram does not indicate the direction of ice-movement.

Cumulative  
percentage



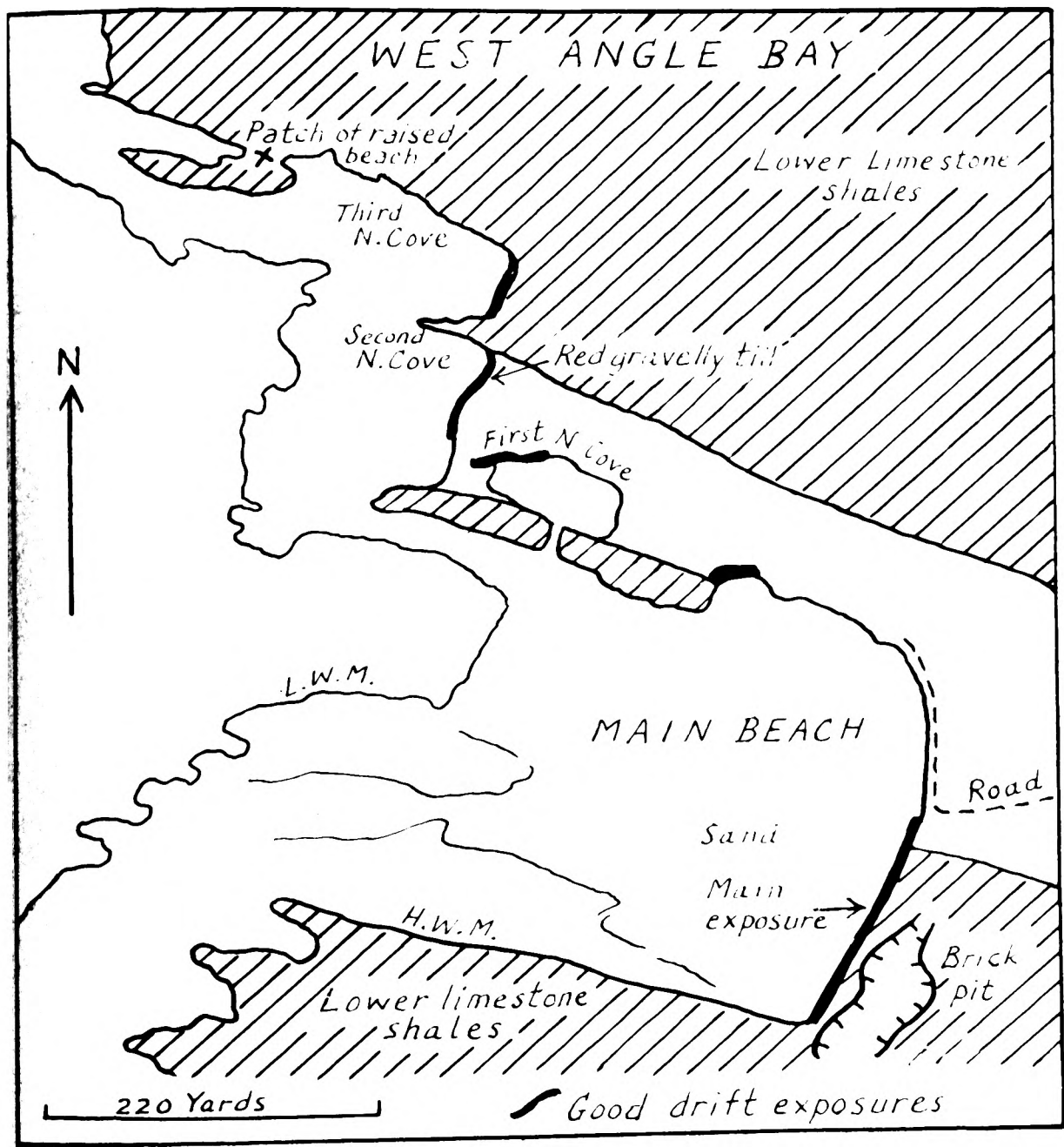
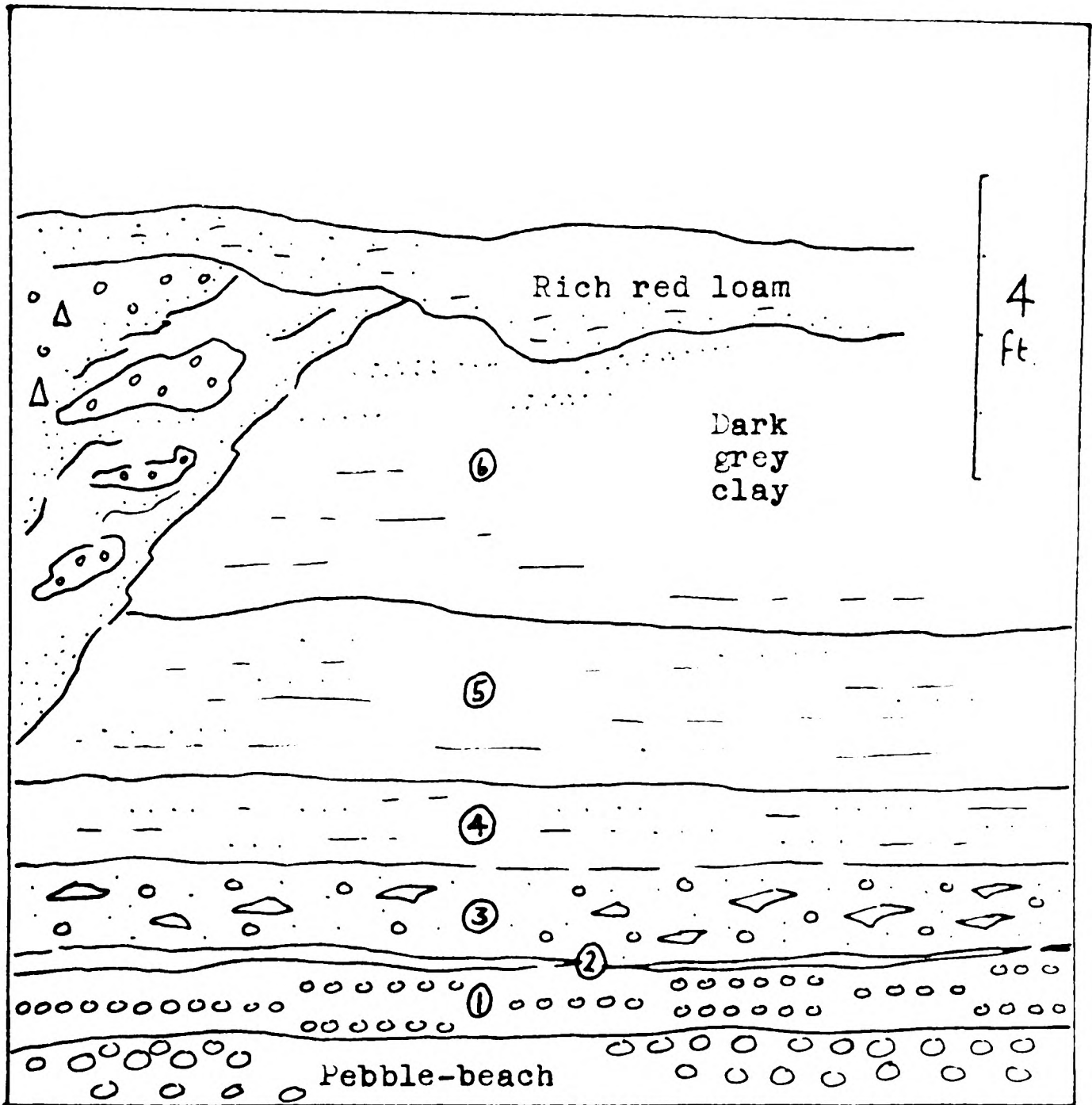
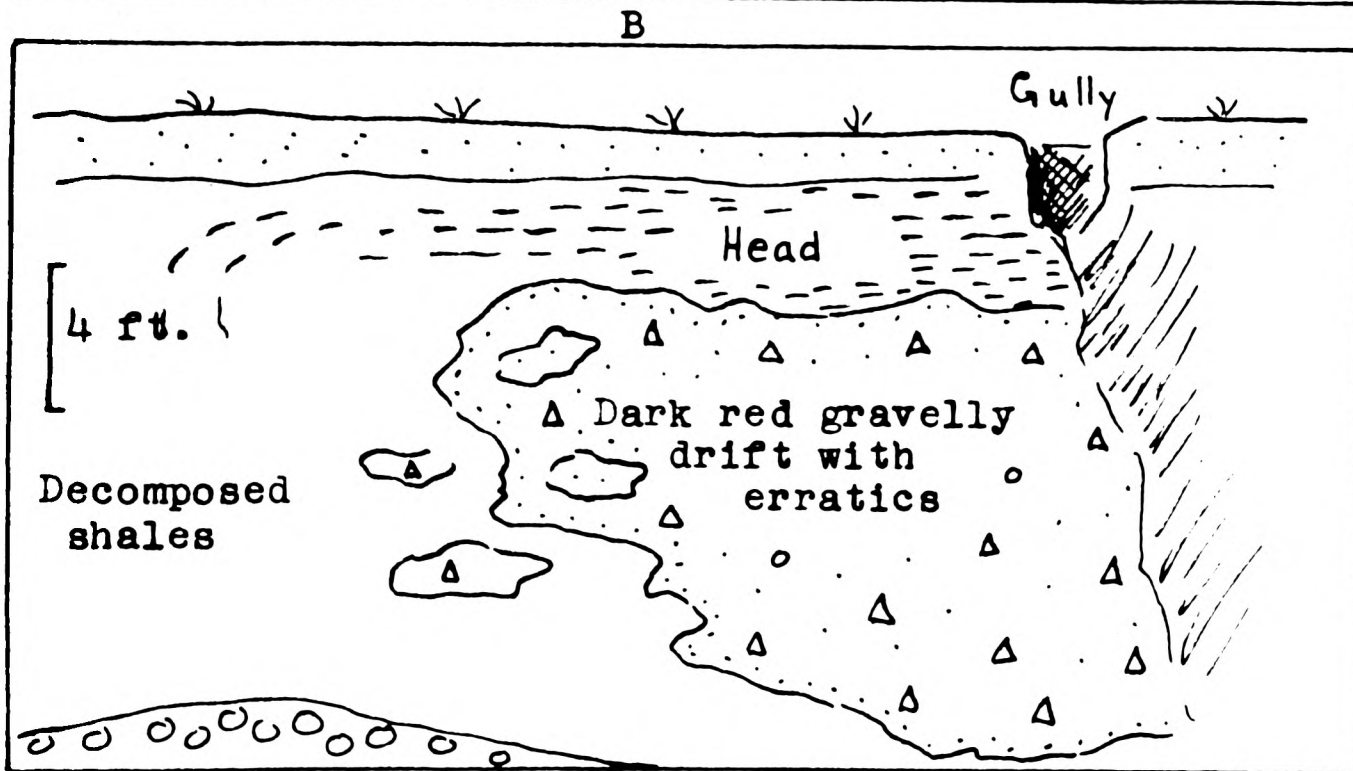
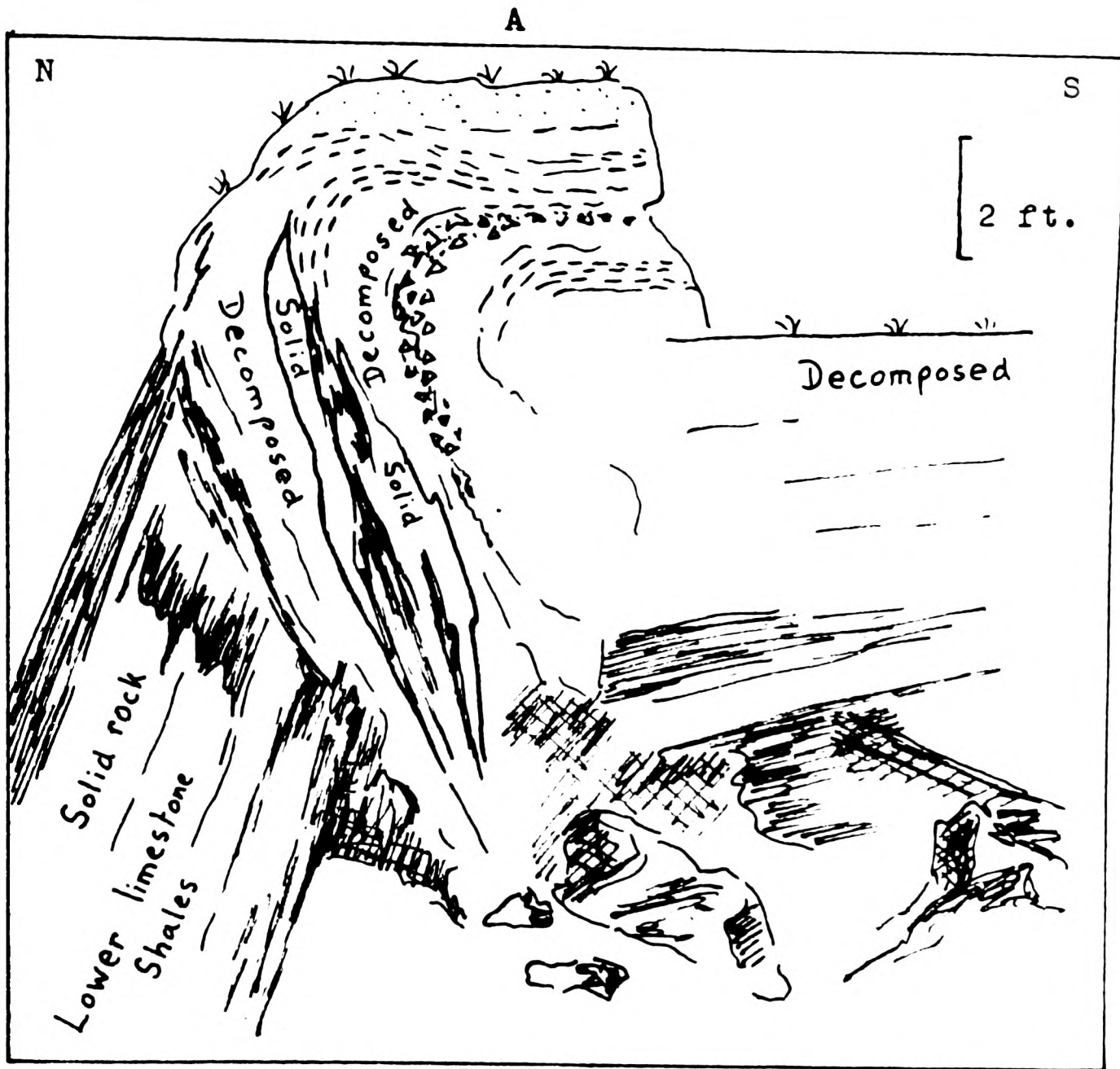


Fig. 77 The Main Beach and Coves at West Angle Bay.



Scale only approximate

Fig. 78. The drift succession in the main drift cliff at West Angle.



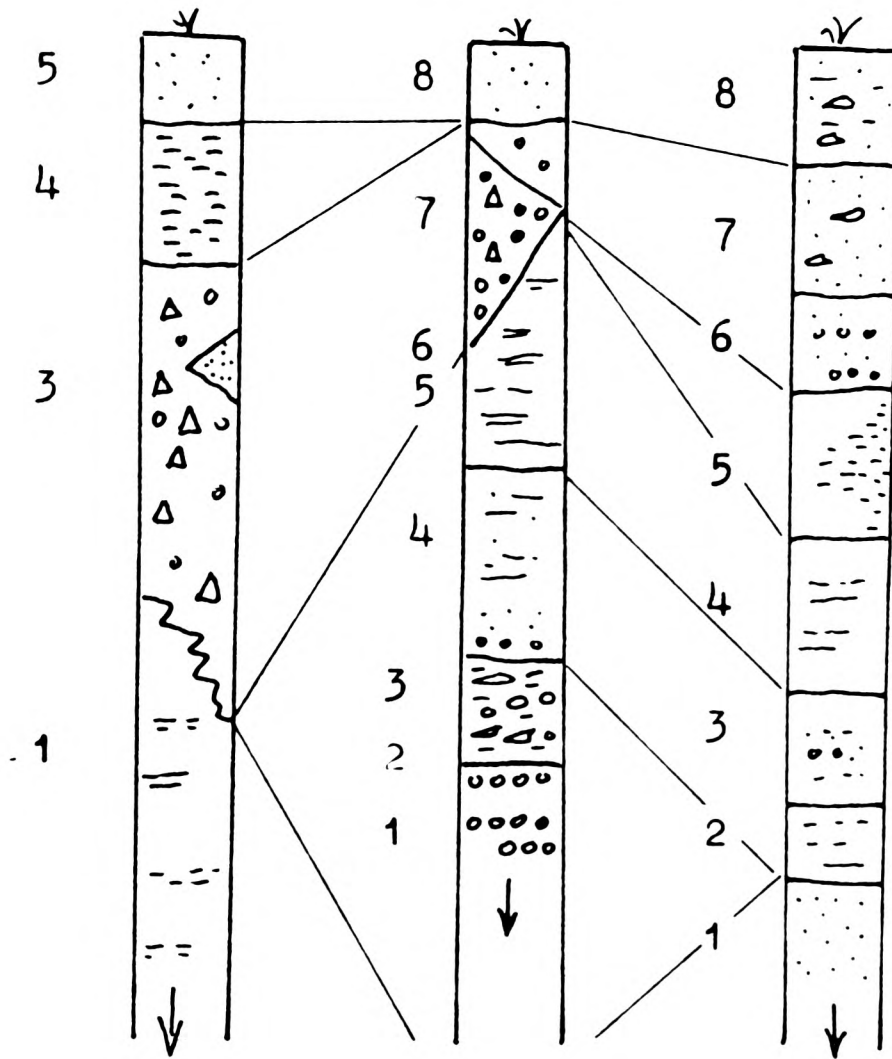
Neither sketch to scale

Fig. 79. Exposures in the northern coves at West Angle.  
 A. The anticline between coves two and three.  
 B. The patches of till in cove two.

Bays 2 & 3

Main Bay

Brickpit  
(Dixon)



Not to scale

For key see Fig. 35

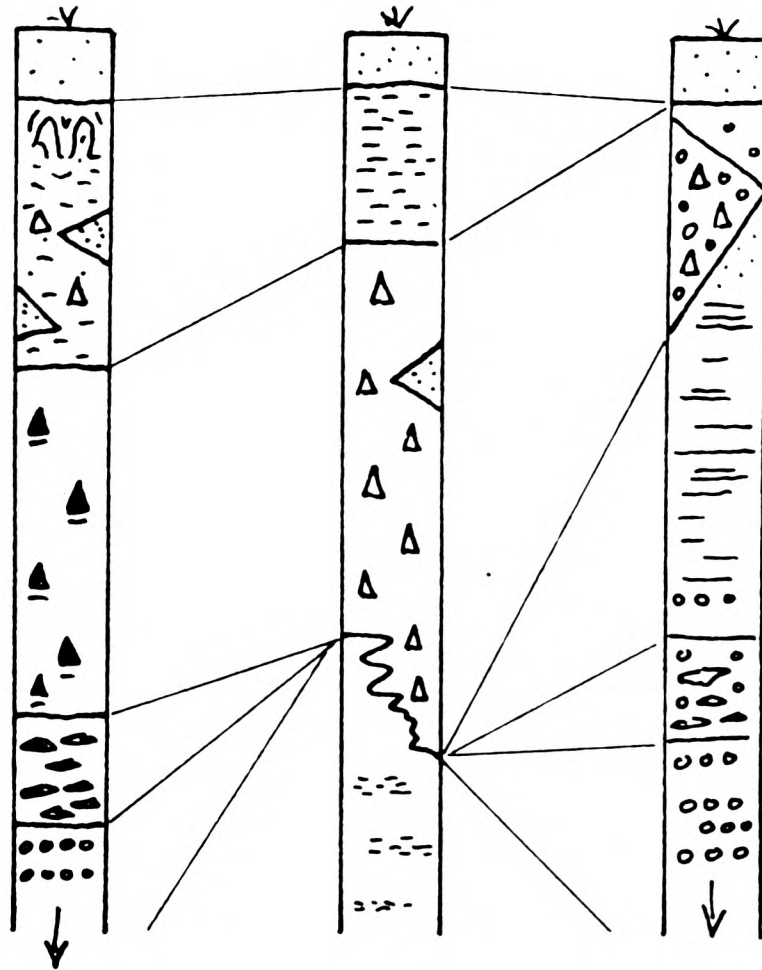
Fig. 80. A tentative correlation of the exposures at West Angle.

West Angle

Druidston

Bays 2 & 3

Main Bay



Not to scale

For key see Fig. 35

Fig. 81. Suggested correlation of the sections in South-west Pembrokeshire.

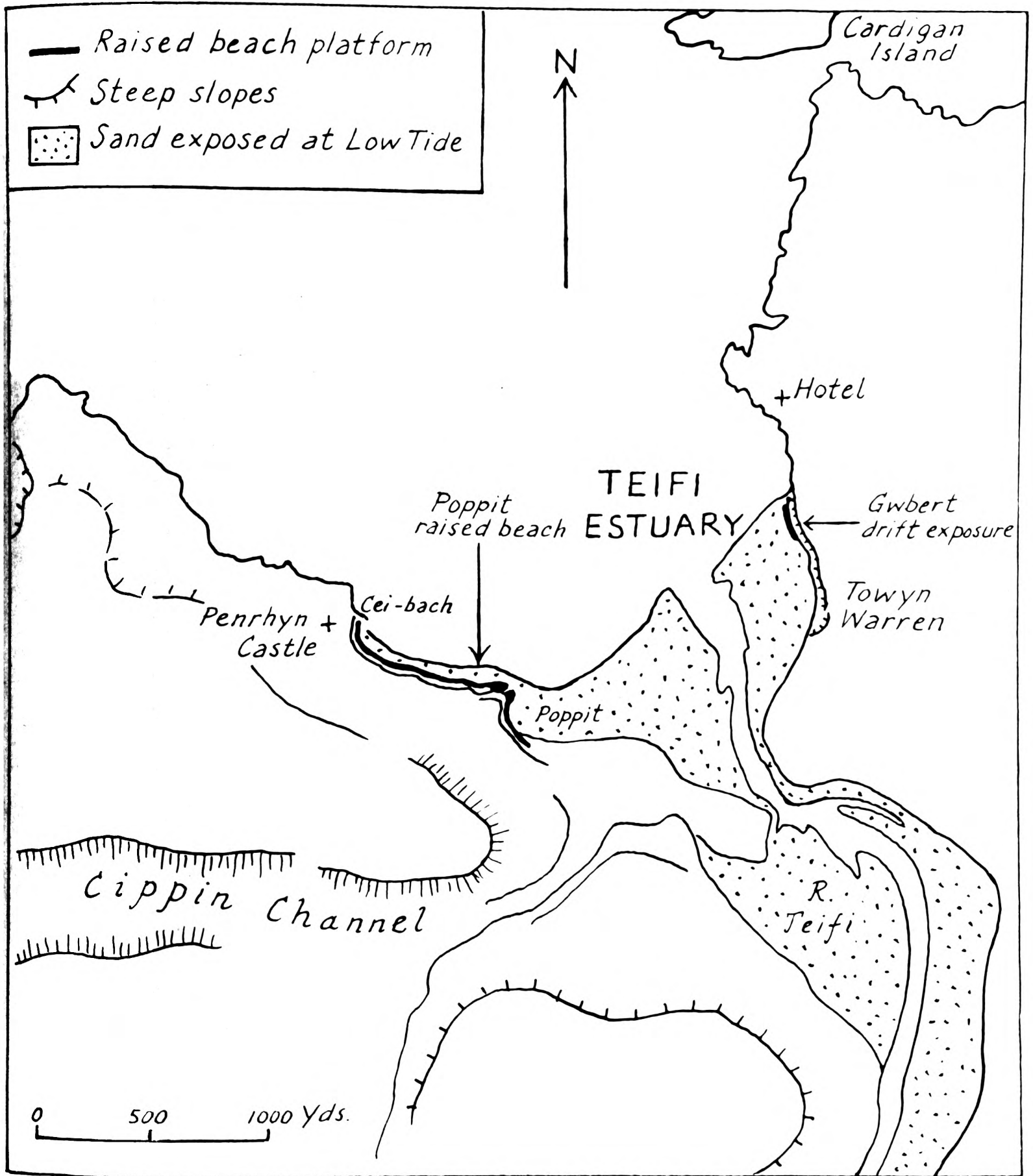
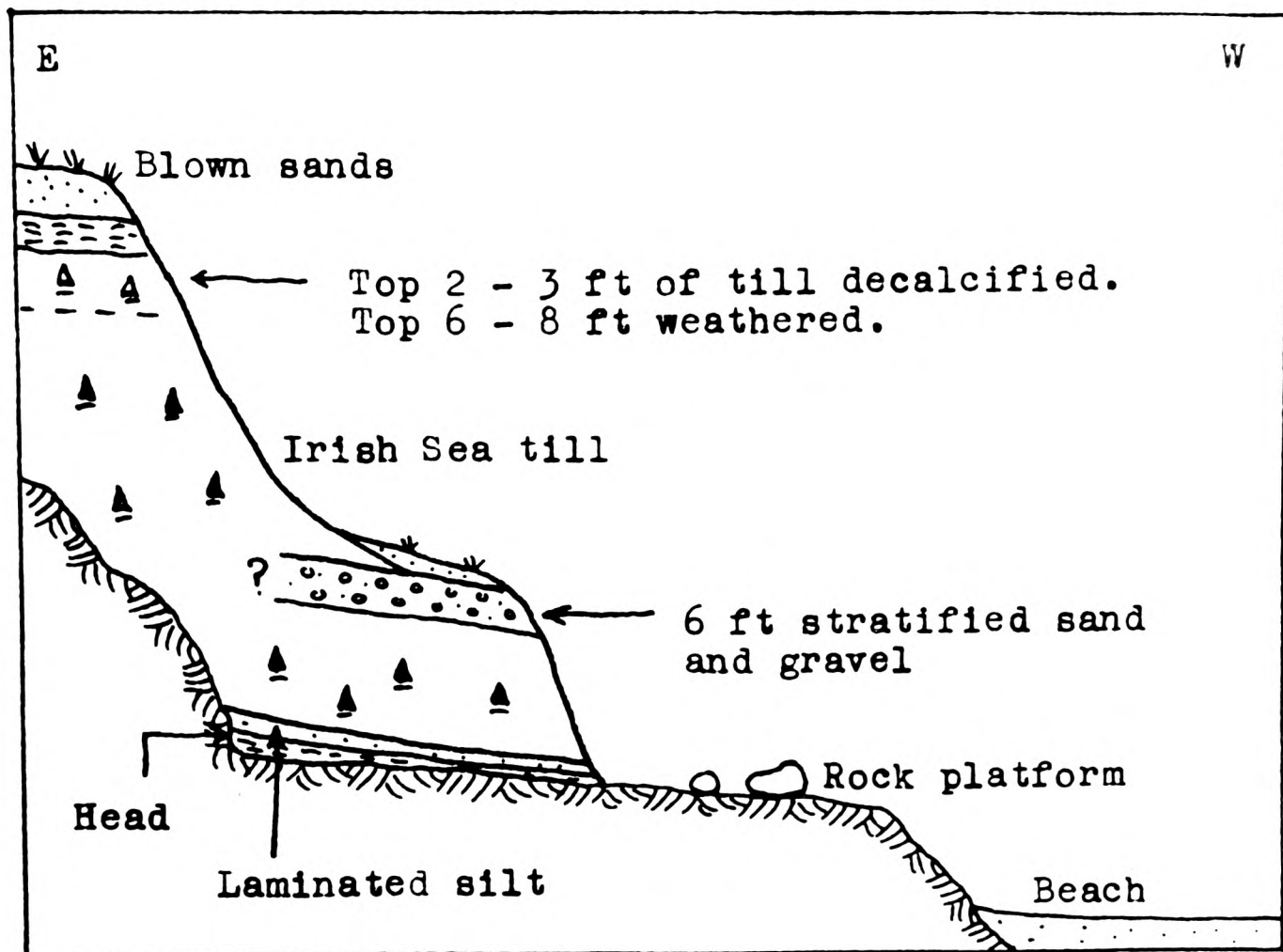


Fig.82 The Teifi Estuary, showing the location of the Gwbert and Poppit exposures.



Not to scale

Fig. 83. Composite idealised section for Gwbert, on the east side of the Teifi estuary. At this locality the bulk of the drift cliff is made up of Irish Sea till; there is no local till, and no trace of lacustrine deposits from "Lake Teifi".

