The Ancient Monuments Laboratory Carbon-14 Data Base: Stage One

AML report number 4267

David Haddon-Reece

Ancient Monuments Laboratory
Historic Buildings and Monuments Commission for England

ABSTRACT

With the acquisition by the Ancient Monuments Laboratory (AML) of an LSI 1123 minicomputer in 1983, it became possible to store at low cost a fairly complete assemblage of records of carbon-14 samples processed for AML by AERE Harwell. The file editing and retrieval facilities of the LSI operating system permit both the easy up-dating of records to match the progress of the samples at Harwell and a rapid on-line retrieval of information, either for AML purposes or for answering customers' enquiries. An up-to-date administrative record is maintained at a single location, with output available both on visual display unit and line printer.

June 10, 1984

The Ancient Monuments Laboratory Data Base: Stage One

List of contents

The Ancient Monuments Laboratory Carbon-14 Data Base: Stage One

AML report number 4267

David Haddon-Reece

Ancient Monuments Laboratory
Historic Buildings and Monuments Commission for England

1 Introduction

(Note: the terms 'excavator' and 'submitter' are used synonymously throughout this document.)

1.1 The carbon-14 dating service

The Ancient Monuments Laboratory (AML) has an annually renewable contract with AERE Harwell for the analysis and carbon-14 dating of samples from archaeological excavations and historic buildings. AML funds the dating of about 150 samples per annum - at a nominal cost of $180 per sample at present - and samples from any source are considered for acceptance provided:

a they are from an HBMC- (formerly DoE-) funded source;

b their dating has a clearly defined archaeological objective; and

c they are scientifically suitable for analysis.

Whenever possible, AML advises the excavator on sampling strategy and the physical collection of samples. Excavators are also encouraged to seek Harwell's involvement in the project at an early stage, which in many cases prevents the taking of inadequate or non-viable samples, and provides continuity. Both AML and Harwell offer advice on calibration and the statistical interpretation of dates.

The procedure for submitting samples is as follows:

a Excavators send their samples to Harwell for pre-analysis assessment, and submit application forms to AML

b Harwell examines the samples for suitability for dating and reports to AML

c AML and the Inspector of Ancient Monuments relevant to the site in question examine the case together - the Inspector confirming that the site is in the financial remit of HBMC, and advising on archaeological aspects when necessary

d If acceptable, the samples are given AML serial numbers and recorded in the AML Labfile finds records system and carbon-14 data base

e Harwell is instructed to go ahead with the dating.

Samples containing more than a certain amount of elemental carbon are termed large, converted to benzene and measured in a liquid scintillation counter; small samples are designated mini or micro, according to size, converted to carbon dioxide, and measured in gas counters.

1.2 The need for a data base

To monitor the service effectively, a single collection of information is needed, giving details of samples sent to Harwell, their progress through the system, and their final results when dated. When the writer took charge of the dating service in 1982, it was evident that the scattered records were simply insufficient in quantity and coherence. They were stored in three separate filing systems, and many were incomplete, out-dated or inaccessible. A new, unified system was clearly desirable, and if it could be incorporated with the Labfile system, under single administrative maintenance, so much the better.

Although the nascent Labfile system included cross-referenced listings of samples at AML, their excavators, sites and site details, movements around AML premises and elsewhere, etc., it held no information specific to the carbon-14 process. Furthermore, its restructuring into a full Data Base Management System is not yet accomplished at May 1984, and may not be for at least another six months.

The only workable solution was to set up a separate data base, with enough flexibility for it to be added, with a minimum of effort, to the main Labfile version when convenient.

Samples are submitted and processed both singly and in batches. The basic data base, therefore, would need a separate record for each sample, containing sufficient information to relate it uniquely to three different administrative systems - the AML records system, the excavator's private filing system, and the Harwell data base.

2 The functional requirements of the data base

There are three main aspects to cater for: administration, reporting and statistics.

2.1 Administration

It must be possible to store and update concise but intelligible details of each sample, so that the progress of any sample from submission to completion can be monitored. Since Harwell groups its records under the unique Project Code allotted to each submitter (excavator), it must be possible to examine and modify all records relating to any particular project code. Records must therefore be readily extractable against either the main AML reference key of Site Number, or the Harwell Project Code Key.

2.2 Reporting

The data base must be able to produce on short notice answers to ad hoc enquiries on samples' progress, details of a batch of samples, the total submission from a certain excavator or site, etc.. These must be in sufficiently intelligble form for immediate distribution to excavators or Inspectors; more than a quick reference to any explanatory key - to the coding of progress stages, for instance - is undesirable. In addition, it must be possible to prepare a well-formatted synopsis of the records comprising any

particular group, such as a batch of samples from one season's excavations of a certain site.

