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# RADIOCARBON

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YALE UNIVERSITY
NEW HAVEN, CONNECTICUT

# RADIOCARBON

*Editors:* RICHARD FOSTER FLINT—J. GORDON OGDEN, III—IRVING ROUSE—MINZE STUIVER
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## THE AMERICAN JOURNAL OF SCIENCE

*Editors:* JOHN RODGERS, JOHN H. OSTROM, AND PHILIP M. ORVILLE

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### INSTRUCTIONS TO CONTRIBUTORS

Manuscripts of radiocarbon papers should follow the recommendations in *Suggestions to Authors*, 5th ed.* All copy (including the bibliography) must be typewritten in *double space*. Manuscripts for vol. 16, no. 1 must be submitted in *duplicate* by June 1, 1973. Vol. 15, no. 3 has already been filled.

*Descriptions* of samples, in date lists, should follow as closely as possible the style shown in this volume. Each separate entry (date or series) in a date list should be considered an *abstract*, prepared in such a way that descriptive material is distinguished from geologic or archaeologic interpretation, but description and interpretation must be both brief and informative, emphasis placed on significant comments. Date lists should therefore not be preceded by abstracts, but abstracts of the more usual form should accompany all papers (e.g. geochemical contributions) that are directed to specific problems.

Each description should include the following data, if possible in the order given:

1. Laboratory number, descriptive name (ordinarily that of the locality of collection), and the date expressed in years B.P. (before present, *i.e.*, before A.D. 1950) and, for finite dates, in years A.D./B.C. The standard error following the date should express, within limits of $\pm 1\sigma$, the laboratory's estimate of the accuracy of the radiocarbon measurement, *as judged on physicochemical (not geologic or archaeologic) grounds.*
2. Substance of which the sample is composed; if a plant or animal fossil, the scientific name if possible; otherwise the popular name; but not both. Also, where pertinent, the name of the person identifying the specimen.
3. Precise geographic location, *including latitude-longitude coordinates.*
4. Occurrence and stratigraphic position in precise terms; use of metric system exclusively. Stratigraphic sequences should *not* be included. However, references that contain them can be cited.
5. Reference to relevant publications. Citations within a description should be to author and year, with specific pages wherever appropriate. References to published date lists should cite the sample no., journal (R. for Radiocarbon), year, vol., and specific page (e.g., M-1832, R., 1968, v. 10, p. 97). Full bibliographic references are listed alphabetically at the end of the manuscript, in the form recommended in *Suggestions to Authors.*
6. Date to collection and name of collector.
7. Name of person submitting the sample to the laboratory, and name and address of institution or organization with which submitter is affiliated.
8. Comment, usually comparing the date with other relevant dates, for each of which sample numbers and references must be quoted, as prescribed above. Interpretive material, summarizing the significance and implicity showing that the radiocarbon measurement was worth making, belongs here, as do technical matters, *e.g.*, chemical pretreatment, special laboratory difficulties, etc.

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

## NOTICE TO READERS

**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 8th International Conference on Radiocarbon Dating, Wellington, New Zealand, 1972. Because of various uncertainties, when $^{14}$C measurements are expressed as dates in years B.P. 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 B.P., can be converted to this basis by multiplying them by 1.03.

**A.D./B.C. dates.** As agreed at the Cambridge Conference in 1962, A.D. 1950 is accepted as the standard year of reference for all dates, whether B.P. or in the A.D./B.C. system.

**Meaning of $\delta^{14}$C.** In Volume 3, 1961, we indorsed the notation $\Delta$ (Lamont VIII, 1961) for geochemical measurements of $^{14}$C activity, corrected for isotopic fractionation in samples and in the NBS oxalic-acid standard. The value of $\delta^{14}$C that entered the calculation of $\Delta$ was defined by reference to Lamont VI, 1959, and **was corrected for age.** This fact has been lost sight of, by the editors as well as by authors, and recent papers have used $\delta^{14}$C as the **observed** deviation from the standard. At the New Zealand Radiocarbon Dating Conference it was recommended to use $\Delta$ only for age-corrected samples. Because we have no complete transcript of the recommendations made by the conference, we will comment in more detail in the next issue of **Radiocarbon.**

**Radiocarbon Measurements: Comprehensive Index, 1950-1965.** This index, covering all published $^{14}$C measurements through Volume 7 of RADIOCARBON, and incorporating revisions made by all laboratories, has been published. It is available to all subscribers to RADIOCARBON at ten dollars U.S. per copy.

**Publication schedule.** Beginning with Volume 15, RADIOCARBON will be published in three numbers: Winter, Spring, and Summer. The next deadline is June 1, 1973. Contributors who meet our deadlines will be given priority but not guaranteed publication in the following issue.

**List of laboratories.** The comprehensive list of laboratories at the end of each volume will now appear in the third number of each volume.

**Index.** All dates appear in index form at the end of the third number of each volume.

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# Radiocarbon

*1973*

## ANU RADIOCARBON DATE LIST V

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The present date list contains only details of $C^{14}$ measurements on sites selected for archaeomagnetic study. Except where otherwise stated in the text, all samples were collected in 1970 or 1971 during fieldwork by one of the authors (M.B.), and were pretreated with hot 2N HCl to remove any possible contamination by pedogenic carbonate. Benzene samples were prepared using updated synthesis techniques (Polach *et al.*, 1972) and measurements of $C^{14}$ activity were made on two Beckman LS-200 liquid scintillation spectrometers following automatic cycling procedures described previously (Polach, 1969). Samples ANU-677-697 were counted on the spectrometer which has been in use since 1968 (LS-1).

The other samples (ANU-651-676) were counted on the second spectrometer (LS-2). We made a series of measurements of background activity with new counting vials before and after measuring the activities of the samples and the activity of a tree-ring sample (*Cryptomeria Japonica*, growth intervals A.D. 1890-1900) provided by K. Kigoshi, Gakushuin Univ., Tokyo, Japan. The measured tree-ring activity, corrected for isotopic fractionation (using $\delta C^{13} = -23.6 \pm 0.5$, suggested by K. Kigoshi) and radioactive decay (between A.D. 1895 and 1950), has been used as the modern standard activity for LS-2. The activity of that wood correlated well with the NBS oxalic standard activity on LS-1. (Polach, 1972). Table 1 compares the activities of duplicate samples counted on LS-1 and LS-2.

The values agree well within their errors, and we concluded that agreement between LS-1 and LS-2 was satisfactory.

Table 2 lists the measured $\delta C^{13}$ values of four samples from the Willandra Lakes series. The values suggest to us that a $\delta C^{13}$ value of $-22 \pm 2‰$ is appropriate for charcoal from the semi-arid zone of Australia, and we have used this value for the remaining samples of the Willandra Lakes series and the Partacoona series. Elsewhere we have used a $\delta C^{13}$ value of $-24 \pm 2‰$. Such estimated values are quoted as est. $-22‰$ or est. $-24‰$ in the text.

ACKNOWLEDGMENTS

We thank H. Allen, J. M. Bowler, D. Edwards, F. E. M. Lilley, M. W. McElhinny, D. J. Mulvaney, and J. Urquhart, Australian National

University; A. Gallus and members of the Archaeological Society of Victoria, T. Langford-Smith, University of Sydney, A. Barnes of Mungo Station, and B. Powell of Partacoona Station for their assistance with fieldwork; J. Head and J. Gower for their help in the laboratory; and J. M. Bowler for providing the base map for Fig. 1.

TABLE 1
Activities of duplicate benzene samples measured by different liquid scintillation spectrometers.
(Results generally constitute good statistical agreement)

| Sample no. | LS-1 measured $\delta C^{14}$ | LS-2 measured $\delta C^{14}$ | Accepted mean $\delta C^{14}$ reported in this date list |
|---|---|---|---|
| ANU-087 | $-187.4 \pm 6.7$<br>$-176.3 \pm 10.1$ | $-179.1 \pm 5.2$ | $-181.4 \pm 3.8$ |
| ANU-387 | $-114.4 \pm 6.9$<br>$-74.1 \pm 14.5$ | $-97.5 \pm 5.5$ | $-101.8 \pm 4.1$ |
| ANU-447 | $-976.2 \pm 3.0$ | $-996.1 \pm 2.3$ | values differ significantly* |
| ANU-448 | $-990.1 \pm 2.0$ | $-986.0 \pm 3.4$ | $-989.0 \pm 1.7$ |
| ANU-656 | $-19.1 \pm 4.2$ | $-6.1 \pm 5.6$ | $-14.5 \pm 3.3$ |
| ANU-660 | $-107.7 \pm 3.9$ | $-100.7 \pm 7.4$ | $-106.1 \pm 3.4$ |
| ANU-672 | $-27.1 \pm 4.0$ | $-16.8 \pm 5.6$ | $-23.7 \pm 3.3$ |

* Discrepancy may have been due to slightly different pretreatment of samples.

TABLE 2
Values of $\delta C^{13}$

| Sample | $\delta C^{13} \pm 0.2‰$* |
|---|---|
| ANU-651 | −22.8 |
| ANU-660 | −22.5 |
| ANU-674 | −20.9 |
| ANU-680 | −22.5 |

* w.r.t. P. D. Belemnite carried out by Krueger Enterprises, Cambridge, Mass.

## SAMPLE DESCRIPTIONS

### Willandra Lakes series

A chain of ancient lakes in W New South Wales forms the terminal system of Willandra Creek, a distributary stream which leaves the Lachlan R. some 250km to the E. The Willandra Creek now carries water only when major flooding of the Lachlan occurs, but in Pleistocene time its flow was sufficient to maintain a high water level in the lakes for long periods. The lakes themselves have been dry for the last 15,000 yr (Bowler, 1971).

The Quaternary geology of the lakes has been described by Bowler (1971); we present a brief summary. In plan, the lakes have cliffed W margins and long transverse dunes (lunettes) around their E shores. Three soil-stratigraphic units are recognized in the lunettes. The basal Golgol unit consists of a deep, red calcareous soil developed on quartz sands, and is beyond the range of radiocarbon dating. The lakes were active by at least 40,000 B.P., and subsequent high water levels resulted in deposition of the quartz sands of the Mungo unit. By ca. 25,000 yr B.P. the lakes were almost dry, and in many places calcareous and argillaceous silty sands were deposited in the lunette. The top of the thin Mungo unit is marked by soil development, overlain by a deposit (up to 32m thick) of aeolian silt with well-preserved bedding (Zanci unit), deposited rapidly during the final drying of the lakes between 17,500 and 16,000 yr B.P.

Fig. 1 shows a plan of the last 4 Willandra Lakes, and the locations of the archaeomagnetic sites for which dates are presented here.

Preliminary archaeomagnetic measurements on baked earth and cooking stones from 5 Aboriginal fireplaces at Lake Mungo (ANU-677, -680-683) show that there was an unusually large geomagnetic excursion 30,000 yr B.P., with the field rotating > 120° away from its present attitude (Barbetti and McElhinny, 1972). The relationship of these fireplaces and the lunette stratigraphy was previously described (Barbetti and Allen, 1972).

### *A. Lake Arumpo*

**ANU-651.** $\delta C^{14} = -8.8 \pm 7.9$ **>Modern**
$\Delta = +4.3 \pm 7.9$ $\delta C^{13} = -22.8 \pm 0.2‰$

Charcoal from Aboriginal oven on low rise, floor of (middle) Lake Chibnalwood. Benzene dilution, 2060 min. count. Indicated contemporary age may be result of fine rootlet contamination which was not necessarily all removed during pretreatment.

**ANU-670.** $\delta C^{14} = -963.2 \pm 8.6$ **$26,580^{+2130}_{-1680}$**
$\Delta = -963.4 \pm 8.5$ *Est.* $\delta C^{13} = -22‰$

Charcoal concentration in topmost clay sediment of Outer Arumpo lunette. Benzene dilution, 2760 min. count.

**ANU-671.** $\delta C^{14} = -154.2 \pm 7.4$ **1390 ± 80**
$\Delta = -159.3 \pm 8.1$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven covered by loose sand on top of Outer Arumpo lunette. Benzene dilution, 1020 min. count.

