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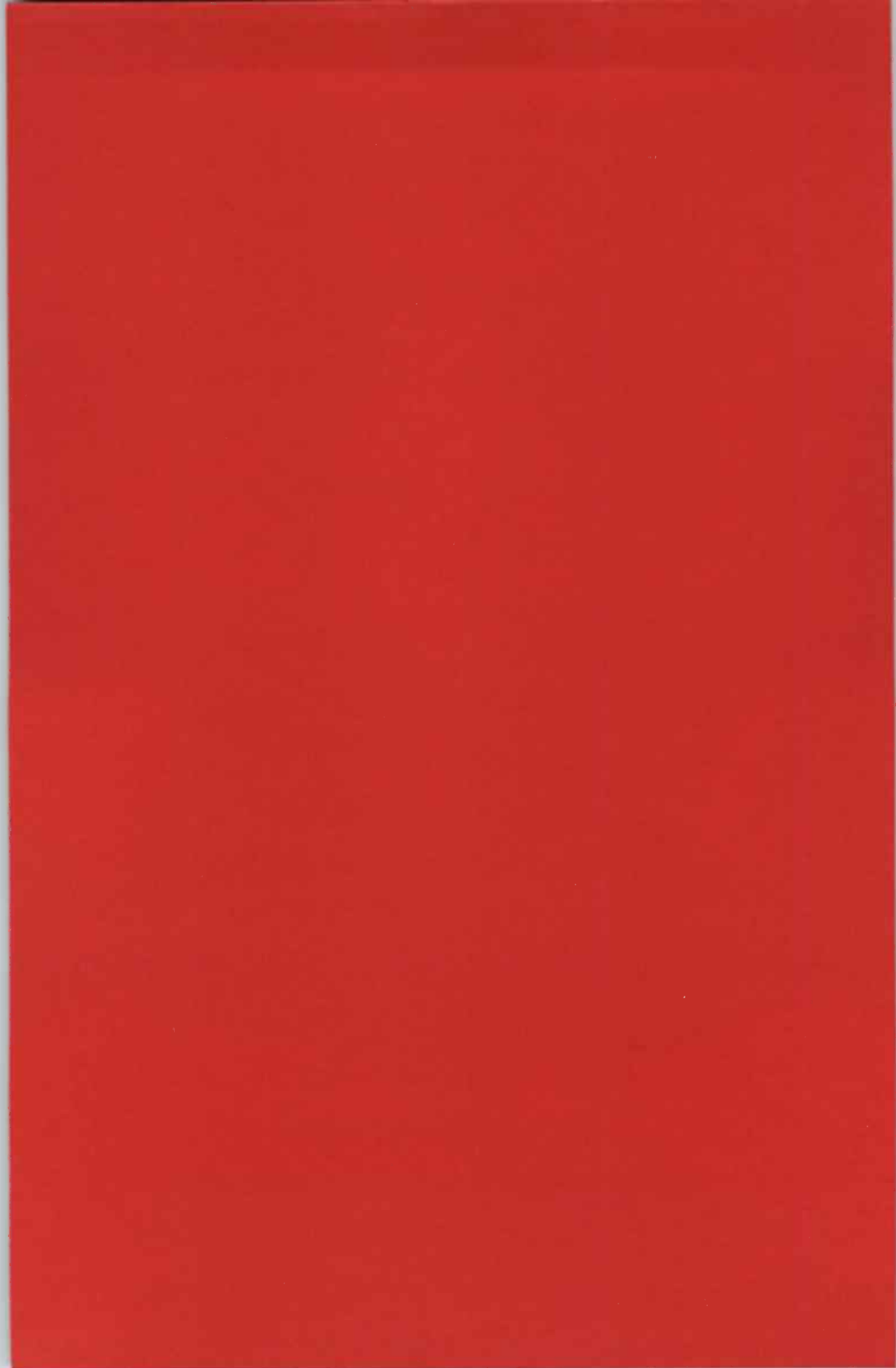
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TWELFTH INTERNATIONAL RADIOCARBON CONFERENCE

June 24–28, 1985

Trondheim, Norway

The Twelfth International Radiocarbon Conference will be held from June 24 to 28, 1985 at the Norwegian Institute of Technology, Trondheim, Norway.

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Natural ^{14}C variations:

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- cosmic ray flux

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- anthropogenic ^{14}C variations
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NOTICE TO READERS AND 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 . We would like to encourage this type of publication on a regular basis. In addition, we will be publishing compilations of published *and unpublished* dates along with interpretative text for these dates on a regional basis. Authors who would like to compose such an article for his/her area of interest should contact the Managing Editor for information.

Our new associate editor for Archaeology, Andrew Moore, is a prehistoric archaeologist who recently became an assistant professor in the Department of Anthropology at Yale University. He received his doctorate from Oxford University and has also taught at the University of Arizona. His research is mainly concerned with the origins of agriculture and sedentary life in Southwest Asia. He is interested, further, in the prehistory of Europe, prehistoric economies, and theory and method in archaeology.

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 includes 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.

Manuscripts of radiocarbon papers should follow the recommendations in *Suggestions to Authors** and *RADIOCARBON* Style Guide (R, 1984, v 26, p 152–158). Our deadline schedule is:

<i>For</i>	<i>Date</i>
Vol 27, No. 3, 1985	May 1, 1985
Vol 28, No. 1, 1986	Sept 1, 1985
Vol 28, No. 2, 1986	Jan 1, 1986

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 11th International Radiocarbon Conference in Seattle, Washington, 1982. 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 $\delta^{14}\text{C}$. 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 $\delta^{14}\text{C}$ 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 $\delta^{14}\text{C}$ as the observed deviation from the standard. At the New Zealand Radiocarbon Dating Conference it was recommended to use $\delta^{14}\text{C}$ 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 $\delta^{13}\text{C} = -19\text{‰}$.

In several fields, however, age corrections are not possible. $\delta^{14}\text{C}$ 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.

*Suggestions to Authors of the Reports of the United States Geological Survey, 6th ed, 1978, Supt of Documents, U S Govt Printing Office, Washington, DC 20402.

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Citations. A number of radiocarbon dates appear in publications without laboratory citation or reference to published date lists. We ask that laboratories remind submitters and users of radiocarbon dates to include proper citation (laboratory number and date-list citation) in all publications in which radiocarbon dates appear.

Radiocarbon Measurements: Comprehensive Index, 1950–1965. This index covers all published ^{14}C measurements through Volume 7 of RADIOCARBON, and incorporates revisions made by all laboratories. It is available to all subscribers to RADIOCARBON at \$20.00 US per copy.

List of laboratories. The comprehensive list of laboratories at the end of each volume appears in the third number of each volume. Changes in names or addresses should be reported to the Managing Editor by May 1.

Annual Index. All dates appear in index form at the end of the third number of each volume. Authors of date lists are asked to supply indexed material of *archaeologic samples only* with their date lists.

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Radiocarbon

1985

THE EFFECT OF ATMOSPHERIC ^{14}C VARIATIONS ON THE ^{14}C LEVELS IN THE JORDAN RIVER SYSTEM

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ABSTRACT. ^{13}C and ^{14}C were measured in the upper Jordan River, in its tributaries which issue from the Mount Hermon aquifer, and in the local atmospheric CO_2 to evaluate the degree to which changes in the atmospheric ^{14}C levels influence the ^{14}C levels in the aquifer and in the Jordan River. The exchange fraction of CO_2 between the river and the atmosphere was calculated for fall 1983 with the two carbon isotopes and it is shown that the value obtained with ^{14}C (0.364) is the more reliable. The ratio of ^{14}C in the Jordan River to that in the atmosphere in 1972 is similar to that in 1983, 0.66 and 0.67, respectively. This implies an approximately constant ratio (0.44) between the ^{14}C level in the Mount Hermon aquifer base-flow and the ^{14}C level in the atmospheric CO_2 . This information can be combined with the known historical fluctuations in the ^{14}C levels of the atmosphere to calculate the ^{14}C fluctuations in the discharge of the Jordan River into Lake Kinneret, backwards in time.

INTRODUCTION

First described by Deevey, Gross, and Kraybill (1954), the hard-water effect in the dating of lake sediments with ^{14}C , is now a well-known phenomenon. The magnitude of this effect remains constant only under stable hydrologic and isotopic conditions. Changes in atmospheric ^{14}C levels as has occurred dramatically since the 1950's because of nuclear testing and in more subdued form throughout the last 8000 years (Clark, 1975; Suess, 1980) can alter the magnitude of the hard-water effect. This alteration, which must be corrected for if valid ^{14}C ages are to be calculated, occurs in several steps. We shall deal with the first two of these: 1) that which occurs in the aquifer prior to the emergence of the bicarbonate in a spring and which is driven by the need for a new balance in ^{14}C levels between the basic aquifer rocks and the changing ^{14}C levels in the dissolved CO_2 ; and 2) that which occurs afterwards in the river that feeds the lake, as the emerged bicarbonate now undergoes exchange with the contemporaneous ^{14}C levels in atmospheric CO_2 . Changes in the magnitude of the hard-water effect caused by processes other than these two will be discussed in a forthcoming article (Kaufman & Stiller, ms in preparation).

In this paper we investigate these first two steps in the Jordan River system north of Lake Kinneret. ^{13}C concentrations and parameters affecting the carbonate equilibrium—pH, alkalinity, and temperature, have also been considered in our investigation.

The Jordan River, one of the principal sources of water for Israel, arises at the confluence of three tributaries fed by the three perennial springs, Snir, Dan, and Hermon (fig 1). The three springs issue from karstic aquifers which are in part calcitic (Dan and Hermon), and in part dolomitic

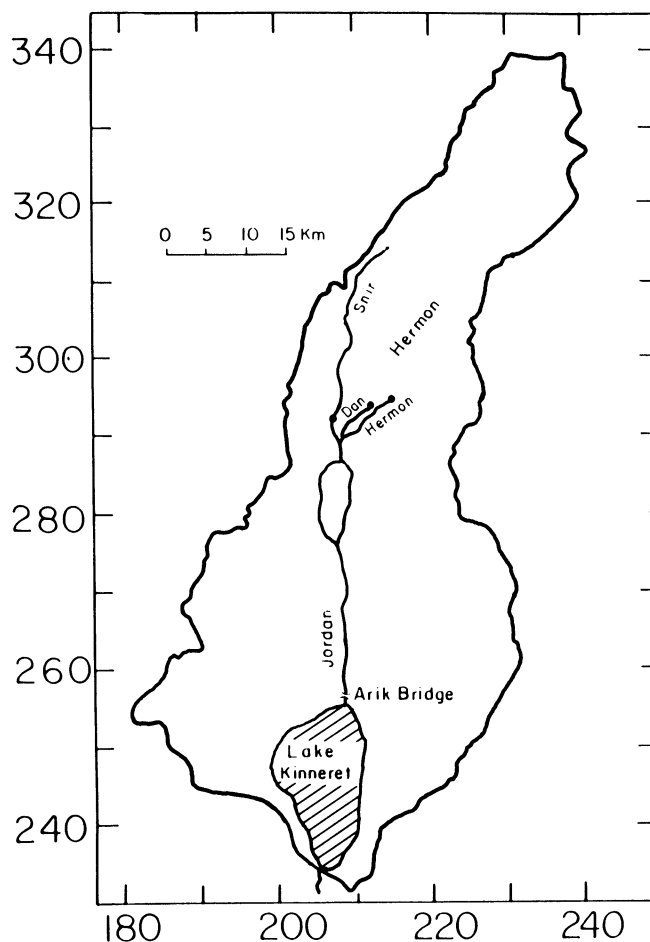


Fig 1. Map of Lake Kinneret watershed with the Jordan River and its tributaries. The Dan and Hermon springs emerge on the southwestern slope of Mt Hermon and the Snir spring emerges on the western slope (Lebanon). The sampling points of the tributaries are shown by (●). Below the confluence of the tributaries, the Jordan River was diverted into two channels for swamp drainage.

(Snir) (Michelson, 1975). Hydrographic and isotopic (tritium and ^{18}O) investigations have shown (Simpson & Carmi, 1983) that the residence time of water in the aquifers that feed these springs is less than 4 yr. The discharge from the Snir and Hermon springs also shows an immediate response to rainfall, but such a response is absent in the Dan spring. The distance between the confluence of the three tributaries and the discharge of the Jordan River into Lake Kinneret is ca 36km.

SAMPLING AND MEASURING TECHNIQUES

Water samples were collected from the three tributaries of the Jordan River and from the river itself (fig 1). The sampling points of the Dan and

the Hermon were very close to their emergence, and the Snir was sampled 34km downstream from its emergence point. The Jordan River was sampled at Arik bridge—near the point of discharge into Lake Kinneret. An atmospheric CO_2 sample was collected at Rehovot, ca 150km south of the upper Jordan River region.

Temperature, pH, and titration alkalinity of the samples were measured on site to a precision of 0.1°C, 0.1 pH units, and 0.1 mmole/L, respectively. Precipitation of BaCO_3 for ^{13}C analysis of the total dissolved carbonate (ΣC) was carried out on site in duplicate, on 1L samples. $\delta^{13}\text{C}$ was measured on a Varian MAT-250 mass spectrometer with an analytical error of <0.1‰; duplicates agreed within the analytical error. For ^{14}C analysis, total dissolved carbonate was precipitated as BaCO_3 from 50L of water within one day after sampling. The ^{14}C activity of the BaCO_3 was measured as described by Carmi, Noter, and Schlesinger (1971). $\Delta^{14}\text{C}_{\Sigma\text{C}}$ was calculated using $\delta^{13}\text{C}$ values measured on the CO_2 prepared for the ^{14}C measurements (Broecker & Olson, 1961).

The values of $\delta^{13}\text{C}_{\text{HCO}_3^-}$ were calculated after accounting for the pH and temperature-dependent distribution of dissolved carbonate among its various species (Riley & Skirrow, 1965) and the isotopic fractionation, ϵ , between them (Mook, 1968; Mook, Bommerson, & Staverman, 1974). The values of $\Delta^{14}\text{C}_{\text{HCO}_3^-}$ were calculated in a similar fashion, considering that the ^{14}C fractionation is twice as large as the ^{13}C fractionation. Despite the recent experimental evidence that these two may differ by a factor of 2.3 (Saliège & Fontes, 1984), the factor of 2 was used for consistency with the conventional calculation of $\Delta^{14}\text{C}$.

RESULTS

Table 1 presents the results of measurements performed on samples collected in 1983 from the Jordan River and its tributaries, and older data from 1971–72 (Stiller, 1974). The ^{14}C level of atmospheric CO_2 measured in 1983 is also given in table 1.

The winter temperatures of the three springs are generally similar at 15°C; but the summer temperature of the Snir tributary at the sampling station is appreciably higher (by 2°C) than that of the other two tributaries because of its exposure to high ambient temperatures during the 34km flow from the emergence point to the sampling station. Similarly, the water of the Jordan River downstream at Arik bridge, after its 36km journey (fig 1) is always warmer than the tributaries.

Each of the three tributaries has its own characteristic pH which does not change appreciably throughout the year. In 1983–84, the pH at Arik bridge was somewhat higher than the pH's of its tributaries. Why the measured pH at Arik bridge in 1971–72 was lower than in 1983–84 is not yet understood.

The relatively high ΣC values in the tributaries (3.3–4.0 mmole/L) reflect the karstic nature of the aquifers that feed them: calcitic for the Dan and Hermon, and dolomitic for the Snir. The weighted average of total dissolved carbon in the three springs is close, within the precision of the measurements, to the value measured at Arik bridge. This suggests that losses

TABLE 1
Isotopic, chemical, and physical data on the Jordan River, its tributaries, and in Rehovot atmosphere

No.	Sample	Date	Discharge $\frac{10^6 m^3}{mon}$	Temp °C	pH	ΣC $\frac{mmole}{L}$	$\delta^{13}C$ ΣC ‰	$\delta^{13}C$ HCO_3^- ‰	$\Delta^{14}C$ ΣC ‰	$\Delta^{14}C$ HCO_3^- ‰
a. Dissolved inorganic carbon										
643B	Snir	2/17/83	23.4	14.8	8.3	4.0	-10.0	-9.9	-201 ± 5	-200
661C		10/19/83	4.0	19.3	8.3	3.5	-9.6	-9.4	-186 ± 17	-186
643A	Dan	2/17/83	8.7	15.8	7.8	3.9	-10.7	-10.3	-434 ± 13	-433
661A		10/19/83	13.3	17.2	7.8	3.3	-10.0	-9.7	-446 ± 12	-445
643C	Hermon	2/17/83	12.8	15.5	7.5	3.5	-11.2	-10.3	-501 ± 5	-499
661B		10/19/83	5.3	16.5	7.3	3.7	-9.6	-8.3	-454 ± 12	-451
	Jordan*	12/7/71		17.0	7.7	3.8	-7.1	-6.7		
371A		7/22/72		27.0	7.8	3.2	-6.3	-6.0	-23 ± 23	-22
661D		8/23/72		28.0	7.5	3.4	-7.0	-6.4		
		10/19/83		22.0	8.5	3.4	-7.4	-7.3	-166 ± 17	-166
b. Atmospheric CO ₂										
651	Rehovot	6/19/83					-10.2	-1.7	+225 ± 25	+242

*Sampled at Arik bridge

or gains of carbon during the flow of the river in 1983 are small. At Arik bridge, no significant variations in ΣC are observed between 1971–72 and 1983, indicating that no greater changes in the carbon balance of the river have taken place in this interval.

The range of $\delta^{13}\text{C}$ values in the three springs is rather small (-11‰ to -9‰). In the Hermon spring, there is an indication that the base flow (represented by October 1983) is more enriched in ^{13}C than is the winter flow (represented by February 1983) which includes the response to rainfall. The bicarbonate at Arik bridge is significantly enriched in ^{13}C compared to the tributaries (by 2‰ to 3‰), and this suggests that exchange with atmospheric CO_2 takes place during the river's flow.

$\Delta^{14}\text{C}$ has distinct values for each of the three tributaries. The discharge of the Dan spring does not respond directly to rainfall and, in fact, no seasonal variation is observed in its ^{14}C levels, which, therefore, represent the baseflow of the aquifer in 1983. In the Hermon spring, the ^{14}C level at the end of the summer is very similar to that of the Dan. This seems reasonable because the baseflows of both springs have the same age distribution. Surprisingly, however, the ^{14}C level in winter 1983 (when the Hermon's monthly discharge has increased up to five-fold by the addition of fresh rain) is distinctly *lower* than that of the summer baseflow with its *older* water. Both of these waters must, therefore, have fallen as precipitation in the unusual period since 1964 when older water had more ^{14}C than did younger water because of the dissipation of the nuclear tests peak (Segl *et al.*, 1983). This constraint on the aquifer residence time (<20 yr) supports the <4 yr residence time discovered independently (Simpson & Carmi, 1983) using tritium. In the Snir, the ^{14}C levels are higher than in the other two springs and no seasonal variation is observed. This indicates that considerable exchange with atmospheric CO_2 occurs between the emergence point of the Snir and our sampling point which is 34km downstream; this exchange apparently masks any minor seasonal variations that may occur in the ^{14}C levels of the spring. The ^{14}C at Arik bridge is enriched compared to the tributaries, which shows that exchange with atmospheric CO_2 significantly affects the levels of ^{14}C in the Jordan River, as observed above for ^{13}C .

DISCUSSION

The carbon isotope data will now be applied to the two modes of change in hard-water effect mentioned in the Introduction: 1) the relationship between changing atmospheric ^{14}C levels and those in the discharge at the spring, which results from processes occurring within the aquifer, and 2) the relationship between changing atmospheric ^{14}C levels and those in the Jordan River which takes place during its flow to Lake Kinneret. The conclusions drawn will be integrated for an estimate of the historic levels of ^{14}C in the Jordan River and its tributaries. We begin by discussing the exchange between the Jordan River and the atmosphere.

The exchange fraction of CO_2 between the atmosphere and the flowing Jordan River, E , can, in principle, be estimated from either ^{13}C or ^{14}C

data as follows:

$$E = \frac{X_{jrd} - X_{trb}}{X_{atm} - X_{trb}} \quad (1)$$

where X is the isotopic composition (either in $\delta^{13}\text{C}$, $\Delta^{14}\text{C}$ units or in concentration units) and the subscripts are: *jrd*—Jordan, *trb*—the combined tributaries, and *atm*—atmosphere.

Of the three terms used to calculate E in the upper Jordan River (Eq 1) two, X_{jrd} and X_{trb} , were obtained by sampling of the Jordan River and its tributaries in October 1983, while the third, X_{atm} , was inferred from an atmospheric CO_2 sample collected 150km away (table 1). The $\Delta^{14}\text{C}$ of this latter sample fits the generally accepted trend of atmospheric ^{14}C levels quite well, but the applicability of its $\delta^{13}\text{C}$ value is far less clear because of the large variability in atmospheric $\delta^{13}\text{C}$ values (Keeling, 1961) which was found to depend on location, plant cover, and exact time of sampling. The effect of this variability on the two carbon isotopes may be demonstrated by considering the extreme case: if X_{atm} is overwhelmed by local plant respiration (with -18‰ fractionation in $\delta^{13}\text{C}$ between the plants and the atmosphere and twice this value for $\Delta^{14}\text{C}$). Here, the effect on the value of $\Delta^{14}\text{C}_{atm}$ would be $<6\%$ of the difference $\Delta^{14}\text{C}_{atm} - \Delta^{14}\text{C}_{trb}$ (Eq 1) measured on 1983 and, therefore, relatively insignificant (the values of X_{trb} are given below). With $\delta^{13}\text{C}$, on the other hand, the corresponding effect would be much larger than the difference $\delta^{13}\text{C}_{atm} - \delta^{13}\text{C}_{trb}$, itself, and therefore very significant. The atmospheric sample was collected far from the Jordan River, during midday and under a completely different plant cover, and it is therefore difficult to extrapolate its $\delta^{13}\text{C}$ value to the atmosphere above the Jordan River. For this reason, although both isotopes qualitatively lead to the same conclusions, we consider the calculated value of ^{14}E to be more reliable than the calculated value of ^{13}E .

In applying Eq 1 to our isotopic measurements, we must remember that dissolved inorganic carbon is distributed among several species, depending on the pH and the temperature of the water, and that each of these species has a distinct isotopic composition determined by the temperature-dependent fractionation between them. The bicarbonate ion is the dominant constituent of the dissolved carbon pool and we used its isotopic composition to follow the exchange of CO_2 between the atmosphere and the river. The isotopic content of the upper Jordan River in fall 1983 at the confluence of the tributaries, X_{trb} , was calculated as a weighted average, the weights being the respective discharges given in table 1. The values obtained for the bicarbonate component are $\delta^{13}\text{C}_{trb} = -9.49\text{‰}$ and $\Delta^{14}\text{C}_{trb} = -400\text{‰}$. From these values, the data for Arik bridge (X_{jrd}) and the atmosphere (X_{atm}) (table 1) we calculate from Eq 1: $^{14}\text{E} = 0.364 \pm 0.023$ and, for the sake of completeness, $^{13}\text{E} = 0.287 \pm 0.019$.

The errors in ^{14}E and ^{13}E , both ca 6.5‰ , were based on analytical errors of 0.1‰ and 10‰ for $\delta^{13}\text{C}$ and $\Delta^{14}\text{C}$, respectively. The former are similar though the latter differ by a factor of 100 because $\Delta^{14}\text{C}_{atm} - \Delta^{14}\text{C}_{trb}$ is ca 80 times greater than $\delta^{13}\text{C}_{atm} - \delta^{13}\text{C}_{trb}$. The discrepancy between ^{14}E and ^{13}E is greater than can be accounted for by the analytical uncertainties and

considering the lower reliability that we ascribe to ^{13}E , we shall restrict all further discussion to ^{14}E .

From our estimate of E , it is possible to calculate the exchange rate along the Jordan River, using the equation of Broecker and Walton (1959), and the stagnant film thickness after Broecker *et al.*, (1980). The relevant parameters and the results are given in table 2. The results are only useful for rough comparison because they are derived values which vary with time and from one part of the river to another. Thus, our 240 ± 30 moles $\text{m}^{-2}\text{yr}^{-1}$ estimate for the CO_2 exchange rate for the Jordan River may be considered to be in good agreement with the 103 ± 50 obtained by Broecker and Walton (1959) for the Truckee River of Nevada (the quoted uncertainties are based on 1σ counting errors). No other estimates of the stagnant film thickness in rivers were found with which to compare our result (table 2). As can be expected for the smaller turbulence, the exchange rates in lakes and oceans are smaller and the stagnant film thickness is much larger (Broecker *et al.*, 1980) than they are in rivers.

The distance between the Snir's emergence point and the confluence point, 34km, is similar to the distance between the confluence point and Arik Bridge, 36km. If similar flow characteristics, *ie*, ratio of average depth to transit time, are assumed for both flow channels, we may use the ^{14}E value obtained for the Jordan River and the October 1983 ^{14}C level of the Snir at the sampling point, to compute $\Delta^{14}\text{C} = -433\text{‰}$ at the emergence point of the Snir. This is a plausible value because of its similarity to the baseflow data at the emergence points of the other two tributary springs in October 1983 (table 1).

We may also combine the 0.364 value of E , computed from the October 1983 data, with the July 1972 $\Delta^{14}\text{C}$ values at Arik bridge (table 1) and the $\Delta^{14}\text{C}_{\text{atm}} = 485\text{‰}$ of the 1972 atmosphere (Segl *et al.*, 1983), to compute the $\Delta^{14}\text{C}$ of the combined tributaries for the baseflow of 1972. The result $\Delta^{14}\text{C}_{\text{trb}} = -315\text{‰}$ is what one would expect because it is higher than the

TABLE 2
Parameters needed to calculate exchange rate of CO_2 and stagnant film thickness in the Jordan River

<i>The CO_2 exchange rate</i>	
Weighted mean ΣCO_2	3.4 mole m^{-3}
Mean depth of river*	0.78 to 0.87m
Transit time	5.3×10^{-3} yr
Exchange rate of CO_2 **	$(226 \text{ to } 253) \pm 30$ moles $\text{m}^{-2} \text{yr}^{-1}$
<i>The stagnant film thickness</i>	
Diffusion coefficient of CO_2 †	$(1.54 \text{ to } 1.74) \times 10^{-5}$ $\text{cm}^2 \text{sec}^{-1}$
Dissolved gaseous CO_2	$(19.3 \text{ to } 2.4) \times 10^{-8}$ moles cm^{-3}
Exchange rate of CO_2 (average)	240 moles $\text{m}^{-2} \text{yr}^{-1}$
Stagnant film thickness	0.4 to 5.2 μ

*Determined for two points along the river's course (Inbar 1977).

**Calculated by Eq 2 of Broecker and Walton (1959)

†In each case, the first value given corresponds to the physico-chemical conditions at the confluence of the tributaries and the second to those at Arik Bridge (36km southwards).

TABLE 3
 ^{14}C in the Jordan River system and its relationship with atmospheric levels
 (m—measured, c—calculated values)

Date	X_{atm}	X_{aquifer}	X_{trb}	X_{jrd}	X_{aquifer}	X_{trb}	X_{jrd}
					X_{atm}	X_{atm}	X_{atm}
10/83	1.242 _m	0.598 _m *	0.598 _m	0.834 _m	0.443	0.482	0.672
7/72	1.487 _m	0.608 _c	0.685 _c	0.978 _m	0.409	0.461	0.657
Pre-bomb	≈ 1.00	0.43 _c	0.48 _c	0.67 _c			

*Average of the Dan and the Hermon

$\Delta^{14}\text{C}_{\text{trb}}$ of 1983 in about the same proportion that $\Delta^{14}\text{C}_{\text{atm}}$ of 1972 is higher than that of 1983.

Now that the estimate of $E = 0.364$ was found to be consistent with the various aspects of our data, we may proceed to undertake our original task, that of deriving a relationship between X_{jrd} and X_{atm} . By substituting for E in Eq 1 and rearranging:¹

$$\frac{X_{\text{jrd}}}{X_{\text{atm}}} = 0.364 + 0.636 \frac{X_{\text{trb}}}{X_{\text{atm}}} \quad (2)$$

This equation permits us to get X_{jrd} from X_{atm} only if the relationship between the latter and X_{trb} is known. From our measurements, we have two estimates of the ratio $X_{\text{jrd}}/X_{\text{atm}}$, 0.66 and 0.67 in 1972 and 1983, respectively. The fact that these two ratios are so similar though X_{atm} has decreased by 20% in the meantime suggests that the ratio $X_{\text{trb}}/X_{\text{atm}}$ is approximately constant. That this, in fact, is the case is demonstrated by the observation that 1) the measurements of X_{atm} and X_{trb} in 1983 yield $X_{\text{trb}}/X_{\text{atm}} = 0.48$; 2) the measurements of X_{jrd} and X_{atm} in 1972 together with Eq 2 yield $X_{\text{trb}}/X_{\text{atm}} = 0.46$ (table 3). The reason for this near constancy is that the value of this ratio is determined primarily by the extent to which CO_2 bearing ^{14}C -rich recharge waters are chemically neutralized by the basic ^{14}C -free aquifer rock; apparently, this process is reproducible regardless of the atmospheric ^{14}C level.

We now use the ratios found above to calculate the pre-bomb ($\Delta^{14}\text{C}_{\text{atm}} = 0$) ^{14}C levels of the Jordan River at Arik bridge, and of the combined tributaries: $\Delta^{14}\text{C}_{\text{jrd}} = -330\text{‰}$ and $\Delta^{14}\text{C}_{\text{trb}} = -518\text{‰}$. The baseflow of the Mount Hermon aquifer is expected to have a somewhat lower ^{14}C activity than that of the combined tributaries. This is because of exchange with atmospheric $^{14}\text{CO}_2$ during the flow of the Snir from its emergence to confluence with the other two tributaries. We can, however, estimate the pre-bomb ^{14}C level in the baseflows of the aquifers that feed the springs as follows: we express $\Delta^{14}\text{C}_{\text{trb}}$ as an average of the $\Delta^{14}\text{C}$ values of the three springs, weighted by their respective estimated discharge fractions of 0.25 for the Snir, 0.25 for the Hermon, and 0.50 for the Dan. The ^{14}C contributions of the Hermon and the Dan are taken to be $\Delta^{14}\text{C}_{\text{aquifer}}$ but that of the Snir has to

¹Note that for ratios between X's, concentration units must be used:

$$X_i = (1000 + \Delta^{14}\text{C}_i)/1000.$$

be corrected, by use of Eq 1 with $^{14}\text{E} = 0.364$, for exchange with the atmosphere between the emergence of this spring and the confluence. Rearranging the expression for $\Delta^{14}\text{C}_{\text{trb}}$, we get $\Delta^{14}\text{C}_{\text{aquifer}} = \Delta^{14}\text{C}_{\text{trb}} - 0.25^{14}\text{E}\Delta^{14}\text{C}_{\text{atm}}/1 - 0.25^{14}\text{E}$, which gives for $\Delta^{14}\text{C}_{\text{atm}} = 0\text{‰}$, $\Delta^{14}\text{C}_{\text{aquifer}} = -570\text{‰}$ or $X_{\text{aquifer}}/X_{\text{atm}} = 0.43$ (table 3). The ratio $X_{\text{aquifer}}/X_{\text{atm}}$, which is fairly constant (table 3: note that in October 1983 it is based on actual measurements), means that the initial ^{14}C activity of the regional aquifer is $\approx 0.44X_{\text{atm}}$. This is apparently a characteristic feature of the Mount Hermon karstic aquifer, and can be used as initial ^{14}C activity for groundwater dating in the region.

Since $\Delta^{14}\text{C}_{\text{atm}}$ of past millennia is known quite well (Clark, 1975), our final conclusion is that we are now in a position to compute the ^{14}C levels of the Jordan River at its discharge into Lake Kinneret for the last 8000 yr, for a better understanding of the hard-water effect in this lake (Kaufman & Stiller, ms in preparation).

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INGEIS RADIOCARBON LABORATORY DATES II*

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The following list consists of archaeological and geologic dates from Argentina processed in the ^{14}C laboratory of INGEIS. The ages presented were obtained by liquid scintillation counting of benzene, using the techniques outlined in a previous paper (Albero & Angiolini, 1983). The results are expressed in ^{14}C years relative to 1950, using the Libby half-life of 5570 yr.

Errors are reported as one standard deviation (1σ), based on combined uncertainties of standard, sample, and background. The standards used are NBS oxalic acid (SRM-4990) and INGEIS C-14-1, secondary standard of barium carbonate (Albero & Angiolini, 1983).

Improvements in our method are: 1) specially designed low background Cu-PTFE vials (Kuc & Rózanski, 1979) used for small volume samples. Up to 2ml sample plus 0.5ml of scintillation cocktail (7g of PPO and 0.5g of Me_2POPOP in 1L of scintillation-grade toluene) were measured in a specially calibrated Packard Tri-Carb Liquid Scintillation Spectrometer, Model 3320. Background of 1.90 ± 0.04 cpm and figure of merit ($Q = S_0^2/B$) of 131 ± 2 with maximally 70% efficiency were obtained; 2) a system of "wet combustion" was designed for samples with low carbon content, such as mud, paleosoils, argillaceous peats, etc. The sample is digested in a glass vessel with $\text{H}_2\text{SO}_4 + \text{Na}_2\text{Cr}_2\text{O}_7$. The evolved CO_2 is purified through AgNO_3 and MnO_2 traps and then is converted to benzene. Up to 1kg of sample can be processed by this method.

The $\delta^{13}\text{C}$ values are measured related to PDB and reported ages are corrected for isotopic fractionation by normalizing to -25‰ . The $\delta^{13}\text{C}$ measurements were performed in the Stable Isotope Laboratory of the Institute.

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GEOLOGIC SAMPLES

AC-0326.

$36,000 \pm 1800$

$\delta^{13}\text{C} = 2.2\text{‰}$

Shell (*Chlamys* [*Zygochlamys*] *anderssoni* Henning) from Pecten Fm, Cockburn I. ($64^\circ 12' 30''$ S, $56^\circ 45' 20''$ W) Antarctica, 265m asl. Coll and subm 1980 by F Medina. *Comment* (FM): sample was dated to establish that

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Pecten Fm corresponds to Pleistocene interglacial age. This age agrees with those obtained by Speden (1962) and Turner (1967) for same sp in Scallop Hill Fm outcropping on Ross I. This date was also used by Malagnino *et al* (1983) to date drift of Vicecomodoro Marambio I., concluding that these glacial sediments are not older than 36,000 yr, based on apparent continuity between marine terraces of Cockburn and Vicecomodoro Marambio I.

Bahía Blanca series

Shells from Bahía Blanca and surroundings, Buenos Aires prov. These samples were used to solve some strat Quaternary problems in particularly complicated area. Coll and subm 1980 by E Farinati.

AC-0119. **4470 ± 100**
 $\delta^{13}C = 1.5\text{‰}$

Undetermined sp from beach ridge, Colonia Ferroviaria (72° 15' S, 38° 44' W) 4m asl, 0.6m depth.

AC-0333. **4820 ± 120**
 $\delta^{13}C = 1.6\text{‰}$

Mixed sample (*Brachydontes rodriguezi*, *Tegula patagonica*, and *Buccinanops deformis*) from beach ridge, Villa Rosas (62° 15' S, 38° 46' W) 8m asl, 0.4m depth.

AC-0334. **4660 ± 100**
 $\delta^{13}C = 1.3\text{‰}$

Mixed sample (*Brachydontes rodriguezi*, *Ostrea* sp, *Pitar rostrata*, and *Buccinanops deformis*) from beach ridge, Loma Paraguaya (62° 17' S, 38° 45' W) 8m asl, 0.1m depth.

AC-0352. **6490 ± 110**
 $\delta^{13}C = 1.6\text{‰}$

Undetermined sp from beach ridge, Frigorífico Viñuelas (62° 07' S, 38° 48' W) 8m asl, 0.2m depth.

General Comment (EF): dates show that these Holocene deposits correspond to two different marine ingressions, one determined by AC-0119, -0333, and -0334; an older one by AC-0352.

Puerto Madryn series

Calcareous paleosol (Typical Paleorthid, according to Soil Survey Staff, 1975) 8km W of Puerto Madryn, Chubut prov (42° 27' S, 65° 02' W), 90m asl. Coll and subm 1981 by M Rostagno.

AC-0323. **5440 ± 160**
 $\delta^{13}C = -4.8\text{‰}$

Upper soil cap (0.4m thick) overlying deckenschotter (Plio-pleistocene) through lithologic discontinuity at 0.3m depth (A₁₂-ca soil horizon).

AC-0324.

24,300 ± 600
 $\delta^{13}C = -8.7\text{‰}$

Calcareous crust of deckenschotter, 3m thick, overlying Miocene sediments (Puerto Madryn Fm, constituted by psamites and pelites at 0.4m depth (IIC1-cam soil horizon).

AC-0325.

36,500 ± 2500
 $\delta^{13}C = -3.7\text{‰}$

Sample below AC-0324, also in upper part of deckenschotter at 0.5m depth (IIC2-cam soil horizon).

General Comment (MR): age difference between AC-0323 and -0324 to -0325 indicates lithologic discontinuity in petrocalcic horizon because of change in environmental conditions.

Villalonga series

Shells from Villalonga site and surroundings, Buenos Aires prov. Coll and subm 1981 by N Weiler. Samples dated to determine different Holocene shorelines in mouth and S of Río Colorado delta. These ancient shorelines were previously geomorphologically determined and are composed of sandy beach barriers, ancient pelithic tidal flats, tidal paleochannels, and river beds at mouth of delta; S of delta are beach barriers and spits of gravel and sands. Two Holocene max marine levels have been determined up to now. Other evidence is under study.

AC-0055.

6760 ± 100
 $\delta^{13}C = 0.6\text{‰}$

Surface sample (*Zidona* sp) extracted from gravel beach ridge (39° 56' 36" S, 62° 20' 39" W) 6m asl.

AC-0250.

4830 ± 110
 $\delta^{13}C = 1.4\text{‰}$

Surface sample, fragmented specimens (*Buccinanops* sp) from dune site, Estancia El Tigre (39° 48' 11" S, 62° 21' 30" W) 5m asl.

AC-0251.

5510 ± 110
 $\delta^{13}C = 1.5\text{‰}$

Samples from beach ridge of gravel and sand, different sp of *Buccinanops*, Estancia El Tigre (39° 48' 30" S, 62° 21' 10" W) 5m asl, 0.4m depth.

AC-0239.

5140 ± 110
 $\delta^{13}C = 1.1\text{‰}$

Surface sample (*Adelomelon* sp) from gravel beach ridge (39° 48' S, 62° 23' 32" W) 7.5m asl.

AC-0240.

5590 ± 110
 $\delta^{13}C = 1.1\text{‰}$

Undetermined sp from bank, 0.15m thick, assoc with gravel mixed with sand (39° 48' S, 62° 23' 32" W) 7.5m asl, 0.3m depth.

AC-0241.**3740 ± 90**
 $\delta^{13}C = 1.4\text{‰}$

Surface sample (*Pitaria* sp) from dune base, Estancia San Antonio Viejo (39° 46' 48" S, 62° 11' 55" W) 3m asl.

AC-0242.**2790 ± 90**
 $\delta^{13}C = 0.9\text{‰}$

Surface sample (*Zidona* sp) from dune, Estancia San Antonio Viejo (39° 46' 36" S, 62° 10' 30" W) 3m asl.

AC-0243.**2620 ± 90**
 $\delta^{13}C = 2\text{‰}$

Surface sample, undetermined sp, from dune, Estancia San Antonio Viejo (39° 46' 47" S, 62° 10' 30" W) 2.5m asl.

AC-0252.**9420 ± 150**
 $\delta^{13}C = 1.4\text{‰}$

Surface sample (*Pitaria rostrata*) from gravel beach ridge, Estancia El Tigre (39° 49' 51" S, 62° 19' W) 5m asl.

AC-0244.**8520 ± 140**
 $\delta^{13}C = 1.9\text{‰}$

Sample, undetermined sp, 1m depth, from left bank of old tributary of Río Colorado, Riacho Azul (39° 49' S, 62° 19' W) 5m asl, used, at present, as irrigation outlet channel and occasionally flooded by tides. *Comment* (NW): shells (*Tagelus gibbus*) were found assoc with this sample dated to 810 ± 80 BP and $\delta^{13}C = -2.7\text{‰}$ which indicates mixing with continental waters.

AC-0253.**7850 ± 130**
 $\delta^{13}C = 1.3\text{‰}$

Surface sample (*Glycimeris* sp) from gravel beach ridge (39° 49' 52" S, 62° 19' 40" W) 5m asl.

AC-0245.**8720 ± 140**
 $\delta^{13}C = 1.1\text{‰}$

Undetermined sp from gravel beach ridge, Estancia El Tigre (39° 49' 53" S, 62° 19' 06" W) 5m asl.

AC-0246.**5500 ± 100**
 $\delta^{13}C = 1.2\text{‰}$

Pitaria rostrata, assoc with gravel-sand spit, formed in outlet of paleo-channel where *Tagelus gibbus* with articulated valves was found (AC-0247) (39° 51' 40" S, 62° 22' W) 4m asl.

AC-0362.**4820 ± 100**
 $\delta^{13}C = 1.1\text{‰}$

Zidona angulata, 0.5m depth, from gravel beach ridges, which constitute cuspidal barrier (39° 51' 40" S, 62° 22' W) 4m asl.

AC-0363.**5050 ± 100** $\delta^{13}C = 1.1\text{‰}$

Surface sample (*Zidona angulata*) overlying AC-0362, with same geomorphol assoc (39° 51' 40" S, 62° 22' W) 4m asl.

AC-0247.**3860 ± 100** $\delta^{13}C = 1.5\text{‰}$

Tagelus gibbus, from sandy-silt sediments, at 1m depth in paleochannel related to cuspidal barrier where AC-0363, -0362, -0246 were found (39° 51' 40" S, 62° 22' W) 4m asl.

AC-0464.**4380 ± 80** $\delta^{13}C = 1.6\text{‰}$

Subsurface sample (*Tagelus gibbus*) (39° 48' S, 62° 30' W) 3m asl.

AC-0248.**4640 ± 100** $\delta^{13}C = 1.5\text{‰}$

Surface sample (*Zidona angulata*) from dune base, Península Verde (39° 21' 30" S, 62° 01' 06" W) 2.5m asl.

AC-0249.**2170 ± 90** $\delta^{13}C = 1.0\text{‰}$

Surface sample (*Adelomelon* sp) from dune base, Península Verde (39° 17' 21" S, 62° 05' 04" W) 2.5m asl.

AC-0463.**5820 ± 110** $\delta^{13}C = 2.2\text{‰}$

Surface sample (*Adelomelon* sp) found in mobile dune with archaeol remains, Mayor Buratovich, Estancia La Asunción (32° 12' 40" S, 62° 44' 15" W) 25m asl. *Comment* (NW): date does not agree with alt, probably transported by prehistoric man.

AC-0067.**3930 ± 70** $\delta^{13}C = 1.0\text{‰}$

Articulated shells (*Tagelus gibbus*) in argillaceous silt in tidal paleochannel, Pedro Luro, Estancia El Chara (39° 24' S, 62° 12' 50" W) 2m asl, 0.5m depth.

AC-0068.**5340 ± 70** $\delta^{13}C = 1.1\text{‰}$

Surface sample (*Zidona angulata*) from dune base, Pedro Luro (39° 29' 30" S, 62° 04' W) 3m asl.

Entre Ríos Holocene series

Holocene marine ingression at Río de la Plata estuary, flooded S part of Entre Ríos prov from Paraná R in W and S to Uruguay R in E. Eurihaline mollusk shells (*Erodona mactroides*) were sampled from beach ridge that crosses cities of Victoria, Gualeguay, Médanos, and Gualeguaychú, to study

chronology of estuarine sediments related to Holocene transgression. Coll and subm 1982 by N Guida and M A González.

AC-0415. 5960 ± 110
 $\delta^{13}C = -2.9\text{‰}$

Sample from surface of Río Gualeguay bed (33° 09' S, 59° 17' W).

AC-0416. 5610 ± 110
 $\delta^{13}C = -1.8\text{‰}$

(33° 15' S, 59° 30' W) 5m asl, 0.8m depth.

AC-0417. 5750 ± 110
 $\delta^{13}C = -1.9\text{‰}$

(33° 15' S, 59° 30' W) 5m asl, 1.4m depth.

AC-0418. 6030 ± 140
 $\delta^{13}C = -1.8\text{‰}$

(33° 13' S, 59° 31' W) 5m asl, 0.7m depth.

AC-0419. 5620 ± 110
 $\delta^{13}C = -1.9\text{‰}$

(33° 13' S, 59° 31' W) 5m asl, 1m depth.

AC-0420. 5680 ± 110
 $\delta^{13}C = -1.8\text{‰}$

(33° 12' S, 59° 32' W) 4m asl, 0.85m depth.

AC-0421. 5720 ± 110
 $\delta^{13}C = -1.9\text{‰}$

Surface sample (33° 14' S, 59° 28' W) 4.5m asl.

AC-0422. 5680 ± 110
 $\delta^{13}C = -1.7\text{‰}$

Surface sample (33° 16' S, 59° 27' W) 5m asl.

AC-0423. 6440 ± 110
 $\delta^{13}C = -2.1\text{‰}$

Surface sample (33° 16' S, 59° 23' W) 5m asl.

AC-0424. 5820 ± 110
 $\delta^{13}C = -2.5\text{‰}$

(32° 59' S, 58° 30' W) 2.5m asl, 2.3m depth.

General Comment (MAG & NG): max level for this postglacial Holocene transgression has been dated to 5700 yr BP; these deposits are between 3 and 5m asl.

Entre Ríos Pleistocene series

Outcroppings of Pleistocene estuarine levels were found in pits in vicinity of some tributaries of Uruguay R. *Erodona mactroides*, *Tagelus gib-*

bus, and *Ostrea* sp shells were dated for Pleistocene max estuarine expansion. Related sediments are at 6m asl. Coll and subm 1982 by N Guida and M A González.

AC-0425. **30,800 ± 1700**
 $\delta^{13}C = -2.5\text{‰}$
Erodona mactroides (33° 05' S, 58° 30' W) 6m asl, 0.65m depth.

AC-0608. **35,400 ± 1800**
 $\delta^{13}C = -4.6\text{‰}$
Tagelus gibbus (33° 03' S, 58° 32' W) 7m asl, 5.5m depth.

AC-0609. **26,600 ± 720**
 $\delta^{13}C = -3.3\text{‰}$
Erodona mactroides (33° 38' S, 58° 32' W) 7m asl, 6m depth.

AC-0610. **32,700 ± 1300**
 $\delta^{13}C = -3.8\text{‰}$
Erodona mactroides (33° 38' S, 58° 31' W) 7m asl, 5.5m depth.

AC-0612. **32,700 ± 1800**
 $\delta^{13}C = -0.6\text{‰}$
Ostrea sp (33° 07' S, 58° 31' W) 7m asl, 5.5m depth.

AC-0613. **33,000 ± 1300**
 $\delta^{13}C = 2.7\text{‰}$
Erodona mactroides (33° 07' S, 58° 31' W) 7m asl, 5.5m depth. *General Comment* (MAG & NG): samples correspond to relatively high marine level related to Plum-Point interstadial. Evidence of this marine level was found along coast from 33° 10' S to 40° S.

General Cerri marine Holocene series

Marine shells from Bahía Blanca inner estuary, Buenos Aires prov (38° 40' S, 62° 15' W). Samples from different clastic shell beach ridges of General Cerri spit, dated to establish chronology of relative oscillations of post-glacial Holocene transgression. Coll and subm 1981 by M A González, N Weiler, and N Guida.

First beach ridge (landward), 11m asl

AC-0311. **5990 ± 120**
 $\delta^{13}C = 0.8\text{‰}$
Buccinanops sp, 2m depth.

AC-0312. **6600 ± 120**
 $\delta^{13}C = 1\text{‰}$
Buccinanops sp, 1m depth.

AC-0313.

Brachydontes rodriguezi, 1m depth.

6100 ± 120

$\delta^{13}C = 2.6\text{‰}$

AC-0314.

