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EDITORIAL STATEMENT TO CONTRIBUTORS

Since its inception, the basic purpose of Radiocarbon has been the publication of compilations of ^{14}C dates produced by various laboratories. These lists are extremely useful for the dissemination of basic ^{14}C information.

In recent years, Radiocarbon has also been publishing technical and interpretative articles on all aspects of ^{14}C. The editors and readers agree that this expansion is broadening the scope of the Journal. Next year we will publish the Proceedings of the Eleventh International Radiocarbon Conference which will be held in Seattle, Washington, June 20-26, 1982. We also published the Proceedings of the Tenth International Radiocarbon Conference in 1980.

Another section is added to our regular issues, "Notes and Comments". Authors are invited to extend discussions or raise pertinent questions to the results of scientific investigations that have appeared on our pages. The section will include short, technical notes to relay information concerning innovative sample preparation procedures. Laboratories may also seek assistance in technical aspects of radiocarbon dating. Book reviews will also be included for special editions.

All correspondence, manuscripts and orders should be sent to the Managing Editor, Radiocarbon, Kline Geology Laboratory, Yale University, 210 Whitney Ave, PO Box 6666, New Haven, Connecticut 06511.

The Editors

INSTRUCTIONS TO CONTRIBUTORS TO THE PROCEEDINGS OF THE 11th INTERNATIONAL RADIOCARBON CONFERENCE

The editors of RADIOCARBON announce the publication of the Proceedings of the 11th International Radiocarbon Conference to be held in Seattle, Washington, June 20-26, 1982. The Proceedings will appear in one of the three regular numbers of Volume 25, 1983, and will be offered as part of the subscription for that year.

Presentation of a paper at the Conference will not guarantee publication in the Proceedings issue. If a paper is accepted but will not fit into the Proceedings, it will be considered for publication in one of the subsequent issues. *Only those manuscripts submitted in proper form (in three typewritten copies) at the Conference will be considered for publication.*

The usual review system will be employed. Manuscripts should follow the recommendations in *Suggestion to Authors**, or the editorial style of the Proceedings of the Tenth International Radiocarbon Conference (Volume 22, Nos. 2 & 3, 1980). *All measurements should be in SI (metric units).* Articles may not exceed ten pages including references, illustrations, and tables. No more than four illustrations are recommended, reducible to two pages. The author will be responsible for photographic reductions, preferably with the original manuscript.

Illustrations must be numbered and accompanied by captions that include explanation of symbols used. Copy that cannot be reproduced will not be accepted. A glossy print, an original inked drawing, or a sharp copy of a drawing should be used. Half-tones (plates) and line drawings (figures) should be designated by Arabic numerals. Multiple parts of a figure or plate should be designated by a capital letter (eg, A,B).

Tables must have titles and be numbered consecutively by Arabic numerals. Footnotes to a table should be cited in order by *, **, †, ‡, ¶, #. Occasionally, a particular situation will call for an alternative citation.

Footnotes in the text should be cited by Arabic numerals.

References should be given particular attention. No substitutes will be accepted for our own editorial style. Full names should be used wherever possible and *all* authors should be cited. For more than three authors, *et al* will be accepted after the first author in a text citation *only*.

For equations, use only standard symbols and abbreviations; define the symbols when necessary for clarity. Equation numbers should be enclosed in parentheses and placed flush with the right-hand margin. Periods are not used with abbreviations.

In the interest of brevity, preference will be given to shorter articles and no discussions will be published. Because we will be using the photo-offset method of printing for this issue, the author whose manuscript has been accepted will receive more detailed instructions as well as standardized forms for the preparation of final copies. If the author prefers, RADIOCARBON will prepare the final text for a reasonable fee, payable in advance.

THE EDITORS OF RADIOCARBON

* Suggestions to authors of the reports of the United States Geological Survey, 5th ed, Washington, DC, 1958 (Government Printing Office, $1.75).

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CALIBRATION OF RADIOCARBON DATES:

Tables based on the consensus data of the Workshop on Calibrating the Radiocarbon Time Scale

JEFFREY KLEIN*, J C LERMAN**, P E DAMON**, and E K RALPH*

A calibration is presented for conventional radiocarbon ages ranging from 10 to 7240 years BP and thus covering a calendric range of 8000 years from 6050 BC to AD 1950. Distinctive features of this calibration include 1) an improved data set consisting of 1154 radiocarbon measurements on samples of known age, 2) an extended range over which radiocarbon ages may be calibrated (an additional 530 years), 3) separate 95% confidence intervals (in tabular from) for six different radiocarbon uncertainties (20, 50, 100, 150, 200, 300 years), and 4) an estimate of the non-Poisson errors related to radiocarbon determinations, including an estimate of the systematic errors between laboratories.

INTRODUCTION

It is now quite generally accepted that "conventional" radiocarbon dates need to be "calibrated" because of temporal variations in the radiocarbon content of atmospheric carbon dioxide. The discovery of this phenomenon was made largely by the pioneering work of de Vries (1958; 1959) and Willis, Tauber, and Münnich (1960), and subsequently has been carried on by more than a dozen radiocarbon laboratories worldwide (for a review see Damon, Lerman, and Long, 1978). The assessment of these variations relies on the measurement of ^{14}C activity in samples of known age. Dendrochronologically dated wood has proved to be an ideal material for such measurements, and currently all radiocarbon calibrations are based on measurements of ^{14}C activity in wood. The longest chronology extant is that of the bristlecone pine, resulting from the efforts of Schulman (1956) and Ferguson (1969; 1970; 1972). It reaches continuously to 8681 years ago, and to 8580 years ago with sufficient material to allow radiocarbon dating. This work includes measurements on wood as old as 8000 years.

Many calibrations have appeared during the past 13 years (Suess, 1979; 1970a; 1967; Clark, 1980; 1979; 1975; McKerrell, 1975; Damon *et al*, 1974; Ralph, Michael, and Han, 1973; Switsur, 1973; Michael

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and Ralph, 1972; Clark and Renfrew, 1972; Damon, Long, and Wallick, 1972; Wendland and Donley, 1971; Lerman, Mook, and Vogel, 1970; Ralph and Michael, 1970; Stuiver and Suess, 1966). Although all reflect similar long-term changes in atmospheric radiocarbon concentrations, they differ significantly in their treatments of shorter period variations. This diversity of available calibrations and the apparently conflicting results obtained when calibrating dates using one in preference to another has resulted in a suspicion on the part of many archaeologists regarding calibration, in particular, and radiocarbon dating, in general. Consequently, in 1978, it was suggested to the USA National Science Foundation that it was time to attempt a consensus among the divergent efforts of the many laboratories then involved in calibration research. With this as a goal, a workshop was held in Tucson, Arizona in early 1979, entitled, "Workshop on the Calibration of the Radiocarbon Dating Time Scale" (Damon *et al,* 1980; Michael and Klein, 1979). This work is largely the implementation of the decisions reached at that meeting.

The Workshop participants decided to provide a calibration table suitable for the calibration of individual or "single" radiocarbon dates. A "single radiocarbon date" is defined as any radiocarbon date that is not associated with another radiocarbon date by a tight, independently determined relative chronology. Such a chronology is exemplified by tree rings, where the number of intervening rings determines the relative ages of samples, and by stratified samples, where the rate of stratification is known independently of the radiocarbon ages of samples contained therein. Included in the category of "single radiocarbon dates" are series of dates from samples thought to be coeval, or series in which the temporal sequence, or even the relative ages of its members is unknown.

A second decision of the participants of the Workshop was to provide the "user" with a realistic assessment of the precision of calibrated dates. A consideration of many factors is necessary in the estimation of this precision. These include the precision with which the sample's activity has been measured, involving not just the "counting" statistics quoted by the measurement laboratory, but also an estimate of the true reproducibility of the measurement, *ie,* the degree to which a particular result can be repeated by the same laboratory or any other laboratory on subsequent measurements. In addition, there is the precision to which the calibration function is known near a particular calendric date. This depends on the quantity and quality of data used in the construction of the calibration. Finally, there is the "shape" of the calibration "curve" in the region in which it is being employed. This factor is often the most influential in determining the magnitude of the uncertainty of a calibrated date, and although its importance has been recognized for some time (Renfrew and Clark, 1974; Grey and Damon, 1970) it is often ignored in the routine calibration of dates.

These objectives were implemented by providing a range of calibrated dates, representing the 95% confidence interval, for each radiocarbon age of specified precision. An advantage of specifying an interval, rather than a midpoint and uncertainty, hinges on the fact that many confidence intervals are asymetrically related to the value obtained from simply calibrating the ^{14}C date without consideration of uncertainties.

THE DATA

This calibration is based on the ^{14}C activity measurements performed by the radiocarbon laboratories at the Universities of Arizona, Groningen, California at La Jolla, Pennsylvania, and Yale, on 1154 samples of dendrochronologically dated wood, principally *Pinus longaeva* and *Sequoia gigantea* (bristlecone pine and giant sequoia). The data set consisting, for the most part, of an updated version of previously published data (current data sets in preparation by individual laboratories), was prepared for the "Workshop on the Calibration of the Radiocarbon Dating Time Scale." Only measurements on samples of wood containing 20 or fewer rings were used in this work so as not to attenuate significantly through averaging, variations occurring on the time scale of the order of 100 years. Beyond this consideration, no selection of the data was undertaken.

As one of the principal objectives of this analysis has been to understand more fully the nature and causes of the variability of radiocarbon dates, the data were examined carefully for signs of non-random errors. Much to our surprise and despite previous findings to the contrary (Damon, Lerman, and Long, 1978; Clark, 1975; Damon, 1970), there is significant evidence of systematic differences between the laboratories represented. Of the five laboratories, one shows an average systematic difference of approximately six per mil, roughly 50 radiocarbon years, significant at less than the 1% level. The other four laboratories agree within experimental uncertainties. Independent comparisons with a sixth laboratory have resulted in similar conclusions (Stuiver, pers commun, 1981). Systematic differences were determined by calculating residuals of each data set with respect to the calibration function calculated on the combined data set. If no systematic differences had existed, then the sum of residuals would have been consistent with zero for all laboratories; it was not. A table of these differences was reported earlier (Klein *et al,* 1980), and is included here with slight modifications (see Table 1). Since it is unlikely that the systematic errors between other radiocarbon laboratories are, in general, less than those encountered here (International Study Group, submitted for publication), we decided to leave the data as they were and to include the uncertainty related to interlaboratory standardization within the calibration uncertainty.

CONSTRUCTION OF TABLES

Though the method used to construct this calibration has been outlined elsewhere (Ralph and Klein, 1979; Klein *et al,* 1980) and will be described in more detail in a forthcoming article, it is briefly described here. The procedure may be divided into three steps: a "global" regression which describes the long period (of the order of a few thousand years) secular changes in the atmospheric ^{14}C concentration; a series of short term intervals called "shingles" which describe variations of a few hundred years; and finally, the construction of the table itself from the combination of these functions.

First, paired dendrochronologic ages and radiocarbon ages are scaled logarithmically so that each ranges over the interval [−1,1]. This is done to avoid the pathology common with polynomial regressions, namely the dominance of measurements at large values of the independent variable in the determination of the coefficients of the function. Next, each measurement is weighted by an estimate of the inverse of its variance. But, as it is widely accepted that the uncertainties quoted by radiocarbon laboratories, based only on counting statistics, are underestimates of the "true" variability, the laboratory uncertainties were increased under the following assumptions: 1) the additional sources of variance are independent of the Poisson error of the activity measurement; 2) this added variance is of approximately the same magnitude for samples of similar age; 3) these "extra" components increase with the age of the sample, as demonstrated by the poorer reproducibility of radiocarbon dates for older samples (Currie and Polach, 1980; Pearson *et al*, 1977; Clark, 1975; Currie, 1972). Consequently, the "counting" variance was increased by an additive term which was allowed to be a slowly increasing function of the age of the sample, hence:

$$w_i = \frac{1}{\sigma^2_i + \left(40 + \frac{x_i}{150}\right)^2}$$

This has the effect of increasing the smallest error to approximately 60 years for samples less than 1000 years old, and to approximately 115 years for samples with ages greater than 6000 years. These figures compare favorably with the error estimates of Otlet *et al* (1980), *viz:* 50 years for samples less than 5000 years and 100 years for samples less than 10,000 years old, and the estimates of Clark (1975), *viz:* 50 years for samples less than 3000 years and 95 years for samples with ages greater than 3000 years.

Finally, the weighted, scaled radiocarbon ages are least squares regressed against their calendric (dendrochronologic) ages using a polynominal basis to obtain the long period trend curve. Polynominals were chosen since 1) a sample's radiocarbon age is, to first order, linearly related to its chronologic age, and 2) though the difference between a sample's uncalibrated age and its true age is bounded, and described reasonably well by a sine function (Damon, Long, and Wallick, 1972; Houtermans, 1971), a polynomial fit is better.

With Fisher's F-test as a criterion, the "best fit" was determined to be a polynominal of order six. Because of its low order, this function is insensitive to short-period variations in the ^{14}C inventory and, for the most part, reflects variations resulting from changes in the earth's magnetic field. (See, eg, Sternberg and Damon, 1979; Lingenfelter and Ramaty, 1970; Damon, 1970; Bucha, 1970; Lal and Venkatavaradan, 1970; Suess, 1970b.) This function and the data are plotted in Figure 1.

The second step involves a piecewise Fourier analysis of the residuals around the polynominal regression. A piecewise regression, *ie,* one that divides the data into a number of similar intervals instead of considering the data set as a whole, was adopted because of several distinctive features observed in the variations of atmospheric ^{14}C. Such characteristic changes are represented by the variations in ^{14}C concentration occurring during the Spörer, Maunder, and Wolf minima (Stuiver and Quay, 1980a; 1980b; Damon, Long and Grey, 1966); by those occurring in the sixth millennium BP (de Jong, Mook, and Becker, 1979; de Jong and Mook, 1980), and by the peaks at 200 years, 150 years, etc, observed in the power spectra of Fourier analyses performed by various investigators (Neftel, Oeschger, and Suess, 1981; Suess, 1980; Lazear, Damon, and Sternberg, 1980; Siegenthaler, Heimann, and Oeschger, 1980; Houtermans, 1971). Damon (1977) has noted that although characteristic periods appear in the spectral analyses of atmospheric ^{14}C, their phase relationships are different depending upon the section of the 8000-year record analyzed. With this in mind, it seemed prudent to divide the entire time period into short segments and consider the fluctuations individually in each. Consequently, the calendric time scale was divided into 28 shingles, each 500 years long, and each overlapping the previous and next shingle by 250 years (50% overlap each end, 100% overlap for the entire shingle). Two Fourier analyses were carried out to a minimum period of 65 or 110 years, depending on the number of measurements in the shingle. The minimum periods were chosen with consideration of the attenuation factors predicted by various models for changes in the atmospheric ^{14}C activity resulting from changes of various durations in the production-forcing function (Oeschger *et al,* 1975; Houtermans, 1966). Such models predict attenuation factors on the order of 25 times for variations in production lasting less than 100 years. The result of these procedures is shown in Figure 2.

Two analyses were performed in order to assess the effects of outlying points on the calibration function. The first analysis used the unmodified data base as described in the section on data, whereas the second analysis used a "winsorized" data set in which the residuals used for winsorization were taken with respect to the function calculated on the unmodified data. "Winsorization" is a process which reduces the effect of a few aberrant measurements by limiting the effect on the mean of a single outlying point to less than $\sim 2.56s/n$, where s is the standard error estimated from the fourth quintile of the variance of the data, and n is the number of points in the interval. Winsorization, as employed here, is described elsewhere (Dixon, 1960). Winsorization was used instead of a simple rejection of "outlying" points for the following reasons: 1) the maximum rate of change of the ^{14}C concentration is not certain, and although it appears that changes of the order of a few per mil per year seem to be

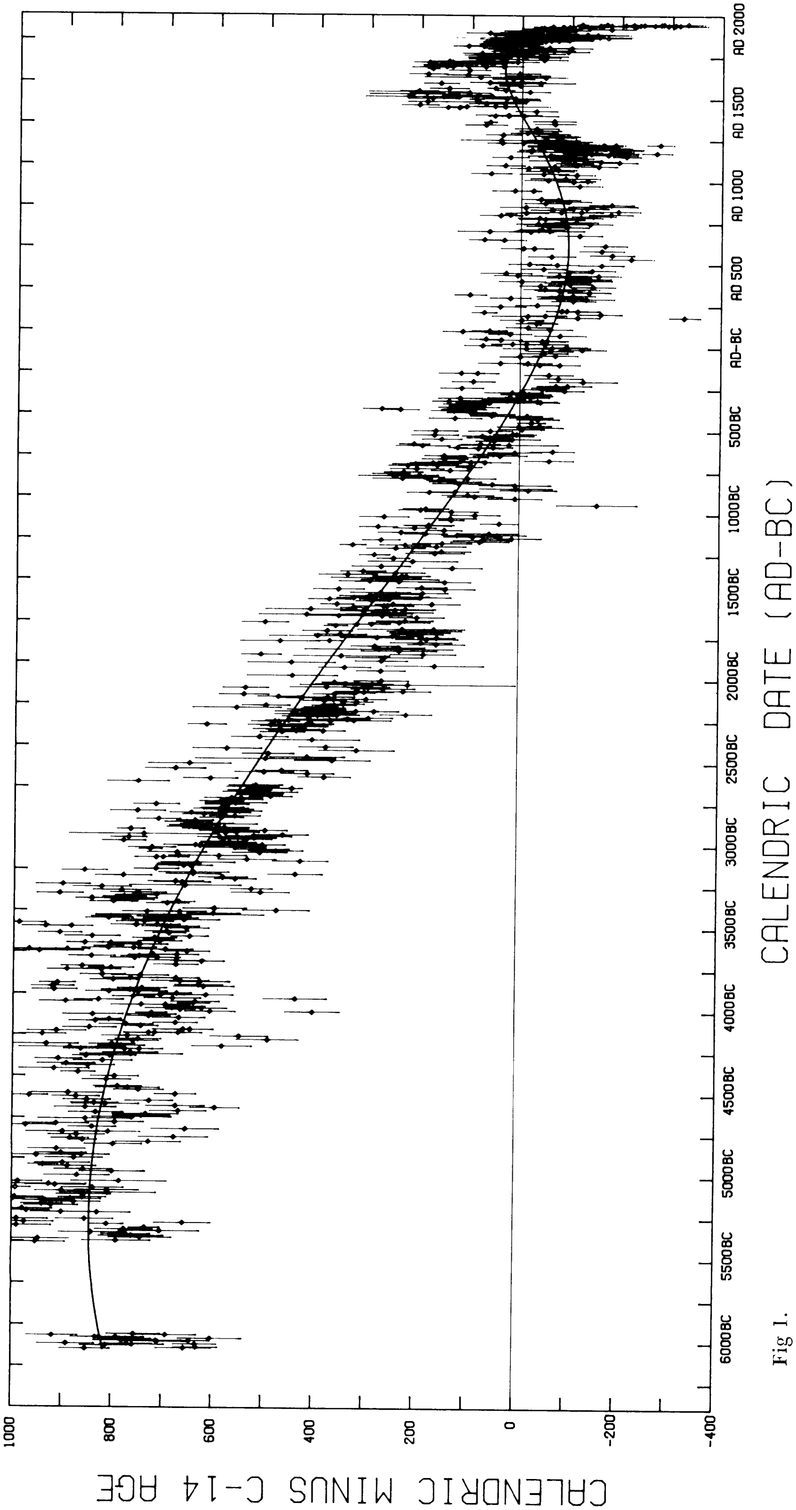
CALENDRIC MINUS C-14 AGE
1000
800
600
400
200
0
-200
-400
CALENDRIC DATE (AD-BC)
6000BC
5500BC
5000BC
4500BC
4000BC
3500BC
3000BC
2500BC
2000BC
1500BC
1000BC
500BC
AD-BC
AD 500
AD 1000
AD 1500
AD 2000

Fig 1.

the rule (Stuiver and Quay, 1980b; Burchuladze *et al,* 1980; Lerman, 1970a; 1970b; Lerman *et al,* 1969; Lerman, Mook, and Vogel, 1967), it seemed preferable not to establish an arbitrary criterion for the rejection of suspect measurements, and 2) in the assessment of the "true" errors associated with radiocarbon dates, the rejection of measurements with large residuals furthers the practice of underestimating the scatter in the data.

Another problem is caused by unequal residuals at the ends of the regression intervals (endpoint effects) and this was eliminated by using a cosine weighted average of the overlapping functions. This weight is equal to one in the center of the interval and zero at the ends, producing a final calibration function that is both continuous and differentiable.

The combined uncertainty of the calibration and the "true" uncertainty of the data are estimated by averaging the residuals of the data around the final calibration function, using the following formula:

$$\bar{\sigma}_{\text{calib}} = \sum_{\text{shingle}}^{n} \{(y_i - \hat{y}_i)^2 - \sigma^2{}_i\} \;/\; (n - a)$$

where the y(i) are winsorized, but the σ(i) are the unmodified laboratory estimates of the measurement uncertainty, and n is the number of measurements in the 500-year interval. The assumption is that

$$\text{Var}(y - \hat{y}) = \text{Var}(y) - \text{Var}(\hat{y}),$$

which is the natural decomposition, assuming the independence of y

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Fig 1. The composite "workshop data set" is plotted against the 6th order polynominal regressed on the logarithmically scaled data. Calendric age minus conventional radiocarbon age is the ordinate; the calendric age is the abscissa. Positive values represent radiocarbon ages that are too young (too recent) and, consequently, atmospheric concentrations were greater than that of the standard atmosphere of 1890. Laboratories are identified by the following symbols: △ = Arizona; ○ = Pennsylvania; □ = La Jolla; × = Groningen; ◇ = Yale; + = Uppsala. Error bars are laboratory estimates of uncertainties calculated from counting statistics. The equation of the trend line in logarithmically compressed cordinates is:

$$\tilde{y}_i = \sum_{n=o}^{6} a_n \tilde{x}_i{}^n$$

where $\tilde{x}_i = \alpha \log_{10}(x_i) + \beta$,

x_i is the dendrochronologic age in years before AD 1975, and the various coefficients are defined by:

α = 0.774607	a_3 = −1.249500
β = −2.024200	a_4 = 0.641460
a_0 = −0.023469	a_5 = 0.591000
a_1 = 1.205700	a_6 = −0.344350
a_2 = 0.143050	

The predicted radiocarbon age (in years before AD 1975 and with $T_{1/2}$ = 5730 years), y_i, is obtained from $\tilde{y}_i$, using the formula:

$$y_i = \exp\left(\frac{\tilde{y}_i - \beta}{\alpha}\right)$$

and ŷ. In fact, this is not the case for linear regression which always leaves residuals correlated with the original data, but this correlation has little effect on the value of this procedure in determining the magnitude of the combined uncertainty of the calibration and the true measurement variability.

Finally, the calibration tables were derived from the composite calibration function and the combined error of the calibration and the quoted error of the radiocarbon date being calibrated. This was done by adding together the variance of the calibration (which includes not only the error of the calibration proper, but also an estimate of the non-Poisson error associated with a typical radiocarbon date) and the variance

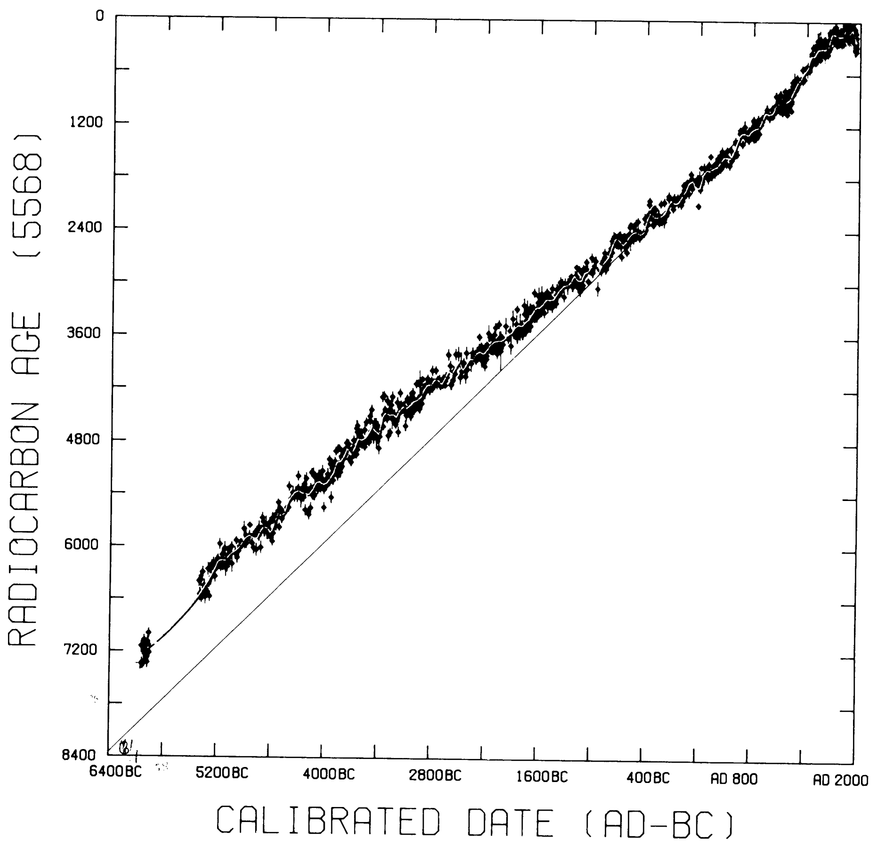

Fig 2. Graphic representation of the period covered by the calibration tables. The ordinate is the conventional radiocarbon age in years BP (1950 used as origin, ages calculated using the 5568-year half-life); the abscissa is the calendric date in years AD-BC. The same data set as in Figure 1 is plotted, but the data here have been winsorized as described in the text. The function includes both the trend analysis and the Fourier analysis of the residuals around the trend. If conventional radiocarbon years were equivalent to calendric years, all the data would fall on the diagonal line; that they do not is readily apparent. The maximum deviations between uncalibrated conventional radiocarbon dates and calendric dates occur ca 5200 BC.

of the particular date. The square root of this "total" variance was added to and subtracted from the composite calibration function, producing an uncertainty band in ^{14}C activity representative of the 95% confidence interval for a single determination of the ^{14}C activity in a sample of given age. This was converted to an uncertainty interval in calibrated age by determining the range of calendric dates for which the ^{14}C age was consistent (see Figure 3). With the exception of the post-industrial period, multiple calibration intervals were found to be statistically unjustifiable. Consequently, after combining the variances associated with the calibration and those associated with an individual date, the bound-

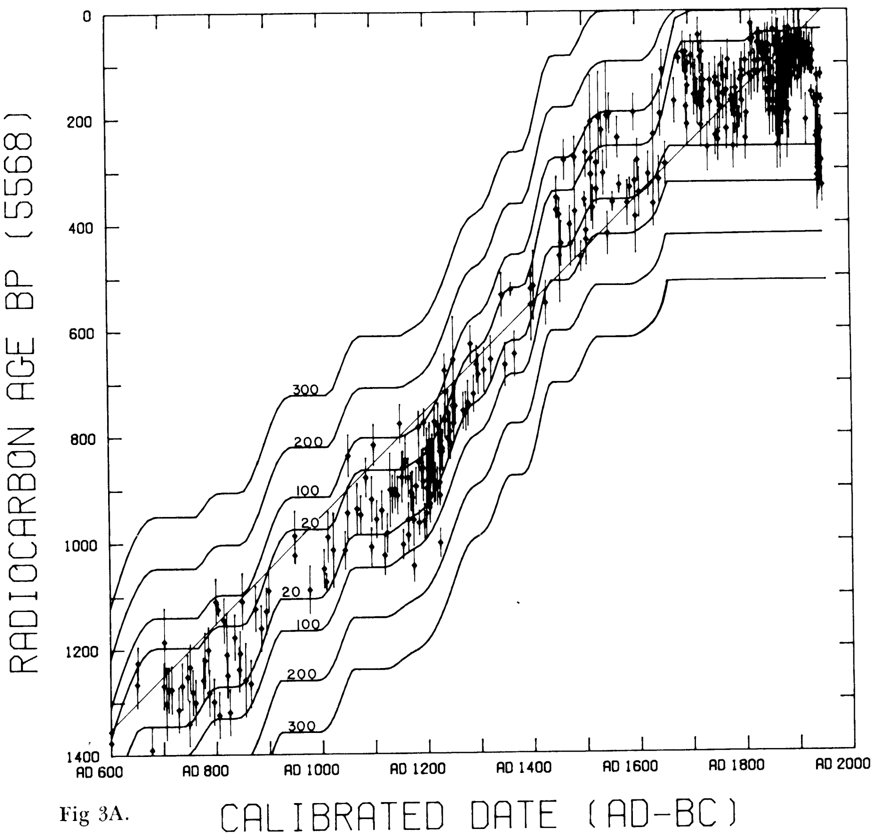

Fig 3A.

Fig 3A-G. Calibration limits (monotonic) for radiocarbon uncertainties of 20, 100, 200, and 300 years. The data are the same as in Figure 2. The error bands include both the error of the calibration and an estimate of the possible systematic differences between laboratories.

The 90% confidence intervals plotted in these graphs are intended primarily for users with multiple dates and will provide calibration intervals shorter than those obtained from the tables. To calibrate a radiocarbon date, first locate the radiocarbon age (BP 1950) on the ordinate (vertical axis), then draw a horizontal line (parallel to the abscissa) through the calibration curves. The projection onto the x-axis of the intersections of this line with the "curves" of appropriate uncertainty gives the calibrated range of the date. Note that each graph spans 1400 radiocarbon years.

ing functions were made monotonic in calendric age before the calibration interval was determined. In the final table, separate intervals are provided for radiocarbon uncertainties of 20, 50, 100, 150, 200, and 300 years. The table represents the 95% confidence interval for the calibrated date and covers the range from 7240 to 10 BP (radiocarbon years). If we assume that the source of the non-counting error is independent of the counting error and similar for samples of similar age, then the procedure described above properly accounts for this error as well.

For samples less than 1000 years BP (radiocarbon) supplementary tables are provided following the main tables. Asterisks in the main table indicate dates for which multiple intervals exist (see Figure 4). The intervals in the main table represent the extremes in range of the multiple intervals in the supplementary tables.

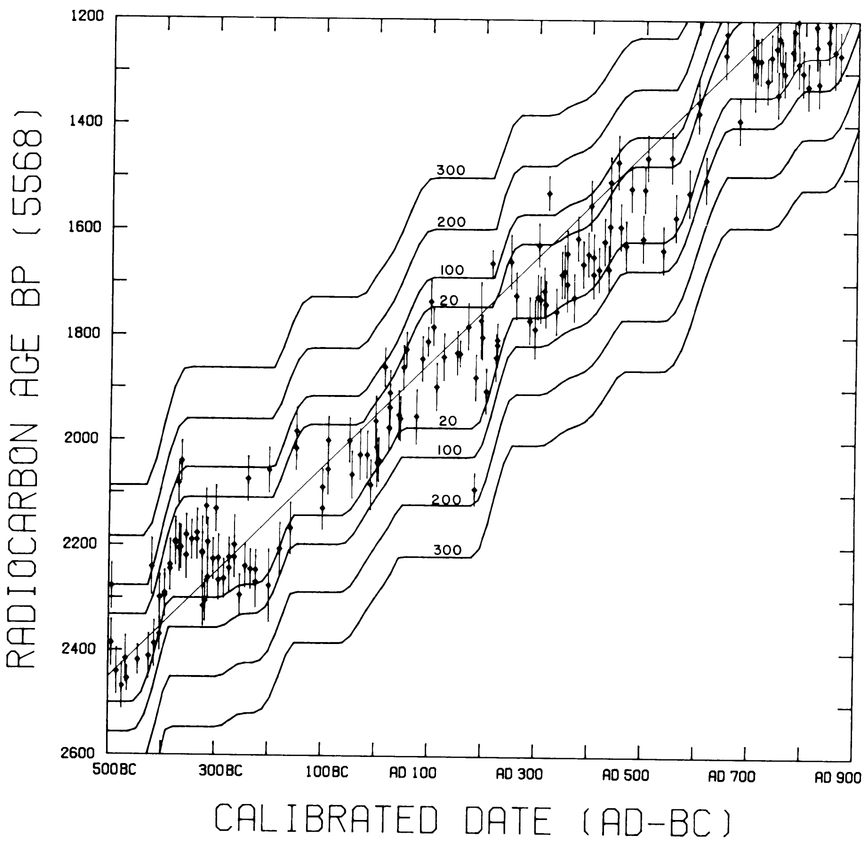

Fig 3B.

INSTRUCTIONS FOR USING CALIBRATION TABLES

The tables on the following pages are to be employed in the calibration of single radiocarbon dates. One enters the tables with a radiocarbon age (years BP, 5568-year, "Libby," half-life) and uncertainty, and leaves with a 95% confidence interval containing the "true", calendric date. The radiocarbon age, rounded to the nearest 10 years and calculated using the Libby half-life, determines the row in which the calibrated age is to be found; the uncertainty determines the columns. All dates within the table have been rounded to the nearest five years. Each radiocarbon age is calibrated to a single calendric range for ages greater than 1000 years, though multiple dates are possible for younger samples. Radiocarbon samples with uncertainties between the tabulated values should have their uncertainties rounded to the nearest tabulated value (see table footnote). Hence, a sample with a date of 1960 BP ± 30 would have a calibrated interval of 145 BC to AD 210, whereas 1960 BP ± 40 would range from 155 BC to AD 215. It will normally not be necessary to

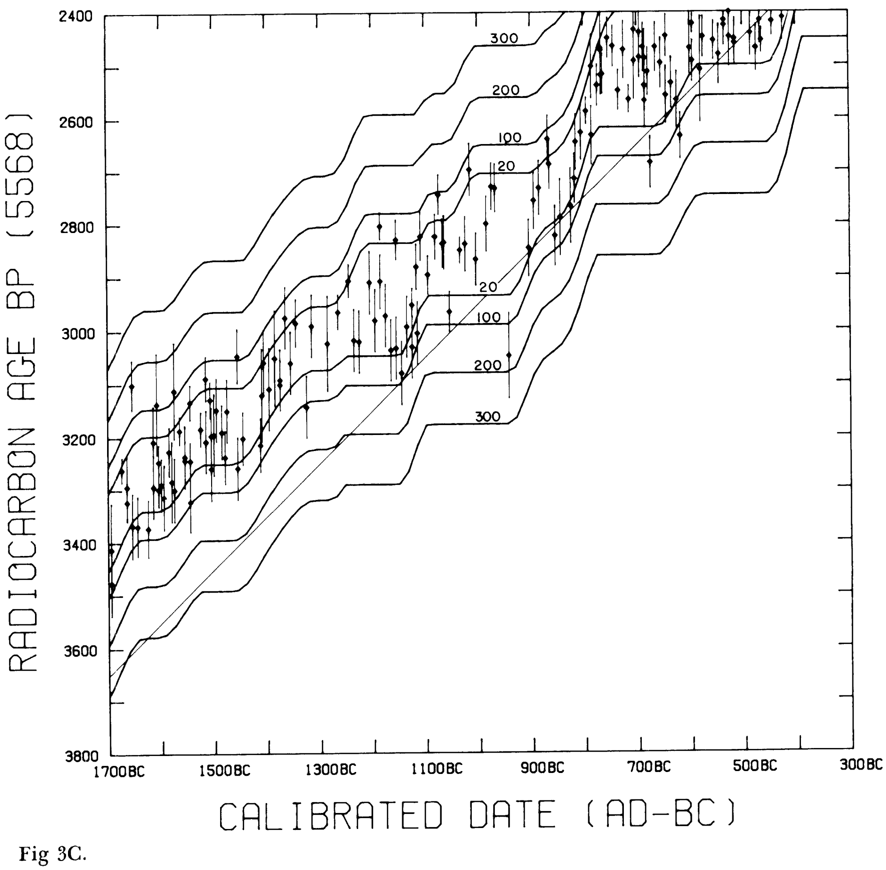

Fig 3C.

interpolate between tabulated ages, as rounding dates to the nearest five years does not significantly affect the calendric interval obtained. Negative values in the body of the table represent BC dates; positive, AD dates; and −1/1 represents the transition year between 1 BC and AD 1 (omitted in the widely-adopted chronology of Dionysius Exiguus (ca 525)).

Occasionally, there are large "jumps" in the length of the calibration intervals as read from the table, eg, between 1920 and 1930 BP ± 20 or between 1770 and 1780 BP ± 150 years. These are caused by "flat" regions in the calibration, *ie,* periods when the ^{14}C in the atmosphere has decreased at a rate greater than 1.2 per mil per 10 years, allowing multiple calendric ages for a single ^{14}C activity. In other calibrations, these periods have often been handled by assigning several calendric dates to a single radiocarbon age. However, as described previously, the ability to distinguish these as separate periods vanishes when the uncertainties of the calibration and radiocarbon activity measurement are considered. Reference to the calibration graphs should clarify this.

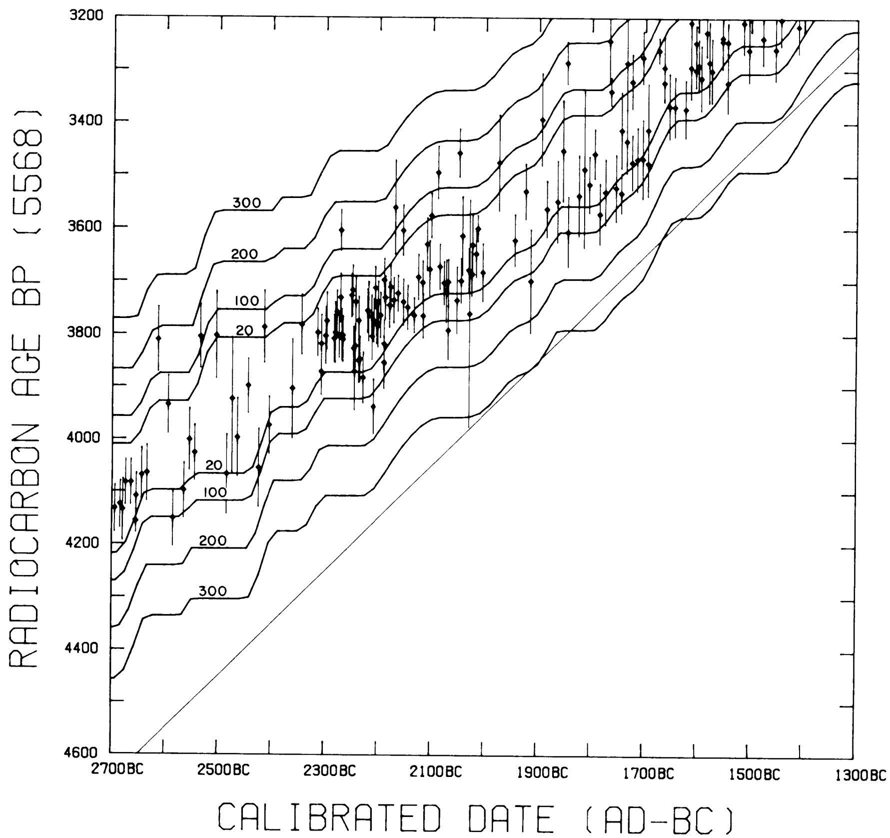

Fig 3D.

