survey of 2006, presumably because it became obscured by the collapse of the bank across it.

Comment

Excavation and cleaning of the standing section revealed a complex sequence of layers within and beneath the physical remains of the bank. These held evidence of the way in which the bank of the monument was constructed, and suggested that both sides may originally have been revetted, the outer edge at least with stone. The bank would originally, therefore, have been narrower than the earthwork seen today, with steeper or vertical sides, in appearance more like a broad wall with a flat top, rather than the present rounded, shallow bank. There also appears to have been a flat berm up to 2m wide between the bank and the inner lip of the surrounding ditch. The section also showed evidence of the later collapse and erosion of the bank's sides. The ancient soil buried by the bank may contain significant evidence of the ancient environment, as may the later buried soils covered by the collapsed bank.

Careful cleaning of the standing section revealed all this complexity and wealth of information to have lain within the layers of earth and clay that make up the earthwork bank. A section can only, however, tell part of the story, and the systematic exposure of these layers in plan, in a controlled archaeological excavation would have confirmed and increased the understanding of the monument glimpsed in the section. Unfortunately, the destruction by machine of a length of up to 10m of the bank has meant the irreplaceable loss of this unique information, along with any associated artefacts and the story that they might have told.

A copy of the full report submitted to English Heritage can be found with the Field Archive of drawings and photographs in the Somerset Record Office.

RADIOCARBON DATING OF SOME LATE MEDIEVAL TIMBERS

John Rickard (SVBRG)

Introduction

The ability to precisely date a building structure is often the aspiration of building and architectural historians. Generally however researchers can only suggest a possible date range based on the similarity of features from buildings whose construction dates are known from documentary sources.

The emergence of dendrochronology, initially as a means of correlating astronomical occurrences with climatic changes, developed steadily from the early 20th century into a refined dating technique, offering the prospect of a precise date, even as to winter or summer, of the year in which a tree was felled. For building researchers this meant that, for the first time, roof structures, even down to the thatching laths, could be dated with precision; framing posts, beams, joists and panelling could be dealt with by the same method.

Previous dating programme

Between 1996 and 2004 the Somerset Vernacular Building Research Group (SVBRG) obtained dates for fifty-three roof structures in a dendrochronology research programme to classify the development and use of differing forms of roof construction [1]. Roofs that had been constructed in oak were selected for examination because the standards compiled by and available to the dendrochronology laboratories, nationally and internationally, are for oak.

However, not every sample of oak will provide a growth sequence that can be matched; fast-grown oak often does not provide the fifty or so rings necessary for reliable correlation. The programme was able to establish dates for just over fifty houses representing around two-thirds of the houses/ structures examined.

Constructional timber in Somerset

Although oak was used for roofs, doorways, doors, beams and partitions found in many of the older houses in the County it tended to occur in the higher status and early houses. Indeed, medieval court records from Winscombe reveal that oak was used not only for repairs to the manor house and its farm buildings, but was also given to selected tenants to repair their houses [2].

In the somewhat lesser houses and further down the social scale as far as cottages built "on the waste" at the end of the 18th century, elm is found to be the constructional timber. The abundance of elm in the countryside is remarked on by John Leland in the mid 16th century and John Billingsley makes a similar observation in 1794.

The Group has recently completed a study of houses in Winscombe & Sandford parish, and with the exceptions of West End Farm which has an oak cruck dated to 1278 and Longfield House, late 18th century, none of the sixty roofs examined were of oak [2]. Elm predominated in the older houses and was gradually superseded during the 19th century by softwoods.

The M-type apex

During the study in Winscombe & Sandford a small number of roofs with a principal truss apex classified as 'type M' were found.

This apex type had been identified in an exposition on cruck construction by N.W. Alcock in 1981 [3]. In his text he says, "At the very end of editing, type M was noted, a rare local variant from Somerset".

