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UNIVERSITY OF PENNSYLVANIA RADIOCARBON DATES XVI

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On two previous occasions we have published lists of ^{14}C results of precisely dated wood samples in Radiocarbon as per mil deviations (R, 1965, v 7, p 179-186; R, 1969, v 11, no. 2, p 469-481). We have also published a list of ^{14}C dates, consolidating all dated wood samples processed in our lab to July 1969 (Ralph and Michael, 1970).

The purpose of this report is three-fold: 1) to publish, in tabular form, actual ^{14}C dates of dendro-dated samples processed in our lab as yet unpublished in Radiocarbon plus those reported only as per mil deviations; 2) to indicate, in graphic form, the use of our results combined with those of other labs (Damon, 1970; Damon *et al,* 1972; Suess, 1970) in determining correction factors for radiocarbon dates, and 3) to publish a short list of aberrant results not used to determine correction factors and calibration curves shown in figs 1-6. Since all labs involved in the radiocarbon dating of precisely dated woods have experienced occasional aberrations in their results, we feel that these should be recorded for future research into the causes of the aberrations. This remark does not apply to those samples which become undersized in processing. These may be unreliable rather than aberrant.

The prefatory remarks of Ralph and Michael (1969) concerning basic causes of the deviations largely apply to the present data, adding the possibility that short-term deviations are caused by variations in the Earth's non-dipole field, the Sun's magnetic field and resultant interplanetary fields (Ralph, 1973), and explosions of supernovae (Dergachev, 1972).

All sequoia and bristlecone pine samples (except as noted) have been corrected for deviations in $^{13}C/^{12}C$ ratios. The $\delta\ ^{13}C_w$ values listed represent deviations of samples measured from the $\delta\ ^{13}C_w$ value of our 130-yr-old standard oak sample which is also the reference value (adjusted for zero age) for the calculation of $\delta\ ^{14}C$. (*NB*: the subscript *W* does not appear in the tables.)

Table 1 lists results of samples dated at the Univ Pennsylvania that were used to calculate the calibration curves (figs 1-6). Table 2 separates those samples that are obviously aberrant, *vs,* and not used in figs 1-6. Most of the samples were coll, dendro-dated, and subm by C W Ferguson, Lab for Tree-Ring Research, Univ Arizona. They are designated with "TRL" in parentheses in the column labelled "Acquisition No." Those designated "P-SW-" only, were coll, dendro-dated, and subm by H N Michael, Mus Applied Sci Center for Archaeol, Univ Mus and were processed by the Univ Pennsylvania lab. All samples designated P-SW-INY- in Tables 1 and 2 are *Pinus aristata*; others are *Sequoia gigantea.*

The provenience of most of the samples was published in Ralph *et al* (1965), and Ralph and Michael (1969). Two new series appear below.

Bristlecone Pine series (P-SW-INY-31, TRL 70-20)

Samples from remnant of *Pinus aristata* 3.2km N of Schulman Grove, White Mts, California-Nevada (37° 25′ N, 118° 10′ W). Coll 1970 and subm by C W Ferguson, Univ Arizona.

Bristlecone Pine series (P-SW-INY-33, TRL 71-52)

Wood (*Pinus aristata*) from Schulman Grove (37° 23′ N, 118° 09′ W), White Mts, California-Nevada. Coll 1971 and subm as floater by C W Ferguson. Subsequently dendro-dated by C W F.

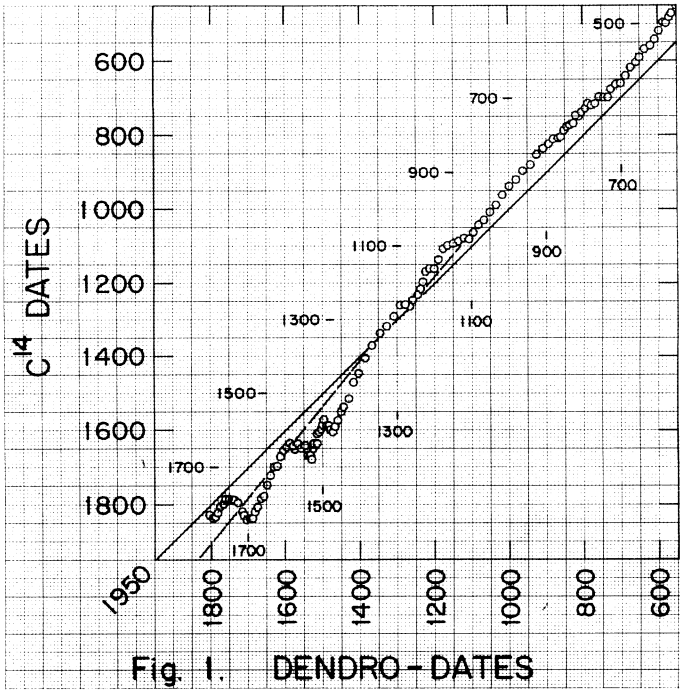
Calibration curves shown in figs 1-6 are based on >600 precisely dated samples processed by the 3 labs mentioned earlier. These curves were based on a 9-cell regression weighted averaging of the raw data, centered on each mid-point. All ^{14}C dates in figs 1-6 were calculated with the 5730 yr half-life.