CALIBRATION INTERVAL FOR SAMPLES WITH UNCERTAINTIES GREATER THAN 300 YEARS

The following procedure should be employed in calibrating ages of samples with radiocarbon uncertainties greater than 300 years. First, 60 years should be subtracted from the uncertainty of the date to be calibrated. This is to remove the uncertainty of the calibration, which is automatically added into the range in the tables. Then, the resultant uncertainty should be added to and subtracted from the radiocarbon age of the sample, producing two ages which are looked up in the calibration table, under the columns headed by sigma=20 years. The calibration interval is formed from the extremes of the intervals obtained from the table. That is, the lower limit of the interval [older limit] is equal to the lower limit of the calibration interval for the radiocarbon age plus the modified uncertainty. Similarly, the upper limit [younger limit] is the upper limit of the calibration range for the radiocarbon age minus the modified uncertainty. As an example, consider the calibration of 3200 ± 400 years. First, subtract 60 years from 400 to obtain 340 years, which,

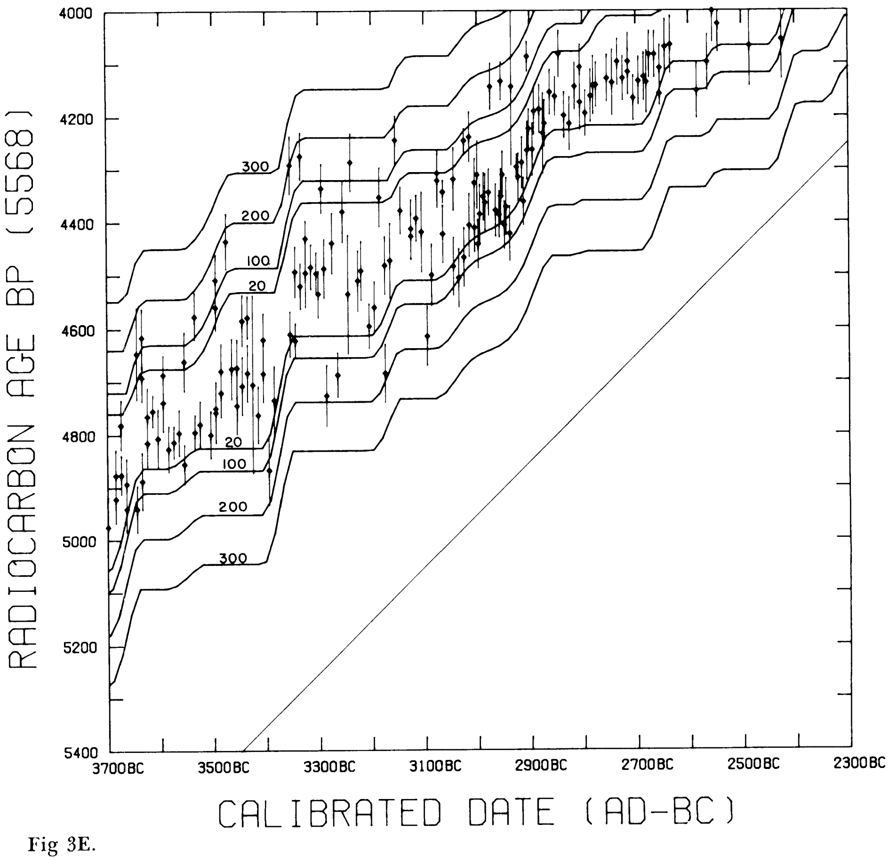

Fig 3E.

alternately added to and subtracted from the sample's radiocarbon age produces 3540 and 2860, respectively. Looking up the appropriate limits for these two ages, the interval 2110 to 875 BC is obtained.

CALIBRATION OF DATES BEYOND TABULATED VALUES

At this time, the only data set of sufficient quality to provide retrospective assessment of atmospheric ^{14}C to a precision suitable for calibration consists of measurements on wood. This is largely because of the stringent requirements for a sample suitable for this purpose. The sample must 1) be independently datable, 2) contain carbon that is reliably associated with atmospheric ^{14}C at the date of the sample formation, and 3) contain sufficient quantities of carbon for an accurate activity measurement.

Beyond the existing range of dendrochronologically dated wood, we must rely either on samples of inferior quality (shorter or less certain chronology, or of smaller size, frequently containing too little carbon to

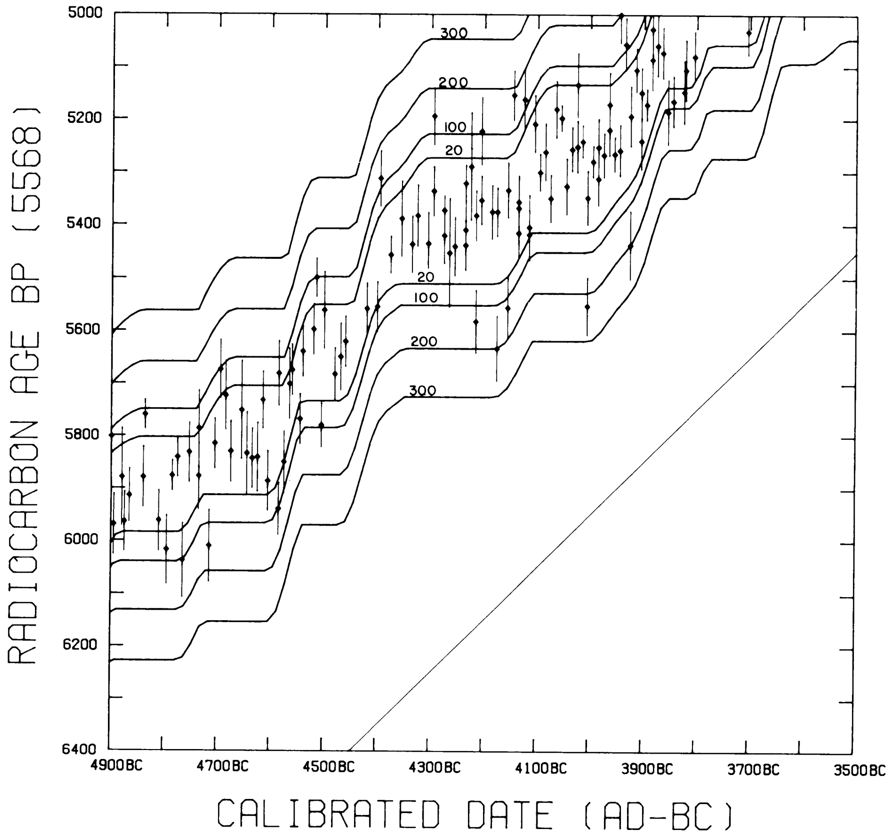

Fig 3F.

obtain an accurate date), or on "secondary" sources that estimate the constancy of cosmic rays from the measurements of other radionuclides, or from the inferred strength of the earth's magnetic field from archaeomagnetism. The consensus of these sources suggests that the cosmic ray flux reaching the earth and producing ^{14}C has probably remained constant to within $\pm 10\%$ over the past 50,000 years or more (Vogel, 1980; Barbetti, 1980; Forman and Shaeffer, 1980; Stuiver, 1971). A 10% uncertainty in a radiocarbon concentration represents an 800-year uncertainty in age, regardless of the age of the sample. Consequently, the current "best estimate" of the date of a sample older than 8000 years BP is obtained by assuming a constant atmospheric concentration of the ^{14}C, and using the 5730 half-life to calculate the date. An uncertainty of 1000 years, or the measurement uncertainty quoted by the laboratory, whichever is larger, would constitute a reasonable estimate of the uncertainty for the calendric age of the sample.

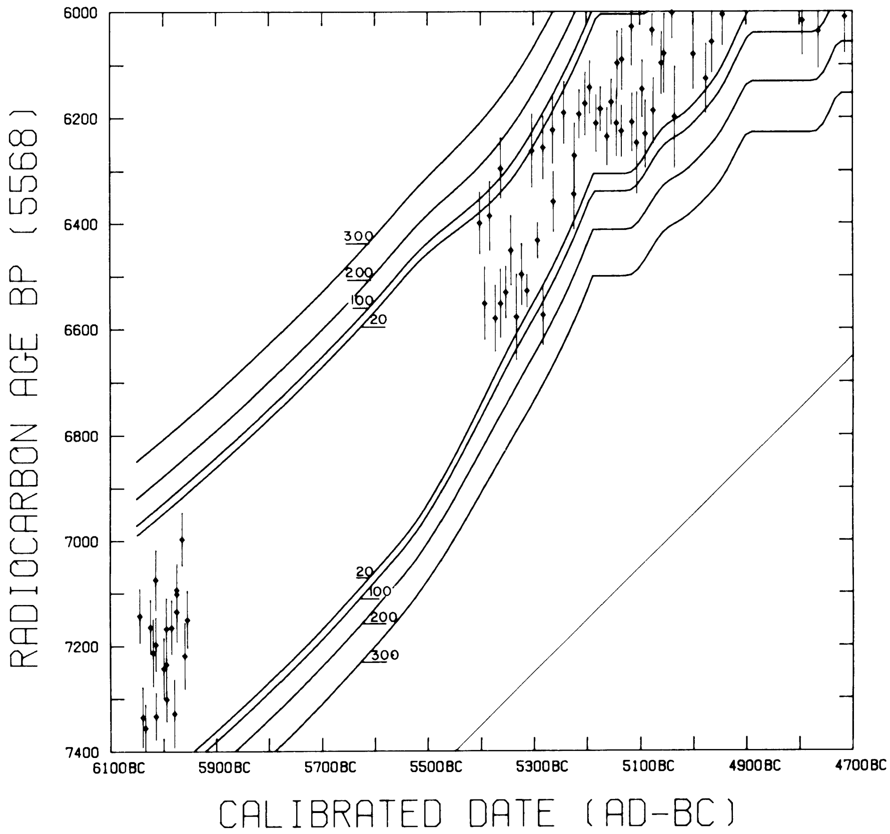

Fig 3G.

CONCLUDING REMARKS

It is the intent of the participants of the Workshop that this should be the first in a series of "consensus" calibrations, updated as warranted by improvements in the data base. At present, 1132 measurements of ^{14}C activity have been made on samples of bristlecone pine, the maximum age of which is 8000 years BP. There are 60 samples of wood currently being dated by the radiocarbon laboratories at the Universities of Arizona, California at La Jolla, Pennsylvania, and Washington which will extend the calibration another 550 years. An additional piece of wood, containing 500 rings, is still undatable dendrochronologically but from preliminary radiocarbon measurements appears to be approximately 9000 to 10,000 years old (Ferguson and Graybill, 1981). Another piece of wood, containing only 200 rings, also antedates the present master chronology.

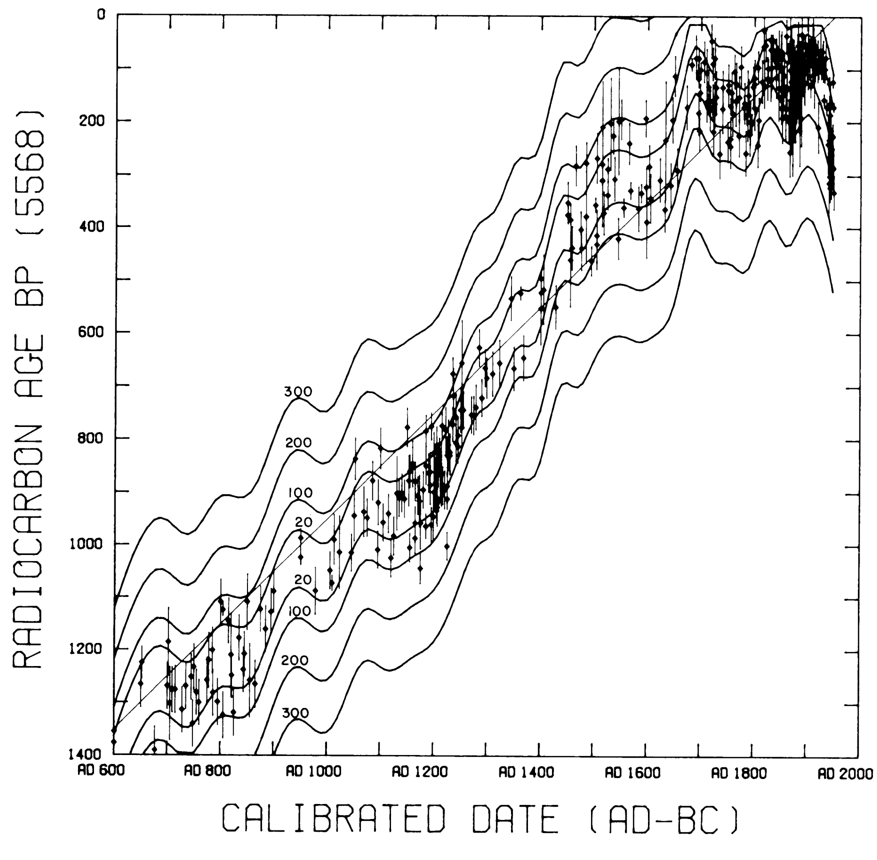

Fig 4. The first 1400 radiocarbon years. Similar to the graph in Figure 3A, here, however, the calibration function is not monotonic, and corresponds to the supplementary tables for the most recent 1000 years. Note that for several ages, multiple calendric intervals are possible for a single radiocarbon age.

Perhaps within the next few years, these pieces will be linked with the present 8681-year chronology extending it to beyond 11,000 years ago.

Still other chronologies are being developed both in this country and in Europe. The University of Washington has made activity measurements on nearly 2000 years of Douglas fir (Stuiver and Quay, 1980a; Stuiver and Quay, 1981). A second bristlecone chronology, 3200 years long, has been established on wood found in Nevada (Graybill, pers commun, 1982). Several floating chronologies are being developed in Europe (Becker, 1979; 1980; Beer *et al,* 1979; Lambert and Orcel, 1979; Pilcher *et al,* 1977) and it is likely that within the next few years it will be possible to connect them with existing recent chronologies. When this is done, they will be valuable in checking and reinforcing the USA chronologies. Even now, they are of some value after their age has been fixed using "wiggle matching" (see eg, Clark and Sowray, 1973) because these data sets are of high quality and their combined use (although not done in this work) with the calibration data set strengthens and reduces the errors of the current calibration.

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Table 1
Systematic differences observed between laboratories

Laboratory	Average deviation from mean (Δ‰)
Arizona (A)	+3.0 ± 1.7
Groningen (GrN)	+2.7 ± 1.5
La Jolla (Lj)	—3.2 ± 1.1
Pennsylvania (P)	+3.4 ± 2.5
Yale (Y)	+3.2 ± 2.0

Table 2
Main calibration tables (P 124)
(See instructions in text and in footnote below)

Look up under nearest tabulated value radiocarbon dates with uncertainties between tabulated values, hence:

for sigma =	look up under:
0 — 35	$\sigma = 20$
36 — 75	$\sigma = 50$
76 — 125	$\sigma = 100$
126 — 175	$\sigma = 150$
176 — 250	$\sigma = 200$
251 — 350	$\sigma = 300$
> 350	use the procedure described in the text

* in body of table indicates multiple calibrated ranges exist for these dates. See supplementary tables.

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
7240	-6545	-5625	-6555	-5615	-6585	-5595	-6630	-5565	-6685	-5530	-6825	-5455
7230	-6535	-5615	-6545	-5610	-6570	-5590	-6615	-5555	-6675	-5520	-6815	-5450
7220	-6520	-5605	-6530	-5600	-6560	-5580	-6605	-5550	-6660	-5515	-6800	-5445
7210	-6510	-5595	-6520	-5590	-6545	-5570	-6590	-5540	-6650	-5510	-6790	-5440
7200	-6495	-5590	-6505	-5585	-6535	-5565	-6580	-5535	-6635	-5500	-6775	-5435
7190	-6485	-5580	-6495	-5575	-6520	-5555	-6565	-5525	-6625	-5495	-6765	-5430
7180	-6470	-5570	-6480	-5565	-6510	-5545	-6555	-5520	-6610	-5490	-6750	-5425
7170	-6460	-5565	-6470	-5555	-6495	-5535	-6540	-5510	-6600	-5485	-6740	-5420
7160	-6445	-5555	-6455	-5550	-6485	-5530	-6530	-5505	-6585	-5480	-6725	-5415
7150	-6435	-5545	-6445	-5540	-6470	-5525	-6515	-5500	-6575	-5475	-6715	-5410
7140	-6420	-5540	-6430	-5530	-6460	-5515	-6505	-5495	-6560	-5470	-6700	-5405
7130	-6410	-5530	-6420	-5525	-6445	-5510	-6490	-5490	-6550	-5465	-6690	-5400
7120	-6395	-5525	-6405	-5520	-6435	-5505	-6480	-5485	-6535	-5455	-6675	-5395
7110	-6385	-5515	-6395	-5510	-6420	-5500	-6465	-5480	-6525	-5450	-6665	-5390
7100	-6370	-5510	-6380	-5505	-6410	-5490	-6455	-5470	-6510	-5445	-6650	-5385
7090	-6360	-5505	-6370	-5500	-6395	-5485	-6440	-5465	-6500	-5440	-6640	-5380
7080	-6345	-5500	-6355	-5495	-6385	-5480	-6430	-5460	-6485	-5435	-6625	-5375
7070	-6335	-5495	-6345	-5490	-6370	-5475	-6415	-5455	-6475	-5435	-6615	-5370
7060	-6320	-5490	-6330	-5485	-6360	-5470	-6405	-5450	-6460	-5430	-6600	-5365
7050	-6310	-5485	-6320	-5480	-6345	-5465	-6390	-5450	-6450	-5425	-6590	-5360
7040	-6295	-5480	-6305	-5475	-6335	-5460	-6380	-5445	-6435	-5420	-6575	-5350
7030	-6285	-5475	-6295	-5470	-6320	-5455	-6365	-5440	-6425	-5415	-6565	-5345
7020	-6270	-5470	-6280	-5465	-6310	-5450	-6355	-5435	-6410	-5410	-6550	-5340
7010	-6260	-5465	-6270	-5460	-6295	-5450	-6340	-5430	-6400	-5405	-6540	-5335
7000	-6245	-5460	-6255	-5455	-6285	-5445	-6330	-5425	-6385	-5400	-6525	-5330
6990	-6235	-5455	-6245	-5450	-6270	-5440	-6315	-5420	-6375	-5395	-6515	-5325
6980	-6220	-5450	-6230	-5445	-6260	-5435	-6305	-5415	-6360	-5390	-6500	-5320
6970	-6210	-5445	-6220	-5440	-6245	-5430	-6290	-5410	-6350	-5385	-6490	-5315
6960	-6195	-5440	-6205	-5435	-6235	-5425	-6280	-5405	-6335	-5380	-6475	-5310
6950	-6185	-5435	-6195	-5435	-6220	-5420	-6265	-5400	-6325	-5375	-6465	-5305
6940	-6170	-5430	-6180	-5430	-6210	-5415	-6255	-5395	-6310	-5370	-6450	-5295
6930	-6160	-5430	-6170	-5425	-6195	-5410	-6240	-5390	-6300	-5365	-6440	-5290
6920	-6145	-5425	-6155	-5420	-6185	-5410	-6230	-5385	-6285	-5360	-6425	-5285
6910	-6135	-5420	-6145	-5415	-6170	-5405	-6215	-5385	-6275	-5355	-6415	-5280
6900	-6120	-5415	-6130	-5410	-6160	-5400	-6205	-5380	-6260	-5350	-6400	-5275

CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF

RADIOCARBON AGE (BP) 5568 HALF-LIFE	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
6890	-6110	-5410	-6120	-5405	-6145	-5395	-6190	-5375	-6250	-5345	-6390	-5270
6880	-6095	-5405	-6105	-5405	-6135	-5390	-6180	-5370	-6235	-5340	-6375	-5265
6870	-6085	-5405	-6095	-5400	-6120	-5385	-6165	-5365	-6225	-5335	-6365	-5260
6860	-6070	-5400	-6080	-5395	-6110	-5380	-6155	-5360	-6210	-5330	-6350	-5255
6850	-6060	-5395	-6070	-5390	-6095	-5375	-6140	-5355	-6200	-5325	-6340	-5250
6840	-6045	-5390	-6055	-5385	-6085	-5370	-6130	-5350	-6185	-5320	-6325	-5245
6830	-6035	-5385	-6045	-5380	-6070	-5365	-6115	-5345	-6175	-5310	-6315	-5240
6820	-6025	-5380	-6030	-5375	-6060	-5365	-6105	-5340	-6160	-5305	-6300	-5235
6810	-6010	-5375	-6020	-5375	-6045	-5360	-6090	-5335	-6150	-5300	-6290	-5230
6800	-6000	-5375	-6005	-5370	-6035	-5355	-6080	-5330	-6135	-5295	-6275	-5225
6790	-5985	-5370	-5995	-5365	-6020	-5350	-6065	-5325	-6125	-5290	-6265	-5220
6780	-5975	-5365	-5985	-5360	-6010	-5345	-6055	-5320	-6110	-5285	-6250	-5215
6770	-5965	-5360	-5970	-5355	-6000	-5340	-6040	-5315	-6100	-5280	-6240	-5210
6760	-5950	-5355	-5960	-5350	-5985	-5335	-6030	-5305	-6085	-5275	-6225	-5210
6750	-5940	-5350	-5950	-5345	-5975	-5330	-6015	-5300	-6075	-5270	-6215	-5205
6740	-5930	-5345	-5935	-5340	-5965	-5325	-6005	-5295	-6060	-5265	-6200	-5200
6730	-5915	-5340	-5925	-5335	-5950	-5320	-5995	-5290	-6050	-5260	-6190	-5195
6720	-5905	-5335	-5915	-5330	-5940	-5315	-5980	-5285	-6035	-5255	-6175	-5190
6710	-5895	-5330	-5900	-5325	-5930	-5310	-5970	-5280	-6025	-5250	-6165	-5190
6700	-5885	-5325	-5890	-5320	-5915	-5305	-5960	-5275	-6010	-5245	-6150	-5185
6690	-5875	-5320	-5880	-5315	-5905	-5295	-5945	-5270	-6000	-5240	-6140	-5105
6680	-5860	-5315	-5870	-5310	-5895	-5290	-5935	-5265	-5990	-5235	-6125	-5095
6670	-5850	-5310	-5860	-5305	-5885	-5285	-5925	-5260	-5975	-5230	-6115	-5090
6660	-5840	-5305	-5845	-5300	-5870	-5280	-5910	-5255	-5965	-5225	-6100	-5080
6650	-5830	-5300	-5835	-5295	-5860	-5275	-5900	-5250	-5955	-5220	-6090	-5075
6640	-5820	-5295	-5825	-5290	-5850	-5270	-5890	-5245	-5940	-5215	-6075	-5070
6630	-5810	-5290	-5815	-5285	-5840	-5265	-5880	-5240	-5930	-5210	-6065	-5065
6620	-5795	-5285	-5805	-5280	-5830	-5260	-5865	-5235	-5920	-5210	-6050	-5055
6610	-5785	-5280	-5795	-5275	-5820	-5255	-5855	-5230	-5905	-5205	-6040	-5050
6600	-5775	-5275	-5785	-5270	-5805	-5250	-5845	-5225	-5895	-5200	-6025	-5035
6590	-5765	-5270	-5775	-5260	-5795	-5245	-5835	-5220	-5885	-5195	-6015	-5015
6580	-5755	-5265	-5760	-5255	-5785	-5240	-5825	-5215	-5875	-5190	-6005	-5005
6570	-5745	-5260	-5750	-5255	-5775	-5235	-5815	-5210	-5865	-5190	-5990	-4995
6560	-5735	-5255	-5740	-5250	-5765	-5230	-5805	-5210	-5850	-5185	-5980	-4985
6550	-5725	-5250	-5730	-5245	-5755	-5225	-5790	-5205	-5840	-5105	-5970	-4975

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
6540	-5715	-5245	-5720	-5240	-5745	-5220	-5780	-5200	-5830	-5095	-5955	-4965
6530	-5705	-5240	-5710	-5235	-5735	-5220	-5770	-5195	-5820	-5090	-5945	-4955
6520	-5695	-5235	-5700	-5230	-5725	-5215	-5760	-5190	-5810	-5085	-5935	-4950
6510	-5685	-5230	-5690	-5225	-5715	-5210	-5750	-5190	-5800	-5075	-5920	-4945
6500	-5675	-5225	-5680	-5220	-5705	-5205	-5740	-5185	-5790	-5070	-5910	-4935
6490	-5665	-5220	-5670	-5215	-5695	-5200	-5730	-5110	-5775	-5065	-5900	-4930
6480	-5655	-5215	-5660	-5210	-5685	-5195	-5720	-5100	-5765	-5060	-5890	-4925
6470	-5645	-5215	-5650	-5210	-5675	-5195	-5710	-5090	-5755	-5050	-5875	-4920
6460	-5635	-5210	-5640	-5205	-5665	-5190	-5700	-5085	-5745	-5035	-5865	-4915
6450	-5625	-5205	-5630	-5200	-5655	-5185	-5690	-5080	-5735	-5020	-5855	-4910
6440	-5615	-5200	-5620	-5195	-5645	-5180	-5680	-5075	-5725	-5005	-5845	-4905
6430	-5605	-5195	-5610	-5190	-5635	-5105	-5670	-5065	-5715	-4995	-5835	-4900
6420	-5595	-5195	-5605	-5190	-5625	-5095	-5660	-5060	-5705	-4985	-5820	-4895
6410	-5590	-5190	-5595	-5185	-5615	-5090	-5650	-5055	-5695	-4980	-5810	-4765
6400	-5580	-5185	-5585	-5115	-5605	-5080	-5640	-5040	-5685	-4970	-5800	-4755
6390	-5570	-5180	-5575	-5105	-5595	-5075	-5630	-5025	-5675	-4960	-5790	-4745
6380	-5560	-5105	-5565	-5095	-5590	-5070	-5620	-5010	-5665	-4955	-5780	-4740
6370	-5555	-5095	-5560	-5090	-5580	-5065	-5610	-5000	-5655	-4945	-5770	-4735
6360	-5545	-5090	-5550	-5080	-5570	-5055	-5600	-4990	-5645	-4940	-5760	-4735
6350	-5535	-5085	-5540	-5075	-5560	-5050	-5595	-4985	-5635	-4935	-5750	-4730
6340	-5525	-5080	-5530	-5070	-5555	-5035	-5585	-4975	-5625	-4930	-5740	-4725
6330	-5515	-5070	-5520	-5065	-5545	-5020	-5575	-4965	-5615	-4925	-5730	-4590
6320	-5500	-5065	-5510	-5055	-5535	-5005	-5565	-4960	-5610	-4920	-5720	-4585
6310	-5485	-5060	-5500	-5050	-5525	-5000	-5560	-4950	-5600	-4915	-5710	-4580
6300	-5470	-5050	-5485	-5035	-5515	-4990	-5550	-4945	-5590	-4910	-5700	-4575
6290	-5445	-5040	-5465	-5020	-5505	-4980	-5540	-4940	-5580	-4905	-5690	-4575
6280	-5420	-5025	-5440	-5010	-5490	-4975	-5530	-4935	-5570	-4900	-5680	-4570
6270	-5400	-5010	-5420	-5000	-5475	-4965	-5520	-4930	-5565	-4895	-5670	-4570
6260	-5380	-5000	-5395	-4990	-5455	-4960	-5510	-4925	-5555	-4890	-5660	-4565
6250	-5365	-4995	-5380	-4985	-5435	-4950	-5500	-4920	-5545	-4755	-5650	-4565
6240	-5355	-4985	-5365	-4975	-5415	-4945	-5485	-4915	-5540	-4750	-5640	-4560
6230	-5345	-4980	-5355	-4970	-5395	-4940	-5470	-4910	-5530	-4745	-5630	-4560
6220	-5335	-4970	-5345	-4960	-5380	-4935	-5455	-4905	-5520	-4740	-5620	-4555
6210	-5325	-4965	-5335	-4955	-5370	-4930	-5440	-4900	-5510	-4735	-5610	-4555
6200	-5320	-4960	-5325	-4950	-5360	-4925	-5420	-4895	-5495	-4730	-5600	-4550

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
6190	-5310	-4950	-5320	-4945	-5350	-4920	-5405	-4890	-5485	-4725	-5595	-4550
6180	-5305	-4945	-5310	-4940	-5340	-4920	-5390	-4765	-5470	-4590	-5585	-4545
6170	-5300	-4940	-5305	-4935	-5330	-4915	-5380	-4755	-5455	-4585	-5575	-4545
6160	-5295	-4935	-5300	-4930	-5325	-4910	-5365	-4745	-5440	-4580	-5565	-4540
6150	-5290	-4930	-5295	-4925	-5315	-4905	-5355	-4740	-5425	-4580	-5560	-4455
6140	-5280	-4930	-5290	-4920	-5310	-4900	-5345	-4735	-5410	-4575	-5550	-4450
6130	-5275	-4925	-5285	-4915	-5305	-4895	-5340	-4735	-5400	-4570	-5540	-4445
6120	-5270	-4920	-5275	-4915	-5295	-4890	-5330	-4730	-5385	-4570	-5530	-4440
6110	-5265	-4915	-5270	-4910	-5290	-4765	-5325	-4725	-5375	-4565	-5525	-4440
6100	-5260	-4910	-5265	-4905	-5285	-4755	-5315	-4590	-5365	-4565	-5515	-4435
6090	-5255	-4905	-5260	-4900	-5280	-4750	-5310	-4585	-5355	-4560	-5500	-4430
6080	-5250	-4905	-5255	-4895	-5275	-4740	-5305	-4580	-5345	-4560	-5490	-4430
6070	-5245	-4900	-5250	-4890	-5270	-4740	-5300	-4575	-5340	-4555	-5480	-4425
6060	-5240	-4895	-5245	-4885	-5265	-4735	-5290	-4575	-5330	-4555	-5470	-4425
6050	-5235	-4890	-5240	-4770	-5260	-4730	-5285	-4570	-5325	-4550	-5455	-4420
6040	-5230	-4885	-5235	-4755	-5255	-4725	-5280	-4565	-5315	-4550	-5445	-4420
6030	-5225	-4880	-5230	-4750	-5250	-4590	-5275	-4565	-5310	-4545	-5430	-4415
6020	-5220	-4755	-5225	-4745	-5245	-4585	-5270	-4565	-5305	-4545	-5420	-4415
6010	-5215	-4750	-5220	-4740	-5240	-4580	-5265	-4560	-5300	-4540	-5405	-4410
6000	-5210	-4745	-5215	-4735	-5235	-4575	-5260	-4560	-5295	-4460	-5395	-4410
5990	-5205	-4740	-5210	-4730	-5230	-4575	-5255	-4555	-5285	-4450	-5385	-4405
5980	-5200	-4735	-5205	-4600	-5225	-4570	-5250	-4555	-5280	-4445	-5375	-4400
5970	-5195	-4730	-5200	-4590	-5220	-4570	-5245	-4550	-5275	-4440	-5365	-4395
5960	-5190	-4725	-5195	-4585	-5215	-4565	-5240	-4550	-5270	-4440	-5360	-4390
5950	-5185	-4590	-5190	-4580	-5210	-4565	-5235	-4545	-5265	-4435	-5350	-4385
5940	-5185	-4585	-5190	-4575	-5205	-4560	-5230	-4545	-5260	-4435	-5345	-4375
5930	-5180	-4580	-5185	-4575	-5200	-4560	-5225	-4540	-5255	-4430	-5335	-4365
5920	-5175	-4575	-5180	-4570	-5195	-4555	-5220	-4455	-5250	-4425	-5330	-4355
5910	-5075	-4575	-5175	-4565	-5190	-4555	-5215	-4450	-5245	-4425	-5320	-4160
5900	-5065	-4570	-5075	-4565	-5185	-4550	-5210	-4445	-5240	-4420	-5315	-4150
5890	-5060	-4570	-5070	-4560	-5180	-4550	-5205	-4440	-5235	-4420	-5310	-4145
5880	-5050	-4565	-5060	-4560	-5180	-4545	-5200	-4435	-5230	-4415	-5305	-4140
5870	-5040	-4565	-5055	-4555	-5080	-4545	-5195	-4435	-5225	-4415	-5295	-4135
5860	-5015	-4560	-5045	-4555	-5075	-4540	-5190	-4430	-5220	-4410	-5290	-4130
5850	-4990	-4560	-5020	-4555	-5070	-4450	-5190	-4430	-5215	-4410	-5285	-4125

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
5840	-4965	-4555	-4995	-4550	-5060	-4445	-5185	-4425	-5210	-4405	-5280	-4120
5830	-4945	-4555	-4975	-4550	-5055	-4445	-5180	-4425	-5205	-4400	-5275	-4115
5820	-4935	-4550	-4950	-4545	-5040	-4440	-5175	-4420	-5200	-4400	-5270	-4110
5810	-4925	-4550	-4940	-4540	-5020	-4435	-5075	-4420	-5195	-4395	-5265	-3990
5800	-4915	-4545	-4930	-4460	-5000	-4435	-5070	-4415	-5195	-4385	-5260	-3980
5790	-4905	-4545	-4920	-4450	-4980	-4430	-5065	-4410	-5190	-4380	-5255	-3970
5780	-4895	-4460	-4910	-4445	-4960	-4430	-5055	-4410	-5185	-4365	-5250	-3965
5770	-4880	-4450	-4905	-4440	-4945	-4425	-5050	-4405	-5180	-4355	-5245	-3960
5760	-4855	-4445	-4895	-4440	-4935	-4420	-5035	-4405	-5175	-4160	-5240	-3950
5750	-4725	-4440	-4880	-4435	-4925	-4420	-5010	-4400	-5080	-4150	-5235	-3945
5740	-4720	-4440	-4855	-4430	-4920	-4415	-4990	-4395	-5075	-4140	-5230	-3935
5730	-4720	-4435	-4730	-4430	-4910	-4415	-4975	-4390	-5065	-4135	-5225	-3925
5720	-4715	-4430	-4725	-4425	-4905	-4410	-4960	-4380	-5060	-4130	-5220	-3920
5710	-4710	-4430	-4720	-4425	-4895	-4410	-4945	-4370	-5050	-4125	-5215	-3915
5700	-4700	-4425	-4715	-4420	-4885	-4405	-4935	-4355	-5040	-4120	-5210	-3910
5690	-4695	-4425	-4710	-4420	-4870	-4400	-4930	-4155	-5020	-4115	-5205	-3905
5680	-4690	-4420	-4705	-4415	-4850	-4400	-4920	-4145	-5000	-4110	-5200	-3900
5670	-4680	-4420	-4700	-4415	-4730	-4395	-4915	-4140	-4985	-4105	-5195	-3895
5660	-4565	-4415	-4690	-4410	-4725	-4385	-4905	-4135	-4970	-3985	-5190	-3895
5650	-4565	-4415	-4685	-4405	-4720	-4380	-4900	-4130	-4955	-3975	-5190	-3890
5640	-4560	-4410	-4670	-4405	-4715	-4365	-4890	-4125	-4945	-3970	-5185	-3890
5630	-4560	-4405	-4565	-4400	-4710	-4155	-4880	-4120	-4935	-3960	-5180	-3885
5620	-4555	-4405	-4560	-4395	-4705	-4150	-4865	-4115	-4930	-3955	-5175	-3880
5610	-4555	-4400	-4560	-4390	-4700	-4140	-4845	-4110	-4920	-3950	-5080	-3880
5600	-4550	-4395	-4555	-4380	-4690	-4135	-4730	-3995	-4915	-3940	-5075	-3875
5590	-4550	-4390	-4555	-4170	-4685	-4130	-4725	-3980	-4910	-3930	-5070	-3875
5580	-4545	-4380	-4550	-4155	-4670	-4125	-4720	-3975	-4900	-3925	-5060	-3870
5570	-4545	-4160	-4550	-4145	-4565	-4120	-4715	-3965	-4895	-3915	-5055	-3865
5560	-4540	-4150	-4550	-4140	-4560	-4115	-4710	-3960	-4885	-3910	-5045	-3865
5550	-4540	-4140	-4545	-4130	-4560	-4110	-4705	-3955	-4870	-3905	-5025	-3860
5540	-4535	-4135	-4540	-4125	-4555	-3990	-4700	-3945	-4855	-3900	-5005	-3855
5530	-4530	-4130	-4540	-4120	-4555	-3980	-4690	-3935	-4730	-3900	-4990	-3800
5520	-4525	-4125	-4535	-4115	-4550	-3970	-4685	-3930	-4725	-3895	-4975	-3795
5510	-4520	-4120	-4530	-4110	-4550	-3965	-4670	-3920	-4720	-3890	-4960	-3790
5500	-4440	-4115	-4530	-3995	-4545	-3960	-4565	-3915	-4715	-3890	-4950	-3785

RADIOCARBON AGE(BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF											
	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
5490	-4435	-4110	-4520	-3980	-4545	-3950	-4560	-3910	-4715	-3885	-4940	-3785
5480	-4435	-3985	-4440	-3975	-4540	-3945	-4560	-3905	-4705	-3885	-4935	-3780
5470	-4430	-3975	-4435	-3965	-4540	-3935	-4555	-3900	-4700	-3880	-4925	-3780
5460	-4430	-3970	-4435	-3960	-4535	-3930	-4555	-3900	-4695	-3880	-4920	-3690
5450	-4425	-3965	-4430	-3955	-4530	-3920	-4550	-3895	-4690	-3875	-4915	-3685
5440	-4425	-3955	-4430	-3945	-4525	-3915	-4550	-3890	-4680	-3870	-4910	-3680
5430	-4420	-3950	-4425	-3940	-4520	-3910	-4545	-3890	-4565	-3870	-4900	-3675
5420	-4420	-3940	-4425	-3930	-4440	-3905	-4545	-3885	-4565	-3865	-4895	-3675
5410	-4415	-3935	-4420	-3925	-4435	-3900	-4540	-3885	-4560	-3860	-4885	-3670
5400	-4415	-3925	-4420	-3915	-4435	-3895	-4540	-3880	-4560	-3860	-4875	-3670
5390	-4410	-3920	-4415	-3910	-4430	-3895	-4535	-3875	-4555	-3805	-4860	-3665
5380	-4410	-3915	-4415	-3905	-4430	-3890	-4530	-3875	-4555	-3795	-4840	-3665
5370	-4405	-3910	-4410	-3900	-4425	-3890	-4525	-3870	-4550	-3790	-4730	-3660
5360	-4405	-3905	-4410	-3900	-4425	-3885	-4520	-3870	-4550	-3790	-4725	-3660
5350	-4400	-3900	-4405	-3895	-4420	-3880	-4440	-3865	-4545	-3785	-4720	-3655
5340	-4395	-3895	-4405	-3890	-4420	-3880	-4435	-3860	-4545	-3780	-4715	-3655
5330	-4390	-3895	-4400	-3890	-4415	-3875	-4435	-3855	-4540	-3780	-4710	-3650
5320	-4385	-3890	-4395	-3885	-4415	-3875	-4430	-3800	-4535	-3775	-4705	-3650
5310	-4380	-3885	-4390	-3885	-4410	-3870	-4430	-3795	-4535	-3690	-4700	-3645
5300	-4370	-3885	-4385	-3880	-4405	-3870	-4425	-3790	-4530	-3685	-4690	-3645
5290	-4360	-3880	-4380	-3880	-4405	-3865	-4425	-3790	-4525	-3680	-4685	-3640
5280	-4350	-3880	-4370	-3875	-4400	-3860	-4420	-3785	-4440	-3675	-4670	-3635
5270	-4345	-3875	-4355	-3870	-4395	-3855	-4420	-3780	-4435	-3675	-4565	-3560
5260	-4335	-3875	-4350	-3870	-4395	-3800	-4415	-3780	-4435	-3670	-4560	-3550
5250	-4330	-3870	-4340	-3865	-4390	-3795	-4410	-3775	-4430	-3670	-4560	-3540
5240	-4325	-3865	-4335	-3860	-4380	-3790	-4410	-3690	-4430	-3665	-4555	-3530
5230	-4320	-3865	-4330	-3860	-4370	-3790	-4405	-3685	-4425	-3665	-4555	-3395
5220	-4305	-3860	-4325	-3805	-4360	-3785	-4405	-3680	-4425	-3660	-4550	-3390
5210	-4145	-3855	-4315	-3800	-4350	-3780	-4400	-3675	-4420	-3660	-4550	-3390
5200	-4140	-3800	-4300	-3795	-4345	-3780	-4395	-3675	-4420	-3655	-4545	-3385
5190	-4135	-3795	-4145	-3790	-4335	-3775	-4390	-3670	-4415	-3655	-4545	-3385
5180	-4130	-3790	-4140	-3785	-4330	-3690	-4385	-3670	-4415	-3650	-4540	-3380
5170	-4130	-3785	-4135	-3785	-4325	-3685	-4380	-3665	-4410	-3650	-4540	-3380
5160	-4125	-3785	-4130	-3780	-4315	-3680	-4365	-3665	-4410	-3645	-4535	-3375
5150	-4120	-3780	-4125	-3775	-4305	-3675	-4355	-3660	-4405	-3645	-4530	-3375