Pitar rostrata, 0.2m depth.

6350 ± 110

$\delta^{13}C = 2.6\text{‰}$

Third beach ridge, 9.5m asl

AC-0390.

Buccinanops sp, 1m depth.

6420 ± 140

$\delta^{13}C = 1.5\text{‰}$

AC-0391.

Brachydontes rodriguezi, 1m depth.

6000 ± 110

$\delta^{13}C = 3.1\text{‰}$

Fourth beach ridge, 9m asl

AC-0381.

Brachydontes rodriguezi, 1.5m depth.

5720 ± 100

$\delta^{13}C = 3\text{‰}$

AC-0382.

Buccinanops sp, 1.5m depth.

6000 ± 110

$\delta^{13}C = 1.2\text{‰}$

AC-0383.

Buccinanops sp, 0.5m depth.

6130 ± 110

$\delta^{13}C = 1.3\text{‰}$

AC-0384.

Brachydontes rodriguezi, 0.5m depth.

5470 ± 100

$\delta^{13}C = 2.6\text{‰}$

Fifth beach ridge, 8.5m asl

AC-0315.

Tagelus gibbus, 1.5m depth.

5280 ± 110

$\delta^{13}C = 2.1\text{‰}$

AC-0316-I.

Buccinanops sp, 1.5m depth.

5100 ± 100

$\delta^{13}C = 1.4\text{‰}$

AC-0316-II.

Brachydontes rodriguezi, 1.5m depth.

5400 ± 140

$\delta^{13}C = 3.1\text{‰}$

AC-0317. **5460 ± 110**
 $\delta^{13}C = 1.6\text{‰}$
Undetermined sp, 0.5m depth.

AC-0380. **5420 ± 110**
 $\delta^{13}C = 1.8\text{‰}$
Buccinanops sp, 1m depth.

General Comment (MAG): high-energy waves ambience caused mixture of shells of different ages. Min ^{14}C age in each ridge is accepted as closest date for ridge build-up.

Bahía Blanca marine and continental Holocene series

Shells from Bahía Blanca and surroundings, Buenos Aires prov (38° 40' S, 62° 20' W). Coll and subm 1981 by M A González.

AC-0386. **3570 ± 100**
 $\delta^{13}C = 1.1\text{‰}$
Brachydontes rodriguezi from Jorge Moore St beach ridge, 7m asl, 0.5m depth.

AC-0387. **3950 ± 90**
 $\delta^{13}C = 1.9\text{‰}$
Buccinanops sp from Jorge Moore St beach ridge, 0.5m depth.

AC-0388. **4950 ± 100**
 $\delta^{13}C = 2\text{‰}$
Buccinanops sp from Villa Serra beach ridge, 7.5m asl, 0.5m depth.

AC-0389. **4460 ± 100**
 $\delta^{13}C = 1.7\text{‰}$
Brachydontes rodriguezi from Villa Serra beach ridge, 0.5m depth.

AC-0349. **4470 ± 90**
 $\delta^{13}C = 1\text{‰}$
Buccinanops sp from Litobril beach ridge, 7m asl, 0.5m depth.

AC-0350. **4520 ± 110**
 $\delta^{13}C = 3\text{‰}$
Brachydontes rodriguezi from Litobril beach ridge, 0.5m depth.

AC-0337. **4220 ± 100**
 $\delta^{13}C = 3\text{‰}$
Tagelus gibbus from Ing White tidal flats, 6m asl, 1m depth; bivalves *in situ* into pelithic sediments.

AC-0338. **5580 ± 130**
 $\delta^{13}C = 1.9\text{‰}$
Pitar rostrata in situ from Ing White tidal flats, 1.5m depth.

AC-0348.

3920 ± 90

$\delta^{13}C = 1.7\text{‰}$

Buccinanops sp from Ing White tidal flats, 1m depth.

AC-0320.

7240 ± 160

$\delta^{13}C = -6.3\text{‰}$

Cyclodontina (Plagiodontes) patagonica (pulmonate odontostomide) from alluvium of Parque de Mayo, 30m asl, 2.5m depth. *Comment* (MAG): soils of Hypsithermal were developed over these sediments.

AC-0322.

5320 ± 100

$\delta^{13}C = -6\text{‰}$

Cyclodontina (Plagiodontes) patagonica and *Austroborus lutescens* from eolian dunes in Parque Independencia, 35m asl, 1m depth. *Comment* (MAG): soils of Hypsithermal were buried by these dunes.

AC-0346.

5350 ± 130

$\delta^{13}C = -5.1\text{‰}$

Cyclodontina (Plagiodontes) patagonica and *Austroborus lutescens* buried into post-Hypsithermal eolian dunes from Est Grünbein, 15m asl, 0.5m depth.

AC-0351.

3810 ± 120

$\delta^{13}C = -6.7\text{‰}$

Cyclodontina (Plagiodontes) patagonica and *Austroborus lutescens* buried into post-Hypsithermal eolian dunes from Est Grünbein, 18m asl, 0.5m depth.

General Comment (MAG): max postglacial Holocene transgression in this loc was established in ca 6000 yr BP. High temperature and humidity episode related to Holocene climatic optimum (Hypsithermal) was developed between 6000 and 5200 yr BP. Dune sands buried Hypsithermal soils ca 5200 yr BP. Clastic beach ridges that indicate max sea levels show periodicity of ca 500 yr that should correspond to extraordinary tidal episodes.

Martín García series

Marine and estuarine shells from Martín García I. (34° 11' S, 58° 15' W). Coll and subm 1981 by M A González.

AC-0431.

5740 ± 130

$\delta^{13}C = 0.2\text{‰}$

Erodona mactroides and *Macra isabelleana* from fine sand level, 4.5m asl, 0.8m depth. *Comment* (MAG): sample dates max postglacial Holocene transgression in Río de la Plata.

AC-0433-I.

18,500 ± 500

$\delta^{13}C = -2.2\text{‰}$

Mixture of estuarine mollusk shells (*Erodona mactroides* and *Macra isabelleana*) from fine gravel level. Sampled sediments show epigenetic carbon-

ate deposits. *Comment* (MAG): because of strat evidence, date is not acceptable (corresponds min global glacio-eustatic sea level). Sample was probably contaminated and inadequately pretreated.

AC-0433-II.**38,500 ± 3000**

Erodona mactroides from same loc as AC-0433-I, carefully pretreated to eliminate epigenetic carbonates.

AC-0484.**32,200 ± 1400** $\delta^{13}C = 0.9\text{‰}$

Thais haemastoma from same loc as AC-0433-I. *Comment* (MAG): this Pleistocene relative high sea level is related to Plum Point interstadial.

ARCHAEOLOGIC SAMPLES

Cave 4 La Martita series

Charcoal from Cave 4 La Martita, Gobernador Gregores, Santa Cruz prov (48° 34' S, 69° 15' W), 350m asl. Coll and subm 1982 by A Aguerre.

AC-0603.**1620 ± 90** $\delta^{13}C = -21.4\text{‰}$

Charcoal from 3rd layer, 0.68m depth, Sq I VIc, assoc with stemmed projectile point, indicating presence of Patagoniense industry, guanaco hunters present in Patagonia up to historic times. Date agrees with those from neighboring area, Río Pinturas.

AC-0604.**2190 ± 120** $\delta^{13}C = -22.9\text{‰}$

Charcoal from 4th layer, 0.94m depth, Sq I VIIc. Sample dates occupation of cave by human groups with stone technol (small blades, scrapers, without projectile points) followers of Casapedrense technol, present at site since 4500 BP. This group was defined as Transitional industries for Río Pinturas area, where it appears earlier with same technol features.

Alero Cárdenas series

Vegetal charcoal from site with rupestrian art, Alero Cárdenas (Gradín, 1977) at Estancia La Lita, Río Pinturas area, NW of Santa Cruz prov. Coll and subm 1980–81 by C Gradín.

AC-0497.**7750 ± 130** $\delta^{13}C = -21.1\text{‰}$

Lower part of Level 7; sample corresponds to beginning of human occupation of site, assoc with artifacts related to Río Pinturas I cultural level. Ages previously obtained for this cultural level at Cueva de las Manos range from ca 9300 – 7280 ± 60 BP.

AC-0499.**7300 ± 200** $\delta^{13}C = -20.9\text{‰}$

Sample, 10cm above and 1m away from AC-0497, in upper part of level 7, *post quem* data for level with triangular points, 1 lanceolate point,

and 1 point with incipient stem and barbs, underlying AC-0499, morphologically related with Magallanes III cultural level.

AC-0498.

3450 ± 110
 $\delta^{13}C = -21.3\text{‰}$

Sample from lower part of Level 5, 0.67m depth; triangular stemless point was found at same depth. Sample dates presence of this type of artifacts (Toldense tradition). Contemporaneity with Patagoniense stem points has been checked in other sq and levels. This age represents *post quem* date for Patagoniense industry.

AC-0500.

1180 ± 90
 $\delta^{13}C = -20.6\text{‰}$

This sample is related to ceramic phase of Patagoniense and indicates early presence of this feature (AD 770) with geometric decoration at site. Date confirms previous date for similar site in SW of Chubut prov (Gradín, Aschero, & Aguerre, 1979).

Lechiguanas series

Shells from Isla Lechiguanas, Entre Ríos prov (33° 44' S, 59° 13' W), dated from third level of dense shell midden, 0.16 to 0.55m thick. Edaphic horizon containing fragments of pottery of Entrerriean cultures (Lechiguanas phase) overlies midden. Behind it, aceramic paleosoil, 0.08 to 0.3m thick, with bone harpoon was id. Coll and subm 1980 by R Raffino and A Caggiano.

AC-0122.

2740 ± 80
 $\delta^{13}C = -6.2\text{‰}$

Ampullaria insularum and other pulmonate mollusks, 0.5m depth.

AC-0124.

2550 ± 90
 $\delta^{13}C = -6.1\text{‰}$

Ampullaria insularum and other pulmonate mollusks, 0.37m depth.

General Comment (RR): samples date aceramic industry of bone harpoons older than 800 BC, for Paraná delta.

Paranacito series

Shells from surroundings of Paranacito R, Entre Ríos prov. Samples dated to establish beginning of Las Mulas cultural phase of Ribereños Plásticos culture. Coll and subm 1980 by A Caggiano.

AC-0183.

1300 ± 80
 $\delta^{13}C = -6.1\text{‰}$

Mollusk shells from Don Santiago site (33° 43' S, 58° 55' W), Level 1, 0.85m depth.

AC-0186.

1090 ± 80
 $\delta^{13}C = -6.3\text{‰}$

Mollusk shells from Don Santiago site, Level 1, 0.35m depth.

AC-0187.

1420 ± 80
 $\delta^{13}C = -6.5\text{‰}$

Mollusk shells from Rodeo Viejo de la Nena site (33° 37' S, 58° 45' W), Level 1, 0.47m depth.

AC-0188.

1420 ± 80
 $\delta^{13}C = -7.4\text{‰}$

Mollusk shells, from Rodeo Viejo de la Nena site, Level 1, 0.65m depth.

General Comment (RR): series dates beginning of Ribereños Plásticos culture in Paraná R.

AC-0450.

870 ± 90
 $\delta^{13}C = -23.5\text{‰}$

Charcoal from Molinos site, Molinos dept, Salta prov, 5km W of confluence of Molinos and Calchaquí Rivers, 1800m asl. Coll and subm 1982 by R Raffino and L Baldini. *Comment* (RR): charcoal came from first layer of midden between rooms, where several lentils of charcoal and ash were found. Pottery fragments assoc with charcoal correspond to early type similar to San José-Hualfin group, estimated to ca AD 1000.

Puerta La Paya series

Samples of charcoal and burned maize grains assoc with archaeol remains from Puerta de La Paya site, on right bank of La Paya gulch, at confluence with right bank of Calchaquí R, Cachi dept, Salta prov (25° 12' S, 66° 11' W), 220m asl. Samples were taken from pit holes in two middens, 30m apart. Coll and subm 1981 by R Raffino and L Baldini.

*Stratigraphy 2***AC-272.**

990 ± 80
 $\delta^{13}C = -8.9\text{‰}$

Mixture of vegetal charcoal and charred maize grains from 2nd layer, 0.1 to 0.2m depth.

AC-0273.

830 ± 100
 $\delta^{13}C = -8.9\text{‰}$

Charred maize grains from 15th layer, 1.4 to 1.5m depth. *Comment* (RR): sample consisted of several types of maize, as rosita colorado, capia, chullpi, pisingallo, and morocho.

General Comment (MCA & FEA): despite submitter's description of sample, $\delta^{13}C$ for AC-0272, different from vegetal charcoal, suggests sample consisted mostly of charred maize grains.

*Stratigraphy 3***AC-0271.**

780 ± 90
 $\delta^{13}C = -23\text{‰}$

Vegetal charcoal from 4th layer, 0.3 to 0.4m depth.

AC-0270.

620 ± 100
 $\delta^{13}C = -22.3\text{‰}$

Vegetal charcoal from 11th layer, 1 to 1.1m depth.

General Comment (RR): ages are, in general, earlier than expected for settlement which corresponds to Inca occupation of area. Evident incongruence between depth and age was attributed to mechanical mixing and alteration of deposits after abandonment of site, especially in upper layers (AC-0272 and -0271). Date of AC-0272 is not acceptable for this settlement where contemporary pottery types are absent. Age of AC-0271 is acceptable but older than AC-0270 which lay in deeper level. Ceramic typology suggests that Stratigraphy 2 is older than Stratigraphy 3, but absence of Inca remains reveals that these middens are earlier than AD 1470.

AC-0364.

760 ± 90
 $\delta^{13}C = -18.5\text{‰}$

Vegetal charcoal from large fire pit, 3m diam, in room assoc with potsherds from Cerro Colorado, E bank of Río Hualfin-Belén in front of Ischanga R mouth, near La Ciénaga, Belén dept, Catamarca prov (27° 30' S, 66° 55' W). Coll and subm 1981 by R Raffino and C Sempé. *Comment (RR):* assoc pottery with zoomorphous figures corresponds to Belén culture, Phase II. Site is fortified occupation over hill. Date is somewhat earlier than suggested by A González for these phases of Belén culture. New evidence supported by recent studies in area confirms earlier settlement of these fortified sites.

Palo Blanco series

Vegetal charcoal assoc with archaeol remains from Palo Blanco site, NW from Abaucán valley, Tinogasta dept, Catamarca prov, over S bank of Río de los Ranchillos, tributary of Abaucán R (27° 20' S, 67° 50' W). Coll and subm 1981 by R Raffino and C Sempé.

AC-0366.

1640 ± 100
 $\delta^{13}C = -21.6\text{‰}$

Group 1, 0.25 to 0.5m depth. Charcoal from fire pit in room. *Comment (RR):* date corresponds to Phase II of Saujil culture; large pottery with striations assoc with this sample.

AC-0365.

1760 ± 100
 $\delta^{13}C = -19.1\text{‰}$

Group 1, 0.75 to 0.8m depth. Charcoal from fire pit in room. *Comment (RR):* date corresponds to Phase I of Saujil culture; black-over-gray polished-surface pottery assoc with this sample.

General Comment (RR): dates are acceptable for cultural relationship of these levels, and agree with previous dates from different sites of Abaucán valley of this culture.

Salto Grande series

Freshwater shells and charcoal from surroundings of Salto Grande site, Federación dept, Entre Ríos prov. Coll and subm 1980–1981 by R

Raffino and J Rodríguez. Samples dated to establish lithic and ceramic chronologies of different sites.

AC-0109. **1650 ± 70**
 $\delta^{13}C = -3.4\text{‰}$

Los Sauces II site, 15m asl. Shells (*Felipponea iheringy*) 0.3m depth, 3rd level.

AC-0110. **1340 ± 70**
 $\delta^{13}C = -3.4\text{‰}$

Los Sauces II site, 15m asl. Shells (*Felipponea iheringy*) 0.5m depth, 5th level. *Comment* (RR & JR): this sample and AC-0109 belong to same profile. No conclusions can be made because of inverted chronology.

AC-0111. **720 ± 70**
 $\delta^{13}C = -3.7\text{‰}$

Rancho Colorado site, 15m asl. Shells (*Felipponea iheringy*, *Asolene megastoma*) 0.3m depth, 3rd level.

AC-0112. **790 ± 70**
 $\delta^{13}C = -3\text{‰}$

Rancho Colorado site, 15m asl. Shells (*Felipponea iheringy*, *Asolene megastoma*) 0.4m depth, 4th level.

AC-0172. **1430 ± 80**
 $\delta^{13}C = -2.3\text{‰}$

Rancho Miño site, 25m asl. Shells (*Asolene megastoma*) 0.3m depth, Level III.

AC-0173. **1440 ± 80**
 $\delta^{13}C = -3\text{‰}$

Arroyo Yará Chico site, 15m asl. Shells (*Felipponea iheringy*, *Asolene megastoma*) 0.55m depth, Level 6B.

AC-0269. **1150 ± 100**
 $\delta^{13}C = -24.7\text{‰}$

Arroyo Yará Chico site, 15m asl. Vegetal charcoal, 0.45m depth, Level 5B.

General Comment (RR & JR): dates establish preliminary chronology of some ceramic units. Some belong to Salto Grande cultural type, present between 400 BC and AD 1200 according to these and previous dates. Other units belong to Cerro Chico cultural type, developed between 300 BC and AD 1150.

AC-0327. **990 ± 80**
 $\delta^{13}C = -22.5\text{‰}$

Charcoal from ceramic site in Agrelo, 25km S of Mendoza (33° 07' S, 68° 53' W), 800m asl; assoc with gray pottery. Coll 1950 by J Semper and

subm 1981 by J Schobinger. *Comment* (JS): first ^{14}C date for Agrelo's culture (Canals Frau, 1956). Date confirms assumption that this culture developed between AD 400 and 1200.

High-altitude ceremonial places series

AC-0329.

570 \pm 80

$\delta^{13}\text{C} = -20.4\text{‰}$

Wood from ritual site at summit of Cerro Negro Overo, Famatina Highlands, La Rioja prov (28° 56' S, 67° 51' W), 6050m asl. Coll 1963 and subm 1981 by J Schobinger. Partially burned wood (*Prosopis* sp) was assoc with antlers of Andean cervine (*Hippocamelus* sp) inside rectangular corral, "pirca". *Comment* (JS): floor of site was stony with no evidence of archaeol remains under it. Site shows late prehispanic features, probably Inca, even when some typical elements of this culture are not present. Site was found by H Harrington in 1941 and rediscovered by E Groch in 1960. Lower limit of 1 σ confidence interval is coincident with oldest arrival of Inca outpost, attributed to beginning of Tupac Inca Yupanki (1471–1493) reign. Other high alt sites must be identified and dated to establish whether this type of sanctuary precedes Inca expansion.

AC-0330.

390 \pm 80

Wood from branch coll at 6000m asl on way to top of Cerro Mercedario (6770m high), Cordillera de los Andes, Calingasta dept, San Juan prov (31° 59' S, 70° 07' W). Coll 1968 and subm 1981 by J Schobinger.

AC-0331.

350 \pm 80

$\delta^{13}\text{C} = -24.6\text{‰}$

Partially burned wood from 6-rm sta, "Pircas Indias", used for prehispanic expeditions to top of Cerro Mercedario, 5300m asl, at nearly same geog coordinates as AC-0330. Wood fragment was found partially buried in one of rooms, assoc with potsherds attributed to Inca period. Coll 1968 and subm 1981 by J Schobinger. *Comment* (JS): construction and potsherds from Cerro Mercedario suggest relation with Inca culture. Thus, ^{14}C dates disagree with archaeol evidence, but are congruent with expected age when calibrated through dendrochronol curves (Ralph, Michael, & Han, 1973).

Chocón Chico series

Sample from archaeol test pits near coast of Río Limay, Confluencia dept, Neuquén prov (39° 10' S, 68° 40' W) 300m asl. Coll and subm 1981 by J Fernández.

AC-0307.

810 \pm 80

$\delta^{13}\text{C} = -6.4\text{‰}$

Shells (*Diplodon* sp) 0.0 to 0.2m depth.

AC-0308.

1380 \pm 90

$\delta^{13}\text{C} = -7.5\text{‰}$

Shells (*Diplodon* sp) 0.2 to 0.45m depth.

AC-0309.

2490 ± 90
 $\delta^{13}C = -11.4\text{‰}$

Charcoal, 0.65 to 0.8m depth.

General Comment (JF): dates are correlated with Haichol series to compare Cordilleran site with others in Patagonian steppe. Lithic artifacts, triangular, stemless projectile points and scrapers, are same in both sites. Riverine shells (*Diplodon*) gathered by the prehistoric people for eating, can be error source in dates.

Caballo Muerto series

This series includes samples from two exposures made by small erosion gully streams near Potreros, W slope of sierra Alta, Tumbaya and Huma-huaca depts, Jujuy prov (23° 30' S, 65° 37' W), 3820m asl. Profiles are of archaeol and paleoenvironmental interest and show sequence of sand, peat, silt, and diatomite layers where archaeol material is present. Coll and subm 1981 by J Fernández.

*Caballo Muerto A-B profile***AC-0290-I.**

2770 ± 100
 $\delta^{13}C = -26.1\text{‰}$

Humic acids extracted from upper layer of peat, exposed by erosion.

AC-0290-II.

2500 ± 100
 $\delta^{13}C = -26.6\text{‰}$

Oxygen-stream combustion of residue of AC-0290-I (after humic acid extraction).

AC-0290-III.

2570 ± 100
 $\delta^{13}C = -25.4\text{‰}$

Wet combustion (acid digestion with sodium dicromate + sulphuric acid) of residue of AC-0290-I (after humic acid extraction).

General Comment (MCA & FEA): sample was used to compare ages obtained on different fractions with different techniques of CO₂ production. There is no significant difference between wet and oxygen-stream combustions. Age of the humic acid extract (AC-0290-I) is slightly older than AC-0290-II, which shows that those humic acids do not come from later or upper vegetal activity, because, in this case, age would be younger.

AC-0291.

2520 ± 100
 $\delta^{13}C = -24.9\text{‰}$

Peat from first layer, 0.29 to 0.34m depth.

AC-0293.

3590 ± 90
 $\delta^{13}C = -23.9\text{‰}$

Peat from second layer under diatomite, 0.65 to 0.73m depth. *Comment* (JF): sample was also dated Wisconsin Lab, Wis-1384: 3410 ± 70 (V Markgraff, pers commun).

AC-0292.**2320 ± 90**

Vegetal remains buried in sand layer, 1m depth. *Comment* (JF): histologic analysis of this material showed they were exclusively intrusive roots. This would explain younger age than AC-0293, despite its depth. Eolian erosion of this sandy stratum revealed large prehistoric workshop from which >1000 foliaceous, pseudofoliaceous, bifacial (Ayampitin type) and unifacial (Saladillo type), stemmed (Aguas Calientes type) lithic projectile points were recovered. Typology defined and illustrated by Menghin (1953–1954, Pl 11), González (1952, Pl 13), and Fernández (1967, figs 23, 32; 1971, Pls 22, 38). These data only postdate archaeol materials interbedded in sandy stratum bearing old roots. Basal organic strata that antedate prehistoric settlement can be sampled in adjacent exposure.

*Caballo Muerto C-D profile***AC-0299.****7550 ± 160** $\delta^{13}C = -22.7\text{‰}$

Peat layer, 2.4 to 2.45m depth, 1.6m under level with archaeol evidence.

AC-0294.**8670 ± 150** $\delta^{13}C = -22.7\text{‰}$

Peat layer, 3.25m depth, 2.4m under archaeol level.

AC-0295.**8600 ± 150** $\delta^{13}C = -23\text{‰}$

Peat layer, 3.5m depth, 2.6m under archaeol level.

General Comment (JF): prehistoric settlement dates between 7550 ± 160 and 3590 ± 90 BP. Coleman (1973) and Fernández (1974) attributed age of site to 5500 BP, based on other evidence. Strat and chronol sequence show two climatic changes which are now being analyzed.

AC-0003.**730 ± 100** $\delta^{13}C = 2.5\text{‰}$

Marine shells (*Mytilus* sp) from Valle de las Fuentes, Cabo Vírgenes, E mouth of Magellan straits, Guer Aike dept, Santa Cruz prov (52° 20' S, 68° 23' W), 10m asl. Coll and subm 1979 by J Fernández. Sample is probably food remains from Spanish settlement, Ciudad del Nombre de Jesús, established in 1584 by Capt Pedro Sarmiento de Gamboa (Fernández, 1983a). Assoc with vitrified potsherds of European manufacture and metal pieces.

General Comment (MCA & FEA): difference between ^{14}C and historic age, ca 360 yr, is probably due to reservoir effect of marine shells.

Mata Molle series

Stratified peat, peaty sediments, and sapropel from banks of Mata Molle Creek, Collon Cura dept, Neuquén prov (40° 10' S, 70° 45' W), 700m asl. Coll and subm 1981–1982 by J Fernández. Data are correlated with

“Mata Molle fossil man” problem (Groeber, 1947; Vignati, 1957–1959) whose min age was estimated at 6000 yr.

AC-0276.

2430 ± 130

Peat, Mata Molle Profile 1, 2.25 to 2.35m depth, from close to skeletal remains recovered in 1942.

AC-0277.

2240 ± 100

$\delta^{13}C = -25.3\text{‰}$

Peat, Mata Molle Profile 1, 1.56 to 1.6m depth.

AC-0278.

1930 ± 90

$\delta^{13}C = -24.6\text{‰}$

Peat, Mata Molle Profile 1, 0.9 to 1m depth; end of Mata Molle aggradational cycle.

AC-0577.

2070 ± 90

$\delta^{13}C = -26.9\text{‰}$

Peat, Mata Molle Profile 2, 2.01 to 2.06m depth. Sample was in same strat position as AC-0277, 5km in headwaters direction.

AC-0593.

2000 ± 120

$\delta^{13}C = -26.8\text{‰}$

Peat, Mata Molle Profile 3, 0.8 to 0.85m depth. Sample has same significance and was in same strat position as AC-0277, 6.5km in headwaters direction.

General Comment (JF): data correspond to three strata of peat overlying and postdating human skeletal remains. Following data correspond to probable max age.

AC-0573.

4930 ± 150

$\delta^{13}C = -26.5\text{‰}$

Peat, Mata Molle Profile 4, 5.85m depth.

AC-0575.

4550 ± 110

Peat, Mata Molle Profile 5, 6.3m depth. Closest to human remains.

AC-0574-I.

7300 ± 150

Sapropel, Mata Molle Profile 6, upper portion of stratum, 6.5m depth. Basal portion of sedimentary sequence bearing human bones. Sample is not directly related to archaeol remains.

AC-0574-II.

8200 ± 150

$\delta^{13}C = -25.2\text{‰}$

Sapropel, basal portion of stratum. Mata Molle Profile 7, 6.5m depth, not directly related to archaeol problem. Sample is only of palynol and paleoclimatic interest.

General Comment (JF): date establishes age of Mata Molle fossil man between 2430 ± 130 (peaty sediments) and 4550 ± 110 BP (sapropelic muds) (Fernández, 1983b).

PALEOENVIRONMENTAL SAMPLES

AC-0099. **3400 ± 150**
 $\delta^{13}C = -25.2\text{‰}$

Peat from E coast of Lago Mascardi, Bariloche dept, Río Negro prov ($41^{\circ} 16' S$, $71^{\circ} 30' W$) 1000m asl. Peat layer at 4m depth in outcropping formed by volcanic ash, gravel strata, and peaty materials. Sample antedates deposition of third stratum from top of volcanic ash. Coll and subm 1980 by J Fernández. *Comment* (JF): profile is interesting for paleoclimatic events and ^{14}C data provide chronol framework for tephros sequence established by Auer (1950; 1974) and palynol profile in Mallin Book site (Markgraff 1979; 1983).

AC-0280-I. **7500 ± 150**
AC-0280-II. $\delta^{13}C = -25.3\text{‰}$

Peat interstratified with volcanic ash and sandy material, 2km W of lago Caviahue, Ñorquin dept, Neuquén prov ($37^{\circ} 52' 30'' S$, $71^{\circ} 02' W$), 1500 asl. Coll and subm 1980 by J Fernández. *Comment* (JF): ligneous peat (*Araucaria araucana* branches) from basal peat stratum, 5.25m depth, coll for palynol and paleoclimatic research.

Guayatayoc series

Peat from Guayatayoc creek, Rinconada dept, Jujuy prov ($22^{\circ} 18' S$, $66^{\circ} 02' W$), 3500m asl, short tributary of Laguna de los Pozuelos; modern hydrologic regime is characterized by downcutting. Cuts show accumulation of basal gravel, clay, limes, and peat, 3m thick, covered by laminated clay with peat and marl layers, lacustrine sediments, and finally peat and diatomite. Coll and subm 1981 by J Fernández.

AC-0283. **2800 ± 100**
 $\delta^{13}C = -24.8\text{‰}$

Peat, 0.6m thick, under diatomite, upper portion of layer.

AC-0284. **3250 ± 110**
 $\delta^{13}C = -23.8\text{‰}$

Basal fraction of same stratum.

General Comment (JF): dates check regional significance and extension of climatic changes developed in Andes through considered interval. Palynol and diatomol studies are in progress. Human occupation of site, ca 2800 BP, signaled by lithic materials. Samples are correlated with Caballo Muerto, Río Abajo, and Azul Pampa-Ésquinas Blancas series. Basal peat remains are undated.

Azul Pampa-Esquinas Blancas series

Peat from headwaters of Río Grande de Jujuy, Humahuaca dept, Jujuy prov (22° 58' S, 62° 25' W) 3690m asl. Coll and subm 1981 by J Fernández.

Esquinas Blancas profile

AC-0298. **1950 ± 90**

0.8m depth.

AC-0297. **2980 ± 120**
 $\delta^{13}C = -24.6\text{‰}$

2.3m depth.

AC-0296. **4950 ± 130**
 $\delta^{13}C = -24.5\text{‰}$

8.1m depth.

Azul Pampa profile

AC-0306. **1830 ± 100**
 $\delta^{13}C = -22.5\text{‰}$

0.65m depth.

AC-0300. **2880 ± 90**
 $\delta^{13}C = -25.0\text{‰}$

1.35m depth.

AC-0301. **3690 ± 100**
 $\delta^{13}C = -22.8\text{‰}$

7.03m depth.

AC-0303. **3940 ± 170**
 $\delta^{13}C = -25.2\text{‰}$

8.8m depth.

AC-0304. **4140 ± 110**
 $\delta^{13}C = -25.2\text{‰}$

10.93m depth.

AC-0310. **4770 ± 130**
 $\delta^{13}C = -25.2\text{‰}$

12.5m depth.

General Comment (JF): fine-grained stratified sediment sec, 10m thick, exposed in narrow canyon where Río Grande cuts across Andes Orientales. Topographic position of such fine-grained deposits in narrowest portion of Valley disagrees with classical principle of sedimentation. Also, sediment type composed of pelitic fraction (clays and limes), interbedded with

organic layers of peat and marl, is incongruent with modern hydrologic regime of river, characterized by downcutting. Modern climate of torrential summer rains (238mm between Dec and March) activates erosion and increases solid load of river. During rest of year, water levels are very low, depending only on spring runoff. Therefore, accumulation of sandy, silty, and clayey sediments (aggradational cycle) that occurred in past, reflect paleoclimate different from present with simultaneous, significant changes in vegetational composition. Sedimentologic features suggest that climate during deposition of fine-grained sediments must have been colder and more arid.

Bajada de Rahue series

Peat from Bajada de Rahue, 10km E of Rahue (39° 22' S, 70° 56' W), Aluminé dept, Neuquén prov, 1000m asl. Coll and subm 1980–1981 by J Fernández.

AC-0175. **28,800 ± 1100**
 $\delta^{13}C = -26.1\text{‰}$
8.5 to 8.7m depth.

AC-0176. **29,000 ± 1400**
 $\delta^{13}C = -26.6\text{‰}$
9.39 to 10.49m depth.

AC-0282. **27,900 ± 1200**
 $\delta^{13}C = -26.6\text{‰}$
10.74 to 10.79m depth.

AC-0177. **32,600 ± 1500**
 $\delta^{13}C = -26.6\text{‰}$
17.36 to 17.51m depth.

General Comment (JF): Auer (1956) attributed interglacial age to this profile. Outcropping is composed of strata of volcanic ash, peat, and diatomite, 21m thick. Age is interstadial; comparison with $\delta^{18}O$ values established for Antarctica by Johnsen *et al* (1972) indicates Denekamp/Hengelo (Plum Point) (Fernández, Angiolini, & Ancibor, 1983).

Salina del Bebedero series

Lacustrine shells and eggshells (*Rhea* sp) from Salina del Bebedero, San Luis prov (33° 30' S, 66° 40' W). Samples dated to establish climatic-changes chronology for Late Pleistocene and Holocene. Coll and subm 1980–1981 by M A González.

AC-0105. **13,000 ± 140**
 $\delta^{13}C = -3.4\text{‰}$

Chilina parchappi from yellowish-green fine sand and tephra level, interstratified with coarse sand and fine gravel, corresponding to old lacustrine shores, 410m asl, 2.1m depth.

AC-0360.**8270 ± 180** $\delta^{13}C = -3\text{‰}$

Eggshell fragment (*Rhea* sp) from archaeol site interstratified in lacustrine sediments, 385m asl, 1m depth. *Comment* (MAG): human presence indicates better environmental conditions than present ones (Hypsithermal?).

AC-0361.**5240 ± 100** $\delta^{13}C = -3.9\text{‰}$

Eggshell fragments (*Rhea* sp) from top of poorly developed paleosoil covered by arid eolian sediments, 430m asl, 1m depth. *Comment* (MAG): age corresponds to covering of Hypsithermal soil by eolian sediments (arid climate).

AC-0368.**17,500 ± 300** $\delta^{13}C = -0.3\text{‰}$

Chilina parchappi from sand level interstratified with lacustrine sands and gravel, 410m asl, 4m depth.

AC-0369.**13,260 ± 200** $\delta^{13}C = -0.8\text{‰}$

Chilina parchappi from same profile AC-0368, 2.3m depth.

AC-0371.**13,200 ± 200** $\delta^{13}C = -0.8\text{‰}$

Chilina parchappi from same profile AC-0368, 2m depth.

General Comment (MAG): occurrence of three max lake levels was defined at 17,500, 15,500, and 13,000 BP (second one by previous dates). Meltwaters from Cordillera de los Andes feed lake through Desaguadero R. The three max lake levels are probably related to glacial advances during Wisconsin-Würm glaciation. Human presence, ca 8200 BP, indicates better environmental conditions than at present (Hypsithermal). Eolian sediments developed ca 5200 BP and buried Hypsithermal soils.

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UNIVERSITY COLLEGE CARDIFF RADIOCARBON DATES I

QUENTIN DRESSER

Radiocarbon Dating Laboratory, Department of Plant Science
University College, Cardiff, Wales

The laboratory was established by University College, Cardiff, in 1974 primarily for research in vegetation history and archaeology in Britain. The laboratory has been supported yearly since 1978 by the Conservation and Land Division of the Welsh Office, Cardiff, which submits archaeological samples from rescue excavations in Wales which are carried out by the Clwyd-Powys Archaeological Trust Ltd (CPAT), the Dyfed Archaeological Trust Ltd (DAT), the Glamorgan Gwent Archaeological Trust Ltd (GGAT), and the Gwynedd Archaeological Trust Ltd (GAT).

The method employed is gas proportional counting of synthetic methane. After initial sorting and possible treatment with 5% H_2O_2 to break up clay, charcoal samples are washed with 2.5% HCl followed by 2.5% NaOH . The sample is then placed in a soxhlet extractor to remove humic substances. The charcoal is acidified and the soxhlet extraction continued for a further period before drying.

Bone pretreatments comprise extraction of collagen. After initial washing, the sample is demineralized in 5% HCl . The solid residue is macerated and suspended in 2.5% NaOH followed by suspension in 2.5% HCl and then distilled water. The suspension is boiled to solubilize the collagen which is then filtered and evaporated to dryness.

Peat pretreatments are designed to provide a physico-chemical fraction which is most likely to be contemporary with the pollen (Dresser, 1970). Unless otherwise stated, peat pretreatments comprise suspension of the sample in 2.5% HCl followed by 2.5% NaOH . After several washes, the sample is acidified and filtered through a $250\mu\text{m}$ mesh to remove rootlets. The fine insoluble residue is washed and dried. Inorganic reagents and distilled water are used in all pretreatments.

Samples are combusted in a "Phonon" unit (Switsur, 1972) or occasionally by the tube method for samples with low C content. The CO_2 is purified by bubbling through KMnO_4 solution and passage over Cu/CuO at 620°C . The CO_2 is converted to CH_4 in a closed circuit system. H_2 is bled into the system through an electronically controlled needle-valve, and a pump circulates the gas mixture over a ruthenium catalyst at 520°C . Within the circuit is a water trap cooled by solid CO_2 . The conversion is completed in $<1.5\text{h}$ and there is no detectable residual CO_2 . All samples are stored for >1 month in gas form before counting to allow radon to decay. The detector is filled through a catalytic deoxygenator containing palladium. The fill pressure of ca 2.5b is measured using a high accuracy pressure transducer and is temperature compensated.

The detector, manufactured at the Atomic Energy Research Establishment, Harwell, is a 2L OFHC copper tube with teflon insulators and a $12.5\mu\text{m}$ tungsten wire anode. It is surrounded by a multianode gas flow guard detector, also manufactured at AERE Harwell. The detector assembly is shielded by $>8\text{cm}$ of boron loaded plastic and $>23\text{cm}$ of steel

plate weighing 8t from a gasometer constructed in 1936. The laboratory is situated in the basement of a 3-story building. Commercial charge sensitive preamplifiers are used and the main amplifiers and logic circuitry are NIM modules. A custom-built scaler counts β , α , gross, and guard pulses, and data is printed out every 72 minutes. In addition, a noise channel is counted. A custom-built unit after a design by Arnow (1977), outputs a pulse when β pulses occur within 1ms. It outputs pulses at a predictable low frequency when the source is truly random but at a higher frequency when non-random noise is present.

The background is ca 4.4cpm and is subject to a barometric effect of 0.18%/mb. The gross and guard counts are similarly affected and are also subject to diurnal variation and a longer term seasonal variation, though no such variation is observed in the background. The modern reference material used is NBS oxalic acid (SRM 4990-B), which is prepared by wet oxidation. Once in the counter, the gas is subject to a slight quenching effect probably due to outgassing of the teflon insulators. The condition of the gas is fully restored by passage through the palladium catalyst, as determined by channels ratio whilst monitoring an external ^{137}Cs source.

$\delta^{13}\text{C}$ measurements are made on CO_2 sub-samples. All sample activities are normalized to -25‰ and the standards to -19‰ (PDB). Date calculations are made using the Libby half-life of 5568 yr and 0.95 of the NBS oxalic activity (ca 25cpm). The 1σ quoted error is derived from all experimental errors and incorporates counting statistics and uncertainties in the fill pressure, barometric correction, quench correction, and $\delta^{13}\text{C}$ assay. No term is included to cover sample integrity or whole system repeatability. Small samples are diluted and the error term then includes uncertainty in the dilution factor. Such samples are counted for a longer time than the normal 23 hr. The laboratory participated in the Harwell intercalibration experiment (Otle *et al*, 1980).

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CHECK SAMPLES

CAR-2. 1830 to 1840 oak wood **100 ± 80**
 $\delta^{13}\text{C} = -25.8\text{‰}$

Sample from tree felled 1970 at Townley Hall, 5.5km W of Drogheda, Co Louth, Ireland (53° 43' N, 6° 27' W, Natl Grid Ref O 035765). Coll by J Hood, Dept Botany, Trinity Coll, Dublin. Result is mean and standard deviation of 5 counts (60 ± 50 , 230 ± 60 , 80 ± 60 , 70 ± 55 , 50 ± 55). *Comment:* similar sample dated at Dublin lab (R, 1974, v 16, p 6).

CAR-3. Ruds Vedby **11,030 ± 100**
 $\delta^{13}C = -26.9\text{‰}$

Wood from dark layer representing pollen zone Boundary II/III, isolated from peaty lake mud in profile at Ruds Vedby, Zealand, Denmark (55° 32' N, 11° 22' E). Coll 1951 by H Krog. *Comment:* sample dated extensively as check sample and summarized by Håkansson (R, 1968, v 10, p 38) who gives mean of previous measurements of 10,995 ± 55.

CAR-4. Tjanefer **3010 ± 50**
 $\delta^{13}C = -25.7\text{‰}$

Wood from branch embedded during construction in mud-brick superstructure of tomb of Tjanefer at Dra' Abu el-Naga', Thebes, Egypt (25° 41' N, 32° 40' E). Coll 1967 by G T Martin. *Comment:* dated by British Mus lab to 3080 ± 75 (BM-337, R, 1971, v 13, p 162).

CAR-5. Mount Pleasant **3890 ± 60**
 $\delta^{13}C = -24.7\text{‰}$

Charcoal from secondary silts of ditch surrounding timber structure at late Neolithic henge monument at Mt Pleasant, Dorchester, Dorset, England (50° 42' N, 2° 24' W, Natl Grid Ref SY 710900). Coll 1970 by G J Wainwright. *Comment:* dated by British Mus lab to 3630 ± 60 (BM-668, R, 1976, v 18, p 23).

GEOLOGIC SAMPLES

Wales

Ardudwy peat series

Peat samples are from excavated trench 180m N of Moel-y-Gerddi archaeol site at Ardudwy, 3.5km ENE of Harlech, Gwynedd (52° 52' N, 4° 03' W, Natl Grid Ref SH 616319). Single peat monolith was coll 1980 by R Kelly, GAT, and was investigated palynologically by S M Price and F M Chambers, Dept Geog, Univ Keele, Staffs. Subm by GAT. Dates were required for determination of accumulation-rate in conjunction with absolute pollen diagram. Comments refer to relative pollen data (based on sum of total land pollen).

CAR-660. 17-19cm **1670 ± 60**
 $\delta^{13}C = -28.9\text{‰}$
Peat at decline of arboreal pollen from 51% at 18cm to 35% at 16cm.

CAR-641. 42-44cm **3720 ± 70**
 $\delta^{13}C = -28.8\text{‰}$
Peat at start of decline in arboreal pollen from 90% at 44cm to 60% at 40cm.

CAR-661. 67-69cm **4730 ± 80**
 $\delta^{13}C = -29.4\text{‰}$
Peat at decline of arboreal pollen from 74% at 68cm to 49% at 66cm.

CAR-642. 80–82cm **5200 ± 80**
 $\delta^{13}C = -28.7\text{‰}$

Peat at horizon just below first appearance of *Plantago lanceolata* pollen at 78cm.

CAR-662. 99–101cm **5710 ± 80**
 $\delta^{13}C = -28.8\text{‰}$

Peat with arboreal pollen at 95%.

CAR-663. 109–111cm **6440 ± 90**
 $\delta^{13}C = -28.9\text{‰}$

Peat with arboreal pollen at 90%.

CAR-664. 129–131cm **7510 ± 100**
 $\delta^{13}C = -29.2\text{‰}$

Peat at peak in *Alnus* pollen at 84%.

CAR-643. 138–140cm **8590 ± 100**
 $\delta^{13}C = -29.8\text{‰}$

Basal layer of peat. *Alnus* pollen at 5%.

General Comment (FMC): confirmation of early *Alnus* in NW Wales given by CAR-643 and -664.

Cefn Graeanog Bog series

Peat samples are from monolith of mire sediments taken in conjunction with archaeol excavations of Romano-British hut group and medieval farmstead (Kelly, 1982) at Cefn Graeanog, 14km S of Caernavon, Gwynedd (53° 01' N, 4° 18' W, Natl Grid Ref SH 453487). Coll 1977 by M Girling and subm by GAT. Pretreatment and pollen analysis by F M Chambers (1980; 1983a), Dept Plant Sci, Univ Coll, Cardiff. *Comment* (FMC): 20×20cm monolith of depth 213cm was taken ca 200m W of Cefn Graeanog Hut Group II, in valley mire. Stratigraphy comprised 0 to 10cm upcast, 10 to 60cm valley bog peat, 65 to 206cm carr peat, and 206 to 213cm bluish gray silt. Sample depths refer to present surface. Dates required for determination of deposition-rate curve for detailed pollen diagram.

CAR-67. CGB 35–37cm **750 ± 40**
 $\delta^{13}C = -28.0\text{‰}$

Peat.

CAR-68. CGB 44–46cm **1230 ± 40**
 $\delta^{13}C = -28.5\text{‰}$

Peat.

CAR-72. CGB 50–51cm **1130 ± 50**
 $\delta^{13}C = -28.6\text{‰}$

Peat. *Comment* (FMC): too young.

CAR-69. CGB 57–58cm **1040 ± 50**
 $\delta^{13}C = -28.5\text{‰}$

Peat. *Comment* (FMC): too young.

CAR-70. CGB 65–66cm **2310 ± 40**
 $\delta^{13}C = -28.4\text{‰}$
Peat from upper horizon of carr peat.

CAR-108. CGB 116–118cm **4750 ± 60**
 $\delta^{13}C = -29.2\text{‰}$
Peat from ca 10cm above elm decline.

CAR-109. CGB 164–166cm **5600 ± 70**
 $\delta^{13}C = -29.1\text{‰}$
Peat.

CAR-110. CGB 202–204cm **7230 ± 90**
 $\delta^{13}C = -28.4\text{‰}$
Peat from base of valley mire. *Alnus* values of 30% to 40% of total land pollen.

General Comment (FMC): results fit relatively smooth deposition-rate curve except for CAR-69 and -72 which appear young.

Breidden Pond series

Organic mud samples are from 2 monoliths taken from natural pond within Iron age hillfort excavated by C R Musson and W J Britnell, CPAT, at Breidden Mt, 10km NE of Welshpool, Powys (52° 43' N, 3° 03' W, Natl Grid Ref SJ 295145). Pollen analysis carried out by C A Green and A G Smith, Dept Plant Sci, Univ Coll, Cardiff. Coll 1976 by AGS and WJB and subm by CPAT. Layers B to H refer to strat sub-units (organic muds and silts) established by excavators. *Comment*: all samples were normal fine fractions and combusted in tube. Depths refer to modern surface.

CAR-382. Br I, 40–41cm **1020 ± 60**
 $\delta^{13}C = -30.2\text{‰}$
Brown organic mud near base of Layer B.

CAR-137. Br I, 44–45cm **2280 ± 60**
 $\delta^{13}C = -30.3\text{‰}$
Gray-brown clayey silt at top of Layer C. *Comment* (AGS): comparison with CAR-382 indicates unconformity between Layers C and B. Conclusion is supported by pollen evidence.

CAR-383. Br I, 45–46cm **2210 ± 60**
 $\delta^{13}C = -30.2\text{‰}$
Gray-brown clayey silt from top of Layer C.

CAR-138. Br I, 49–50cm **2390 ± 60**
 $\delta^{13}C = -30.4\text{‰}$
Gray-brown clayey silt from Layer C.

CAR-381. Br I, 54–55cm **2440 ± 70**
 $\delta^{13}C = -29.9\text{‰}$

Gray-brown clayey silt from Layer C.

CAR-139. Br I, 56–57cm **2810 ± 60**

Gray-brown clayey silt from Layer C, at beginning of decline of tree pollen. *Comment:* $\delta^{13}C$ value of $-30\text{‰} \pm 0.5$ used (mean and standard deviation of other samples in series).

CAR-140. Br I, 62–63cm **2970 ± 60**
 $\delta^{13}C = -29.7\text{‰}$

Gray-brown clayey silt near base of Layer C.

CAR-141. Br I, 67–68cm **3150 ± 70**
 $\delta^{13}C = -30.1\text{‰}$

Dark brown organic mud from top of Layer D.

CAR-142. Br I, 71–73cm **3250 ± 70**
 $\delta^{13}C = -30.0\text{‰}$

Dark brown organic mud from Layer D.

CAR-143. Br I, 82–84cm **4420 ± 70**
 $\delta^{13}C = -30.1\text{‰}$

Dark brown organic mud from Layer D, at decline of *Quercus* and *Ulmus* pollen curves.

