Marine Pleistocene deposits in the Vale of Gordano, Somerset

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INTRODUCTION

The Vale of Gordano is a low-lying tract of moor extending from Portishead south-westwards to East Clevedon, bounded on either side by ridges of palæozoic rocks. The vale is open to the north-east, but the only outlet to the south-west is through the East Clevedon gap, a narrow dry valley forming a low col at about 30 ft. O.D. Recent excavations by public works contractors at Weston in Gordano, on the north-western slopes of the vale, revealed a section of great interest, showing marine deposits of Pleistocene date, overlain by terrestrial accumulations of a type already known from the area. Marine Pleistocene strata are very rarely exposed in the Bristol district. Some additional excavation was carried out by the writers and a line of levels run from the nearest bench-mark in order to determine the exact altitude of the section. The excavations were subsequently filled and nothing can now be seen of the exposures. Dr. Welch informs us that he found no exposure of the marine deposits in the Vale of Gordano when he recently carried out the geological survey of the area.

We are indebted to Mr. D. F. W. Baden-Powell for kindly identifying the mollusca found in the deposits.

Details of Section

A number of sections were measured but the most complete sequence was shown by the one reproduced below. The stratigraphy was constant throughout the area covered by the exposures and for the sake of brevity a few details from other sections have been incorporated in the main section. In the section on page 131 the beds are numbered in order of their age, 1 being the lowest layer seen.

SOURCES OF CONSTITUENTS

All the rock fragments seen in the deposits, which were large enough to be identified, were of local rocks (Old Red Sandstone, Carboniferous Limestone and the Triassic breccias) with the exception of flint, found in layers 1 and 4 and fairly abundant in the latter horizon, and brown chert of the kind ultimately derived from the Upper Greensand, of which a few

		Thickness Ft.	In.	Mean Altitude Ft.
	Modern Turf, etc. Over the same distance as that used in the case of layer 6, the valleyward gradient of the present turf line is 1 : 17. The modern soil profile has been broken down by ploughing.			50·0
7.	*Reddish-brown Sandy Loam.* Unstratified. The hollows in the surface of 6 appear to contain a darker version of 7. Uphill from the main section this stratum reached a thickness of 6 ft.	2	0	50·0 to 48·0
6.	*Sandy Breccia.* Angular fragments of Carboniferous Limestone, with some Old Red Sandstone in loamy-sandy matrix. The matrix of the basal 4–5 in. is sand derived from 5, becoming less sandy towards the top. Sandy lenses seen. Unstratified. Top surface undulating or festooned, with hollows up to 1 ft. deep. No clear evidence of weathering of the top of the layer. The top surface has an average valleyward gradient of 1 : 24.	3	6	48·0 to 44·6
5.	*Upper Marine Clayey Sand.* Grey clayey sand with a few stones, bands of coarser and finer material. Well stratified with thin, horizontal laminations. Elsewhere in the excavation this layer was seen up to an altitude of 46·2 ft. O.D.	1 to 3	10 3	44·6 to 42·7
4.	*Ferruginous Marine Gravel.* Waterworn Carboniferous Limestone pebbles, small subangular flints, a little honey-coloured chert, and yellow, ochreous fragments, probably from the Trias, in sandy matrix. Grey sand at the base (1½–2 in.) separating the gravel from 3. The lowest 2 ft. of the gravel were very compact and required the use of a pick for their excavation. From 9 in. to 1 ft. below the top was a concreted layer, with patches of grey, sandy clay beneath. Above this layer the gravel was finer, looser and more ferruginous than below. There are some sandy bands. *Tellina balthica* L. fairly common throughout.	3 to 3	0 6	42·7 to 39·3
3.	*Red Clay.* Red clay with a number of waterworn pebbles and angular flints. The matrix very sticky, with green patches, especially in the lower part. Black stains noted.		6 to 10	39·3 to 38·6
2.	*Lower Marine Sand.* Three subdivisions: (*c*) Discontinuous layer of very hard, coarse, concretionary sandstone, 1 in.; (*b*) Gravelly sand, coarser than (*a*), 6–8 in.; (*a*) Medium-grained, impure silver sand, with black and reddish streaks, no obvious bedding, 1 ft. to 1 ft. 3 in.	1 to 1	6 9	38·6 to 36·85
1.	*Conglomerate.* Subangular fragments of Carboniferous Limestone, average 4–5 in., also Triassic rocks and flint, in sandy and gravelly matrix. One pebble of Old Red Sandstone (7×4 in.) at top. A few specimens of *Tellina balthica* L.	seen to	9	36·85 to 36·1

pieces were found in layer 4. Almost all the flint was in the form of small (<1″), angular fragments showing little wear. Both flint and chert are common in the Bristol Avon Gravels, although their relative abundance is there usually reversed. The other possible known immediate source is the high-level gravels which lie in patches on the summits of the ridges bounding

