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HIGH-PRECISION DECADAL CALIBRATION OF THE RADIOCARBON TIME SCALE, AD 1950–6000 BC

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INTRODUCTION

The radiocarbon ages of dendrochronologically-dated wood samples, each covering 10 years, are now available for the cal AD 1950–6000 BC age range. The decadal calibration curve constructed from these data comprises 1) the previously published AD 1950–2500 BC portion (Stuiver & Becker 1986), to which minor ^{14}C age corrections were applied, and 2) the new 2500–6000 BC extension.

The calibration error (standard deviation in ^{14}C age) is based on 1) an estimate of the reproducibility in the ^{14}C age determination in the Seattle laboratory, and 2) interlaboratory comparisons that provide information on the sum total of uncertainty tied to the processes of wood allocation, dendro-age determination, sample pretreatment, laboratory ^{14}C determination, regional ^{14}C distribution and ^{14}C differences between individual trees of the same chronology (Stuiver & Pearson 1992, 1993). The standard deviations of the Table 1 ^{14}C calibration data for the AD 1950–2500 and 2500–6000 BC intervals are, respectively, equal to 1.6 and 1.7 times the standard deviation derived from the near-Gaussian counting statistics of the accumulated number of counts for the sample and standards.

The ^{14}C ages for the decadal wood samples (Table 1) were used to construct the bidecadal Seattle-Belfast calibration curve reported in this issue (Stuiver & Pearson 1993; Pearson & Stuiver 1993). The ^{14}C age errors are substantially smaller for the bidecadal curve, as most bidecadal data points were obtained by averaging 2 Seattle decadal ^{14}C ages, and 1 Belfast bidecadal ^{14}C age. Thus, the bidecadal curves should be used for most purposes. However, the decadal curve is more important when accounting for the fine structure of ^{14}C age calibration of samples formed during intervals of a decade or less.

DENDROCHRONOLOGY AND SAMPLE TREATMENT

The trees used for the AD interval were mainly from the US Pacific Northwest or California (Table 2 in Stuiver & Becker 1986). Most of the BC material was dendrochronologically dated wood from the German Main-Donau chronology (Becker 1993). Thirteen samples from the US bristlecone pine chronology (Ferguson & Graybill 1983) were ^{14}C dated as well. A limited number of samples from the Irish oak chronology (Pilcher *et al.* 1984) was used near 500 BC. Refer to Stuiver and Becker (1986) for wood pretreatment procedures. Cellulose, isolated from the decadal wood samples, was used for all 2500–6000 BC ^{14}C determinations.

CORRECTIONS

At the start of our time-scale calibration efforts in 1973, the CO_2 samples were stored in pyrex reservoirs for at least four weeks (Procedure 1). Radon decay took place during storage, and as a result, no detectable α particles were present in our α channel. Having never detected tree-ring radon in the α channels, we terminated their use some years later. Unfortunately, laboratory procedures were changed in 1976. Since then, tree-ring samples, after storage for four weeks, were purified on a self-circulating Cu oven (a pyrex reservoir filled with electrolytic copper wire and silver ribbon) at 450 °C before being admitted into the counter (Procedure 2). Small amounts of radon, most likely released from the walls of the heated reservoir, became part of the CO_2 sample. Once the problem was recognized, we determined the count-rate differences (routinely four days of counting) of samples subjected either to Procedure 1 or Procedure 2 for three of our counters to be $\Delta Ra = 0.274 \pm 0.090$, 0.276 ± 0.028 and 0.319 ± 0.090 counts per minute (cpm) (weighted average, 0.279 ± 0.026 cpm). Our radon correction for tree-ring samples (those measured for the 1977–1987 interval) is based on the above incremental four-day sample count-rate increase. As we kept Procedure 1 for routine (as opposed to high-precision) ^{14}C determinations, a radon correction is not needed for these samples.

The radon contribution can also be estimated from a comparison of the first- and last-day count-rate differences of 1) samples (ΔSa), and 2) oxalic acid and background standards (ΔOx and ΔB). Routine sample counts lasted four days; standards were routinely counted for three days. Procedure 2 was followed for all samples during the 1977–1987 period, and Procedure 1 for the standards, except for one counter where the oxalic acid CO_2, after repurification, was subjected to Procedure 2. In this case, the radon contribution was also properly accounted for, but for simplicity, we discuss only the results obtained for Procedure 1 standard counts.

Each counter completes about 50 sample runs per year, as well as 25 runs of oxalic acid and background. Figure 1 gives the yearly averaged ΔSa and ΔB values of the counter longest in operation (LC-4), together with ΔOx values of the LC-5 counter (for LC-4, the oxalic acid treatments did not always follow Procedure 1).

Procedure 1 background runs for 1977–1987 yield $\Delta B = 0.025 \pm 0.017$ cpm; Procedure 2 sample runs over the same interval yield $\Delta Sa = 0.189 \pm 0.049$ cpm. As expected, lower ΔSa values (0.035 ± 0.024 and 0.073 ± 0.081 cpm) are encountered for the 1973–1975 and 1989–1990 periods, when only Procedure 1 was used. Further, oxalic acid runs with Procedure 1 only in counter LC-5 yield a 14-yr ΔOx average of 0.012 ± 0.070 cpm (Fig. 1).

First- and last-day sample count-rate differences, ΔSa, were converted to ΔRa, using the half-life of radon of slightly less than four days. For our tree-ring counters, we determined ΔRa values of 0.285 ± 0.028, 0.247 ± 0.029 and 0.295 ± 0.030 cpm (LC4, 5 and 6, respectively). The weighted average, 0.276 ± 0.016 cpm, is in excellent agreement with the directly measured ΔRa values averaging 0.279 ± 0.026.

The above analysis not only confirms the validity of the radon correction, but can also be used as a test of counting stability. For instance, for the four years, 1984–1987, the scatter standard deviation in the first- to last-day count differences, ΔSa, ΔOx and ΔB (Counter LC-5) are 0.297, 0.315, 0.400 and 0.371 cpm for ΔSa; 0.468, 0.419, 0.459 and 0.372 cpm for ΔOx; and 0.090, 0.075, 0.072, and 0.070 cpm for ΔB. This gives a four-year average scatter standard deviation in the count differences of 0.346 cpm for ΔSa, 0.430 cpm for ΔOx and 0.077 cpm for ΔB. The (average) total counts accumulated during a counting day yields a Poisson standard deviation in the difference of about 0.308 cpm for ΔSa, 0.400 cpm for ΔOx and 0.060 cpm for ΔB. Thus, we

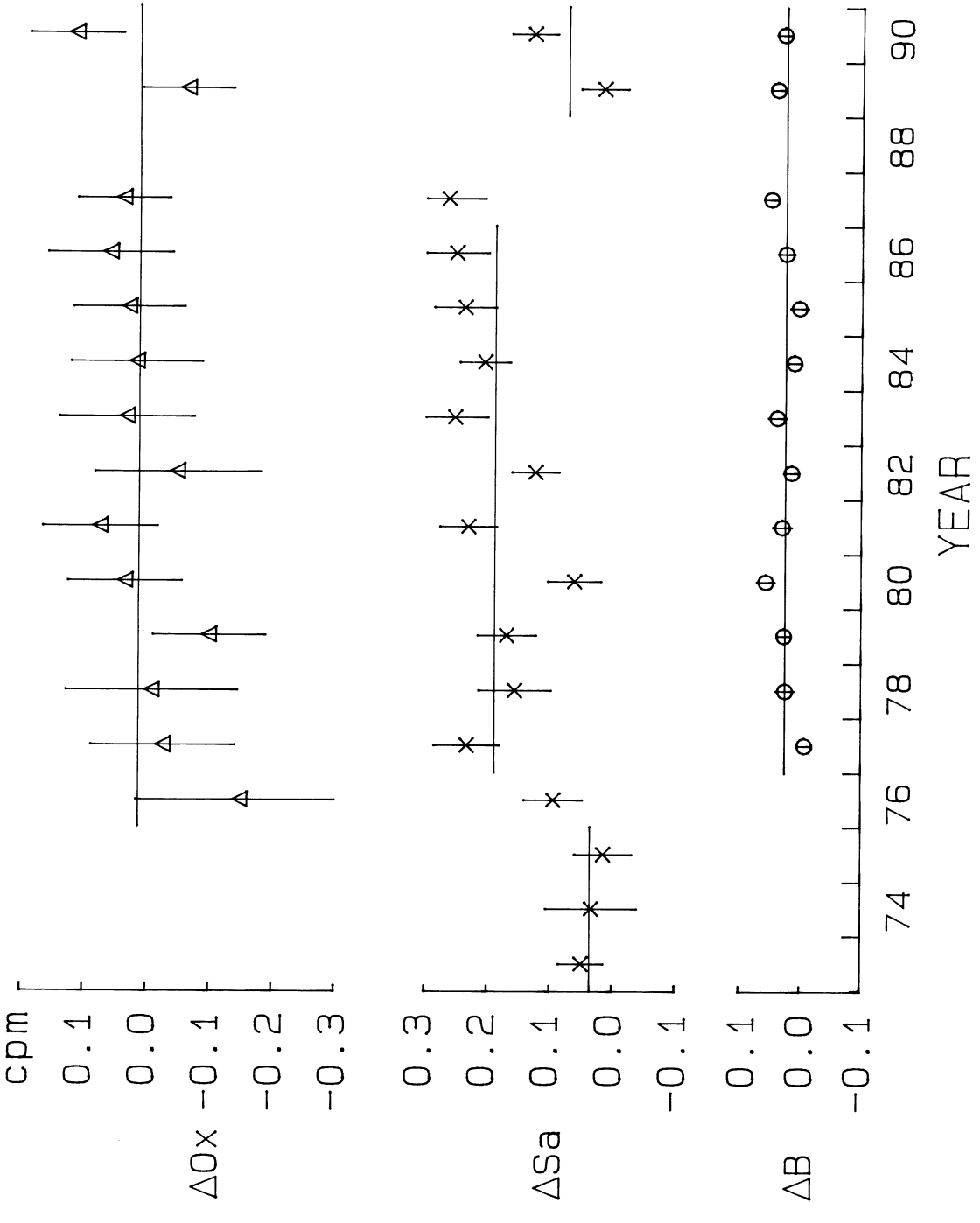

Fig. 1. First- and last-day counting-rate differences of samples (ΔSa, 4-day count) and standards (ΔOx and ΔB; 3-day counts). Sample and background values are yearly averages in Counter LC-4, oxalic acid similarly for Counter LC-5 (see text).

obtain error multipliers for the counting of samples and standards of 0.346/0.308 = 1.12(K_{Sa}), 0.430/0.400 = 1.08(K_{Ox}) and 0.077/0.060 = 1.28(K_B). Results for different years and different counters yield similar results, demonstrating excellent long-term counting stability.

The relative radon count-rate contribution, as a percentage of the observed sample counting rate, decreases when sample counts increase (younger samples). Correcting for the radon contribution results in an age increase of 10 ^{14}C yr for tree-ring samples that are a few hundred years old, and about 30 ^{14}C yr for 4500 yr-old samples.

REPRODUCIBILITY AND SYSTEMATIC DIFFERENCES

The ^{14}C ages reported are conventional ^{14}C ages (Stuiver & Polach 1977). As noted in the introduction, the Poisson-derived standard deviation has been multiplied with an error multiplier, K, of either 1.6 or 1.7. The justification of such a multiplier is given in Stuiver and Pearson (1992, 1993). The standard deviations shown in Table 1 reflect actual reproducibility. The CO_2 gas proportional counters used for the previous study (Stuiver & Becker 1986) also were used for the present one.

A comparison of Table 1 Seattle ^{14}C ages to those obtained by other laboratories confirms the validity of the choice of error multiplier. Systematic differences, although often confined to a decade or less, are more problematic. For the nearly 8000-yr Seattle and Belfast series (nearly 400 bidecadal data points), we find an average offset of <1 ^{14}C yr, but this offset is not uniformly distributed. The offsets found for individual millennia are in the 0–17 ^{14}C-yr range, with the exception of the 5180–5500 BC interval, where the ^{14}C ages differ by an unacceptable 54±5 yr (Stuiver & Pearson 1993). Seattle and Heidelberg (Kromer *et al.* 1986) results differ by 41±4 yr for the 4075–5265 BC and 5805–5995 BC intervals. The reasons for these offsets in the 40–50 yr range are not clear. Several other comparisons, *e.g.,* with Groningen (3210–3910 BC), Tucson (5680–5810 BC), La Jolla (2500–5000 BC), Pretoria (1930–3350 BC) imply the lack of statistically significant offsets (Stuiver& Pearson 1993). It is fair to conclude that systematic offsets in Table 1 are most likely confined to 1 or 2 decades, except for the 5180–5500 BC interval, where an offset up to 54 yr is possible.

CALIBRATION INSTRUCTIONS

We recommend that users of ^{14}C dates obtain additional information on reproducibility (and systematic error, if any) from the laboratory reporting the ^{14}C date. This information should lead to a realistic standard deviation in the reported age. A systematic error has to be deducted from, or added to, the reported ^{14}C age prior to age calibration.

Only the calibration curve is given in Figure 2; the one sigma (1σ; standard deviation) uncertainty in the curve is not given. The standard deviation (averaging 24 ^{14}C yr) is tabulated in Table 1 for each decadal midpoint. Table 1 standard deviations reflect the entire variance in the age determination process.

Cal BP ages are relative to the year AD 1950, with 0 cal BP equal to AD 1950. The relationship between cal AD/BC and Cal BP ages is cal BP = 1950 – cal AD, and cal BP = 1949 + cal BC. The switch from 1950 to 1949 when converting BC ages is caused by the absence of the year zero in the AD/BC chronology.

The conversion of a ^{14}C age to a cal age is as follows: 1) draw line A parallel to the bottom axis through the ^{14}C age to be converted; 2) draw vertical line(s) through the intercept(s) of line A and

the calibration curve. The cal AD/BC ages can be read at the bottom axis, the cal BP ages at the top.

To convert the standard error in the ^{14}C age into a range of cal AD/BC (BP) ages, determine the sample standard deviation, σ, by multiplying the quoted laboratory standard deviation with the "error multiplier". Unfortunately, information on error multipliers is often lacking. Here, the ^{14}C age user should refer to K values given above, or to the Scott, Long and Kra (1990).

Once the sample σ is known, the curve σ should be read from Table 1. The curve σ and sample σ should then be used to calculate total $\sigma = ((\text{sample } \sigma)^2 + (\text{curve } \sigma)^2)^{1/2}$ (Stuiver 1982). Lines parallel to A should now be drawn through the ^{14}C age + total σ, and ^{14}C age – total σ value. The vertical lines drawn through the intercepts now yield the outer limits of possible cal AD/BC (cal BP) ages that are compatible with the sample standard deviation.

The conversion procedure yields 1) single or multiple cal AD/BC (BP) ages that are compatible with a certain ^{14}C age, and 2) the range(s) of cal ages that correspond(s) to the standard deviation in the ^{14}C age (and calibration curve). Here, the user has to determine the calibrated ages from the Figure 2 graphs by drawing lines, whereas an alternate approach would be to use the computerized calibration (CALIB 3.0) program discussed elsewhere in this issue (Stuiver & Reimer 1993).

The probability that a certain cal age is the actual sample age may be quite variable within the cal age range. Higher probabilities are encountered around the intercept ages. The non-linear transform of a near-Gaussian distribution around a ^{14}C age into cal AD/BC (cal BP) age is not a simple matter, and computer programs are needed to derive the complex probability distribution. The CALIB 3.0 program (Stuiver & Reimer 1993) incorporates such probability distributions.

The calibration data presented here are valid for northern hemispheric samples that were formed in equilibrium with atmospheric $^{14}CO_2$. Systematic age differences are possible for the southern hemisphere, where ^{14}C ages of wood samples tend to be about 40 yr older (Vogel *et al.* 1993). Thus, ^{14}C ages of southern hemispheric samples preceding our era of fossil-fuel combustion should be reduced by 40 yr before being converted into cal AD/BC (BP) ages.

The calibration curve is valid only for age conversion of samples that were formed in equilibrium with atmospheric CO_2. Conventional ^{14}C ages of materials not in equilibrium with atmospheric reservoirs do not take into account the offset in ^{14}C age that may occur (Stuiver & Polach 1977). A constant offset, or reservoir deficiency, must be deducted from the reported ^{14}C age before any attempt can be made to convert to cal AD/BC (BP) ages.

The reservoir deficiency is time dependent for the mixed (and deep) layer of the ocean. For the calibration of marine Holocene samples, the reader is referred to Stuiver and Braziunas (1993), and, of course, the CALIB 3.0 program.

