Minchin Hole Cave

Highlights

The complex story of changing Pleistocene sea-levels is nowhere better seen than in the rocks and mammal faunas of this site. Its detailed evidence for Ipswichian and earlier interglacial events is unrivalled, and forms one of the most important Pleistocene sites in Wales.

Introduction

Minchin Hole Cave [SS 555 869] has been studied for over a century and is noted for the diverse faunal remains contained in its sequence of marginal marine and terrestrial sediments. The sequence provides an opportunity to study the simultaneous effect of climatic change on sea-levels and local terrestrial environments. The site was chosen by George (1932) as the type locality for the *Patella* raised beach. The first major excavations at the site were carried out by Wood in 1850 (see Falconer 1860, 1868). It was also noted by Prestwich (1892), Strahan (1907a) and Baden-Powell (1933) and was partially re-excavated by George (1932, 1933b). From the early 1940s to 1957, further extensive investigations were conducted by Allen and Rutter (1948) and Rutter and Mason (Rutter 1948, 1949, 1950, 1952, 1953, 1955, 1956, 1957), and its stratigraphical significance in the context of the Pleistocene history of the Irish Sea Basin discussed (Bowen 1966, 1969a, 1970a, 1971a, 1973a, 1973b). Minchin Hole was further excavated in the 1970s and the initial results and implications presented by Sutcliffe and Bowen (1973) and Bowen (1973c). The site has also been mentioned by Williams (1941), Bowen (1973d, 1974, 1977a, 1977b, 1980a, 1984), Peake *et al.* (1973), Sutcliffe (1976), Harrison (1977), Campbell *et al.* (1982) and Campbell (1984). A geochronology has been based on the epimerization of isoleucine in fossil shell protein from the raised beaches (Andrews *et al.* 1979; Bowen 1981a; Davies 1983; Bowen *et al.* 1984; Bowen et *al.* 1985; Bowen and Sykes 1988). Detailed biostratigraphical descriptions have been given by Sutcliffe (1981), Sutcliffe and Currant (1984) and Henry (1984a).

Description

Minchin Hole is the largest of the Gower caves. It is a single chambered fissure cave cut in Carboniferous Limestone; it opens onto a narrow gully entered by the sea at high tides.

William Buckland visited Minchin Hole in July 1831, but there is no record of any excavation (Sutcliffe 1981). Falconer (1860, 1868) documented Wood's excavations in 1850 and recorded a sequence of sands with extant marine shell species, overlain by bone-bearing beds containing remains of narrow-nosed rhinoceros *Dicerorhinus hemitoechus* and straight-tusked elephant *Palaeoloxodon antiquus.* He noted that the Gower caves contained two apparently distinct faunal assemblages: one with the above temperate species, and another with woolly mammoth *Mammuthus primigenius* and woolly rhinoceros *Coelodonta antiquitatis* Blumenbach, indicating colder conditions (Sutcliffe 1981). *Hippopotamus* was not recorded from the deposits at either Minchin Hole or Bacon Hole, but Falconer did record it as a member of a comparable 'warm' fauna at nearby Ravenscliff Cave.

George (1932) provided the first detailed description of the stratigraphic succession near the cave entrance:

4 Wind-blown sand

3 Coarse gritty sand with common remains of *Neritoides obtusata* (L.) — the *Neritoides* Beach

2 Ossiferous breccia with remains of a temperate mammal fauna

1 Pebbly beach with common remains of *Patella vulgata* (L.) — the *Patella* Beach

Allen and Rutter (1948) and Rutter (1948, 1949, 1950, 1952, 1953, 1955, 1956, 1957) recorded additional Pleistocene mammalian specimens, the stratigraphic context of which is uncertain, and evidence of human occupation (Iron Age, Roman and Saxon) from the upper levels. Details of the Iron Age B and Roman remains were given by Williams (1941). This series of excavations exposed, for the first time, an earlier raised beach deposit, subsequently rediscovered and called the Inner Beach (Sutcliffe and Bowen 1973) which was not encountered by George at the cave entrance.