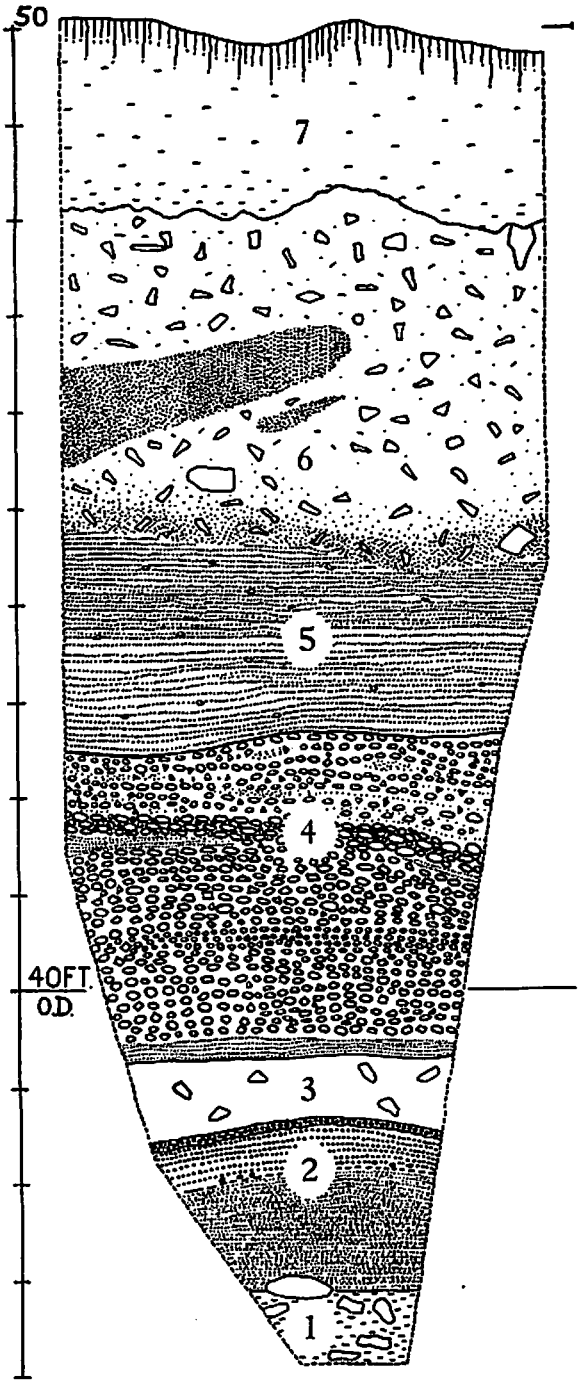

Fig. 20.—Section through Pleistocene deposits at Weston-in-Gordano. Vertical scale : $\frac{1}{2}$ in. to 1 ft.

the Vale of Gordano (Trimmer, 1853; Davies and Fry, 1929, p. 164). The later authors record flint as a constituent of the gravels. In a pocket of clay and gravel recently exposed on Bathampton Down, Bath, at an altitude of about 650 ft. O.D., one of us (D. T. D.) recently noticed flints of exactly the same character, and formed the opinion that they resulted from the fracture, presumably by frost action, of larger nodules or pebbles.

INTERPRETATION

Layers 1 and 4 yielded the marine bivalve *Tellina balthica*, and a single shell of *Buccinum undatum* Linn., a marine gastropod, was picked up on the spoil heap, almost certainly thrown out from layer 4. Layers 2 and 5 are shown by their stratification to have been water-laid, and as the geography seems to render the possibility of a large river in this position out of the question, we believe all the deposits 1 to 5 inclusive, with the possible exception of 3, to be marine, estuarine or beach deposits. By contrast, layer 6 is clearly a " head ", and 7 is likewise of terrestrial origin.

Layer 1 is considered probably a beach conglomerate. It was only possible to expose a very small area of this deposit, and it is regretted that the physical circumstances prevented us from going any deeper and from finding out whether this horizon rests, as might be supposed, on solid rock. Layer 2 could be a beach sand presumably deposited below H.W.M.O.T. and possibly, of course, below L.W.M.O.T. Layer 3 reflects the immediate proximity of land (which could never have been more than about 200 yards distant), the red clay matrix being doubtless derived from the weathering of the local Triassic rocks. There is no evidence as to its mode of origin; it could be a terrestrial deposit washed down over the beach and incorporating pebbles from it. Layer 4 may be another beach deposit, or perhaps a very shallow water accumulation. Layer 5, which was strongly laminated, seems to have accumulated in quiet water below low tide mark, although an origin in the lower part of the intertidal zone is possible.

Layer 6 bears all the marks of a solifluction deposit, formed under periglacial climatic conditions, and can be matched at many localities in North Somerset. The solifluction has eroded the top of the underlying marine deposits to an unknown extent, and the matrix of the basal part 6 is derived from 5. The source of the rock fragments, which are all of local formations, is probably to be found in the Pleistocene breccias known to occur along this side of the Vale of Gordano (Palmer and Hinton, 1929). Layer 7 is interpreted as a " hillwash ", perhaps with æolian constituents, and in any case probably derived from the æolian deposits associated with the breccias already mentioned. Its lack of marked internal differentiation suggests reasonably rapid formation, and this in turn implies an incomplete vegetation cover, and probably, therefore, colder conditions than prevail to-day.

