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A Preliminary Report on the Middle Pleistocene Mammal Bearing Deposits of Westbury-Sub-Mendip, Somerset

By
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ABSTRACT. A brief account is given of current research upon Middle Pleistocene deposits exposed in a working limestone quarry near Westbury-sub-Mendip, Somerset. The geology and fossil mammal content are outlined, and show the deposits divisible into an upper group, formed in a cave environment, and a lower group of waterlaid deposits washed in from outside. Stratified deposits representing the cave environment contain rich temperate mammalian faunas, not later than Elsterian (Anglian) in age. The underlying waterlaid deposits represent an earlier climatic phase, containing a sparse mammalian fauna no later than 'Cromerian' *s.s.* in age, but probably not as early as the pre-glacial Lower Pleistocene. Several mammal species are recorded from this site for the first time in Britain.

INTRODUCTION

The Pleistocene deposits are exposed in a working quarry excavated in Carboniferous Limestone near Westbury-sub-Mendip (Nat. Grid. Ref. ST506504). They lie between 213 m. (700 ft.) and 244 m. (800 ft.) O.D., on the edge of the Mendip plateau.

The deposits were discovered in 1969 during quarrying operations, whereupon Prof. E. K. Tratman and helpers initiated the collecting of specimens and samples. Heal (1970) briefly described the site and included a faunal list of the mammals found at that time, which has since been modified and added to. His account indicated the presence, in part, of 'Cromerian' deposits. Since then, exposure of the deposits has greatly enlarged, and understanding of the site's history has been much improved.

Excavation in the normal sense is not feasable due to exposure of the deposits in a high, near vertical face. Parts of the section can be reached by ascending their scree slope, but the constant disintegration of the exposed face of the deposits makes this a hazardous task. Valuable collecting has been made by descending over the lip of the deposits in the quarry face, by means of rope ladder and lifeline. As a result of working difficulties there is a large proportion of unstratified finds.

This paper is of an interim nature, outlining the progress in research so far, whereas a thorough account of the deposits and their content is to be published later elsewhere.

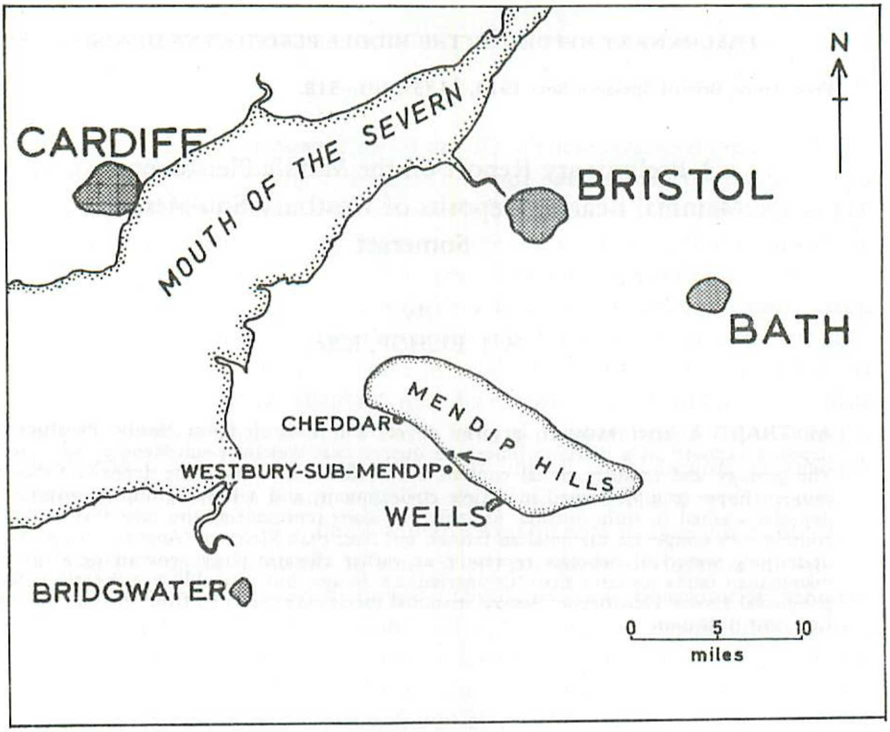

Fig. 88

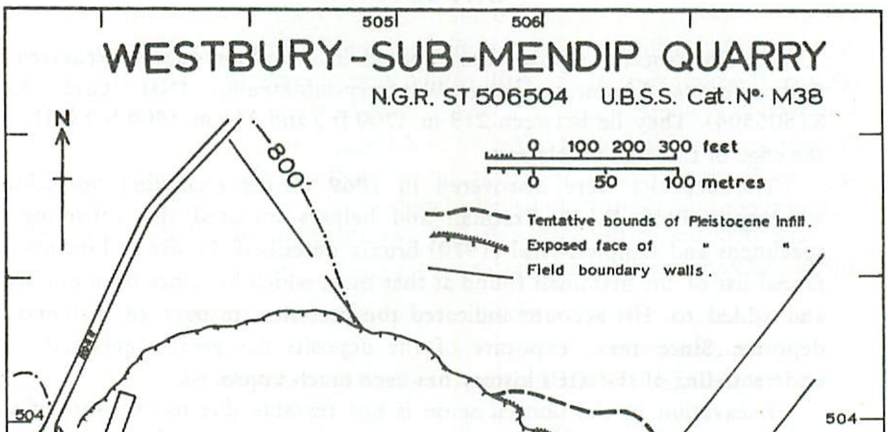

Fig. 89 Map showing the limits of the quarry in February 1974, and the approximate position of the infill. Contours are in feet O.D.

GEOLOGY

The quarry is excavated in the Clifton Down Limestone, which in this area dips at about 40 degrees due south. The present quarry floor lies at about 213 m. (700 ft.) O.D., while the top of the north face in which the deposits lie is at 244 m. (800 ft.) O.D. The deposits infill an irregular trough in the limestone whose lowest point so far exposed is within 3.0 m. (10 ft.) of the quarry floor. The lateral extent of their exposure is at present about 91.5 m. (300 ft.) wide at ground level. On the eastern side the limestone overhangs the infill by at least 4.6 m. (15 ft.). On the western side the infill rapidly shallows to 3.7 m. (12 ft.) deep, and then gradually wedges out over about 6.1 m. (20 ft.) horizontally to ground level. There is little evidence of the deposits at ground level. Behind the northeast corner of the quarry face however, there is a depression which develops into a small valley running south down the edge of Mendip into Foxhills Wood.