CAR-157. Br I, 109–110cm **6900 ± 90**
 $\delta^{13}C = -29.5\text{‰}$

Dark brown clay-mud from Layer E, at rise of *Alnus* pollen curve.

CAR-158. Br I, 124–125cm **8510 ± 100**
 $\delta^{13}C = -27.5\text{‰}$

Dark brown clayey silt from Layer F.

CAR-159. Br II, 150–152cm **14,560 ± 210**
 $\delta^{13}C = -26.1\text{‰}$

Dark brown clayey silt from Layer H. *Comment* (AGS): remnant portion of truncated Layer H belongs to earliest part of Windermere Interstadial as SRR-681, $14,560 \pm 280$ (R, 1981, v 23, p 268; Pennington, 1977). Pollen evidence shows open plant community.

Pen Rhiw Wen series

Peat samples are from series of 5 monoliths and 1 core in varying depths of blanket peat on several substrates all within 1km² at Pen Rhiw Wen, 4.5km N of Brynamman, Dyfed (51° 50' N, 3° 50' W, Natl Grid Ref SN 732183). Coll and subm 1977 by E. Cloutman, Dept Plant Sci, Univ Coll, Cardiff. *Comment* (EC): palynol studies were made to obtain 3-dimensional appraisal of development of peat and surrounding vegetation (Cloutman,

1983). Monolith H was taken in one 90cm sec from blanket peat over conglomerate at alt 510m. Core J was taken in 3 secs from valley bog in swallow hole on conglomerate at alt 490m. Length of core, 4.7m. Monolith K was taken in 2 secs from blanket peat overlying podsolic soil on 4° slope on conglomerate at alt 495m. Length of monolith, 1.29m. Monolith L was taken in one 66cm sec from blanket peat overlying iron pan podsol with surface gleying on 11° slope immediately below Site M at alt 512m. Monolith M was taken in one 76cm sec from blanket peat overlying iron pan with surface gleying on 6° slope at alt 540m. Monolith N was taken in one 44cm sec from shallow blanket peat directly over conglomerate ca 30m from cairn of Garreg-lwyd Mt at alt 600m. All samples are fine fraction of peat.

CAR-21. Monolith H 11cm **780 ± 60**
 $\delta^{13}C = -27.8\text{‰}$
Ombrogenous peat with high Gramineae and *Plantago* pollen values.

CAR-22. Monolith H 26cm **1250 ± 60**
 $\delta^{13}C = -28.2\text{‰}$
Ombrogenous peat at increase in *Corylus* and other tree pollen values.

CAR-23. Monolith H 49cm **2100 ± 70**
 $\delta^{13}C = -28.3\text{‰}$
Ombrogenous peat at rise in *Plantago* and Gramineae pollen, with high *Calluna* pollen values.

CAR-24. Monolith H 69cm **2750 ± 70**
 $\delta^{13}C = -28.8\text{‰}$
Ombrogenous peat at start of rise in *Calluna* pollen value.

CAR-25. Monolith H 79cm **2970 ± 80**
 $\delta^{13}C = -28.7\text{‰}$
Ombrogenous peat at fall in *Corylus* and rise in Cyperaceae pollen values.

CAR-26. Monolith H 87cm **3380 ± 70**
 $\delta^{13}C = -28.8\text{‰}$
Ombrogenous peat directly above mineral soil.

CAR-28. Core J 22cm **890 ± 70**
 $\delta^{13}C = -27.1\text{‰}$
Eriophorum peat with high Gramineae and *Corylus* pollen values.

CAR-29. Core J 69cm **990 ± 70**
 $\delta^{13}C = -27.1\text{‰}$
Ombrogenous peat at increasing Gramineae, *Plantago* and Cyperaceae pollen and declining *Betula* pollen values.

CAR-30. Core J 173cm **2400 ± 50**
 $\delta^{13}C = -27.8\text{‰}$

Ombrogenous peat at rising *Corylus* pollen value.

CAR-31. Core J 284cm **2670 ± 70**
 $\delta^{13}C = -27.2\text{‰}$

Ombrogenous peat at rising *Corylus* pollen value but decline in other tree spp pollen.

CAR-32. Core J 370cm **3150 ± 90**
 $\delta^{13}C = -27.8\text{‰}$

Ombrogenous peat with *Calluna* fragments.

CAR-33. Monolith K 15cm **530 ± 80**
 $\delta^{13}C = -28.3\text{‰}$

Ombrogenous peat with high *Calluna* and Gramineae pollen values.

CAR-34. Monolith K 37cm **2060 ± 70**
 $\delta^{13}C = -27.5\text{‰}$

Ombrogenous peat at rise in *Calluna* and *Plantago* pollen values.

CAR-35. Monolith K 77cm **3130 ± 60**
 $\delta^{13}C = -27.5\text{‰}$

Ombrogenous peat at rise in *Betula* and *Quercus* pollen and decline in *Pteridium* and *Corylus* pollen values.

CAR-36. Monolith K 115cm **3860 ± 90**
 $\delta^{13}C = -27.5\text{‰}$

Mor deposit containing charcoal, at rise in *Corylus* and *Calluna* pollen values.

CAR-37. Monolith K 123cm **4800 ± 90**
 $\delta^{13}C = -28.3\text{‰}$

Mor deposit containing charcoal from near elm decline.

CAR-38. Monolith K 126cm **5450 ± 70**
 $\delta^{13}C = -27.7\text{‰}$

Mor deposit at mineral interface with high *Corylus* pollen value.

CAR-15. Monolith L 9cm **1150 ± 50**
 $\delta^{13}C = -28.2\text{‰}$

Ombrogenous peat at rising *Calluna* pollen value.

CAR-16. Monolith L 19cm **2340 ± 70**
 $\delta^{13}C = -27.6\text{‰}$

Ombrogenous peat at rising Gramineae, *Plantago*, and *Potentilla* pollen values.

- CAR-17. Monolith L 57cm** **4720 ± 80**
 $\delta^{13}C = -28.7\text{‰}$
Ombrogenous peat at elm decline.
- CAR-18. Monolith L 60cm** **5830 ± 70**
 $\delta^{13}C = -27.7\text{‰}$
Mor deposit with charcoal at decline in *Corylus* and increase in *Calluna* pollen values.
- CAR-63. Monolith L 62cm** **4120 ± 70**
 $\delta^{13}C = -27.6\text{‰}$
Ombrogenous peat at decline in *Corylus* and increase in *Calluna* pollen values.
- CAR-10. Monolith M 34cm** **3330 ± 60**
 $\delta^{13}C = -28.1\text{‰}$
Ombrogenous peat at increase in Gramineae and decline in *Calluna* pollen values.
- CAR-11. Monolith M 54cm** **4250 ± 70**
 $\delta^{13}C = -28.1\text{‰}$
Ombrogenous peat at increase in *Calluna* pollen value.
- CAR-12. Monolith M 65cm** **4770 ± 70**
 $\delta^{13}C = -28.1\text{‰}$
Sample from junction of greasy black amorphous peat and ombrogenous peat at decline in *Ulmus* pollen value.
- CAR-13. Monolith M 71cm** **5710 ± 80**
 $\delta^{13}C = -28.3\text{‰}$
Mor deposit at high *Calluna* pollen value.
- CAR-14. Monolith M 76cm** **5740 ± 80**
Sample of mor deposit at junction with mineral soil, at reduction in *Corylus* pollen and rise in *Calluna* pollen values. *Comment:* $\delta^{13}C$ value not determined; estimated value of $-28\text{‰} \pm 1$ used in date calculation.
- CAR-64. Monolith N 11cm** **710 ± 60**
 $\delta^{13}C = -27.6\text{‰}$
Ombrogenous peat.
- CAR-83. Monolith N 13cm** **1230 ± 60**
 $\delta^{13}C = -28.4\text{‰}$
Ombrogenous peat with high *Calluna* and Gramineae pollen values.
- CAR-84. Monolith N 26cm** **4860 ± 80**
 $\delta^{13}C = -28.8\text{‰}$
Humified ombrogenous peat with high *Corylus* and *Quercus* pollen values.

CAR-85. Monolith N 32cm

Humified ombrogenous peat.

4930 ± 60 $\delta^{13}C = -28.3\text{‰}$ **CAR-66. Monolith N 40cm**

Humified ombrogenous peat.

4830 ± 60 $\delta^{13}C = -28.1\text{‰}$ **Waun-Fignen-Felen series**

Peat samples are from series of 15 monoliths and 1 core taken from upland basin and surrounding area at Waun-Fignen-Felen, 5km N of Abercraf, Powys (51° 50' N, 3° 42' W, Natl Grid Ref SS 825179). Coll 1980 by A G Smith and E W Cloutman, Dept Plant Sci, Univ Coll, Cardiff. Site consists of peat-filled late glacial lake basin surrounded by ombrogenous peats, some of which began to form in Mesolithic times. Core WFF/G00, 500cm long, came from center of basin and consisted of reedswamp peat and ombrogenous peat. Monolith WFF/E13N, 250cm long, from NE edge of basin, comprised basal reedswamp peat overlain by ombrogenous peat. Monolith WFF/E1N, 60cm long, from NE edge of basin, comprised lake muds overlain by ombrogenous peat. Monolith WFF/B125N, 50cm long, from near basin, comprised basal till, 6cm mor with ombrogenous peat above. Monolith WFF/B90S, 28cm long, from near basin, comprised ironpan podsol, 4cm mor with ombrogenous peat above. Monolith WFF/B32S, 55cm long, from near basin, comprised basal till, 4cm mor with ombrogenous peat above. Monolith WFF/A16W, 60cm long, from near basin, comprised basal till with 52cm ombrogenous peat above. Monolith WFF/E188S, 145cm long, from near basin, comprised basal till, narrow horizon of humified peat overlain by ombrogenous peat. Monolith WFF/A0, 25cm long, from near basin, comprised basal till, 22cm black humified peat with mineral particles and included worked Mesolithic flint. Monolith WFF/A78E, 90cm long, from near basin, contained basal till, 8cm humified peat with ombrogenous peat above. Monolith WFF/B46.5N, 190cm long, from near basin, contained basal till, 48cm moderately humified peat and ombrogenous peat. Monolith WFF/F117S, 100cm long, from near basin, contained basal till, 8cm mor and ombrogenous peat. Monolith WFF/EE17E, 76cm long, from near basin, contained basal till, 4cm humified peat with ombrogenous peat above. Monolith WFF/NE, 50cm long from slope NE of basin at alt 660m, contained basal till, 4cm humified peat with ombrogenous peat above. Monolith WFF/NP, 50cm long, from plateau N of basin at alt 500m, contained basal till, 5cm humified peat with ombrogenous peat above. Monolith WFF/SW, 50cm long, from slope to SW of basin at alt 530m, contained basal till, thin layer of humified peat with 48cm ombrogenous peat above. Samples taken to construct 3-dimensional vegetational history of area using relative and absolute pollen diagrams (Cloutman, 1983). Monoliths and cores from basin contained aquatic deposits. Monoliths from near basin sites are within 150m of aquatic deposits and alts are taken from peat base. All near-basin sites lie between 477m and 484m alt. All depths refer to tops of monoliths, which are not necessarily at original bog surface.

- CAR-625. WFF/NE 48cm** **5940 ± 90**
 $\delta^{13}C = -27.4\text{‰}$
Black amorphous peat immediately above basal mineral.
- CAR-626. WFF/SW 46cm** **4250 ± 80**
 $\delta^{13}C = -28.4\text{‰}$
Ombrogenous peat with *Eriophorum*.
- CAR-627. WFF/SW 48cm** **4370 ± 80**
 $\delta^{13}C = -28.3\text{‰}$
Black humified peat with charcoal above basal mineral.
- CAR-628. WFF/NP 34 + 36cm** **5100 ± 80**
 $\delta^{13}C = -28.5\text{‰}$
Ombrogenous peat directly above basal mineral.
- CAR-421. WFF/E1N 2 + 3cm** **4160 ± 80**
 $\delta^{13}C = -27.7\text{‰}$
Ombrogenous peat with *Calluna* remains; *Calluna* pollen percentage increasing sharply.
- CAR-422. WFF/E1N 13 + 14cm** **4270 ± 70**
 $\delta^{13}C = -27.9\text{‰}$
Coarse *Eriophorum* peat.
- CAR-423. WFF/E1N 21 + 22cm** **4470 ± 80**
 $\delta^{13}C = -29.0\text{‰}$
Coarse *Eriophorum* peat.
- CAR-424. WFF/E1N 26 + 27cm** **4670 ± 80**
 $\delta^{13}C = -28.6\text{‰}$
Coarse *Eriophorum* peat at start of rise of *Plantago* pollen and fall in *Ulmus* pollen curve.
- CAR-425. WFF/E1N 33 + 34cm** **4660 ± 80**
 $\delta^{13}C = -28.3\text{‰}$
Coarse detritus mud with *Phragmites* rhizomes and *Betula* and *Salix* wood fragments.
- CAR-426. WFF/E1N 40 + 41cm** **4820 ± 80**
 $\delta^{13}C = -28.7\text{‰}$
Coarse detritus mud with *Phragmites* rhizomes and *Sphagnum* leaves.
- CAR-427. WFF/E1N 42 + 43cm** **4900 ± 80**
 $\delta^{13}C = -28.6\text{‰}$
Peat at transition to organic mud, at fall in *Ulmus* and *Corylus* pollen and rise in Gramineae pollen levels.

CAR-428. WFF/E1N 45 + 46cm Organic mud with <i>Juncus</i> seeds.	5180 ± 80 $\delta^{13}C = -28.5\text{‰}$
CAR-429. WFF/E1N 51 + 52cm Organic mud with <i>Juncus</i> seeds.	6110 ± 90 $\delta^{13}C = -28.5\text{‰}$
CAR-430. WFF/E1N 56 + 57cm Organic mud with <i>Juncus</i> seeds.	6310 ± 90 $\delta^{13}C = -28.2\text{‰}$
CAR-635. WFF/E13N 15–18cm <i>Eriophorum</i> peat.	830 ± 60 $\delta^{13}C = -27.5\text{‰}$
CAR-634. WFF/E13N 79 + 80cm <i>Eriophorum</i> peat at rise in <i>Plantago</i> pollen curve.	2170 ± 60 $\delta^{13}C = -27.5\text{‰}$
CAR-636. WFF/E13N 143 + 144cm <i>Eriophorum</i> peat.	3510 ± 70 $\delta^{13}C = -27.6\text{‰}$
CAR-637. WFF/E13N 175 + 176cm <i>Eriophorum</i> peat with <i>Calluna</i> at fall in <i>Ulmus</i> pollen curve.	3960 ± 70 $\delta^{13}C = -27.6\text{‰}$
CAR-638. WFF/E13N 223 + 224cm Coarse detritus mud with <i>Phragmites</i> rhizomes. <i>Ulmus</i> pollen values falling, <i>Plantago</i> and <i>Calluna</i> values rising.	5280 ± 80 $\delta^{13}C = -28.5\text{‰}$
CAR-639. WFF/E13N 225 + 226cm Coarse detritus mud with <i>Phragmites</i> rhizomes.	5230 ± 80 $\delta^{13}C = -28.9\text{‰}$
CAR-640. WFF/E13N 258cm Coarse detritus mud at mineral/peat interface.	6520 ± 90 $\delta^{13}C = -28.2\text{‰}$
CAR-686. WFF/G00 121–124cm <i>Eriophorum</i> peat with <i>Calluna</i> .	3670 ± 70 $\delta^{13}C = -27.6\text{‰}$
CAR-687. WFF/G00 253–256cm Ombrogenous peat with <i>Eriophorum</i> at rise in <i>Plantago</i> and fall in <i>Ulmus</i> pollen percentages.	5020 ± 70 $\delta^{13}C = -28.2\text{‰}$

- CAR-688. WFF/G00 285–288cm** **5770 ± 80**
 $\delta^{13}C = -27.7\text{‰}$
Coarse detritus mud with *Phragmites* rhizomes.
- CAR-689. WFF/G00 301–304cm** **6240 ± 90**
 $\delta^{13}C = -27.5\text{‰}$
Phragmites peat with *Betula* fragments.
- CAR-690. WFF/G00 369–376cm** **7460 ± 90**
 $\delta^{13}C = -27.3\text{‰}$
Phragmites peat. *Alnus* pollen value starts to increase.
- CAR-691. WFF/G00 473–476cm** **9340 ± 110**
 $\delta^{13}C = -26.7\text{‰}$
Phragmites peat. Decline in *Betula* and rise in *Corylus* pollen curves.
- CAR-692. WFF/G00 499–504cm** **10,180 ± 110**
 $\delta^{13}C = -26.6\text{‰}$
Organic mud with mineral particles. *Comment* (AGS): date confirms stratigraphic evidence of early Flandrian age of this level.
- CAR-504. WFF/B125N 4cm** **4380 ± 80**
 $\delta^{13}C = -29.0\text{‰}$
Ombrogenous peat.
- CAR-505. WFF/B125N 16cm** **5220 ± 80**
 $\delta^{13}C = -29.0\text{‰}$
Ombrogenous peat.
- CAR-506. WFF/B125N 32cm** **6060 ± 80**
 $\delta^{13}C = -28.7\text{‰}$
Peat at decline in *Ulmus* pollen values.
- CAR-507. WFF/B125N 44cm** **7610 ± 90**
 $\delta^{13}C = -28.2\text{‰}$
Peat at junction of greasy black peat and ombrogenous peat.
- CAR-508. WFF/B125N 46cm** **7830 ± 100**
 $\delta^{13}C = -28.1\text{‰}$
Black greasy ombrogenous peat containing charcoal and *Juncus* seeds.
- CAR-509. WFF/B125N 49cm** **7940 ± 100**
 $\delta^{13}C = -27.8\text{‰}$
Black greasy ombrogenous peat immediately above mineral soil, at fall in *Betula* and rise in *Corylus* pollen values.
- CAR-499. WFF/B90S 2cm** **4850 ± 70**
 $\delta^{13}C = -27.9\text{‰}$
Ombrogenous peat.

- CAR-500. WFF/B90S 8cm** 5220 ± 80
 $\delta^{13}C = -28.3\text{‰}$
Ombrogenous peat at decline in *Ulmus* pollen value.
- CAR-501. WFF/B90S 15cm** 5490 ± 80
 $\delta^{13}C = -28.3\text{‰}$
Peat at interface between basal mor and ombrogenous peat, at fall in *Calluna* pollen value.
- CAR-502. WFF/B90S 18 + 19cm** 6490 ± 90
 $\delta^{13}C = -27.6\text{‰}$
Organic mineral soil at rising *Alnus* and high *Calluna* pollen values.
- CAR-337. WFF/B32S 8 + 9cm** 4060 ± 70
 $\delta^{13}C = -28.5\text{‰}$
Ombrogenous peat.
- CAR-338. WFF/B32S 16 + 17cm** 4030 ± 70
 $\delta^{13}C = -28.4\text{‰}$
Ombrogenous peat.
- CAR-339. WFF/B32S 24 + 25cm** 4870 ± 80
 $\delta^{13}C = -28.2\text{‰}$
Ombrogenous peat at fall in *Ulmus* pollen value.
- CAR-340. WFF/B32S 32 + 33cm** 5200 ± 80
 $\delta^{13}C = -28.5\text{‰}$
Ombrogenous peat.
- CAR-341. WFF/B32S 40 + 41cm** 5770 ± 80
 $\delta^{13}C = -28.1\text{‰}$
Ombrogenous peat with mineral particles.
- CAR-342. WFF/B32S 49cm** 5860 ± 80
 $\delta^{13}C = -28.3\text{‰}$
Peat at interface between black mor and ombrogenous peat, at rising *Alnus* and high *Calluna* pollen values.
- CAR-343. WFF/B32S 53cm** 6520 ± 100
 $\delta^{13}C = -27.9\text{‰}$
Mor deposit with much mineral material immediately above mineral soil, at high levels of *Corylus* and *Calluna* pollen.
- CAR-323. WFF/A16W 8cm** 3800 ± 70
 $\delta^{13}C = -28.5\text{‰}$
Ombrogenous peat.

CAR-324. WFF/A16W 15 + 16cm	4350 ± 70 $\delta^{13}C = -28.3\text{‰}$
Ombrogenous peat.	
CAR-325. WFF/A16W 23 + 24cm	4820 ± 80 $\delta^{13}C = -28.8\text{‰}$
Ombrogenous peat.	
CAR-326. WFF/A16W 32cm	5240 ± 80 $\delta^{13}C = -28.3\text{‰}$
Black greasy peat with much charcoal, at fall in <i>Ulmus</i> pollen value.	
CAR-327. WFF/A16W 40cm	5660 ± 80 $\delta^{13}C = -28.5\text{‰}$
Black greasy peat with mineral particles.	
CAR-328. WFF/A16W 48cm	5970 ± 80 $\delta^{13}C = -28.6\text{‰}$
Black greasy peat with mineral particles.	
CAR-329. WFF/A16W 52cm	5790 ± 70 $\delta^{13}C = -28.4\text{‰}$
Black greasy peat directly above mineral soil, at high <i>Corylus</i> pollen value.	
CAR-61. WFF/A0 17cm	7700 ± 90 $\delta^{13}C = -28.4\text{‰}$
Black humified peat with mineral material at level of worked Mesolithic flint lying 3cm above mineral soil.	
CAR-330. WFF/A78E 12 + 13cm	2290 ± 70 $\delta^{13}C = -27.7\text{‰}$
Ombrogenous peat.	
CAR-331. WFF/A78E 28 + 29cm	3000 ± 60 $\delta^{13}C = -27.9\text{‰}$
Ombrogenous peat at rise in <i>Fraxinus</i> and <i>Narthecium</i> pollen values.	
CAR-332. WFF/A78E 44 + 45cm	3370 ± 70 $\delta^{13}C = -28.1\text{‰}$
Ombrogenous peat.	
CAR-333. WFF/A78E 52 + 53cm	3710 ± 60 $\delta^{13}C = -28.1\text{‰}$
Ombrogenous peat at fall in <i>Ulmus</i> and rise in <i>Plantago</i> pollen values.	
CAR-334. WFF/A78E 60 + 61cm	4310 ± 80 $\delta^{13}C = -28.3\text{‰}$
Ombrogenous peat with some mineral particles.	

- CAR-335. WFF/A78E 77cm** **5530 ± 90**
 $\delta^{13}C = -28.0\text{‰}$
Dark brown greasy peat with mineral particles and charred *Calluna* fragments.
- CAR-336. WFF/A78E 81cm** **5340 ± 80**
 $\delta^{13}C = -27.4\text{‰}$
Dark brown greasy peat directly above mineral soil, at high values of *Corylus* and *Calluna* pollen.
- CAR-439. WFF/E188S 2 + 3cm** **1630 ± 70**
 $\delta^{13}C = -28.5\text{‰}$
Ombrogenous peat with *Eriophorum* and *Calluna* fragments.
- CAR-440. WFF/E188S 31 + 32cm** **2530 ± 70**
 $\delta^{13}C = -28.1\text{‰}$
Ombrogenous peat at rising *Fraxinus* and *Nartheceium* pollen values.
- CAR-441. WFF/E188S 55 + 56cm** **3150 ± 70**
 $\delta^{13}C = -27.9\text{‰}$
Ombrogenous peat.
- CAR-442. WFF/E188S 83cm** **3520 ± 70**
 $\delta^{13}C = -28.2\text{‰}$
Ombrogenous peat with rising *Plantago* and *Pteridium* and declining *Ulmus* pollen levels.
- CAR-443. WFF/E188S 99 + 100cm** **4220 ± 80**
Ombrogenous peat. *Comment:* $\delta^{13}C = -28\text{‰} \pm 1$ used in date calculation.
- CAR-444. WFF/E188S 119 + 120cm** **4690 ± 80**
 $\delta^{13}C = -28.4\text{‰}$
Ombrogenous peat.
- CAR-445. WFF/E188S 144cm** **6210 ± 90**
 $\delta^{13}C = -28.4\text{‰}$
Black peat with charcoal and some mineral particles directly above mineral soil at declining *Calluna* pollen curve.
- CAR-406. WFF/B46.5N 7 + 8cm** **1150 ± 60**
 $\delta^{13}C = -27.0\text{‰}$
Ombrogenous peat with *Calluna* and *Eriophorum* fragments.
- CAR-407. WFF/B46.5N 39 + 40cm** **2110 ± 70**
 $\delta^{13}C = -27.5\text{‰}$
Ombrogenous peat with *Calluna* and *Eriophorum* fragments.

- CAR-408. WFF/B46.5N 71 + 72cm** **2850 ± 70**
 $\delta^{13}C = -27.5\text{‰}$
Ombrogenous peat at rising *Fraxinus* and *Nartheicum* pollen curves.
- CAR-409. WFF/B46.5N 87 + 88cm** **3030 ± 70**
 $\delta^{13}C = -28.0\text{‰}$
Ombrogenous peat.
- CAR-410. WFF/B46.5N 119 + 120cm** **3610 ± 70**
 $\delta^{13}C = -28.4\text{‰}$
Humified ombrogenous peat at rising *Plantago* and *Pteridium* and declining *Ulmus* pollen curves.
- CAR-411. WFF/B46.5N 151 + 152cm** **4450 ± 80**
 $\delta^{13}C = -27.0\text{‰}$
Ombrogenous peat.
- CAR-412. WFF/B46.5N 167 + 168cm** **5140 ± 80**
Ombrogenous peat. *Comment:* $\delta^{13}C = -27.7\text{‰} \pm 1$ used in date calculation.
- CAR-413. WFF/B46.5N 183 + 184cm** **5670 ± 70**
Humified ombrogenous peat with much charcoal directly above peat/soil interface. *Comment:* $\delta^{13}C = -27.7\text{‰} \pm 1$ used in date calculation.
- CAR-629. WFF/F117S 48cm** **3720 ± 70**
 $\delta^{13}C = -27.9\text{‰}$
Ombrogenous peat with *Calluna* and *Eriophorum* fragments.
- CAR-630. WFF/F117S 65cm** **4440 ± 70**
 $\delta^{13}C = -28.0\text{‰}$
Ombrogenous peat.
- CAR-631. WFF/F117S 80cm** **5490 ± 80**
 $\delta^{13}C = -28.8\text{‰}$
Humified ombrogenous peat.
- CAR-632. WFF/F117S 83cm** **5780 ± 80**
 $\delta^{13}C = -28.9\text{‰}$
Black humified peat at rising *Alnus* and falling *Pinus* and *Calluna* pollen values.
- CAR-633. WFF/F117S 91cm** **6770 ± 90**
 $\delta^{13}C = -28.6\text{‰}$
Black humified peat with much mineral material directly above mineral soil interface.

CAR-624. WFF/EE17.5E 32 + 33cm **3520 ± 70**
 $\delta^{13}C = -28.3\text{‰}$

Ombrogenous peat with *Calluna* and *Eriophorum* fragments.

CAR-623. WFF/EE17.5E 51cm **4810 ± 80**
 $\delta^{13}C = -28.5\text{‰}$

Humified ombrogenous peat at decline of *Ulmus* pollen value.

CAR-622. WFF/EE17.5E 63cm **5660 ± 80**
 $\delta^{13}C = -28.8\text{‰}$

Humified ombrogenous peat.

CAR-621. WFF/EE17.5E 69cm **7020 ± 90**
 $\delta^{13}C = -28.4\text{‰}$

Black humified ombrogenous peat with mineral particles at declining *Pinus* pollen value.

General Comment (AGS): dates from basal levels of monoliths from basin margin show variations in initiation of growth of organic deposits of ca 2000 yr.

Cefn Gwernffrwd series

Peat samples are from 3 cores taken on plateau near stone circle and alignment at Cefn Gwernffrwd (Briggs, 1975; Morgan & Ruggles, 1976). Site, at alt of ca 400m, is 15km N of Llandovery, Dyfed (52° 08' N, 3° 50' W). Coll and subm 1975 by F M Chambers, Dept Plant Sci, Univ Coll, Cardiff. Core A was taken close to archaeol site (Natl Grid Ref SN 738494), Core B was taken ca 150m NW (Natl Grid Ref SN 735494), and Core C ca 500m SE (Natl Grid Ref SN 743492). Cores A and B were of blanket peat and Core C was of deeper basin peat. They were taken as part of study of peat initiation in upland S Wales (Chambers, 1980; 1982b; 1983c).

CAR-76. CG Core A 9.5–10cm **Modern**
 $\delta^{13}C = -31.2\text{‰}$

Peat at transition from high *Calluna* to high Gramineae and Cyperaceae pollen values.

CAR-75. CG Core A 23–24cm **730 ± 40**
 $\delta^{13}C = -28.2\text{‰}$

Peat at change from high Gramineae to high *Calluna* pollen values.

CAR-74. CG Core A 43–44cm **1900 ± 45**
 $\delta^{13}C = -28.3\text{‰}$

Peat at *Corylus* pollen min and increasing Gramineae pollen values.

CAR-73. CG Core A 49–50cm **2030 ± 45**
 $\delta^{13}C = -28.4\text{‰}$

Peat at decline in *Betula* and Gramineae and increase in *Corylus*, *Plantago*, and Cyperaceae pollen values.

CAR-39. CG Core A 58–59cm	2730 ± 70 $\delta^{13}C = -28.4\text{‰}$
Peat at final episode of high level of <i>Plantago</i> pollen.	
CAR-71. CG Core A 62–63cm	2860 ± 50 $\delta^{13}C = -28.7\text{‰}$
Peat at start of rise in level of <i>Plantago</i> pollen.	
CAR-19. CG Core A 68–69cm	3470 ± 70 $\delta^{13}C = -28.2\text{‰}$
Basal layer of peat with charcoal in horizon.	
CAR-44. CG Core B 26–27cm	380 ± 60 $\delta^{13}C = -28.5\text{‰}$
Peat at change from high to lower <i>Calluna</i> pollen value.	
CAR-43. CG Core B 51–52cm	2140 ± 70 $\delta^{13}C = -28.3\text{‰}$
Peat marking rise in <i>Calluna</i> and Cyperaceae pollen values.	
CAR-42. CG Core B 64–65cm	3720 ± 70 $\delta^{13}C = -28.5\text{‰}$
Peat at resurgence of <i>Plantago</i> pollen.	
CAR-7. CG Core B 72–73cm	3850 ± 80 $\delta^{13}C = -28.7\text{‰}$
Peat at decline in <i>Ulmus</i> pollen, close to first appearance of <i>Plantago</i> pollen at 75cm.	
CAR-41. CG Core B 89–90cm	4990 ± 80 $\delta^{13}C = -27.8\text{‰}$
Peat at start of sustained rise in <i>Alnus</i> pollen value.	
CAR-40. CG Core B 104–105cm	5490 ± 80 $\delta^{13}C = -28.1\text{‰}$
Basal layer of peat.	
CAR-93. CG Core C 114–118cm	2580 ± 60 $\delta^{13}C = -28.4\text{‰}$
Peat at peak in <i>Calluna</i> pollen value.	
CAR-20. CG Core C 170–174cm	3340 ± 80 $\delta^{13}C = -28.6\text{‰}$
Peat at decline in <i>Calluna</i> and increasing Gramineae pollen values.	
CAR-45. CG Core C 212–216cm	4930 ± 90 $\delta^{13}C = -27.9\text{‰}$
Peat at <i>Ulmus</i> pollen decline.	

CAR-94. CG Core C 236–240cm **5490 ± 80**
 $\delta^{13}C = -28.2\text{‰}$

Peat at peak in *Ulmus* pollen and declining *Corylus* pollen values.

CAR-95. CG Core C 258–262cm **5870 ± 80**
 $\delta^{13}C = -27.8\text{‰}$

Peat with abundant *Sphagnum* spores and marking increase in *Calluna* pollen value.

CAR-96. CG Core C 304–308cm **6820 ± 90**
 $\delta^{13}C = -28.4\text{‰}$

Peat at start of rise in *Alnus* pollen value.

CAR-97. CG Core C 412–420cm **9430 ± 110**
 $\delta^{13}C = -28.2\text{‰}$

Coarse reedswamp peat.

CAR-98. CG Core C 446–452cm **9070 ± 120**
 $\delta^{13}C = -26.6\text{‰}$

Coarse reedswamp peat at start of rise in *Corylus* pollen.

CAR-99. CG Core C 478–482cm **9670 ± 120**
 $\delta^{13}C = -28.3\text{‰}$

Fine detritus mud overlying clayey mud at 484cm.

Cefn Fford series

Peat samples are from core taken by F M Chambers, from shallow blanket peat at alt 600m. Sampling point lies 95m W of triangulation point at Cefn Fford, 23km N of Bridgend, Mid Glamorgan (51° 43' N, 3° 35' W, Natl Grid Ref SN 906032). Coll and subm 1974 by FMC. *Comment* (FMC): site overlies Pennant sandstone. Samples taken in conjunction with investigations of blanket peat initiation in S Wales (Chambers, 1981; 1982a). All samples are fine fractions of peat pretreated by FMC. Depths refer to modern surface.

CAR-47. CFF 4–5cm **2970 ± 50**
 $\delta^{13}C = -27.1\text{‰}$

Peat at rise in Gramineae pollen concentration. *Comment*: much older than expected, probably due to presence of dead carbon deposited as soot during industrial revolution (Chambers, Dresser, & Smith, 1979).

CAR-106. CFF 8–10cm **930 ± 50**
 $\delta^{13}C = -28.2\text{‰}$

CAR-46. CFF 14–15cm **1410 ± 60**
 $\delta^{13}C = -27.7\text{‰}$

CAR-107. CFF 16–18cm **1660 ± 60**
 $\delta^{13}C = -28.5\text{‰}$

CAR-8. CFF 22–24cm**3160 ± 60** $\delta^{13}C = -27.9\text{‰}$

Peat with high value of Ericaceae pollen.

CAR-9. CFF 24–26cm**3630 ± 80** $\delta^{13}C = -28.2\text{‰}$

Peat from mineral/peat interface.

Coed Taf series

Peat samples are from 3 cores taken within 200m of each other from plateau overlying gray grits and S of area of carboniferous limestone 7km NW of Merthyr Tydfil, Mid Glamorgan (51° 47' N, 3° 28' W). Coll and subm 1975 by F M Chambers. *Comment* (FMC): Core A comprised amorphous blanket peat at alt 400m (Natl Grid Ref SN 988108). Core B was of amorphous blanket peat twice depth of Core A, 51m to E (Natl Grid Ref SN 989108), at alt 400m. Core C was taken from deepest part of basin peat area ca 200m S of blanket peat sites at alt 380m (Natl Grid Ref SN 988107). Samples taken as part of study of blanket peat initiation in S Wales uplands; Core C was coll for inf on pre-blanket peat vegetation at site (Chambers, 1980; 1983b).

CAR-82. CT Core A 6–8cm**3710 ± 90** $\delta^{13}C = -26.5\text{‰}$

Peat antedating substantial rise in Gramineae pollen representation. *Comment*: much older than expected, probably due to presence of inactive carbon in soot deposited in industrial revolution, as in CAR-47. Humic acid fraction also dated; CAR-82C, 70 ± 55 . Result indicates inactive carbon deposition rate of order of $4\text{g/m}^2/\text{yr}$ over estimated 32yr accumulation period of sample (Chambers, Dresser, & Smith, 1979).

CAR-81. CT Core A 11–13cm**140 ± 50** $\delta^{13}C = -27.9\text{‰}$ Peat at final decline of *Corylus* pollen.**CAR-80. CT Core A 14–16cm****470 ± 70** $\delta^{13}C = -28.3\text{‰}$ Peat at change from Gramineae to *Calluna* pollen types.**CAR-79. CT Core A 20–22cm****350 ± 70** $\delta^{13}C = -28.0\text{‰}$

Peat containing abundant Campanulaceae, Cyperaceae, and *Potentilla* pollen.

CAR-78. CT Core A 27–28cm**1200 ± 50** $\delta^{13}C = -28.6\text{‰}$ Well-humified peat at start of decline in *Calluna* pollen.

- CAR-77. CT Core A 28–30cm** **1440 ± 60**
 $\delta^{13}C = -28.6\text{‰}$
Peat from mineral/peat transition containing abundant *Calluna* pollen.
- CAR-50. CT Core B 68–70cm** **1540 ± 60**
 $\delta^{13}C = -28.2\text{‰}$
Humic acid fraction of peat at point where Cyperaceae pollen is at peak.
- CAR-48. CT Core B 70–72cm** **1310 ± 70**
 $\delta^{13}C = -28.0\text{‰}$
Peat at mineral/peat interface. *Comment:* humic acid fraction also dated; CAR-48C, 1630 ± 60 .
- CAR-92. CT Core C 140–146cm** **2990 ± 50**
 $\delta^{13}C = -27.6\text{‰}$
Calluna Eriophorum peat at min in arboreal pollen.
- CAR-91. CT Core C 290–294cm** **4620 ± 70**
 $\delta^{13}C = -28.1\text{‰}$
Sphagnum Cyperaceae peat at decline in *Ulmus* pollen.
- CAR-90. CT Core C 326–330cm** **6120 ± 80**
 $\delta^{13}C = -28.7\text{‰}$
Fen peat with wood fragments at decline in *Corylus* pollen.
- CAR-89. CT Core C 342–346cm** **6650 ± 90**
 $\delta^{13}C = -28.4\text{‰}$
Peat at rise in *Alnus* and decline in *Pinus* pollen. Boreal-Atlantic transition *sensu* Mitchell (1956).
- CAR-88. CT Core C 350–353cm** **6890 ± 110**
 $\delta^{13}C = -29.5\text{‰}$
Basal layer of reed peat directly above mineral.

Brecon Beacons series

Peat samples are from monolith taken above and S of N facing Old Red Sandstone scarp, 3km SE of peak of Pen-y-Fan Mt, Powys (51° 52' N, 3° 23' W, Natl Grid Ref SO 043196) at alt 715m. Coll and subm 1975 by F M Chambers. *Comment* (FMC): site is at highest elev in study of blanket peat initiation in S Wales uplands (Chambers, 1980; 1981; 1982a).

- CAR-59. 19–21cm** **470 ± 70**
 $\delta^{13}C = -27.5\text{‰}$
Fibrous blanket peat at rise in *Calluna* and start of rise in *Empetrum* pollen.

CAR-58. 38–40cm **1860 ± 80**
 $\delta^{13}C = -28.2\text{‰}$

Fibrous blanket peat at fall in Cyperaceae and rise in *Calluna* pollen.

CAR-57. 49–51cm **2070 ± 70**
 $\delta^{13}C = -27.6\text{‰}$

Peat at peak in Cyperaceae pollen.

CAR-56. 63–65cm **2340 ± 70**
 $\delta^{13}C = -27.6\text{‰}$

Blanket peat.

CAR-55. 67–71cm **2870 ± 80**
 $\delta^{13}C = -27.9\text{‰}$

Blanket peat.

CAR-54. 75–77cm **2880 ± 80**
 $\delta^{13}C = -28.2\text{‰}$

Peat at fall in *Calluna* and rise in Gramineae, Cyperaceae, and start of rise in *Fraxinus* pollen.

CAR-53. 81–83cm **3430 ± 70**
 $\delta^{13}C = -28.0\text{‰}$

Peat postdating fall in *Corylus* and rise in *Calluna* pollen.

CAR-52. 95–97cm **4090 ± 70**
 $\delta^{13}C = -28.6\text{‰}$

Blanket peat at fall in *Calluna* and rise in Cyperaceae pollen.

CAR-51. 100–102cm **4380 ± 70**
 $\delta^{13}C = -28.7\text{‰}$

Basal blanket peat at mineral peat transition, marking drop in *Corylus* pollen.

Llangorse Lake series

Samples of organic nekron mud sub-sampled from core taken using pneumatic Mackereth corer from center of Llangorse Lake, Powys (51° 55' N, 3° 16' W, Natl Grid Ref SO 135265). Coll and subm 1975 by R Jones, Dept Plant Sci, Univ Coll, Cardiff. Samples taken in conjunction with studies in diatom, pollen, and chemical content of core. Previous cores taken in E basin of lake (Jones *et al*, 1978). *Comment*: acid wash pretreatment.

CAR-87. 280–290cm **610 ± 70**
 $\delta^{13}C = -30.5\text{‰}$

Organic nekron mud from directly below transition to red-brown silty clay.

CAR-86. 300–310cm**2170 ± 70**
 $\delta^{13}\text{C} = -29.4\text{‰}$

Organic nekron mud.

General Comment: CAR-86 agrees with results obtained previously (SSR-129 to -132: R, 1974, v 16, p 247–248). CAR-87 is far too young.*England***Foulshaw Moss series**

Peat samples are from Foulshaw Moss, 10km SW of Kendal, Cumbria (54° 15' N, 2° 50' W, Natl Grid Ref SD 458837). Samples coll directly from exposed peat face and as sub-samples from 2 monoliths of peat which were taken from peat face for strat and palynol study. Coll 1981 by G T Wimble and A G Smith, Dept Plant Sci, Univ Coll, Cardiff, and subm 1981 by GTW. Monolith FM1/A was taken at depth 50cm below present bog surface. Monolith FM1/B was taken at depth 25cm. Depths for all samples are relative to present bog surface.

CAR-545. FM1/A 63–64cm**1450 ± 70**
 $\delta^{13}\text{C} = -27.5\text{‰}$ Unhumified *Sphagnum* peat dating end of *Betula* pollen peak.**CAR-546. FM1/A 73–74cm****1680 ± 60**
 $\delta^{13}\text{C} = -26.9\text{‰}$ Moderately humified *Sphagnum* peat dating top of retardation layer.**CAR-547. FM1/A 79–80cm****1690 ± 60**
 $\delta^{13}\text{C} = -27.5\text{‰}$ Moderately humified *Sphagnum* peat dating max clearance of forest as indicated by high NAP (non-arboreal pollen) values.**CAR-548. FM1/A 89–90cm****2020 ± 60**
 $\delta^{13}\text{C} = -27.4\text{‰}$ Well humified *Sphagnum* peat dating start of cereal pollen curve in clearance episode.**CAR-549. FM1/A 93–94cm****2090 ± 70**
 $\delta^{13}\text{C} = -27.0\text{‰}$ Well humified *Sphagnum* peat dating start of clearance episode.**CAR-550. FM1/A 104–105cm****2280 ± 70**
 $\delta^{13}\text{C} = -27.2\text{‰}$ Slightly humified *Sphagnum* peat dating lower boundary of retardation layer.

- CAR-551. FM1/A 110–111cm** **2520 ± 80**
 $\delta^{13}C = -27.9\text{‰}$
Unhumified *Sphagnum* peat dating start of *Sphagnum imbricatum* infill of pool.
- CAR-552. FM1/A 117–118cm** **3060 ± 70**
 $\delta^{13}C = -28.4\text{‰}$
Sphagnum cuspidatum peat dating base of recurrence surface pool peat.
- CAR-553. FM1/A 118–119cm** **3140 ± 70**
 $\delta^{13}C = -28.4\text{‰}$
Well humified *Sphagnum* peat dating top of retardation layer and start of small clearance episode.
- CAR-554. FM1/A 137–138cm** **3690 ± 70**
 $\delta^{13}C = -27.2\text{‰}$
Well humified *Sphagnum* peat dating fall in *Ulmus* pollen percentages and rise in NAP percentages.
- CAR-536. FM1/B 42–43cm** **1820 ± 70**
 $\delta^{13}C = -27.1\text{‰}$
Slightly humified *Sphagnum* peat with some *Eriophorum vaginatum* dating end of clearance episode.
- CAR-537. FM1/B 48–49cm** **1840 ± 70**
 $\delta^{13}C = -26.9\text{‰}$
Well humified *Sphagnum* peat dating max clearance of forest as indicated by high NAP percentages.
- CAR-538. FM1/B 54–55cm** **2200 ± 70**
 $\delta^{13}C = -27.3\text{‰}$
Well humified *Sphagnum* peat dating start of cereal pollen curve in clearance episode.
- CAR-539. FM1/B 62–63cm** **2420 ± 70**
 $\delta^{13}C = -27.2\text{‰}$
Well humified *Sphagnum* peat dating start of gradual clearance of forest.
- CAR-540. FM1/B 80–81cm** **2740 ± 70**
 $\delta^{13}C = -26.1\text{‰}$
Well humified *Sphagnum* peat with some *Calluna* dating end of pollen phase.
- CAR-541. FM1/B 89–90cm** **2920 ± 70**
 $\delta^{13}C = -26.5\text{‰}$
Moderately humified *Sphagnum* peat dating end of clearance episode.

CAR-542. FM1/B 95–96cm **3110 ± 70**
 $\delta^{13}\text{C} = -27.4\text{‰}$

Moderately humified *Sphagnum* peat dating start of clearance episode.

CAR-543. FM1/B 125–126cm **3590 ± 70**
 $\delta^{13}\text{C} = -26.5\text{‰}$

Well humified *Sphagnum* peat dating fall in *Ulmus* pollen percentages and rise in NAP percentages.

CAR-544. FM1/B 143–144cm **3870 ± 70**
 $\delta^{13}\text{C} = -26.7\text{‰}$

Well humified *Sphagnum* peat dating small clearance episode and fall in *Ulmus* pollen percentages.

CAR-577. FM2 70cm **1320 ± 60**
 $\delta^{13}\text{C} = -25.9\text{‰}$

Eriophorum vaginatum tussock dating top of retardation layer.

CAR-578. FM3 50cm **1370 ± 70**
 $\delta^{13}\text{C} = -27.7\text{‰}$

Eriophorum vaginatum and some *Calluna* dating top of retardation layer.

CAR-579. FM4 35cm **1500 ± 60**
 $\delta^{13}\text{C} = -26.8\text{‰}$

Well humified *Sphagnum* peat dating top of retardation layer.

CAR-580. FM5 35cm **1470 ± 60**
 $\delta^{13}\text{C} = -27.2\text{‰}$

Well humified *Calluna* and *Sphagnum* peat dating top of retardation layer.

CAR-581. FM6 75cm **2160 ± 70**
 $\delta^{13}\text{C} = -31.0\text{‰}$

Sphagnum cuspidatum mud dating small lens of pool peat.

CAR-582. FM8 115cm **3200 ± 70**
 $\delta^{13}\text{C} = -27.0\text{‰}$

Eriophorum vaginatum tussock dating top of retardation layer.

CAR-583. FM9 120cm **3200 ± 70**
 $\delta^{13}\text{C} = -28.0\text{‰}$

Well humified *Sphagnum* peat dating top of retardation layer.

CAR-584. FM10 105cm **3180 ± 70**
 $\delta^{13}\text{C} = -26.9\text{‰}$

Eriophorum vaginatum peat dating top of retardation layer.

CAR-585. FM11 95cm **3230 ± 70**
 $\delta^{13}C = -27.8\text{‰}$
Calluna and *Sphagnum* peat dating top of retardation layer.

CAR-586. FM12 85cm **2840 ± 70**
 $\delta^{13}C = -27.2\text{‰}$
Calluna and *Sphagnum* peat dating top of retardation layer.

CAR-587. FM13 105cm **3200 ± 70**
 $\delta^{13}C = -27.8\text{‰}$
Calluna and *Sphagnum* peat dating top of retardation layer.

CAR-590. FM22 115cm **3160 ± 70**
 $\delta^{13}C = -26.8\text{‰}$
 Well humified *Sphagnum* and *Eriophorum* peat dating top of retardation layer.

Helsington Moss series

Peat samples are from cutting on Helsington Moss, 5km SW of Kendal, Cumbria (54° 17' N, 2° 49' W, Natl Grid Ref SD 466889). Coll 1982 by G T Wimble and L A Morgan, Dept Plant Sci, Univ Coll, Cardiff, and subm by GTW. Samples were taken from 4 monoliths of peat and 5 discrete samples which were coll at intervals along exposed peat face for strat and palynol studies. Monolith HM1 was taken at depth 115cm, HM2 at 110cm, HM3 at 110cm, and HM4 at 40cm. All depths are relative to present mire surface.

CAR-594. HM1 116–118cm **2770 ± 70**
 $\delta^{13}C = -26.9\text{‰}$
 Unhumified *Sphagnum* peat dating base of recurrence surface.

