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Upper Pleistocene Deposits and Landforms at Holly Lane, Clevedon, Somerset. (ST 419727)

By

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ABSTRACT. Periglacial sands and breccias are described as overlying a marine platform with a notch and cave at Holly Lane, Clevedon. The sequence of periglacial deposits is believed to represent local climatic fluctuations during the last (Devensian) stage. The contained Mollusca and foraminiferid fossils are described and former records discussed. The buried littoral features are attributed to the Ipswichian interglacial stage and represent a maximum height of wave activity in the order of 20 m. O.D.

INTRODUCTION

Early this century a breccia deposit resting against a steep, smooth slope of Carboniferous Limestone was found at Holly Lane, Clevedon (ST 418726), on the eastern side of the Clevedon-Portishead Ridge. In December 1905, quarrying of this breccia exposed a small cave (the Walton bone cave) in the limestone, which here dips about 30° SE. The cave is shown by Davies (1907) to be unrelated to the limestone structure and in no way associated with a karst cave system. The cave contained a rich vertebrate fauna (Hinton 1907; Reynolds 1907). The breccia beds were again studied by Greenly (1922). In his two papers Greenly concludes that the blocks of limestone are all of local, upslope lithology (scree) while the sandy matrix and sand layers were aeolian in origin. A study of the heavy minerals in the sands indicated a South Wales source. Palmer (1934) supported a scree, freeze-thaw, origin of the breccias and suggested they were formed during the last glacial period. He supported Greenly's aeolian hypothesis, but from a further study of the heavy minerals suggested the source was Devon and Cornwall. A marked wave cut notch and cliff uncovered from beneath the deposits were correlated by Palmer and Hinton (1929) and Palmer (1934) with the 15 m. (50 ft.) raised beaches of the upper Bristol Channel. On the 1968 Geological Sheet (ST 47) the deposits are shown as head overlying Gully Oolite.

During 1971, exposures of the breccia recorded by Palmer (1934) were re-examined (*fig.* 105). The nature of the deposits, their fossil content and their significance in the Pleistocene chronology of the area are discussed below.

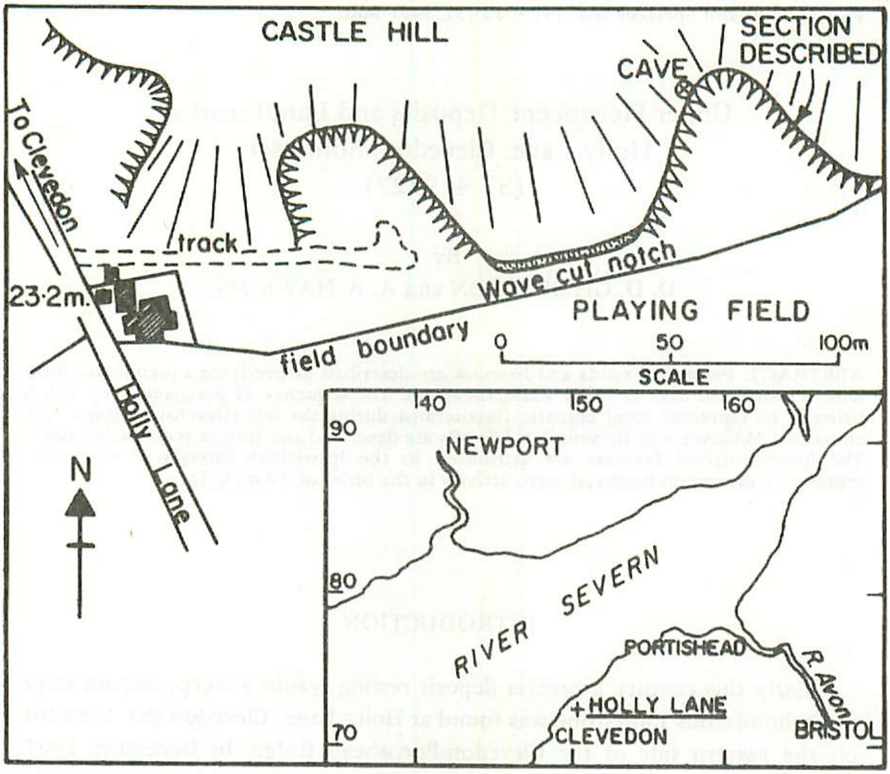

Fig. 105.