In an attempt to delineate the bounds of the infill at ground level a hammer seismograph was employed. Sound waves should travel faster through solid limestone than through the sediments of the infill. To test this a seismic profile was recorded across a known limestone/infill boundary. The velocity of the sound waves calculated from the 'first arrivals' in the limestone was between 1,830 m. (6,000 ft.) and 3,350 m. (11,000 ft.) per second, whereas that through the infill was between 305 m. (1,000 ft.) and 915 m. (3,000 ft.) per second. Values between these ranges could indicate shallow infill, or infill below a limestone roof. With large differences in velocity the boundary of the infill can be plotted fairly accurately (to within 3 m. (10 ft.) where there is a sharp change from limestone to infill). Preliminary results are used in *fig.* 89 to delineate the apparent bounds of the deposits. Several more profiles must be run to clarify these bounds, and with further recordings depths can be calculated.

The deposits in the infill fall into two main groups based on lithology and faunal content. They are the:

2. CALCAREOUS GROUP comprising limestone brecias and conglomerates.
1. SILICEOUS GROUP comprising sands and gravels.

1. *The Siliceous Group*

This is represented by at least 15.2 m. (50 ft.) of well bedded fine sandy clays, fine sands and fine to coarse gravels. The constituents of these sediments are wholly non-calcareous. The fine sandy clays are usually a pale grey-white in colour, while the fine sands are to a varying degree yellow and brown. The fine sand constituent is a uniform fine grained clear silica, grain size being predominately between 0.05 and 0.10 mm. The grains are well rounded. Gravels occur at various levels, the coarsest variety of 3-4 cm. size, occurs in the lowest level of the Siliceous Group, while progressively less coarse gravels occur upwards. The uppermost 3-4.6 m. (10-15 ft.) of the Siliceous Group appear to be devoid of a gravel fraction greater than 0.5 cm. Gravels occur predominately as lenses up to 30 cm. (1 ft.) in thickness and 1-1.2 m. (3-4 ft.) wide. Gravels over 0.5 cm. pebble size are mainly composed of a very well rounded pale yellow-white siliceous rock of, so far, unknown provenance. Features of this lithology in hand specimen and thin section suggest it is a siliceous replacement of a weathered Mesozoic rock. In this respect it is similar to rocks of the Harptree Beds, as described by Green and Welch (1965). Nearly every specimen appears to have been extensively bored by a very small organism, giving the rock a porous character. This has occurred prior to the rock being formed into pebbles. Several specimens contain poorly preserved pieces of marine macrofossil, so it is hoped that eventually an identifiable fragment may elucidate their age. Angular pale yellow-brown chert pebbles, also 'bored' but to a lesser degree, occur in the gravels together with angular pebbles of Carboniferous Limestone chert. Quartz is common below a grain size of 0.5 cm. when it occurs as highly rounded clear grains. Above this grain size there occur occasional pieces of opaque vein quartz. In the finer gravels, those below about 1.5 cm., limonitic pebbles are often abundant, occurring in gravel lenses rich in a limonitic matrix. They are dark brown in colour. Often closely associated with these limonitic gravels are grey-black layers of sandy gravels.

There are no traces of any limestone fragments in the sands and gravels other than the occasional boulder whose outer centimetre or so is rotted to a black breakdown deposit. These boulders, and the bedrock limestone forming the surrounding walls, are highly waterworn.

Bedding in the sands and silts is fine in places, sometimes bands of alternating yellow and pale grey white fine sands being 3-4 mm. in thickness. In other instances the sands are over a metre thick and uniform in character. Grading and cross-bedding are common, and contortions of strata and minor faulting occur. On average, beds of the Siliceous Group dip at a shallow angle due south, indicating an introduction into the area from the north. There was certainly a source entering from the west side of the limestone spur in the infill, but exposure is not yet sufficient to indicate whether there was also an influx from the east side. The beds of the Siliceous Group laterally extend just over 30.5 m. (100 ft.) to the east of the limestone spur where they are abruptly displaced by breccias. The westerly extent of the Siliceous Group has been hard to determine since it is covered by scree.

Only a sparse fauna has been obtained from the Siliceous Group. Such remains have only been found in the coarse gravels, and consist of well rounded mineralised fragments of bones and teeth of large mammals.

At about 1.5 m. (5 ft.) below the top of the Siliceous Group the sediments gradually become more silty and brown, and the last 1 m. (3 ft.) are a brown silty clay with less sand constituent. Occasional bone fragments occur in this layer, not of the rounded mineralised type found in the gravels but sharp friable fragments like those occurring in the Calcareous Group above.

Very large limestone boulders frequently occur at this horizon and are more angular than those seen below, but still retain the rotted exterior. The brown silty clays associated with limestone boulders may be regarded as transitional between the Siliceous Group and the Calcareous Group.

2. *The Calcareous Group*

The deposits comprising the overlying Calcareous Group extend over a proportionately large area of the infill forming well stratified horizons. These basically include layers of limestone conglomerates and breccias. Deposits lateral to this layered sequence lying in the midst of the infill appear to have undergone a rather different history of deposition.

The contact between the Siliceous Group and the Calcareous Group is seen in the middle of the exposed section, but contact relations to the east, where the Calcareous Group is lower than the top of the Siliceous Group, have not been seen so far. The contact of the brown silty clays with the above Calcareous Group member is very sharp, occurring over just 0.5 cm. Here there is a colour change from dark red brown to a pale grey white. This overlying pale sediment forms a uniform layer 1-1.2 m. (3-4 ft.) thick and is exposed about 30.5 m. (100 ft.) laterally. It has a fine grained texture, the grains being small agglomerations of silt, and is a pale grey-white to a pale yellow-white. Compared with other sediments of the Calcareous Group the limestone content is less, there being mainly small angular pebbles scattered through the matrix. Occasionally, larger cobbles and boulders occur, which are angular or subangular. No fine stratification is seen within this layer. Bone material is extremely abundant, often blackened, and frequently well preserved. Two of only four instances of articulated bone remains were found in this layer, one being the bones of a bear's forearm, and the other several skeletal elements of a mustelid. On rare occasions small pockets of bat bones have been found in this deposit. This layer has been termed the Yellow Silty Layer.