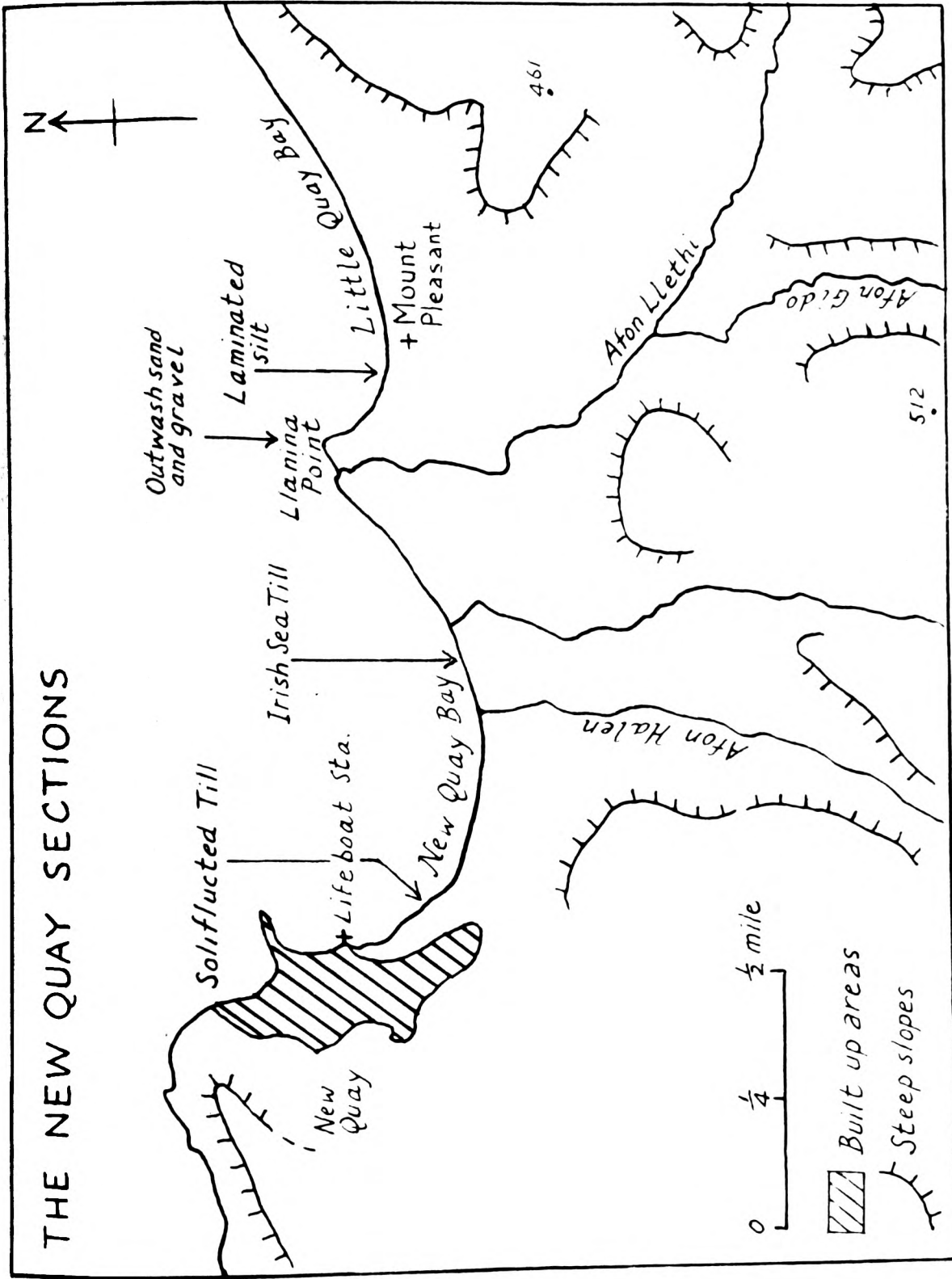
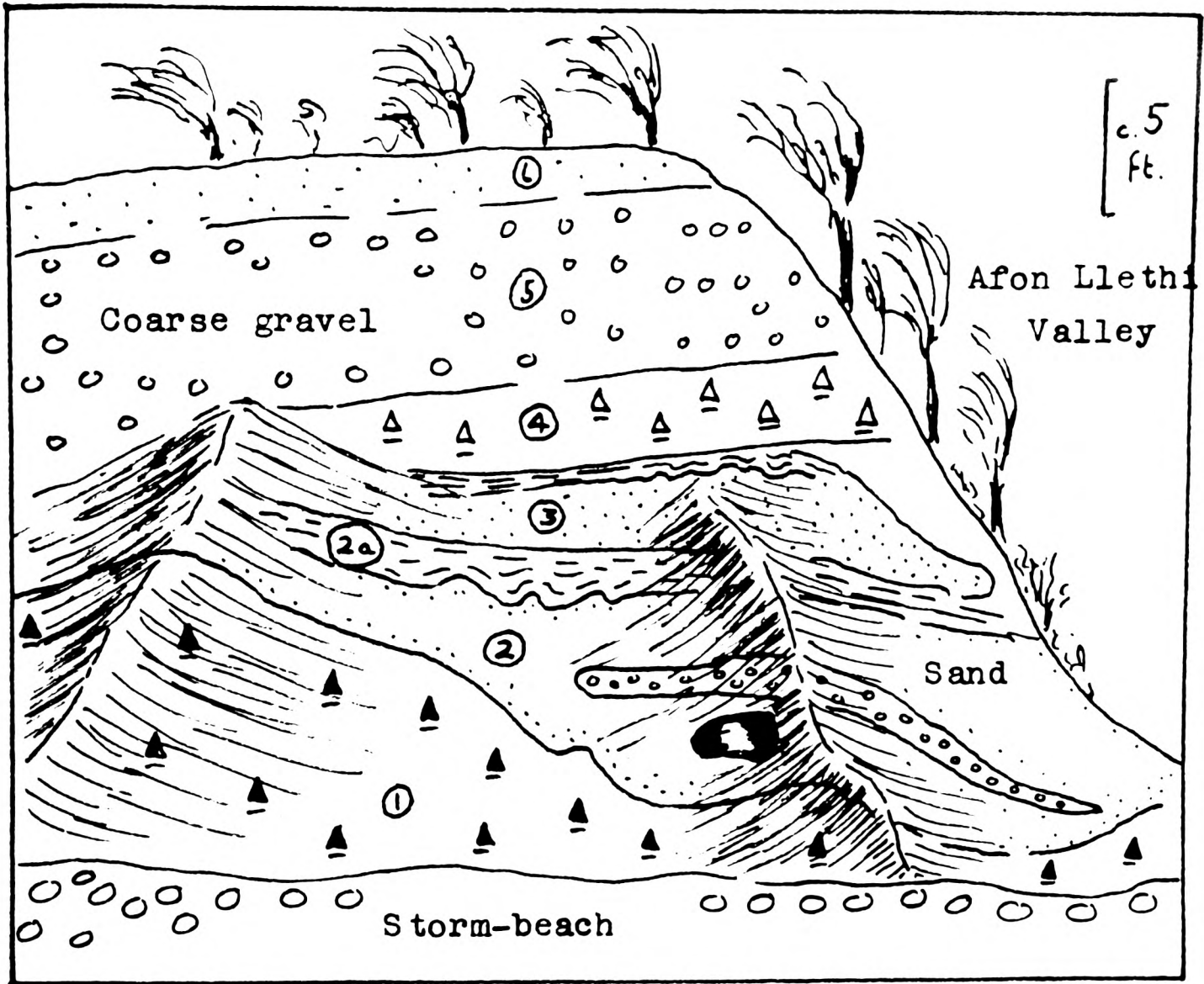
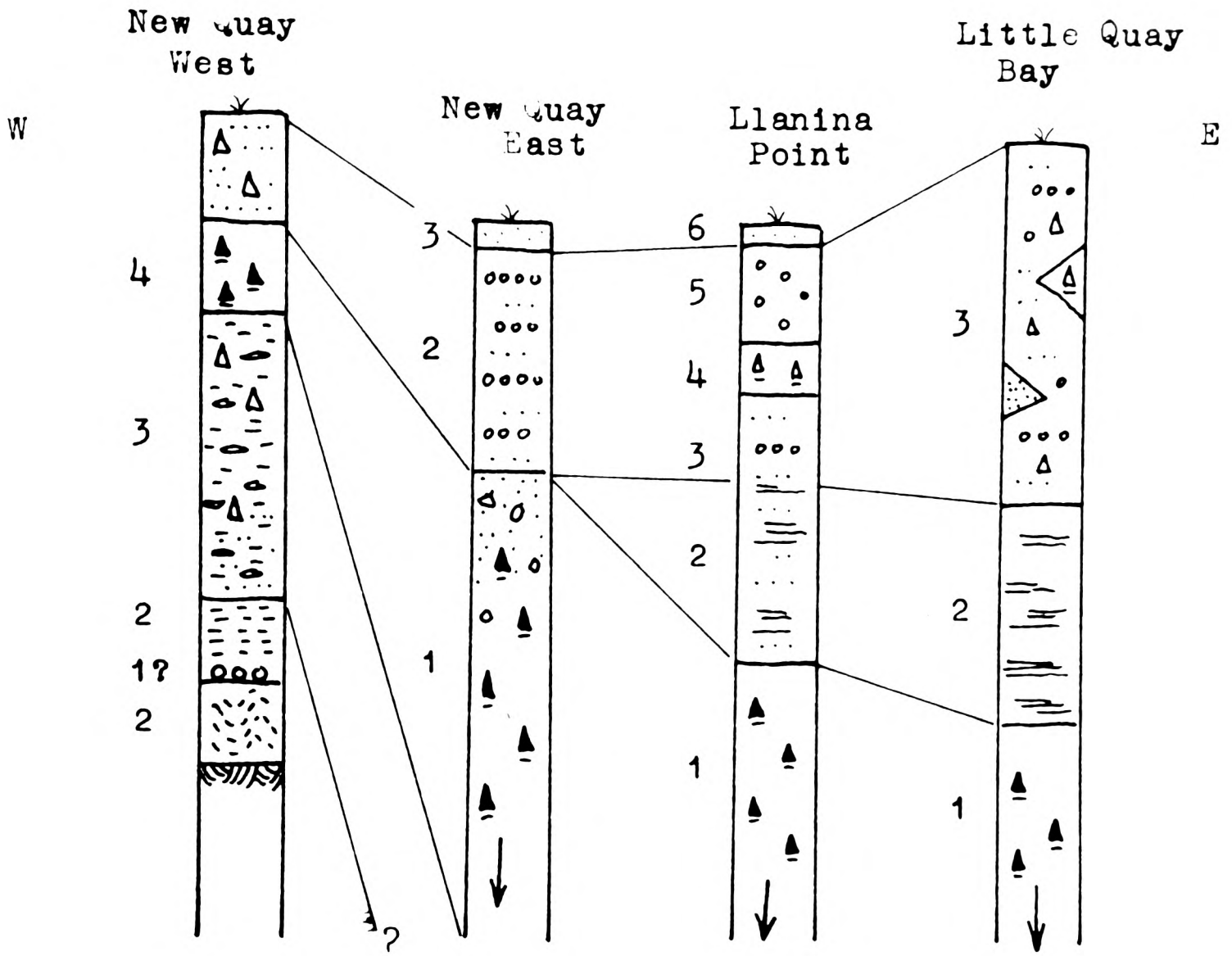


Fig.84 The New Quay District



Not to scale

Fig. 85. The drift section on Llanina Headland. The Upper Coarse gravel may be the "Upper Boulder-clay" of Williams. In view of the interbedding of till masses and outwash sands and gravels the suite of deposits was possible laid down in an ice-contact environment.



Not to scale

For key see Fig. 35

Fig. 86. Idealised stratigraphic columns for four drift exposures in New Quay and Little Quay Bays.

Contrast with Mitchell's (1962) figure of a fourfold New Quay succession of head, New Quay till, Fremington till, and Pencoeed till above bedrock near the lifeboat station.

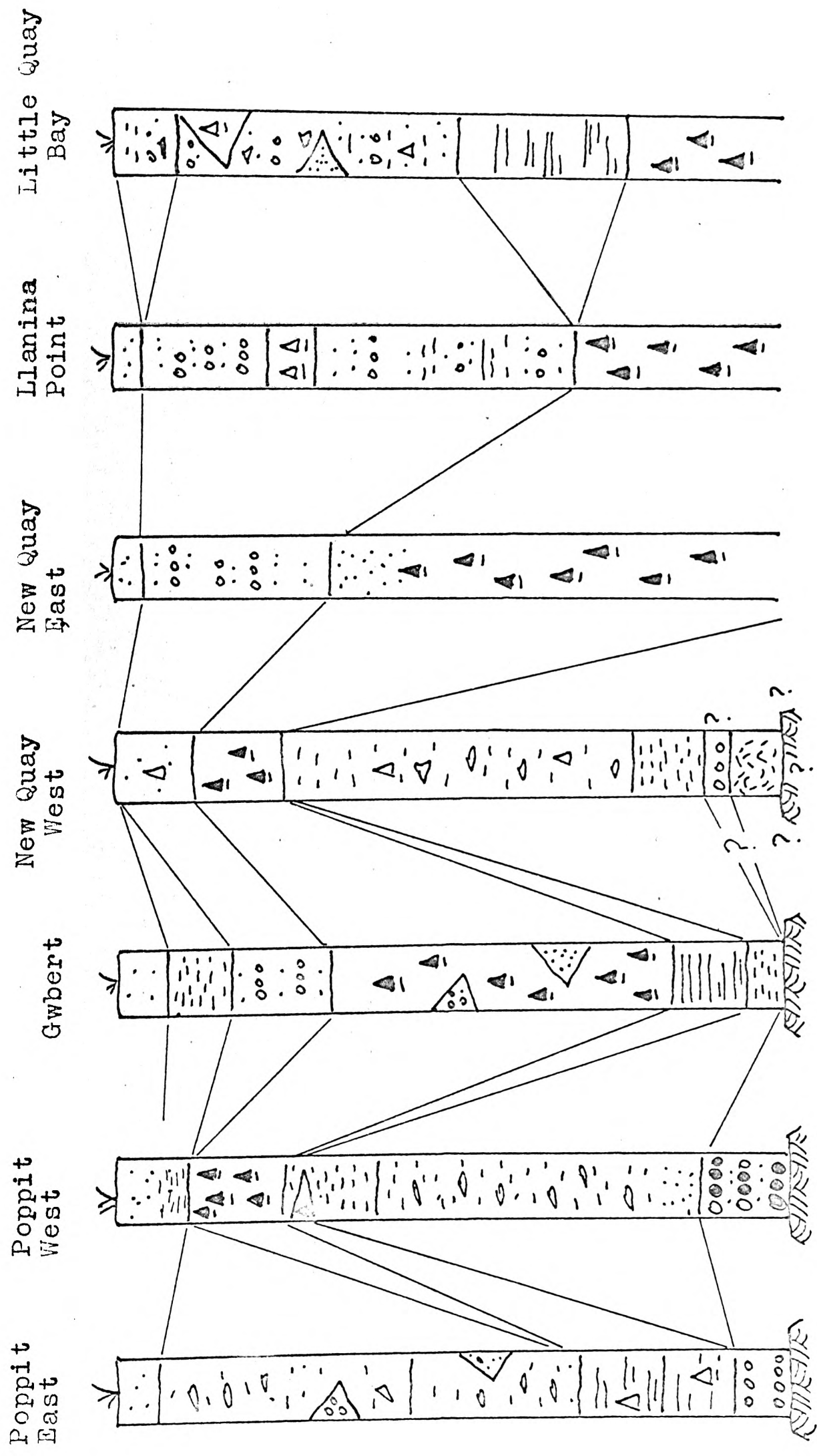


Fig. 87. A correlation of the drift successions in South Cardiganshire and Poppit.

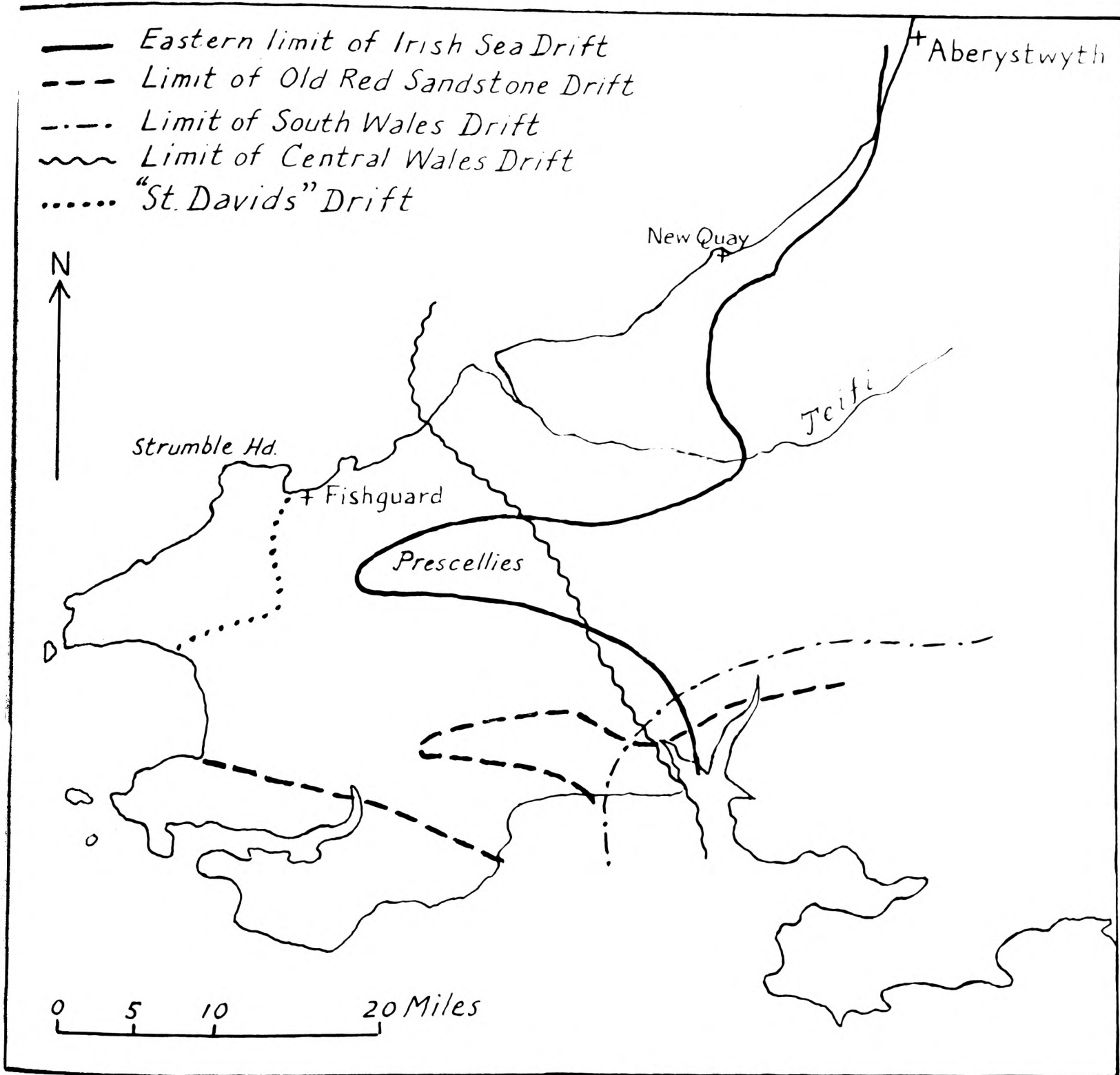


Fig.88 Some drift limits in West Wales  
 (after J. C. Griffiths (1940) Fig. 3)

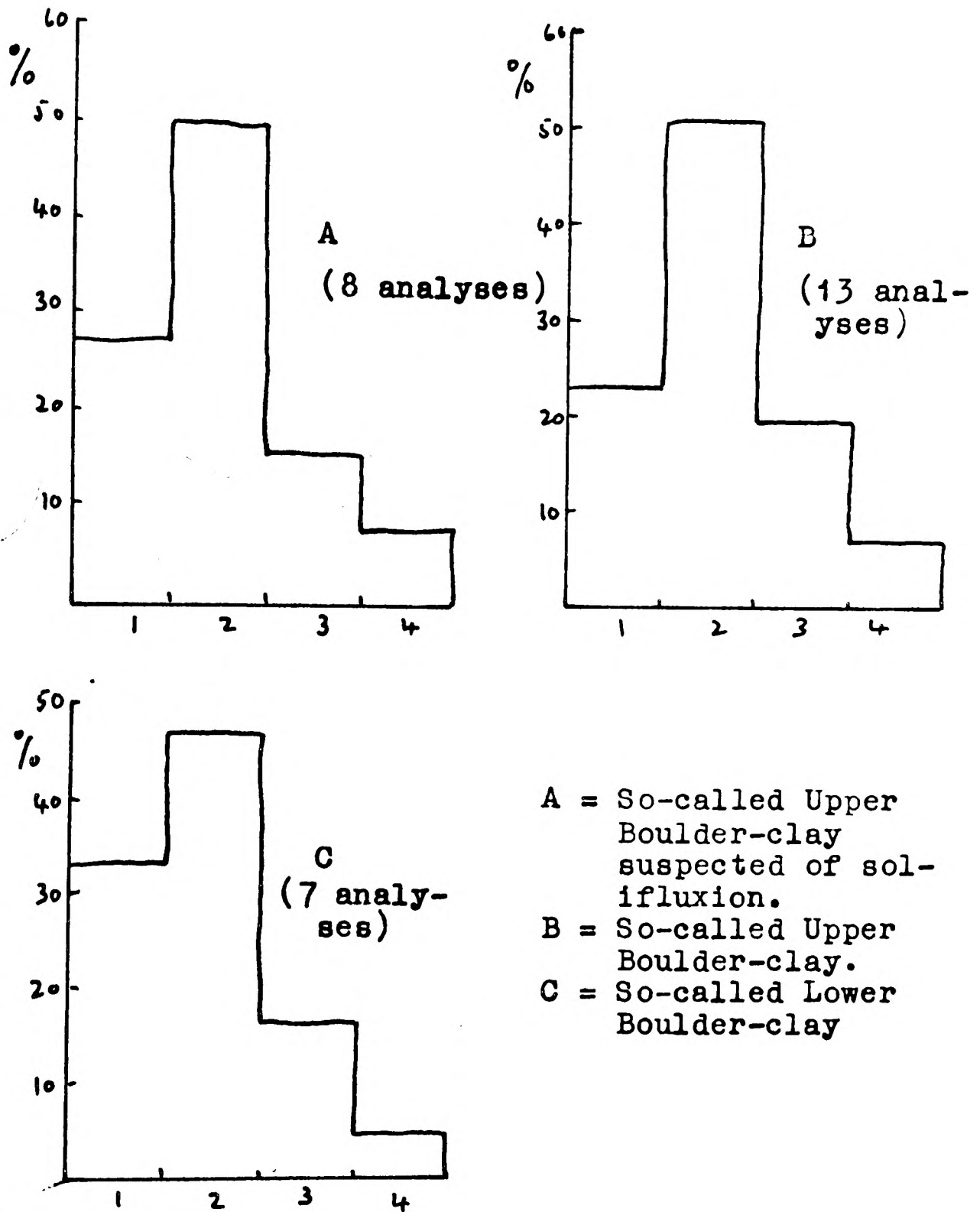


Fig. 89.

Roundness analysis histograms for the so-called Upper and Lower Boulder-clays of Dewisland.

Note that all the diagrams are rather similar, and are characteristic for till (For comparison with North Pembrokeshire mean diagrams see Fig.

32).

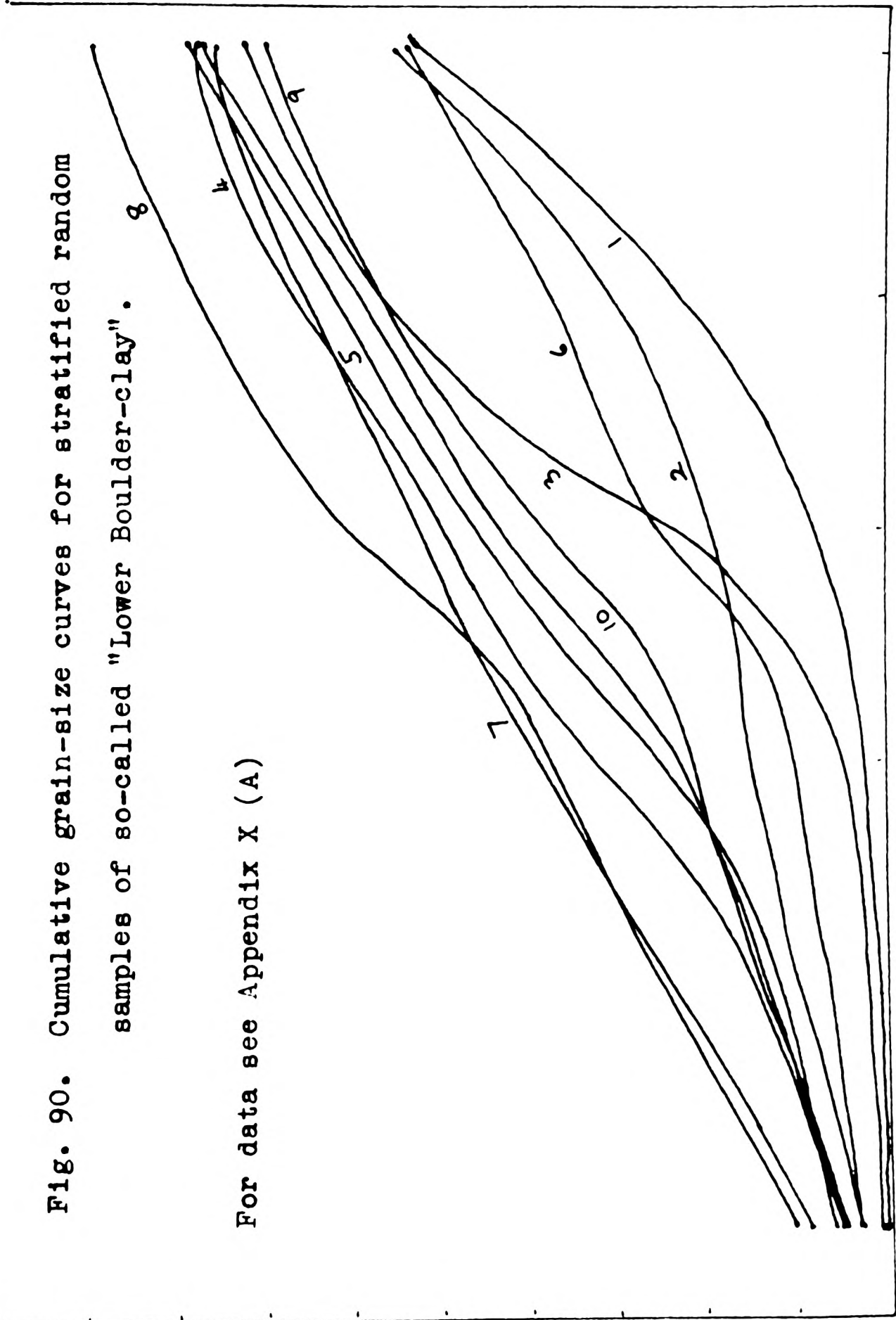
For construction data see Appendix VI (B) and Appendix IX.

Cumulative percentage

100  
90  
80  
70  
60  
50  
40  
30  
20  
10

Fig. 90. Cumulative grain-size curves for stratified random samples of so-called "Lower Boulder-clay".

For data see Appendix X (A)



Diameter in mm.

2.0 mm.

1.0

0.5

0.25

0.12

0.064

Very coarse sand

Coarse sand

Medium sand

Fine sand

Very fine sand

Cumulative percentage

100

90

80

70

60

50

40

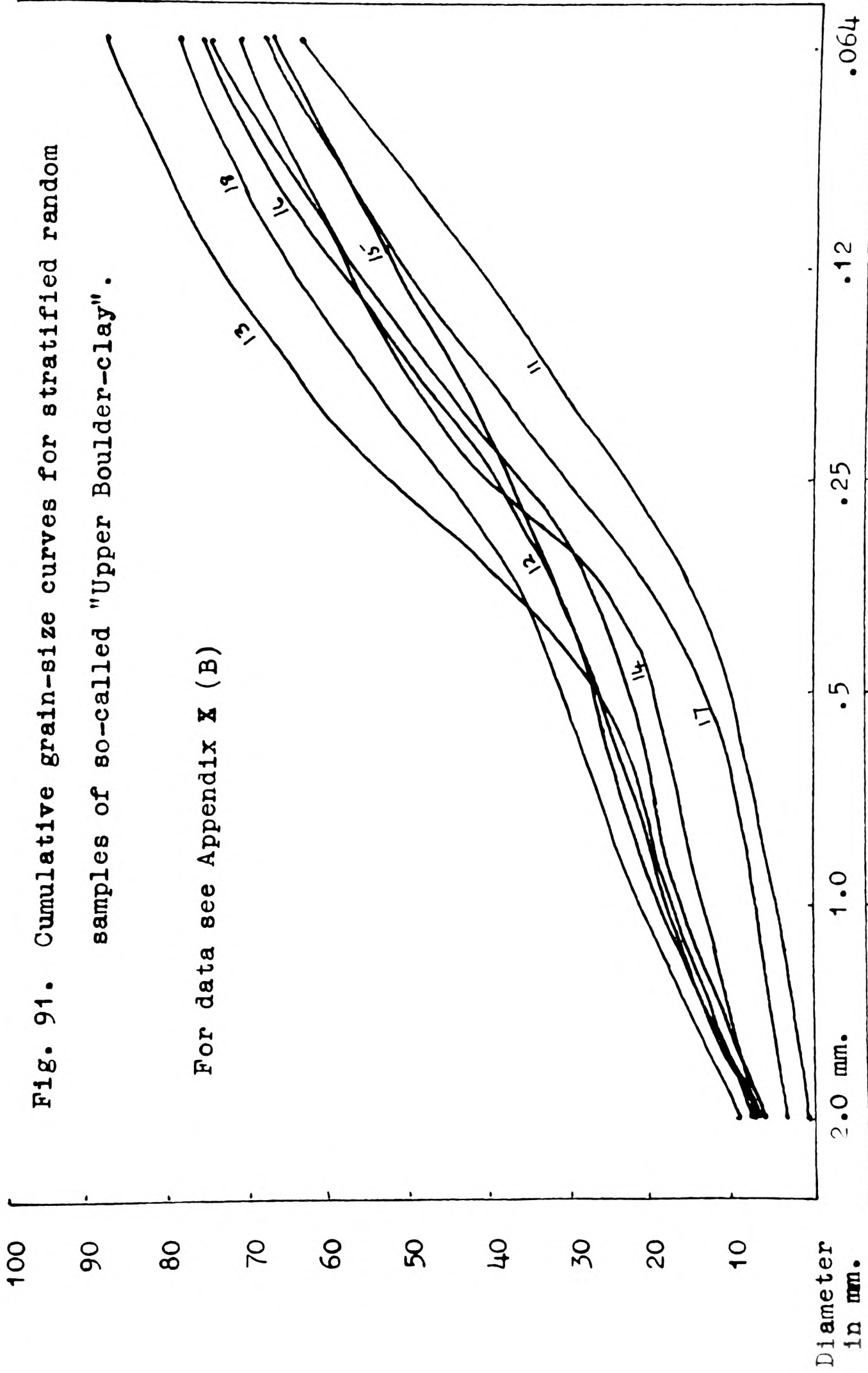
30

20

10

Fig. 91. Cumulative grain-size curves for stratified random samples of so-called "Upper Boulder-clay".

For data see Appendix X (B)



Diameter  
in mm.

2.0 mm.