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
5140	-4115	-3780	-4120	-3775	-4140	-3675	-4350	-3660	-4400	-3640	-4525	-3375
5130	-4110	-3775	-4120	-3690	-4135	-3670	-4340	-3655	-4395	-3635	-4520	-3370
5120	-4110	-3695	-4115	-3685	-4130	-3670	-4335	-3655	-4395	-3565	-4440	-3370
5110	-4105	-3685	-4110	-3680	-4130	-3665	-4330	-3655	-4385	-3550	-4435	-3370
5100	-4100	-3680	-4105	-3675	-4125	-3665	-4320	-3650	-4380	-3540	-4430	-3365
5090	-4095	-3680	-4100	-3675	-4120	-3660	-4315	-3645	-4370	-3530	-4430	-3365
5080	-4090	-3675	-4095	-3670	-4115	-3660	-4140	-3645	-4360	-3395	-4425	-3360
5070	-4080	-3675	-4090	-3670	-4110	-3660	-4135	-3640	-4350	-3390	-4425	-3360
5060	-3955	-3670	-4085	-3665	-4105	-3655	-4130	-3640	-4340	-3390	-4420	-3360
5050	-3945	-3670	-4075	-3665	-4100	-3655	-4130	-3570	-4335	-3385	-4420	-3355
5040	-3935	-3665	-3950	-3660	-4100	-3650	-4125	-3555	-4330	-3385	-4415	-3355
5030	-3930	-3665	-3940	-3660	-4090	-3650	-4120	-3545	-4325	-3380	-4415	-3350
5020	-3920	-3660	-3930	-3660	-4085	-3645	-4115	-3535	-4315	-3380	-4410	-3195
5010	-3915	-3660	-3925	-3655	-4075	-3645	-4110	-3395	-4140	-3375	-4410	-3185
5000	-3910	-3655	-3915	-3655	-3950	-3640	-4105	-3390	-4135	-3375	-4405	-3175
4990	-3905	-3655	-3910	-3650	-3945	-3635	-4100	-3390	-4130	-3375	-4400	-3175
4980	-3900	-3655	-3905	-3650	-3935	-3565	-4095	-3385	-4125	-3370	-4400	-3170
4970	-3895	-3650	-3900	-3645	-3925	-3550	-4090	-3385	-4120	-3370	-4395	-3165
4960	-3895	-3650	-3895	-3645	-3920	-3540	-4085	-3380	-4120	-3365	-4390	-3160
4950	-3890	-3645	-3895	-3640	-3910	-3400	-4075	-3380	-4115	-3365	-4380	-3155
4940	-3885	-3640	-3890	-3635	-3905	-3395	-3950	-3375	-4110	-3365	-4370	-3150
4930	-3885	-3640	-3890	-3570	-3900	-3390	-3940	-3375	-4105	-3360	-4360	-3150
4920	-3880	-3635	-3885	-3555	-3900	-3385	-3935	-3375	-4100	-3360	-4350	-3070
4910	-3880	-3565	-3880	-3545	-3895	-3385	-3925	-3370	-4095	-3360	-4345	-3055
4900	-3875	-3555	-3880	-3400	-3890	-3380	-3915	-3370	-4090	-3355	-4335	-3045
4890	-3870	-3545	-3875	-3395	-3890	-3380	-3910	-3365	-4080	-3355	-4330	-3040
4880	-3870	-3395	-3875	-3390	-3885	-3375	-3905	-3365	-3955	-3350	-4325	-3035
4870	-3865	-3390	-3870	-3385	-3885	-3375	-3900	-3365	-3945	-3190	-4315	-3025
4860	-3860	-3390	-3865	-3385	-3880	-3375	-3900	-3360	-3940	-3180	-4300	-3020
4850	-3855	-3385	-3865	-3380	-3875	-3370	-3895	-3360	-3930	-3175	-4135	-3010
4840	-3850	-3385	-3860	-3380	-3875	-3370	-3890	-3360	-3920	-3170	-4130	-2995
4830	-3795	-3380	-3855	-3375	-3870	-3370	-3890	-3355	-3915	-3170	-4125	-2970
4820	-3790	-3380	-3800	-3375	-3870	-3365	-3885	-3355	-3910	-3165	-4120	-2950
4810	-3785	-3375	-3795	-3375	-3865	-3365	-3885	-3350	-3905	-3160	-4115	-2940
4800	-3785	-3375	-3790	-3370	-3860	-3360	-3880	-3190	-3900	-3155	-4110	-2930

CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF

RADIOCARBON AGE (BP) 5568 HALF-LIFE	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
4790	-3780	-3370	-3785	-3370	-3855	-3360	-3875	-3180	-3895	-3150	-4105	-2920
4780	-3780	-3370	-3780	-3370	-3850	-3360	-3875	-3175	-3895	-3145	-4105	-2915
4770	-3775	-3370	-3780	-3365	-3795	-3355	-3870	-3170	-3890	-3070	-4100	-2910
4760	-3775	-3365	-3775	-3365	-3790	-3355	-3870	-3170	-3890	-3055	-4090	-2905
4750	-3770	-3365	-3775	-3360	-3785	-3350	-3865	-3165	-3885	-3045	-4085	-2900
4740	-3765	-3365	-3770	-3360	-3785	-3200	-3860	-3160	-3880	-3040	-4075	-2895
4730	-3765	-3360	-3770	-3360	-3780	-3185	-3855	-3155	-3880	-3035	-3950	-2895
4720	-3760	-3360	-3765	-3355	-3780	-3180	-3850	-3150	-3875	-3025	-3945	-2890
4710	-3760	-3355	-3765	-3355	-3775	-3175	-3795	-3150	-3875	-3020	-3935	-2885
4700	-3755	-3355	-3760	-3350	-3775	-3170	-3790	-3075	-3870	-3010	-3925	-2880
4690	-3655	-3355	-3755	-3195	-3770	-3165	-3785	-3055	-3865	-2995	-3920	-2875
4680	-3655	-3350	-3750	-3185	-3765	-3160	-3785	-3050	-3865	-2975	-3910	-2875
4670	-3650	-3190	-3655	-3180	-3765	-3160	-3780	-3040	-3860	-2955	-3905	-2870
4660	-3650	-3180	-3655	-3175	-3760	-3155	-3780	-3035	-3855	-2940	-3905	-2865
4650	-3645	-3175	-3650	-3170	-3755	-3150	-3775	-3025	-3845	-2930	-3900	-2855
4640	-3640	-3170	-3645	-3165	-3755	-3145	-3775	-3020	-3795	-2925	-3895	-2685
4630	-3635	-3165	-3645	-3160	-3655	-3060	-3770	-3010	-3790	-2915	-3890	-2675
4620	-3625	-3165	-3640	-3155	-3655	-3050	-3765	-3000	-3785	-2910	-3890	-2670
4610	-3530	-3160	-3635	-3155	-3650	-3045	-3765	-2980	-3785	-2905	-3885	-2665
4600	-3520	-3155	-3535	-3150	-3650	-3035	-3760	-2960	-3780	-2900	-3885	-2660
4590	-3515	-3150	-3530	-3145	-3645	-3030	-3755	-2945	-3775	-2900	-3880	-2655
4580	-3510	-3145	-3520	-3065	-3645	-3025	-3755	-2935	-3775	-2895	-3880	-2655
4570	-3505	-3140	-3515	-3050	-3640	-3015	-3660	-2925	-3770	-2890	-3875	-2650
4560	-3500	-3060	-3510	-3045	-3635	-3005	-3655	-2920	-3770	-2885	-3870	-2645
4550	-3495	-3050	-3505	-3035	-3540	-2990	-3655	-2915	-3765	-2885	-3870	-2645
4540	-3490	-3045	-3500	-3030	-3530	-2970	-3650	-2910	-3765	-2880	-3865	-2640
4530	-3490	-3035	-3495	-3025	-3525	-2950	-3650	-2905	-3760	-2875	-3860	-2635
4520	-3485	-3030	-3490	-3015	-3515	-2940	-3645	-2900	-3755	-2870	-3855	-2560
4510	-3480	-3020	-3485	-3005	-3510	-2930	-3640	-2895	-3750	-2865	-3850	-2555
4500	-3475	-3015	-3485	-2995	-3505	-2925	-3635	-2890	-3660	-2860	-3795	-2550
4490	-3470	-3005	-3480	-2975	-3500	-2915	-3630	-2890	-3655	-2800	-3790	-2545
4480	-3465	-2990	-3475	-2955	-3495	-2910	-3540	-2885	-3655	-2675	-3790	-2435
4470	-3370	-2970	-3470	-2945	-3490	-2905	-3530	-2880	-3650	-2670	-3785	-2430
4460	-3370	-2955	-3460	-2935	-3490	-2900	-3520	-2875	-3650	-2665	-3780	-2425
4450	-3370	-2940	-3370	-2925	-3485	-2900	-3515	-2870	-3645	-2660	-3780	-2420

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF											
	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
4440	-3365	-2930	-3370	-2920	-3480	-2895	-3510	-2865	-3640	-2660	-3775	-2420
4430	-3365	-2925	-3370	-2915	-3475	-2890	-3505	-2860	-3640	-2655	-3775	-2415
4420	-3365	-2920	-3365	-2910	-3470	-2885	-3500	-2805	-3630	-2650	-3770	-2410
4410	-3360	-2915	-3365	-2905	-3465	-2885	-3495	-2680	-3540	-2645	-3770	-2410
4400	-3360	-2910	-3365	-2900	-3370	-2880	-3490	-2675	-3530	-2645	-3765	-2405
4390	-3360	-2905	-3360	-2895	-3370	-2875	-3485	-2665	-3520	-2640	-3760	-2405
4380	-3355	-2900	-3360	-2895	-3365	-2870	-3485	-2665	-3515	-2635	-3760	-2400
4370	-3355	-2895	-3355	-2890	-3365	-2865	-3480	-2660	-3510	-2635	-3755	-2395
4360	-3350	-2895	-3355	-2885	-3365	-2860	-3475	-2655	-3505	-2555	-3750	-2340
4350	-3350	-2890	-3355	-2880	-3360	-2805	-3470	-2650	-3500	-2550	-3660	-2330
4340	-3345	-2885	-3350	-2880	-3360	-2680	-3370	-2650	-3495	-2545	-3655	-2325
4330	-3345	-2880	-3350	-2875	-3360	-2670	-3370	-2645	-3490	-2435	-3655	-2320
4320	-3340	-2880	-3345	-2870	-3355	-2665	-3370	-2640	-3490	-2430	-3650	-2315
4310	-3335	-2875	-3345	-2865	-3355	-2665	-3365	-2640	-3485	-2425	-3650	-2310
4300	-3330	-2870	-3340	-2860	-3350	-2660	-3365	-2635	-3480	-2420	-3645	-2305
4290	-3155	-2865	-3335	-2800	-3350	-2655	-3365	-2560	-3475	-2420	-3640	-2215
4280	-3150	-2860	-3160	-2680	-3350	-2650	-3360	-2555	-3470	-2415	-3640	-2205
4270	-3145	-2805	-3155	-2670	-3345	-2650	-3360	-2550	-3460	-2415	-3630	-2195
4260	-3140	-2680	-3150	-2665	-3340	-2645	-3355	-2440	-3370	-2410	-3545	-2190
4250	-3130	-2670	-3145	-2660	-3340	-2640	-3355	-2430	-3370	-2405	-3535	-2180
4240	-3040	-2665	-3135	-2660	-3330	-2640	-3355	-2425	-3365	-2405	-3525	-2175
4230	-3030	-2665	-3045	-2655	-3160	-2635	-3350	-2425	-3365	-2400	-3515	-2170
4220	-3025	-2660	-3035	-2650	-3155	-2560	-3350	-2420	-3365	-2395	-3510	-2165
4210	-3015	-2655	-3030	-2650	-3150	-2555	-3345	-2415	-3360	-2395	-3505	-2155
4200	-3005	-2650	-3020	-2645	-3145	-2550	-3345	-2415	-3360	-2330	-3500	-2150
4190	-2970	-2650	-3015	-2640	-3135	-2440	-3340	-2410	-3355	-2325	-3495	-2140
4180	-2940	-2645	-3000	-2640	-3045	-2430	-3335	-2410	-3355	-2320	-3490	-2135
4170	-2930	-2640	-2965	-2635	-3035	-2425	-3160	-2405	-3355	-2315	-3490	-2125
4160	-2920	-2640	-2940	-2560	-3030	-2425	-3155	-2400	-3350	-2310	-3485	-2115
4150	-2915	-2635	-2925	-2550	-3020	-2420	-3150	-2400	-3350	-2305	-3480	-2100
4140	-2905	-2560	-2920	-2545	-3015	-2415	-3145	-2395	-3345	-2220	-3475	-2015
4130	-2900	-2550	-2910	-2435	-3000	-2415	-3140	-2335	-3340	-2205	-3470	-1995
4120	-2895	-2550	-2905	-2430	-2970	-2410	-3130	-2325	-3340	-2200	-3460	-1985
4110	-2895	-2435	-2900	-2425	-2945	-2410	-3040	-2320	-3330	-2190	-3370	-1980
4100	-2890	-2430	-2895	-2420	-2930	-2405	-3035	-2315	-3160	-2185	-3370	-1970

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF											
	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
4090	-2885	-2425	-2895	-2420	-2920	-2400	-3025	-2310	-3155	-2180	-3365	-1965
4080	-2880	-2425	-2890	-2415	-2915	-2400	-3020	-2310	-3150	-2170	-3365	-1955
4070	-2875	-2420	-2885	-2415	-2910	-2395	-3010	-2305	-3145	-2165	-3360	-1945
4060	-2870	-2415	-2880	-2410	-2905	-2335	-2990	-2210	-3140	-2160	-3360	-1925
4050	-2865	-2415	-2875	-2405	-2900	-2325	-2960	-2200	-3130	-2150	-3360	-1905
4040	-2860	-2410	-2870	-2405	-2895	-2320	-2940	-2195	-3040	-2145	-3355	-1895
4030	-2795	-2410	-2865	-2400	-2890	-2315	-2930	-2185	-3035	-2135	-3355	-1890
4020	-2785	-2405	-2860	-2395	-2885	-2310	-2920	-2180	-3025	-2130	-3355	-1885
4010	-2780	-2400	-2795	-2395	-2885	-2310	-2915	-2175	-3020	-2120	-3350	-1875
4000	-2775	-2400	-2785	-2330	-2880	-2305	-2910	-2170	-3010	-2105	-3350	-1870
3990	-2770	-2395	-2780	-2325	-2875	-2210	-2905	-2160	-2995	-2035	-3345	-1865
3980	-2765	-2330	-2775	-2320	-2870	-2200	-2900	-2155	-2965	-2000	-3340	-1860
3970	-2755	-2325	-2770	-2315	-2865	-2190	-2895	-2150	-2945	-1990	-3335	-1780
3960	-2650	-2320	-2765	-2310	-2855	-2185	-2890	-2140	-2930	-1980	-3330	-1770
3950	-2645	-2315	-2760	-2305	-2795	-2180	-2885	-2130	-2920	-1975	-3160	-1765
3940	-2640	-2310	-2650	-2215	-2785	-2175	-2880	-2120	-2915	-1965	-3155	-1760
3930	-2640	-2305	-2645	-2205	-2780	-2165	-2880	-2110	-2910	-1955	-3150	-1750
3920	-2635	-2215	-2640	-2195	-2775	-2160	-2875	-2095	-2905	-1950	-3145	-1740
3910	-2630	-2205	-2640	-2190	-2770	-2155	-2870	-2010	-2900	-1930	-3140	-1730
3900	-2625	-2195	-2635	-2185	-2765	-2145	-2865	-1995	-2895	-1910	-3130	-1715
3890	-2620	-2190	-2630	-2180	-2755	-2140	-2855	-1985	-2890	-1900	-3040	-1705
3880	-2545	-2185	-2625	-2170	-2650	-2130	-2795	-1975	-2890	-1890	-3035	-1700
3870	-2540	-2180	-2620	-2165	-2645	-2120	-2785	-1970	-2885	-1885	-3025	-1695
3860	-2540	-2170	-2545	-2160	-2640	-2110	-2780	-1960	-2880	-1880	-3020	-1690
3850	-2535	-2165	-2540	-2150	-2640	-2090	-2775	-1950	-2875	-1875	-3010	-1685
3840	-2530	-2160	-2540	-2145	-2635	-2005	-2770	-1940	-2870	-1870	-2995	-1680
3830	-2530	-2150	-2535	-2135	-2630	-1990	-2765	-1915	-2865	-1865	-2965	-1675
3820	-2525	-2145	-2530	-2125	-2625	-1980	-2755	-1900	-2860	-1785	-2945	-1670
3810	-2525	-2135	-2530	-2115	-2620	-1975	-2650	-1895	-2845	-1775	-2935	-1665
3800	-2520	-2125	-2525	-2105	-2545	-1965	-2645	-1885	-2790	-1765	-2925	-1660
3790	-2515	-2115	-2525	-2025	-2540	-1960	-2640	-1880	-2785	-1760	-2915	-1655
3780	-2515	-2105	-2520	-2000	-2535	-1950	-2640	-1875	-2780	-1750	-2910	-1650
3770	-2510	-2025	-2515	-1990	-2535	-1935	-2635	-1870	-2770	-1745	-2905	-1640
3760	-2395	-2000	-2515	-1980	-2530	-1910	-2630	-1865	-2765	-1735	-2900	-1590
3750	-2395	-1990	-2510	-1970	-2530	-1900	-2625	-1790	-2760	-1720	-2895	-1575

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
3740	-2385	-1980	-2500	-1965	-2525	-1890	-2620	-1775	-2650	-1710	-2895	-1570
3730	-2325	-1970	-2395	-1955	-2525	-1885	-2545	-1770	-2645	-1700	-2890	-1560
3720	-2320	-1965	-2390	-1945	-2520	-1880	-2540	-1760	-2645	-1695	-2885	-1555
3710	-2315	-1955	-2325	-1925	-2515	-1875	-2535	-1755	-2640	-1690	-2880	-1550
3700	-2310	-1945	-2320	-1905	-2515	-1870	-2535	-1745	-2635	-1685	-2875	-1540
3690	-2310	-1925	-2315	-1895	-2510	-1865	-2530	-1735	-2630	-1680	-2875	-1535
3680	-2305	-1905	-2310	-1890	-2395	-1785	-2530	-1725	-2625	-1675	-2870	-1525
3670	-2300	-1895	-2310	-1885	-2390	-1775	-2525	-1710	-2620	-1670	-2860	-1440
3660	-2295	-1890	-2305	-1875	-2385	-1770	-2525	-1705	-2610	-1670	-2855	-1430
3650	-2285	-1885	-2300	-1870	-2325	-1760	-2520	-1695	-2540	-1665	-2790	-1425
3640	-2185	-1875	-2295	-1865	-2320	-1755	-2515	-1690	-2540	-1660	-2785	-1420
3630	-2180	-1870	-2285	-1860	-2315	-1745	-2515	-1685	-2535	-1655	-2780	-1415
3620	-2175	-1865	-2185	-1780	-2310	-1735	-2510	-1680	-2535	-1645	-2775	-1405
3610	-2170	-1860	-2180	-1770	-2305	-1720	-2395	-1680	-2530	-1635	-2770	-1400
3600	-2160	-1780	-2175	-1765	-2300	-1710	-2390	-1675	-2525	-1580	-2765	-1395
3590	-2155	-1770	-2170	-1755	-2295	-1705	-2385	-1670	-2525	-1570	-2755	-1390
3580	-2145	-1765	-2160	-1750	-2290	-1695	-2325	-1665	-2520	-1565	-2650	-1385
3570	-2140	-1755	-2155	-1740	-2285	-1690	-2320	-1660	-2520	-1555	-2645	-1375
3560	-2130	-1750	-2145	-1730	-2185	-1685	-2315	-1655	-2515	-1550	-2640	-1370
3550	-2120	-1740	-2140	-1715	-2180	-1680	-2310	-1650	-2510	-1545	-2635	-1360
3540	-2110	-1730	-2130	-1705	-2170	-1675	-2305	-1640	-2505	-1535	-2635	-1355
3530	-2090	-1715	-2120	-1700	-2165	-1675	-2300	-1585	-2395	-1530	-2630	-1345
3520	-2005	-1705	-2110	-1695	-2160	-1670	-2295	-1575	-2390	-1450	-2625	-1335
3510	-1995	-1700	-2095	-1690	-2150	-1665	-2290	-1565	-2325	-1435	-2615	-1325
3500	-1985	-1695	-2005	-1685	-2145	-1660	-2280	-1560	-2320	-1430	-2545	-1270
3490	-1975	-1690	-1995	-1680	-2135	-1655	-2185	-1555	-2315	-1420	-2540	-1255
3480	-1970	-1685	-1985	-1675	-2125	-1650	-2175	-1545	-2310	-1415	-2535	-1250
3470	-1960	-1680	-1975	-1670	-2115	-1640	-2170	-1540	-2305	-1410	-2535	-1140
3460	-1950	-1675	-1970	-1665	-2105	-1585	-2165	-1535	-2305	-1405	-2530	-1130
3450	-1940	-1670	-1960	-1665	-2080	-1575	-2160	-1525	-2300	-1400	-2530	-1125
3440	-1920	-1670	-1955	-1660	-2000	-1565	-2150	-1440	-2295	-1390	-2525	-1125
3430	-1905	-1665	-1940	-1655	-1990	-1560	-2145	-1430	-2285	-1385	-2525	-1120
3420	-1895	-1660	-1920	-1645	-1980	-1555	-2135	-1425	-2185	-1380	-2520	-1115
3410	-1890	-1655	-1905	-1635	-1975	-1545	-2125	-1420	-2180	-1375	-2515	-1115
3400	-1885	-1645	-1895	-1585	-1965	-1540	-2115	-1415	-2175	-1365	-2510	-1110

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF											
	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
3390	-1875	-1635	-1890	-1575	-1960	-1535	-2100	-1405	-2165	-1360	-2505	-1105
3380	-1870	-1585	-1885	-1565	-1950	-1525	-2020	-1400	-2160	-1350	-2395	-1105
3370	-1865	-1575	-1875	-1560	-1935	-1440	-2000	-1395	-2155	-1340	-2390	-1100
3360	-1860	-1565	-1870	-1550	-1910	-1435	-1990	-1390	-2145	-1330	-2380	-935
3350	-1855	-1560	-1865	-1545	-1900	-1425	-1980	-1385	-2140	-1315	-2320	-925
3340	-1845	-1555	-1860	-1540	-1890	-1420	-1970	-1375	-2130	-1260	-2320	-920
3330	-1765	-1545	-1855	-1530	-1885	-1415	-1965	-1370	-2120	-1255	-2315	-915
3320	-1760	-1540	-1845	-1520	-1880	-1410	-1955	-1360	-2110	-1145	-2310	-910
3310	-1750	-1530	-1765	-1440	-1875	-1400	-1945	-1355	-2090	-1135	-2305	-905
3300	-1740	-1525	-1760	-1430	-1870	-1395	-1930	-1345	-2005	-1130	-2300	-905
3290	-1730	-1445	-1750	-1425	-1865	-1390	-1910	-1335	-1990	-1125	-2295	-900
3280	-1715	-1435	-1740	-1420	-1860	-1385	-1900	-1325	-1985	-1120	-2290	-895
3270	-1705	-1425	-1730	-1415	-1850	-1380	-1890	-1270	-1975	-1120	-2275	-890
3260	-1695	-1420	-1715	-1410	-1770	-1370	-1885	-1260	-1965	-1115	-2180	-885
3250	-1690	-1415	-1705	-1400	-1760	-1365	-1880	-1250	-1960	-1110	-2175	-880
3240	-1685	-1410	-1695	-1395	-1755	-1355	-1875	-1140	-1950	-1110	-2170	-870
3230	-1680	-1405	-1690	-1390	-1745	-1345	-1870	-1130	-1940	-1105	-2165	-860
3220	-1675	-1400	-1685	-1385	-1735	-1340	-1865	-1125	-1915	-1100	-2155	-845
3210	-1670	-1395	-1680	-1380	-1720	-1325	-1860	-1125	-1900	-1095	-2150	-835
3200	-1670	-1385	-1675	-1370	-1710	-1275	-1850	-1120	-1895	-930	-2140	-830
3190	-1665	-1380	-1675	-1365	-1700	-1260	-1770	-1115	-1885	-920	-2135	-825
3180	-1660	-1375	-1670	-1355	-1695	-1250	-1760	-1115	-1880	-915	-2125	-820
3170	-1650	-1365	-1665	-1350	-1690	-1140	-1755	-1110	-1875	-910	-2110	-815
3160	-1645	-1360	-1660	-1340	-1685	-1130	-1745	-1105	-1870	-910	-2095	-810
3150	-1585	-1350	-1655	-1330	-1680	-1130	-1735	-1105	-1865	-905	-2010	-805
3140	-1575	-1345	-1645	-1310	-1675	-1125	-1720	-1100	-1860	-900	-1995	-805
3130	-1565	-1335	-1625	-1260	-1670	-1120	-1710	-935	-1855	-895	-1985	-800
3120	-1560	-1320	-1575	-1255	-1665	-1115	-1700	-925	-1840	-895	-1975	-795
3110	-1555	-1265	-1570	-1140	-1660	-1115	-1695	-920	-1765	-890	-1970	-795
3100	-1545	-1255	-1560	-1135	-1655	-1110	-1690	-915	-1755	-885	-1960	-790
3090	-1540	-1145	-1555	-1130	-1650	-1105	-1685	-910	-1750	-875	-1955	-790
3080	-1530	-1135	-1545	-1125	-1640	-1105	-1680	-905	-1740	-865	-1945	-785
3070	-1520	-1130	-1540	-1120	-1585	-1100	-1675	-905	-1725	-850	-1925	-785
3060	-1430	-1125	-1535	-1115	-1575	-935	-1670	-900	-1710	-840	-1905	-780
3050	-1425	-1120	-1525	-1115	-1565	-925	-1665	-895	-1705	-830	-1895	-775

CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF

RADIOCARBON AGE (BP) 5568 HALF-LIFE	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
3040	-1420	-1120	-1505	-1110	-1560	-920	-1660	-890	-1695	-825	-1890	-645
3030	-1410	-1115	-1425	-1105	-1550	-915	-1655	-885	-1690	-820	-1885	-635
3020	-1405	-1110	-1420	-1105	-1545	-910	-1650	-880	-1685	-815	-1875	-630
3010	-1400	-1110	-1415	-1100	-1540	-905	-1640	-870	-1680	-810	-1870	-625
3000	-1395	-1105	-1405	-935	-1530	-905	-1585	-860	-1675	-810	-1865	-620
2990	-1385	-1100	-1400	-925	-1520	-900	-1575	-845	-1670	-805	-1860	-615
2980	-1380	-1095	-1395	-920	-1435	-895	-1565	-835	-1670	-800	-1855	-610
2970	-1370	-925	-1390	-915	-1425	-890	-1560	-830	-1665	-800	-1845	-605
2960	-1365	-920	-1380	-910	-1420	-885	-1550	-825	-1660	-795	-1765	-600
2950	-1355	-915	-1375	-905	-1415	-880	-1545	-820	-1655	-795	-1760	-595
2940	-1345	-910	-1365	-905	-1405	-870	-1540	-815	-1645	-790	-1750	-590
2930	-1335	-910	-1360	-900	-1400	-860	-1530	-810	-1630	-785	-1740	-580
2920	-1325	-905	-1350	-895	-1395	-845	-1520	-805	-1580	-785	-1730	-440
2910	-1270	-900	-1340	-890	-1390	-835	-1435	-805	-1570	-780	-1715	-430
2900	-1260	-895	-1330	-885	-1380	-830	-1425	-800	-1560	-780	-1705	-430
2890	-1250	-890	-1310	-880	-1375	-825	-1420	-795	-1555	-655	-1700	-425
2880	-1245	-885	-1260	-870	-1370	-820	-1415	-795	-1550	-640	-1690	-420
2870	-1240	-880	-1255	-860	-1360	-815	-1410	-790	-1540	-635	-1685	-420
2860	-1235	-875	-1250	-845	-1350	-810	-1400	-790	-1535	-630	-1680	-415
2850	-1235	-860	-1245	-835	-1340	-805	-1395	-785	-1525	-625	-1680	-410
2840	-1230	-850	-1240	-830	-1330	-805	-1390	-785	-1515	-620	-1675	-410
2830	-1225	-835	-1235	-825	-1315	-800	-1385	-780	-1430	-615	-1670	-410
2820	-1220	-830	-1230	-820	-1265	-795	-1375	-775	-1425	-610	-1665	-405
2810	-1215	-825	-1225	-815	-1255	-795	-1370	-645	-1415	-605	-1660	-405
2800	-1210	-820	-1225	-810	-1250	-790	-1360	-640	-1410	-600	-1655	-400
2790	-1105	-815	-1220	-805	-1245	-790	-1355	-630	-1405	-590	-1650	-400
2780	-1100	-810	-1210	-805	-1240	-785	-1345	-625	-1400	-585	-1640	-395
2770	-1095	-805	-1105	-800	-1235	-785	-1335	-620	-1395	-440	-1585	-395
2760	-1090	-805	-1105	-795	-1230	-780	-1320	-615	-1385	-435	-1570	-390
2750	-1075	-800	-1100	-795	-1225	-775	-1265	-610	-1380	-430	-1565	-390
2740	-1045	-800	-1095	-790	-1225	-645	-1255	-605	-1375	-425	-1560	-385
2730	-1035	-795	-1085	-790	-1220	-640	-1250	-600	-1365	-425	-1550	-285
2720	-1030	-790	-1045	-785	-1215	-630	-1245	-595	-1355	-420	-1545	-270
2710	-1025	-790	-1040	-785	-1105	-625	-1240	-590	-1350	-415	-1540	-255
2700	-1020	-785	-1035	-780	-1105	-620	-1235	-580	-1340	-415	-1530	-210

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
2690	-1020	-785	-1030	-775	-1100	-615	-1230	-440	-1330	-410	-1520	-200
2680	-1015	-780	-1025	-650	-1095	-615	-1230	-435	-1275	-410	-1435	-195
2670	-1005	-775	-1020	-640	-1085	-610	-1225	-430	-1260	-405	-1425	-190
2660	-885	-655	-1015	-635	-1045	-600	-1220	-425	-1255	-405	-1420	-185
2650	-880	-640	-1010	-625	-1040	-595	-1215	-420	-1245	-400	-1415	-180
2640	-875	-635	-1000	-625	-1035	-590	-1205	-420	-1245	-400	-1410	-180
2630	-860	-630	-880	-620	-1030	-580	-1105	-415	-1240	-395	-1400	-175
2620	-845	-625	-875	-615	-1025	-440	-1100	-415	-1235	-395	-1395	-170
2610	-835	-620	-865	-610	-1020	-435	-1095	-410	-1230	-395	-1390	-165
2600	-830	-615	-850	-605	-1015	-430	-1085	-410	-1225	-390	-1385	-165
2590	-825	-610	-840	-595	-1010	-425	-1045	-405	-1220	-390	-1375	-160
2580	-820	-605	-830	-590	-1000	-420	-1040	-405	-1215	-385	-1370	-155
2570	-815	-600	-825	-585	-880	-420	-1035	-400	-1210	-275	-1360	-155
2560	-810	-595	-820	-440	-875	-415	-1030	-400	-1105	-265	-1355	-45
2550	-805	-585	-815	-435	-865	-415	-1025	-395	-1100	-245	-1345	-35
2540	-805	-445	-810	-430	-850	-410	-1020	-395	-1095	-205	-1335	-30
2530	-800	-435	-810	-425	-840	-410	-1015	-390	-1090	-195	-1320	-25
2520	-800	-430	-805	-420	-830	-405	-1010	-390	-1050	-190	-1265	-20
2510	-795	-425	-800	-420	-825	-405	-1000	-385	-1040	-185	-1255	-15
2500	-790	-425	-800	-415	-820	-400	-880	-385	-1035	-185	-1250	-5
2490	-790	-420	-795	-415	-815	-400	-875	-270	-1030	-180	-1245	-1/1
2480	-785	-415	-790	-410	-810	-395	-865	-260	-1025	-175	-1240	-1/1
2470	-785	-415	-790	-410	-810	-395	-850	-210	-1020	-170	-1235	10
2460	-780	-410	-785	-405	-805	-390	-840	-200	-1015	-170	-1230	15
2450	-775	-410	-785	-405	-800	-390	-830	-195	-1010	-165	-1230	25
2440	-775	-405	-780	-400	-800	-385	-825	-190	-1005	-160	-1225	30
2430	-770	-405	-780	-400	-795	-385	-820	-185	-885	-160	-1220	35
2420	-770	-400	-775	-395	-790	-275	-815	-180	-880	-155	-1215	40
2410	-765	-400	-770	-395	-790	-260	-810	-180	-870	-50	-1205	45
2400	-760	-400	-770	-395	-785	-215	-810	-175	-855	-40	-1105	190
2390	-755	-395	-765	-390	-785	-200	-805	-170	-845	-35	-1100	195
2380	-755	-395	-760	-390	-780	-195	-800	-165	-835	-25	-1095	200
2370	-750	-390	-760	-385	-780	-190	-800	-165	-830	-20	-1085	205
2360	-740	-390	-755	-275	-775	-185	-795	-160	-820	-15	-1045	205
2350	-590	-385	-750	-265	-770	-180	-790	-155	-820	-10	-1040	210

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
2340	-580	-285	-740	-245	-770	-180	-790	-150	-815	-5	-1035	210
2330	-575	-270	-595	-205	-765	-175	-785	-45	-810	-1/1	-1030	215
2320	-560	-255	-585	-195	-760	-170	-785	-35	-805	5	-1025	215
2310	-550	-205	-575	-190	-760	-170	-780	-30	-805	15	-1020	220
2300	-535	-200	-565	-185	-755	-165	-780	-25	-800	20	-1015	220
2290	-420	-190	-555	-180	-750	-160	-775	-20	-795	25	-1010	225
2280	-420	-190	-540	-180	-740	-155	-770	-15	-795	30	-1000	225
2270	-415	-185	-525	-175	-595	-155	-770	-5	-790	35	-880	230
2260	-415	-180	-420	-170	-585	-45	-765	-1/1	-790	40	-875	230
2250	-410	-175	-415	-170	-580	-35	-760	5	-785	45	-865	235
2240	-410	-170	-415	-165	-565	-30	-760	10	-780	190	-850	235
2230	-405	-170	-410	-160	-555	-25	-755	15	-780	195	-840	240
2220	-405	-165	-410	-155	-545	-20	-750	25	-775	200	-830	240
2210	-400	-160	-405	-155	-525	-15	-745	30	-775	205	-825	245
2200	-400	-160	-405	-45	-420	-5	-595	35	-770	205	-820	250
2190	-395	-155	-400	-35	-415	-1/1	-590	40	-765	210	-815	315
2180	-395	-45	-400	-30	-415	-1/1	-580	45	-765	215	-810	330
2170	-390	-35	-395	-25	-410	10	-570	185	-760	215	-810	345
2160	-390	-30	-395	-20	-410	15	-555	195	-755	220	-805	360
2150	-385	-25	-390	-15	-405	25	-545	200	-750	220	-800	385
2140	-385	-20	-390	-5	-405	30	-530	205	-745	225	-800	400
2130	-380	-15	-390	-1/1	-400	35	-420	205	-735	225	-795	410
2120	-380	-10	-385	5	-400	40	-415	210	-590	225	-790	415
2110	-375	-1/1	-385	10	-395	45	-415	210	-585	230	-790	420
2100	-375	-1/1	-380	15	-395	185	-410	215	-575	230	-785	425
2090	-370	10	-375	25	-395	195	-410	215	-565	235	-785	435
2080	-365	15	-375	30	-390	200	-405	220	-550	240	-780	440
2070	-355	20	-370	35	-390	200	-405	220	-540	240	-780	445
2060	-185	25	-365	40	-385	205	-400	225	-520	245	-775	450
2050	-180	35	-360	45	-385	210	-400	225	-420	250	-770	460
2040	-175	40	-185	185	-380	210	-400	230	-415	250	-770	550
2030	-170	40	-180	195	-380	215	-395	230	-415	325	-765	560
2020	-170	45	-175	200	-375	215	-395	235	-410	335	-760	565
2010	-165	190	-175	200	-370	220	-390	235	-410	350	-760	570
2000	-160	195	-170	205	-365	220	-390	240	-405	370	-755	575

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF											
	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
1990	-160	200	-165	210	-360	225	-385	240	-405	390	-750	575
1980	-155	205	-165	210	-185	225	-385	245	-400	405	-740	580
1970	-150	205	-160	215	-180	230	-380	250	-400	410	-595	585
1960	-145	210	-155	215	-175	230	-380	315	-395	420	-590	585
1950	-145	215	-155	220	-175	235	-375	330	-395	425	-580	590
1940	-135	215	-150	220	-170	235	-370	345	-390	430	-570	595
1930	-125	220	-145	225	-165	240	-370	360	-390	435	-560	595
1920	-20	220	-140	225	-165	240	-365	380	-390	440	-545	600
1910	-15	225	-130	230	-160	245	-185	400	-385	450	-530	605
1900	-10	225	-20	230	-155	250	-180	410	-385	455	-420	605
1890	-1/1	225	-15	235	-155	255	-180	415	-380	545	-420	610
1880	-1/1	230	-10	235	-150	330	-175	420	-375	555	-415	610
1870	10	230	-5	240	-145	340	-170	425	-375	560	-410	615
1860	15	235	-1/1	240	-140	355	-165	435	-370	565	-410	620
1850	25	240	5	245	-130	380	-165	440	-365	570	-405	620
1840	30	240	15	250	-20	395	-160	445	-360	575	-405	625
1830	35	245	20	255	-15	405	-155	450	-185	580	-405	630
1820	40	250	25	330	-10	415	-155	460	-180	580	-400	635
1810	45	255	35	340	-1/1	420	-150	550	-175	585	-400	640
1800	45	325	40	355	-1/1	425	-145	560	-170	590	-395	640
1790	50	335	40	380	10	430	-140	565	-170	590	-395	645
1780	55	350	45	395	15	440	-130	570	-165	595	-390	650
1770	60	370	50	405	20	445	-20	575	-160	600	-390	750
1760	65	395	55	415	25	450	-15	575	-160	600	-385	760
1750	70	405	60	420	35	455	-10	580	-155	605	-385	765
1740	70	410	60	425	40	550	-5	585	-150	605	-380	770
1730	75	420	65	430	40	560	-1/1	585	-145	610	-380	775
1720	80	425	70	440	45	565	5	590	-140	615	-375	785
1710	90	430	75	445	50	570	15	595	-135	615	-370	790
1700	220	435	80	450	55	570	20	595	-125	620	-370	850
1690	225	440	85	455	60	575	25	600	-20	625	-365	860
1680	225	450	100	550	65	580	30	600	-10	630	-185	865
1670	230	455	225	555	65	585	35	605	-5	630	-180	870
1660	230	545	225	565	70	585	40	610	-1/1	635	-180	875
1650	235	555	230	570	75	590	45	610	5	640	-175	880