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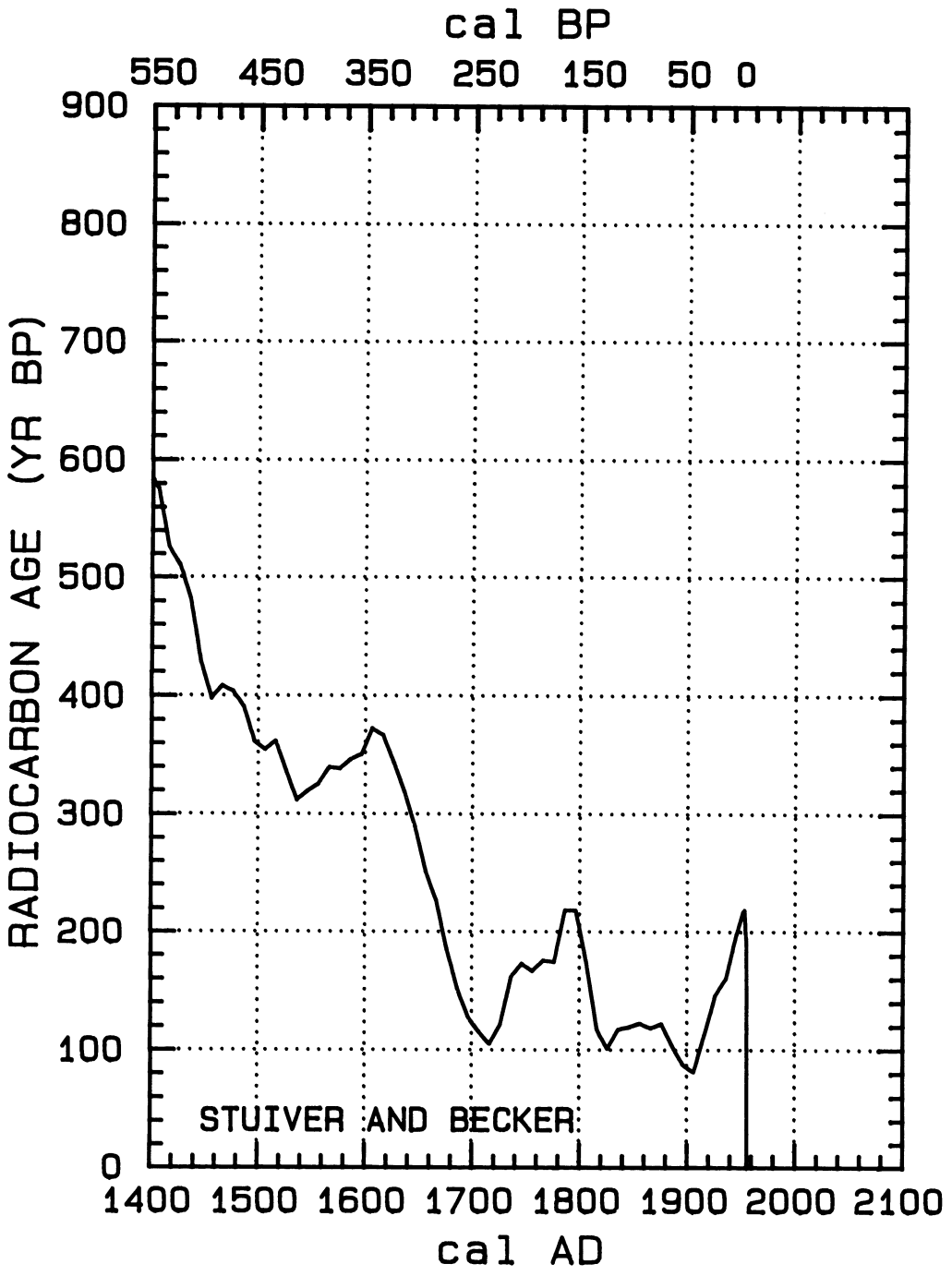


Fig. 2A–P. ^{14}C calibration curve derived from decadal samples

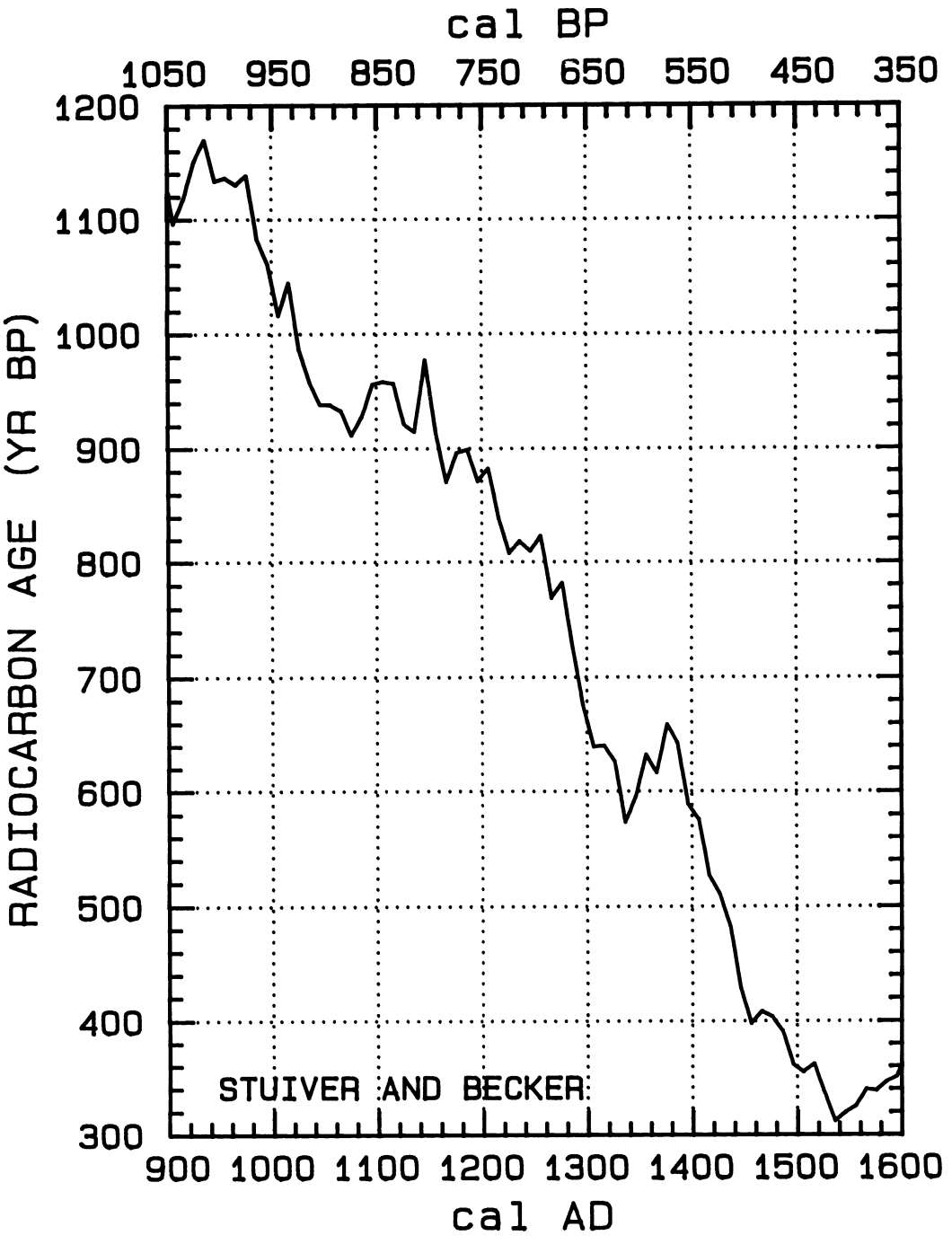

cal BP
1050 950 850 750 650 550 450 350
1200
1100
1000
900
800
700
600
500
400
300
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
900 1000 1100 1200 1300 1400 1500 1600
cal AD

Fig. 2B

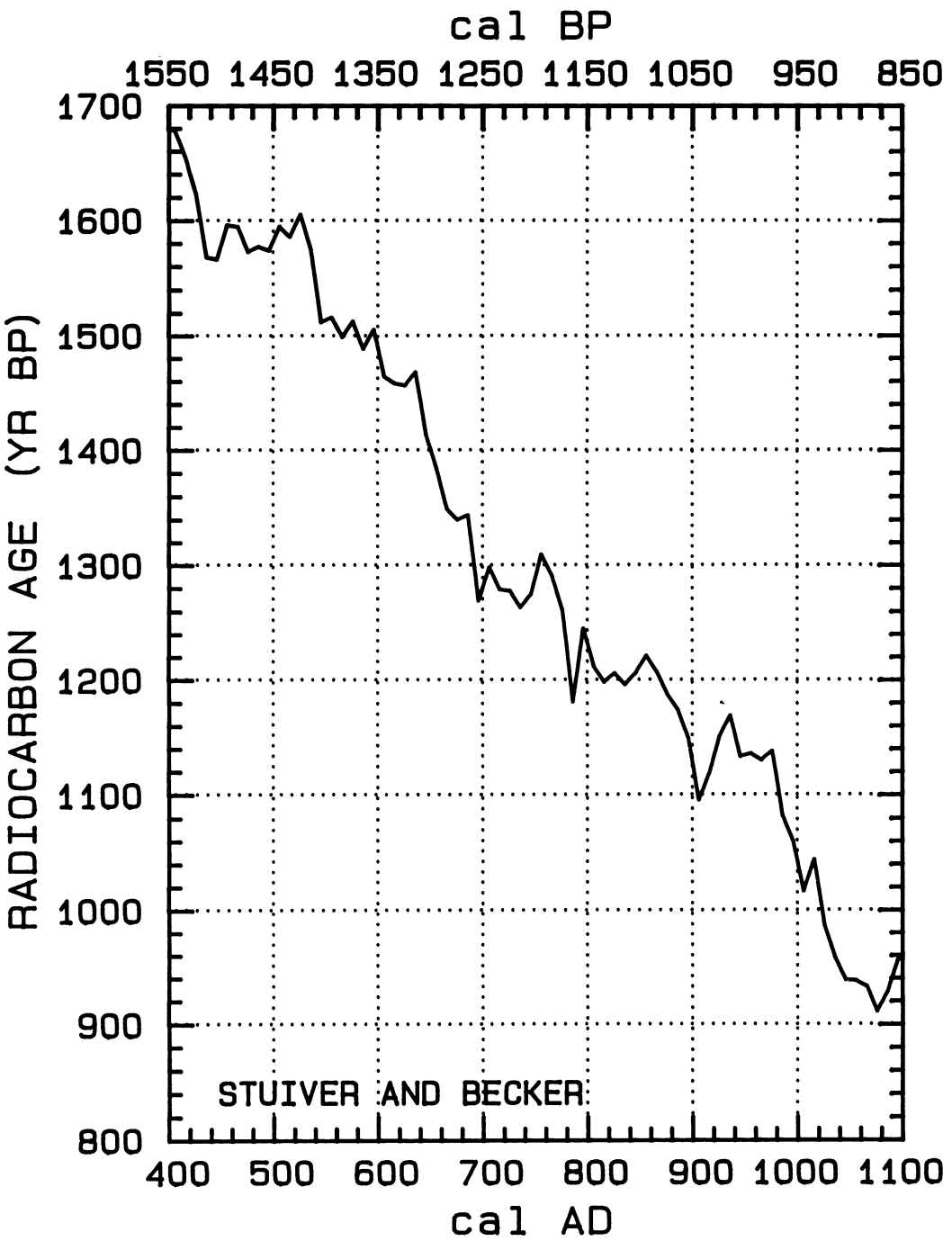
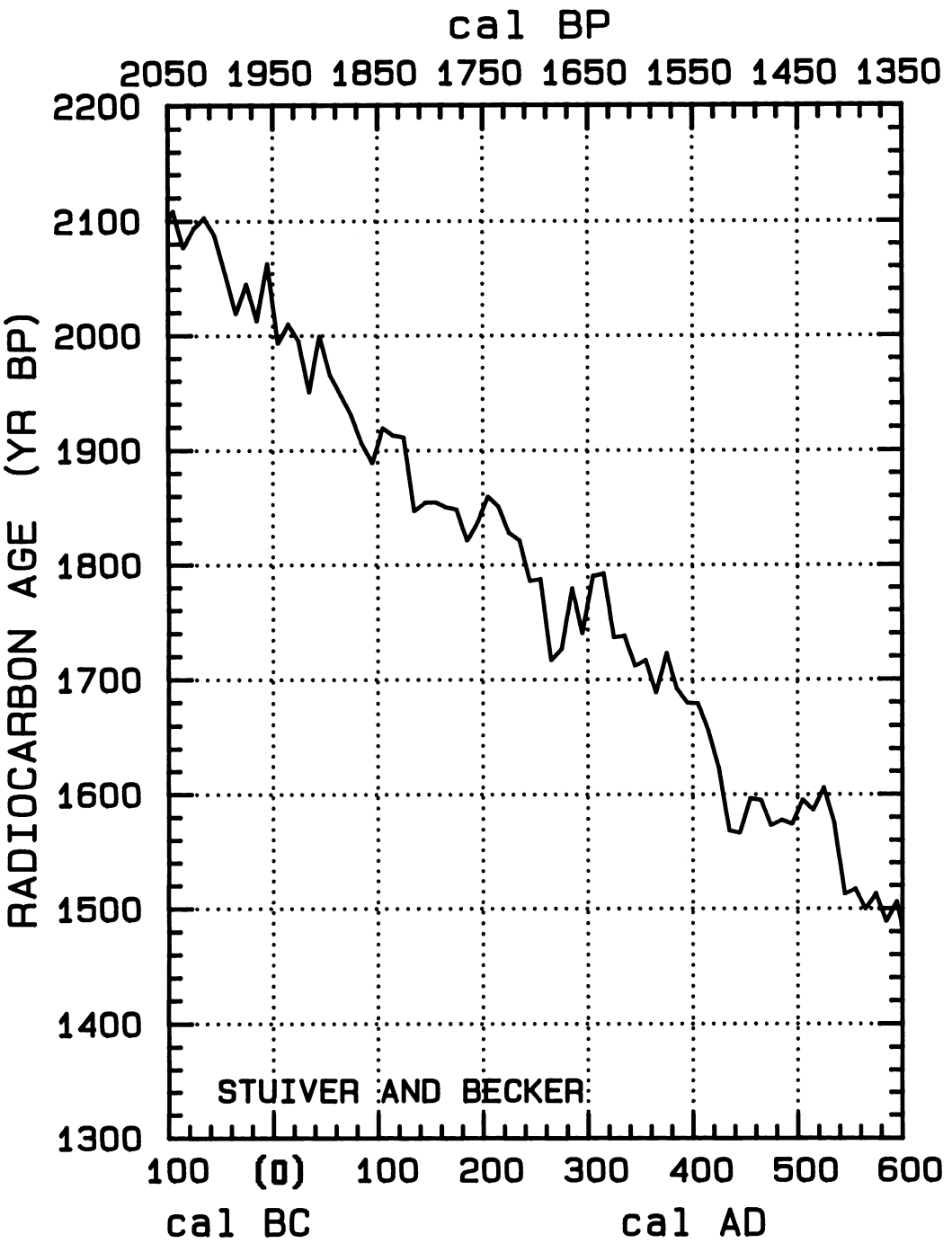

cal BP
1550 1450 1350 1250 1150 1050 950 850
1700
1600
1500
1400
1300
1200
1100
1000
900
800
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
400 500 600 700 800 900 1000 1100
cal AD