At the top of the Yellow Silty Layer well rounded pebbles appear, the silt grains form large agglomerations and the whole is flecked with black staining. The overlying Black Conglomerate into which this develops averages 0.3 m. (1 ft.) in thickness. The greater part of this layer consists of well rounded limestone pebbles (5-8 cm. size) which contact one another. Matrix partially infills the voids, and consists of small agglomerations of pale silt. The whole layer is coated with a black stain, which Auger Electron Spectroscopy has shown to consist of 8 atomic % iron and 4 to 5 atomic % manganese. Bones are very common in this layer, and are totally blackened and often show signs of wear around projecting edges. Laterally the Black Conglomerate changes character, and is termed the Brown Conglomerate where it extends into the breccias on the eastern side of the exposure. Here the rounding and size of the pebbles is similar, but a matrix is sparse, and instead of a black staining, a thin veneer of fine brown silt covers the pebbles and bones. Locally stalagmite infiltrates the layer welding the pebbles together. Bones are very well preserved in this part of the conglomerate. In particular an extremely well preserved facial portion of a bear skull was found bearing a complete upper dentition, less the incisors, (see *pl.* 24B).

The Black and Brown Conglomerates pass vertically into more conglomerate horizons, the Red and Yellow Bone Conglomerates, whose pebbles are interspersed within a silty, often calcareous matrix. In places the change from the Black Conglomerates is very sharp, there being a thin compacted surface to the layer, this changing to the overlying conglomerate within a millimetre or two. Elsewhere the change is only perceptible as a change in matrix colour over two or three centimetres. The conglomerates above are 1.2-1.5 m. (4-5 ft.) thick, with red stained matrix at the base and top, and pale yellow matrix in between. In the red bands the rounded limestone pebbles are blackened on the outside, and the matrix is frequently flecked with a black deposit. The conglomerate in between is pale yellow in a fresh section but after some weeks appears green (as does the Yellow Silty Layer), since moss plants are partial to this medium. The matrix is of silt grade and varies from being soft and workable by trowel, to well cemented where calcium carbonate has been incorporated. Bone material is extremely abundant, in places making up an important percentage of the deposit. Much of this material is bone scrap, but teeth are also very common. Few complete long-bones are found in the Yellow Bone Conglomerates.

These rich Bone Conglomerates pass upwards into another conglomerate, the Upper Conglomerate, of higher pebble concentration. This layer is about 1.5 m. (5 ft.) thick, but not extensive laterally, being replaced by breccias to the west and east. The matrix is a pale grey-white silt becoming red upwards, and bones are abundant. It passes upwards into the Stalagmitic Breccia, an extensive layer of coarse angular limestone cobbles and boulders whose voids are filled or partially filled with a red brown silty clay and abundant stalagmite. Bones are common but usually crushed and splintered. This horizon passes irregularly into the Upper Breccia which is similar to the Stalagmitic Breccia, but lacks stalagmite, and its limestone constituents are somewhat less angular. Bones are relatively uncommon in this horizon. It passed into 30 cm. (1 ft.) or so of surface soil.

The deposits on the eastern side of the layered sequence are nearly all coarse angular breccias whose matrix is a dark silty clay. A layer was exposed about 12.2 m. (40 ft.) from the quarry floor, very similar to the Yellow Bone Conglomerate, but it is at present covered by scree. At some levels in the breccias the limestone is frequently rotted on the outside. The breccias change vertically with regard to the size of the brecciated limestone and matrix colour and constituency, but the changes are comparatively small. Further work is in progress on this side of the infill in the hope of determining a definite stratigraphy. Viewed from a distance stratification within these breccias can be discerned, for layers appear to rise towards the easterly end wall and curve back down to meet it at a lower angle. Here the limestone overhangs the deposits considerably.

The stratigraphy on the western side of the exposure is difficult to relate to the main layered sequence at present. It was this westerly exposure that was seen late in 1969. At this time the Siliceous Group was not exposed, but instead, about 15.2 m. (50 ft.) of breccias and conglomerates were seen. A trough of dark red brown earth was then visible at the top and near the middle of the deposits. At present the section still shows this trough of earth which is bounded by angular breccias to the west and by the limestone spur to the east. The earth is very rich in small mammal remains, particularly on its eastern side. In places, small mammal bones form over fifty per cent of the deposit, and consist of many complete bones and mandibles, but no complete skulls. It is termed here the Rodent Earth because it has a predominance of rodents over other small mammals.

The breccias to the west of the Rodent Earth contain few bones. They are similar to the Upper Breccia of the mid section, and to the breccias on the eastern side. Though 7.6 cm. (25 ft.) thick next to the Rodent Earth, they thin out rapidly westwards to ground level.

Only two erratic lithologies have so far been recorded in the Calcareous Group. One is the presence of occasional rounded pebbles of limonitic ironstone, probably originating from a Jurassic deposit, found in the Yellow Bone Conglomerate. The other is the frequent occurrence of pieces of rotted flint. Curry (1963) has drawn attention to similarly rotted flints from the Palaeogene of Southern England, and has shown that Foraminifera can be used to date the flint. One of the Westbury samples has yielded Foraminifera which Curry has dated as Coniacian (Upper Chalk). The majority of flints are small angular fragments, white in colour and extremely soft. There are, to date, five large flints of 5-10 cm. size, two of which are of such a form that it is extremely difficult to attribute their shape to the work of a natural agency.* These and all other stratified flint finds come from the Red and Yellow Bone Conglomerates.

Thorough sedimentary analysis have still to be undertaken upon the various sediment types in the infill. The report above only outlines knowledge gained in the field, and includes some preliminary results from sedimentary analysis.

* Since this paper went to press the flints have been examined by Dr. Kenneth Oakley, who considers some of them show human workmanship, which he would describe as 'earliest Acheulean'.

