

The Age and Context of the KC4 Maxilla, Kent's Cavern, UK

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Kent's Cavern is one of Britain's most important Palaeolithic sites. The Torquay Natural History Society excavations in the Vestibule (1926–1928 and 1932–1938) yielded Middle and Early Upper Palaeolithic deposits as well as a fragment of human jaw (KC4). Higham et al. (2011) recently identified it as the oldest modern human fossil known from North West Europe, with a date estimated, using Bayesian modelling, at 44,200–41,500 cal BP (at 95.4% probability). However, White and Pettitt (2012) and Zilhão (2013) have claimed that the poor quality of the excavations and lack of stratigraphic integrity cast doubt on the archaeological and dating evidence from the site. Here, we present a thorough re-analysis of the excavations and show that they were in fact conducted to a reasonable standard. We also carefully examine the stratigraphic and sedimentological sequence and present twelve new AMS determinations from key contexts to test the previous model and chronology. We find that, while Trench C has good stratigraphic integrity, there is some evidence of post-depositional disruption of certain parts; some post-depositional movement is also shown by a limited number of artefact refits. There are two outlying AMS determinations dating to c. 32,000 BP. We therefore cannot exclude completely the possibility that the maxilla's age could be younger than the published probability distribution function (PDF). Our analysis lends support to the assessment by Higham et al. (2011) of the site and KC4 and shows that it offers considerable potential for future study.

Keywords: Kent's Cavern, Torquay Natural History Society, AMS radiocarbon dating, Palaeolithic archaeology, KC4 maxilla, ultrafiltration, Bayesian modelling

INTRODUCTION

Kent's Cavern (Torquay, Devon, UK) has been excavated many times, notably by Pengelly between 1865 and 1880 (Pengelly, 1884; Campbell & Sampson, 1971; Lundberg & McFarlane, 2005) and the Torquay Natural History Society (TNHS) from 1926 to 1941 (Campbell & Sampson, 1971). The TNHS dug in several parts of the cave (Figure 1, and Online Supplementary Materials) but their most significant work was carried out just

inside the north entrance to the cave in the Vestibule, where excavations were conducted from 1926 to 1928 and again from 1932 to 1938. In this chamber Pengelly had already excavated the top 4 ft (1.22 m) of the Cave Earth, which was of Devensian age. The TNHS excavators extended this work, reaching a depth of 34 ft (10.36 m) below datum in the middle of the chamber. Finds included Earlier Upper Palaeolithic and Middle Palaeolithic artefacts, and a small fragment of a human maxilla, KC4, recovered in pieces at a depth of 10 ft 6 in

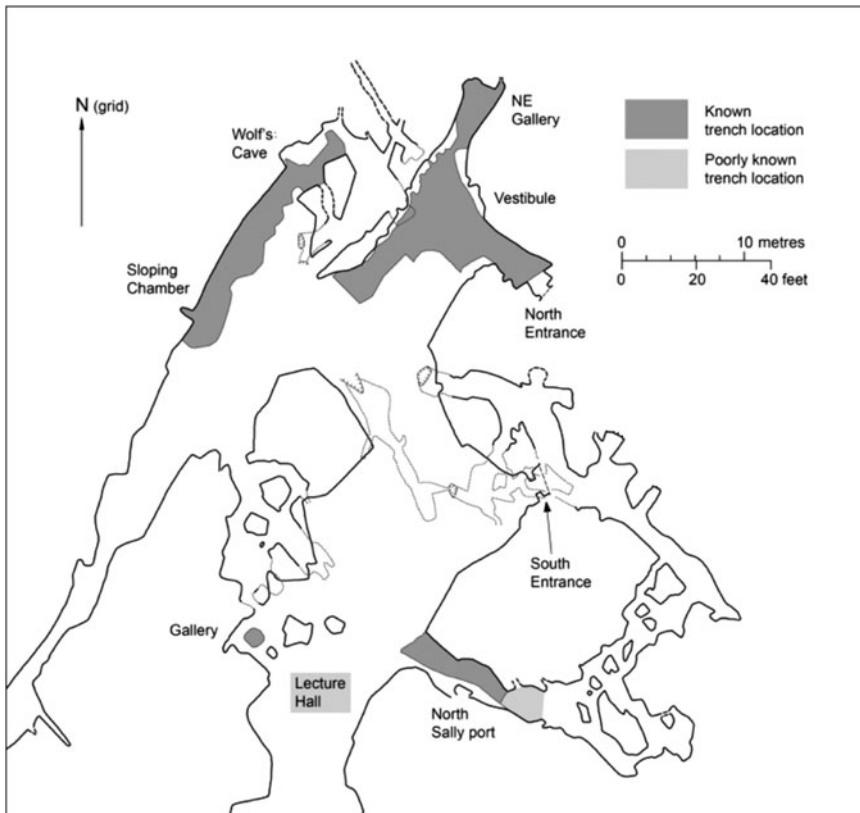


Figure 1. Plan of the outer part of the cave showing location of the Vestibule and other areas excavated by the TNHS.

(3.20 m) on 14 March 1927. This was examined by Keith (1927), who considered it to be of modern human type. Higham and colleagues (2011) confirmed a modern human attribution based on extensive morphometric analysis and comparison against a range of modern human and Neanderthal teeth. The KC4 maxilla was directly radiocarbon-dated in 1988, yielding an age of $30,900 \pm 900$ BP, confirming its Earlier Upper Palaeolithic age (Hedges et al., 1989). More recently, new dating work undertaken to better define the age of the maxilla by dating associated fauna has suggested an earlier age of *c.* 41,000–44,000 cal BP for the specimen (Higham et al., 2011).

This result has been challenged by White and Pettitt (2012), who claim to

have examined fully the circumstances of the maxilla's discovery, and conclude that the TNHS excavation in the Vestibule was 'a poorly executed and poorly recorded enterprise' (White & Pettitt, 2012: 10). In addition they state that the context of the KC4 maxilla is so unclear that it 'may just as well have stayed in the ground for all its value to modern Palaeoanthropology' (White & Pettitt, 2012: 24). Their claims are repeated by Zilhão (2013: 32), who further suggests that the Vestibule sequence has little or no stratigraphic integrity. Here we provide a detailed assessment of the excavation and demonstrate, in contrast, that it was conducted to a reasonable standard, giving the potential to reconstruct a reliable context and therefore inferred age for KC4.

In addition, we acquired new data to examine the stratigraphy and test the integrity of the sequence by refitting artefacts and obtaining a series of new AMS dates.

THE TNHS EXCAVATIONS: ORIGIN AND EXCAVATORS

The TNHS excavations were overseen by a committee of the British Association for the Advancement of Science (Roberts, 1999), with TNHS directors supervising work in the cave. For the first three seasons (January 1926 to July 1928, the crucial period of excavations in the Vestibule during which the KC4 maxilla was recovered) work was co-directed by H.G. Dowie, Frederick Beynon, and Arthur H. Ogilvie (Beynon et al., 1926, 1929a, 1929b; Dowie & Ogilvie, 1927). Dowie had some archaeological training, having worked with Dorothy Garrod at Torbryan in 1924 (Roberts, 1999). Beynon and Ogilvie acted as leaders in geology and palaeontology respectively (Dowie, 1928). From January 1929 to December 1935 work was directed by Beynon and Ogilvie, while from 1936 to 1941 the excavations were directed by Ogilvie assisted by B.N. Tebbs and E.H. Rogers (Beynon & Ogilvie, 1930; 1931; 1932a; 1932b; 1933; 1934; 1935; 1936; Ogilvie et al., 1937; Ogilvie & Tebbs, 1938; Ogilvie, 1938–1941).

Before the start of the Kent's Cavern excavation, the TNHS members had gained experience over two seasons at Torcourt Cave (Dowie, 1925)—an excavation that Roberts (1999) has described as having been conducted to a high standard. Excavation at Kent's Cavern was carried out by the directors and male members of the TNHS, assisted by a paid workman, the latter taking on heavy work such as breaking large rocks and removing sorted spoil. The material excavated was

then sorted by team members, which included men and women (Beynon et al., 1926; 1929b). These early published reports make it clear that the directors were active in the excavation, and that a limited number of other volunteers were involved. We have no detailed day-by-day records of attendance at the excavation for the early years but the excavation journals list the persons present for its later stages (see Online Supplementary Materials). These confirm that even at this late stage, the directors (Beynon and Ogilvie in November 1935, Ogilvie from 1936 onwards) were present on every single day on which intact deposits were being dug. Furthermore, the other members present generally consisted of a small nucleus of regular attendees, who would have become skilled at their respective tasks.