Output for ad hoc enquiries can be via a vdu, with line printer paper record for more permanent reports.

2.3 Calibration and Statistics

In order to be able to guide submitters in obtaining the best calibration and statistical interpretation for their dates, which AML has always tried to do, the data base should have ready access to programs for the purpose. It would be clearly most efficient to mount them on the same computer and within the same user space.

3 Establishment of the data base

It was planned to establish the data base in three stages:

a In stage 1, all records relating to carbon-14 sample submission would be manually extracted from AML files and collated as an electronic corpus on the computer. Editing and retrieval at this stage would be simple but manual, because the corpus would not be structured into a Data Base Management System with programs for data matching and file refreshing.

b Stage 2 would introduce electronic up-dating. Instead of revisions being manually typed into the files, the regular 20-day printouts from Harwell would be accompanied by a floppy disc version which would be read electronically into the system via an auxiliary Research Machines 380Z microcomputer. Special programs would have to be written to up-date the files.

c In Stage 3, depending on decisions still to be made, the carbon-14 records would be subsumed into the main AML Labfile inventory data base, under the control of a full Data Base Management System.

In a ready-made Data Base Management System, the records and files are usually arranged hierarchically; that it to say, a single 'parent' record, such as one containing site details,

may have several or many dependent records, such as those describing the samples. This stores information quite efficiently, and parent and dependent records may be kept quite separate, provided that the relationship between them is indicated by pointers contained in the records. For such a system to work efficiently, it must be very carefully planned in advance, because even slight changes in record and file structure may be impossible to achieve later without radical, sometimes total, revision of the whole system.

Before the present data base was assembled, the information held at AML was spread over nearly 2000 files covering sites and excavators, containing an incomplete mixture of past Harwell progress sheets, AML finds sheets, copy Harwell dating certificates and correspondence, and two Day Books listing transfers of samples to Harwell. To have carefully planned the structure of a data base of all this before extracting it, and viewing it as a coherent whole, would have been impossible. It was therefore decided to establish an ad hoc data base by collecting all available records, storing them in a uniform format, and letting experience gained in use dictate the formal revision of structure.

This report describes the state and operation of the data base at the successful conclusion of Stage 1.

4 The structure and contents of the data base (Stage 1)

The basic unit of the data base is the unique record defining each sample. Records are grouped into files of a convenient size, one file being allocated to each submitter. Other files contain cross-referencing indexes, a day-book of sample submissions, background information on the system, a standard caption for report-writing, and various programs, look-up tables and output space for calibration and statistics. All files comprising the data base - record files, programs, glossaries, etc., are held in the directory '/users/carbon'.

4.1 The sample record

see: Appendix I - file 'sample.Key'

As explained in the Introduction, each sample has its own, complete record, set in a uniform format. On extraction, the record gives all available information on a sample without the need for further reference, and records may be re-grouped without loss of information. Each record contains 16 fields, separated by commas, which allows item matching by field position, and sorting. The fields, which can be variable in length and can contain mixed alphanumeric characters, are defined in file 'sample.Key' (see Appendix I). They are designated as follows:

1 Site name - as recorded in the AML filing system

2 Name of Excavator (or Submitter)

3 AA registry file number

4 Site number - as allocated by AML; prefaced with L

5 Harwell project code for excavator - prefaced with H

6 AML sample number - prefaced with L

7 Excavator's sample number

8 Harwell HAR number for sample - prefaced with H

9 Sample material

10 Date of submission to Harwell

11 Sample size - "small", "mini" or "micro" as appropriate; blank otherwise

12 Sample priority - "***" indicates sample has been given express status; blank otherwise

13 Deadline date for completion if requested. Blank otherwise

14 Progress code (see below and Appendix I)

15 Comments and/or date of most recent Harwell report

16 Final result when known, blank until then. Date is given in years b.p.+-error in the form: date#error [typed as date(shift3)error].

Where information is not known, the field may be left blank, or filled with a question mark or a comment; the correct number of commas must be maintained.

The following is a typical record:

> Borwick: Manor Farm, Olivier A, AA?, L1661, H456, L831221, MF82SS49, H5656, char, 15:6:83, , , , MC, r@20:2:84,

In full, this says that A Olivier (Harwell code 456) submitted a (large) charcoal sample (AML no. 831221, his no. MF82SS49, Harwell no. HAR5656) from Manor Farm, Borwick (AML site 1661, AA no. unknown); according to the latest Harwell report (February 20th 1984) this had been accepted into the system on June 15th 1983, and had been counted, and the measurements completed (MC) by the date of the report.