**ANU-672.** $\delta C^{14} = -23.7 \pm 3.3$ **240 ± 60**
$\Delta = -29.5 \pm 5.1$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven in sand on top of Outer Arumpo lunette. Result is error weighted mean of 2 independent determinations:

ANU-672/1 ($\delta C^{14}$ = −27.1 ± 4.0, 270 ± 50 B.P.) and ANU-672/2 ($\delta C^{14}$ = −16.8 ± 5.6, 180 ± 60 B.P.). Benzene 6080 min. total count.

**ANU-688.** *$\delta C^{14} = -986.8 \pm 1.7$* **$34{,}820^{+1140}_{-1000}$**

*$\Delta = -986.9 \pm 1.7$* *Est. $\delta C^{13} = -22‰$*

Charcoal from area of burnt sand overlain by 3m clay sediment, exposed in a gully in Outer Arumpo lunette. Benzene dilution, 4220

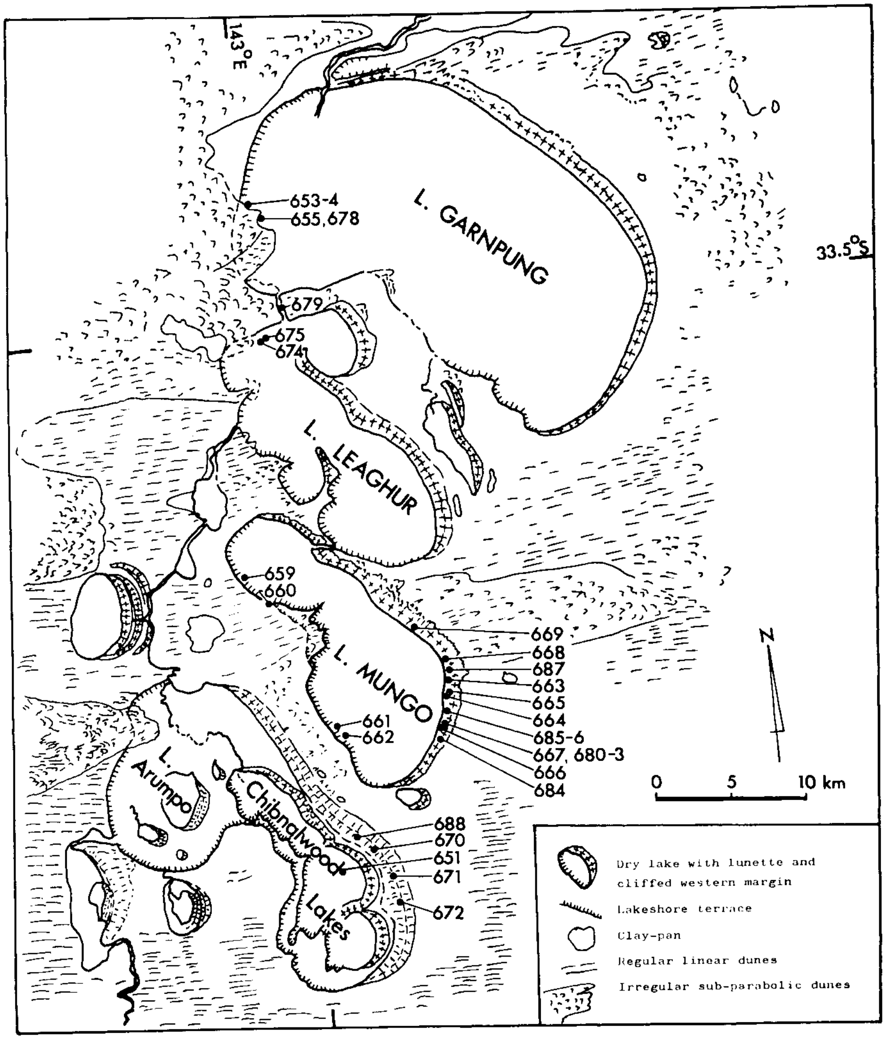


Fig. 1. Site locations for Willandra Lakes series, identified by radiocarbon (ANU) sample numbers. (Base map with geomorphic detail provided by J. M. Bowler).

min count. Charcoal pieces dated were encountered during excavation of archaeomagnetic samples for site previously dated (R., v. 12, p. 13: ANU-304, $\Delta = -965.0 \pm 11.2$, 26,900 $^{+3100}_{-2200}$ B.P.). Ages are in statistical agreement; better precision obtained with ANU-688.

### *B. Lake Mungo*

**ANU-659.** $\delta C^{14} = -84.4 \pm 16.9$ **760 ± 150**
$\Delta = -89.8 \pm 17.2$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on sloping W shore, 6m above lake floor. Microlithic stone implements found nearby (H. Allen, pers. commun.). Benzene dilution, 1020 min. count.

**ANU-660.** $\delta C^{14} = -106.1 \pm 3.4$ **940 ± 50**
$\Delta = -110.6 \pm 3.4$ $\delta C^{13} = -22.5 \pm 0.2‰$

Charcoal from Aboriginal oven on plain overlooking W margin of lake. Clay ovenstones were coated with secondary carbonate crust. Microlithic stone artifacts found nearby (H. Allen, *pers. commun.*). Result is error weighted mean of 2 independent determinations: ANU-660/1 ($\delta C^{14} = -107.7 \pm 3.9$, 960 ± 40 B.P.) and ANU-660/2 ($\delta C^{14} = -100.7 \pm 7.4$, 890 ± 70 B.P.) Benzene dilution, 4380 min. total count.

**ANU-661.** $\delta C^{14} = -176.9 \pm 10.5$ **1610 ± 110**
$\Delta = -181.9 \pm 11.0$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on lake floor. 300m from cliffed margin of lake. Benzene dilution, 1100 min. count.

**ANU-662.** $\delta C^{14} = -232.7 \pm 6.9$ **2180 ± 80**
$\Delta = -237.3 \pm 7.6$ *Est.* $\delta C^{13} = -22‰$

Charcoal from small area of burnt clayey earth, preserved underneath 50cm stabilized sand. Lake floor, 300m from cliffed W margin. Benzene dilution, 1060 min. count.

**ANU-663.** $\delta C^{14} = -106.6 \pm 12.2$ **950 ± 120**
$\Delta = -111.9 \pm 12.7$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on stabilized surface, lower part of lunette. Ca. 5m above lake floor. Benzene dilution, 1040 min. count.

**ANU-664.** $\delta C^{14} = -221.6 \pm 15.7$ **2060 ± 170**
$\Delta = -226.2 \pm 15.9$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on brown sand on lunette, facing lake floor. Benzene dilution, 1080 min. count.

**ANU-665.** $\delta C^{14} = -390.1 \pm 6.9$ **4020 ± 100**
$\Delta = -393.7 \pm 7.3$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven buried 50cm below top of brown sand on lunette. Benzene dilution, 1040 min. count.

**ANU-666.** $\delta C^{14} = -82.4 \pm 7.7$ **740 ± 70**
$\Delta = -87.9 \pm 8.5$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on top of brown sand on lunette, overlooking lake. Benzene dilution, 1080 min. count.

**ANU-667.** $\delta C^{14} = -961.8 \pm 2.2$ **26,270 ± 470**
$\Delta = -962.0 \pm 2.2$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven at base of greenish-gray clay sediments overlying a sandy horizon with numerous traces of Aboriginal occupation. Benzene dilution, 3120 min. count.

**ANU-668.** $\delta C^{14} = -910.3 \pm 3.9$ **19,420 ± 360**
$\Delta = -910.8 \pm 3.9$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven dug into ancient Golgol horizon and covered by aeolian sandy clays of Zanci unit; near base of lunette overlooking lake. Benzene dilution, 3140 min. count.

**ANU-669.** $\delta C^{14} = -408.2 \pm 13.5$ **4260 ± 190**
$\Delta = -411.7 \pm 13.6$ *Est.* $\delta C^{13} = -22‰$

Charcoal from under baked clay mound on stabilized surface, lower part of lunette, overlooking lake. Benzene dilution, 1020 min. count.

**ANU-680.** $\delta C^{14} = -978.2 \pm 1.4$ **30,780 ± 520**
$\Delta = -978.3 \pm 1.4$ $\delta C^{13} = -22.5 \pm 0.2‰$

Charcoal from Aboriginal oven in gray-brown sand of Mungo unit, overlooking lake. Result is error weighted mean of 3 determinations: ANU-680/1 ($\delta C^{14}$ = −970.4 ± 3.8, 28,330 ± 1100 B.P.); ANU-680/2 ($\delta C^{14}$ = −980.3 ± 2.1, 31,590 ± 900 B.P.); ANU-680/3 ($\delta C^{14}$ = −978.5 ± 2.2, 30,880 ± 870 B.P.); Benzene 7140 min. total count. Ages from ANU-680/1 and ANU-680/2 are from charcoal in shallow depression not covered by clay lumps. ANU-680/3 is from charcoal underneath undisturbed lumps of baked clay, used as cooking stones.

**ANU-681.** $\delta C^{14} = -970.4 \pm 1.5$ **28,310 ± 410**
$\Delta = -970.5 \pm 1.5$ *Est.* $\delta C^{13} = -22‰$

Charcoal from small area of burnt earth (probably Aboriginal hearth) in gray-brown sand of Mungo unit overlooking lake. Result is error weighted mean of 2 independent determinations: ANU-681/1 ($\delta C^{14}$ = −970.9 ± 2.2, 28,450 ± 630 B.P.); ANU-681/2 ($\delta C^{14}$ = −969.9 ± 2.1, 28,190 ± 590 B.P.). Benzene 6160 min. total count.

**ANU-682.** $\delta C^{14} = -967.3 \pm 1.3$ **27,530 ± 340**
$\Delta = -967.5 \pm 1.3$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven in gray-brown sand of Mungo unit, overlooking lake. Result is error weighted mean of 3 independent determinations: ANU-682/1 ($\delta C^{14}$ = −966.5 ± 2.1, 27,320 ± 530 B.P.); ANU-682/2 ($\delta C^{14}$ = −967.5 ± 3.0, 27,580 ± 770 B.P.); ANU-682/3 ($\delta C^{14}$ = −968.1 ± 2.2, 27,720 ± 580 B.P.). Benzene 9180 min. total count. Charcoal mixed in ash spread out in a pit. Baked clay lumps arranged on one side of pit only; archaeomagnetic studies of baked earth suggest fires at other side of pit predating oven.

**ANU-683.** $\delta C^{14} = -969.2 \pm 1.5$ **28,000 ± 410**
$\Delta = -969.4 \pm 1.5$ *Est.* $\delta C^{13} = -22‰$

Charcoal from area of burnt earth (probably Aboriginal hearth) in gray-brown sand of Mungo unit, overlooking lake. Result is error weighted mean of 2 independent determinations: ANU-683/1 ($\delta C^{14} = -967.8 \pm 2.2$, 27,650 ± 560 B.P.); ANU-683/2 ($\delta C^{14} = -970.5 \pm 2.2$, 28,360 ± 620 B.P.). Benzene 6180 min. total count. Archaeomagnetic studies on baked earth suggest date of baking may be earlier than $C^{14}$ age.

**ANU-684.** $\delta C^{14} = -798.6 \pm 13.3$ **12,920 ± 550**
$\Delta = -799.8 \pm 13.2$ *Est.* $\delta C^{13} = -22‰$

Total organic material (including small fragments of charcoal) from small area of blackened earth (probably Aboriginal hearth) within aeolian sediments near top of Zanci unit. Age is younger than expected. Benzene dilution, 2020 min. count.

**ANU-685.** $\delta C^{14} = -969.7 \pm 1.3$ **28,140 ± 370**
$\Delta = -969.9 \pm 1.3$ *Est.* $\delta C^{13} = -22‰$

Charcoal from under baked clay mound in gray-brown sand of lunette, overlooking lake. Result is mean of 2 independent determinations: ANU-685/1 ($\delta C^{14} = -969.3 \pm 1.9$, 28,040 ± 520 B.P.); and ANU-685/2 ($\delta C^{14} = -970.1 \pm 1.9$, 28,250 ± 540 B.P.). Benzene 6820 min. total count.

**ANU-686.** $\delta C^{14} = -958.3 \pm 2.6$ **25,570 ± 520**
$\Delta = -958.5 \pm 2.6$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven at base of greenish-gray sandy clay overlying gray-brown sand horizon. Benzene dilution, 3100 min. count.