In the definition he describes the apex thus: M – Blades (*of the cruck*) meet on vertical line below threaded ridge, diagonal above. Several houses with M-apexes were included in the Dendrochronology Programme providing dates between 1342 and 1439.

Two houses in Sandford (Wellage Cottage and Orchard Cottage) had M-type apices and in both

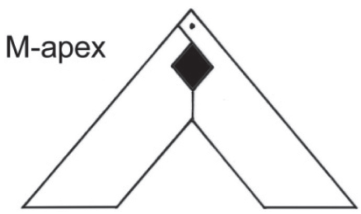

Fig. 1 The M apex

houses the roof structure was smoke-blackened, indicating that both were built as open-hall houses. The roof trusses were closed collar trusses with cambered collars set in the upper section of what were probably jointed crucks, although the joints had been lost or encased during repair or refurbishment of the houses. The remainder of an almost identical truss was found at Laurel Farm, Barton in the south west of the parish but in this instance the roof was not smoke-blackened.

A date for this apex type would not only help date the houses but would indicate the transition period from open-hall to chimneyed houses in this locality. The only way in which these elm roofs might be dated would be by the use of radiocarbon dating, a technique that would provide a statistically-based date range rather than the potentially more precise date obtainable from dendrochronology.

Radiocarbon dating

The principles behind radiocarbon dating are fairly straightforward but the science involved in understanding and correcting the variations is extremely complex as is the process of standardising the statistics that lie behind the final result. The following section attempts to provide a suitably simplified account of the method.

The process by which radiocarbon dating is possible starts with cosmic rays from the sun colliding with atoms in the atmosphere. These collisions produce free neutrons which, if they collide with a nitrogen atom in the air create an unstable carbon isotope, C^{14}. Carbon dioxide (CO_2) in the air contains molecules with normal C^{12} atoms and a small proportion of molecules with C^{14} atoms. The latter are radioactive and hence will decay, reducing their number to half the current level in about 5700 years, (i.e. the isotope has a half life of 5700 years). Plants continuously absorb atmospheric CO_2 and thus always contain a small amount of C^{14} that is continuously increased by "new" C^{14} as the plant continues to grow. The natural ratio of C^{12} to C^{14} is nearly constant in the air and in all living organisms but when the organism dies it ceases to absorb any more C^{14}. From knowing the half-life of C^{14} and measuring the ratio of the two isotopes (i.e. C^{14}: C^{12}) in a sample, it is possible to calculate when the ratio was at its natural value and hence to date the death of the organism.

The currently favoured analytical method for establishing the isotope ratio is AMS (accelerator mass spectrometry) which counts the number of

C^{12} and C^{14} atoms from the sample; the method is faster and utilises smaller sample weights than the alternative LSC (liquid scintillation counting) method.

The "nearly constant" isotope ratio on which the method is based has been found to be variable over time and by location. Natural events such as the absorption of CO_2 into the oceans and volcanic activity cause variations, the burning of fossil fuels releases "old" carbon at later dates. Solar activity and atomic explosions similarly alter the natural ratio. The processing of analytical output data is complex and seeks to compensate for the variability. The result is described as the Radiocarbon Age or Age BP (Before Present) and is usually given as a date range representing one standard deviation from the average of the data processed by the analyser.

To convert this result to Calendar Years the Radiocarbon Age is modified by way of a calibration curve that compares radiocarbon dates with those derived from dendrochronology.

Dendrochronology sequences that go back some 14,000 years have been established through studies of long-lived trees such as bristlecone pine and trees preserved in peat bogs.

Earlier C^{14} data comes from plant macrofossils, speleothems and corals.