1.0

.5

.25

.12

.064

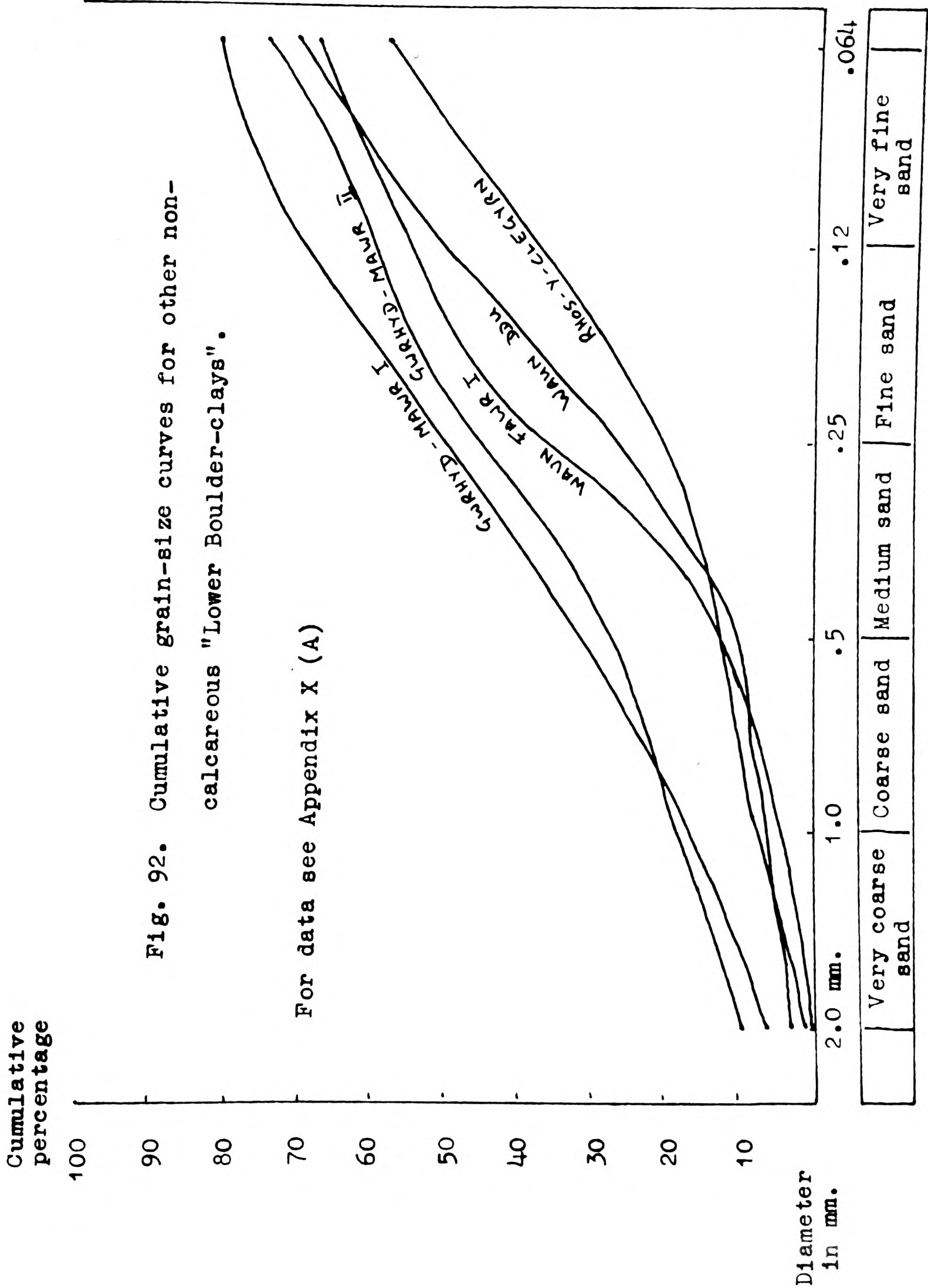
Very coarse  
sand

Coarse sand

Medium sand

Fine sand

Very fine  
sand



Cumulative percentage

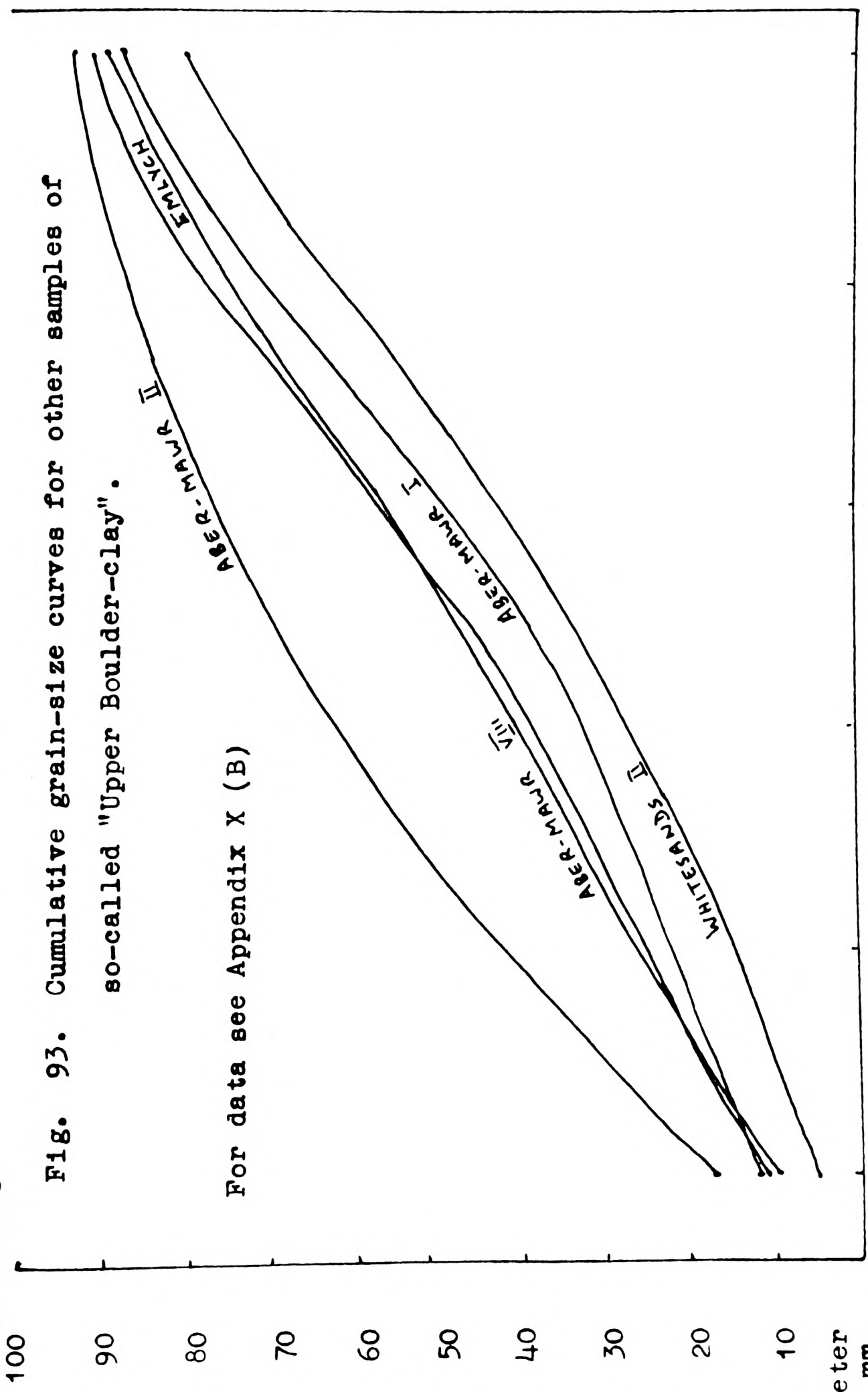


Fig. 93. Cumulative grain-size curves for other samples of so-called "Upper Boulder-clay".

For data see Appendix X (B)

Diameter in mm.

2.0 mm.	1.0	0.5	0.25	0.12	0.064
Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	

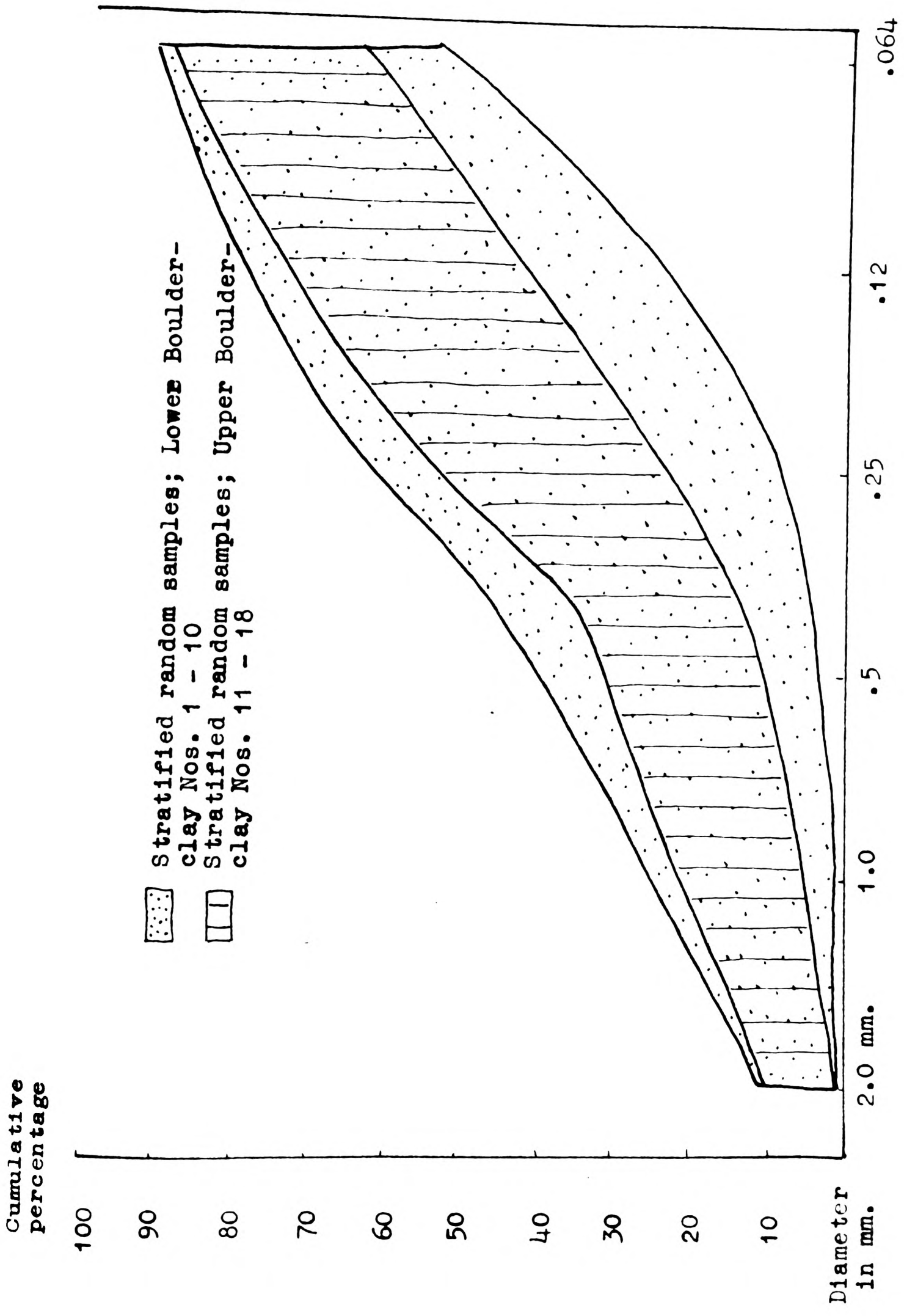


Fig. 94. A comparison of the range covered by the two sets of stratified random samples in Western Dewisland.

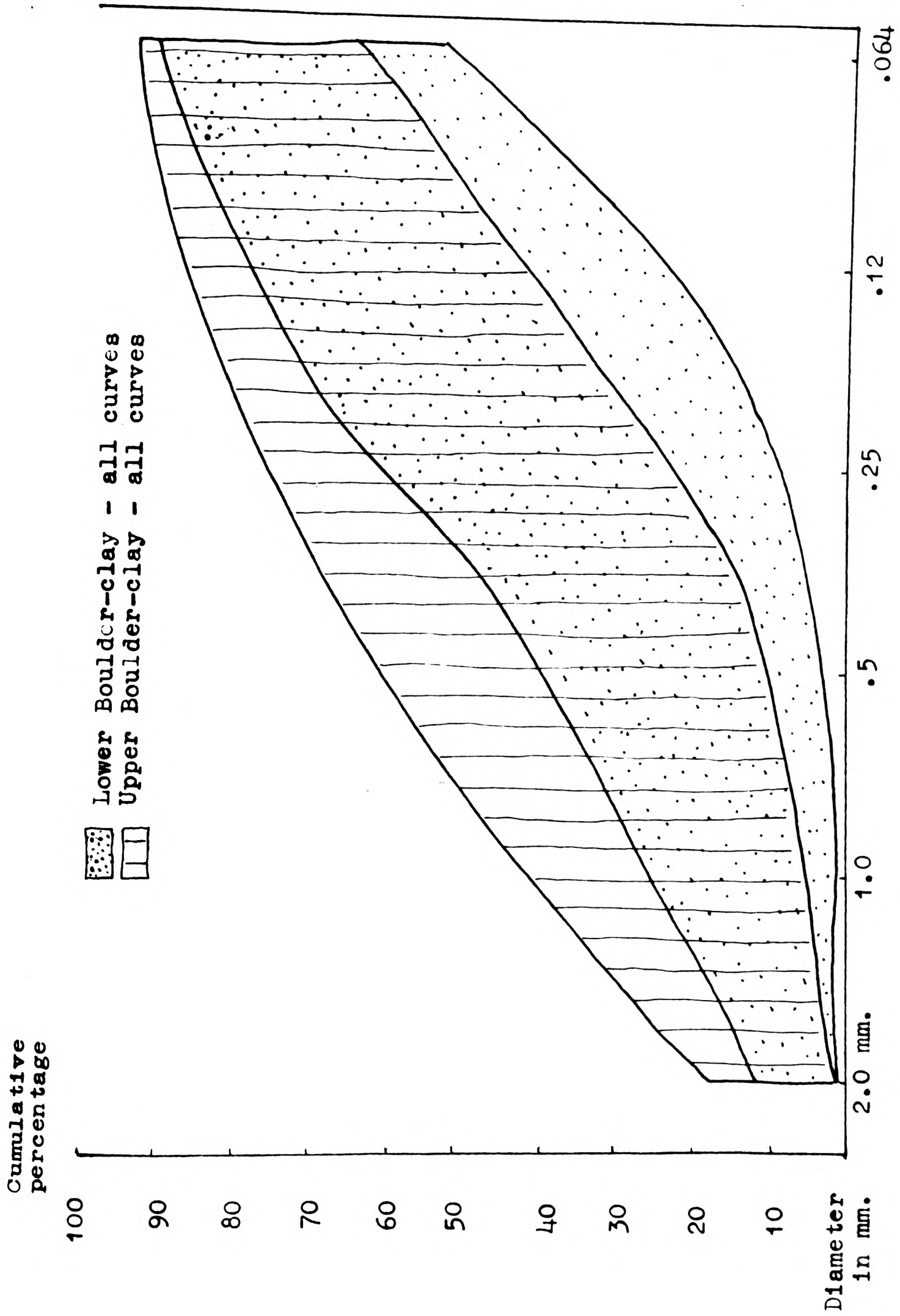
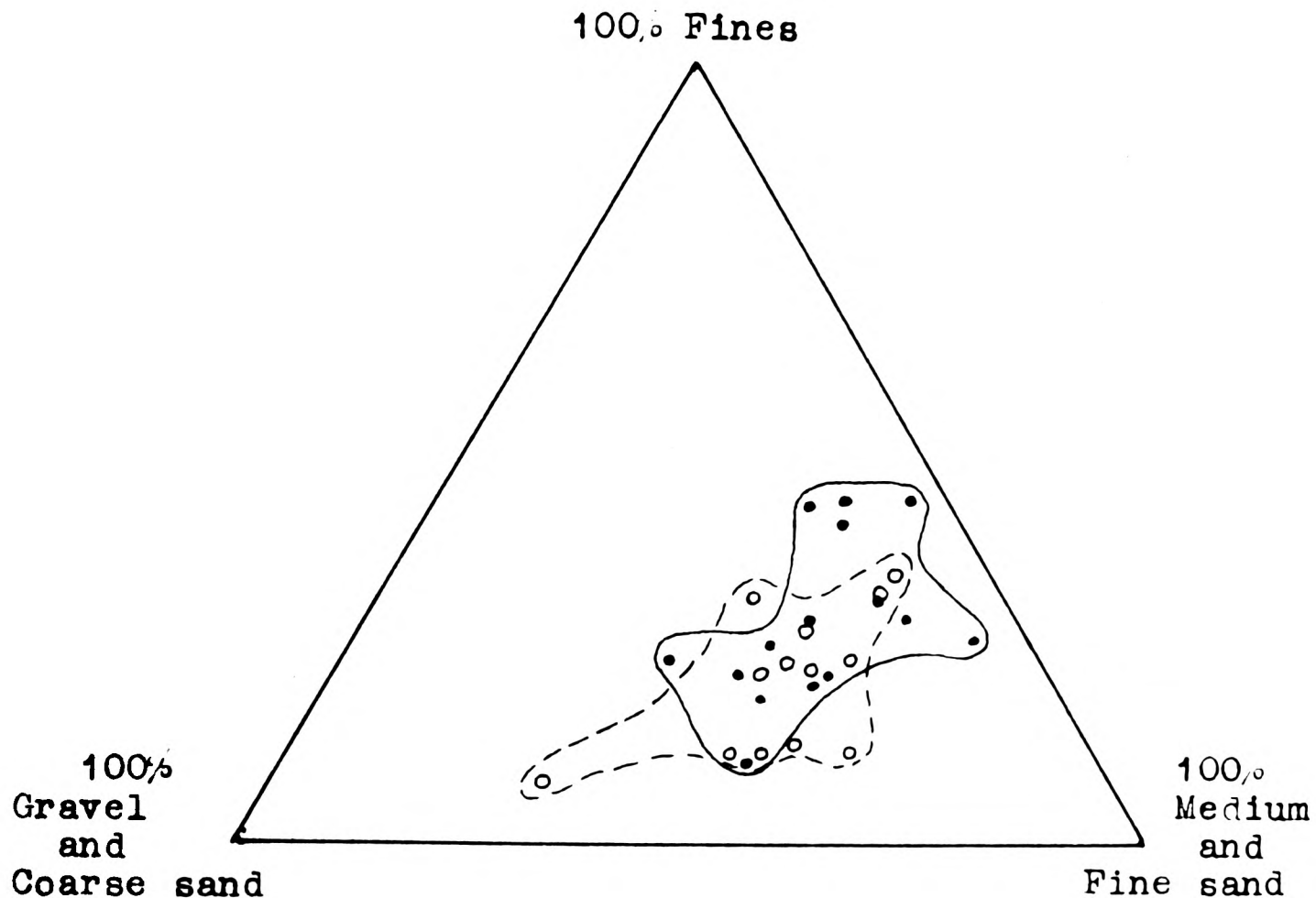


Fig. 95. A comparison of the range covered by all the stratified till samples collected in Western Dew Island.



Field covered by "Lower Boulder-clay" samples



Field covered by "Upper Boulder-clay" samples

Fig. 96. A comparison of the grain-size distributions of samples of Lower Boulder-clay and Upper Boulder-clay on a triangular diagram.

Note that the field covered by the two sets of samples is almost the same.

Cumulative percentage

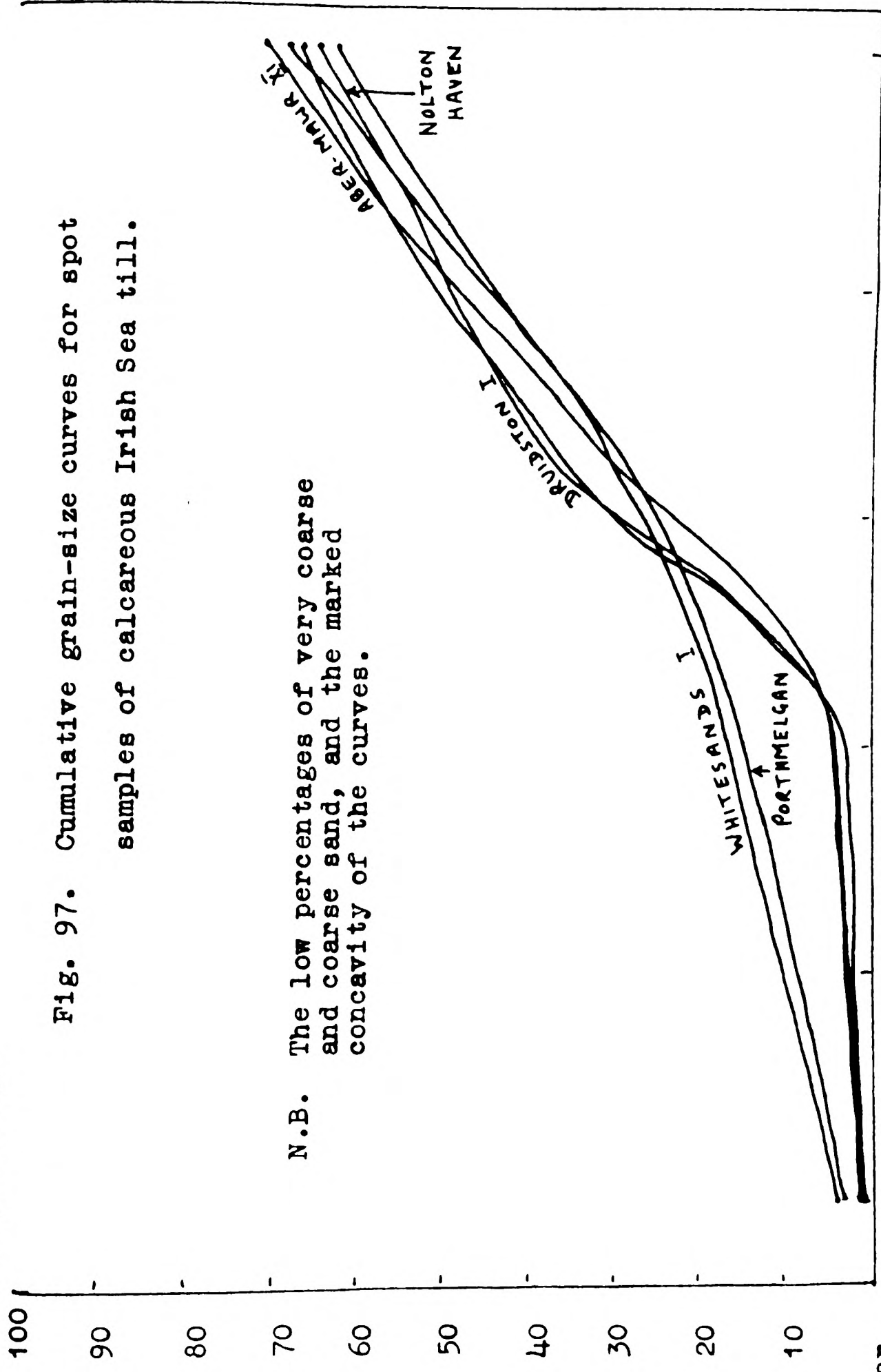
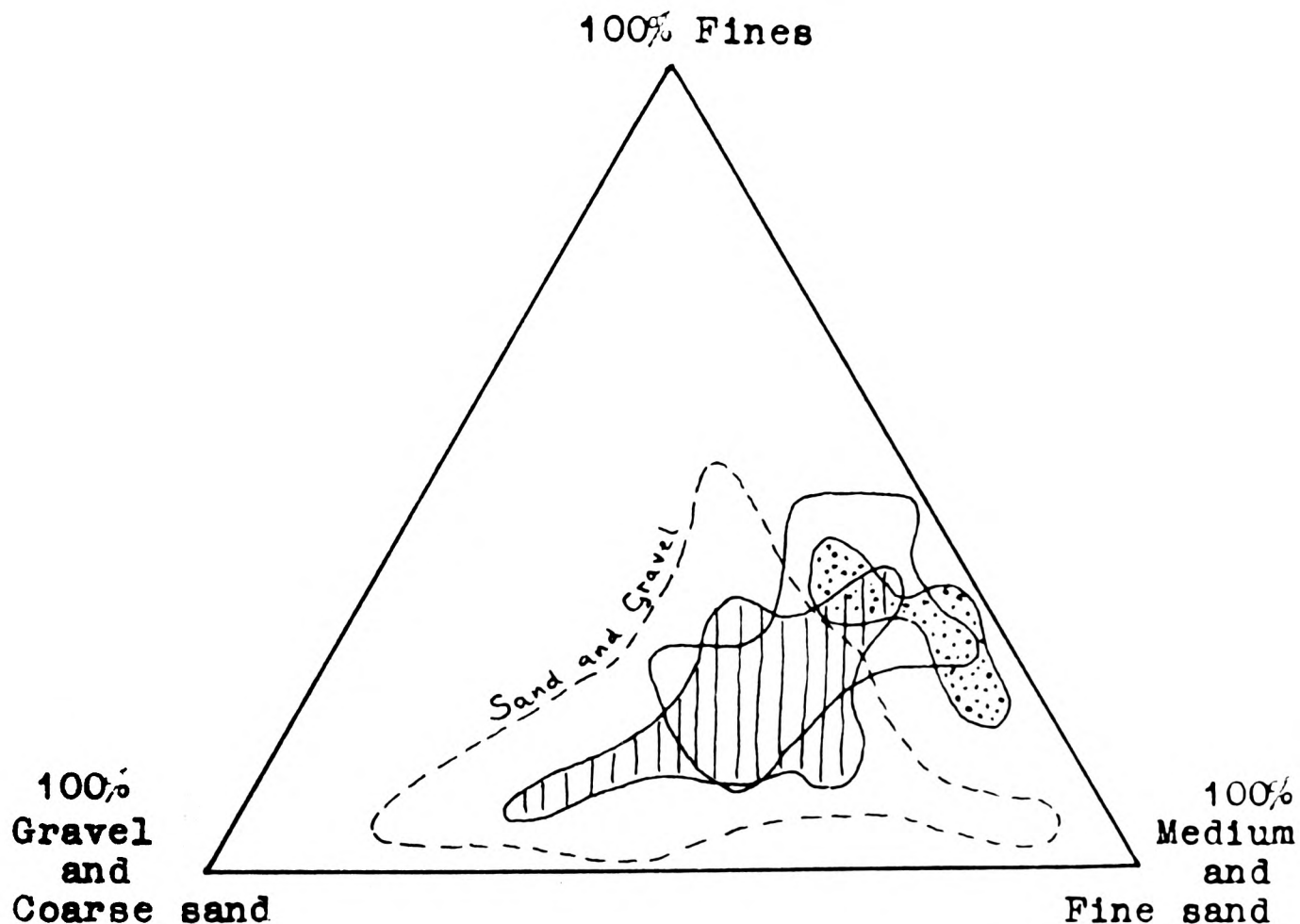


Fig. 97. Cumulative grain-size curves for spot samples of calcareous Irish Sea till.

N.B. The low percentages of very coarse and coarse sand, and the marked concavity of the curves.

Diameter in mm.

2.0 mm	1.0	.5	.25	.12	.064
Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	







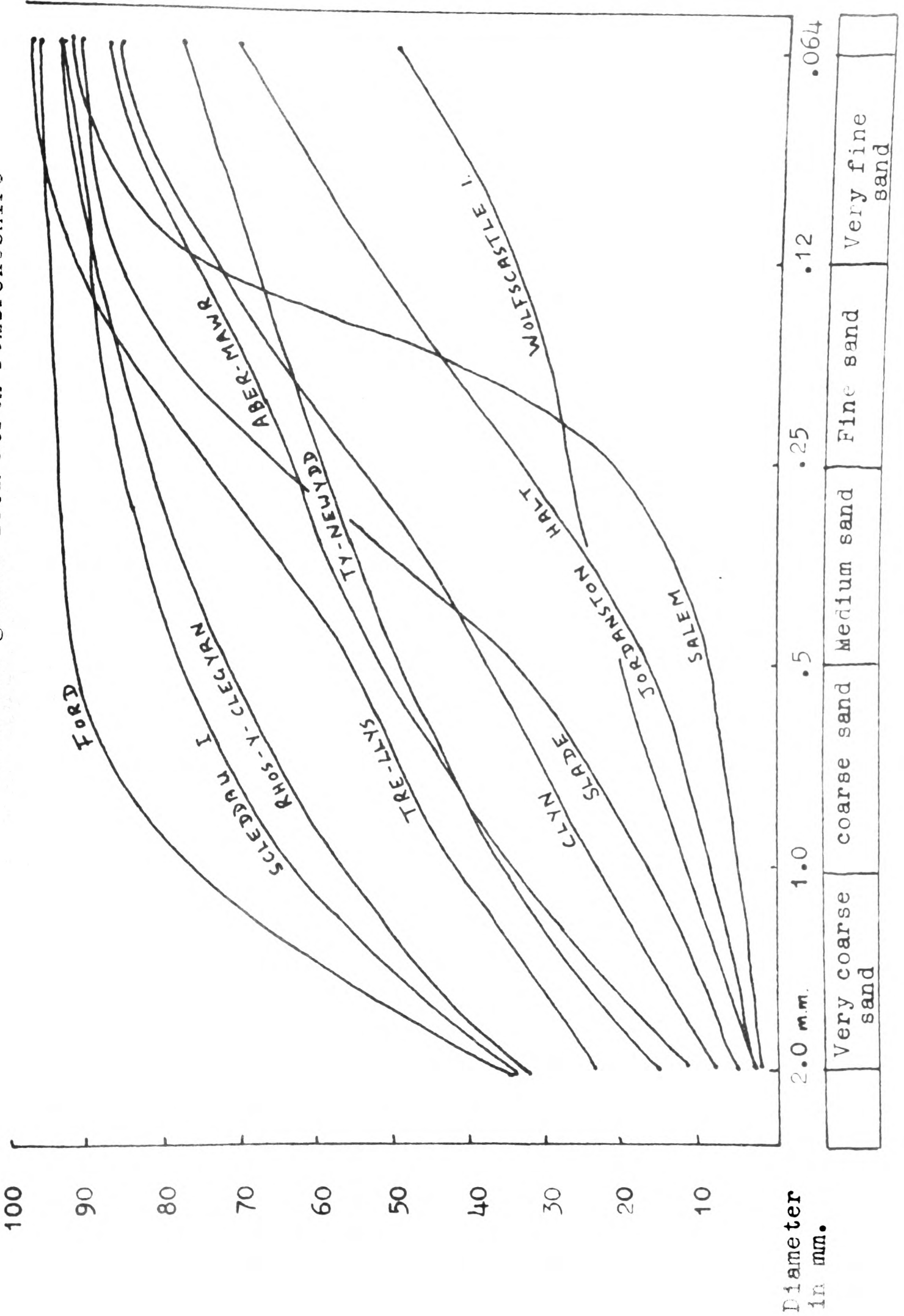
-  Lower Boulder-clay samples
-  Upper Boulder-clay samples
-  Calcareous Irish Sea till samples
-  Samples of outwash sand and gravel

Fig. 98. A comparison of Lower Boulder-clay, Upper Boulder-clay, Irish Sea till, and outwash sands and gravels on a triangular diagram.

Note the characteristic field covered by the Irish Sea till samples, and the extensive field covered by the sand and gravel samples.

Cumulative percentage

Fig. 99. Cumulative grain-size curves for samples of outwash sand and gravel from North Pembrokeshire




Diameter in mm.

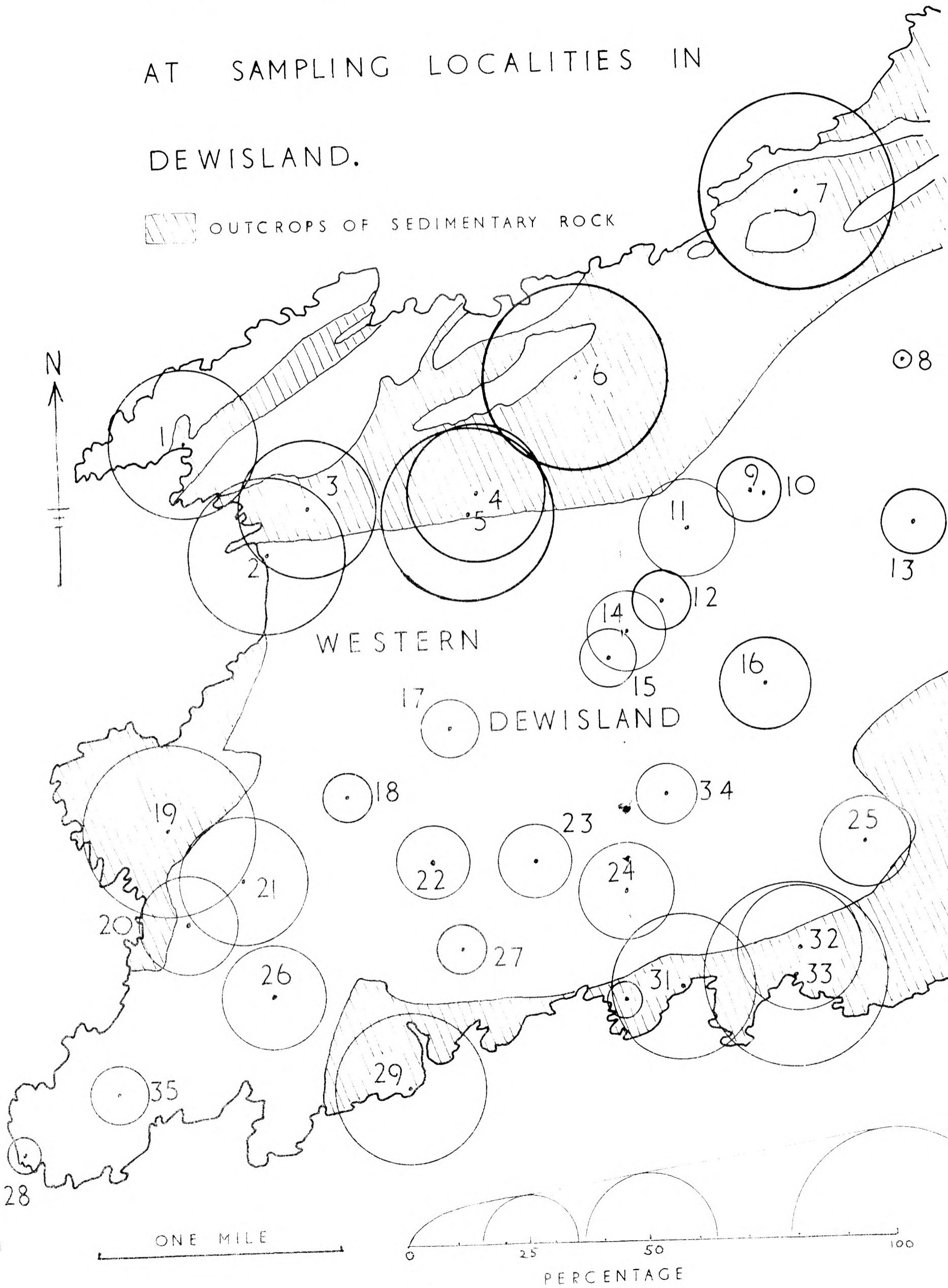
THE PERCENTAGE OF SEDIMENTARY

PEBBLES (ORDOVICIAN AND CAMBRIAN)

AT SAMPLING LOCALITIES IN

DEWISLAND.

