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A NOTE UPON A FOSSIL CAVE FEATURE IN CHEPSTOW

WITH SOME COMMENTS UPON ITS BROADER GEOMORPHOLOGICAL CONTEXT

BY

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ABSTRACT

A bedrock depression revealed during construction work, together with its sedimentary infill, is described. It is concluded that the depression is probably a small fossil swallet cave system, infilled with sediments which are fluvial at the base, overlain by solifluction and loessic head. In a discussion of the wider regional geomorphology it is suggested that the site described was on an early high level valley route from the Old Red Sandstone in the north, towards the Severn-Wye system. This route had been substantially dissected by river captures and the drainage has now been captured by the Otter Hole cave system.

INTRODUCTION

During construction of foundations for a new supermarket in Thomas Street, Chepstow, NGR ST 5317.9374, a sediment-filled depression in the limestone bedrock surface was encountered. Prior to redevelopment, the site was occupied by a large inn, fronting onto Thomas Street, and by Chepstow Bus Station. Behind the inn and to the north-east of the bus station was an area of heavily overgrown, derelict land which also formed part of the site.

The site (Fig. 17) lies at an altitude of about 50 m O.D. and is close to the centre of Chepstow. It is underlain by the Lower Dolomite of the Carboniferous Limestone which, according to the published geological map (Sheet 250, Chepstow) dips at about 8° to the south east. Two conjectural fault lines are also shown quite near to the site, trending NNE-SSW respectively.

The natural ground slope appeared to be roughly from west to east at an average gradient of about 4° though increasing towards the south-west and west of the site. The original topography, was so extensively modified to create a level bus station and terraced gardens behind the inn that it is difficult to interpret accurately.

THE BEDROCK FEATURE

A plan of the site, showing generalised bedrock contours, is given in Fig. 18. This drawing is based on rockhead levels observed in trial pits and boreholes, excavated during the ground investigation, and also upon numerous levels taken upon rockhead during excavations for the supermarket formation, foundations and car park. Fig. 18 clearly shows a general rockhead gradient from west to east of about 4-5°, interrupted by a very well defined depression in the western corner of the supermarket and a lesser