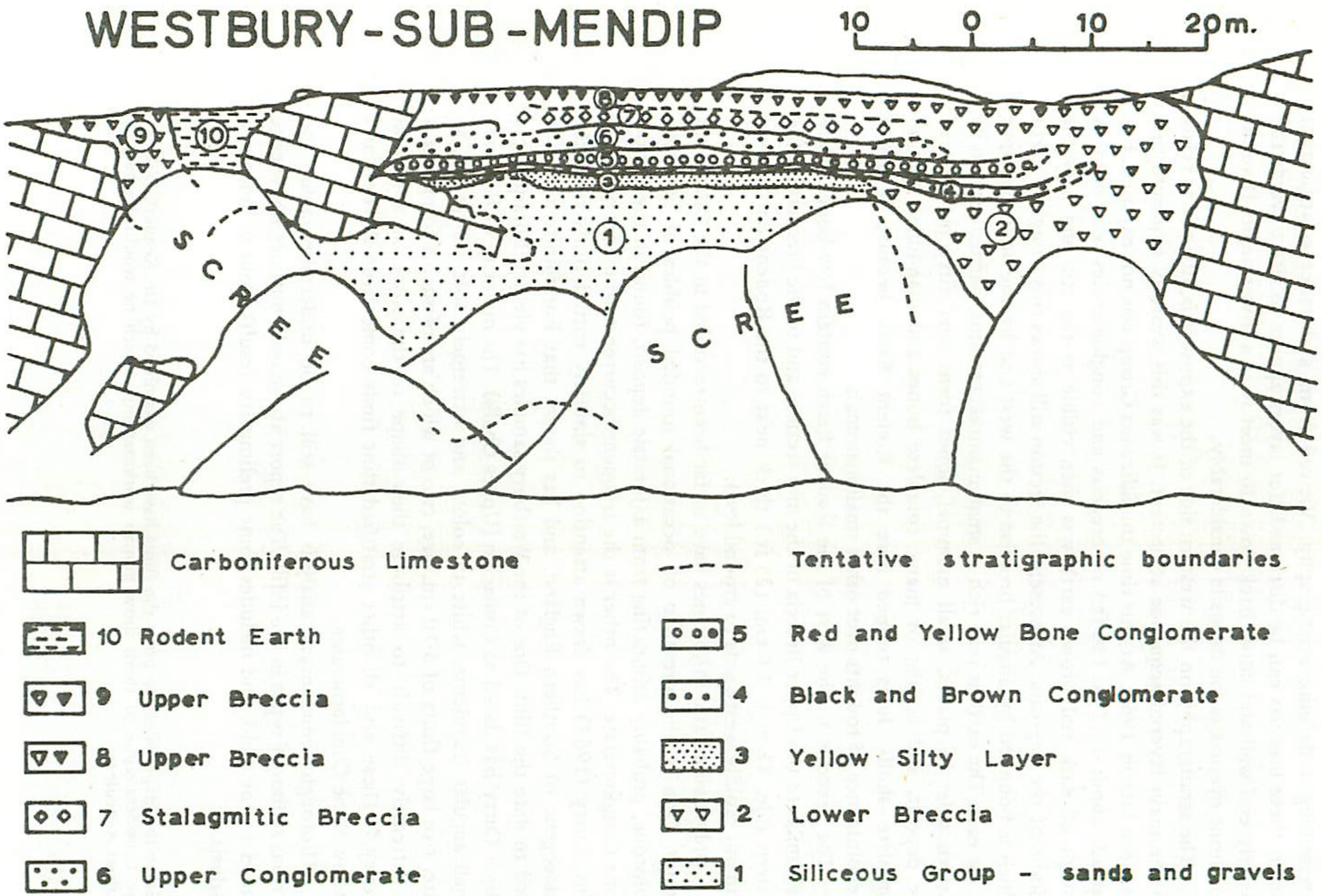

Fig. 90

Section of the deposits as exposed in the quarry face, showing the principal stratigraphic units and their relations to the bedrock limestone. Bed numbers are reproduced in the faunal list (table 1).

Plate 24A. The depsoits exposed in the quarry face looking Northeast. This face is 30 m. (100 ft.) high, and the infilling deposits, from the top, extend down to within 3 m (10 ft.) of the quarry floor. Bedrock is visible at the far right of the photograph.

Photo: M. J. Bishop.

TABLE 1
FAUNAL LIST AND STRATIGRAPHIC OCCURRENCE OF VERTEBRATES

	BED NUMBER									
	1	2	3	4	5	6	7	8	9	10
INSECTIVORA										
Erinaceus sp.										r
Sorex minutus L.										r
S. species A										VC
S. species B										VC
S. (*Drepanosorex*) *savini* Hinton										C
Neomys sp.										C
Desmana moschata Pallas										C
Talpa europaea L.										VC
T. minor Freudenberg										r
CHIROPTERA										
Myotis sp.							?			
Plecotus auritus L.				r				r		
Barbastella barbastellus Schreber			r	r						
CARNIVORA										
Hyaena brevirostris Aymard	r									
Crocuta crocuta Erxleben				r						
Homotherium latidens Owen				r	r					
Felis (*Lynx*) sp.	r				r					
F. gombaszoegensis Kretzoi		r	o	r	o			r		
F. leo fossilis Reichenau			r	r	o					
Gulo sp.			r	r						
Mustela cf. *M. palerminea* Petényi			r							VC
M. cf. *M. praenivalis* Kormos										VC
Canis lupus mosbachensis Soergel		o	VC	o	o			r		
Xenocyon lycaonoides Kretzoi			r	r	r					
Vulpes sp.				r						
Ursus deningeri Reichenau		C	VC	VC	VC	VC	VC	C	C	C
PERISSODACTYLA										
Dicerorhinus etruscus Falconer					?					
Dicerorhinus sp.	o	r								
Equus mosbachensis Reichenau				r	o					
ARTIODACTYLA										
Cervus cf. *C. elaphus* L.			r	r	o					
Dama sp.	r			r						r
Bison sp. (large)			o	o	C	r	r	r	r	?
Bison sp. (small)	VC									
Capra or *Ovis* sp.			?							
RODENTIA										
Castor fiber L.	r									
Clethrionomys glareolus Schreber										r
Pliomys episcopalis Méhely										r
Arvicola cantiana Hinton					r					VC
Microtus arvalis group			r	r	o		o			VC
Pitymys gregaloides Hinton		r			C		o	r		VC
Lemmus sp.					r					r
Dicrostonyx sp.										r
Apodemus sylvaticus L.							r			r
LAGOMORPHA										
Ochotona pusilla Pallas										?
Lepus sp.				r						o
PISCES					r					VC
AMPHIBIA										o
REPTILIA										o
AVES										C

Recognizable bones

r = rare = 1–4
o = occurs = 5–9
C = common = 10–19
VC = very common = >19
? = uncertain stratigraphic occurrence

THE FAUNA

Stratified mammal finds may be divided into three groups according to their occurrence in:

1. The Siliceous Group
2. The Calcareous Group excluding the Rodent Earth
3. The Rodent Earth

1. *The Siliceous Group* – this yields a sparse and poorly preserved fauna, whose main element is a relatively small bovid, probably *Bison* sp. *Dama* sp. is represented by one upper and one lower third molar of small size, similar to *Dama nestii nestii.*

The record of *Hyaena brevirostris* is based upon just one upper third premolar, a species to which this specimen closely agrees, rather than *Crocuta* or any other hyaenid. *Felis (Lynx)* sp. is represented by the distal end of a humerus.