**ANU-687.** $\delta C^{14} = -987.6 \pm 2.2$ **35,300 $^{+1550}_{-1300}$**
$\Delta = -987.6 \pm 2.2$ *Est.* $\delta C^{13} = -22‰$

Charcoal from blackened, friable sandy sediment of Mungo unit, possibly large Aboriginal fireplace. Benzene dilution, 3380 min. count.

### *C. Lakes Leaghur and Garnpung*

**ANU-653.** $\delta C^{14} = -156.5 \pm 9.5$ **1420 ± 100**
$\Delta = -161.6 \pm 10.0$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on floor of Lake Garnpung. Benzene dilution, 1200 min. count. One of ca. 20 ovens.

**ANU-654.** $\delta C^{14} = -21.5 \pm 5.2$ **220 ± 60**
$\Delta = -27.4 \pm 6.5$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on floor of Lake Garnpung. Benzene, 3720 min. count. Oven 9m from another dated at 1420 ± 100 B.P. (ANU-653).

**ANU-655.** $\delta C^{14} = -216.4 \pm 9.7$ **2010 ± 100**
$\Delta = -221.1 \pm 10.1$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on floor of Lake Garnpung. Benzene dilution, 1220 min. count. See ANU-678 for comment.

**ANU-674.** $\delta C^{14} = -109.2 \pm 8.1$ **990 ± 70**
$\Delta = -116.5 \pm 8.0$ $\delta C^{13} = -20.9 \pm 0.2‰$

Charcoal from Aboriginal oven on floor of Lake Leaghur. Benzene dilution, 1200 min. count.

**ANU-675.** $\delta C^{14} = -83.4 \pm 7.4$ **750 ± 70**
$\Delta = -88.9 \pm 8.3$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on floor of Lake Leaghur. Benzene, 1080 min. count.

**ANU-678.** $\delta C^{14} = -257.1 \pm 6.3$ **2440 ± 80**
$\Delta = -261.6 \pm 6.9$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven set in hard clay on floor of Lake Garnpung, partly covered by sand, Benezene, 1020 min. count. From group of ovens (with ANU-655, 2010 ± 100 B.P.) exposed in a claypan scattered with microlithic stone artifacts, including pirri points. (Allen, *pers. commun.*).

**ANU-679.** $\delta C^{14} = -330.8 \pm 7.4$ **3270 ± 90**
$\Delta = -334.8 \pm 7.8$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on terrace in ancient channel linking Lakes Garnpang and Leaghur. Benzene dilution, 1020 min. count.

**ANU-689.** $\delta C^{14} = -140.8 \pm 14.3$ **1270 ± 140**
$\Delta = -146.0 \pm 14.6$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven on surface at W side of Lake Yantara (29° 54′ S Lat, 142° 16′ E Long). Benzene dilution, 2080 min. count.

**Partacoona series**

Partacoona Sta. is 330km N of Adelaide, South Australia on W side of Flinders Range. Samples coll. from Aboriginal ovens by M. W. McElhinny and F. E. M. Lilley, Australian Natl. Univ., and B. Powell, Partacoona Sta.

**ANU-656.** $\delta C^{14} = -14.5 \pm 3.3$ **170 ± 60**
$\Delta = -20.4 \pm 5.2$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven in gully on bank of Kanyaka Cr. (32° 05′ S Lat, 138° 03′ E Long). Result is error weighted mean of 2 independent determinations from ANU-656/1 ($\delta C^{14} = -19.1 \pm 4.2$, $200 \pm 50$ B.P.), and ANU-656/2 ($\delta C^{14} = -6.1 \pm 5.6$, $100 \pm 60$ B.P.). Benzene 5980 min. total count.

**ANU-657.** $\delta C^{14} = -105.6 \pm 38.3$ **940 ± 350**
$\Delta = -111.0 \pm 38.1$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven covered by soil in gully on E bank of Kanyaka Cr. (32° 03′ S Lat, 138° 05′ E Long). Benzene dilution, 2260 min. count.

**ANU-658.** $\delta C^{14} = -100.7 \pm 9.3$ **900 ± 90**
$\Delta = -106.1 \pm 10.0$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven exposed in cliffed E bank of Kanyaka Cr. ca. 7m above present river level and 50cm below top of bank. Ca. 30m N from ANU-657. Benzene dilution, 1060 min. count.

**ANU-673.** $\delta C^{14} = +34.7 \pm 40.0$ **>Modern**
$\Delta = +28.5 \pm 40.0$ *Est.* $\delta C^{13} = -22‰$

Charcoal from Aboriginal oven overlooking E bank of Willocra R. (32° 00′ S Lat, 138° 11′ E Long) ca. 2km E of Partacoona Homestead. Benzene dilution, 2260 min. count.

**Murray River series**

Several burnt tree stumps surrounded by baked earth were shown to one of the authors (M.B.) by J. Urquhart, Australian Natl. Univ. The sites are in fluviatile sediments, and have been useful in studies of the history of the Murray R. (J. Urquhart, ms. in preparation), as well as archaeomagnetic investigations. The Aboriginal ovens (ANU-676, -677) are ca. 20km from present-day Murray R.

**ANU-676.** $\delta C^{14} = -207.5 \pm 17.7$ **1880 ± 180**
$\Delta = -209.1 \pm 18.0$ *Est.* $\delta C^{13} = -24‰$

Charcoal from Aboriginal oven covered by a few cm of sandy clay on Loreto Sta. (35° 49′ S Lat, 144° 38′ E Long). Benzene dilution, 1200 min. count. Coll. by D. Edwards.

**ANU-677.** $\delta C^{14} = -256.5 \pm 12.6$ **2400 ± 140**
$\Delta = -258.0 \pm 12.9$ *Est.* $\delta C^{13} = -24‰$

Charcoal from Aboriginal oven (0.5km NW of ANU-676). Benzene dilution, 1120 min. count. Sample contained some very fine rootlets. Coll. by D. Edwards.

**ANU-690.** $\delta C^{14} = -158.8 \pm 11.4$ **1400 ± 110**
$\Delta = -160.4 \pm 11.8$ *Est.* $\delta C^{13} = -24‰$

Charcoal from under lumps of baked clay 5m below top Victoria bank of Murray R. (34° 44′ S Lat, 143° 07′ E Long). Benzene dilution, 2000 min. count.

**ANU-691.** $\delta C^{14} = -46.1 \pm 6.7$ $\Delta = -48.0 \pm 7.7$ **400 ± 70** *Est.* $\delta C^{13} = -24‰$

Charcoal from burnt tree stump 2m below top of New South Wales bank of Murray R. (35° 50′ S Lat, 145° 25′ E Long). Benzene, 1000 min. count.

**ANU-692.** $\delta C^{14} = -533.7 \pm 8.9$ $\Delta = -534.6 \pm 9.1$ **6140 ± 160** *Est.* $\delta C^{13} = -24‰$

Charcoal from burnt tree stump 6m below top of Victoria bank of Murray R. (35° 56′ S Lat, 144° 28′ E Long). Benzene dilution, 2140 min. count.

**ANU-693.** $\delta C^{14} = -481.5 \pm 5.4$ $\Delta = -482.5 \pm 5.8$ **5290 ± 90** *Est.* $\delta C^{13} = -24‰$

Charcoal from area of burnt earth, 2m below top of Victoria bank of Murray R., 70m downstream from ANU-692. Benzene, 1000 min. count.

**Keilor series**

Soil pit operators have uncovered areas of burnt earth in terrace silts (Holocene age) of Marybyrnong R. near Keilor, Victoria. These sites appear to have been disturbed by ancient floods which deposited silt on them (ANU-652, -694, -695).

A section of Pleistocene Maribyrnong R. sediments is exposed in Dry Creek, near its confluence with Maribyrnong. Several excavations are being made by A. Gallus and the Archaeol. Soc. Victoria in ancient river sediments and a series of channel deposits cut into those sediments (Gallus, 1971). Excavation A (Gallus, unpub.) is in one of these channels. Yellow-gray (KW) clay is unconformably overlain by chocolate (A) clay.

**ANU-652.** $\delta C^{14} = -570.9 \pm 23.9$ $\Delta = -571.7 \pm 23.9$ **6810 ± 460** *Est.* $\delta C^{13} = -24‰$

Charcoal mixed with burnt earth uncovered by front-end loader in soil pit at Green Gully, Keilor (37° 44′ S Lat, 144° 49′ E Long). Benzene dilution, 1100 min. count. Coll. by D. J. Mulvaney and M. W. McElhinny.

**ANU-694.** $\delta C^{14} = -498.8 \pm 5.3$ $\Delta = -499.8 \pm 5.7$ **5570 ± 90** *Est.* $\delta C^{13} = -24‰$

Charcoal mixed with burnt earth 2m below surface in terrace sediments, 41m from E bank of Marybyrnong R. (37° 42′ S Lat, 144° 50′ E Long). Benzene, 1020 min. count.

**ANU-695.** $\delta C^{14} = -562.9 \pm 5.4$ $\Delta = -563.8 \pm 5.7$ **6660 ± 110** *Est.* $\delta C^{13} = -24‰$

Charcoal mixed with burnt earth 5m below surface, exposed in soil pit. Ca. 11m from ANU-694, towards Marybyrnong R. Benzene dilution, 2040 min. count.

**ANU-696.** $\delta C^{14} = -992.2 \pm 3.2$ **>31,180**

$\Delta = -992.2 \pm 3.2$ *Est.* $\delta C^{13} = -24‰$

Large piece of charcoal embedded 5cm below top of yellow-gray (KW) clay in Excavation A, Dry Creek. Sample treated with hot 2% NaOH solution to remove any possible humic acid contamination. Benzene dilution, 4000 min. count. Measured activity is within $C^{14}$ dating limits at 95% confidence level. Indicated age 39,000 $^{+4260}_{-2770}$ B.P.

**ANU-697.** $\delta C^{14} = -960.8 \pm 6.3$ **26,030** $^{\mathbf{+1400}}_{\mathbf{-1190}}$

$\Delta = -960.8 \pm 6.3$ *Est.* $\delta C^{13} = -24‰$

NaOH soluble fraction of charcoal from presumed human hearth (Gallus, pers. commun.) in chocolate clay of Excavation A. Charcoal fragments showed wood-grain texture, with humic acid stains spreading into clay around each pellet. Sample exhaustively leached in hot 2% NaOH, large soluble fraction recovered, acidified, and precipitate coll. for $C^{14}$ analysis. Benzene dilution, 3180 min. count. Charcoal appears to have decayed *in situ,* with clay sediment around fireplace preventing appreciable movement of humic acid; date therefore considered reliable. Coll. by A. Gallus.

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# UNIVERSITY OF BONN NATURAL RADIOCARBON MEASUREMENTS VI

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Continuation of radiocarbon measurements, mainly on ground water, soil, and subhydric sediment samples. Sample preparation was described earlier (Scharpenseel and Pietig, 1969).