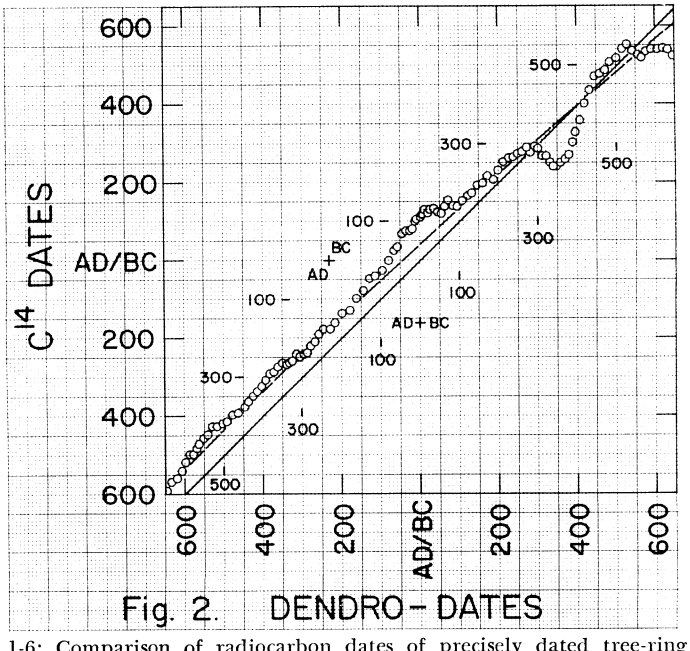
The curve reveals that in 85% of the cases, the radiocarbon date (y-axis) will cross the curve only once and thereby determine the correction factor within the limits imposed on it by its standard statistical uncertainty in the ^{14}C correction of the 9-cell regression average. For example, the radiocarbon date, AD 900, crosses the curve at the dendrochronologically determined date, AD 960. Thus, the correction factor for the mid-point is 60 yr. More realistically, however, one should include the statistical uncertainty of the ^{14}C date as well as approx ± 10 yr uncertainty in the curve. If, for example, the ^{14}C date has a tolerance of ± 40 yr, one adds ± 10 yr and then finds that the corrected range from AD 850 to AD 950 is AD 920 to AD 1010. In the remaining 15% of cases the radiocarbon date crosses the calibration curve more than once, or follows the curve for a distance, or does both. In all these cases, the correction factor will have to be cited as a multiple one, or as a span of time, and sometimes both as a span and a crossing or crossings, and the resultant over-all range will be greater.

A more detailed explanation of the use of the calibration curves and of tables of correction factors derived from the curves was published by Ralph *et al* (1973).

ACKNOWLEDGMENTS

We are indebted to C W Ferguson and Bryant Bannister, Lab for Tree-Ring Research, Univ Arizona, for supplying the precisely dated samples. The Univ Arizona's program was supported by NSF grant GA-20618. Barbara Lawn, John Hedrick, Raymond Costa, and David Wood have processed the samples since 1970. The National Science Foundation, through continuing grant GA-12572, supported these years of the known-age dating program at Univ Pennsylvania.





Figs 1-6: Comparison of radiocarbon dates of precisely dated tree-ring samples and the dendro-dates of same samples. Each circle represents the mid-point of the

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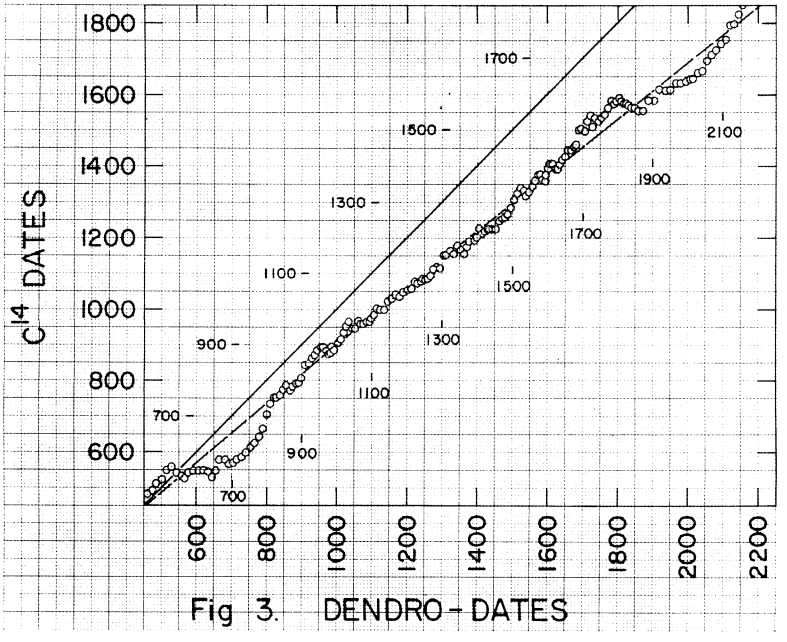

Fig 3. DENDRO-DATES

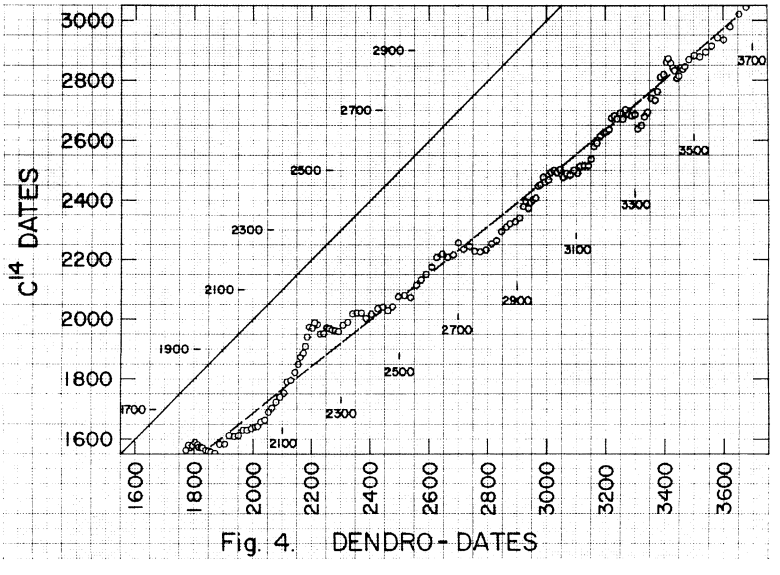

Fig. 4. DENDRO-DATES

average of 9 samples. To determine corrected radiocarbon date, find radiocarbon date on scale at left, proceed on horizontal line until circle is encountered. From circle read corrected date on vertical scale. For details and example, see text.