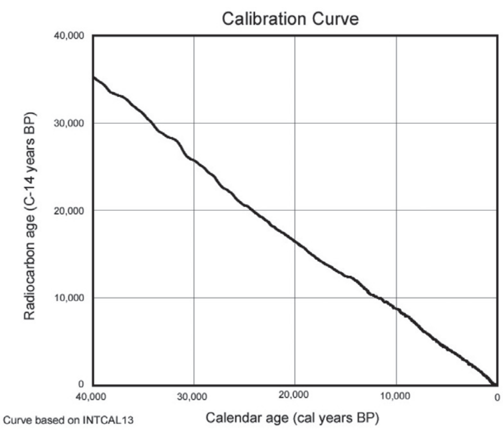

Fig. 2 Radiocarbon /Calendar years calibration

The departure from an idealised linear correlation of radiocarbon age to calendar age is comparatively small and in practical terms is relatively insignificant when analysing material that is thousands of years old [4].

In material from the medieval period the discrepancies, caused by the sum of natural variables and human activity can be such as to render the result almost meaningless as the calibration curve in Fig. 3 shows.

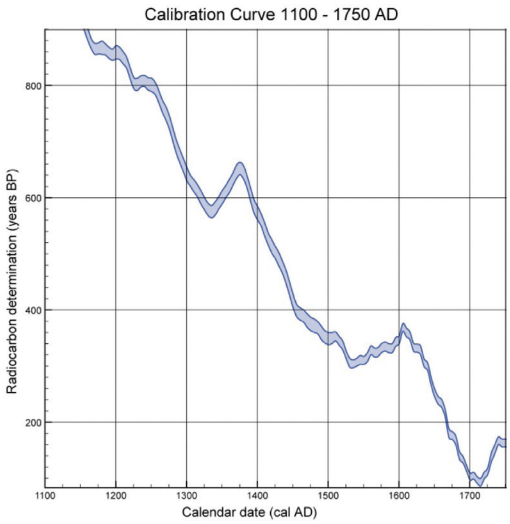

Fig. 3 Detail of Fig. 2 showing the convoluted shape of the calibration curve in the post-medieval period

Some of the uncertainty in the study of timber can be overcome by taking a sequence of samples with known date intervals between them, as determined by counting annual growth rings. The results from several locations in the sample are analysed using Bayesian statistical methods to reduce the uncertainty in the final result, a method known as "wiggle-matching", [5] for which dedicated calibration programmes have been devised which are used throughout the profession.

The dating of a tree by either dendrochronology or radiocarbon methods is usually given as that of the last growth ring at the heartwood-sapwood boundary. A limited amount of research, principally on oak, enables sapwood growth to be included in the wiggle-matching process which in turn enables an estimation for the felling date of the tree.

The SVBRG Radiocarbon dating programme

As this programme was exploratory it was limited to samples from three houses, sufficient to obtain useful information at an affordable cost.

It was important to include Orchard Cottage and Laurel Farm as these represented the smoke-blackened and clean versions of the roof with the M apex. Another house Hale Farm was included because its construction confirmed it as an open-hall house which, although the roof had been replaced, had original timbers in the ceiling of the inner room that could be sampled.

To provide enough material for possible wiggle-matching it was necessary to extract a sample from the timbers that had the greatest number of growth rings and to include the heartwood/sapwood interface if the bark surface was absent; the simplest means of ensuring this was to have a conventional 'dendro-core' removed by a dendro-chronologist.

Considerations

Cost: Preliminary enquiries had indicated that a single determination by this method would cost in the region of £350 - £540, to which would have to be added the cost for the services of a dendrochronologist.

Delays: Back-logs at the dating laboratories could be between six and twenty weeks.

The need for wiggle-matching: There was a chance that all three samples would require a minimum of two supplementary sub-samples to obtain a wiggle-matched date. However there was also the chance that the 'wiggle-matching' process would not be needed.

Grant funds: Any application would have to be presented to meet the submission date for a grant committee to consider the request.

Strategy

The decision was taken to pay for dendro-coring and initial analyses (Phase 1) out of Group funds and to apply for a grant if further analytical work was necessary. This opened up a way to obtain results from Phase 1 and hence to quantify the amount of grant funding needed for a possible Phase 2 without having to wait for funding committee agreement before Phase 1 work could commence.