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
1640	240	560	230	570	80	595	50	615	10	645	-170	885
1630	240	565	235	575	85	595	55	620	20	650	-165	885
1620	245	570	235	580	100	600	60	620	25	740	-165	890
1610	245	575	240	585	225	600	60	625	30	755	-160	895
1600	250	580	245	585	225	605	65	630	35	760	-155	895
1590	260	580	245	590	230	610	70	635	40	770	-155	900
1580	335	585	250	590	230	610	75	635	45	775	-150	905
1570	345	590	255	595	235	615	80	640	50	780	-145	905
1560	365	590	270	600	235	620	85	645	50	785	-140	910
1550	390	595	345	600	240	620	95	650	55	795	-130	915
1540	400	595	360	605	245	625	225	750	60	855	-20	995
1530	410	600	385	610	245	630	225	755	65	860	-15	1010
1520	415	605	400	610	250	630	230	765	70	865	-10	1015
1510	425	605	410	615	255	635	230	770	75	870	-1/1	1020
1500	430	610	415	615	265	640	235	775	80	875	-1/1	1025
1490	435	615	420	620	345	645	235	780	85	880	10	1030
1480	440	615	425	625	360	650	240	790	90	885	15	1035
1470	445	620	435	630	385	745	240	845	220	885	20	1040
1460	455	625	440	630	400	755	245	855	225	890	25	1040
1450	460	625	445	635	410	765	250	865	225	895	35	1045
1440	470	630	450	640	415	770	255	870	230	900	40	1050
1430	565	635	460	645	420	775	265	875	230	900	40	1055
1420	570	640	470	650	425	780	340	880	235	905	45	1130
1410	570	640	560	655	435	785	355	880	240	910	50	1145
1400	575	645	565	755	440	795	380	885	240	915	55	1160
1390	580	650	570	760	445	855	395	890	245	915	60	1175
1380	585	750	575	765	450	860	405	890	245	1005	60	1190
1370	585	760	580	775	460	865	415	895	250	1015	65	1200
1360	590	765	580	780	465	870	420	900	260	1020	70	1205
1350	595	770	585	785	560	875	425	900	335	1025	75	1210
1340	595	775	590	795	565	880	430	905	350	1030	80	1220
1330	600	780	590	850	570	885	440	910	365	1030	85	1225
1320	605	790	595	860	575	885	445	915	390	1035	95	1225
1310	605	800	600	865	580	890	450	920	400	1040	225	1230
1300	610	855	600	870	580	895	455	1005	410	1045	225	1235

CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF

RADIOCARBON AGE (BP) 5568 HALF-LIFE	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
1290	610	860	605	875	585	900	465	1015	415	1045	230	1240
1280	615	865	610	880	590	900	485	1020	425	1050	230	1245
1270	620	870	610	880	590	905	565	1025	430	1055	235	1245
1260	620	875	615	885	595	910	570	1030	435	1135	235	1250
1250	625	880	620	890	600	910	575	1035	440	1150	240	1255
1240	630	885	620	895	600	915	580	1035	445	1165	240	1255
1230	635	885	625	895	605	1005	580	1040	455	1180	245	1260
1220	640	890	630	900	605	1010	585	1045	460	1195	250	1265
1210	645	895	630	905	610	1020	590	1050	470	1200	255	1270
1200	645	895	635	905	615	1025	590	1050	560	1210	265	1275
1190	655	900	640	910	615	1025	595	1055	565	1215	340	1280
1180	660	905	645	915	620	1030	595	1140	570	1220	355	1285
1170	665	910	650	920	625	1035	600	1155	575	1225	380	1300
1160	675	910	655	1010	630	1040	605	1170	580	1230	395	1310
1150	775	915	665	1015	630	1045	605	1185	585	1235	405	1320
1140	780	1000	670	1020	635	1045	610	1195	585	1235	415	1325
1130	785	1010	770	1025	640	1050	615	1205	590	1240	420	1325
1120	800	1015	775	1030	645	1055	615	1210	590	1245	425	1330
1110	860	1020	785	1035	650	1135	620	1215	595	1245	430	1335
1100	865	1025	790	1035	655	1150	625	1220	600	1250	440	1335
1090	870	1030	855	1040	660	1160	625	1225	600	1255	445	1340
1080	875	1035	865	1045	670	1180	630	1230	605	1260	450	1345
1070	880	1040	870	1050	770	1190	635	1235	610	1260	455	1350
1060	885	1040	875	1055	775	1200	640	1240	610	1265	465	1355
1050	885	1045	875	1055	780	1210	645	1240	615	1270	485	1390
1040	890	1050	880	1140	790	1215	650	1245	620	1275	565	1395
1030	895	1055	885	1155	800	1220	655	1250	620	1280	570	1400
1020	900	1130	890	1170	860	1225	660	1250	625	1290	575	1400
1010	900	1145	890	1185	865	1230	665	1255	630	1305	575	1405
1000	905	1160	895	1195	870	1230	680	1260	630	1315	580	1405
990	910	1175	900	1205	875	1235	775	1260	635	1320	585	1410
980	910	1190	900	1210	880	1240	780	1265	640	1325	585	1410
970	915	1200	905	1215	885	1245	785	1270	645	1325	590	1415
960	920	1205*	910	1220	885	1245	795	1275	650	1330	595	1415
950	930	1210*	915	1225	890	1250	855	1285	655	1335*	595	1415

RADIOCARBON AGE (BP) 5568 HALF-LIFE	CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
940	1020	1215	920	1230	895	1255	865	1295	660	1340*	600	1420
930	1025	1220	925	1235*	895	1255	870	1310	670	1340*	605	1420
920	1030	1225	930	1235*	900	1260	875	1315	770	1345	605	1425
910	1030	1230	1020	1240	905	1265	880	1320	775	1350	610	1425
900	1035	1235	1025	1245	910	1270	880	1325	780	1360	610	1430
890	1040	1240	1030	1250	910	1275	885	1330	790	1390	615	1435
880	1045	1240	1035	1250	915	1280	890	1330	850	1395	620	1440
870	1045	1245	1035	1255	920	1290*	890	1335	860	1400	620	1485
860	1050	1250	1040	1260	925	1305*	895	1340	865	1400	625	1490
850	1055	1255	1045	1260	935	1315*	900	1345	870	1405	630	1495
840	1060	1255*	1050	1265	1025	1320	905	1345	875	1405	635	1495
830	1155	1260	1055	1270	1025	1325	905	1355	880	1410	640	1500
820	1170	1265	1060	1275*	1030	1325	910	1385	885	1410	640	1505
810	1185	1265	1065	1285*	1035	1330	915	1395	885	1415	645	1510
800	1195	1270	1160	1295	1040	1335	920	1395	890	1415	650	1520
790	1205	1275	1175	1310	1040	1335	925	1400*	895	1420	660	1605*
780	1210	1285	1190	1315	1045	1340	935	1405*	895	1420	665	1620*
770	1215	1300	1200	1320	1050	1345	1020	1405	900	1420	675	1630*
760	1220	1310	1205	1325	1055	1350	1025	1410	905	1425	770	1635
750	1225	1315	1210	1330	1060	1360*	1030	1410	910	1425	780	1640
740	1230	1320	1215	1330	1070	1390*	1035	1410	910	1430	785	1645
730	1235	1325	1220	1335	1165	1395	1035	1415	915	1435	795	1650
720	1235	1330	1225	1340	1180	1400	1040	1415	920	1480*	855	1650
710	1240	1335	1230	1340	1195	1400	1045	1420	925	1485*	860	1655
700	1245	1335	1235	1345	1200	1405	1050	1420	935	1490*	870	1655
690	1250	1340	1240	1350	1210	1405	1055	1425	1025	1495	870	1660
680	1250	1345	1240	1385	1215	1410	1060	1425*	1025	1500	875	1660
670	1255	1350	1245	1395	1220	1410	1065	1430*	1030	1505	880	1665
660	1260	1355	1250	1395	1225	1415	1160	1430	1035	1510	885	1790*
650	1265	1390	1255	1400	1230	1415	1175	1435	1040	1515	890	1795*
640	1265	1395	1255	1405	1235	1415	1190	1480	1040	1525	890	1800*
630	1270	1400	1260	1405	1235	1420	1200	1485	1045	1610*	895	1950*
620	1275	1400	1265	1405	1240	1420	1205	1490	1050	1625	900	1950*
610	1285	1405	1270	1410	1245	1425	1210	1495	1055	1630	900	1950*
600	1300	1405	1270	1410	1245	1425	1215	1500	1060	1640*	905	1950*

CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF

RADIOCARBON AGE (BP) 5568 HALF-LIFE	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
590	1310	1410	1280	1415	1250	1430	1220	1505	1070	1645*	910	1950*
580	1315	1410	1285	1415	1255	1435	1225	1510	1165	1645	915	1950*
570	1320	1410	1305	1420	1260	1475	1230	1515	1180	1650	920	1950*
560	1325	1415	1315	1420	1260	1485	1235	1595*	1195	1650	925	1950*
550	1330	1415	1320	1425	1265	1490	1240	1615	1200	1655	930	1950*
540	1335	1420	1325	1425	1270	1495	1240	1625	1210	1655	1020	1950
530	1335	1420	1325	1430	1275	1500	1245	1635	1215	1660	1025	1950
520	1340	1425	1330	1430	1280	1500	1250	1640	1220	1660	1030	1950
510	1345	1425	1335	1435	1295	1505	1255	1645	1225	1665	1030	1950
500	1350	1430	1335	1480	1310	1515	1255	1645	1230	1790*	1035	1950
490	1355	1430	1340	1485	1315	1520	1260	1650	1230	1795*	1040	1950
480	1390	1435	1345	1490	1320	1605*	1265	1655	1235	1800*	1045	1950
470	1395	1480	1350	1495	1325	1620	1270	1655	1240	1950*	1045	1950
460	1400	1485	1385	1500	1330	1630	1270	1655	1245	1950*	1050	1950
450	1400	1490	1390	1505	1330	1635	1280	1660	1245	1950*	1055	1950
440	1405	1495	1395	1510	1335	1640	1285	1660	1250	1950*	1060	1950*
430	1405	1500	1400	1515	1340	1645	1305	1665	1255	1950*	1155	1950
420	1410	1505	1400	1525	1340	1650	1315	1790*	1255	1950*	1170	1950
410	1410	1510	1405	1605*	1345	1650	1320	1795*	1260	1950*	1185	1950
400	1415	1515	1405	1620	1350	1655	1325	1800*	1265	1950	1195	1950
390	1415	1525	1410	1630	1385	1655	1325	1950*	1270	1950	1205	1950
380	1415	1605	1410	1635	1395	1660	1330	1950*	1275	1950	1210	1950
370	1420	1620	1415	1640	1395	1660	1335	1950*	1280	1950	1215	1950
360	1420	1630	1415	1645	1400	1660	1335	1950*	1290	1950	1220	1950
350	1425	1635	1420	1650	1405	1665	1340	1950*	1305	1950	1225	1950
340	1425	1640	1420	1650	1405	1795*	1345	1950*	1315	1950	1230	1950
330	1430	1645	1420	1655	1410	1795*	1350	1950	1320	1950	1235	1950
320	1435	1650	1425	1655	1410	1800*	1355	1950	1325	1950	1235	1950
310	1440	1650	1425	1660	1410	1950*	1390	1950	1330	1950	1240	1950
300	1485	1655	1430	1660	1415	1950*	1395	1950	1330	1950	1245	1950
290	1490	1655	1435	1665	1415	1950*	1400	1950	1335	1950	1250	1950
280	1495	1660	1480	1665	1420	1950*	1400	1950	1340	1950	1250	1950
270	1500	1660	1485	1795*	1420	1950*	1405	1950	1340	1950	1255	1950
260	1505	1660	1490	1795*	1425	1950*	1405	1950	1345	1950	1260	1950
250	1510	1665	1495	1800*	1425	1950	1410	1950	1350	1950	1260	1950

CALIBRATED RANGES (95% CONFIDENCE) FOR MEASUREMENT UNCERTAINTIES OF

RADIOCARBON AGE (BP) 5568 HALF-LIFE	SIGMA= 20 YRS.		SIGMA= 50 YRS.		SIGMA=100 YRS.		SIGMA=150 YRS.		SIGMA=200 YRS.		SIGMA=300 YRS.	
240	1515	1790*	1500	1950*	1430	1950	1410	1950	1385	1950	1265	1950
230	1525	1795*	1505	1950*	1430	1950	1415	1950	1395	1950	1270	1950
220	1620	1800*	1510	1950*	1435	1950	1415	1950	1395	1950	1275	1950
210	1630	1950*	1515	1950*	1480	1950	1415	1950	1400	1950	1285	1950
200	1640	1950*	1525	1950*	1485	1950	1420	1950	1405	1950	1295	1950
190	1645	1950*	1620	1950*	1490	1950	1420	1950	1405	1950	1310	1950
180	1645	1950*	1630	1950	1495	1950	1425	1950	1405	1950	1315	1950
170	1650	1950*	1640	1950	1500	1950	1425	1950	1410	1950	1320	1950
160	1650	1950*	1645	1950	1505	1950	1430	1950	1410	1950	1325	1950
150	1655	1950	1645	1950	1510	1950	1435	1950	1415	1950	1330	1950
140	1655	1950	1650	1950	1520	1950	1480	1950	1415	1950	1330	1950
130	1660	1945	1650	1950	1530	1950*	1485	1950	1420	1950	1335	1950
120	1660	1945	1655	1950	1625	1950	1490	1950	1420	1950	1340	1950
110	1665	1940	1655	1950	1630	1950	1495	1950	1425	1950	1345	1950
100	1665	1940*	1660	1945	1640	1950	1500	1950	1425	1950	1345	1950
90	1670	1935*	1660	1945	1645	1950	1505	1950	1430	1950	1355	1950
80	1670	1935*	1665	1940	1645	1950	1510	1950	1430	1950	1390	1950
70	1675	1930*	1665	1940*	1650	1950	1515	1950	1435	1950	1395	1950
60	1675	1930*	1670	1935*	1650	1950	1525	1950*	1480	1950	1400	1950
50	1680	1925*	1670	1935*	1655	1950	1615	1950	1485	1950	1400	1950
40	1680	1920*	1670	1930*	1655	1950	1625	1950	1490	1950	1405	1950
30	1815	1920*	1675	1930*	1660	1945	1635	1950	1495	1950	1405	1950
20	1820	1915*	1680	1925*	1660	1945	1640	1950	1500	1950	1410	1950
10			1680	1920*	1665	1940	1645	1950	1505	1950	1410	1950

TABLE 3

SUPPLEMENTARY CALIBRATION TABLES FOR THE MOST RECENT 1000 YEARS

This table lists calibration intervals only for the starred values in the main table, *ie,* only for ages consistent with more than one calibration interval

Spaces between rows indicate steps of more than 10 years between tabulated radiocarbon ages.

SUPPLEMENTARY TABLES FOR SIGMA = 20

RADIOCARBON AGE (BP)	CALIBRATED RANGES (95% CONFIDENCE)							
960	920	980	1005	1205				
950	930	970	1015	1210				
840	1060	1100	1140	1255				
240	1515	1665	1760	1790				
230	1525	1570	1605	1670	1725	1795		
220	1620	1670	1720	1800				
210	1630	1675	1715	1805	1930	1950		
200	1640	1675	1710	1805	1925	1950		
190	1645	1680	1705	1810	1850	1875	1925	1950
180	1645	1810	1845	1880	1920	1950		
170	1650	1815	1840	1885	1915	1950		
160	1650	1890	1915	1950				
100	1665	1765	1790	1940				
90	1670	1730	1795	1935				
80	1670	1720	1800	1935				
70	1675	1715	1800	1930				
60	1675	1710	1805	1930				
50	1680	1705	1810	1855	1875	1925		
40	1680	1700	1810	1850	1880	1920		
30	1815	1845	1885	1920				
20	1820	1840	1885	1915				

SUPPLEMENTARY TABLES FOR SIGMA = 50

RADIOCARBON AGE (BP)	CALIBRATED RANGES (95% CONFIDENCE)							
930	925	975	1010	1235				
920	930	965	1015	1235				
820	1060	1110	1130	1275				
810	1065	1095	1145	1285				
410	1405	1540	1560	1605				
270	1485	1665	1760	1795				
260	1490	1670	1725	1795				
250	1495	1670	1720	1800				
240	1500	1675	1715	1805	1930	1950		
230	1505	1675	1710	1805	1925	1950		
220	1510	1680	1705	1810	1850	1875	1925	1950
210	1515	1810	1845	1880	1920	1950		
200	1525	1570	1605	1815	1840	1885	1915	1950
190	1620	1890	1910	1950				
70	1665	1765	1790	1940				
60	1670	1730	1795	1935				
50	1670	1720	1800	1935				
40	1670	1715	1800	1930				
30	1675	1710	1805	1930				
20	1680	1705	1810	1855	1875	1925		
10	1680	1705	1810	1850	1880	1920		

SUPPLEMENTARY TABLES FOR SIGMA = 100

RADIOCARBON AGE (BP)	CALIBRATED RANGES (95% CONFIDENCE)							
870	920	980	1005	1290				
860	925	970	1010	1305				
850	935	955	1020	1315				
750	1060	1105	1135	1360				
740	1070	1090	1150	1390				
480	1320	1535	1565	1605				
340	1405	1665	1760	1795				
330	1410	1670	1725	1795				
320	1410	1670	1720	1800				
310	1410	1675	1715	1805	1930	1950		
300	1415	1675	1710	1805	1925	1950		
290	1415	1680	1705	1810	1850	1875	1925	1950
280	1420	1810	1845	1880	1920	1950		
270	1420	1815	1840	1885	1915	1950		
260	1425	1890	1910	1950				
130	1530	1565	1610	1950				

SUPPLEMENTARY TABLES FOR SIGMA = 150

RADIOCARBON AGE (BP)	CALIBRATED RANGES (95% CONFIDENCE)							
790	925	975	1010	1400				
780	935	960	1015	1405				
680	1060	1110	1130	1425				
670	1065	1095	1145	1430				
560	1235	1525	1575	1595				
420	1315	1665	1765	1790				
410	1320	1670	1730	1795				
400	1325	1670	1720	1800				
390	1325	1675	1715	1800	1930	1950		
380	1330	1675	1710	1805	1930	1950		
370	1335	1680	1705	1810	1855	1875	1925	1950
360	1335	1680	1705	1810	1850	1880	1920	1950
350	1340	1815	1845	1885	1920	1950		
340	1345	1820	1840	1885	1915	1950		
60	1525	1575	1600	1950				

SUPPLEMENTARY TABLES FOR SIGMA = 200

RADIOCARBON AGE (BP)	CALIBRATED RANGES (95% CONFIDENCE)							
950	655	725	750	1335				
940	660	715	755	1340				
930	670	705	765	1340				
720	920	985	1005	1480				
710	925	970	1010	1485				
700	935	960	1020	1490				
630	1045	1540	1560	1610				
600	1060	1105	1135	1640				
590	1070	1090	1150	1645				
500	1230	1665	1765	1790				
490	1230	1670	1755	1795				
480	1235	1670	1720	1800				
470	1240	1670	1715	1800	1930	1950		
460	1245	1675	1710	1805	1930	1950		
450	1245	1675	1710	1805	1855	1875	1925	1950
440	1250	1680	1705	1810	1850	1880	1920	1950
430	1255	1815	1845	1880	1920	1950		
420	1255	1820	1840	1885	1915	1950		
410	1260	1890	1910	1950				

SUPPLEMENTARY TABLES FOR SIGMA = 300

RADIOCARBON AGE (BP)	CALIBRATED RANGES (95% CONFIDENCE)							
790	660	720	750	1535	1565	1605		
780	665	710	760	1620				
770	675	695	765	1630				
660	885	1665	1770	1790				
650	890	1665	1760	1795				
640	890	1670	1725	1800				
630	895	1670	1720	1800	1930	1950		
620	900	1675	1715	1805	1930	1950		
610	900	1675	1710	1805	1925	1950		
600	905	1680	1705	1810	1850	1875	1925	1950
590	910	1815	1845	1880	1920	1950		
580	915	1815	1840	1885	1915	1950		
570	920	1890	1910	1950				
560	925	980	1005	1950				
550	930	965	1015	1950				
440	1060	1100	1140	1950				

[RADIOCARBON, VOL 24, No. 2, 1982, P 151-170]

BRITISH MUSEUM NATURAL RADIOCARBON MEASUREMENTS XIII

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The following list consists of dates for archaeologic samples mostly measured from July 1976 to December 1977*. The dates were obtained by liquid scintillation counting of benzene using the laboratory procedures outlined in previous lists (see, eg, BM-VIII, R, 1976, v 18, p 16). Dates are expressed in radiocarbon years relative to AD 1950 based on the Libby half-life for ^{14}C of 5570 yr, and are corrected for isotopic fractionation ($\delta^{13}C$ values are relative to PDB). No corrections have been made for natural ^{14}C variations (although in some instances approximate calibrated dates taken from the tables of R M Clark (1975) have been given in the comments where this aids interpretation of results). The modern reference standard is NBS oxalic acid (SRM 4990). Errors quoted with the dates are based on counting statistics alone and are equivalent to $\pm$ 1 standard deviation ($\pm 1\sigma$), Dates in this and the next list (BM-XIV) reported to submitters or published elsewhere before the introduction of the new guidelines for rounding of computed figures have deliberately been left unrounded. From BM-XV onwards all BM dates will be rounded before publication in conformity with the recently recommended procedures (R, 1977, v 19, p 362). Descriptions, comments, and references to publications are based on information supplied by submitters.

SAMPLE DESCRIPTIONS

ARCHAEOLOGIC SAMPLES

A. British Isles

3245 ± 37

BM-731. Blagdon, Somerset *$\delta^{13}C = -19.3$‰*

Collagen from proximal end of left radius of skeleton of wild aurochs (*Bos primigenius* Bojanus) from archaeol deposit in limestone fissure at Charterhouse Warren Farm, Blagdon, Mendip, Somerset, England (51° 20′ N, 2° 45′ W, Natl Grid Ref ST 494545). Coll 1971 and subm 1976 by R F Everton, Univ Bristol Spelaeol Soc. Remains were loosely assoc with Iron age pottery, and horn cores had cut-marks supposedly made with iron sword (Everton, 1975), suggesting late date. Measured as part of program for dating late-Glacial and Postglacial mammals in British Isles. *Comment* (RB): although one of latest results so far obtained for survival of *Bos primigenius* in Britain, date still lies fully within middle Bronze age (Burleigh and Clutton-Brock, 1977).

* Dates obtained over the same period for samples from Grime's Graves, Norfolk, England, formed part of a separate list, BM X (R, 1979, v 21, p 41-47).

Callis Wold series, Yorkshire

Charcoal samples from Barrow 275, Callis Wold, Bishop Wilton, Yorkshire, England (54° 0′ N, 0° 45′ W, Natl Grid Ref SE 832559). Coll 1974 and subm by D G Coombs, Dept Environment, to date Neolithic platform burial assoc with Towthorpe ware, and later Beaker deposit.

4803 ± 71

BM-1167. Callis Wold $\delta^{13}C = -25.5‰$

Sample ref CW74 III 31; burned plank from bedding trench S of platform.

3794 ± 70

BM-1168. Callis Wold $\delta^{13}C = -25.8‰$

Sample ref CW74 II 31; continuation of CW74 II 29 (BM-1169, below) under turf mound.

3677 ± 68

BM-1169. Callis Wold $\delta^{13}C = -25.0‰$

Sample ref CW74 II 29; from layer with All-Over-Cord, European, Plain and Finger Nail Beakers (*cf* BM-1168, above).

4933 ± 64

BM-1170. Callis Wold $\delta^{13}C = -24.3‰$

Sample ref CW74 III 18; from upper fill of bedding trench containing Neolithic Towthorpe ware.

General Comment (DGC): BM-1167, -1170 relate to straight facade trench at front of burial complex (Coombs, 1976) containing burial platform excavated by Mortimer (1905, p 161-163) and are first radiocarbon dates directly assoc with Neolithic Towthorpe ware, contained in upper fill of trench; dates compare favorably with those for comparable Neolithic burial structures (eg, Wayland's Smithy, Berks; Aldwincle, Northants). BM-1168, -1169 relate to Beaker level found on top of small and mound covering Neolithic burials and agree with other dates for similar Beakers.

2280 ± 60

BM-1181. Great Wilbraham, Cambridgeshire $\delta^{13}C = -25.2‰$

Wood (*Quercus* sp) from site of henge monument at Great Wilbraham, Cambridgeshire, England (52° 10′ N, 0° 15′ E, Natl Grid Ref TL 550570). Coll 1975 and subm by D L Clarke, Dept Archaeol, Univ Cambridge. *Comment* (RB): sample refluxed with hot water to remove polyethylene glycol used as a consolidant; wood was worked and came from peat deposit cut by later henge monument; expected to be of Mesolithic date, but evidently derived from much later human activity at site.

Orsett series, Essex

Charcoal samples from Neolithic causewayed enclosure at Orsett, Tilbury, Essex, England (51° 30′ N, 0° 20′ E, Natl Grid Ref TQ 653 806). Coll 1975-1976 and subm by J D Hedges, Essex Co Council, to date construction and occupation phases of monument (Hedges and Buckley, 1978).

BM-1213. Orsett **4741 ± 113**
$\delta^{13}C = -24.0‰$

Sample ref 1731/BF14 (3); charcoal from post-hole in palisade entrance, NW side of enclosure.

BM-1214. Orsett **4533 ± 112**
$\delta^{13}C = -22.7‰$

Sample ref 1731/BF2 II (6); charcoal from top of primary silts of middle ditch, assoc with Mildenhall pottery.

BM-1215. Orsett **4585 ± 82**
$\delta^{13}C = -25.3‰$

Sample ref 1731/CF4 IV (10); charcoal from base of primary silts of inner ditch, assoc with Mildenhall pottery.

BM-1377. Orsett **4620 ± 43**
$\delta^{13}C = -25.5‰$

Sample ref 1731/BF 45 (3); charcoal from pit S of palisade.

BM-1378. Orsett **4726 ± 74**
$\delta^{13}C = -24.3‰$

Sample ref 1731/BF 85 (4); charcoal from post-hole in central gate structure of causeway entrance. *Comment* (JDH): sample came from sealed context of post-hole within larger post-pit central to causeway of middle interrupted ditch. Post-pit contained sherds of Mildenhall-style pottery; date corresponds closely with BM-1213 (above) and suggests that timber causeway entrance structure was contemporary with palisade.

BM-1379. Orsett **2514 ± 81**
$\delta^{13}C = -24.3‰$

Sample ref 1731/CF4 I (3); charcoal from upper silts of inner causewayed ditch. *Comment* (JDH): date is consistent with final phase of silting within inner causewayed ditch, which contained early Iron age pottery.

BM-1380. Orsett **3871 ± 62**
$\delta^{13}C = -23.5‰$

Sample ref 1731/CF4 IV (5); charcoal from middle silts of inner circuit of causewayed ditch. *Comment* (JDH): middle silts of inner ditch contained Grooved ware sherds of Clacton sub-style; date is appropriate for this horizon.

Eskmeals series, Cumbria

Charcoal from features on Mesolithic occupation sites at Monk Moors and Williamson's Moss, Eskmeals, Cumbria, England (54° 20′ N, 3° 25′ W, Natl Grid Ref SD 085920). Coll 1974-1977 and subm by J C Bonsall, Dept Archaeol, Univ Edinburgh.

BM-1216. Monk Moors, Eskmeals **6752 ± 156**
$\delta^{13}C = -25.7‰$

Charcoal, ref Sample 2, from Site 1, Feature 134.

4028 ± 54
BM-1385. Monk Moors, Eskmeals $\delta^{13}C = -26.4‰$
Charcoal, ref Sample 3, from Site 2, Feature 1.

2859 ± 49
BM-1386. Monk Moors, Eskmeals $\delta^{13}C = -26.5‰$
Charcoal, ref Sample 4, from Site 2, Feature 33.

3654 ± 118
BM-1395. Monk Moors, Eskmeals $\delta^{13}C = -24.6‰$
Charcoal, ref Sample 5, from Site 1, Feature 399.

3756 ± 104
BM-1396. Williamson's Moss, Eskmeals $\delta^{13}C = -26.0‰$
Charcoal, ref Sample 1, from Site 1, Feature 23.

General Comment (JCB): samples coll from hearths and other features on sites assoc with main Postglacial raised shoreline. Only BM-1216 falls within expected age range 8000-6000 radiocarbon yr bp[1] (and is in broad agreement with Q-1356 (unpub) on charcoal from same feature); other determinations (BM-1385, -1386, -1395, -1396) must be regarded as invalid, as features to which they relate have unequivocal late Mesolithic assoc (Bonsall, 1981).

Fisher's Green series, Essex

Peat samples from gravel pit at Fisher's Green, 2 km N of Waltham Abbey, valley of R Lea, Essex, England (51° 40′ N, 0° 0′ E, Natl Grid Ref TL 377026). Coll 1974 and subm by J C Bonsall, to date uniserially barbed antler point found assoc with peat.

8390 ± 70
BM-1241. Fisher's Green $\delta^{13}C = -26.7‰$
Peat, ref S1, base, 10cm above peat/sand boundary.

5490 ± 70
BM-1242. Fisher's Green $\delta^{13}C = -25.1‰$
Peat, ref S2, top, 40cm above peat/sand boundary.

General Comment (JCB): there are only two reliably dated occurrences of this type of barbed point in Britain, at High Furlong, Lancashire (St-3832, 12,200 ± 160; St-3836, 11,665 ± 140; Hallam *et al,* 1973, p 110) and Star Carr, N Yorkshire (Clark, 1954; Q-14, 9557 ± 210; R, 1959, v 1, p 69). Fisher's Green dates are at variance with results of pollen analysis of peat, and their validity must be in question.

Blashenwell series, Dorset

Samples of mammalian bone (prob *Cervus elaphus)* from kitchen midden in Blashenwell tufa, Blashenwell Farm, near Corfe, Dorset, England (50° 40′ N, 2° 5′ W, Natl Grid Ref SY 952805). Coll ca 1895 by Clement Reid and subm 1976 by R C Preece and M P Kerney, Dept Geol, Imperial Coll, London, from colln of Dorset Co Mus, Dorchester,

[1] British convention for uncorrected radiocarbon dates

to provide dates for molluscan biostratigraphy of Mesolithic site (Bury, 1950; Preece, 1980; Reid, 1896). Stratigraphic horizon of samples not recorded (see *General Comment,* below).

5750 ± 140
BM-1257. Blashenwell $\delta^{13}C = -21.4‰$

Collagen from mammalian bone, ref DCM1.

5425 ± 150
BM-1258. Blashenwell $\delta^{13}C = -22.7‰$

Collagen from mammalian bone, ref DCM2.

General Comment (RCP and MPK): dates are younger than previously pub date from site (BM-89, 6450 ± 150: R, 1961, v 3, p 40; bone from middle zone of tufa, not directly related to molluscan sequence), but Mollusca from marrow cavities of bones dated by BM-1257, -1258 are referable to Zone d of sequence proposed by Kerney (1977). Also, dates are consistent with those obtained for similar assemblages elsewhere (Kerney, 1976; Kerney, Preece, and Turner, 1980; Preece, 1978), and suggest bones are from upper levels of tufa (Preece, 1980). Direct dating of nodules from base of tufa (HAR-3766, unpub) gives corrected age range of 9400-8900 BP for onset of tufa formation at Blashenwell, in agreement with biostratigraphic prediction (Thorpe, in Preece, 1980, p 361). Dates for bone are all from Mesolithic midden material and indicate occupation of site over 1000-yr period.

27,600 ± 1300
BM-1367. Paviland, W Glamorgan $\delta^{13}C = -19.9‰$

Collagen from distal part of fragmentary left humerus (ref 24.94 171) of *Bos primigenius* or *Bison* sp (id by Juliet Clutton-Brock, Dept Zool, British Mus (Nat Hist)), from deposits containing Upper Palaeolithic artifacts in Goat's Hole Cave, Paviland, Gower Peninsula, W Glamorgan, S Wales (51° 35′ N, 4° 15′ W, Natl Grid Ref SS 437859). Coll 1912 by W J Sollas and subm 1977 by Theya Molleson, Subdept Anthropol, British Mus (Nat Hist) from colln of Natl Mus Wales, Cardiff. *Comment* (RB): date allows presence of typologically early artifacts in cave (now completely cleared of original deposits) to be reconciled with date of 18,460 ± 340 (BM-374: R, 1969, v 11, p 289) previously obtained for post-cranial bones of "Red Lady" of Paviland (Molleson and Burleigh, 1978).

2135 ± 152
BM-1374. Godmanchester $\delta^{13}C = -20.0‰$

Collagen from femur (ref ARC 72.5036) of domestic dog from Pit K103 (494A), Pinfold Lane, Godmanchester, Huntingdonshire, England (52° 20′ N, 0° 10′ W, Natl Grid Ref TL 250700). Coll 1970 by H J M Green for Dept Environment and subm 1977 by Juliet Clutton-Brock to verify dating of dog for archaeozool purposes and to provide comparative material for carbon isotope studies (BM-1236-1240, -1359-1364, this list, below; Burleigh and Brothwell, 1978, p 357). *Comment* (RB): expected date, 1st to 3rd century AD (Green, 1969).

1170 ± 47

BM-1387. Ardingly, Sussex $\delta^{13}C = -25.5‰$

Wood sample (bog oak, *Quercus robur* L type) id by D F Cutler, Royal Botanic Gardens, Kew, from timbers found during excavation for reservoir, lying horizontally at depth 4m in alluvial organic silt at Shell Brook, Ardingly, Haywards Heath, W Sussex, England (51° 5′ N, 0° 10′ W, Natl Grid Ref TQ 335288). Coll 1976 and subm by A D Schilling, Deputy Curator, Royal Botanic Gardens, Kew (Wakehurst Place). *Comment* (RB): date agrees with expected age of ca 500-1000 yr BP for timbers.

North Stoke series, Oxfordshire

Samples of antler and charcoal from cursus monument and long mortuary enclosure at North Stoke, Crowmarsh Parish, Oxfordshire, England (51° 35′ N, 1° 10′ W, Natl Grid Ref SU 611856). Coll 1951-1952 and subm 1976 by H J Case, Dept Antiquities, Ashmolean Mus, Oxford (Case, 1959; Catling, 1959).

4672 ± 49

BM-1405. North Stoke $\delta^{13}C = -22.9‰$

Collagen from red deer antler, ref Sample 1, from primary silt of W ditch of cursus.

3374 ± 83

BM-1406. North Stoke $\delta^{13}C = -25.0‰$

Charcoal from cremation pit with miniature Collared Urn, within long mortuary enclosure (Oxoniensia, 1951, v 16, p 81, fig 19).

General Comment (HJC): BM-1405 is 1st date available for cursus monument and agrees with expectations (*cf* BM-355, 4460 ± 140, date for antler from Middle Neolithic enclosure at Abingdon ca 19km to W; R, 1971, v 13, p 171). BM-1406 also agrees with expectations (*cf* GrN-1686, 3440 ± 60, date for charcoal assoc with small Secondary Series Collared Urn from City Farm, Hanborough, ca 35km to W; R, 1964, v 6, p 356).

B. Chile

Mylodon Cave series

Samples of mylodon and guanaco bone, charcoal, mylodon dung, and owl pellets from levels in Mylodon Cave, Ultima Esperanza (51° 35′ S, 72° 35′ W). Coll 1976 and subm by E C Saxon, Dept Anthropol, Univ Durham, to date alternating occupation of cave by mylodon (giant sloth) and man (Saxon, 1979); *cf* date previously obtained for mylodon bone from colln of British Mus (Nat Hist): 12,984 ± 76, R, 1977, v 19, p 143.

5366 ± 55

BM-1201. Mylodon Cave $\delta^{13}C = -23.1‰$

Charcoal from Trench 2, Layer 7. *Comment* (ECS): artifacts assoc with butchered guanaco bone; mylodon absent.

5395 ± 58

BM-1201A. Mylodon Cave $\delta^{13}C = -23.1‰$

Charcoal from Trench 2, Layer 7. Recount of BM-1201.

BM-1202. Mylodon Cave **2556 ± 45**
$\delta^{13}C = -25.1‰$

Charcoal from Nordenskjold midden, Layer A. *Comment* (ECS): artifacts assoc with guanaco bone and *Mytilus* shells; no evidence of mylodon.

BM-1203. Mylodon Cave **7803 ± 82**
$\delta^{13}C = -24.6‰$

Owl pellets from Trench 3, Layer 6.9w. *Comment* (ECS): humid forest replaces boggy grassland vegetation; guanaco replace mylodon in cave deposit.

BM-1204. Mylodon Cave **5684 ± 52**
$\delta^{13}C = -23.4‰$

Charcoal from Trench 2, Layer 7. *Comment* (ECS): artifacts assoc with butchered guanaco bone; mylodon absent.

BM-1204B. Mylodon Cave **5643 ± 60**
$\delta^{13}C = -23.4‰$

Charcoal from Trench 2, Layer 7. Recount of BM-1204.

BM-1207. Mylodon Cave **7785 ± 747**

Burned guanaco bone from Trench 2, Layer 9.1. *Comment* (ECS): artifacts assoc with butchered guanaco bone; mylodon absent.

BM-1208. Mylodon Cave **13,183 ± 202**
$\delta^{13}C = -22.4‰$

Collagen from mylodon bone from Trench 2, Layer 10. *Comment* (ECS): glacial retreat sufficient for mylodon to enter cave.

BM-1209. Mylodon Cave **12,496 ± 148**
$\delta^{13}C = -25.6‰$

Mylodon dung from Trench 5, Layer 1. *Comment* (ECS): ca 1m layer of rapidly accumulated mylodon dung; *cf* BM-1210, -1210B, -1375, below.

BM-1210. Mylodon Cave **11,810 ± 229**
$\delta^{13}C = -28.6‰$

Mylodon dung from Trench 5, Layers 14-15; *cf* BM-1209, above, and -1210B, -1375, below.

BM-1210B. Mylodon Cave **12,308 ± 288**
$\delta^{13}C = -28.6‰$

Mylodon dung from Trench 5, Layers 14-15. Recount of BM-1210.

BM-1375. Mylodon Cave **12,552 ± 128**
$\delta^{13}C = -26.1‰$

Mylodon dung from Trench 5, Layer 10; *cf* BM-1209, -1210, -1210B, above.

C. Colombia

Cueva de la Antigua series

Charcoal from occupation site at Cueva de la Antigua, Municipio San Gil, Dept Santander (6° 35′ N, 73° 10′ W). Coll 1972 and subm by

W Bray, Inst Archaeol, Univ London, to date beginning and end of Antigua phase occupation at site.