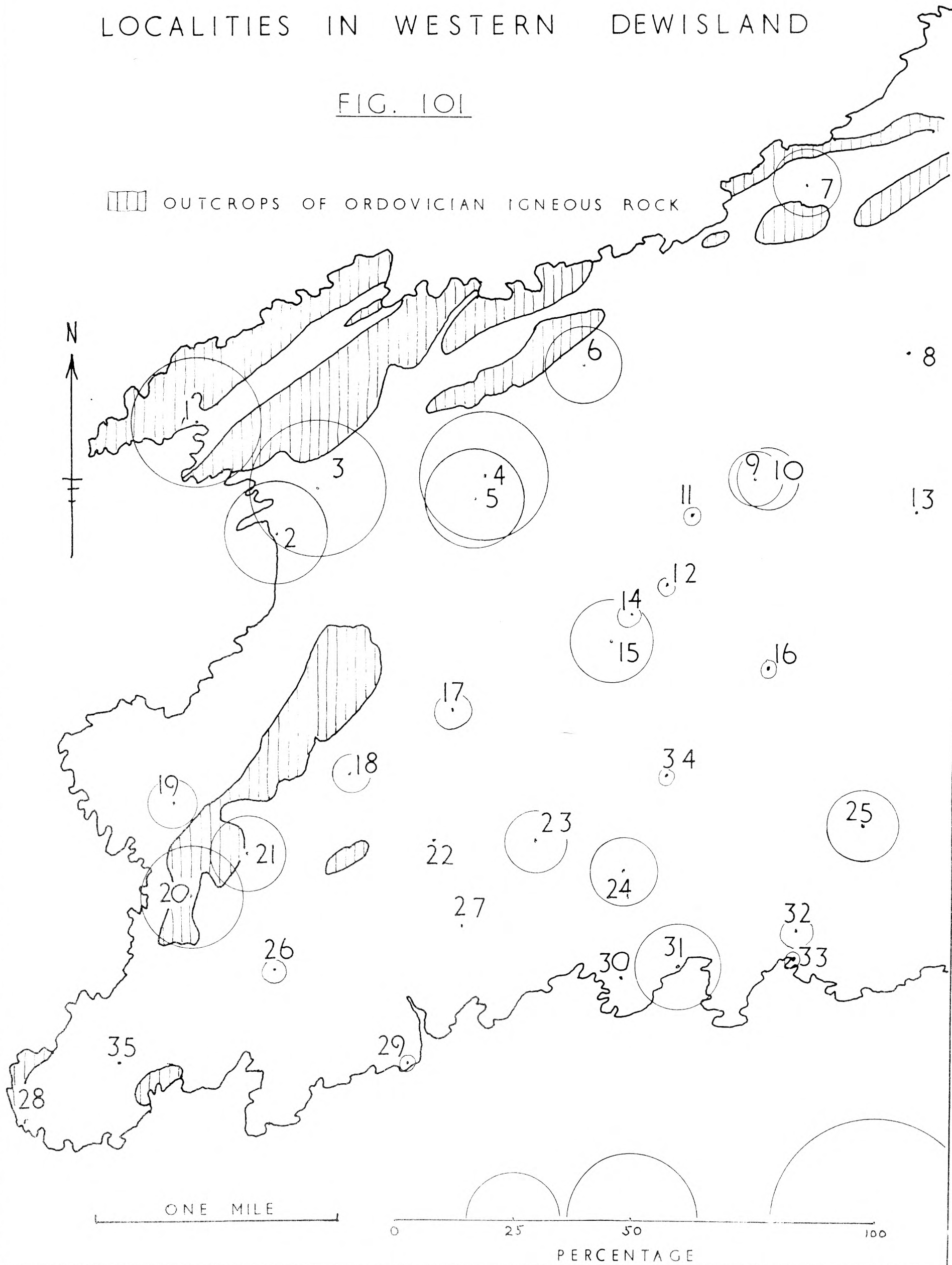
 OUTCROPS OF SEDIMENTARY ROCK



THE PERCENTAGE OF ORDOVICIAN  
 IGNEOUS PEBBLES AT SAMPLING  
 LOCALITIES IN WESTERN DEWISLAND

FIG. 101

OUTCROPS OF ORDOVICIAN IGNEOUS ROCK



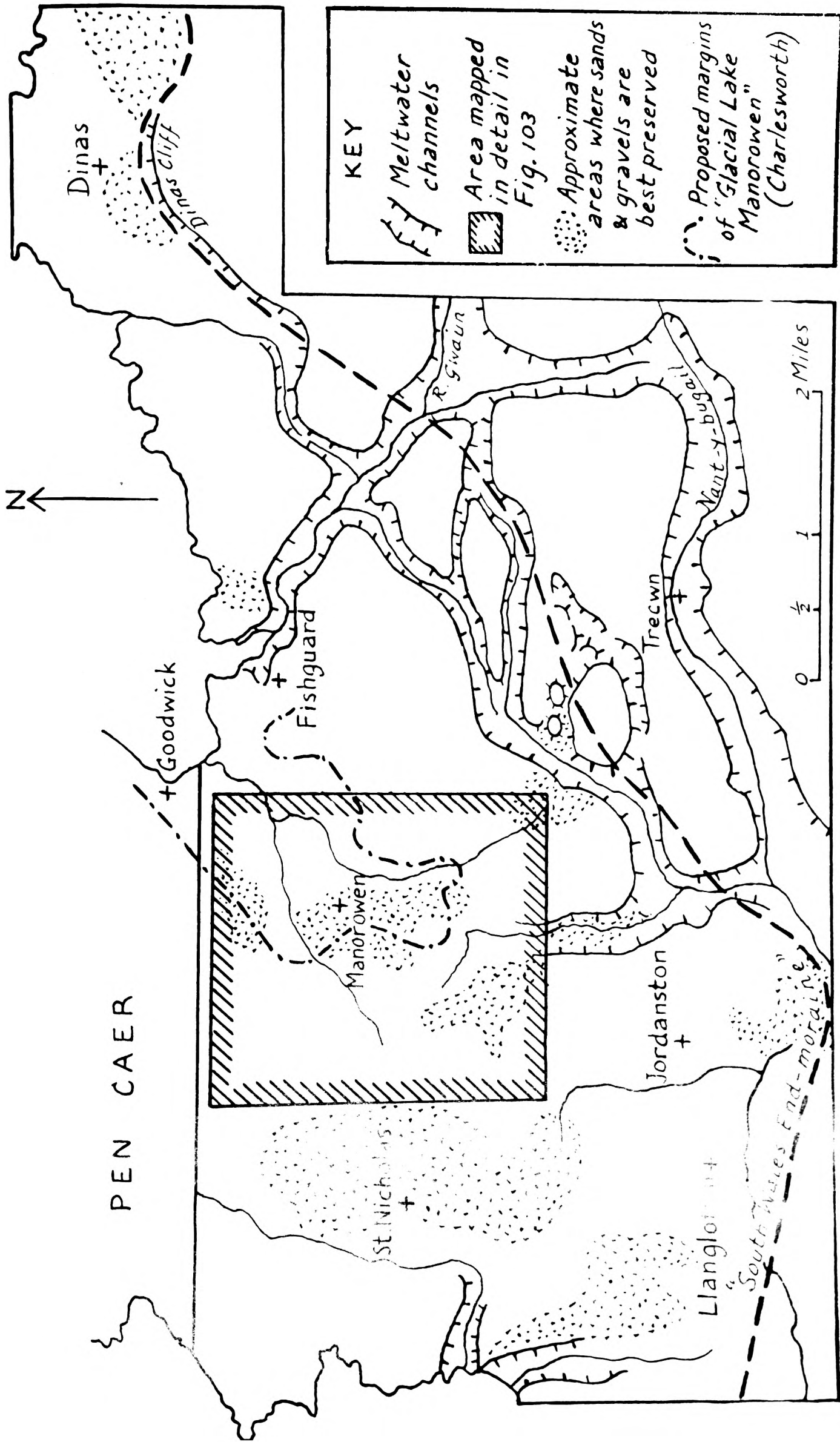
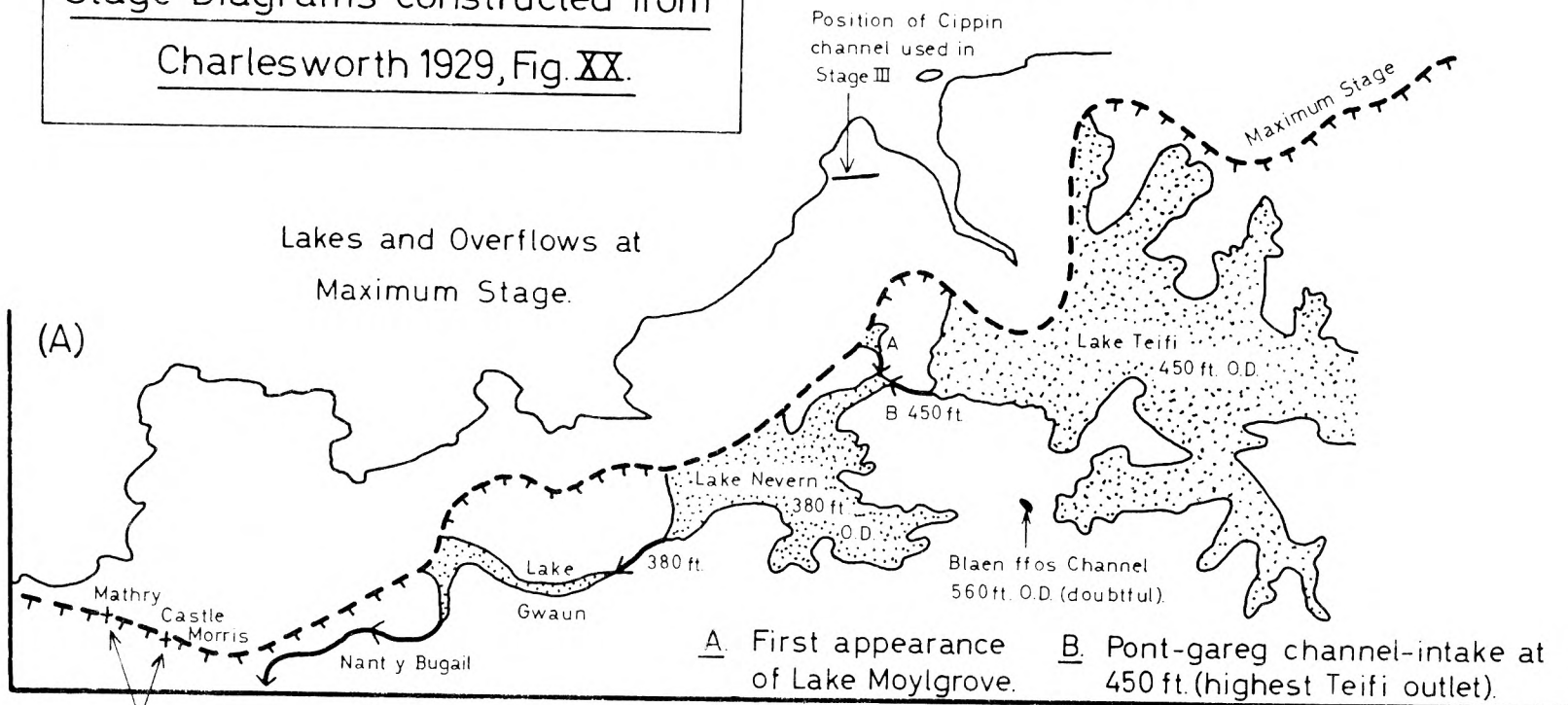


Fig.102 THE MAJOR GLACIAL FEATURES OF THE FISHGUARD AREA

Stage Diagrams constructed from  
Charlesworth 1929, Fig. XX.

FIG. III

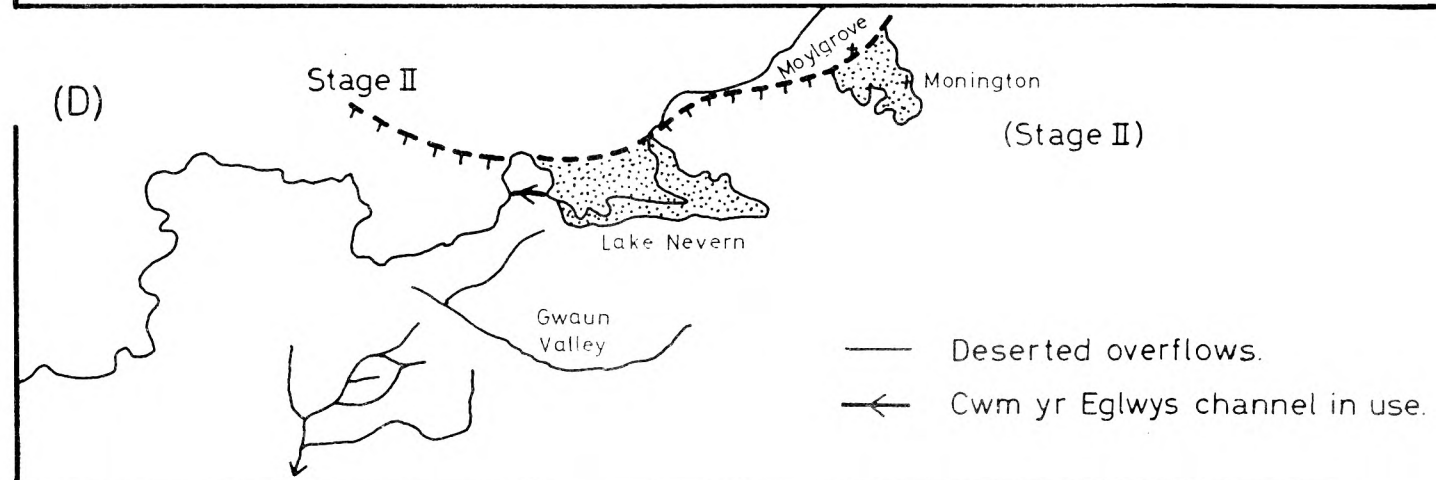
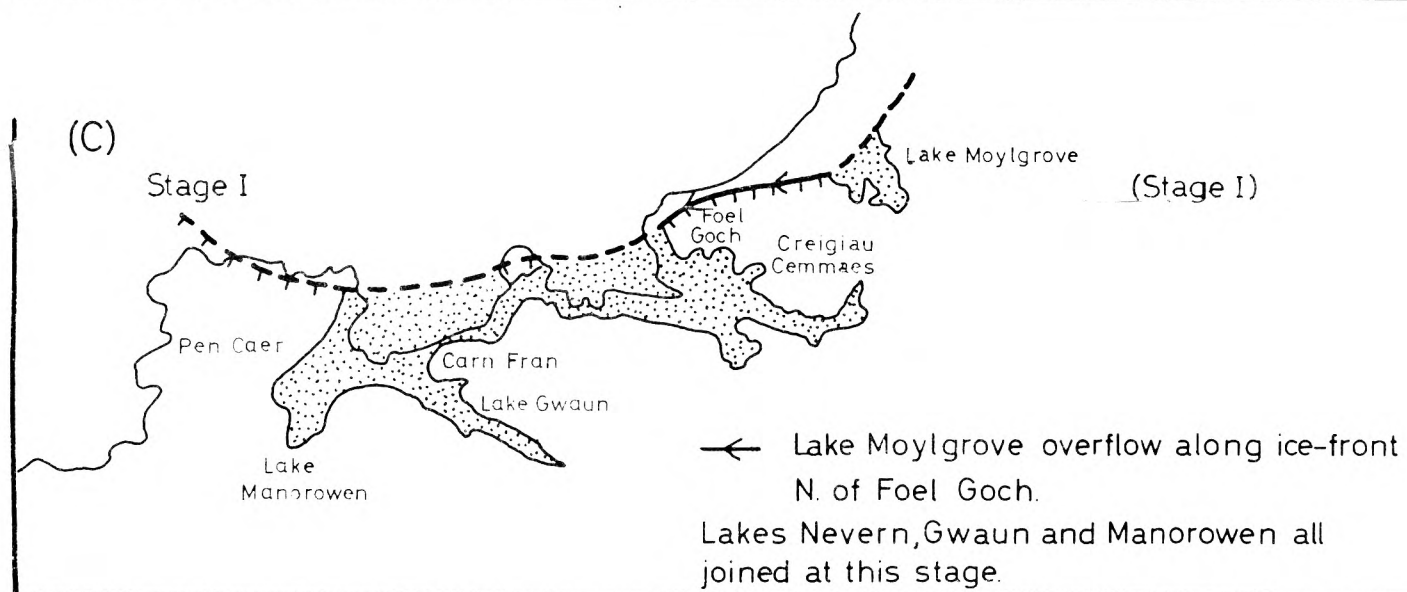
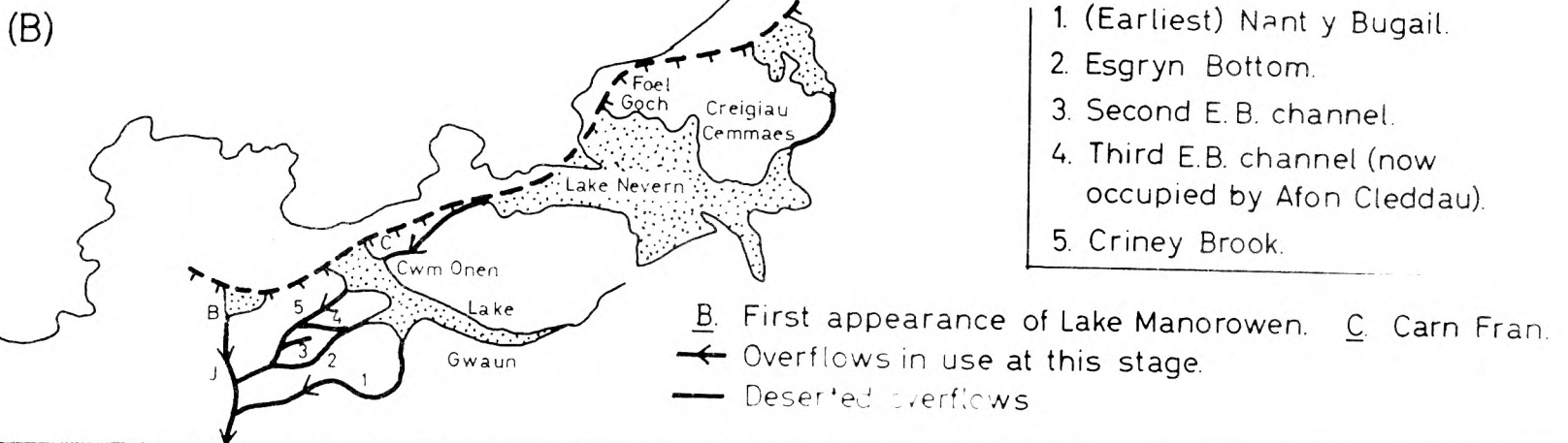
Lakes and Overflows at  
Maximum Stage.



J. Jordanston Channel.

Sequence of drainage of  
Lake Gwaun.

1. (Earliest) Nant y Bugail.
2. Esgryn Bottom.
3. Second E. B. channel.
4. Third E. B. channel (now occupied by Afon Cleddau).
5. Criney Brook.



Llanrhian  
Overflow channel  
100 yds NW of Llanrhian?  
(page 343).

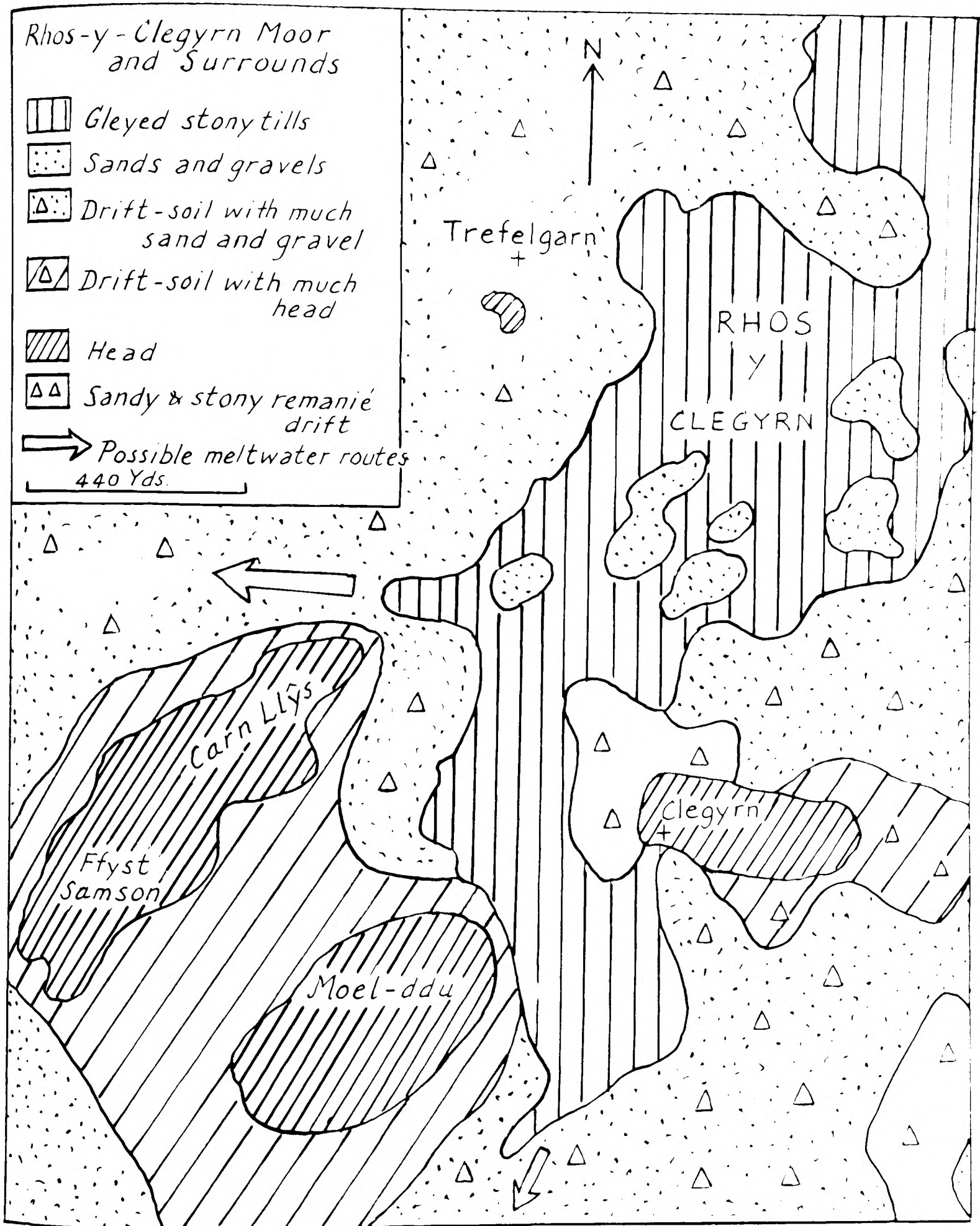


Fig.104 The distribution of drifts around Rhos-y-Clegyrn

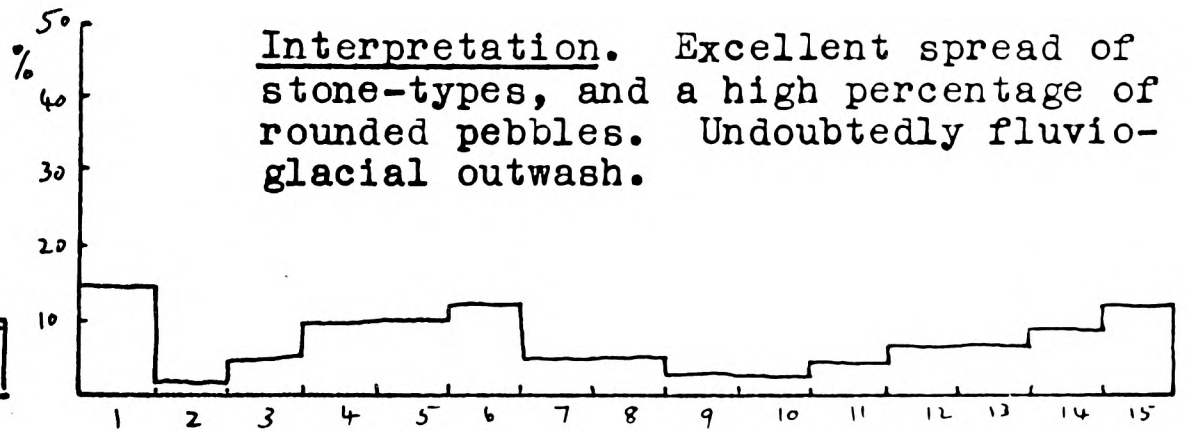
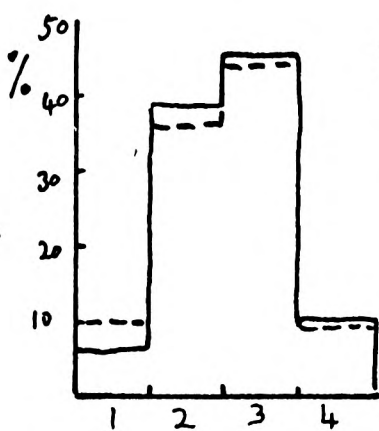
Fig. 105. Analysis of pebbles from the drifts  
at Rhos-y-Clegyrn

 First sample     
  Second sample

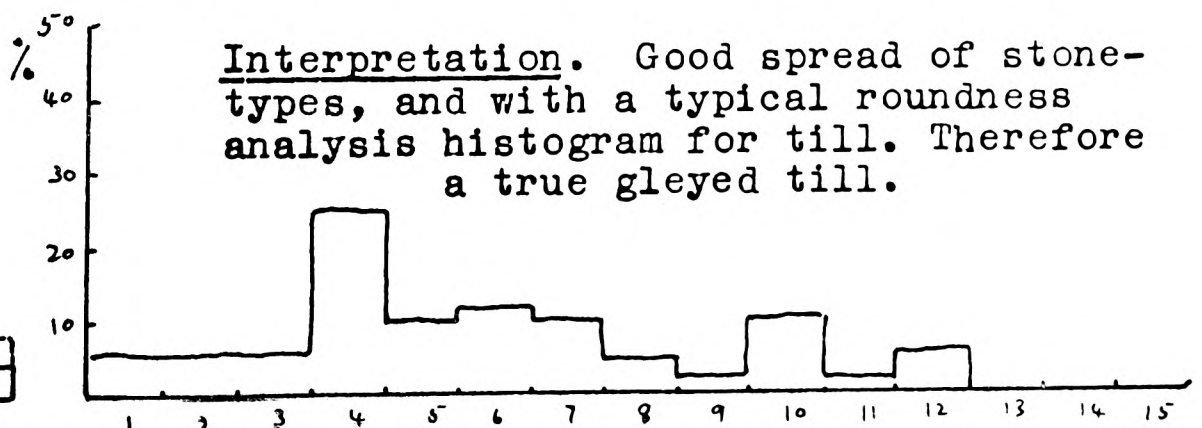
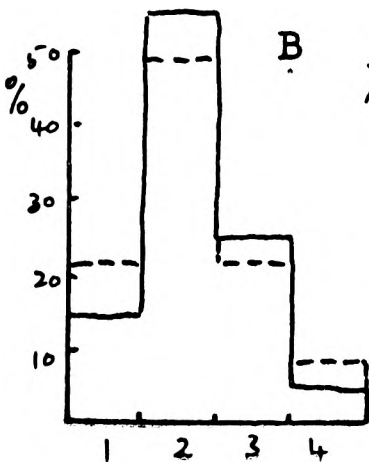
Roundness Analysis

Stone-type Analysis

A



B



A.= Samples from the sand and gravel hummocks shown in Fig. 104.

B.= Samples from the lower gleyed moorland surface a few yards to the west of the hummocks.

This test indicates that the moorland drift is not simply gleyed outwash; the yellow gleyed drift is a true till.

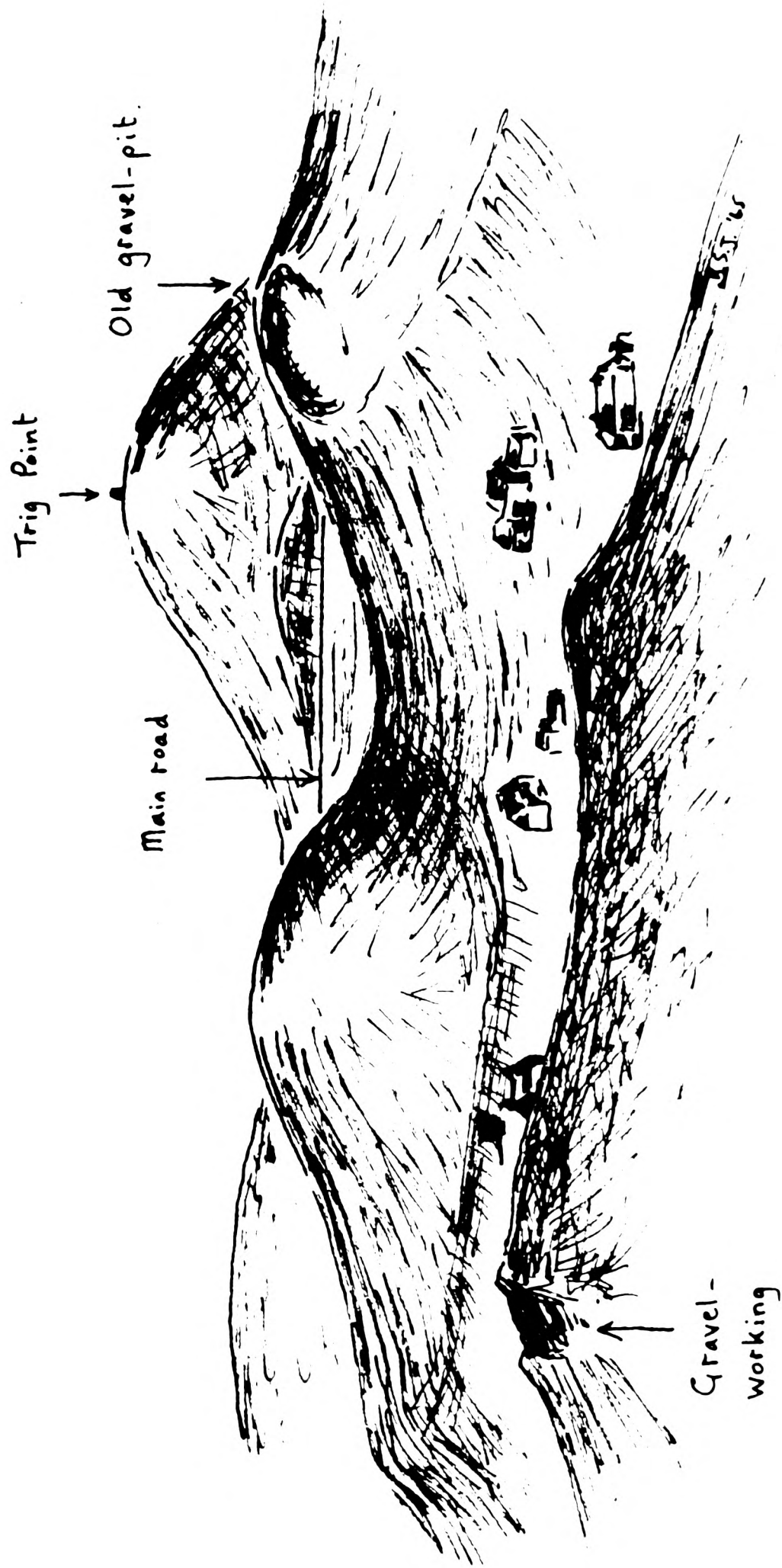


Fig. 106

The sand and gravel hummocks at Bancywarren, near Cardigan.  
View towards the south from near Cilmaenllwyd Pit.