2. *The Calcareous Group excluding the Rodent Earth* – these deposits yield the majority of finds of large mammals. About 85% of all identifiable finds belong to *Ursus* (see *fig.* 91). Despite the large amount of material collected it has been hard to attribute the majority of finds to a species, since most finds are isolated teeth and bones. Only two sizeable portions of skull have been found so far. These and about twenty mandibles are referable to *Ursus deningeri* Reichenau. Measurements of all the bear teeth found span the ranges and agree with the mean measurements seen in this species (Reichenau 1906, Schütt 1968). As further bear material is constantly being found it is hoped that it can be analysed right through the stratigraphic section with regard to any evolutionary developments that might be present.

Alongside *Ursus* many other carnivores are found. Wolf is the next most common carnivore, remains of which all belong to a small sub-species referable to *Canis lupus mosbachensis* Soergel. Another canid found in several horizons is the extinct dhole *Xenocyon lycaonoides* Kretzoi (= *Cuon dubius stehlini* Thenius), recorded here for the first time in Britain. Of the four large felids *Felis gombaszoegensis* Kretzoi (= *Felis toscana* Schaub), described by Hemmer (1971) as the 'European jaguar', is recorded here for the first time in Britain. The very large Westbury lion appears to be *Felis leo fossilis* (Reichenau) rather than *F.leo spelaea* (Goldfuss), the differences of which have been outlined by Schütt (1969).

Dicerorhinus etruscus Falconer is represented by two finds of upper dentitions. One, consisting of the upper left P3 to M2 and upper right P2 to P4, was found in a fallen block of red breccia of unknown stratigraphic horizon. The other find was a piece of palate with left P3 and P4 and right P4 attached. The preservation and adhering matrix are identical to that seen in the Yellow Bone Conglomerate.

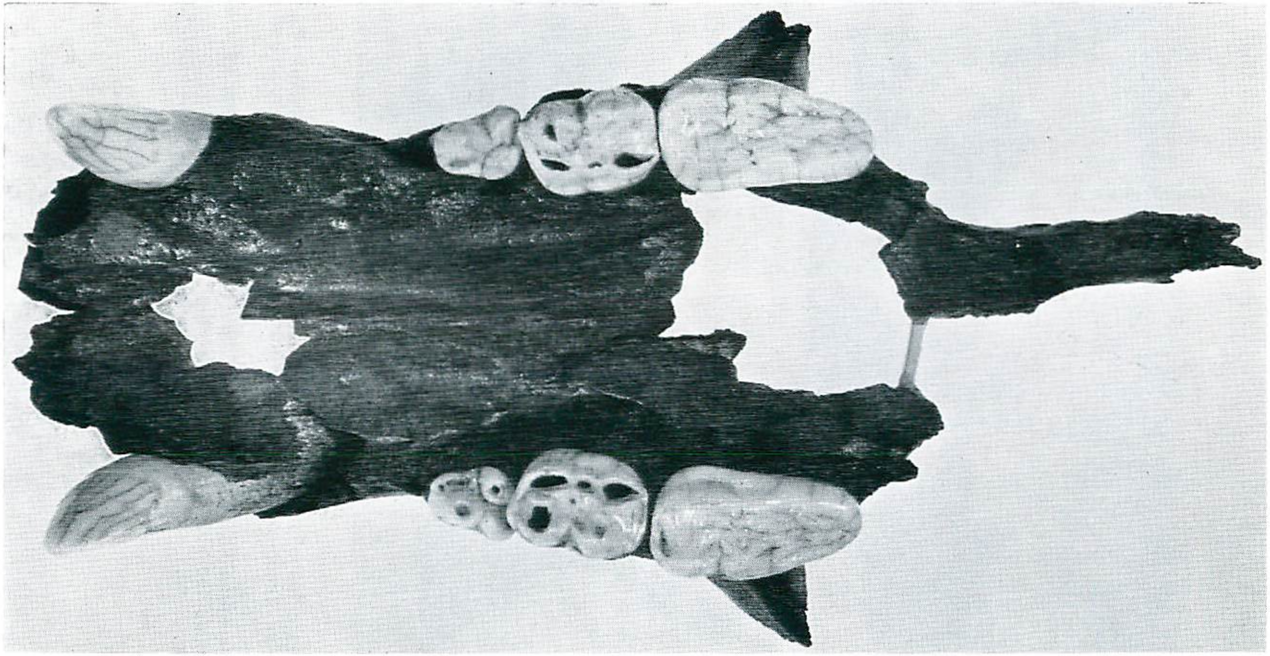

Plate 24B. View of the palate of an extinct cave-dwelling bear, *Ursus deningeri*, remains of which are more abundant than any other mammal at Westbury. Sc. 3/4qrs. Photo: M. Gray, Dept. Geol. Univ. Coll. Lond.