PERIGLACIAL DEPOSITS

At the northern end of the second quarry (ST 41907270), approximately 100 m. north east of the main mapped quarry, there are good exposures of the breccias and aeolian sands banked up against a buried limestone cliff (*figs.* 106 and 108).

2. (a) Description of the main Section

Section AA′ and BB′ below have been measured in the deposits at distances of 0.5 m. and 5 m. respectively from the buried cliff shown in *fig.* 106. The height above Ordnance Datum of the various exposures was obtained by levelling.

Unit No	Thicknesses Section AA′	Section BB′	Description of Strata
12	0.5 m.	0.5 m.	Black topsoil developed on angular limestone breccia with sandy matrix.
11	1 m.	1 m.	Reddish sandy loam and few pebbles or cobbles.
7 (b)		1 m.	Angular limestone breccia in loam matrix. Cobbles up to 0.25 m. long. Very rich in cobbles compared with unit 9 below.

10		0.3 m.	Lense of red brown silty sand, some angular fragments, indistinct boundary with Unit 8 below.
9	not present locally. Thickness up to 0.5 m.		Discontinuous pockets of angular limestone boulders, in sandy cobble-rich matrix. Boundaries often indistinct.
8		0.2 m.	Angular limestone breccia in sandy loam matrix. Fragments up to 0.3 m. long. Unit thickens downslope. Distinct boundary with Unit 7a below.
7 (a)	1.5 m.	0.35 m.	Angular limestone breccia in sandy matrix. Angular boulders up to 0.4 m. in length. Very poorly bedded with occasional layer of fine angular fragments. Coarsens upwards in section BB'.
6	0.4 m.	0.35 m.	Reddish brown loamy sand, with a few tabular fragments up to 0.04 m. long, many lying parallel to apparent dip of deposit 30°/150°N. The deposit is very distinct and is further emphasised by the green algae and mosses growing preferentially on it. (This has now become less noticeable since the overhanging bush vegetation was removed).
5	0.4 m.	0.45 m.	Angular boulder layer. Boulders up to 0.5 x 0.25 m. seen with many smaller cobbles in a sand matrix.
4	0.65 m.	1.1 m.	Angular limestone breccia in a sandy matrix. Rare boulders up to 0.4 m. long. Average size of fragments 0.02 to 0.04 m. becoming coarser with height to give frequently indistinct boundary with Unit 5 above.
3	0.45 m.	0.45 m.	Reddish brown loamy sand with occasional angular limestone fragments up to 0.01 m. square. In BB' these fragments increase in proportion upwards to an upper boundary, which is occasionally indistinct, and has an apparent dip of 30°/150°N. The loamy sand is banked against a former cliff to the north west and buries the dome of breccia below (Unit 2).
2	1.1 m.		Poorly bedded, angular limestone breccia in red sandy matrix. Cobbles up to 0.25 m. square, average size 0.08 m. In the main section this deposit forms an asymmetrical dome shaped structure lying directly over a fissue in Unit 1.
1			Small flat surface of Carboniferous Limestone cut by a narrow fissure observed to a depth of 0.80 m. This rock is just possibly *in situ*.