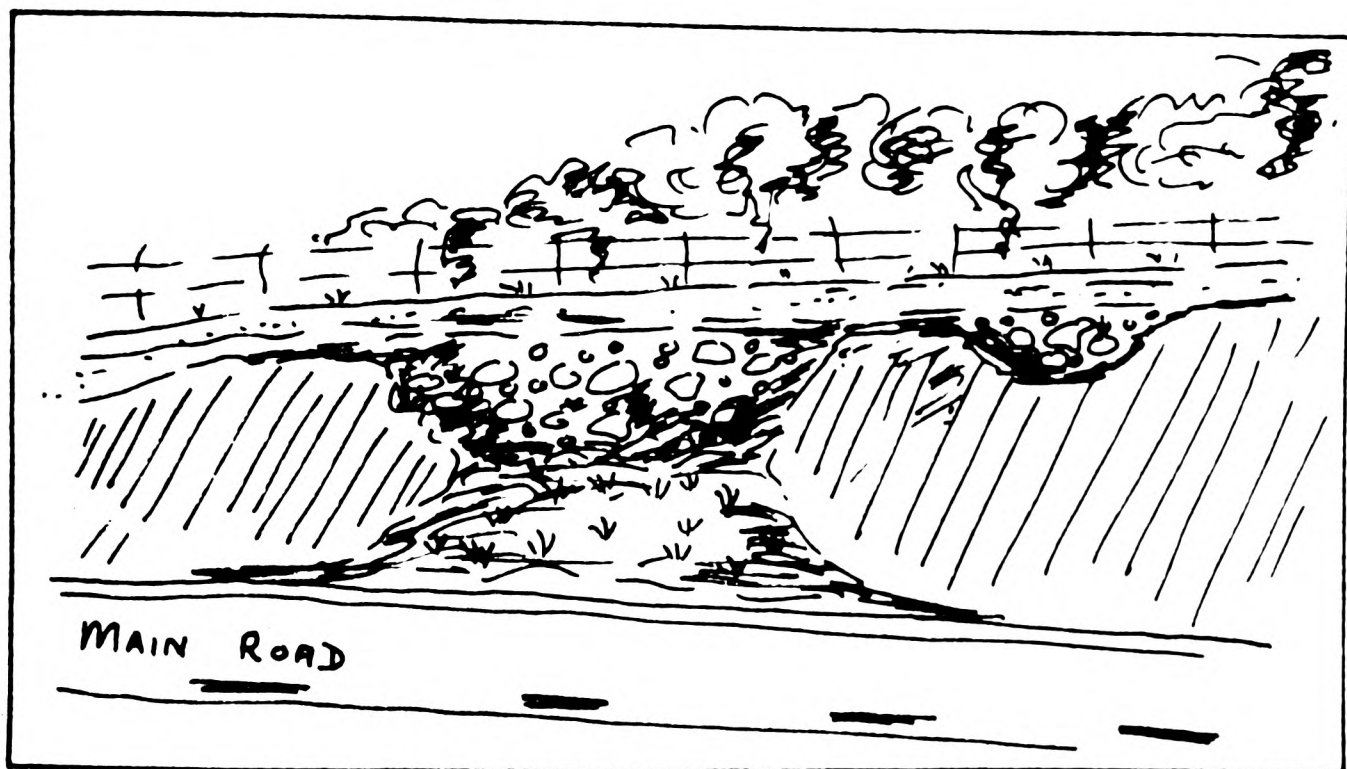


Fig. 107. Torrential outwash gravels and boulders preserved in bedrock hollows at the A 40 roadside at Scleddau. These deposits are part of a veneer of fluvio-glacial outwash laid down in the vicinity of the Scleddau Channel during the wastage of the Dewisland ice-sheet.

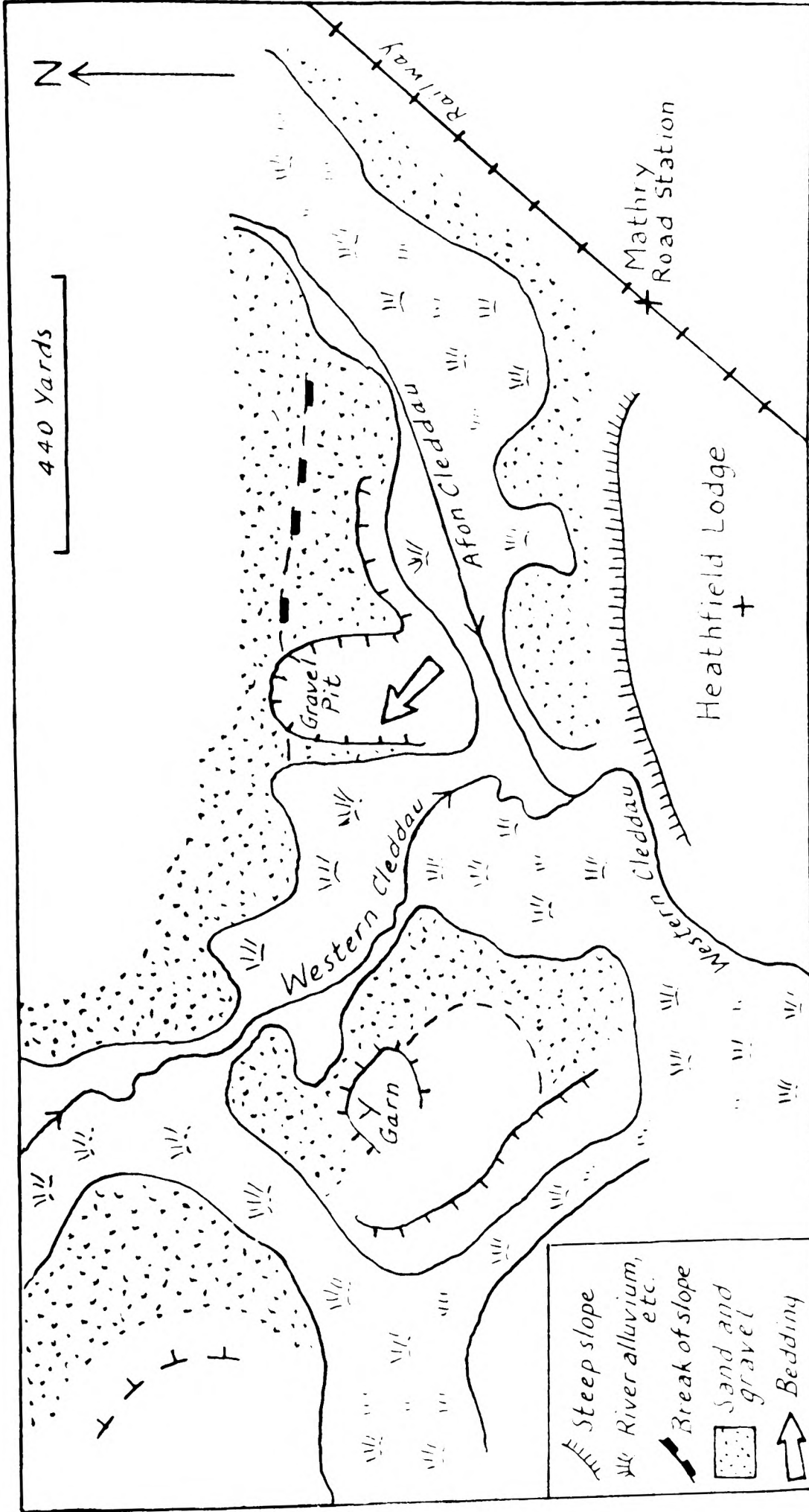
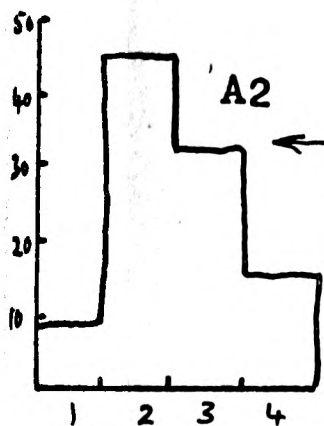
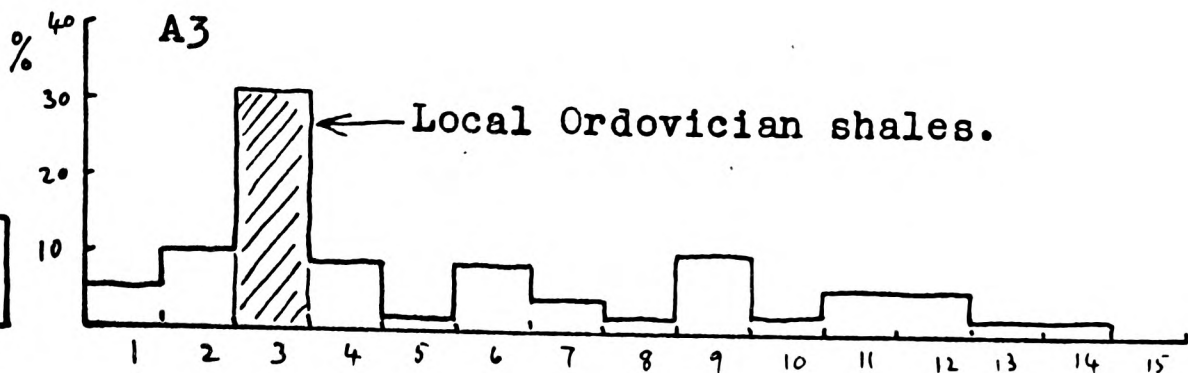
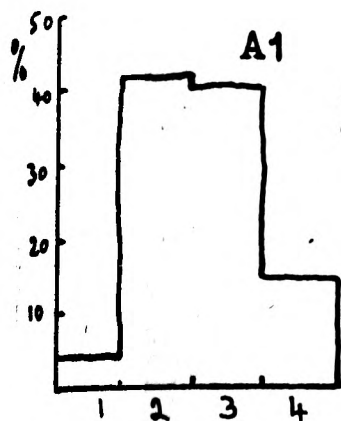


Fig.108 The location of Mathry Road Gravel-pit.

Fig. 109. Analysis of pebbles from the gravel-pit at Mathry Road.

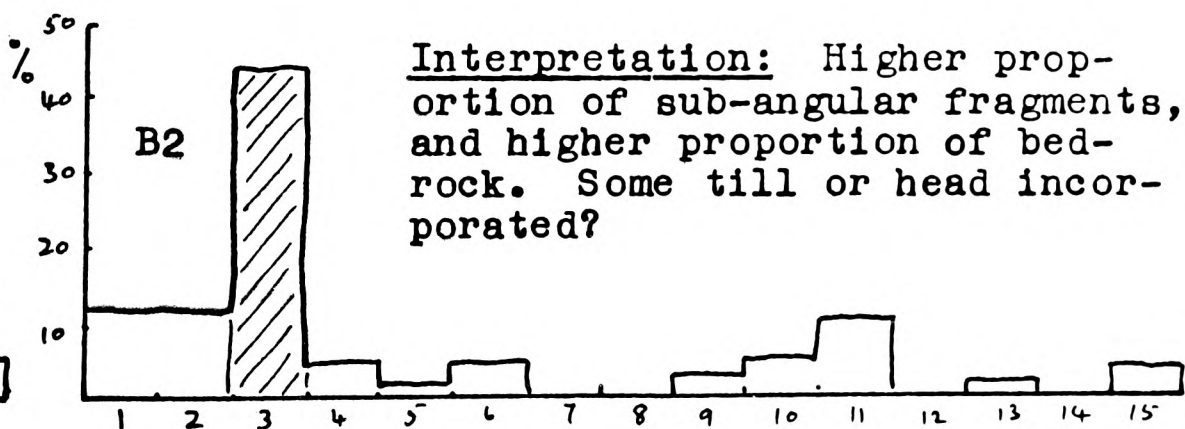
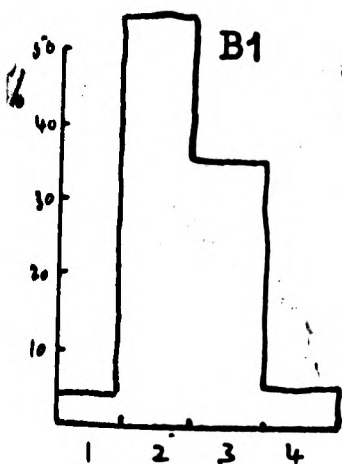
Roundness Analysis

Stone-type analysis



(second independent sample of 50 pebbles from site A)

Interpretation: Very good spread of stone-types, and a good percentage of rounded pebbles. Over 40% sub-angular pebbles results from % of easily breakable shales. Undoubtedly fluvio-glacial outwash.



Interpretation: Higher proportion of sub-angular fragments, and higher proportion of bed-rock. Some till or head incorporated?

A = Coarse gravels close to the surface

B = Coarse gravels at the base of the exposure.

A tentative reconst

a y

N

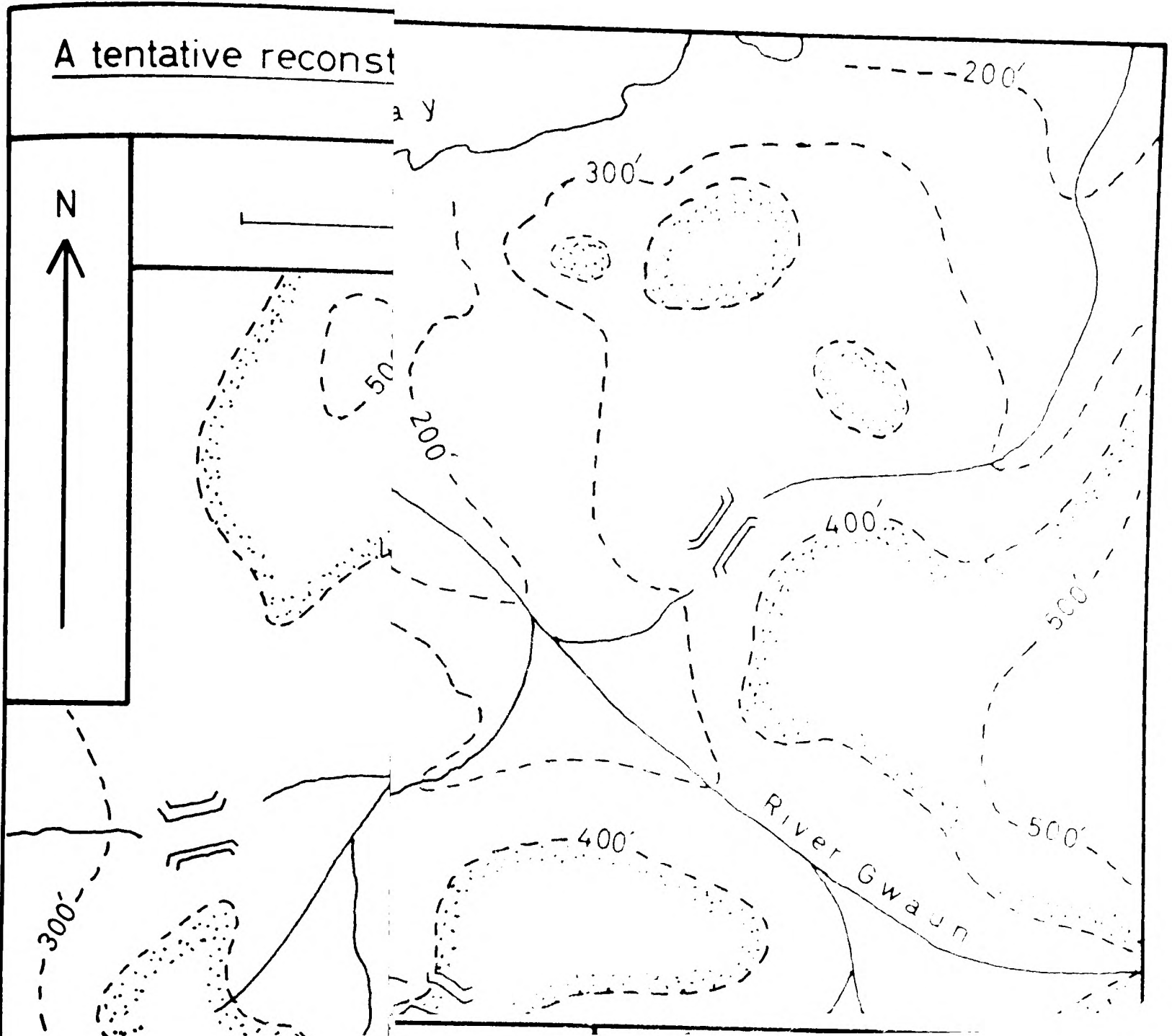
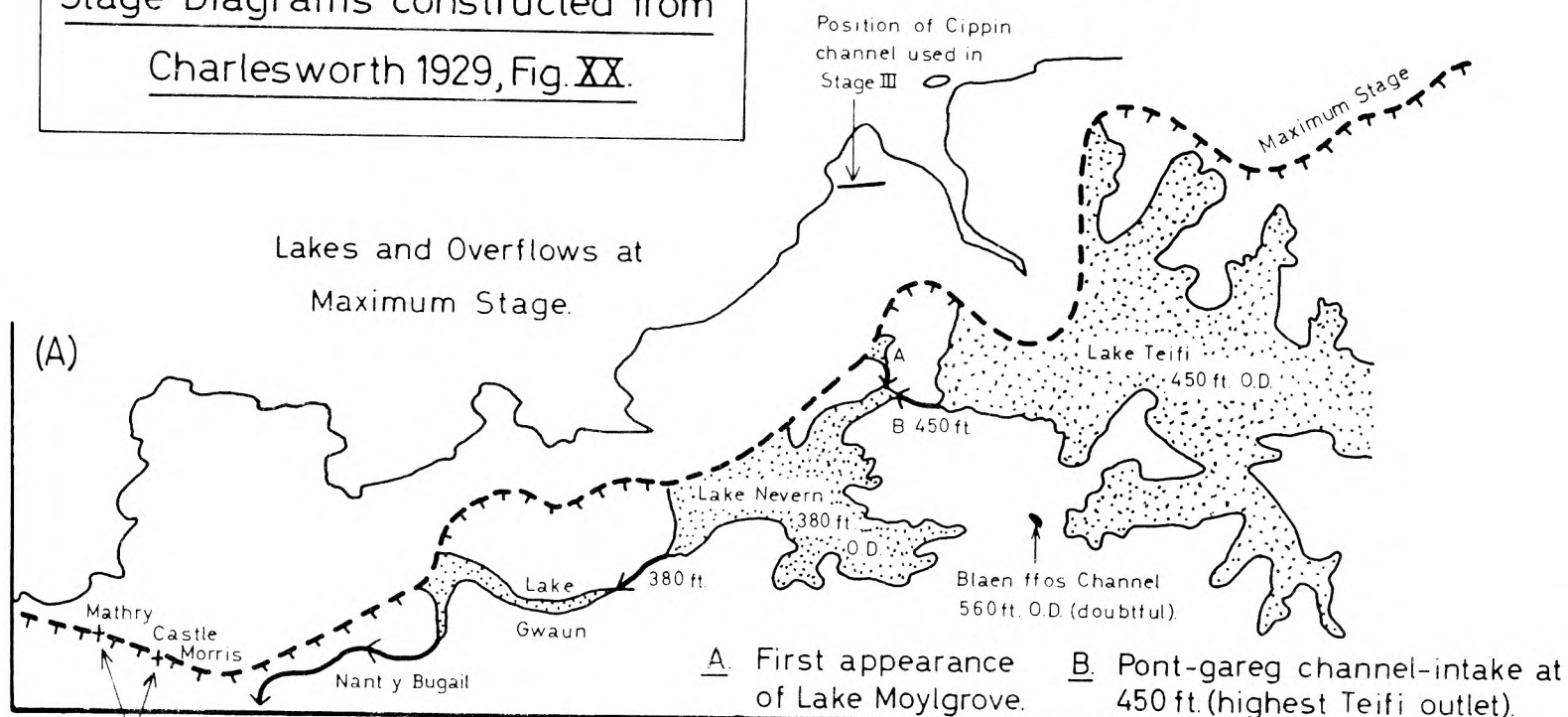


FIG. III

Stage Diagrams constructed from  
Charlesworth 1929, Fig. XX.

Lakes and Overflows at  
Maximum Stage.

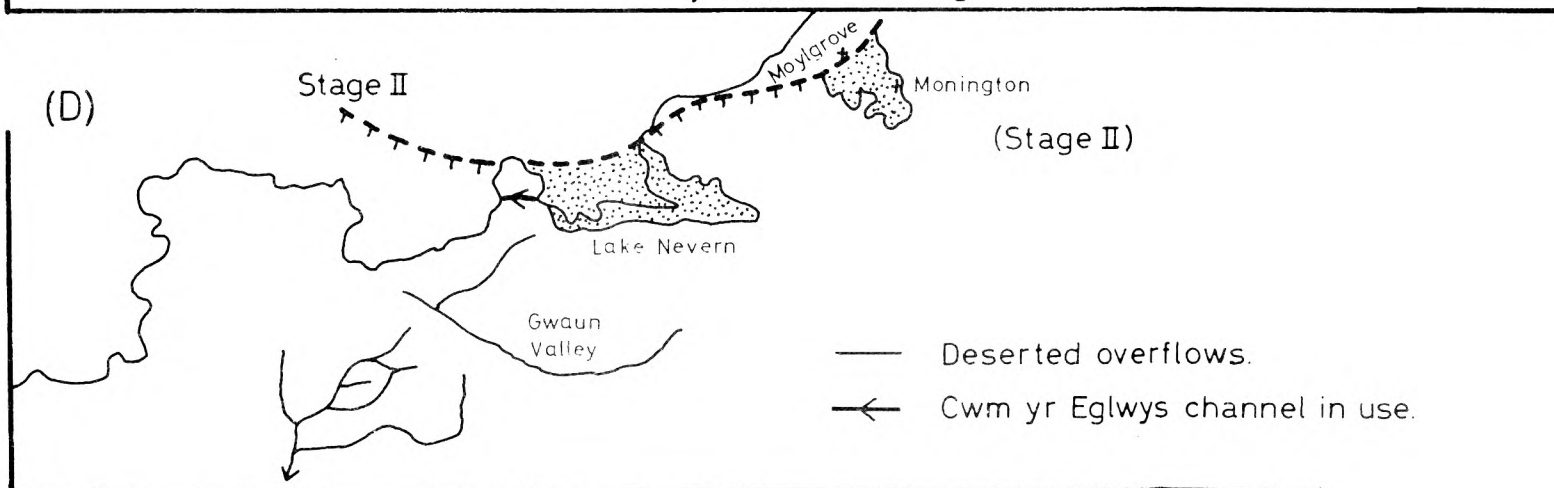
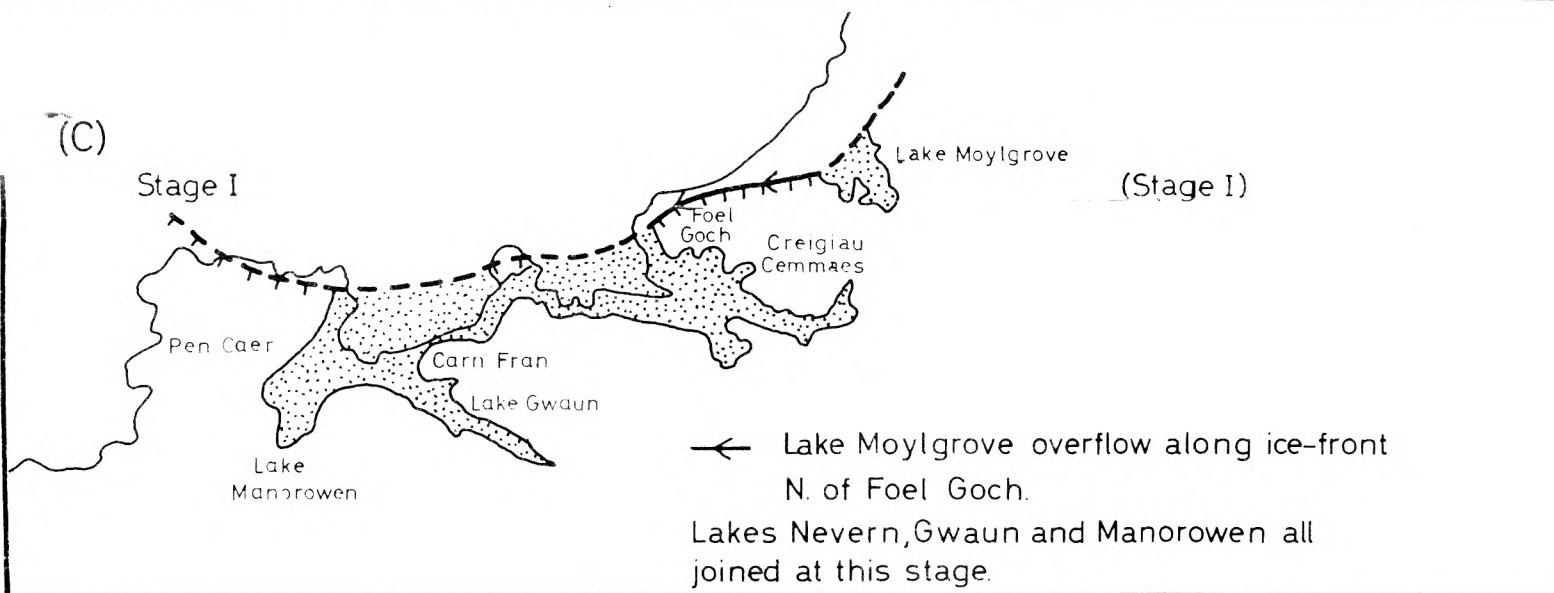
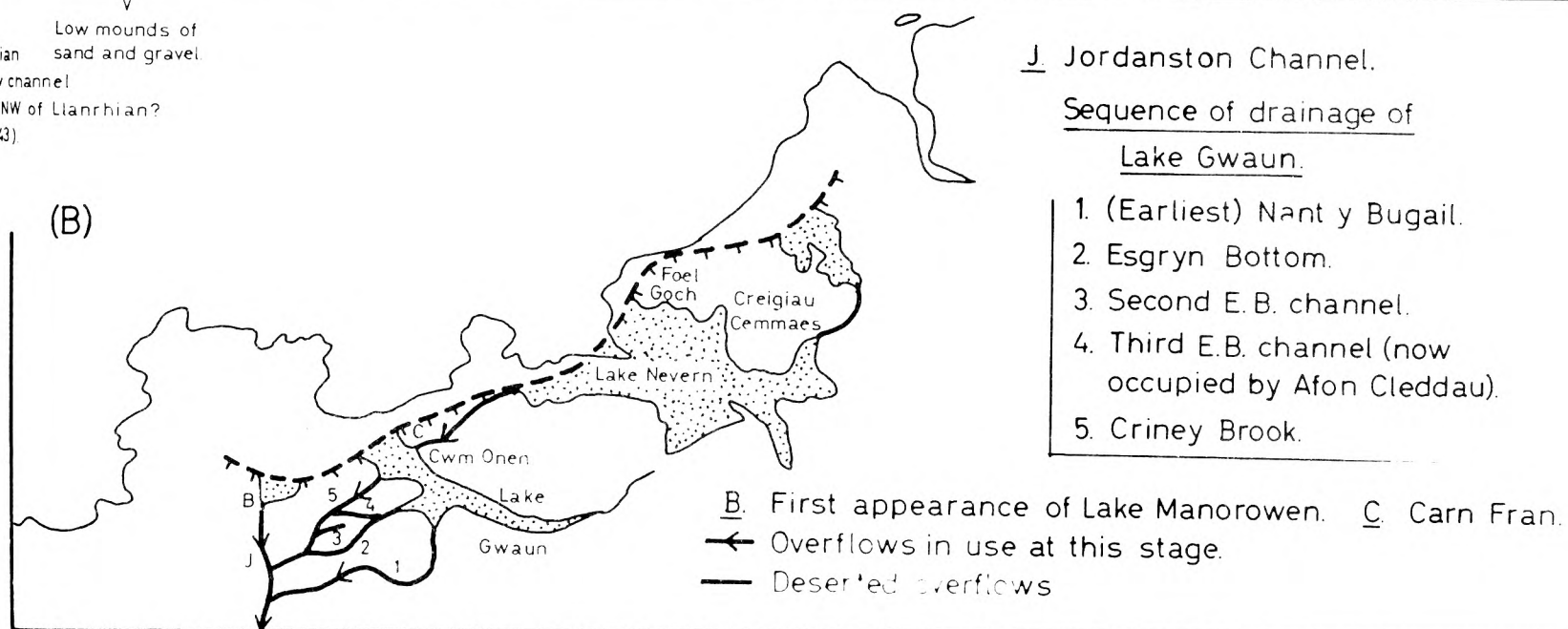


Low mounds of sand and gravel  
Llanrhian  
flow channel  
NW of Llanrhian?  
(343)

J. Jordanston Channel.

Sequence of drainage of  
Lake Gwaun.

1. (Earliest) Nant y Bugail.
2. Esgryn Bottom.
3. Second E. B. channel.
4. Third E. B. channel (now occupied by Afon Cleddau).
5. Criney Brook.