1540 ± 200

BM-1381. Cueva de la Antigua $\delta^{13}C = -29.1‰$

Charcoal from Unit Y2, base of ashy stratum with sherds of Antigua phase.

1335 ± 60

BM-1382. Cueva de la Antigua $\delta^{13}C = -23.2‰$

Charcoal from Unit Y2, Spit 7, upper interface of Antigua-phase occupation.

General Comment (WB): determinations fall within range of previous dates for Antigua strata at this site (BM-804, -805, -806: R, 1977, v 19, p 144) and conform with stratigraphic position (separated by sterile layer from overlying Carrizal ceramics).

380 ± 80

BM-1384. Finca Llano de los Gallos $\delta^{13}C = -22.9‰$

Charcoal, ref Los Gallos A (Extension), Level III, from test pit at Finca Llano de los Gallos, Municipio Los Santos, Dept Santander (6° 45′ N, 73° 5′ W). Coll 1972 and subm by W Bray, to date assoc pottery style related to Carrizal ware. *Comment* (WB): date corroborates archaeol data; this style of pottery was made by Guane Indians who occupied region of Los Santos at time of European conquest.

D. Crete

Knossos series

Charcoal samples from Neolithic levels in soundings in W Court of Minoan Palace of Knossos, N central Crete (35° 30′ N, 25° 10′ E). Coll 1970 and subm by J D Evans, Inst Archaeol, Univ London. (For previous series of dates for pre-Palace settlement at Knossos, see R, 1963, v 5, p 104-105; R, 1969, v 11, p 279-280; R, 1977, v 19, p 145; Evans, 1971).

5003 ± 213

BM-716. Knossos $\delta^{13}C = -25.0‰$

Charcoal, ref W Court, Sounding FF, Level 38, Sample 3, Final Neolithic.

5806 ± 124

BM-717. Knossos $\delta^{13}C = -25.8‰$

Charcoal, ref W Court, Sounding EE, Level 18, Sample 19, Late Neolithic.

5892 ± 91

BM-718. Knossos $\delta^{13}C = -24.5‰$

Charcoal, ref W Court, Sounding EE, Level 27, Sample 23; Level 34, Samples 27-29, Middle Neolithic.

5967 ± 41

BM-719. Knossos $\delta^{13}C = -24.4‰$

Charcoal, ref W Court, Sounding AA/BB, Level 164, Sample AR (IA); Level 174, Sample AY (IA); Level 181, Sample BA (IA); Level 183, Sample BI (IA), Early Neolithic II.

6201 ± 252

BM-1371. Knossos $\delta^{13}C = -24.7‰$

Charcoal, ref W Court, Sounding AA/BB, Level 272, Sample CW (II); Level 277, Sample CY (II), Early Neolithic I.

6482 ± 161

BM-1372. Knossos $\delta^{13}C = -24.3‰$

Charcoal, ref W Court, Sounding AA/BB, Level 279, Samples CM, DF, DG (II); Level 286, Sample CL (II), Early Neolithic I.

General Comment (JDE): end of EN I phase at ca 4200-4100 bc is confirmed by BM-1371 and -719, which support previous dates for late EN I and EN II (BM-274, -577), though contradicting another for late EN I (BM-126); MN and LN dates (BM-718, -717) are rather old in comparison both with BM-274 and -577, and with previous dates for MN and LN at Knossos (BM-575, -579 and -581), but confirm impression that both EN II and MN were very short phases. Date for Final Neolithic (BM-716) is very striking; although it fits quite well with LN dates, suggesting longish LN phase, if calibrated, it seems to imply very old date for beginning of Early Minoan period.

E. Egypt

Hierakonpolis series

Shells of freshwater Mollusca from Tomb 100 (Decorated Tomb) at Hierakonpolis, on W bank of R Nile N of Edfu, Nubia, Upper Egypt (25° 10′ N, 32° 45′ E). Coll 1898-1899 by F W Green and subm 1976 by Joan Crowfoot Payne, Dept Antiquities, Ashmolean Mus, Oxford, from reserve colln of Cambridge Mus Archaeol and Anthropol, to provide date for important Predynastic (Gerzean) tomb in absence of alternative sample material; modern live-coll shells of related sp from Nile Valley from colln of Dept Zool, British Mus (Nat Hist) dated to assess probable hard-water effect.

12,911 ± 118

BM-1127A. Hierakonpolis (Tomb 100) $\delta^{13}C = -7.1‰$

Shell carbonate (aragonite) from 5 separate valves of *Unio willcocksi* RB Newton, from Tomb 100, ref 1973.1025, z15390e, f, h, i, j.

5003 ± 88

BM-1127B. Hierakonpolis (Tomb 100) $\delta^{13}C = -9.8‰$

Shell carbonate (aragonite) from single valve of *Etheria elliptica* Lamarck, from Tomb 100, ref 1973.1025, z15390p.

2200 ± 70

BM-1342. Shell carbonate $\delta^{13}C = -6.0‰$

Shell carbonate (aragonite) from single valve of *Unio* sp from Nile Valley, date of coll unknown (date suggests sub-fossil rather than live-coll shell).

3030 ± 520

BM-1343. Shell protein $\delta^{13}C = -23.8‰$

Shell protein (conchiolin) from single valve of *Unio* sp from Nile Valley, date of coll unknown (date suggests sub-fossil rather than live-coll shell).

200 ± 40

BM-1344. Shell carbonate $\delta^{13}C = -6.8‰$

Shell carbonate (aragonite) from single valve of *Etheria elliptica,* live-coll, Nile Valley, ca AD 1920.

580 ± 40

BM-1345. Shell carbonate $\delta^{13}C = -8.1‰$

Shell carbonate (aragonite) from single valve of *Aspatharia rubens* Lamarck (Unionidae), live-coll, Nile Valley, AD 1941. Other valve used to provide protein sample, BM-1346, below.

640 ± 180

BM-1346. Shell protein $\delta^{13}C = -23.2‰$

Shell protein (conchiolin) from single valve of *Aspatharia rubens.* Other valve used to provide carbonate sample, BM-1345, above.

General Comment (RB): BM-1127A dates fossil shells of *Unio willcocksi* that probably derive from nearby deposits corresponding to major episode of Nile accumulation (Sahaba-Darau aggradation event; Fred Wendorf, written commun; Wendorf and Schild, 1976, p 278-280), and may have been deliberately placed in tomb; date for *Etheria elliptica* (BM-1127B) agrees with C-812, 5020 ± 290 (Libby, 1955, p 79), date for human hair and skin from Grave T56 at Naqada of Naqada II period to which Tomb 100 at Hierakonpolis belongs. Dates for live-coll shells (BM-1344-1346) suggest hard-water effects of ca 600 and 200 yr for *Unio* and *Etheria elliptica,* respectively. Result for *E elliptica* (BM-1127B) corrected on this basis and calibrated from tables of R M Clark (1975) gives date of ca 3650 BC for Tomb 100, in good agreement with archaeol evidence (Adams, 1974, p 86; Burleigh, ms in preparation; Case and Payne, 1962; Payne, 1973; Quibell and Green, 1902, p 20-22, pl LXVII).

Tell el-Dab'a

Charcoal samples from Tell el-Dab'a (25° 40′ N, 32° 25′ E), representing conflagration layers connected with rise of Hyksos rule in Egypt, ca 1650 BC. Coll 1974 and subm by M Bietak, Österreichische Botschaft Kairo, Vienna.

3400 ± 113

BM-1165. Tell el-Dab'a $\delta^{13}C = -19.7‰$

Charcoal, ref Sample 43, AII-n11, layer above St G, W sec (12th Dynasty).

3436 ± 43
BM-1225. Tell el-Dab'a $\delta^{13}C = -24.8‰$

Charcoal from conflagration layer.

General Comment (RB): dates agree with archaeol evidence (Bietak, 1979); mean calibrated date from tables of R M Clark (1975) is ca 1800 BC (12th Dynasty).

Saqqara series

Samples of charcoal and chopped straw from Tomb of Horemheb, New Kingdom Necropolis, Saqqara (29° 50′ N, 31° 15′ E). Coll 1976-1978 and subm by G T Martin, Dept Egyptol, Univ Coll, London. Horemheb was Commander-in-Chief and Regent of Tutankhamūn, and King of Egypt from ca 1335 BC; samples should date to end of 18th Dynasty, ca 1350 BC. Few samples from Egyptian New Kingdom period have been dated by radiocarbon.

2867 ± 65
BM-1211. Saqqara $\delta^{13}C = -23.7‰$

Chopped straw from mud-plaster from N wall of Statue Room of Tomb of Horemheb. Calibrated date (Clark, 1975) is ca 1150 ± 100 BC.

3032 ± 57
BM-1370. Saqqara $\delta^{13}C = -22.8‰$

Chopped straw from mud-plaster from E end of S wall of First Court of Tomb of Horemheb. Wall was surfaced with limestone blocks decorated with reliefs depicting scenes in career of tomb owner; plaster must be contemporary with building of tomb (Martin, 1976). Calibrated date (Clark, 1975) is ca 1350 ± 100 BC.

2910 ± 40
BM-1641. Saqqara $\delta^{13}C = -24.5‰$

Charcoal from 3.5kg cache found in Pillared Hall, N of subterranean complex of Shaft IV of Tomb of Horemheb. Presumed to relate to burial made ca 1323-1321 BC (from evidence of inscribed wine amphora; Martin, 1979, p 15), but calibrated date (Clark, 1975) is ca 1190 ± 100 BC (*cf* BM-1211, above).

General Comment (RB & GTM): BM-1370 agrees with historic evidence for date of Horemheb and BM-1211 probably represents embellishment and replastering of Statue Room for cult of Horemheb in Ramesside period, but date of ca 1190 ± 100 BC for charcoal from Shaft IV (BM-1641) is inexplicable at present as no archaeol evidence was found for later use of this part of tomb.

Egyptian axe series

Samples of wood from hafts of ceremonial bronze axes and one box with decoration depicting an axe, in colln of Dept of Egyptian Antiquities, British Mus, from various localities in Egypt (ca 30° N, 31° E). Coll 1842-1925 and subm 1976 by W V Davies, Dept Egyptian Antiquities, British Mus, to provide confirmatory dates for hafts of axes dated by inscription, typol or metal analysis, as part of projected catalogue of

Ancient Egyptian tools and weapons in British Mus colln (Davies, ms in preparation). Wood id by Rowena Gale, Jodrell Lab, Royal Botanic Gardens, Kew. Approx calibrated dates from tables of R M Clark (1975).

3570 ± 60
BM-1245. Axe-haft $\delta^{13}C = -25.3‰$

Wood (*Tamarix* sp) from haft of 1st Intermediate Period/Middle Kingdom axe, EA58074 (ca 2100-1780 BC); calibrated date ca 2000 ± 110 BC.

4470 ± 70
BM-1246. Axe-haft $\delta^{13}C = -24.8‰$

Wood (*Acacia* sp) from haft of New Kingdom axe, EA65663 (ca 1500 BC); calibrated date ca 3270 ± 120 BC.

3580 ± 90
BM-1247. Axe-haft $\delta^{13}C = -21.6‰$

Wood (*Cedrus sp)* from haft of New Kingdom axe, EA36770 (18th Dynasty, ca 1400 BC); calibrated date ca 2010 ± 130 BC.

3310 ± 70
BM-1248. Wooden box $\delta^{13}C = -26.2‰$

Wood (*Ficus* sp) from Middle Kingdom/2nd Intermediate Period box, EA20648 (ca 1850-1550 BC) with painted depiction of axe; calibrated date ca 1660 ± 115 BC.

3480 ± 70
BM-1249. Axe-haft $\delta^{13}C = -23.7‰$

Wood (*Ziziphus* sp) from haft of 1st Intermediate Period/Middle Kingdom axe, EA30083 (ca 2100-1780 BC); calibrated date ca 1870 ± 120 BC.

1840 ± 70
BM-1250. Axe-haft $\delta^{13}C = -25.1‰$

Wood (*Acacia* sp) from shaft of 2nd Intermediate Period axe, EA-65664 (ca 1600 BC); calibrated date ca AD 190 ± 90.

3550 ± 60
BM-1251. Axe-haft $\delta^{13}C = -22.1‰$

Wood (*Prunus* sp) from haft of 1st Intermediate Period/Middle Kingdom axe, EA67479 (ca 2100-1780 BC); calibrated date ca 1980 ± 110 BC.

General Comment (RB): four of dates (BM-1245, -1248, -1249, -1251) conform with expected historic dating. Of remaining three, BM-1246 is ca 1800 yr earlier than expected and this probably arises from re-use of older wood in antiquity, as original thong binding axe to haft appears undisturbed. BM-1250 is ca 1800 yr later than expected and evidently represents misassoc of haft dating to Coptic period with older axe broadly dated by metal analysis and typol to 2nd Intermediate Period. BM-1247 dates haft of cedar and is ca 700 yr older than expected, but could represent age of wood at time of 1st use. For full discussion of results, see Burleigh, in Davies (catalogue of Ancient Egyptian tools and weapons in British Mus Colln, in preparation).

328 ± 52

BM-1357. Petrie horse $\delta^{13}C = -18.8‰$

Collagen from right ulna of horse skeleton from Egypt (ca 30° N, 31° E; exact provenance unknown), from colln of British Mus (Nat Hist), London. Coll ca 1900 by Sir Flinders Petrie and subm 1977 by Juliet Clutton-Brock, Dept Zool, British Mus (Nat Hist), to provide date for fragmentary cranium and complete mandible and skeleton, as part of collaborative program for archaeozool study and dating of early domesticated animal remains. *Comment* (RB): skeletal remains of horse are rare even from later periods in Egypt, so that this skull and skeleton would have been important if shown by radiocarbon dating to be ancient (3rd-1st millennium BC). Result disproves this, but shows that these remains are relevant to study of early hist of Arab horse in Europe (Clutton-Brock and Burleigh, 1979).

F. Iraq

Abu Salabikh series

Charcoal samples excavated from remains of buildings in Early Dynastic tell of Abu Salabikh, Diwaniyah Governorate (32° 15′ N, 45° 5′ E). Coll 1975-1976 and subm by J N Postgate, Dir, British Archaeol Exped to Iraq, Baghdad.

3938 ± 54

BM-1365A. Abu Salabikh $\delta^{13}C = -24.4‰$

Charcoal, ref 6G 64:655 (60), from Area E, Room 39, burned layer on I C floor (roofing material); *cf* date for separate sample from same locus, 3830 ± 70 (HAR-1877, unpub).

3963 ± 57

BM-1365B. Abu Salabikh $\delta^{13}C = -24.4‰$

Recount of BM-1365A.

3826 ± 47

BM-1365C. Abu Salabikh $\delta^{13}C = -25.1‰$

Charcoal, ref 6G 64:655 (60), as BM-1365A, but fresh sample.

3916 ± 50

BM-1365D. Abu Salabikh $\delta^{13}C = -25.6‰$

Charcoal, ref 6G 64:655 (60), as BM-1365A-1365C, but further fresh sample.

3869 ± 56

BM-1366. Abu Salabikh $\delta^{13}C = -25.3‰$

Charcoal, ref 5I 10:184, from carbonized beam lying on Level II floor of Room 1 in Area A, Sq 5I 10b.

4267 ± 85

BM-1390. Abu Salabikh $\delta^{13}C = -26.5‰$

Charcoal, ref 5I 21:360 (1157).

General Comment (JNP): calibrated dates (mean of BM-1365A-D, 2460 ± 65 BC; BM-1366, 2410 ± 80 BC; BM-1390; 2990 ± 105 BC; Clark, 1975) agree with archaeol dates expected (Postgate, 1977; 1978; 1980a; Postgate and Moorey, 1976).

1102 ± 43

BM-1416. Zibliyat $\delta^{13}C = -23.7‰$

Reeds *(Phragmites australis)* id by S Renvoise, Herbarium, Royal Botanic Gardens, Kew, from layers incorporated between mud-brick courses in monument of Zibliyat, tower-like structure 20km NW of Nippur and 5km E of Abu Salabikh, Diwaniyah Governorate (32° 20′ N, 45° 5′ E). Coll 1977 and subm by R Burleigh to provide date for building long believed to be Parthian or Sassanian (250 BC-AD 650), but recently suggested as Islamic. *Comment* (RB): mud-brick structure of Zibliyat appears to represent single phase of building. Date confirms that it belongs to Islamic (early Abbasid) period (Burleigh, 1980), when it may have been used for regulation or defense of canal system, of which traces survive in neighborhood although area has now reverted to desert. Program is proposed for dating construction and later building phases of other ancient mud-brick structures in Iraq incorporating layers of reeds (*cf* date for reed rope from brickwork of 2nd stage of ziggurat at Aqar Quf, BM-1477, 3110 ± 35; BM-XIV, in press; Postgate, 1980b). Two problems are survival of reeds only as inert ash in some buildings and, unlike situation in Egypt where same procedure already successfully used (see, eg, BM-VII, R, 1971, v 13, p 159-166; BM-IX, R, 1977, v 19, p 149-150), possible presence of bitumen.

G. Israel

Monastery of St Catherine series, Sinai

Wood samples from structural timbers in mid-6th century AD Church of the Transfiguration, Monastery of St Catherine, Wadi ed-Deir, 1.6km N of Jebel Musa (Mt Sinai), central Sinai Peninsula (28° 45′ N, 34° 0′ E). Coll 1963-1965 and subm 1974 by G H Forsyth, Kelsey Mus Ancient and Mediaeval Archaeol, Univ Michigan, as check (Sample 65AA) on previous series of dates by Michigan Lab (M-1673-1677; R, 1966, v 8, p 283, M-1812-1814: R, 1968, v 10, p 108), to determine contemporaneity of ceiling of NW tower of church with original nave roof or possible later repair and restoration of roof (Sample 63AB), and contemporaneity of nave roof with supporting trusses (Sample 63AC). Expected date, ca AD 550 or later (Forsyth, 1968; Forsyth and Weitzmann, 1973).

1330 ± 40

BM-1222. Monastery of St Catherine $\delta^{13}C = -24.6‰$

Wood, ref 65AA, from top of N end of tie-beam of 2nd truss from E over nave (sapwood; bark and cut branches visible); *cf* M-1813, 1280 ± 140.

1450 ± 50

BM-1223. Monastery of St Catherine $\delta^{13}C = -23.0‰$

Wood, ref 63AB, from lower surface or joist supporting ceiling in NW corner tower of church.

1490 ± 60

BM-1224. Monastery of St Catherine $\delta^{13}C = -24.9‰$

Wood, ref 63AC, cross-sec of purlin from nave roof.

General Comment (GHF): BM-1222 removes previous problem of aberrant date of ca AD 1800 for sample from same location (M-1677) and with BM-1224 confirms that roof frame and sheathing are of original 6th century construction, earlier by some five centuries than similar structures in comparable state of preservation elsewhere; BM-1223 shows that tower ceiling and nave roof are contemporary.

Timna series

Charcoal samples from early smelting sites in Timna Valley, Wadi Arabah, ca 30km N of Elat, Gulf of Aquaba (34° 55′ N, 29° 45′ E). Coll ca 1974 and subm by B Rothenberg, Inst Archaeo-Metallurgical Studies, London. (For other dates for Timna, see BM-1115-1117, -1162, -1163: R, 1979, v 21, p 349-350; Rothenberg, 1972; Rothenberg, Tylecote, and Boydell, 1978). Comments based on information supplied by P T Craddock, Research Lab, British Mus.

3030 ± 50

BM-1368. Timna $\delta^{13}C = -23.5‰$

Charcoal from Site F2, Sq 3, Layer 3. *Comment* (PTC): Site F2 is small smelting installation thought to have belonged to Chalcolithic period by analogy with adjacent sites, but date shows that it was contemporaneous with main, larger scale, late Bronze age smelting activities.

2790 ± 50

BM-1598. Timna $\delta^{13}C = -21.3‰$

Charcoal, ref Sample 684, from Timna-30, Layer 3. *Comment* (PTC): *cf* date for charcoal inclusions in slag from Timna-30 (Sample 632), 2480 ± 35 (BM-1162).

H. Jordan

Jericho series

Charcoal samples excavated from stratified levels in tell of Jericho (31° 50′ N, 35° 30′ E). Coll ca 1955 and subm 1976 by Kathleen Kenyon as supplement to previous series (Burleigh, 1981).

8540 ± 65

BM-1320. Jericho $\delta^{13}C = -20.4‰$

Charcoal, ref SA1009, JPM 6.11, from Site MI, phase XI.1v, PPNB.

9230 ± 80

BM-1321. Jericho $\delta^{13}C = -25.4‰$

Charcoal, ref CS1002, JPF 300.1a, from Site FI, phase VIIIA.xvib, PPNA; *cf* BM-1326, below.

9380 ± 85

BM-1322. Jericho $\delta^{13}C = -24.0‰$

Charcoal, ref CS1021, JPF 301.12, from Site FI, phase IVA.iiib, PPNA; *cf* BM-1327, below.

9380 ± 85

BM-1323. Jericho $\delta^{13}C = -25.1‰$

Charcoal, ref CS1017, JPF 303.16, from Site DI, phase VIA.x-xi, PPNA.

9430 ± 85

BM-1324. Jericho $\delta^{13}C = -24.9‰$

Charcoal, ref SA954, JPE 13.14, from Sites EI, II, V, phase VI.xxvii, PPNA.

40,500 ± 2700

BM-1325. Jericho $\delta^{13}C = -28.0‰$

Sample, ref SA754, JPM 7/6 (8), from Site MI, phase XIII.1xxiva; invalidated by misassoc.

9230 ± 220

BM-1326. Jericho $\delta^{13}C = -24.6‰$

Charcoal, ref CS1001, JPF 300.1a, from Site FI, phase VIIIA.xvib, PPNA; *cf* BM-1321, above.

9560 ± 65

BM-1327. Jericho $\delta^{13}C = -25.4‰$

Charcoal, ref CS1020, JPF 301.12, from Site FI, phase IVA.iiib, PPNA; *cf* BM-1322, above.

4570 ± 50

BM-1328. Jericho $\delta^{13}C = -23.7‰$

Charcoal from Tomb A94 (Proto-Urban period); check on GL-24, 5210 ± 110 (Zeuner, 1955, p 49) (different sample).

4500 ± 60

BM-1329. Jericho $\delta^{13}C = -24.0‰$

Charcoal from Tomb A94, same sample as GL-24; *cf* BM-1328, above.

11,090 ± 90

BM-1407. Jericho $\delta^{13}C = -25.2‰$

Charcoal, ref CS1029, JPE 515.41, from Sites EI, II, V, phase I.ii, Mesolithic (Natufian).

General Comment (RB): for check-list of all BM-, GL-, Gro-, GrN-, and P- dates for Jericho (55 dates), see Burleigh, 1981; full assessment of these dates and supplementary series (19 dates; BM-XV, forthcoming) will appear in Jericho excavation mon, v 4 (Burleigh, ms in preparation).

I. Oman

1899 ± 56

BM-1352. Jabal al Hammah $\delta^{13}C = -24.9‰$

Charcoal, ref JH Pit 4, Layer 3, Sample 13 (prob *Acacia* sp) from base of firepit assoc with trilith site immediately W of track from Tawi

Silaim to Mudaybi at N edge of Jabal al Hammah (Site 61; Doe, 1977), 2km W of Ramlat al Wahiba, central Oman (22° 30′ N, 58° 40′ E). Coll 1976 by S Roskams and subm by Beatrice de Cardi. *Comment* (BdeC): known distribution of triliths extends from central Oman to Wadi Hadhramaut in S Arabia (Dostal, 1968) and this is 1st such site excavated in Oman; date suggests practice of erecting triliths is pre-Islamic in region and was probably introduced by frankincense traders or early immigrants from S Arabia (de Cardi, Doe, and Roskams, 1977, p 28).

J. Peru

Early Peruvian domestic dogs series

Samples of keratin (hair and skin) from mummified remains of domestic dogs from three archaeol sites in Peru: Ancon (11° 45′ S, 77° 10′ W), Chancay (11° 35′ S, 77° 15′ W) and Mala (12° 40′ S, 76° 35′ W), from Forbes Colln (ca 1913), British Mus (Nat Hist) (Ancon samples) and colln of Lab of Palaeoethnozool, Univ San Marcos, Lima, Peru (Chancay and Mala samples). Subm by D R Brothwell, Inst Archaeol, Univ London.

757 ± 48
BM-1236. Ancon $\delta^{13}C = -14.1‰$
Keratin sample, ref 243.

834 ± 88
BM-1237. Ancon $\delta^{13}C = -13.5‰$
Keratin sample, ref 250.

710 ± 41
BM-1238. Ancon $\delta^{13}C = -14.3‰$
Keratin sample, ref 251.

1278 ± 70
BM-1239. Ancon $\delta^{13}C = -15.1‰$
Keratin sample, ref 635.

2801 ± 87
BM-1240. Ancon $\delta^{13}C = -16.5‰$
Keratin sample, ref 729.

949 ± 50
BM-1359. Ancon $\delta^{13}C = -13.1‰$
Keratin sample, ref DBa.

687 ± 67
BM-1360. Ancon $\delta^{13}C = -12.8‰$
Keratin sample, ref DBb.

1365 ± 77
BM-1361. Mala $\delta^{13}C = -17.3‰$
Keratin sample, ref A157.

1077 ± 122
BM-1362. Chancay $\delta^{13}C = -12.1‰$
Keratin sample, ref A162 (skull).

BM-1363. Chancay **1420 ± 221** $\delta^{13}C = -12.1‰$

Keratin sample, ref A162 (post-cranial).

BM-1364. Mala **839 ± 181** $\delta^{13}C = -13.6‰$

Keratin sample, ref A166.

General Comment (RB): samples dated as part of program for comparative study of remains of early Amerindian dogs (Brothwell, Malaga, and Burleigh, 1979; Burleigh and Brothwell, 1978).

K. Poland

BM-1235. Polany II **3490 ± 80** $\delta^{13}C = -24.3‰$

Charcoal from Cutting I/72, Sq 10/III, depth 190 to 200cm below surface in deposit of limestone rubble with karstic clay, base of Shaft no. 1, Polany II flint mine (Chmielewska, 1973), Polany, Szydlowiec dist, Poland (51° 15′ N, 21° 5′ E). Coll 1972 and subm 1976 by Jacek Lech, Inst Hist Material Culture, Polish Acad Sci, Warsaw. *Comment* (JL): result dates flint mining activity to early Bronze age of Vistula catchment basin (late Mierzanowice/early Trzciniec cultures) and is youngest date for flint mining in region, but agrees with age expected for site (Lech, 1975); *cf* date for late Danubian flint mine at Saspow, Olkusz dist, 5046 ± 102 (BM-1128: R, 1979, v 21, p 350).

L. Yugoslavia

Padina series

Bone samples from Padina, Iron Gate gorge, Djerdap region (44° 40′ N, 22° 30′ E). Excavation on narrow strip of land along bank of Danube in advance of dam construction revealed human occupation site from which skeletal remains of 51 individuals were recovered. Coll 1968 and subm 1975 by S Živanović, Dept Anatomy, St Bartholomew's Hospital Medical Coll, London, to provide dates in support of anthropol study of Padina population (Živanović, 1975; 1976).

BM-1143. Padina **7738 ± 51** $\delta^{13}C = -20.7‰$

Collagen from femur of Skeleton no. 2 (mature male), Sector I.

BM-1144. Padina **8797 ± 83** $\delta^{13}C = -19.4‰$

Collagen from femur of Skeleton no. 7 (senile female), Sector III.

BM-1146. Padina **9331 ± 58** $\delta^{13}C = -21.7‰$

Collagen from femur of Skeleton no. 12 (mature male), Sector III.

BM-1147. Padina **9198 ± 103** $\delta^{13}C = -20.6‰$

Collagen from femur of Skeleton no. 14 (adult male), Sector III.

8138 ± 121

BM-1403. Padina $\delta^{13}C = -20.9‰$

Collagen from fragmentary bones of bear *(Ursus arctos)*, Sector III.

9292 ± 148

BM-1404. Padina $\delta^{13}C = -19.3‰$

Collagen from post-cranial bones of Skeleton no. 39 (infant), Sector III.

General Comment (RB): dates confirm early Holocene (Mesolithic) age of Padina population (Burleigh and Živanović, 1980).

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[RADIOCARBON, VOL 24, No. 2, 1982, P 171-181]

GLIWICE RADIOCARBON DATES VII

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The following list contains the measurements of archaeologic samples made during 1978 and 1979 using carbon-dioxide-filled proportional counters. Most of the samples were dated with counter No. 3 (L3) filled to 1 or 2 atm pressure (Mościcki and Zastawny, 1977). Our counter No. 1 (L1) previously described (Mościcki and Zastawny, 1976) has been remounted and is now operating at 2 atm pressure of carbon dioxide. Samples measured with this counter have date numbers starting with Gd-1000. Parameters of proportional counters are listed in Table 1. Our transistorized electronics is being gradually replaced by more compact integrated-circuit electronics in CAMAC system (Bluszcz and Walanus, 1980). Counts from proportional counter and guard counters are recorded in 5 channels and punched every 100 minutes. Typical measurement of any sample, including background and oxalic acid samples, consists of a series of 20 to 25 partial measurements. Partial results obtained in such series are analyzed on ODRA 1325 computer at the Computing Centre of the Silesian Technical University according to code C14C written in ALGOL (Pazdur and Walanus, 1979). Age calculations are based on contemporary value equal to 0.95 of the activity of NBS oxalic acid standard and on the Libby value for the half-life of radiocarbon. Ages are reported as conventional radiocarbon dates in years before AD 1950. Corrections for isotopic fractionation in nature are made only for some samples with indicated values of $\delta^{13}C$. Errors quoted ($\pm 1\sigma$) include estimated overall standard deviations of count rates of the unknown sample, contemporary standard, and background (Pazdur and Walanus, 1979).

Our earlier methods of sample pretreatment were described by Pazdur and Pazdur (1979) but in 1979 they were modified to ensure more complete removal of humic acid contaminants and now follow, to some extent, those described by Olsson (1979). Combustion and purification lines have been described by Pazdur *et al* (1979a). It is worthwhile to note that, in a series of experiments, a significant isotopic fractionation occurs during absorption of CO_2 in NH_4OH solution, amounting to $-3.41 \pm 0.8‰$.

As part of our continuous efforts to achieve greater dating accuracy, a series of interlaboratory cross-check datings was made in 1978 and 1979. The results presented in Table 2 show no systematic difference between Gd dates and other dates. With the exception of our date, Gd-560, which must be suspect, all other dates agree with corresponding dates from other laboratories.

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SAMPLE DESCRIPTIONS

ARCHAEOLOGIC SAMPLES

A. Cuba

Charcoal samples are from prehistoric Paleo-Indian sites in Cuba. All samples, except for Levisa and Rio Canimar, coll by Dept Archaeol, Acad Sci Cuba; subm Sept 1978 by Romuald Schild, Inst Hist Material Culture, Polish Acad Sci, Warsaw. For general bibliog of Funche culture, Seboruco-Mordan culture, and Canimar-Aguas Verdes cultures, see Kozłowski (1974). Sub-Taino culture is discussed by Tabio and Rey (1966).

TABLE 1
Parameters of proportional counters

Counter	CO_2 pressure atm	B (Counts/minute)	$S_o = 0.95 A_{ox}$ (Counts/minute)	$F = S_o/\sqrt{B}$
L1	2	9.4	37.8	12.3
L3	1	3.1	10.3	5.9
L3	2	3.4	20.6	11.2

TABLE 2
Results of interlaboratory cross-check samples

Sample material	Gliwice dates		Other dates		References
	Lab no.	Age: yr BP	Lab no.	Age: yr BP	
Wood	Gd-558	11,940 ± 120	Hv-6958	11,850 ± 110	Geyh (1978, wc*)
	Gd-1003	11,690 ± 110			
Wood	Gd-559	9810 ± 110	Hv-6960	9915 ± 95	Geyh (1978, wc)
Charcoal	Gd-567	3190 ± 45	GrN-5250	3235 ± 35	Swiesznikow (1967)
Charcoal	Gd-1044	8870 ± 100	R-5590	9105 ± 105	O'Brien (1978, wc)
			GrN-5045	4710 ± 40	Vogel & Waterbolk (1972)
			M-1846	4860 ± 200	Crane & Griffin (1970)
Charred grain	Gd-574	4720 ± 60	Lod-1	4670 ± 380	Kanwiszer (1978, wc)
Charred grain	Gd-560	690 ± 60	Hv-9105	1230 ± 65	Geyh (1979, wc)
Peat	Gd-548	9870 ± 110	Hv-9104	9855 ± 315	Geyh (1979, wc)
Peat	Gd-541	11,190 ± 180	GrN-8890	10,710 ± 150	Mook (1979, wc)

* wc = written commun

Funche culture

Cueva de la Pintura series

Samples from midden close to Cueva de la Pintura, Barrio La Furnia, Peninsula Guanahacabibes, Pinar del Rio (21° 55′ 28″ N, 84° 02′ 48″ W), assoc with kitchen-midden refuse; some artifacts made of marine shell and stone; coll Jan 1973.

Gd-591. Cueva de la Pintura 1 **2930 ± 80**

Unit U/E #1, Block 1-I, Sec D, level 1.5 to 1.8m.

Gd-601. Cueva de la Pintura 2 **2800 ± 60**

Unit U/E #1, Block 1-I, Sec D, level 1 to 1.25m.

Gd-1039. Cueva de la Pintura 3 **2160 ± 60**

Unit U/E #1, Block 1-I, Sec A, level 0.5 to 0.75m.

Gd-613. Cueva de la Pintura 4 **2880 ± 70**

Unit U/E #2, Block 5, Sec D, level 1.5 to 1.75m.

Gd-1046. Cueva de la Pintura 5 **2840 ± 60**

Unit U/E #2, Block 5, Sec D, level 1.25 to 1.5m.

Gd-614. Cueva de la Pintura 6 **2720 ± 70**

Unit U/E #2, Block 5, Sec D, level 1 to 1.25m. *Comment* (MFP): dates agree fairly well with expected ages for Funche culture (Kozłowski, 1974, p 77-78).

Perico I series

From burial cave Perico I, Bahia Honda, Pinar del Rio (22° 52′ 42″ N, 83°16′ 18″ W). Assoc material consists of kitchen-midden refuse with many human burials and a few artifacts made of marine shell and stone; coll March 1972. Dated to establish chronology of Funche culture. More detailed site inf is given by Pino and Alonso (1973).

Gd-616. Perico I/1 **1350 ± 70**

From Trench 2, Sec 2, level 1.5 to 1.75m.

Gd-1051. Perico I/2 **1990 ± 80**

From Trench 1, Sec 1, level 1.3 to 1.4m.

Gd-617. Perico I/3 **1500 ± 60**

From Trench 1, Sec 1, level 1 to 1.2m.

Gd-618. Cueva de Isla 1 **910 ± 90**

From midden in front of Cueva de Isla, Punta del Este, Isle of Pines (21° 37′ 36″ N, 82° 32′ 58″ W), Block I, Sec A, level 0.5 to 0.75m, depth 0.57m. Assoc with a few artifacts of marine shell and stone, probably belonging to later phase of Funche culture. Coll March 1967. *Comment:* undersized, diluted.

Gd-619. Los Pedregales 1 **1170 ± 90**

From Cave #1 near Los Pedregales, Bauta, Prov Havana (22° 55′16″ N, 82° 34′ 02″ W), Trench #2, Sec B, level 2 to 2.25m, depth 2.0m. Assoc with kitchen-midden refuse; a few artifacts of marine shell and stone, quite poor in manufacture. Coll July 1976.

Sub-Taino culture

Gd-1053. El Convento 1 **670 ± 50**

From Site El Convento, Prov Cienfuegos (22° 01′ 25″ N, 80° 22′ 06″ W), Pit #2, level 0.25 to 0.5m, depth 0.45m. Assoc with much pottery; some artifacts of marine shell and stone; coll Nov 1974.

Aguas Gordas series

From Aguas Gordas, Rio Seco, Prov Holguin (21° 05′ 00″ N, 75° 42′ 01″ W). Assoc cultural material was much pottery and artifacts of marine shell and stone; coll March 1971. Previous date from this site made in 1963 at Vernadsky Inst Geochem, Acad Sci USSR: MO-399, 1000 ± 95, (Nuria Gregori, 1978, written commun).

Gd-620. Aguas Gordas 1 **170 ± 60**

From Midden #2, Pit #1, level 0.5 to 0.75m.

Gd-1054. Aguas Gordas 2 **490 ± 50**

Same loc, level 0.75 to 1m.

Gd-1055. Aguas Gordas 3 **580 ± 60**

Same loc, level 1 to 1.25m.

Gd-621. Aguas Gordas 4 **710 ± 70**

Same loc, level 1.25 to 1.5m.

La Campana series

From La Campana site, Banes, Prov Holguin (20° 58′ 00″ N, 75° 42′ 58″ W). Assoc material was kitchen-midden refuse, much pottery, and artifacts of marine shell and stone; coll March 1972.

Gd-1056. La Campana 1 **600 ± 60**

From Midden #2, Block II, Sec D, level 1 to 1.5m.

Gd-624. La Campana 2 **510 ± 40**

Same loc, level 0.75 to 1m.

Gd-1057. La Campana 3 **490 ± 45**

From Midden #2, Block I, Sec C, level 0.5 to 0.75m.

Seboruco-Mordan culture

Levisa I series

Charcoal and other carbonized organic substances from traces of hearths intercalated into clay and rubbish clay deposits, Site Levisa I/1, near Nicaro, Prov Oriente (20° 40′ N, 75° 30′ W), in rock shelter ca 7m above mean level of Levisa R. Coll and subm 1973 by J K Kozłowski, Inst Archaeol, Jagellonian Univ, Cracow. For other dates of Seboruco-Mordan culture, *cf* Kozłowski (1974, p 67, Table X).

Gd-204. Levisa I/1, Layer V **3460 ± 160**

Gd-250. Levisa I/1, Layer VII **5140 ± 170**

Comment (JKK): agrees fairly well with archaeol estimate and other dates of Seboruco-Mordan culture.

Canimar-Aguas Verdes culture

Gd-203. Rio Canimar 17/VI **1010 ± 110**

Charcoal from traces of hearths in alluvial deposits on lower terrace of Rio Canimar R, near mouth in Gulf of Mexico, Prov Matanzas (23° 01′ 49″ N, 81° 29′ 38″ W), depth 0.7 to 0.8m, ca 3m asl. Coll and subm 1973 by J K Kozłowski. *Comment* (JKK): much younger than expected. According to classification of Kozłowski (1974), this site represents early formative period of Canimar-Aguas Verdes cultural complex.

B. Egypt

El-Tarif series

Charcoal from hearths in anthropogenic layer at El-Tarif, near Luxor, W bank of Nile R (32° 30′ N, 25° 50′ E), assoc with Nagadian finds, overlaying silty loam with Epipaleolithic finds, covered with anthropogenic rubble from Dynastic time (Ginter, Kozłowski, and Sliwa, 1979; Ginter, Kozłowski, and Drobniewicz, 1979). Coll 1978 and subm 1979 by Bolesław Ginter, Inst Archaeol, Jagellonian Univ, Cracow.

Gd-689. Tarif P1 **5070 ± 60**

From depth ca 2m.

Gd-1127. Tarif P2 **4620 ± 60**

From depth ca 1.8m.