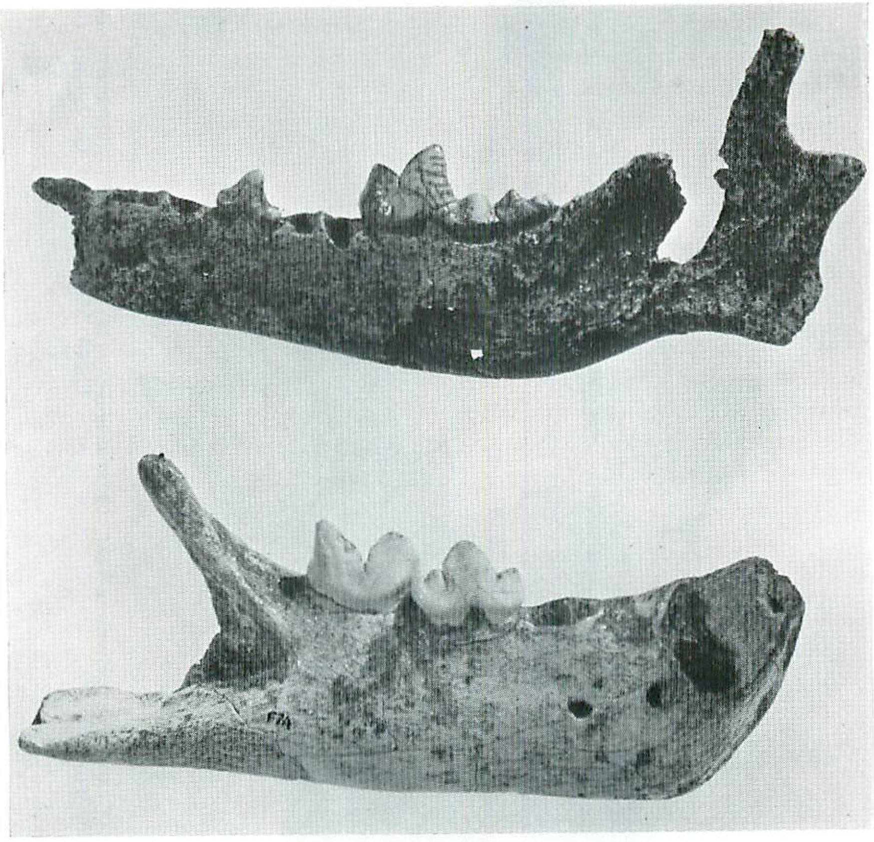

Plate 24C.

Top. Left mandible of an extinct species of dhole (today represented by the 'Wild Dogs' of Asia), *Xenocyon lycaonoides*. Westbury provides the first record of this canid in Britain. Sc. 2/3rd.

Below. Right mandible of an extinct species of large cat (the size of a lion), *Felis gombaszeogensis*, the 'European Jaguar'. Westbury provides the first record of this felid in Britain. Sc. 2/3rd. Photo: M. Gray, Dept. Geol. Univ. Coll. Lond.

The majority of horse remains belong to a very large caballine horse, referable to *Equus mosbachensis* Reichenau. One molar tooth has been found which appears to belong to a zebrine horse.

Small mammal material has been obtained from some horizons, but breakdown of large samples specifically to find them is yet to be undertaken.

3. *The Rodent Earth* – contains predominately small mammals. The occasional large mammal finds are usually the teeth and bones of young individuals. No clear stratification is seen, so the fauna has been listed as a whole, though samples were collected at various recorded levels in the deposit. *Pitymys gregaloides* Hinton is by far the most common mammal present, while *Microtus* is far less common. The *Microtus* specimens require closer examination to assign them to a species. There are no definite records of *Mimomys* as yet, but *Arvicola* is well represented by *Arvicola cantiana* Hinton. The vole *Pliomys* is recorded here for the first time in Britain. Shrews are very common, the majority being smaller than *Sorex araneus* L. and very similar to *Sorex runtonensis* Hinton, but many differing from the latter to a variable degree. At present it may be said that two small *Sorex* species are represented, one of which is comparable to *S. runtonensis*. The occurrence of the desman, *Desmana moschata* Pallas marks the only other record of this genus in Britain outside the Cromer Forest Bed Series.

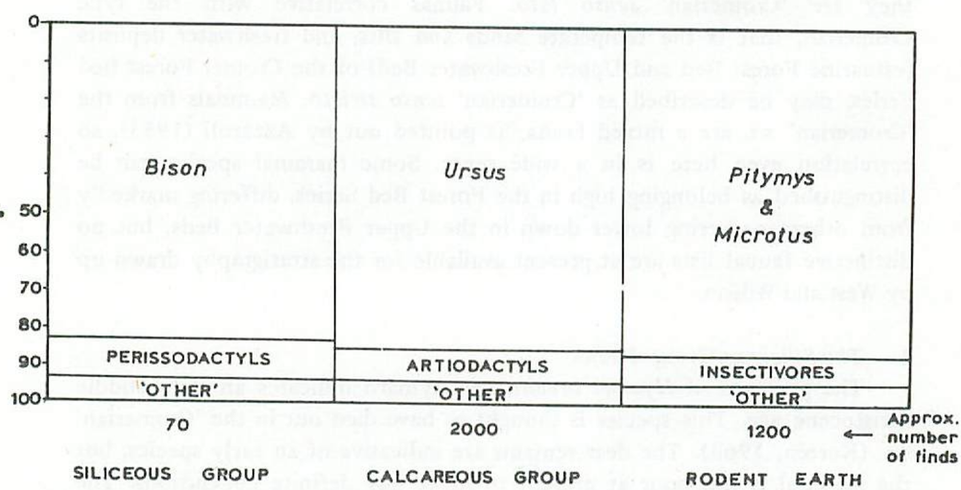

Fig. 91

The relative number of recognizable mammal finds in the three main stratigraphic groups, expressed as approximate percentages, (± 5% in each case).

AGE OF THE FAUNAS

Terminology

Unfortunately the subdivision of the early Pleistocene is confusing, since different usages have been employed in different areas, and previous attempts of correlation are now being critically questioned. Since the Westbury faunas correlate well with those of continental sites, a continental usage is prefered here (see Table 2). The Holsteinian interglacial is taken to be the equivalent of the Hoxnian, and the Elsterian denotes the preceding glacial phase, possibly the Anglian (Mitchell *et al.* 1973). Earlier stage names are difficult to apply. Zagwijn *et al.* (1971) have shown that in the Netherlands the Elsterian is preceded by three interglacials with two glacials between, termed the "Cromerian Complex", which is preceded by the Menapian glacial phase. West and Wilson (1966), and West (1972) have distinguished two interglacials in the Cromer Forest Bed Series, the Cromerian and the Pastonian, in between which is the Beestonian cold phase. These cannot, so far, be correlated with the Dutch "Cromerian Complex" by palynology. Shackleton and Opdyke (1971) offer correlation with the Dutch sequence, for their results show that there was a very complex period of warm and cold phases between the Elsterian and Menapian, representing at least 400,000 years. The Waalian temperate and Eburonian cold phases are usually envisaged as preceding the Menapian, marking the beginning of the main glacial epoch in the late Lower Pleistocene. So called 'Cromerian' mammal faunas can in general only be related to a pre-Elsterian and post-Menapian age therefore, so they are 'Cromerian' *senso lato*. Faunas correlative with the type Cromerian, that is the temperate sands and silts, and freshwater deposits (estuarine Forest Bed and Upper Freshwater Bed) of the Cromer Forest Bed Series, may be described as 'Cromerian' *senso stricto*. Mammals from the 'Cromerian' *s.s.* are a mixed fauna, as pointed out by Azzaroli (1953), so correlation even here is in a wide sense. Some mammal species can be distinguished as belonging high in the Forest Bed Series, differing markedly from others occurring lower down in the Upper Freshwater Beds, but no distinctive faunal lists are at present available for the stratigraphy drawn up by West and Wilson.