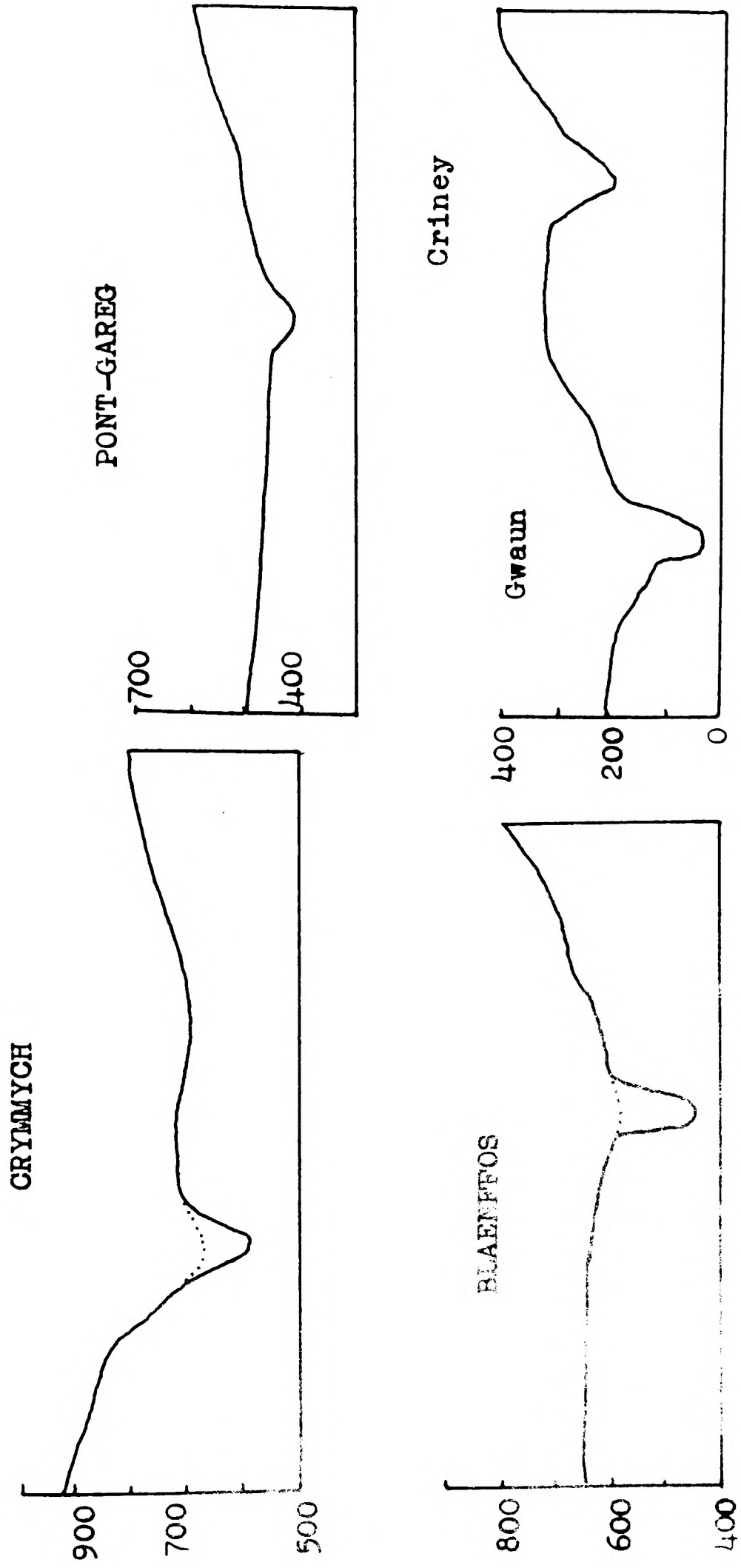
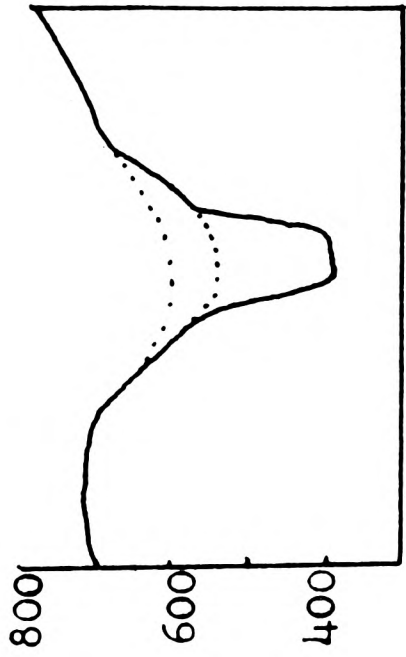


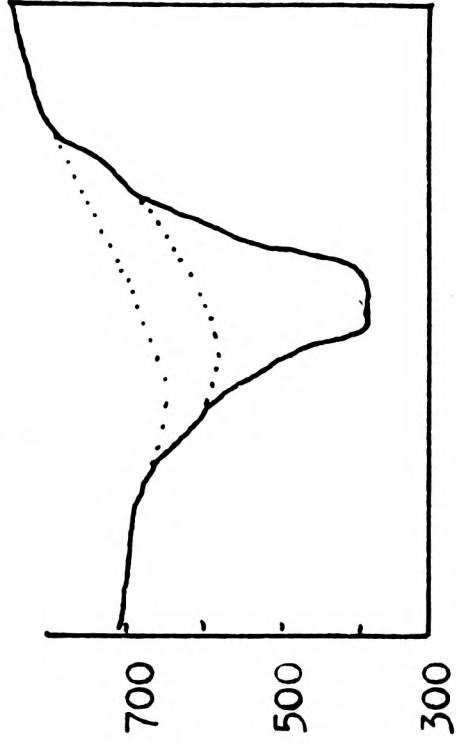
Fig. 112. A comparison of the form of some North Pembrokeshire meltwater channels.

Constructed from O.S. 2½" sheets.  
Vertical exaggeration x6

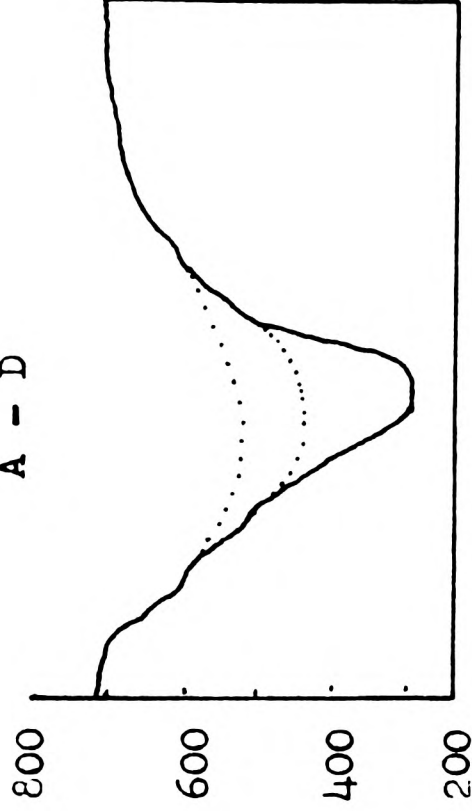
A - B



A - C



A - D



Vertical exaggeration x6

Fig. 113. Cross-profiles of the Nant-y-Bugain Channel.

A - B is approximately the position of the pre-glacial col and the present-day valley-bottom drainage divide.

Grid references: A = 985329

B = 000332

C = 983312

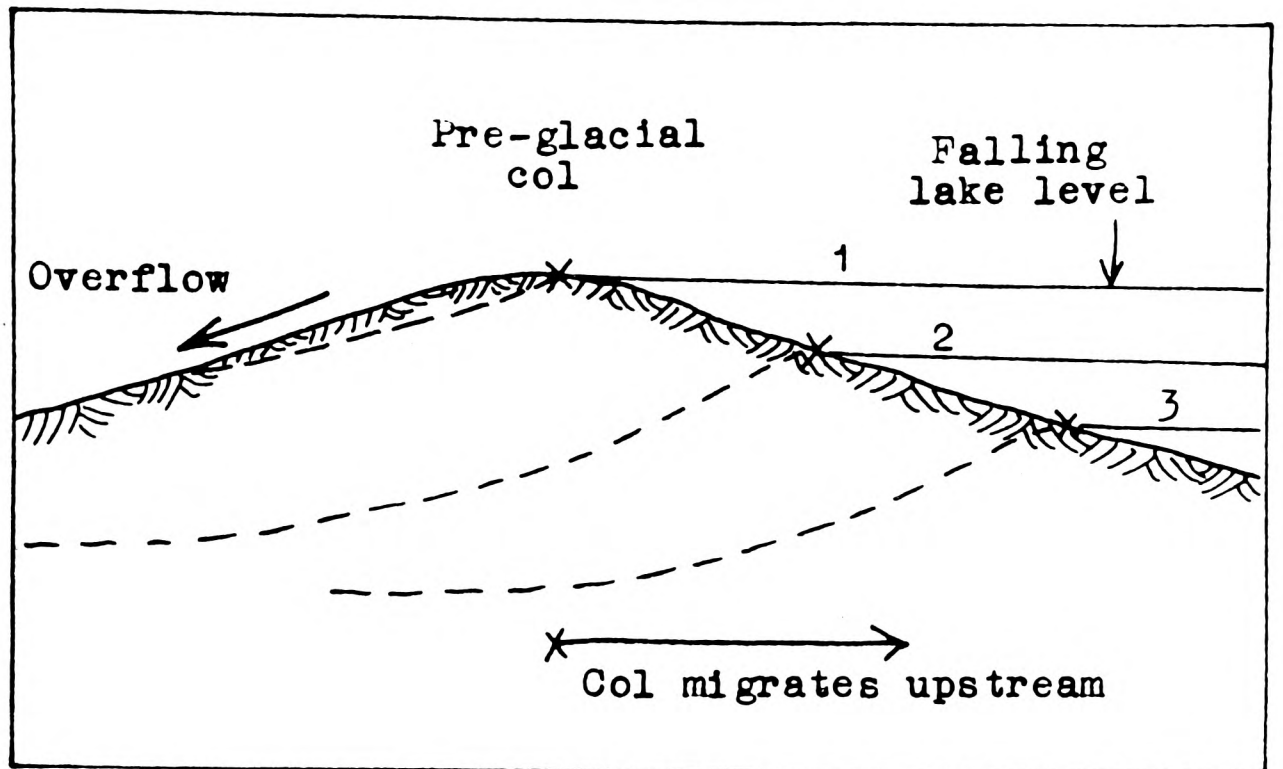


Fig. 114. Postulated sequence of events when a meltwater lake overflows a pre-glacial col (after Joy, 1963).

As the overflowing meltwater cuts its channel and as the surface level of the meltwater lake is lowered, the col must migrate upstream.

Ft. O.D.

Possible post-  
glacial modification  
of profile.

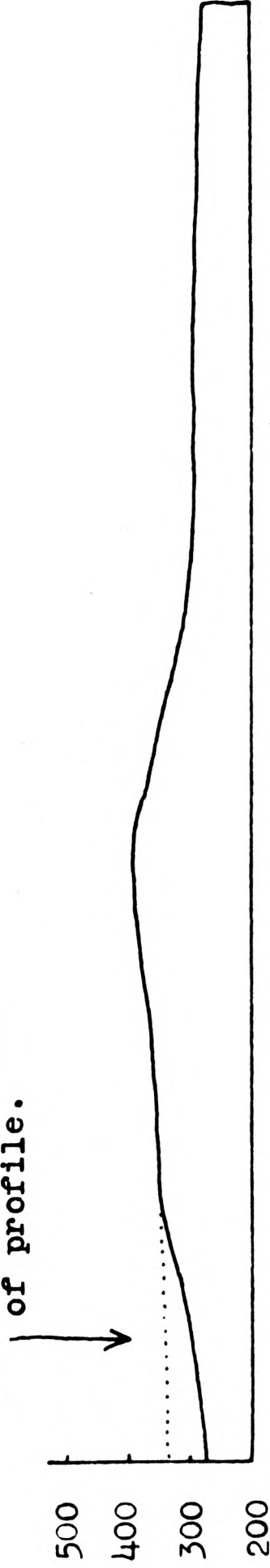
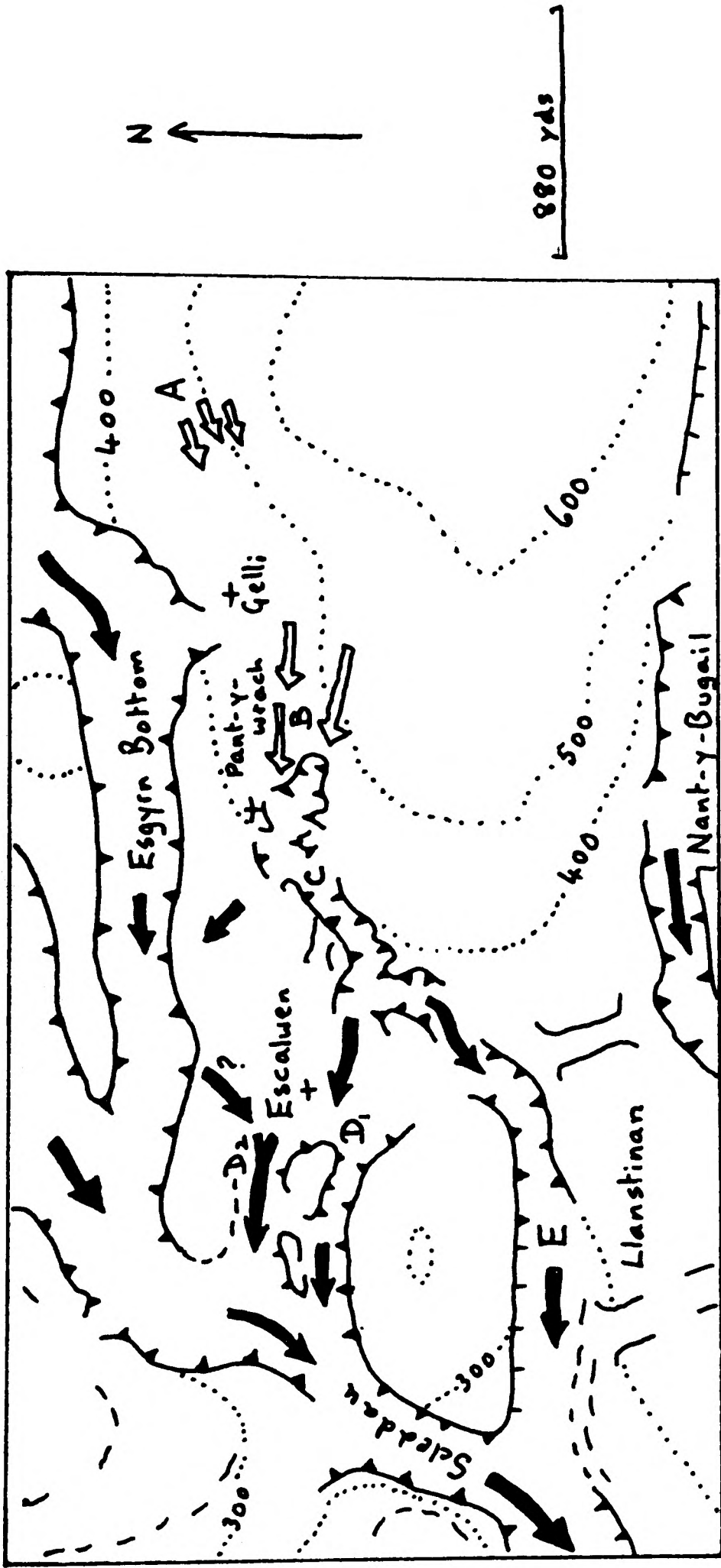


Fig. 115. Reconstructed long profile on the floor of Nant-y-Bugail Channel. Profile drawn along floor from grid ref. 989347 to 972326 (from O.S. 2 $\frac{1}{2}$ " map).

This channel floor could not be surveyed accurately because the whole valley has been sealed off as an Admiralty Arms depot.



← Possible sub-glacial meltwater flow  
 ↗ Possible marginal flow  
 - - - Steep slopes  
 [ Possible shallow meltwater routes ]  
 [ Meltwater channels ]  
 A = Gelli East channels      B = Gelli West channels      C = Escalwen East channel  
 D<sub>1</sub> = Escalwen West channel      D<sub>2</sub> = Escalwen North channel  
 E = Panty Phillip channel.

Fig. 116. The Escalwen Channel-System

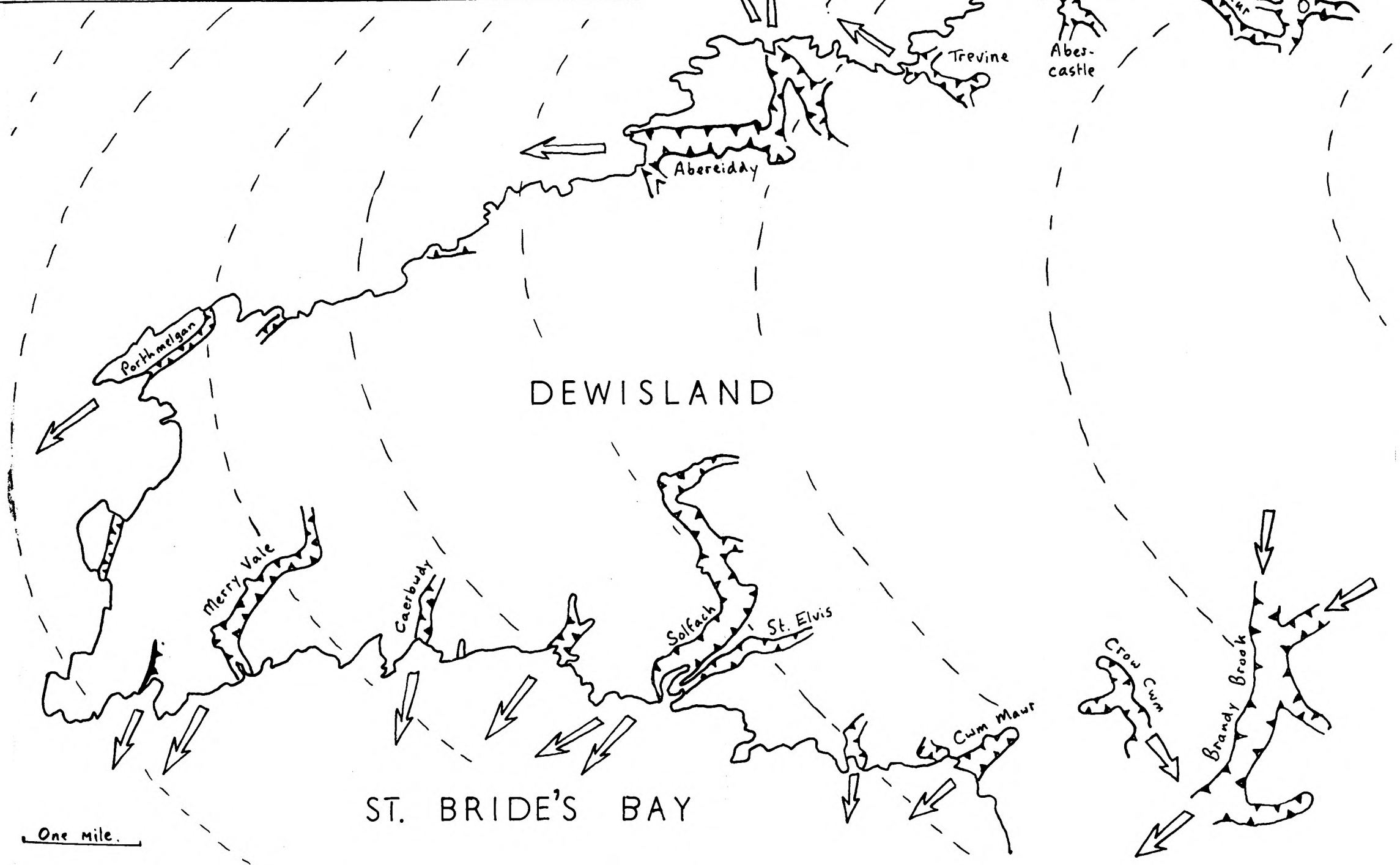
# THE MELTWATER CHANNELS OF DEWISLAND.

FIG. 117

➔ HYPOTHETICAL DIRECTIONS OF MELTWATER FLOW.

--- HYPOTHETICAL SURFACE CONTOURS OF ICE-SHEET IF THE CHANNEL GRADIENTS ACCURATELY REFLECT THE DIRECTION OF MELTWATER FLOW.

▬ MELTWATER CHANNELS.

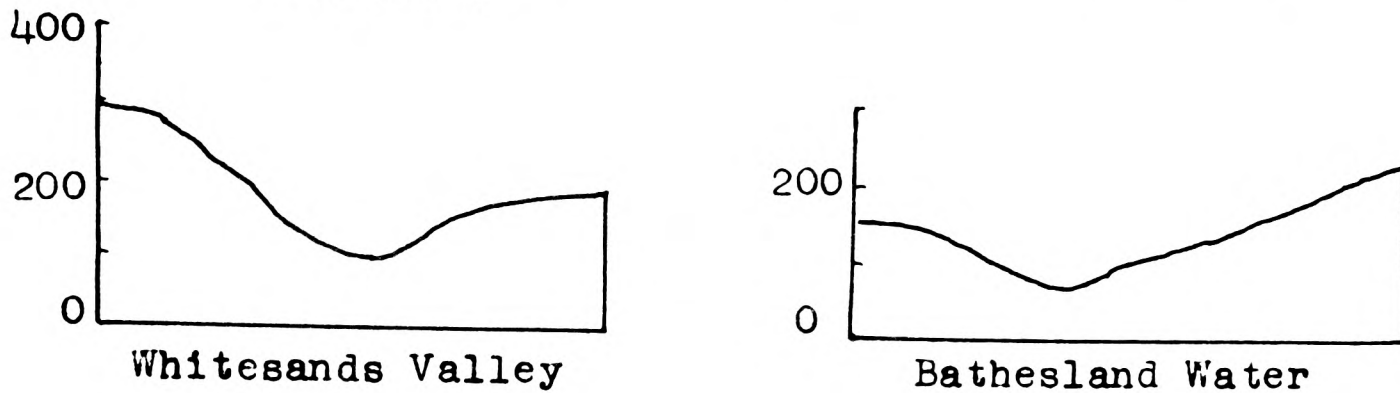


DEWISLAND

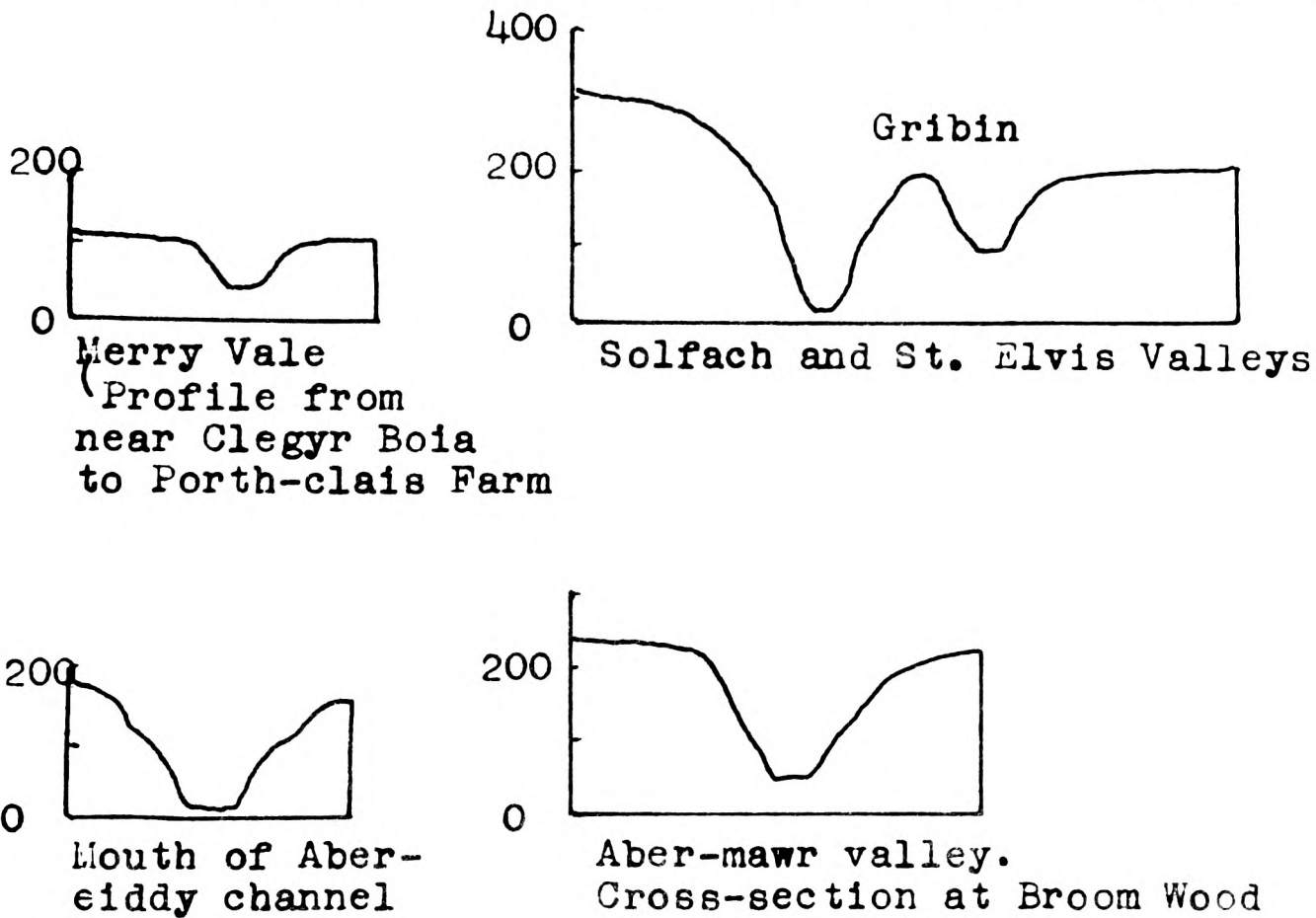
ST. BRIDE'S BAY

One mile.

A. Cross-profiles of broad river-valleys in Dewisland

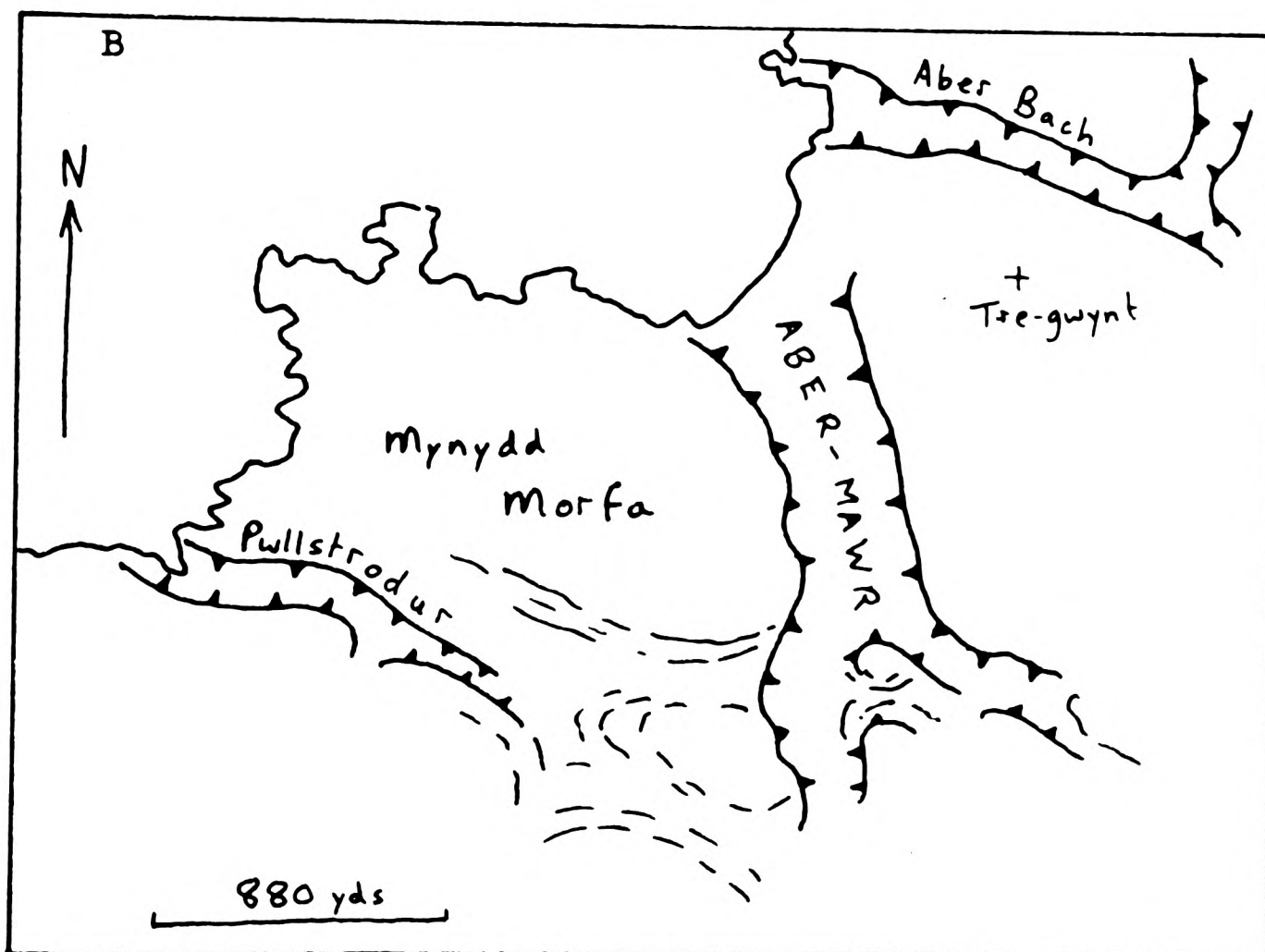
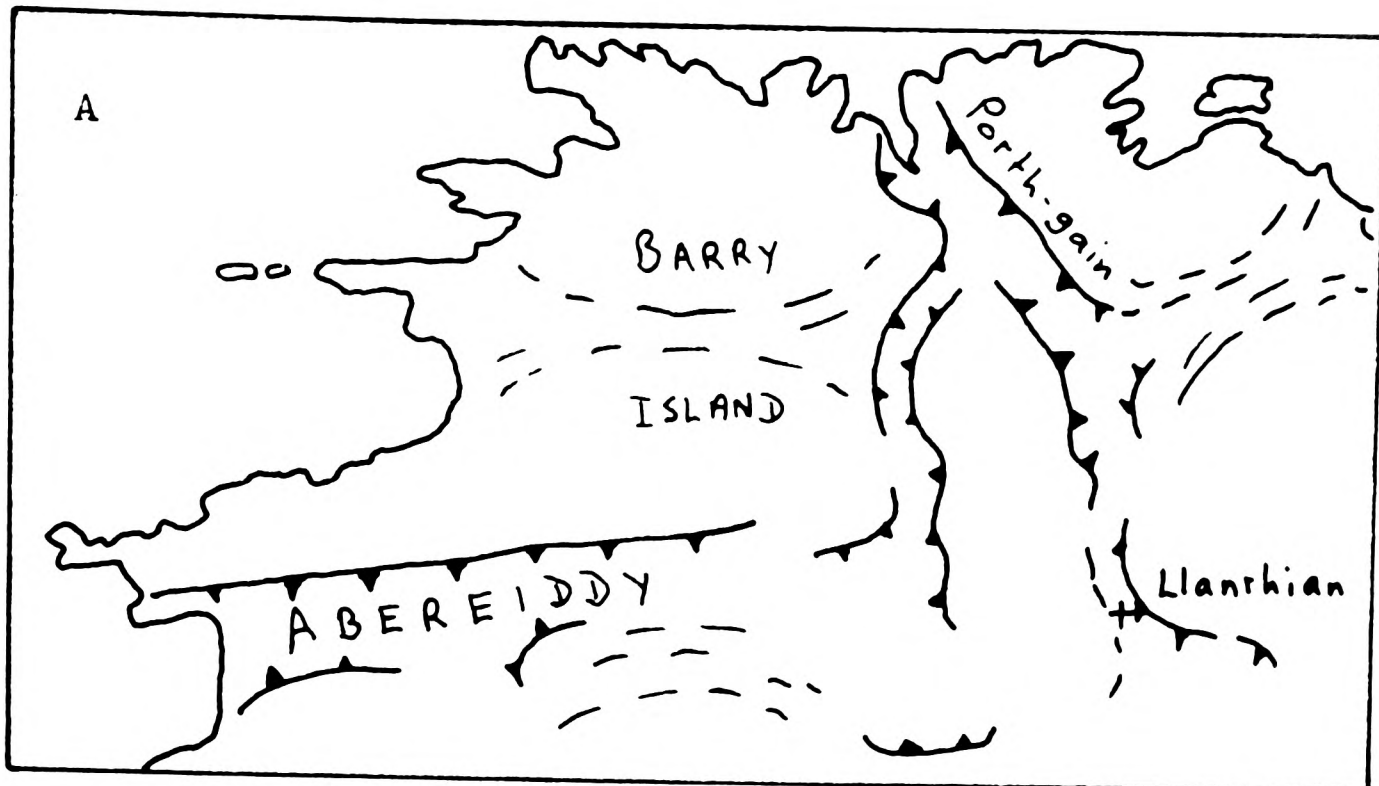


B. Cross-profiles of Dewisland meltwater channels



Vertical exaggeration  
x6

Fig. 118. A comparison of some valley cross-sections in Dewisland. Note that the meltwater channels have steep sides and flat floors.