Professional quarrymen were employed occasionally and, when needed, carried out blasting and heavy rock clearing work. On days when the quarrymen were in the cave, the journal records that no digging of the deposits took place.

EXCAVATION METHODS

The TNHS learnt their techniques at Torcourt Cave among the Torbryan caves, and the archives for the excavations at both Torcourt Cave and Kent's Cavern show considerable similarities in approach. Working methods at Torcourt Cave are described in a preliminary manuscript report in the Torquay Museum archive: 'The method of excavation was the same throughout, the earth being taken out by means of small hand picks, and sent up to the entrance in buckets to be sorted in full daylight. Measurements were taken as the work proceeded' (Interim report on the further Exploration of Cave A.i at Torbryan, Torquay Museum [hereafter TM]: AR4422).

Tool receipts in the Kent's Cavern excavation archive (TM: AR4300) include references to small picks. Several archive photographs also show small tools including small hand shovels and a small pick with a total blade length which can be estimated from the photograph as about 20 cm long (TM: PR20558; see Online Supplementary Materials). Other smaller tools are likely to have been used but if so they would probably have been owned by the excavators (as is common on archaeological excavations today) and so are not recorded. Confirmation that the fossiliferous deposits were dug with care is provided by the excellent state of the bones in the Torquay Museum. Their condition is inconsistent with removal by large, heavy tools, and we conclude that they must have been extracted from the matrix with considerable care (B. Chandler, *pers. comm.*).

In some parts of the deposit, the journal and early published accounts of the excavation make reference to the difficulty of work in heavy, bouldery ground and hard stalagmite. Accordingly, heavy tools and occasionally blasting were sometimes required to make any headway. Beynon et al. (1926: 326) noted:

The depth of the trench varies, according to the nature of the deposit encountered, from 2 ft 6 inches to 13 ft [0.76–3.96 m]. Over quite half of the ground the work has been largely of the nature of pure quarrying, owing to the presence, in large numbers, of fallen blocks of limestone of considerable size. The best area has been near the east wall, where a good section has been kept going nearly 4 ft [1.21 m] deep, and has yielded a heavy proportion of the finds.

The reference to 'quarrying' is an honest acknowledgement of the difficulty of making progress in deposits with large boulders and massive, hard stalagmite

floors and bosses. It is important to note that similar approaches are used, by necessity, on Palaeolithic sites to this day, to remove large boulders and break up rocks that would otherwise make proper excavation impossible.¹ The work undertaken in Kent's Cavern was little different in its basic approach. Beynon et al. (1926) noted that 'quarrying' was necessary over only half the area and in fact they rapidly abandoned attempts to excavate such ground in the 1926–1928 trench, which covered Trench B, and the adjacent areas, which were only excavated to a shallow depth. The deposits near the east wall are noted as 'the best area', implying that the heavy digging methods described would not have been necessary there. This covers the area of Trench C, which was later to yield the KC4 maxilla. Here, a coherent and easily excavated deposit of loamy Cave Earth was present, which they eventually excavated to a depth of 23 ft (7 m) below datum.

Beynon et al. (1926: 326) describe the excavation method thus: 'So far as it has been physically possible, the deposits have been taken out foot by foot in slices 3 ft [91 cm] long by 1 ft [30.5 cm] broad by 1 ft in vertical depth.' This method is clearly based on that of Pengelly before them, who excavated in blocks of similar size (Lundberg & McFarlane, 2005). Pengelly's working method was to start with a cut face 4 ft (1.21 m) deep, and to advance this face across the area to be excavated in vertical, 1-ft (30.5 cm) slices or 'parallels'. One would therefore expect the TNHS excavators to have used a similar technique.

¹ We have all worked or been present at several Palaeolithic sites in which the drilling of large limestone boulders or their removal using quarrying techniques has been required (eg Abri Castanet (France), Abri Romani (Spain) and Grand Abri des Puces (France)). This is common practice in large caves with limestone boulders.

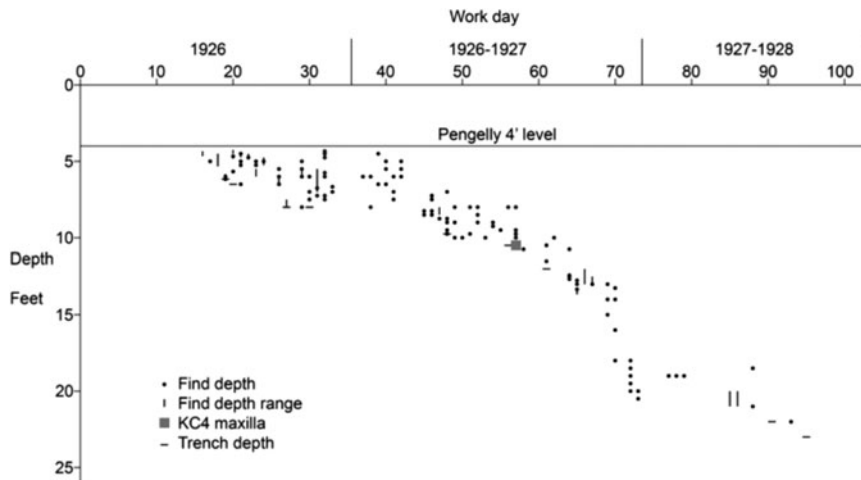


Figure 2. Plot of find depths in the 1926–1928 Trench C against find date (after Beynon, et al., 1926–1932).

We have analysed the recorded find depths for the Vestibule excavation of 1926–1928 (see Online Supplementary Materials). Figure 2 illustrates the depths of finds in Trench C (the deepest trench and the findspot for the KC4 maxilla) plotted against the date the finds were made. This shows that the excavators must have dug down to a depth of 4 ft (1.21 m) at one spot and then widened the trench, consistent with a technique similar to Pengelly’s. After the first 4 ft (1.21 m) had been excavated in Trench C, the method appears to have been modified slightly with the base of the trench taken down by 2 ft (0.61 m). Thereafter the pattern of find depths is consistent with the excavation being taken down in steps 2 ft deep (0.61 m), with no more than a 2-ft depth range being recorded for finds on any one day. An exception is 13 June 1927, on which date the trench was deepened by 3 ft (0.91 m) from 15 ft (4.57 m) to 18 ft (5.49 m) below datum. Over this depth range the deposit appears to have been almost barren (only one find was recorded in the whole trench), which doubtless accounts for the speed with

which this part of the sequence was excavated.

Further evidence is provided by the excavation journal, which refers to trench widening on 11 March 1926, 16 March 1926, and 21 October 1926, also wholly consistent with this excavation method (Beynon et al., 1926–1932). As work proceeded to greater depths, a trench with a stepped bottom profile would have resulted. This is seen in the drawn sections (TM: AR4271, AR4273) which show regularly stepped profiles of the base of the excavation at the end of the 1926 and 1926–1927 seasons. The excavation journals, the drawn sections, and the published accounts therefore all indicate that the excavations proceeded in an organized and systematic manner (*contra* White & Pettitt, 2012: 10).

After excavation, the deposits were spread out on sorting tables and sorted by hand. Sieving was not generally used, almost certainly because of the nature of the sediment. The Cave Earth is a very poorly sorted, damp deposit that is sticky with a marked tendency to form clay balls. Wet sieving of the very large volumes of