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## SAMPLE DESCRIPTIONS

### I. GROUND WATER SAMPLES

**A Cologne 07 sand aquifer**

After 3 yr repetitions of radiocarbon measurements from 1967 to 1969 (R., 1968, v. 10, p. 8-28; 1969, v. 11, p. 3-14; 1970, v. 12, p. 19-39) a 4th sampling and measurement was done in 1971. Since the 3 sets of dates (1967-1969) did not allow flow speed calculation from movement of bomb-carbon peak, due to geologic ruptures, mixing and unsteady flow-pattern (Tamers and Scharpenseel, 1970), further tests at intervals of several yr are expected to yield new data.

| Samples Kölner Bucht | Measured $C^{14}$ age |
|---|---|
| BONN-1227. Synthern 93730/4 (50° 58′ N Lat, 6° 47′ E Long) | 1940 ± 100<br>A.D. 10 |
| BONN-1228. Glessen 93715/1 (50° 58′ N Lat, 6° 45′ E Long) | 2050 ± 60<br>100 B.C. |
| BONN-1229. Dansweiler 93732/4 (50° 57′ N Lat, 6° 46′ E Long) | 10,270 ± 160<br>8320 B.C. |
| BONN-1230. Widdersdorf 83002/2 (50° 58′ N Lat, 6° 50′ E Long) | 1470 ± 70<br>A.D. 480 |
| BONN-1231. Ingendorf 83114/3 (51° 1′ N Lat, 6° 44′ E Long) | 7840 ± 220<br>5890 B.C. |

| Samples Kölner Bucht | Measured $C^{14}$ age |
|---|---|
| BONN-1232. Königsdorf 83131/3 (50° 56′ N Lat, 6° 46′ E Long) | 22,610 ± 500<br>20,660 B.C. |
| BONN-1233. Bottenbroich 85075/4 (50° 55′ N Lat, 6° 44′ E Long) | 6220 ± 110<br>4270 B.C. |
| BONN-1234. Buschbell 85082/2 (50° 56′ N Lat, 6° 48′ E Long) | 8860 ± 120<br>6910 B.C. |
| BONN-1235. Herbertzkaul 85197/3 (50° 54′ N Lat, 6° 48′ E Long) | 10,600 ± 140<br>8650 B.C. |

*Comment*: samples from piezometric tubes Ingendorf and Königsdorf shifted towards considerably older age, Widdersdorf dropped correspondingly. Two further sets of samples in 2 or 3 yr intervals expected to elucidate rather complicated flow and recharge pattern of highly exploited aquifer.

## II. SOIL SAMPLES

Methods of pretreating soil samples are compared and reviewed elsewhere (Scharpenseel and Pietig, 1969; Scharpenseel, 1972).

### *A. Spain*

Dates belong to continued natural radiocarbon measurements in Vertisols (see R., 1973, v. 15, p. 23-25, II A to D). Profiles are from Andalusia, S Spain with help of local pedologists.

Vertisol, rich in swelling and cracking clay, La Rimconada (Sevilla), Casas vacas, 20m above NN, 18.5°C ann. t, 559mm ann. rainfall, plain (37° 23′ N Lat, 2° 12′ W Long). Samples from same location.

| | | |
|---|---|---|
| BONN-1388. | Vertisol La Rimconada, 1.7% C, Ap 20 to 30cm | 590 ± 70<br>A.D. 1360 |
| BONN-1389. | 0.8% C, ABv 40 to 50cm | 1570 ±80<br>A.D. 380 |
| BONN-1390. | 0.6% C, Bv 75 to 95cm | 2840 ± 160<br>890 B.C. |
| BONN-1391. | 0.4% C, BvCal 125 to 145cm | 3160 ± 160<br>1210 B.C. |
| BONN-1392. | 0.3% C, BvCa2 160 to 180cm | 6470 ± 130<br>4520 B.C. |

Vertisol, Carmona, km 10.5 Carmona-Arahal St., 75m above NN, 19°C ann. t., 540mm ann. rainfall, marl, (37° 25′ N Lat 1° 55′ W Long). Samples from same location.

**BONN-1393. Vertisol, Carmona, 0.7% C, Bv1 10 to 30cm** — 2410 ± 70; 460 B.C.

**BONN-1394. 1.0% C, Bv2 30 to 50cm** — 3150 ± 80; 1200 B.C.

**BONN-1395. 2.8% C, Bv3 80 to 100cm** — 4480 ± 90; 2530 B.C.

**BONN-1396. 1.0% C, Ccal 130 to 140cm** — 5510 ± 100; 3560 B.C.

**BONN-1397. 0.5% C, Cca2 >150cm** — 6650 ± 120; 4700 B.C.

Vertisol, Los Palacios, Farm Torbiscal, 18°C ann. t., 600mm ann. rainfall, alluvial soil, (37° 4′ N Lat, 2° 10′ W Long). Samples from same location.

**BONN-1398. Vertisol, Los Palacios, 3.4% C, Ap1 5 to 15cm** — 1580 ± 70; A.D. 370

**BONN-1399. 2.6% C, ApBv1 20 to 35cm** — 2080 ± 80; 130 B.C.

**BONN-1400. 2.3% C, Bv21 35 to 50cm** — 2580 ± 70; 630 B.C.

**BONN-1401. 2.3% C, Bv21 55 to 70cm** — 6350 ± 140; 4400 B.C.

**BONN-1402. 3.2% C, Bv21 80 to 100cm** — 4940 ± 90; 2990 B.C.

**BONN-1403. 0.9% C, Bv22 110 to 130cm** — 8850 ± 130; 6900 B.C.

**BONN-1405. 0.3% C, Cca1 170 to 200cm** — 7660 ± 130; 5710 B.C.

**BONN-1406. 0.4% C, Cca2 >200cm** — 7510 ± 140; 5560 B.C.

Vertisol, El Arahal, Farm l'Estrella, 40km E Sevilla, 60 to 80m above NN, 19.5°C ann. t, 518mm ann. rainfall, plain, alluvial sand cover on top of Vertisol, (37° 15′ N Lat, 1° 53′ W Long). Samples from same location.

**BONN-1407. Vertisol, El Arahal, 1.4% S, Ap1 5 to 15cm** — 108.4 ± 0.6%; Modern

BONN-1408. 1.0% C, Ap2 17 to 30cm — 690 ± 70, A.D. 1260

BONN-1409. 0.3% C, Bvl 32 to 42cm — 2320 ± 90, 370 B.C.

BONN-1410. 1.4% C, Bv2 47 to 59cm — 3640 ± 50, 1690 B.C.

BONN-1411. 1.4% C, Bv2 61 to 70cm — 3480 ± 100, 1530 B.C.

BONN-1413. 0.2% C, CcaBv3 90 to 104cm — 3520 ± 230, 1570 B.C.

Vertisol, Carmona, Far, la motilla chica, 160m above NN, 19°C ϕ ann. t, 540mm ϕ ann. rainfall, plain, pebbles of old Quaternary terrace sediment intermixed, (37° 28′ N Lat, 1° 49′ W Long). Samples from same location.

BONN-1417. Vertisol, Carmona, Far, 2.4% C, Ap 5 to 12cm — 103.3 ± 0.5%, Modern

BONN-1418. 1.5% C, Ap 16 to 25cm — 730 ± 70, A.D. 1220

BONN-1419. 1.2% C, AB 36 to 48cm — 1710 ± 80, A.D. 240

BONN-1420. 1.0% C, B21 61 to 82cm — 2740 ± 70, 790 B.C.

BONN-1421. 0.2% C, B22 83 to 94cm — 2750 ± 140, 800 B.C.

BONN-1423. 0.3% C, II Cca 108 to 128cm — 3440 ± 290, 1490 B.C.

Samples coll. and subm. 1970 by W. Kerpen and H. Gewehr, Inst. Bodenkunde, Bonn. *Comment*: last 2 profiles, El Arahal and Carmona Far show to the full depth about the same apparent mean residence time (Scharpenseel, 1972), indicating transport of surface material through cracks and self-mulching. La Rimconada and Carmona profiles have an age break at ca. 100cm, Los Palacios at ca. 70cm with steep increase of C-residence times in downward direction, below the crack zone.

## *B. Portugal*

The Portugal series contributes 7 Barros profiles to the natural radiocarbon measurements in Vertisols. Profiles are selected in central and S Portugal with help of local pedologists.

Vertisol, black Barros, Béja, free of $CaCO_3$, 250m above NN (38° 0′ N Lat, 1° 16′ W Long). Samples from same location.

BONN-1425. Vertisol, Beja, 0.6% C, Ap 2 to 7cm — 101.0 ± 0.4% Modern

BONN-1426. 0.9% C, B11 10 to 18cm — 330 ± 100 A.D. 1620

BONN-1427. 1.9% C, B12 24 to 37cm — 1550 ± 70 A.D. 400

BONN-1428. 3.0% C, B13 43 to 52cm — 1220 ± 70 A.D. 730

BONN-1429. 3.1% C, B14 58 to 72cm — 2000 ± 120 50 B.C.

BONN-1432. 0.2% C, Cca 120 to 130cm — 3070 ± 140 1120 B.C.

Brown Mediterranean soil till Vertisol, Safara-Camauros Farm, 180m above NN, hilly, (38° 5′ N Lat, 1° 52′ W Long). Samples from same location.

BONN-1433. Vertisol, Safara-Camauros, 0.4% C, Ap 20 to 32cm — 300 ± 80 A.D. 1650

BONN-1434. 0.3% C, BC 45 to 55cm — 2430 ± 70 480 B.C.

BONN-1436. 0.3% C, BC 55 to 69cm — 1870 ± 90 A.D. 80

BONN-1437. 0.3% C, C1 70 to 90cm — 2140 ± 220 190 B.C.

Black Vertisol, not totally free of $CaCO_3$, Safara (field), 197m above NN, hilly, (38° 5′ N Lat, 1° 51′ W Long). Samples from same location.

BONN-1438. Vertisol, Safara, field, 0.4% C, IB 23 to 32cm — 970 ± 70 A.D. 980

BONN-1439. 0.5% C, IB 33 to 44cm — 1490 ± 80 A.D. 460

BONN-1440. 0.8% C, IB 44 to 54cm — 2190 ± 80 240 B.C.

BONN-1441. 0.3% C, IIBca 56 to 67cm — 2230 ± 190 280 B.C.

BONN-1442. 0.3% C, IICca 72 to 95cm — 1860 ± 100 A.D. 90

Red Vertisol, secondarily recalcified, Salvada-Beja, 195m above NN, slightly slopy, (37° 56′ N Lat, 1° 20′ W Long). Samples from same location.

| | | |
|---|---|---|
| BONN-1443. | Vertisol, Salvada-Beja, 1.0% C, Ap 15 to 32cm | 103.3 ± 0.4% Modern |
| BONN-1444. | 1.2% C, B 41 to 51cm | 104.4 ± 0.5% Modern |
| BONN-1445. | 0.5% C, B 52 to 65cm | 600 ± 70 A.D. 1350 |
| BONN-1446. | 0.5% C, BC 71 to 85cm | 1380 ± 70 A.D. 570 |

Roman Cereal silo in Vertisol profile, Beja-Serpa, 150m above NN, street cut, hilly, (37° 54′ N Lat, 1° 27′ W Long).

| | | |
|---|---|---|
| BONN-1447. | Cereal silo Vertisol, Beja-Serpa, 0.3% C, 0 to 20cm from deepest point of cut | 5150 ± 100 3200 B.C. |
| BONN-1451. | 0.8% C, 35 to 50cm | 1320 ± 70 A.D. 630 |

Dark red-brown Vertisol, not completely free of $CaCO_3$, Montes velhos Aljustrel, 104m above NN, slightly slopy (37° 55′ N Lat, 0° 57′ W Long). Samples from same location.

| | | |
|---|---|---|
| BONN-1452. | Dark red-brown Vertisol, Montes-velhos Aljustrel, 0.8% C, Ap 28 to 43cm | 960 ± 100 A.D. 990 |
| BONN-1453. | 0.6% C, B 47 to 62cm | 1620 ± 70 A.D. 330 |
| BONN-1454. | 0.5% C, B 67 to 83cm | 2240 ± 80 290 B.C. |
| BONN-1455. | 0.5% C, B 87 to 103cm | 1970 ± 150 20 B.C. |
| BONN-1457. | 0.3% C, Cca 140 to 150cm | 2000 ± 110 50 B.C. |

Red-brown Vertisol almost purely montmorollinitic, Terra Grande de Lisboa, Tapaiao da Ajuda, univ. campus, near Lisboa, 73m above NN, 16.9°C ϕ ann. t., upper slope, (38° 42′ N Lat, 0° 11′ W Long). Samples from same location.

| | | |
|---|---|---|
| BONN-1458. | Red-brown Vertisol, Tapaiao de Ajuda, 3.8% C, Ap 10 to 21cm | 470 ± 70 A.D. 1480 |
| BONN-1459. | 1.4% C, Bv 35 to 50cm | 1760 ± 80 A.D. 190 |
| BONN-1460. | 1.2% C, Bv 56 to 70cm | 2530 ± 80 580 B.C. |

| | | |
|---|---|---|
| BONN-1461. | 0.9% C, Bv 77 to 91cm | 2580 ± 100<br>630 B.C. |
| BONN-1462. | 0.5% C, BC 98 to 106cm | 3170 ± 80<br>1220 B.C. |
| BONN-1463. | 0.3% C, Cv 115 to 130cm | 8900 ± 170<br>6950 B.C. |

Samples coll. and subm. 1970 by W. Kerpen and H. Gewehr. *Comment*: most profiles are rather shallow and wholly within cracking zone, apparent mean residence times are low. Just the last red-brown Vertisol Tapaiao de Ajuda shows jump of age in Cv horizon, which probably lies outside normal depth of cracking.