Fig. 2C


cal BP
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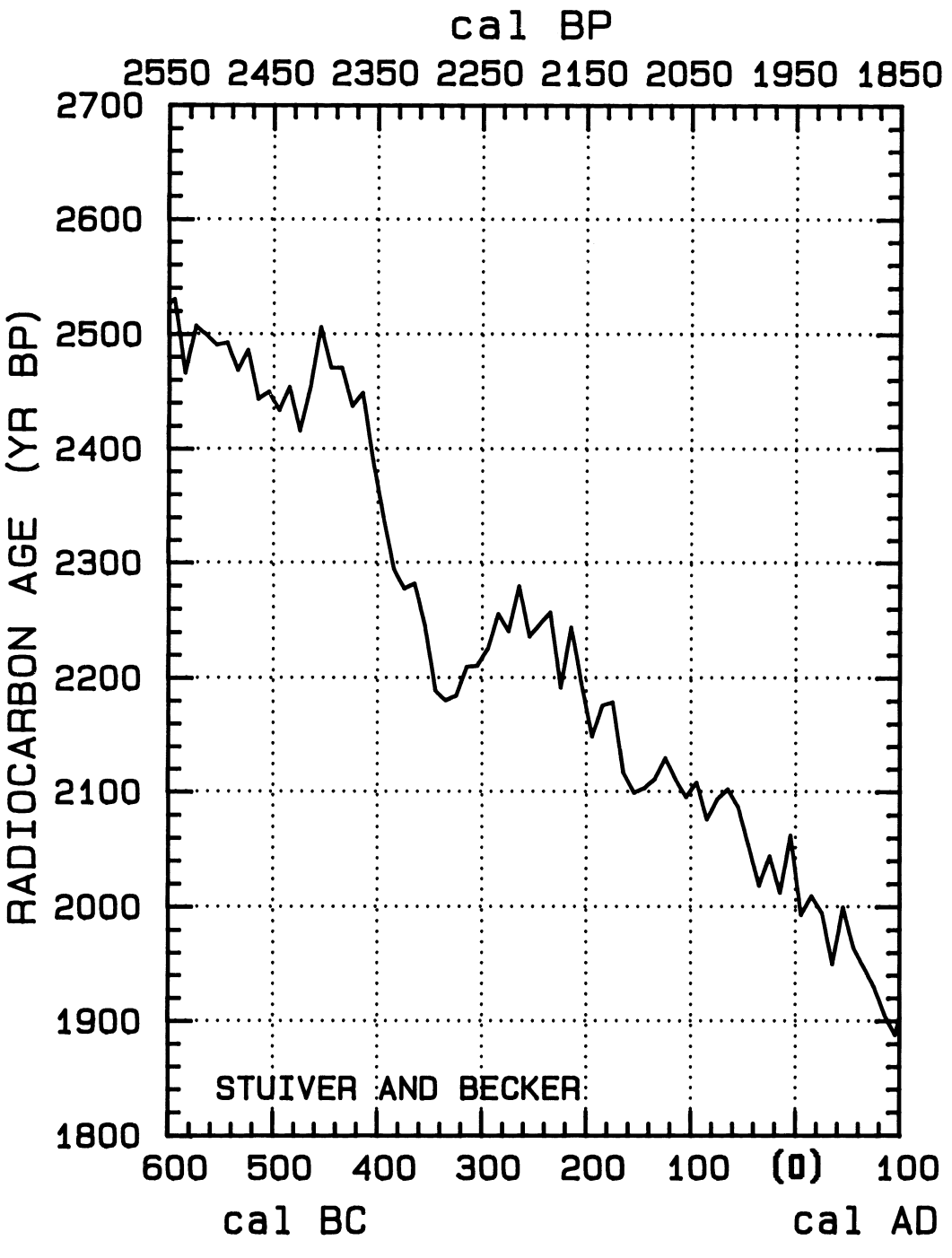
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
100 (0) 100 200 300 400 500 600
cal BC
cal AD

Fig. 2D


cal BP
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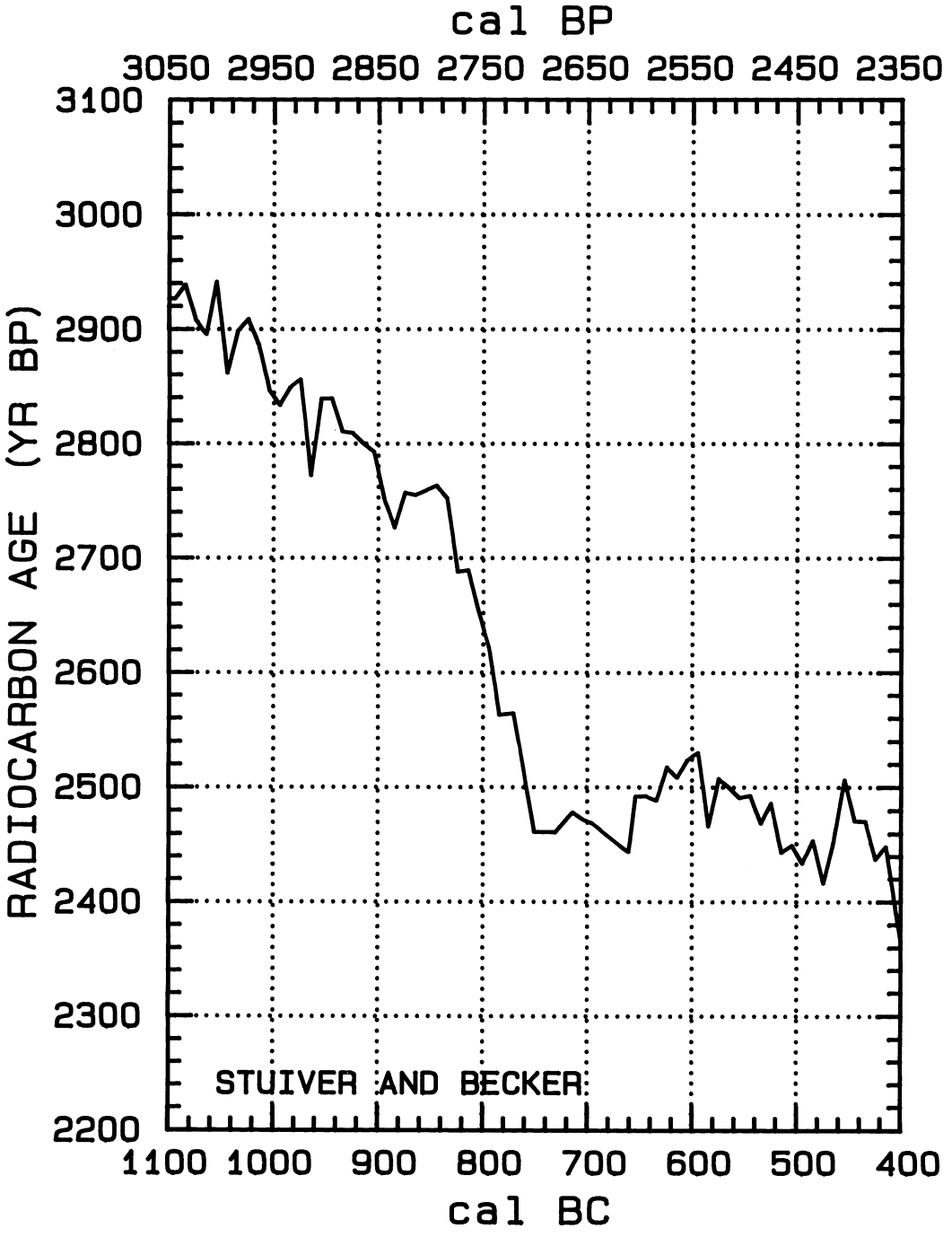
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
600 500 400 300 200 100 (0) 100
cal BC
cal AD

Fig. 2E


cal BP
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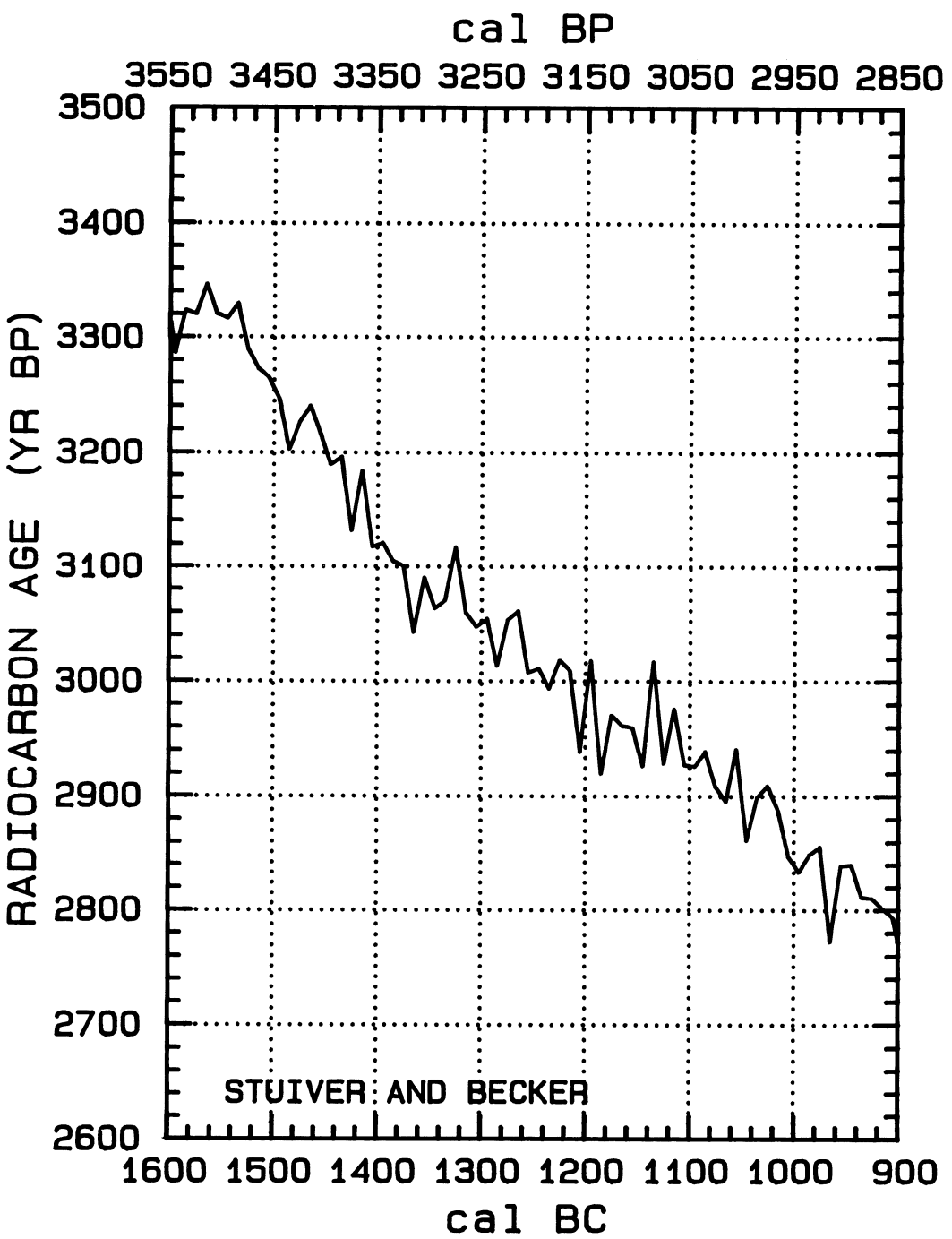
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
1100 1000 900 800 700 600 500 400
cal BC

Fig. 2F


cal BP
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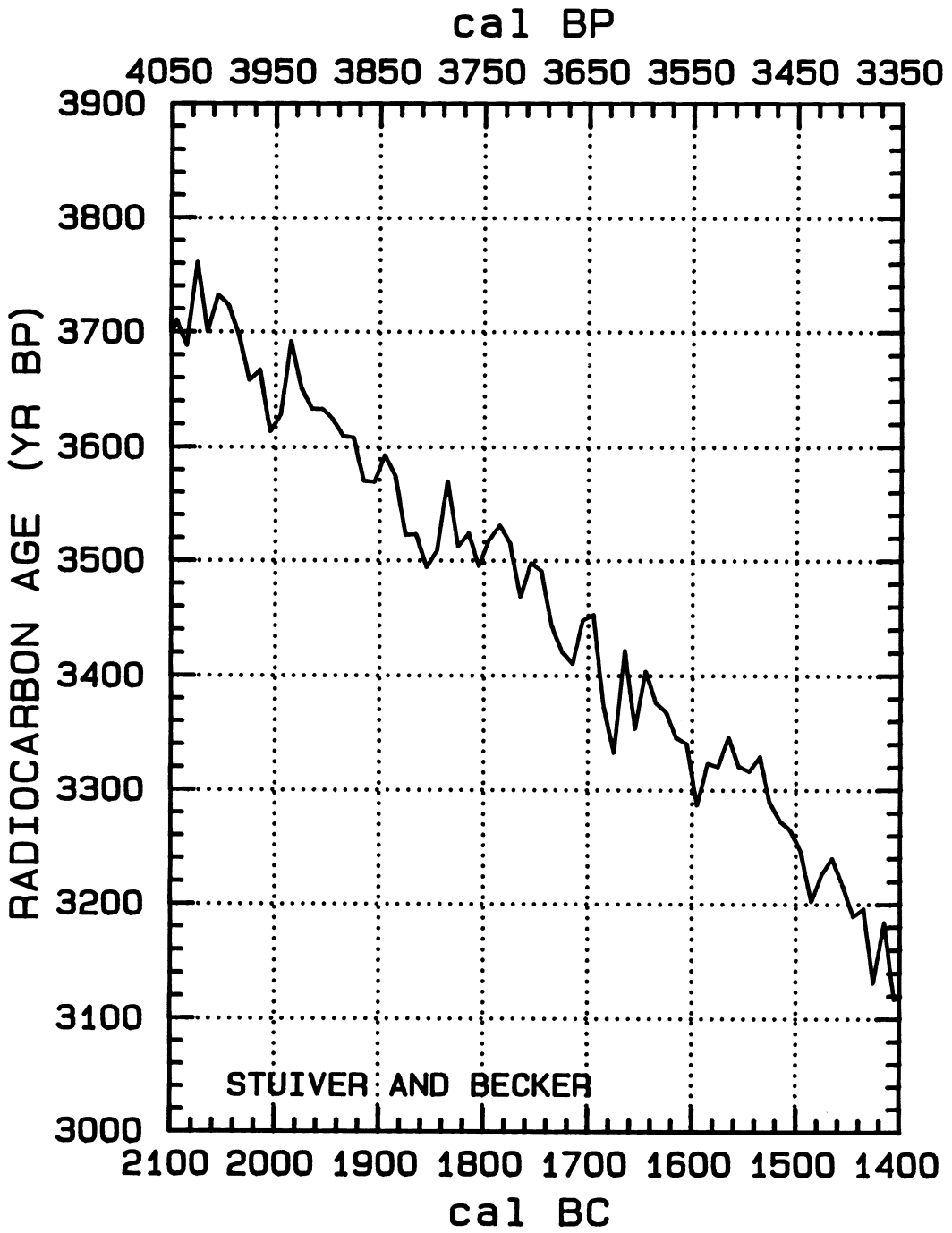
3500
3400
3300
3200
3100
3000
2900
2800
2700
2600
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
1600 1500 1400 1300 1200 1100 1000 900
cal BC

Fig. 2G


cal BP
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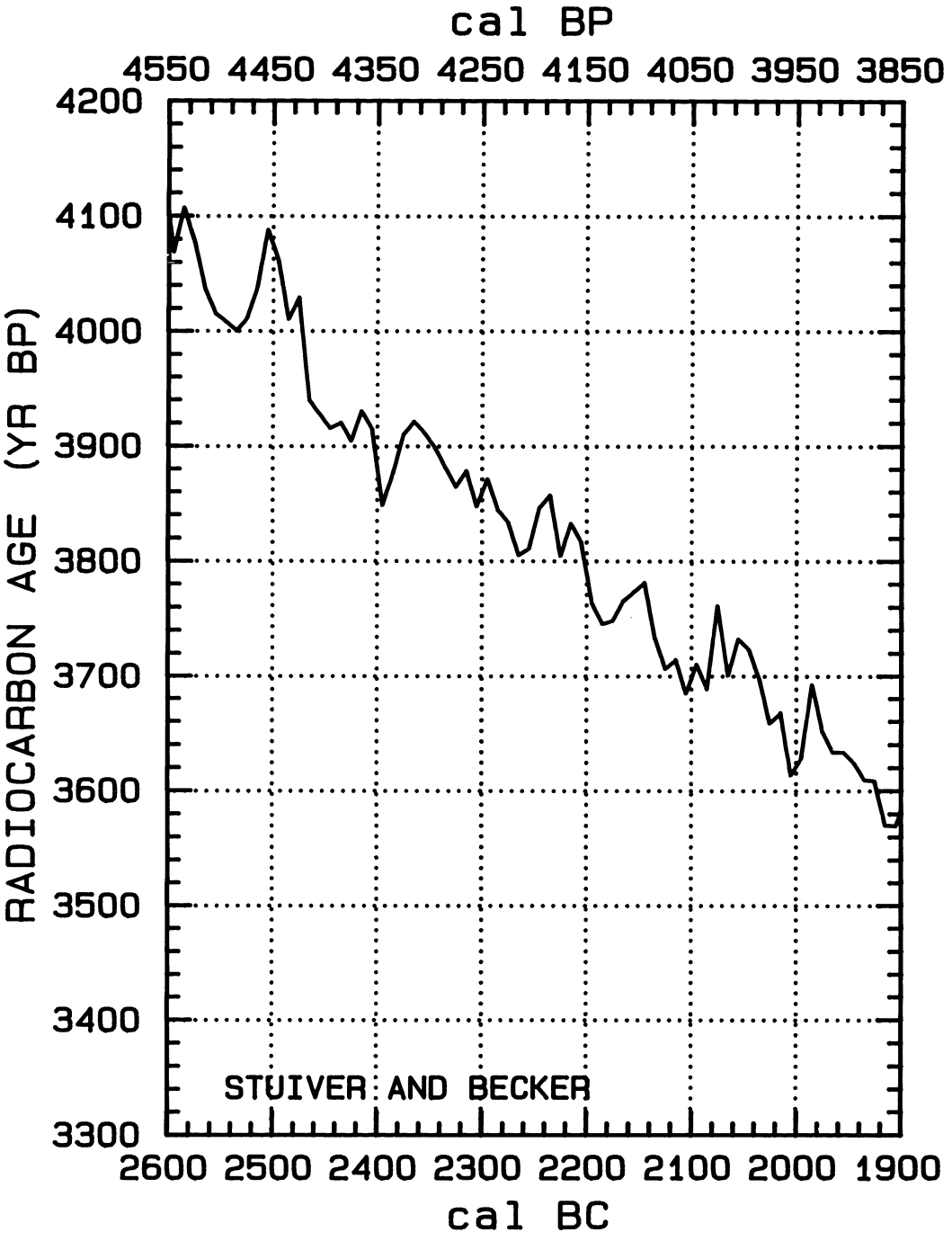
3900
3800
3700
3600
3500
3400
3300
3200
3100
3000
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
2100 2000 1900 1800 1700 1600 1500 1400
cal BC