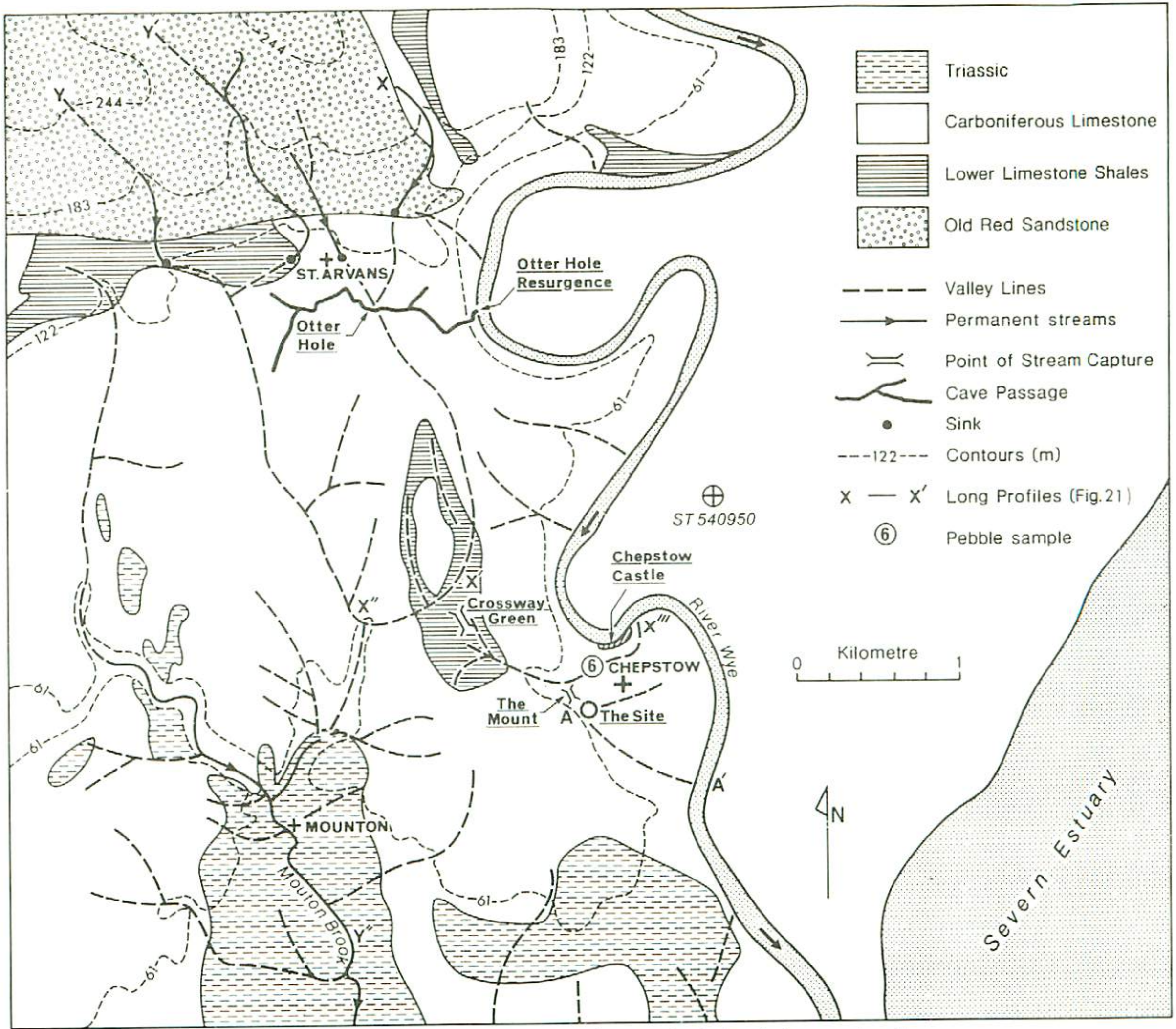

Fig. 17 Site location showing geology and existing drainage network.

depression near to the centre of the building. An area of clay sediments with little or no bedrock exposure was noted in the car park excavation, shown in Fig. 18, and could mark the position of a third feature.

The main depression is an elongate shaft, falling to about 41 m O.D. and about 8-9 m deep at its maximum. Around its western end, the sides were exposed during construction work and were nearly vertical, with abundant evidence of solutional activity on them. Elsewhere the sides were not well exposed and their gradients are not known. Solutional channels and widened joint lines were seen in the bedrock surface along the exposed face between the bus station and supermarket (Section A-A', Fig. 19) and also on the cut slope west of the car park. Boreholes drilled in the depression revealed gently dipping, thinly bedded limestones beneath the infill, with sediment-filled voids developed along some bedding planes, 0.3-0.75 m high. These are interpreted as choked bedding-plane cave passages extending down-dip from the base of the depression. A conjectural cross section is shown in Fig. 20 which, in conjunction with the bedrock contour plan in Fig. 18, suggests a small swallet cave system. The feature is complex, with two or perhaps three depressions, though this is quite typical of a swallet. An alternative explanation is that the depression is a collapse feature, but this is less likely because: the caves appear too small to have caused major collapse, very little collapse debris was seen, solutional features on the bedrock are evidence of substantial flow and the feature is filled by non-locally derived, waterlain sediments.

THE SEDIMENTS

The bedrock feature has been completely infilled by a sedimentary sequence to leave no topographic feature whatsoever. Further, there is no hint from the broader topography around the site that such a feature was to be expected. Three main sediment types were identified from the section logs (Fig. 19). These are:

A) Swallet sediments – water-lain, laminated clayey silts with many rounded pebbles.
B) Coarse-grained head – angular limestone cobbles with interstitial clayey silt matrix.
C) Fine-grained head – structureless clayey silt with very few pebbles. Compositionally similar to the matrix of B.