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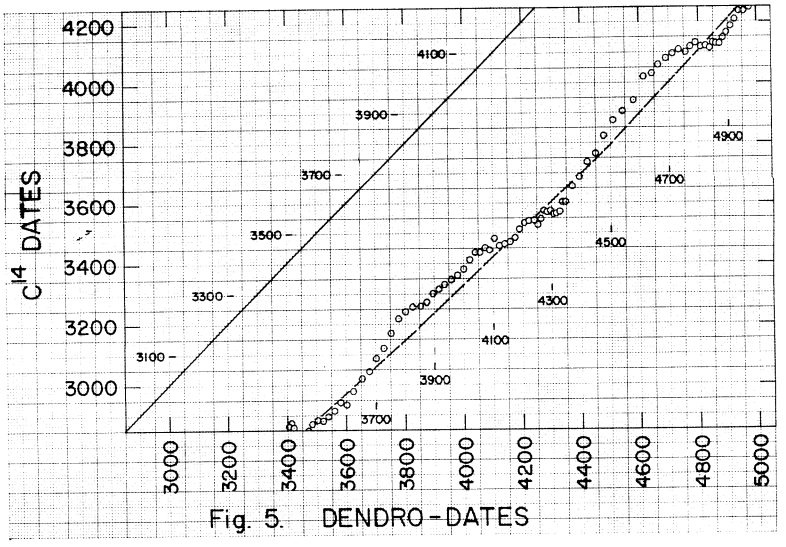

Fig. 5. DENDRO-DATES

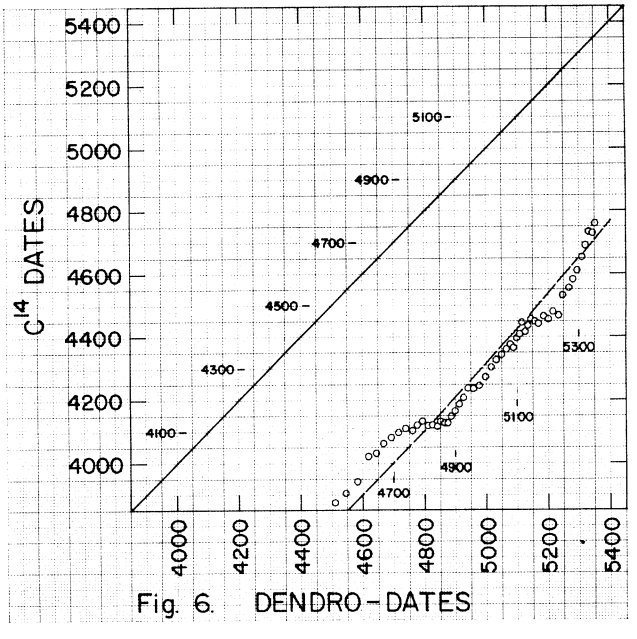

Fig. 6. DENDRO-DATES

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TABLE 1

List of radiocarbon dates of dendro-dated samples from sequoias and bristlecone pines processed in the University of Pennsylvania Laboratory and used for the calculation of correction factors. ^{14}C dates calculated with 5730 half-life.

Lab no.	Acquisition no.	No. of rings	Tree-ring AD/BC	midpoint BP (1950)	^{14}C date 5568 half-life AD/BC	^{14}C date 5568 half-life BP (1950)	^{14}C date 5730 half-life AD/BC	$\delta^{13}C$ (‰) from oak standard	Comments
P-651	P-SW-SEQ-2	20	AD 1900	50	1857 ± 32	93	1854 ± 33	+0.9	Not used in calculating correction factors
P-543a	P-SW-SEQ-2	26	AD 1855	95	1896 ± 30	54	1894 ± 31	+5.5	
P-416	P-SW-INY-1	50	AD 1829	121	1781 ± 47	169	1776 ± 48		No $\delta^{13}C$
P-346	P-SW-SEQ-2	26	AD 1829	121	1841 ± 40	109	1837 ± 41		$\delta^{13}C$ from average value
P-650	P-SW-SEQ-2	20	AD 1800	150	1835 ± 31	115	1831 ± 32	+1.4	
P-649	P-SW-SEQ-2	20	AD 1750	200	1714 ± 36	236	1706 ± 37	0	
P-702	P-SW-SEQ-2	10	AD 1697	253	1733 ± 40	217	1726 ± 41	+5.3	
P-648	P-SW-SEQ-2	20	AD 1650	300	1875 ± 40	75	1872 ± 41	+0.9	
P-545a	P-SW-SEQ-2	8	AD 1646	304	1753 ± 44	197	1747 ± 45		$\delta^{13}C$ from average value
P-630	P-SW-SEQ-2	10	AD 1597	353	1629 ± 40	321	1619 ± 41	+4.4	
P-880	P-SW-SEQ-2	14	AD 1596	354	1758 ± 32	192	1752 ± 33	+1.4	
P-881	P-SW-SEQ-2	16	AD 1550	400	1755 ± 35	195	1749 ± 36	+2.7	
P-631	P-SW-SEQ-2	26	AD 1505	445	1570 ± 40	380	1558 ± 41	+1.8	
P-631a	P-SW-SEQ-2	26	AD 1505	445	1532 ± 36	418	1519 ± 37	+4.4	
P-1113	P-SW-ENT-1	40	AD 1450	500	1646 ± 40	304	1637 ± 41	+2.8	

TABLE 1 (continued)

Lab no.	Acquisition no.	No. of rings	Tree-ring AD/BC	midpoint BP (1950)	^{14}C date 5568 half-life AD/BC	^{14}C date 5568 half-life BP (1950)	^{14}C date 5730 half-life AD/BC	$\delta\,^{13}$C (‰) from oak standard	Comments
P-1114	P-SW-SEQ-1	30	AD 1450	500	1625 ± 39	325	1615 ± 40		$\delta\,^{13}$C from average value
P-647	P-SW-SEQ-2	20	AD 1450	500	1610 ± 40	340	1599 ± 41	+3.9	
P-700	P-SW-SEQ-2	16	AD 1400	550	1428 ± 40	522	1412 ± 41	+4.5	
P-882	P-SW-SEQ-2	14	AD 1350	600	1283 ± 40	667	1263 ± 41	+3.9	
P-701	P-SW-SEQ-2	14	AD 1299	651	1265 ± 40	685	1244 ± 41	+4.4	
P-431	P-SW-INY-1	20	AD 1252	698	1294 ± 40	656	1274 ± 41		No $\delta\,^{13}$C
P-549	P-SW-SEQ-2	14	AD 1250	700	1158 ± 40	792	1134 ± 41		$\delta\,^{13}$C from average value
P-433	P-SW-INY-1	30	AD 1248	702	1323 ± 56	627	1304 ± 58		No $\delta\,^{13}$C
P-453	P-SW-INY-1	30	AD 1248	702	1349 ± 48	601	1331 ± 49		No $\delta\,^{13}$C
P-632	P-SW-SEQ-2	14	AD 1200	750	1125 ± 50	825	1100 ± 52		$\delta\,^{13}$C from average value
P-883	P-SW-SEQ-2	14	AD 1150	800	1172 ± 36	778	1148 ± 37	+4.6	
P-633	P-SW-SEQ-2	16	AD 1100	850	1133 ± 40	817	1108 ± 41	+2.7	
P-551	P-SW-SEQ-2	20	AD 1052	898	1083 ± 35	867	1057 ± 36		$\delta\,^{13}$C from average value
P-634	P-SW-SEQ-2	22	AD 1003	947	1000 ± 40	950	971 ± 41	+4.4	
P-646	P-SW-SEQ-2	10	AD 950	1000	962 ± 50	988	932 ± 52	+5.3	
P-703	P-SW-SEQ-2	16	AD 900	1050	860 ± 30	1090	827 ± 31	+3.5	
P-645	P-SW-SEQ-2	10	AD 850	1100	841 ± 50	1109	807 ± 52		$\delta\,^{13}$C from average value
P-644	P-SW-SEQ-2	10	AD 800	1150	840 ± 40	1110	806 ± 41		$\delta\,^{13}$C from average value