Fig. 2H


cal BP
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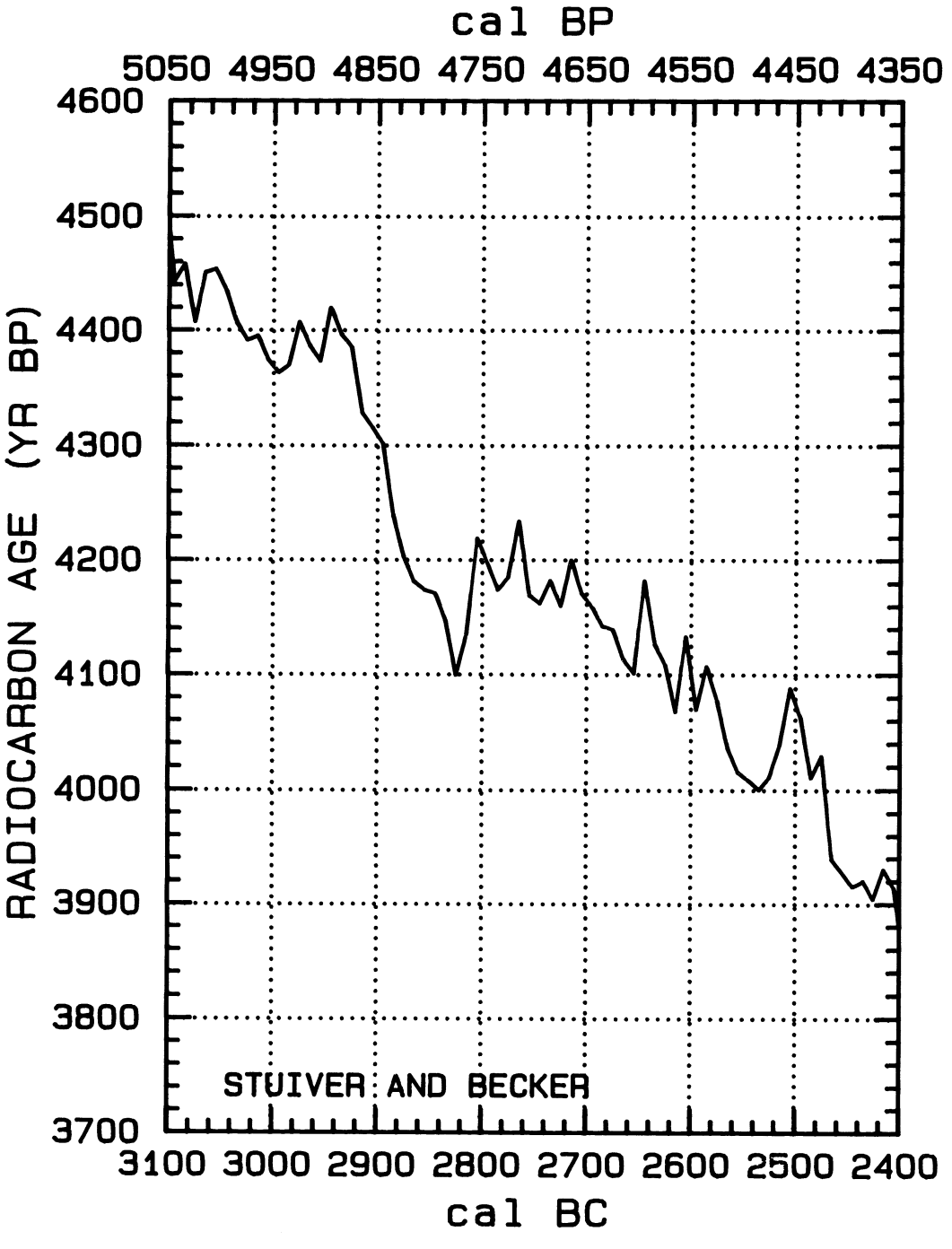
4200
4100
4000
3900
3800
3700
3600
3500
3400
3300
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
2600 2500 2400 2300 2200 2100 2000 1900
cal BC

Fig. 2I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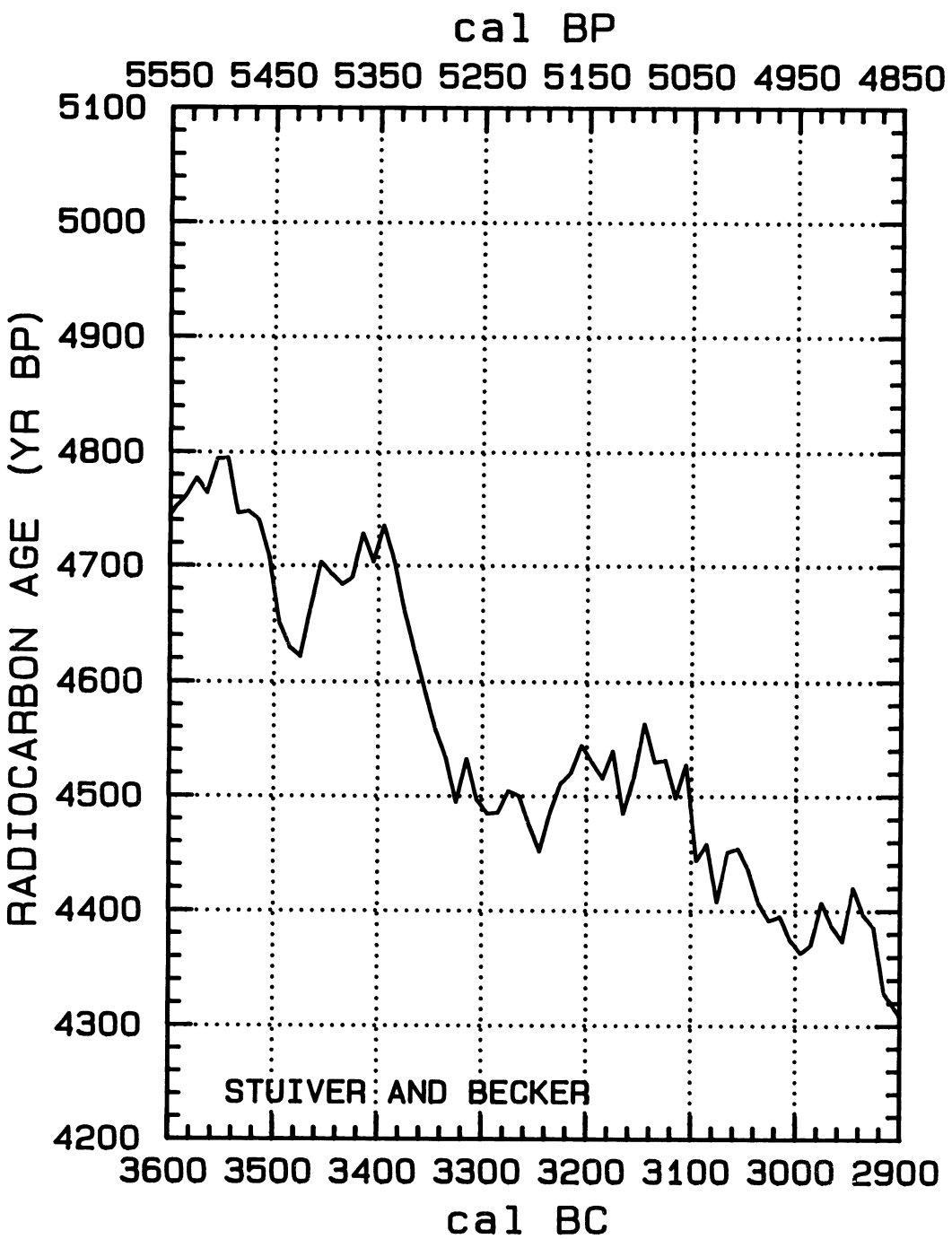
4600
4500
4400
4300
4200
4100
4000
3900
3800
3700
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
3100 3000 2900 2800 2700 2600 2500 2400
cal BC

Fig. 2J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5100
5000
4900
4800
4700
4600
4500
4400
4300
4200
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
3600 3500 3400 3300 3200 3100 3000 2900
cal BC

Fig. 2K

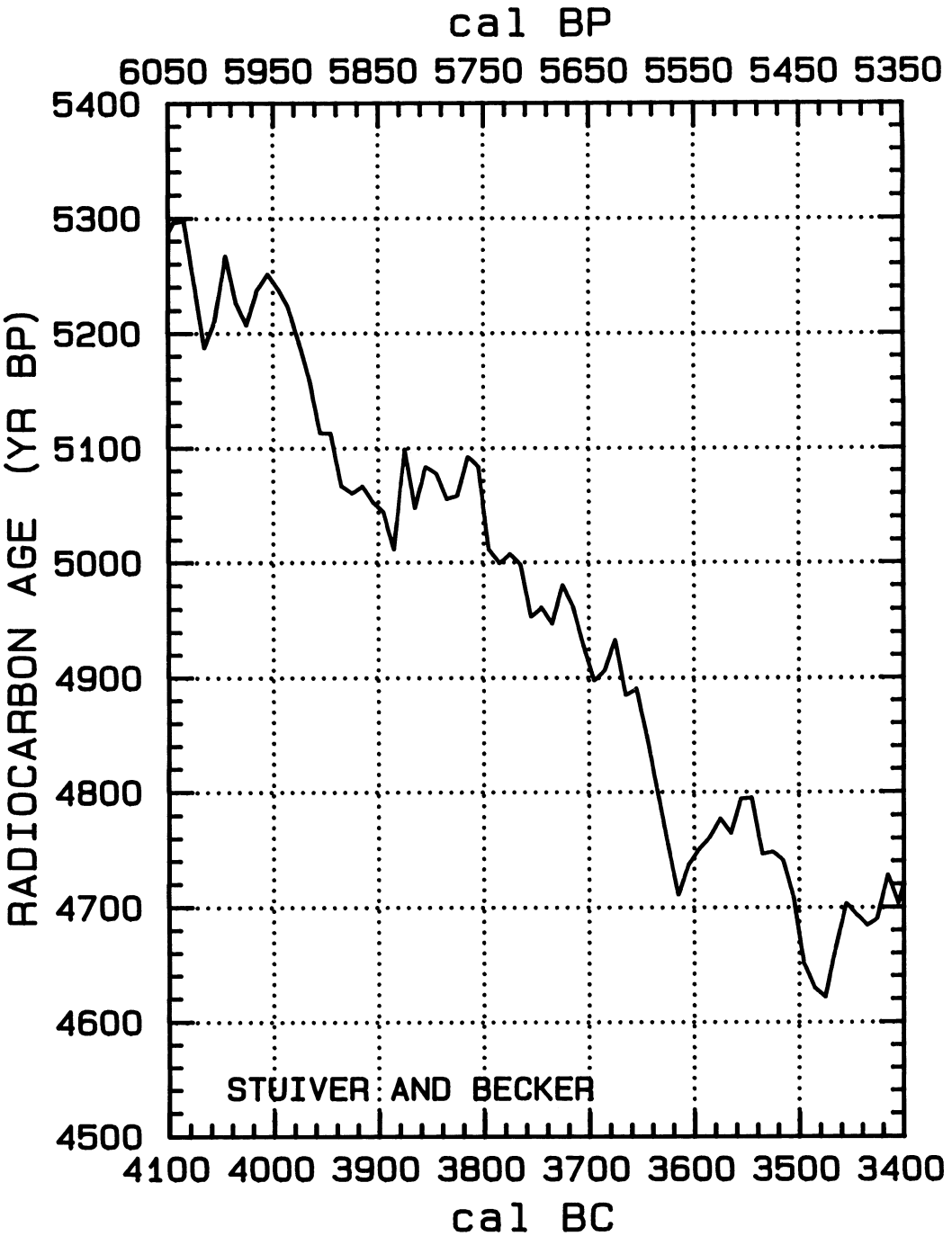

cal BP
6050 5950 5850 5750 5650 5550 5450 5350
5400
5300
5200
5100
5000
4900
4800
4700
4600
4500
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
4100 4000 3900 3800 3700 3600 3500 3400
cal BC

Fig. 2L

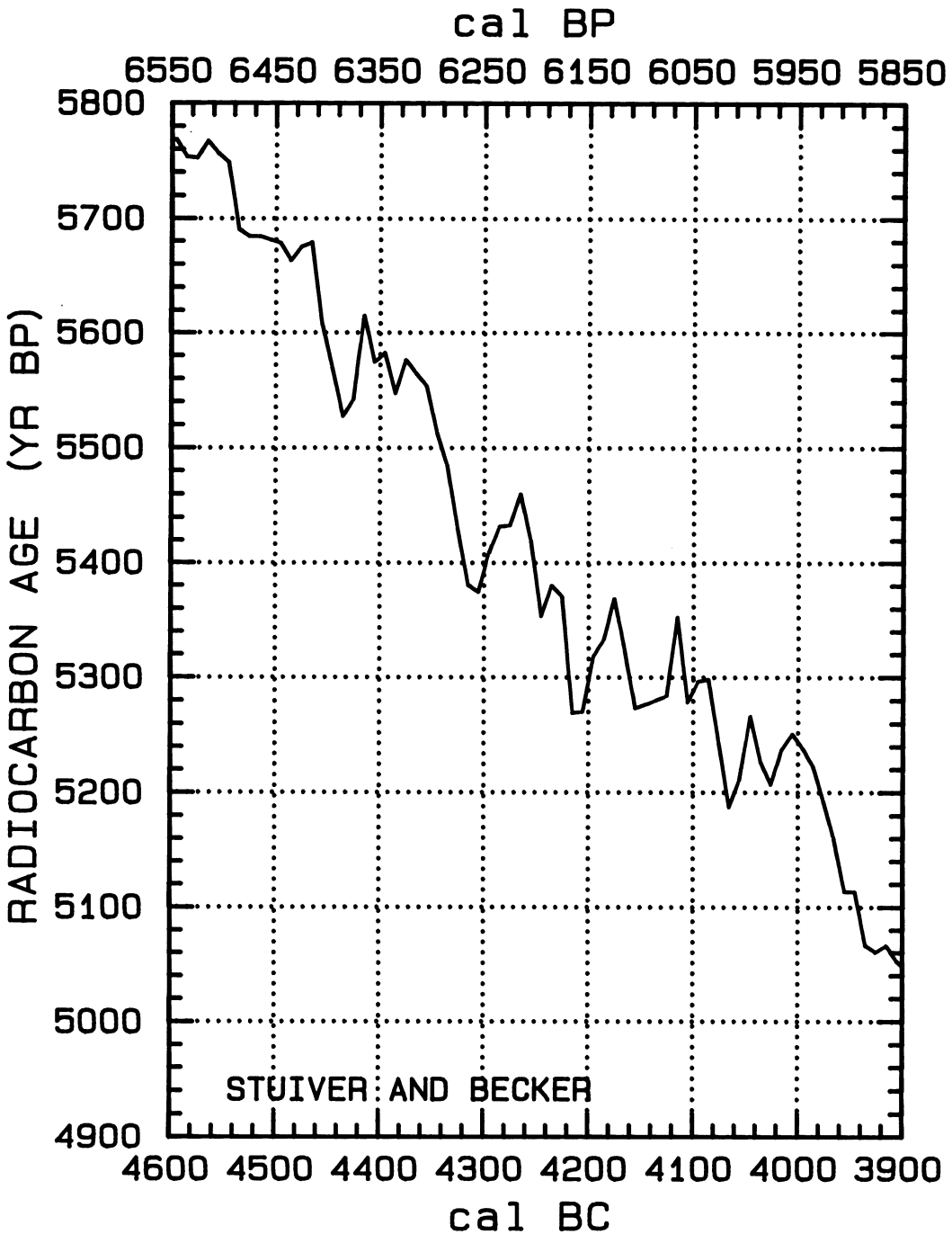

cal BP
6550 6450 6350 6250 6150 6050 5950 5850
5800
5700
5600
5500
5400
5300
5200
5100
5000
4900
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
4600 4500 4400 4300 4200 4100 4000 3900
cal BC