Another (small) sample from the site, which has produced a date (3270 +/- 80 b.p.), is listed as:

> Borwick: Manor Farm, Olivier A, AA?, L1661, H456, L831222, MF82SF55, H5658, bone, 8:7:83, small, , , , , 3270#80

4.2 The record files

see: Appendix II for specimen
files: various named Excavator files
'carbonAF'
'carbonGL'
'carbonMS'
'carbonTZ'
'small'

As explained above, Harwell groups its records under the Project Code heading - one unique code for each submitter - while AML uses the basis of Site Number. To reconcile the different systems, two possible groupings of records suggest themselves: one file per site, or one file per excavator. While the former would suit the AML arangement better, it would be inefficient in its use of disc space, as one site only rarely has more than one excavator, while one excavator may have submitted samples from several sites. Matching the Harwell progress sheets, one per excavator, would therefore be made less complicated by listing sites, alphabetically, within excavator files. Record files are accordingly designated by the excavator's name.

Where information is not known, the field may be left blank, or filled with a question mark or a comment; the correct number of commas must be maintained.

The following is a typical record:

> Borwick: Manor Farm, Olivier A, AA?, L1661, H456, L831221, MF82SS49, H5656, char, 15:6:83, , , , MC, r@20:2:84,

In full, this says that A Olivier (Harwell code 456) submitted a (large) charcoal sample (AML no. 831221, his no. MF82SS49, Harwell no. HAR5656) from Manor Farm, Borwick (AML site 1661, AA no. unknown); according to the latest Harwell report (February 20th 1984) this had been accepted into the system on June 15th 1983, and had been counted, and the measurements completed (MC) by the date of the report.

Another (small) sample from the site, which has produced a date (3270 +/- 80 b.p.), is listed as:

> Borwick: Manor Farm, Olivier A, AA?, L1661, H456, L831222, MF82SF55, H5658, bone, 8:7:83, small, , , , , 3270#80

4.2 The record files

see: Appendix II for specimen
files: various named Excavator files
'carbonAF'
'carbonCL'
'carbonMS'
'carbonTZ'
'small'

As explained above, Harwell groups its records under the Project Code heading - one unique code for each submitter - while AML uses the basis of Site Number. To reconcile the different systems, two possible groupings of records suggest themselves: one file per site, or one file per excavator. While the former would suit the AML arangement better, it would be inefficient in its use of disc space, as one site only rarely has more than one excavator, while one excavator may have submitted samples from several sites. Matching the Harwell progress sheets, one per excavator, would therefore be made less complicated by listing sites, alphabetically, within excavator files. Record files are accordingly designated by the excavator's name.

When the sample is small, its record is duplicated in file 'small'. This satisfies the need to monitor closely the work-load for the small counter; with the long turn-round time of this counter, the queue has at present acquired a maximum delay of around 2 years.

In many cases, an excavator has submitted only a few samples - less than 10. Since placing these batches in separate excavator would be as inefficient as grouping them in separate site files, they have been coalesced into four alphabetically successive compendium files called 'carbonAF', 'carbonGL', 'carbonMS' and 'carbonTZ'.

4.3 Cross-reference files

see: Appendix III - 'names', 'codes' and 'sites'

These files are used for quick cross-reference.

names — cross-references excavators' names against their Harwell codes and the names of the files in which their samples are listed. This is particularly of value in indicating whether there are small samples, and shows where to finds the records associated with a particular excavator.

codes — holds the same information as 'names', but is sorted numerically in order of Harwell code.

sites — is a copy of the current site list used by the Labfile catalogue, and cross-references site number, site name and excavator's name.

Sections of these three files are shown in Appendix III. The 'sites' file is copied across to the Carbon directory from the Labfile directory; there, where it is frequently updated, it has no provision to include details of Carbon files or project codes, so it can not be incorporated efficiently with 'names' or 'codes' at present.

4.4 Submissions day-book

see: Appendix IV - section of 'book'

File 'book' holds details of transfers of samples to Harwell. It records whether the samples have gone direct from the excavator to Harwell or via AML, when they went, when the forms were sent, the AML and excavator's sample numbers, and a note saying that the movement of finds has been notified to the Labfile supervisor.

5 Up-dating

At present, progress reports from Harwell are produced at 20-day intervals. These list all the work in hand on a computer-produced printout, with one entry per excavator.

To revise the AML records for that excavator, the file(s) containing his records have to be identified, using the cross-reference in 'names' if necessary, which will also detect records in 'small' or 'carbon'. The file is then edited using the file editor package. This allows global searching and editing, so that, for instance, to modify only those records listed by the 20-day printout, they would be identified by Harwell number and marked; the marked records would then be edited en bloc for report date, and edited in smaller multiples, or singly, for each category of progress code.