Phase 1 analysis

A slice from each core representing the outer rings of the timber was sent for analysis to establish whether further sub-samples would be needed for wiggle-matching.

The result from Hale Farm fell in a fairly straight part of the calibration curve (Fig. 4).

The other two results (Figs. 5 and 6) were in more

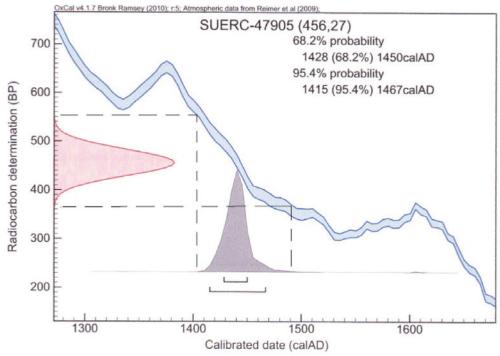

Fig. 4 The result from Hale Farm. The radiocarbon age (red peak) is converted to calendar years directly from the calibration curve

complex areas and would need wiggle-matching to provide a more reliable result.

Phase 2 analysis

To proceed further the cores were examined to establish the number of growth rings. In the event it was found that the cores from Orchard Cottage had thirty-one rings and Laurel Farm had slightly fewer. The laboratory advised concentrating on Orchard Cottage and accordingly sub-samples from rings 1-3 and rings 14-19 were selected.

The reported results after the Bayesian analysis gave the dates the outer rings, which were at the heartwood/sapwood boundary, as 1400-1420 AD at 63% probability. The incorporation of a correction for sapwood, based on English oak data, indicates a felling date of 1405-1460 at 77% probability.

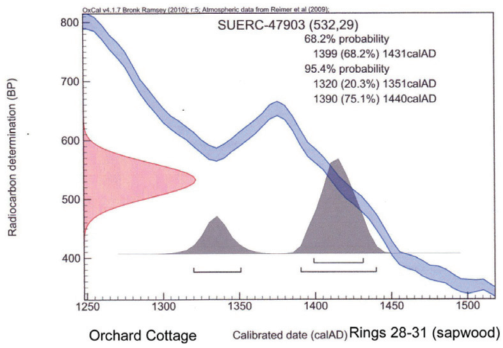

Fig. 5 The result from the outer rings at Orchard Cottage. The radiocarbon age intersects the calibration curve in two places

Appraisal of results
Based on the results from Orchard Cottage and Hale Farm it was possible to make a visual appraisal of the Laurel Farm result and to estimate the felling-date ranges for the three houses.

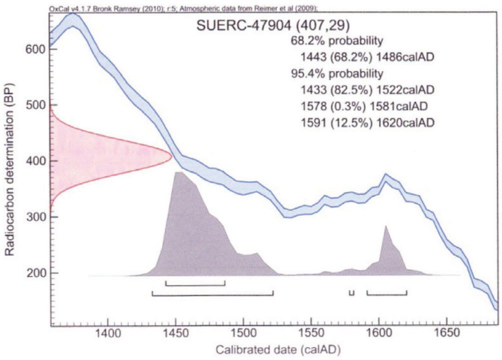

Fig. 6 The radiocarbon age for Laurel Farm intersects the calibration curve in several places

Results

The results are given in the table below and are listed in date-range order. The dates put Orchard Cottage as the earliest of the houses studied here with a date range that is consistent with the presumed jointed cruck construction of the house.

The date for Hale Farm consolidates our knowledge that in this locality open-hall houses were being built into the middle of the 15th century. In this particular house it also confirms that two-centred arch-headed timber doorways were still in vogue.

The slightly later date for the truss at Laurel Farm revealed that not only is a new house being erected in the parish using the same roof construction but that it is built with a chimney. Unfortunately this portion of a truss is all that is left of the original roof.