The lowest deposit at Weston in Gordano, if it belonged to the higher part of a beach, was deposited when the mean sea-level was at about 15–20 ft. (4·5–6·0 m.) O.D. Layer 2 may denote a slight rise. The apparently terrigenous nature of layer 3, however, suggests a retreat of the sea, after which there was certainly a new transgression. The change from gravel (layer 4) to laminated sand (layer 5) may have resulted from a further rise in sea-level. The significant fact about layer 5 is that, assuming that it was laid down in the lower part of the intertidal zone (if not below L.W.M.), it is evidence for a mean sea-level not lower than 45 ft. (14 m.) O.D.

LOCAL COMPARISONS

Local marine Pleistocene deposits suitable for comparison with the present occurrence are few and far between, and only two need be considered: the raised beaches and the Kenn Gravels. More or less clear traces of wave-cut platforms, and old sea-cliffs, representing higher sea-levels, are common in North Somerset, but few deposits remain. The nearest is on the north side of Middle Hope (N.G.R. ST324660), described by Sanders (1841). A recent visit disclosed a small exposure in a re-entrant of the coast, showing a bed of limestone pebbles with abundant marine shells, interpreted as probably a storm beach. The base of the beach deposit lay about 15 ft. above the top of the present-day beach, or about 35–40 ft. above O.D.

The gravels at Kenn, south-east of Clevedon, are described in this number of *Proceedings* (p. 137) by Dr. Welch, who interprets them as marine gravels. Like the Weston deposits, they contain *Tellina balthica*, which still flourishes in the Severn estuary. The highest surface level shown on the O.S. map at Kenn is 22 ft. O.D. and all the deposits therefore lie at a much lower level than those at Weston. The Kenn Gravels resemble layer 4 in the dominance of flint over chert, but Jurassic rocks are also present and Palæozoic ones are absent. The Kenn Gravels are tentatively correlated by Dr. Welch with the Burtle Beds of South Somerset.

CONCLUSIONS

As far as we know, the Bristol region was not affected by depression and recovery due to loading by Pleistocene ice-sheets, nor is there evidence of recent tectonic movement. Sea-level values may therefore be used for comparison and correlation with other areas where similar conditions obtain. In terms of the scheme favoured by Prof. Zeuner, the evidence points to correlation of beds 1 to 5 with the 18 m. (60 ft.) " Main Monastirian " phase. This is the lowest of the recognized phases which could have provided a mean sea-level high enough for the accumulation of the upper part of the marine succession. The " Late Monastirian ", 7·5 m. (25 ft.) may be rejected,

for although with a tidal range of about 40 ft. beach material could have been thrown up to a present-day level of 50 ft. O.D., in our opinion, as already mentioned, layer 5 cannot be accounted for in this way. Our section presents some, though certainly not conclusive evidence for a lower sea-level preceding the attainment of the generally recognized level for the Main Monastirian.

If our correlation is correct, the correspondence in level between bed 1 of our section and the raised beach at Middle Hope is clearly fortuitous, for the latter probably belongs to either the Late Monastirian (7·5 m.), or even the Epi-Monastirian or Halling Stage (3 m.) mentioned by Zeuner (1954, p. 101) as being widely represented by fossil shore-lines in South-west England.

According to Zeuner (e.g., 1954, pp. 101–102) the Main Monastirian phase corresponds to the Taplow Terrace aggradation of the lower Thames valley, and to the earlier warm phase of the Last Interglacial. The present authors recently reached the conclusion, independently of one another, that the Burtle Beds were probably deposited during the Last Interglacial. It is not intended here to review the correlation of the Burtle Beds (described by Bulleid and Jackson, 1938, 1942), but as a provisional hypothesis we suggest that the Weston in Gordano marine deposits, the Kenn Gravels, and the Burtle Beds* may all belong to an episode of aggradation in the Last Interglacial, corresponding to the Main Monastirian sea-level.

The sandy breccia (6) clearly belongs to a very late phase of the Pleistocene ice age, and is ascribed by us to the last period of solifluction in the district, perhaps to be equated with the cold phase characterized in the Mendip cave deposits by the Creswellian culture (Donovan, 1955, pp. 99–100). Its formation has clearly been responsible for the destruction of an unknown thickness of the underlying marine beds, and possibly of deposits of intermediate age.

There is no direct evidence for the date of the sandy hill-wash (7), but the absence of any well-marked weathering layer at the top of (6) suggests that it followed fairly rapidly on the latter, in final Glacial or early Post-Glacial time, before the hillside had been covered by vegetation.

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* The highest levels reached to-day by the Kenn Gravels and the Burtle Beds (about 22 ft. and 30 ft. above O.D. respectively) cannot be used as guides to the maximum sea-levels at the time of their formation, as they have suffered subsequent erosion.

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