General Comment (BG): good agreement with samples from other sites related to Nagadian culture dated to 4th millennium BC. Thermoluminescence dates from El-Tarif range from 4100 to 3600 BC (Whittle, 1975).

Quasr el-Saghe series

Scattered charcoal from washed hearth in upper silty layer, from ancient deltaic deposits of Moeris Lake, Western Desert, N of Bisket Qarun Lake, SW of Quasr el-Saghe Temple (30° 40′ N, 29° 20′ E). Layer of cross-bedded sand contains remains of Fayum A culture (Ginter *et al,* 1980). Coll and subm 1979 by Bolesław Ginter.

Gd-709. QS I/79/1/P1 **8840 ± 890**

From depth 1.7 to 1.8m. *Comment:* undersized, diluted.

Gd-1140. QS I/79/1/P2 **5540 ± 70**

From depth 1.7 to 1.75m.

Gd-708. QS I/79/1/P3 **6040 ± 650**

From depth ca 40cm. *Comment:* undersized, diluted.

Gd-693. QS V/79/P5 **5990 ± 60**

From depth ca 10cm.

C. Nigeria

Gd-640. Ayorou 12/72 **830 ± 60**

Charcoal from cultural layer at depth ca 3m on left bank of Niger R (14° 55′ N, 0° 35′ E), 20km N of Ayorou, Nigeria, W Africa. Coll Dec 1972 and subm 1979 by Jerzy Lis, Inst Geol, Warsaw. *Comment* (JL): site probably belongs to Yatakala culture.

D. Poland

Bronze and Iron Ages

Swibie series

Charcoal from cemetery of mixed use, Site 16, on culmination of parabolic dune 1.5km N of Swibie, ca 25km N of Gliwice (51° 31′ 43″ N, 18° 31′ 47″ E). Cemetery belongs to Upper Silesian — Little Poland group, Gliwice-Częstochowa subgroup of Lusatian culture (Kostrzewski, Chmielewski, and Jazdzewski, 1965, p 213-216; Gedl, 1959). Systematic excavations, conducted from 1961, yielded more than 350 burials with much pottery and bronze and iron artifacts (Wojciechowska, 1968; 1972; 1973; 1976; Węgrzykowa, 1964; 1969). Coll and subm 1977 and 1978 by Halina Wojciechowska, Gliwice Mus, Gliwice.

Gd-543. Swibie 324 **2590 ± 60**
$\delta^{13}C = -18.8‰$

From fireplace in upper layer of skeletal burial, depth 40cm. Coll July 1977.

Gd-544. Swibie 325 **2250 ± 60**
$\delta^{13}C = -25.5‰$

From fireplace in upper layer of skeletal burial No. 325, depth 63cm. Coll July 1977.

Gd-612. Swibie 355A **2650 ± 70**

From cremation burial No. 355, cinerary urn covered with remains of funeral pile, depth below 27cm. Coll Aug 1978.

Gd-1045. Swibie 348 **730 ± 50**

From fireplace in layer at depth 64 to 74cm, above skeletal burial No. 348. *Comment* (HW): assoc with Middle Age iron artifacts, sample dates later phase of occupation.

Dobrzeń Mały series

Charcoal from Site B of iron foundry settlement at Dobrzeń Mały near Opole (50° 45′ 00″ N, 17° 52′ 45″ E). Coll June 1975 by Antoni Pawłowski; subm 1976 by Jerzy Rozpędowski, Inst Hist Architecture, Arts & Tech, Wrocław Tech Univ, Wrocław.

Gd-533. Dobrzeń Mały ob 690 **1890 ± 70**

From object No. 690, ar 211.

Gd-530. Dobrzeń Mały ob 720 **1870 ± 40**

From object No. 720, ar 191.

General Comment: other dates from this site: Object 19: Gd-263, 1770 ± 140; Object 25: Gd-298, 1660 ± 120 (R, v 20, p 407); Object 685: Gd-488, 1720 ± 70; Object 722: Gd-489, 1760 ± 70 (R, v 22, p 64).

Rudki series

Wood fragments from old mine "Staszic" in Rudki, NE part of Holy Cross Mts, N of Góra Chełmowa Mt (50° 54′ N, 21° 06′ E), from layer IV at depth 16 to 18m. Systematic archaeol excavations of 1958 and 1959 resulted in discovery of large area of ancient dog headings. Coll Feb 1959 and subm 1977 by Kazimierz Bielenin, Archaeol Mus, Cracow.

Gd-511. Rudki 1 **1750 ± 70**

Fragment of undecorticated round log (*Pinus* sp), 8cm diam and 40cm long, probably used as pit prop.

Gd-512. Rudki 2 **1760 ± 60**

Fragment of splintered beech wood, ca 2 to 3cm thick and 22cm long, probably fragment of shovel.

Nowa Słupia series

Charcoal (*Abies alba* and *Pinus silvestris,* id by Irena Gluza) from set of primitive iron-smelting furnaces, Site 11 at Nowa Słupia, ca 32km E of Kielce (50° 52′ N, 21° 06′ E). Site, on NE slope of Łysa Góra Mt, consists of 102 bloomery-type furnaces arranged in 2 series of 4 furnaces, type 2 × 4, according to Bielenin (1977). Coll Aug 1977 and subm by Kazimierz Bielenin.

Gd-507. Nowa Słupia, furn 63 **1800 ± 100**

From depth ca 40cm, base of furnace No. 63, below large ferruginеous slag.

Gd-508. Nowa Słupia, furn 87 **1930 ± 100**

From depth ca 40cm, base of furnace No. 87, below large ferruginеous slag.

Gd-506. Nowa Słupia, furn 38/39 **1010 ± 80**

From base of cupola holes of two destroyed furnaces, No. 38 and No. 39, at depth ca 25cm.

Gd-505. Nowa Słupia, common **1510 ± 80**

From traces of several destroyed furnace holes, depth ca 25cm.

General Comment (KB): dates for furnaces No. 63 and 87 agree well with archaeol evidence and other radiocarbon dates from this region. Other two dates are considerably younger than expected; contamination with younger material is suspected.

Historic period

Gd-577. Władysławowo stem **50 ± 50**

Fragment of oak stem at depth ca 30cm at base of Baltic sea near Władysławowo (54° 48′ N, 18° 25′ E). Coll July 1978 by Wiesław Urbański; subm Sept 1978 by Maria Dyrkowa, Central Maritime Mus, Gdańsk. Dated typologically to 16th century AD by Przemysław Smolarek.

Tolkmicko series

Timber from fragments of ship from meadow 3km SW of Tolkmicko (54° 19′ N, 19° 32′ E) on former ground of Vistula Bay, ca 2m below sea level. Coll July 1979 by Zdzisław Kocur; subm Aug 1979 by Maria Dyrkowa. Samples dated typologically to Middle Ages by Jerzy Litwin.

Gd-1138. Tolkmicko rib **190 ± 45**

Gd-1139. Tolkmicko keel **520 ± 50**

Gdańsk Shipwreck W-5 series

Samples from wreck of ancient merchant ship W-5 (Smolarek, 1979) from depth 16m at base of Gdańsk Bay, roadstead of Gdańsk harbor, ca 6.5km NE of estuary of Vistula R (54° 28′ N, 18° 43′ E). Wreck was raised Oct 1975. Samples were prepared and subm in 1977 and 1978 by Przemysław Smolarek. General inf about shipwreck is given by Smolarek (1979). Samples dated as part of complex interdisciplinary study of shipwreck, including its construction and classification (Litwin, 1977; 1979), analysis of wood from ship's hold (Heymanowski, 1979), and study of merchant marks found on barrels containing iron ore, tar, pitch, and potash (Sledź, 1979).

Gd-423. W-5:Frame No. 10 **580 ± 140**

Oak wood, fragment of frame No. 10.

Gd-491. W-5:Tree nail A **630 ± 70**

Oak wood covered with tar. Tar removed by successive boiling in trichloroethylene.

Gd-500. W-5:Tree nail B **670 ± 60**

Independent run on 2nd part of same sample.

Gd-490. W-5:Animal hair A **620 ± 60**

$\delta^{13}C = -31.9‰$

Caulking of animal hair, impregnated with tar and covered with sand and mud. Tar removed by successive boiling in trichloroethylene. Pretreatment: 1h boiling in 1% HCl.

640 ± 45

Gd-502. W-5:Animal hair B $\delta^{13}C = -21.1‰$

Independent run on 2nd part of same sample.

Gd-501. W-5:Tar **520 ± 50**
$\delta^{13}C = -33.2‰$

High purity tar from one of undestroyed barrels belonging to cargo. Not pretreated.

Gd-499. W-5:Beeswax **470 ± 45**
$\delta^{13}C = -34.8‰$

Fragment of big blocks of pure beeswax from ship's cargo. Only mechanical cleaning of surface.

Gd-534. W-5:Clamping ring **590 ± 40**
$\delta^{13}C = -21.9‰$

Beech clamping ring from one of undestroyed barrels belonging to cargo.

Gd-535. W-5:Line **590 ± 40**
$\delta^{13}C = -23.7‰$

Pieces of partly charred line, covered with tar and mud, found in ship's hold. Tar removed by successive boiling in trichloroethylene.

Gd-590. W-5:Straw **450 ± 100**
$\delta^{13}C = -26.6‰$

Pieces of unid. straw found in ship's hold. *Comment:* undersized, diluted.

General Comment (MFP): for detailed discussion of results of radiocarbon dating, see Pazdur *et al* (1979b). First five dates for frame, tree nails, and animal hair provide estimated date of launching; next five dates for materials belonging to ship's cargo provide estimate of date of sinking. Good agreement with historic dates suggested by Sledź (1979).

Gd-1010. Charzykowy boat **<150**

Fragment of outer part of boat made of single oak trunk ca 50cm and 5.8m long found at base of Charzykowy Lake ca 200m S of Góra Zamkowa site (53° 47′ N, 17° 28′ E) at depth 26m. Coll and subm May 1978 by Krzysztof Kruszelnicki, Underwater Archaeol Club, Warsaw.

Góra Dobrzeszowska series

Charcoal from Góra Dobrzeszowska site near Dobrzeszów village (50° 58′ N, 20° 15′ E), ca 25km NW of Kielce. Coll April and subm June 1978 by Eligia Gassowska, Admin Board, Kielce.

Gd-566. Góra Dobrzeszowska GD1 **1170 ± 35**

From burning layer in fill of culture wall made of loose stones, ar 08, Wall 1.

Gd-1015. Góra Dobrzeszowska GD2 **110 ± 50**

From thick layer of charcoal and ash at S altar, ar G11.

General Comment (EG): site expected to be from Roman period, 1st to 4th century AD; dates much younger than expected.

Stołpie series

Burned grains and wood from lowest wooden layer of construction at Stołpie village (51° 10′ N, 23° 21′ E), ca 9km NW of Chełm. Samples taken from embankment made of wooden boxes filled with chalk rubble at depth 2.7 to 3m. Coll and subm 1978 and 1979 by Irena Kutyłowska, Dept Archaeol, Maria Curie Skłodowska Univ, Lublin. Botanical id of grains by Leszek Halicki and Władysław Kulpa, and burned wood by Agnieszka Kadej. For cultural stratigraphy, see Kutyłowska (1977); archaeol dating based on Early Medieval pottery indicates 11th to 13th century AD (*cf* Zaki, 1974, p 182-184); architectonic chronology 11th to 14th cent AD (Dalbor, 1959, p 179-192; Zaki, 1974, p 151-153).

Gd-553. Stołpie 1 **1000 ± 60**

Burned coniferous wood, E part of embankment.

Gd-554. Stołpie 2 **740 ± 60**

Burned grains of *Triticum compactum* and *Secale cereale,* same locality.

Gd-560. Stołpie 3 **690 ± 60**

Burned grains of *Pisum stativum* and *Vicia faba,* same locality.

Gd-684. Stołpie 4 **1090 ± 50**

Burned coniferous wood, W part of embankment.

Gd-1260. Stołpie 5 **1000 ± 50**

Burned grains of *Triticum compactum* and *Secale cereale,* same locality.

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GLIWICE RADIOCARBON DATES VIII

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The following list sums up the results of radiocarbon dating of geologic samples obtained mostly during 1978 and 1979. Measurements have continued with the same proportional counters, pretreatment procedures, carbon dioxide purification, measurement and calculation as described previously (Pazdur *et al,* 1982). Ages are reported as conventional radiocarbon dates in years before AD 1950. No corrections for $^{13}C/^{12}C$ ratio were made for samples reported in this date list. Infinite dates are based on a 2-sigma criterion (Pazdur and Walanus, 1979). Sample descriptions and comments are based on information provided by the submitters.

ACKNOWLEDGMENTS

All samples listed here have been dated with the technical assistance of Helena Skorupka during sample pretreatment and carbon dioxide purification.

SAMPLE DESCRIPTIONS

GEOLOGIC SAMPLES

A. Poland

Baltic Coast and N Poland

Swietousć series

Charcoal from fossil soil levels covered with eolian sands in cliff undercutting Wolin end moraine, Wolin I. ca 1km W of Swiętouść (59° 30′ N, 14° 38′ E). Wolin end moraine is built of deposits formed by glacial tectonic processes; upper part of glacial tectonic structures is sheared and covered with fluvial and eolian cover sands with two fossil soil levels. Coll Nov 1978 by R K Borówka and Ryszard Gonera; subm 1979 by R K Borówka, Inst Geog, Adam Mickiewicz Univ, Poznań.

Gd-1062. Swietousć K-35 **1880 ± 70**

Sample from younger fossil soil separating 2 series of eolian sands, depth 3.5m.

Gd-631. Swietousć K-43 **11,590 ± 270**

Sample from older fossil soil developed on fluvial (?) sands and covered with eolian sands, depth 7m. *Comment:* undersized, diluted.

Troszyn series

Charcoal and gyttja from fossil soil levels in N part of parabolic dune near Troszyn, Western Pomerania (53° 52′ N, 14° 45′ E). Subm 1978 by Stefan Kozarski, Inst Geog, Adam Mickiewicz Univ, Poznań.

Gd-546. Troszyn 11/BN/77 **1580 ± 70**

Charcoal from upper soil level, depth ca 80cm. Coll Sept 1977 by Bolesław Nowaczyk.

Gd-528. Troszyn 9/BN/76 **2300 ± 170**

Charcoal from middle soil level, depth 3.75 to 3.85m. Coll Oct 1976 by Bolesław Nowaczyk.

Gd-529. Troszyn 10/BN/76 **3130 ± 70**

Charcoal from fire layer at top of lower fossil soil, depth 6.40 to 6.46m. Coll Oct 1976 by Bolesław Nowaczyk.

Gd-538. Troszyn 13/BN/77 **8020 ± 110**

Coarse-detritus gyttja, thin layer at depth 6m underlain by terrace sands and covered with dune sands. Coll Nov 1977 by Andrzej Karczewski and Kazimierz Tobolski. *Comment* (KT & BN): expected age: Late Glacial. Contamination with younger rootlets cannot be excluded.

Gd-537. Troszyn 12/BN/77 **2440 ± 60**

Charcoal from pit underlying fossil soil in S part of dune, assoc with pottery remains, depth ca 80cm. Coll Nov 1977 by Tadeusz Wiślański. *Comment* (TW): assoc cultural material indicates Hallstadt C/D period.

Pomorska Bay R-3 series

Peaty detritus from lowest part of Core R-3 taken from sea bottom in S part of Pomorska Bay, ca 15.6km W of Międzyzdroje (53° 55′ 55″ N, 14° 23′ 13″ E). Core from sublittoral zone at bottom of a large valley filled up to high level during late stages of Baltic transgression. Now in accumulation zone (Rosa, 1967; Kolp, 1966) at water depth ca 10m. Coll with vibrocorer July 1979 by Radosław Pikies and Zdzisław Sliwiński; subm 1979 by Włodzimierz Kroczka, Geol Inst, Dept Marine Geol, Sopot.

Gd-1143. R3-2220G **7240 ± 150**

Top part of peaty slime layer, depth 80 to 87cm.

Gd-1144. R3-2221G **7700 ± 120**

Peaty slime with shells and shell detritus, depth 87 to 107cm.

Gd-1142. R3-2222G **8090 ± 110**

Peaty and shell detritus, depth 107 to 122cm. *Comment* (WK): core did not reach base of organic sediments.

Gd-541. Miodowice 1 **11,190 ± 180**

Thin layer of peat at depth 2.4m underlying alluvial sands near Miodowice village, W Pomerania (53° 45′ N, 14° 42′ E). Coll Oct 1977 and subm by J E Mojski, Geol Inst, Warsaw. *Comment* (MFP): another portion of sample was dated by Groningen lab: GrN-8890, 10,710 ± 150 (Mook, written commun, 1979; *cf* R, 1982, v 24, p 000-000).

Gd-602. Gac 1/78 **7520 ± 330**

Sand with sticky humus from bottom layer in deflation basin, depth 115 to 129cm, from peat bog in dune area at SE shore of Łebsko Lake, Słowiński Natl Park, 1km NE of Gac village (54° 42′ N, 17° 29′ E). Coll and subm 1978 by Kazimierz Tobolski, Inst Geog, Adam Mickiewicz Univ, Poznań. Dated for studies of dune stratigraphy and paleogeog of Gardno-Łeba Lowland (Tobolski, 1972). *Comment* (KT): younger than expected, pollen analysis indicates pre-Boreal age. Rejuvenation by penetration of younger rootlets is possible.

Sarbsko series

Peat and wood from two cores taken at shore of Sarbsko Lake near Łeba (54° 45′ 30″ N, 17° 35′ 40″ E). Coll 1978 by Bogusław Rosa; subm by Stanisław Fedorowicz, Dept Geomorphol and Quaternary Geol, Gdańsk Univ, Gdynia.

Gd-1028. Sarbsko 3 **5080 ± 80**

Peat from depth 3 to 3.65m.

Gd-592. Sarbsko 4 **15,020 ± 200**

Fragments of wood in peat layer at depth 9.7 to 11.2m. *Comment* (SF): probably driftwood dated; age much older than expected.

Machowinko series

Peat from layer at depth 2.10 to 3.25m in basin without outflow in foreland of frontal moraine surrounding Gardno Lake, 1km N of Machowinko village (54° 37′ N, 17° 00′ E), 15km E of Ustka. Coll Dec 1978 by Krzysztof Petelski; subm by Stanisław Fedorowicz.

Gd-1075. Machowinko P-1 **8620 ± 90**

From depth 2.2 to 2.25m.

Gd-635. Machowinko P-2 **8590 ± 100**

From depth 2.65 to 2.75m.

Gd-594. Mierzeja Łebska 5/BR **1800 ± 60**

Fragment of decayed tree trunk found *in situ* on surface of biogenic sediments in beach at Mierzeja Łebska (54° 45′ 45″ N, 17° 30′ 00″ E). Coll 1978 by Bogusław Rosa; subm by Stanisław Fedorowicz.

Gd-1066. Gardno 78/KP **7300 ± 70**

Single layer of peat in vicinity of Gardno Lake (54° 39′ 48″ N, 17° 09′ 20″ E). Coll 1978 by Krzysztof Petelski, subm by Stanisław Fedorowicz.

Gd-1230. Osieki **9760 ± 80**

Sandy detritus with wood fragments from layer at depth 1.1 to 1.2m on slope of small valley in N part of Lębork Upland, NNW of Choczewo (54° 47′ N, 17° 51′ E). Coll Nov 1979 and subm by Sylwester Skompski, Geol Inst, Warsaw (Sylwestrzak, 1969).

Gd-1049. Czymanowo prof a **10,600 ± 100**

Peat from layer at bottom of postlacustrine depression overlain by other lacustrine sediments (calcareous gyttja and lacustrine chalk) and peat, from peaty plain at Czymanowo near Choczewo (54° 44′ N, 18° 5′ E). Coll Sept 1978 and subm by Sylwester Skompski. *Comment* (MFP): alkali-soluble fraction dated.

Hel-Jastarnia series

Samples from two organic layers in core reaching Tertiary sediments near Jastarnia, Hel peninsula (54° 40′ 35″ N, 18° 40′ 30″ E). Coll 1978 by Bogusław Rosa; subm by Stanisław Fedorowicz.

Gd-1027. Hel-Jastarnia 1 **5370 ± 100**

Peat from depth 3 to 5m.

Gd-593. Hel-Jastarnia 2 **>38,800**

Wood fragments from peat layer at depth 59 to 59.8m. *Comment* (SF): probably driftwood was dated; age much older than expected.

Gd-539. Lipce 3c **9690 ± 150**

Humic detritus from bottom layer at depth 21 to 23.6m underlying Wisła R deltaic sediments in Lipce village, Zuławy (51° 54′ N, 19° 56′ E). Coll and subm 1978 by J E Mojski.

Orunia series

Layer of humic detritus ca 8m thick, in deltaic sediment of Wisła R, loc Orunia, Gdańsk, Zulawy (54° 18′ 00″ N, 18° 37′ 30″ E). Coll and subm 1978 by J E Mojski.

Gd-549. Orunia 9b+a, S2 **7300 ± 110**

From depth 8 to 11.2m.

Gd-540. Orunia 9b+a, S1 **5420 ± 110**

From depth 5 to 8m.

Wisłoujscie series

Peat with plant detritus and fragments of wood and twigs with admixture of amber in two layers separated by and underlying fine-grained sands in Gdańsk, loc Wisłoujście (54° 24′ N, 18° 40′ E). Coll Sept 1978 by Stefan Kozłowski and subm by J E Mojski.

Gd-1042. Wisłoujscie 1 **2380 ± 60**

Single pieces of plant detritus and small twigs coll with tweezers. Upper peat layer at depth 7 to 7.1 m.

Gd-638. Wisłoujscie 1, 7-7.1m, A **3560 ± 70**

Same layer, fine plant detritus obtained after careful removal of amber grains.

Gd-608. Wisłoujscie **6440 ± 90**

Fragments of wood and twigs from lower peat layer at depth 9 to 9.3m overlying black clay with shell fragments and amber.

Gd-639. Wisłoujscie 1, 9-9.3m, A **3860 ± 80**

Same layer, fine plant detritus.

General Comment (MFP): both samples were heterogeneous, composed of some *in situ* peat with twigs of probably same age, pieces of wood washed in by storm waves, and amber of Tertiary age. Since rejuvenation by rootlets penetration or younger humus, leaching seems improbable. Younger dates of both organic horizons should be considered better approx to real age of formation.

Great Poland Lowland and W Poland

Gd-611. Laskowo 1/78/BN **11,380 ± 170**

Charcoal from fossil humus level at depth 1.45m overlying terrace sands of first terrace of Warsaw-Berlin Pradolina and underlying sands of alluvial cone developed in mouth of erosion – denudational valley, 750m E of Laskowo, 8km of Sulechów, Great Poland Lowland (52° 04′ N, 15° 32′ E). Coll Aug 1978 and subm by Bolesław Nowaczyk.

Zbrudzewo series

Organic sediments from peaty paleomeander of older generation filled with biogenic-mineral sediments. Recently used as meadow at SW margin of Zbrudzewo (52° 07′ N, 17° 02′ E) Warta R valley, 3km N of Srem. Dated for studies in IGCP 158A Project. Coll July 1978 by Stefan Kozarski and Kazimierz Tobolski; subm by Stefan Kozarski (Kozarski and Rotnicki, 1977).

Gd-1020. Zbrudzewo Zb/I/78 **24,230 ± 550**

Black detritus gyttja, top part of gyttja layer at contact with low peat, depth 235 to 241cm.

Gd-1016. Zbrudzewo Zb/I/78 **23,700 ± 370**

Brown sandy organic mud laminated with fine-grained sand, bottom part of biogenic sediments, depth 350 to 357cm.

Gd-1022. Zbrudzewo Zb/II/78 **20,270 ± 200**

Black detritus gyttja from top part of gyttja layer at contact with overlying low peat, depth 170 to 175cm.

Gd-1021. Zbrudzewo Zb/II/78 **27,500 ± 1000**

Black detritus gyttja with laminae of mud, bottom part of biogenic sediments, depth 350 to 356 cm.

Gd-1083. Zbrudzewo Zb/I/78A **1670 ± 60**

Carex peat, marked change in local phytocenosis, depth 55 to 61cm.

Gd-651. Zbrudzewo Zb/I/78A **8870 ± 120**

Carex peat, marked change in local phytocenosis, depth 119 to 125cm.

Gd-656. Zbrudzewo Zb/I/78A **9400 ± 100**

Carex peat, marked change in local phytocenosis, depth 175 to 180cm.

Gd-1084. Zbrudzewo Zb/I/78A **14,690 ± 150**

Carex peat, marked change in local phytocenosis, depth 190 to 195cm.

Czmoniec series

Organic sediments from peaty paleomeander of older generation, Warta R valley near Czmoniec, ca 10km N of Srem, Great Poland Lowland (52° 11′ N, 17° 00′ E). Coll July 1978 by Stefan Kozarski and Kazimierz Tobolski and subm by Stefan Kozarski. Dated for studies in IGCP 158A Project.

Gd-585. Czmoniec Cz/I/78 **4130 ± 70**

Sand with laminae of detritus gyttja and allochthonous wood, boundary between sands and underlying gyttja, 219 to 225cm below surface of peaty paleomeander.

Gd-584. Czmoniec Cz/I/78 **4130 ± 80**

Detritus gyttja with admixture of sand from bottom of organic sediments, 250 to 256cm below surface of peaty paleomeander.

Gd-589. Czmoniec Cz/II/78 **1960 ± 70**

Brown-gray organic mud from bottom part of organic sediments, depth 415 to 420cm.

Gd-588. Czmoniec Cz/II/78 **2380 ± 70**

Gray detritus gyttja with rich admixture of sand, bottom part of organic sediments, depth 445 to 450cm.

Jaszkowo series

Carex peat with charcoal layers from upper peat layer in peaty paleomeander, flood plain of Warta R valley near Jaszkowo (52° 10′ N, 16° 57′ E) ca 9km N of Srem, Great Poland Lowland. Coll 1977 by Kazimierz Tobolski; subm 1978 by Stefan Kozarski. Dated for studies in IGCP 158A Project of stratigraphy of floodplain deposits and changes of Warta R channel during Late Würn and Holocene (Kozarski and Rotnicki, 1977).

Gd-1079. Jaszkowo Ja/77A **6210 ± 80**

Depth 75 to 80cm.

Gd-1081. Jaszkowo Ja/77A **7790 ± 80**

Depth 115 to 120cm.

Gd-1082. Jaszkowo Ja/77A **8500 ± 100**

Depth 185 to 190cm. *Comment* (MFP): for other dates from this locality, see Kozarski and Rotnicki (1977) and R, 1978, v 20, p 409; R, 1979, v 21, p 166-167.

Bóbr River series

Wood, fragments of largest tree trunks, found during exploitation of sands and gravels in gravel pits in Bóbr R valley. Subm 1978 by

Teofil Dzioba and Ireneusz Wróbel, Polish Fellows Soc Earth Sci, Zielona Góra. For more general outline, see Dzioba (1978).

Gd-513. Nowogród Bobrzański 1/77 **1230 ± 60**

Oak wood from trunk, 10.5m long and 1.2m diam, lying horizontally at depth 7m in accumulation terrace of Bóbr R near Nowogród Bobrzański (51° 49′ 18″ N, 15° 13′ 54″ E). Coll Nov 1977 by Henryk Łysik.

Gd-514. Olszna 2/77A **1750 ± 70**

Oak wood from trunk found in accumulation terrace of Bóbr R near Olszna (51° 25′ 24″ N, 15° 36′ 30″ E). Coll Oct 1977 by Henryk Łysik.

Gd-515. Olszna 2/77B **1700 ± 80**

Duplicate run on second part of same sample.

Gd-517. Gryzyce 4/77 **3670 ± 80**

Oak wood from tree trunk, 12.5m long and 0.9m diam, found in series of sandy gravels, accumulation terrace of Bóbr R near Gryzyce (51° 38′ 24″ N, 15° 17′ 24″ E). Coll Oct 1977 by Henryk Łysik.

Gd-516. Dobruszów 3/77 **4120 ± 130**

Oak wood from trunk, 14.5m long and 0.8m diam, found at depth 7m in sandy gravel sediments of accumulation terrace of Bóbr R near Dobruszów (51° 46′ 28″ N, 15° 15′ 18″ E). Coll Nov 1977 by Henryk Łysik.

Gd-1040. Dobruszów 5/78 **950 ± 50**

Pine wood from trunk, ca 12m long and 0.6m diam, found at depth ca 3m in sandy gravels, accumulation terrace of Bóbr R near Dobruszów (51° 46′ 29″ N, 15° 15′ 18″ E). Coll April 1978 by Teofil Dzioba.

Gd-606. Jedrzychowice n/Zgorzelec **6380 ± 90**

Oak wood from tree trunk, 0.6m diam, found at depth ca 3m in sandy gravel sediments of Nysa Łuzycka R near Jędrzychowice (51° 10′ 51″ N, 15° 1′ 38″ E). Coll March 1978 by Jerzy Baczyński.

Kujawy and Mazowiecka Plain

Toruń-Nieszawka series

Peat, small fossil layer in substratum of flood plain of Wisła R valley, Toruń-Bydgoszcz basin, left bank of Wisła R between Toruń and Mała Nieszawka, inside flood rampart (53° 00′ 00″ N, 18° 35′ 30″ E). Peat layer overlies fine sands and underlies packing of sandy-gravelly sediments, 40cm thick, with cobbles and alluvial series of fine sands and silts, 3.6m thick. For general inf on geomorphology of area, see Tomczak (1965) and Niewiarowski and Tomczak (1969). Coll Nov 1978 by Anna Tomczak and Bozena Noryśkiewicz; subm 1979 by Anna Tomczak, Inst Geog, Mikołaj Kopernik Univ, Toruń.

Gd-1065. Toruń-Nieszawka 5A **>43,000**

From top of peat layer, depth 4m.

Gd-633. Toruń-Nieszawka 5B **>39,000**

From bottom of peat layer, depth 5.1m.

Toruń-Pedzewo series

Peat from organic layer in substratum of flood plain of Wisła R valley, Toruń-Bydgoszcz Basin, ca 15km W of Toruń, right bank of Wisła R near Pędzewo (53° 05′ 00″ N, 18° 21′ 30″ E). Peat layer overlies sandy mud and underlies fine- and medium-grained sands with laminae of sandy mud. Coll Nov 1978 by Bozena Noryśkiewicz and Anna Tomczak and subm 1979 by Anna Tomczak.

Gd-627. Toruń-Pedzewo A **1930 ± 70**

From top of peat layer, depth 0.5m. *Comment* (AT): contamination by contemporary rootlets possible; date fits limits of expected age fairly well.

Gd-630. Toruń-Pedzewo B **5350 ± 80**

From bottom of peat layer, depth 1.7m. *Comment* (AT): pollen analysis of bottom part of peat layer made by Bozena Noryśkiewicz indicates Atlantic or younger age.

Zgłowiaczka R series

Samples from valley of Zgłowiączka R, Kujawy region, dated to establish chronology of river channel formation during Late Glacial and Holocene in relation to development of Wisła R valley. Coll 1979 and subm by Leon Andrzejewski, Inst Geog and Spatial Org, Polish Acad Sci, Toruń.

Gd-1149. Wieniec WI **9530 ± 100**

Peat from bottom part of floodplain sediments, 2.5 to 3.5m thick, composed of peats with inserted layers of muds or fine silty sands. Coll from depth 2.8 to 2.95m, ca 10km W of Włocławek, 1km W of Wieniec village (52° 39′ N, 18° 54′ E).

Gd-1153. Wieniec WII **9750 ± 100**

Peat from bottom part of fossil meander, depth 1.85 to 2m, ca 2km E of Wieniec village (52° 40′ N, 18° 58′ E).

Gd-1156. Wieniec WIII **10,160 ± 180**

Dusty gyttja with fragments of partly decomposed plants from bottom part of old meander, depth 2.3 to 2.45m, ca 2.5km E of Wieniec village (52° 40′ N, 18° 58′ E).

Gd-1155. Kazanie KI **9250 ± 140**

Sandy detritus with organic matter from bottom part of glacial trough, depth 7.5 to 7.7m, 600m S of Kazanie village (52° 33′ 30″ N, 18° 54′ E).

Gd-1147. Kazanie KII **6620 ± 70**

Peat from same profile, depth 5.4 to 5.5m.

Raciazek series

Dispersed fragments of charcoal and amorphic humus coal in loess layer below fossil soil in Raciązek, Kujawy region (52° 51° 30″ N, 18° 49′ 30″ E). Coll March 1979 and subm by MD Baraniecka, Geol Inst, Warsaw.

Gd-672. Raciazek **7300 ± 210**

From depth 2.5 to 2.6m. *Comment:* undersized, diluted.

Gd-792. Raciazek **11,130 ± 230**

From depth 3 to 3.1m. *Comment* (MDB): loess layer corresponds to Poznanian stage of Vistulian Glaciation, according to Łyczewska (1973).

Gd-1073. Skorupy **>44,000**

Sandy peat from peat layer covered with fluvial and eolian sands of parabolic dune ca 1km SW of Skorupy village near Celestynów (52° 03′ N, 21° 25′ E), profile Skorupy 2, depth 6.89 to 6.91m. Coll and subm 1979 by M D Baraniecka.

General Comment (MDB): pollen analysis by Zofia Janczyk-Kopikowa (written commun, 1978) indicates cold period from end of Brorup interstadial or younger. Fluvial sediments overlying peat layer are of Late Vistulian age. Other radiocarbon dates for this profile measured in Archaeol and Etnogr Mus, Łodź: Lod-25, depth 6.9 to 7m, >28,000; Lod-26, depth 7 to 7.15m, >28,000 (Kanwiszer, written commun, 1978; Konecka-Betley and Baraniecka, 1978).

Piaski series

Peat and peaty detritus from Profile 1 in Piaski (51° 14° N, 19° 23′ E) near Bełchatów, former flood plain of Widawka R. Quaternary sediments in area of Bełchatów brown-coal open-cast mine were studied by Jurkiewiczowa (1961), Janczyk-Kopikowa (1971), Baraniecka (1971), Baraniecka and Sarnacka (1971) and Rzechowski (1971). Lacustrine deposits in central part of presently studied sec of exposure are described by Baraniecka (1978) and Baraniecka and Pazdur (1979). Coll Oct 1977 and subm 1978 and 1979 by M D Baraniecka.

Gd-1072. Piaski, prof 1/061077, s1 $\mathbf{43{,}700^{+3700}_{-2400}}$

Peat from depth ca 16m.

Gd-777. Piaski, prof 1/061077, s2 **21,970 ± 810**

Peaty detritus, depth ca 12.2m.

Lesznowola 2 series

Organic deposits from profile Lesznowola 2, Core 9, near Lesznowola village (51° 54′ 45″ N, 20° 54′ 20″ E) Polish Lowland, 6km NE of Grójec, flood plain of Jeziorka R. Core taken in 1976; samples for dating coll and subm 1977 and 1978 by M D Baraniecka.

Gd-527. Lesznowola 2/I **30,300 +2600 −1900**
Fossil soil, depth 7.15 to 7.3m.

Gd-551. Lesznowola 2/III **38,200 +3200 −2300**
Brown organic detritus, depth 7.9 to 8m.

Gd-552. Lesznowola 2/IV **22,800 ± 470**
Sandy mud with organic layer, depth 8.8 to 9.0m.

Gd-518. Lesznowola 2/II, sol **27,400 +2300 −1800**
Peat, depth 10.3 to 10.4m, alkali-soluble fraction.

Gd-519. Lesznowola 2/II, res **29,500 +3200 −2300**
Same sample as Gd-518, insoluble organic residue.

Zoliborz series

Organic sediments consisting of fossil soil covered by peat and overlain by fine- and medium-grained sands and artificial embankment, near fossil lake, Zoliborz, Warsaw (52° 16′ N, 20° 56′ E). Coll 1976 and subm 1977 by M D Baraniecka.

Gd-526. Zoliborz Ia **460 ± 60**
Peat, depth 2.2 to 2.28m.

Gd-524. Zoliborz II, sol **1560 ± 60**
Fossil soil from depth 2.28 to 2.38, alkali-soluble fraction.

Gd-525. Zoliborz II, res **1560 ± 60**
Same sample, insoluble residue dated.

S Poland

Gd-1041. Debno **1880 ± 50**

Wood, mostly twigs (*Alnus incana* (?)) id. by Andrzej Obidowicz, from bottom of old channel of Dunajec R in series of silty, sandy deposits at depth 1.15m, near present mouth of Białka R, alt ca 530m asl, S of Dębno village (49° 28′ N, 20° 13′ E), Podhale. Coll Aug 1975 by Maria Baumgart-Kotarba and Ewa Niedziałkowska, Inst Geog, Dept Geomorphol and Hydrol Mts and Uplands, Polish Acad Sci, Kraków; subm 1978 by MBK. *Comment* (MBK): younger than expected.

Gd-659. Brzeczowice 10 **1060 ± 70**

Wood, fragments of trunks of alder and maple at depth ca 5.2m, overlain by organic slime, sandy dust, dusty till, and artificial embankment, near Brzęczowice, Jasiołka R valley (49° 44′ N, 21° 33′ E). Coll and subm 1978 by Antoni Wójcik, Geol Inst, Carpathian Branch, Cracow. *Comment* (AW): much younger than expected.

Gd-605. Kraków-Dabie 2900 ± 70

Fragment of oak trunk (probably *Quercus robur)* 0.9m diam, exposed at courtyard of Inst Bot, Polish Acad Sci, Cracow. Sample found in 1913 in Wisła R at Dąbie near mouth of Prądnik R (Srodoń, 1980). Subm 1978 by Andrzej Srodoń, Inst Bot, Polish Acad Sci, Cracow.

Gd-610. Zemborzyce 1974:150 10,040 ± 120

Valley peat from lower part of Holocene peat cover, depth 3.92 to 3.94m, flood plain of Bystrzyca R valley, Lublin, Zemborzyce (51° 11′ 12″ N, 22° 32′ 34″ E). Coll March 1974 and subm 1978 by Henryk Maruszczak, Inst Earth Sci, Maria Curie Skłodowska Univ, Lublin. *Comment* (HM): pollen analysis by Krystyna Bałaga indicates boundary between Pleistocene and Holocene.

Jarosław (1972:4C:d4:10.33-10.40) series

Organic loam and peat in form of irregular lenses in fossil bog soil horizon, outcrop in Jarosław, depth 10.33 to 10.4m, (50° 01′ 13″ N, 22° 38′ 50″ E). Transitional zone between upper terrace of San R and slope of Carpathian Foreland, younger loess deposits with interstadial soil (Maruszczak, 1976; 1980). Coll Oct 1972 and subm 1978 by Henryk Maruszczak.

Gd-607. Jarosław: acid-sol 27,300 ± 790

Acid-soluble fraction. *Comment:* undersized, diluted.

Gd-1052. Jarosław: alkali-sol 21,700 ± 250

Alkali-soluble fraction, acid-precipitated part of NaOH-soluble fraction of same sample.

Gd-615. Jarosław: res 24,000 ± 630

Organic residue, insoluble during acid and alkali treatment.

General Comment (HM): pollen analysis by Zofia Janczyk-Kopikowa (written commun, 1974) indicates cold climate Boreal flora with *Selaginella* spores. For detailed geol profile, *cf* Maruszczak (1976, p 146, fig 2). Bone remains from same level subm for dating by fluorine–apatite–collagen method to Wysoczański-Minkowicz.