Copies of the dating certificate are also sent from Harwell to AML. These contain the Harwell project code, excavator's, AML and Harwell sample numbers, and the final date; they can therefore be matched against the relevant data base record using the methods outlined in the previous paragraph.

6 Reporting

see: Appendix V - specimen report

file: 'caption'

6.1 Ad hoc enquiries

Ad hoc enquiries which require no printed record are carried out with the 'grep' command, which can be applied to any readable file in the catalogue. This is a global retrieve and print function which extracts copies of any records containing the given string of characters, and can therefore be used for all records from a given site, of a given material, at a particular progress stage, containing a certain code number, etc.. The greatest drawback of this is that it only permits searching on a single key at one time, but this can be overcome by writing the retrieval output to a file and searching that file for a second string. For instance, the sequence of commands:

```
grep "char" drewett >temp.drewett
grep "#" temp.drewett
```

copies all charcoal records from file 'drewett' into file 'temp.drewett', then retrieves all records containing the character "#" (meaning +/-); the net result is to obtain all final results for charcoal samples submitted by P Drewett.

6.2 Written reports

These can be produced in list form with a suitable caption by first copying all relevant records into another file, as described in 6.1, adding a copy of file 'caption', and editing the information into the required format with the editor. This report is then suitable for distribution, with the addition of a copy of 'sample.key' (see Appendix I), which explains the progress codes. All enquirers have been satisfied with this up to present. It is not satisfactory, however, as it requires a considerable amount of manual editing, and is one feature which would be greatly improved if the system were under the control of a Data Base Management System.

In the example given in Appendix V, it will be noted that the dates b.p. have been calibrated; a program for this is described in section 7.

7 Calibration

see: Appendix VI - interactive terminal record

files: 'calib.f': program source file
'calibrate': loaded version
'clarkin': calibration values look-up table
'calout': output file space

For routine calibration, AML and Harwell use two calibration curves:

a 0 - 2000 years b.p.: Stuiver (1981). This high precision curve is in graphical form, and dates are calibrated by reading off the calendar year range corresponding to the given date b.p. +/- error. Harwell (R L Otlet, pers comm) is currently preparing a computer program for this calibration which uses Stuiver's original data to take account of the local variance along the curve.

b 0 - 6500 b.p.: R M Clark (1975). Program 'calibrate' is used for this, and its working is explained in a separate report (Haddon-Reece, 1984a). It can be run interactively by typing the command 'calibrate', and on request entering the date b.p. +/- error to be calibrated. The program refers to a look-up table taken from values published by Clark, and interpolates to calculate the exact date. Results are given to one, two and three standard deviations, both with and without Clark's extra error term. The counting error on Harwell dates is sufficiently comprehensive for Clark's extra error term not to be needed, but the facility is included to cope with dates from other laboratories when necessary. Output is returned to the vdu terminal and written to file 'calout'.

STUIVER, M, 1982: A high-precision calibration of the AD radiocarbon time scale. Radiocarbon, v 24, pp 103-150.
CLARK, R M, 1975: A calibration curve for radiocarbon dates. Antiquity XLIX, pp 251-266.
HADDON-REECE, D, 1984a: A Fortran IV program for the R M Clark calibration of radiocarbon dates. AML report no. 4268, unpublished.

8 Group-testing and amalgamation statistics

see: Appendix VII - interactive terminal record

files: 'amal.f': source version of program
'amalgamate': loaded program
'chi': chi-square values look-up table

The statistical technique recommended by Harwell to test the coherence of a group of dates is that published by Ward and Wilson (1978) and Wilson and Ward (1981); similar techniques are explained in Topping (1972) and Snedecor and Cochran (1980). The working of the program is described in another report (Haddon-Reece, 1984b). This is a prototype program for group-testing, and in its present form it calculates and reports the following values:

a Group mean

b Internal variance (a composite of the counting errors alone)

c External variance (a composite of the counting errors weighted according to the date associated with them)

d Z (+/- standard error): the square root of the ratio of the external variance to the internal variance

e T, which tests for consistency between the dates. It is obtained by dividing the deviation of each date from the group mean by its counting error, squaring and summing. As this statistic is distributed as chi-square, the degrees of freedom are also displayed.