Samples of the clasts were taken from these materials and analysed for lithology, grainsize, sphericity and roundness and the results are summarised in Table 1. Grainsize analyses were carried out on the matrix from the sediments by wet sieving down to 63 microns.

A. *Swallet sediments*

The swallet sediments underlie the head deposits (B & C) throughout the site. They are best developed within the depression but were seen infilling irregularities of the bedrock surface elsewhere (see Section A-A', Fig. 19). They consist largely of reddish-brown (5YR 4/4) laminated clayey silts with interlaminations of many other colours, for example orange (5YR 5/6), green (5Y 6/3), purplish-red (10R 3/6) and black. All of these colours could be obtained from the weathering of thin shaly bands in the Carboniferous Limestone in the vicinity. Occasional laminations of brown medium sand (7.5YR 7/8) were also seen. Individual laminations were laterally impersistent and sub-horizontal, though tending to dip gently into the depression. Between 76% and 97% of the matrix passed a 63 μm sieve (silt and clay). The coarse fraction was of gravel to small cobble size, with a few large limestone boulders towards the base of the depression. Two pebble samples (3 and 4, Table 1) were taken from this deposit. In both cases the majority were of coarse sandstone or quartz in composition with only small percentages of limestone and other rocky types. One distinctive pebble of a quartz conglomerate was also recovered. The limestone pebbles tended to be