Recent excavations have described a more detailed sequence (Sutcliffe 1981; Henry 1984a; Sutcliffe and Currant 1984):

12 Flowstone floor**

11 Breccia**

10 Flowstone floor**

9 Upper Red Cave Earth**

8 Earthy Breccias

7 Neritoides Beach*

6 Fallen flowstone block

5 *Patella* Beach*

4 Flowstone floor

3 Lower Red Cave Earth

2 White layer (incipient stalagmite?)

1 Inner Beach

* These beds make up the Outer Beach

** Inner and Outer Talus Cones

This sequence is shown schematically in (Figure 5).

Interpretation

In discussing the evidence from the Gower caves, in particular, the relationship between the glacial deposits and breccias of the area, Prestwich (1892) concluded that the caves had probably been filled with their mammalian remains after deposition of the local boulder clay. Strahan (1907a), however, considered that the bone-bearing beds were related to and were similar in age to, the raised beach deposits of Gower, which he believed to be of pre-glacial or interglacial age. He believed that the bone-beds pre-dated the earliest glaciation of Gower.

This relationship was confirmed by George (1932, 1933b). By recognising two distinct marine units (his beds 1 and 3) separated by terrestrial deposits (bed 2), George (1932) concluded that "the stratigraphical distinction that can be made between the *Patella* Beach and the *Neritoides* Beach thus represents a time interval of not inconsiderable dimensions". He regarded both beaches as being older than the first ('Older Drift') glaciation of the area, and considered the *Patella* Beach to have been deposited under conditions of incipient glaciation. The latter claim was refuted by Baden-Powell (1933) who observed that the fauna of the *Patella* Beach could easily be found in the area today. George (1970) maintained, however, that distantly-derived igneous erratics in the *Patella* Beach of South Wales may have been carried by drifting ice at the onset of arctic conditions.

The Pleistocene chronology of Minchin Hole was discussed in the context of a wider region by Bowen (1966, 1969a, 1970a, 1971a, 1973a, 1973b). Originally, he accepted Mitchell's (1960) proposal that the *Patella* Beach (bed 5) at Minchin Hole was Hoxnian, and from this, argued that the Ossiferous Breccia (bed 2 of George 1932) was Saalian, the *Neritoides* Beach was Ipswichian Stage and the overlying breccias (beds 9–12) were Devensian Stage (Bowen 1966). Subsequently, however, Bowen (1969a, 1970a, 1971a, 1973b) after establishing a lithostratigraphy for the coastal Pleistocene deposits around Gower, argued that the marine and bone-bearing beds were Ipswichian, and the overlying deposits were Devensian. Bowen (1971a) noted that the evidence from Minchin Hole could be used to support Zeuner's (1959) claim that the 'last interglacial' was characterised by two discrete high sea-level events (Main and Late Monastirian).

New excavations (Bowen 1973c; Sutcliffe and Bowen 1973) revealed an 'Inner Beach' (bed 1) as well as a *Patella* (Outer) Beach recorded by George. George considered the *Neritoides* deposit to be a transitional marine and terrestrial lithofacies. Sutcliffe and Bowen reconstructed the following sequence of events — the Inner Beach (bed 1) was deposited during a sea-level stand higher than at present. With a fall of sea-level, the surface of the Inner Beach became cemented (unit 2) and the Lower Red Cave Earth (bed 3) accumulated with its contained bones. A subsequent rise of sea-level to just above the present level cut a cliff in the Inner Beach and Red Cave Earth. The Outer Beach (consisting of the *Patella* (bed 5) and *Neritoides* (bed 7) Beaches combined) was deposited unconformably on the earlier sediments. As sea-level fell again, sand from the exposed sea floor was blown into the cave. Environmental conditions deteriorated during the Devensian, and the Outer and Inner Talus Cones (beds 9–12), made up of frost-shattered scree, accumulated, with the Outer Talus Cone blocking the cave entrance. This was all but completely removed during the Holocene.