CAR-595. HM1 118–119cm **2790 ± 70**
 $\delta^{13}C = -27.2\text{‰}$
 Well humified *Sphagnum* peat dating top of retardation layer.

CAR-596. HM1 127–128cm **3230 ± 70**
 $\delta^{13}C = -26.8\text{‰}$
 Well humified *Sphagnum* peat dating base of retardation layer and max forest clearance as indicated by high NAP values.

CAR-597. HM1 135–136cm **3320 ± 70**
 $\delta^{13}C = -27.9\text{‰}$
 Well humified *Sphagnum* peat dating top of retardation layer.

CAR-598. HM2 114–116cm **2810 ± 70**
 $\delta^{13}C = -26.5\text{‰}$
 Unhumified *Sphagnum* peat dating base of recurrence surface.

CAR-599. HM2 116–117cm **2930 ± 70**
 $\delta^{13}C = -26.8\text{‰}$

Fairly humified *Sphagnum* peat dating top of retardation layer.

CAR-602. HM2 122–124cm **2990 ± 70**
 $\delta^{13}C = -27.1\text{‰}$

Fairly humified *Sphagnum* peat dating base of retardation layer and max forest clearance as indicated by high NAP values.

CAR-603. HM2 137–139cm **3200 ± 70**
 $\delta^{13}C = -27.1\text{‰}$

Slightly humified *Sphagnum* peat dating slight increase in peat humification and start of clearance episode.

CAR-604. HM2 154–155cm **3660 ± 70**
 $\delta^{13}C = -27.3\text{‰}$

Well humified *Sphagnum* peat dating top of retardation layer.

CAR-605. HM3 133cm **3390 ± 70**
 $\delta^{13}C = -26.1\text{‰}$

Top of *Eriophorum vaginatum* tussock dating top of retardation layer.

CAR-609. HM4 46–47cm **1860 ± 60**
 $\delta^{13}C = -26.7\text{‰}$

Well humified *Sphagnum* peat dating top of retardation layer.

CAR-610. HM4 50–51cm **1970 ± 70**
 $\delta^{13}C = -26.1\text{‰}$

Well humified *Sphagnum* peat dating base of retardation layer.

CAR-611. HM4 56–57cm **2190 ± 70**
 $\delta^{13}C = -26.1\text{‰}$

Unhumified *Sphagnum* peat dating base of recurrence surface and start of clearance episode.

CAR-612. HM4 57–58cm **2240 ± 70**
 $\delta^{13}C = -27.3\text{‰}$

Well humified *Sphagnum* peat dating top of retardation layer and start of clearance episode.

CAR-613. HM4 66–67cm **2480 ± 70**
 $\delta^{13}C = -26.5\text{‰}$

Well humified *Sphagnum* and *Eriophorum* peat dating base of retardation layer.

CAR-614. HM4 72–73cm **2470 ± 70**
 $\delta^{13}C = -27.2\text{‰}$

Well humified *Sphagnum* peat dating humified layer.

CAR-615. HM4 81–82cm **2600 ± 70**
 $\delta^{13}C = -27.1\text{‰}$

Well humified *Sphagnum* peat dating top of humified layer.

CAR-606. HM11 155cm **3620 ± 70**
 $\delta^{13}C = -27.4\text{‰}$

Well humified *Sphagnum* peat dating top of retardation layer.

CAR-607. HM12 125cm **2890 ± 70**
 $\delta^{13}C = -27.2\text{‰}$

Sphagnum peat dating top of retardation layer.

CAR-608. HM13 130cm **3230 ± 70**
 $\delta^{13}C = -27.0\text{‰}$

Well humified *Sphagnum* and *Eriophorum* peat dating retardation layer.

CAR-616. HM27 95cm **2880 ± 70**
 $\delta^{13}C = -26.2\text{‰}$

Top of *Eriophorum* tussock below monolith HM4 dating top of retardation layer.

CAR-617. HM28 70cm **2150 ± 70**
 $\delta^{13}C = -26.6\text{‰}$

Well humified *Sphagnum* peat dating retardation layer.

CAR-683. HM1 40–43cm **3670 ± 70**
 $\delta^{13}C = -27.4\text{‰}$

Well humified *Sphagnum* peat with some *Eriophorum* and *Calluna* dating end of *Betula* pollen peak.

CAR-684. HM3 51–52cm **3550 ± 70**
 $\delta^{13}C = -27.3\text{‰}$

Well humified *Sphagnum* peat with some *Eriophorum* dating end of *Betula* pollen peak.

CAR-685. HM3 16–18cm **2750 ± 70**
 $\delta^{13}C = -26.1\text{‰}$

Unhumified *Sphagnum* peat dating end of clearance episode.

White Moss series

Peat samples are from two exposed peat faces at White Moss, 15km N of Barrow-in-Furness, Cumbria (54° 15' N, 3° 13' W). Samples were coll from peat faces and as sub-samples from series of monoliths from sites as part of strat and palynol study. Coll 1981 by G T Wimble and E W Cloutman, and subm 1983 by GTW. *Comment* (GTW): at 1st site, WMN (Natl Grid Ref SD 216855), Monolith WMN1 was taken at surface. Monolith WMN3 was taken 1.5m to N of WMN1 and 20cm lower (40cm from surface). Mo-

nolith WMN2 was taken 2m to N of WMN3 and at same depth as WMN1. Monolith WMS1 was taken at 2nd site 1km SW of 1st (Natl Grid Ref SD 221848) at depth 10cm below present bog surface.

CAR-701. WMN1 15–17cm **730 ± 60**
 $\delta^{13}C = -25.8\text{‰}$

Moderately unhumified *Sphagnum* peat taken in lowest few cm of recurrence peat.

CAR-704. WMN1 41–42cm **1770 ± 60**
 $\delta^{13}C = -26.9\text{‰}$

Moderately unhumified *Sphagnum* peat dating recurrence surface and end of clearance episode.

CAR-700. WMN1 49–50cm **1860 ± 60**
 $\delta^{13}C = -27.0\text{‰}$

Moderately unhumified *Sphagnum* peat dating change from more to less humified peat, and max clearance of forest as indicated by high NAP values.

CAR-726. WMN1 55–56cm **2130 ± 70**
 $\delta^{13}C = -26.4\text{‰}$

Muddy *Sphagnum* peat dating top of rather humified *Sphagnum/Calluna* hummock.

CAR-727. WMN1 67–68cm **2320 ± 70**
 $\delta^{13}C = -27.8\text{‰}$

Unhumified *Sphagnum* peat dating approx start of clearance episode.

CAR-728. WMN1 97–98cm **3000 ± 70**
 $\delta^{13}C = -27.5\text{‰}$

Slightly humified peat dating base of possible retardation layer and end of clearance episode.

CAR-699. WMN2 16–17cm **840 ± 60**
 $\delta^{13}C = -26.7\text{‰}$

Moderately humified *Sphagnum* peat dating top of retardation layer and beginning of clearance episode.

CAR-703. WMN2 36–38cm **1630 ± 60**
 $\delta^{13}C = -26.4\text{‰}$

Moderately humified *Sphagnum* peat dating top of retardation layer and max forest regeneration between two clearance episodes.

CAR-695. WMN2 51–52cm **2070 ± 60**
 $\delta^{13}C = -26.8\text{‰}$

Humified *Sphagnum* peat dating top of retardation layer and max clearance of forest as indicated by high NAP values.

- CAR-696. WMN2 73–74cm** 2690 ± 70
 $\delta^{13}C = -26.4\text{‰}$
 Moderately unhumified *Sphagnum* peat dating possible recurrence peat.
- CAR-697. WMN2 93–94cm** 2940 ± 70
 $\delta^{13}C = -25.8\text{‰}$
 Moderately unhumified *Sphagnum* peat taken near end of clearance episode.
- CAR-698. WMN2 103–104cm** 3240 ± 70
 $\delta^{13}C = -26.7\text{‰}$
 Moderately humified *Sphagnum* peat dating start of clearance episode.
- CAR-731. WMN3 24–25cm** 1850 ± 70
 $\delta^{13}C = -27.8\text{‰}$
 Unhumified *Sphagnum* peat dating base of retardation layer.
- CAR-729. Sample B** 1470 ± 60
 $\delta^{13}C = -26.7\text{‰}$
 Fairly humified *Sphagnum* peat from 40cm N of Monolith WMN3 at depth 50cm dating top of retardation layer.
- CAR-730. Sample D** 2210 ± 70
 $\delta^{13}C = -25.7\text{‰}$
 Muddy *Sphagnum* peat from 40cm N of Monolith WMN3 at depth 80cm dating possible base of retardation layer.
- CAR-680. WMS1 18–19cm** 390 ± 60
 $\delta^{13}C = -25.9\text{‰}$
 Moderately unhumified *Sphagnum* peat dating possible recurrence surface.
- CAR-693. WMS1 28–29cm** 940 ± 60
 $\delta^{13}C = -25.9\text{‰}$
 Unhumified *Sphagnum* peat dating start of clearance episode.
- CAR-694. WMS1 39–40cm** 1160 ± 60
 $\delta^{13}C = -26.4\text{‰}$
 Moderately humified *Sphagnum* peat dating max forest clearance as indicated by high NAP values.
- CAR-702. WMS1 50–51cm** 1570 ± 60
 $\delta^{13}C = -27.5\text{‰}$
 Moderately humified *Sphagnum* peat dating probable recurrence surface and start of clearance episode.

CAR-681. WMS1 67–68cm **2010 ± 60**
 $\delta^{13}C = -26.8\text{‰}$

Muddy peat with *Menyanthes* rhizomes dating recurrence peat and max clearance of forest as indicated by high NAP values.

CAR-682. WMS1 80–81cm **2490 ± 70**
 $\delta^{13}C = -26.7\text{‰}$

Muddy peat with charcoal fragments dating start of clearance episode.

Greece

Sigitikos series

Samples are sediments from sapropelic horizons within hemipelagic sediments in Sigitikos Gulf, N Greece. Samples are sub-samples of cores taken in sea depths from 315 to 992m. Coll 1978 by C Perissoratis, Inst Geol and Mineral Exploration, Athens, during marine geol research cruise. Subm 1980 by M Brooks, Dept Geol, Univ Coll, Cardiff. *Comment:* acid wash pretreatment.

CAR-368. AG1 58–111 **8210 ± 90**
 $\delta^{13}C = -24.4\text{‰}$

Sapropelic layer at 58 to 111cm from Core AG1, length 175cm, taken 7km W of Ammuliani Is. (40° 15' 00" N, 23° 50' 27" E) at water depth 315m.

CAR-369. AG3 113–153 **8590 ± 100**
 $\delta^{13}C = -24.4\text{‰}$

Sapropelic layer at 113 to 153cm from Core AG3, length 184cm, taken 4.5km W of peninsula of Sithonia (40° 11' 50" N, 23° 53' 10" E) near basin of ca 400m depth. Core taken at water depth 372m.

CAR-370. AG8 95–139 **8600 ± 110**
 $\delta^{13}C = -24.2\text{‰}$

Sapropelic layer at 95 to 139cm from Core AG8, length 180cm, taken in middle of mouth of Gulf of Sigitikos (40° 05' 15" N, 24° 09' 11" E) at water depth 396m.

CAR-371. NA25 120–165 **10,140 ± 110**
 $\delta^{13}C = -24.6\text{‰}$

Sapropelic layer at 120 to 165cm from Core NA25, length 176cm, taken 10km SE of Athos peninsula (40° 05' 55" N, 24° 29' 30" E) at water depth 992m.

ARCHAEOLOGIC SAMPLES

Wales

Magor series

Samples are from coffin buried 2m under present surface, within and sealed by estuarine silt and deposited under conditions of complete inundation, excavated 1978 by G Dowdell (1978), GGAT, at Magor, 13km ESE of Newport, Gwent (51° 34' N, 2° 49' W, Natl Grid Ref ST 436850). Coll 1978 by GD and subm by GGAT. Site 1km from present HWM in Caldicot levels and close to site of Roman finds (Boon, 1976).

CAR-198. Magor 1

$$1660 \pm 60$$

$$\delta^{13}C = -20.1\text{‰}$$

Collagen from human bone from within coffin id by T P O'Connor, Dept Archaeol, Univ Coll, Cardiff.

CAR-199. Magor 2

$$1570 \pm 70$$

$$\delta^{13}C = -24.8\text{‰}$$

Wood from coffin.

Llandough series

Samples are human bone from burials on site of Roman villa excavated 1979 by H S Owen-John for GGAT at Llandough, 5km SW of Cardiff, S Glamorgan (51° 27' N, 3° 12' W, Natl Grid Ref ST 168731). Site comprised Roman villa with some Iron age antecedents and with Medieval and later occupations. Samples taken to establish period of burials. Coll 1979 by A D Russel and subm by GGAT.

CAR-271. Sample 25/052

$$890 \pm 60$$

$$\delta^{13}C = -20.9\text{‰}$$

Collagen from human bone from grave dug through W wall of Room M of Roman bldg and demolition rubble.

CAR-305. Sample 25/122

$$1160 \pm 70$$

$$\delta^{13}C = -20.9\text{‰}$$

Collagen from human bone from one of series of graves dug into natural subsoil within area of Medieval village to NW of Roman bldg.

CAR-306. Sample 25/145

$$1180 \pm 60$$

$$\delta^{13}C = -20.9\text{‰}$$

Collagen from human bone from one of series of graves dug into natural subsoil within area of Medieval village to NW of Roman bldg.

Biglis series

Bone samples are from late Iron age to Romano British farmstead excavated 1978 to 1979 by J Parkhouse, GGAT, at Biglis, 1km E of Barry, S Glamorgan (51° 25' N, 3° 14' W, Natl Grid Ref ST 142694). Coll 1978 and

1979 by JP and subm by GGAT. Three construction phases were id. Unenclosed settlement was followed by double enclosure with double palisade. Third phase comprised replacement of palisade by bank. Human burials from 3rd phase were cut through bank.

CAR-269. Sample 21/270 **1830 ± 70**
 $\delta^{13}C = -20.6\text{‰}$

Collagen from human bone from grave, partially lined with stone slabs, cut through inner palisade trench surrounding site. Dates time of palisade disuse.

CAR-270. 21/387 **1520 ± 70**
 $\delta^{13}C = -21.0\text{‰}$

Collagen from human bone from slab-lined grave constructed within corn drying kiln. Grave postdates construction of stone boundary bank and possibly postdates bank disuse.

CAR-307. Sample 21/537 **1980 ± 70**
 $\delta^{13}C = -22.2\text{‰}$

Collagen from animal bone from rubbish pit used in 2nd phase of settlement and underlying bank of 3rd phase.

CAR-308. Sample 21/544 **1870 ± 70**
 $\delta^{13}C = -21.5\text{‰}$

Collagen from animal bone from rubbish pit used in 2nd phase of settlement and underlying bank of 3rd phase.

Coed-y-Cymdda series

Samples are from hill slope enclosure excavated 1978 and 1979 by H S Owen-John for GGAT, at Coed-y-Cymdda, 6.5km SW of Cardiff, S Glamorgan (51° 27' N, 3° 15' W, Natl Grid Ref ST 133740). Coll 1978 and 1979 by D Russel, GGAT, and subm by GGAT.

CAR-205. Object 053/1047 **2600 ± 70**
 $\delta^{13}C = -22.6\text{‰}$

Collagen from antler from lower fill of S ditch terminal of E entrance to enclosure, dating silting of enclosure ditch.

CAR-206. Object 053/1046 **2250 ± 70**
 $\delta^{13}C = -21.1\text{‰}$

Collagen from human bones from lower fill of S ditch terminal at E entrance of enclosure, dating silting of enclosure ditch.

CAR-207. Object 054/1044 **2680 ± 70**
 $\delta^{13}C = -21.7\text{‰}$

Collagen from antler and bone from lower fill of N ditch terminal of E entrance of enclosure, dating silting of ditch.

CAR-304. Object 079/1118**3110 ± 70**
 $\delta^{13}C = -26.3\text{‰}$

Charcoal from occupation horizon stratified beneath main enclosure bank of site, antedating bank construction.

General Comment (HSOJ): site was first cleared in late Neolithic period and was occupied in late Bronze age as attested by pottery fragments and CAR-304. CAR-205 and -207 are earlier than expected from pottery remains from same context; date for CAR-206 is more consistent.

Ardudwy series

Charcoal samples are from two circular enclosure sites excavated 1980 to 1981 by R Kelly, GAT, in Ardudwy. Moel-y-Gerddi lies 3.5km ENE of Harlech, Gwynedd (52° 52' N, 4° 03' W, Natl Grid Ref SH 617317) and embraced 2 phases of construction probably belonging to single period of occupancy. First phase was characterized by slot ca 30m across supporting wooden palisade which surrounded central house. Second phase followed same construction lines but in stone. Remnant magnetic date for last firing of hearth stone in second phase estimated date at 100–200 BC. Other site ca 1km NW at Erw-wen was very similar. Coll 1980 and 1981 by RK and subm by GAT. Peat core samples were also taken (see Geologic Samples, above).

CAR-397. Moel-y-Gerddi 80 SO28**4590 ± 80**
 $\delta^{13}C = -27.5\text{‰}$

Charcoal from fill of hearth pit sealed by and antedating 2nd phase stone wall.

CAR-398. Moel-y-Gerddi 80 SO34**2350 ± 70**
 $\delta^{13}C = -26.1\text{‰}$

Charcoal from fill of pit surrounding central hearth in 2nd phase house dating end of house use. Hearth stone dated magnetically.

CAR-525. Moel-y-Gerddi 80 SO13/15/23**4760 ± 70**
 $\delta^{13}C = -25.9\text{‰}$

Charcoal from primary fill of 1st phase palisade slot, possibly representing remains of timber used in palisade construction.

CAR-526. Moel-y-Gerddi 80 SO16(i) + SO16/21**2250 ± 110**
 $\delta^{13}C = -23.7\text{‰}$

Charcoal from fill of post hole sealed by stone wall dating 1st phase and antedating 2nd.

CAR-527. Moel-y-Gerddi 80 SO28(ii)**4540 ± 70**
 $\delta^{13}C = -25.9\text{‰}$

Charcoal from fill of hearth pit sealed by 2nd phase stone wall. Duplicates CAR-397.

CAR-528. Moel-y-Gerddi 80 SO33 **4030 ± 80**
 $\delta^{13}C = -25.9\text{‰}$

Charcoal from fill of hearth sealed by 2nd phase stone house floor.
Hearth stone dated magnetically to beyond present range for this method.

CAR-529. Moel-y-Gerddi 80 SO34(ii) **2290 ± 70**
 $\delta^{13}C = -26.0\text{‰}$

Charcoal from pit adjacent to central hearth stone in 2nd phase stone house. Duplicates CAR-398.

CAR-530. Erw-wen 81 SO01 **2410 ± 60**
 $\delta^{13}C = -25.8\text{‰}$

Charcoal from occupation surface colluvially formed against inside face of main enclosure wall, and sealed by further colluvium. Should provide latest date for occupation of site.

CAR-531. Erw-wen 81 SO04 **2660 ± 60**
 $\delta^{13}C = -26.1\text{‰}$

Charcoal from shallow deposit comprising remains of hearth pit dug into floor of stone phase house and sealed by later surface laid after abandonment of house.

CAR-532. Erw-wen 81 SO09 **2470 ± 70**
 $\delta^{13}C = -26.0\text{‰}$

Charcoal from fill of 1st phase timber house wall slot. Slot had been deliberately filled in and whole site levelled prior to bldg of 2nd phase stone house.

Cyfannedd series

Charcoal samples from hut circle site excavated 1978 by P Crew, Snowdonia Natl Park Study Centre, Gwynedd, at Cyfannedd, 11km WSW of Dolgellau, Gwynedd (52° 41' N, 4° 01' W, Natl Grid Ref SH 633117). Site, on N facing shelf at alt 370m on slope of Cader Idris, consists of single hut circle with 3 phases of activity. Coll 1978 by PC and subm by GAT.

CAR-418. Cyfannedd Sample 1 **2010 ± 70**
 $\delta^{13}C = -27.4\text{‰}$

Charcoal from concentration within matrix of burned clay and stone sealed by Phase 3 cairn material.

CAR-419. Cyfannedd Sample 2 **1970 ± 70**
 $\delta^{13}C = -27.2\text{‰}$

Charcoal from upper part of hearth of Phase 1 hut circle, partly sealed by clay floor of Phase 2 hut circle.

CAR-420. Cyfannedd Sample 3 **1740 ± 70**
 $\delta^{13}C = -27.2\text{‰}$

Charcoal from hearth of Phase 1 hut circle, partly sealed by clay floor of Phase 2 hut circle.

Gwernvale series

Charcoal samples from Neolithic chambered tomb on kame terrace on N side of Usk Valley, excavated 1977 to 1978 by W J Britnell (1979; 1980), CPAT, at Gwernvale, 0.5km W of Crickhowell, Powys (51° 52' N, 3° 09' W, Natl Grid Ref SO 211192). Coll 1977, 1978 by WJB and subm by CPAT.

CAR-113. Pit F68 **5050 ± 80**
 $\delta^{13}C = -26.0\text{‰}$

Charcoal from upper layer of pit beneath cairn in dark ashy soil, assoc with early Neolithic pottery. Dates pre-cairn activity.

CAR-114. Pit F58 **4390 ± 70**
 $\delta^{13}C = -26.2\text{‰}$

Charcoal from various depths in pit outside Chamber 2, assoc with late Neolithic pottery. Antedates closure of cairn.

CAR-116. Pit F47 **4590 ± 80**
 $\delta^{13}C = -25.8\text{‰}$

Charcoal from various depths in pit outside Chamber 2, assoc with late Neolithic pottery. Antedates closure of cairn.

CAR-118. Pit F308 **6900 ± 80**
 $\delta^{13}C = -26.4\text{‰}$

Charcoal from pit beneath outer revetment wall of long cairn. *Comment* (WJB): no assoc artifacts but possibly dates late Mesolithic activity.

Dinorben series

Charcoal and bone samples are from hillfort excavated 1977 to 1978 by G Guilbert, CPAT, at Dinorben (Gardner & Savory, 1964; Savory, 1971; Guilbert, 1979; 1980a,b) 2.5km SE of Abergele, Clwyd (53° 15' N, 3° 33' W, Natl Grid Ref SH 968757). Coll 1977, 1978 by GG and subm by CPAT. Floral id by G Hillman, Dept Plant Sci, Univ Coll, Cardiff, and faunal id by B Noddle, Dept Anatomy, Univ Coll, Cardiff.

CAR-119. B300(J) **2390 ± 45**
 $\delta^{13}C = -27.1\text{‰}$

Corylus charcoal from discrete branch burned *in situ* in early timber-laced rampart.

CAR-120. B300(K) **2410 ± 60**
 $\delta^{13}C = -25.6\text{‰}$

Fraxinus excelsior charcoal from discrete branch burned *in situ* in early timber-laced rampart.

CAR-121. B300(Q) **2410 ± 60**
 $\delta^{13}C = -25.3\text{‰}$

Fraxinus excelsior charcoal from discrete branch burned *in situ* in early timber-laced rampart.

CAR-122. B300(U)**2450 ± 60** $\delta^{13}C = -23.6\text{‰}$

Quercus charcoal from discrete branch burned *in situ* in early timber-laced rampart.

CAR-123. B287(3)**2430 ± 60** $\delta^{13}C = -25.3\text{‰}$

Charred inner 20 rings of *Quercus* fragment with no bark apparent, from burned floor deposit on quarried Platform 38. Postdates earliest bldg of Bank 1 and antedates 2nd.

CAR-124. B287(5)**2360 ± 60** $\delta^{13}C = -25.7\text{‰}$

Charred twig fragments from scatter through burned floor deposit on Platform 38, postdating earliest bldg of Bank 1 and antedating 2nd.

CAR-125. B184**2300 ± 60** $\delta^{13}C = -26.0\text{‰}$

Charcoal from thin spread of sooty soil surrounding clay hearth at center of stake-built structure on Platform 39 and contemporary with usage of structure. Sample coll by flotation of deposit.

CAR-126. B29**2310 ± 60** $\delta^{13}C = -26.3\text{‰}$

Charcoal from fill of shallow pit overlain by topsoil. Pit cut through by post hole at entrance to curvilinear ditched structure inside hillfort.

CAR-128. B343**2500 ± 70** $\delta^{13}C = -21.8\text{‰}$

Collagen from bones of cattle and sheep from clay and rubble fill of Ditch 1, antedating early rampart.

CAR-129. B352b**1920 ± 60** $\delta^{13}C = -22.0\text{‰}$

Collagen from bones of cattle from basal 0.5m of rubble fill of Ditch 3, dating dereliction of outer defenses.

CAR-130. B352b**1480 ± 60** $\delta^{13}C = -22.0\text{‰}$

Collagen from bones of cattle from rubble fill of Ditch 3 at 0.5 to 1m above ditch floor and above level of CAR-129.

CAR-131. B348b**2170 ± 60** $\delta^{13}C = -22.0\text{‰}$

Collagen from bones of cattle from fine-grained silt deposit under Bank 2.

2050 ± 60
 $\delta^{13}C = -22.2\text{‰}$

CAR-132. B348b
 Collagen from bones of cattle from fine-grained silt deposit under Bank 2, duplicating CAR-131.

1810 ± 50
 $\delta^{13}C = -22.4\text{‰}$

CAR-133. B346
 Collagen from bones of sheep and cattle from fill of Ditch 2.

2470 ± 60
 $\delta^{13}C = -24.6\text{‰}$

CAR-167. B317 & B318
 Collagen from bones of cattle and roe deer from occupation horizon at surface of silty soil under Bank 1, antedating earliest bldg of Bank 1.

1600 ± 70

CAR-203. B352b
 Collagen from bones of cattle, sheep, pig, and dog from same level of Ditch 3 as CAR-130. *Comment:* $\delta^{13}C$ value of $-22\text{‰} \pm 2$ used in date calculation.

1550 ± 50
 $\delta^{13}C = -21.8\text{‰}$

CAR-204. B352a
 Collagen from bones of cattle from rubble fill of Ditch 3 at 1 to 1.5m above ditch floor and above level of CAR-130 and -203.

Rhuddlan series

Charcoal and bone samples from town ditch and bank excavated 1979 by J F Manley, Clwyd Co Council, ca 1km S of Rhuddlan, Clwyd (53° 17' N, 3° 27' W, Natl Grid Ref SJ 030773). Coll 1979 by JFM; subm by CPAT.

510 ± 60
 $\delta^{13}C = -23.4\text{‰}$

CAR-239. Sample 1
 Collagen from bones and teeth of *Bos* and *Ovis* id by B Noddle, from primary silt fill of main ditch.

1160 ± 60
 $\delta^{13}C = -26.2\text{‰}$

CAR-240. Sample 2
 Charcoal. Fragments of *Quercus* and some *Ulex* id by G Hillman, from middle of outer bank underlying topmost layer of bank. Sample coll as discrete lumps on site.

1160 ± 60
 $\delta^{13}C = -26.4\text{‰}$

CAR-241. Sample 3
 Charcoal fragments of *Quercus* and *Ulex* id by G Hillman from middle of outer bank beneath topmost layer. Sample obtained by flotation of bulk deposit on site.

Trelystan series

Charcoal samples are from two adjacent round barrows excavated 1979 by W J Britnell (1981; 1982), at Trelystan, Long Mt, 8km E of Welshpool, Powys (52° 39' N, 3° 04' W, Natl Grid Ref SJ 277070). Coll 1979 by WJB and subm by CPAT. Site comprised late Neolithic settlement superseded by Bronze age burials and round barrows.

CAR-272. Object 1006 Context D 8 **4260 ± 70**
 $\delta^{13}C = -25.7\text{‰}$

Charcoal from Pit 13 within pre-barrow stake-built Structure B dating pre-barrow settlement, antedating Barrow I.

CAR-273. Object 1007 Context D 7 **4140 ± 70**
 $\delta^{13}C = -25.7\text{‰}$

Charcoal from Pit 14 within stake-built Structure B dating pre-barrow settlement, antedating Barrow I.

CAR-274. Object 946 Context D 6 **3990 ± 70**
 $\delta^{13}C = -25.1\text{‰}$

Charred hazel nutshells from surface of hearth within stake-built Structure B dating pre-barrow settlement, antedating Barrow I.

CAR-275. Object 325 Context C 16 **4050 ± 70**
 $\delta^{13}C = -26.2\text{‰}$

Charcoal from Pit 1 within stake-built Structure A dating pre-barrow settlement.

CAR-276. Object 350 Context C 21 **3960 ± 70**
 $\delta^{13}C = -26.2\text{‰}$

Corylus Avellana charcoal id by G Hillman, from slot adjacent to hearth within stake-built Structure A.

CAR-277. Object 538 Context BI 22 **3450 ± 70**
 $\delta^{13}C = -26.1\text{‰}$

Charred wood and hazel nuts from Pit 18 antedating enlargement of Barrow I. *Comment:* date previously reported as 3455 ± 70 (Britnell, 1981).

CAR-278. Object 337 Context BI 10 **3500 ± 60**
 $\delta^{13}C = -26.2\text{‰}$

Charcoal from area of burning beneath enlargement of Barrow I and postdating early settlement phase.

CAR-279. Object 620 Context BI 25 **3750 ± 70**
 $\delta^{13}C = -26.0\text{‰}$

Charcoal from large burned area on ground surface beneath enlargement of Barrow I.

- CAR-280. Object 507, Context BI 21** 3650 ± 70
 $\delta^{13}C = -25.4\text{‰}$
 Charcoal from Stake 5 of setting accompanying Barrow I, Burial 4.
- CAR-281. Object 335 Context BI 16** 3700 ± 70
 $\delta^{13}C = -25.6\text{‰}$
 Charcoal from burned log assoc with cremation burial Barrow I, Burial 4, dating enlargement of Barrow I.
- CAR-282. Object 446 Context BII 4** 4350 ± 70
 $\delta^{13}C = -25.2\text{‰}$
 Charcoal from within rubble fill of pit grave of Barrow II, Burial 1.
- CAR-283. Object 148 Context BII 2** 3550 ± 60
 $\delta^{13}C = -25.3\text{‰}$
 Charcoal from cremation material in enlarged food vessel in Barrow II, Burial 3. Dates later use of Barrow II.
- CAR-285. Object 603 Context BI 19** 3540 ± 70
 $\delta^{13}C = -26.7\text{‰}$
 Charcoal from significant spread on stabilized surface of early phase of Barrow I.
- CAR-390. Object 843 Context BII 13** 3550 ± 70
 $\delta^{13}C = -26.8\text{‰}$
 Charcoal from thin layer on surface of buried soil beneath Phase 2 of Barrow II providing approx construction date.
- CAR-290. Church Street** 1770 ± 70
 $\delta^{13}C = -27.4\text{‰}$
 Outer 12-yr growth of *Quercus* branch with bark from top of 1st phase defensive ditch and sealed by 2nd phase of Roman town defenses, excavated 1978 by H J James, DAT, at Church St, Carmarthen, Dyfed (51° 51' N, 4° 18' W, Natl Grid Ref SN 415201). Coll 1978 by HJJ and subm by DAT.
- CAR-291. Caer Bayvil** 1290 ± 60
 $\delta^{13}C = -21.1\text{‰}$
 Collagen from human bone from cist grave at Iron age enclosure and Early Christian cemetery excavated 1979 by H J James, at Caer Bayvil, 8km SW of Cardigan, Dyfed (52° 02' N, 4° 45' W, Natl Grid Ref SN 112417). Coll 1979 by HJJ and subm by DAT. *Comment*(HJJ): sample dated to determine if grave was Christian.
- CAR-315. Longstone Field** 3310 ± 70
 $\delta^{13}C = -26.4\text{‰}$
 Charcoal, possibly from heartwood of *Quercus* branch from pit on site comprising standing stone, stake-built structures and pits, excavated 1979

by D Benson and G Williams, DAT, at Longstone Field, St Ishmael's 6km W of Milford Haven, Dyfed (51° 44' N, 5° 07' W, Natl Grid Ref SM 848084). Coll 1979 by DB and GW and subm by DAT.

St John's Priory series

Charcoal samples recovered by flotation are from Early Christian and Medieval monastery excavated 1979 by T James, at St John's Priory, Carmarthen, Dyfed (51° 51' N, 4° 18' W, Natl Grid Ref SN 419204). Coll 1979 by TAJ and subm by DAT.

CAR-288. Ditch

1220 ± 60
 $\delta^{13}C = -25.8\text{‰}$

Charcoal from primary silt fill of Ditch 234 dating series of ditches beneath later Medieval cemetery.

CAR-289. Lime kiln

870 ± 60
 $\delta^{13}C = -26.5\text{‰}$

Charcoal from basal fill of lime kiln antedating extension to Priory church and some Medieval graves.

Corn Du series

Peat samples are from mountain-top cist constructed directly on undisturbed peat surface (Crew, 1978) excavated 1978 by P Crew, at Corn Du Mt, 8km SW of Brecon, Powys (51° 52' N, 3° 26' W, Natl Grid Ref SO 007213) alt 873m. Coll 1978 by D Roe; subm by CPAT. *Comment:* samples pretreated to remove fulvic and humic materials.

CAR-201. Sample SO4

3800 ± 80
 $\delta^{13}C = -26.9\text{‰}$

Calluna fragments id by B Smith, from uppermost 1.5cm layer of yellow-green peat at pre-cairn surface sealed by redeposited peat of cairn structure.

CAR-202. Sample SO5

3700 ± 80
 $\delta^{13}C = -26.8\text{‰}$

Calluna fragments id by BS from uppermost 1cm layer of undisturbed peat sealed by large basal slab of cist.

Moel Goedog Circle I series

Charcoal samples are from pits at early Bronze age ring cairn excavated 1978 by F M Lynch, Univ Coll, Bangor, at Moel Goedog, 3km NE of Harlech, Gwynedd (52° 52' N, 4° 04' W, Natl Grid Ref SH 610324). Coll 1978 by FML; subm by GAT. *Comment* (FML): site, 1 of 2 on either side of Bronze age trackway, lies at alt 270m on open mt side. Twelve upright stones, of which 3 remain, were placed in circle backed by low ring of cairn material on level terrace cut into hillside. Within central area were 10 pits, most of which contained dark earth and charcoal. Some pits contained urns and cremated bones (Lynch, in press a).

CAR-160. SS9a & SS9 **3500 ± 70**
 $\delta^{13}C = -25.8\text{‰}$
Charcoal from fill of Pit F8, containing food vessel urn.

CAR-161. SS7 **3450 ± 70**
 $\delta^{13}C = -25.7\text{‰}$
Charcoal from fill of Pit F5 at center of circle.

CAR-162. SS15 **3610 ± 70**
 $\delta^{13}C = -26.7\text{‰}$
Charcoal from fill of Pit F11 close to edge of central area and covered by flat stone and collapsed cairn material.

CAR-163. SS6 **3600 ± 70**
 $\delta^{13}C = -25.7\text{‰}$
Charcoal from fill of Pit F1 in central area and covered by stone slabs. Pit also contained small quantity of bone.

CAR-164. SS5 **3470 ± 70**
 $\delta^{13}C = -25.2\text{‰}$
Charcoal from small pit in central area, Pit F3, covered by spread of stones.

CAR-165. SS13 **3640 ± 70**
 $\delta^{13}C = -25.6\text{‰}$
Charcoal from within and around mouth of cremation urn from base of Pit F10.

CAR-166. SS16 **3470 ± 70**
 $\delta^{13}C = -25.0\text{‰}$
Charcoal from immediately around remains of broken urn in Pit F7.

General Comment (FML): dates fall in expected range and confirm early Bronze date for this type of site. Three strat phases noted during excavation implied possible spread over longer period than results indicated. Although dates span nearly 200 yr, their sequence does not appear to conform to that of strat though this does not deny field observations.

Cefn Caer Euni series

Charcoal samples are from early Bronze age kerb circle excavated 1971 by F M Lynch, at Cefn Caer Euni, 7km SW of Corwen, Merioneth (52° 57' N, 3° 30' W, Natl Grid Ref SH 994410). Coll 1971 and subm 1982 by FML. Site was on rocky peat-covered ridge and comprised ritual monument with underlying occupation horizon containing "Domestic Beaker" sherds and charcoal (Lynch, in press b).

CAR-600. Sample A **4130 ± 70**
 $\delta^{13}C = -25.9\text{‰}$

Charcoal from settlement layer, trodden into gray-blue horizon assoc with "Domestic Beaker" sherds; horizon was covered by sterile yellow clay before construction of monument. Provides date for settlement.

CAR-601. Sample B

3380 ± 70
 $\delta^{13}C = -26.8\text{‰}$

Charcoal from pit within false portal of monument and related to use of kerb circle.

General Comment (FML): date for monument is within expected range but date for settlement is earlier than expected, both because it was thought that occupation had been rapidly succeeded by erection of monument and because pottery had been id as Beaker. However, it is not classic and should perhaps be reconsidered.

Carreg Coetan series

Charcoal samples are from Neolithic chambered tomb in Afon Nyfer valley 12km E of Fishguard, Dyfed (52° 01' N, 4° 50' W, Natl Grid Ref SN 060394). Site, excavated 1979 and 1980 by S E Rees, Ancient Monuments Branch, Welsh Office, comprised mound of redeposited subsoil surrounded by stone kerb. Coll 1979, 1980 and subm 1980 by SER.

CAR-391. Sample 1

4560 ± 80
 $\delta^{13}C = -28.2\text{‰}$

Charcoal from old ground surface sealed beneath mound material, antedating erection of mound.

CAR-392. Sample 2

4830 ± 80
 $\delta^{13}C = -27.8\text{‰}$

Charcoal from area of burning, Area F36, sealed beneath stone kerb, antedating erection of kerb.

CAR-393. Sample 3

4470 ± 80
 $\delta^{13}C = -26.8\text{‰}$

Charcoal from within material of mound, dating construction of mound.

CAR-394. Sample 4

4700 ± 80
 $\delta^{13}C = -27.6\text{‰}$

Charcoal from Socket hole F44 of chamber upright.

*England***Seamer Carr series**

Samples are from Tr C IX on palynol and archaeol site excavated 1979 by T Schadler-Hall, Kingston-upon-Hull Mus, Humberside, on shores of late Devonian Lake Pickering, at Seamer Carr, 6km S of Scarborough, N Yorkshire (54° 13' N, 0° 25' W, Natl Grid Ref TA 034819). Coll and subm 1979 by E Cloutman.

CAR-195. SCW1

9480 ± 110
 $\delta^{13}C = -30.0\text{‰}$

Birch branch from coarse detritus mud directly beneath Bone Layer 2135. Dates Late V or Early VI pollen zone.

CAR-196. SCB1

9100 ± 100
 $\delta^{13}C = -24.2\text{‰}$

Collagen from bones (*Cervus elephas*, *Bos primigenius*) id by J Clutton Brock, British Mus (Nat Hist), London, from detritus mud assoc with mineral erosion deposit and hazel nut. Dates Late V or Early VI pollen zone.

CAR-197. Sample 2157

9260 ± 90
 $\delta^{13}C = -26.0\text{‰}$

Charcoal from Mineral Deposit 25, alt 13m, assoc with flint layer on shelf at lake edge.

*Scotland***Scord of Brouster series**

Charcoal samples are from settlement site comprising three houses, cairn, and surrounding irregular fields, excavated 1977 to 1979 by A W R Whittle, Dept Archaeol, Univ Coll, Cardiff, at Scord of Brouster, 25km N of Lerwick, Shetland Isles (60° 15' N, 1° 32' W, Natl Grid Ref HU 255516). Site, one of series of similar settlements, lies at head of sea inlet on W mainland of Shetland (Calder, 1958; Whittle, 1979). Site was excavated to examine chronology, subsistence, and environment and dated to examine chronol development at site. Coll 1977 to 1979 and subm 1980 by AWRW. Sample id by G Hillman.

CAR-242. Sample SB4

4220 ± 80
 $\delta^{13}C = -26.0\text{‰}$

Charcoal (*Betula*) from lower part of kerb cairn, Site IV. Dates construction of inner part of kerb cairn, in primary use as clearance cairn.

CAR-243. Sample SB5

4100 ± 70
 $\delta^{13}C = -25.7\text{‰}$

Charcoal (*Betula*, *Corylus*) from occupation layer preceding construction of oval stone house, House 1, Phase 1, Tr D/E, Layer 4.

CAR-244. Sample SB6

4460 ± 70
 $\delta^{13}C = -25.5\text{‰}$

Charcoal (*Betula*) from pre-house feature in E interior of House 1, Phase 1.

CAR-245. Sample SB7

4350 ± 90
 $\delta^{13}C = -25.9\text{‰}$

Charcoal (mostly *Betula*) from pre-house occupation layer beneath House 1, Phase 1, Layer 4.

CAR-246. Sample SB8

4050 ± 70
 $\delta^{13}C = -26.1\text{‰}$

Charcoal (*Betula*) from core of wall of oval stone house in Tr A and C, House 1, Phase 2. Dates construction of House 1.

CAR-247. Sample SB9 4130 ± 80
 $\delta^{13}C = -25.9\text{‰}$

Charcoal (some *Betula*) from lowest level of Layer 3 at N half of interior of House 1, Phase 2, dating onset of use of house.

CAR-248. Sample SB10 3670 ± 80
 $\delta^{13}C = -26.9\text{‰}$

Charcoal from base of Layer 3 in N half of interior of House 1, Phase 2, dating main phase of occupation of house.

CAR-249. Sample SB11 4500 ± 80
 $\delta^{13}C = -25.2\text{‰}$

Charcoal (*Betula*, *Corylus*) from base of layer beneath wall on NW side of House 2, Phase 1, dating pre-house occupation.

CAR-250. Sample SB12 4460 ± 70
 $\delta^{13}C = -25.7\text{‰}$

Charcoal (*Betula* with some *Corylus*) from layer beneath wall, above Sample SB11, House 2, Phase 1. With CAR-249, should date length of pre-house occupation.

CAR-251. Sample SB13 4540 ± 70
 $\delta^{13}C = -24.6\text{‰}$

Charcoal (*Betula*, *Corylus* and some blistered 6-row naked barley, *Hordeum nudum*) from concentration in Layer 3d, in interior of House 2, Phase 1.

CAR-252. Sample SB14 4390 ± 80
 $\delta^{13}C = -25.6\text{‰}$

Charred fragments of *Erica*, *Calluna* plus grass stem and rhizomes and occasional cereal grains from within wall on NW side of House 2, Phase 2, dating construction of house.

CAR-253. Sample SB15 5050 ± 90
 $\delta^{13}C = -26.3\text{‰}$

Charcoal (*Betula* and *Corylus*) from Layer 2 within House 2, Phase 2, dating use of house.

CAR-477. Sample SB16 3320 ± 60
 $\delta^{13}C = -24.9\text{‰}$

Charcoal and charred grain from W end of floor of House 1, Phase 1, dating main occupation of structure.

CAR-479. Sample SB17 3420 ± 70
 $\delta^{13}C = -24.8\text{‰}$

Charcoal and charred grain from middle and W part of floor of House 3, Phase 1, dating occupation of structure.

General Comment (AWRW): series is within expected date range. CAR-253 is out of sequence. House 2 would appear to be slightly older than House 1. CAR-246 and -247 are compatible with earlier determination (HAR-2413: 4170 ± 80) from House 1, Phase 2.

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LYON NATURAL RADIOCARBON MEASUREMENTS X

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INTRODUCTION

This list includes most of the measurements made since the beginning of the compilation of our previous list (R, 1983, v 25, p 59–126), in 1982 and 1983, as well as some earlier measurements of extended geologic or archaeological studies.

Three ml benzene samples were measured by the liquid scintillation process. When the amount of available carbon was too low, inactive benzene was added; dilution ratio (dr) is the amount of active benzene in the total 3ml. Pretreatment, treatment, and counting procedures remain as previously described (R, 1983, v 25, p 59).

Calculations followed international rules (^{14}C half-life = 5570 ± 0 ; age error is based on one standard deviation of contemporary standard, background, and sample counts). An isotopic fractionation correction is made only for bones (+80 yr). The published intervals of corrected dates for samples younger than 7250 BP are derived from Klein *et al* (1982) and appear under the BP date with an asterisk (*).

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GEOLOGIC SAMPLES

Samples from Peat Bogs

Ly-2852. Coron, Belley, Ain **630 \pm 160**
**AD1200–1485*

Peat from base of small bog (45° 45' N, 5° 31' E), coll 1981 and subm 1982 by J P Bravard, Lab Geog, Univ Lyon III. *Comment* (JPB): as peat bog overlies settlement of Gallo-Roman period or High Middle ages, date proves that peat developed after several centuries and might correspond to "Little Ice Age."

Ly-2851. Le Grand Marais, Les Avenières, Isère **1260 \pm 170**
**AD570–1030*

Peat from base of bog in former bed of Rhône R (45° 36' N, 5° 31' E). Coll and subm 1983 by J P Bravard (0.7 dr). *Comment* (JPB): date agrees perfectly with expected age and results from Brégnier-Cordon and Cham-

pagneux (below). It confirms that development of bog began just after change in course of Rhône R which probably occurred during 6th century (Bravard, 1983).

2020 ± 120

Ly-2514. La Touvière, Massignieu de Rives, Ain

**375BC–AD215*

Wood from lacustrine clay outcropping on side of Bart Lake (45° 46' N, 5° 45' E). Coll and subm 1981 by R Vilain, Lab Geol, Univ Lyon I. *Comment* (RV): date is much younger than expected and proves that wood was brought in by recent colluvia.

Marais de Landes series, Saint-Loup, Charente-Maritime

Samples from three levels of Boring P4 in marsh (46° 10' N, 0° 38' W). Coll and subm 1982 by M Mazeau, Fr Geophys Prospection Cie, Limoges. *General Comment* (MM): dates show that peat development recently finished. Because clays ("Le Bri") embedding wood (Ly-2692) are of marine origin and may correspond to max of Flandrian transgression, Ly-2691 proves there was relatively long sedimentation hiatus before peat formation.

TABLE 1
Marais de Landes

Sample no.	Depth (m)	Sample	DR	Age BP	Corrected date interval
Ly-2690	0.0–0.1	"Surface" peat	1	640 ± 120	AD1235–1415
-2691	3.0–3.1	Basal peat	0.7	5130 ± 180	4395–3635BC
-2692	3.1–3.2	Wood from clay	0.7	8720 ± 210	

4960 ± 150

Ly-2999. Ichtratzheim, Bas-Rhin

**4085–3380BC*

Peat with wood debris interbedded in alluvia of former bed of Ill R (48° 27' N, 7° 41' E). Coll and subm 1983 by A Schnitzler, Lab Bot, Univ Strasbourg. *Comment* (AS): date is much older than expected for N extension of Ill R bed, because of geomorphol and hist data; Ill R was assumed to have joined Rhine R much further S in Middle ages.

Marais de Brière series, Loire Atlantique

Samples from several levels in two borings drilled as part of PICG 158b "Lake and Sea environment" proj at Le Butteau-Piquet, near Saint-Lyphard (47° 23' N, 2° 17' W) and Penlys (47° 26' N, 2° 14' W) near La Chapelle des Marais. Coll and subm 1982 by L Visset, Lab Ecol, Univ Nantes.

General Comment (LV): all dates are a little older than expected. They confirm Sub-boreal age of dated level and regression from edges of former Brière gulf. They may be compared with two other unpub results from same peat bog: Ny-682: 4330 ± 75 in Errand I. (Visset, 1982) from level comparable to that from Le Butteau-Piquet (Ly-2903), and Ny-523: 4120 ± 90 in Canal des Fougères from fossilized tree trunk as Ly-2904.