Fig. 2M

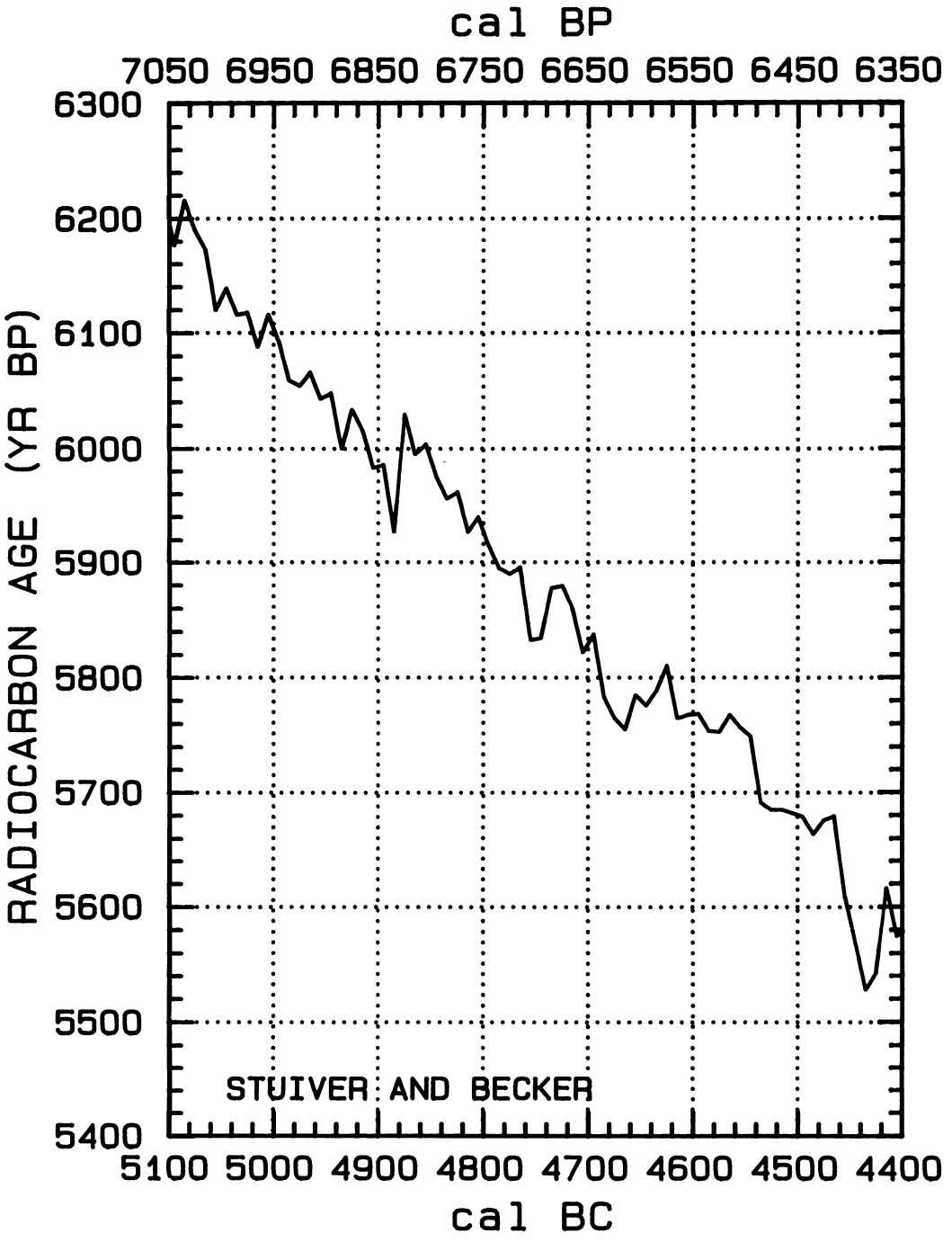
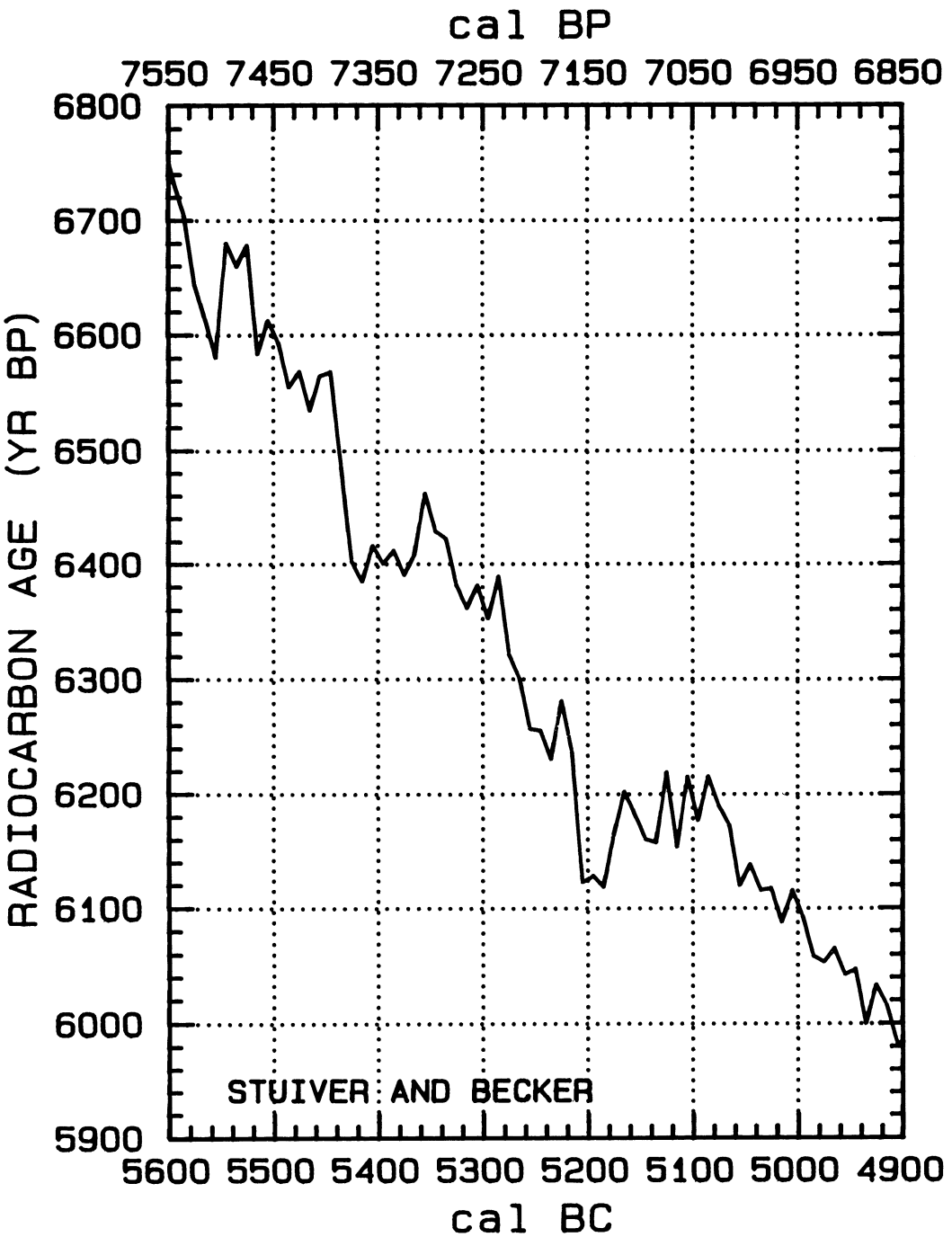

cal BP
7050 6950 6850 6750 6650 6550 6450 6350
6300
6200
6100
6000
5900
5800
5700
5600
5500
5400
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
5100 5000 4900 4800 4700 4600 4500 4400
cal BC

Fig. 2N


cal BP
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6800
6700
6600
6500
6400
6300
6200
6100
6000
5900
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
5600 5500 5400 5300 5200 5100 5000 4900
cal BC

Fig. 20

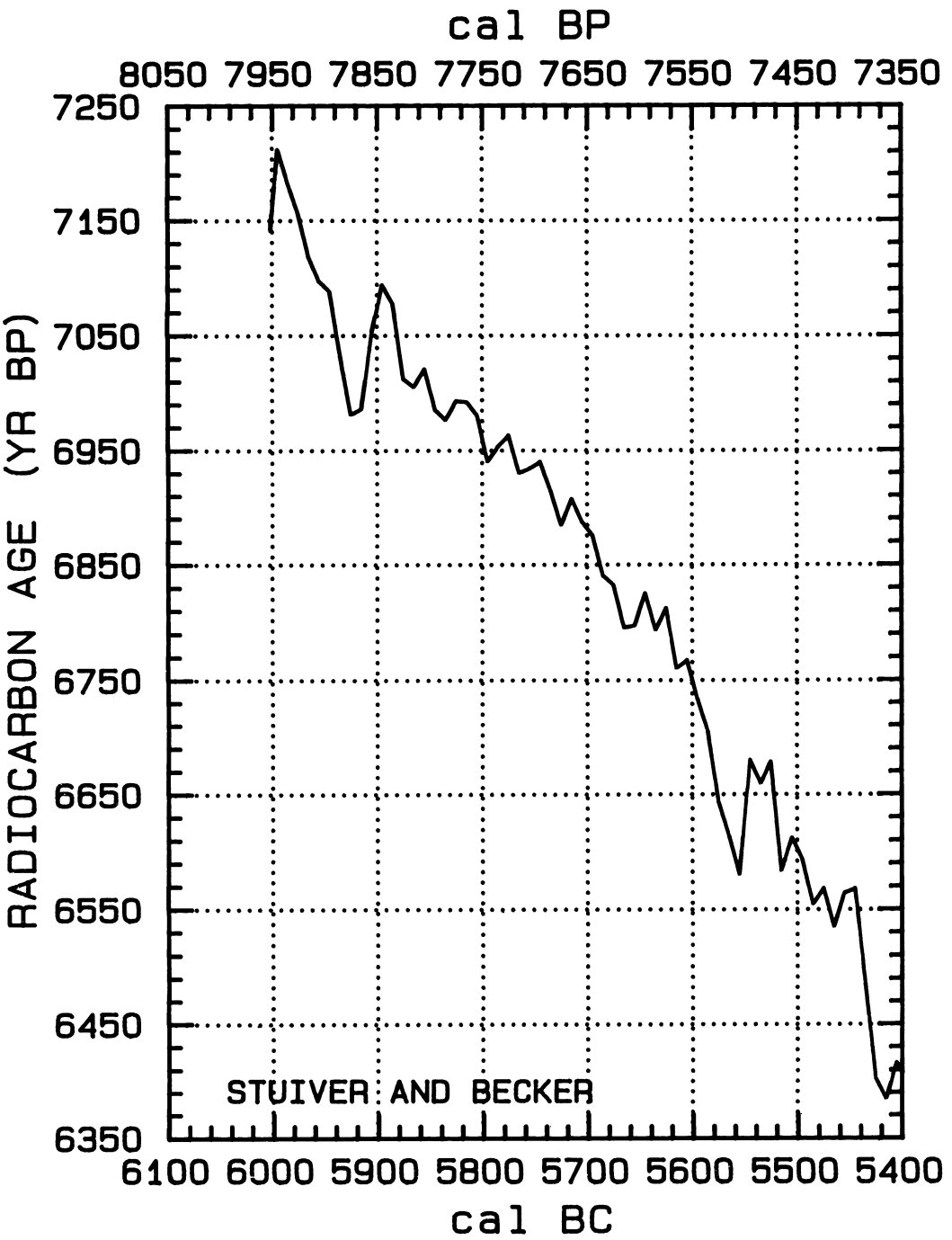
cal BP
8050 7950 7850 7750 7650 7550 7450 7350
7250
7150
7050
6950
6850
6750
6650
6550
6450
6350
RADIOCARBON AGE (YR BP)
STUIVER AND BECKER
6100 6000 5900 5800 5700 5600 5500 5400
cal BC

Fig. 2P

TABLE 1. ^{14}C age determinations made at the University of Washington (Seattle). The cal AD/BC ages (or cal BP) represent the midpoints of 10-yr wood sections, except when 20-yr samples were needed to obtain the quantity of treated wood used for a measurement (661.5, 696.5, 731.5, 751.5 and 771.5 BC). The standard deviation in the age and $\Delta^{14}C$ (defined in Stuiver & Polach (1977)) values includes a 1.6 or 1.7 error multiplier (see text). Overlapping decadal samples with midpoints no greater than 1 yr apart were averaged. Single-year data were averaged with decadal data for the AD 1515–1935 interval, and only single-year data were used for the AD 1945 data point.

Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP	Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP
AD 1945	−23.7 ± .8	199 ± 7	5	AD 1535	11.5 ± .7	312 ± 5	415
AD 1935	−18.0 ± .8	161 ± 6	15	AD 1525	9.7 ± .8	336 ± 7	425
AD 1925	−15.0 ± .8	146 ± 6	25	AD 1515	7.7 ± .9	362 ± 7	435
AD 1915	−9.8 ± .6	113 ± 5	35	AD 1505	9.8 ± 1.6	355 ± 13	445
AD 1905	−4.7 ± 1.0	81 ± 8	45	AD 1495	10.1 ± 2.0	362 ± 16	455
AD 1895	−4.2 ± 1.1	88 ± 9	55	AD 1485	7.6 ± 2.6	392 ± 21	465
AD 1885	−5.0 ± .7	104 ± 5	65	AD 1475	7.2 ± 2.8	404 ± 23	475
AD 1875	−6.1 ± .7	122 ± 5	75	AD 1465	7.9 ± 2.9	409 ± 23	485
AD 1865	−4.5 ± .7	119 ± 6	85	AD 1455	10.5 ± 2.0	398 ± 16	495
AD 1855	−3.9 ± .9	123 ± 8	95	AD 1445	7.9 ± 2.4	428 ± 19	505
AD 1845	−2.1 ± .8	120 ± 6	105	AD 1435	2.3 ± 2.9	483 ± 23	515
AD 1835	−0.7 ± .7	117 ± 6	115	AD 1425	0.0 ± 2.7	511 ± 21	525
AD 1825	2.6 ± .6	101 ± 5	125	AD 1415	−0.8 ± 2.8	527 ± 22	535
AD 1815	1.7 ± .8	118 ± 7	135	AD 1405	−5.7 ± 2.6	576 ± 21	545
AD 1805	−3.9 ± .8	173 ± 6	145	AD 1395	−6.1 ± 2.8	589 ± 23	555
AD 1795	−8.4 ± .8	219 ± 7	155	AD 1385	−11.6 ± 2.0	643 ± 16	565
AD 1785	−7.3 ± .8	219 ± 7	165	AD 1375	−12.4 ± 2.2	659 ± 18	575
AD 1775	−0.9 ± .7	174 ± 6	175	AD 1365	−5.9 ± 2.1	616 ± 17	585
AD 1765	0.2 ± .8	175 ± 6	185	AD 1355	−6.7 ± 2.3	632 ± 18	595
AD 1755	2.6 ± .6	167 ± 5	195	AD 1345	−0.9 ± 2.3	596 ± 19	605
AD 1745	3.0 ± .7	173 ± 6	205	AD 1335	3.1 ± 2.0	573 ± 16	615
AD 1735	5.5 ± .8	161 ± 6	215	AD 1325	−2.4 ± 2.1	627 ± 17	625
AD 1725	12.0 ± .6	122 ± 5	225	AD 1315	−2.9 ± 2.6	641 ± 21	635
AD 1715	15.2 ± .5	105 ± 4	235	AD 1305	−1.6 ± 1.6	640 ± 13	645
AD 1705	15.2 ± .5	116 ± 4	245	AD 1295	−4.9 ± 2.9	676 ± 24	655
AD 1695	14.8 ± .5	129 ± 4	255	AD 1285	−9.7 ± 2.7	725 ± 22	665
AD 1685	13.1 ± .7	152 ± 6	265	AD 1275	−15.5 ± 2.9	782 ± 24	675
AD 1675	10.4 ± .7	185 ± 6	275	AD 1265	−12.7 ± 2.9	769 ± 23	685
AD 1665	6.3 ± .7	227 ± 6	285	AD 1255	−18.2 ± 2.7	823 ± 22	695
AD 1655	4.5 ± .8	251 ± 6	295	AD 1245	−15.4 ± 2.8	810 ± 23	705
AD 1645	0.9 ± .7	290 ± 6	305	AD 1235	−15.2 ± 2.8	819 ± 23	715
AD 1635	−1.7 ± .7	320 ± 6	315	AD 1225	−12.7 ± 2.0	808 ± 16	725
AD 1625	−3.4 ± .7	344 ± 6	325	AD 1215	−15.4 ± 2.8	839 ± 23	735
AD 1615	−5.1 ± .8	367 ± 6	335	AD 1205	−19.5 ± 2.8	883 ± 23	745
AD 1605	−4.6 ± .7	373 ± 6	345	AD 1195	−16.9 ± 2.8	871 ± 23	755
AD 1595	−0.7 ± .9	351 ± 7	355	AD 1185	−19.1 ± 2.6	899 ± 21	765
AD 1585	1.1 ± .8	346 ± 7	365	AD 1175	−17.6 ± 2.8	896 ± 23	775
AD 1575	3.3 ± .9	338 ± 7	375	AD 1165	−13.2 ± 2.0	870 ± 16	785
AD 1565	4.3 ± .8	340 ± 6	385	AD 1155	−17.4 ± 2.8	914 ± 23	795
AD 1555	7.4 ± .8	325 ± 6	395	AD 1145	−23.9 ± 2.0	977 ± 16	805
AD 1545	9.4 ± .8	319 ± 6	405	AD 1135	−15.2 ± 2.2	915 ± 18	815