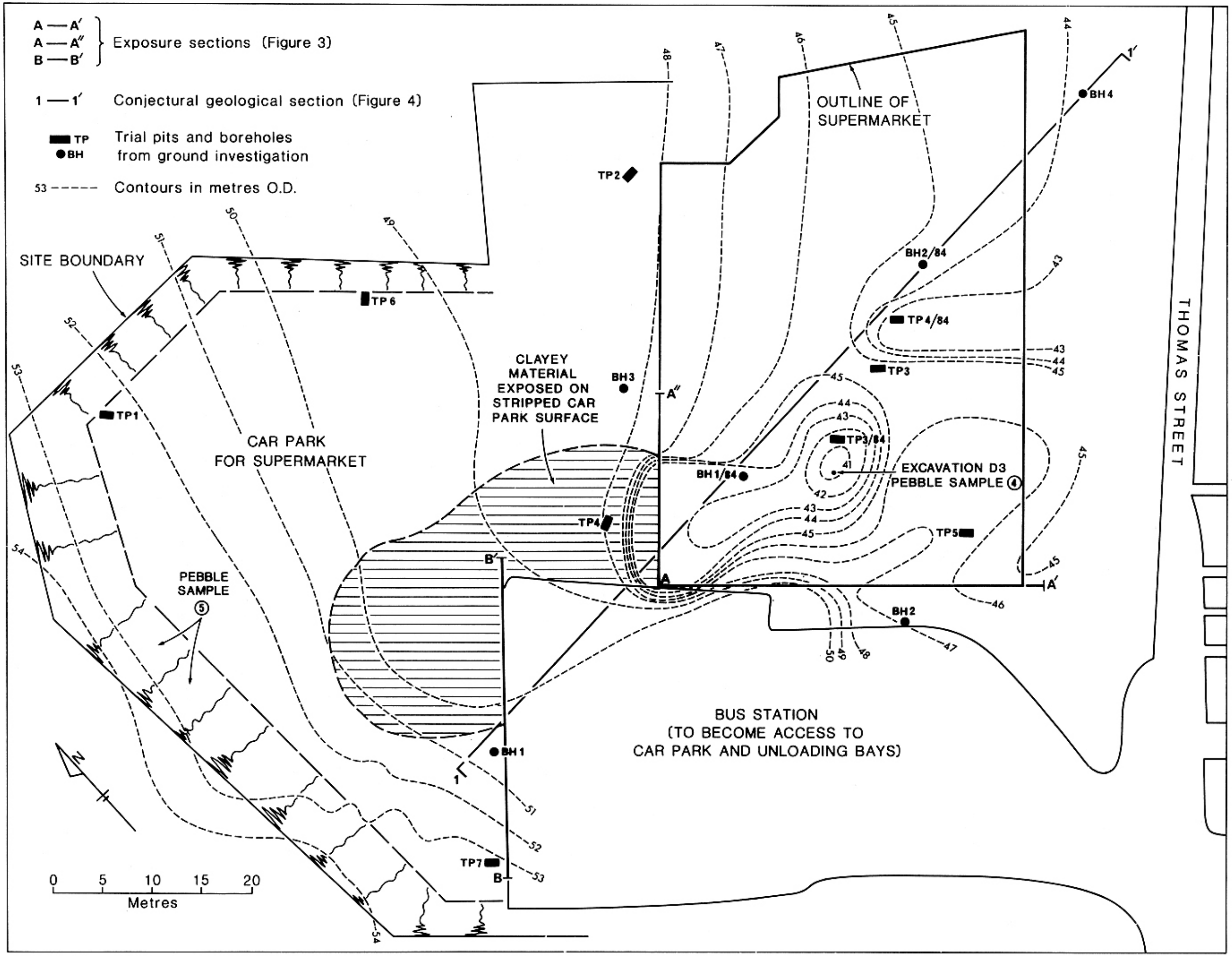

Fig. 18 Site plan showing generalised contours on rockhead (m O.D.)

decalcified and soft, suggesting *in situ* solution, and it is probable that there was originally a greater percentage of limestone clasts. In all cases the clasts had a well-rounded appearance and mean Cailleux Indices (Cailleux and Tricart, 1963) of 0.27-0.54 were recorded, the lowest values being for the quartz pebbles. Roundness values for the sandstone pebbles are lower than their appearance suggests, since many were broken in transport to the depositonal site.

B. *Coarse grained head*

The coarse grained head consisted of angular limestone cobbles in a reddish brown (5 YR 4/4) clayey silt matrix, of which 85% passed a 63 μm sieve (silt and clay). The coarse clasts, which were 98% limestone, were strongly orientated downslope and were generally touching or very close to each other (clast supported). Some *in situ* solution had undoubtedly occurred since deposition, causing some rounding of the sharper edges, and hence the mean Cailleux Index was about 0.26. Some of the larger clasts also showed a white, powdery deposit of calcite on their underside which probably developed as secondary deposition under conditions of evaporation when the head was exposed at the surface.

Stratigraphically, this material was close to the base of the finer grained head (C), though definitely within it, and its matrix was very similar in grainsize.

C. *Fine grained head*

The fine grained head was again reddish brown (5 YR 4/4) – clayey silt with occasional well rounded pebbles of quartz, sandstone and siltstone. About 90% of the matrix was smaller than 63 μm (silt and clay). It possessed no visible structure, except for very indistinct fissuring.

INTERPRETATION OF THE SEDIMENTS

The sediments are considered to represent two phases of deposition during which the swallet was infilled. The first phase resulted in the deposition of Unit A and was certainly fluvial, as indicated by clast rounding and laminations within the sediments. The clast content strongly indicates that at least some of the sediment was derived from the Old Red Sandstone outcrop to the north, since quartz and sandstone pebbles predominate. The single quartz conglomerate pebble could, perhaps, have come from the rock unit of that name at the base of the Upper Old Red Sandstone some 3 km north of the site.