TABLE 2
Marais de Brière

Sample no.	Boring	Level (cm)	Pollen phase	Sample	Expected age (BP)	Age (BP)	Corrected date interval (BC)
Ly-2906	Penlys	130–140	End of Sub-boreal	Peat and wood	ca3600	4440 ± 120	3480–2985
-2905	Penlys	142–148	Middle of Sub-boreal	Peaty clay	ca4150	4680 ± 110	3765–3160
-2904	Penlys	145	Middle of Sub-boreal	Fragment of tree trunk	ca4150	4710 ± 140	3795–3150
-2903	Butteau-Piquet	222–228	Beginning of Sub-boreal	Peaty clay	ca4300	5010 ± 130	4110–3395

Marais de Syl series, Lavau-sur-Loire, Loire Atlantique

Peat from four levels in boring at “Pré du Fauchais” in bog (47° 20’ N, 1° 56’ W). Coll and subm 1982 by D Voeltzel and L Visset.

General Comment (LV): all dates are much older than expected. They confirm that base of boring (Ly-2907) belongs to Atlantic and upper level (Ly-2910) dates to Sub-boreal. Discrepancies between results and palynol data and results from La Grande Brière peat bog (above) remain unexplained and need further confirmation from other borings.

TABLE 3
Marais de Syl

Sample no.	Level (m)	Pollen phase	Expected age (BP)	Age (BP)	Corrected date interval (BC)
Ly-2910	2–2.08	Sub-atlantic/ Sub-boreal limit	3000	4070 ± 130	3010–2305
-2909	4.42–4.52	Middle of Sub-boreal	4500	5680 ± 140	4920–4145
-2908	5.05–5.15	Beginning of Sub-boreal	5000	5840 ± 140	5185–4425
-2907	5.45–5.53	Sub-boreal/ Atlantic limit	5700	6010 ± 140	5265–4560

Le Marais series, Barrou, Indre-et-Loire

Wood from two depths of peaty levels of fill of former channel (46° 53’ N, 0° 44’ E). Some levels contain well-known Grand Pressigny flint artifacts manufactured locally and assoc with ceramics of Bronze or Neolithic age. Coll 1979 by “Les Amis du Grand Pressigny” Soc and subm 1980 by J Allain and J Despriée, Dir Antiquités Prehist Orléans.

Ly-2307. Le Marais F6 **7340 ± 100**
From upper level, 1.2 to 1.5m depth.

Ly-2308. Le Marais F8**7010 ± 150**
***6340–5430BC**

From lower level, 2 to 2.3m depth.

General Comment (JD): dates are close in age and similar to those obtained for other peaty fills in region which were also formed during Atlantic period corresponding to Neolithic. They show that Bronze age remains are intrusive.

Le Pré Maudit series, Gathemo, Manche

Peat from several levels of N400 boring of bog (48° 45' N, 1° 37' W). Coll and subm 1983 by C Lechevalier and L Barthélémy, Lab Geog Phys, Univ Paris X, Nanterre; these samples complete previous series (R, 1983, v 25, p 64) (Lechevalier, 1983).

General Comment (CL): all results are within expected range and confirm previously dated series, particularly for beginning of site deposits. Ly-3014 suggests that Ly-2046: 9250 ± 180 may be a little too old due to local colluvium of gray clay deposited during Pre-boreal before peat development.

TABLE 4
Le Pré Maudit

Sample no.	Depth (cm)	Pollen phase and expected climatic phase	DR	Age (BP)	Corrected date interval (BC)
Ly-3012	317–326	VIIa: Atlantic	0.5	6580 ± 170	5825–5215
-3013	329–336	VIIa: Beginning of Atlantic	1	7110 ± 150	6465–5480
-3014	341–345	V: 1st part of Boreal	0.8	8560 ± 190	
-3015	350–358	IV: End of Pre-boreal	0.7	9120 ± 200	

Vallat-Neuf series, Berre l'Etang, Bouches-du-Rhône

Clay with low organic content from three levels of two borings in bog on N side of Etang de Berre gulf (43° 29' N, 5° 13' E). Coll 1981 and subm 1982 by H Triat-Laval, Lab Palynol, Univ Aix-Marseille III.

Ly-2685. Vallat-Neuf 180–190**1770 ± 310**

From 180 to 190cm depth in D4 boring (0.07 dr). Pollen diagram shows Sub-atlantic phase during the extension of olive-tree (*Olea* sp) cultivation. *Comment* (HTL): date confirms that extension of olive cultivation occurred earlier in Provence region than in neighboring W Languedoc region where it was dated at Mauguio site, MC-1404: 1300 ± 60 (Planchais, 1982).

Ly-2686. Vallat-Neuf 200–205**2090 ± 200**
***565BC–AD235**

From 200 to 205cm depth in D4 boring (0.3 dr). Pollen diagram shows beginning of continuous curve of *Olea*. *Comment* (HTL): date attributes

beginning of olive cultivation to Historic period following Protohistoric precultivation period (Triat-Laval, 1982).

Ly-2650. Vallat-Neuf 355–362 7340 ± 270

From 355 to 362cm depth near base of D3 boring. Pollen diagram suggests beginning of Atlantic climatic phase with thermophilic vegetation and extension of *Quercus* forest. *Comment* (HTL): date confirms expected age and agrees with previous data from W Provence, eg, at Mollègès (R, 1978, v 20, p 20) (Triat-Laval, 1979).

L'Alpe d'Huez series, Isère

Wood from two peaty outcroppings in ski sta (45° 6' N, 6° 4' E). Coll and subm by M Chardon, Lab Geog, Univ Grenoble.

Ly-2696. Alpes d'Huez, Le Rif 3540 ± 160
**2305–1640BC*

From 1.5m depth in small bog near cablecar sta. Coll and subm 1981.

Ly-1967. Alpes d'Huez, Le Lynx 5090 ± 150
**4315–3645BC*

From 0.8m depth at top of peaty and clayey layer in center of village. Coll and subm 1978.

General Comment (MC): both dates indicate that peat formation is relatively old. They also show presence of forest at alt, ca 1800 to 2000m in Les Rousses massif at end of Atlantic and beginning of Sub-boreal, *ie*, several hundred m higher than present timber line in region.

Bonnecombe series, Salces, Lozère

Peat from several levels of bog near Los Pesquio (44° 34' N, 3° 8' E). Coll 1980 and subm 1982 by J L de Beaulieu and M Reille, Lab Palynol, Univ Aix-Marseille III.

TABLE 5
Bonnecombe

Sample no.	Depth (cm)	Pollen event	Climatic phase	DR	Age (BP)	Corrected date interval
Ly-2558	20–30	<i>Fagus</i> decrease, presence of cereals	Sub-atlantic	0.7	2220 ± 210	775BC–AD205
-2559	105–112	Beginning of <i>Fagus</i>	End of Atlantic	0.7	5150 ± 210	4405–3645BC
-2560	200–210	Beginning of <i>Tilia</i>	Beginning of Atlantic	0.5	6910 ± 170	6215–5385BC
-2561	285–290	Beginning of <i>Corylus</i>	Pre-boreal	0.3	9500 ± 240	
-2562	300–307	<i>Betula</i>	Pre-boreal	0.2	9180 ± 290	
-2563	335–345		Pre-boreal	0.5	10240 ± 210	
-2564	355–360	<i>Pinus</i>	Beginning of Pre-boreal	0.2	10640 ± 300	

General Comment (JLdeB): except for Ly-2564, which is ca 1500 yr too old for unknown reason, all values are in expected range suggested by pollen diagram. They all agree with previously pub series from peat bog in region (de Beaulieu, Pons, & Reille, in press), eg, Ly-2560 is contemporaneous with Ly-2605: 6990 ± 160 from Brameloup and Ly-2112: 6880 ± 200 from Chaumette bogs.

Cheylane series, Laveissenet, Cantal

Peat from several levels of bog presently submerged in pond at alt 1040m on La Plan  ze de Saint-Flour plateau (45   10' N, 2   53' E). Coll 1979 and subm 1980 by J L de Beaulieu.

General Comment (JLdeB): almost all dates agree with expected ages, except Ly-2071, which, because of large statistical margin, is ca 800 yr too old; Ly-2072 is also ca 1000 yr too old for unknown reason. Ly-2068 indicates much older age than in other pollen diagram from region for extension of *Abies* (de Beaulieu, Pons, & Reille, in press).

TABLE 6
Cheylane

Sample no.	Depth (cm)	Pollen event	Climatic phase	DR	Age (BP)	Corrected date interval (BC)
Ly-2067	80–90	Extension of <i>Fagus</i>	Sub-boreal	0.7	4180 ± 160	3335–2410
-2068	130–140	Extension of <i>Abies</i>	Middle of Atlantic	1	5560 ± 170	4710–3960
-2069	170–180	Appearance of <i>Tilia</i>	Atlantic	0.8	6790 ± 190	6125–5270
-2070	220–230	Decrease of <i>Corylus</i>	Boreal	1	8220 ± 200	
-2071	250–260	Extension of <i>Corylus</i>	Pre-boreal	0.2	7870 ± 360	
-2108	260–270	Extension of <i>Corylus</i>	Pre-boreal	0.7	8930 ± 180	
-2109	280–290	Appearance of <i>Corylus</i>	Pre-boreal	0.2	9250 ± 350	
-2072	320–330	Appearance of <i>Betula</i>	Beginning of Aller��d	0.8	10440 ± 220	

Suc du Lac d'En Bas series, La Godivelle, Puy de D  me

Gyttja with low organic content from three levels of bog at 1260m alt, Le C  zali  r massif (45   23' N, 2   55' E). Coll and subm 1982 by M Reille and J L de Beaulieu. Samples dated to complete data from three previous borings from region (R, 1983, v 25, p 67).

TABLE 7
Suc du Lac d'En Bas

Sample no.	Depth (cm)	Expected climatic phase	DR	Age (BP)
Ly-2893	910–950	Pre-boreal	0.7	9850 ± 240
-2894	1060–1080	Late Dryas	0.5	$10,140 \pm 250$
-2895	1100–1120			
	1200–1230	Aller��d	0.15	$10,390 \pm 560$

General Comment (JLdB): Ly-2893 is as expected. Ly-2894 comes from sec of boring which is too long, and Ly-2895 has too large a statistical margin; they look ca 500 and 1000 yr younger, respectively, compared to pollen data and unpub result from same boring at about same depths: 1025–1050cm: Gif-6216, 10,220 \pm 200; 1080–1100cm: Gif-6217, 10,600 \pm 200; and 1150–1180cm: Gif-6218, 11,200 \pm 150 (de Beaulieu, Pons, & Reille, in press).

Dar Fatma series, Aïn Draham, N W Tunisia

Peat from six levels of boring in small bog at alt 910m in La Kroumirie massif (36° 46' N, 8° 42' E). Coll 1977 and subm 1980 by B Ben Tiba, Sylvopastoral Inst, Tunis and M Reille.

General Comment (MR): previous series confirmed that last deforestation was consequence of Arabian invasion: Ly-1650: 700 \pm 110 (R, 1979, v 21, p 413) (Ben Tiba, 1980). Ly-2570 shows that first deforestation occurred at end of Atlantic. All other dates are much older than expected and show that boring reached Recent Pleistocene fms which had almost been eroded before Holocene fm of bog. Ly-2238, even with finite age, belongs to Pleistocene series and appears younger due to roots having penetrated from Holocene series (Ben Tiba & Reille, 1982).

TABLE 8
Dar Fatma

Sample no.	Depth (cm)	DR	Age (BP)
Ly-2570	150–170	0.05	4630 \pm 580
-2238	200–220	0.5	19,640 \pm 530
-2569	225–250	0.5	\geq = 33,000
-2239	360–380	1	\geq = 28,200
-2241	380–400	1	\geq = 31,000
-2240	730–750	0.8	\geq = 33,700

Pompillon series, Lans en Vercors, Isère

Peat from ca 1.5m depth, in middle of lacustrine clayey sediments (45° 6' N, 5° 28' E). Coll and subm 1977 by G Monjuvent, Lab Geol, Univ Grenoble.

Ly-1658. Pompillon 6 $\geq 31,440$ + 1890
– 1560

Ly-2052. Pompillon 6b $\geq 33,500$ + 5200
– 3100

General Comment (GM): despite apparent contemporaneity, both dates are too young and must be considered as min. Pollen strongly suggests interglacial environment dating to Eemian or Rissian interglacial.

Les Echets series, Miribel, Ain

Clay with high organic content from exploratory borings (I, A, B, and F) and a wider core-boring (G), all drilled in glacio-lacustrine clay, deepest

TABLE 9
Les Echets

Sample no.	Boring	Depth (m)	DR	Age (BP)
Ly-2763	I	3.9–4	0.2	11,910 ± 350
-2764	I	5.5–5.6	0.3	12,190 ± 290
-1908	A	ca 6.5	1	16,250 ± 480
-1909	A	ca 14.5	1	18,560 ± 580
-1747	A	21.8–21.9	0.3	24,300 ± 1100
-1910	B	ca 9.1	1	32,100 + 1100 – 2300
-1746	B	17–18	1	≥35,000
-2061	F	24.5–24.6	1	≥34,000
-2765	G	1.2–1.3	0.5	10,810 ± 230
-2063	G	2.9–3	1	15,050 ± 250
-2766	G	3.6–3.7	1	17,320 ± 250
-2767	G	4.05–4.15	0.5	15,260 ± 290
-3060	G	6.9–7.1	0.5	18,590 ± 410
-2062	G	11.7–11.8	1	17,530 ± 270
-2768	G	15.2–15.5	0.7	18,030 ± 250
-2221	G	20.2–20.3	0.7	20,050 ± 380
-2769	G	21.1–21.2	1	20,420 ± 380
-2770	G	22.1–22.2	0.8	21,120 ± 400
-2771	G	23–23.2	0.5	25,450 ± 550
-3061	G	23.7–23.8	0.4	21,760 ± 650
-2772	G	24.1–24.3	1	24,500 ± 500
-3062	G	25.5–25.6	0.8	≥33,700

sediments in a large bog (45° 53' N, 4° 55' E). Ancient lake was inside innermost fold of external moraines of fluvio-glacial and glacial Würmian complex in Lyon region (Mandier, 1981). Coll from 1976 to 1979 and subm 1976 to 1983 by P Mandier, CNRS Assoc Lab No.260 and Lab Geog, Univ Lyon II, by G Monjuvent, by J L de Beaulieu and J Evin (Beaulieu *et al*, 1980).

General Comment (JLdB & PM): eight preliminary results helped to determine best location for main core boring G, 56.6m deep, which sampled sediments from Late Rissian to Late Würmian, as demonstrated by palynol study of all levels (Beaulieu & Reille, 1984) and by ¹⁴C dates of upper levels. Most dates for core G are in good strat sequence (fig 1) and suggest average sediment accumulation rate of ca 3m per millennium below 6m in middle part of lake during almost entire end of Late Würmian. Only Ly-2767, -3060, and -2771 are out of sequence. Infinite ages obtained from below 24.5m in boring G and neighboring boring F, and at base of boring B (Ly-1746, -2062, -3062) confirm pollen data that suggest markedly slower sediment accumulation rate and even hiatus just before 25,000 BP. Pollen results also suggest that 24.5m to 29m dates to Würmian II, and 29m to 34.5m, to Würmian I. Entire pollen diagram has been compared to that of La Grande Pile peat bog, NE France, previously studied by Woillard (1975) and dated by Groningen Lab.

Romandie series, Switzerland

Samples from palustrine and lacustrine sediments underlying moraines in Vaud and Fribourg dist. Coll 1979 to 1981 and subm 1980 and 1982 by R Arn, Lab Geol, Univ Lausanne.

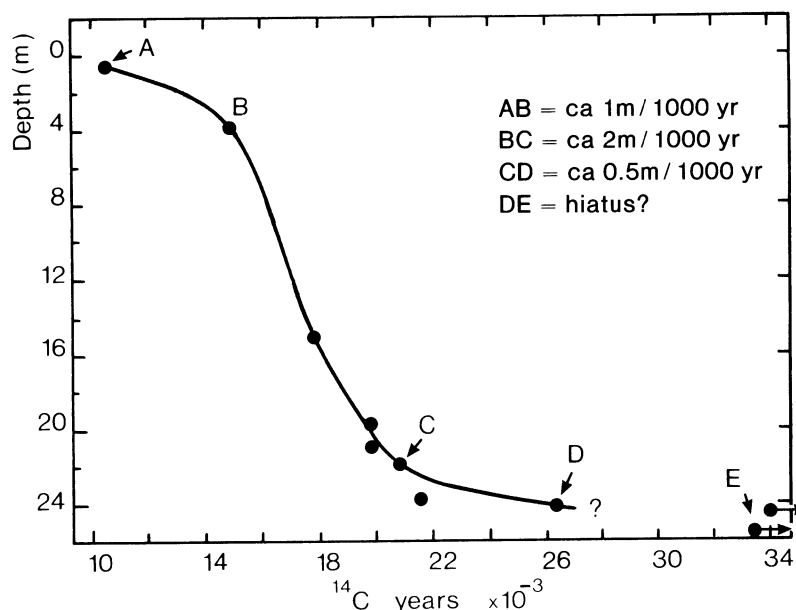


Fig 1. Sediment accumulation rate in boring G of Les Echets site

General Comment (RA): Ly-2580 fits previous measurement:

Ly-751: $34,600 \pm 2700$ from mammoth tusk in lower level of same site (R, 1975, v 17, p 12). The five other results agree with pollen analyses. Peat from Pont-la-Ville contains temperate forest flora attributed to Early Würmian while other sites contain flora of cold climate with many herbaceous plants, and may be attributed either to Middle Würmian or Early Würmian interstadial, Signal de Bougy particularly (Arn, 1981).

TABLE 10
Romandie

Sample no.	Site	Geog coordinates	Sample	Age (BP)
Ly-2059	Signal de Bougy, Vaud	(46° 29' N, 6° 25' E)	Peaty slime	≥32,000
-2060	Tartegnin, Vaud	(46° 28' N, 6° 19' E)	Peaty slime	≥34,000
-2215	Pont-la-Ville, Vaud	(46° 43' N, 6° 06' E)	Wood	≥36,000
-2216	Saumont-Derrière, Fribourg	(46° 31' N, 6° 55' E)	Wood	≥36,000
-2350	Senarclans, Vaud	(46° 36' N, 6° 29' E)	Peat	≥36,000
-2580	Bettens, Vaud	(46° 37' N, 6° 35' E)	Peat	25,090 ± 550

Samples from Caves

W Pyrénées series, Hautes pyrénées and Pyrénées Atlantique

Bones of large mammals from fill of several caves or pits. Subm 1982 by A Clot, Bordère sur Echez, as part of study on extinction of large mammals in Pyrénées massif at end of Würmian period.

TABLE 11
West Pyrénées mammals

Sample no.	Site, village, and dept	Geog coordinates	Collector and colln date	Fauna	DR	Age (BP) and corrected date interval (BC/AD)
Ly-2856	Grotte d'Oillascoa, Saint-Michel, Pyrénées-Atlantique	(43° 04' N, 1° 14' W)	Speleol group of Bayonne, 1976	<i>Ursus spelaeus</i>	1	18,720 ± 350
-2857	Grotte de l'Oeil du Nez, Rébénacq, Pyrénées-Atlantique	(43° 09' N, 0° 03' W)	P Robert, 1978	<i>Ursus spelaeus</i>	1	26,000 ± 500
-2858	Grotte de Couraü, Saint-Pé de Bigorre, Hautes Pyrénées	(43° 06' N, 0° 09' W)	P Robert, 1947	<i>Ursus spelaeus</i>	0.9	28,870 ± 700
-2859	Grotte de Couret, Ilhet, Hautes-Pyrénées	(42° 57' N, 0° 06' E)	A Clot, 1967	<i>Cervus elephas</i>	1	4230 ± 160 (3350–2425BC)
-2860	Grotte de Peyreignes, Tíbiran-Jaunac, Hautes-Pyrénées	(43° 03' N, 0° 33' E)	V Ferrer, 1970	<i>Bison priscus</i>	1	14,470 ± 230
-2762	Grotte de Permayou, Accous, Pyrénées-Atlantique	(42° 56' N, 0° 31' W)	JP Besson & R Caille, 1972	<i>Capra pyrenaica</i>	1	1520 ± 120 (AD240–690)
-2760	Gouffre PT 10, Osse en Aspe, Pyrénées Atlantique	(43° 00' N, 0° 42' W)	M Froissardet & H Laborde, 1978	<i>Capra pyrenaica</i>	1	5260 ± 120 (4405–3790BC)
-2761	Grotte des Arrats, Saint-Pé de Bigorre, Hautes Pyrénées	(43° 04' N, 0° 06' W)	A Clot, 1971	<i>Capra pyrenaica</i>	0.5	11,630 ± 280

General Comment (AC): three dates on *Ursus spelaeus* bones confirm that extinction of cave bear was more recent than previously thought, as Ly-2856 dates to end of Würmian III period. Ly-2860 suggests contemporaneity of dated fauna with Magdalenian settlement in neighboring Tiberan painted cave. Three dates on *Capra pyrenaica* show Pyrenean goat was present during entire Holocene (Clot & Evin, 1983).

Anthracology series, W Spain

Charcoal from three levels in fills of two caves; subm by JL Vernet, Lab Bot, Univ Montpellier as part of anthracol study.

Ly-2848. Cova Recambra, IVb

3850 ± 160
*2775–1930BC

From Layer IVb, in cave near Gandia, Valencia prov (39° 0' N, 0° 20' W). Coll 1982 by J Aparicio-Perez (0.5 dr).

Ly-2849. Cova Recambra, VII

5790 ± 220
*5000–4020BC

From Layer VII, in same cave as Ly-2848. Coll 1962 by E Grau-Almero (0.2 dr).

Ly-2850. Cova Ampla, II

6550 ± 180
*5820–5185BC

From Layer II, in cave near Alicante, Alicante prov (38°, 23' N, 0° 30' W). Coll 1982 by E Barlal-Garcia.

General Comment (JLV): dates confirm data from anthracol analyses that indicate first human deforestation is relatively old, while Ly-2848 appears a little too young from archaeol data.

**Ly-2313. Grotte de Bouxès, La Roque-Sainte-Marguerite, 9330 ± 200
Aveyron**

Bones from clayey fill of cave (44° 8' N, 3° 13' E). Coll and subm 1981 by A Tavoso, Prehist Dept, Univ Marseille. *Comment* (AT): date is younger than expected because assoc cold-climate fauna suggests more Tardiglacial period than Pre-boreal age.

**Ly-2614. Grotte du Bois du Cantet, Espèche, 10,920 ± 160
Hautes-Pyrénées**

Bird bones from cave gallery (43° 3' N, 0° 8' E). Coll 1977 by A Clot, subm by A Clot and C Mourer-Chauviré, Geol Lab, Univ Lyon I. C Mourer-Chauviré attributes cave fill to Tardiglacial period by bird bones study. *Comment* (CM): date agrees with two previous measurements, Ly-1403: 13,370 ± 270 and Ly-1404: 13,060 ± 430 from two other areas of same cave (R, 1979, v 21, p 444) (Clot, 1934).

Ly-3001. Gouffre de Taille-Petit, Sainte-Orse, Dordogne 10,870 ± 330

Bones from fill of small pit (45° 22' N, 1° 4' E). Coll 1982 by C Mourer-Chauviré and subm by M Philippe, Mus Hist Natl, Lyon. *Comment* (MP): date is youngest of all samples from caves and pits of karstic calcareous plateaus, called "Causses" in region (see Gramat and Martel Causse series, R, 1979, v 21, p 416–418) (Philippe, Mourer-Chauviré, & Evin, 1980).

Igue de Barrière series, Miers, Lot

Bones from fill in karstic network (44° 53' N, 1° 42' E). Coll 1981 and subm 1983 by M Philippe. Provenience of previously dated bone sample, Ly-1576: 19,940 ± 800 (R, 1979, v 21, p 417) seems doubtful and is probably result of mixing of bone fragments from three other loci in site.

Ly-3030. Igue de Barrière No. 3 19,340 ± 1850
From calcified dome at base of Pit 1 (0.1 dr).

Ly-3031. Igue de Barrière No. 1 24,420 ± 560
From same area as Ly-3030 (0.7 dr).

Ly-3002. Igue de Barrière No. 4 27,290 ± 710
From partially emptied ancient gallery.

Ly-3003. Igue de Barrière No. 5 1070 ± 120
**AD770–1190*

From recent gallery which is deepest.

General Comment (MP): large differences in dates and collagen contents indicate that fill of karstic network comprises very complex mix of numerous successive layers of deposits, removals, and redepositions sometimes affecting only oldest sediments, in downward direction (Philippe & Durand, 1984).

Ly-2811. Grotte de la Balme Rousse, Choranche, Isère 26,000 ± 1500

Bones (*Ursus spelaeus*) from Layer E3 at base of cave fill (45° 4' N, 50° 24' E). Coll and subm 1982 by P Bintz, Lab Geol, Univ Grenoble (0.2 dr). *Comment* (PB): date corresponds to Würmian III and confirms that *Ursus spelaeus* became extinct in Alpine massif as late as in Pyrénées massif (see West Pyrénées mammals series, above).

Jaurens series, Nespouls, Corrèze

Bones from each extremity of fossiliferous layer of cave fill (45° 2' N, 1° 41' E). Coll 1970 and subm 1978 by C Mourer-Chauviré.

Ly-1939. Jaurens, Sec 1 **29,700 + 1500**
- 1300

From sec 1.

Ly-1938. Jaurens, Sec 20 **32,630 + 2900**
- 2100

From sec 20.

General Comment (CM): dates are close and agree with two previous results from same site, Ly-359: 29,300 ± 1400 and Ly-892:30,350 ⁺³⁰⁰⁰ ₋₁₉₀₀ (R, 1976, v 18, p 66–67). All four values indicate cave fill is homogeneous and dates to beginning of Würmian III (Guérin, Philippe, & Vilain, 1979).

Ly-2697. Grotte des Camisards, Sumène, Gard **≥35,000**

Bones (*Ursus spelaeus*) from top of fill of cave gallery (43° 58' N, 3° 3' E). Coll and subm 1981 by A Bonnet, Nîmes. *Comment* (AB): date is older than others for *Ursus spelaeus* bones from caves in area, eg, Grotte Latrone cave, Ly-1966: 29,600 ± 1100 (R, 1983, v 25, p 74) and La Baume Longue cave, Ly-2415: 26,500 ± 1000 (R, 1983, v 25, p 73).

Samples from Fluvial and Fluvio-Glacial Sediments

Ly-2527. Les Touches, Sinard, Isère **Modern**
δ¹⁴C = 445 ± 25‰

Stalks of *Equisetum* sp from glacio-lacustrine clay deposit corresponding to max advance of Würmian glacier in Le Triève region near Grenoble (44° 56' N, 5° 40' E). Coll and subm 1981 by G Monjuvent, Lab Geol, Univ Grenoble. *Comment* (GM): date shows that despite ancient appearance and depth of burial in sediments, *Equisetum* could have grown quickly in rather compact clays.

La Plaine series, Brégnier-Cordon, Ain

Wood from several levels of Rhône R sediments (45° 39' N, 5° 36' E). Coll and subm 1982 by J Evin and J P Bravard, Lab Geog, Univ Lyon III and 1983 (Ly-3051) by G Monjuvent.

- Modern**
- Ly-3051. Brégnier-Cordon No. 4** $\delta^{14}\text{C} = -0.1 \pm 15.4\text{‰}$
Wood from underlying moraine, coll by boring (0.8 dr).
- 1050 \pm 120**
Ly-2777. Brégnier-Cordon No. 1 **AD780–1210*
Wood from fluvial gravels.
- 1420 \pm 140**
Ly-2776. Brégnier-Cordon No. 2 **AD340–880*
Wood from S sec of site, overlying clays that underlay fluvial gravels.
- 1660 \pm 110**
Ly-2775. Brégnier-Cordon No. 3 **AD70–585*
Wood from same level as Ly-2776, in N sec of site (0.7 dr).
General Comment (JPB): Ly-3051 shows this wood does not belong to geom. Ly-2776 and -2775 represent end of lacustrine sedimentation in valley which just precedes filling by gravel horizon, 10m deep deposited after sudden change in river course, historically dated to Early Middle ages (Bravard, 1983) agrees perfectly with Ly-2777.
- 2770 \pm 120**
Ly-3029. Pont de l'Hers, L'Union, Haute-Garonne **1235–785BC*
Fragment of oak trunk, buried ca 4m deep in Hers R alluvium (43° 39' N, 1° 28' E). Coll 1979 and subm 1983 by J C Revel, Lab Pédol, Univ Toulouse (0.8 dr). Assumed to be assoc with overlying Bronze age site (Gif-5499: 3660 \pm 100, unpub). *Comment* (JCR): date is much younger than archaeol site and shows that river channel filling is complex, as only few m away, lowest level of fill is much more recent.
- 4770 \pm 180**
Ly-1853. Les Crés, Saint-Maurice l'Exil, Isère **3890–3070BC*
Wood from tree trunk found 3m deep in alluvium of small tributary of Rhône R, near Nuclear Power Plant at Saint-Alban-Saint-Maurice (45° 31' N, 4° 45' E). Coll and subm 1979 by M Délétié, Electricité France Soc, Paris. *Comment* (MD): date indicates Atlantic age for end of alluvial filling in tributary valley.
- Livet series, Isère**
Sample from La Romanche R alluvium in its middle valley (45° 6' N, 5° 56' E); subm 1982 by M Dubie, Electricité France Soc, Chambéry.
- 590 \pm 120**
Ly-2648. Tranchée de Livet **AD1250–1430*
Charcoal from trench coll 1982.

Ly-2616. Sondage du Pont de Livet 7460 ± 230

General Comment (MD): dates represent two stages of postglacial alluviation of valley. Ly-2616 indicates that large stone blocks found very deep in level may come from relatively recent collapse.

La Haute-Romanche series, Hautes-Alpes

Sample from two borings in high alt sediments drilled by hydroelectric equipment in high valley of Romanche R. Coll 1981 by Bachy Soc and subm 1982 by F Rosset, Electricité France Soc, Chambéry.

Ly-2854. Plan de l'Alpe, Villar d'Arène 4870 ± 130
**3895-3365BC*

Wood, 9m depth, in Boring VPA-8201 at alt 1960m (45° 1' N, 6° 22' E).

Ly-2853. Lac de Goléon, La Grave 5020 ± 140
**4100-3580BC*

Peat, 3.5m depth, in Boring VGO-8104 at alt 2440m (45° 5' N, 6° 19' E).

General Comment (FR): dates are in expected range, and represent end of Atlantic climatic phase. They prove that forest developed at much higher alt than present in this area, as well as in Alpe d'Huez area (above).

Les Isles series, Champagneux, Savoie

Sample from top and base of sandy formation underlying fluvial gravels in stream channel of Rhône R (45° 38' N, 5° 39' E). Coll and subm 1982 by J P Bravard, Lab Geog, Univ Lyon III.

Ly-2778. Les Isles de Champagneux, Tourbe 6330 ± 140
**5575-4965BC*

Water-rolled peat blocks from 10m depth directly overlying fluvial gravels.

Ly-2779. Les Isles de Champagneux, Bois 8560 ± 190

Fragment of tree trunk at 12m depth directly overlying glaciolacustrine sediments.

General Comment (JPB): Ly-2779 marks end of lacustrine filling of glacial valley of Rhône R; Ly-2778 marks beginning of fluvial sedimentation.

Ly-3059. Saint-Marceau, Orléans, Loiret 7300 ± 140

Wood from tree trunk at 6m depth from boring in alluvium of Loire R (47° 54' N, 1° 52' E). Coll and subm 1983 by Y M Allain, Service Espace Verts, Orléans. *Comment* (YMA): date indicates that alluvial substratum of area of Orléans, built several centuries ago, was deposited at beginning of Atlantic period.

Ly-3026. Moulin Tampon, Perreux, Loire **8430 ± 130**

Wood from central part of tree trunk found at ca 2.5m depth in alluvial plain of Loire R (46° 2' N, 4° 5' E). Coll 1981 and subm 1983 by M Vaginay, Dir Antiquités Hist Lyon. *Comment* (MV): date is of Boreal period, indicating relatively thick sedimentation in middle Loire valley since beginning of Holocene.

Ly-2981. Saint-Egrève, Isère **10,310 ± 170**

Wood, ca 20m depth, in Isère R alluvia (45° 15' N, 5° 41' E). Coll and subm 1983 by M Guimard, Electricité France Soc, Chambéry. *Comment* (MG): date indicates relatively thick alluviation in this valley from beginning of Holocene, coinciding with previous dates on this site, from similar samples, Sa-221: 7300 ± 350 and Sa-220: 9500 ± 400 (R, 1975, v 7, p 239)

Ly-2815. Allaman, Vaud, Switzerland **13,090 ± 160**

Bones (*Bos primigenius*) from terrace of Lake Lemman at alt 400m (46° 28' N, 6° 21' E). Coll and subm 1982 by M Weidmann, Geol Mus, Lausanne. *Comment* (MW): date suggests Bölling period and confirms presence of this climatic phase in region (Arn, in press a).

Pugneux series, Bressoles, Ain

Vegetal debris from several levels of two sandy clay fms (45° 51' N, 5° 6' E). Coll and subm 1981 by R Vilain, Lab Geol, Univ Lyon I and J Evin. Lowest fm is terminal moraine of last Würmian glacier and uppermost fm is lacustrine deposited behind morain dam.

General Comment (RV & JE): Ly-2317 and -2994 confirm paleontol data from rodents and gasteropods, and paleobot data which attribute Miocene origin to vegetal debris redeposited by Würmian glacier in lower fm. Other results are in perfect strat agreement, indicating beginning of Würmian III period as min age for last retreat of Würmian glacier.

TABLE 12
Pugneux

Sample no.	Location in section	DR	Age (BP)
Ly-2997	Middle of upper fm	0.5	17,300 ± 510
-2996	10cm above base of upper fm	0.7	22,580 ± 500
-2995	10cm above base of upper fm	1	22,640 ± 600
-2993	Base of upper fm	0.7	23,440 ± 450
-2318	Base of upper fm	1	24,110 ± 900
-2994	Top of lower fm	1	≥35,000
-2317	Ca 10cm under top of lower fm	1	≥35,000

Ly-2525. Font du Renard, Bras d'Asse, Alpes de Haute Provence **32,300 ± 900**

Fragment of charred tree trunk, ca 4m depth, at base of brown paleosol in Asse R alluvia (43° 55' N, 6° 17' E). Coll 1980 and subm 1981 by M Dubar, Centre Recherche Archeol, Valbonne. *Comment* (MD): as sample

was assoc with flora and fauna of temperate climate, date, as expected, may correspond to Würmian II/III interstadial, and shows that overlying cryoclastic sediments were deposited at end of Late Würmian (Dubar, 1983).

Ly-2515. Montagnat, Ain $\geq 33,000$

Wood, 5m depth, from boring in La Vallière R alluvia (46° 4' N, 5° 18' E). Coll 1981 by G Vicherd, Dir Antiquités Hist, Lyon and subm by R Vilain. *Comment* (RV): date is much older than expected as overlying sediments seemed to be of Holocene origin. Thus, pronounced erosion must have occurred during early Quaternary.

Ly-2530. Armoy, Haute-Savoie $\geq 35,000$

Peat from alt 545m in Drance R valley (46° 21' N, 6° 31' E). Coll and subm 1981 by R Arn. *Comment* (RA): date agrees with palynol, which suggests older age for all underlying fms (Arn, in press b) previously attributed to Würmian (Brun, 1977). Other samples, Gif-491: $\geq 35,000$ and Gif-739: $\geq 35,000$ (R, 1969, v 11, p 331) come from neighboring site.

Samples from Various Continental Sediments

La Vieille Citerne series, Bonnevaux, Doubs

Charcoal from soil in dolina containing three levels rich in charcoal, separated by two levels of silts, 10cm thick (46° 50' N, 6° 11' E). Coll 1979 and subm 1980 by M Gaiffe, Lab Bot, Univ Besançon.

General Comment (MG): dates indicate filling rate of ca 30cm per millennium for bottom of dolina by material from erosion of neighboring soils (Gaiffe, 1983).

TABLE 13
La Vieille Citerne

Sample no.	Ref no.	Depth (cm)	DR	Age (BP)	^{14}C activity or corrected date interval (AD)
Ly-2362	1	8	0.7	Modern	$\delta^{14}\text{C} = -3 \pm 18\text{‰}$
-2363	2	30-35	1	Modern	$\delta^{14}\text{C} = +9 \pm 14\text{‰}$
-2258	3	38-40	0.2	1030 \pm 190	620-1280

Vallon du Po series, Tiébelé, Haute-Volta

Black potsherds from 1 to 1.5m depth from top of alluvium of small valley (11° 14' N, 1° 5' W). Coll 1982 by M Mietton and subm 1982 by M Chardon, Lab Geog, Univ Grenoble (0.8 dr).

Ly-2802. P B F 1 930 ± 200
**AD605-1420*

Ly-2803. P B F 3 840 ± 150
**AD905-1345*

General Comment (MC): despite lack of data on origin of carbon contained in black potsherd (Evin, 1983), both dates agree and indicate alluvium is

recent, and erosion rate has been greater than sedimentation rate since 17th century.

Ly-2862. Uré, Ile des Pins, New Caledonia **3470 ± 210**
*2305–1410BC

Bone debris (*Silviornis neocaledoniae*) and other vertebrates from corale breccia filling fossiliferous well in raised reef barrier of island in Kameruna Bay (22° 40' S, 167° 25' E). Coll 1980, extracted from breccia cement using formic acid leaching and subm 1983 by F Poplin, Mus Nat Hist Natl Paris. *Comment* (FP): date confirms hypothesis based on previous measurement of cement of breccia from same site, Ly-2105: 19,490 ± 330 (R, 1983, v 25, p 8); breccia should correlate ancient coral elements with very recent bone remains. It also proves *Silviornis* and other assoc animal sp have only recently become extinct, probably at time of human arrival on island (Poplin, Mourer-Chauviré, & Evin, 1983).

Baringo Lake series, Kenya

Clay with low organic content from cores in basal sediments of lake in Gregory rift (0° 36' N, 36° 6' E). Coll 1976 and 1978 and subm 1979 by J J Tiercelin, Lab Quaternary Geol, Univ Marseille.

Ly-1822. BAR 78-3, No. 1 **1740 ± 500**

From Levels 1 to 7, 0 to 20cm depth in BAR 78-3 Core (0.1 dr).

Ly-1823. BAR 78-3, No. 2 **920 ± 270**

From Levels 31 to 37, 90 to 112cm in BAR 78-3 Core (0.2 dr).

Ly-1850. 62002 **5330 ± 500**

From 0 to 22cm depth in 62002 Core (0.2 dr).

Ly-1758. 36016/36020 **2670 ± 570**

From 75 to 105cm depth in 36016 and 36020 Cores (0.1 dr).

General Comment (JJT): first three dates appear aberrant. Ly-1822 and -1823 have inverted values for top and base of same core; Ly-1850 seems much too old for upper part of core. This may be due to complex origin of organic component of sediment which may come in part from older soil horizons (Tiercelin *et al*, 1981). Ly-1758 is meaningless because of mixing of sediments from two cores with no strat relationship.

Bogoria Lake series, Kenya

Samples from base of bank sediments of lake in Gregory rift (0° 15' N, 36° 3' E). Coll 1977 by J J Tiercelin and R W Renaut, Queen Mary College, London, and subm 1979 by J J Tiercelin.

Ly-1820. BOG 77-83 No. 1 **3900 ± 410**

Clay with low organic content from Levels 1 to 6, 0 to 20cm depth, from BOG 77-83 Core (0.3 dr).

Ly-1821. BOG 77-83 No. 2 **3500 ± 390**

Clay with low organic content from Levels 17 to 22, 48 to 64cm depth, from BOG 77-83 Core (0.2 dr).

Ly-1819. BOG 77-94 **6290 ± 460**

Clay with low organic content from Levels 20 to 24, 59 to 73cm depth from 77-94 Core (0.3 dr).

Ly-1818. BOG 77-62 **6310 ± 440**

Clay with low organic content from Levels 28 to 32, 80 to 95cm depth from BOG 77-62 Core.

Ly-1981. Stromatolithe **3730 ± 180**
**2645–1700BC*

Stromatolithic calcareous crust from W side of lake at alt corresponding to former high level of lake.

Ly-1982. Shells **15,520 ± 420**

Shells (*Melanoïdes* sp) from W side of lake corresponding to former high level of lake.

General Comment (JJT): Ly-1981 and -1982 agree with expected ages and coincide with other results from identical samples (Young & Renaut, 1979; Tiercelin, 1981). Other measurements from organic clays give less reliable results: Ly-1820 and -1821 are in inverted order, although they come from top and base of same core, whereas Ly-1818 and -1819 give dates which appear much too old compared to levels from core.

Le Grand Etang series, La Réunion Island

Wood from two levels in S3 Boring (18° S, 55° E). Coll 1980 and subm 1981 by P Délétie, Electricité France Soc, Paris.

Ly-2368. Le Grand Etang A **5650 ± 180**
**4955–3975BC*

From 24m depth above level of volcanic scoria (0.8 dr).

Ly-2369. Le Grand Etang B **5000 ± 290**
**4955–3975BC*

From 26.8m depth under same volcanic scoria level as Ly-2368.

General Comment (PD): although both dates are very close, they are in inverted strat order. However, they date to ca 5200 BP with volcanic scoria level occurring between them; this level corresponds to eccentric eruption of La Fournaise volcano which agrees with other dates (Bachelery, 1981).

Ly-2809. Blirh, Caïda de Ksabi, Prov Missour, Morocco **8260 ± 180**

Clay with large amount of small charcoal fragments from lacustrine sediments from presently arid region (32° 51' N, 4° 13' W). Coll 1982 by D Lefevre and subm 1982 by J P Raynal, Lab Quaternary Geol, Univ Bordeaux I. *Comment* (JPR & DL): as expected, date corresponds to beginning

of Holocene, relatively humid climatic period in N Africa. Date confirms another unpub date, SUA-2014: 9220 ± 110 taken from carbonaceous concretions at top of same geol level (Lefevre, 1985).

Izimane series, Hassi Bel Gebbour, Ouargla Willaya, Algeria

Samples from four levels of geol outcropping on slope of isolated mound ($26^{\circ} 45' \text{ N}$, $6^{\circ} 54' \text{ E}$). Coll and subm 1981 (paleosol) and 1984 (calcareous) by A Bonnet, Nîmes.

4200 \pm 190

Ly-3082. Calcaire du Sommet **3360-2330BC*
Dolomitic limestone and gypsum from top of sec (0.6 dr).

6780 \pm 140

Ly-2642. Sommet du Paléosol **6055-5320BC*
Organic matter from upper part of black hydromorphic paleosol, middle part of sec.

8060 \pm 140

Ly-2643. Base du Paléosol
Organic matter from base of same paleosol of Ly-2642.

9810 \pm 250

Ly-3083. Calcaire de la Base
Dolomitic limestone and gypsum from base of sec (0.5 dr).

General Comment (AB): Ly-3082 agrees with expected age and marks end of sedimentation and beginning of present arid period. Ly-2642 perfectly agrees with two other dates from another black paleosol in Tichodaïne region, Ly-407: 6870 ± 150 (R, 1973, v 15, p 146) and Ly-2483: 6010 ± 160 (R, 1983, v 25, p 110). These three values date max of swamp vegetation in region which is now entirely desert. Ly-2643 marks beginning of humid period and confirmed by Ly-3083, which is assumed to come from lateral calcareous level equivalent to base of paleosol and which may seem older due to influence of surrounding Mesozoic limestone (Roubet & Matheu, 1970).

8370 \pm 200

Ly-3032. Amguid, Tamanrasset Willaya, Algeria
Calcareous tufa from upper part of tufa level of ancient waterfall near Amguid ($26^{\circ} 26' \text{ N}$, $5^{\circ} 23' \text{ E}$). Coll 1982 and subm 1983 by A Bonnet. *Comment (AB):* as waterfall probably flowed for last time during last Saharan Pluvial, date agrees perfectly with expected age of this humid climatic phase, and corresponds to base of Izimane series (above) as well as to another measurement from lacustrine limestone near Hirafok, Gif-325: 8380 ± 300 (Delibrias & Dutil, 1966).

Oued series, N Tunisia

Samples from alluvial sediments from valleys of three wadis. Coll 1977 (Ly-2897) and 1982 and subm 1982 by A Miossec, Lab Geog, Univ Nantes.

Ly-2899. Oued Hamman, Argoub Hassine, Modern
Nefza Dept $\delta^{14}\text{C} = +7.1 \pm 17.9\text{‰}$

Charcoal from base of alluvial cone (41° 14' N, 7° 55' E). *Comment* (AM): date shows charcoals do not belong to geol fm.

Ly-2900. Oued El Hamman, Ragoubet Tassera, 5870 \pm 320
Nefza Dept *5305–4140BC

Gastropod shells from scree slope older than low terrace of wadi (41° 14' N, 7° 54' E) (0.2 dr). *Comment* (AM): date shows relatively late Holocene deposit of scree, but difference from Ly-2897 (below) does not seem significant.

Ly-2897. Djebel El Hara, Hedil region, Joumine Dept 8690 \pm 280

Small gastropod shells from slope deposit in small wadi valley (41° 1' N, 7° 89' E). *Comment* (AM): date agrees with expected age as it shows that slope deposit took place at beginning of Holocene before this deposit of "Rhabian" terrace which is older than series of cones from Nefza region (Ly-2900, above).

Ly-2581. Cours Sablon, Clermont-Ferrand, Puy-de-Dôme $\geq 32,000$

Sandy silts with high organic content from foundation of bldg in city (45° 47' N, 3° 5' E). Coll and subm 1981 by J P Daugas, Dir Antiquités Prehist Clermont-Ferrand, and J P Raynal. Level underlies pyroclastic volcanic sediments from the Clermont maar (ancient lake in crater of extinct volcano). *Comment* (JPD & JPR): as expected, result is infinite age because volcanic eruption surely occurred before Würmian period, as suggested by TL date by Clermont Lab: Cler-TL-23: 156,000 \pm 17,000 before 1980 (Miallier, 1982).

Samples from Marine and Lagoonal Sediments

Ly-2896. Sondage DJ6, Ahémé lake, Bénin $\delta^{14}\text{C} = +8 \pm 18\text{‰}$
Modern

Shells from Level 6, 30cm depth, from boring in Aho R bank, between Lake Ahémé and sea (6° 19' N, 1° 58' E). Coll 1982 by M Oyédé, Univ Cotonou, and subm 1983 by J Lang, Lab Geol, Univ Dijon (0.5 dr). *Comment* (JL & MO): slightly older date was expected. This date shows change in sedimentation rate in N part of Lake Ahémé (Oyédé, 1983).

Bonthe Distric Coast series, Sierra Leone

Shells from top of offshore sand bar in coastal sites. Coll 1979 and 1980 by E Anthony and subm 1981 by P Michel Lab Geol, Univ Strasbourg.

General Comment (EA): dates of ca 2000 BP were expected because of previous measurements made by Gif Lab (Labeyrie & Delibrias, 1976). Dates show that samples come from kitchen middens of recent human settlements and have no relation to sea level change.

TABLE 14
Bonthe District

Sample no.	Site	Geog coordinates	Sample	DR	Age (BP)	Corrected date interval or ¹⁴ C activity
Ly-2484	Yoni	(7° 29' N, 12° 30' W)	<i>Anadara senelis</i>	0.7	690 ± 140	AD1190–1480
-2485	Tisana	(7° 35' N, 12° 37' W)	<i>Anadara senelis</i>	1	Modern	δ ¹⁴ C = −15 ± 18‰
-2486	Jimaï	(7° 25' N, 12° 30' W)	<i>Anadara senelis</i>	0.8	Modern	δ ¹⁴ C = +29 ± 19‰
			<i>Crasostrea gasar</i>			
-2487	Baki	(7° 35' N, 13° 00' W)	Undetermined	0.7	Modern	δ ¹⁴ C = +1 ± 19‰

Red Sea coast series, Sudan

Samples from Marsa Odudu (21° 3' N, 37° 3' E) and Aydhab (22° 20' N, 36° 30' E) on Red Sea coast. Coll and subm 1981 by R Dalongeville, Maison de l'Orient Méditerranéen, Univ Lyon II.

General Comment (RD): all results are very consistent with expected values (Dalongeville & Sanlaville, 1981) but Ly-2466 must be considered according to widest statistical margin.