2. (b) The Sandy Loams

Three distinct sandy loam horizons are present (Units 3, 6, 11). These contain few or no large limestone fragments. Particle size analysis of these deposits are shown in *fig.* 107. Unit 6 is the most distinct horizon in the whole deposit, with clear upper and lower boundaries, except near the buried cliff where its identification becomes more difficult. It is of almost constant thickness and of uniform character throughout its length. No bedding structures have been seen in it. Unit 3 is a much stiffer, silt rich deposit, sedimentary structures are faintly visible and indicate that part of the deposit collected in the hollow behind the asymmetrical dome of breccia (Unit 2). It extends over the dome and down its eastern flank. The third sandy loam horizon (Unit 11) is continuous over the western end of the section. Again structureless, it abuts directly against the upper parts of the buried cliff.

Greenly (1922), Palmer (1934) and Vink (1949) regarded the sandy loam as having an essentially aeolian origin. This interpretation is supported by the general lack of sedimentary structures, the high silt to fine sand content, an abundance of calcareous root concretions and the uniform thickness of the individual layers. Recent research has indicated that the sandy loams occur over a wide area. Previously they have been identified as components of local soils (Findlay 1965) and occur over much of Mendip, Middlehope and Failand Ridge to Leigh Woods in the east and as far south as Grey Lake

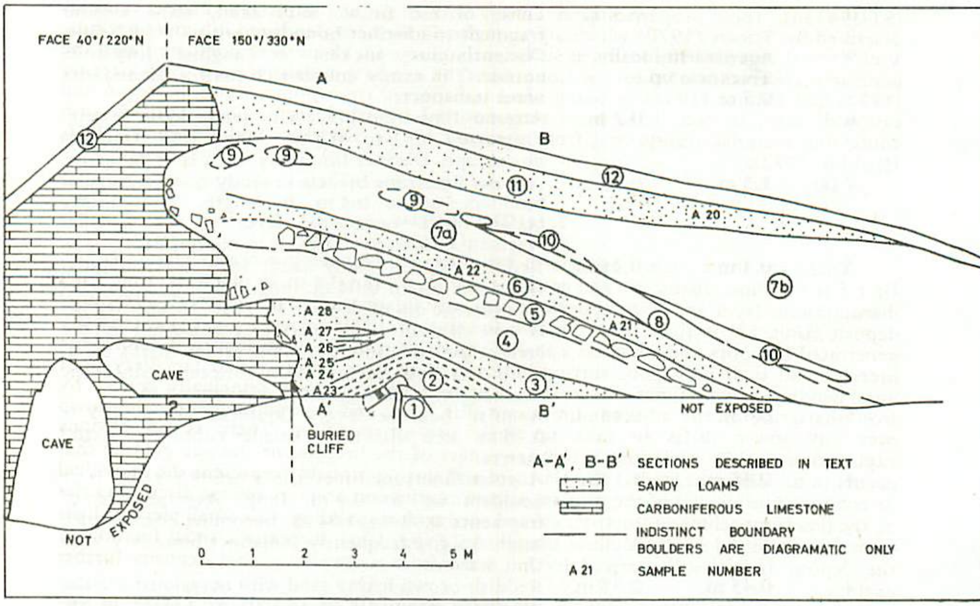

Fig. 106.