After depositon of Unit A it is apparent from Section A-A″ (Fig. 19) that a topographic depression was still present over the shafts and it is possible that some bedrock was still exposed on the sides. The second phase of infilling followed with the deposition of the head deposits, Units B and C. The coarser head probably represents a solifluction deposit formed beneath degrading limestone slopes in the vicinity and is therefore locally derived. The finer grained material, including the matrix of the coarser head, is, on the basis of grainsize and general lack of visible structure, likely to be loessic in origin. The two head materials were therefore deposited more or less contemporaneously but the solifluction deposits have been best preserved in the topographic depressions left over the swallet following the fluvial phase. Further sections of similar head materials are common in numerous temporary exposures, upslope and to the west of the site.

The head deposits were probably formed during the last glacial phase, that is, the Devensian. The age of the fluvial deposits is much less certain but they probably relate to a much earlier cold phase, as discussed below. It is quite certain, however, that a considerable time hiatus is represented by the boundary between A and B/C because, whereas B/C can be related

TABLE 1

Sample Location		No. of pebbles	Whole Sample	Quartz	Sandstone	Limestone	Siltstone	Other	Remarks
1) Upper Red Clay (See Fig. 3)		20	—	45%	25%	—	30%	—	
	S		0.68	0.67	0.69	—	0.71	—	
	b		7.9	3.4	6.6	—	4.66	—	
	CI		0.46	0.35	0.44	—	0.67	—	
2) Coarse Head deposits (see Fig. 3)		35	—	1%	—	98%	1%	—	40% of sample possessed white powdery surface patina. These pebbles tended to be more angular (CI = 0.22) as opposed to 0.30 for pebbles with no patina) and larger (mean b axis = 37.1 mm as opposed to 18.3 mm where no patina present)
	S		0.64	—	—	—	—	—	
	b		7	—	—	—	—	—	
	CI		0.26	—	—	—	—	—	
3) Lower Red Clay (Swallet infill – see Fig. 3)		29	—	17%	76%	—	—	—	Sample from stony horizon, immediately below coarse head deposits in swallet sediments. Sandstone pebbles soft and tend to have been broken during fluvial transport. Hence CI values suggest more angular than their appearance. CI for unbroken pebbles = 0.69.
	S		0.68	0.69	0.67	—	—	—	
	b		21	17	22	—	—	—	
	CI		0.47	0.27	0.54	—	—	—	
4) Swallet infill Excavation D3 – (see Fig 2)		30	—	30%	60%†	3%	3%	3%*	* Haematite † One pebble of quartz conglomerate recovered Sandstone pebbles tend to be soft and broken (see sample 2 above).
	S		0.71	0.74	0.71	—	—	—	
	b		13	5.3	3	—	—	—	
	CI		0.34	0.36	0.32	—	—	—	
5) Supermarket car park (see Fig. 2)		67	—	60%	18%	—	12%	1%*	* Haematite Pebbles selected by inspection from exposed slope to rear of car park.
	S		0.72	0.74	0.73	—	0.67	—	
	b		22	20	28	—	34	—	
	CI		0.26	0.25	0.36	—	0.21	—	
6) Chepstow Castle Valley (see Fig. 1)		101	—	—	28%	57%	—	15%*	* Chert Limestone mainly derived from adjacent slopes, or immediately up-valley from sampling point
	S		0.69	—	0.71	0.68	—	0.69	
	b		18	—	13	22	—	13	
	CI		0.22	—	0.35	0.17	—	0.21	