Sutcliffe and Bowen (1973) proposed that both the Inner and Outer Beaches, together with the intervening ossiferous deposits, were Ipswichian, although Bowen (1973c) noted the possibility that the two beaches could represent separate interglacials (the Hoxnian and the Ipswichian), with the intervening cave earth perhaps representing a cold interval (the Wolstonian?), or with the Inner Beach representing an interglacial between the Hoxnian and Ipswichian (Oxygen Isotope Stage 7). Bowen noted that if the beaches were Hoxnian and Ipswichian respectively, then the Red Cave Earth must have formed over a period of 200,000 years which is unlikely. He therefore regarded the two high sea-level phases as two events in the Ipswichian Stage. The *Neritoides* Beach was grouped as part of a *Patella* Beach sequence (see also Bowen 1973d, 1974, 1977a, 1977b; Peake *et al.* 1973).

In a study of the bird fauna, Harrison (1977) recorded dunlin *Calidris alpina* (L.) and razorbill *Alca torda* (L.) from the lower beds of the sequence at Minchin Hole, tending to confirm their interglacial character. He noted that the dunlin bones had probably been introduced in owl pellets, but that the razorbill may have nested within the cave.

Recent work at Minchin Hole has provided a more precise chronological framework for the sequence, with the application of amino acid geochronology and Uranium-series techniques (for example, Andrews *et al.* 1979; Davies 1983; Bowen *et al.* 1985; Bowen and Sykes 1988). Further amplification of the lithostratigraphy and biostratigraphy have also been provided (Sutcliffe 1981; Sutcliffe and Currant 1984; Henry 1984a).

Andrews *et al.* (1979) used amino acid ratios from *Patella vulgata* to correlate the Outer (*Patella)* Beach at Minchin Hole with raised beach remnants elsewhere in south-west Britain and suggested that it was Ipswichian in age. Following this, Bowen (1980a) suggested that the *Neritoides,* the *Patella* and the Inner Beaches at Minchin Hole might correspond with the high sea-level stands of Oxygen Isotope Sub-stages 5e, 5c and 5a. The amino acid ratio derived from the Inner Beach (Bowen 1981a), indicated a greater age than that obtained from the *Patella* Beach; but both were still considered to belong to the Ipswichian.

Following the earlier amino acid work (Andrews *et al.* 1979; Davies 1983), and using Uranium-series age determinations from broken stalagmite at Bacon Hole, the current amino acid dating (Bowen *et al.* 1985) shows that the Outer Beach (*Patella)* is probably time-equivalent to Oxygen Isotope Substage 5e, and the Inner Beach contains faunal elements of Oxygen Isotope Sub-stages 7a and 7c (Bowen and Sykes 1988).

Work at Minchin Hole by Sutcliffe (1981), Henry (1984a) and Sutcliffe and Currant (1984) allows the following generalised sequence of events to be reconstructed. 1) The Inner Beach (bed 1) probably formed during temperate conditions with

relative sea-level from 3 to 5m higher than at present (Sutcliffe 1981; Sutcliffe and Currant 1984). Its mixed molluscan fauna has been ascribed to sub-stages of Oxygen Isotope Stage 7 (Bowen and Sykes 1988). An erratic of volcanic tuff (perhaps from south Pembrokeshire or Anglesey) may derive from an Irish Sea glaciation which pre-dates Stage 7 (Bowen 1984; Henry 1984a). Following partial cementation and cracking of the Inner Beach, the Lower Red Cave Earth (bed 3) was deposited. This indicates a fall in relative sea-level when frost-shattered and colluviated material accumulated during colder conditions. The fauna from the Lower Red Cave Earth contains a large form of northern vole, *Microtus oeconomus* (Pallas), which led Sutcliffe (1981) to correlate the bed with the Basal Sands horizon at Bacon Hole, where similar remains were recovered (Stringer 1977b).