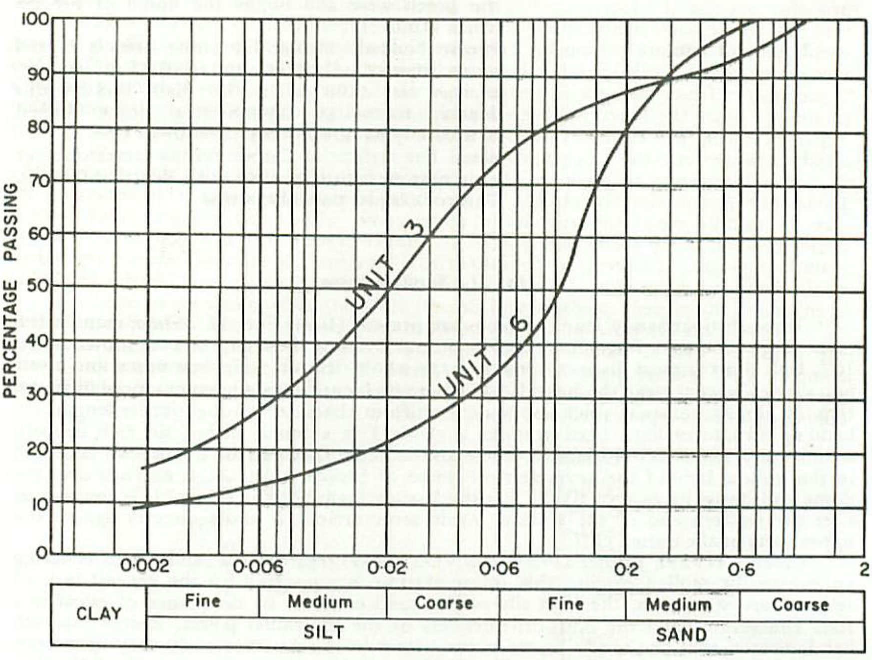

Fig. 107.

(ST 394336). These properties agree closely with those of the niveo-aeolian coversands described by Tricart (1970) which are though to have been deposited in snow blizzards. Vink (1949) regarded the loams as sufficiently coarse for them to be compared with the periglacial coversands of the Low Countries. The exotic minerals referred to by Greenly (1922) and Palmer (1934) as being wind transported from South Wales or Devon and Cornwall may, in fact, have been retransported by wind from more localised sites containing material transported from the west by ice (Hawkins and Kellaway, 1971, Hawkins, 1972).

2. (c) The Breccias

There are three main horizons of very coarse limestone breccias (Units 5, 9, 12). Unit 5 is the most distinctive and contains boulders up to 0.5 m. in diameter. Unit 9 is a discontinuous layer and is composed of generally smaller material, whilst the uppermost deposit (Unit 12) is finer than the two lower Units. This upper deposit is extensively penetrated by roots and supports a shallow rendzina soil. The very angular nature of the breccias and their very poor sorting indicates they have not travelled far. Very poor quasi-bedding is sometimes discernable. The breccias have been principally derived by frost shattering of the adjacent limestone cliff faces, and have subsequently slid down over any lower drifts to take up their present position. There is no obvious explanation for the variation in the size ranges of the breccias or the size grading that occurs in the different layers. The clast size and sorting probably represent the individual or combined influences of the original discontinuities and pressure release discontinuities of the limestone, climatic fluctuations and sorting during sliding. One small piece of light brown chert found in the Mollusc sample A 22 (*fig.* 106), indicates a small fraction of the deposit is probably derived by hill wash from unlocated glacial deposits further upslope.

A general relationship between the coarseness of the breccia and cliff recession can be demonstrated in the lower part of the section (*fig.* 106). At points where there is a marked recession in the cliff face, boulders and cobbles are dominant in the drift section. The Cliff face retreats as the clast of the breccia coarsens at the interface of the cliff with Units 3, 4 and 5. Above the boulder bed (Unit 5) the relationship breaks down probably because the face providing the breccias lies behind the exposure of sands and breccias. These angular limestone breccias can be explained by a series of cold and wet oscillations of climate promoting extensive frost shattering of the rock. The increasing representation of aeolian sands relative to breccias in the transition between Units 5 and 6 probably reflects changes to rather drier conditions, where frost shattering was at a minimum. Since the breccias have a loamy sand matrix, either some aeolian deposition occurred during the cold wet periods and the loamy sands were soliflucted in, or they later penetrated into the breccia deposit.

It is interesting to compare the present section (*fig.* 106) with that described by Davies (1907) and Greenly (1922). Davies shows in ascending order (a) lower gravel, (b) clay, (c) middle gravel, (d) sand and (e) upper gravel, while Greenly shows lower breccia, coarse breccia, sandy loam, loamy sand and upper breccia. It is probable that the sandy loam/loamy sand of Greenly is equivalent to Unit 6 and the sand of Davies is equivalent to the sandy loam horizon (Unit 11) of this description. No clay band (Davies 1907) has been seen in the present exposure and Greenly does not make reference to one.