CI = mean Cailleux Index b = mean 'B' axis in mm S = mean sphericity

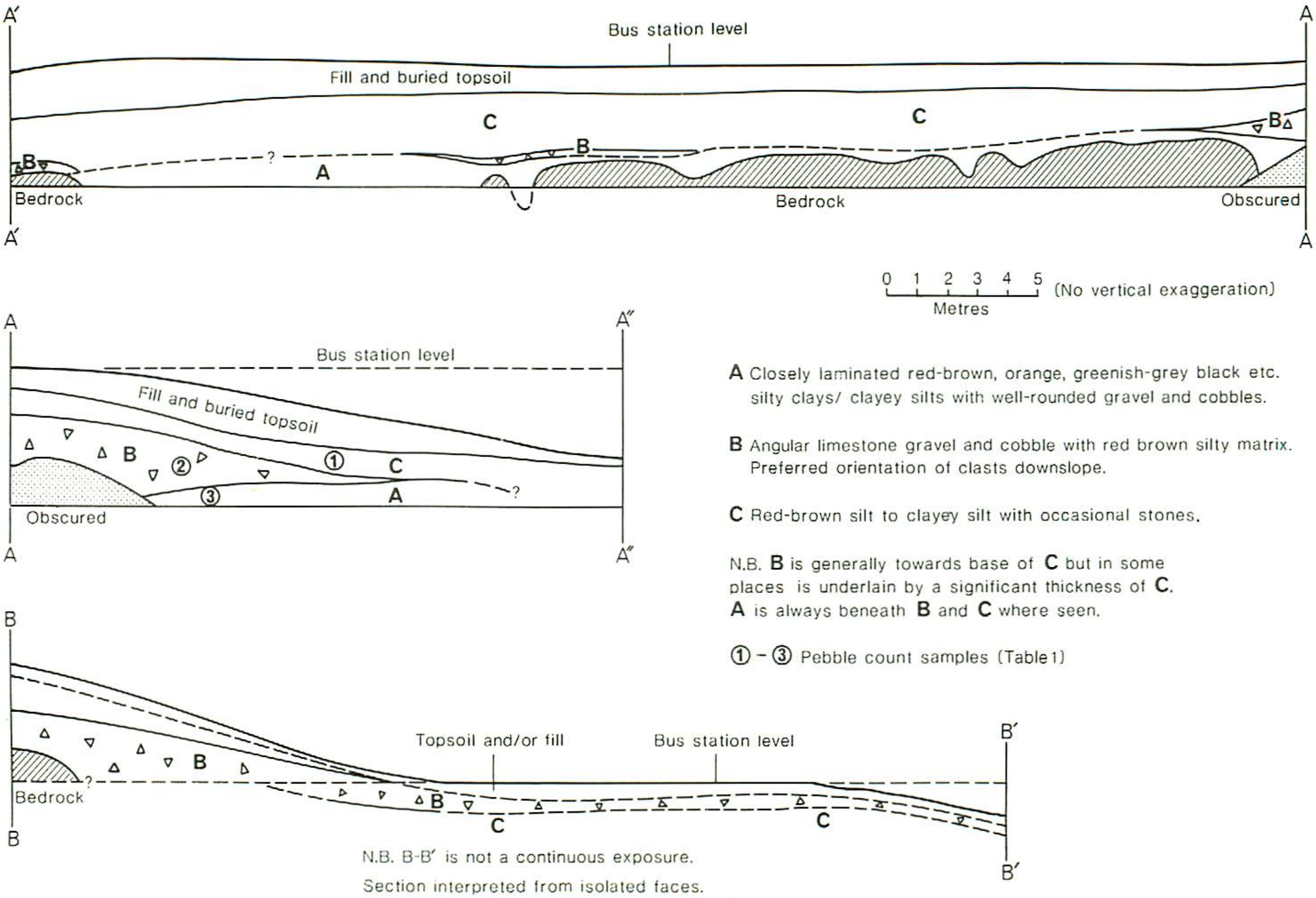

Fig. 19 Sketch sections of exposed faces at site.

(more or less) to existing topography, A clearly can not, since the site no longer obviously lies within an active or even abandoned valley system.