TABLE 15
Sudan Coast

Sample no.	Site	Ref no.	Sample	DR	Expected age (centuries)	Age (BP)	Corrected date interval or ¹⁴ C activity
Ly-2465	Marsa Odudu	11	Corals	1	recent	Modern	δ ¹⁴ C = +178 ± 17‰
-2466	Aydhab	24	Charcoal	0.15	9th–16th	Modern	δ ¹⁴ C = +25 ± 25‰
-2467	Aydhab	25	Shells	1	9th–16th	790 ± 120	AD1040–1335
-2468	Aydhab	27	Shells	1	5th–10th	270 ± 110	AD1420–1950
-2469	Aydhab	28	Corals	0.6	Holocene	Modern	δ ¹⁴ C = +170 ± 23‰
-2470	Aydhab	30	Charcoal	0.15	5th–15th	630 ± 200	AD1045–1610

Coast series, La Grande-Terre Island, Guadeloupe

Sample from continental sediments from boring at −5.4m under msl on W coast (Ly-2952) and from raised beaches at +2m and +3m on E

TABLE 16
La Grande Terre Island

Sample no.	Site	Geog coordinates	Ref no.	Sample	Age (BP)	Corrected date interval
Ly-2952	Belle Plaine,	(16° 18' N, 61° 31' W)	0	Peat	4010 ± 180	3020–2120BC
	Les Abymes					
-2945	Pointe Gros Boeuf,	(16° 14' N, 61° 18' W)	1	Charcoal	2090 ± 120	395BC–AD195
	Ste Anne					
-2947	Pointe Gros Boeuf,	(16° 14' N, 61° 18' W)	3	Coral	2480 ± 160	865BC–260BC
	Ste Anne					
-2949	Pointe Gros Boeuf,	(16° 14' N, 61° 18' W)	5	Shells	3920 ± 200	2905–1950BC
	Ste Anne					
-2950	Pointe Gros Boeuf,	(16° 14' N, 61° 18' W)	6	Beach rock	2650 ± 100	1040–595BC
	Ste Anne					
-2946	Plage Gros Boeuf,	(16° 14' N, 61° 17' W)	2	Coral	3080 ± 160	1685–910BC
	St François					
-2948	Porte d'Enfer,	(16° 19' N, 61° 18' W)	4	Shells	1000 ± 120	AD870–1230
	Le Moule					
-2953	Baie du Moule,	(16° 20' N, 61° 21' W)	9	Coral	27,600 ± 650	
	Le Moule					

coast. Coll and subm 1982 by A Assor and A Klingebiel, Lab Geol, Univ Bordeaux.

General Comment (AK): dates confirm shifting of La Grande Terre I. due to westward movement downward and eastward rising along axis, La Plaine des Abymes-Grand Culs de Sac-Pointe du Château.

Carribee Sea coast series, Colombia

Sample from marine sediments outcropping several m above present msl in Cartagena Bay. Coll 1979 and subm 1981 by T Burel, Lab Geol, Univ Bordeaux I.

General Comment (TB): dates agree with two previous measurements, from Tierrabomba I. (unpub), 2850 ± 150 (Richards & Broecker, 1963), and from Cienaga Honda, S part of Catagena Bay, Gif-5038: 2700 ± 90 (Burel, Klingebiel, & Vernet, 1982). They confirm contemporaneity of deposits of shell conglomerates and building of coral reef during rise in sea level at ca 3000 BP.

TABLE 17
Carribee Sea coast

Sample no.	Site	Ref no.	Geog coordinates	Sample	Age (BP)	Corrected date interval
Ly-2477	Tierrabomba I.	24 bis	(10° 24' N, 75° 35' W)	Shell	1930 ± 120	165BC-AD240
-2479	Tierrabomba I.	30	(10° 24' N, 75° 33' W)	Coral	2670 ± 120	AD65-585
-2481	Tierrabomba I.	79TB21	(10° 24' N, 75° 35' W)	Coral	3690 ± 160	2530-1735BC
-2478	Escuela Naval	333	(10° 25' N, 75° 30' W)	Coral	2470 ± 120	810-395BC
-2480	Manzanillo	140	(10° 31' N, 75° 40' W)	Shell	1450 ± 130	AD250-865
-2482	Tesoro I.	131	(10° 18' N, 75° 40' W)	Coral	1780 ± 120	AD15-440

2170 ± 210

Ly-2633. Moulay Bou Salham, Kénitra Prov, Morocco *760BC-AD215

Shells from 30 to 35cm depth from boring in sediments of dessicating lagoon (34° 50' N, 6° 13' W). Coll 1978 and subm 1982 by C Carruesco, Lab Geol, Univ Bordeaux I. *Comment* (CC): date agrees with Gif-4542: 3490 ± 100 (unpub) from underlying level, 59 to 64cm depth, of same site and marks end of Mellahian transgression, also dated in Oualidia lagoon (below) (Bidet & Carruesco, 1980)

Oualidia series, El Jalida Prov, Morocco

Shell debris from borings in dessicating lagoon (32° 45' N, 9° 0' W). Samples come from transgressional marine sediments underlying lagoon sediments. Coll 1977 and subm 1978 by C Carruesco.

TABLE 18
Oualidia

Sample no.	Boring no.	Depth (cm)	DR	Age (BP)	Corrected date interval
Ly-2627	77008	30-35	0.07	4880 ± 490	4325-3035
-2628	77013	50-55	1	2120 ± 130	415BC-AD210
-2629	77014	60-75	1	3840 ± 130	1770-1940BC
-2630	77016	50-55	1	3320 ± 130	1965-1360BC
-2631	77018	80-85	0.25	3330 ± 240	2110-1145BC
-2632	77019	base	0.8	6420 ± 190	5915-4995BC

General Comment (CC): dates mark beginning and max of Mellahian transgression in region, also called Flandrian or Nouakchottian, often dated in Mauritania (Ortlieb, 1980).

4520 ± 130

Ly-2615. Tin Ouéich, Mauritania

**3545–2900BC*

Shells (*Cerastoderma edule*) from lagoonal clayey sand level (18° 4' N, 15° 49' W). Coll and subm 1982 by D Carité, Nouakchott. Sample was dated to confirm geol interpretation of site previously based on dates: Ly-2160: 35,000 $\begin{smallmatrix} + 1900 \\ - 1600 \end{smallmatrix}$ and Ly-2189: 29,900 ± 600 (R, 1983, v 25, p 64). *Comment* (DC): date corresponding to max of Nouakchottian transgression shows that level dated to Inchirian was later cut by channel before Nouakchottian transgression, which deposited sediment with same facies as Inchirian (Carité, 1983).

Sea coast series, Bahraïn

Samples from two coastal archaeol sites, Ras Hayyan (26° 2' N, 50° 38' E) and Qalaat el Bahraïn (26° 14' N, 50° 31' E). Coll and subm 1982 by P Sanlaville, Maison Orient Méditerranéen, Univ Lyon II, and R Paskoff, Univ Tunis, during study of sea level changes and human settlements on coast.

General Comment (PS): at Qalaat, except for Ly-2868, which was probably redeposited older material, all dates suggest evolution of sea shore occurred as expected from results of strat study of archaeol sites and agree with most Birmingham dates from same site (Doornkamp, Brunsten, & Jones, 1980). At Ras Hayyan, Ly-2872 fits better with expected value than 4 Birmingham dates, ca 7000 to 6000 BP.

TABLE 19
Bahraïn Sea coast

Sample no.	Site	Sample	Alt (cm)	Age (BP)	Corrected date interval (BC)
Ly-2871	Qalaat	Shells	–80	3430 ± 120	2030–1520
-2870	Qalaat	Shells	+35–15	3260 ± 160	1885–1260
-2869	Qalaat	Shells	+65–35	3030 ± 120	1550–915
-2868	Qalaat	<i>Vermitidae</i> crust	+50–100	5960 ± 140	5240–4450
-2867	Qalaat	<i>Vermitidae</i> crust	+50–100	4350 ± 160	3470–2650
-2872	Ras Hayyan	Shells	+200	5070 ± 160	4135–3640

Sidi Salhem formation series, Gabès gulf, S Tunisia

Mollusk shells from shelly sands in Sidi-Salhem sandstone dunes, in Jerba I. region. Coll and subm 1982 by R Paskoff and P Sanlaville.

Ly-2617. Borj Gourine**4210 ± 250****3430–2275BC*

Shells (*Helix* sp) from Gourine ancient Borj (33° 39' N, 10° 56' E) (0.7 dr).

Ly-2618. Borj Gastil**6890 ± 390****6550–5220BC*

Shells (*Helix* sp, *Lucina* sp) from S coast of Jerba I. (33° 42' N, 10° 56' E) (0.15 dr).

General Comment (PS): both dates attribute Holocene age to Sidi-Salhem sandstone, previously assumed to be marine deposit from Middle Würmian (Paskoff & Sanlaville, 1983). They agree with other unpub results from Monaco lab.

Ly-2873. Sidi Fredj, Kerkennah I., S Tunisia**17,850 ± 430**

Shells (*Helix* sp) from red sandy silt outcropping on beach in Cherguia I. (39° 49' N, 11° 8' E). Coll 1981 and subm 1983 by P Sanlaville and R Paskoff. *Comment* (PS): silts were attributed to Holocene because of presence of Neolithic potsherds. However, date shows they are redeposited Würmian silts. Other measurements showing importance of neotectonics in site were pub previously (R, 1983, v 25, p 83).

Le Tlêt formation series, Gabès gulf, S Tunisia

Samples from Tlêt shelly sandstone outcropping forming slope deposit on sea shore. Coll and subm 1982 by R Paskoff and P Sanlaville.

Ly-2644. Oued Fahmine**20,690 ± 360**

Shells of various sp from S shore of Jerba I. (33° 43' N, 10° 51' E).

Ly-2645. Guellala and Oued Ogla**23,090 ± 560**

Small fragments of ostrich eggs from two sampling areas in Tlêt sandstone, near wadi Ogla R valley on Zarzis peninsula (33° 34' N, 10° 55' E) (0.5 dr).

General Comment (PS): agreement of these dates confirms that ostrich eggs may be used as dating material, even in old sediments (Evin, 1983). Although both dates seem ca 2 or 3 millennia too young, they prove Tlêt fm is not Tyrrhenian (ca 85,000 BP), but is rather Würmian, ca 27,000 BP in Gabès gulf region.

Coastal Crete and Naxos I. series, Greece

Samples from S shore of Crete I. at Preveli near Ayla Galini (35° 8' N, 24° 40' E), at Akrotiri, near Khania (35° 8' N, 24° 3' E), from N shore of Crete I. at Aghia Barbara, near Mallia (35° 16' N, 25° 30' E), and from N shore of Naxos I. at Palati cave near Naxos (37° 6' N, 25° 22' E). Coll and subm by R Dalongeville, during study of shoreline variation.

General Comment (RD): large age differences are due to variations in influence of neotectonics at different points along shoreline. Thus, Ly-

TABLE 20
Crete and Naxos Islands

Sample no.	Site	Ref no.	Sample	DR	Expected age	Age (BP)	Corrected date interval
Ly-2471	Preveli		<i>Vermetidae</i>	1	5th century AD	2320 ± 160	785–45BC
-2472	Aghia Barbara	1	<i>Vermetidae</i>	1	ca 1600 BC	1420 ± 120	AD435–785
-2473	Aghia Barbara	2	<i>Vermetidae</i>	0.8	ca 1600 BC	22,840 ± 450	
-2474	Aghia Barbara	3	<i>Vermetidae</i>	0.8	Holocene	25,530 ± 440	
-2475	Grotta Palati	1	<i>Cardium</i> shells	1	2800 BC	5560 ± 160	4710–3960BC
-2476	Akrotiri		<i>Vermetidae</i>	1	3000 BC	11,570 ± 170	

2473 and -2474 show some sediments were formed during transgression prior to Flandrian.

N W Mediterranean Sea series

Calcium carbonate from marine sediments from cores from Rhône R delta to W shore of Corsica. Coll 1981 by M Fernex, Lab Marine Geol, Villefranche-sur-Mer, and subm by L Blanc, Lab Quaternary Geol, Univ Marseille and MT Morzadec, Lab Geol, Univ Rennes. All measurements were made on total carbonate fraction even where detritic elements might have been present, as in previous study on Pelagian Sea (Buroillet & Winnock, 1979).

General Comment (LB & MTM): for Cores KS3030, MKS7, and KSPF, there seems to be agreement between dates and data from other analytical methods, such as sedimentol, palynol, and *Dinoflagellae* studies, even for samples with possible detritic carbonates. Only Ly-2491 seems too recent for unknown reasons. Results from Cores MKS1 and BRK were not able to be interpreted.

TABLE 21
NW Mediterranean Sea

Sample no.	Core	Geog coordinates	Depth (cm)	DR	Age (BP)
Ly-2493	MKS 1	(42° 59' N, 5° 12' E)	44–54	0.5	13,450 ± 290
-2547	MKS 7	(42° 51' N, 5° 04' E)	10–20	0.7	14,260 ± 260
-2548	MKS 7	(42° 51' N, 5° 04' E)	105–110	1	26,420 ± 550
-2549	MKS 7	(42° 51' N, 5° 04' E)	195–205	1	29,730 ± 750
-2545	KSPF 80-04	(42° 21' N, 4° 55' E)	90–97	0.7	11,080 ± 220
-2546	KSPF 80-04	(42° 21' N, 4° 55' E)	130–142	0.7	21,230 ± 430
-2543	KSPF 79-02	(42° 01' N, 5° 13' E)	30–40	0.6	10,760 ± 240
-2544	KSPF 79-02	(42° 01' N, 5° 13' E)	65–75	0.8	23,180 ± 470
-2489	K 30-30	(41° 49' N, 8° 24' E)	10–20	1	15,720 ± 300
-2490	K 30-30	(41° 49' N, 8° 24' E)	29–39	0.8	31,300 ± 1200
-2557	K 30-30	(41° 49' N, 8° 24' E)	50–60	0.3	≥34,600
-2491	K 30-30	(41° 49' N, 8° 24' E)	60–70	1	31,700 ± 1000
-2492	K 30-30	(41° 49' N, 8° 24' E)	130–140	1	≥37,000
-2556	BRK	Undetermined		0.5	16,560 ± 330

Ly-2951. Le Marin, Martinique29,000 ± 720

Coral outcrops at several m above msl in Le Marin Bay (14° 28' N, 60° 53' W). Coll 1982 by A Klingebiel and R Assor and subm 1983 by C

Carruesco. *Comment* (CC): date is older than expected, and indicates local neotectonic influence.

Ly-2898. Sidi El Fallagui, Bizerte Dept, N Tunisia $\geq 31,000$

Marine or lagoonal shells from sandy marl and clayey horizon, outcropping at alt ca 60m, 3km from shore (41° 45' N, 9° 40' E). Coll and subm 1982 by A Miossec, Lab Geog, Univ Nantes (0.3 dr). *Comment* (AM): date indicates sediments date from at least Tyrrhenian transgression; alts show that tectonic deformation has been marked since this period (Miossec, 1977).

ARCHAEOLOGIC SAMPLES

Historic Period

France

Ly-2998. Le Parc, Gournay sur Aronde, Oise $\delta^{14}\text{C} = -8 \pm 12\text{‰}$ Modern

Ribs of large horse found in pit in Gallic sanctuary (49° 29' N, 2° 40' E). Coll 1980 by JL Brunaux and P Méniel; subm 1983 by P Méniel and F Poplin, Mus Hist Nat Paris. Sample subm to determine horse's origin. Archaeol data suggest horse belonged to Gallic level (Brunaux, Méniel, & Rapin, 1980); osteol data (mainly large size) favors 19th century. *Comment* (FP): date confirms later hypothesis, *ie*, bone is probably from horse of one of Franco-German wars.

Bayeux tapestry series, Bayeux, Calvados

Linen thread from back of Bayeux tapestry from Bayeux Mus (49° 17' N, 0° 42' W). Coll 1982 and subm 1983 by F Macé de Lépinay, Hist Monuments Dept, Paris, as part of study of known Medieval "Queen Matilda tapestry" which is actually wool embroidered on linen.

**Ly-3047. Fragment de doublure 390 ± 120
*AD1385-1635**

Threads from piece of lining added during repair (0.7 dr). Corrected date interval from Stuiver (1982): *AD1300 to 1660.

**Ly-3048. Fil de bagage 260 ± 90
*AD1425-1950**

Threads from attached lining of tapestry. Stuiver corrected date interval: *AD1420 to 1950.

General Comment (FM de L): as expected, study of threads and linen both confirm that repairs occurred long after embroidery (very well-dated to end of 11th century). Large date range obtained after applying both types of correction intervals does not exclude extreme end of Middle Ages as date of weaving of lining, nor 19th century for its final repair.

Dognon series, Le Châtenet en Dognon, Haute-Vienne

Charcoal from two levels in former bldg near Pont du Dognon (45° 56' N, 1° 30' E). Coll 1982 by G Cantié and subm by JM Desbordes, Dir Antiquités prehist, Limoges.

Ly-3145. Le Dognon, JI-1/2 **770 ± 100**
**AD1050–1345*
Sample from pit, subm 1984.

Ly-3004. Le Dognon, KI-1 **790 ± 100**
**AD1040–1335*
Sample from hearth, subm 1983.

Ly-3005. Le Dognon, SI-1 **960 ± 120**
**AD885–1245*
Sample from silo, subm 1983.

General Comment (JMD): dates are within same statistical margins; indicating 11th century, *ie*, beginning of date range (11th–15th centuries) expected according to typology of assoc ceramics (Cantié, in press).

Ly-2438. Le Moléron-Sablons, Décines, Rhône **680 ± 130**
**AD1140–1420*

Charcoal from habitation level at base of feudal mound (45° 47' N, 4° 59' E). Coll and subm 1981 by G Marien and JM Monnier, Meyzieu. *Comment* (JM): date is a little younger than that suggested by 10th century coins in same level.

Coyroux series, Aubazine, Corrèze

Charcoal from two superimposed levels in terrace built as basement of Cistercian abbey (Barrière, 1983) (45° 10' N, 1° 40' E). Coll 1981 and subm 1983 by JM Desbordes.

Ly-3006. Coyroux-Aubazine, M-18 **780 ± 170**
**AD935–1405*
From upper level (0.3 dr).

Ly-3007. Coyroux-Aubazine, H-17 **1100 ± 100**
**AD655–1150*
From lower level.

General Comment (JMC): Ly-3007 agrees with period of abbey's expansion (12th century). Ly-3006 shows relatively old date for beginning of terrace construction.

Ly-2554. Carrière de Beaulieu, Bardouville, Seine Maritime **820 ± 120**
**AD1030–1325*

Human bones from sand quarry near Late Neolithic collective sepulture (Graindor, 1966) (49° 26' N, 0° 51' E). Coll and subm 1981 by G Ver-

ron, Dir Antiquités Prehist, Caen. *Comment* (GV): date shows inhumation occurred long after sand was deposited and neighboring Neolithic burials took place; latter were previously dated, Ly-2348: 4550 ± 130 (R, 1983, v 25, p 101).

Ly-2665. Le-Haut-du-Château, Aingeray, Meurthe et Moselle **990 \pm 120**
**AD875–1235*

Charcoal from Layer C, lowest level of test excavation in fill of barred-spur ($48^{\circ} 45' \text{ N}$, $6^{\circ} 0' \text{ E}$). Coll 1981 and subm 1982 by A Lieger, Toul. *Comment* (AL): two dates were expected, according to ancient texts and structure of fortification—either Late Bronze age or end of Gallo-Roman period. Date represents much later occupation.

La Folie series, Meunes, Loir et Cher

Charcoal from lime plaster kiln of primitive type found in sandy alluvia of Le Cher R ($47^{\circ} 15' \text{ N}$, $1^{\circ} 28' \text{ E}$). Coll 1981 and subm 1982 by J Despriée, Dir Antiquités Prehist, Orléans. No assoc industry.

Ly-2702. La Folie P4 **1030 \pm 150**
**AD655–1250*

Ly-2703. La Folie P5 **820 \pm 150**
**AD910–1385*

General Comment (JD): primitive nature of kiln suggested relatively old age, eg, contemporaneous with neighboring sites of “Les Champs d’Urnes” period (Late Bronze age). Date shows kiln is Medieval.

Ly-3008. Champmain, Saint-Léonard de Noblat Haute-Vienne **1190 \pm 150**
**AD595–1055*

Charcoal from tomb ($45^{\circ} 50' \text{ N}$, $1^{\circ} 29' \text{ E}$). Coll 1981 by M Tandeau de Marsac and subm 1982 by JM Desbordes; assoc with less characteristic Medieval ceramics (Tandeau de Marsac, 1982). *Comment* (JMD): date shows assoc potsherds are Carolingian in age.

Colletière series, Charavines, Isère

Samples from Layer II of Paladru Lake sediments, in area of submerged village site ($45^{\circ} 25' \text{ N}$, $5^{\circ} 30' \text{ E}$). Coll 1977 and subm 1979 by M Collardelle, Archaeol Hist Mus, Grenoble. Coins found on site as well as typol of assoc material and hist evidence indicate settlement of village occurred during 11th century (Collardelle, 1980).

Ly-1869. Colletière, charcoal **1240 \pm 140**
**AD570–1030*

Ly-1870. Colletière, bark **1200 \pm 150**
**AD590–1050*

900 ± 110**AD910–1270***Ly-1959. Colletière, seeds**

General Comment (MC): only Ly-1959 agrees exactly with hist age; Ly-1870 and -1869 remain unexplained, as they do not fit dendrochronol data indicating more recent date for wood at site (ca 9th or 11th century). However, this deviation is reduced with corrected dates (Evin & Olive, in press).

La Dent series, Meyzieu, Rhône

Human bones from several graves in cemetery (45° 47' N, 5° 0' E). Coll 1979 and subm 1980 and 1981 by J Monnier.

General Comment (JM): although 1st 3 graves were superimposed, all dates except Ly-2330 are very close, suggesting relatively short period for all burials in necropolis, corresponding to “Burgonde” period, or beginning of High Middle Ages, as had been expected from osteol of skeletons.

TABLE 22
La Dent

Sample no.	Ref no.	DR	Age (BP)	Corrected date interval (AD)
Ly-2229	T 37A	1	1480 ± 90	350–650
-2230	T 37B	1	1480 ± 90	350–650
-2231	T 37C	1	1330 ± 110	570–885
-2669	T 43	0.7	1370 ± 150	415–895
-2670	T 7	1	1290 ± 140	465–1015

Cemeteries series, Tours, Indre et Loire

Human bones from several graves in two cemeteries (47° 22' N, 0° 40' E) coll 1981 by Lab Archéol Urbaine and subm 1981 by H Galinié, Tours.

General Comment (HG): dates are within same statistical margin and differences in dr of all samples reflect variation in preservation of organic matter in open-air sites. As expected (Galinié & Thureau, 1976), both graves from Saint-Pierre le Puellier cemetery are dated to end of Middle Ages. However, according to archaeol data, which attributes them to 11th or 12th centuries, Ly-2659 is too young by ca 200 yr, and Ly-2660 fits only if its large

TABLE 23
Tours cemeteries

Sample no.	Site	Ref no.	DR	Age (BP)	Corrected date interval (AD)
Ly-2659	St Pierre le Puellier	1-S-269	1	640 ± 100	1235–1415
-2660	St Pierre le Puellier	1-S-372	0.1	720 ± 220	920–1480
-2661	Rue des Ursulines	6-S-2	1	1570 ± 130	160–630
-2662	Rue des Ursulines	6-S-8	1	1540 ± 150	225–750

statistical margin is considered. Both dates from La Rue des Ursulines cemetery are within expected range (4th to 8th centuries). Archaeol evidence attributes Ly-2661 to 4th or 5th century and Ly-2662 was assumed to be from 6th to 8th centuries.

Ly-3039. Maison-Rouge, Marvejols, Lozère **1460 ± 100**
*AD400–755

Human bones from Grave 15 of cemetery (44° 33' N, 3° 19' E). Coll 1982 and subm 1983 by J Thomas-Beeching, Marvejols. *Comment* (JTB): date agrees with expected age based on Merovingian style (beginning of Middle Ages) of tombs in region.

Ly-2855. Village d'Agos, Agos-et-Vildalos, Hautes-Pyrénées **1450 ± 160**
*AD250–865

Bones of domestic animals from hearth revealed by excavations near cemetery from High Middle Ages (43° 2' N, 0° 4' W). Coll 1981 by R Vié and subm 1982 by A Clot, Bordères/Echez (0.7 dr). *Comment* (AC): date shows that hearth could not have been part of cemetery (Coquerel & Pousthamis, 1977) although it is later than expected from assoc rare Roman tiles (*Tegulae*) (Vié, Koutnetzoff, & Clott, 1983).

Albigny-Condion series, Seyssel, Haute-Savoie

Human bones from several graves in necropolis surrounding funerary basilica (47° 57' N, 5° 50' E). Coll 1980 and subm 1982 by B Bizot, Dir Antiquités Hist, Lyon, and J Serralongue, Centre Archéol Annecy.

Ly-2866. Sepulture S-50 **1080 ± 130**
*AD645–1200

From SE part of necropolis (0.8 dr). Expected age: 7th century.

Ly-2865. Sepulture S-89 **1390 ± 90**
*AD445–855

From outside and near W wall of basilica. Expected age: 6th to 9th centuries.

Ly-2864. Sepulture S-90 **1420 ± 120**
*AD390–820

From inside and near N gate of basilica. Expected age: 5th to 7th centuries.

Ly-2863. Sepulture S-48 **1720 ± 130**
*AD20–590

From small necropolis ca 50m from basilica (0.7 dr). Expected age: 3rd to 5th centuries.

General Comment (BB & JS): all dates are in expected range from assoc archaeol material (Bizot & Serralongue, in press). They confirm long use of site and much older age of small adjacent necropolis (Ly-2863).

Ly-2955. Sainte-Colombe le Vieux, Sainte-Colombe, Rhône **1730 ± 150**
*1BC-AD584

Human bones from Grave no. 9 of cemetery (45° 31' N, 4° 50' E). Coll 1981 by B Hély and subm 1983 by A Cogoluènes, Lab Geol, Univ Lyon I (0.7 dr). Necropolis is near Gallo-Roman city, Saint-Romain-en-Gal, former quarter of Vienne. *Comment* (AC): date confirms that necropolis belonged to Gallo-Roman site, despite lack of assoc archaeol material.

La Place series, Villiers-le-Sec, Val d'Oise

Bones from animal sp from refuse pit of house (49° 5' N, 2° 23' E). Coll 1981-82 and subm 1982 by R Guadagnin, Arts et Traditions Populaires Mus, Paris.

Ly-2599. Villiers le Sec, No. 2 **1010 ± 160**
*AD665-1235
From Pit 2 (0.5 dr).

Ly-2598. Villiers le Sec, No. 1 **1930 ± 150**
*370BC-AD360
From Pit 1 (0.5 dr).

Ly-2728. Villiers le Sec, No. 1b **1810 ± 150**
*150BC-AD550
From Pit 1 (0.5 dr).

General Comment (RG): Ly-2599 agrees perfectly with assumed age of house (7th century). Ly-2728 from 1982 excavation was to check Ly-2598 which appeared aberrant. Both dates were later confirmed by data from 1983 excavation, which revealed refuse pit from High Roman Empire (1st or 2nd century AD) with Sigillate ceramics and fibula (Guadagnin, in press).

Saône Boats series, Châlon sur Saône, Saône et Loire

Wood from remains of boats submerged in Saône R, coll by river dredging, Châlon-sur-Saône from 1977 to 1981 and subm 1982 by L Bonnamour, Denon Mus, Châlon-sur-Saône.

General Comment (LB): dates show evolution in boat form, which for centuries changed little (Bonnamour, 1978-79, 1980, 1981).

TABLE 24
Saône boats

Sample no.	Site	Geog coordinates	Origin of wood	DR	Age (BP)	Corrected date interval
Ly-2743	Ormes	(46° 38' N, 4° 56' E)	Monoxylic barge	1	720 ± 120	AD1180-1400
-2744	Ormes	(46° 38' N, 4° 56' E)	Boat timber	0.6	990 ± 170	AD775-1260
-2742	Lux	(46° 45' N, 4° 52' E)	Helm oar	1	1910 ± 120	160BC-AD245
-2741	Bragny	(46° 54' N, 5° 03' E)	Boat timber	1	1920 ± 130	365BC-AD380

Ateliers Municipaux series, Saintes, Charente Maritime

Human bones from two levels in funeral pit from Gallo-Roman villa (45° 45' N, 0° 37' W). Coll 1970–72 by M Rouvreau and subm 1983 by M Collillieux, Lab Anthropol, Univ Caen.

Ly-3024. Saintes No. 7 **1990 ± 110**
*360BC–AD225
From 6 to 8m depth in upper level of bone fill of pit (0.7 dr).

Ly-3025. Saintes No. 8 **2030 ± 70**
*180BC–AD195
From 8 to 20m depth in lower level of bone fill of pit.

General Comment (MC): both dates are within same statistical margins, indicating rapid filling rate for all 12m of Roman sediments in pit. They agree well with expected age (Maurin, 1978), 1st or 2nd century AD.

*Protohistoric Period**Africa*

Ly-3028. Bekrat, El Goléa, Laghouat Willava, Algeria **Modern**
 $\delta^{14}\text{C} = 26.5 \pm 15.7\text{‰}$

Charcoal from ca 15m depth, under sandy level containing ostrich egg fragments (30° 50' N, 2° 45' E). Coll 1982 by M Montanari and subm 1983 by R Leclerc, El Goléa. *Comment* (RL): age corresponding to presence of ostrich in area was expected, but date shows site was disturbed.

Ly-2528. Babanki-Tungo, Le Mézam Dept, Cameroun **Modern**
 $\delta^{14}\text{C} = 0.0 \pm 16.0\text{‰}$

Charcoal from base of 4m deposit of scoria near smelting furnace at Agric Sta (5° 58' N, 10° 20' E). Coll 1980 and subm 1981 by JP Warnier, Univ Yaoundé. *Comment* (JPW): date and strat position of sample shows 4m accumulation of scoria occurred quite rapidly.

Ly-2817. Grand Jacques, Ivory Coast **750 ± 160**
*AD1030–1410

Charcoal from 2.1m in depth of boring in shelly kitchen midden on beach strand at ca 50m from coast (5° 10' N, 4° 31' E). Coll and subm 1982 by J Rivallain, Univ Abidjan. Change in style of assoc ceramics in level suggests change in human population. *Comment* (JR): date is older than assumed from oral histories (Rivallain, 1983).

Ly-2687. Bagamoyo, Labattoir, Mayotte Comores I. **820 ± 110**
*AD1035–1325

Human bones from Grave 9 of large necropolis, partly submerged on La Petite Terre I. coast (12° 47' S, 45° 15' E). Coll 1981 and subm 1982 by C Allibert, Lyon, A Argant, and J Argant, Bron. Assoc with few scattered pot-

sherds. *Comment* (AA): date precisely confirms age expected from ceramics, 11th or 13th centuries, Hagnoundou period (Allibert, Argant, & Argant, 1983).

House of Koumbi Saleh city, Timbedra, Mauritania

Samples from several archaeol levels of house in S Central area of main tell of Koumbi Saleh (15° 46' N, 7° 59' W). Site was supposedly capital of kingdom of Ghana. Excavations on site were directed by S Robert, Mauritanian Inst Sci Research; house was excavated 1975, 1976 by S Berthier, Univ Lyon II, who coll samples previously pub (R, 1979, v 21, p 430), and coll and subm 1980 following samples (tables 25a, b). House was probably occupied continuously for six centuries according to following strat:

TABLE 25a
Stratigraphy of House of Koumbi Saleh

Level	Archaeol event	Expected date (century)	Previous dates
V	Abandonment and destruction	End of 14th/or beginning of 15th	
IV			Ly-1521:230 ± 120 -1525:440 ± 180
IVa, b	End of max occupation	14th	-1524:550 ± 230
III	Max prosperity of city	13th	-1526:860 ± 210
II	Max city development	End of 11th beginning of 12th	-1341:1000 ± 150 -1520:590 ± 120
I	Short period of 1st bldg	Middle of 11th	
O	Refuse pit in basal soil	End of 9th or 10th	

TABLE 25b
House of Koumbi Saleh

Sample no.	Ref no.	Level	Depth (cm)	Sample	DR	Age (BP)	Age (AD)	Corrected date interval (AD)
Ly-2509	SB III 41/48	V	190–215	Potsherd	0.5	720 ± 140	1230	1040–1415
-2510	SB III 67	V	190–215	Charcoal	1	530 ± 140	1420	1245–1635
-2540	SB III 80	IVb	140–250	Charcoal	1	1020 ± 150	930	660–1250
-2539	SB III 101	IVa	295–310	Charcoal	1	530 ± 100	1420	1275–1500
-2507	SB III 131	III	315–320	Potsherd	1	750 ± 130	1500	1030–1410
-2508	SB III 130	III	315–320	Charcoal	0.6	780 ± 100	1170	1045–1315
-2506	SB III 247	IIb	430–435	Charcoal	1	710 ± 100	1240	1195–1400
-2505	SB III 249	IIb	445–450	Potsherd	0.2	810 ± 170	1140	915–1395
-2538	SB III 195	IIa	460–470	Charcoal	1	790 ± 120	1160	1040–1335
-2537	SB III 265	IIa	490–510	Charcoal	0.5	880 ± 170	1070	890–1330
-2536	SB III 210	I	520–530	Charcoal	1	850 ± 100	1100	935–1315
-2535	SB III 271	I	530–565	Charcoal	1	800 ± 100	1150	1040–1335
-2534	SB III 274	I	560–570	Charcoal	1	730 ± 140	1220	1035–1415
-3147	SB IV 30	O		Charcoal	1	1620 ± 150	330	60–620
-2533	SB III 289	O	600–610	Charcoal	1	770 ± 150	1180	1020–1405
-2532	SB III 287	O	600–625	Charcoal	1	870 ± 140	1080	920–1290
-2504	SB III 295	O	620–650	Charcoal	0.7	950 ± 130	1000	855–1285
-2503	SB III 305/306	O	620–670	Potsherd	0.2	Modern: ¹⁴ C = +5 ± 18‰		
-3146	SB IV 35	O		Charcoal	1	1270 ± 90	680	590–905

General Comment (SB): results agree better with strat and expected ages than previous series, samples of which were probably too small. Ly-3147, -2540, and -3146 are outside general trend by ca 400 yr, or more (Ly-3147) and remain so even after correction. This may indicate use of ancient wood as fuel at time of destruction of city as was frequent, especially in arid regions (see, eg, Les Kellia Qoucour Isa; Ly-267: 1645 ± 80 and B-988: 1530 ± 100 (R, 1971, v 13, p 55). Dates obtained from potsherds either agree exactly with those from charcoal (Ly-2505, -2538), are somewhat different, but within statistical margin (Ly-2509, -2507), or are completely erratic for unknown reasons (Ly-2503). All dates from Level III, IV, and V are comparable to those from equivalent archaeol levels in neighboring sites excavated by S Robert (R, 1979, v 21, p 430–431), or excavated by A Cros and later pub (R, 1977, v 19, p 162). They confirm that at least area of excavated house was not occupied before end of 10th century, *ie*, Mauny's (1951) Last Pre-Islamic period (Berthier, 1983).

Mutwarubona series, Ndora, Rwanda

Charcoal from 50cm depth in remains of two smelting furnaces (2° 36' S, 29° 48' E). Coll and subm 1982 by F Van Noten, Mus Royal Afrique Centrale, Tervuren, Belgium.

Ly-2668. Haut-Fourneaux 2

1380 ± 170

**AD245–1005*

From smelting furnace No. 2 (0.6 dr).

Ly-2667. Haut-Fourneaux 1

2020 ± 330

**760BC–AD565*

From smelting furnace No. 1 (0.65 dr).

General Comment (FVN): despite wide statistical margin, both dates agree with expected date range (IBC to AD700), as smelting furnaces were in use since Early Iron age (Van Noten, 1983).

Akagéra National Park, Kinbungo, Mutata Prov, Rwanda

Charcoal from several sites in park: N'Dama Cave (2° 23' S, 30° 26' E), Muhororo rock shelter (2° 54' S, 30° 31' E) and Mucucu II rock shelter (2° 35' N, 30° 30' E). Coll 1978 (Ly-2798) and 1980 and subm 1980 by B Lugan, Hist Dept, Univ Lyon III. Assoc industries were ceramics of recent rolled type, eg, at N'Dama (Lugan, Sirven, & Vérin, 1979), and flint microliths of Wiltonian type, eg, at Muhororo (Lugan, 1983). Samples indicate occupation from Late Stone age (LSA) with ceramics from end of Early Iron age (EIA) of Uréwé type, ending with Late Iron age (LIA) with rolled ceramics and microliths.

General Comment (BL): Ly-2798 shows that site occupation is only recent. Ly-2382 suggests that majority of microlith industries date from ca 2000 BP or just before EIA. All dates for Mucucu II site agree with age expected from assoc industries, archaeol attribution, and strat despite limited

TABLE 26
Akagéra National Park

Sample no.	Site	Sq or level	Depth (cm)	Assoc industry	DR	Age (BP)	Corrected date interval or activity
Ly-2798	N'Dama	Base level	110	Potsherd	0.7	Modern	$\delta^{14}\text{C} = +20 \pm 16\text{‰}$
-2450	Muhororo	Sq 1	20–25	Potsherd and microliths	0.10	350 \pm 200	AD1305–1950
-2382	Muhororo	Sq 1	55–65	Potsherd and microliths	0.3	1970 \pm 190	400BC–AD410
-2449	Mucucu II	Sq 1	10–20	L I A	0.10	1220 \pm 220	AD460–1195
-2235	Mucucu II	Sq 1	20–30	E I A	0.15	2380 \pm 270	1095BC–AD200
-2383	Mucucu II	Sq 2a	30–35	L S A	0.6	2040 \pm 180	415BC–AD250
-2385	Mucucu II	Sq 2, 3	30–35	L S A	0.2	1210 \pm 160	AD590–1050
-2384	Mucucu II	Sq 2, 3a	40–45	L S A	0.25	2020 \pm 200	410BC–AD335
-2236	Mucucu II	Sq 1	ca 45	L S A	0.5	1880 \pm 170	375BC–AD555
-2237	Mucucu II	Sq 1	45–55	L S A	0.10	3940 \pm 320	3155–1765BC
-2386	Mucucu II	Sq 3	50–55	L S A	0.6	Modern	$\delta^{14}\text{C} = +3 \pm 22\text{‰}$
-2387	Mucucu II	Sq 2a	50–60	L S A	0.07	2620 \pm 320	1395BC–AD170

amount of dating material. Ly-2449 shows relatively early age for LIA whereas 1st appearance of ceramics occurs at ca 2000 BP, as suggested by Ly-2235 and -2383.

Oceania

1040 \pm 110

Ly-2310. La Roche, Maré I., New Caledonia

***AD790–1215**

Human bones from collective grave in open-air site near airport (21° 28' S, 168° 2' E). Coll 1977 by J P Maitre and subm 1980 by D Frimigacci, Office Recherche Sci Tech, Outre-Mer, Nouméa. *Comment* (DF): date agrees with type of burial and general data on human settlement of island.

Iron Age

France

2380 \pm 90

Ly-2780. Gypsum mine, Carcès, Var

***780–195BC**

Wood from support timbers of gypsum mine (43° 29' N, 6° 11' E). Coll 1980 by G Truc, Lab Geol, Univ Lyon I. Sample dated to check previous result, Ly-2223: 2570 \pm 130 (R, 1983, v 25, p 61). *Comment*: date is within statistical margin of previous one, and average of both measurements is 2440 \pm 70.

Derrière le Moulin series, Mours, Val d'Oise

Samples from two levels of ditch found in quarry of Mafa Cie (49° 8' N, 2° 16' E). Coll and subm 1982 by JL Brulé, Cergy.

General Comment (JLB): as expected, boundary between La Tène II and III is dated at ca 2200 BP. Ly-2976 shows that charcoal from Layer VII may have descended into Layer V, below.

TABLE 27
Derrière le Moulin

Sample no.	Layer	Depth (m)	Expected period	DR	Age (BP)	Corrected date interval
Ly-2977	VII	1	La Tène III	0.7	2120 ± 120	400BC–AD40
-2976	V-AB	2	La Tène II & III	1	2150 ± 110	405BC–AD25
-2975	V-AB	2.5	La Tène II & III	1	2320 ± 110	760BC–AD170

La Pierre d'Appel series, Etival-Clairefontaine, Vosges

Samples from two excavation areas in fortified promontory at top of plateau (48° 23' N, 6° 51' E). Coll 1974 from W excavation, inside fortified habitat and 1981 from SW excavation in oldest fortification rampart, subm 1978 and 1982 by A Deyber, Herpiacum Soc, Etival-Clairefontaine (Deyber *et al.*, 1984).

General Comment (AD): Ly-1731, from charred beam, does not come from archaeol level. Ly-2705 and -2704 agree with expected age, La Tène II. Ly-1732 is older by ca 300 yr, and comes from structure which is older than main habitation level.

TABLE 28
La Pierre d'Appel

Sample no.	Ref, colln yr	Layer	Sample	Age (BP)	Corrected date interval
Ly-1731	B-22, 1974	Passage 5	Charred beam	690 ± 140	AD1055–1425
-1732	B-22, 1974	Passage 3	Ash	2530 ± 130	1015–390 BC
-2705	B-11, 1981	Level 4g	Charcoal	2220 ± 100	545–20BC
-2704	B-11, 1981	Level 4a	Charcoal	2300 ± 100	755–165BC

2340 ± 150**Ly-2874. Caramontron, Sinzelle, Polignac, Haute Loire** *790–150BC

Bones from ditch outcropping along roadside (45° 4' N, 3° 52' E). Coll 1978 and subm 1982 by J Vital, Ampilhac-Vernassal. Sample coll as control for two previous measurements, Ly-2036: 2410 ± 130, and Ly-2037: 2520 ± 120 (R, 1983, v 25, p 95), both estimated to be too young in relation to assoc industry from 1st Iron age or Late Bronze age. *Comment* (JV): latest date agrees with two preceding ones, from Middle of Iron age. This may be due to continuation of Late Bronze and Early Iron age industries throughout Iron age (Houdré & Vital, 1981).

2520 ± 140**Ly-2845. La Chauve-Souris cave, Donzère, Drôme** *1010–390BC

Charcoal from Layer 8c/9 of cave fill (44° 28' N, 4° 41' E). Coll and subm 1982 by J Vital. Assoc with industry from beginning of Iron age (Vital, 1981). *Comment* (JV): date probably indicates Middle of Iron age, but remains compatible with expected age if max statistical margin is considered.

En Bizier series, Juy, Saône et Loire

Samples from 10 to 20cm depth in hearth structure of only habitation level (46° 37' N, 4° 52' E). Coll 1967 and subm 1983 by A Jeannet, Charnay-lès-Macon.

Ly-3053. En Bizier 1

Charcoal (0.5 dr).

2580 ± 150
*1040–405BC

Ly-3054. En Bizier 2

Bones (*Ovicapridae*).

2510 ± 100
*825–405BC

General Comment (AJ): dates agree perfectly and are within expected range of assoc Early Iron age industry assumed to come from W Germany or N Switzerland (Jeannet, 1981).

Ly-2529. La Prée tumulus, Thury, Côte d'Or

Charcoal from beneath endmost upright flagstone of sepulture of Tumulus III (47° 2' N, 4° 30' E). Coll 1980 and subm 1981 by JP Guillaumet, Centre Natl Recherche Sci, Autun (0.7 dr); assoc with Middle Hallstatt industry. *Comment (FPG)*: date seems too young, perhaps due to wide statistical margin (Guillaumet & Maranski, 1982).

2300 ± 220
*800BC–AD20

Ly-2678. Ravin de Mardou, La Roche-Blanche, Puy de Dôme

Bones (*Ovicapridae*) from ditch atop colluvial deposit (45° 43' N, 3° 9' E). Coll 1980 and subm 1982 by JP Daugas and JP Raynal, assoc with painted ceramics attributed to beginning of Early Iron age. *Comment (JPD & JPDR)*: date agrees with archaeol data (Daugas, Gilbert, & Raynal, 1982) and with measurements obtained from another ditch site, Caramontron (above).

2590 ± 120
*1010–425BC

Bronze Age

France

Ly-2698. Champ d'Ile, Assenay, Aube

Charcoal from 1.25m depth in open-air site (48° 11' N, 4° 3' E). Coll 1980 and subm 1981 by JL Coudrot, Troyes (0.3 dr). Assoc with Late Bronze age industry corresponding to end of "Champ d'Urnes" period and assumed to date from ca 700 BC (Chertier, 1981). *Comment (JLC)*: date is too young by ca 200 yr but suggests continuation of "Champ d'Urnes" civilization until beginning of Iron age.

2450 ± 140
*830–195BC

Marais de Saint-Clair series, Marchezieux, Manche

Wood from marsh sediments (49° 10' N, 1° 18' W) in which eight probably contemporaneous caches of bronze axes “à douille” were found (Veron & Tabbagh, 1983).

Ly-2813. Cache F**1430 ± 150****AD265–875*

From stake near Cache F.

Ly-2676. Cache B**2470 ± 120****830–300BC*

From tree branch placed over Cache B, probably to conceal it.

General Comment (GV): Ly-2813 shows stake had no connection with axe caches. Ly-2676 confirms that caches are one of last manifestations of Bronze age, which is contemporaneous with 1st Iron age.

Gué des Plies series, Châlon-sur-Saône, Saône et Loire

Samples from Bronze age habitation excavated from present river bed of La Saône R (46° 48' N, 4° 50' E). Coll and subm 1982 by L Bonnamour, Mus Denon, Châlon-sur-Saône.

Ly-2746. Châlon-sur-Saône, No. 2**2600 ± 130****1085–410BC*

Wood from upper part of archaeol level, corresponding to site destruction.

Ly-2745. Châlon-sur-Saône, No. 1**2860 ± 130****1400–790BC*

Charred branches from middle of archaeol level, assoc with rich Late Bronze age IIIB industry.

General Comment (LB): both dates are within expected range (Bonnamour, 1983). However, Ly-2746 may be slightly later than actual site abandonment.

Chabris Island series, Indre

Charcoal from several areas and depths of open-air site comprising ca 2m ashy layers in sandy alluvia of Le Cher R (47° 17' N, 1° 37' E). Coll 1981 and subm 1983 by J Despriés, Dir Antiquités Prehist, Orléans. Archeol level contains flint and ceramic artifacts attributed to Late Bronze age, as well as two deposits of bronze artifacts (Allain, 1981).

Ly-3040. Chabris D3 425**2790 ± 160****1355–630BC*

From 173cm depth, Sq D3 (0.5 dr).

Ly-3041. Chabris D5 246 **3390 ± 180**
*2165–1360BC
From 165cm depth, Sq D5 (0.7 dr).

Ly-3042. Chabris E3 173 **2790 ± 150**
*1355–630BC
From 110 to 115cm depth, Sq E3 (0.3 dr).

General Comment (JD): Ly-3040 and -3042 completely agree with expected age of assoc industry. Ly-3041 could indicate that site had already been occupied during Middle Bronze age or beginning of Late Bronze age.

Mont Sainte-Odile series, Ottrott, Bas-Rhin

Charcoal from beneath and between foundation stones of long megalithic wall, “Le Mur Païen” (48° 26' N, 7° 24' E). Coll 1966 in excavation Site A and subm by H Zumstein, Archéol Mus, Strasbourg. Very diluted samples despite large size, due to solubility at alkaline pretreatment, caused by long exposure to forest soil.

Ly-2800. Mont Sainte-Odile A **4400 ± 400**
*3900–2300BC
From 130cm depth, between stones (0.1 dr), subm 1982.

Ly-2801. Mont Sainte-Odile B **3200 ± 120**
*1780–1190BC
From 130cm depth, 80cm from Ly-2800 (0.5 dr), subm 1982.

Ly-2927. Mont Sainte-Odile 9.3–9.6 **2560 ± 110**
*865–415BC
From under wall (0.8 dr), subm 1983.