There is no evidence of any major weathering surface or soil development within the sequence and it would appear that the deposits represent one continuous but complex cold, glacial stage of the Pleistocene. If the climatic interpretation of the changing nature of the deposits is accepted then a complex sequence of cold-wet and cold-dry phases is represented, and is set out below.

Climate	Deposit
cold-wet	Unit 12
cold-dry	11
cold-wet	7 (b)
cold-dry	10
	9
cold-wet	8
	7 (a)
cold-dry	6
cold-wet	5
transitional	4
cold-dry	3
cold-wet	2

The oscillation of phases of intense and less intense frost shattering with periods of aeolian deposition matches the variations observed at the Sand Cliff, Brean Down (ST 296587) (ApSimon, Donovan, and Taylor, 1961) but a detailed correlation is not yet possible. The highly distinctive boulder pile at the Sand Cliff (their Layer 13) may correlate with the angular boulder layer (Unit 5) at Holly Lane. As yet it is not possible to correlate this sequence with the better known periglacial successions worked out by Kerney (1965) in south-east England.

The alternation of coarse, angular, limestone breccias with finer loamy horizons suggests the deposits represent an English example of the periglacial formation known as *stratified slope waste deposits* (Dylik, 1960), *grèzes litées* and *éboulis ordonnées* (Guillien, 1951; Tricart 1970). The most recent account of this type of formation is by Washburn (1973). The red colouration, particularly of the fine fraction, suggests that either Keuper Marl "dust" as well as sand was being blown on to the face, or that possibly some sheetwash was taking place incorporating glacial sands and also clayey silts from outliers of Keuper Marl.

The breccias have probably become poorly stratified as a result of sliding rather than by water transport; whilst the loams show few signs of bedding and still retain a high silt content. The Holly Lane sequence seems to be determined mainly by the interaction of aeolian deposition with phases of frost shattering and associated downslope movement of the breccias. The slope angle of 30° is essentially similar to the low slope angles noted in continental Europe and New Zealand (Embleton and King, 1968). Other localities in the British Isles from which similar formations have been described are in the district inland of Aberwystwyth (Watson 1965) and in the Southern Uplands of Scotland (Tivy 1967).

NON-MARINE MOLLUSCA

Kennard and Woodward (1934) discussed the Mollusca collected from the sands and breccias by Greenly (1922) and Palmer (1934). The snails most frequently found in the Lower Breccia and middle aeolian sand were *Hygromia hispida* (Linné) and *Pupilla muscorum* (Linné). The association of these species is very common in Pleistocene periglacial deposits in the British Isles. Their presence is in keeping with the evidence of the aeolian sands and frost shattered breccias for the prevalence of extremely cold climatic conditions. The records of the more thermophilous species or those previously thought to be only recently introduced are much more doubtful. Snails such as *Discus rotundatus* (Müller), *Helix nemoralis* (Linné), *Pomatias elegans* (Müller), previously recorded from the subsoil, together particularly with *Helix aspersa* (Müller), from the upper breccia (Upper Coarse Gravel of Palmer, 1934) may well have been able to penetrate from the surface down the many cracks and fissures in these upper horizons. The presence of *Discus rotundatus* in the Lower Breccia is more difficult to explain except by a contamination of the sample.

A series of 2 kg. samples were taken from the loams for molluscan analysis; the positions are located in *fig.* 106 and 107.