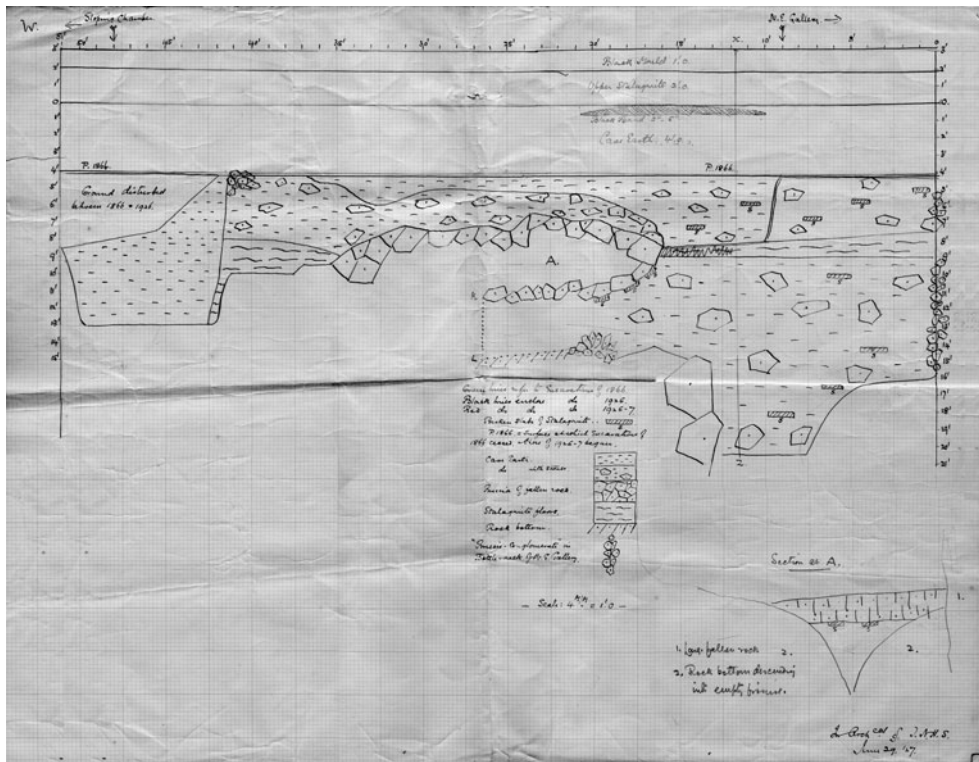


Figure 3. AR4273 Longitudinal section of the Vestibule trench, June 1927. Note that on this section the datum line is drawn horizontal, though elsewhere (Section AR4271) the slope of the deposits and datum line is accurately recorded.

sediment excavated during the TNHS excavation would have been impractical, so the system of hand sorting was a practical solution to a problem posed by the nature of the sediment. The recovery of small spalls resulting from scraper retouch shows that the recovery of finds was in fact very efficient (Jacobi & Higham, 2011).

RECORDING AND PUBLICATIONS

A substantial archive survives from the 1926–1941 TNHS excavations (TM: AR4262–AR4304; see Online Supplementary Materials). It comprises the three excavation journals, which provide a detailed record of the entire excavation and the finds made (Beynon et al., 1926–

1932; Beynon & Ogilvie, 1932–1938; Ogilvie, 1938–1941), five drawn sections (Figure 3), an inventory of flints, manuscript accounts of the excavation, and receipts, letters, and photographs.

The excavation was nonetheless criticized by Campbell and Sampson (1971) and Tingley and Chandler (2008) as being poorly recorded. These views have been accepted by White and Pettitt (2012). Campbell and Sampson (1971: 6) said of the TNHS excavations that ‘for most of their finds one only knows that they come from Kent’s Cavern, since no data on locality or even depth were recorded’. This shows that these authors cannot have seen the excavation journals, which contain extensive records of find locations and depths (see below). Indeed it is not clear

whether Campbell and Sampson saw any of the archive. They were thus scarcely in a position to fairly judge the excavation. Tingley and Chandler (2008) did use the archive but found the journals confusing and cryptic. It is important to note, however, that Tingley and Chandler (2008) is an unrefereed and unpublished student undergraduate project report (C. Jones, B. Chandler, *pers. comm.*). Moreover, Tingley carried out no work in the cave, nor was he apparently aware of the British Association excavation reports (which are not referenced anywhere in Tingley & Chandler, 2008); it is not surprising, therefore, that Tingley found the excavation journals difficult to comprehend. Again, our conclusion is that we can set these authors' work to one side.

Our study of the journals has revealed a very different situation. We have established, by comparison with known samples of the handwriting of Beynon, Dowie, and Ogilvie, that the journals were written by the directors themselves (Beynon et al., 1926–1932; Beynon & Ogilvie, 1932–1938; Ogilvie, 1938–1941). Over most of the period of the Vestibule excavation the record provided by the journals is generally good, with detailed accounts of excavation by a series of trenches between 1926 and 1928, and 1932 and 1938. We have cross-referenced the journals with the sections, the publications of the excavations, and Lake's (1934) survey, which clarifies what the journal entries refer to. In addition, a number of measurements that were made in the early stages of the excavation are repeatable today and we have found them to be accurate. This gives us confidence that the measurements given in the journals and other sources are reliable.

Over the Vestibule as a whole, finds can be assigned to fourteen identifiable trenches. No single plan of the Vestibule trenches was produced, but the sections, plans in the excavation journal (Beynon & Ogilvie,

1932–1938), and Lake's (1934) survey provide significant information, to which numerous measurements and descriptions of trench locations in the excavation journals and publications can be added. We have found that these sources are consistent, and they provide enough information to enable us to reconstruct a plan of the trench layout (Figure 4). In many cases precise measurements allow us to plot trench locations exactly: elsewhere uncertainties remain but these are generally not more than 1 ft (30.5 cm) to 2 ft (61 cm). Given that the horizontal dimensions of trenches were normally given to a precision of 1 ft this is an acceptable degree of uncertainty. The reconstructed trench layout for the Vestibule provides a coarse grid within the chamber. Given the dimensions of the largest trenches, 10 × 10 ft (c. 3 × 3 m) for Trench A (1926–1927) and 8 × 10 ft (c. 2.44 × 3 m) for Trench C (1926–1928) and Trench F (1934–1938), this grid is of fairly low resolution. Nonetheless it offers considerable potential for future work as it can be used to approximately reconstruct the sedimentary sequence and finds in three dimensions.

The excavations in the Vestibule were carried out relative to datum lines that were set to obtain as closely as possible the depth below the original top of the Cave Earth (or the base of the overlying Granular Stalagmite), allowing for the 4 ft (1.21 m) of Cave Earth excavated by Pengelly. For the 1926–1928 trench along the north-western wall of the Vestibule, the TNHS excavators assumed the existing sediment surface to be the base of Pengelly's 4 ft deep excavation. Find depths were obtained by measuring the depth below this surface, and then adding 4 ft (1.21 m) to obtain the depth below datum, which was set to represent the original top of the Cave Earth (Beynon et al., 1926–32: entry for 3 February

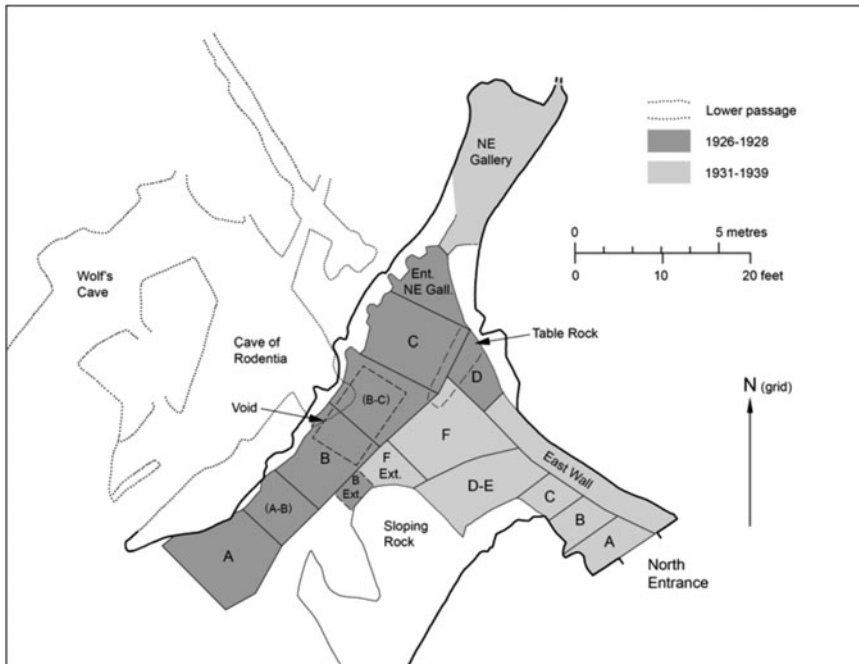


Figure 4. Plan of the Vestibule showing the location of the trenches.

1926). The excavators recorded that this produced a datum line sloping down by 2 ft (0.61 m) over the 41 ft (12.5 m) length of trenches A-C, parallel with the slope of the existing sediment surface (Section drawing AR4271). We have surveyed sediment remnants on the Vestibule walls and located both the base of the Granular Stalagmite and features shown on the TNHS sections, confirming that the 1926 sediment surface was indeed the base of the Pengelly excavation and enabling us to accurately reconstruct the position of the TNHS datum line.