TABLE 1. (Continued)

Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP	Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP
AD 1125	−14.8 ± 2.9	922 ± 24	825	AD 655	−15.5 ± 3.0	1384 ± 25	1295
AD 1115	−17.9 ± 2.1	957 ± 17	835	AD 645	−17.9 ± 3.4	1414 ± 28	1305
AD 1105	−17.0 ± 1.9	958 ± 16	845	AD 635	−23.4 ± 2.3	1468 ± 19	1315
AD 1095	−15.5 ± 2.1	956 ± 17	855	AD 625	−20.8 ± 3.1	1457 ± 25	1325
AD 1085	−10.8 ± 1.5	928 ± 12	865	AD 615	−19.8 ± 6.2	1458 ± 51	1335
AD 1075	−7.6 ± 1.5	911 ± 12	875	AD 605	−19.4 ± 2.9	1465 ± 24	1345
AD 1065	−9.1 ± 1.7	933 ± 14	885	AD 595	−23.2 ± 3.2	1506 ± 27	1355
AD 1055	−8.5 ± 1.8	938 ± 15	895	AD 585	−19.9 ± 3.0	1488 ± 25	1365
AD 1045	−7.4 ± 2.0	939 ± 17	905	AD 575	−21.7 ± 3.4	1513 ± 28	1375
AD 1035	−8.6 ± 2.0	958 ± 16	915	AD 565	−18.8 ± 3.2	1499 ± 26	1385
AD 1025	−10.8 ± 2.8	986 ± 23	925	AD 555	−19.8 ± 3.3	1517 ± 27	1395
AD 1015	−16.7 ± 2.9	1044 ± 24	935	AD 545	−18.1 ± 2.2	1512 ± 18	1405
AD 1005	−12.1 ± 2.9	1016 ± 24	945	AD 535	−24.6 ± 3.1	1575 ± 26	1415
AD 995	−16.3 ± 2.5	1060 ± 21	955	AD 525	−27.1 ± 1.9	1606 ± 16	1425
AD 985	−17.8 ± 2.5	1082 ± 21	965	AD 515	−23.5 ± 2.8	1586 ± 23	1435
AD 975	−23.4 ± 2.9	1138 ± 24	975	AD 505	−23.4 ± 2.9	1595 ± 23	1445
AD 965	−21.2 ± 2.9	1130 ± 24	985	AD 495	−19.7 ± 2.6	1574 ± 21	1455
AD 955	−20.8 ± 3.0	1136 ± 25	995	AD 485	−18.9 ± 3.2	1577 ± 27	1465
AD 945	−19.3 ± 3.0	1133 ± 25	1005	AD 475	−17.1 ± 3.0	1573 ± 25	1475
AD 935	−22.5 ± 3.2	1170 ± 26	1015	AD 465	−18.6 ± 3.2	1595 ± 26	1485
AD 925	−19.3 ± 2.1	1151 ± 17	1025	AD 455	−17.6 ± 3.2	1596 ± 26	1495
AD 915	−13.8 ± 2.9	1118 ± 23	1035	AD 445	−12.7 ± 3.2	1566 ± 26	1505
AD 905	−10.3 ± 1.8	1096 ± 14	1045	AD 435	−11.8 ± 3.2	1568 ± 26	1515
AD 895	−15.3 ± 3.0	1150 ± 25	1055	AD 425	−17.4 ± 2.4	1623 ± 20	1525
AD 885	−17.5 ± 2.2	1175 ± 18	1065	AD 415	−20.1 ± 3.2	1656 ± 26	1535
AD 875	−17.6 ± 2.9	1188 ± 24	1075	AD 405	−21.8 ± 2.9	1679 ± 24	1545
AD 865	−19.2 ± 2.0	1207 ± 16	1085	AD 395	−20.7 ± 2.4	1679 ± 20	1555
AD 855	−19.3 ± 2.2	1222 ± 18	1095	AD 385	−21.0 ± 2.2	1692 ± 18	1565
AD 845	−16.7 ± 2.0	1206 ± 16	1105	AD 375	−23.6 ± 1.8	1723 ± 15	1575
AD 835	−13.9 ± 2.9	1196 ± 23	1115	AD 365	−18.2 ± 2.9	1688 ± 24	1585
AD 825	−14.2 ± 2.0	1206 ± 16	1125	AD 355	−20.5 ± 3.2	1717 ± 26	1595
AD 815	−11.8 ± 2.9	1198 ± 24	1135	AD 345	−18.6 ± 3.0	1711 ± 24	1605
AD 805	−12.6 ± 2.1	1212 ± 17	1145	AD 335	−20.7 ± 3.2	1738 ± 26	1615
AD 795	−15.2 ± 1.7	1246 ± 14	1155	AD 325	−19.3 ± 3.2	1736 ± 27	1625
AD 785	−6.4 ± 1.6	1181 ± 13	1165	AD 315	−25.0 ± 3.2	1792 ± 26	1635
AD 775	−14.7 ± 2.2	1261 ± 18	1175	AD 305	−23.5 ± 3.1	1790 ± 25	1645
AD 765	−17.2 ± 1.7	1291 ± 14	1185	AD 295	−16.1 ± 3.0	1740 ± 24	1655
AD 755	−18.3 ± 1.5	1310 ± 12	1195	AD 285	−19.8 ± 3.1	1779 ± 25	1665
AD 745	−12.8 ± 1.8	1275 ± 14	1205	AD 275	−12.2 ± 3.0	1726 ± 24	1675
AD 735	−10.2 ± 1.6	1264 ± 13	1215	AD 265	−9.7 ± 2.3	1716 ± 18	1685
AD 725	−10.8 ± 1.7	1278 ± 14	1225	AD 255	−17.2 ± 1.7	1787 ± 14	1695
AD 715	−9.8 ± 2.1	1279 ± 17	1235	AD 245	−15.8 ± 1.7	1785 ± 13	1705
AD 705	−10.9 ± 2.2	1299 ± 17	1245	AD 235	−19.0 ± 2.3	1821 ± 19	1715
AD 695	−6.1 ± 3.3	1270 ± 26	1255	AD 225	−18.7 ± 3.2	1828 ± 26	1725
AD 685	−14.2 ± 3.5	1345 ± 28	1265	AD 215	−20.3 ± 3.2	1851 ± 27	1735
AD 675	−12.5 ± 3.3	1340 ± 27	1275	AD 205	−20.1 ± 2.3	1860 ± 19	1745
AD 665	−12.5 ± 3.3	1350 ± 27	1285	AD 195	−16.2 ± 3.2	1837 ± 26	1755

TABLE 1. (Continued)

Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP	Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP
AD 185	−13.0 ± 2.9	1821 ± 24	1765	285 BC	−10.5 ± 2.9	2256 ± 24	2234
AD 175	−15.1 ± 3.2	1848 ± 26	1775	295 BC	−5.5 ± 2.2	2225 ± 18	2244
AD 165	−14.2 ± 3.5	1850 ± 28	1785	305 BC	−2.5 ± 3.1	2211 ± 25	2254
AD 155	−13.6 ± 3.0	1854 ± 24	1795	315 BC	−1.1 ± 3.1	2210 ± 25	2264
AD 145	−12.3 ± 3.2	1854 ± 26	1805	325 BC	3.2 ± 2.2	2185 ± 18	2274
AD 135	−10.2 ± 2.1	1847 ± 17	1815	335 BC	4.9 ± 3.1	2181 ± 25	2284
AD 125	−16.9 ± 1.7	1911 ± 14	1825	345 BC	5.0 ± 2.2	2189 ± 18	2294
AD 115	−15.9 ± 3.5	1913 ± 28	1835	355 BC	−0.8 ± 2.2	2246 ± 18	2304
AD 105	−15.5 ± 3.3	1919 ± 27	1845	365 BC	−4.1 ± 2.2	2282 ± 18	2314
AD 95	−10.6 ± 1.9	1888 ± 16	1855	375 BC	−2.3 ± 2.2	2278 ± 18	2324
AD 85	−11.5 ± 3.2	1906 ± 26	1865	385 BC	−3.3 ± 3.1	2295 ± 25	2334
AD 75	−13.3 ± 2.2	1930 ± 18	1875	395 BC	−7.8 ± 2.3	2341 ± 19	2344
AD 65	−14.2 ± 2.2	1947 ± 18	1885	405 BC	−12.6 ± 1.8	2390 ± 14	2354
AD 55	−15.2 ± 1.9	1965 ± 15	1895	415 BC	−18.7 ± 3.2	2449 ± 26	2364
AD 45	−18.3 ± 1.6	2000 ± 13	1905	425 BC	−16.0 ± 3.3	2437 ± 27	2374
AD 35	−11.0 ± 2.5	1950 ± 20	1915	435 BC	−18.9 ± 3.1	2471 ± 25	2384
AD 25	−15.3 ± 2.2	1995 ± 18	1925	445 BC	−17.8 ± 5.3	2471 ± 44	2394
AD 15	−15.9 ± 1.8	2010 ± 15	1935	455 BC	−21.0 ± 3.6	2507 ± 30	2404
AD 5	−12.6 ± 1.6	1993 ± 13	1945	465 BC	−13.3 ± 4.0	2454 ± 33	2414
5 BC	−20.2 ± 1.8	2063 ± 15	1954	475 BC	−7.4 ± 2.3	2416 ± 19	2424
15 BC	−12.9 ± 1.6	2012 ± 13	1964	485 BC	−10.9 ± 3.3	2454 ± 26	2434
25 BC	−15.6 ± 2.1	2044 ± 17	1974	495 BC	−7.3 ± 2.5	2434 ± 20	2444
35 BC	−11.2 ± 1.2	2018 ± 10	1984	505 BC	−8.0 ± 3.3	2450 ± 26	2454
45 BC	−14.3 ± 1.7	2053 ± 14	1994	515 BC	−6.1 ± 2.5	2444 ± 20	2464
55 BC	−17.3 ± 1.5	2087 ± 12	2004	525 BC	−10.1 ± 2.7	2487 ± 22	2474
65 BC	−18.0 ± 1.8	2103 ± 15	2014	535 BC	−6.8 ± 1.8	2469 ± 14	2484
75 BC	−15.6 ± 2.3	2094 ± 19	2024	545 BC	−8.6 ± 1.7	2493 ± 13	2494
85 BC	−12.4 ± 1.8	2076 ± 15	2034	555 BC	−7.1 ± 2.9	2491 ± 23	2504
95 BC	−15.1 ± 2.2	2108 ± 18	2044	565 BC	−7.0 ± 3.6	2500 ± 29	2514
105 BC	−12.3 ± 2.0	2095 ± 16	2054	575 BC	−6.7 ± 3.5	2508 ± 28	2524
115 BC	−13.0 ± 1.9	2111 ± 16	2064	585 BC	−0.4 ± 3.5	2466 ± 29	2534
125 BC	−14.2 ± 1.9	2130 ± 16	2074	595 BC	−7.2 ± 2.8	2530 ± 23	2544
135 BC	−10.7 ± 2.3	2111 ± 19	2084	605 BC	−5.1 ± 3.0	2524 ± 24	2554
145 BC	−8.5 ± 1.9	2103 ± 16	2094	615 BC	−2.0 ± 2.6	2508 ± 21	2564
155 BC	−6.7 ± 3.4	2099 ± 27	2104	625 BC	−1.9 ± 2.7	2517 ± 22	2574
165 BC	−7.7 ± 2.2	2117 ± 18	2114	635 BC	2.6 ± 2.3	2488 ± 19	2584
175 BC	−14.2 ± 3.3	2179 ± 27	2124	645 BC	3.6 ± 2.3	2492 ± 19	2594
185 BC	−12.6 ± 3.3	2176 ± 27	2134	655 BC	4.9 ± 2.1	2492 ± 17	2604
195 BC	−8.0 ± 2.2	2149 ± 18	2144	661 BC	11.6 ± 3.2	2444 ± 25	2610
205 BC	−12.6 ± 3.0	2195 ± 25	2154	696 BC	12.7 ± 5.3	2469 ± 42	2645
215 BC	−17.4 ± 1.7	2244 ± 14	2164	705 BC	13.5 ± 5.4	2473 ± 43	2654
225 BC	−9.7 ± 2.4	2192 ± 20	2174	715 BC	14.0 ± 5.4	2479 ± 43	2664
235 BC	−16.6 ± 1.8	2258 ± 15	2184	731 BC	18.1 ± 2.3	2461 ± 18	2680
245 BC	−14.1 ± 2.4	2247 ± 19	2194	751 BC	20.5 ± 3.4	2461 ± 27	2700
255 BC	−11.6 ± 3.2	2236 ± 26	2204	771 BC	9.9 ± 3.2	2565 ± 26	2720
265 BC	−15.8 ± 3.1	2280 ± 25	2214	785 BC	11.9 ± 2.5	2563 ± 20	2734
275 BC	−9.8 ± 2.2	2241 ± 18	2224	795 BC	5.7 ± 2.5	2622 ± 20	2744

TABLE 1. (Continued)

Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP	Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP
805 BC	3.0 ± 2.5	2654 ± 20	2754	1275 BC	10.2 ± 3.4	3053 ± 27	3224
815 BC	−0.3 ± 3.3	2690 ± 27	2764	1285 BC	16.4 ± 3.6	3013 ± 28	3234
825 BC	1.1 ± 2.6	2688 ± 21	2774	1295 BC	12.5 ± 3.5	3054 ± 28	3244
835 BC	−5.7 ± 2.5	2752 ± 20	2784	1305 BC	14.6 ± 3.7	3047 ± 29	3254
845 BC	−5.8 ± 2.5	2763 ± 20	2794	1315 BC	14.3 ± 3.5	3059 ± 28	3264
855 BC	−4.1 ± 3.3	2759 ± 27	2804	1325 BC	8.2 ± 3.0	3117 ± 24	3274
865 BC	−2.3 ± 3.2	2755 ± 26	2814	1335 BC	15.3 ± 3.5	3070 ± 27	3284
875 BC	−1.4 ± 3.4	2757 ± 27	2824	1345 BC	17.5 ± 3.6	3063 ± 28	3294
885 BC	3.6 ± 3.4	2727 ± 27	2834	1355 BC	15.3 ± 3.5	3090 ± 27	3304
895 BC	1.7 ± 3.3	2752 ± 27	2844	1365 BC	22.6 ± 3.3	3042 ± 26	3314
905 BC	−2.3 ± 3.2	2793 ± 26	2854	1375 BC	16.6 ± 3.2	3100 ± 25	3324
915 BC	−2.0 ± 3.3	2801 ± 27	2864	1385 BC	17.3 ± 3.3	3104 ± 26	3334
925 BC	−1.9 ± 3.3	2810 ± 27	2874	1395 BC	16.4 ± 2.4	3121 ± 19	3344
935 BC	−0.9 ± 2.5	2811 ± 20	2884	1405 BC	18.1 ± 3.3	3117 ± 26	3354
945 BC	−3.2 ± 2.4	2840 ± 19	2894	1415 BC	10.8 ± 3.3	3184 ± 26	3364
955 BC	−2.0 ± 2.6	2839 ± 21	2904	1425 BC	18.8 ± 3.4	3131 ± 27	3374
965 BC	7.7 ± 3.4	2772 ± 27	2914	1435 BC	11.8 ± 2.4	3196 ± 19	3384
975 BC	−1.6 ± 2.4	2856 ± 19	2924	1445 BC	13.8 ± 2.4	3189 ± 19	3394
985 BC	0.4 ± 3.2	2849 ± 25	2934	1455 BC	11.6 ± 2.3	3216 ± 18	3404
995 BC	3.6 ± 3.2	2833 ± 25	2944	1465 BC	9.9 ± 2.4	3240 ± 19	3414
1005 BC	3.2 ± 3.3	2847 ± 27	2954	1475 BC	12.9 ± 2.4	3226 ± 19	3424
1015 BC	−0.6 ± 3.2	2887 ± 26	2964	1485 BC	17.2 ± 2.6	3202 ± 21	3434
1025 BC	−2.2 ± 3.5	2909 ± 28	2974	1495 BC	12.8 ± 3.7	3246 ± 29	3444
1035 BC	0.3 ± 3.4	2899 ± 27	2984	1505 BC	11.8 ± 3.3	3264 ± 26	3454
1045 BC	6.2 ± 3.5	2861 ± 28	2994	1515 BC	12.0 ± 3.5	3272 ± 28	3464
1055 BC	−2.6 ± 3.2	2941 ± 26	3004	1525 BC	11.1 ± 3.2	3289 ± 25	3474
1065 BC	4.4 ± 3.6	2895 ± 29	3014	1535 BC	7.2 ± 3.4	3329 ± 27	3484
1075 BC	4.0 ± 3.5	2908 ± 28	3024	1545 BC	10.0 ± 3.5	3316 ± 28	3494
1085 BC	1.4 ± 3.6	2939 ± 29	3034	1555 BC	10.8 ± 3.3	3320 ± 27	3504
1095 BC	4.1 ± 2.3	2926 ± 19	3044	1565 BC	8.8 ± 5.8	3346 ± 46	3514
1105 BC	5.3 ± 2.5	2927 ± 20	3054	1575 BC	13.2 ± 5.8	3320 ± 46	3524
1115 BC	0.4 ± 3.8	2976 ± 30	3064	1585 BC	14.2 ± 3.6	3323 ± 28	3534
1125 BC	7.5 ± 3.4	2928 ± 27	3074	1595 BC	20.1 ± 2.8	3286 ± 22	3544
1135 BC	−2.3 ± 2.3	3017 ± 18	3084	1605 BC	14.5 ± 2.6	3340 ± 20	3554
1145 BC	10.3 ± 3.4	2926 ± 27	3094	1615 BC	15.1 ± 2.8	3345 ± 22	3564
1155 BC	7.4 ± 3.5	2959 ± 28	3104	1625 BC	13.5 ± 2.7	3367 ± 21	3574
1165 BC	8.3 ± 3.3	2961 ± 26	3114	1635 BC	13.5 ± 3.6	3376 ± 28	3584
1175 BC	8.4 ± 4.2	2970 ± 33	3124	1645 BC	11.3 ± 2.0	3404 ± 16	3594
1185 BC	16.0 ± 3.5	2919 ± 28	3134	1655 BC	19.0 ± 2.6	3353 ± 21	3604
1195 BC	4.9 ± 3.2	3018 ± 26	3144	1665 BC	11.5 ± 3.7	3422 ± 30	3614
1205 BC	16.1 ± 3.6	2938 ± 28	3154	1675 BC	24.1 ± 3.5	3332 ± 28	3624
1215 BC	8.3 ± 1.9	3009 ± 15	3164	1685 BC	20.2 ± 3.5	3372 ± 28	3634
1225 BC	8.5 ± 3.3	3018 ± 27	3174	1695 BC	11.2 ± 2.4	3453 ± 20	3644
1235 BC	12.9 ± 3.6	2993 ± 29	3184	1705 BC	13.1 ± 3.6	3448 ± 28	3654
1245 BC	11.9 ± 3.5	3011 ± 28	3194	1715 BC	19.0 ± 3.5	3410 ± 28	3664
1255 BC	14.5 ± 2.7	3007 ± 22	3204	1725 BC	19.1 ± 3.5	3420 ± 28	3674
1265 BC	8.0 ± 3.5	3061 ± 28	3214	1735 BC	17.3 ± 3.5	3443 ± 28	3684

TABLE 1. (Continued)

Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP	Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP
1745 BC	12.6 ± 3.6	3491 ± 28	3694	2215 BC	27.2 ± 2.5	3832 ± 20	4164
1755 BC	12.9 ± 2.5	3498 ± 20	3704	2225 BC	32.1 ± 2.1	3804 ± 17	4174
1765 BC	17.9 ± 2.8	3468 ± 22	3714	2235 BC	26.6 ± 3.9	3857 ± 31	4184
1775 BC	13.2 ± 2.7	3515 ± 21	3724	2245 BC	29.2 ± 2.6	3846 ± 21	4194
1785 BC	12.4 ± 2.4	3531 ± 19	3734	2255 BC	34.9 ± 2.5	3811 ± 19	4204
1795 BC	15.2 ± 2.4	3518 ± 19	3744	2265 BC	37.0 ± 3.6	3805 ± 28	4214
1805 BC	19.3 ± 2.4	3495 ± 19	3754	2275 BC	34.6 ± 4.3	3833 ± 34	4224
1815 BC	17.0 ± 2.5	3524 ± 20	3764	2285 BC	34.4 ± 3.0	3844 ± 23	4234
1825 BC	19.7 ± 3.6	3512 ± 28	3774	2295 BC	32.2 ± 2.7	3871 ± 21	4244
1835 BC	13.6 ± 3.4	3570 ± 26	3784	2305 BC	36.5 ± 4.0	3847 ± 31	4254
1845 BC	22.6 ± 3.6	3509 ± 28	3794	2315 BC	33.8 ± 3.6	3878 ± 28	4264
1855 BC	25.7 ± 3.6	3494 ± 28	3804	2325 BC	36.8 ± 2.6	3864 ± 20	4274
1865 BC	23.3 ± 3.6	3523 ± 28	3814	2335 BC	35.9 ± 3.6	3881 ± 28	4284
1875 BC	24.7 ± 2.5	3522 ± 19	3824	2345 BC	35.0 ± 2.6	3898 ± 20	4294
1885 BC	19.2 ± 3.4	3575 ± 27	3834	2355 BC	34.6 ± 3.7	3911 ± 29	4304
1895 BC	18.1 ± 3.6	3593 ± 28	3844	2365 BC	34.5 ± 2.6	3921 ± 20	4314
1905 BC	22.4 ± 3.5	3569 ± 28	3854	2375 BC	37.2 ± 3.6	3910 ± 28	4324
1915 BC	23.4 ± 3.5	3570 ± 28	3864	2385 BC	42.8 ± 2.6	3876 ± 20	4334
1925 BC	19.9 ± 2.7	3608 ± 22	3874	2395 BC	47.7 ± 4.1	3848 ± 31	4344
1935 BC	21.0 ± 3.2	3609 ± 25	3884	2405 BC	40.5 ± 2.7	3914 ± 21	4354
1945 BC	20.3 ± 3.7	3624 ± 29	3894	2415 BC	39.6 ± 2.9	3930 ± 22	4364
1955 BC	20.3 ± 3.6	3633 ± 28	3904	2425 BC	44.2 ± 3.6	3904 ± 28	4374
1965 BC	21.7 ± 3.5	3633 ± 28	3914	2435 BC	43.4 ± 1.9	3920 ± 15	4384
1975 BC	20.5 ± 3.5	3651 ± 27	3924	2445 BC	45.3 ± 3.8	3915 ± 29	4394
1985 BC	16.6 ± 3.5	3692 ± 28	3934	2465 BC	44.8 ± 3.7	3939 ± 28	4414
1995 BC	25.9 ± 3.5	3628 ± 27	3944	2475 BC	34.4 ± 2.6	4029 ± 20	4424
2005 BC	29.2 ± 3.6	3613 ± 28	3954	2485 BC	38.1 ± 2.7	4010 ± 21	4434
2015 BC	23.5 ± 3.4	3667 ± 27	3964	2495 BC	32.7 ± 3.9	4062 ± 30	4444
2025 BC	25.9 ± 3.5	3658 ± 28	3974	2505 BC	30.5 ± 2.9	4088 ± 23	4454
2035 BC	22.2 ± 2.2	3697 ± 17	3984	2515 BC	38.2 ± 2.9	4038 ± 22	4464
2045 BC	20.1 ± 2.5	3723 ± 19	3994	2525 BC	43.0 ± 2.0	4011 ± 16	4474
2055 BC	20.1 ± 2.5	3732 ± 20	4004	2535 BC	45.7 ± 2.7	4000 ± 21	4484
2065 BC	25.5 ± 3.5	3700 ± 28	4014	2545 BC	45.9 ± 2.7	4008 ± 21	4494
2075 BC	18.9 ± 2.5	3761 ± 20	4024	2555 BC	46.2 ± 2.5	4015 ± 19	4504
2085 BC	29.5 ± 3.6	3688 ± 28	4034	2565 BC	44.8 ± 2.5	4036 ± 19	4514
2095 BC	27.9 ± 3.5	3710 ± 27	4044	2575 BC	40.8 ± 3.0	4077 ± 23	4524
2105 BC	32.6 ± 2.5	3684 ± 19	4054	2585 BC	38.1 ± 2.4	4107 ± 19	4534
2115 BC	29.9 ± 3.5	3714 ± 27	4064	2595 BC	44.3 ± 2.7	4069 ± 21	4544
2125 BC	32.2 ± 3.5	3706 ± 28	4074	2605 BC	37.2 ± 4.1	4133 ± 32	4554
2135 BC	29.9 ± 3.5	3733 ± 27	4084	2615 BC	47.1 ± 2.7	4067 ± 21	4564
2145 BC	25.1 ± 2.2	3781 ± 17	4094	2625 BC	43.1 ± 2.8	4108 ± 22	4574
2155 BC	27.3 ± 2.3	3773 ± 18	4104	2635 BC	42.0 ± 2.4	4126 ± 18	4584
2165 BC	29.6 ± 3.6	3765 ± 28	4114	2645 BC	36.0 ± 4.0	4182 ± 31	4594
2175 BC	33.0 ± 2.4	3748 ± 18	4124	2655 BC	47.5 ± 4.0	4101 ± 31	4604
2185 BC	34.6 ± 2.0	3745 ± 16	4134	2665 BC	47.2 ± 2.7	4113 ± 21	4614
2195 BC	33.6 ± 2.0	3763 ± 16	4144	2675 BC	45.1 ± 2.7	4139 ± 21	4624
2205 BC	28.1 ± 3.0	3816 ± 24	4154	2685 BC	45.9 ± 2.8	4142 ± 21	4634

TABLE 1. (Continued)

Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP	Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP
2695 BC	45.0 ± 4.1	4159 ± 31	4644	3165 BC	62.3 ± 2.8	4484 ± 21	5114
2705 BC	44.6 ± 2.2	4171 ± 17	4654	3175 BC	56.3 ± 4.0	4539 ± 31	5124
2715 BC	42.2 ± 4.1	4200 ± 32	4664	3185 BC	60.8 ± 2.9	4515 ± 22	5134
2725 BC	48.7 ± 4.1	4160 ± 32	4674	3195 BC	60.2 ± 2.8	4529 ± 21	5144
2735 BC	47.2 ± 3.3	4182 ± 26	4684	3205 BC	59.5 ± 4.1	4544 ± 31	5154
2745 BC	51.0 ± 4.1	4162 ± 31	4694	3215 BC	64.0 ± 2.5	4520 ± 19	5164
2755 BC	51.4 ± 4.1	4169 ± 31	4704	3225 BC	66.5 ± 4.1	4511 ± 31	5174
2765 BC	44.2 ± 4.3	4234 ± 33	4714	3235 BC	71.2 ± 4.1	4485 ± 31	5184
2775 BC	51.8 ± 3.5	4185 ± 27	4724	3245 BC	77.1 ± 4.2	4451 ± 31	5194
2785 BC	54.6 ± 2.8	4174 ± 21	4734	3255 BC	75.3 ± 4.1	4474 ± 30	5204
2795 BC	52.8 ± 2.8	4197 ± 22	4744	3265 BC	73.1 ± 3.6	4500 ± 27	5214
2805 BC	51.2 ± 3.8	4219 ± 29	4754	3275 BC	73.9 ± 4.4	4504 ± 33	5224
2815 BC	63.5 ± 2.9	4135 ± 22	4764	3285 BC	77.8 ± 4.1	4485 ± 31	5234
2825 BC	69.6 ± 4.3	4099 ± 33	4774	3295 BC	79.2 ± 4.1	4484 ± 31	5244
2835 BC	64.4 ± 3.9	4147 ± 30	4784	3305 BC	78.8 ± 4.2	4496 ± 31	5254
2845 BC	62.6 ± 3.8	4171 ± 29	4794	3315 BC	75.4 ± 3.0	4532 ± 22	5264
2855 BC	63.5 ± 4.0	4174 ± 30	4804	3325 BC	81.8 ± 2.9	4494 ± 22	5274
2865 BC	63.8 ± 3.7	4181 ± 28	4814	3335 BC	77.8 ± 2.6	4533 ± 20	5284
2875 BC	62.2 ± 2.7	4203 ± 21	4824	3345 BC	75.8 ± 2.7	4557 ± 20	5294
2885 BC	58.7 ± 3.8	4239 ± 29	4834	3355 BC	72.6 ± 4.2	4591 ± 32	5304
2895 BC	51.9 ± 4.0	4301 ± 30	4844	3365 BC	69.3 ± 4.1	4625 ± 31	5314
2905 BC	51.2 ± 4.0	4315 ± 30	4854	3375 BC	66.0 ± 4.1	4660 ± 31	5324
2915 BC	50.9 ± 3.8	4328 ± 29	4864	3385 BC	61.5 ± 4.1	4704 ± 31	5334
2925 BC	44.7 ± 4.0	4385 ± 30	4874	3395 BC	58.7 ± 3.1	4735 ± 23	5344
2935 BC	44.5 ± 4.4	4396 ± 34	4884	3405 BC	64.1 ± 4.1	4703 ± 31	5354
2945 BC	42.7 ± 3.8	4420 ± 29	4894	3415 BC	62.2 ± 4.5	4728 ± 34	5364
2955 BC	50.0 ± 2.7	4373 ± 21	4904	3425 BC	68.5 ± 3.4	4690 ± 26	5374
2965 BC	49.6 ± 3.8	4386 ± 29	4914	3435 BC	70.6 ± 2.9	4684 ± 22	5384
2975 BC	48.1 ± 4.0	4407 ± 30	4924	3445 BC	70.7 ± 4.9	4693 ± 37	5394
2985 BC	54.2 ± 2.7	4370 ± 21	4934	3455 BC	70.6 ± 4.5	4703 ± 34	5404
2995 BC	56.5 ± 4.0	4363 ± 31	4944	3465 BC	77.2 ± 3.0	4664 ± 22	5414
3005 BC	56.3 ± 4.0	4374 ± 31	4954	3475 BC	84.3 ± 2.9	4621 ± 21	5424
3015 BC	54.9 ± 3.9	4395 ± 30	4964	3485 BC	84.4 ± 2.9	4629 ± 22	5434
3025 BC	56.7 ± 3.9	4391 ± 30	4974	3495 BC	82.9 ± 3.0	4650 ± 23	5444
3035 BC	55.9 ± 4.1	4406 ± 31	4984	3505 BC	76.4 ± 3.0	4708 ± 23	5454
3045 BC	53.3 ± 2.6	4435 ± 20	4994	3515 BC	73.5 ± 2.9	4740 ± 22	5464
3055 BC	52.2 ± 2.8	4454 ± 21	5004	3525 BC	73.8 ± 3.0	4748 ± 22	5474
3065 BC	53.9 ± 4.0	4451 ± 31	5014	3535 BC	75.3 ± 3.0	4746 ± 22	5484
3075 BC	61.0 ± 2.1	4407 ± 16	5024	3545 BC	70.0 ± 3.0	4795 ± 22	5494
3085 BC	55.5 ± 4.1	4458 ± 31	5034	3555 BC	71.5 ± 3.1	4794 ± 23	5504
3095 BC	58.7 ± 4.1	4443 ± 31	5044	3565 BC	76.8 ± 3.0	4764 ± 22	5514
3105 BC	49.0 ± 4.1	4527 ± 31	5054	3575 BC	76.4 ± 3.0	4777 ± 22	5524
3115 BC	54.1 ± 2.9	4498 ± 22	5064	3585 BC	79.7 ± 3.0	4761 ± 22	5534
3125 BC	51.1 ± 4.0	4531 ± 30	5074	3595 BC	82.5 ± 2.4	4751 ± 18	5544
3135 BC	52.5 ± 3.9	4529 ± 29	5084	3605 BC	85.7 ± 2.6	4737 ± 20	5554
3145 BC	49.3 ± 4.0	4563 ± 30	5094	3615 BC	90.6 ± 2.3	4710 ± 17	5564
3155 BC	56.8 ± 4.0	4516 ± 31	5104	3625 BC	85.9 ± 4.3	4754 ± 32	5574