Molluscs

Sample A32	*Pupilla muscorum* 1, and much debris
A31	shell debris
A30	*Succinea* sp.1. shell debris
A29	*P. muscorum* 1, and shell debris
A28	barren
A27	shell debris – calcareous root concretions

A26	barren, some broken and abraded plant and shell debris
A25	barren – calcareous root concretions
A24	barren – calcareous root concretions
A23	barren – calcareous root concretions
A22	*P. muscorum* 1, and shell debris and calcareous root concretions
A21	shell debris – *P. muscorum* ? and calcareous root concretions
A20	shell debris and calcareous root concretions

The outer layers of the loams are contaminated by recent specimens of *Vitrea* sp., *Carychium tridentatum* (Risso), *Acanthinula aculeata* (Müller) and *Discus rotundatus.* Most of the species listed by Kennard and Woodward (1934) collected over many years of excavation were not found in this study. Specimens and debris of *Pupilla muscorum* were the commonest molluscan fossils present, which confirms the earlier evidence of the abundance of this species. It is characteristic of periglacial environment in the British Pleistocene and is usually indicative of open, exposed conditions. Of special interest is the find of a juvenile succineid from sample A30 near the base of the notch. It parallels the earlier finds of *Succinea putris* (Linné) from the original Clevedon cave and *Lymnaea stagnalis* (Linné) from the lower breccias. These hygrophilous and aquatic snails suggest the local presence of very damp ground conditions. This phenomena has been associated with impeded drainage over permafrost in subsoil, which Kerney (1971) has suggested might have been emphasised by low air temperatures perhaps reducing evaporation; as in the Weichselian interstadial deposits at Halling, Kent.

The molluscan evidence is very limited but supports the proposed periglacial origins of the sands and breccias. Kerney's (1966) suggestion that the Upper Pleistocene records of *Helix aspersa* in particular and other thermophilous species are erroneous or doubtful must be upheld, because of the observed frequency with which modern snails contaminate the deposits.

FORAMINIFERA

The lower and middle sandy horizons, Units 3 and 6, have been examined for microfauna. The following foraminiferids were identified by Dr. J. W. Murray: *Trifarina angulosa, Cibicides lobatulus* (immature), *Cassidulina obtusa, Oolina squamosa, Elphidium macellum, Elphidium excavatum, Ammonia beccari, Brizalina variabilis, Bolivina pseudoplicata, Oolina williamsoni, Oolina melo, Protelphidium anglicum, Fissurina lucida, Planorbulina mediterranensis, Lenticulina, Oolina hexagona, Lagena perlucida, Oolina globosa.* (The last three species were only found in Unit 6.)

This foraminiferid assemblage suggests the life habitat was fine muddy sand of near marine environment with the species *Cibicides lobatulus* indicating firm substrate such as animals or weeds. Although the foraminiferid assemblage indicates they lived in the outer Bristol Channel, the fossils do not show abrasion characteristic of long distance wind transport and may have been derived locally from previous interglacial or glacial deposits.

LANDFORMS

A buried cliff up to 5 m. high, *fig.* 108, is traceable through part of the exposures. Frequently occurring at the cliff base is a large smoothly curving notch up to 2 m. in height and undercutting the cliff by up to 1 m. The base of this notch flattens out to become a platform traceable for several metres away from the cliff. These features are also illustrated by Palmer and Hinton