White and Pettitt (2012: 11) question the reliability of the 1926–1928 datum, citing an entry in the excavation journal for 2 January 1928 (Beynon et al., 1926–1932), which reads: ‘Remeasurement, direct from base Gran. S. to lowest point reached in Trench C. shows over measurement last year = c. 1.’ The probable source of the excavators’ confusion lies with a

second stalagmite remnant, which lies about 1 ft (30.5 cm) lower. This is in fact a thin skim of stalagmite that grew in a compaction void between the Cave Earth and the wall, which overhangs at this point. If the excavators mistook this feature for the true Granular Stalagmite on 2 January 1928 (at which time it would have been 18 ft (5.49 m) above the trench floor and impossible to examine closely), then that would account for the journal entry. Regardless of the reasons for the journal entry, this does not affect depth measurements made before that date. As noted above, this consisted *not* of measuring directly from an assumed position of the base of the Granular Stalagmite, but in measuring from the known level of the existing sediment surface, and then adding 4 ft to obtain the depth below datum. Thus, all measurements up to 2 January 1928, at which a depth of 19 ft (5.79 m) below datum had been reached, well

below the 10 ft 6 in (3.20 m) depth of the KC4 maxilla, *were internally consistent relative to each other*.

Although it is clear that all measured depths made before 2 January 1928 are relative to the same datum and therefore directly comparable, the question remains of whether the excavators changed the datum after this date. This would introduce an uncertainty of 1 ft (30.5 cm) in depth measurements made from 2 January 1928 until the trench was bottomed on 7 May 1928. In fact this affects very few finds—no artefacts and only fifteen bones and teeth of animals were recorded from Trench C over this period. It affects only the deepest dated sample used in the Bayesian analysis reported by Jacobi and Higham (2011) and Higham et al. (2011), and in no way invalidates the analysis; indeed the sample concerned lies at least 4 ft (1.21 m) below the next sample higher in the sequence and it is simply modelled as being below the archaeology and at the bottom.

For the first three field seasons in the Vestibule, from 1926 to 1928, the excavation journal provides detailed measurements of trench positions, depths, and details of the sediments. Artefacts and fauna were recorded by giving the trench in which they were found and their depth below datum. Beynon et al. (1926: 326) reported: 'Every find, whether of flints, bones or teeth, has been carefully measured in regard to its depth in the deposit, and entered in a Field Book on the spot, to be subsequently transferred to a Journal.'

A high proportion of the depth measurements are recorded to the nearest inch, which shows that the finds concerned must have been located and their depth measured *in situ*. Critically, this includes the KC4 maxilla, which was found in three fragments within an area of 2 × 2 ft (0.61 × 0.61 m), all at the same depth (10 ft 6 in; 3.20 m) (Beynon et al.,

1926–1932: entry for 14 March 1927). Other finds have a depth range recorded and may have been recovered on the sorting tables. The journal for this period is supplemented by the section drawings, all of which date from this phase of the excavation. On the resumption of excavations in the Vestibule in October 1932, the journal again describes the trenches and their depths, supplemented by diagrams of their layout and details of the sediments. The locations of finds are given by trench as before. However, the depths of faunal remains were no longer measured although their approximate find depth can be inferred from the trench depth measurements. In most cases, the depths of artefacts continued to be recorded individually. Late in the excavation the level of detail given in the journals declined significantly. From late 1934 onwards the recording of find and trench depths became erratic, although the journal continued to list finds of fauna and artefacts made on each day. The ultimate reason for this decline in recording standards in the 1930s must lie with the departure of Dowie in 1928 followed by Beynon in 1935.

The excavation archive is supplemented by a series of photographs (see Online Supplementary Materials). One of them (Torquay Library, Kent's Cavern A. Ogilvie 025, showing one of the trenches) is reproduced by White and Pettitt (2012: fig. 4) and Zilhão (2013: fig. 3.5) who claim that this picture was taken in the Vestibule in 1927. We have established, however, that the entire archive of photographs of the Kent's Cavern excavations are by professional or press photographers and date from the 1938–1939 and 1939–1940 seasons, very late in the excavation. While the photographs are useful for showing some of the tools and methods used, they are heavily biased towards 'human interest' subjects and are clearly posed (Figure 5). Such



Figure 5. Press photograph of members of the excavation team at the sorting tables in the Vestibule, dating from between 7 November 1938 and 6 February 1939. Torquay library photo A. Ogilvie 019; see Online Supplementary Materials for further details. Reproduced with permission of Torbay Libraries.

press manipulation of photographs is routine and must be taken into account in their interpretation.

The excavations were published annually in the British Association reports (Beynon et al., 1926; Dowie & Ogilvie, 1927; Beynon et al., 1929a; Beynon & Ogilvie, 1930; Dowie, 1930; Beynon & Ogilvie, 1931; 1932a; 1932b; 1933; 1934; 1935; 1936; Ogilvie et al., 1937; Ogilvie & Tebbs, 1938). Several other publications describe the 1926–1928 excavation in the Vestibule (Dowie, 1928; Beynon et al., 1929b), and the KC4 maxilla and some of the artefacts (Keith, 1927; Smith, 1940). Lake's (1934) survey of the cave shows trenches and other features described in the journals. These publications add up to a substantial corpus, and have the great merit that they were published within months of the excavations they described and must therefore have been written immediately after each season was completed. This is a far more satisfactory situation than the

common practice of delaying publication until a final report is produced, often many years after the excavation was completed and with all the attendant problems of lost data and fading memory.

The excavation reports are also very useful for reconstructing the sequence. Most of the reports (with the exception of Keith, 1927; Dowie, 1928; and Smith, 1940) are concerned primarily with describing the excavations. This includes the locations and depths of trenches, and the types of sediments encountered. The latter are crucial and include much that is not contained in the excavation journals, suggesting that Beynon (the excavation geologist) probably kept his own notes, which have not survived. By comparison, the relatively brief descriptions of fauna and artefacts are less important because very substantial museum collections from the excavation are still available for study.

Taken together the 1926–1941 TNHS excavation in Kent's Cavern was a competently

conducted enterprise. Its poor reputation is owed to previous workers either not examining the excavation archive at all, or doing so in insufficient detail to understand it properly. Several other British caves were excavated around the same time as the TNHS excavations, including Gough's Cave in 1927–1931 (Donovan, 1985; Jacobi, 1985), Aveline's Hole in 1919–1930 (Donovan, 2005), and the Creswell Crags caves (notably Pin Hole in 1924–1936) (Jacobi et al., 1998; Pettitt & Jacobi, 2009). While these excavations differed considerably in their standards and methods of recording the stratigraphy and finds, none used a grid system for recording; the horizontal position of finds were recorded, if at all, using a simple measurement of distance from the entrance. Thus, at none of these sites can the distribution of finds now be accurately reconstructed in three dimensions. Comparing the TNHS Kent's Cavern excavation with the contemporary excavations described above shows that it was in fact typical of its period in its execution and level of recording. This is to be expected: the Kent's Cavern excavation was made not by unsupervised amateurs but with the funding and guidance of a committee of the British Association and would thus have been expected to satisfy a certain standard.

STRATIGRAPHY OF THE VESTIBULE CAVE EARTH

Beynon et al. (1929) describe the Cave Earth in the Vestibule as an unstratified deposit of soil containing fragments of limestone and stalagmite. It is a good description of a typical colluvial cave earth, but the excavators also suggest that the deposit was ravined and overturned by heavy floods (Dowie & Ogilvie, 1927: 304; Beynon et al., 1929b: 238), a proposal repeated by White and Pettitt (2012:

11). Zilhão (2013: 32) has gone further, to state that part or all of the Vestibule Cave Earth was accumulated by torrential flooding, and that this will have resulted in material of different ages becoming mixed with no internal stratigraphic order. In the light of this claim, the original excavators' proposal needs reassessment.

The flooding hypothesis can be traced back to two observations, neither of which stands up to modern scrutiny. On 7 March 1927 the excavators discovered a void within the sediment, roofed by cemented boulders. Although it was broken into from the side of Trench C, the void itself wholly underlies the adjacent trenches (Figure 4). The journal entry for that day suggests that the void had been eroded by running water coming from the direction of the NE Gallery (Beynon et al., 1926–1932: entry for 7 March 1927), an explanation elaborated by Dowie & Ogilvie (1927) and Beynon et al. (1929b) where it was described as due to 'torrential flooding' or 'heavy floods'. However, we now know that the void directly overlies a large choked passage opening into the Cave of Rodentia below (Figure 4). This passage is clearly the source for the Cave Earth that filled the Cave of Rodentia, and the sediment choke itself shows clear signs of suffosion (C.J. Proctor, unpublished data), providing good evidence that the void was formed by suffosion and collapse of sediment down into the Cave of Rodentia.