### *C. Australia*

The Australia series comprises 2 Gilgai sites with 1 mound and 1 depression profile each. Besides the framework of global Vertisol profile studies, comparison of apparent mean residence time vs. depth in profiles, on mounds and in depressions, was expected to reveal Vertisol dynamics, (Blackburn and Coppi, 1970).

Vertisol, Lillimur, Kaniva dist., Victoria, Gilgai mound, (36° 27′ S Lat, 141° 6′ E Long). Samples from same location.

| | | |
|---|---|---|
| BONN-1465. | Vertisol, Lillimur, Gilgai mound, 3.2% C 0 to 10cm | 100.0 ± 0.4%<br>Modern |
| BONN-1466. | 4.1% C, 10 to 20cm | 1130 ± 70<br>A.D. 820 |
| BONN-1467. | 3.4% C, 20 to 30cm | 1240 ± 80<br>A.D. 710 |
| BONN-1468. | 2.4% C, 30 to 40cm | 2620 ± 80<br>670 B.C. |
| BONN-1469. | 1.8% C, 40 to 50cm | 2520 ± 80<br>570 B.C. |
| BONN-1470. | 0.5% C, 50 to 60cm | 2600 ± 70<br>650 B.C. |
| BONN-1471. | 0.5% C, 60 to 70cm | 2410 ± 80<br>460 B.C. |
| BONN-1472. | 0.5% C, 70 to 80cm | 2780 ± 80<br>830 B.C. |
| BONN-1473. | 0.4% C, 80 to 90cm | 4120 ± 110<br>2170 B.C. |
| BONN-1474. | 0.3% C, 90 to 100cm | 3800 ± 140<br>1850 B.C. |

| | | |
|---|---|---|
| BONN-1475. | 0.3% C, 100 to 110cm | 4680 ± 90<br>2730 B.C. |
| BONN-1476. | 0.3% C, 110 to 120cm | 5160 ± 110<br>3210 B.C. |
| BONN-1477. | 0.3% C, 120 to 130cm | 5880 ± 180<br>3930 B.C. |
| BONN-1478. | 0.2% C, 130 to 140cm | 5100 ± 140<br>3150 B.C. |
| BONN-1479. | 0.2% C, 140 to 150cm | 4190 ± 100<br>2240 B.C. |
| BONN-1481. | 0.2% C, 150 to 160cm | 4460 ± 350<br>2510 B.C. |
| BONN-1482. | 0.3% C, 160 to 170cm | 4960 ± 250<br>3010 B.C. |
| BONN-1483. | 0.2% C, 170 to 180cm | 4930 ± 210<br>2980 B.C. |
| BONN-1484. | 0.1% C, 180 to 190cm | 4480 ± 200<br>2530 B.C. |
| BONN-1485. | 0.1% C, 190 to 200cm | 4950 ± 150<br>3000 B.C. |

Vertisol, Lillimur, Kaniva dist., Victoria, Gilgai depression, (36° 27° S Lat, 141° 6′ E Long). Samples from same location.

| | | |
|---|---|---|
| BONN-1486. | Vertisol, Lillimur, Gilgai depression<br>4.5% C, 0 to 5cm | 109.4 ± 0.5%<br>Modern |
| BONN-1487. | 1.1% C, 5 to 10cm | 102.7 ± 0.6%<br>Modern |
| BONN-1488. | 0.6% C, 10 to 17cm | 104.0 ± 0.4%<br>Modern |
| BONN-1489. | 0.6% C, 17 to 20cm | 108.8 ± 0.6%<br>Modern |
| BONN-1490. | 0.7% C, 20 to 30cm | 112.1 ± 0.5%<br>Modern |
| BONN-1491. | 0.6% C, 30 to 40cm | 116.5 ± 0.8%<br>Modern |
| BONN-1492. | 0.5% C, 40 to 50cm | 112.8 ± 0.5%<br>Modern |
| BONN-1493. | 0.4% C, 50 to 60cm | 1380 ± 110<br>A.D. 570 |

| | | |
|---|---|---|
| BONN-1494. | 0.5% C, 60 to 70cm | 103.9 ± 0.4%<br>Modern |
| BONN-1495. | 0.3% C, 70 to 80cm | 1530 ± 100<br>A.D. 420 |
| BONN-1496. | 0.3% C, 80 to 90cm | 2150 ± 100<br>200 B.C. |
| BONN-1497. | 0.3% C, 90 to 100cm | 700 ± 120<br>A.D. 1250 |
| BONN-1498. | 0.3% C, 100 to 110cm | 590 ± 80<br>A.D. 1360 |
| BONN-1499. | 0.3% C, 110 to 120cm | 1230 ± 100<br>A.D. 720 |
| BONN-1501. | 0.2% C, 130 to 140cm | 1520 ± 250<br>A.D. 430 |
| BONN-1502. | 0.1% C, 140 to 150cm | 480 ± 80<br>A.D. 1470 |
| BONN-1503. | 0.2% C, 150 to 160cm | 390 ± 250<br>A.D. 1560 |
| BONN-1504. | 0.2% C, 160 to 170cm | 690 ± 280<br>A.D. 1260 |
| BONN-1505. | 0.2% C, 170 to 180cm | 1110 ± 160<br>A.D. 840 |
| BONN-1506. | 0.2% C, 180 to 190cm | 2280 ± 150<br>330 B.C. |
| BONN-1507. | 0.3% C, 190 to 200cm | 1680 ± 150<br>A.D. 270 |

Vertisol, Miram, Kaniva dist., Victoria, Gilgai mound, (36° 28′ S Lat, 141° 21′ E Long). Samples from same location.

| | | |
|---|---|---|
| BONN-1508. | Vertisol, Miram, Gilgai mound,<br>1.8% C, 0 to 10cm | 119.9 ± 0.4%<br>Modern |
| BONN-1509. | 0.9% C, 10 to 20cm | 107.9 ± 0.5%<br>Modern |
| BONN-1510. | 0.5% C, 20 to 30cm | 104.8 ± 0.6%<br>Modern |
| BONN-1511. | 0.6% C, 30 to 40cm | 560 ± 90<br>A.D. 1390 |
| BONN-1512. | 0.3% C, 40 to 50cm | 710 ± 70<br>A.D. 1240 |

| | | |
|---|---|---|
| BONN-1513. | 0.3% C, 50 to 60cm | 750 ± 70<br>A.D. 1200 |
| BONN-1514. | 0.5% C, 60 to 70cm | 1610 ± 70<br>A.D. 340 |
| BONN-1515. | 0.3% C, 70 to 80cm | 1110 ± 100<br>A.D. 840 |
| BONN-1516. | 0.3% C, 80 to 90cm | 2100 ± 80<br>150 B.C. |
| BONN-1517. | 0.4% C, 90 to 100cm | 3110 ± 120<br>1160 B.C. |
| BONN-1518. | 0.3% C, 100 to 110cm | 3470 ± 130<br>1520 B.C. |
| BONN-1519. | 0.3% C, 110 to 120cm | 4060 ± 120<br>2110 B.C. |
| BONN-1520. | 0.5% C, 120 to 130cm | 5170 ± 130<br>3220 B.C. |
| BONN-1521. | 0.3% C, 130 to 140cm | 5410 ± 130<br>3460 B.C. |
| BONN-1522. | 0.3% C, 140 to 150cm | 5940 ± 160<br>3990 B.C. |
| BONN-1523. | 0.2% C, 150 to 160 cm | 5920 ± 160<br>3970 B.C. |
| BONN-1524. | 0.2% C, 160 to 170cm | 8050 ± 160<br>6110 B.C. |
| BONN-1525. | 0.2% C, 170 to 180cm | 8440 ± 110<br>6490 B.C. |
| BONN-1526. | 0.2% C, 180 to 190cm | 8140 ± 180<br>6190 B.C. |
| BONN-1527. | 0.2% C, 190 to 200cm | 8530 ± 250<br>6580 B.C. |

Vertisol, Miram, Kaniva dist., Victoria, Gilgai depression, (36° 28′ S Lat, 141° 21′ E Long). Samples from same location.

| | | |
|---|---|---|
| BONN-1528. | Vertisol, Miram, Gilgai depression, 4.9% C, 0 to 5cm | 102.3 ± 0.6%<br>Modern |
| BONN-1529. | 2.1% C, 5 to 10cm | 101.0 ± 0.5%<br>Modern |
| BONN-1530. | 0.8% C, 10 to 20cm | 110.6 ± 0.5%<br>Modern |

BONN-1531. 0.9% C, 20 to 30cm — 106.8 ± 0.7% Modern

BONN-1532. 0.8% C, 30 to 40cm — 101.1 ± 0.4% Modern

BONN-1533. 0.5% C, 40 to 50cm — 108.2 ± 0.5% Modern

BONN-1534. 0.4% C, 50 to 60cm — 780 ± 80 A.D. 1170

BONN-1535. 0.4% C, 60 to 70cm — 810 ± 70 A.D. 1140

BONN-1536. 0.4% C, 70 to 80cm — 1070 ± 110 A.D. 880

BONN-1537. 0.3% C, 80 to 90cm — 3380 ± 290 1430 B.C.

BONN-1538. 0.2% C, 90 to 100cm — 3660 ± 140 1710 B.C.

BONN-1539. 0.2% C, 100 to 110cm — 3790 ± 330 1840 B.C.

BONN-1540. 0.2% C, 110 to 120cm — 4750 ± 320 2800 B.C.

BONN-1541. 0.2% C, 120 to 130cm — 4990 ± 240 3010 B.C.

BONN-1542. 0.2% C, 130 to 140cm — 5300 ± 260 3350 B.C.

BONN-1543. 0.2% C, 140 to 150cm — 5720 ± 440 3770 B.C.

BONN-1544. 0.2% C, 150 to 160cm — 4880 ± 320 2930 B.C.

BONN-1545. 0.4% C, 160 to 170cm — 6730 ± 200 4780 B.C.

BONN-1546. 0.2% C, 170 to 180cm — 7540 ± 390 5590 B.C.

BONN-1547. 0.2% C, 180 to 190cm — 8330 ± 400 6380 B.C.

BONN-1548. 0.2% C, 190 to 200cm — 8450 ± 260 6500 B.C.

Samples coll. and subm. 1970 by G. Blackburn, CSIRO, Div. Soils, Adelaide. *Comment*: Gilgai Lillimur shows extremely different age vs. depth profiles on mounds and in depressions with lagging apparent mean residence time in the depression due to excessive deposits of surface material in dry-season cracks. Mound profile is also unusual in that 2 zones of almost homogenous apparent mean residence time are differentiated (30 to 80 cm, ca. 2500 yr, 80 to 200cm, ca. 4500 to 5000 yr). In Gilgai Miram, apparent mean residence times are higher in mound and depression as well, up to 8500 yr. Mound and depression profiles both are to a level of ca. 80cm, strongly intermixed with surface material, especially in the depression profile.

*D. Germany*

Fossil Ah, Eberspoint, 10km W Freising, 100cm under loess-loam (eroded Hapludalf). Time of chernozem formation in Bavaria is questioned (48° 30′ N Lat, 11° 40′ E Long).

**BONN-1464.** **6160 ± 90**
**4210 B.C.**

Fossil A-Horizon, Ezerspoint, 2.6% C, 100cm. Sample coll. and subm. 1971 by U. Schwertmann, Inst. Bodenkunde, Techn. Univ. Munich. *Comment*: result agrees well with apparent mean residence time found in AC transition zone of recent chernozem profiles in other parts of Germany (Scharpenseel, 1972).

Fossil A horizon, and charcoal in terrace brown earth, 5km S Siegenburg, Abens valley, N Bacaria, (48° 46′ N Lat, 11° 50′ E Long). Samples from same location.