P-1572	P-SW-SEQ-2	20	AD	750	1200	717 ± 44	1233	679 ± 45	+1.9	
P-387	P-SW-SEQ-2	20	AD	702	1248	679 ± 40	1271	641 ± 41		δ ^{13}C from average value
P-813	P-SW-SEQ-2	20	AD	700	1250	681 ± 40	1269	643 ± 41		δ ^{13}C from average value
P-821	P-SW-ENT-2	40	AD	677	1273	650 ± 40	1300	611 ± 41	+3.6	
P-643	P-SW-SEQ-2	10	AD	650	1300	684 ± 60	1266	646 ± 62	+3.6	
P-787	P-SW-INY-11a	54	AD	601	134	567 ± 66	1383	526 ± 68	+4.5	
P-638a	P-SW-SEQ-2	16	AD	600	1350	595 ± 40	1355	554 ± 41		δ ^{13}C from average value
P-812	P-SW-SEQ-2	14	AD	600	1350	574 ± 35	1376	532 ± 36	+4.1	
P-818	P-SW-ENT-2	40	AD	577	1373	599 ± 40	1351	558 ± 41	+2.7	
P-636	P-SW-ENT-1	44	AD	544	1406	546 ± 40	1404	503 ± 41	+4.4	
P-815	P-SW-ENT-1	40	AD	532	1418	507 ± 40	1443	463 ± 41	+3.6	
P-589b	P-SW-SEQ-2	16	AD	500	1450	427 ± 40	1523	381 ± 41	+4.4	
P-610	P-SW-SEQ-2	10	AD	450	1500	479 ± 40	1471	434 ± 41	+2.0	
P-738	P-SW-ENT-1	22	AD	436	1514	442 ± 50	1508	396 ± 52	+1.8	
P-609	P-SW-SEQ-2	10	AD	400	1550	400 ± 45	1550	353 ± 46	+2.7	
P-608	P-SW-SEQ-2	10	AD	350	1600	272 ± 45	1678	221 ± 46		δ ^{13}C from average value
P-428	P-SW-INY-2	40	AD	345	1605	356 ± 40	1594	308 ± 41		No δ ^{13}C
P-397a	P-SW-SEQ-2	20	AD	302	1648	322 ± 40	1628	273 ± 41		δ ^{13}C from average value
P-607	P-SW-SEQ-2	10	AD	300	1650	242 ± 40	1708	190 ± 41	+3.6	
P-786	P-SW-INY-11a	30	AD	266	1684	316 ± 43	1634	267 ± 44	+3.6	
P-396a	P-SW-SEQ-2	16	AD	250	1700	291 ± 50	1659	241 ± 52	+4.4	
P-395	P-SW-SEQ-2	10	AD	197	1753	148 ± 44	1802	93 ± 45	+1.9	
P-606	P-SW-SEQ-2	10	AD	150	1800	118 ± 40	1832	63 ± 41	+2.7	
P-499	P-SW-SEQ-2	10	AD	100	1850	213 ± 45	1737	160 ± 46	+2.7	
P-1574	P-SW-SEQ-2	10	AD	75	1875	4 ± 53 BC	1954	63 ± 55 BC	+0.9	
P-498	P-SW-SEQ-2	10	AD	50	1900	AD 88 ± 40	1862	AD 32 ± 41		δ ^{13}C from average value

TABLE 1 (continued)

Lab no.	Acquisition no.	No. of rings	Tree-ring AD/BC	midpoint BP (1950)	^{14}C date 5568 half-life AD/BC	^{14}C date 5568 half-life BP (1950)	^{14}C date half-life AD/BC 5730	$\delta\,^{13}$C (‰) from oak standard	Comments
P-1573	P-SW-SEQ-2	10	AD 25	1925	13 ± 45	1937	46 ± 46 BC	+1.9	
P-375	P-SW-SEQ-2	16	AD 1	1949	67 ± 35 BC	2017	128 ± 36 BC		$\delta\,^{13}$C from average value ^{14}C dates are BC from this point
P-497	P-SW-SEQ-2	10	50 BC	2000	51 ± 50	2001	111 ± 52	+4.5	
P-496	P-SW-SEQ-2	10	100 BC	2050	140 ± 40	2090	203 ± 41		$\delta\,^{13}$C from average value
P-884	P-SW-SEQ-2	12	100 BC	2050	179 ± 40	2129	243 ± 42	+2.8	
P-885	P-SW-ENT-1	16	150 BC	2100	34 ± 44	1984	94 ± 45	+2.8	
P-495	P-SW-SEQ-2	10	150 BC	2100	66 ± 50	2016	127 ± 52	+3.6	
P-494	P-SW-SEQ-2	10	200 BC	2150	108 ± 50	2058	170 ± 52	+3.1	
P-1575	P-SW-ENT-1	20	240 BC	2190	105 ± 45	2055	167 ± 46	+1.9	
P-785	P-SW-INY-11a	30	285 BC	2235	255 ± 46	2205	316 ± 47	+5.1	
P-886	P-SW-ENT-1	16	300 BC	2250	185 ± 50	2135	250 ± 52	+3.0	
P-655	P-SW-ENT-1	10	318 BC	2268	177 ± 33	2124	241 ± 34	+1.2	
P-656	P-SW-ENT-1	10	368 BC	2318	92 ± 50	2042	154 ± 52	+5.0	
P-1340	P-SW-ENT-1	20	370 BC	2320	132 ± 37	2082	195 ± 38	0	
P-1341	P-SW-ENT-1	20	420 BC	2370	277 ± 57	2227	344 ± 59	+3.7	
P-658	P-SW-ENT-1	10	468 BC	2418	466 ± 43	2416	539 ± 44	+0.3	
P-491	P-SW-ENT-1	20	520 BC	2474	377 ± 50	2327	447 ± 52	+3.5	
P-1342	P-SW-ENT-1	10	580 BC	2530	558 ± 88	2508	634 ± 91		No $\delta\,^{13}$C
P-888	P-SW-ENT-1	10	600 BC	2550	516 ± 50	2466	590 ± 52	−2.9	