The second observation concerns the lithic assemblage. Dorothy Garrod (1926) had identified material from Pengelly's 4 ft (1.21 m) level as Middle Aurignacian, whereas material from the TNHS excavations, supposedly from a deeper level, had been assigned by the Abbé Breuil to the Upper Aurignacian, thus implying an inverted stratigraphy (Beynon et al., 1929a; 1929b). However modern study has not supported the attribution of the

Kent's Cavern Aurignacian assemblage to more than one industry (Jacobi & Higham, 2011). Moreover the only lithic artefacts illustrated by Garrod (1926) from the Vestibule are culturally undiagnostic (R. Dinnis, *pers. comm.*).

In fact, the nature of the sediment is well known. The Vestibule Cave Earth forms part of a larger body of sediment, the proximal and distal ends of which have been investigated by modern excavations in the NE Gallery entrance and Wolf's Cave, respectively (Proctor, 1995; Proctor, unpublished data; Dinnis & Proctor, 2015). It is a typical colluvial cave earth gradually deposited in subaerial conditions by a combination of processes including cryoturbation, soil creep, minor hill-wash, and collapse of the cave walls and roof. Remnants of the top 6 ft (1.82 m) of the Vestibule Cave Earth are visible today in wall pockets in the position of Trench C and the sediment closely resembles the well-studied Cave Earth of the Wolf's Cave. The sediment in the Cave of Rodentia, derived from deeper in the Vestibule sequence, is broadly similar. The radiocarbon-dated sequence (see below) supports the hypothesis of a gradual deposition of sediment. The most rapid accumulation was between 7 and 11 ft (2.13–3.35 m), a depth range over which the Bayesian model implies deposition over around 1000–2000 years. Even assuming deposition over 1000 years, this equates to 4 ft (1.21 m) over this period, or 1.2 mm/year, a rate of accumulation entirely consistent with gradual deposition by the colluvial processes described above. Thus, there is no reason to believe that any of the Cave Earth in this part of the cave was any different in terms of its mode of emplacement. There is certainly no evidence for emplacement or overturning of the Vestibule Cave Earth by torrential flooding, *contra* Zilhão (2013: 32). Research into the sedimentology of the

Cave Earth in this part of the cave continues and should further inform our knowledge of the Vestibule sequence.

Several distinct stratigraphic horizons can be distinguished within the Vestibule Cave Earth. These include the Late Magdalenian Black Band within the top 1 ft (30.5 cm) (Pengelly, 1884; Jacobi & Higham, 2009); the top of the middle Devensian faunal assemblage in Pengelly's 4 ft (1.21 m) level (Pengelly, 1864–1879); the main scatter of Aurignacian artefacts recovered by the TNHS from the 4–7 ft (1.21–2.13 m) level (Beynon et al., 1926–1932); and a lower stalagmite floor recorded by the excavators in Trench C and the adjacent Entrance to the NE Gallery (ENEG) trench at a depth of 8 ft (2.43 m) (Beynon, et al., 1926–1932; Dowie & Ogilvie, 1927; Beynon et al., 1929b; section drawings AR4271, AR4273 (Figure 3); see Online Supplementary Materials). All these features parallel the top of the Cave Earth and demonstrate that it is reasonably well stratified.

NEW RADIOCARBON DATING

Work undertaken over the last decade has confirmed the widely held suspicion that radiocarbon determinations from Middle and Early Upper Palaeolithic sites in Europe often underestimate the true age, sometimes significantly (>10,000 years offset) (Higham, 2011). This is due to the low concentrations of ^{14}C in bones of this age and the fact that even a trace contaminant can create problems. The contaminant must be modern in origin for it to be significant, however. If the contaminant is ancient and ^{14}C -free then it must be present in a significant proportion to shift the age to make it older. For this reason radiocarbon specialists usually only have to concern themselves with modern C

contamination at this age. Previously, we identified animal-based glues on the surface of KC4 (Higham et al., 2011) that indicate a potential modern contaminant which if unremoved, would make the date younger than it would be in reality. In addition, the original determination on KC4 of $30,900 \pm 900$ BP may be an underestimate because of the lack of correction made at the time for pretreatment background. This correction is applied to take into account the routine uptake of trace contaminants derived from sample handling and pretreatment chemistry in the laboratory. It is important to make corrections for this, based on the dating of standards of known age that date to before the radiocarbon limit (see Wood, et al., 2010). This all suggests that the age of KC4 must be at least 35,000 cal BP in age and not younger. It is, as Higham, et al. (2011) concluded, very probably older than this, based on the regular underestimation of radiocarbon ages produced 20–30 years ago for this period, the presence of modern animal glue on the specimen, and the fact that the maxilla is surrounded by samples that are 5000–7000 years older. By this logic, KC4 must date to between 35,000 cal BP and 43,000 cal BP, and not later. White and Pettitt (2012: 22) make much of previous dating experiences wherein samples previously assumed on stratigraphic grounds to be Pleistocene in age turned out to be Holocene (see Street, et al., 2006). As is clear from the discussion above, this is not relevant to the Kent's Cavern case since the maxilla is already demonstrably old by virtue of the initial AMS date.

It is important to point to the severe underestimates of age demonstrated at the same site on several previously dated bones. When redated using ultrafiltration methods they became significantly older. OxA-6108, a direct date on a *Coelodonta* (rhinoceros) cranial fragment found 1 ft

(30.5 cm) above the *Homo* maxilla initially yielded an age of $30,220 \pm 460$ BP. A new ultrafiltered determination on the same cranium gave an age some 7000 years older (OxA-13965: $37,200 \pm 550$ BP) (Higham et al., 2006). Determinations of other rhinoceros bones above this find spot were also underestimates, by some 2000 years.

White and Pettitt (2012: 22) criticize the selection of samples by Jacobi and Higham (2011) to date the Kent's Cavern sequence, saying that the approach contradicts their written recommendations for selecting good samples for radiocarbon dating. At Kent's Cavern it was sadly not possible to select cut-marked or humanly modified bones, because apart from one bone pin there were none, probably due to the activities of hyenas (Jacobi, 2007). Instead, samples were obtained to attempt to date the excavated sequence surrounding the archaeological finds, with careful attention to the depths recorded by the TNHS excavators.

Bayesian modelling helps to provide a probabilistic estimate of the degree to which the original age of KC4 is aberrant. With a Bayesian model it is possible to incorporate the prior information reflected in the relative sequence of finds made by the TNHS during their excavations. White and Pettitt (2012: 17) criticize this aspect of the work, saying that the 'ordered stratigraphic sequence' 'critical to any Bayesian statistical program' is not available. As we have shown, the stratigraphy and excavation is not as problematic as they claim. In terms of the Bayesian modelling, of course there is no right model and all models are to a degree wrong. However, several pieces of evidence allowed Higham et al. (2011) to have some confidence about the model constructed:

- 1) Articulated woolly rhinoceros bones provide support for inferring that at

- least some of the material in the sequence is in its original location on the site and has not been subject to significant post-depositional movement. These remains provide three indistinguishable radiocarbon ages from two bones. The bones in question were found together in 'pocket 3', 2 ft 3 in (68.5 cm) above the maxilla (Beynon, et al., 1926–1932: entry for 20 December 1926; Jacobi & Higham, 2011) and do not appear to have moved in prehistory. They ought to constrain the age of material below to be older.
- 2) The excavators recorded that a lower stalagmitic floor at 8 ft (2.44 m) below datum covered about half the surface of Trench C and the adjacent ENEG trench, the remainder of the area being covered by a pavement of brecciated limestone blocks at the same level (Beynon et al., 1929b). This surface demonstrates the basic integrity of the sedimentary sequence in this area of the site.
 - 3) A sequence of age and depth consistent with the radiocarbon-dated samples suggests that the stratigraphic succession of material is not mixed or grossly distorted. This is supported by the Bayesian modelling, which showed a low number of outliers in the corpus of results, and a steady increase with depth. This provides evidence in support of a lack of mixing in the key sediments within which the maxilla was found.