1. *The Siliceous Group Fauna*

The presence of *Hyaena brevirostris* Aymard indicates an early Middle Pleistocene age. This species is thought to have died out in the 'Cromerian' *s.s.* (Kurtén, 1968). The deer remains are indicative of an early species, but the material is too poor at present to make any definite conclusions. The genus *Bison* is thought to have entered Europe in the late Lower Pleistocene (Kurtén 1968), it being *Bison schoetensacki* Freudenberg, a relatively small species. The small *Bison* sp. from Westbury may be this species. The rest of the Siliceous Group fauna is too poorly preserved or too long ranging to give any more clues as to its age. The fauna therefore appears to be no later than 'Cromerian' *s.s.* and no earlier than late Lower Pleistocene. As is discussed below in the conclusions the fauna appears to be derived, the Siliceous Group deposits not being contemporary with their contained fauna.

TABLE 2

		British Isles	N.W. Europe	Range of the Westbury Faunas		
				Silic.Gp.	Calc.Gp.	Rodent E.
PLEISTOCENE	Upper	Flandrian DEVENSIAN Ipswichian WOLSTONIAN	Holocene WEICHSELIAN Eemian SAALIAN			
	Middle	Hoxnian ANGLIAN Cromerian *s.s.* BEESTONIAN Pastonian	Holsteinian ELSTERIAN 'Cromerian' Complex	?	t	t
	Lower	BAVENTIAN Antian THURNIAN Ludhamian	MENAPIAN Waalian EBURONIAN Tiglian			
KEY		COLD Temperate		t = temperate fauna ? = fauna too sparse to reflect climate		

Table 2. Correlation table of the Pleistocene in the British Isles and Northwest Europe, essentially after West (1972) and Mitchell *et al.* (1973), against which are marked the approximate ranges of the three main Westbury faunas as indicated by mammals of restricted range. The Wolstonian and Anglian have also been termed the Gippingian and Lowestoftian respectfully. *N.B.* Pleistocene correlation before the Devensian is highly controversial.

2. *The Calcareous Group Fauna excluding the Rodent Earth Fauna*

The presence of *Felis gombaszoegenis* Kretzoi, *Ursus deningeri* Reichenau, *Xenocyon lycaonoides* Kretzoi, *Canis lupus mosbachensis* Soergel, *Dicerorhinus etruscus* Falconer and *Equus mosbachensis* Reichenau strongly suggest the fauna is no younger than Elsterian (Anglian).

Hemmer (1971) has reviewed *Felis gombaszoegensis*, which occurs at several sites in Europe up to the Elsterian. *Ursus deningeri* is found up to the Elsterian, and by the Holstenian has evolved into *Ursus spelaeus*. It is interesting to note that the Westbury bears are well advanced in the *'spelaeus'* direction as far as many dental measurements are concerned. The material does however still contain primitive elements in the form of the dentition and in some measurements, indicating that true *Ursus spelaeus* has not been reached. The dhole *Xenocyon lycaonoides* has been reviewed recently together with other dholes by Schütt (1973). The genus *Xenocyon* appears to have arisen to become extinct within the 'Cromerian' *s.l.*. *Canis lupus mosbachensis* has a similarly restricted range. *Dicerorhinus etruscus* is firmly believed to have become extinct in the Elsterian, to be replaced by *Dicerorhinus kirchbergensis* found in the Holsteinian (Hoxnian). *Equus mosbachensis* is distinguishable on the Westbury fauna mainly by its great size. It is larger than the caballine horse from Grays Thurrock, but is as big as that from the Cromer Forest Bed. In the Forest Bed, zebrine horses are more common than the caballine horse, the latter replacing zebrine horses in Europe through the Middle and Upper Pleistocene. At Westbury all fifteen, (except possibly one), teeth remains belong to a large caballine horse. The remains suggest a post-Forest Bed age but a pre-Holstenian age.

A lower limit of age determination, apart from the examples mentioned above, is indicated by *Felis leo fossilis* and a very large *Bison* sp. suggesting the deposits are no earlier than 'Cromerian' *s.l.* In addition *Barbastella barbastellus, Arvicola cantiana, Microtus,* and *Lemmus* are not recorded in an interglacial earlier than 'Cromerian' *s.s.* so far. The presence of *Lemmus* sp. at Westbury marks it's earliest record in the British Pleistocene.

The Calcareous Group faunas have been considered here as a whole since the relations of the Rodent Earth to the uppermost breccias, and the fauna of the Rodent Earth, suggest the highest stratigraphic layers are still no later than Elsterian. In conclusion, these faunas appear to be no earlier than 'Cromerian' *s.s.*, probably later than the Upper Freshwater Bed of the Cromer Forest Bed Series, but no later than Elsterian.

3. *The Rodent Earth Fauna*

The presence of *Pitymys gregaloides* Hinton and *Arvicola cantiana* Hinton indicate that these deposits are no later than Holstenian (Hoxnian), while *Pliomys episcopalis* Méhely indicates the fauna is no later than Elsterian. This same early age is indicated by the *Sorex* material which appears to represent an early species. The apparent absence of *Desmana* outside the Cromerian in Britain, also suggests a correlation with an early age.