P-660	P-SW-ENT-1	10	618 BC	2568	685 ± 44	2635	765 ± 45	+2.6	
P-448	P-SW-ENT-1	10	679 BC	2629	564 ± 50	2514	640 ± 52		δ ^{13}C from average value
P-449	P-SW-ENT-1	8	688 BC	2638	518 ± 50	2468	592 ± 52		δ ^{13}C from average value
P-811	P-SW-INY-11a	38	690 BC	2640	491 ± 46	2441	564 ± 47	+4.5	
P-427	P-SW-INY-2	30	728 BC	2678	412 ± 48	2362	483 ± 49	+0.9	
P-661	P-SW-ENT-1	10	768 BC	2718	524 ± 50	2474	599 ± 52	+3.6	
P-661a	P-SW-ENT-1	10	768 BC	2718	569 ± 38	2519	645 ± 39	+2.6	
P-816	P-SW-ENT-2	20	768 BC	2718	518 ± 150	2468	593 ± 155	−0.9	Undersized sample (95.88%)
P-662	P-SW-ENT-1	10	818 BC	2778	764 ± 50	2714	846 ± 52	+1.9	
P-663	P-SW-ENT-1	10	868 BC	2818	691 ± 50	2641	771 ± 52	+2.9	
P-1023	P-SW-INY-20 (TRL 63-43)	78	900 BC	2850	637 ± 40	2587	715 ± 41	+3.0	
P-1022	P-SW-INY-20 (TRL 63-43)	36	958 BC	2908	921 ± 36	2871	1008 ± 37	+3.1	
P-665	P-SW-ENT-1	10	968 BC	2918	791 ± 40	2741	874 ± 42	+9.5	
P-1021	P-SW-INY-20 (TRL 63-43)	46	1001 BC	2951	960 ± 39	2910	1048 ± 40	+3.4	
P-1719	P-SW-INY-20 (TRL 63-43)	10	1016 BC	2966	747 ± 52	2697	828 ± 54	−1.0	
P-1020	P-SW-INY-20 (TRL 63-43)	54	1052 BC	3002	1009 ± 39	2959	1098 ± 40	+3.2	
P-667	P-SW-ENT-1	10	1068 BC	3018	889 ± 50	2839	925 ± 52	+2.7	
P-450	P-SW-ENT-1	16	1082 BC	3032	903 ± 40	2853	989 ± 41		δ ^{13}C from average value
P-1019	P-SW-INY-20 (TRL 63-43)	40	1100 BC	3050	759 ± 45	2709	841 ± 46	+2.8	
P-780	P-SW-ENT-1	6	1109 BC	3059	876 ± 45	2826	961 ± 46	+3.6	

Table 1 (continued)

Lab no.	Acquisition no.	No. of rings	Tree-ring midpoint AD/BC	BP (1950)	^{14}C date 5568 half-life AD/BC	BP (1950)	^{14}C date half-life 5730 AD/BC	δ^{13}C (‰) from oak standard	Comments
P-668	P-SW-ENT-1	8	1117 BC	3067	966 ± 40	2916	1054 ± 41	+4.4	
P-1018	P-SW-INY-20 (TRL 63-43)	58	1150 BC	3100	927 ± 43	2877	1014 ± 44	+2.4	
P-1017	P-SW-INY-20 (TRL 63-43)	38	1200 BC	3150	947 ± 46	2897	1034 ± 47	+3.8	
P-429	P-SW-INY-2	50	1203 BC	3153	886 ± 42	2836	972 ± 43	+0.9	
P-1015	P-SW-INY-20 (TRL 63-43)	28	1249 BC	3199	1045 ± 44	2995	1135 ± 45	+1.5	
P-1013	P-SW-INY-20 (TRL 63-43)	30	1300 BC	3250	1170 ± 43	3120	1264 ± 44	+3.9	
P-1011	P-SW-INY-20 (TRL 63-43)	28	1350 BC	3300	1234 ± 58	3184	1330 ± 60	+2.1	
P-1010	P-SW-INY-20 (TRL 63-43)	20	1375 BC	3325	1153 ± 48	3103	1246 ± 49	+3.8	
P-1009	P-SW-INY-20 (TRL 63-43)	28	1400 BC	3350	1163 ± 45	3113	1257 ± 46	+2.8	
P-1007	P-SW-INY-20 (TRL 63-43)	36	1453 BC	3403	1042 ± 48	2992	1132 ± 49	+0.7	
P-1287	P-SW-INY-19 (TRL 63-89)	10	1455 BC	3405	1097 ± 54	3047	1188 ± 56	−1.0	
P-1005	P-SW-INY-20 (TRL 63-43)	30	1500 BC	3450	1260 ± 146	3210	1357 ± 150	+1.9	
P-1255	P-SW-INY-19 (TRL 63-89)	10	1515 BC	3465	1140 ± 59	3090	1233 ± 61	+0.9	