White and Pettitt (2012: 15) suggest that the age estimate for KC4 'relies heavily on Bayesian modelling', inferring, given their criticisms of the site and the excavation of the dated material, that it cannot be reliable. This is not the case. Comparing the likelihoods and the

posterior distributions, as one can see in Higham et al. (2011: fig. 2), is to compare virtually like with like. The Bayesian modelling does not have a significant effect on the posterior age ranges; we would know almost as much without the modelling than with it. The model does help to generate a probability distribution function (PDF) for the maxilla, but it does not dramatically alter the picture one would obtain simply by looking at the age-depth characteristics of the chronology and inferring the likely age that way. Bayesian modelling simply allows us to provide a probabilistic estimate of its age. We can examine the effect of the priors by sensitivity testing and varying the parameters of the model, and in doing so quantify the effect of the priors upon the posterior distributions, thereby testing the suggestion of White and Pettitt (2012: 15). Higham, et al. (2011) undertook these tests and modelled determinations from the upper part of the sequence with and without constraining the results to be in absolute sequential order (see Higham, et al., 2011). We have undertaken other modelling with several different scenarios. In one of the least constrained models we merely included the determinations from 10 ft 6 in (3.20 m) up to the Lower Stalagmite as an unordered phase, and similarly made another unordered phase of the determinations above the stalagmite. The deeper determinations (below 12–13 ft, or 3.66–3.96 m) were also placed in a phase. Under these constraints the effect on the inferred age of KC4 is to move it to 43,070–40,120 cal BP (at 95.4% probability) rather than 44,180–41,530 cal BP. Other scenarios have very similar and overlapping results that suggest the model is insensitive to the priors applied and therefore that the age estimate is not likely to be significantly affected by these changes.

NEW AMS RESULTS

We have also undertaken new AMS dating to test the previous model and determine how robust the Higham et al. (2011) age estimate for KC4 is. We obtained nineteen new samples for AMS dating, using the journals of the TNHS excavations to guide our selection. We attempted to identify bone or teeth with a secure depth assignment with respect to the stalagmite levels and depths recorded. We were particularly interested in sampling material from around the find spot of the maxilla, but also above the lower stalagmite and in the Upper Palaeolithic sections of the site above 10 ft (3.05 m) below datum. The samples were AMS-dated at the Oxford Radiocarbon Accelerator Unit (ORAU) using the same laboratory methods as previously reported (see Higham et al., 2011). The new results are shown in Table 1. There were seven samples that failed to produce a good enough yield of collagen, or any collagen in some instances. These samples could therefore not be dated. In all other cases the collagen yields and other analytical data were acceptable and twelve new AMS dates were obtained.

We incorporated the results into the Bayesian model of Higham et al. (2011). The model shows a similarly good level of agreement by age and depth (Figure 6). There are twenty-eight AMS determinations in the model and three appear as outliers (see Online Supplementary Materials). This is around twice as many outliers as would be expected on the basis of statistics alone. The outliers occur in the section of the sequence in Trench C below the Lower Stalagmite, within which the maxilla is found. Here, there are eighteen AMS determinations in total, fifteen of which are consistent and sit within the expected stratigraphic sequence.

Two of the new results that produce ages at odds with the model are teeth samples. One

of these is OxA-27442 ($32,800 \pm 500$ BP), catalogued as 'Megaceros' and selected because it matched a journal entry for a deer tooth found at 12 ft 8 in (3.86 m), excavated on the day it was recorded. We have now re-identified this as the tooth of a Bovid, but finding as clear a match in the journal discloses uncertainty as to its proper position (see Online Supplementary Materials). Our assessment is that the specimen probably comes from between 10 ft 9 in and 12 ft 8 in (3.28–3.86 m). Regardless, the result does not fit within the expected sequence and is an outlier.

A second outlier in the model is OxA-27443 ($32,200 \pm 450$ BP) a *Cervus* tooth from a depth of 13 ft (3.96 m). The sample was found on 29 April 1927. On this date the excavation journal lists a piece of deer jaw with three teeth, but the dated sample was a single deer tooth. For this reason we cannot definitely relate the specimen to a journal entry. The best indication of depth might be to take the range from which finds were recorded on that day—12 ft 9 in–13 ft 8 in (3.89–4.17 m) in this case. Again, however, the determination is not in agreement with the sequence established previously by radiocarbon.

We have tried to explain these two aberrant determinations by assessing, and rejecting, the possibility that the bones were picked out from the side of the excavation trench or that the results were due to problematic AMS determinations. Although the precise context remains elusive, it is likely that within the margins of uncertainty, the most plausible reason for these two results is post-depositional intrusion of younger material (see Online Supplementary Materials).

Further evidence of post-depositional intrusion is provided by refitting artefacts. Most of the artefacts found in the 1926–1928 trench consist of a Middle Aurignacian assemblage found at depths of between 4 and 7 ft (1.21–2.13 m), above the lower stalagmite floor (Jacobi & Higham, 2011).

Table 1. *New Radiocarbon Determinations from Kent's Cavern.*

OxA/OxA-X-	PCode	CRA	±	F14C	±	Material	Species	Kent's Cat. number	Used (mg)	Yield (mg)	% Yld	%C	δ ¹³ C (‰)	δ ¹⁵ N (‰)	CN
X-2582-19 [‡]	AF	33,150	550	0.01611	0.00114	Tooth	<i>Cervus elaphus</i>	P17581	970	4.17	0.4	38.4	-19.8	7.6	3.3
30161	AF*	36,500	750	0.01063	0.001	Bone	<i>Coelodonta antiquitatis</i>	P16009	750	47.9	6.4	42.2	-20.0	1.8	3.3
30162	AF*	34,850	600	0.01307	0.00101	Antler	<i>Rangifer tarandus</i>	P16006	700	13.8	2	42.3	-18.8	3.2	3.4
30272	AF	35,100	650	0.01269	0.00103	Antler	<i>Rangifer tarandus</i>	P16011	920	47.6	5.2	39.2	-19.1	-0.7	3.3
30273	AF	38,900	1100	0.00788	0.00106	Tooth	Bovid	P15709	770	6.8	0.9	39.4	-19.3	6.3	3.3
30274	AF	34,950	650	0.01291	0.00101	Bone	<i>Coelodonta antiquitatis</i>	P16048	750	38.5	5.1	43.9	-20.4	5.9	3.3
30351 [‡]	AF	30,630	380	0.02207	0.00104	Bone	<i>Crocota crocuta</i>	P17573	630	8.5	1.4	40.9	-18.4	6.8	3.2
30352 [‡]	AF	30,850	400	0.02151	0.00113	Tooth	<i>Cervus elaphus</i>	P17579	460	4.9	1.1	42	-18.1	5.0	3.3
27442	AF*	32,800	500	0.01684	0.00104	Tooth	Bovid	P15705	620	6.7	1.1	44.3	-20.4	5.2	3.2
27443	AF*	32,200	450	0.01816	0.00105	Tooth	<i>Cervus elaphus</i>	P15699	620	26.9	4.3	44.2	-20.3	5.2	3.2
27444	AF	36,100	700	0.01119	0.00099	Bone	<i>Coelodonta antiquitatis</i>	P16028	1000	59.2	5.9	44.2	-20.1	3.6	3.2
27527	AF	36,700	750	0.01035	0.00099	Bone	<i>Coelodonta antiquitatis</i>	P16049	1005	75.6	7.5	44.4	-18.9	3.3	3.2

PCode refers to the pretreatment chemistry. 'AF' denotes the ultrafiltration preparation method outlined previously (e.g. Bronk Ramsey et al., 2004; Higham et al., 2006; Brock et al., 2010). An asterisk denotes a solvent extraction prior to collagen chemistry. This is done in order to remove possible consolidants or glues suspected of being present. In the case of these samples great care was taken to ensure that sampling avoided visible areas; so it is important to note that the solvent prewash was undertaken only as a precaution in case any had been missed. *CRA* is 'conventional radiocarbon age', expressed in years BP, after Stuiver and Polach (1977). *F14C* is the fraction modern carbon. This value is used in calibration. Stable isotope ratios are expressed in ‰ relative to ν PDB with a mass spectrometric precision of ± 0.2 ‰. Collagen yield represents the weight of gelatin or ultrafiltered gelatin in milligrams. %Yld is the per cent yield of extracted collagen as a function of the starting weight of the bone analysed. %C is the carbon present in the combusted gelatin. CN is the atomic ratio of carbon to nitrogen and is acceptable if it ranges between 2.9 and 3.5. The result with OxA-X- prefix is given to indicate low collagen yield in the pretreatment chemistry. All samples are from Trench C in Kent's Cavern, with the exception of those denoted by \ddagger which come from the Entrance to NE Gallery trench. See Figure 6 for details of the depth below the granular stalagmite of the the dated bones.