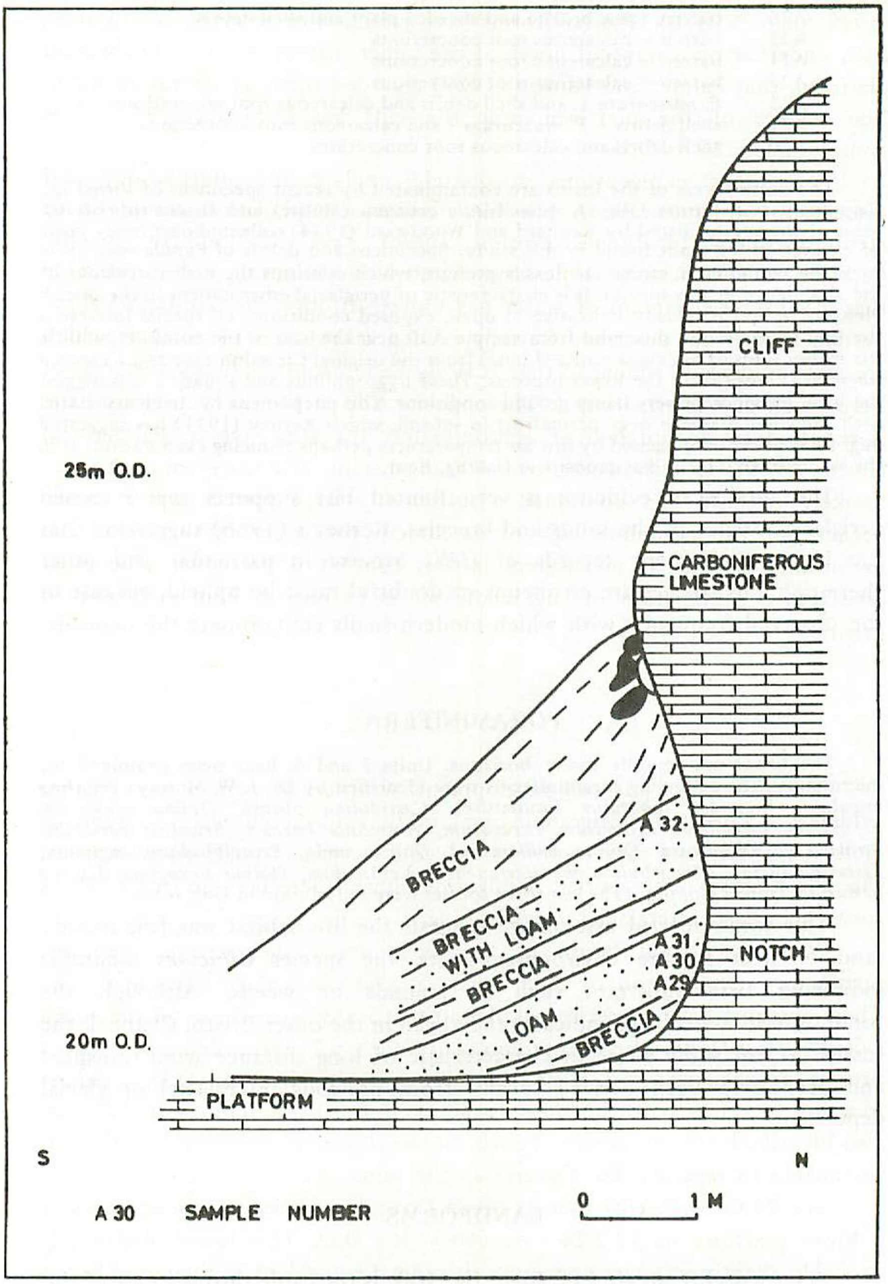
CLIFF
25m O.D.
CARBONIFEROUS
LIMESTONE
A 32
BRECCIA
BRECCIA
WITH LOAM
A 31
A 30
A 29
NOTCH
BRECCIA
LOAM
BRECCIA
20m O.D.
PLATFORM
S
N
A 30 SAMPLE NUMBER
0
1 M

Fig. 108.

(1929, plate VIII B). The landforms have such a close resemblance to a sea cliff, undercut by a wavecut notch at the upper margin of a coastal abrasion platform, that Palmer and Hinton (1929) regarded them as littoral in origin. The surface of the platform near the cliff has been surveyed and is approximately 20 m. O.D.