The Inner Beach and Lower Red Cave Earth were cuffed by the sea when the Outer Beach was deposited. The Outer Beach is a storm beach facies, and is best developed at the cave mouth where it comprises a mixture of boulders, shingle and shell fragments (Sutcliffe 1981). It has an altitudinal range of about 6m within the cave and is ascribed to Oxygen Isotope Sub-stage 5e by aminostratigraphic correlations with Bacon Hole Cave (Bowen *et al.* 1985; Bowen and Sykes 1988). Uranium-series determinations of 127,000 ± 21,000 to 107,000 ± 10,000 BP on a fragment of flowstone (unit 6) resting on the surface of the Outer (*Patella)* Beach (bed 5) precludes a later age for the Outer Beach (Sutcliffe and Currant 1984). The *Patella* Beach is overlain by the *Neritoides* deposit, (bed 7) and although George (1932) described a breccia between the two units, more recent excavations have not yet confirmed this relationship, although in places the *Neritoides* Beach does merge with brecciated limestone. For the most part, the *Neritoides* Beach is a sandy deposit containing the remains of rodents, other small mammals and many small littoral gastropods. The deposit formed during a fall in relative sea-level after the *Patella* Beach event (Sutcliffe 1981; Henry, 1984a). It is thought to be a transitional deposit between the fully marine *Patella* Beach and the overlying terrestrial sediments (the Earthy Breccias).

The Earthy Breccias (bed 8) contain the remains of birds (Harrison 1977; Sutcliffe and Currant 1984) and relatively abundant mammalian remains including — spotted hyaena *Crocuta crocuta,* lion *Panthera leo* (L.), bear *Ursus* sp., narrow-nosed rhinoceros *Dicerorhinus hemitoechus,* red deer *Cervus elaphus* L., fallow deer *Dama dama* (L.), field vole *Microtus gregalis* Pallas and wood mouse *Apodemus sylvaticus* (L.). A previous record of horse (Sutcliffe 1981) was erroneous (Sutcliffe and Currant 1984). This fauna is typical of the Ipswichian Stage, though it lacks *Hippopotamus* (Sutcliffe and Currant 1984). The Earthy Breccias were deposited at a time of relatively lower sea-level than that of today.

As environmental conditions deteriorated after the Ipswichian Stage, sea-level continued to fall and the Outer and Inner Talus Cones formed at Minchin Hole. Cemented sand in the Outer Talus deposits was probably deflated from the exposed shore as sea-level fell. The uppermost layers of the talus are thermoclastic in origin and are of presumed (Late) Devensian age.

The Inner Talus is capped with a thick flowstone, and this is overlain by some Holocene deposits, including Romano-British occupation debris (Sutcliffe and Currant 1984). Finally, the continuing rise of the Holocene sea to its present level removed most of the Outer Talus deposits from the cave entrance.