Steep-sided channels

Shallow channels

Fig. 119. The two meltwater systems of Northern Lewisland which virtually isolate the "islands" of Barry Island and Mynydd Morfa.

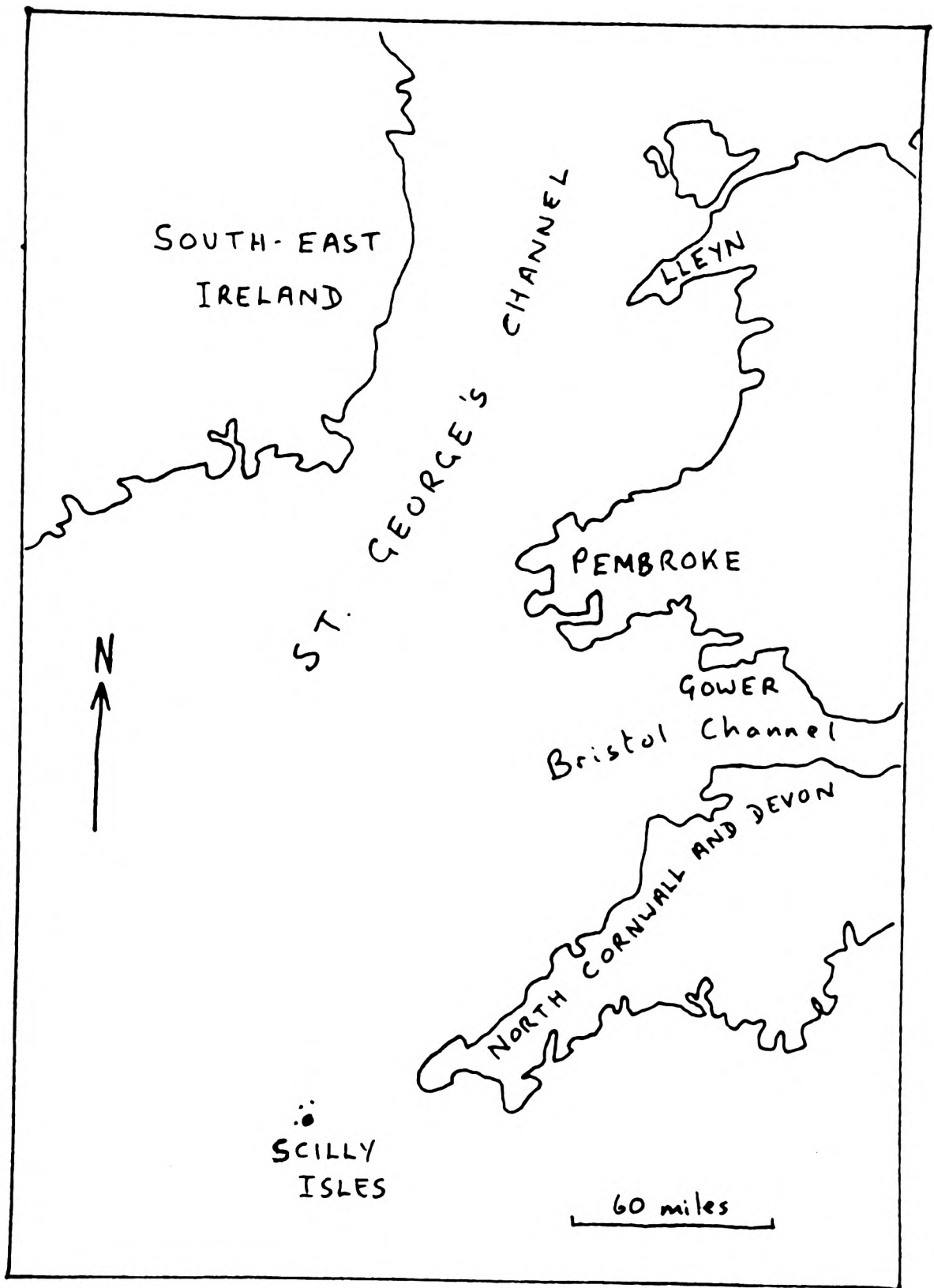
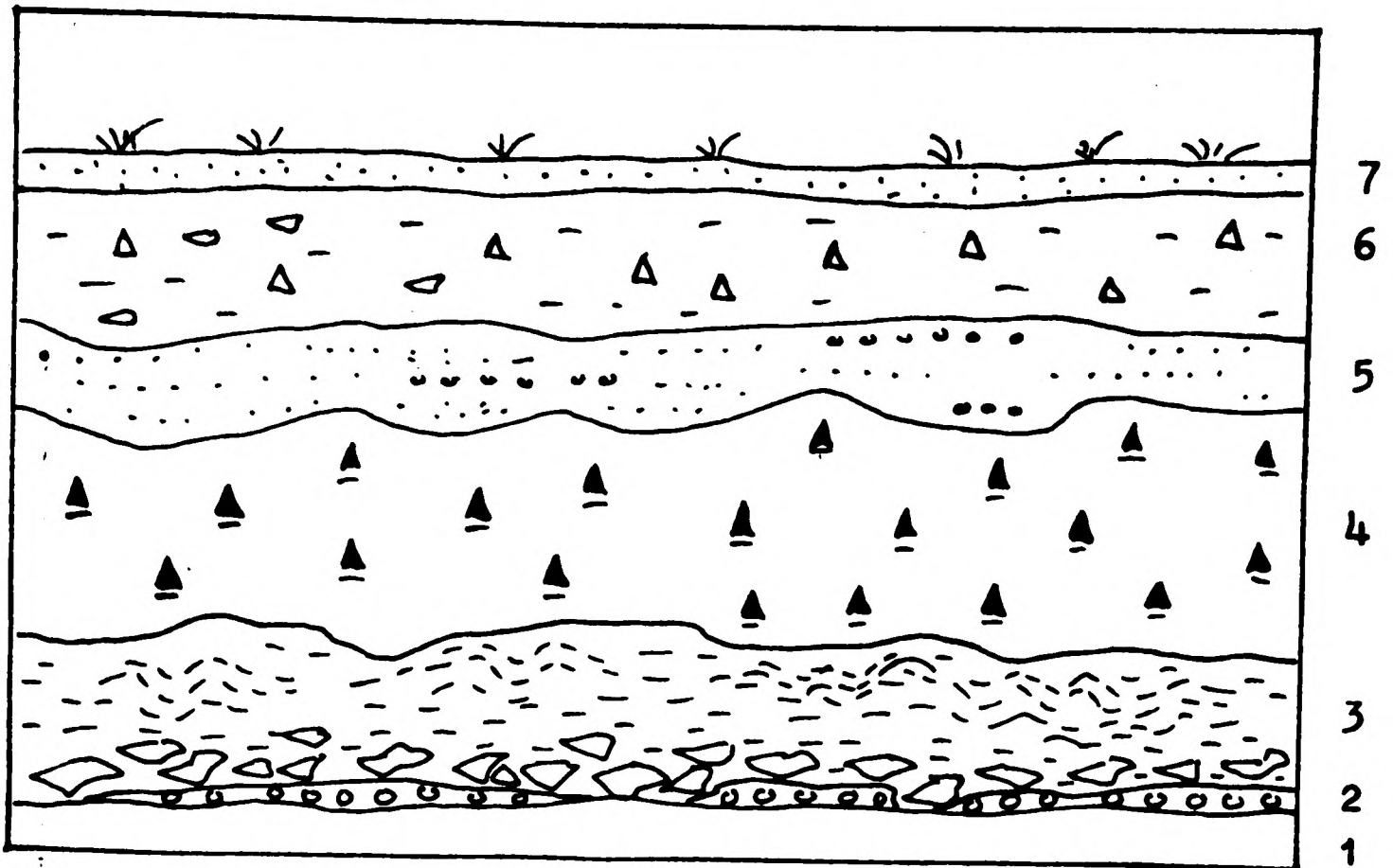


Fig. 120. The location of the areas of Western Britain examined in Chapter 13.

Key to Fig. 121.

1. Interglacial sites
2. Terminal moraines of the Last Glaciation
3. "Pre-glacial" wave-cut platform
4. Late-glacial marine shingle beaches
5. Late-glacial red marine clay
6. Post glacial raised beach above 30 ft I.O.D.
7. Post-glacial raised beach above 20 ft I.O.D.
8. Intermittent post-glacial raised beach below 20 ft I.O.D.
9. Large fossil landslips in North-east Ireland





Not to scale

7. sandy loam/weathering horizon
6. Kork - Kerry till (= Bannow till)
5. Outwash sands and gravels
4. Eastern General till
3. Main Head (blocky at base, finer at top)
2. Raised beach
1. Rock platform

Fig. 122. The Drift Succession at Garryvoe, Ballycotton Bay (idealised). After Farrington (1954) and based in part on the section demonstrated to I.G.C. Field Study Tour F 17 p, 31st July, 1964.

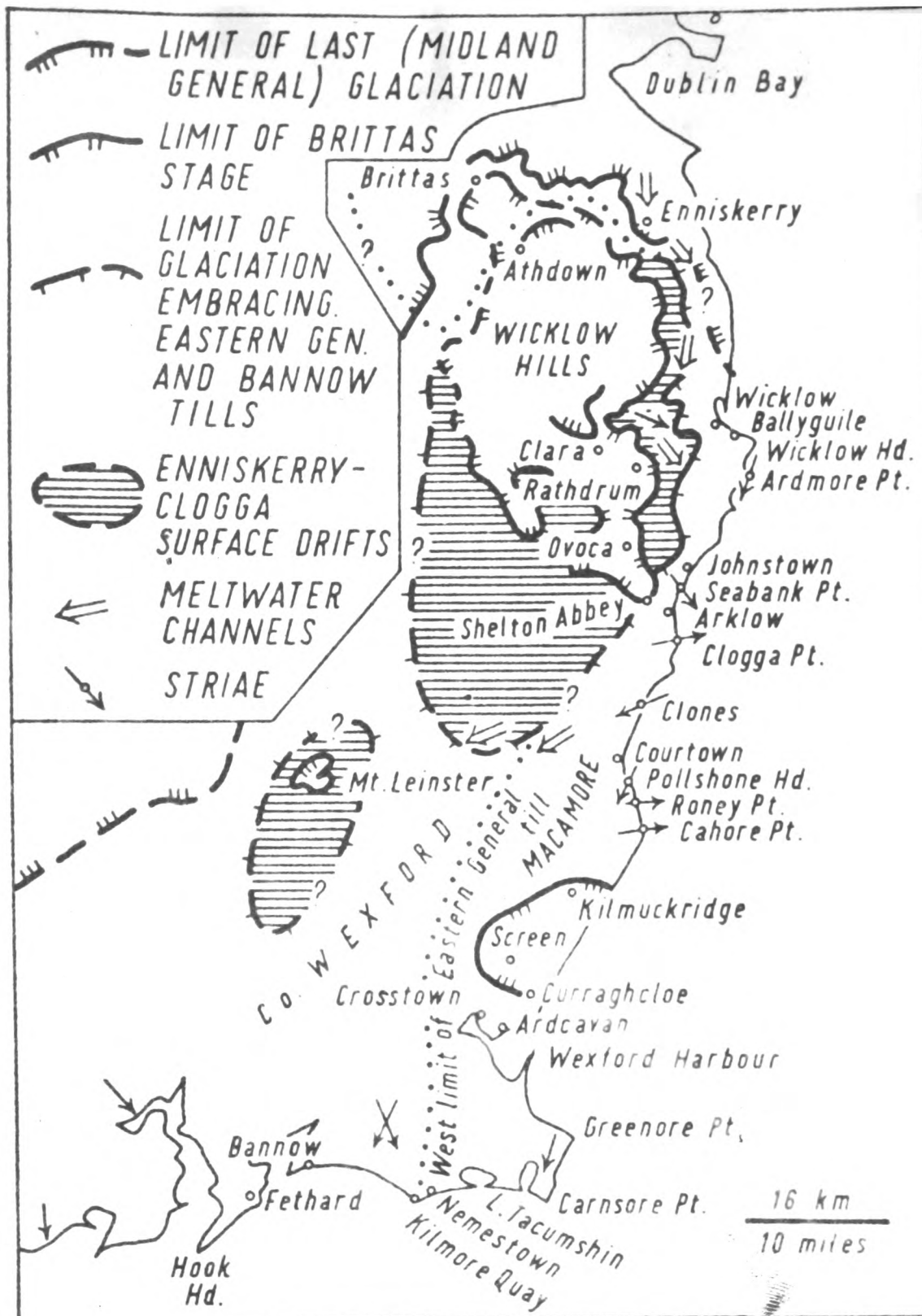


Fig. 123.

The distribution of the Enniskerry - Clogga drifts in South-East Ireland, from Synge, 1964 b.

Note also the western limit of Eastern General till and the supposed fragment of end-moraine of the Last Glaciation around Screen.

Key to Fig. 124.

1. Terminal moraines of the Last Glaciation
2. Drumlins
3. Eskers
4. Dead-ice topography
5. Outwash fans of sand and gravel associated with terminal moraines of the Last Glaciation
6. Striae
7. Corries of the Last Glaciation
8. Solifluxion deposits of Last Glaciation age.
9. Important river terraces
10. Furthest extent of Cork-Kerry drift
11. Western extent of Galway and Midland drift
12. Other limits of so-called Riss/Saale Glaciation

(From handout to I.G.C. Field Study Tour  
F17p, August 1964)

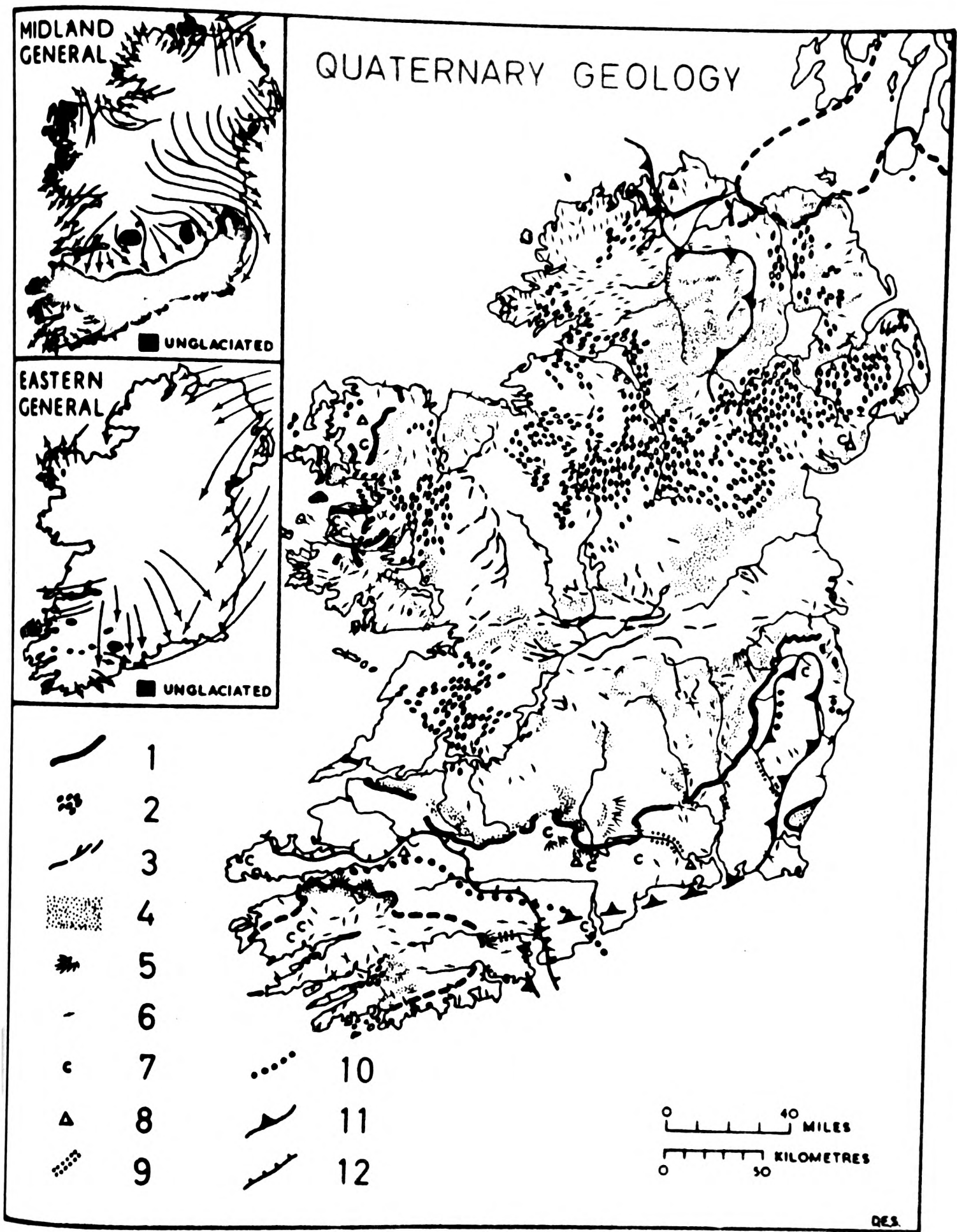


Fig. 124. Some of the Pleistocene features of Ireland. From handout to I.G.C. Field Study Tour F17p, Organised by Mr. N. Stephens, August 1964.



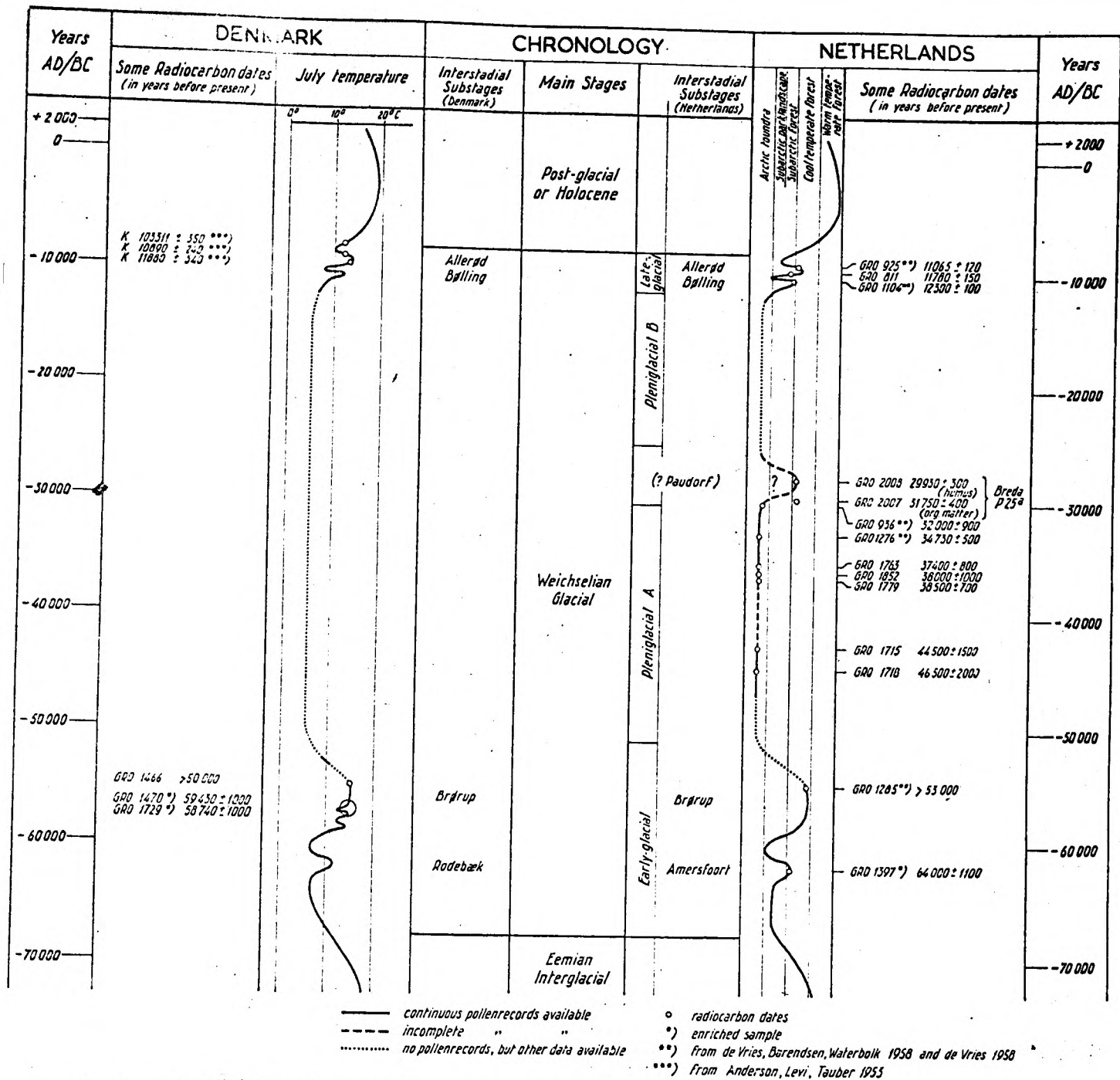


Fig. 3 — Radiocarbon dates and chronological comparison between Denmark and the Netherlands.

Fig. 126.

Palaeotemperature curve and radiocarbon dates for the Weichselian Stage in Denmark and the Netherlands, from Andersen et al 1960.

Note that the Eemian Interglacial ended shortly after 70,000 B.P.; also note the lack of C14 dates for the period 29,000 to 12,000 B.P. - this was the time of the maximum extension of the ice-sheet.



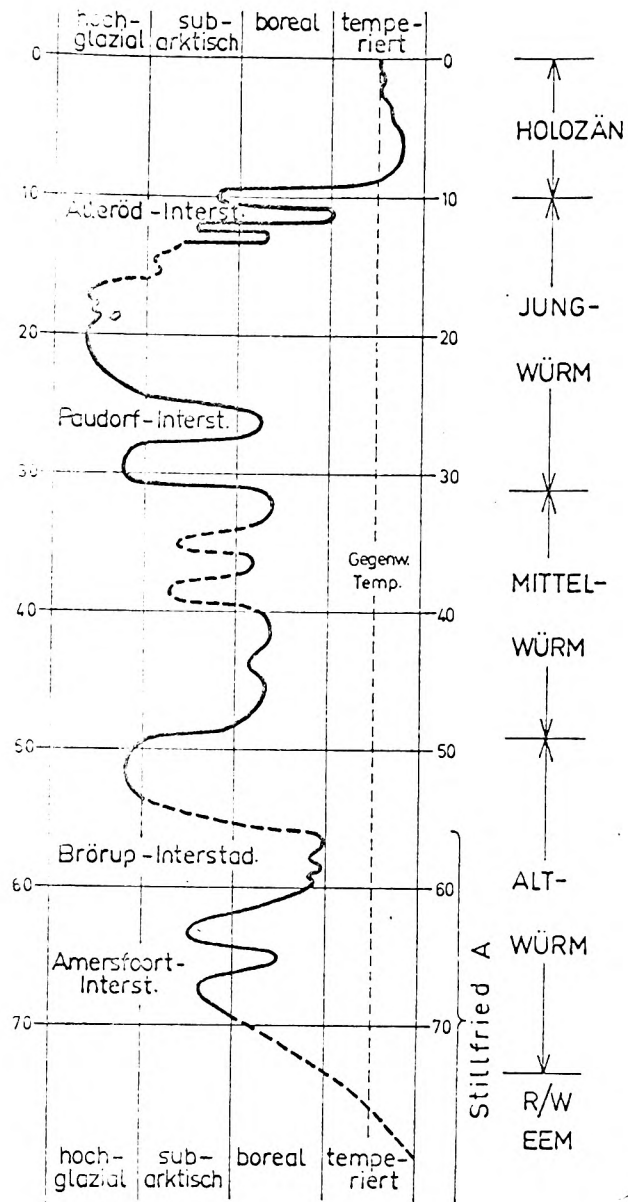
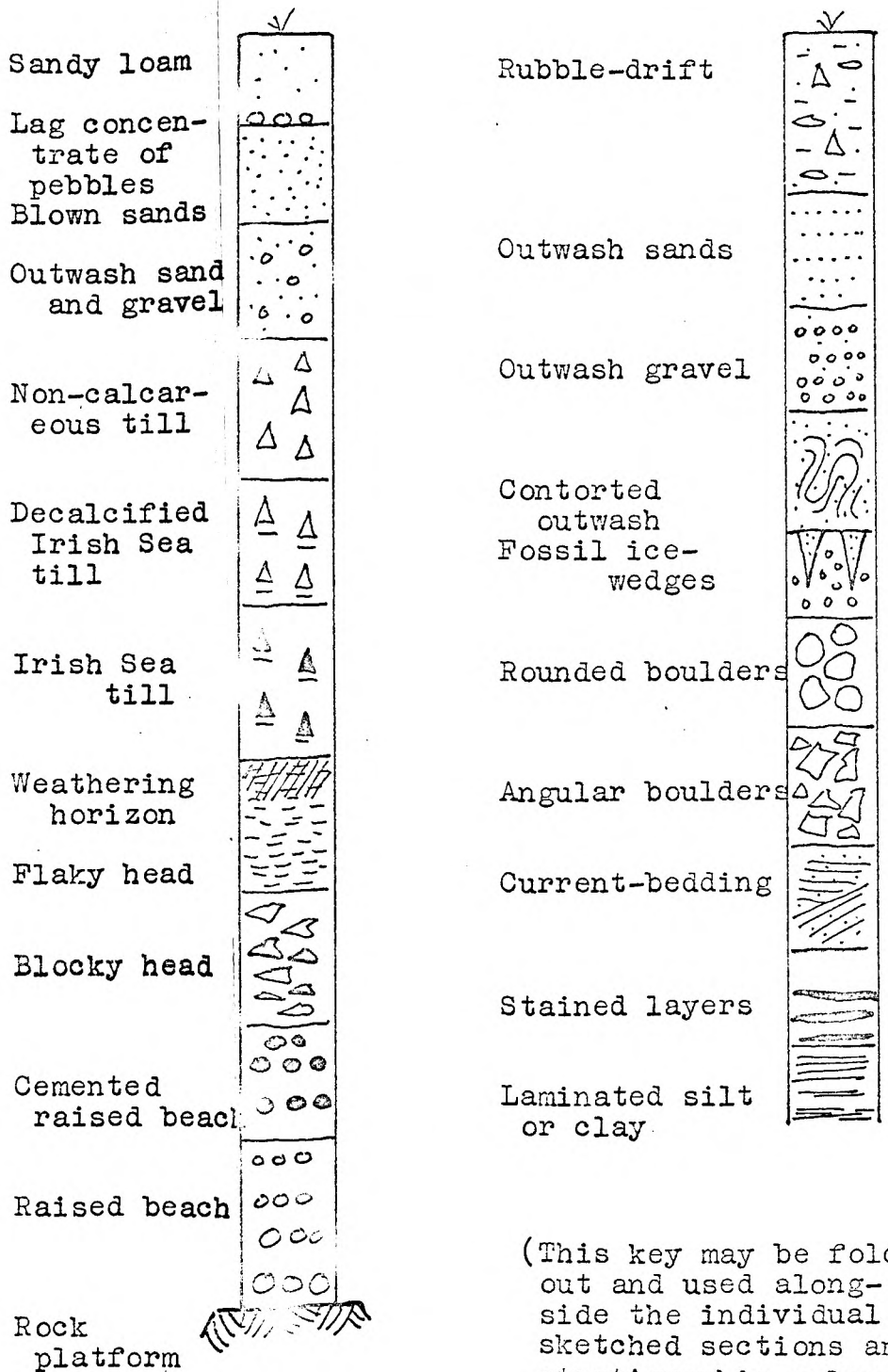


Fig. 128.

Palaeotemperature curve for the Würm/Weichsel Stage in Northern Europe, from Gross, 1964. Note that the "Jung-würm" is the time of severest climate, and that the proposed climate of the Middle Würm varied from boreal to sub-arctic. The term "Göttweiger Interstadial" is not used here.

Fig 35. KEY TO STRATIGRAPHIC DIAGRAMS



(This key may be folded out and used alongside the individual sketched sections and stratigraphic columns in the text.)

VOLUME II

APPENDICES

Nos. I - XIII

## APPENDIX I

### A BRIEF GLOSSARY OF SOME IMPORTANT TERMS USED IN THE THESIS

(Other terms are defined in the text, in footnotes,  
and in Stamp (ed.) 1961)

**Carn**                    A rock or hill. Used to describe rocky  
eminences in the St. David's District and  
elsewhere.

#### Channel features:

##### Arcuate channel

A small channel arcuate in plan and often  
with a humped long-profile. Considered to  
be diagnostic of sub-glacial erosion.

##### Marginal channel

A channel cut by meltwater flowing along  
the edge of ice in contact with a hill slope.

##### Sub-glacial chute

A steep gully generally cut at the point  
where sub-aerial meltwaters fall beneath an  
ice-surface in contact with a hill slope.

##### Sub-marginal channel

A channel cut on a hillside by meltwaters  
flowing sub-glacially yet approximately  
in the direction of ice-surface slope.

The channels may have a steeper gradient than  
true marginal channels.

## APPENDIX I (continued)

- Cwm As used here, a steep valley-head
- Dead-ice topography Hummocky deposits of sand and gravel and ablation till. The hummocks are original depositional features.
- Head A solifluxion slope deposit of blocks or flakes of upslope bedrock or other material. Pseudo-bedding may be well-developed. Individual fragments may have long axes orientated downslope.
- Irish Sea till. A highly calcareous plastic shelly till consisting largely of material dredged from the sea-floor by the Irish Sea Glacier.
- Outwash Sands and gravels deposited by glacial meltwater streams.
- Raised beach A beach deposit preserved above present O.D. The term, as used in its old sense, does not imply that there has been uplift of the coast since deposition.
- Rubble-drift A stony and sandy drift of angular bedrock fragments and rounded erratics. There may be marked pseudo-stratification, and the deposit is often found to be soliflucted.

## APPENDIX I (continued)

- Sandur** An outwash plain laid down within restricted valley sides by pro-glacial braided streams.
- Sandy loam** A stony and silty deposit, possibly wind-blown and often with a characteristic brick-earth appearance, which caps most cliffs in Pembrokeshire. It is often associated with upper head.
- Sludging** As used here, a relatively rapid mass-movement of glacial deposits, often upon a surface of wasting ice.
- Solifluxion potential**  
A term to describe the favourability of various factors at a particular site for good solifluxion.
- Till** A glacial deposit laid down directly by ice without the intervention of meltwaters etc. Generally consists of pebbles and boulders of all sizes and shapes in a compact matrix of finer material. Stones generally striated; stratification seldom well-marked.

## APPENDIX II

### GRID REFERENCES FOR SOME IMPORTANT LOCALITIES MENTIONED IN THE TEXT

Abereiddy	796310	Gwaun	975365
Aber-mawr	883347	Gwbert	163495
Caerbwdy	766245	Jordanston	918325
Caerfai	760243	Little Quay	410600
Caersalem	079368	Llanerch	059355
Carnllidi	737280	Manorowen	933363
Castell	743252	Mathry Road	923310
Cwm-mawr	844228	Mullock Bridge	811080
Dinas	012389	Newport Sands	055405
Dowrog	776273	New Quay	395595
Drim	944373	Ogof Golchfa	742237
Druidston	862173	Panty Phillip	948332
Emlych	755265	Parrog	048397
Escalwen	959338	Penbiri	768296
Fishguard	958370	Pen Dal-aderyn	717233
Gelli	975342	Pen Deudraeth	882349
Goodwick	939378	Poppit	145490

APPENDIX II (continued)

Porthlysgi	732241	Trefeiddan	731251
Porthmelgan	728279	Trefelly	747276
Pwllstrodur	867338	Treleddyd-fawr	761273
Rhos-y-Clegyrn	913355	Tre-llys	898349
Scleddau	947341	Treswni	738257
Solva	800243	Trevine	833326
St. David's	753253	Ty-canol	092368
Teifi	165475	West Angle	853032
		Whitesands	733273

All the grid references fall within  
 100 kilometre squares SM (12) and SN (22)

EARLY DISCOVERERS  
XXI

DESCRIPTION AND EXPLANATION OF GLACIAL TILL IN 1603  
GEORGE OWEN (1552-1613)

By B. S. JOHN

(Jesus College, Oxford, England)

GEORGE OWEN of Henllys, in Pembrokeshire, was a man of acute observation with a keen interest in the geological and geomorphological features of his home county. Through a section of the limestone and coal outcrops of the county in his *Description of Pembrokeshire* (Owen, 1892) he gained a nineteenth-century reputation as the "patriarch of English geologists" (Anon., p. 3). Conybeare and Phillips (1822, introduction, p. xl) believed that his geological observations represented "undoubtedly the earliest attempt to establish the important and fundamental geological fact that the same series of rocks succeed each other in a regular order throughout extensive tracts of country, and to elucidate the geological structure thus indicated".