General Comment (HZ): statistical margin of Ly-2800 is too large; sample is obviously too old and has no connection with wall. As archaeol data suggest, wall was constructed on Late Bronze age site, with which Ly-2801 fits, either at end of this period, ca 1000 BC, or at beginning of Iron age (Ly-2927).

Ly-2812. La Baume Layrou, Trèves, Gard **3520 ± 110**
*2160–1670BC

Wood from top of fill in Sec C of cave (44° 5' N, 3° 24' E). Coll and subm 1982 by L Fagès, Florac. Two occupations took place in cave, during Late Neolithic and mainly during Late Bronze age, from evidence of numerous potsherds (Fagès, 1982). *Comment* (GF): date confirms soil of cave remained unmodified since Middle Bronze age or very beginning of Late Bronze age.

Lescar and Lons Tumuli series, Pyrénées Atlantiques

Charcoal from hillock with several tumuli assumed to be from Bronze age (Blanc, 1982) (43° 20' N, 0° 24' W), subm 1982 by C Blanc, Pau.

Ly-2707. Tumulus T1, Lescar **3650 ± 150**
*2520–1695BC

From 74cm depth in Sq I-13 of tumulus in central part of hillock (0.3 dr). Coll 1982. No assoc industry;

Ly-2708. Tumulus T6, Lons **4260 ± 150**
*3355–2440BC

From 35cm depth in all sqs, P-Q/5–6, of tumulus from S part of hillock. Coll 1980 (0.6 dr). Assoc with pebble structure with potsherds.

Ly-2709. Tumulus T5, Lons **3510 ± 100**
*2150–1665BC

From 57cm depth, in Zone R-S/7–8, pit near Tumulus 5 in NE part of hillock. Coll 1982.

General Comment (CB): dates from Tumuli T1 and T5 are as expected. Date from Tumulus T6 seems too old although possible as archaeol data are same as for other 2 tumuli; 3 dates are comparable to unpub results from Tumulus BBL I of Boueilh (Gif-5525: 3620 ± 120) and from Tumulus T II of Lescar (Ny-250: 3959 ± 70), unpub.

Ly-2641. Le Grand Marais, Bucy le Long, Aisne **3710 ± 200**
*2640–1690BC

Charcoal from 80cm depth at base of pit with cremated remains in funerary urn (49° 23' N, 3° 25' E). Coll 1980 and subm 1982 by C Pommepuy, Dir Antiquités Prehist, Amiens (0.2 dr). Pit is part of funerary circle from Early or Middle Bronze age (Pommepuy & Brun, 1984). *Comment* (CP): despite wide margin, date adequately confirms archaeol attribution of remains to Early Bronze age. This result cannot be compared with any others because cremation remains are rarely preserved in this type of site.

Ly-2734. Chaleil, Saint-Cernin-de-Larche, Corrèze **3760 ± 130**
*2630–1865BC

Human bones from sepulchral room of dolmen (45° 6' N, 1° 24' E). Coll 1981 and subm 1982 by G Mazière, Dir Antiquités Prehist, Limoges. Assoc with remains of pearls and pendants (Mazière, 1983). *Comment* (GM): date indicates beginning of Bronze age and fits well with dates from similar monuments nearby in Quercy prov, such as La Bertrandoune dolmen at Prayssac, Ly-1220: 4170 ± 120 (R, 1978, v 20, p 41), Les Grèzes dolmen at Souillac, Ly-895: 3910 ± 120 (R, 1976, v 18, p 73), and Le Riffat dolmen at Thédillac, Ly-1188: 4090 ± 130 (R, 1978, v 20, p 41).

Switzerland

Ly-2922. Horn, Wittnau, Basel Canton **2680 ± 170**
*1275–410BC

Bones of animal spp from hearth, ca 1m depth, in fortified promontory site (47° 28' N, 7° 7' E). Coll 1982 by P Gutzwiller and subm 1982 by LR Berger, Univ Basel (0.5 dr). Assoc with ceramic industry from Late Bronze

age IIIb (Gassler, 1982). *Comment* (LRB): date agrees with chronol data from region, which show Iron age began at ca 700 BC. It also confirms dendrochronol dates from Zurich lab.

Spain

S Spain sites series

Samples coll and subm by F Molina, Prehist Dept, Univ Granada.
General Comment (FM): all results agree with expected values and confirm several dates from Groningen lab from other sites in region with same assoc industry. These results suggest relatively late date for end of Copper age (Ly-2653) and date comparable with Middle Bronze age, French equivalent of Spanish Argar B.

TABLE 29a
Spanish sites

Site	Ref	Village	Province	Geog coordinates	Colln yr
Cerros de los Castellones	(C d C)	Laborcillas	Granada	(37° 27' N, 3° 17' W)	1973
Motilla des Azuer	(M d A)	Daimiel	Ciudad Real	(39° 03' N, 3° 30' W)	1976
Cerro de la Encina	(C d E)	Monachil	Granada	(37° 08' N, 3° 33' W)	1977

TABLE 29b
Spanish sites

Sample no.	Site ref	Sample ref	Sample	Depth (m)	Assoc industry	Age (BP)	Corrected date interval (BC)
Ly-2653	C d C	CB5-5125	Charred seed	3-1.4	Late Copper	3500 ± 130	2280-1560
-2654	M d A	D6-6016	Charred seed	1-1.2	Middle Bronze	3530 ± 130	2300-1585
-2655	M d A	D1-327	Charred seed	0.8-0.9	Middle Bronze	3540 ± 130	2305-1640
-2656	C d E	M7-21177	Charcoal	ca 2.8	Middle Bronze	3350 ± 100	1900-1425
-2657	C d E	M17-16053	Charcoal	ca 2.6	Middle Bronze	3520 ± 110	2160-1670

Chalcolithic/Late Neolithic Periods

France

Ly-2964. Fond Pernant, Compiègne, Oise **3890 ± 180**
**2890-1900BC*

Bones from 60cm depth from Ditch 28 of open-air site habitation area (49° 24' N, 2° 48' E). Coll 1982 by B Lambot and subm 1982 by JC Blanchet, Centre Recherche Archéol Oise, Compiègne. Assoc with Chalcolithic industry of “Groupe des Urnes” type, just before Early Bronze age Atlantic type. *Comment* (JCB): date agrees perfectly with age expected for this type of industry in N France (Blanchet, 1983).

Ly-2688. Broum cave, Hérault**1280 ± 130****AD540-960*

Charcoal from hearth in copper cave mine (43° 35' N, 2° 48' E). Coll and subm 1981 by P Ambert, Lab Geog, Univ Aix-Marseille; assoc with Late Neolithic industry of Ferrières type. This site may be oldest copper mine in region (Vasseur, 1911). *Comment* (PA): despite hearth's strat context, date shows it is not part of archaeol level. Another hearth in site analyzed by Gif lab yielded date in expected age range, Gif-6048: 3990 ± 70 (unpub).

Ly-2954. Chomérac cave, Chomérac, Ardèche**3940 ± 160****2880-2120BC*

Human bones from fill of lower part of cave, embedded in recent level of calcareous breccia (44° 43' N, 4° 39' E). Coll 1983 by B Aubert and subm 1983 by A Cogoluèhès, Lab Geol, Univ Lyon I (0.5 dr). *Comment* (AC): upper part of cave was used as communal grave during Neolithic, then was occupied during Wars of Religion (16th century). Date indicates fill preserved in lowest part of grave is Neolithic, in fact from Chalcolithic, as are many other such sepulchral caves in region.

Boussargues series, Argelliers, Hérault

Charred acorns from two areas in fortified habitation site (43° 44' N, 3° 42' E). Coll and subm 1982 by X Gutherz, Dir Antiquités, Montpellier. Site has only one habitation level, containing Chalcolithic artifacts of Fontbouïsse type.

Ly-3016. Boussargues Loc 1**4170 ± 140****3160-2405BC*

From Loc 1 near Hut 1 (0.7 dr).

Ly-3017. Boussargues Cabane 1**4070 ± 170****3160-2405BC*

From center of Hut 1.

General Comment (XG): date agrees perfectly with others obtained for same cultural period and is comparable to dates from fortified sites from region such as Le Lébus at Saint-Martin-de-Trévières, Hérault, as well as to dates from several unfortified villages, such as Campous at Viols en Laval, MC-719: 3970 ± 90 (unpub).

Claux cave series, Gourniès, Hérault

Charcoal from 2 areas in cave (43° 51' N, 3° 34' E). Coll 1981 and subm 1982 by JL Roudil, Dir Antiquités Prehist, Montpellier.

Ly-2735. Claux, Zone C**4040 ± 130****2940-2195BC*

From burial sepulture in superficial hearth, attributed to Chalcolithic of Fontbouïsse type.

Ly-2736. Claux, Zone H**4500 ± 170**
***3635–2890BC**

From base of archaeol level at ca 15cm depth corresponding to occupation attributed to Late Neolithic of Ferrières type (0.3 dr).

General Comment (JRL): both values agree perfectly with generally accepted age range for assoc industries in both occupation levels of site; they also agree with result from Aven de Jacques (below).

Aven de Jacques series, Chabessière, Lussas, Ardèche

Human bones from two areas in cave near La Chabessière (44° 37' N, 5° 21' E). Coll 1981 and subm 1982 by A Héritier, Romans, and A Cogoluenhes. Cave was used for communal burial ground during Late Neolithic to Chalcolithic and until Late Bronze age, because it contains artifacts from these three cultural periods.

Ly-2847. Aven de Jacques No. 2**3860 ± 130**
2730–2050BC*Ly-2846. Aven de Jacques No. 1**
(0.4 dr)**4140 ± 170**
***3245–2305BC**

General Comment (AH): both dates agree with archaeol attribution to Chalcolithic period; Ly-2846 corresponds to beginning of period, which may be contemporaneous with Late Neolithic period of Ferrières type, and Ly-2847 marks end of Chalcolithic period and may be contemporaneous with previous date from same site, Ly-2295: 3660 ± 130 (R, 1983, v 25, p 99). All three dates suggest rather lengthy use of cave as burial place, perhaps as late as Early Bronze age.

Ly-2689. Roque-Fenêtre, Cabrières, Hérault**3900 ± 130**
***2815–2075BC**

Charcoal from pit in copper mine (43° 35' N, 3° 22' E). Coll and subm 1981 by P Ambert. Assoc with Late Neolithic industry of Verazian type. *Comment* (PA): date is within expected range and may be comparable to many other dates for Fontbouïsse and Verazian Chalcolithic or Late Neolithic industries in region (Gasco & Binder, 1983).

Ly-2571. La Pointe aux Oies, Wimereux, Pas de Calais**1890 ± 180**
***380BC–AD545**

Human bones from communal burial in covered passage of long dolmen embedded in dunes on sea coast (50° 47' N, 1° 36' E). Coll 1979 and subm 1981 by JF Piningre, Dir Antiquités Prehist, Lille. No characteristic artifacts were assoc, but this type of megalithic monument is similar to those from Neolithic of "Seine-Oise-Marne" (SOM) type in Picardie region (Piningre, 1979). *Comment* (JFP): date shows burial occurred much later than construction of megalith, as reworked aspect of monument fill had suggested.

- Ly-3023. Villevieille, Demandolx, Alpes de Haute-Provence** **3970 \pm 140**
**2895–2150BC*

Human bones from communal burial in dolmen chamber (43° 52' N, 6° 35' E). Coll 1974 and 1975 and subm 1983 by G Sauzade, Dir Antiquités Prehist, Aix en Provence. Assoc with Late Neolithic industry. *Comment* (GS): date is younger than expected and suggests site was in use for prolonged period; no archaeol evidence.

- Ly-2980. Cala Barbarina, Tizzano, Corse du Sud** **4020 \pm 140**
**2920–2180BC*

Bones (*Suidae*) from complete skeleton found beside human burial in Layer III of Le Sanglier rock shelter (41° 31' N, 9° 13' E). Coll 1980 by A Pasquet and subm 1983 by JD Vigne, Lab Anatomie Comparée, Natl Mus Hist Nat, Paris. Assoc with somewhat characteristic Early or Middle Neolithic industry. *Comment* (JDV): date is younger than expected and dates burial to Late Neolithic.

- Ly-2658. Le Trou des Fées, Bayonville-sur-Mad, Meurthe et Moselle** **4210 \pm 170**
**3345–2415BC*

Human bones from peculiar burial in sepulchral cave (49° 1' N, 5° 58' E). Coll 1977 and subm 1981 by C Guillaume, Dir Antiquités Prehist, Metz. Burials occurred in cave during two periods, Late Neolithic, corresponding to previous dates, Ly-1622: 4170 \pm 200, and Ly-1623: 4280 \pm 150 (R, 1979, v 21, p 435), and Early Middle ages (ca 10th century). Skeleton lay at boundaries of both periods and was thought to be assoc with older level. *Comment* (CG): date is within statistical margins of both previous measurements and confirms attribution of burial to Neolithic.

- Ly-3021. Le Capitaine, Grillon, Vaucluse** **4330 \pm 180**
**3360–2670BC*

Human bones from collective sepulture below hypogeum (44° 24' N, 4° 56' E). Coll 1977 and 1978 by G Sauzade. Assoc with Late Neolithic industry. *Comment* (GS): date agrees perfectly with expected age and results obtained from lowest level of Roaix site, Gif-1620: 4100 \pm 140 (R, 1971, v 13, p 219) (Sauzade, 1983).

- Ly-2550. Chironlon or Fabrègues cave, Gras, Ardèche** **5110 \pm 250**
**4435–3370BC*

Human bones from sepulchral ditch (44° 24' N, 4° 38' E). Coll 1970 by A Héritier, Romans, and subm 1980 by A Cogoluënhes. Communal sepulture with ca 20 individuals and Chalcolithic industry of Fontbouïsse type. *Comment* (AH): date is much older than expected and does not correspond with archaeol data. As site does not contain proof of Middle Neolithic occupation, there may be error in origin of bones, due to long delay between colln and subm of sample.

Middle Neolithic Period

France

Cul-Froid series, Boury-en-Vexin, Oise

Bones from enclosure ditch of habitation (49° 14' N, 1° 3' E). Coll by R Martinez and subm 1982 by JC Blanchet.

Ly-2712. Cul-Froid, No. 4 **4570 ± 130**
*3660–2995BC

From Layer D1 at top of fill, coll 1982 (0.6 dr). Assoc with evolved Chassean industry.

Lv-2711. Cul-Froid, No. 1 **5180 ± 100**
*4330–3690BC

From middle layer of fill, coll 1981. Assoc with Middle Chassean industry.

Ly-2961. Cul-Froid, No. 3 **5240 ± 150**
*4410–3690BC

From Layer G2 at base of fill, coll 1982 (0.5 dr). Assoc with Chassean industry with Roessen influence.

General Comment (JCB): three dates agree perfectly with strat and evolution of Chassean industry. They are comparable to dates from samples assoc with similar industries at Camp-de-César site and Le-Coq-Galleux site (below).

Camp de César series, Catenoy, Oise

Bones from several levels and sqs of excavation on edge of plateau of fortified promontory (49° 22' N, 2° 31' E). Coll and subm by JC Blanchet (Blanchet & Decormeille, 1984).

General Comment (JCB): dates agree perfectly with strat and evolution of industry. They compare well with 3 dates from Cul-Froid site (above) for same industries.

TABLE 30
Camp de César

Sample no.	Layer	Colln yr	Industry	DR	Age (BP)	Corrected date interval (BC)
Ly-2967	5a	1982	Late Chassean	1	4550 ± 160	3655–2915
-2965	5b	1982	Late Chassean	1	4620 ± 120	3655–3050
-2968	5bc	1982	Chassean	0.7	4820 ± 150	3885–3355
-2713	5c	1981	Middle Chassean	1	4980 ± 120	3935–3565
-2966	5d	1982	Middle Chassean	0.5	5280 ± 140	4420–3785

Ly-3020. Malvoisin, Orgon, Bouches-du-Rhône **5270 ± 140**
*4420–3780BC

Bones from only occupation level of open-air site (43° 48' N, 5° 1' E). Coll 1972 by A Carry and subm 1983 by G Sauzade; assoc with Chassean potsherds (Sauzade, 1983). *Comment* (GS): date fits well with expected age and numerous other dates from many Chassean sites in Provence region, particularly with nearby Claparouse site at Lagen, MC-1691: 5380 ± 125 (unpub).

La Vergentièrre series, Cohons, Haute-Marne

Charcoal from three excavation loci (2 borings and 1 hearth in dolmen) on fortified promontory (47° 46' N, 5° 20' E). Coll and subm by L Lepage, Saint-Dizier. Test excavation of archaeol levels reveal Middle Neolithic industry of Bourgogne type, whereas dolmen has no assoc industry (Lepage, 1980).

Ly-2646. La Vergentièrre S1-R18-117 **5110 ± 130**
*4330–3655BC

From upper part of Level D in Boring S1; coll and subm 1981.

Ly-2647. La Vergentièrre S2-A7-150 **5270 ± 390**
*4565–3560BC

From lowest level of Boring S2; coll and subm 1981 (0.1 dr).

Ly-3055. La Vergentièrre, Dolmen 1 **5300 ± 260**
*4690–3645BC

From hearth in tumulus of Dolmen 1; coll and subm 1982 (0.2 dr).

General Comment (LL): despite wide statistical margin for Ly-2647 and -3055, 3 dates are quite similar to previous results from Boring 1, Ly-1859: 5230 ± 300 and Ly-1860: 5350 ± 270 (R, 1983, v 25, p 105). They suggest relatively short occupation of site and contemporaneity of dolmen with habitation level excavated in borings (Lepage, 1982).

Roquefort series, Lugasson, Gironde

Bones from two levels of fortified promontory (44° 44' N, 0° 9' W) coll from 1973 to 1976 and subm 1981 by J Roussot-Larroque, Lab Quaternary Geol, Univ Bordeaux I. Site has two parts, Le Plateau and Le Talus. Archaeol levels contain complete sequence from Middle Neolithic of Roquefort group to Late Neolithic of Matigon and Artenacian types.

Ly-2683. Roquefort-Plateau, Layer 2 **3650 ± 190**
*2540–1665BC

From Layer 2, Plateau site; assoc with Matignon Late Neolithic industry (0.25 dr).

5680 ± 200**Ly-2684. Roquefort-Plateau, Layer 3*****5000-4110BC**

From Layer 3, Plateau site, assoc with 1st phase of Roquefort Middle Neolithic (0.2 dr).

General Comment (JRL): Ly-2683 is obviously too young for Neolithic industry. Such aberrant results were already observed for charcoal from same level, Gif-3597: 3960 ± 135 (unpub). Ly-2684 agrees perfectly with other results from both phases of Roquefort group in Talus site, Gif-1732: 5000 ± 140 for Phase 2, and Gif-1731: 4800 ± 140 for Phase 1 (Roussot-Larroque, 1976).

5480 ± 130**Ly-2613. Le Trou qui fume, Saint-Romain, Côte d'Or*****4560-3905BC**

Bones (*Bovidae*) from top of fill of small cave (47° 0' N, 4° 43' E). Coll 1981 by PY Jacquet and subm 1981 by S Grappin, Dijon. Cave was used only as refuse pit. *Comment* (SG): date confirms homogeneity of fill and end of use of pit in Middle Neolithic (Grappin, 1982).

5300 ± 140**Ly-2970. Le Mont d'Huette, Jonquières, Oise*****4425-3790BC**

Bones from base of palisade ditch of fortified habitation (49° 24' N, 2° 44' E). Coll and subm 1982 by JC Blanchet. Sample comes from Sec 14, with Early Chassean industry of Paris basin type. *Comment* (JCB): date agrees with expected age and dates from other sites in region with Early Chassean industries (see, eg, Ly-2996 and -2961, above). Three other measurements were made for same site: Gif-1623: 1600 ± 300 (R, 1974, v 16, p 38) and Gif-2918: 4290 ± 100 (unpub) are obviously too young and are from charcoal which may have been polluted by roots; Gif-2929: 5120 ± 130 (unpub) was on bones from same ditch and also fits with same industry as Ly-2970, Early Chassean of Epi-Rössen type of Menneville.

Le Verger series, Saint-Romain, Côte d'Or

Charcoal from Layer 2 of site at foot of cliff (46° 59' N, 4° 43' E). Coll and subm 1982 by S Grappin. Assoc with industry attributed to beginning of Middle Neolithic (Grappin, 1982) (0.3 and 0.8 dr, respectively).

5260 ± 180**Ly-2706. Le Verger No. 4*****4435-3670BC****5710 ± 140****Ly-2971. Le Verger No. 5*****4945-4370BC**

General Comment (SG): both dates confirm two previous results from samples from same archaeol level, Ly-1985: 5590 ± 130 and Ly-2243: 5860 ± 170 (R, 1983, v 25, p 105). These 4 dates have same statistical margin and their average is 5620 ± 80 BP. This confirms, as presumed, that this type of industry precedes Middle Neolithic Chassean in region (see Chassey series, R, 1983, v 25, p 103) and is contemporaneous with industry from Chichery

site, Yonne, Gif-3354: 5600 ± 120 (unpub) and with Middle Neolithic industries of Cerny type.

Montagne de Comin series, Bourg-et-Comin, Aisne

Charcoal from burned layer assoc with earth mound in open-air fortified habitation atop plateau ($49^{\circ} 25' \text{ N}$, $3^{\circ} 40' \text{ E}$). Coll and subm by Unité Recherche No. 12 Centre de Recherche Archéol, Paris.

Ly-2972. BMC No. 6 **5440 ± 160**
**4550–3890BC*

From 1.8m depth underlying earth mound (0.5 dr); coll and subm 1982.

Ly-2973. BMC No. 7 **4640 ± 220**
**3795–2925BC*

From 1m depth at base of earth mound (0.3 dr); coll and subm 1982.

Ly-3052. BMC No. 9 **5870 ± 160**
**5195–4435BC*

From 1.7m depth at base of earth mound above ditch of palisade (0.5 dr); coll and subm 1983.

General Comment (URA No. 12): three dates, as well as Ly-2525: 4880 ± 120 (R, 1983, v 25, p 102) from 1.2m depth in same layer prove that earth mound dates from prehist period, despite uncertainty of results of strat study. Dates show that burned layer is assoc with oldest occupation period of site, contemporaneous with Middle Neolithic of Michelsberg type industry, previously dated to ca 5100 BP, eg, in two sites in Aisne R valley (R, 1983, v 25, p 106). However, Ly-3051 seems too old even if double statistical margin is used.

Champ de Bataille series, L'Etoile, Somme

Charcoal from open-air habitation surrounded by palisade ($50^{\circ} 2' \text{ N}$, $2^{\circ} 39' \text{ E}$). Coll and subm by B Bréart, Dir Antiquités Préhist, Amiens. Ditches contain fairly sparse industry attributed to beginning of Middle Neolithic, perhaps of "Cerny" type.

Ly-2679. Champ de Bataille No. 1 **5390 ± 100**
**4430–3895BC*

From base of post hole of palisade; coll and subm 1981.

Ly-3058. Champ de Bataille No. 2 **5990 ± 160**
**5255–4555BC*

From base of ditch assoc with palisade (0.3 dr). Coll and subm 1983.

General Comment (BB): Ly-2679 agrees with attribution of industry to Middle Neolithic; Ly-3058 is comparable to many dates for Early Neolithic of late Rubané type, and suggests relatively old date for Cerny group, even taking into account double statistical margin.

Early Neolithic Period

France

5380 ± 220

*4555–3795BC

Ly-2969. Le Jocoy, Pontpoint, Oise

Bones from middle of Ditch 1 in river-bank site in Oise R alluvia (49° 20' N, 2° 39' E) (Blanchet, Decormeille, & Marquis, 1980). Coll 1982 by A Decormeille and subm 1982 by JC Blanchet. Assoc with Early Neolithic industry of Late Rubané type (0.25 dr). *Comment* (JCB): for unknown reason, date is much too young, by ca 500 yr, as compared, eg, to Le-Coq-Galleux and Cuiry-Les-Chaudardes sites (below).

Les Fontinettes series, Cuiry-les-Chaudardes, Aisne

Bones from two refuse pits in Neolithic village (49° 23' N, 3° 45' E). Coll and subm 1981 by Unité de Recherche No. 12, Paris, to complement previously pub series of 13 samples assoc with Early Neolithic Late Rubané type industry (R, 1983, v 25, p 106).

5870 ± 170

*5195–4435BC

Ly-2551. CCF No. 378-2

Coll 1980 (0.8 dr).

5730 ± 170

*4975–4930BC

Ly-2552. CCF No. 382

Coll 1981 (0.9 dr).

General Comment (URA No. 12): both dates agree perfectly with all previously pub dates. Bell-shaped curve drawn from 15 results indicates that occupation responsible for this industry was very short, *ie*, 200 yr, and occurred ca 5950 BP (Constantin & Lasserre, 1983).

5910 ± 150

*5215–4450BC

Ly-2838. Balise d'Amélie, Soulac-sur-Mer, Gironde

Oak wood from peaty layer outcrop on offshore sand bar (45° 29' N, 1° 7' W). Coll 1982 by J Moreau and subm 1983 by J Roussot Larroque. Assoc with Cardial Early Neolithic industry of Atlantic type. *Comment* (JRL): date is a little younger than other dates from shoreline sites on W French coast, eg, at Les Gouillauds, on Ré I., Gif-4878: 5950 ± 100 (Pautreau & Robert, 1980) and at La-Tranche-sur-Mer, Vendée, Gif-4372: 6300 ± 160 (Jousseau *et al*, 1979). Both sites also contain Early Neolithic industry, but Balise site shows Middle Neolithic attributes (Roussot-Larroque, 1976) and, thus, may be younger.

5990 ± 200

*5285–4450BC

Ly-2651. Breisberg, Oudrenne, Moselle

Charcoal from 50cm depth in Ditch VIII of habitation site (49° 25' N, 6° 19' E). Coll 1981 by T Kleg and subm 1981 by C Guillaume, Dir Antiquités Prehist, Metz. Assoc with Early Neolithic industry of Late Danubian

linear Rubané type (0.7 dr). *Comment* (CG): date agrees with expected value and fits exactly with one from Kirchnaumen, nearby site with same industry, Ly-1181: 6060 ± 200 (R, 1978, v 20, p 43) (Decker, Guillaume, & Michels, 1977). Thus, as expected, it is also a little younger than Late Rubané sites in neighboring regions but similar to Paris basin sites such as Cuiry-Les-Chaudardes (above) and Le-Coq-Galleux (below).

Le Rochas series, Saint-Remèze, Ardèche

Charcoal from three superimposed sub-levels in Layer 4 of cave fill ($44^{\circ} 21' \text{ N}$, $4^{\circ} 29' \text{ E}$). Coll 1981 and subm 1982 by A Beeching, Centre Natl Recherche Sci, Marseille. Layer 4 contains homogeneous Middle or Late Cardial Early Neolithic industry.

Ly-2749. Rochas 4-1/4-2

5060 ± 250
*4340–3390BC

Samples from upper sub-levels 4-1 and 4-2; only 0.2 dr despite availability of ca 20g of charcoal before alkaline pretreatment.

Ly-2748. Rochas 4-3

6090 ± 210
*5365–4565BC

From lowest sub-level 4-3; only 0.4 dr also after large dissolution of charcoal during alkaline pretreatment.

General Comment (AB): Ly-2748 agrees with expected age for Late Cardial Neolithic and previously obtained results from region, eg, in nearby site, La Baume-Bourbon at Cabrières, Ly-412: 6050 ± 120 and Ly-538: 6180 ± 180 (R, 1973, v 15, p 525–526) or in La Baume rock shelter at Montclus, Ly-303/304: 6220 ± 100 (R, 1971, v 13, p 62). Ly-2749 is obviously too young and may be explained by presence of some charcoal originating from overlying layers which contain industries dating from Chalcolithic to Middle Ages, despite presence of stalagmitic floor overlying Layer 4. Discrepancy may also be due to large statistical margin caused by small dr (Beeching & Thomas-Beeching, 1982).

Rufacher Huben series, Colmar, Haut-Rhin

Bones from several refuse pits of village ($48^{\circ} 2' \text{ N}$, $7^{\circ} 20' \text{ E}$). Coll 1979 by C Bonnet and subm 1982 by A Thévenin, Dir Antiquités Prehist, Stras-

TABLE 31
Rufacher Huben

Sample no.	Site ref	DR	Age (BP)	Corrected date interval (BC)
Ly-2729	RST 13–14	0.4	5990 ± 230	5285–4450
-2730	MN 2	0.5	5860 ± 140	5190–4430
-2731	HI 13–15	0.4	5690 ± 180	5020–4115
-2732	DE 18–20	0.5	6050 ± 200	5325–4550
-2733	CD 13-14-15	1	5740 ± 130	4990–4395

bourg. Assoc with Rubané artifacts. Each pit contains unstrat mixture of bones and potsherds from Early, Middle, and Late Rubané.

General Comment (CB): despite dilution of samples due to low collagen content of most of bones, as is usual for open-air sites, dates are very similar for all pits. This suggests either homogeneous mixture of bones or very short site occupation which was contemporaneous with Late Rubané in Lorraine prov, eg, in Breisberg site (above), or in Paris basin, eg, in Cuiry-les-Chaudardes site (above). Brevity of occupation does not agree with typol data from potsherds mixed in ditches, of which most are Early Rubané and surely older than 6000 BP. Thus, due to lack of strat in ditches, results do not actually date whole site, but demonstrate homogeneity of bone mixture.

Le Coq Galleux series, Compiègne, Oise

Bones from habitation site on lowest terrace of Oise R (49° 24' N, 2° 48' E). Coll 1978 (Ly-2714 and -2715) by C Toupet and 1979 by JC Blanchet and subm 1982 by JC Blanchet.

General Comment (JCB): except for Ly-2715, which was sampled at very shallow depth and may, thus, be younger, all dates are perfectly within expected range indicated by strat study and typol of assoc industries (Toupet, 1980; Blanchet & Decormeille, 1980). First phase of site occupation occurred during Early Neolithic (Paris basis Rubané type). Three dates from this period (Ly-2717, 2716, -2720) are very close and similar to those obtained for same industry in many other sites of region, such as Cuiry-Les-Chaudardes (above; R, 1983, v 25, p 106). Second phase of site occupation corresponds to Cerny type Middle Neolithic; both dates from this period agree with similar samples from Paris basin and N France, such as Les Sablins at Etaples, Gif-3701: 5660 ± 120 and Gif-4024: 5690 ± 120

TABLE 32
Le Coq Galleux

Sample no.	Loc in site	Assoc industry	DR	Age (BP)	Corrected date interval (BC)
Ly-2962	Struct 12, pit	Late Neolithic	0.3	3870 ± 130	2785–1970
		Chalcolithic			
-2715	Pit 2	Chassean	1	4450 ± 140	3315–2870
-2714	Level 2 Sec 3	Chassean	1	4950 ± 160	4075–3880
-2718	Struct 14	Early Chassean	1	5330 ± 110	4415–3875
	Camp ditch				
-2963	Struct 45	Cerny	0.3	5420 ± 180	4545–3885
	Ritual pit				
-2719	Struct 49	Danubian or	0.3	5710 ± 180	5050–4125
		Cerny			
-2717	Struct 3	Danubian Late	0.2	5920 ± 260	5295–4320
	Advanced ditch	Rubané			
-2716	Struct 2 Main ditch	Late Rubané of	1	6080 ± 110	5270–4740
		Paris basin			
-2720	Struct 4	Late Rubané	1	5950 ± 120	5210–4565
	Refuse pit				

(Hutrelle & Piningre, 1978), or Pincevent at La Grande Paroisse, Gif-5005: 5630 ± 120 (unpub), or La Grève de Frécul at Barbuisse-Courtavent, Ly-2455: 5530 ± 150 (R, 1983, v 25, p 108). Third phase of occupation is Chassean Middle Neolithic. Three dates from this period, Ly-2718, -2714, -2715, are similar to those from Chassean levels in Boury-en-Vexin and Catenoy sites (above). Fourth phase of site occupation, corresponding to Late Neolithic, has previously been dated by Louvain, Lv-1221: 4250 ± 75 (unpub). Ly-2962 corresponds to Chalcolithic period, probably of "Champs d'Urnes" type. Thus, all these results summarize well entire Neolithic chronology for Paris basin (Blanchet, 1983).

6590 \pm 140

Ly-2677. La Madeleine, Pont du Château, Puy de Dôme *5835–5220BC

Human bones from burial in isolated ditch in silty colluvia overlying low terrace of Allier R ($45^{\circ} 49' N$, $3^{\circ} 15' E$). Coll 1981 by Lab Regional Ponts et Chaussées, Clermont-Ferrand and subm 1981 by JP Daugas, Dir Antiquités Prehist, Clermont-Ferrand. No assoc industry (0.7 dr). *Comment* (JPD): date confirms Neolithic suggested by burial loc and osteol study by A Gilbert (Daugas, Gilbert, & Raynal, 1982). Date is comparable to Le Creux Rouge sepulture at Clermont-Ferrand, Ly-1944: 6070 ± 140 (R, 1983, v 25, p 108).

Abri de Strette series, Babaghju, Haute Corse

Charcoal from two levels in rock shelter ($42^{\circ} 42' N$, $9^{\circ} 12' E$). Coll 1982 and subm 1983 by J Magdeleine, Bastia.

6420 \pm 300

Ly-2835. Strette No. 4

*5820–4975BC

From Layer XXb, assoc with Cardial Early Neolithic industry (0.1 dr).

6480 \pm 430

Ly-2836. Strette No. 5

*6000–4800BC

Same layer and assoc industry as previous one (0.2 dr).

Ly-2837. Strette No. 7

9140 \pm 300

From Layer XXIV, assoc with Pre-Neolithic lithic industry (0.2 dr).

General Comment (JM): average of Ly-2835/2836: 6460 ± 250 , corresponding to most dates for Cardial Neolithic in Provence, eg, at Château-neuf-Lès-Martigues (below). Ly-2837 confirms Pre-Neolithic origin of industry.

La Font des Pigeons series, Châteauneuf-Lès-Martigues, Bouches-du-Rhône

Charcoal from large rock shelter ($43^{\circ} 23' N$, $5^{\circ} 10' E$). Coll 1979 and subm 1982 and 1983 by J Courtin, Dir Antiquités Prehist, Aix-en-Provence (0.07 dr only for Ly-2823).

General Comment (JC): three series were previously dated from 1960 excavation by M Escalon de Fonton (1967). One was done by Köln lab from

TABLE 33
Châteauneuf-Lès-Martigues

Sample no.	Layer	Assoc industry	Age (BP)	Corrected date interval (BC)
Ly-2823	1	Chassean, Middle Neolithic	5160 ± 360	4655–3255
-2824	2	Chassean, Middle Neolithic	5460 ± 130	4525–3920
-2825	6	Epicardial, Early Neolithic	5590 ± 120	4700–4170
-2826	12	Late Cardial, Early Neolithic	5900 ± 140	5205–4465
-2827	13	Middle Cardial, Early Neolithic	6200 ± 160	5435–4865
-2828	16A	Early Cardial, Early Neolithic	6550 ± 100	5755–5225
-2829	17	Early Cardial, Early Neolithic	6200 ± 100	5360–4925
-2830	18G	Late Castelnovian, Mesolithic	7260 ± 120	
-2831	19	Late Castelnovian, Mesolithic	6720 ± 140	5970–5290
-2832	19	Late Castelnovian, Mesolithic	7290 ± 130	
-2833	20	Middle Castelnovian, Mesolithic	7630 ± 150	

charcoal: Kn-208: 6700 ± 200, for Late Cardial level, and Kn-182: 7520 ± 240 for Early Cardial level. Latter result suggested very early appearance of Neolithic industries in region (Escalon de Fonton, 1967). Two other series were done by Lyon lab, 7 dates from bones and charcoal from all levels (R, 1977, v 15, p 526–527), and by Monaco lab, MC-2514: 6050 ± 100 from Layer 7–8, MC-2515: 6900 ± 100 from Layer 17, and MC-2516: 7220 ± 100 from Layer 18. All dates from Lyon and Monaco indicate much younger date, by ca 1000, for beginning of Neolithic. New excavation was later carried out by J Courtin to check previous data. New series agrees with Ly and MC results, and with archaeol and chronol data from other sites in region (Courtin, Evin, & Thommeret, in press).

Mesolithic Period

France

La Doue series, Saint-Cernin de Larche, Corrèze

Charcoal from carbonaceous masses (hearth or discharge zones) from rock shelter (45° 5' N, 1° 24' E) (Mazière, 1983). Coll and subm 1980 (Ly-2223, -2234) and 1982 by G Mazière, Dir Antiquités Prehist, Limoges.

TABLE 34
La Doue

Sample no.	Loc	Depth (cm)	DR	Assoc industry	Age (BP) and corrected date interval
Ly-2649	O/P-VI	214–220	0.25	Medieval	1430 ± 200 AD230–900
-2818	F-V	98–100	0.2	Early Neolithic	6390 ± 290 5790–4745BC
-2233	H-V	160	1	Sauveterrian	8750 ± 150
-2234	H-V	180	1	Sauveterrian	8880 ± 160
-2819	I-V	178–182	0.3	Sauveterrian	9260 ± 200
-2820	I-V	183–196	0.3	Sauveterrian	8980 ± 210
-2821	I-V	203–208	0.5	Sauveterrian	8860 ± 210
-2822	M-V	478–480	1	Late Magdalenian	11,520 ± 170

General Comment (GM): all dates agree with chronol expected from assoc industries. Ly-2649 corresponds to beginning of Middle Ages. Ly-2818 may be correlated with Ly-1600: 7010 ± 430 (R, 1979, v 21, p 440) from Layer 3 in nearby Chez-Jugie site at Cosnac, which contains some industry, with "Le Martinet" trapezoid type. Sauveterrian dates are very close, at ca 9000 BP. They are identical to those from Les Fieux site at Miers, Lot, Gif-4281: 9060 ± 190 (unpub) and show that industry is much older than at Chez-Jugie (3 dates at ca 8000 BP). Ly-2822 is also identical to two dates from Chez-Jugie assoc with Magdalenian industry with Azilian characteristics, Ly-1572: $11,840 \pm 580$ and Ly-1601: $11,730 \pm 530$.

La Vieille Eglise series, La Balme de Thuy, Haute-Savoie

Charcoal from lowest levels of rock shelter (45° 55' N, 6° 17' E). Coll and subm by JP Ginestet, Thônes.

Ly-1936. La Vielle-Eglise 6A **8170 \pm 160**

From Level 6A; coll 1978 and subm 1979 (0.7 dr). Assoc with Tardenoisian Mesolithic industry.

Ly-2619. La Vielle-Eglise 7A **9820 \pm 200**

From Level 7A; coll 1981 and subm 1982. Assoc with Tardenoisian Mesolithic industry.

General Comment (JPG): both dates agree perfectly with expected values. They date intermediate levels, 6B and 6C, at ca 9000 BP. Upper levels, 5A and 5B, containing Middle and Early Neolithic ceramic industry were previously dated, Ly-1934: 5930 ± 210 and Ly-1935: 6500 ± 230 (R, 1983, v 25, p 108–109; Bintz *et al*, 1981).

Allée Tortue series, Fère-en-Tardenois, Aisne

Charcoal from 4 hearths found in middle of open-air site at ca 30 to 50cm depth in sand (49° 13' N, 3° 31' E). Coll and subm by JG Rozoy, Charleville-Mézières. Site contains rich Late Tardenoisian Mesolithic flint industry (Rozoy, 1978).

Ly-2738. Allée Tortue J-50 **4070 \pm 170**
**3010–2305BC*

From deepest hearth J-50; coll 1981 and subm 1982; 0.5 dr despite large sample size before alkaline pretreatment.

Ly-2739. Allée Tortue F-51 NE **3470 \pm 130**
**2170–1540BC*

From hearth F-51 NE in upper part of archaeol level. Coll 1979 and subm 1982.

Ly-2740. Allée Tortue C-54 NW **3100 \pm 210**
**1755–835BC*

From hearth C-54 NW in upper part of archaeol level. Coll and subm 1982.

Ly-3149. Allée Tortue I-50 SW**9120 ± 210**

From beneath hearth I-50 SW (0.3 dr).

General Comment (JGR): first three samples date hearth to Chalcolithic and Bronze ages and show that hearths are intrusive in Mesolithic upper layer of site. Such disturbance of archaeol layer was indicated by inside discovery of flint arrow with peduncle and wings. Ly-3149 shows hearth with Later Tardenoisian industry overlying older charcoal, demonstrating human presence at site early in Mesolithic period.

Ly-2814. Campagnol des Neiges cave, Gresse, Isère**9010 ± 200**

Charcoal (*Pinus* sp) from base of gallery of cave opening at ca 1950m alt at foot of Séguret Mt in Les Hauts Plateaux du Vercors massif (44° 52' N, 5° 31' E). Coll 1981 and subm 1982 by P Bintz. Gallery contains several skeletons of various animal spp and some Epipaleolithic flints. *Comment* (PB): date confirms age of flint which indicates temporary presence of man in this deep cave, despite high alt and difficult access of site.

*Magdalenian Period**France***Ly-2531. La Roche cave, Courchapon, Doubs****8450 ± 150**

Bones and fragments of antlers from fill near entrance of cave (47° 14' N, 6° 46' E). Coll 1950 to 1955 by P Ripotot and R Seibel (1958), preserved in Dôle Mus and subm by M Campy, Dir Antiquité Prehist, Besançon. Fauna underlay level containing Late Magdalenian industry. *Comment* (MC): date indicates fauna is not contemporaneous with industry, despite proximity.

Ly-2781. Loubressac cave, Mazerolles, Vienne**9690 ± 160**

Bones from only archaeol layer in fill of terrace of small cave (46° 25' N, 0° 41' E). Coll 1947 and subm 1981 by L Pradel, Châtellerault. Assoc with Magdalenian VI₂ industry. *Comment* (LP): date is obviously too young for assoc industry as it corresponds to beginning of Holocene. This discrepancy cannot be explained (Pradel, 1983).

Ly-2314. Le Pré des Forges, Marsangy, Yonne**8440 ± 190**

Gastropod shells from lowest and upper parts of Layer 5 in open-air site (48° 7' N, 3° 18' E). Coll 1979 and subm 1980 by B Schmider, Lab Prehist, Coll France, Paris. Layer 5 contains faunal bones without collagen and Magdalenian industry. Gif TL date from burned sandstones is ca 11,700 BP. *Comment* (BS): date is too young but shells were coll from entire layer whereas industry was found in only lowest part of level. It confirms unreliability of terrestrial shells for dating archaeol events (Evin *et al*, 1980; Schmider, 1979).

Abri de Campalou series, Saint-Nazaire-en-Royan, Drôme

Bones from rock shelter (45° 15' N, 5° 12' E). Coll and subm 1972 by JE Brochier and JL Brochier (1973), Romans/Isère.

Ly-2286. Campalou 2a 9720 ± 1100

From Layer 2a in Zone 6–7 (0.07 dr); assoc with Late Magdalenian industry with Azilian characteristics, previously dated, Ly-436: 12,800 ± 300 (R, 1973, v 15, p 148). Date was considered too old by ca 1000 yr, as typol, sedimentol, and palynol data suggest beginning of Alleröd.

Ly-2285. Campalou 3a 9400 ± 500

From level underlying previous one (0.2 dr); assoc with Late Magdalenian industry attributed to Middle Dryas, ca 12,000 BP.

Ly-1958. Campalou base 13,400 ± 350

From lowest level of fill (0.7 dr); assoc with Magdalenian industry attributed to Early Dryas or Bölling.

General Comment (JEB & JLB): Ly-2286 and -2285 appear too young by ca 1000 yr while previously pub sample was too old also for unknown reasons. Ly-1958 agrees with expected age.

Ly-2693. Gare de Conduché cave, Bouziès, Lot 12,040 ± 160

Bones from only black layer of fill in small cave (44° 29' N, 1° 39' E). Coll and subm 1982 by M Lorblanchet, Cabrerets Mus. Assoc with Late Magdalenian industry with microlithic remains. *Comment* (ML): date agrees with many others for Late Magdalenian of SW France, except those from nearby site, Sainte-Eulalie at Espagnac, Gif-2193: 10,400 ± 300 and Gif-1697: 10,830 ± 200, which suggested prolonged presence of Magdalenian industry in Quercy region. Date does not confirm latter hypothesis and indicates that more measurements on samples from Sainte-Eulalie site are needed.

Caves and rock shelters of Bordelais series, Gironde

Bones from Magdalenian sites in Bordeaux region (Lenoir 1983). Subm by M Lenoir, Lab Quaternary Geol, Univ Bordeaux I (Table 35a,b).

General Comment (ML): dates are generally as expected from assoc industries. Ly-3148 shows bone-bearing breccia is not part of same archaeol assemblage as underlying Middle Magdalenian levels but is contemporaneous with fills of many neighboring sites containing Late Magdalenian industries, such as La Grotte des Fées (undated). Ly-2632 confirms that lowest level is from beginning of Upper Paleolithic; Ly-2699 agrees with previous dates of samples from neighboring rock shelter Arbi I du Moulin Neuf, Level 2a, Ly-2352: 13,570 ± 260 and Level 2b, Ly-2275: 14,280 ± 440 (R, 1983, v 25, p 114). Ly-2701 suggests that bone may come from underlying level.

Roc La Tour 1 series, Monthermé, Ardennes

Charcoal underlying archaeol level of open-air site (49° 54' N, 3° 27' E). Coll and subm 1982 by JG Rozoy. Site contains Late Magdalenian V industry.

TABLE 35a
Bordelais

Site	Village	Geog coordinates	Colln yr	Ref	Subm yr
Abri Faustin	Cessac	(44° 44' N, 0° 10' W)	1975	M Lenoir	1982
Vidon	Juillac	(44° 49' N, 0° 16' W)	1950	E Prot	1982
Roc de Marcamps	Prignac and Marcamps	(45° 02' N, 0° 30' E)	1979	M Lenoir	1980, 1981
Abri 2 du Moulin Neuf	Saint-Quentin de Baron	(44° 49' N, 0° 16' W)	1980	M Lenoir	1982

TABLE 35b
Bordelais

Sample no.	Site	Layer	Sq	Assoc industry	DR	Age (BP)
Ly-2700	Abri Faustin	1	K-24	Late Magdalenian	0.7	12,370 ± 220
-2699	Abri 2 du Moulin Neuf	2	M-13	Middle Magdalenian	0.5	13,380 ± 250
-2701	Vidon	B		Late Magdalenian	0.7	14,000 ± 350
-3148	Roc de Marcamps		Breccia		1	11,910 ± 230
-2290	Roc de Marcamps	1b	N-28	Late Magdalenian	1	14,200 ± 190
-2680	Roc de Marcamps	2	N-29	Middle Magdalenian	0.7	13,570 ± 420
-2291	Roc de Marcamps	2	N-26-28	Middle Magdalenian	0.7	14,910 ± 240
-2681	Roc de Marcamps	3b	Core S	Middle Magdalenian	0.3	15,700 ± 450
-2292	Roc de Marcamps	4c	M-30	Middle Magdalenian	1	17,410 ± 310
-2682	Roc de Marcamps	8	M-30 N-30	Aurignacian	0.5	26,520 ± 830

Ly-2924. Roc de La Tour N-51 **4710 ± 110**
**3775–3175BC*
From Sq N-51.

Ly-2925. Roc de La Tour F-61 **650 ± 150**
**AD1175–1435*
From Sq F-61.

Ly-2926. Roc de La Tour **1990 ± 200**
**405BC–AD390*
From Sq L-50 (0.3 dr).

General Comment (JGR): dates show large-scale disturbance of site, frequent in relatively superficial sites where downward migrations of charcoal can occur via root holes or animal burrows.