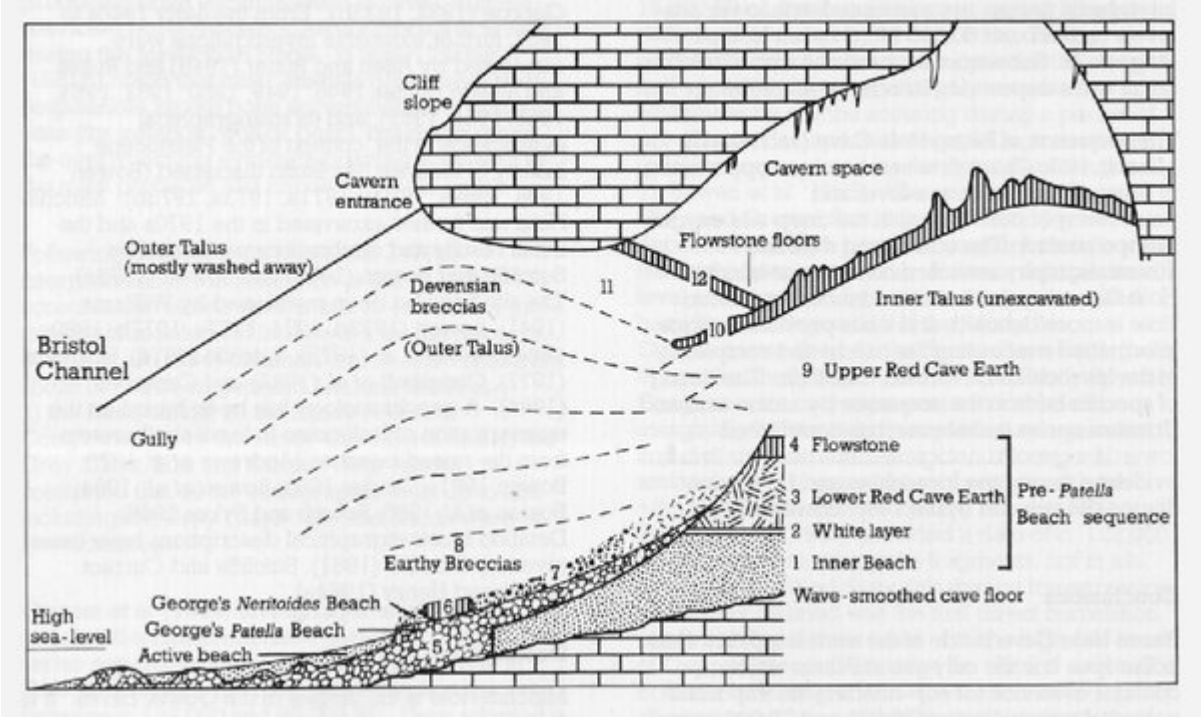
Minchin Hole provides one of the longest Pleistocene records in Wales. Of particular importance is the existence of two distinct marine deposits (Inner and Outer Beaches), both representing former relative high sea-level stands. A composite single interglacial age for these beaches was once proposed, but recent evidence suggests that the Outer (*Patella)* Beach is Ipswichian (Oxygen Isotope Sub-stage 5e), while the Inner Beach has been ascribed to Oxygen Isotope Stage 7. The intervening Lower Red Cave Earth, therefore, represents a period of lowered sea-level later in age than the Inner Beach, but earlier than the Outer (*Patella)* Beach. The *Neritoides* Beach represents a transition between the fully marine Outer (*Patella)* Beach and the overlying terrestrial sediments. Faunal, amino acid ratio and Uranium-series evidence points strongly to an Ipswichian age for the Outer Beach, *Neritoides* Beach, and the overlying Earthy Breccias. All succeeding deposits are interpreted as having accumulated when sea-level was lower than at present during the Devensian Stage.

Although Bacon Hole provides the more complete faunal record for the Ipswichian and Early Devensian (Stringer *et al.* 1986), Minchin Hole provides a longer record of sea-level changes.

Conclusions

Minchin Hole Cave contains the longest record of ice age time in Wales. Of European significance, is evidence at the site for two high global sea-level events, one at 200,000 years ago, the other 125,000 years ago. It proves a period of severe climate between about 200,000 and 130,000 years ago, and evidence for the last ice age. Because Minchin Hole was beyond the extent of the last ice-sheets, such evidence from that time relates to cold climate processes and events. The changeover from the last interglacial (125,000 years ago) to the last ice age is of some significance. This may contain important pointers for future climate. The full range of modern techniques has been applied at Minchin Hole Cave, and its scientific status is international in importance.

References



(Figure 5) Pleistocene sequence at Minchin Hole (from Sutcliffe and Currant 1984)