Lemmus is also found in this fauna, together with another lemming *Dicrostonyx,* marking another earliest record in British Pleistocene. The former appears to be a large form and the latter a small form. Small forms of lemmings are generally found in the European Middle Pleistocene (Koenigswald 1973). The dominance of *Pitymys* over *Microtus*, and *Talpa europaea* over *T. minor*, which is the case at Westbury, is a feature seen in the earlier Middle Pleistocene sites, also mentioned by Koenigswald. He draws attention to certain elements in Pleistocene faunas, and uses their associations to delineate four main faunal types ranging from the 'Cromerian' *s.s.* up to the Eemian. The Westbury Rodent Earth fauna falls into his 'Arvicola – Fauna Type 1'. Comparable faunas cited in this are those of Mauer, Erpfingen 1 and 3, Hundsheim, Sudmer Berg 2, Tarkö, and Mosbach middle and upper sands. The Calcareous Group faunas considered as a whole are very similar to the mammal faunas from these sites. In fact all the Calcareous Group mammals are present at Tarkö and Mosbach, except *Neomys* and *Dama.** These European sites are considered to be of post Upper Freshwater Bed age, and no later than Elsterian.

The geological relations of the Rodent Earth to the rest of the Calcareous Group are such that it may be contemporary with the Upper Breccias, or be a later infill. In either case the youngest deposits in the whole infill appear to be no later than Elsterian.

* See Jánossy 1969 for Tärko faunal list.

CURRENT CONCLUSIONS

The following tentative history of the site may be drawn up, subject naturally, to the continuing work in progress, especially the sedimentology.

The original cavity in which the deposits lie, opened up under phreatic conditions in pre-Middle Pleistocene times, when the local water table must have been at least 800 ft. O.D. The cavity probably became part of a larger cave system which developed an entrance at ground level to become a sedimentary trap. Stream waters, possibly intermittent, were of low energy mainly, bringing in a fine sand. Occasional episodes of higher energy brought in gravel fractions forming washout lenses within the sands. The gravel constituents are very rounded, suggesting either that they have been transported a long way, that they were relatively soft, or that they were already rounded at their source. In the case of the pale white siliceous pebbles, the associated pale chert, and the rounded Carboniferous Limestone chert, the latter would seem to be the case. They probably occurred as pebbles within a cover rock similar to, but later than the Littorial Lias conglomerates seen flanking the Mendips. If these pebbles do belong to the Harptree Beds, as suggested earlier, they must have been eroded into pebble form later than Lower or Middle Jurassic times. The following erosive cycles occur in the Cretaceous and Tertiary transgressions. The former would be in agreement with Donovan (1969) who emphasized pre-Gault Cretaceous erosion in the Mendip plateau formation, and the later with Ford and Stanton (1968) who regard it as late Pliocene. A close study of the gravels is in hand since they are clearly of considerable importance. The lateritic gravels and the bone remains appear to have been derived from pre-existing mineralised deposits. The age of this derived Siliceous Group fauna is probably no earlier than the late or pre-glacial Lower Pleistocene, and no younger than 'Cromerian' *s.s.* The actual age of the Siliceous Group is hard to determine at present. It may have been deposited by meltwaters at the end of a cold phase, which would account for surface stream water at this high level. In addition the uniform fine grained sand is of an aeolian character. Similar sands commonly form under cold conditions, and become ice trapped, and are redeposited after melting.

The energy of the supply stream appears to have gradually dropped during deposition of the Siliceous Group, and silting up within the cave finally occurred at about 760 ft. O.D. At this stage large roof falls occurred, and a part of the cave system, probably upstream, became available as a den for carnivores.

The fauna of the overlying Calcareous Group is highly reflective of a den environment. *Fig.* 91 indicates the high proportion bears over all other mammals. These are represented by bones and teeth of individuals of all ages, from milk teeth and cub bones, to highly worn teeth of old individuals. An area must therefore have existed providing a well sheltered environment for this complete age spectrum. The apparently fallen roof limestone seen throughout the Calcareous Group suggest that the area exposed at present was formerly roofed, and it is proposed that this area was the lower part of a cavern system whose upper northerly area was the living quarters for carnivores. For such a cavern to have existed a considerable amount of relief must have been since removed from the Mendip plateau. The breccia horizons are typical of those found in caves, having sticky red-brown matrices, frequent stalagmite, and little or no sharp horizontal stratification. On the other hand the conglomerates form wide stratified layers, containing well rounded pebbles and extremely abundant bone scrap and teeth. Manganese and iron staining is heavy in some layers. All these facts suggest that water has played some part in their deposition. Thus, incoming fluxes of water would be transporting bone and limestone material from the higher den quarters of the cavern, to deposit it in the sediment trap which is the exposure seen today. The later stages of the Calcareous Group exposure appear to be the general breakdown of the limestone roof, and the formation of a red brown earth infill, rich in small mammals which were possibly introduced in owl pellets. The latter could indicate a local breach in the limestone roof. These deposits are no later than Elsterian, and their rich fauna indicates they belong to a temperate phase.

The flints are hard to relate to the sedimentological history of the Calcareous Group. If they had been transported in by water due to the erosion of some sort of cover or residual deposit, one would expect to find them in the gravels below, which include a far greater variety of the area's former cover history by way of erratics. In addition, the gravel conditions favour siliceous preservation, but no trace of flint has been found in them. If conditions of erratic transportation into the infill were possible in Calcareous Group times, one would expect a far greater range than just flint. The fact that at least one appears to have been worked by man is suggestive of all the flint being brought into the area by him. The nearest chalk to the site today is nineteen miles South East (N.G.R. ST 785378). If future finds confirm the presence of man, Westbury will be the earliest record in Britain so far (p. 307).

The Calcareous Group faunas of Westbury provide a good faunal link in this country between the type 'Cromerian', the Cromer Forest Bed

Series, and the classic 'late Cromerian' sites of Europe, in particular, Mauer, Hundsheim, Tarkö and Mosbach).

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DISPOSAL

The majority of finds are housed in the Department of Geology, Bristol University, under the University of Bristol Spelaeological Society's catalogue number M.38. Bristol City Museum has a small collection of Westbury material. A representative collection is to be presented to the Department of Palaeontology at the British Museum (Natural History).

ACCESS and COLLECTING

The Westbury site is a working quarry. Visits can only be made with the permission of the management on each occasion. Each visit is made entirely at the visitor's own risk and the owners do not accept any liability for any accident that may occur. A quarry is a dangerous place. A visitor may be required to sign an indemnity form.

If specimens are collected they should in each case be made available to the author of this paper, Mr. M. J. Bishop, Department of Geology, University College London, Gower Street, London WC1, for examination.

Editors

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