A table of chi-square values is stored in file 'chi' for reference, which will be written into the future versions of

---

WARD, G K, and WILSON, S R, 1978: Procedures for comparing and combining radiocarbon age determinations: a critique. Archaeometry 20, 1, pp 19-32.
WILSON, S R, and WARD, G K, 1981: Evaluation and clustering of radiocarbon age paradigms. Archaeometry 23, 1, pp 19-40.
SNEDECOR, G W, and COCHRAN W G, 1980: Statistical Methods, Iowa State University Press, USA.
TOPPING, J, 1972: Errors of observation and their treatment. Chapman and Hall, London.
HADDON-REECE, D, 1984b: A Fortran IV program for comparing and combining radiocarbon dates. AML report no. 4269, unpublished.

the program.

The program is run interactively by typing 'amalgamate', and entering on request the number of dates, their values and counting errors, and an instruction to include or ignore the Clark extra error term. The program displays the values described above, and the amalgamated date, which can be accepted or rejected according to the probability levels of the test parameters. A value of T below the .95 chi-square level for the given degrees of freedom is acceptable, ie there is no reason to suspect the dates of being anything other than estimates of the same event, and Z should be within one standard error of unity to indicate a reasonable consistency between internal and external variances.

It should be noted that this program requires the null hypothesis that the dates all result from determinations of the same object or event (eg an archaeological context). Otherwise it has no validity. In reporting the amalgamated date, the greater value of variance is chosen, and rounded up to the nearest 5, and the group mean is rounded to the nearest 10.

In Wilson and Ward (1981), the authors give an ALGOL program for the detection of outliers using the maximum likelihood technique. This is currently being translated (by DHR) into a FORTRAN version for use on the AML computer.

9 Plans for the future and improvements

As explained in the Introduction, the data base has now been commisioned up to the successful conclusion of Stage I.

Plans are being drawn up at present for Stage II: the updating of files using data transmitted from Harwell on floppy disc. Programs will read the Harwell report, match the excavator's code to his file(s) with the cross-reference files, match the Harwell code or excavator's code for his sample, and revise the progress code and reporting date. Three important prerequisites have already been met - all samples have the same number and designation of fields, the progress codes are all two-character, and the reporting dates are all in identical format. A considerable expenditure of time and effort is anticipated, however, on the rooting out of a number of existing errors, many of them involving non-printing characters.

As explained in section 8, work on expanded programs for the statistical comparisons of dates and their grouping and amalgamation is currently in hand.

The problem of whether this data base should eventually be incorporated into the Labfile data base has not yet been resolved. There are various factors to consider:

a one half of the information in the carbon-14 sample record is of no concern to the Labfile processes

b samples with carbon-14 involvement amount to only about 1 in 250 of the total AML holding, which makes the carbon-14 task a small and containable one by comparison, but would involve identifying nearly 2000 Labfile records and and affixing pointers to the carbon-14 files

c although a data base structure has been defined for Labfile, the enormous undertaking of transferring all paper records and existing computer records will take several months at least, and the currently working carbon-14 system can hardly be expected to go into abeyance for that length of time

d on the other hand, given adequate preparatory planning, the Data Base Management System controlling Labfile should be able to cope more efficiently with the carbon-14 records than manual methods.

These manual methods, however, have been able to collect, incorporate and edit the carbon-14 records into a very useful single body of information, and it may be that, with the provision of a few matching and reporting programs, it can stand alone. At least, with all records in a uniform format, programs to read files and match items by field position will be simple to write and operate.

References

CLARK, R M, 1975: A calibration curve for radiocarbon dates. Antiquity XLIX, pp 251-266.

HADDON-REECE, D, 1984a: A Fortran IV program for the R M Clark calibration of radiocarbon dates. AML report no. 4268, unpublished.

HADDON-REECE, D, 1984b: A Fortran IV program for comparing and combining radiocarbon dates. AML report no. 4269, unpublished.

SNEDECOR, G W, and COCHRAN W G, 1980: Statistical Methods. Iowa State University Press, USA.

STUIVER, M, 1982: A high-precision calibration of the AD radiocarbon time scale. Radiocarbon, v 24, pp 103-150

TOPPING, J, 1972: Errors of observation and their treatment. Chapman and Hall, London.

WARD, G K, and WILSON, S R, 1978: Procedures for comparing and combining radiocarbon age determinations: a critique. Archaeometry 20, 1, pp 19-32.

WILSON, S R, and WARD, G K, 1981: Evaluation and clustering of radiocarbon age paradigms. Archaeometry 23, 1, pp 19-40.