However, of equal importance and interest is a neglected passage in the same work (Owen, 1892) in which Owen (unpublished) set down what must be one of the most accurate descriptions of glacial till. Referring to the till as "Claye Marle", he wrote:

This kind of Marle is digged out of the Earthe where it is found in great quantitie and thought to be rounde great heapes and lompes of Erthe as bigg as round hills, and is of nature fatt toughe and heavy. . . [p. 71]. This marle is of couler with vs most commonlie blwe and in some place redd. . . . verie hard to digg by reason of the toughness, much like to waxe, and the pickax or mattock beinge driven into it, is hardlie drawne out againe, so fast is it holden; it is also verie heavie as ledd." [p. 72-73]

Turning his attention to the origin of the marl, Owen was prompted by all his carefully collected evidence to accept the current theory that the drift had been deposited catastrophically by the sea:

The opinion of the Countrie people where this Marle is founde is that it is the fattnes of the Earthe created at Noes flood, when the Erthe was Covered withe the said flood a whole yeare, and the surginge tossinginge of the said flood, the fattnes of the Earthe beinge clamye & slymie of nature did gather together, and by rowlinge vpon the Earthe became round in forme, and when the flood departed from the face of the Earthe, the same was left drie in sondrie partes, which is nowe this Marle that is found. Now the Comon people Cam to this opinion I knowe not but it is verie like to be true, for where the same is founde, it is loppie [loose] and covered with sande gravell and rounde pebblestones as you shall finde at the sea side verie plaine, appearing that the stones hath ben worne by the sea in the swift river.

Also in the harte of the Marle is founde diverse sortes of shells, of fishe, as Cogle shells, Muskell shells, and such like, some altogether rotten and some yet unrotted as also you shall therein finde peaces of timber that ben hewen with edge tooles & fire brandes, the one ende burned and diverse other thinges that hath ben before tyme vsed, & this XX<sup>th</sup> foote and more deepe in the Earth in places that never ben digged before, and over the which great oakes are now growinge: and this seaven or eight miles from the sea so that it is verie probable that the same came into these places at the tyme of the last and generall flood." [p. 71-72]

Owen noted the widespread, intermittent distribution of the till, and wrote further:

This Marle is founde in Kemes and both Emlyns from Dynas vpp to Penboyr in Carmarthen, beinge about twentie myles in lengthe and fowre myles in bredeth in most places to the sea syde, but of this compasse I cannot heare that the same ys founde: I think more for want of Industrie then otherwise. . . ." [p. 73]

He ended his description of the clay marl with these words:

"... and who so list to learne more of this marle: let him peruse a pamphlett which I have vtherof, wherein I have declared the nature of the marle, how to know yt and finde yt. . . And brevities sake I Cesse here to writte any more thereof." [p. 73]

Henry Owen, who edited and commented on the description when it was re-published in 1892, noted in his preface (p. xxiv) that this "pamphlett" was completed in 1599. It is found in the Vairdre Book of MSS. at the National Library of Wales, and contains, among other things, details of the origin and characteristics of the marl and information on where various types of marl may be found.

Thus it seems that as early as 1599 Owen had completed his observations on the clay marl to his own satisfaction. He did not ascribe a glacial origin to the drift, but accepted, in the fashion of the day, that the marl and associated deposits had been laid down by the "universal and generall flood". Nevertheless, his work was quite outstanding for its accuracy. His description is such that one has no difficulty in recognizing his "claye marle" as the Irish till which is found in both eastern Ireland and west Wales. He was correct in his observation that the till contains shell and wood fragments, and he also clearly recognized that it is elsewhere characterized by a tough, compact clay matrix. He even noticed the subtle difference between the calcareous unweathered blue clay and the weathered and decolorized red clay which overlies it. Significantly, he recognized the till's most important stratigraphical relationship, namely, that it is often overlain by water-deposited sands and gravels.

Jehu (1904), who quoted Owen's work at length in his classic paper on the glacial deposits of north Pembrokeshire, stated that his 1599 pamphlet on the clay marl contained "perhaps the earliest attempt to give a full description of the boulder-clay". Indeed, it may represent the earliest attempt to differentiate on a stratigraphical basis between the "Lower Till" and the "Middle Glacial Sands and Gravels" of Britain, the lower members of a tripartite glacial succession which has excited the attention of British geologists and glaciologists for so many years.

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## Appendix IV

## Points used for Stone-counts

No.	Locality	Grid ref.	1	2	3	4	5	
1	Porthmelgan	728279	0	0	0	60	40	Exposure
2	Whitesands N.	733273	0	6	66	2	26	Exposure
3	Porth-mawr	735275	0	0	0	50	50	
4	Trefelly Moor N.E.	747276	0	0	28	26	46	
5	Trefelly Moor S.E.	746275	0	0	42	30	28	Exposure
6	Carn Trelwyd	753284	0	18	0	64	18	
7	Penbiri	768296	0	0	0	90	10	
8	Tre-iago	775284	28	70	2	0	0	
9	Gwrhyd-mawr W.	765276	0	82	4	6	8	
10	Gwrhyd-mawr E.	766276	0	78	8	4	10	
11	Treleddyd-fawr Moor	761273	6	68	20	4	2	
12	Tre-farchan E.	759268	0	92	6	0	2	
13	Dowrog	776273	50	40	8	2	0	
14	Tre-farchan W.	757267	0	84	6	6	4	
15	Emlych	755265	16	60	4	4	16	Exposure
16	Mynydd-du	766363	14	66	16	2	2	
17	Croes-Philip	744261	4	80	2	6	8	
18	Treswni Res.	738257	0	82	4	2	12	
19	Shosson	726255	4	12	76	0	8	
20	Trefeiddan W.	727248	0	42	24	0	34	
21	Trefeiddan	731251	12	30	42	2	14	
22	Castell	743252	62	28	10	0	0	Exposure
23	White Well	750252	4	76	8	4	8	
24	Ffordd Caerfai	757250	6	66	18	6	14	

No.	Locality	Grid ref.	1	2	3	4	5	
25	Clegyr	773254	8	56	18	0	18	
26	Treginnis	733244	0	68	28	0	14	
27	Waun Isaf	746246	86	8	6	0	0	
28	Pen Dal-aderyn	717233	0	96	4	0	0	
29	Ogof Golchfa	742237	14	21	63	0	2	Exposure
30	St. Non's	756242	32	64	4	0	0	
31	Caerfai	760243	2	16	58	0	24	Exposure
32	Caerbwdy stream	766245	10	37	46	0	7	Exposure
33	Caerbwdy cliff	766245	6	12	80	0	2	Exposure
34	Glasfryn	758257	10	80	8	0	2	
35	Lower Treginnis	723237	0	92	8	0	0	

(See Map 4).

**Stone-type categories:**

1. Pre-Cambrian Intrusives
2. Pre-Cambrian Extrusives
3. Cambrian Sedimentaries
4. Ordovician Sedimentaries
5. Ordovician Intrusives

Z	Locality	Deposit	5-185	15-195	25-205	35-215	45-225	55-235	65-245	75-255	85-265	95-275	105-285	115-295	125-305	135-315	145-325	155-335	165-345	175-355	Actual centre of dominant 30° sectn I	% stones in dominant 30° sector	Centre of postulated sludge sector II	Difference between I and II
A	Newgate N ①	Head	16	4	12	8	4	8	4	8	4	2	2	2	4	2	2	4	4	10	195°	30	215°	20°
B	Norton ①	"	10	12	6	12	4		6	4	6	4	2	2	4	4	2	4	4	12	125°	34	145°	20°
C	Ogof Galdra ①	"	14	12	10		6					2		2		12	2	10	10	30	235°	56	145°	90°
D	" " ②	"	10	8	6	8	6		2	4	2	2	6	8	2	10	10	10	6	10	185°	28	145°	40°
E	Portkey-Rhau ①	"	16	6	10	2	2	4	4	6	2	6	4	2	4	4	4	10	4	12	155°	34	155°	0
F	" " ②	"	10	10	2	4	2	4		2	10	6	2	10	2	8	4	6	4	14	5°	34	295°	70°
G	Silbermochn Pt	"	16	16	2	4	2	2		4	2	4	6	4	4	2	8	4	4	8	265°	40	305°	40°
H	Caerbury ②	"	8	6	8	2	4	8	2	6	6	6	6	4	4	4	2	4	6	14	275°	32	345°	70°
I	" " ②	"	10	10	2	8	2	6	6	4	8	8	6	6	2	10	4	8	4	10	305°	30	345°	40°
J	Aber-mans ②	"	12	22	8	6	2	4				2				2	4	12	6	20	285°	54	275°	10°
K	Whitesands ①	Head + erratics	10	14	8	8	4	2					4	6	4	4	4	6	14	10	275°	34	295°	20°
L	" N ①	Head?	8	12	6	2	2	4	8	2	8	12		4	8	6	2	4	4	10	165°	30	175°	10°
M	Postmelyan ②	Solifl. till	24	16	10	8	2	4	4	4	2			2	4	4		2	2	12	195°	52	190°	0
N	Whitesands N ③	"	18	12	6		2	10	4	4	6	2	2	4	4	2		2	12	8	195°	38	195°	0
O	Ogof Galdra ③	"	11	14	4	6	4	2	4	4					2	2	2	12	8	24	135°	54	125°	10°

Averages: 13.2 11.6 6.6 5.2 3.2 3.9 2.9 3.3 3.2 3.7 1.9 3.4 3.2 4.1 3.1 7.1 5.8 13.9

APPENDIX V. Data for construction of mean preferred orientation diagram for solifluxion deposits.

Appendix VI (A) Samples used for roundness analysis histograms. Figures indicate percentage of pebbles in each roundness category.

Histogram A (Head)

No.	Locality	Grid ref.	Roundness Categories			
			1	2	3	4
1	Nolton	858186	42	52	6	0
2	Porth-y-Rhaw	787243	82	18	0	0
3	Ogof Golchfa	742237	12	80	8	0
4	Newgale	845224	48	52	0	0
5	Sibbernock Pt	852215	70	30	0	0
6	Pen-y-Cwm	850234	34	62	4	0
7	Newgale Hill	850225	86	14	0	0
8	Druidston	862173	82	18	0	0
9	Abereiddy	796310	44	56	0	0
10	St. Elvis	818244	82	18	0	0
11	Caerfai	760243	36	64	0	0
12	Whitesands	733270	74	20	4	2
13	Wood	866217	42	58	0	0
14	Little Hilton	883198	80	20	0	0
15	Admiralty Site	943163	40	60	0	0
16	Pelcomb	915183	78	20	2	0
17	Aber-Mawr S.	880345	76	22	2	0
18	Aber-Mawr S.	880345	50	34	16	0
19	Aber-Mawr N.	883347	42	44	12	2
20	Aber-Mawr N.	883347	66	32	2	0
Totals:			1166	774	56	4
Averages:			58.3	38.7	2.8	0.2

## Appendix VI (B)

## Histogram B (Non-calcareous Till)

No.	Locality	Grid ref.	Roundness Categories			
			1	2	3	4
1	Rhos-y-Clegyrn	913355	14	56	26	4
2	Clyn Bach	936348	12	42	36	10
3	Rhos Felen	939343	24	62	12	2
4	Ogof Golchfa	742237	14	64	18	4
5	Caerbwdy A	766245	8	34	38	20
6	Caerbwdy B	766245	20	50	24	6
7	Caerbwdy C	766245	10	34	42	14
8	Croes Philip	744261	40	48	8	4
9	Treswni	738258	70	30	0	0
10	Goodwick	939378	44	28	14	14
11	Pen-y-Cwm I	844228	36	46	14	4
12	Pen-y-Cwm II	844228	32	32	20	16
13	Caerfai A	760243	28	54	16	2
14	Abereiddy	796310	38	24	28	10
15	Trefelly Moor S.E.	746275	24	62	12	2
16	Trefelly Moor N.E.	747276	42	44	10	4
17	Treleddyd-Fawr	762273	44	44	8	4
18	Clegyr	773254	16	66	14	4
19	Trefeiddan	732252	12	70	14	4
20	Trefeiddan	733254	12	72	16	0
	Totals:		540	962	370	128
	Averages:		27.0	48.1	18.5	6.4

Appendix VI (C)

Histogram C (Calcareous Till)

No.	Locality	Grid ref.	Roundness Categories			
			1	2	3	4
1	Whitesands N.	733273	24	52	14	10
2	Porthmelgan I	728279	32	36	20	12
3	Aber-mawr N.	883347	24	50	16	10
4	Druidston	862173	22	38	28	12
5	Nolton	858186	7	55	30	8
6	Aber-mawr S.	880345	8	46	36	10
7	Porthmelgan II	728279	10	64	22	4
8	Porthmelgan III	728279	30	40	20	10
9	Aber-mawr N. (2)	883347	2	26	62	10
10	Aber-mawr N. (3)	883347	6	38	42	14
		<b>Totals:</b>	165	445	290	100
		<b>Averages:</b>	16.5	44.5	29.0	10.0

Appendix VI (D)

Histogram D (Outwash Sands and Gravels)

No.	Locality	Grid ref.	Roundness Categories			
			1	2	3	4
1	Tre-llys	898349	7	44	35	14
2	Ty-nwydd	051306	18	70	12	0
3	Clyn	936355	20	48	20	12
4	Scleddau I	947341	12	54	32	2
5	Scleddau II	947341	9	63	27	1
6	Wolfscastle	957262	20	74	6	0
7	Aber-mawr N.	883347	4	24	58	14
8	Rhos-y-Clegyrn I	913355	6	38	46	10
9	Rhos-y-Clegyrn II	913355	10	37	44	9
10	Mathry Road A	923310	4	42	40	14
11	Mathry Road B	923310	8	44	32	16
12	Ford	956257	18	30	34	18
13	Tax Office	958158	10	22	42	26
14	Ridgeway	958158	2	46	38	14
15	Picton P.F.	958155	6	26	40	28
16	Nolton	858186	6	44	46	4
17	Mullock Bridge I	811080	0	28	58	14
18	Ford II	956257	16	24	58	2
19	Aber-mawr S.	880345	4	22	56	18
20	Mullock Bridge II	811080	6	18	60	16
Totals:			182	808	788	222
Averages:			9.1	40.4	39.4	11.1

## APPENDIX VII

### COASTAL LOCALITIES IN DEWISLAND WHICH MAY BE OF USE TO FUTURE WORKERS

(Arranged alphabetically)

1. Aber Castell. Up to 10 ft of buff stony till resting on thick lower head of shale fragments.
2. Aberciddy. North side of bay, flaky heads with erratics. Above cutting on cliff-top, stiff compact non-calcareous till full of erratic pebbles. Iron-stained bands and veins of silt and clay in till.
3. Aberciddy Valley. About 1000 yards from valley mouth, small drainage reservoir on floor. Stony non-calcareous till beneath c. 3 ft of alluvium and humic matter.
4. Aber-pwll. On floor of valley, above present pebble-beach, deposit of pebbly head and till. Pebbly horizons and silt layers may indicate presence of a raised beach.
5. Caerfai. At head of bay, severely contorted shale head above small quarry. Also non-calcareous till overlying weathered bedrock, and itself overlain by gravels, soliflucted till, slumped masses of bedrock, and head.
6. Cwm-mawr (Pen-y-cwm). Soliflucted stratified local

## APPENDIX VII (continued)

- till lying between two heads. Lowest head is of soliflucted beach pebbles? Drift possibly rests upon a rock platform.
7. Gwadrn (East side of Gribin, Solva). Possible vegetated raised beach c. 10 ft A.H.W.M. - rounded pebbles in a sandy matrix. Grades laterally into hillside sludge and head.
  8. Ogof Tobacco. On clifftop, thin layer of local till between thick lower head and thin upper head with erratics.
  9. Penmaenmelyn. Good traces of low raised beach platform. Up to 6 ft well-stratified local head.
  10. Porth-clais. Stony local till and head exposed at roadside near bungalow.
  11. Porthlysgi. Just above beach, soliflucted local till overlain by layers of head and slumped masses of bedrock. Some head severely-weathered.
  12. Porthmynawyd. Up to 8 ft of soliflucted till and head in valley. Drift full of erratics, especially near base.
  13. Porthselau. Above beach, 5 - 6 ft of weathered head above bedrock. No till, but igneous erratics in head.
  14. Porthtaflod. Several head layers on clifftop; total thickness of over 10 ft. 4 ft of upper head contains many striated erratics.

APPENDIX VII (continued)

15. Porth-y-Bwch. On clifftop up to 8 ft of chalky local non-calcareous till. Full of erratic pebbles. Slight signs of stratification.
16. Porth-y-Ffynnon. On clifftop, 12" of local till resting on 3 ft of blocky head. Till is overlain by 2 ft of sandy loam with erratics.
17. Porth-y-Rhaw. On floor of valley, 2 - 3 ft of angular head with many erratics. Head and till also exposed on clifftop near promontory fort.
18. St. Non's Bay. On clifftop, 6 - 10 ft angular local head overlain by thin local sandy till.

(These localities are located on Map 3)

## APPENDIX VIII

### DRAINAGE RESERVOIRS IN WESTERN DEWISLAND WHERE GLEYED TILL IS EXPOSED

Treswni Moor. Reservoir near south end of moor. Stony till dredged up from depth 8 - 10 ft. Till grey-blue in colour; matrix sticky when wet, but often gravelly and stony. Most pebbles are local greenish Pre-Cambrian tuff. Many striated erratics. Large boulders over 4 ft diameter - from St. David's Head area. Weathered till buff or bright brown - iron-stained. Shell fragments (including Patella) found on sides of reservoir - carried by birds? Till non-calcareous.

Treleddyf-fawr Moor. Reservoir 40 yds long. Till exposed in sides is relatively stoneless massive clay; till dredged from depth is sandy and gravelly. Till gleyed and oxidised at least to depth 5 ft; unweathered till is rich purple-blue colour, non-calcareous. Shells on surface - carried by birds? Erratics include Cretaceous flints, vein quartz, green shales, micaceous sandstones and igneous pebbles; often striated.

Trefelly Moor. Drainage reservoir almost stretches across moor. Purple-blue till full of flakes of

APPENDIX VIII (continued)

local shale and erratics of sandstones, Cretaceous flint, and igneous rocks. Till non-calcareous; weathered to a rich reddish colour near surface. Many large erratic boulders from igneous masses to the north.

Llandigige Fawr. Very stony till. Large proportion of local shale fragments. Till mottled and gleyed near surface. Non-calcareous. Large erratics and smaller pebbles of Cretaceous flint, black mudstone, grey sandstones, quartz pebbles. Igneous boulders.

(These reservoirs, and others where stony sandy till is exposed, are located on Map 3.)

Appendix IX

Calculation of Mean Histogram for so-called  
 "Upper Boulder-clay" suspected of Solifluxion

	Whitesands N.	Aber-mawr UHC	Castell	Porthmelgan	Nolton car-park	Pen-y-cwm BC/Hd. I	Pen-y-cwm II	Goodwick Brickworks
Angular	6	34	40	12	16	36	32	44
Sub-Angular	76	42	58	64	52	46	32	28
Rounded	16	18	2	16	24	14	20	14
Well-Rounded	2	6	0	8	8	4	16	14

Angular	- Total =	220	=	$\frac{220}{8}$	=	27.5
Sub-Angular	- Total =	398	=	$\frac{398}{8}$	=	49.7
Rounded	- Total =	124	=	$\frac{124}{8}$	=	15.5
Well-Rounded	- Total =	58	=	$\frac{58}{8}$	=	$\frac{7.3}{100.01}$

For histogram see Fig. 89

"Lower Boulder-clay"  
Random Samples

Appendix X (A)

Grain-size Categories for Triangular Graph

Locality	Grid ref.	Gravel & coarse sand (i.e. in meshes 8,16,30)	Medium & fine sand (i.e. in meshes 60,120,240)	Silt & Clay (caught in pan)	Total
1 Trefelly Moor E.	SM 747276	3.0	51.9	45.0	99.9
2 Upper Treginnis	731244	15.3	41.5	43.2	100.0
3 Trefeiddan Moor E.	734252	24.4	53.7	21.8	99.9
4 " N.	732253	34.0	45.1	20.8	99.9
5 Roman Road	758276	26.1	53.6	20.2	99.9
6 Treswni Moor	738257	10.2	44.7	45.2	100.1
7 Waun Fawr	764264	40.3	36.0	23.6	99.9
8 Dowrog Common	773275	38.9	51.1	9.9	99.9
9 Trefelly Moor W.	741275	4.5	68.7	26.7	99.9
10 Treleddydd Fawr Moor	761273	22.1	49.1	28.6	99.8

Other Non-calcareous "Lower Boulder-clays"

Waun Fawr I L2c(b) (Test case - 10 mins.)		13.1	55.2	31.7	100.0
Clyn Bach I (Yellow Clay)	936348	10.8	59.8	29.5	100.1
Rhos-y-Clegyrn	913355	12.2	46.5	41.4	100.1
Gwrhyd-Mawr (5)	765276	32.4	48.6	18.9	99.9
Gwrhyd-Mawr (6)	766276	28.3	46.6	25.1	100.0

(See Fig. 96)

"Upper Boulder-clay"  
Random Samples

Appendix X (B)

Grain-size Categories for Triangular Graph

Locality	Grid ref.	Gravel & coarse sand (i.e. in meshes 8,16,30)	Medium & fine sand (i.e. in meshes 60,120,240)	Silt & Clay (caught in pan)	Total
11 Porth Lysgi	SM 732241	10.4	54.8	34.8	100.0
12 Pont Clegyr	770251	20.2	55.7	24.2	100.1
13 Tre-hysbys	766283	26.9	61.1	12.0	100.0
14 Trefeiddan W.	727248	23.4	48.4	27.7	99.9
15 Trefeiddan	731251	27.2	42.2	30.7	100.1
16 Waun Isaf	746246	27.6	48.7	23.6	99.9
17 White Well	750252	13.7	55.6	30.8	100.1
18 Ffordd Caerfai	757250	32.0	47.2	20.9	100.1

Other "Upper Boulder-clays"

Emlych I UBC	756265	38.6	51.1	10.3	100.0
White-sands II UBC	733273	26.7	52.3	21.2	100.2
Aber-mawr I UBC	883347	32.4	55.0	12.7	100.1
Aber-mawr II UBC	883347	62.6	21.8	7.6	100.0
Aber-mawr VIII UBC	883347	40.5	49.1	10.4	100.0

(See Fig. 96)

Calcareous  
Shelly Tillis.

Appendix X (C)

Grain-size Categories for Triangular Graph

Locality	Grid ref.	Gravel & coarse sand	Medium & fine sand	Silt & Clay	Total
Aber-mawr III	883347	6.8	65.1	28.2	100.1
Aber-mawr IV	883347	6.0	68.7	25.3	100.0
Aber-mawr V	883347	5.7	65.0	29.3	100.0
Aber-mawr VI	883347	5.1	65.5	29.5	100.1
Aber-mawr VII	883347	8.6	68.4	23.0	100.0
Aber-mawr XI	883347	4.0	67.1	28.9	100.0
Nolton Haven	858186	3.6	62.1	34.4	100.1
Cahore Pt - Ireland	-	6.1	73.9	19.9	99.9
Porth-melgan	728279	14.9	47.8	37.4	100.1
Druidston	862173	3.5	64.4	32.1	100.0
White-sands I	733273	16.5	50.3	32.9	99.7

(See Figs. 97 and 98)

**Outwash Sands  
and Gravels**

Appendix X (D)

Grain-size Categories for Triangular Graph

Locality	Grid ref.	Gravel and coarse sand	Medium & fine sand	Silt & Clay	Total
Scleddau	947341	79.2	16.8	5.1	101.1
Salem		8.7	87.5	5.5	101.7
Jordan- ston Halt		17.1	54.9	27.6	99.6
Wolfs- castle	957262	20.3	31.3	48.3	99.9
Ty-newydd	051306	50.0	28.6	21.5	100.1
Ford	956257	92.7	6.5	.9	100.1
Tre-llys	898349	56.2	41.9	1.5	
Aber-mawr IX	883347	53.1	34.9	12.1	100.1
Slade		35.1	57.7	7.0	99.8
Clyn	936355	38.4	48.0	13.6	100.0
Rhos-y- Clegyrn	913355	73.1	22.0	4.9	100.0

(See Figs 98 and 99)

APPENDIX XI

SITE DETAILS FOR 20 PREFERRED ORIENTATION DIAGRAMS  
PLOTTED ON MAP 4.

<u>Locality</u>	<u>Grid ref.</u>	<u>Site</u>
Porthmelgan 2.	728279	Drift cliff. 7 ft below cliff-top.
Whitesands 4.	733273	Drift cliff. Where the cliff is 8 ft high.
Whitesands 5.	"	Drift cliff. Alongside large striated boulder.
Emlych 1 & 2	755265	Exposure in Plate 38. Above small quarry.
Croes Philip	744261	1 sq. ft. Depth 18". Shattered bedrock?
Treswni Moor	738257	Depth 27". 80 yds N. of reservoir.
Castell	743252	Exposure. 6 yds. N of telegraph pole.
Trefeiddan West	727248	1 sq. ft. Depth 24".
Porth-lysgi	732237	5 ft above path. Cliff exposure
Caerfai	760243	7 ft below surface. West side of old quarry.
Clegyr Farm	773254	1 sq. ft. Depth 18".
Ogof Golchfa 3-6	742237	Drift cliff. Various sites (see text)
Caerbwdy 1, 3, 4, 5.	766245	Drift cliff. Cliff-top, cutting, base of cliff.



Appendix XIII (A)

NATIONAL PHYSICAL LABORATORY

Teddington, Middlesex, England

REPORT

ON  
RADIOCARBON MEASUREMENT

SCHOOL OF GEOGRAPHY,  
MANSFIELD ROAD,  
OXFORD.

LABORATORY REFERENCE: NPL-80  
DESCRIPTION OF SAMPLE AND SITE REFERENCE: Marine Shell  
Mullock Bridge  
SUBMITTED BY: B.S. John, Esq.

DETAILS OF CHEMICAL PRETREATMENT:

Sample leached in 4% HCl in three stages to remove one-third by weight. (Of the remaining two-thirds, only the inner third was used for the measurement).

$$\delta C^{14} = \frac{\text{Activity of Sample} - 0.95 \text{ Activity of Standard}}{0.95 \text{ Activity of Standard}} \times 1000 = -991 \pm 1.7$$

STANDARD USED AS REFERENCE FOR C<sup>14</sup>:

National Bureau of Standards, Oxalic Acid C<sup>14</sup> Standard

$$\delta C^{13} = \frac{\frac{C^{13}}{C^{12}} \text{ of Sample} - \frac{C^{13}}{C^{12}} \text{ of Standard}}{\frac{C^{13}}{C^{12}} \text{ of Standard}} \times 1000 = +0.3 \pm 1$$

STANDARD USED AS ULTIMATE REFERENCE FOR C<sup>13</sup>:

University of Chicago PDB C<sup>13</sup> Standard

NORMALIZED C<sup>14</sup> ABUNDANCE (Δ):

$$\Delta = \delta C^{14} - (2\delta C^{13} \text{ ~~1000~~})(1 + \frac{\delta C^{14}}{1000}) = -991 \pm 1.7$$

DATE 27th August, 1964

G. B. B. M. SUTHERLAND

REFERENCE C.66

Director

for Superintendent, Applied Physics Division

Laboratory Certificate or Report may not be published, except in full, unless permission for the publication of an approved abstract has been obtained in writing from the Director.

Appendix XIII (A)

NATIONAL PHYSICAL LABORATORY

-2-

CONTINUATION  
of Report on  
Radiocarbon Measurement  
-----

AGE IN YEARS BEFORE PRESENT (BP) A.D. 1950: 37,960 <sup>+1700</sup>  
-1400

STATEMENT OF ERRORS INVOLVED

No correction has been applied for the uncertainty in marine shell contemporary activity.

NOTE:

The precision quoted in 5, 9 and 10 is that of the physical measurement only and is one standard deviation.

The half life of  $C^{14}$  used in the calculation of the age is 5,568 years; see Nature, 1962, 195, (4845), 984.

27th August, 1964

G. B. B. M. SUTHERLAND

REFERENCE C.66

  
for Superintendent, Applied Physics Division



## NATIONAL PHYSICAL LABORATORY

Teddington, Middlesex, England

## REPORT

ON  
RADIOCARBON MEASUREMENTSCHOOL OF GEOGRAPHY,  
MANSFIELD ROAD,  
OXFORD.

LABORATORY REFERENCE: NPL-97

DESCRIPTION OF SAMPLE AND  
SITE REFERENCE: Marine Shell  
Tre-Llys

SUBMITTED BY: B.S. John, Esq.

## DETAILS OF CHEMICAL PRETREATMENT:

Sample leached in 4% HCl in six stages to remove one-third by weight.  
(The results reported below relate only to the inner of the remaining two-thirds).

$$\delta C^{14} = \frac{\text{Activity of Sample} - 0.95 \text{ Activity of Standard}}{0.95 \text{ Activity of Standard}} \times 1000 = -990 \pm 1.6$$

STANDARD USED AS REFERENCE FOR C<sup>14</sup>:National Bureau of Standards, Oxalic Acid C<sup>14</sup> Standard

$$\delta C^{13} = \frac{\frac{C^{13}}{C^{12}} \text{ of Sample} - \frac{C^{13}}{C^{12}} \text{ of Standard}}{\frac{C^{13}}{C^{12}} \text{ of Standard}} \times 1000 = -8.2 \pm 1$$

STANDARD USED AS ULTIMATE REFERENCE FOR C<sup>13</sup>:University of Chicago PDB C<sup>13</sup> StandardNORMALIZED C<sup>14</sup> ABUNDANCE ( $\Delta$ ):

$$\Delta = \delta C^{14} - (2 \delta C^{13} + 11.4) \left( 1 + \frac{\delta C^{14}}{1000} \right) = -990 \pm 1.7$$


/ 10.

DATE 14th April, 1965

G. F. B. M. SUTHERLAND

REFERENCE C.73

Director


  
for Superintendent, Applied Physics Division

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NATIONAL PHYSICAL LABORATORY

- 2 -

CONTINUATION

of Report on  
Radiocarbon Measurement

-----

AGE IN YEARS BEFORE PRESENT (BP) A.D. 1950: 37,310 <sup>+1515</sup>  
-1275

STATEMENT OF ERRORS INVOLVED:

No correction has been applied for the uncertainty in marine shell contemporary activity.

NOTE:

The precision quoted in 5, 9 and 10 is that of the physical measurement only and is one standard deviation.

The half life of  $C^{14}$  used in the calculation of the age is 5,568 years; see Nature, 1962, 195, (4845), 984.

DATE 14th April, 1965

REFERENCE C.73

C.S. 2

~~G. B. S. M. SUTHERLAND~~

Director

for Superintendent, Applied Physics Division