Few other explanations adequately explain the morphology and association of landforms. A possible alternative explanation would be to attribute them to fluvial erosion and/or cave development in the Carboniferous Limestone. Unless associated with glaciation, it is improbable that a substantial stream of water has moved through the Gordano Valley. Ternan (1966) has described fluvially eroded valley sides 14 m. apart which are morphologically similar to that at Holly Lane, from the limestone areas of Fermanagh in Western Ireland. The opposite side of the valley at Holly Lane is reported to be notched at approximately the same height (Palmer and Hinton 1929). It is, however, over 400 m. distant. The intervening valley is unlikely to have ever contained a sufficiently large surface water course because of the complete lack of catchment for water in this area. The importance of glacial meltwaters in this context is unknown. The most satisfactory explanation of the landforms is to regard them as littoral in origin.

DATING AND CORRELATION

The absence of any soil development, weathering horizon or any other evidence of a marked stratigraphic break in the sands and breccias sequence at Holly Lane, suggests they represent only the Devensian (last) glacial stage of the Pleistocene. The buried landforms must therefore be regarded as Ipswichian (last) interglacial in age or older.

Whilst a littoral origin of the cliff, notch and cave is the most satisfactory explanation of their origin, it also raises difficulties in dating. These features have a precise parallel altimetrically with those on the south side of Brean Down where ApSimon *et al* (1961, p.71) recorded that a "most prominent ancient cliff line had its base at 70 ft. (21.3 m.) O.D.", almost identical in height with the Holly Lane notch. Ford and Stanton (1968) have also identified a 21 m. erosion bench on the slopes of the Mendip Hills. It is reasonable to regard these features as the same age.

The 21 m. O.D. cliff base at Brean Down lies some 8 m. above traces of a lower platform at 12.2-14.3 m. (40-47 ft.) O.D. This lower platform is probably slightly younger and is the altitudinal equivalent of the raised beach deposits at Swallow Cliff, Middlehope (Sanders, 1841); the marine deposits at Walton-in-Gordano (ApSimon and Donovan 1950); the marine sands at Kenn (Hawkins and Kellaway 1971) and possibly the Burtle Beds (Bulleid and Jackson 1937, 1941 and Kidson 1970).

Apart from the Howe Rock platform of ApSimon *et al* (1961) there is in North West Somerset evidence of two higher sea levels at 12-14 m. O.D. and 21 m. O.D. respectively. Both are older than the last glaciation. When tidal factors are considered, the Holly Lane notch would seem too low for correlation with the Hoxnian sea level of about 30 m. (100 ft.) O.D. recognised near Swanscombe (West, 1972). Sparks and West (1963; 1970) discuss palaeoecological evidence for an oscillation of sea level during the Ipswichian inter-glacial. A tentative correlation between the 12-14 m. O.D. and 21 m. O.D. platforms along the Somerset coast with the two Ipswichian interglacial sea levels is possible. Similarly, Guilcher (1969) refers to two raised shorelines with similar height relationships to those at Holly Lane and Swallow Cliff which he calls the Upper and Lower Normannian shorelines. These two high sea levels are both thought to have occurred in the Ipswichian (Eemian, Normannian, last) interglacial. In the present state of local Pleistocene stratigraphy these Ipswichian ages seem the most satisfactory dating for the littoral landforms at Holly Lane and the Swallow Cliff beach deposits respectively.

CONCLUSION

Pleistocene periglacial sands and breccias are described from a disused quarry at Holly Lane, Clevedon. It is suggested they accumulated as a result of aeolian deposition and frost shattering processes in the Devensian (last) glacial stage of the Pleistocene. The snails *Pupilla muscorum* and *Hygromia hispida* probably occurred here at various times on the damp and cold soils. Apart from these species the earlier records of more thermophilous snails are probably incorrect. They were almost certainly based on derived, or recent specimens. The periglacial deposits bury landforms regarded as littoral in origin, with their base at 20 m. O.D.

At present it is difficult to correlate this sequence in detail with other local Pleistocene sands and breccias. The littoral landforms at Holly Lane can be correlated with similar landforms on Brean Down. The landforms at 20 m. and the Swallow Cliff platform and raised beach deposits at 12-14 m. were probably both developed during the Ipswichian interglacial stage.

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