B. USSR

Mongolia series

Charcoal from fire layers in deposits of small fossil lake, Mongolia, N Gobi Desert, E slope of Chojra rift valley (45° N, 108° E). Site is on parapediment developed on granite massive, Iche Narate, ca 1160m asl, covered with two series of mud-flow deposits separated by fossil-lake deposits with four fire layers. Coll July 1977 by R K Borówka and Karol Rotnicki; subm 1978 by Karol Rotnicki, Inst Geog, Adam Mickiewicz Univ, Poznań.

Gd-556. Mongolia 176/77 >44,200

From upper fire layer, depth ca 1.5m.

Gd-557. Mongolia 174/77 **>39,900**

From lowest fire layer, depth ca 2.4m.

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UNIVERSITY OF LUND RADIOCARBON DATES XV

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INTRODUCTION

Most of the ^{14}C measurements reported here were made between October 1980 and October 1981. Equipment, measurement, and treatment of samples are as reported previously (R, 1968, v 10, p 36-37; 1976, v 18, p 290; 1980, v 22, p 1045).

Age calculations are based on a contemporary value equal to 95% of the activity of NBS oxalic acid standard and on the conventional half-life for ^{14}C of 5568 yr. Results are reported in years before 1950 (years BP). Errors quoted with the dates are based on counting statistics alone and are equivalent to ± 1 standard deviation ($\pm 1\sigma$). When measured activity is less than 2σ above background, minimum age is given. Basis for calculation of age limit is measured net activity plus 3σ. If net activity is negative, only $+3\sigma$ is used for age limit.

Corrections for deviations from $\delta^{13}C = -25.0‰$ in the PDB scale are applied for all samples; also for marine shells. The apparent age for marine material due to the reservoir effect must be subtracted from our dates on such samples.

The remark "undersized; diluted", in *Comments* means the sample did not produce enough CO_2 to fill the counter to normal pressure and "dead" CO_2 from anthracite was introduced to make up the pressure. "% sample" indicates amount of CO_2 derived from the sample present in the diluted counting gas; the rest is "dead" CO_2. Organic carbon content reported for bone samples is calculated from yield of CO_2 by combustion of gelatine remaining after treatment. Organic carbon lost during treatment is not included in calculated percentage.

The description of each sample is based on information provided by the submitter.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Sweden

Hunneberg series (III)

Coarse organic matter (>0.2mm) and mollusk shell fragments washed from sediment from lakes Domsjön (58° 18′ N, 12° 27′ E), Ekelunds Gransjö (58° 19′ N, 12° 25′ E), and Kroppsjön (58° 18′ N, 12° 25′ E) on hill Hunneberg, NW Västergötland. Coll 1980 and subm by G Digerfeldt and S Björck, Dept Quaternary Geol, Univ Lund. For other dates from area, see R, 1977, v 19, p 425-427; 1981, v 23, p 386-387. Dating is part of study of Late Weichselian shore displacement in area. Isolation of lakes established by diatom analysis. Rept on highest shore-line on Hunneberg pub by Digerfeldt (1979). Series is also of importance for deglaciation chronology (Björck and Digerfeldt, 1981). Depths refer to sediment surface.

Domsjön

All samples consist of coarse organic matter (>0.2mm). Pretreated with HCl.

11,960 ± 90
Lu-1812. Domsjön, 643 to 651cm $\delta^{13}C = -16.7‰$

Comment: (3 1-day counts.)

11,990 ± 90
Lu-1813. Domsjön, 651 to 659cm $\delta^{13}C = -15.9‰$

Comment: (3 1-day counts.)

12,140 ± 90
Lu-1814. Domsjön, 659 to 667cm $\delta^{13}C = -15.7‰$

Comment: (3 1-day counts.)

12,160 ± 130
Lu-1815. Domsjön, 670 to 691cm $\delta^{13}C = -18.0‰$

Comment: sample undersized; diluted; 52% sample. (4 1-day counts.)

Ekelunds Gransjö

11,870 ± 110
Lu-1902. Ekelunds Gransjö, Core I $\delta^{13}C = -16.3‰$

Coarse organic matter, 664 to 680cm, insoluble fraction. *Comment:* pretreated with HCl and NaOH.

11,750 ± 110
Lu-1902A. Ekelunds Gransjö, Core I $\delta^{13}C = -16.2‰$

Acid-precipitated part of NaOH-soluble fraction from Lu-1902, from 664 to 680cm.

12,130 ± 100
Lu-1885. Ekelunds Gransjö, Core I $\delta^{13}C = -18.0‰$

Fine detritus, acid-precipitated part of NaOH-soluble matter extr from fraction <0.2mm, from 664 to 680cm. *Comment:* sample undersized; diluted; 88% sample. (3 1-day counts.)

12,100 ± 110
Lu-1903. Ekelunds Gransjö, Core II $\delta^{13}C = -0.3‰$

Shell fragments of *Mytilus* from 411 to 422cm. *Comment:* outer 46% removed by acid leaching.

11,970 ± 90
Lu-1904. Ekelunds Gransjö, Core II $\delta^{13}C = -0.3‰$

Shell fragments of *Mytilus* from 394 to 404cm. *Comment:* outer 55% removed by acid leaching. (3 1-day counts.)

Kroppsjön

12,170 ± 110
Lu-1906. Kroppsjön, 680 to 689cm $\delta^{13}C = -0.9‰$

Shell fragments of *Mytilus*. *Comment:* outer 43% removed by acid leaching.

12,120 ± 110
Lu-1907. Kroppsjön, 670 to 679cm $\delta^{13}C = -0.5‰$

Shell fragments of *Mytilus*. *Comment:* outer 52% removed by acid leaching.

11,910 ± 110
Lu-1905. Kroppsjön, 660 to 669cm $\delta^{13}C = -16.6‰$

Coarse organic matter, insoluble fraction. *Comment:* pretreated with HCl and NaOH.

11,960 ± 110
Lu-1905A. Kroppsjön, 660 to 669cm $\delta^{13}C = -16.2‰$

Acid-precipitated part of NaOH-soluble fraction from Lu-1905.

12,140 ± 110
Lu-1908. Kroppsjön, 660 to 669cm $\delta^{13}C = -0.3‰$

Shell fragments of *Mytilus*. *Comment:* outer 33% removed by acid leaching.

Bjursjön series

Sediment from Lake Bjursjön (58° 30′ N, 13° 41′ E), E Västergötland. Coll 1980 and subm by G Digerfeldt and S Björck. Dating is part of study of Late Weichselian shore displacement in area. Isolation of lake established by diatom analysis. Depths refer to sediment surface. Pretreated with HCl.

10,620 ± 100
Lu-1829. Bjursjön, 356 to 360cm $\delta^{13}C = -22.9‰$

Clay gyttja.

10,310 ± 100
Lu-1830. Bjursjön, 352 to 356cm $\delta^{13}C = -24.4‰$

Clay gyttja.

Kullsjön series

Sediment from Lake Kullsjön (58° 28′ N, 13° 34′ E), E Västergotland. Coll 1980 and subm by G Digerfeldt and S Björck. Dating is part of same study as Bjursjön series, above. Isolation of lake established by diatom analysis. Depths refer to sediment surface. Pretreated with HCl.

10,480 ± 100
Lu-1831. Kullsjön, 358 to 362cm $\delta^{13}C = -29.6‰$

Clay gyttja.

9720 ± 95
Lu-1832. Kullsjön, 352 to 356cm $\delta^{13}C = -31.4‰$

Clay gyttja.

730 ± 55
Lu-1847. Kårsavagge, insoluble $\delta^{13}C = -24.7‰$

Organic matter from fossil soil horizon below 30 to 40cm unsorted avalanche material S of small lake Kaskamus Kårsavaggejaure (68° 20′ N, 18° 31′ E) in Kårsavagge valley. Alt ca 700m. Coll Aug 1980 and subm by R Nyberg, Dept Phys Geog, Univ Lund. Distribution and geomorphologic effect of slush avalanches in Abisko Mt area were studied by submitter (Nyberg, 1980). *Comment:* pretreated with HCl and NaOH. Sample undersized; diluted; 71% sample.

730 ± 50
Lu-1847A. Kårsavagge $\delta^{13}C = -25.4‰$

Acid-precipitated part of NaOH-soluble fraction from Lu-1847.

Nissunvagge series

Salix twigs from blocky material of old debris flow lobe in Nissunvagge valley (68° 16′ N, 18° 52′ E), Abisko area, N Sweden. Alt ca 1000m. Coll July 1980 by A Rapp and R Nyberg; subm by A Rapp, Dept Phys Geog, Univ Lund. Rept about debris flows in Abisko area pub by Rapp and Nyberg (1981). Samples pretreated with HCl.

Δ = −0.7 ± 5.5‰
Lu-1851. Nissunvagge, Sample 1 $\delta^{13}C = -29.7‰$

Depth 10cm.

Δ = −1.0 ± 5.5‰
Lu-1852. Nissunvagge, Sample 2 $\delta^{13}C = -26.8‰$

Depth 15cm.

General Comment: Δ values correspond approx to ^{14}C activity in plant material formed during 1953 to 1955.

510 ± 45
Lu-1877. Svalöv $\delta^{13}C = -21.4‰$

Collagen from horse skull found by well-digging in N part of Svalöv, Scania (55° 55′ N, 13° 06′ E). Coll unknown; subm by E Furuby, Stockholm. Stratigraphy and pollen analysis indicated interglacial age (Lundholm, 1953). Collagen extracted as described previously (R, 1976, v 18, p 290). Organic carbon content: 4.1%.

Southern Baltic series

Wood and gyttja dredged by fisherman from bottom of S Baltic Sea at water depth ca 40m, 5.5km E of Stenshuvud (55° 39′ N, 14° 21′ E). Coll 1981 by H Hjelm, Vitemölla; subm by H Alebo, Kivik. Pretreated with HCl and NaOH.

9660 ± 90
Lu-1900. Southern Baltic 7 $\delta^{13}C = -26.4‰$

Wood from 25 innermost tree rings of pine branch, id by T Bartholin. Branch is part of trunk with ca 45 tree rings.

9680 ± 95

Lu-1901. Southern Baltic 8 $\delta^{13}C = -28.3‰$

Gyttja, with seeds of *Nuphar,* attached to fork of tree dated as Lu-1900, above.

General Comment: dates agree well with previous dates for pine stumps from same area (*cf* R, 1972, v 14, p 386; 1974, v 16, p 310-311; 1976, v 18, p 293).

1280 ± 50

Lu-1762. Höckhultesjön $\delta^{13}C = -26.0‰$

Detritus gyttja, 55 to 57.5cm below sediment surface, from Lake Höckhultesjön, Kristdala parish, S Sweden (57° 23′ N, 16° 07′ E). Coll 1979 and subm by M Aronsson and Th Persson, Dept Quaternary Geol, Univ Lund. Water depth at sampling point 9.9m. Dated level shows increase of *Juniperus* and herbs indicating human activity. Pollen analysis by Th Persson. Pretreated with HCl.

Härön (Herrön) series

Peat from shallow depression in W part of Härön I., W Sweden (58° 01′ N, 11° 29′ E). Coll 1980 and subm by Th Persson. Pollen analysis by submitter. Depths given are below surface. Samples received mild pretreatment with NaOH and HCl.

2150 ± 50

Lu-1943. Härön 2, 68 to 71cm $\delta^{13}C = -26.8‰$

Beginning of strong increase of *Calluna.*

730 ± 45

Lu-1942. Härön 1, 30 to 33cm $\delta^{13}C = -27.0‰$

Further increase of *Calluna.*

12,410 ± 130

Lu-1833. Lilla sjö 1 $\delta^{13}C = -22.7‰$

Silty clay with ca 2.4% organic matter, 8.97 to 9.01m below water surface and underlain by muddy silt in small lake at Hästveda, Scania (56° 17′ N, 13° 55′ E). Coll 1980 and subm by S Björck, Dept Quaternary Geol, Univ Lund. Expected ^{14}C age 11,500 to 12,000 yr BP. *Comment:* pretreated with HCl. Sample undersized; diluted 85% sample.

Åsnen series

Coarse organic matter (>0.2mm) washed from sediment from Lake Åsnen, S Småland. Coll 1981 and subm by S Björck. Dating is part of study of deglaciation chronology of S Sweden. Depths refer to water surface. All samples undersized; diluted. Amount of CO_2 from sample is given in *Comments* below as "% sample". No pretreatment. Burned at <600°C to avoid pyrolysis of carbonates that may be present in untreated samples.

11,020 ± 250

Lu-1916. Herrängsviken 1, Åsnen $\delta^{13}C = -25.9‰$

Coarse detritus, mainly water moss, depth 6.15 to 6.25m, from Herrängsviken (56° 42′ N, 14° 38′ E), Åsnen. *Comment:* 24% sample. (3 1-day counts.)

Lu-1917. Herrängsviken 2 **10,530 ± 360** $\delta^{13}C = -24.1‰$

Coarse detritus, mainly water moss, depth 6.05 to 6.15m. *Comment:* 16% sample. (3 1-day counts.)

Lu-1918. Herrängsviken 4 **9100 ± 320**

Coarse detritus, depth 5.85 to 5.95m. *Comment:* 15% sample. (3 1-day counts.) No ^{13}C measurement. Average $\delta^{13}C$ value for Lu-1916 and -1917 was used: $\delta^{13}C = -25.0‰$.

Lu-1920. Sånnahult 1 + 2, Åsnen **11,070 ± 200** $\delta^{13}C = -23.0‰$

Coarse detritus, depth 7.27 to 7.37m, underlain by varved clay, off Sånnahult (56° 35′ N, 14° 48′ E), Åsnen. *Comment:* 40% sample.

Lu-1919. Sånnahult 6 **10,270 ± 130** $\delta^{13}C = -24.2‰$

Coarse detritus, mainly water moss, depth 7.07 to 7.12m. *Comment:* 70% sample.

B. Greenland

North Greenland Series II

Bivalve shells from *in situ* marine deposits and from redeposited sediments in terminal moraines. Coll 1980 during Swedish Ymer-80 exped and subm by C Hjort, Dept Quaternary Geol, Univ Lund. Samples are related to study of glacial history of NE-most part of Greenland (Funder and Hjort, 1980). Other samples were dated in Lund (R, 1981, v 23, p 390-391) and in Denmark and UK (Funder, in press).

Lu-1874. Hanseraks Fjord **7490 ± 75** $\delta^{13}C = +1.0‰$

Shells and fragments *(Mya truncata, Hiatella arctica, Astarte borealis)* from surface of marine silt deposit, alt 20 to 22m, at Hanseraks Fjord, Holms Land (ca 80° 17′ N, 16° 10′ W). *Comment:* outer 25% removed by acid leaching.

Lu-1875. Maagegletscher **5240 ± 60** $\delta^{13}C = +0.7‰$

Redeposited shells *(Mya truncata, Hiatella arctica, Astarte borealis, Astarte elliptica)* from terminal moraine in front of Maagegletscher, Holms Land, Ingolfs Fjord (ca 80° 28′ N, 16° 20′ W). *Comment:* outer 20% removed by acid leaching.

Lu-1876. Nordostrundingen **4180 ± 60** $\delta^{13}C = +1.7‰$

Redeposited shells *(Mya truncata, Hiatella arctica, Astarte borealis, Astarte elliptica)* from moraines 2km in front of present margin of Flade Isblink ice cap at Nordostrundingen (ca 81° 27′ N, 11° 25′ W). *Comment:* outer 52% removed by acid leaching.

Lu-1884:1. Kilen, inner fraction **>40,300** $\delta^{13}C = +0.5‰$

Shells *(Hiatella arctica)* from heavily shell-bearing bed in sandy and silty sequence, 10m thick, reaching 22m in ice-free enclave Kilen (ca 81° 12′ N, 13° W). Sediment sequence was not disturbed by glacial overriding or covered by any glacial deposits. *Comment:* inner fraction (46% of shells) was used. (3 1-day counts.)

Lu-1884:2. Kilen, outer fraction **>39,000**

Outer fraction of shells used for Lu-1884:1. *Comment:* outer fraction was 46% of shells; outermost 8% removed by acid leaching. (4 1-day counts.)

General Comment: corrections for deviations from $\delta^{13}C = -25‰$ PDB are applied also for shell samples. No corrections are made for apparent age of shells of living marine mollusks. Apparent age of recent shells from East Greenland is reported by Hjort (1973) but value given there needs some revision because of better knowledge of ^{14}C activity during last centuries (Stuiver, 1978; Olsson, 1980).

C. Switzerland

Lu-1953. Bardonnex **10,980 ± 100** $\delta^{13}C = -25.0‰$

Charcoal of *Pinus* from fossil soil in loess-like deposit at Bardonnex in Basin of Geneva, Switzerland (46° 14′ N, 6° 14′ E). Alt 407m. Coll 1981 by C Reynaud and G Amberger; subm by C Reynaud, Dept Geol, Univ Geneva. Dated as complement to geotechnical study. Pretreated with HCl and NaOH.

D. Czechoslovakia

Bobrov series

Peat from calcitrophic spring mire, 2km NE of the Bobrov village near Dolný Kubín, NE Czechoslovakia (49° 27′ N, 19° 34′ E). Coll 1971 by E and K Rybníček; subm by E Rybníčková, Dept Ecol Bot, Czechoslovak Acad Sci, Brno. Dating is part of palaeoecol study belonging to IGCP Subproject 158B (Berglund, 1979). Peat is classified by submitter as fen-peat with small Ca content for all samples. Estimated ^{14}C ages given below are based on pollen analysis. Lu-1922, -1923, and -1924 are only pretreated with HCl; all other samples are pretreated with HCl and NaOH.

Lu-1922. Bobrov OK-1-B, Sample 1 **9830 ± 85** $\delta^{13}C = -26.7‰$

Depth 204 to 206cm. Estimated ^{14}C age: between 10,100 and 10,800 yr BP.

Lu-1928. Bobrov OK-1-B, Sample 6 **9480 ± 85** $\delta^{13}C = -26.5‰$

Depth 175 to 178cm. Estimated ^{14}C age: between 9300 and 10,000 yr BP.

9330 ± 85

Lu-1923. Bobrov OK-1-B, Sample 2 $\delta^{13}C = -21.9‰$

Depth 163 to 165cm. Estimated ^{14}C age: between 8500 and 9500 yr BP.

8660 ± 80

Lu-1924. Bobrov OK-1-B, Sample 3 $\delta^{13}C = -26.4‰$

Depth 141 to 144cm. Estimated ^{14}C age: between 7000 and 8500 yr BP.

8510 ± 80

Lu-1925. Bobrov OK-1-B, Sample 7 $\delta^{13}C = -25.7‰$

Depth 128 to 131cm. Insoluble fraction. Estimated ^{14}C age: Between 7000 and 8000 yr BP.

8390 ± 80

Lu-1925A. Bobrov OK-1-B, Sample 7 $\delta^{13}C = -26.0‰$

Acid-precipitated part of NaOH-soluble fraction from Sample 7.

7780 ± 75

Lu-1930. Bobrov OK-1-B, Sample 9 $\delta^{13}C = -26.6‰$

Depth 105 to 107cm. Estimated ^{14}C age: between 6000 and 7000 yr BP.

6880 ± 85

Lu-1926. Bobrov OK-1-B, Sample 4 $\delta^{13}C = -26.9‰$

Depth 77 to 80cm. Insoluble fraction. Estimated ^{14}C age: between 4500 and 6000 yr BP. *Comment:* sample undersized; diluted; 73% sample.

6910 ± 70

Lu-1926A. Bobrov OK-1-B, Sample 4 $\delta^{13}C = -26.9‰$

Acid-precipitated part of NaOH-soluble fraction from Sample 4.

4180 ± 55

Lu-1927. Bobrov OK-1-B, Sample 5 $\delta^{13}C = -25.9‰$

Depth 53 to 55cm. Insoluble fraction. Estimated ^{14}C age: between 1800 and 2500 yr BP.

3940 ± 55

Lu-1927A. Bobrov OK-1-B, Sample 5 $\delta^{13}C = -25.1‰$

Acid-precipitated part of NaOH-soluble fraction from Sample 5.

990 ± 45

Lu-1929. Bobrov OK-1-B, Sample 8 $\delta^{13}C = -25.4‰$

Depth 30 to 32cm. Insoluble fraction. Estimated ^{14}C age: between 500 and 2000 yr BP. *Comment:* date probably too late because of possible contamination with recent root material (*cf* Lu-1929A, below).

1260 ± 45

Lu-1929A. Bobrov OK-1-B, Sample 8 $\delta^{13}C = -25.3‰$

Acid-precipitated part of NaOH-soluble fraction from Sample 8. *Comment:* this date may also be somewhat too late because of downward migration of humic matter (*cf,* eg, Lu-1927A and -1927, above).

Vernérovice series

Samples from mire 0.5km S of village Vernéřovice near Broumov, N Czechoslovakia (50° 06′ N, 16° 15′ E). Alt ca 400m. Coll 1973 by M Peichlová, E Rybníčková, and K Rybníček; subm by M Peichlová, Dept Ecol Bot, Czechoslovak Acad Sci, Brno. Dating is part of same IGCP project as Bobrov series, above. Pollen zones according to Firbas (1949). All samples except Lu-1932 and -1936 undersized; diluted. Amount of CO_2 from sample is given in *Comments* below as "% sample". Sample thickness one cm at all levels.

11,790 ± 170
Lu-1931. Vernérovice BV-2-A, Sample 1 $\delta^{13}C = -25.2‰$

Clay with ca 5% organic carbon content. Depth 173cm. Alleröd pollen zone. *Comment:* pretreated with HCl. 42% sample. (3 1-day counts.)

10,460 ± 100
Lu-1937. Vernérovice BV-2-A, Sample 7 $\delta^{13}C = -26.5‰$

Peat with wood fragments, insoluble fraction. Depth 165cm. Alleröd pollen zone. *Comment:* pretreated with NaOH and HCl. 70% sample. (3 1-day counts.)

10,510 ± 130
Lu-1937A. Vernérovice BV-2-A, Sample 7 $\delta^{13}C = -26.3‰$

Acid-precipitated part of NaOH-soluble fraction from Sample 7. *Comment:* 65% sample.

10,160 ± 90
Lu-1932. Vernérovice BV-2-A, Sample 2 $\delta^{13}C = -26.7‰$

Peat with wood fragments. Depth 160cm. Younger Dryas pollen zone. *Comment:* pretreated with HCl.

10,140 ± 130
Lu-1933. Vernérovice BV-2-A, Sample 3 $\delta^{13}C = -26.5‰$

Peat with wood fragments. Depth 150cm. Younger Dryas pollen zone. *Comment:* pretreated with HCl. 59% sample.

9590 ± 150
Lu-1934. Vernérovice BV-2-A, Sample 4 $\delta^{13}C = -26.5‰$

Peat with wood fragments. Depth 130cm. Pre-Boreal period. *Comment:* pretreated with HCl. 47% sample.

8600 ± 80
Lu-1936. Vernérovice BV-2-A, Sample 6 $\delta^{13}C = -26.1‰$

Woody peat. Depth 90cm. Boreal period. *Comment:* no pretreatment.

5220 ± 75
Lu-1935. Vernérovice BV-2-A, Sample 5 $\delta^{13}C = -25.6‰$

Woody peat. Depth 60cm. Atlantic period. *Comment:* no pretreatment. 75% sample.

E. Jamaica

Black River Morass Series I

Peat from coastal wetland at Black R, S Jamaica (18° 05′ N, 77° 50′ W). Coll 1981 and subm by G Digerfeldt, Lund and E Robinson, Dept Geol, Univ West Indies, Kingston, Jamaica. Dating is part of study of development of coastal wetland. Depths given are below surface. All samples pretreated with HCl.

Black River Morass 1

5870 ± 65
Lu-1880. Black R Morass 1, 610 to 620cm $\delta^{13}C = -22.2‰$

Sedge peat, highly humified.

3690 ± 60
Lu-1882. Black R Morass 1, 280 to 290cm $\delta^{13}C = -24.2‰$

Sedge peat, moderately humified.

Black River Morass 2

4880 ± 60
Lu-1881. Black R Morass 2, 320 to 330cm $\delta^{13}C = -26.0‰$

Sedge peat, moderately humified.

2720 ± 55
Lu-1883. Black R Morass 2, 120 to 130cm $\delta^{13}C = -25.3‰$

Sedge peat, highly humified.

Black River Morass 3

4810 ± 65
Lu-1893. Black R Morass 3, 565 to 578cm $\delta^{13}C = -26.1‰$

Sedge peat, highly humified.

Negril Morass Series I

Peat from coastal wetland at Negril, W Jamaica (18° 20′ N, 78° 20′ W). Coll 1981 and subm by G Digerfeldt and E Robinson. Dating is part of same study as Black River Morass series, above. Depths given are below surface. All samples pretreated with HCl.

Negril Morass 1

5000 ± 65
Lu-1878. Negril Morass 1, 610 to 620cm $\delta^{13}C = -19.1‰$

Mangrove peat, highly humified.

2480 ± 55
Lu-1879. Negril Morass 1, 160 to 170cm $\delta^{13}C = -25.6‰$

Sedge peat, moderately humified.

Negril Morass 2

6510 ± 70
Lu-1892. Negril Morass 2, 1047.5 to 1052.5cm $\delta^{13}C = -26.3‰$

Peat.

5850 ± 70
Lu-1894. Negril Morass 2, 897.5 to 902.5cm $\delta^{13}C = -26.7‰$
Peat.

4580 ± 60
Lu-1891. Negril Morass 2, 597.5 to 602.5cm $\delta^{13}C = -25.2‰$
Peat.

710 ± 50
Lu-1895. Negril Morass 2, 147.5 to 152.5cm $\delta^{13}C = -25.5‰$
Peat.

Negril Morass 3

5730 ± 70
Lu-1896. Negril Morass 3, 897.5 to 902.5cm $\delta^{13}C = -26.2‰$
Peat, moderately humified.

4480 ± 60
Lu-1890. Negril Morass 3, 597.5 to 602.5cm $\delta^{13}C = -25.9‰$
Peat, moderately humified.

II. ARCHAEOLOGIC SAMPLES

A. Sweden

Gårdlösa interlaboratory comparison series

Charcoal from Iron age settlement at Gårdlösa, Smedstorp parish, SE Scania (55° 34′ N, 14° 08′ E). Coll 1963-1964 and subm by B Stjernquist, Hist Mus, Univ Lund. Dated to test probability of systematic difference between dates on samples dated by Lund and Uppsala labs for Gårdlösa research project (Stjernquist, 1981). Pretreated with HCl and NaOH.

1370 ± 40
Lu-1825. Gårdlösa 3, House VII $\delta^{13}C = -24.5‰$
Comment: (3 1-day counts.) Part of same sample dated at Uppsala lab as U-1012; 1490 ± 40 BP (R, 1965, v 7, p 327).

1740 ± 40
Lu-1826. Gårdlösa 3, Hearth 40 $\delta^{13}C = -24.5‰$
Comment: (3 1-day counts.) Part of same sample dated at Uppsala lab as U-534; 1760 ± 80 BP (R, 1967, v 9, p 466).

1660 ± 40
Lu-1827. Gårdlösa 3, Hearth 102 $\delta^{13}C = -24.9‰$
Comment: (3 1-day counts.) Part of same sample dated at Uppsala lab as U-536; 1670 ± 70 BP (R, 1967, v 9, p 466).

General Comment: six samples from different structures were included in comparison and agreement between the two laboratories was very good (Olsson, 1981) indicating that systematic difference is highly unlikely.

Önsvala series (II)

Human bones from Late Roman Iron age and Viking period grave field at Önsvala 5:1, Nevishög parish, S Scania (55° 37′ 30″ N, 13° 13′ 50″

E). Coll 1968 by J Pettersson; subm by L Larsson, Hist Mus, Univ Lund. For other dates from Önsvala, see R, 1973, v 15, p 512. Collagen extracted as described previously (R, 1976, v 18, p 290), including NaOH treatment for Lu-1794 and -1795.

1380 ± 50

Lu-1794. Önsvala 5:1, Structure 02 $\delta^{13}C = -18.8‰$

Collagen from well-preserved human tibia from grave destroyed by gravel exploitation. No assoc artifacts. *Comment:* organic carbon content: 4.9%.

1090 ± 50

Lu-1795. Önsvala 5:1, Structure 03 $\delta^{13}C = -18.1‰$

Collagen from well-preserved human humerus. No assoc artifacts. *Comment:* organic carbon content: 4.3%.

1430 ± 50

Lu-1796. Önsvala 5:1, Structure 7 $\delta^{13}C = -19.0‰$

Collagen from ill-preserved fragments of human femur and skull from undestroyed grave. No grave gifts. *Comment:* sample undersized; diluted; 91% sample. Organic carbon content: 1.3%.

1230 ± 50

Lu-1797. Önsvala 5:1, Structure 12 $\delta^{13}C = -20.1‰$

Collagen from ill-preserved human femur from undestroyed grave. Assoc with glass and amber beads. *Comment:* sample undersized; diluted; 93% sample. Organic carbon content: 2.3%.

1010 ± 60

Lu-1798. Önsvala 5:1, Structure 91 $\delta^{13}C = -20.1‰$

Collagen from various ill-preserved human bone fragments from undestroyed grave. Assoc with sherds of pottery. *Comment:* sample undersized; diluted; 74% sample. Organic carbon content: 3.1%.

990 ± 50

Lu-1800. Önsvala 5:1, Structure 97B $\delta^{13}C = -18.8‰$

Collagen from ill-preserved human femur from undestroyed grave. No grave gifts. *Comment:* sample undersized; diluted; 83% sample. Organic carbon content: 0.9%.

1460 ± 50

Lu-1801. Önsvala 5:1, Structure 116:I $\delta^{13}C = -18.3‰$

Collagen from very well-preserved human femur from partly destroyed grave. Assoc with bronze ring. *Comment:* organic carbon content: 6.6%.

Skateholm Series I

Charcoal, charred hazel-nut shells, and bones from settlement area with grave field (Early Ertebølle culture) ca 600m from Baltic Sea, alt 4 to 6m, at Skateholm, Tullstorp parish, S Scania (55° 23′ 10″ N, 13° 29′ E). Coll May to Sept 1980 and subm by L Larsson. Preliminary results of excavation pub by submitter (Larsson, 1980).

Lu-1834. Skateholm, Sample 1 **6240 ± 85** $\delta^{13}C = -20.1‰$

Collagen from ill-preserved human femur from Structure 2 (grave). *Comment:* collagen extracted as described previously (R, 1976, v 18, p 290) without NaOH treatment. Sample undersized; diluted; 55% sample. (3 1-day counts.) Organic carbon content: 0.8%.

Lu-1835. Skateholm, Sample 2 **6290 ± 95** $\delta^{13}C = -25.5‰$

Charcoal, mainly from below cultural layer; x = 104, y = 117; x = 104, y = 118. Assoc with burned bones. *Comment:* mild pretreatment with HCl and NaOH. Sample undersized; diluted; 63% sample.

Lu-1848. Skateholm, Sample 3 **5790 ± 70** $\delta^{13}C = -24.1‰$

Charcoal from cultural layer; x = 104, y = 124. *Comment:* mild pretreatment with HCl and NaOH.

Lu-1849. Skateholm, Sample 4 **5800 ± 70** $\delta^{13}C = -23.7‰$

Charcoal from cultural layer; x = 104, y = 121. *Comment:* mild pretreatment with HCl and NaOH.

Lu-1853. Skateholm, Sample 5 **6020 ± 70** $\delta^{13}C = -23.1‰$

Charred hazel-nut shells from pit below cultural layer; x = 98, y = 124. *Comment:* pretreated with HCl.

Lu-1886. Skateholm, Sample 6 **5930 ± 125** $\delta^{13}C = -24.3‰$

Charcoal from grave structure below cultural layer; x = 100, y = 126. *Comment:* mild pretreatment with NaOH and HCl. Sample undersized; diluted; 45% sample.

Lu-1887. Skateholm, Sample 7 **6900 ± 80** $\delta^{13}C = -26.4‰$

Charcoal from Test Pit A with sandy gyttja. *Comment:* no pretreatment; undersized; diluted; 72% sample. (3 1-day counts.)

Lu-1888. Skateholm, Sample 8 **6220 ± 100** $\delta^{13}C = -23.7‰$

Charcoal from Grave 9, Structure 15, below cultural layer. *Comment:* no pretreatment; sample undersized; diluted; 47% sample. (3 1-day counts.)

Lu-1802. Bulltoftagården, *Cervus elaphus* **6640 ± 85** $\delta^{13}C = -21.2‰$

Collagen from moderately well-preserved calcaneus and tibia fragment of red deer from Sq 56/14, St 5B, at Bulltoftagården, Malmö, S Scania (55° 35′ 40″ N, 13° 04′ 20″ E). Coll 1973 and subm by L Larsson. Assoc with transverse arrowheads, handle-cores, and blade tools (Late Kongemose culture). Site described by submitter (Larsson, in press). Hazelnut shells from same site were dated at 6660 ± 80 BP (R, 1980, v 22, p

1062). Collagen extracted as described previously (R, 1976, v 18, p 290) without NaOH treatment. *Comment:* sample undersized; diluted; 75% sample. Organic carbon content: 3%.

Löddesborg series

Charcoal from settlement area at Skarorna, Löddesborg, W Scania (55° 43′ N, 12° 59′ E). Coll 1964 by C A Mildner and 1966 by P U Hörberg; subm by K Jennbert-Spång, Hist Mus, Univ Lund. Assoc pottery and flints indicate Ertebølle culture.

5260 ± 80
Lu-1842. Löddesborg, Sample 1 $\delta^{13}C = -30.1‰$

Charcoal from Layer 2UN (clay floor), x = 44.35 to 45.35, y = 205.5 to 206.75. *Comment:* sample received mild pretreatment with NaOH and HCl; undersized; diluted; 69% sample.

1190 ± 50
Lu-1843. Löddesborg, Sample 2 $\delta^{13}C = -25.3‰$

Charcoal of *Corylus avellana,* id by T Bartholin, from Layer 2, x = 26, y = 129. *Comment:* normal pretreatment with HCl and NaOH.

4220 ± 115
Lu-1850. Ingelstorp 10, Sample 1:80 $\delta^{13}C = -25.0‰$

Charcoal from offering feature assoc with Grave 4 on Late Neolithic grave field at Ingelstorp 10, Ingelstorp parish, S Scania (55° 25′ N, 14° 03′ E). Coll 1974 and subm by M Strömberg, Hist Mus, Univ Lund. Preliminary excavation rept pub by submitter (Strömberg, 1977). Sample assoc with stone with three cup marks, flint implements, and burned bones. *Comment:* no pretreatment; sample undersized; diluted; 36% sample.

2480 ± 45
Lu-1854. Hedvigsdal, Sample 2:80 $\delta^{13}C = -24.2‰$

Charcoal from cremation grave (No. 83/F4) at Hedvigsdal, Möllevången, Ingelstorp parish, S Scania (55° 25′ N, 14° 03′ E). Coll 1980 and subm by M Strömberg. Assoc with pieces of resin and burned bones. Archaeol estimate: Late Bronze age/Early Iron age. *Comment:* pretreated with HCl and NaOH. (3 1-day counts.)

Gislöv series

Charcoal and bones from settlement area at Gislöv 7, Ö Nöbbelöv parish, Scania (55° 29′ N, 14° 17′ E). Coll 1980 and subm by M Strömberg. Assoc artifacts indicate Late Vendel period or Viking age. For other date from Gislöv 7, see R, 1980, v 22, p 1062. Bone collagen extracted as described previously (R, 1976, v 18, p 290) without NaOH treatment. Charcoal samples pretreated with HCl and NaOH.

1360 ± 50
Lu-1855. Gislöv 7, Sample 3:80 $\delta^{13}C = -24.3‰$

Charcoal from basal layer in House 1:80. Assoc with pottery, iron and bronze objects, and bones.

Lu-1857. Gislöv 7, Sample 5:80 **1360 ± 50** $\delta^{13}C = -19.4‰$

Collagen from rib fragments, small vertebrae, and other bone fragments of domestic animals, id by O Persson, from basal layer in House 1:80. Assoc with pottery and iron and bronze objects. *Comment:* organic carbon content: 2.9%.

Lu-1858. Gislöv 7, Sample 6:80 **1250 ± 50** $\delta^{13}C = -19.0‰$

Collagen from ill-preserved bone fragments of domestic animals from upper filling material in House 1:80. Assoc with pottery. *Comment:* organic carbon content: 1.8%.

Lu-1856. Gislöv 7, Sample 4:80 **1180 ± 50** $\delta^{13}C = -24.4‰$

Charcoal from hearth N of House 1:80. No artifacts.

Ystad series (II)

Charcoal from settlement area at Block Tankbåten in W part of Ystad town, S Scania (55° 25′ N, 13° 48′ E). Coll 1980 and subm by M Strömberg. Preliminary excavation repts pub by Strömberg (1978; 1980). For other dates from Block Tankbåten, Ystad, see R, 1979, v 21, p 398-399. Artifact assemblage indicates Late Iron age. Samples pretreated with HCl and NaOH.

Lu-1859. Kv Tankbåten, Sample 7:80 **1640 ± 50** $\delta^{13}C = -23.8‰$

Charcoal from Hearth 1. Assoc with iron slag and bones.

Lu-1860. Kv Tankbåten, Sample 8:80 **1490 ± 50** $\delta^{13}C = -24.2‰$

Charcoal from Hearth 2.

Lu-1861. Kv Tankbåten, Sample 9:80 **1350 ± 50** $\delta^{13}C = -24.1‰$

Charcoal from hearth in Pit-house 1:80. Assoc with iron objects, pottery, and bones.

Lu-1866. Bronsyxegatan, Structure 1 **4860 ± 60** $\delta^{13}C = -24.2‰$

Charcoal of *Betula* sp, *Fraxinus excelsior, Quercus* sp, and Pomoideae, id by T Bartholin, from refuse pit in Stone age settlement area at Bronsyxegatan, Fosie parish, S Scania (55° 33.5′ N, 13° 02.5′ E). Coll 1969 by B Salomonsson, Malmö Mus; subm by M Larsson. Assoc with flint tools and pottery indicating Funnel-Beaker culture, Face C. *Comment:* no pretreatment; small sample.

Sturup series

Charcoal from Settlement 62 at Sturup 1^{88}, Börringe parish, Scania (55° 33′ N, 13° 22.5′ E). Coll 1970 by K Christofferson; subm by M Larsson, Hist Mus, Univ Lund. Artifact assemblage indicates Funnel-Beaker culture, Face A.

3420 ± 95

Lu-1864. Sturup 1[88], Sample 1 $\delta^{13}C = -23.4‰$

Charcoal of *Ulmus* sp and *Fraxinus excelsior,* id by T Bartholin, from refuse pit without visible stratigraphy. Assoc with pottery and flint tools. *Comment:* no pretreatment; sample undersized; diluted; 42% sample.

3250 ± 60

Lu-1865. Sturup 1[88], Sample 2 $\delta^{13}C = -24.1‰$

Charcoal from root wood of unid. sp from same refuse pit as Lu-1864, above. *Comment:* mild pretreatment with NaOH and HCl.

General Comment: dates ca 1300 and 1500 yr later than expected.

Yngsjö Series II

Charcoal from coastal settlement area at Yngsjö 1:167, Åhus parish, Scania (55° 54′ 44″ N, 14° 15′ 56″ E). Coll 1980 and subm by J Callmer, Hist Mus, Univ Lund. Dated as complement to Yngsjö Series I (R, 1981, v 23, p 398-399).