Conclusions
The Method. This programme has demonstrated the applicability of radiocarbon dating to elm timbers in medieval houses. It can be a substitute for oak dendrochronology where an oak sample is otherwise judged unsuitable. The use of standard extracted 'dendro cores' makes further analysis by 'wiggle-matching' a simple extension to the process. The method is intrinsically expensive but will consistently give a date range for the sample.

The Houses. Through the use of radiocarbon dating the Group has established a threshold date for the transition to chimneyed houses in the parish and confirmation that open-hall houses were still being constructed in the middle of the 15th century.

The M-apex. This exercise has shown that carpentry traditions are long-lived and do not necessarily change when the type of house changes. In this exercise dates of 1405-1460 and 1480-1510 have been deduced for this form of apex.

ACKNOWLEDGEMENTS

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House	Sample taken from	Felling Date range
Orchard Cottage	North principal rafter	1405-1460 AD (reported)
Hale Farm	Inner room ceiling joist	1445-1485 AD (est'd)
Laurel Farm	South principal rafter	1480-1510 AD (est'd)

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EXCAVATIONS AT HAM HILL, STOKE SUB HAMDON, 2013

Marcus Brittain[1], Niall Sharples[2] and Christopher Evans[1]

The third and final season of excavations at Ham Hill by the Cambridge Archaeological Unit and Cardiff University was carried out over July-September 2013 (Brittain *et al*. 2014; previous years' findings are summarised in SANH 156, 160-63). This saw the completion of a 1.28ha open area within the hillfort's south-west interior in advance of quarry extension (Figure 1), along with the opening of two trenches across the hillfort's inner rampart, one being an extension of Trench 2 first opened on the hill's north 'spur' in 2012, and the other (Trench 4) newly positioned along the hill's south-west aspect.

Early prehistory

The earliest features comprised two clusters of Neolithic pits, one containing early, plain ware pottery with later Peterborough ware pottery in the other. This helps to provide some context for previous seasons' considerable surface collection of finds from this period. The project's overall worked flint assemblage tallies to 3600, one half of which has derived from the rampart trenches, either from within deposits dumped in the rampart construction or from land surfaces and features sealed by the ramparts. Of note here is a polished flint axe from the Iron Age rampart in Trench 2 and a segmented ditch that pre-dates the rampart in Trench 4. This, with similar features in Trenches 1 and 3, may represent a sizeable Neolithic complex. The hill's next major phase of activity is an Early to Middle Bronze Age landscape of ditched enclosures that has now been revealed in the open area as comprising at least nine enclosed rectilinear plots with a minimum of four access points. Nearly half of the enclosing ditches have been hand dug with over 25% sieved and sampled. The results from this intensity of investigation are being processed, but it seems probable that contemporary settlement and related activity zones were situated outside of the investigation area.

Iron Age

Only minimal traces of Early Iron Age activity were present in the open area, however the establishment of a rampart along the hilltop's circuit in the Late Bronze Age / Early Iron Age was confirmed in Trench 4. Here, along the south-west of the hilltop, the rampart has been subject to hillslope erosion, quarrying and partial levelling, but these early constructional phases could be seen to conform to those observed at the north of the hillfort: a simple rubble dump against a stone revetment.

Trench 2 revealed a complex multi-phase stone, earth and timber construction, estimated to have been *c*.4m high, with loam deposits behind the rampart showing soil formation and occupation horizons from the early Iron Age to the Roman period. Four main phases of construction were identified but owing to the complexity and density of deposits the earliest rampart construction phase could not be investigated. The second phase was a simple revetted rubble dump with an entrance defined by a stone-lined revetment that was subsequently infilled with rubble and soil as part of the third phase construction. This massive enlargement of the rampart with multiple layers of material was supported by stone revetments erected gradually rather than to any obvious plan. Considerable amounts of occupation debris was found associated with this phase to the rear of the rampart. A thick soil accumulation separated the end of the third and the beginning of the fourth construction phases, indicating a considerable period of time had elapsed between the two events. The fourth phase rampart, broadly dated to the Late