**BONN-1648.** **2270 ± 70**
**320 B.C.**

Fossil A-horizon, terrace Abens valley, Siegenburg, 60 to 80cm.

**BONN-1649.** **1220 ± 80**
**A.D. 730**

Charcoal fireplace, 1m ø.

**BONN-1651.** **1460 ± 70**
**A.D. 490**

Charcoal from different fireplace, 150cm below sand blanket. Samples Coll. and subm. 1971 by U. Schwertmann. *Comment*: dates alluviation of material embedding fossil A-horizon and fireplaces.

Humus horizons in high flood loam, Hapludalf, on nether terrace of Rhine R., gravel pit Horn, Bonn-Hersel, (50° 43′ N Lat, 7° 8′ E Long).

**BONN-1652.** **5080 ± 110**
**3130 B.C.**

Hapludalf in high flood loam on nether terrace, 0.5% C, Bt 60 to 100cm.

**BONN-1653.** **8230 ± 470**
**6280 B.C.**

fA-horizon below Hapludalf, same location, 0.4% C, fA 160 to 180cm.

Samples coll. and subm. 1972 by Chr. Haupenthal, Inst. Bodenkunde, Bonn Univ. *Comment*: date of Bt horizon is minimum for recent Hapludalf, date of fA horizon indicates 1st soil development on nether terrace, showing good agreement with expectation due to terrace history.

Carbonaceous, bituminous coating of gravel remnant in younger terrace of Isar, Ascholding, Wolfratshausener Becken, (47° 51′ N Lat, 11° 28′ E Long).

**BONN-1657.** **28,320 ± 470**
**26,370 B.C.**

Carbonaceous, bituminous coating on gravel relic, 280cm. Sample coll. and subm. 1971 by W. Kerpen, Chr. Haupenthal, and H. W. Scharpenseel. *Comment*: terrace thought to be late Pleistocene, most likely Holocene in origin (Dietz, 1971). Old date difficult to interpret. Secondary quartz crystallization adjacent and partly covering C material. Gravel relic is void of $CaCO_3$ in otherwise calcareous milieu and rounded by water transport. Conflicting views on terrace chronology make date controversial, confirmed by repetition.

Brownearth of unusually high and deep organic matter, meadow on Würm basal moraine of Isar foreland glacier, Unterbuchen, (11° 30′ N Lat, 47° 42′ E Long). Soil suspected of amelioration by plaggen (swards). Existence and time of plaggen management in Bavarian Alps foreland is of interest.

**BONN-1669.** **1090 ± 70**
**A.D. 860**

Brownearth, humus to great depth on basal moraine, 4.4% C, Ah1 20 to 30cm. Samples from same location.

**BONN-1670.** **1630 ± 70**
**A.D. 320**

2.8% C, Ah2 30 to 40cm

**BONN-1671.** **2350 ± 80**
**400 B.C.**

2.5% C, Ah3 40 to 50cm

**BONN-1672.** **3800 ± 80**
**1850 B.C.**

2.5% C, Ah4 50 to 60 cm

Samples coll. and subm. 1972 by H. Jertz, Bayr. Geol. Landesamt, Munich. *Comment*: dates are older than corresponding results on plaggen soils in NW Germany and Ireland (Mückenhausen *et al.*, 1968, Scharpenseel, 1972). Micromorphologic studies on thin sections should decide nature of plaggen soil.

Roots and fossil A horizon from gravel pit, Gemeinde Trieb, Oberfranken, Bavaria, (50° 9′ N Lat, 11° 8′ E Long). Samples serve stratigraphic study of terraces in upper Main valley.

**BONN-1700.** **1810 ± 70**
**A.D. 140**

Root, gravel pit Maintag, Trieb 170 to 145cm.

**BONN-1801.** **7980 ± 110**
**6030 B.C.**

Ah horizon, pit Maintag, 180 to 200cm.

**BONN-1802.** **4360 ± 90**
**2410 B.C.**

Root, vertical in sediment, 200 to 270cm. Samples coll. and subm. 1972 by W. Schirmer, Geol. Inst., Univ. Cologne. *Comment*: dates. estimated to be Sub-Atlantic, are older and require new approach.

Fossil loessic A horizon, covered by Pleistocene terrace material, Kärlich, mining pit, (50° 26′ N Lat, 7° 30′ E Long).

**BONN-1659.** **30,450 ± 1270**
**28,500 B.C.**

Humus containing soil, Kärlich, 2.6% C. Coll. and subm. 1972 by J. Frechen, Inst. Petrol., Bonn Univ. *Comment*: date confirms expectation, contemporaneous with Paudorf interstadial.

Humus containing silty A horizon, sandwiched by loess material, underlying tuffaceous material, probably of Rodderberg volcanism. N slope Bausenberg, Lengsdorf, 140m above NN, (50° 42.5′ N Lat 7° 2′ E Long). Dated to determine age of Rodderberg volcanism, Quaternary profile of Bonn area.

**BONN-1699.** **22,360 ± 510**
**20,410 B.C.**

Humus containing horizon, silty, Lengsdorf, 400cm deep. Coll. and subm. 1972 by G. Bartels, Geogr. Inst., Univ. Bonn. *Comment*: date lags behind expected age: >30,000 yr. Thorough study of existence of rejuvenating principles, such as small roots, will follow.

Fossil A horizon in gravelly gley, Gammelsbach valley, N Eberbach, buntsandstone Odenwald, (49° 29′ N Lat, 8° 57′ E Long). Date of fossil A is taken to estimate sedimentation speed of younger accumulations on top.

**BONN-1815.** **1350 ± 110**
**A.D. 600**

Gleyey fAh, Gammelsbach valley, Eberbach, Odenwald, 3.0% C. Coll. and subm. 1972 by E. Szabados, Inst. Bodenkunde, Techn. Univ. Berlin. *Comment*: estimates were either Boreal age or pre-medieval deforestation. Results confirm latter.

## III. SOIL ORGANIC MATTER FRACTIONS

Soil organic matter fractions were dated after different pretreatments of the soil samples.

### *A. Particle size*

Similar to particle size dating on Inden parabrownearth (R., 1971, v. 13, p. 207; Scharpenseel, 1970), texture fractions of a fossil A horizon, underlying trachyt tuff of Alleröd volcanism, were dated, compared to charcoal from same horizon. Niedermendig, tephrit quarry Michels, (50° 26′ N Lat, 7° 15′ E Long). Material belongs to same fossil horizon as BONN-413, (R., 1970, v. 12, p. 27).

**BONN-1681.** **11,550 ± 160**
**9600 B.C.**

Fossil A horizon, Niedermendig, charcoal, 300 to 350cm.

**BONN-1682.** **7570 ± 190**
**5620 B.C.**

Same location, particle size fraction >0.2mm, 0.86% C.

**BONN-1684.** **10,950 ± 150**
**9000 B.C.**

Same location, particle size fraction 63 to 2$\mu$, 0.68% C.

Samples coll., fractioned, and synthesized 1972 by Chr. Haupenthal, Inst. Bodenkunde, Bonn Univ. *Comment*: between charcoal and organic C fraction, particle size 63 to 2$\mu$, agreement is rather good. Exclusive use of larger particle fraction leads to drastic decrease of age. Particle size fractions 60 to 1$\mu$ seem optimal in loessic soils (Scharpenseel, 1970; 1972).

### *B. Fractions from continuous extraction*

One chernozem and podzol each were continuously extracted by 0.15 M $Na_4P_2O_7$ solution (chernozem required pretreatment with 0.1 N $H_2SO_4$). Successive fractions of extracted humic acids were separately dated, after acid precipitation and drying of humic acids.

**BONN-1809.** **1030 ± 100**
**A.D. 920**

Chernozem, Aseler Holz, 22.5% C, AC 40 to 60cm, (52° 10′ N Lat, 10° 1′ E Long), 1. fraction.

**BONN-1810.** **4130 ± 270**
**2180 B.C.**

Same location, 36.3% C, 2, fraction.

**BONN-1811.** **4970 ± 80**
**3020 B.C.**

Same location, 1.05% C, whole sample, unfractioned.

Samples coll., extracted, and subm. 1972 by Chr. Haupenthal. *Comment*: preceding 1st extract sample of low C concentration was modern. Alkali extract of hard-to-extract soils is highly susceptible to atmospheric bomb C contamination, even if work was performed, wherever possible, under $N_2$ gas. In the BONN lab., this method was rejected.

| | | |
|---|---|---|
| BONN-1688. | Podzol Scherpenseel, gravel pit Weber, 22.5% C, Bh 120 to 140cm, (50° 56′ N Lat, 6° 0.5′ E Long). Samples are from same location. | 1400 ± 140<br>A.D. 550 |
| BONN-1689. | 24.8% C | 1160 ± 70<br>A.D. 790 |
| BONN-1691. | 27.0% C | 1460 ± 80<br>A.D. 490 |
| BONN-1692. | 25.5% C | 1350 ± 110<br>A.D. 600 |
| BONN-1693. | 24.0% C | 1510 ± 130<br>A.D. 440 |
| BONN-1697. | Podzol Scherpenseel, gravel pit Weber, 20.8% C, Ah 80 to 100cm | 1290 ± 70<br>A.D. 660 |
| BONN-1698. | Same location, 16.5% C | 1220 ± 70<br>A.D. 730 |

Samples coll., extracted, and subm. 1972 by Chr. Haupenthal. *Comment*: extraction of humus-C from podzols proceeds quickly and efficiently, yielding large quantities of organic carbon till gray-white sand remains. Danger of contamination is lower than in case of chernozem due to much shorter exposure time required for phase of alkali extraction. Results do not favor taking one special fraction out of continuous extraction.

## IV. SUBHYDRIC SOILS, GYTTJA

### *A. Schalkenmehren*

Gyttja in Schalkenmehren-Maar, Eifel. Continuation of BONN-781 -802, Profile III (R., 1971, v. 12, p. 207). Profiles I to V are part of larger program of subhydric soil studies in Eifel Maaren. The origin of Schalkenmehren Maar, a true gas explosion funnel of ca. 25m depth, was lately palynologically dated to ca. 10,950 B.P., by $C^{14}$ dating of adjacent dry maar layers to 13,900 B.P. (Erlenkäuser *et al.*, 1970). Erlenkäuser and co-workers estimate that, based on stable isotope measurements, mud of Eifel maars might be contaminated by magmatic $CO_2$, which could account for ca. 2000 yr gap between palynologic and $C^{14}$ dates. Samples are taken with a case lot, (50° 11.5′ N Lat, 6° 50′ E Long).