DISCUSSION – WIDER GEOMORPHOLOGICAL CONTEXT

At first sight the feature described is a fairly minor, fossil karst phenomenon. However, the presence of fluvial infill sediments containing clasts almost certainly from the Old Red Sandstone, 3 km to the north, indicates that the site once lay on an active drainage route towards the Severn. This route is represented by a now dissected dry valley, called the St. Arvans valley in the subsequent discussion, which runs south-east from St. Arvans to Crossway Green (X-X′, Figs. 21 and 17). The original route south of Crossway Green is unclear due to the development of a number of steep gullies and valleys along the incised course of the River Wye. The dry valley is adjusted to a fairly high level (about 85 m O.D.), which is above the level of the fourth and fifth terraces of the River Severn (about 50-60 m O.D. respectively in the area, Welch and Trotter, 1961). It is therefore of considerable antiquity. This early St. Arvans valley has been dissected by capture at two places into the Mounton Brook valley, which is developed at a somewhat lower level on the softer Triassic rocks (Y-X″-Y″ on Fig. 17). The elbow of capture at St. Arvan's is particularly pronounced, but at Crossway Green capture is marked by a low col into the present Chepstow Castle valley. Both of these captures have occurred on the outcrop of the mechanically weak, Lower Limestone Shales. More recently, incision of the River Wye has resulted in the development of steep, short valleys running towards the main river, for example the Chepstow Castle Valley (Crossway Green – X″ on Fig. 17). This steep valley has intercepted the earlier course of the St. Arvan's valley south east of Crossway Green at the Mount, and it is considered that the fluvial sediments preserved at the supermarket site are a surviving remnant of that earlier course. The course onwards to the Wye was probably roughly along A-A′ (as shown on Fig. 17). Dissection of the Wye valley slopes in this area by a number of steep gullies makes accurate interpretation impossible.

At present, drainage from the Old Red Sandstone north of St. Arvan's passes underground into the Otter Hole cave system, which runs eastward to an inter-tidal resurgence in the River Wye. Elliott *et al.* (1979) correlate the main high level phreatic passage in Otter Hole, at 32-42 m O.D., with Number 2 Wye Terrace at 25-30 m O.D. This is generally ascribed to the early Devensian, but it is an aggradation feature, its lateral equivalent in the River Avon overlying a lower gravel with Ipswichian fauna. Vadose modification of the initial phreatic passage would therefore be occurring by Ipswichian times at the latest and it therefore follows that the phreatic development must be older. This suggestion is supported by the well decorated nature of the high level passage. Karst circulation has therefore occurred in this area for a very long time. Active modification of the St. Arvan's and Mounton Brook valley system must therefore have been restricted either to a very early phase, when solutional development of the limestone did not permit active karst circulation (cf. Smith, 1975), or to periods of colder climate when groundwater circulation may be restricted by permafrost. It is also possible that greater sediment movement and peak