Appendix I — file SAMPLE.KEY

Fields

1 Site name
2 Excavator's name
3 AA file number
4 AML site number
5 Harwell project code
6 AML sample number
7 Excavator's sample number
8 HAR number
9 material
10 submission date
11 sample size category
12 priority [=***]
13 publication (etc) deadline
14 progress code (see below)
15 comments and last Harwell report date
16 final result when known

Status codes for samples' progress

Code: SF Shelved awaiting further instructions
Code: AS Awaiting further supplies
Code: NS Received but not not started
Code: BP Being pre-treated
Code: RC Pretreated; ready for combustion
Code: CG Converted to carbon dioxide
Code: CB Converted to benzene
Code: BC Being counted
Code: MC Measurement completed
Code: PR Preliminary results sent
Code: CM Certificate made but not sent

Appendix II — section of records file 'murphy'

Hullbridge, Murphy P, AA?, L1635, H269, L832741, H29/68, H5735, wood, 15:9:83, , , , BC, r@30:4:83,
Hullbridge, Murphy P, AA?, L1635, H269, L832742, H22WOOD, H5736, wood, 15:9:83, , , , BC, r@30:4:83,
Hullbridge, Murphy P, AA?, L1635, H269, L832743, H23WOOD, H5737, wood, 15:9:83, , , , BC, r@30:4:83,
Hullbridge, Murphy P, AA?, L1635, H269, L823049, H4LPEATW, H5223, wood, 8:10:82, , , , , , 3660#70
Hullbridge, Murphy P, AA?, L1635, H269, L823050, H9UPEAT, H5224, peat(soil), 8:10:82, , , , , , 1500#70
Hullbridge, Murphy P, AA?, L1635, H269, L823051, H4UPEATB, H5225, peat(soil), 8:10:82, , , , , , 1610#70
Hullbridge, Murphy P, AA?, L1635, H269, L823053, H8ROOTS, H5227, wood, 8:10:82, , , , , , 4100#70
Ipswich (IAS 3410), Murphy P, AA?, L726, H269, L813637, 34100031, H4627, char, 17:9:81, , , , , , 1070#60
Ipswich (IAS AA?410), Murphy P, 3, L726, H269, L813638, IASAL02, H4628, wood, 17:9:81, , , , PR, r@17:10:83,
Ipswich, Murphy P, AA?, L726, H269, L781588, 55020280, H2764, wood, 12:7:78, , , , , , 1120#70
Kelling Heath, Murphy P, AA?, L1621, H269, L822552, KELLING, H5103, char, 23:7:82, , , , , , 4960#70
Kelvedon, Murphy P, AA?, L1190, H269, L813643, KL81J162, H4633, char, 17:9:81, , , , , , 6740$90
Kings Lynn, Murphy, AA?, L1349, H269, L777993, 999, H2539, wood, 21:2:78, , , , , , 940#70
Levington, Murphy P, AA?, L1498, H269, L800235, LVT02345, H3706, char, 5:3:80, , , , , , 1950#70
Levington, Murphy P, AA?, L1498, H269, L800236, LVT02422, H3741, char, 5:3:80, , , , , , 3340#80
Little Cressingham, Murphy P, AA?, L1347, H269, L777991, 54, H2541, char, 21:2:78, , , , , , 3540#110
Little Cressingham, Murphy P, AA?, L1347, H269, L777992, 65, H2528, char, 21:2:78, small, , , CG, r@17:10:83q15
Mildenhall: West Row Fen, Murphy P, AA?, L1207, H269, L775940, MNL0173, H-?, ?, ?, , , , , ?not sent,
Mildenhall: West Row Fen, Murphy P, AA?, L1207, H269, L777667, MNL0486, H2516, wood, 24:1:78, , , , , , 3510#80

Appendix III		part of file 'names'
373	Fleming A	fleming, small
076	Fletcher J M	carbonAF
515	Freke D	freke, small
090	Gibson-Hill J	carbonAF
222	Gilmour B	small (=C Colyer)
234	Girling M	carbonTZ, small
040	Green H S	small
044	Green H S	small
072	Gregory V	carbonAF
255	Greig J	carbonAF
311	Griffith F	carbonAF
130	Hassal J	carbonAF
022	Hassal T	durham, small
192	Heighway C	carbonGL
310	Hirst SM	hirst, small
149	Holdsworth P C	small
256	Horsey I P	carbonAF
453	Hough P	carbonAF, small
172	Hurst J G	hurst, small
198	Jackson D	small
459	Jacobi R M	small
395	Jenkins F	carbonAF
178	Jobey G	carbonAF
403	Johnson J S	carbonAF
532	Jones A J K	carbonTZ, small
062	Jones M U	small
152	Jones R T	carbonAF
030	Keeley H C M	small
037	Keen L	small
183	Kenward H	Kenward, small
299	Lamb R G	carbonAF
471	Lambrick G H	carbonMS (see also 278)
533	Leach P	carbonGL
356	Limbrey S	small
129	Losco-Bradley S	carbonAF, small
463	Lyne M B	carbonAF
034	Manby T	carbonAF, carbonTZ
126	Martin E A	small
153	McCormick A G	small
123	McWhirr A	carbonAF
218	Mercer R	mercer, small
398	Millet M	small