TABLE 1. (Continued)

Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP	Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP
3635 BC	80.9 ± 2.9	4801 ± 22	5584	4105 BC	78.3 ± 4.2	5278 ± 31	6054
3645 BC	75.8 ± 3.0	4849 ± 22	5594	4115 BC	69.4 ± 2.9	5353 ± 22	6064
3655 BC	71.7 ± 2.9	4890 ± 22	5604	4125 BC	80.1 ± 4.3	5284 ± 32	6074
3665 BC	73.8 ± 2.9	4884 ± 22	5614	4135 BC	81.9 ± 3.0	5280 ± 23	6084
3675 BC	68.5 ± 2.4	4933 ± 18	5624	4155 BC	85.4 ± 4.3	5273 ± 32	6104
3685 BC	73.4 ± 2.9	4906 ± 21	5634	4165 BC	80.0 ± 4.2	5323 ± 31	6114
3695 BC	75.8 ± 2.9	4897 ± 22	5644	4175 BC	75.2 ± 4.4	5369 ± 33	6124
3705 BC	73.1 ± 2.9	4928 ± 22	5654	4185 BC	81.2 ± 4.3	5333 ± 32	6134
3715 BC	69.9 ± 2.9	4961 ± 22	5664	4195 BC	84.7 ± 3.0	5318 ± 22	6144
3725 BC	68.6 ± 4.6	4980 ± 35	5674	4205 BC	92.5 ± 4.1	5270 ± 30	6154
3735 BC	74.4 ± 3.0	4947 ± 23	5684	4215 BC	93.9 ± 4.4	5269 ± 33	6164
3745 BC	73.8 ± 2.6	4961 ± 20	5694	4225 BC	81.5 ± 3.0	5370 ± 23	6174
3755 BC	76.2 ± 2.9	4953 ± 22	5704	4235 BC	81.5 ± 3.0	5380 ± 22	6184
3765 BC	71.4 ± 2.9	4998 ± 22	5714	4245 BC	86.4 ± 3.0	5353 ± 22	6194
3775 BC	71.5 ± 3.0	5007 ± 22	5724	4255 BC	78.8 ± 5.0	5419 ± 37	6204
3785 BC	74.0 ± 2.4	4999 ± 18	5734	4265 BC	74.8 ± 3.2	5460 ± 24	6214
3795 BC	73.7 ± 3.1	5011 ± 23	5744	4275 BC	79.5 ± 5.0	5433 ± 37	6224
3805 BC	65.3 ± 2.8	5083 ± 21	5754	4285 BC	81.2 ± 3.0	5432 ± 23	6234
3815 BC	65.4 ± 3.9	5092 ± 30	5764	4295 BC	85.4 ± 4.5	5409 ± 33	6244
3825 BC	71.3 ± 3.9	5058 ± 29	5774	4305 BC	91.5 ± 4.3	5374 ± 32	6254
3835 BC	73.0 ± 4.1	5055 ± 31	5784	4315 BC	92.0 ± 4.4	5380 ± 33	6264
3845 BC	71.3 ± 4.1	5077 ± 31	5794	4325 BC	86.6 ± 4.4	5430 ± 33	6274
3855 BC	71.7 ± 2.4	5083 ± 18	5804	4335 BC	80.8 ± 3.0	5484 ± 23	6284
3865 BC	78.0 ± 2.1	5047 ± 16	5814	4345 BC	78.2 ± 3.1	5512 ± 23	6294
3875 BC	72.2 ± 2.2	5099 ± 17	5824	4355 BC	73.9 ± 4.3	5553 ± 33	6304
3885 BC	85.3 ± 2.7	5011 ± 20	5834	4365 BC	73.7 ± 4.2	5564 ± 32	6314
3895 BC	82.3 ± 3.5	5044 ± 26	5844	4375 BC	68.8 ± 4.3	5576 ± 22	6324
3905 BC	82.5 ± 2.9	5052 ± 21	5854	4385 BC	78.6 ± 4.5	5547 ± 33	6334
3915 BC	81.9 ± 2.8	5066 ± 21	5864	4395 BC	75.3 ± 4.4	5582 ± 33	6344
3925 BC	84.4 ± 3.1	5060 ± 23	5874	4405 BC	77.5 ± 4.4	5574 ± 33	6354
3935 BC	84.5 ± 4.2	5066 ± 31	5884	4415 BC	73.2 ± 4.4	5616 ± 33	6364
3945 BC	79.9 ± 2.4	5113 ± 18	5894	4425 BC	84.5 ± 4.6	5542 ± 35	6374
3955 BC	80.9 ± 5.2	5113 ± 39	5904	4435 BC	87.8 ± 4.6	5527 ± 34	6384
3965 BC	76.3 ± 1.8	5159 ± 13	5914	4445 BC	83.5 ± 4.4	5569 ± 32	6394
3975 BC	72.9 ± 2.6	5192 ± 19	5924	4455 BC	79.6 ± 4.6	5608 ± 34	6404
3985 BC	70.1 ± 2.7	5222 ± 20	5934	4465 BC	71.4 ± 3.0	5679 ± 22	6414
3995 BC	69.3 ± 3.0	5238 ± 22	5944	4475 BC	73.3 ± 4.4	5675 ± 33	6424
4005 BC	68.8 ± 3.0	5251 ± 23	5954	4485 BC	76.1 ± 4.6	5663 ± 35	6434
4015 BC	71.9 ± 4.1	5237 ± 31	5964	4495 BC	75.4 ± 4.4	5678 ± 33	6444
4025 BC	77.3 ± 3.2	5207 ± 24	5974	4505 BC	76.3 ± 4.3	5681 ± 32	6454
4035 BC	76.0 ± 2.7	5226 ± 20	5984	4515 BC	77.2 ± 4.4	5684 ± 33	6464
4045 BC	72.0 ± 4.2	5267 ± 31	5994	4525 BC	78.6 ± 4.7	5684 ± 35	6474
4055 BC	80.7 ± 3.7	5211 ± 28	6004	4535 BC	79.0 ± 4.2	5690 ± 32	6484
4065 BC	85.3 ± 3.0	5187 ± 22	6014	4545 BC	72.5 ± 4.7	5748 ± 35	6494
4075 BC	79.0 ± 4.2	5243 ± 31	6024	4555 BC	72.8 ± 4.4	5756 ± 33	6504
4085 BC	73.0 ± 3.5	5298 ± 26	6034	4565 BC	72.6 ± 3.2	5767 ± 24	6514
4095 BC	74.5 ± 3.0	5296 ± 22	6044	4575 BC	75.9 ± 3.0	5752 ± 23	6524

TABLE 1. (Continued)

Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP	Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP
4585 BC	77.1 ± 3.1	5753 ± 23	6534	5055 BC	89.3 ± 4.1	6119 ± 33	7004
4595 BC	76.4 ± 4.4	5768 ± 33	6544	5065 BC	83.4 ± 4.0	6172 ± 32	7014
4605 BC	77.9 ± 4.3	5767 ± 32	6554	5075 BC	82.4 ± 4.2	6189 ± 34	7024
4615 BC	79.6 ± 4.7	5764 ± 35	6564	5085 BC	80.3 ± 4.1	6215 ± 33	7034
4625 BC	74.7 ± 2.7	5810 ± 21	6574	5095 BC	86.9 ± 2.9	6176 ± 24	7044
4635 BC	78.9 ± 3.7	5788 ± 28	6584	5105 BC	82.9 ± 4.1	6215 ± 33	7054
4645 BC	81.9 ± 2.3	5775 ± 17	6594	5115 BC	92.6 ± 4.0	6153 ± 32	7064
4655 BC	82.1 ± 3.1	5784 ± 23	6604	5125 BC	85.0 ± 4.0	6219 ± 32	7074
4665 BC	87.4 ± 4.4	5754 ± 32	6614	5135 BC	94.8 ± 3.9	6157 ± 31	7084
4675 BC	87.3 ± 4.8	5764 ± 35	6624	5145 BC	95.6 ± 3.0	6160 ± 24	7094
4685 BC	86.2 ± 2.6	5782 ± 19	6634	5165 BC	92.6 ± 4.1	6202 ± 33	7114
4695 BC	80.1 ± 3.2	5837 ± 24	6644	5175 BC	99.0 ± 4.0	6164 ± 32	7124
4705 BC	83.6 ± 3.0	5821 ± 23	6654	5185 BC	106.7 ± 2.9	6118 ± 24	7134
4715 BC	79.8 ± 4.3	5859 ± 32	6664	5195 BC	106.7 ± 4.0	6128 ± 33	7144
4725 BC	78.4 ± 4.4	5879 ± 33	6674	5205 BC	108.9 ± 4.3	6122 ± 34	7154
4735 BC	80.0 ± 4.3	5877 ± 32	6684	5215 BC	94.6 ± 4.2	6236 ± 34	7164
4745 BC	87.1 ± 4.4	5834 ± 33	6694	5225 BC	89.7 ± 4.3	6281 ± 35	7174
4755 BC	88.7 ± 4.4	5832 ± 32	6704	5235 BC	98.1 ± 4.2	6230 ± 34	7184
4765 BC	81.6 ± 4.3	5895 ± 32	6714	5245 BC	96.0 ± 2.9	6255 ± 24	7194
4775 BC	83.7 ± 4.4	5889 ± 33	6724	5255 BC	97.1 ± 2.9	6256 ± 23	7204
4785 BC	84.3 ± 4.3	5894 ± 32	6734	5265 BC	92.4 ± 4.0	6300 ± 32	7214
4795 BC	82.8 ± 4.3	5914 ± 32	6744	5275 BC	90.9 ± 2.7	6321 ± 22	7224
4805 BC	80.9 ± 4.6	5939 ± 34	6754	5285 BC	83.0 ± 2.8	6389 ± 23	7234
4815 BC	83.8 ± 4.5	5926 ± 34	6764	5295 BC	89.3 ± 4.2	6352 ± 34	7244
4825 BC	80.5 ± 4.4	5961 ± 33	6774	5305 BC	86.7 ± 4.3	6381 ± 35	7254
4835 BC	82.6 ± 4.3	5955 ± 32	6784	5315 BC	90.7 ± 3.0	6361 ± 24	7264
4845 BC	81.3 ± 4.6	5974 ± 34	6794	5325 BC	89.3 ± 3.0	6381 ± 24	7274
4855 BC	78.8 ± 3.1	6003 ± 23	6804	5335 BC	85.1 ± 4.0	6422 ± 32	7284
4865 BC	81.3 ± 4.4	5994 ± 33	6814	5345 BC	85.7 ± 3.0	6428 ± 24	7294
4875 BC	77.8 ± 4.5	6029 ± 33	6824	5355 BC	82.4 ± 3.0	6462 ± 24	7304
4885 BC	93.1 ± 4.6	5926 ± 34	6834	5365 BC	91.0 ± 4.2	6408 ± 34	7314
4895 BC	86.4 ± 3.3	5985 ± 25	6844	5375 BC	94.7 ± 4.4	6390 ± 36	7324
4905 BC	88.1 ± 2.6	5982 ± 19	6854	5385 BC	93.1 ± 4.9	6412 ± 39	7334
4915 BC	85.0 ± 3.5	6015 ± 26	6864	5395 BC	96.0 ± 4.2	6400 ± 34	7344
4925 BC	83.8 ± 4.5	6033 ± 33	6874	5405 BC	95.2 ± 4.2	6416 ± 34	7354
4935 BC	89.8 ± 3.2	5999 ± 24	6884	5415 BC	100.9 ± 3.0	6384 ± 24	7364
4945 BC	84.4 ± 2.3	6047 ± 17	6894	5425 BC	99.8 ± 3.1	6402 ± 25	7374
4955 BC	86.4 ± 3.1	6042 ± 23	6904	5435 BC	89.7 ± 4.1	6485 ± 33	7384
4965 BC	84.8 ± 3.3	6065 ± 24	6914	5445 BC	79.8 ± 3.1	6568 ± 25	7394
4975 BC	87.8 ± 3.1	6053 ± 23	6924	5455 BC	81.7 ± 4.3	6564 ± 34	7404
4985 BC	88.3 ± 3.3	6058 ± 25	6934	5465 BC	87.1 ± 3.0	6534 ± 24	7414
4995 BC	85.1 ± 4.3	6092 ± 32	6944	5475 BC	83.7 ± 4.3	6568 ± 35	7424
5005 BC	83.3 ± 4.1	6115 ± 33	6954	5485 BC	86.9 ± 4.4	6554 ± 35	7434
5015 BC	88.4 ± 4.2	6087 ± 34	6964	5495 BC	83.0 ± 4.3	6593 ± 35	7444
5025 BC	85.6 ± 4.1	6117 ± 33	6974	5505 BC	81.8 ± 4.3	6612 ± 35	7454
5035 BC	87.2 ± 4.3	6115 ± 34	6984	5515 BC	87.0 ± 4.3	6583 ± 35	7464
5045 BC	85.4 ± 4.3	6138 ± 34	6994	5525 BC	75.5 ± 4.2	6678 ± 34	7474

TABLE 1. (Continued)

Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP	Cal AD/BC	$\Delta^{14}C$ ‰	^{14}C age (BP)	Cal BP
5535 BC	79.4 ± 4.4	6659 ± 35	7484	5775 BC	69.2 ± 2.9	6969 ± 22	7724
5545 BC	77.9 ± 4.4	6680 ± 35	7494	5785 BC	72.8 ± 2.2	6953 ± 17	7734
5555 BC	89.8 ± 3.3	6604 ± 25	7504	5795 BC	75.1 ± 2.4	6947 ± 18	7744
5565 BC	90.7 ± 3.3	6606 ± 25	7514	5805 BC	71.3 ± 2.4	6982 ± 19	7754
5575 BC	83.5 ± 2.4	6670 ± 18	7524	5815 BC	69.9 ± 2.1	7004 ± 17	7764
5585 BC	77.7 ± 3.3	6721 ± 25	7534	5825 BC	75.8 ± 2.5	6969 ± 20	7774
5595 BC	76.1 ± 3.4	6742 ± 26	7544	5835 BC	75.2 ± 2.6	6983 ± 20	7784
5605 BC	70.8 ± 2.5	6793 ± 19	7554	5845 BC	76.8 ± 2.6	6981 ± 21	7794
5615 BC	74.9 ± 2.2	6774 ± 17	7564	5855 BC	70.7 ± 4.7	7035 ± 38	7804
5625 BC	74.9 ± 2.7	6780 ± 21	7574	5865 BC	76.0 ± 3.9	7005 ± 31	7814
5635 BC	70.8 ± 2.4	6822 ± 19	7584	5875 BC	76.3 ± 4.2	7012 ± 34	7824
5645 BC	75.2 ± 2.6	6799 ± 20	7594	5885 BC	68.9 ± 4.2	7077 ± 34	7834
5655 BC	76.4 ± 2.8	6800 ± 21	7604	5895 BC	68.0 ± 4.6	7094 ± 37	7844
5665 BC	75.8 ± 2.1	6815 ± 16	7614	5905 BC	74.8 ± 3.1	7053 ± 25	7854
5675 BC	75.2 ± 2.7	6828 ± 20	7624	5915 BC	85.0 ± 3.2	6986 ± 26	7864
5685 BC	71.7 ± 3.1	6863 ± 24	7634	5925 BC	87.0 ± 3.0	6981 ± 24	7874
5695 BC	71.2 ± 2.7	6875 ± 21	7644	5935 BC	81.5 ± 5.2	7032 ± 42	7884
5705 BC	70.9 ± 2.5	6885 ± 20	7654	5945 BC	75.3 ± 4.2	7088 ± 34	7894
5715 BC	69.5 ± 3.3	6907 ± 26	7664	5955 BC	75.3 ± 4.1	7097 ± 33	7904
5725 BC	73.7 ± 3.1	6884 ± 24	7674	5965 BC	73.9 ± 4.4	7118 ± 35	7914
5735 BC	69.4 ± 2.5	6929 ± 19	7684	5975 BC	70.2 ± 5.0	7155 ± 40	7924
5745 BC	70.2 ± 2.3	6933 ± 18	7694	5985 BC	67.8 ± 2.8	7182 ± 23	7934
5755 BC	70.8 ± 2.6	6938 ± 20	7704	5995 BC	65.2 ± 4.8	7212 ± 36	7944
5765 BC	73.1 ± 2.2	6931 ± 17	7714	6000 BC	75.6 ± 3.3	7141 ± 25	7949