P-1258	P-SW-INY-19 (TRL 63-89)	10	1575 BC	3525	1162 ± 65	3112	1256 ± 67		No $\delta^{13}C$
P-1001	P-SW-INY-20 (TRL 63-43)	20	1600 BC	3550	1338 ± 46	3288	1437 ± 47	+4.5	
P-1260	P-SW-INY-19 (TRL 63-89)	10	1615 BC	3565	1269 ± 70	3219	1366 ± 72	+8.4	
P-1000	P-SW-INY-20 (TRL 63-43)	30	1625 BC	3575	1338 ± 42	3288	1437 ± 43	+0.9	
P-415	P-SW-INY-2	100	1648 BC	3598	1287 ± 55	3237	1384 ± 57		No $\delta^{13}C$
P-1262 (I-2992)	P-SW-INY-19 (TRL 63-89)	10	1655 BC	3605	1328 ± 85	3278	1427 ± 88	+3.6	
P-1264 (I-2983)	P-SW-INY-19 (TRL 63-89)	10	1695 BC	3645	1471 ± 120	3421	1574 ± 124	+4.2	
P-1266 (I-2989)	P-SW-INY-19 (TRL 63-89)	10	1735 BC	3685	1348 ± 128	3298	1447 ± 132	+4.4	
P-1269	P-SW-INY-19 (TRL 63-89)	10	1795 BC	3745	1509 ± 47	3459	1614 ± 48	+0.9	
P-1270 (I-2984)	P-SW-INY-19 (TRL 63-89)	10	1815 BC	3765	1534 ± 164	3484	1639 ± 169	+2.8	
P-1272 (I-2988)	P-SW-INY-19 (TRL 63-89)	10	1855 BC	3805	1502 ± 130	3452	1606 ± 134	+1.8	
P-1274 (I-2987)	P-SW-INY-19 (TRL 63-89)	10	1895 BC	3845	1452 ± 118	3402	1555 ± 124	+3.8	
P-1350 (I-2991)	P-SW-INY-19 (TRL 63-89)	10	1975 BC	3925	1530 ± 122	3480	1635 ± 125	+4.9	
P-1136	P-SW-INY-19 (TRL 63-89)	20	2050 BC	4000	1513 ± 50	3463	1617 ± 52	+3.8	
P-1137	P-SW-INY-19 (TRL 63-89)	20	2070 BC	4020	1843 ± 61	3793	1957 ± 63	+2.5	
P-1139	P-SW-INY-19 (TRL 63-89)	20	2110 BC	4060	1683 ± 50	3633	1792 ± 52	+3.5	

TABLE 1 (continued)

Lab no.	Acquisition no.	No. of rings	Tree-ring midpoint AD/BC	BP (1950)	^{14}C date 5568 half-life AD/BC	BP (1950)	^{14}C date 5730 half-life AD/BC	δ^{13}C (‰) from oak standard	Comments
P-1345	P-SW-INY-24 (TRL 63-53)	10	2155 BC	4105	1655 ± 52	3605	1764 ± 54	+0.9	
P-1142 (I-2992)	P-SW-INY-19 (TRL 63-89)	20	2170 BC	4120	1613 ± 120	3563	1720 ± 124	+5.5	
P-1346	P-SW-INY-24 (TRL 63-53)	10	2190 BC	4140	1909 ± 55	3859	2025 ± 57	+2.1	
P-1143	P-SW-INY-19 (TRL 63-89)	20	2190 BC	4140	1870 ± 49	3820	1985 ± 50	+5.1	
P-1347	P-SW-INY-24 (TRL 63-53)	4	2208 BC	4158	1798 ± 49	3748	1911 ± 50	+5.5	
P-1144	P-SW-INY-19 (TRL 63-89)	20	2210 BC	4160	1990 ± 50	3940	2109 ± 52	+3.2	
P-1145	P-SW-INY-19 (TRL 63-89)	20	2230 BC	4180	1933 ± 50	3883	2049 ± 52	−2.0	
P-1348	P-SW-INY-24 (TRL 63-53)	6	2238 BC	4188	1830 ± 50	3780	1944 ± 52	+5.5	
P-1146	P-SW-INY-19 (TRL 63-89)	20	2250 BC	4200	1771 ± 50	3721	1883 ± 52	+2.7	
P-1147	P-SW-INY-19 (TRL 63-89)	20	2270 BC	4220	1852 ± 49	3802	1967 ± 50	+2.7	
P-1159	P-SW-INY-19 (TRL 63-89)	10	2415 BC	4365	1840 ± 50	3790	1954 ± 52	+2.8	
P-1559	P-SW-INY-19 (TRL 63-89)	30	2445 BC	4395	1934 ± 112	3884	2051 ± 115		No δ^{13}C. Cellulose only

P-1156	P-SW-INY-19 (TRL 63-89)	10	2475 BC	4425	1981 ± 130	3931	2099 ± 134	+3.7	
P-1529	P-SW-INY-19 (TRL 63-89)	30	2505 BC	4455	1853 ± 45	3803	1968 ± 46	0	Cellulose only
P-1153	P-SW-INY-19 (TRL 63-89)	10	2535 BC	4485	1860 ± 50	3810	1975 ± 52	+3.0	
P-1148	P-SW-INY-19 (TRL 63-89)	10	2555 BC	4505	2054 ± 50	4004	2175 ± 52	+2.8	
P-1150	P-SW-INY-19 (TRL 63-89)	10	2595 BC	4545	1984 ± 59	3934	2103 ± 61	−1.0	
P-1151	P-SW-INY-19 (TRL 63-89)	10	2615 BC	4565	1867 ± 74	3817	1982 ± 76	+2.8	
P-1152	P-SW-INY-19 (TRL 63-89)	10	2635 BC	4585	2118 ± 50	4068	2241 ± 52	+1.9	
P-1313	P-SW-INY-19 (TRL 63-89)	10	2715 BC	4665	2147 ± 61	4097	2270 ± 63	0	
P-1315	P-SW-INY-19 (TRL 63-89)	10	2755 BC	4705	2040 ± 52	3990	2160 ± 54	+1.9	
P-1317	P-SW-INY-10 (TRL 63-89)	10	2795 BC	4745	2027 ± 58	3977	2147 ± 60	+6.5	
P-1303	P-SW-INY-19 (TRL 63-89)	10	2895 BC	4845	2323 ± 54	4273	2452 ± 56	+5.6	
P-1304	P-SW-INY-19 (TRL 63-89)	10	2915 BC	4865	2336 ± 53	4286	2465 ± 55	0	
P-1305	P-SW-INY-19 (TRL 63-89)	10	2935 BC	4885	2160 ± 145	4110	2284 ± 150	+8.2	Undersized sample (86.64%)
P-1306	P-SW-INY-19 (TRL 63-89)	10	2955 BC	4905	2404 ± 54	4354	2534 ± 56	+1.9	
P-1307	P-SW-INY-19 (TRL 63-89)	10	2975 BC	4925	2129 ± 50	4079	2252 ± 52	−0.9	

TABLE 1 (continued)