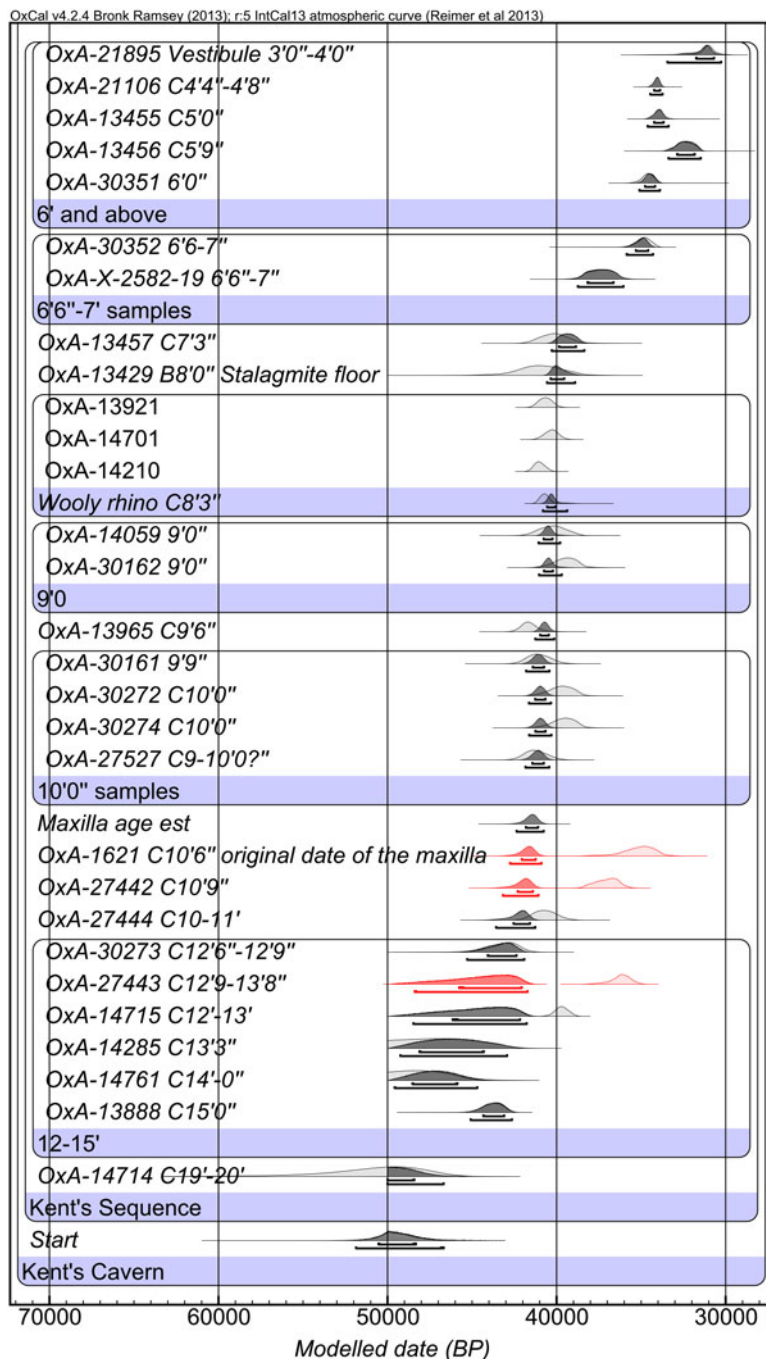


Figure 6. Bayesian model for the Kent's Cavern sequence. The two new outlying determinations are shown in red. Model produced using OxCal 4.2 (Bronk Ramsey, 2009) and the calibration curve (INTCAL13) of Reimer et al. (2013). See Online Supplementary Materials for details of outliers and CQL code.

A number of break refits are present in this assemblage. While most lie within the 4–7 ft (1.21–2.13 m) depth range of the main assemblage, two include fragments which were found at much greater depths. The first of these is a blade (Jacobi & Higham, 2011: fig. 11.7.1) comprising three fragments found at depths of 6 ft 6 in and 7 ft 3 in (1.98 m and 2.21 m), and a fourth found at a depth of 9 ft 6 in (2.90 m), all in Trench C. The second is an oblique scraper (Jacobi & Higham, 2011: fig. 11.13.5), one fragment of which was found in Trench C at a depth of 7 ft 3 in (2.21 m), the other at 11 ft 6 in (3.50 m) in the adjacent ENEG trench. The occurrence of fragments of both these refits within the main Middle Aurignacian assemblage strongly suggests that the deeper fragments are derived from material of the same assemblage that has intruded into the older underlying sediments.

The probable explanation of this intrusion of younger sediment into the older part of the sequence is the presence of pipes within the sequence, within which sediment has moved down into underlying passages. The presence of one such structure is attested: the void beneath a cemented mass of boulders in Trench B, which directly overlies a substantial choked passage opening into the Cave of Rodentia below and was formed by suffosion and collapse of sediment into the underlying cavity. We have identified a similar feature in a rift to the northeast of the Cave of Rodentia (Figure 4). The southeast end of this rift opens into the Vestibule beneath the Trench C/ENEG trench boundary at a depth of approximately 22 ft (6.70 m), and is filled with suffused sediment similar to that in the choked passage underlying the Trench B void, implying that a second pipe is almost certainly present within the Vestibule sequence above. Further evidence for piping is provided by the condition of the artefacts. Overall, the Aurignacian assemblage

is in good condition; however, some fragments from the refitting artefacts found at depth show deep edge-notching which probably result from sediment shearing within the pipe (R. Dinnis, *pers. comm.*).

Although these pipes are deep, they must be of very restricted horizontal extent. As already noted, the well-ordered sequence of AMS determinations clearly implies that the bulk of the sequence is intact and undisturbed. Furthermore the excavators noted that the lower stalagmite floor and its lateral equivalent, the 'pavement' of limestone blocks, formed a continuous surface over trench C (Beynon et al., 1929b). Any extensive disruption of the sequence would have led to large-scale foundering of the lower stalagmite floor that would have undoubtedly been recorded by the excavators. Of the main Aurignacian lithic assemblage overlying the floor, only very few examples have intruded to a greater depth, with the same implication.

Incorporating the new AMS dates within the Bayesian model allows us to generate a PDF for the maxilla. We obtained a range of 42,350–40,760 cal BP (at 95.4% probability) for the PDF (Figure 7). This compares with the initial estimate of 44,180–41,530 cal BP produced by Higham et al. (2011). The estimates are not statistically significantly different but it is clear that the additional AMS determinations we have obtained enable a greater precision in the PDF.

Given that artefacts have intruded into the lower part of the sequence from above, the possibility that the KC4 maxilla has also been so affected must be considered. While this possibility cannot be eliminated, support for it being *in situ* is provided by its recorded location. It was not found immediately adjacent to the void, as this part of Trench C was not cleared until 31 March 1927, two weeks after the maxilla's discovery (Beynon et al., 1926–

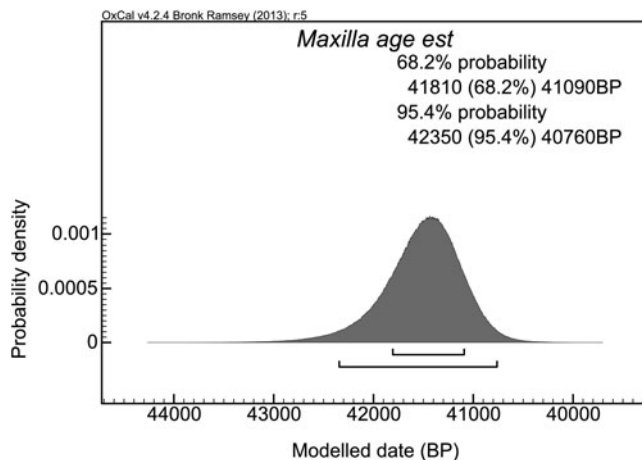


Figure 7. Age estimate probability distribution function (PDF) for the KC4 maxilla based on the model shown in Figure 6.