Appendix III cont		part of file 'codes'
161	Brewster T C M	carbon, brewster, clark, smalls
162	Ashbee P	smalls
168	Clark A J	clark, carbonAF, carbonTZ, smalls
169	Robinson M	carbon, carbonGL, smalls
170	Burl A	smalls
172	Hurst J G	hurst, smalls
173	Saville A	saville, smalls
178	Jobey G	carbonAF
179	O'Connor T P	carbonAF
182	Coombs D G	smalls
183	Kenward H	kenward, smalls
184	Simmons B	smalls
190	Donaldson P	carbonAF
191	Macpherson-Grant N	carbonAF
192	Heighway C	carbonGL
194	Bidwell P T	carbonAF
198	Jackson D	smalls
199	Dent J S	carbonTZ
202	Wills J	wills, smalls
203	Vatcher F	carbonAF
206	Hyde E	carbonAF
218	Mercer R	mercer, smalls
221	Clack P	carbonAF
222	Gilmour B	smalls (=C Colyer)
232	Whimster R P	smalls
233	Balaam N	balaam, smalls
234	Girling M	carbonTZ, smalls
255	Greig J	carbonAF
256	Horsey I P	carbonAF
257	Bedwin O	carbonAF
258	Chowne P	chowne, smalls
261	Richards J C	carbonAF
269	Murphy P	murphy, smalls
278	Miles D	carbonAF, carbonMS, smalls (=Lambrick G)
290	Colchester Arch Trust	carbonAF (=Brooks H)
297	Rhodes M	carbonGL
299	Lamb R G	carbonAF
300	Rahtz P A	smalls
308	Rodwell W	rodwell
310	Hirst SM	hirst, smalls
311	Griffith F	carbonAF
312	Courtney T	smalls
318	Donaldson A M	carbonMS, smalls
331	Schadla-Hall T	schadla, smalls
338	Fenwick V	carbonAF

Appendix III contd — part of file 'sites'

```
305,GREAT DUNMOW,ZZZ,ESSEX,N,YF,
306,WEASENHAM,ZZZ,ZZZ,ZZZ,YF,
307,BRIGSTOCK,JACKSON D,NORTHANTS,ZZZ,YF,
308,HENLEY WOOD  YATTON,GREENFIELD E,SOMER,N,YF,
309,HARLOW  STAFFORD HOUSE,SEWTER MRS J,ESSEX,ZZZ,YF,
310,EMBURY BEACON,CEU,ZZZ,N,YF,
311,EYNSFORD CASTLE,RIGOLD S E,GTR LONDON,G,YF,
312,BALDOCK,STEAD DR I,HERTS,N,YF,
313,IRTON MOOR  NORTH RIDING,SIMPSON D,N YORKS,ZZZ,YF,
314,WALLINGFORD CASTLE,CARR R,OXON,ZZZ,YF,
315,MELBOURNE,COURTNEY T,HUMBS,ZZZ,YF,
316,CHINGLEY,CROSSLEY D W,ZZZ,ZZZ,YF,
317,CROXDEN ABBEY,CRAVE P W,STAFFS,G,YF,
318,WREKIN CAMP,STANFORD S,SHROP,ZZZ,YF,
319,LILLESHALL  REDHILL,BROWNE D,SHROP,ZZZ,YF,
320,WHITCHURCH,ROGERSON A,ZZZ,ZZZ,YF,
321,BAYLHAM HOUSE,LOUGHLIN N,ZZZ,ZZZ,YF,
322,SOMERSET HOUSE,ZZZ,GTR LONDON,ZZZ,YF,
323,HART,AUSTIN D,CLEVE,ZZZ,YF,
324,BACONSTHORPE CASTLE,AMES S,NORF,G,YF,
325,WORTHY PARK,HAWKES S,ZZZ,ZZZ,YF,
326,WATCH HILL AND GREENSPLATT,MILES H,ZZZ,ZZZ,YF,
327,GRANTHAM (GREYFRIARS),ROGERSON A,LINCS,N,YF,
328,COVENTRY STONEHOUSE MUCH PARK STREET,G ASTILL,WARW,N,YF,
329,COWDOWN  LONGBRIDGE DEVERILL,HAWKES S,
330,OVERMOIGNE,WALKER P
331,OLD BOLINGBROKE CASTLE,DREWETT P L,LINCS,G,
332,STREATLEY WARREN,ZZZ
333,CAERLOGGAS  SAINT AUSTELL,MILES HENRIETTA
```