Lab no.	Acquisition no.	No. of rings	Tree-ring midpoint AD/BC	BP (1950)	^{14}C date 5568 half-life AD/BC	BP (1950)	^{14}C date 5730 half-life AD/BC	$\delta\,^{13}C$ (‰) from oak standard	Comments
P-1308	P-SW-INY-19 (TRL 63-89)	10	3015 BC	4965	2289 ± 51	4239	2417 ± 53	0	
P-1160	P-SW-INY-21 (TRL 63-34)	10	3045 BC	4995	2376 ± 100	4326	2506 ± 103	+4.2	Undersized sample
P-1310	P-SW-INY-19 (TRL 63-89)	10	3075 BC	5025	2373 ± 55	4323	2503 ± 57	0	(85.43%)
P-1851	P-SW-INY-21 (TRL 63-34)	10	3086 BC	5036	2557 ± 65	4507	2693 ± 67	+5.7	
P-1294	P-SW-INY-21 (TRL 63-34)	10	3155 BC	5105	2297 ± 49	4247	2425 ± 50	+0.9	
P-1163	P-SW-INY-21 (TRL 63-34)	10	3195 BC	5145	2615 ± 51	4565	2752 ± 53		$\delta\,^{13}C$ from average value
P-1852	P-SW-INY-21 (TRL 63-34)	10	3226 BC	5176	2557 ± 60	4507	2692 ± 62	−3.8	
P-1164	P-SW-INY-21 (TRL 63-34)	10	3245 BC	5195	2590 ± 106	4540	2727 ± 110	+2.3	
P-1853	P-SW-INY-21 (TRL 63-34)	10	3286 BC	5236	2788 ± 61	4738	2931 ± 63	+8.5	
P-1165	P-SW-INY-21 (TRL 63-34)	10	3295 BC	5245	2333 ± 49	4283	2462 ± 50	+1.5	
P-1169	P-SW-INY-21 (TRL 63-34)	10	3345 BC	5295	2593 ± 48	4543	2730 ± 49	+2.3	

P-1168	P-SW-INY-21 (TRL 63-34)	10	3395 BC	5345	2921 ± 70	4871	3068 ± 72		δ ^{13}C from average value
P-1167	P-SW-INY-21 (TRL 63-34)	10	3445 BC	5395	2640 ± 49	4590	2778 ± 50	+2.8	
P-1166	P-SW-INY-21 (TRL 63-34)	10	3495 BC	5445	2616 ± 44	4566	2753 ± 45		δ ^{13}C from average value
P-1424	P-SW-INY-21 (TRL 63-34)	10	3645 BC	5595	2697 ± 54	4647	2837 ± 56		No δ ^{13}C
P-1867	P-SW-INY-33 (TRL 71-52)	10	3855 BC	5805	3242 ± 64	5192	3398 ± 66	+1.7	
P-1868	P-SW-INY-33 (TRL 71-52)	10	3875 BC	5825	3115 ± 62	5065	3267 ± 64	+3.3	
P-1869	P-SW-INY-33 (TRL 71-52)	10	3885 BC	5835	3138 ± 65	5088	3291 ± 67	+1.7	
P-1865	P-SW-INY-33 (TRL 71-52)	10	3945 BC	5895	3043 ± 63	4993	3193 ± 65	+1.7	
P-1864	P-SW-INY-33 (TRL 71-52)	10	3965 BC	5915	3225 ± 70	5175	3380 ± 72	+3.3	
P-1863	P-SW-INY-33 (TRL 71-52)	10	3985 BC	5935	3308 ± 64	5258	3466 ± 66	+4.2	
P-1861	P-SW-INY-33 (TRL 71-52)	10	4025 BC	5975	3199 ± 69	5149	3353 ± 71	+7.2	
P-1860	P-SW-INY-33 (TRL 71-52)	10	4045 BC	5995	3388 ± 60	5338	3548 ± 62	+4.8	
P-1858	P-SW-INY-33 (TRL 71-52)	10	4065 BC	6015	3233 ± 64	5183	3388 ± 66	+0.8	
P-1859	P-SW-INY-33 (TRL 71-52)	10	4085 BC	6035	3313 ± 59	5263	3471 ± 61	+2.4	
P-1855	P-SW-INY-33 (TRL 71-52)	10	4105 BC	6055	3262 ± 62	5212	3418 ± 64	+0.8	
P-1856	P-SW-INY-33 (TRL 71-52)	10	4125 BC	6075	3223 ± 61	5173	3379 ± 63	+3.4	

Table 1 (continued)

Lab no.	Acquisition no.	No. of rings	Tree-ring AD/BC	midpoint BP (1950)	^{14}C date 5568 half-life AD/BC	^{14}C date 5568 half-life BP (1950)	^{14}C date 5730 half-life AD/BC	$\delta\,^{13}$C (‰) from oak standard	Comments
P-1318	P-SW-INY-23 (TRL 63-92)	10	4135 BC	6085	3428 ± 71	5378	3590 ± 73	+4.6	
P-1857	P-SW-INY-33 (TRL 71-52)	10	4145 BC	6095	3218 ± 49	5168	3373 ± 50	+5.6	
P-1296	P-SW-INY-23 (TRL 63-92)	10	4235 BC	6185	3463 ± 63	5413	3626 ± 65	+1.8	
P-1297	P-SW-INY-23 (TRL 63-92)	10	4255 BC	6205	3500 ± 61	5450	3664 ± 63	+4.6	
P-1298	P-SW-INY-23 (TRL 63-92)	10	4275 BC	6225	3474 ± 59	5424	3637 ± 61	+0.9	
P-1299	P-SW-INY-23 (TRL 63-92)	10	4295 BC	6245	3251 ± 59	5201	3408 ± 61	+2.9	
P-1301	P-SW-INY-23 (TRL 63-92)	10	4335 BC	6285	3497 ± 55	5447	3661 ± 57	+4.6	
P-1302	P-SW-INY-23 (TRL 63-92)	10	4395 BC	6345	3364 ± 55	5316	3524 ± 57	+2.8	
P-1580	P-SW-INY-22 (TRL 63-92E)	10	4505 BC	6455	3835 ± 49	5785	4009 ± 50	+2.8	
P-1700	P-SW-INY-22 (TRL 63-92E)	10	4565 BC	6515	3752 ± 80	5702	3923 ± 82	0	