1932: entry for 31 March 1927). Nor is its find date close to that of any of the known intrusive artefacts or fauna. The maxilla was found in three fragments, all at the same depth, and scattered horizontally over an area some 2 ft (61 cm) across (Beynon et al., 1926–1932: entry for 14 March 1927). This distribution is consistent with its being *in situ*. It is in marked contrast to the artefacts which have demonstrably been affected by post-depositional disturbance and intrusion, where different fragments were found scattered over a range of depths as would be expected when resulting from shear forces within a pipe of restricted horizontal extent.

CONCLUSIONS

Our work has found that the TNHS excavations of Kent's Cavern were conducted and recorded to a reasonable standard that was typical of its time (*contra* White & Pettitt, 2012). A substantial archive of excavation journals, plans, drawn sections, and other materials supports this conclusion. The excavation was competently led by a team of TNHS directors working in

conjunction with a committee of the British Association. Trenches were excavated in an organized and systematic manner, using a variety of small to large tools that were appropriate to the conditions encountered, not just using heavy tools as claimed by White and Pettitt (2012: 9). The excavation trenches are consistently described in the journals, which give their locations and dimensions. Sections and publications allow us to reconstruct a plan of their positions to a good degree of precision, providing a coarse horizontal grid for the excavation. The datum lines were set up to obtain as closely as possible the depth below the original top of the Cave Earth and their positions can be accurately reconstructed today. The location of the finds was recorded by the trench in which they were found and their depth below the datum. This provides the means to reconstruct approximately the distribution of finds in three dimensions. Problems with the datum, alleged by White and Pettitt (2012: 11) to have affected the depth measurements over 1927–1928, in fact apply only to a short period well after the discovery of the KC4 maxilla. This in no way

affects the Bayesian analysis used by Higham et al. (2011) to model the age of the maxilla. The excavation journals provide a detailed daily record of the excavation and finds and the results were extensively and promptly published in a series of short reports written soon after each excavation season was concluded. These provide important details about the excavation, the sediments, and stratigraphy as well as describe some of the more notable finds.

Although the techniques of early twentieth-century cave excavators may fall short of the methods used today, this does not mean that they should be dismissed out of hand. Modern excavation of the remaining sediments in the caves concerned are capable of providing the data required for a detailed analysis of a small part of the deposits; but to understand the site as a whole it is necessary to combine the results of these modern excavations with detailed studies of the archives and museum collections from the earlier excavations. This approach has repeatedly been shown to yield important new insights and has great potential when applied to the TNHS excavations at Kent's Cavern, both to provide an improved context for the KC4 maxilla and to contribute to our overall understanding of this important site.

Our new series of AMS determinations was obtained in order to test the Bayesian model published by Higham et al. (2011), which contained an age estimate for the KC4 human maxilla. The results suggest a robust sequence with few outliers. Two AMS dates of *c.* 32,000 BP appear too young within the sequence. Despite problems with precisely identifying their original provenance, these outliers suggest some post-depositional movement on a small scale within what appears to be a robust sedimentary sequence. This is supported by new geological observations and a detailed assessment of the reliability of the TNHS excavations as described above. Overall, the bulk of the sequence appears

to be intact and not affected by significant taphonomic or post-depositional reworking. We contend that the probability distribution function we have obtained (42,350–40,760 cal BP) is a good estimate for the likely age of the maxilla, although the possibility that it has been affected by later piping and is therefore younger cannot be completely eliminated. This estimate is testable only by dating the maxilla directly. As outlined by Higham et al. (2011), this will not be possible until further technical developments for dating very small samples are more routinely available.

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SUPPLEMENTARY MATERIAL

For supplementary material accompanying this paper visit <https://doi.org/10.1017/eea.2016.1>.

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Age et contexte du maxillaire humain KC4 provenant de Kent's Cavern, Royaume Uni

Kent's Cavern est un des sites paléolithiques les plus importants de Grande Bretagne. Des fouilles entreprises entre 1926 et 1928 et de 1932 à 1938 par la Torquay Natural History Society dans le vestibule

de cette grotte ont révélé des couches du Paléolithique Moyen et du début du Paléolithique Supérieur ainsi qu'un fragment de maxillaire humain (KC4). Il y a quelques années Higham et al. (2011) ont déterminé qu'il s'agissait du fragment de squelette le plus ancien d'Europe du nord-ouest, sur la base d'une datation (utilisant une modélisation statistique bayésienne) estimée autour de 44,200–41,500 cal BP (à 95,4% de probabilité). Mais White et Pettitt (2012) ainsi que Zilhão (2013) ont affirmé que la qualité médiocre des fouilles et le manque d'intégrité stratigraphique mettent en doute les données archéologiques et chronologiques provenant du site. Notre article contient une nouvelle analyse de ces fouilles qui démontre qu'elles avaient été relativement bien effectuées. Nous examinons également en détail la séquence stratigraphique et sédimentologie et publions 12 nouvelles dates radiocarbone AMS provenant de contextes clefs pour la vérification de la chronologie et de l'interprétation proposées précédemment. Il en ressort que la tranchée C n'est pas compromise du point de vue stratigraphique mais que certaines parties avaient été remaniées ultérieurement; le remontage d'une quantité restreinte d'objets témoigne aussi que certains remaniements avaient eu lieu après déposition. Deux dates AMS autour de 32,000 BP sortent du cadre chronologique proposé. Nous ne pouvons donc pas exclure catégoriquement que le maxillaire soit plus récent que la fonction de densité de probabilité (PDF) publiée. Nos analyses corroborent l'évaluation du site et de KC4 publiée par Higham et al. (2011) et laissent penser qu'il existe un potentiel considérable pour des études ultérieures. Translation by Madeleine Hummler

Mots-clés: Kent's Cavern, Torquay Natural History Society, datation radiocarbone AMS, archéologie du Paléolithique, maxillaire KC4, ultrafiltration, modélisation statistique bayésienne

Das Alter und der Zusammenhang des menschlichen Oberkiefers KC4 von Kent's Cavern, Großbritannien

Kent's Cavern ist eine der bedeutendsten paläolithischen Fundstätten in Großbritannien. Die Torquay Natural History Society hat von 1926 bis 1928 und zwischen 1932 und 1938 Ausgrabungen im Vestibül der Höhle durchgeführt und dort Schichten des Mittelpaläolithikums und frühen Jungpaläolithikums, und auch das Bruchstück eines menschlichen Oberkiefers (KC4) aufgedeckt. Letztlich haben Higham et al. (2011) bestimmt, dass es sich um das älteste bekannte menschliche Fossil aus Nordwesteuropa handelt, und haben es, dank einer bayesschen Modellierung, um 44,200–41,500 cal BP datiert (mit 95,4 % Wahrscheinlichkeit). White und Pettitt (2012) und Zilhão (2013) haben aber behauptet, dass die Qualität der Ausgrabungen nicht genügend war und dass die Stratigraphie mangelhaft war, sodass die archäologischen Befunde und chronologischen Belege wohl bezweifelt werden müssen. Der vorliegende Artikel enthält eine grundsätzliche neue Analyse der Ausgrabungen; es wird hier gezeigt, dass diese relativ gut durchgeführt worden waren. Wir haben auch die stratigraphische und sedimentologische Nachfolge sorgfältig untersucht und veröffentlichen 12 neue AMS-Radiokarbondatierungen von Kontexten, die maßgebend für die Überprüfung der veröffentlichten Chronologie und Modells sind. Es lässt sich daraus schließen, dass Schnitt C stratigraphisch zuverlässig ist. Störungen nach der Ablagerung sind aber auch in gewissen Teilen der Grabung belegt und Bewegungen von Material nach der Ablagerung sind auch durch die Wiederausammenfügung von bestimmten Artefakten nachgewiesen. Zwei AMS-Datierungen von ca. 32,000 BP fallen aus dem Rahmen. Es kann also nicht kategorisch ausgeschlossen werden, dass das Alter des KC4 Oberkiefers jünger als die veröffentlichte Wahrscheinlichkeitsdichtefunktion (WDF = PDF) sein kann. Die Ergebnisse unserer Untersuchungen unterstützen die Auswertung des Befundes und des Oberkiefers KC4 von Higham et al. (2011) und zeigen, dass es potenziell noch viele Möglichkeiten gibt, weitere Untersuchungen durchzuführen. Translation by Madeleine Hummler

Stichworte: Stichworte, Kent's Cavern, Torquay Natural History Society, AMS Radiokarbondatierung, paläolithische Archäologie, Oberkiefer KC4, Ultrafiltration, bayessche Modellierung