| | | |
|---|---|---|
| BONN-994. | Schalkenmehren maar, Profile I, NE of maar, taken by case lot, 20.0% C, 0 to 10cm. Samples from same location. | 4690 ± 90<br>2740 B.C. |

| | | |
|---|---|---|
| BONN-995. | 24.0% C, 10 to 20cm | 4790 ± 70<br>2840 B.C. |
| BONN-996. | 18.4% C, 20 to 30cm | 5240 ± 80<br>3290 B.C. |
| BONN-997. | 23.5% C, 30 to 40cm | 5340 ± 90<br>3390 B.C. |
| BONN-998. | 30.6% C, 40 to 50cm | 7260 ± 130<br>5310 B.C. |
| BONN-999. | 31.9% C, 50 to 60cm | 7170 ± 110<br>5220 B.C. |
| BONN-1000. | 17.5% C, 60 to 70cm | 9220 ± 130<br>7270 B.C. |
| BONN-1001. | 26.9% C, 70 to 80cm | 8480 ± 140<br>6530 B.C. |
| BONN-1002. | 27.0% C, 80 to 90cm | 9740 ± 110<br>7790 B.C. |
| BONN-1003. | 27.5% C, 90 to 100cm | 9910 ± 100<br>7960 B.C. |
| BONN-1004. | 26.6% C, 100 to 110cm | 9800 ± 90<br>7850 B.C. |
| BONN-1005. | 20.0% C, 110 to 120cm | 12,130 ± 140<br>10,180 B.C. |
| BONN-1662. | 25.5% C, 120 to 150cm | 12,190 ± 170<br>10,240 B.C. |
| BONN-1007. | Schalkenmehren maar, Profile II, E of maar, taken by case lot, 6.8% C, 0 to 20cm. Samples from same location. | 3470 ± 70<br>1520 B.C. |
| BONN-1008. | 4.9% C, 20 to 30cm | 3300 ± 100<br>1350 B.C. |
| BONN-1009. | 4.6% C, 30 to 40cm | 3580 ± 90<br>1630 B.C. |
| BONN-1010. | 4.2% C, 40 to 50cm | 2660 ± 90<br>710 B.C. |
| BONN-1011. | 5.7% C, 50 to 60cm | 3220 ± 80<br>1270 B.C. |
| BONN-1012. | 6.0% C, 60 to 70cm | 4020 ± 80<br>2070 B.C. |

| | | |
|---|---|---|
| BONN-1013. | 5.0% C, 70 to 80cm | 4750 ± 80<br>2800 B.C. |
| BONN-1014. | 4.3% C, 80 to 90cm | 3200 ± 80<br>1250 B.C. |
| BONN-1015. | 3.4% C, 90 to 100cm | 3120 ± 80<br>1170 B.C. |
| BONN-1016. | 5.3% C, 100 to 110cm | 3290 ± 80<br>1340 B.C. |
| BONN-1017. | 6.9% C, 110 to 120cm | 3570 ± 80<br>1620 B.C. |
| BONN-1018. | 8.5% C, 120 to 130cm | 3740 ± 70<br>1790 B.C. |
| BONN-1019. | 14.4% C, 130 to 140cm | 3340 ± 80<br>1390 B.C. |
| BONN-1020. | 14.3% C, 140 to 150cm | 4930 ± 90<br>2980 B.C. |
| BONN-1021. | 6.0% C, 150 to 160cm | 4770 ± 90<br>2820 B.C. |
| BONN-1022. | 13.5% C, 160 to 167cm | 5200 ± 80<br>3250 B.C. |
| BONN-1023. | 8.3% C, 167 to 170cm | 8930 ± 100<br>6980 B.C. |
| BONN-1024. | 15.3% C, 170 to 185cm | 11,060 ± 150<br>9110 B.C. |
| BONN-1025. | 20.6% C, 185 to 200cm | 12,160 ± 130<br>10,210 B.C. |
| BONN-1026. | Schalkenmehren maar, Profile IV, N of maar, taken by case lot, 6.6% C, 0 to 10cm. Samples from same location. | 3160 ± 70<br>1210 B.C. |
| BONN-1027. | 4.8% C, 10 to 20cm | 2940 ± 70<br>990 B.C. |
| BONN-1028. | 4.6% C, 20 to 30cm | 2790 ± 70<br>840 B.C. |
| BONN-1029. | 6.5% C, 30 to 40cm | 2470 ± 80<br>520 B.C. |
| BONN-1030. | 6.0% C, 40 to 50cm | 3960 ± 60<br>2010 B.C. |

| | | |
|---|---|---|
| BONN-1031. | 7.6% C, 50 to 60cm | 3580 ± 60<br>1630 B.C. |
| BONN-1032. | 5.7% C, 60 to 70cm | 3520 ± 70<br>1570 B.C. |
| BONN-1033. | 9.8% C, 70 to 80cm | 3390 ± 60<br>1440 B.C. |
| BONN-1034. | 3.8% C, 80 to 90cm | 3060 ± 60<br>1110 B.C. |
| BONN-1036. | 5.8% C, 100 to 110cm | 2630 ± 60<br>680 B.C. |
| BONN-1037. | 6.3% C, 110 to 120cm | 3000 ± 70<br>1050 B.C. |
| BONN-1038. | 6.7% C, 120 to 130cm | 2930 ± 70<br>980 B.C. |
| BONN-1039. | 13.1% C, 130 to 140cm | 2930 ± 60<br>980 B.C. |
| BONN-1040. | 13.5% C, 140 to 150cm | 3020 ± 60<br>1070 B.C. |
| BONN-1041. | 18.3% C, 150 to 160cm | 3220 ± 60<br>1270 B.C. |
| BONN-1043. | 19.5% C, 170 to 180cm | 3110 ± 70<br>1160 B.C. |
| BONN-1044. | 17.7% C, 180 to 190cm | 3270 ± 70<br>1320 B.C. |
| BONN-1045. | 12.8% C, 190 to 200cm | 9290 ± 130<br>7340 B.C. |
| BONN-1046. | Schalkenmehren maar, Profile V, SW of maar, taken by case lot, 8.3% C, 0 to 10cm. Samples from same location. | 3450 ± 80<br>1500 B.C. |
| BONN-1047. | 2.8% C, 10 to 20cm | 2800 ± 80<br>850 B.C. |
| BONN-1048. | 4.3% C, 20 to 30cm | 2770 ± 90<br>820 B.C. |
| BONN-1049. | 4.5% C, 30 to 40cm | 3680 ± 80<br>1730 B.C. |
| BONN-1050. | 4.9% C, 40 to 50cm | 3840 ± 80<br>1890 B.C. |

**BONN-1051. 4.4% C, 50 to 60cm** — 3580 ± 80, 1630 B.C.

**BONN-1052. 3.6% C, 60 to 70cm** — 2710 ± 80, 760 B.C.

**BONN-1053. 2.3% C, 70 to 80cm** — 3000 ± 80, 1050 B.C.

**BONN-1054. 8.1% C, 80 to 90cm** — 2980 ± 80, 1030 B.C.

**BONN-1055. 2.8% C, 90 to 100cm** — 3090 ± 70, 1140 B.C.

**BONN-1056. 3.0% C, 100 to 110cm** — 2920 ± 80, 979 B.C.

**BONN-1057. 5.0% C, 110 to 120cm** — 2950 ± 80, 1000 B.C.

**BONN-1058. 4.0% C, 120 to 130cm** — 2920 ± 100, 970 B.C.

**BONN-1059. 12.0% C, 130 to 140cm** — 3340 ± 80, 1390 B.C.

**BONN-1060. 14.5% C, 140 to 150cm** — 2850 ± 80, 900 B.C.

**BONN-1061. 19.2% C, 150 to 160cm** — 2510 ± 80, 560 B.C.

**BONN-1062. 19.9% C, 160 to 170cm** — 2350 ± 70, 400 B.C.

**BONN-1063. 30.0% C, 170 to 180cm** — 2800 ± 80, 850 B.C.

**BONN-1064. 20.8% C, 180 to 190cm** — 2630 ± 80, 680 B.C.

**BONN-1065. 20.8% C, 190 to 200cm** — 2670 ± 80, 720 B.C.

Samples coll. and subm. 1969 by H. W. Scharpenseel, W. Kerpen, and H. Gewehr, Inst. Bodenkunde, Bonn Univ. *Comment*: dependent on location of sampling, age vs. depth progression is very different, sometimes even to the point of trend reversal. Also, the mixing effect with rejuvenation to considerable depth, e.g. by inflowing sewage or methane bubbles, is assoc. with site of sampling spot, distance as well as windward direction from lake shore village. C concentrations of gyttja vary greatly with location and depth. Highest dates in Profile I and II, which were ending on top of tuffaceous sand, blocking further penetration of the case lot, reach ca. 12,000 yr. Profile IV is intermediate, dates of Profiles III and IV, near inhabited S lake shore are much lower. Apparently, Erlenkäuser *et al.* (1970), besides using dry maar samples, disposed of cores, penetrating also through the sandy tuff layers, which could account for 1600 yr more, compared with our deepest samples. Results show danger of lake sediment dating, relying on too few sampling spots.

### *B. Selent*

Gyttja in lake of Selent, E Holsteen. Continuation of BONN-882 -908, Profile II (R., 1971, v. 13, p. 209). In this second biggest glacier lake of E Holsteen, with max. depth ca. 45m, thickness of mud sediment varies with echo sounder between <1m and 5 to 10m. Thickest sediment corresponds with shallow water in E part of lake. Profile cores were taken by means of case lot (Profiles I, III, IV), as well as with Livingstone borer (Profiles II, V, VI) (54° 41′ N Lat, 10° 35′ E Long).

**BONN-869.** Selent lake, Profile I, in front of Giekau, taken by case lot, 11.8% C, 0 to 25cm. Samples from same location. — **380 ± 70**, A.D. 1570

**BONN-871.** 12.3% C, 25 to 35cm — **500 ± 70**, A.D. 1450

**BONN-873.** 12.7% C, 45 to 55cm — **450 ± 70**, A.D. 1500

**BONN-874.** 15.9% C, 55 to 65cm — **1670 ± 100**, A.D. 280

**BONN-875.** 22.3% C, 65 to 75cm — **700 ± 70**, A.D. 1250

**BONN-876.** 17.5% C, 75 to 85cm — **790 ± 80**, A.D. 1160

**BONN-877.** 19.5% C, 85 to 100cm — **970 ± 70**, A.D. 980

**BONN-878.** 19.9% C, 100 to 115cm — **930 ± 70**, A.D. 1020

**BONN-879.** 14.6% C, 115 to 125cm — **1190 ± 70**, A.D. 760

**BONN-880.** Tube sample, 2m below end of case lot, underneath sand, 3.7% C. — **10,170 ± 140**, 8220 B.C.

**BONN-1122.** Soil profile on shore, opposite Profile I in front of Giekau, 6% C, Ah1 10 to 25cm. Samples from same location. — **140 ± 60**, A.D. 1810

| | | |
|---|---|---|
| BONN-1123. | 1.2% C, Ah2 25 to 40cm | 390 ± 60<br>A.D. 1560 |
| BONN-1124. | 0.9% C, GoAh3, 40 to 60cm | 620 ± 60<br>A.D. 1330 |
| BONN-1125. | 0.4% C, GorC1 60 to 80cm | 1400 ± 70<br>A.D. 550 |
| BONN-961. | Selent lake, Profile III, between Selent and Bellin, taken by case lot, 7.5% C, 0 to 15cm. Samples from same location. | 1290 ± 70<br>A.D. 660 |
| BONN-962. | 18.5% C, 10 to 15cm | 1300 ± 70<br>A.D. 650 |
| BONN-911. | 4.9% C, 15 to 20cm | 1910 ± 100<br>A.D. 40 |
| BONN-912. | 5.3% C, 20 to 30cm | 1430 ± 100<br>A.D. 520 |
| BONN-913. | 6.4% C, 30 to 40cm | 2360 ± 80<br>410 B.C. |
| BONN-914. | 6.4% C, 40 to 50cm | 3830 ± 80<br>1880 B.C. |
| BONN-915. | 7.1% C, 50 to 55cm | 6380 ± 100<br>4430 B.C. |
| BONN-916. | 2.8% C, 55 to 60cm | 6660 ± 100<br>4710 B.C. |
| BONN-917. | 2.3% C, 60 to 70cm | 9760 ± 130<br>7810 B.C. |
| BONN-918. | 2.1% C, 70 to 80cm | 11,350 ± 150<br>9400 B.C. |
| BONN-919. | 0.9% C, 80 to 90cm | 11,520 ± 130<br>9570 B.C. |
| BONN-920. | 1.0% C, 90 to 100cm | 9930 ± 120<br>7980 B.C. |
| BONN-921. | 0.5% C, 100 to 110cm | 13,050 ± 420<br>11,100 B.C. |
| BONN-922. | 0.4% C, 110 to 120cm | 12,570 ± 440<br>10,620 B.C. |
| BONN-924. | 0.9% C, 130 to 140cm | 15,200 ± 260<br>13,250 B.C. |