Ly-3000. La Garenne, Saint-Marcel, Indre **14,270 ± 270**
Bone of microfaunal spp, mainly *Microtus* sp, from Sec B1 and B2 in cave (46° 36' N, 1° 30' E). Coll 1955 by J Allain, Dir Antiquités Prehist, Bourges, and subm 1983 by R Desbrosse, Centre Natl Recherche Sci, Blanzay and JF Kosłowsky, Archaeol Inst Jagielonski, Krakow, Poland (0.4 dr). Site contains Magdalenain industry with “navettes” found in several other sites in distant points of Europe. Many dates from this site were erratic (R, 1978, v 20, p 49–50). *Comment* (JK): date confirms feasibility of using microfaunal bones as dating material as collagen content is often higher than in macrofaunal bones. Date falls within range of other sites of

Arlay, Jura, France (R, 1979, v 21, p 446) and Maszyska cave, near Krakow, Poland (R, 1983, v 25, p 115). It confirms contemporaneity of “à Navette” Magdalenian industry in all three sites despite their distance (Desbrosse *et al*, in press). Pollen analysis indicates beginning of warm oscillation attributed to Bölling but date is more likely to be Early Dryas.

Monthaud series, Chalais, Indre

Bones of several spp from three levels of fill of rock shelter (46° 32' N, 1° 2' E). Coll 1966 and subm 1980 by L Pradel, Châtellerault (Pradel & Pradel, 1967).

Ly-2757. Monthaud III 13,420 ± 200

From Layer III, assoc with Late Solutrean industry like one from La Tannerie site, previously dated, Ly-2228: 18,020 ± 270 (R, 1983, v 25, p 116).

Ly-2758. Monthaud II 15,450 ± 290

From Layer II assoc with Middle Solutrean industry (0.7 dr).

Ly-2759. Monthaud I 16,970 ± 300

From Layer I assoc with Early Solutrean industry like one from Layer H of Laugerie Haute site, previously dated, GrN-1888: 20,890 ± 300 (R, 1963, v 5, p 167) (0.5 dr).

General Comment (LP): dates fit strat sequence but are in Early Magdalenian rather than Solutrean time range. Date remains unexplained as these two industries have never been contemporaneous.

Ly-2737. Les Guinards, Creuzier le Vieux, Allier 17,420 ± 330

Reindeer antler from solifluction flow excavated during work on road (46° 11' N, 3° 25' E). Coll 1981 by L Magoda, JP Daugas and JP Raynal and subm 1982 by JP Daugas and JP Raynal. *Comment* (JPD & JPR): date suggests Early Magdalenian. Sparse assoc industry with many backed bladelets neither exclude nor confirm such attribution (Daugas & Raynal, 1982) as deposits such as solifluction flows often involve mixing of materials. Date may be compared with several other results from Velay region, such as Les Cottiers site at Retournac, Ly-719: 18,550 ± 150 (R, 1975, v 17, p 27) and Le Rond du Barry site at Polignac, Gif-3038: 17,100 ± 450 (unpub).

Czechoslovakia

Ly-2553. Pekarna cave, Mokra, Moravia 12,940 ± 250

Bones (*Equus* sp) first attributed to Layer g/h but probably from only Layer g (49° 15' N, 16° 41' E). Coll during excavation 1925 to 1930 (Abso- lon & Czierek, 1932), preserved in Moravic Mus, Brno, and subm 1981 by K Valoch, Anthropol Inst, Brno. Assoc with Moravian Magdalenian with “navettes” industry, attributed to Middle Dryas. *Comment* (KV): date as expected from paleontol study of horse bones by R Musil.

*Spain***La Riera series, Posada de Lianes, Asturias**

Bones from cave deposit (43° 26' N, 4° 52' W). Coll 1977 and subm by LG Straus, Univ New Mexico, and GA Clark, Arizona State Univ.

Ly-1646. La Riera 23 **10,340 ± 560**

From Level 23, Sq H-10, subm 1978; assoc with Upper Magdalenian industry (0.3 dr).

Ly-1645. La Riera 20 **12,360 ± 670**

From Level 20, Sq E-9, subm 1978; assoc with Magdalenian industry (0.1 dr).

Ly-1783. La Riera 1 **20,360 ± 450**

From Level 1, Sq G-10, subm 1979; assoc with Pre-Solutrean industry, may be Late Aurignacian.

General Comment (LGS): La Riera sequence was dated with 28 samples by Gakushuin, Cambridge, British Mus, Riverside, and Lyon labs on both bones and charcoal. Ly-1646 agrees with GaK-6982: 10,890 ± 430, for immediately overlying Level 24. Ly-1645 provides reasonable estimate for Level 20, although 2 other dates, UCR-1273D, which is far too young and GaK-6980: 17,160 ± 440 which is conceivable at 2σ due to depositional hiatus, both sedimentol and palynol detected at this depth. Ly-1783 falls within statistical error of two other dates for Level 1, UCR-1270A: 19,620 ± 390 and BM-1739: 20,860 ± 410. No Solutrean points were found in this basal layer, which is overlain by 16 Solutrean levels with 11 ¹⁴C dates ranging from 20,970 ± 620 to 16,900 ± 200 (Straus *et al*, 1981).

*Beginning of Late Paleolithic
and Middle Paleolithic Periods*

*France***La Vigne Brun series, Villereest, Loire**

Powder of burned bones (Ly-2151 and -2153) and burned bones from hearths in several areas of open-air habitation site (45° 59' N, 3° 19' E). Coll and subm by J Combier and JL Porte, Dir Antiquités Prehist, Lyon. In all secs dated, hearths contain rich Upper Perigordian industry and site generally resembles settlements with wall of mammoth bones discovered in W Russia (Combier *et al*, 1982).

General Comment (JC): Ly-2512 comes from much eroded area and is unexplained as it seems there was no human occupation of site after Upper Perigordian period. Ly-2151 and -2153 are too young because powdery material did not allow for thorough cleaning. Sample contained carefully selected large fragments of completely charred bones (Evin, 1982). Thus, last 4 dates mutually agree and suggest relatively short occupation of site at

TABLE 36
Vigne Brun

Sample no.	Loc	Colln yr	Subm yr	DR	Age (BP)
Ly-2152	Sec XX	1979	1979	0.4	16,180 ± 260
-2151	Sq P-16	1979	1979	0.3	19,500 ± 480
-2153	Sq 0-16	1979	1979	0.5	20,840 ± 390
-2637	Sec VIII-IX	1981	1982	0.3	23,450 ± 690
-2638	Sec VIII-IX	1981	1982	1	21,580 ± 600
-2639	Sec VII	1981	1982	0.4	23,230 ± 750
-2640	Sec I-IX	1981	1982	0.1	23,500 ± 1000

ca 23,000 BP. They also agree with previously pub dates from same site, Ly-391: 24,900 ± 2000 (R, 1975, v 17, p 29) and with other results from two sites in same region that contain similar industry: Saint-Martin-sous-Montaigu, Ly-311: 22,900 ± 600 and Ly-309: 24,150 ± 700 (R, 1971, v 13, p 64) and Solutr : 4 dates between 21,600 ± 700 and 24,050 ± 600 (R, 1971, v 13, p 63; R, 1973, v 15, p 518).

Le Flageolet I series, B zenac, Dordogne

Bones from several archaeol levels of rock shelter (44° 51' N, 1° 5' E). Coll 1976 and 1980 by JP Rigaud, Dir Antiquit s Prehist, Bordeaux. Site was successively occupied from beginning of Upper Paleolithic until Late Perigordian (Rigaud, 1982).

General Comment (JPR): use of ammonia contaminated by atmospheric CO₂ during lab treatment surely caused all first-measured samples (Ly-1606 to -1608, -1748, -1749) to appear too young. Exact amount of contamination could not be calculated but dates are probably off in proportion to dilution ratio; thus, they must be all considered min ages. All other dates are in mutual agreement and are within expected age range, although some are a little younger than Groningen samples from levels containing similar industries in Abri Pataud rock shelter (R, 1967, v 9, p 114-115; R, 1972, v 14, p 56).

TABLE 37
Le Flageolet I

Sample no.	Layer	Assoc industry	Subm yr	DR	Age (BP)
Ly-1606	I/III	Late Perigordian	1977	0.7	≥22,440 ± 680
-2185	I/III	Late Perigordian	1979	0.3	18,610 ± 440
-1607	IV	Late Perigordian	1979	0.5	≥21,190 ± 920
-2186	IV	Late Perigordian	1979	0.8	22,950 ± 500
-2721	V	Late Perigordian	1977-1981	0.5	22,520 ± 500
-2722	VI	Late Perigordian	1977-1981	0.6	24,280 ± 500
-1748	VII	Late Perigordian	1977	1	≥25,720 ± 610
-2723	VII	Late Perigordian	1977-1981	0.3	26,150 ± 600
-1608	VIII	Aurignacian	1977	1	≥23,280 ± 670
-2724	VIII/1	Aurignacian	1981	0.3	26,800 ± 1000
-2725	VIII/2	Aurignacian	1981	0.8	27,350 ± 1400
-1749	IX	Aurignacian	1977	0.2	≥20,270 ± 1760
-2726	IX	Aurignacian	1981	0.4	27,000 ± 1000
-2727	XI	Early Aurignacian	1977-1981	0.3	≥31,500

Le Fonténioux cave series, Saint-Pierre de Maillé, Vienne

Bones and teeth of animal spp from cave fill (46° 40' N, 0° 50' E). Coll 1951 and subm 1982 by L Pradel.

Ly-2785. Fonténioux, No. 2 **25,230 ± 500**

From level containing Upper Aurignacian V industry.

Ly-2784. Fonténioux, No. 1 **25,400 ± 450**

From level containing Upper Perigordian IVa industry (0.7 dr).

General Comment (LP): both dates agree perfectly with expected age (Pradel, 1953). They confirm generally assumed contemporaneity of Late Aurignacian and Perigordian. They also agree with dates from neighboring Laroux site, Ly-1740: 23,510 ± 640 (R, 1979, v 21, p 447).

Le Raysse series, Brive-La-Gaillarde, Corrèze

Bones of several animal spp from rock shelter fill (45° 7' N, 1° 32' E). Coll 1964 and subm 1982 by L Pradel (Pradel & Pradel, 1966).

Ly-2782. Le Raysse, No. 4 **25,000 ± 660**

From Layer 4; assoc with Upper Perigordian V_C industry (0.5 dr).

Ly-2783. Le Raysse, No. 3 **23,630 ± 480**

From Layer 3; assoc with Aurignacien I industry (0.5 dr).

General Comment (LP): Ly-2782 is within age generally accepted for Late Perigordian industry but Ly-2783 is obviously too young for Early Aurignacian.

Ly-2752. Les Cottés, Saint-Pierre de Maillé, Vienne **23,420 ± 710**

Bones from animal spp from Layer IV of terrace fill of cave (46° 40' N, 0° 50' E). Coll 1958 to 1960 and subm 1980 by L Pradel. Assoc with evolved Early Perigordian industry (Pradel, 1961). *Comment* (LP): date is much younger than those from Layers I, G, and E, dated by Groningen (R, 1967, v 9, p 107–155). It is too young to be attributed to Early Perigordian, but sterile layer overlying Layer E in cave contains scattered Perigordian IVa industry to which date could correspond.

Dousse series, Angles-sur-l'Anglin, Vienne

Bones from fill of two rock shelters in close proximity (46° 42' N, 0° 51' E). Coll 1957 and subm 1980 by L Pradel.

Ly-2753. Abri Sabourin **29,300 ± 800**

From only archaeol level of rock shelter; assoc with Mousterian industry without bifaces.

Ly-2755. Abri Rousseau II-3 **≥30,000**

From Level II, Layer 3, upper layer of fill of rock shelter; assoc with Mousterian industry without handaxes, more evolved than previous one.

Ly-2754. Abri Rousseau, I-2**≥33,200**

From Level I, Layer 2, lower layer of fill of rock shelter; assoc with Mousterian industry without handaxes.

General Comment (LP): Ly-2753 is rather young for Middle Paleolithic industry or could indicate localized continuation of Mousterian contemporaneity with Early Perigordian and Aurignacian industries in neighboring sites, *ie*, at Les Cottés (above). Ly-2755 and -2754 confirm that this Mousterian industry is older than Würmian III stadial.

Ly-2756. L'Ermitage, Lussac-les-Châteaux, Vienne**26,600 ± 600**

Bones of animal spp from only level of cave fill (46° 23' N, 0° 43' E). Coll 1953 and subm 1980 by L Pradel. Assoc with Mousterian industry of La Quina or Charentian type (Pradel & Pradel, 1954) (0.8 dr). *Comment* (LP): for unknown reason, date is too young even for very Late Middle Paleolithic.

Ly-2902. Abri Moula, Soyons, Ardèche**20,060 ± 320**

Bones from several sqs at 5.4m depth in fill of rock shelter (44° 43' N, 4° 50' E). Coll 1982 by Archaeol Club, Crouzet Cie, and P Payen, Valence. Assoc with Mousterian industry. *Comment* (PP): date is younger than previous result, Ly-2488: 32,200 ± 1500 from overlying level which also gave similar date, Ly-2217: 20,100 ± 310 (R, 1983, v 25, p 118).

Les Pêcheurs series, Casteljau, Ardèche

Bones from superimposed hearths (F) of habitation level, from base (S) of fill, from layer at presumed base of isolated hut (L) (Lhomme, Enétério, & Moulin, 1980) in rock shelter (44° 24' N, 4° 23' E). Coll 1976 to 1981 and subm 1978 and 1981 (Ly-2343) by G Lhomme, Les Vans.

General Comment (GL): Ly-2339 and -2342 are obviously much too young by ca 10,000 yr. Although other values seem to agree with strat sequence confirmed by amino acid racemization of bones (Lafont, 1984), they all seem a little too young for French sites from beginning of Late Paleolithic, either in Perigord (eg, at Les Eyzies) or in Bourgogne (eg, at Arcy-sur-Cure) (Delibrias & Evin, 1974). This general tendency to younger ages remains unex-

TABLE 38
Les Pêcheurs

Sample no.	Loc	Assoc industry	Depth (cm)	DR	Age (BP)
Ly-2337	F-9	Aurignacian I	210–230	0.5	26,760 ± 1000
-2338	F-11-12	Aurignacian 0	225–230	0.6	29,400 ± 900
-2339	F-10-11	Early Aurignacian	230–240	1	23,880 ± 750
-2340	L-1-2	Early Aurignacian or Mousterian	270–300	0.4	29,700 ± 900
-2341	F-13	Early Aurignacian or Mousterian	240–250	0.5	28,440 ± 1280
-2343	F-16	Early Aurignacian or Mousterian	260	1	≥31,000
-2342	5-base	Mousterian	395–420	0.7	24,940 ± 680

plained, maybe due to contaminant in bones which was not eliminated during normal pretreatment.

La Baume de Gigny series, Gigny-sur-Suran, Jura

Bones from middle fill of rock shelter (46° 27' N, 5° 27' E). Coll and subm by M Vuilleme, Lons-le-Saunier, to complete and check earlier series (see, eg, R, 1979, v 21, p 447) and to confirm presence of sedimentation hiatus or erosion level beneath Layer VIII, as suggested by sedimentol study (Vuilleme, in press). Later, Layer VIII yielded Ly-789: 28,500 ± 1400 and Ly-566: 29,500 ± 1400, and contains Late Mousterian industry.

Ly-3063. La Baume de Gigny, IX ≥31,500

Macrofaunal bones from Layer IX, just overlying presumed hiatus or erosion level (0.1 dr).

Ly-1701. La Baume de Gigny, X 27,000 ± 1400

Microfaunal bones from small Layer X, interbedded with previous one on side of fill, against rockshelter wall.

Ly-2526. La Baume de Gigny, XI ≥33,000

Microfaunal bones from Layer XI, same level as Ly-3063 (0.15 dr).

General Comment (MB): Ly-1701 is too young for its strat position. Sample may include bones from overlying levels. Ly-3063 and -2526 demonstrate great difference in age between Layer VIII and IX as suggested by sedimentol study and organic content of bones, which is 6 times lower in lowest level of fill, below Layer VIII (Evin, in press).

Saint-Marcel cave series, Bidon, Ardèche

Samples from fill at entrance of rock shelter (44° 19' N, 4° 37' E). Coll and subm by R Gilles, Saint-Marcel d'Ardèche. Assoc with Mousterian industry.

Ly-2276. Saint-Marcel E 29,330 ± 650

Bones from Layer E at ca 2.3m depth; coll 1976 and subm 1979 (0.7 dr).

Ly-2861. Saint-Marcel G1 23,260 ± 370

Bones from Layer G at ca 2.5m depth; coll 1979 and subm 1982.

Ly-2901. Saint-Marcel G2 ≥25,000

Charcoal from Layer G; coll 1979 and subm 1982; 0.1 dr due to extensive dissolution during alkaline pretreatment.

General Comment (RG): Ly-2861 is much too young for assoc industry and cannot be explained. Ly-2901 is too diluted to be conclusive; Ly-2276 is younger than expected but should indicate continuation of Mousterian industry in region.

Czechoslovakia

Dolni-Vestonice series, Mikulov, S Moravia

Charcoal from center of open-air site (48° 48' N, 16° 39' E). Coll 1975 and 1977 at base of Würmian III loess at ca 4.5m depth and subm by B Klima, Aücsav, Brno. Assoc with Gravettian industry of Pavlovian type (Klima, 1981).

Ly-1303. Dolni Vestonice, No. 1 **22,250 ± 570**

Ly-1999. Dolni Vestonice, No. 2 **19,640 ± 540**

General Comment (BK): dates are much younger than expected, ca 25,000 BP, corresponding to Tursac interstadial, *ie*, only a little younger than Gro-1286: 25,600 ± 170 (Klima, 1981) from 1928–1929 excavation. According to strat data, such a great discrepancy, ca 3000 yr, cannot be explained by contamination or mixing of material.

Poland

U1 Spadzista series, Krakow

Burned bones from Layer 6, Loc C2 in open-air site (50° 4' N, 19° 57' E). Coll and subm 1980 by JK Kozłowski. From silty solifluction layer at base of last Würmian loess or Upper Late Loess. Assoc with Gravettian industry of Kostenk Avdeyev type.

Ly-2541. U1 Spadzista No. 1 **17,400 ± 310**

From Sqs B1 and B2 at top of Layer 6, underlying base of Layer 5, which is most typical Late Loess, at ca 480cm depth under present soil level, and at 222 to 228cm from excavation ref level “0” (0.6 dr).

Ly-2542. U1 Spadzista No. 2 **21,000 ± 900**

From Sq B7 at base of Layer 6 at ca 420cm under present surface, and at 127 to 137cm from excavation ref level “0.”

General Comment (JKK): Ly-2542 is close to Ly-631: 20,600 ± 1050 (R, 1975, v 17, p 29) from Loc B in same site, at base of same Layer 6. Ly-2541 is, as expected, younger than Ly-2542, and marks beginning of typical Late Loess deposits. Apparent inversion of dates with regard to depth occurs because soliflucted sediments slope downward in comparison to present soil level surface.

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UNIVERSITY OF WISCONSIN RADIOCARBON DATES XXII

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Procedures and equipment used in the University of Wisconsin laboratory have been described in previous date lists (Steventon & Kutzbach 1983; 1984). Except as otherwise indicated, wood, charcoal, and peat samples are pretreated with dilute NaOH- $\text{Na}_4\text{P}_2\text{O}_7$ and dilute H_3PO_4 before conversion to the counting gas methane; when noted, marls and lake cores are treated with acid only. Very calcareous materials are treated with HCl instead of H_3PO_4 . Pretreatment of bone varies with the condition of the bone sample; solid bone with little deterioration is first cleaned manually and ultrasonically. The bone is treated with 8% HCl for 15 minutes, then dilute NaOH- $\text{Na}_4\text{P}_2\text{O}_7$ for 3 hours at room temperature, washed until neutral, and the collagen extracted according to Longin (1971). Charred bone is treated with dilute HCl, NaOH- $\text{Na}_4\text{P}_2\text{O}_7$, and then dilute HCl again.

The dates reported have been calculated using 5568 yr as the half-life of ^{14}C . The standard deviation quoted includes only 1σ of the counting statistics of background, sample, and standard counts. Background methane is prepared from anthracite, standard methane from NBS oxalic acid. The activities of the dated samples for which $\delta^{13}\text{C}$ values are listed have been corrected to correspond to a $\delta^{13}\text{C}$ value of -25‰ ; the activity of the standard methane has been corrected to -19‰ .

Sample descriptions are based on information supplied by those who submitted samples.

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ARCHAEOLOGIC SAMPLES

United States

Illinois

Fentress Lake Slough site (11Jd126) series

Samples from Fentress Lake Slough site, Jo Davies Co (42° 27' N, 90° 35' W) coll Aug 1983 and subm by R A Birmingham, Berg-Zimmer and Assocs, West Allis, Wisconsin. Dates Late Woodland occupation zone (Boszhardt & Overstreet, 1981; Overstreet, 1983). Dates previously reported (R, 1984, v 26, p 135).

WIS-1546. 1170 ± 70

Charcoal from Feature 4, 28cm below disturbed surface, in top level of small pit, beneath mussel shell concentration. Pit yielded lithic debitage and undefined Woodland pottery.

WIS-1547. 1220 ± 70

Charcoal from Feature 7, 13cm below disturbed surface, large basin-shaped pit. Sample underlay large concentration of Madison Ware pottery.

*South Dakota***Archaeological site (39Pn607) series**

Samples coll June 1983 from Site 39Pn607, W Badlands, Pennington Co (43° 43' N, 102° 02' W) and subm by R J Rood, South Dakota Archaeol Research Center, Ft Meade. Assoc artifacts indicate Late Plains Archaic period utilization, although later component assoc with Plains Village period may be present.

WIS-1535. 920 ± 70

Wood charcoal from Feature 2, basin-shaped hearth 30 to 40cm below surface. Hearth was intact with assoc fire-cracked rock.

WIS-1539. 1090 ± 70

Wood charcoal from Feature 7, basin-shaped hearth 20 to 30cm below surface. Hearth was intact with assoc flakes and fire-cracked rock.

WIS-1540. 1510 ± 70

Wood charcoal from Feature 8, basin-shaped hearth 20 to 40cm below surface. Hearth was intact with assoc burned bone fragments, flakes, and fire-cracked rock.

WIS-1541. 640 ± 70

Wood charcoal from Feature 9, basin-shaped hearth 35 to 40cm below surface. Hearth was intact with assoc burned bone and fire-cracked rock.

WIS-1536. Archaeological site (39Pn616) 990 ± 70

Wood charcoal from Feature 2, Site 39Pn616, W Badlands, Pennington Co (43° 42' N, 102° 09' W). Coll June 1983 and subm by R J Rood. Sample from basin-shaped hearth; inadequate artifacts for confident cultural affiliation.

WIS-1538. Archaeological site (39Pn102) 2490 ± 70

Wood charcoal from Feature 1, Site 39Pn102, W Badlands, Pennington Co (43° 44' N, 102° 25' W). Coll Aug 1983 and subm by R A Alex, South Dakota Archaeol Research Center. Sample from shallow hearth 271cm below present surface; inadequate artifacts for confident cultural affiliation.

Archaeological site (39Pn214) series

Charcoal samples from Site 39Pn214, central Black Hills, Pennington Co (44° 02' N, 103° 46' W). Coll 1983 and subm by J Buechler, South Dakota Archaeol Research Center. Artifactual materials range from late Paleo-Indian period through Historic period. Strat separation of various components is not apparent.

WIS-1563.	760 ± 70
Sample from Feature 35, slab-lined hearth.	
WIS-1564.	940 ± 70
Sample from Feature 122, N-most of two superimposed rock-filled hearth features.	
WIS-1565.	600 ± 70
Sample from Feature 122A, S-most of two superimposed rock-filled hearth features.	
WIS-1566.	990 ± 70
Sample from Feature 311, rock-filled hearth.	
WIS-1570.	1150 ± 70
Sample from Feature 180, large oval-shaped charcoal stain.	
WIS-1571.	300 ± 70
Sample from Feature 229, basin-shaped, rock-filled hearth.	
WIS-1572.	390 ± 70
Sample from Feature 107, large concentration of fire-cracked rock.	
WIS-1573.	1060 ± 70
Sample from Feature 69, rock-lined hearth.	
WIS-1574.	630 ± 70
Sample from Feature 25, rock-filled, basin-shaped hearth.	
WIS-1576.	790 ± 70
Sample from Feature 26, large rock-filled hearth. Non-diagnostic lithic debitage was also observed in fill.	
WIS-1577.	3690 ± 70
Sample from Feature 108, schist-lined hearth.	
WIS-1578.	3410 ± 70
Sample from Feature 115, rock-filled hearth.	
WIS-1586.	4980 ± 70
Sample from Feature 165, shallow rock-filled hearth.	

WIS-1587.	460 ± 70
Sample from Feature 205, rock-filled hearth.	
WIS-1588.	2340 ± 70
Sample from Feature 302, rock-filled hearth.	
WIS-1589.	580 ± 70
Sample from Feature 230, large rock-filled hearth.	
WIS-1590.	2670 ± 80
Sample from Feature 208, slab-lined hearth.	
WIS-1591.	3590 ± 80
Sample from Feature 193, rock-lined hearth.	
WIS-1592.	3330 ± 80
Sample from Feature 204, hearth.	
WIS-1593.	620 ± 70
Sample from Feature 135, rock-filled hearth containing micro-flakes, flakes, and lithic tools.	
WIS-1594.	3480 ± 80 $\delta^{13}C = -24.3\text{‰}$
Sample from Feature 144, rock-lined hearth.	
WIS-1595.	1390 ± 70 $\delta^{13}C = -24.9\text{‰}$
Sample from Feature 168, rock-filled hearth.	

*Wisconsin***WIS-1517. Flambeau Lake canoe** **220 ± 50**

Wood sample taken from white pine dugout canoe found at depth 3m in Flambeau Lake, Vilas Co (45° 55' N, 89° 55' W). Sample coll May 1980 by Lac du Flambeau Tribal Council and subm by Lac du Flambeau Band of Lake Superior Chippewa Indians. Canoe was in upright position and was loaded with clay (lake bottom is sand) containing two iron spade blades, 1 adze, 1 ax, and 1 animal trap. Sample was from hull sec.

Pammel Creek (47Lc61) series

Charcoal samples coll June–July 1983 from Pammel Creek, La Crosse Co (43° 45' 44" N, 91° 12' 35" W) by J P Gallagher *et al* and subm by J P Gallagher, Mississippi Valley Archaeol Center, La Crosse. Dates are of Oneota refuse/storage pits at village site. Ceramics from these features are predominantly representative of Orr phase, however, Blue Earth traits are also present.

WIS-1522. **520 ± 70**

Sample from Level 3, Feature 99.

WIS-1523. **480 ± 70**

Sample from Level 6, Feature 2.

WIS-1524. **430 ± 70**

Sample from Level 2, Feature 7.

WIS-1525. **510 ± 70**

Sample from Level 5, Feature 96.

WIS-1584. State Road Coulee site (47Lc176) **400 ± 60**
 $\delta^{13}C = -10.0\text{‰}$

Charred corn kernels coll Aug 1983 from State Road Coulee site, LaCrosse Co (43° 47' N, 91° 12' 30" W) by R F Boszhardt; subm by J P Gallagher. Sample from Zone E of Bank Cut 1 profile, undisturbed Oneota ridged field, 1m below surface. Layer also yielded ceramic sherds, flakes, bone, charcoal, and shell (Boszhardt & Gallagher, 1983).

WIS-1617. State Road Coulee site (47Lc176) **420 ± 70**

Charcoal coll April 1984 from State Road Coulee site, LaCrosse Co (43° 47' N, 91° 12' 00") by R F Boszhardt *et al* and subm by J P Gallagher. Sample from Oneota midden which may include ridged agric fields (Boszhardt & Gallagher, 1983).

WIS-1585. Mill Coulee shell heap (47Cr100) **1180 ± 70**

Charcoal from site in Crawford Co (43° 04' N, 91° 09' W) coll July 1983 and subm by J B Stoltman, Univ Wisconsin, Madison. Dates charcoal directly assoc with shell midden containing preponderantly Lane Farm Cord-Imprinted pottery. Provides first reliable data for Lane Farm phase in SW Wisconsin.

WIS-1607. Zoots site (47Ve512) **1620 ± 70**

Charcoal coll July 1981 from Zoots site, Vernon Co (43° 41' 26" N, 91° 13' 7" W) by R Saft and D M Stemper. Sample subm by J T Penman, State Hist Soc Wisconsin, Madison. Feature eroded from creek bank contained flakes and mussel shell (Penman, 1984).

WIS-1608. Striped Steer site (47Bn161) **1560 ± 70**
 $\delta^{13}C = -26.3\text{‰}$

Charcoal coll July 1981 from Striped Steer site, Barron Co (45° 25' N, 92° 06' W) by R Saft and subm by L Rusch, State Hist Soc Wisconsin. Sample from Feature 3, possibly Middle Woodland component not represented in artifact assemblage (Rusch & Penman, 1984).

GEOLOGIC SAMPLES

United States

Alaska

WIS-1575. Pleasant Island **8520 ± 90**

Three overlapping drives of Davis sampler, coll Sept 1983 from Pleasant I., SE Alaska, near town of Gustavus and Glacial Bay National Park (58° 21' N, 135° 39' W) by D R Engstrom and M Noble; subm by D R Engstrom, Univ Minnesota, Minneapolis. Sample from 250 to 260cm below peat surface, at base of peat, overlying contact with mineral soil. Dated to provide first est of age of Pleasant I. surface, which is just outside limits of neoglacial advance in Glacial Bay region (Reiners, Worley, & Lawrence, 1981).

Florida

WIS-1618. Lake Tulane **>33,000**

Core coll April 1984 from Lake Tulane, Highlands Co (27° 35' N, 81° 30' W) and subm by H E Wright Jr, Univ Minnesota, Minneapolis. Organic silty lake sediment from 4095 to 4105cm below water surface. Lake depth 23.2m. Basal date of late Wisconsin age or older (Watts, 1980). (1 4-day count.)

Massachusetts

Winneconnet Pond series

Core coll Sept 1982 from Winneconnet Pond, Bristol Co (41° 58' N, 71° 07' W) by D C Gaudreau *et al*; subm by S Suter and T Webb, III, Brown Univ, Providence. Water depth 3m. Measurements from sediment surface. Core is being used in study of vegetational history of New England.

WIS-1508. **6520 ± 80**

Gyttja from 520 to 523cm depth, first significant appearance of *Fagus* pollen.

WIS-1509. **9710 ± 100**

Gyttja from 650 to 655cm depth, first appearance of *Tsuga* pollen.

WIS-1510. **10,820 ± 100**

Gyttja from 777 to 782cm depth, date for second peak in spruce pollen.

WIS-1511. **13,360 ± 110**

Gyttja from 949 to 956cm depth, basal date for core.

WIS-1567. **3480 ± 70**

Gyttja from 150 to 156cm depth, uppermost absolute data in sedimentary record.

WIS-1568. 4020 ± 70

Gyttja from 284 to 290cm depth, marks decline in *Tsuga* pollen percentages.

WIS-1569. 11,860 ± 120

Gyttja from 858 to 865cm depth, marks rise in *Alnus* pollen percentages and decline in *Quercus*.

*Minnesota***WIS-1605. Wentzel's Pond 590 ± 70**

Livingston core, 5cm diam, from Wentzel's Pond, Hubbard Co (46° 57' N, 94° 57' W). Coll March 1980 and subm by J C Almendinger, Univ Minnesota. Calcareous algal copropel, 46 to 55cm below sediment surface. Water depth 1.57m. Dates rise in *Ambrosia* pollen and decline in pine pollen. Marks beginning of land clearance and logging ca AD 1860 to 1870. Difference will be used to adjust ¹⁴C dates down core (R, 1983, v 25, p 159). Acid treatment only.

WIS-1606. Peterson Slough 510 ± 70

Livingston core, 5cm diam, from Peterson Slough, Becker Co (46° 58' N, 95° 19' W). Coll Feb 1981 and subm by J C Almendinger. Calcareous algal copropel, 21 to 30cm below sediment surface. Water depth 3.9m. Dates rise in *Ambrosia* pollen and decline in pine pollen. Marks beginning of land clearance and logging ca AD 1860 to 1870. Difference will be used to adjust ¹⁴C dates down core (R, 1983, v 25, p 160). Acid treatment only.

*Nebraska***WIS-1537. Swan Lake 3680 ± 70**

Core coll Jan 1967 from Swan Lake, Garden Co (41° 43' N, 102° 30' W) and subm by H E Wright, Jr, Univ Minnesota. Organic lake sediment from 800 to 820cm below water surface. Date marks conversion of interdune marsh to lake, and thus, rise in water table.

*New York***WIS-1518. Cayuga Lake 1630 ± 70**

Core coll from Cayuga Lake (42° 35' 48" N, 76° 39' 25" W) by M Heit, Dept Energy, New York, NY; subm by A M Swain, Univ Wisconsin-Madison. Water depth 126m. Sample was 68 to 70 cm below sediment surface. Acid treatment only.

WIS-1516. West Sand Lake 10,300 ± 100

Livingstone core, 5cm diam, from West Sand Lake peat bog, Rennselaer Co (42° 32' N, 73° 36' W) coll by D C Gaudreau *et al*, subm by T Webb, III. Sample 245 to 250cm below surface dates uppermost marly sediment. Core is being used for Holocene pollen analysis. Date previously reported (R, 1984, v 26, p 140).

*Wisconsin***Lake Mendota—Middleton series**

Livingston core, 5cm diam, from Lake Mendota, Dane Co (43° 06' N, 89° 29' W) coll Feb 1983 and subm by A M Swain. Water depth 360cm. Measurements from sediment surface. Dates bracket sand lens and hiatus in pollen record from this core. Acid treatment only. Dates previously reported (R, 1983, v 25, p 164; R, 1984, v 26, p 142–143).

WIS-1512. **2320 ± 70**

Fine sandy marly gyttja from 120 to 130cm depth. Sec of core above sand lens.

WIS-1513. **8870 ± 90**

Silty marly gyttja from 170 to 180cm depth. Sec of core below sand lens.

Leopold Marsh series

Livingstone core, 5cm diam, from Leopold Marsh, Sauk Co (43° 33' N, 89° 39' W) coll July 1982 and subm by M J Winkler, Univ Wisconsin-Madison. Site is within present Wisconsin R floodplain on Aldo Leopold Memorial Reserve. Dates should define paleoenvironmental changes during deglaciation of area and subsequent vegetational changes during postglacial period.

WIS-1514. **10,980 ± 110**

Decomposed peat from 557 to 567cm depth. Dates presence of spruce-*Sphagnum* bog assoc during late glacial time.

WIS-1515. **16,580 ± 120**

Fibrous peat grading into blue-gray clay and then red coarse sand from 757 to 773cm depth. Basal date in spruce-sedge late glacial zone.

WIS-1548. **1670 ± 70**

Decomposed peat and charcoal from 20 to 23cm depth.

WIS-1549. **6630 ± 80**

Fibrous peat from 200 to 204cm depth.

WIS-1550. **9100 ± 90**

Fibrous peat from 400 to 403cm depth. Dates disappearance of alder and hazel shrubs.

WIS-1551. **13,130 ± 120**

Fibrous peaty silt and clay from 752 to 757cm depth, dates high amounts of spruce, ash, and sedge pollen.

Hook Lake Bog series

Livingstone core, 5cm diam, from Hook Lake Bog, Dane Co (42° 57' N, 89° 20' W) coll July 1980 and subm by M J Winkler. Dated to correlate late glacial and Holocene pollen and charcoal changes. All measurements from bog surface.

WIS-1600. **2300 ± 70**

Fibrous peat from 187 to 191cm depth, marks beginning of very low charcoal levels and increase in ericad and *Sphagnum* growth.

WIS-1601. **4350 ± 70**

Fibrous peat from 295 to 300cm depth, dates lowest percentages of elm pollen and low pollen percentages from other mesophytic trees.

WIS-1602. **7880 ± 90**

Peat from 491 to 495cm depth, dates decrease in high charcoal levels and elm pollen and increase in oak, grass, composite, and aquatic macrophyte pollen.

WIS-1603. **8950 ± 90**

Decomposed peat from 750 to 756cm depth, dates spruce and fir pollen percentages below 1%, decrease in ash pollen and increase in oak pollen.

WIS-1604. **12,410 ± 120**

Clayey gyttja from 836 to 846cm depth, organic matter increased to over 10%, presence of sponge spicules indicates standing water. Pollen strat shows high percentages of spruce, ash, and poplar.

WIS-1519. **15,940 ± 150**

Gray-green clay from 986 to 1006cm depth, pollen is predominately spruce, *Artemisia*, and grass, suggesting open taiga-like environment as glacier receded. Basal date.

Washburn Bog series

Livingstone core, 5cm diam, from Washburn Bog, Sauk Co (43° 32' N, 89° 39' W) coll and subm by M J Winkler. Dates to be used in Holocene pollen analysis. Measurements from bog surface. Dates previously reported (R, 1984, v 26, p 145).

WIS-1520. **11,260 ± 100**

Spruce wood from 1117 to 1118cm depth, spruce and ash pollen are dominant.

WIS-1521. **13,500 ± 120**

Organic clay and sand from 1119 to 1147cm depth, dates basal sediment. Sample is in spruce pollen zone during late glacial time.

Ridges Sanctuary series

Core coll Aug 13, 1983 from Lake Michigan beach ridge, Door Co (45° 04' 40" N, 87° 06' 50" W) and subm by T Marquardt, Univ Wisconsin-Green Bay. Dates provide time frame for onset and periodicity of ridge formation and palynol interpretations.

WIS-1609. **280 ± 70**

Peat from 55 to 60cm depth.

WIS-1610. **880 ± 70**

Peat from 103 to 113cm depth.

*Bermuda***Mangrove Lake series**

Core coll April 1979 from Mangrove Lake, Bermuda (32° 18' N, 64° 45' W) by W A Watts and H E Wright, Jr; subm by H E Wright, Jr. Samples determine vegetational and climatic history during late Quaternary. All samples were of organic lake sediment gyttja (with occasional mollusk shells), water depth 140cm. Depths measured from water surface.

WIS-1556. **970 ± 70**

250 to 260cm depth.

WIS-1557. **2690 ± 70**

450 to 460cm depth.

WIS-1558. **3170 ± 70**

650 to 660cm depth.

WIS-1559. **4240 ± 70**

850 to 860cm depth.

WIS-1560. **4940 ± 80**

1050 to 1060cm depth.

WIS-1561. **6020 ± 80**

1250 to 1260cm depth.

WIS-1562. **7310 ± 80**

1450 to 1460cm depth.

WIS-1579. **9260 ± 90**

1609 to 1620cm depth.

Canada

Lac Gras series

Livingstone core, 5cm diam, Lac Gras, Quebec (52° 15' N, 67° 04' W) coll June 1981 and subm by H E Wright and G A King, Univ Minnesota, Minneapolis. One of 7 sites being studied along transect from Sept-Iles to Schefferville, Quebec. Closed black spruce forest and old black spruce-jack pine lichen woodland surround lake. Dated to calculate sediment accumulation dates and pollen influx. All measurements from water surface. Water depth 7.95m. Samples previously dated from Harrie Lake (R, 1984, v 26, p 145–146; Short, 1981).

WIS-1542. **3830 ± 70**

Gyttja from 938 to 950cm, just after beginning of *Picea* zone.

WIS-1543. **2450 ± 70**

Gyttja from 897 to 909cm, in *Picea* zone, just before slight increase in *Pinus* pollen percentages.

WIS-1544. **1730 ± 70**

Gyttja from 863 to 875cm, in *Picea* zone after slight increase in *Pinus* pollen percentages.

WIS-1545. **690 ± 70**

Gyttja from 825 to 837cm, in *Picea* zone.

Ranger Bog series

Cores coll July 1982 from Ranger Bog, Labrador (53° 52' N, 59° 49' W) by D R Foster and G A King; subm by G A King. Cores will be used in strat interpretation of bog development. All measurements from surface of bog (Foster & King, 1983).

WIS-1532. **5360 ± 80**

Peat from 173 to 177cm sec of core in *Sphagnum fuscum* hummock. Dates transition from sedge fen to ombrotrophic raised bog.

WIS-1533. **6300 ± 80**

Basal peat from 233 to 237cm sec of core, in *Sphagnum rubellum* hollow in ombrotrophic raised bog. Dates peatland initiation.

WIS-1534. **5940 ± 80**

Basal wood from 252cm depth in *Sphagnum fuscum* hummock of ombrotrophic raised bog. Dates peatland initiation.

Shovel Fen series

Cores coll July 1982 from Shovel Fen, Labrador (52° 32' N, 65° 56' W) by D R Foster and G A King; subm by G A King. Cores will be used in strat interpretation of patterned fen development (Foster & King, 1983).

WIS-1526. 3210 ± 80

Wood from peat/water interface 90cm below surface of pool on mine-rotrophic patterned fen. Dates timing of pattern development.

WIS-1527. 5940 ± 80

Basal peat from 136 to 139cm below surface of a wooden peat ridge. Dates peatland initiation.

Rose Fen series

Cores coll June 1982 from Rose Fen, Labrador (55° 14' N, 67° 14' W) by D R Foster and G A King; subm by G A King. Same observations as for Shovel Fen series above.

WIS-1528. 3430 ± 70

Fibrous sedge peat from 20 to 22cm below sediment surface of pool 1.2m deep. Dates pool formation on this patterned fen.

WIS-1529. 4120 ± 80

Wood basal peat from 143 to 148cm below surface of peat ridge. Dates peatland initiation.

WIS-1530. 4510 ± 80

Well-humified sedge peat from 168 to 173cm below surface. Date provides correlation with adjacent cores.

WIS-1531. 4700 ± 70

Basal peat from 190 to 195cm below surface of sedge mat. Dates peatland initiation.

Lac au Sable series

Livingstone core, 5cm diam, from Lac au Sable, Quebec (51° 42' N, 66° 13' W) coll June 1982 and subm by D R Foster and G A King. Dated to calculate tree arrival time, sediment accumulation rates, and pollen influx. All depths from water surface. Water depth 6.95m. Contact with glacial silt at 9.57m (Mott, 1976; Short, 1981).

WIS-1554. 3620 ± 70

Gyttja from 849 to 860cm depth, *Picea* zone.

WIS-1555. 5090 ± 70

Gyttja from 902 to 912cm depth, *Picea* zone. Dates dip in *Picea* pollen percentages following initial rapid increase after deglaciation.

Coghill Lake series

Core, 7.5cm diam, from Coghill Lake, Labrador (53° 36' N, 66° 46' W) coll July 1981 and subm by H E Wright, Jr and G A King. Dated to calculate sediment accumulation rates and pollen "influx." All depths from water

surface. Water depth 5.65m. Contact with glacial silt at 7.8m (Short, 1981; Stravers, 1981).

WIS-1552. **3350 ± 70**

Silty gyttja from 683 to 690cm depth.

WIS-1553. **4100 ± 70**

Silty gyttja from 720 to 728cm depth, *Picea* zone.

Lac Pètel series

Core, 5cm diam, coll June 1982 from Lac Pètel, Quebec (50° 33' N, 66° 16' W) 40km N of Sept-Iles by G A King and D R Foster, subm by G A King and H E Wright, Jr. Lake elev 290m, which is above marine limit of 130m. Dates will be used to calculate time of tree arrival, sediment accumulation rates, and pollen influx. All depths from water surface. Water depth 5.7m. Sediment contact with glacial silt at 7.73m (Mott, 1976; Lowdon, Robertson, & Blake, 1971).

WIS-1580. **2380 ± 70**

Gyttja from 595 to 603cm depth.

WIS-1581. **3180 ± 70**

Gyttja from 620 to 628cm depth.

WIS-1582. **4670 ± 70**

Gyttja from 650 to 660cm depth.

WIS-1583. **6180 ± 80**

Silty gyttja from 683 to 688cm depth.

WIS-1596. Battery Lake **6120 ± 90**

Core 7.5cm diam coll July 1982 from Battery Lake (unofficial name), S-central Labrador (52° 18' N, 62° 07' W) and subm by H E Wright, Jr and G A King. Gyttja from 613 to 618cm below water surface where percent organic matter reaches first peak. Water depth 5.2m and sediment contact with glacial silt at 6.52m. Dated to determine tree arrival time at site (Morrison, 1970).

WIS-1597. Leaky Lake **4640 ± 80**

Core 7.5cm diam coll July 1982 from Leaky Lake (unofficial name), S-central Labrador (52° 34' N, 63° 36' W) and subm by H E Wright, Jr and G A King. Gyttja from 773 to 779cm below water surface where percent organic matter reaches first peak. Water depth 6.18m and sediment contact with glacial silt at 8.18m. Dated to determine tree arrival time at site (Morrison, 1970).

Pine Lake series

Core 7.5cm diam coll July 1982 from Pine Lake (unofficial name), E Quebec (51° 08' N, 69° 16' W) by H E Wright, Jr and G A King. Dates for calculating sediment accumulation rates and pollen influx. Depths from water surface. Water depth 9.14m and sediment contact with glacial silt at 10.91m (Mott, 1976).

WIS-1598. **3440 ± 70**

Gyttja from 995 to 1001cm depth.

WIS-1599. **4980 ± 80**

Gyttja from 1038 to 1048cm depth, dates dip in percent organic matter.

*England***Forest of Bowland series**

Wood samples coll 1983–84 from 8 sites in Langden/Dunsop/Hodder drainage basin of Central Bowland, Lancashire by A M Harvey and W H Renwick. Subm by W H Renwick, Dept Geog, Rutgers Univ, New Brunswick, New Jersey. Dated to detail sequence of Holocene erosion and deposition in upland England (Harvey, in press).

WIS-1611. **980 ± 70**

Wood (*Betula*) from Langden Valley, below Langden Castle (53° 57' N, 02° 36' N). Antedates main aggradation of Langdon Castle Fen.

WIS-1612. **1790 ± 70**

Wood (*Betula*) from Fiendsdale/Langden Valley (53° 57' N, 02° 37' W). Marks late stage in main aggradation of Fiendsdale Fen and is approx equivalent in age to lower terrace in Langden Valley at this site.

WIS-1613. **4320 ± 80**

Wood from Hodder Valley (53° 56' N, 02° 31' W). Occurs within abandoned channel, equivalent in age to lower terrace of Hodder near confluence of Langden and Dunsop valleys. Pollen indicates valley floor woodland dominated by *Alnus* and *Corylus*, probably of Zone VIIb, post 3000 BP.

WIS-1614. **4680 ± 80**

Wood from Langden Valley, terrace opposite Langden Castle (53° 57' N, 02° 36' W). Postdates aggradation of main terrace in Langden Valley and probably marks onset of peat formation on this terrace.

WIS-1615. **2000 ± 70**

Wood (*Betula*) from Little Haredon Fen (53° 57' N, 02° 34' W). Postdates first main aggradation phase of Little Haredon Fen.

WIS-1616.**1020 ± 70**

Wood (*Betula*) from Little Haredon Fen (53° 57' N, 02° 34' W). Antedates aggradation phase of Little Haredon Fen.

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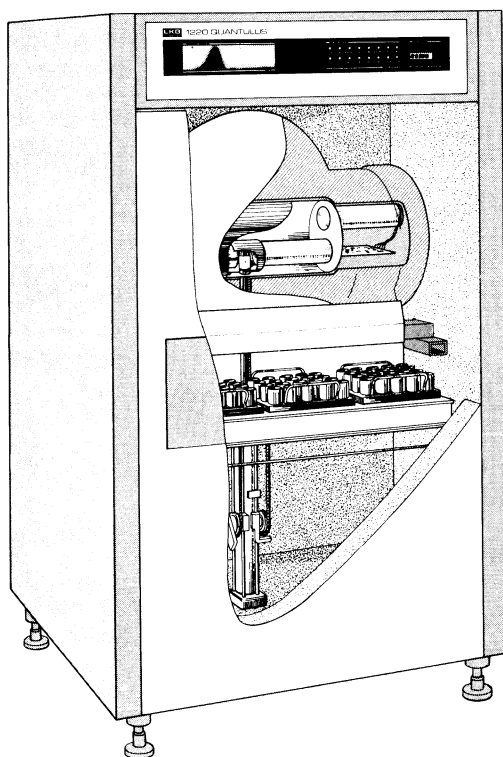
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