Appendix IV part of file 'book'

RADIOCARBON FORMS AND SAMPLES SENT TO HARWELL

Sample forms to Harwell 14:10:83

Ulwell Cemetery 102 Peter Cox (Samples via AML 25:1:84, mof)

830930	W30/7	human bone
830931	W30/16	human bone
830932	W30/50	human bone
830933	W30/3	human bone

W181 Wraysbury 854 Sue Lobb (dfe,mof)

833187	W181/198	charcoal
833188	W181/201	charcoal
833189	W181/70	charcoal
833190	W181/537	human bone

Samples to Harwell 25:1:84

Avebury 243 M Pitts (via AML 25:1:84, mof)

822622	226	antler
826585	227	antler

Coppergate, York 173 A K G Jones (via AML 25:1:84, mof)

834741	82/22/68	wood
834742	82/22/72	wood

Ewanrigg, Cumbria 1752 B Bewley (dfe, mof)

840104	EWR83105	charcoal
840105	EWR83222	charcoal
840106	EWR83218	charcoal
840107	EWR83114	calcined bone

(dfe = samples to come direct from excavator)
(mof = movement of finds card given to Chris Sullivan)

Appendix V Specimen report

Radiocarbon dates from Hullbridge for samples submitted by P Murphy.

Laboratory site number: 1635

Harwell project code: 269

Information from data base on December 16th 1983.

Latest report from Harwell: December 9th 1983.

AMLab number	Excavator's number	HAR number	mat'l	Submission dat	Results (c)	
					bp	Calibrated
823047	H11ROOTS	5221	wood	8:10:82	2620+/-70	855BC (915-800)
823048	H1WOOD14	5222	wood	8:10:82	2730+/-60	954BC (1010-879)
823049	H4LPEATW	5223	wood	8:10:82	3660+/-70	2107BC (2201-2022)
823050	H9UPEAT	5224	peat	8:10:82	1500+/-70	AD470 (415-560)
823051	H4UPEATB	5225	peat	8:10:82	1610+/-70	AD382 (307-439)
823052	H4LPEATB	5226	peat	8:10:82	3670+/-70	2120BC (2215-2035)
823053	H8ROOTS	5227	wood	8:10:82	4100+/-70	3530BC (3601-3462)
831123	H44TWIGS	5549	wood	10:5:83	(a)	
831124	H45POST	5550	wood	10:5:83	(a)	
832738	H56/97	5732	peat	14:9:83	(b)	
832739	H2/91	5733	char	14:9:83	(b)	
832740	H29/67	5734	twigs	14:9:83	(b)	
832741	H29/68	5735	wood	14:9:83	(b)	
832742	H22WOOD	5736	wood	14:9:83	(b)	
832743	H23WOOD	5737	wood	14:9:83	(b)	

(a) Measurements completed; results to be sent

(b) Converted to benzene; awaiting counting

(c) Dates are calibrated on R M Clark curve with 68% confidence limits

---

D Haddon-Reece

Ancient Monuments Laboratory

16:12:83

Appendix VI interactive terminal record of 'calibrate'

```
R M Clark calibration of C14 dates.
**********************************

Calibration curves extends to about 6500 bp

Results are given without and then with Clark error

Enter date bp, error      1570,40

Dates without extra error term
******************************

68% confidence interval:

Date is AD 415 (-  33, +  32)
Range is AD  382 to AD  447

95% confidence interval:

Date is AD 415 (-  70, +  69)
Range is AD  345 to AD  484

99% confidence interval:

Date is AD 415 (- 121, + 120)
Range is AD  294 to AD  535


Dates with extra error term
***************************

68% confidence interval:

Date is AD 415 (-  55, +  51)
Range is AD  360 to AD  466

95% confidence interval:

Date is AD 415 (- 132, + 130)
Range is AD  283 to AD  545

99% confidence interval:

Date is AD 415 (- 177, + 200)
Range is AD  238 to AD  615


Results writen to file calout

Another date (yes:1, no:2)       2
```

Appendix VII Interactive terminal record of 'amalgamate'

```
Program amalgamates dates, and tests for consistency.
Final date is uncalibrated [bp].


How many samples:     4

Enter data as [ date bp, error ]
1500,70
1610,70
1580,80
1600,90

Include R M Clark correction (yes:1, no:2)  2

Mean date =  1569.
var (int) =   1454.
T =   1.45 with  3 degrees of freedom
var (ext) =   703.7
Z =  .83 +/- .41


Grouped date =  1569. +/-  38. (internal)
 or
                1569. +/-  27. (external)


Start again (1), or stop (2)    2
```