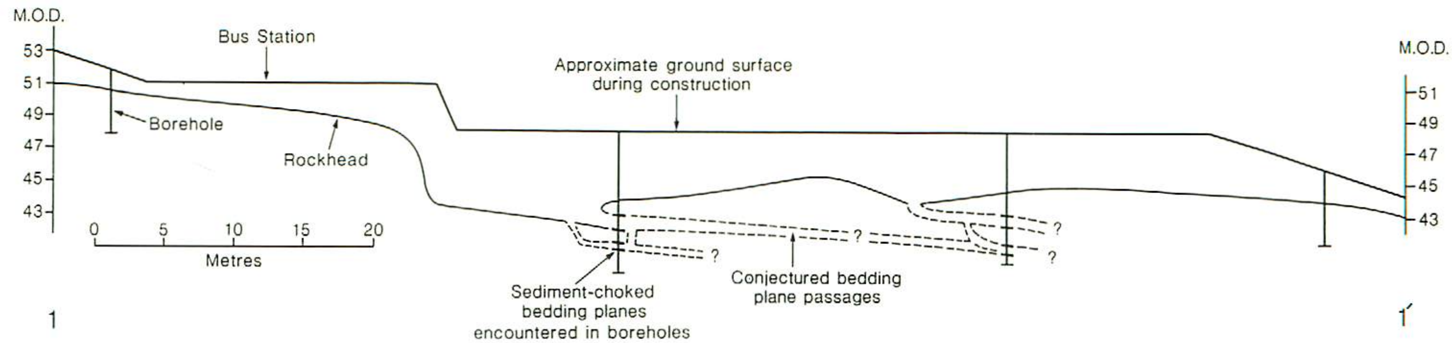

Fig. 20 Interpolated section through site showing rockhead

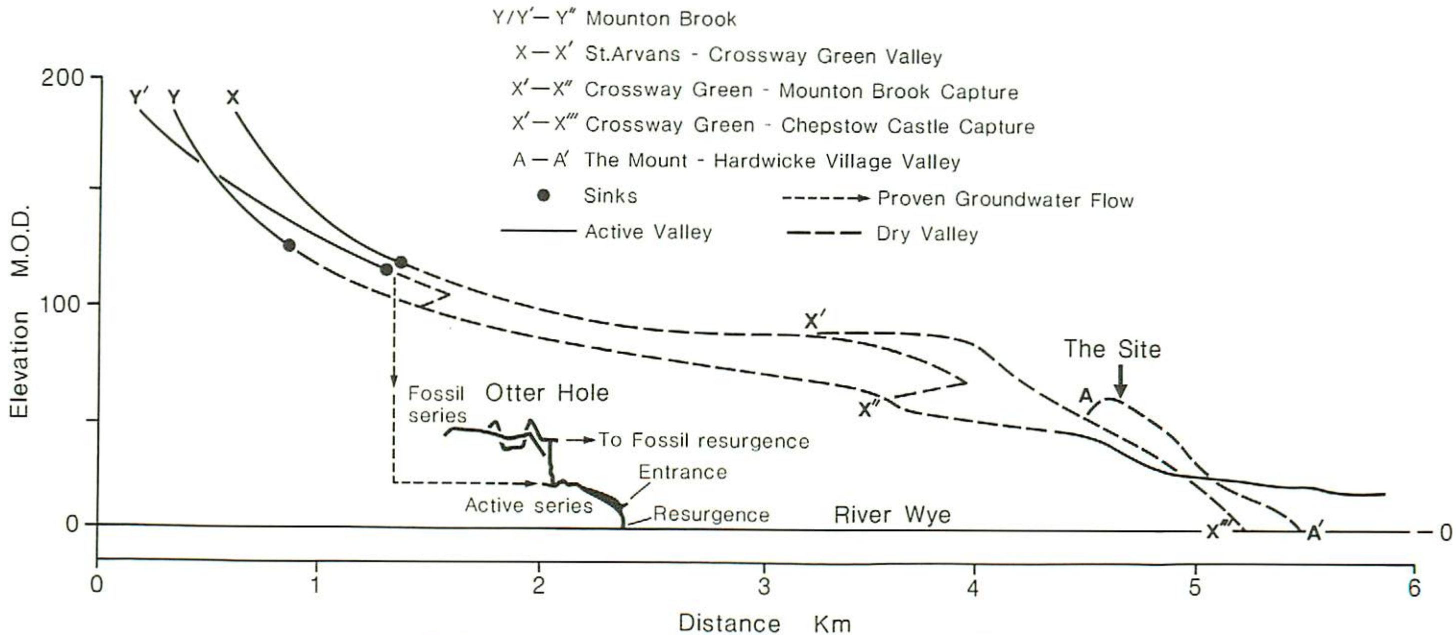

Fig. 21 Longitudinal profiles of valleys north and west of Chepstow.

flows associated with a nival climatic regime could give rise to fluvial activity in the valley network.

At this stage, suggestion of a chronology for the development of landforms in the Chepstow area would be speculative. Much more work is necessary to explain the inter-relationships between different components of the drainage network; in particular the interaction between surface and subsurface flow requires attention. One possible approach would be dating of Otter Hole speleothems by the uranium series technique, in conjunction with a closer inspection of surviving sediments, both in surface and subsurface systems.

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