1350 ± 60

Lu-1869. Yngsjö 1:167, Sample 1:80 $\delta^{13}C = -23.5‰$

Sample from lower charcoal layer in fill of pit (Structure 5:4). Assoc with glass and metal debris, slag, crucibles, and animal bones. Artifact assemblage indicates Late Vendel period. *Comment:* mild pretreatment with NaOH and HCl. Sample undersized; diluted; 72% sample.

1910 ± 65

Lu-1870. Yngsjö 1:167, Sample 2:80 $\delta^{13}C = -22.7‰$

Charcoal from hearth (Structure 11) in lower part of cultural layer. Assoc with burned daub and flint. No diagnostic artifacts. *Comment:* no pretreatment; sample undersized; diluted; 64% sample.

1210 ± 75

Lu-1871. Yngsjö 1:167, Sample 3:80 $\delta^{13}C = -24.3‰$

Charcoal from Structure 13 (post-hole). Assoc with daub and flint. No diagnostic artifacts. *Comment:* no pretreatment; sample undersized; diluted; 51% sample.

2360 ± 55

Lu-1872. Yngsjö 1:167, Sample 4:80 $\delta^{13}C = -24.8‰$

Charcoal from Structure 14 (hearth) overlain by Structure 5. No assoc artifacts. *Comment:* no pretreatment; sample undersized; diluted; 94% sample.

1610 ± 80

Lu-1873. Yngsjö 1:167, Sample 5:80 $\delta^{13}C = -24.5‰$

Charcoal from floor level of house (Structure 15:6). Assoc with daub, pottery, and knife. *Comment:* no pretreatment; sample undersized; diluted; 45% sample.

Nymölla series

Finely dispersed charcoal and ash from coastal Pitted Ware culture settlement at Nymölla 12[35], Gualöv parish, NE Scania (56° 02′ N, 14° 28′ E). Coll 1980 and subm by B Wyszomirski, Hist Mus, Univ Lund. Dated as complement to Möllehusen series (R, 1976, v 18, p 309-310). Site described by submitter (Wyzsomirski, 1979). It was not possible to separate charcoal and ash from sand, and samples were too small to allow pretreatment. Burned at $<600°C$ in order to avoid pyrolysis of carbonates that may be present in unseparated samples.

2020 ± 65
Lu-1909. Nymölla 12[35], Sample 1 $\delta^{13}C = -26.3‰$

Charcoal fragments in sand from cultural layer near hearth, Sq V15. *Comment:* sample undersized; diluted; 63% sample.

1830 ± 50
Lu-1910. Nymölla 12[35], Sample 2 $\delta^{13}C = -25.7‰$

Charcoal fragments and ash in sand from hearth in cultural layer, Sq V14, x = 13.2, y = 15.5; x = 13.25, y = 15.05; alt ca 3.5m. Assoc with animal bones, yellow ocher, flint implements, and Pitted Ware potsherds.

1930 ± 50
Lu-1911. Nymölla 12[35], Sample 3 $\delta^{13}C = -24.0‰$

Charcoal fragments and ash in sand from hearth in cultural layer, Sq V14, x = 13.3, y = 15.3; alt ca 3.5m.

110 ± 40
Lu-1944. Hembyn, Bursiljum $\delta^{13}C = -23.2‰$

Wood (*Pinus* sp) id by T Bartholin, from primitive oarlock found by ditching at Hembyn, Bursiljum, Burträsk parish, Västerbotten (64° 29′ N, 20° 51.5′ E). Coll 1964 by G Marklund; subm by A Huggert, Västerbottens Mus, Umeå. No pretreatment. Sample undersized; diluted; 59% sample. (3 1-day counts.) *Comment:* according to measurements by Stuiver (1978, p 271), 110 ± 40 BP corresponds to AD 1670 to 1740 or AD 1800 to 1940.

Tofta högar series

Charcoal from Bronze and Iron age cult and burial place Tofta Högar, Hovs parish, NW Scania (56° 27′ N, 12° 43′ E). Coll 1979 and subm by G Burenhult, Dept Archaeol, Univ Stockholm. Pretreated with HCl and NaOH. Site described by submitter (Burenhult, 1975).

1070 ± 50
Lu-1777. Tofta Högar, Wall 2, Structure 1 $\delta^{13}C = -24.7‰$

Charcoal in rectangular wall with stone foundation.

880 ± 50
Lu-1778. Tofta Högar, Wall 2, Structure II $\delta^{13}C = -25.1‰$

Charcoal in same wall as Lu-1777, above.

Lu-1776. Gladsax No. 18 **4960 ± 95**
$\delta^{13}C = -24.8‰$

Charcoal from surface of former soil horizon below large stones in passage grave, Sq 24 and 30; x + 13.0, y + 13.6, at Gladsax No. 18, SE Scania (55° 34′ 20″ N, 14° 16′ 20″ E). Coll 1979 and subm by G Burenhult. No pretreatment; sample undersized; diluted; 53% sample.

B. Denmark

Lu-1952. Store Harreskov **4500 ± 55**
$\delta^{13}C = -19.6‰$

Collagen from mixture of human and animal bones from below floor of flat stones in megalithic construction "Tre kroner" at Store Harreskov, NW of Copenhagen (55° 46′ N, 12° 17.5′ E). Coll 1980 and subm by E Laumann Jörgensen, Værlöse Mus, Værlöse. Collagen extracted as described previously (R, 1976, v 18, p 290) without NaOH treatment. *Comment:* organic carbon content: 4%.

C. Ireland

Carrowmore Series II

Charcoal from settlement remains and grave at Carrowmore area, Co Sligo, Ireland. Coll 1979-81 and subm by G Burenhult, Inst Archaeol, Univ Stockholm. Dated as complement to Carrowmore Series I (R, 1981, v 23, p 399-402). Results of excavations 1977-79 reported by submitter (Burenhult, 1980).

Lu-1862. Luffertan, Settlement 8 **2020 ± 55**
$\delta^{13}C = -23.7‰$

Charcoal from Settlement 8, Field VIII, at Luffertan (54° 15′ N, 8° 32′ W), x − 30.15, y + 0.8; 60.82m above OD (Burenhult, 1980, p 101; map 15, p 104). *Comment:* no pretreatment; sample undersized; diluted; 89% sample.

Lu-1863. Carrowmore, Cist B **1260 ± 50**
$\delta^{13}C = -23.1‰$

Charcoal from Cist B, Structure 10, level 52.5 to 52.7m, at Carrowmore Megalithic cemetery (54° 15′ N, 8° 32′ W). *Comment:* pretreated with HCl and NaOH.

Lu-1947. Knocknarea North, Hut Site I **4250 ± 75**
$\delta^{13}C = -24.6‰$

Charcoal (Samples 9, 10, and 12) from basal cultural layer (floor) at Hut Site I, Knocknarea North (54° 15′ N, 8° 35′ W). Assoc with hollow-scrapers and leaf-shaped arrowhead. *Comment:* mild pretreatment with NaOH and HCl. Sample undersized; diluted; 47% sample. (3 1-day counts.)

Lu-1948. Culleenamore, Settlement 15 **3970 ± 75**
$\delta^{13}C = -24.4‰$

Charcoal (Sample 30) from hearth in basal layer of shell midden, 0.95m above OD, Settlement 15, Culleenamore (Burenhult, 1980, p 91). *Comment:* mild pretreatment with NaOH and HCl. Sample undersized; diluted; 47% sample. (3 1-day counts.)

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UDINE RADIOCARBON LABORATORY DATE LIST I

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INTRODUCTION

The radiocarbon laboratory of the Center of Applied Research and Documentation of Udine (CRAD), became operative early in 1977 and uses a benzene liquid scintillation counting method. Benzene is prepared as outlined by Legers and Tamers (1963), Noakes, Kim, and Akers (1967), Belluomini *et al* (1978). The procedure of chemical synthesis is detailed in CRAD (1977).

The main features of the physical detection system are described by Calligaris and Ciuti (1978) and by Barbina, Calligaris, and Ciuti (1979) and here. Counting vials are low potassium glass cylinders of $5cm^3$ volume. An NE 216 liquid scintillator is used, with typical mixing ratio of $3.5cm^3$ of benzene in $1.0cm^3$ of scintillator. Radiocarbon decay is detected by two 56 DVP photomultipliers in coincidence. A shielding iron-tunnel and a system of plastic scintillators with four anticoincidence photomultipliers are used for minimizing background.

Typical performance figures for a measurement time of 24 hours are:

Background	B	: (1.70 ± 0.03) cpm,
Modern sample net	G	: (23.0 ± 0.1) cpm,
Detection efficiency		: 60%,
Figure of merit		: $G/\sqrt{B} = 18$,
Age limit		: 46,900 y (2 σ criterion).

Dates are reported in conventional radiocarbon years, assuming year 1950 as reference standard and Libby's half-life of 5570 ± 30 years (Libby, 1955). Our modern standard has been obtained from the 1950 core of an *Abies picea* trunk. It has not been calibrated against National Bureau of Standard's oxalic acid. The counting rate is not corrected for isotopic fractionation, because a mass-spectrometer is not available at present.

SAMPLE DESCRIPTIONS

The results reported here are part of a study of the paleography of the lagoon of Venice. The list contains dates of different samples selected from the same core at different depths in the stratigraphic sequence, in order to verify the sedimentation rate. Also, some dates of samples from other cores are reported, which may give some information on local stratigraphic sequence.

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In all cases, samples have been prepared from the most suitable materials, *ie,* wood and peat or, if these were not available, mollusk shells.

GEOLOGIC SAMPLES

Laguna di Venezia

Terre Perse series

Peat from lagoon of Venice, Terre Perse, Italy (45° 22′ N, 12° 20′ 56″ E). Coll 1973 by P Da Roit, Lab Geol Appl CNR, Univ Padova, and subm by P Gatto, Ist Studio Dinamica Grandi Masse, CNR, Venice.

UD-3. **21,000 ± 800**

Peat from drilling 7 at depth 17.2m.

UD-4. **23,000 ± 1000**

Peat from drilling 7 at depth 25.60m.

UD-5. **16,400 ± 500**

Peat from drilling 7 at depth 14.85m.

Ca' Bianca series

Peat and shells from Lagoon of Venice, Ca' Bianca (45° 23′ 33″ N, 12° 21′ 18″ E). Coll 1973 by P Da Roit and subm by P Gatto.

UD-6. **28,000 ± 1700**

Peat from drilling 8 at depth 29.6m.

UD-7. **22,000 ± 900**

Peat from drilling 8 at depth 25m.

UD-21. **4700 ± 150**

Shells from drilling 8 at depth 9.6m.

Malamocco series

Peat and carbonate (mollusk shells) from lagoon of Venice, Malamocco (45° 21′ 53″ N, 12° 20′ 14″). Coll 1974 by P Da Roit and subm by P Gatto.

UD-9. **25,000 ± 1500**

Peat from drilling 6 at depth 26m.

UD-14. **21,000 ± 1000**

Peat from drilling 6 at depth 18.3m.

UD-20. **5300 ± 200**

Carbonate (mollusk shells) from drilling 6 at depth 8.9m.

UD-23. **5250 ± 200**

Carbonate (mollusk shells) from drilling 6 at depth 11.6m.

S Pietro in Volta series

Carbonate from S Pietro in Volta (45° 21′ 53″ N, 12° 19′ 01″ E). 1976 by P Da Roit and subm by P Gatto.

UD-22. **7150 ± 200**

Carbonate (mollusk shells) from drilling 1 at depth 11.6m.

Pellestrina series

Carbonate from Pellestrina (45° 15′ 58″ N, 12° 18′ 04″ E). Coll 1976 by P Da Roit and subm by P Gatto.

UD-18. **11,000 ± 200**

Carbonate (mollusk shells) from drilling 4 at depth 17.35m.

Alberoni series

Carbonate from Alberoni (45° 20′ 48″ N, 12° 19′ 33″ E). Coll 1976 by P Da Roit and subm by P Gatto.

UD-19. **4300 ± 200**

Carbonate (mollusk shells) from drilling 5 at depth 6.9m.

Forte di S Andrea series

Peat from Forte di S Andrea (45° 26′ 01″ N, 12° 22′ 53″ E). Coll 1974 by P Da Roit and subm by P Gatto.

UD-15. **22,000 ± 1000**

Peat from drilling 9 at depth 27.9m.

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UNIVERSITY OF GRANADA RADIOCARBON DATES I

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The Radiocarbon Dating Laboratory of The Granada University was established to support the work of archaeologists and geologists. The method of dating is benzene synthesis and liquid scintillation counting developed by a number of investigators (Polach and Stipp, 1967; Tamers, 1969; Pietig and Scharpenseel, 1966) with sample combustion in pure oxygen (Switsur, 1974).

Samples dated thus far have been primarily charcoal or peat, although some bone samples have been dated. Pretreatment of charcoal is a standard acid-alkali procedure, using 2% ClH and 0.5% NaOH at elevated temperature. Peat is subjected to treatment with acid only. The collagen of bone samples is obtained by the Longin (1971) method. Contaminating materials such as rootlets and pebbles are mechanically removed. Counting is done in a Nuclear Chicago Isocap 300 liquid scintillation system Model 6870 with a background of 9 to 10cpm for 5ml benzene samples, using a 20ml low ^{40}K counting vial. Efficiency is approximately 70%, using the part of spectrum above the end point of tritium.

$\delta^{13}C$ values are based on data reported in Radiocarbon (Stuiver and Polach, 1977). Errors are reported as 1σ which include only the combined counting uncertainty of the background, modern, and sample and the error of estimating $\delta^{13}C$. Dates reported here are based on 95% of the activity of NBS oxalic acid standard and the Libby half-life of 5568 years. Ages of check samples determined in this laboratory agree with the results of other laboratories. Reproducibility of multiple runs is satisfactory.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Padul series II

Peat and clay samples from peat bog at Padul, Granada, Spain, which represent considerable part of Pleistocene. Samples from eight cores coll and subm 1978 by Empresa Nac Electricidad SA (ENDESA) are reported in Table 1. Earlier dates on peat from Padul were reported (Vogel and Waterbolk, 1972). Results of preliminary palynologic investigation were pub (Menendez Amor and Florschütz, 1962; 1964).

II. ARCHAEOLOGIC SAMPLES

Spain

El Malagón series

Charcoal from El Malagón (37° 37′ 33″ N, 2° 25′ 18″ W) prov Granada. Samples coll 1975 and subm by F Molina, Dept Prehistory, Univ Granada to date beginning of metallurgy in Upper Andalucia.

UGRA-11. CB 2118 **4520 ± 220**

Charcoal at 0.95m depth.

UGRA-12. CB 2323 **4070 ± 150**

Charcoal.

General Comment: dates agree with expected ages.

Cerro de la Encina series

Wood and charcoal from Cerro de la Encina (37° 08′ 16″ N, 3° 32′ 51″ W) prov Granada. Samples coll 1970 and subm by F Molina to date Bronze age in Upper Andalucia.

UGRA-14. M 1931 **3290 ± 140**

Charcoal at 3.3m depth.

TABLE 1

Padul Series II

Sample	Core no.	Coordinates	Core depth (m)	^{14}C age
UGRA-40	24	37° 01′ 16″ N, 3° 36′ 32″ W	1.10	5660 ± 160
UGRA-41	24	″	2.10	3860 ± 150
UGRA-42	24	″	3.10	5660 ± 150
UGRA-43	24	″	4.12	5160 ± 150
UGRA-44	24	″	6.02	8800 ± 350
UGRA-49	24	″	7.82	15,370 ± 260
UGRA-50	24	″	9.32	6030 ± 140
UGRA-51	24	″	11.12	15,150 ± 300
UGRA-55	25	37° 01′ 06″ N, 3° 36′ 26″ W	1.5-1.6	12,480 ± 220
UGRA-56	25	″	12.16-12.51	14,750 ± 240
UGRA-57	25	″	19.26-19.96	18,180 ± 350
UGRA-36	26	37° 01′ 03″ N, 3° 36′ 03″ W	1.70	3860 ± 140
UGRA-37	26	″	3.55	3560 ± 140
UGRA-38	26	″	6.60	7190 ± 160
UGRA-39	26	″	9.95	7730 ± 190
UGRA-26	29	37° 00′ 53″ N, 3° 36′ 42″ W	2.00	4670 ± 170
UGRA-27	29	″	3.20	4970 ± 140
UGRA-28	29	″	6.20	8540 ± 160
UGRA-29	29	″	9.00	16,000 ± 280
UGRA-31	29	″	10.40	10,180 ± 180
UGRA-32	29	″	12.50	31,000 ± 2600
UGRA-58	31	37° 00′ 37″ N, 3° 36′ 33″ W	0.85-1.20	2170 ± 150
UGRA-59	31	″	5-6	8300 ± 150
UGRA-22	33	37° 00′ 49″ N, 3° 37′ 12″ W	1.30	4280 ± 150
UGRA-23	33	″	1.80	4940 ± 160
UGRA-24	33	″	2.80	9180 ± 160
UGRA-33	35	37° 00′ 17″ N, 3° 36′ 20″ W	4.50	15,140 ± 210
UGRA-34	35	″	5.80	17,130 ± 310
UGRA-35	35	″	7.85	41,000 (apparent age)
UGRA-9	37	37° 00′ 00″ N, 3° 36′ 20″ W	3.50	6110 ± 140
UGRA-8	37	″	4.00	9990 ± 160
UGRA-7	37	″	4.50	24,000 ± 600
UGRA-6	37	″	5.00	24,000 ± 450
UGRA-5	37	″	5.50	31,000 ± 1000
UGRA-4	37	″	6.00	39,000 ± 2700

UGRA-15. M 16067 **3620 ± 130**

Wood at 3m depth.

UGRA-16. M 26277 **3550 ± 140**

Charcoal at 2.8m depth.

General Comment: age for M 1931 probably too young.

Motilla del Azuer series

Charcoal from Motilla del Azuer (39° 03′ 14″ N, 3° 29′ 48″ W) prov Ciudad Real. Samples coll and subm by F Molina to date Bronze age.

UGRA-19. D 37 **3260 ± 140**

Charcoal at 1.25m depth.

UGRA-20. D 328 **3480 ± 140**

Charcoal at 0.85m depth.

UGRA-21. D 443 **3500 ± 140**

Charcoal at 3.2m depth.

UGRA-97. D 475 **3490 ± 180**

Charcoal at 4.05m depth.

General Comment: age for D 37 probably too young.

El Raso de Candeleda series

Charcoal from El Raso de Candeleda (40° 07′ 00″ N, 5° 19′ 10″ W) prov Avila. Samples coll and subm 1979 by F Fernández, Archaeol Mus Sevilla to date pre-Roman town.

UGRA-45. El Raso 1 **2190 ± 130**

Charcoal at 1.1m depth.

UGRA-46. El Raso 3 **1840 ± 140**

Charcoal at 1.4m depth.

Morra del Quintanar series

Five samples from Morra del Quintanar site (39° 01′ 05″ N, 2° 27′ 15″ W) prov Albacete. Coll 1979 and subm 1980-81 by C Martín, Subdir Gen Arqueol, Madrid.

UGRA-47. Q 227-79 **3610 ± 140**

Charcoal at 1.25m depth.

UGRA-78. Q 849-80 **3670 ± 120**

Charcoal at 2.35m depth.

UGRA-79. Q 1639-80 **3630 ± 130**

Charcoal at 0.66m depth.

UGRA-100. Q 455a-80 **3490 ± 150**

Charcoal at 3.5m depth.

UGRA-101. Q 642-80 **3610 ± 130**

Charcoal at 1.36m depth.

General Comment: dates agree with expected ages.

Las Angosturas series

Charcoal from Las Angosturas site (37° 21′ N, 3° 50′ W) prov Granada. Samples coll and subm 1981 by M Botella, Diputación prov Granada to date Eneolithic period in E Andalucia.

UGRA-80. Ag 41038 **3860 ± 140**

Charcoal at 3.7m depth.

UGRA-81. Ag 42433 **4150 ± 170**

Charcoal at 3.69m depth.

UGRA-82. Ag 42698 **4210 ± 140**

Charcoal at 3.8m depth.

General Comment: dates agree with expected ages.

UGRA-70. Peñaflor 1 **2540 ± 160**

Charcoal from Peñaflor site (37° 44′ N, 5° 15′ W) prov Sevilla. Sample coll and subm 1980 by F Fernández to date foundation of Celfi town (Ponsich, 1979).

UGRA-72. Valencina **3380 ± 150**

Bone from Valencina (37° 25′ 40″ N, 6° 04′ 30″ W) prov Sevilla, coll at 2m depth. Sample coll and subm 1980 by F Fernández to date beginning of Campaniforme culture.

Portugal

Castelo de Santa Justa series

Samples from Cerro do Castelo de Santa Justa (37° 29′ N, 7° 29′ W) Alcoutim, Faro. Coll and subm 1981 by V Gonçalves, Centro Hist, Univ Lisboa.

UGRA-90. E 17 **4310 ± 170**

Charcoal.

UGRA-77. H 14 **3960 ± 180**

Charcoal at 1.32m depth.

UGRA-75. I 16 **3990 ± 130**

Charcoal at 0.35m depth.

UGRA-89. I 15 **5180 ± 160**

Charcoal at 0.53m depth.

UGRA-76. J 14 **3920 ± 130**

Seed at 0.6m depth.

UGRA-91. K 18 **4100 ± 140**

Charcoal at 0.55m depth.

UGRA-86. L 18 **3910 ± 120**

Charcoal at 0.28m depth.

UGRA-85. M 18 **3890 ± 130**

Charcoal at 0.25m depth.

General Comment: expected ages: 4150 to 4950 (Gonçalves, 1980).

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VIENNA RADIUM INSTITUTE RADIOCARBON DATES XII

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Measurements have continued with the same proportional counter system, pretreatment procedure, methane preparation and measurement, and calculation, as described previously (R, 1970, v 12, p 298-318). Uncertainties quoted are single standard deviations originating from standard, sample, and background counting rates. No $^{13}C/^{12}C$ ratios were measured. Sample descriptions have been prepared in cooperation with submitters.

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I express my thanks to Ing L Stein for excellent work in sample preparation, and to Konrad Flandorfer for careful operation of the dating equipment.

SAMPLE DESCRIPTIONS

I. GEOLOGIC, LIMNOLOGIC, AND BOTANIC SAMPLES

Austria

VRI-678. Stöttera, Bgld **<250**

Wood from youngest terrace, depth −90cm (47° 47′ N, 16° 28′ E), N Stöttera, Burgenland. Coll 1978 and subm by Franz Sauerzopf, Biol Inst Burgenland, Illmitz. *Comment* (FS): dates subfossil fauna.

VRI-729. Oberschütt, Kärnten **400 ± 80**

Wood sample V 46/2a from fall area of Dobratsch Mt, Oberschütt (46° 33′ N, 13° 45′ E), Gailtal, Carinthia. Coll 1980 by Bäk and Herzog, Amt d Kärntner Landesregierung, Klagenfurt. *Comment* (B&H): dates fall of Dobratsch Mt. DeVries-corrected calendric age: AD $1450 {+50 \atop -40}$ (Suess, 1970).

VRI-734. Marchegg, N Ö **2660 ± 90**

Wood from oak embedded in water and mud at surroundings of March R near Marchegg (48° 17′ N, 16° 55′ E), Lower Austria. Coll 1980 and subm by Alois Machalek, Zentralanst f Meteorol and Geodynamik, Vienna. *Comment* (AM): dating for dendro-climatic studies.

VRI-685. Frankenburg, O Ö **10,260 ± 160**

Wood from boring core at depth −7m, Remigen, near Frankenburg am Hausruck (48° 03′ 48″ N, 13° 30′ E), Upper Austria. Coll 1980 by Fritsch and subm by Christian Veder, Inst Bodenmechanik, TU Graz. *Comment* (CV): dates soil slide.

VRI-689. Steyregg, O Ö **1670 ± 80**

Oak stem, −14m, 6m below subsoil water level in deposits of Danube R near Steyregg (48° 17′ N, 14° 22′ E), O Ö. Coll 1980 and subm by Robert Schindele, Gansbach-Kicking, O Ö.

Badgastein series, Salzburg

Wood from excavation for reconstruction of Elisabeth-Stollen adit in Badgastein thermal area (47° 07′ N, 13° 08′ 30″ E), Salzburg. Coll 1979/1980 and subm by Franz Kahler, Klagenfurt.

VRI-679. Sample 1 **2770 ± 80**

Rolled Larch in blue ground moraine or polished granite. *Comment* (FK): too young to date glacial advance.

VRI-680. Sample 2 **2170 ± 80**

Abies with root-stock in upright position in slope detritus –5m below retaining wall in Bismarck St. *Comment* (FK): date provides chronologic information on slope movement.

Böckstein series, Salzburg

Wood from area of Bockhartsee lake (47° 04′ 25″ N, 13° 03′ 30″ E, Nassfeld near Böckstein, Salzburg. Coll 1981 at building site of water power sta and subm by SAFE, Salzburg.

General Comment (SAFE): stems at bottom of lake are remains of former warm period. Presently, surroundings are completely deforested.

VRI-721. Bog **5130 ± 140**

Wood at –2m from bog E Bockhartsee lake, 1875m asl.

VRI-722. Lake **840 ± 80**

Wood at –27m from lake bottom, 1820m asl.

VRI-718. Neurath-Stainz, Stmk **19,720 ± 390**

Sand with gyttja below gravel deposit, probably "Niederterrasse", SE Neurath-Stainz (46° 54′ N, 15° 16′ E), Styria. Coll 1980 by P Beck-Mannagetta; subm by Ilse Draxler, Geol BA, Vienna. *Comment* (ID): dates pollen analysis. Organic material was concentrated by submitter.

VRI-728. Pichling, Stmk **2630 ± 80**

Wood in sand and gyttja of "Niederterrasse" N Zirknitzbach bridge, WSW Pommer, 317m asl, E Pichling near Stainz (46° 54′ N, 15° 16′ E), Styria. Coll 1981 by P Beck-Mannagetta; subm by Ilse Draxler. *Comment* (ID): chronologic clue for horizon in which sample was found.

Lebenberg series, Tirol

Peat coal in layer, 3m thick, below 17.6m moraine, Lebenberg (47° 27′ 20″ N, 12° 23′ 30″ E), NW Kitzbühel, Tyrol. Coll by boring 1976 by firm Etschel & Meyer; subm by Sigmar Bortenschlager, Bot Inst, Univ Innsbruck.

General Comment (SB): pollen analysis points to interglacial period. Samples VRI-556, -557 should clarify incomprehensible age of VRI-555.

VRI-555. T2/1955 **29,340 ± 1200**

Sample from –19.55m.

VRI-556. T2/1755 **>35,800**

Sample from –17.55m, uppermost part of peat layer.

VRI-557. T2/2055 **>35,800**

Sample from –20.55m, lowermost part of peat layer.

Kühtai series, Tirol

Peat from base of bogs at Kühtai, Tyrol. Coll 1981 by H Hüttemann; subm by Sigmar Bortenschlager.

General Comments (SB, HF): dates beginning of bog growth. No NaOH pretreatment.

VRI-622. Kühtai I **2800 ± 100**

Peat from depth –200 to –210cm of bog near rivulet Finstertaler Bach (47° 12′ 20″ N, 11° 01′ 10″ E), alt 1970m.

VRI-623. Kühtai II **8300 ± 130**

Peat from depth –185 to –200cm of bog near Dortmunder-hut (47° 12′ 20″ N, 11° 00′ 38″ E), alt 1980m.

VRI-624. Zillertal, Tirol **6800 ± 150**

Peat from base of bog, depth –240 to –250cm in area of Gr Möseler Mt (47° 01′ 33″ N, 11° 48′ 19″ E), Zillertaler Alps, Tyrol. Coll 1981 by H Hüttemann; subm by Sigmar Bortenschlager. *Comment* (SB): dates beginning of peat growth.

Deffereggental series, Tirol

Wood *(Pinus cembra)* from bog (46° 58′ 50″ N, 12° 09′ 30″ E), 2035m asl, Jagdhausalm, Deffereggental, E Tyrol. Coll 1980 and subm by Friedrich Kral, Univ Bodenkultur, Vienna.

General Comment (FK): absolute dates for pollen analysis.

VRI-724. Jagd 80/100 **6180 ± 180**

Wood from base of bog at –80cm. *Comment* (FK): gives bog age and fixes early human activity in woods.

VRI-725. Jagd 28 **1240 ± 80**

Wood from younger sandy layer at –28cm. *Comment* (FK): dates extended human activity starting development to treeless landscape of today.

VRI-726. Matrei, Osttirol **2310 ± 90**

Wood *(Larix)* at –38cm from bog at Hauptmer Alm (47° 06′ 10″ N, 12° 31′ 20″ E), 1780m asl, near Matrei, E Tyrol. Coll 1980 and subm by Friedrich and Renate Kral. *Comment* (FK): sample at change from *Carex* peat to wood peat fixes pollen-anaytically detected extended wood cutting.

VRI-727. Huben, Osttirol **470 ± 80**

Pine cones in Bärenlacke bog change from *Carex* peat to wood peat at –30cm (46° 54′ 45″ N, 12° 34′ 55″ E), 1640m asl, near Huben, E Tyrol.

Coll 1980 and subm by Friedrich und Renate Kral. *Comments* (FK, HF): dates pollen-analytically detected local human encroachment upon forestland. No NaOH pretreatment.

VRI-740. Kienberg, Tirol **Modern**

Humic acids extracted from lowermost A_h horizon of thin brown earth layer, 10cm below ground on landslide material in woodland near Kienberg/Jerzens, Pitztal (47° 08′ N, 10° 45′ E), Tyrol. Coll 1981, extracted and subm by Irmentraud Neuwinger, Forstl BVA, Innsbruck. *Comment* (IN): date of landslide was expected.

VRI-741. Telfs, Tirol **<260**

Humic acids extracted from –20 to –25cm, lowermost A_h horizon of Rendzina near Telfs (47° 19′ N, 11° 04′ E), Tyrol. Coll 1981, extracted and subm by Irmentraud Neuwinger. *Comment* (IN): dates uppermost layers of alluvial cone.

CSSR

VRI-620. Hohe Tatra, CSSR **6050 ± 110**

Peat sample VT-1-A at depth –200 to –212cm from base of bog near Triangelsee lake, Hohe Tatra Mt, 1600m asl (49° 13′ 15″ N, 20° 13′ 50″ E), CSSR. Coll 1980 by K Rybnicek and H Hüttemann; subm by Sigmar Bortenschlager. *Comment* (SB): dates beginning of bog growth.

VRI-621. Riesengebirge, CSSR **7600 ± 130**

Peat sample KR-1-B at depth –220 to –225cm from base of Pancica bog near Elbebaude, 1300 to 1370m asl (50° 46′ 45″ N, 15° 32′ 30″ E), Riesengebirge Mt, CSSR. Coll 1980 by K Rynicek and H Hüttemann; subm by Sigmar Bortenschlager. *Comments* (SB, HF): dates beginning of bog growth. No humic acids separation.

II. ARCHAEOLOGIC SAMPLES

Austria

Bernhardsthal series, N Ö

Charcoal from excavation of Germanic settlement at Bernhardsthal, Aulüssen field (48° 42′ N, 16° 52′ E), Mistelbach dist, Lower Austria. Coll 1980 and subm by Horst Adler, Bundesdenkmalamt, Vienna.

General Comment (HA): check for stratigraphic and archaeol dates.

VRI-705. Quad U/16/B **1690 ± 80**

Sample from Quad U/16, Color B. *Comment* (HF): deVries correction (Suess, 1970) gives AD 300 ± 60.

VRI-716. Quad U/22/A **1800 ± 90**

Sample from Quad U/22, Color A. *Comment* (HF): deVries correction (Suess, 1970) gives AD 200 ± 90.

VRI-717. Villach, Kärnten **<260**

Wooden remnant of axe, –6m, near Stadtbrücke bridge of Drau R, Villach (46° 36′ 59″ N, 13° 50′ 55″ E), Carinthia. Coll 1959 and subm by

Dieter Neumann, Mus Villach. *Comment* (DN): accompanying finds point to Middle Ages or early modern times. DeVries-corrected age (Suess, 1970) is younger than AD 1650.

VRI-681. Untersee, O Ö **500 ± 80**

Wood coll near shore from bottom of Hallstättersee lake (47° 36′ 40″ N, 13° 38′ 20″ E), near Untersee, Upper Austria. Coll 1980 by Union-Tauchclub Wels, subm by Johann Offenberger, Bundesdenkmalamt, Vienna. *Comment* (JO): date confirms suggestion of medieval lake dwelling.

VRI-683. Schörfling, O Ö **910 ± 80**

Wood soaked with water from bottom of Attersee lake (47° 55° 58″ N, 13° 33′ 34″ E) near Schörfling, Upper Austria. Coll 1980 by Union-Tauchclub Wels; subm by Johann Offenberger. *Comment* (JO): date invalidates suggestion of Neolithic lake dwelling remnants.

VRI-684. Irrsee, O Ö **350 ± 80**

Wood soaked with water from bottom of Irrsee lake (47° 55′ 53″ N, 13° 18′ 00″ E). Coll 1980 by Union-Tauchclub Wels; subm by Johann Offenberger. *Comment* (JO): date confirms suggestion of medieval lake dwelling remains.

VRI-687. Kammer, O Ö **4420 ± 100**

Wooden piling (*Fraxinus* sp) —3m below water level from bottom of Attersee lake ca 50m offshore in bay of Kammer yacht port (47° 34′ N, 13° 21′ E) near Schörfling, Upper Austria. Coll by Robert Gotsleben; subm by Johann Offenberger. *Comment* (JO): date confirms Neolithic origin.

VRI-723. Seewalchen, O Ö **4910 ± 110**

Wooden pile, —1.7m below water level at bottom of Attersee lake, 15m offshore, Kammer outlet region (47° 57′ N, 13° 35′ E) near Seewalchen, Upper Austria. Coll and subm 1980 by Johann Offenberger. *Comment* (JO): remains of Neolithic lake dwelling.

Attersee 1 series, O Ö

Wood remnants of lake dwellings in Attersee lake, Upper Austria. Coll 1981 and subm by Johann Offenberger.

General Comment (HF): dates confirm Neolithic origin.

VRI-730. 166/1-1981 **4720 ± 100**

Sample at —2.5m below level, Attersee (47° 55′ 17″ N, 13° 32′ 21″ E).

VRI-731. 181/1-1981 **4680 ± 100**

Abtsdorf III (47° 53′ 36″ N, 13° 32′ 02″ E).

Attersee 2 series

Wood from bottom of lake Attersee near Attersee, Upper Austria. Coll 1981 and subm by Johann Offenberger.

General Comment (JO): dates clarify unknown age of lake dwelling remnants.

VRI-735. 183/1-1981 Abtsdorf I **3180 ± 90**

Sample coll in Abtsdorf (47° 53′ 40″ N, 13° 32′ 03″ E). *Comment* (JO&HF): Bronze age date rejects assumption of Neolithic origin. DeVries correction (Suess, 1970) gives 1500^{+100}_{-50} BC.

VRI-738. 186/1-1981 Oberndorfer **220 ± 70**

Sample taken at Oberndorfer farm (47° 54′ 58″ N, 13° 32′ 30″ E), 1.5m below water level. *Comment* (JO&HF): date confirms historic age. DeVries correction (Suess, 1970) gives AD 1650^{+110}_{-170}.

Weyregg a Attersee series, O Ö

Wood, –2m below water level from bottom of Attersee lake, Weyregg (47° 54′ N, 13° 34′ E), Upper Austria. Lake dwelling remnants from two different cultural layers one above another separated by lake marl. Coll 1981 and subm by Johann Offenberger.

General Comment (JO): dates confirm Neolithic origin.

VRI-732. Weyregg I/Sch I/OKS 1-1981 **4640 ± 110**

Wood from upper layer.

VRI-733. Weyregg I/Sch II/UKS 1-1981 **4660 ± 100**

Wood from lower layer.

VRI-745. Gmunden, O Ö **800 ± 80**

Wooden piling from prospecting ditch –2.5m below water level near Orth castle, Traunsee lake, Gmunden (47° 57′ N, 13° 35′ E), Upper Austria. Coll 1981 by R Gotsleben; subm by Johann Offenberger. *Comment* (JO): dates oldest pilings.

Gaishorn series, Stmk

Charcoal from excavation of smelting site Oberschwärzen, Gaishorn (47° 28′ N, 14° 32′ E), Paltental, Styria. Coll 1980 and subm by Clemens Eibner, Inst Ur-Frühgesch, Univ Vienna.

General Comment (CE): excavated ceramics not significant. Early Bronze age to ancient historic origin is possible.

VRI-719. Find no. 20 **1070 ± 70**

Charcoal band in loess above copper smelting site. Formation of sample layer unknown.

VRI-720. Find no. 65 **2640 ± 90**

Remains rich in charcoal from smelting furnace. *Comment* (HF): no NaOH pretreatment.

VRI-682. Eisenerz, Stmk **410 ± 120**

Charcoal and slag from Feistawiese (47° 31′ 42″ N, 14° 55′ 24″ E), Mt Steirischer Erzberg near Eisenerz, Styria. Coll 1972 by F Hofer and J Slesak, subm by Gerhard Sperl, Erich-Schmid Inst f Festkörperphysik d Österr Akad Wiss, Leoben. *Comment* (GS): date confirms medieval age of sample that was previously thought to be late Roman.

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Half life of ^{14}C. In accordance with the decision of the Fifth Radiocarbon Dating Conference, Cambridge, 1962, all dates published in this volume (as in previous volumes) are based on the Libby value, 5570 ± 30 yr, for the half life. This decision was reaffirmed at the 9th International Conference on Radiocarbon Dating, Los Angeles/La Jolla, 1976. Because of various uncertainties, when ^{14}C measurements are expressed as dates in years BP the accuracy of the dates is limited, and refinements that take some but not all uncertainties into account may be misleading. The mean of three recent determinations of the half life, 5730 ± 40 yr, (Nature, v 195, no. 4845, p 984, 1962), is regarded as the best value presently available. Published dates in years BP, can be converted to this basis by multiplying them by 1.03.

AD/BC Dates. In accordance with the decision of the Ninth International Radiocarbon Conference, Los Angeles and San Diego, 1976, the designation of AD/BC, obtained by subtracting AD 1950 from conventional BP determinations is discontinued in Radiocarbon. Authors or submitters may include calendar estimates as a comment, and report these estimates as AD/BC, citing the specific calibration curve used to obtain the estimate.

Meaning of $\delta^{14}C$. In Volume 3, 1961, we endorsed the notation Δ (Lamont VIII, 1961) for geochemical measurements of ^{14}C activity, corrected for isotopic fractionation in samples and in the NBS oxalic-acid standard. The value of $\delta^{14}C$ that entered the calculation of Δ was defined by reference to Lamont VI, 1959, and was corrected for age. This fact has been lost sight of, by editors as well as by authors, and recent papers have used $\delta^{14}C$ as the observed deviation from the standard. At the New Zealand Radiocarbon Dating Conference it was recommended to use $\delta^{14}C$ only for age-corrected samples. Without an age correction, the value should then be reported as percent of modern relative to 0.95 NBS oxalic acid (Proceedings 8th Conference on Radiocarbon Dating, Wellington, New Zealand, 1972). The Ninth International Radiocarbon Conference, Los Angeles and San Diego, 1976, recommended that the reference standard, 0.95 times NBS oxalic acid activity, be normalized to $\delta^{13}C = -19‰$.

In several fields, however, age corrections are not possible. $\delta^{14}C$ and Δ, uncorrected for age, have been used extensively in oceanography, and are an integral part of models and theories. For the present, therefore, we continue the editorial policy of using Δ notations for samples not corrected for age.

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