P-1702	P-SW-INY-22 (TRL 63-92E)	10	4585 BC	6535	3730 ± 67	5680	3901 ± 69	−0.9	
P-1576	P-SW-INY-22 (TRL 63-92E)	10	4625 BC	6575	3899 ± 77	5849	4075 ± 79	+3.8	
P-1703	P-SW-INY-22 (TRL 63-92E)	10	4665 BC	6615	3832 ± 71	5782	4005 ± 73		No $\delta^{13}C$
P-1577	P-SW-INY-22 (TRL 63-92E)	10	4685 BC	6635	3767 ± 78	5717	3940 ± 80	−3.8	
P-1578	P-SW-INY-22 (TRL 63-92E)	10	4715 BC	6665	4059 ± 80	6009	4240 ± 82	−0.9	
P-1420	P-SW-INY-22 (TRL 63-92E)	10	4810 BC	6760	4037 ± 63	5987	4217 ± 65	+10.3	
P-1419	P-SW-INY-22 (TRL 63-92E)	10	4840 BC	6790	3934 ± 61	5884	4111 ± 63	+2.8	
P-1423	P-SW-INY-22 (TRL 63-92E)	10	4880 BC	6830	3930 ± 63	5880	4107 ± 65		No $\delta^{13}C$
P-1422	P-SW-INY-22 (TRL 63-92E)	10	4900 BC	6850	3856 ± 94	5806	4031 ± 97	+0.9	
P-1418	P-SW-INY-22 (TRL 63-92E)	10	5000 BC	6950	4137 ± 71	6087	4320 ± 73	+2.8	
P-1417	P-SW-INY-22 (TRL 63-92E)	10	5040 BC	6990	4061 ± 64	6011	4242 ± 66	+3.7	
P-1416	P-SW-INY-22 (TRL 63-92E)	10	5060 BC	7010	4149 ± 64	6099	4333 ± 66	+0.9	
P-1291	P-SW-INY-22 (TRL 63-92E)	10	5090 BC	7040	4288 ± 66	6238	4476 ± 68	+3.0	
P-1290	P-SW-INY-22 (TRL 63-92E)	10	5116 BC	7066	4085 ± 77	6035	4267 ± 80	+2.7	

TABLE 1 (continued)

Lab no.	Acquisition no.	No. of rings	midpoint BP (1950)	Tree-ring AD/BC	^{14}C date 5568 half-life AD/BC	^{14}C date 5568 half-life BP (1950)	^{14}C date 5730 half-life AD/BC	$\delta\,^{13}C$ (‰) from oak standard	Comments
P-1718	P-SW-INY-31 (TRL 70-20)	10	5134 BC	7084	4134 ± 67	6084	4317 ± 69	−3.8	
P-1717	P-SW-INY-31 (TRL 70-20)	10	5144 BC	7094	4265 ± 78	6215	4451 ± 80	+2.3	
P-1716	P-SW-INY-31 (TRL 70-20)	10	5173 BC	7123	4012 ± 66	5962	4191 ± 68	+1.0	
P-1715	P-SW-INY-31 (TRL 70-20)	10	5224 BC	7174	4396 ± 75	6346	4586 ± 77	−1.0	
P-1714	P-SW-INY-31 (TRL 70-20)	10	5264 BC	7214	4290 ± 71	6240	4477 ± 74	+4.7	
P-1712	P-SW-INY-31 (TRL 70-20)	10	5303 BC	7253	4315 ± 83	6265	4503 ± 85	+0.9	
P-1711	P-SW-INY-31 (TRL 70-20)	10	5323 BC	7273	4555 ± 62	6505	4750 ± 64	+4.0	
P-1710	P-SW-INY-31 (TRL 70-20)	10	5343 BC	7293	4503 ± 70	6453	4697 ± 72	+0.8	
P-1709	P-SW-INY-31 (TRL 70-20)	10	5363 BC	7313	4604 ± 71	6554	4801 ± 73	+0.8	
P-1708	P-SW-INY-31 (TRL 70-20)	10	5383 BC	7333	4438 ± 70	6388	4630 ± 72	+1.0	

TABLE 2
Aberrant radiocarbon dates of dendro-dated samples, not used in figs 1-6, calculated with 5730 half-life

Lab no.	Acquisition no.	No. of rings	Tree-ring AD/BC	midpoint BP (1950)	^{14}C date 5568 half-life AD/BC	^{14}C date 5568 half-life BP (1950)	^{14}C date 5730 half-life AD/BC	$\delta^{13}C$ (‰) from oak standard	Comments
P-1275 (I-2986)	P-SW-INY-19 (TRL 63-89)	10	1915 BC	3865	1755 ± 130	3705	1867 ± 134	+5.5	Aberrant
P-1135 (I-2990)	P-SW-INY-19 (TRL 63-89)	20	2030 BC	3980	1818 ± 233	3768	1932 ± 240	+5.5	Aberrant
P-1138	P-SW-INY-19 (TRL 63-89)	20	2090 BC	4040	1313 ± 50	3263	1411 ± 52	+3.3	Aberrant
P-1161	P-SW-INY-21 (TRL 63-34)	10	3095 BC	5045	2667 ± 50	4617	2806 ± 52	+2.2	Aberrant
P-910	P-SW-INY-19 (TRL 63-89)	94	3802 BC	5752	2813 ± 51	4763	2956 ± 53	0	Aberrant
P-1862	P-SW-INY-33 (TRL 71-52)	10	4005 BC	5955	3682 ± 63	5632	3851 ± 65	+1.7	Aberrant
P-1319	P-SW-INY-23 (TRL 63-92)	10	4155 BC	6105	3611 ± 65	5561	3778 ± 67	+3.6	Aberrant
P-1323	P-SW-INY-23 (TRL 63-92)	10	4175 BC	6125	3686 ± 69	5636	3856 ± 71	+1.9	Aberrant
P-1295	P-SW-INY-23 (TRL 63-92)	10	4215 BC	6165	3637 ± 58	5587	3805 ± 60	+3.6	Aberrant
P-1569	P-SW-INY-26 (TRL 67-35)	16	5275 BC	7225	3696 ± 53	5646	3866 ± 55	+1.8	Aberrant
P-1713	P-SW-INY-31 (TRL 70-20)	10	5283 BC	7233	5101 ± 69	7059	5313 ± 71	−1.9	Aberrant

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