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|---|---|---|
| BONN-925. | 0.5% C, 140 to 150cm | 11,020 ± 160<br>9070 B.C. |
| BONN-926. | 0.5% C, 150 to 160cm | 21,640 ± 550<br>19,690 B.C. |
| BONN-927. | 0.8% C, 160 to 170cm | 21,200 ± 550<br>19,250 B.C. |
| BONN-930. | 0.8% C, 190 to 200cm | 20,510 ± 460<br>18,560 B.C. |
| BONN-931. | 0.5% C, 200 to 210cm | 23,890 ±700<br>21,940 B.C. |
| BONN-932. | 0.8% C, 210 to 220cm | 24,410 ± 630<br>22,460 B.C. |
| BONN-963. | 0.5% C, 220 to 240cm | 24,790 ± 800<br>22,840 B.C. |
| BONN-964. | 1.4% C, 240 to 250cm | 24,830 ± 970<br>22,880 B.C. |
| BONN-933. | Selent lake, Profile IV, in front of beach of Selent village, taken by case lot, 14.6% C, 0 to 5cm. Samples from same location. | 1630 ± 70<br>A.D. 320 |
| BONN-934. | 12.5% C, 5 to 10cm | 920 ± 80<br>A.D. 1030 |
| BONN-935. | 9.5% C, 10 to 20cm | 1550 ± 70<br>A.D. 400 |
| BONN-936. | 10.3% C, 20 to 30cm | 1220 ± 70<br>A.D. 730 |
| BONN-937. | 10.1% C, 30 to 40cm | 1050 ± 70<br>A.D. 900 |
| BONN-938. | 14.3% C, 40 to 50cm | 1150 ± 70<br>A.D. 800 |
| BONN-939. | 10.9% C, 50 to 60cm | 1090 ± 70<br>A.D. 860 |
| BONN-940. | 11.3% C, 60 to 70cm | 1040 ± 80<br>A.D. 950 |
| BONN-941. | 11.1% C, 50 to 70cm (rep) | 1080 ± 70<br>A.D. 870 |
| BONN-942. | 11.0% C, 70 to 80cm | 1160 ± 70<br>A.D. 790 |

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|---|---|---|
| BONN-943. | 10.5% C, 80 to 90cm | 1770 ± 70<br>A.D. 180 |
| BONN-944. | 11.4% C, 80 to 100cm (rep) | 1670 ± 220<br>A.D. 280 |
| BONN-945. | 9.0% C, 90 to 100cm | 1780 ± 70<br>A.D. 170 |
| BONN-946. | 8.5% C, 100 to 110cm | 2060 ± 70<br>110 B.C. |
| BONN-948. | 8.6% C, 110 to 120cm | 2570 ± 80<br>620 B.C. |
| BONN-949. | 10.5% C, 120 to 130cm | 3350 ± 80<br>1400 B.C. |
| BONN-951. | 10.5% C, 130 to 144cm | 2920 ± 70<br>970 B.C. |
| BONN-952. | 5.4% C, 144 to 154cm | 2690 ± 80<br>740 B.C. |
| BONN-953. | 8.0% C, 154 to 157cm | 8500 ± 120<br>6550 B.C. |
| BONN-954. | 4.4% C, 157 to 160cm | 10,390 ± 190<br>8440 B.C. |
| BONN-955. | 0.8% C, 160 to 170cm | 9810 ± 180<br>7860 B.C. |
| BONN-956. | 1.8% C, 170 to 180cm | 11,470 ± 160<br>9520 B.C. |
| BONN-957. | 0.5% C, 180 to 190cm | 12,330 ± 220<br>10,380 B.C. |
| BONN-959. | 0.3% C, 190 to 215cm | 17,390 ± 460<br>15,440 B.C. |
| BONN-1127. | Soil profile on shore, opposite Profile IV, in front of beach, Selent village, peaty, 36.4% C, T1 10 to 30cm. Samples from same location. | 1750 ± 50<br>A.D. 200 |
| BONN-1128. | 41.3% C, T2 30 to 50cm | 2460 ± 60<br>510 B.C. |
| BONN-1129. | 35.6% C, T3 40 to 60cm | 2210 ± 70<br>260 B.C. |
| BONN-1130. | 34.1% C, T4 60 to 80cm | 2580 ± 70<br>630 B.C. |

| | | | |
|---|---|---|---|
| BONN-1131. | 35.6% C, T5 80 to 100cm | | 2670 ± 70<br>720 B.C. |
| | | Carbonate C | Organic C |
| BONN-967. | Selent lake, Profile V, in lake center ahead of narrowing NE branch towards Giekau, taken by Livingstone borer, 0.7% C, 0 to 20 cm. | 24,590 ± 690<br>22,640 B.C. | 106.3 ± 0.2<br>Modern |
| BONN-968. | 0.4% C, 20 to 40cm | 28,500 ± 1100<br>26,550 B.C. | 470 ± 110<br>A.D. 1480 |
| BONN-969. | 0.7% C, 40 to 60cm | 27,810 ± 820<br>25,860 B.C. | 3160 ± 330<br>1210 B.C. |
| BONN-970. | 0.5% C, 60 to 80cm | 30,280 ± 1200<br>28,330 B.C. | 6660 ± 510<br>4710 B.C. |
| BONN-971. | 0.4% C, 80 to 100cm | 29,170 ± 1190<br>27,220 B.C. | 9070 ± 420<br>7120 B.C. |
| BONN-972. | 0.6% C, 100 to 120cm | 37,810 ± 3190<br>35,860 B.C. | 8640 ± 420<br>6690 B.C. |
| BONN-973. | 0.3% C, 120 to 140cm | 32,940 ± 1870<br>30,990 B.C. | 11,650 ± 590<br>9700 B.C. |
| BONN-974. | 0.4% C, 140 to 160cm | 37,600 ± 3310<br>35,650 B.C. | 10,620 ± 390<br>8670 B.C. |
| BONN-975. | 0.5% C, 160 to 180cm | 37,890 ± 2980<br>35,940 B.C. | 10,930 ± 460<br>8980 B.C. |
| BONN-976. | 0.4% C, 180 to 200cm | 36,250 ± 2660<br>34,300 B.C. | 14,180 ± 670<br>12,230 B.C. |
| BONN-977. | Selent lake, Profile VI, bay near Seekrug, taken by Livingstone borer, 11.7% C, 0 to 20cm. Samples from same location. | | 780 ± 70<br>A.D. 1170 |
| BONN-978. | 10.1% C, 20 to 40cm | | 980 ± 90<br>A.D. 970 |
| BONN-979. | 7.1% C, 40 to 60cm | | 1580 ± 80<br>A.D. 370 |
| BONN-980. | 5.1% C, 60 to 80cm | | 2290 ± 80<br>340 B.C. |
| BONN-981. | 6.6% C, 80 to 96cm | | 2970 ± 110<br>1020 B.C. |

| | | |
|---|---|---|
| BONN-982. | 9.5% C, 100 to 120cm | 3120 ± 80<br>1170 B.C. |
| BONN-983. | 9.8% C, 120 to 140cm | 2350 ± 90<br>400 B.C. |
| BONN-984. | 10.2% C, 140 to 160cm | 3430 ± 80<br>1480 B.C. |
| BONN-985. | 6.3% C, 160 to 180cm | 4260 ± 110<br>2310 B.C. |
| BONN-986. | 9.2% C, 180 to 200cm | 4850 ± 90<br>2900 B.C. |
| BONN-987. | 12.6% C, 200 to 220cm | 4670 ± 120<br>2720 B.C. |
| BONN-988. | 7.6% C, 220 to 240cm | 4850 ± 100<br>2900 B.C. |
| BONN-989. | 5.7% C, 240 to 260cm | 5870 ± 230<br>3920 B.C. |
| BONN-990. | 1.0% C, 260 to 280cm | 5340 ± 180<br>3390 B.C. |
| BONN-991. | 1.5% C, 280 to 300cm | 5590 ± 360<br>3640 B.C. |
| BONN-992. | 0.6% C, 300 to 320cm | 10,080 ± 520<br>8130 B.C. |
| BONN-993. | 0.2% C, 320 to 340cm | 30,930 ± 1150<br>28,980 B.C. |

Samples coll. and subm. 1969 by H. W. Scharpenseel, W. Kerpen, and H. Gewehr. *Comment*: as in Schalkenmehren series, the extent of anthropogenic influence, exerted on sampling sites, correlates with age vs. depth pattern of profiles. Selent I and II sites are close to present day village Giekau and a presumed submerged prehistoric settlement. Profile I is young, it has maximum dates of 7000 yr. Selent III to VI date to 25,000 yr, 17,000 yr, 14,200 yr, and 10,000 yr (with a doubtful jump to 31,000 yr in deepest sample, which should be verified). The lake sediment was possibly influenced by partly available free carbonates (Münnich, 1957; Münnich and Vogel, 1959). Selent V was tested on the basis of carbonate C as well as on remaining organic C. Results show no strict relationship, except for general trend of age vs. depth increase. Results suggest, that formation of Selent lake sediment began at least since Boelling, or even Paudorf interval. Measurement of apparent mean residence time in 2 soil profiles on shore, opposite Profile I and IV, reveals young lake alluvium, just as in Profile I, or at Selent lake beach (opposite Profile IV) peat layers up to 2700 yr, indicating filling of certain parts of lake fringes by low moor formation since Sub-Boreal.

## V. ARCHAEOLOGIC SAMPLES

### Iran series

Age of old mine, S fringe of Great Kavir, Central Iran, Chah Nukluk or Nakhlak, dated through work on 3 buildings from Sasanitic origin (4 to 7th century), (33° 12′ N Lat, 53° 46′ E Long).

**1790 ± 100**
**BONN-1666.** **A.D. 160**

Relic of decaying supporting pole, assoc. archeol. materials, mining tools, wedges, earthen ware.

**1190 ± 80**
**BONN-1667.** **A.D. 760**

Parts of 2 wooden containers, assoc. archeol. materials, mining tools, wedges, earthen ware.

**1820 ± 80**
**BONN-1668.** **A.D. 130**

Truncated wooden pole, in gate of antique fort, beside 2 Sasanidic fire temples. Samples coll. and subm. 1971 by U. W. Hallier, Inst. Bot., Düsseldorf Univ. *Comment*: dates agree with expectations.

### Netherrhine series

Dates different buildings or parts of buildings of Burg Meer, Meerbusch-Büderich, Kreis Grevenbroich as part of regional study by Dr. Janssen, Rheinisches Landesmus. Bonn, (51° 16′ N Lat, 6° 41′ E Long).

**1130 ± 70**
**BONN-1673.** **A.D. 820**

Burning relics of wooden Building VI, 120cm below surface.

**1130 ± 70**
**BONN-1674.** **A.D. 820**

Roof cover, oak wood, Building III.

**910 ± 70**
**BONN-1675.** **A.D. 1040**

Palisade pole, layer younger Period B.

**1100 ± 70**
**BONN-1676.** **A.D. 850**

Slice of oak tree, layer younger Period B.

**1090 ± 70**
**BONN-1677.** **A.D. 860**

Roof cover, oak wood, Building III.

**1140 ± 80**
**BONN-1678.** **A.D. 180**

Burning relics, wooden Building V.

**BONN-1679.** **840 ± 80**
**A.D. 1110**

Wooden swimmer from fishing net.

**BONN-1680.** **1180 ± 70**
**A.D. 770**

Parts of oak wooden Boat III. Samples coll. and subm. 1971 by Dr. Janssen. *Comment*: estimated age of samples, 11 to 12th century, exceeded by measured dates, except for BONN-1675 and BONN-1679.

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[RADIOCARBON, VOL. 15, No. 2, 1973, P. 280-298]

# ISOTOPES' RADIOCARBON MEASUREMENTS X

JAMES BUCKLEY

TELEDYNE ISOTOPES, Westwood, New Jersey

## INTRODUCTION

The measurements presented below were made during 1970-71 by techniques described in R., 1968, v. 10, p. 246, and 1970, v. 12, p. 87. Errors associated with the de Vries effect and the uncertainty of the half-life are not included. In November 1971 a new low level, quartz-lined 1/2L counter designed by M. Stuiver was put into operation. It has allowed routine measurements with the samples representing 500mg to 1g pure carbon.

## ACKNOWLEDGMENTS

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## SAMPLE DESCRIPTIONS

### I. GEOLOGIC SAMPLES

### *A. United States*

**10,980 ± 190**
**I-5872. La Nacion Fault, San Diego, California** **9030 B.C.**

Basal organic alluvium offset by La Nacion Fault in Otay (32° 36′ N Lat, 117° 02′ W Long), San Diego, California. Maximum thickness of alluvium is 7m, upper 2 to 3m are unaffected by fault (Artim and Pickney, mss. in preparation). Coll. and subm. 1971 by E. R. Artim, Woodward-Gizienski Assoc., San Diego, California. *Comment* (E.R.A.): fault mapped through 32km and shows vertical displacement of at least 65m since deposition of mid-Pleistocene sediments.

**2100 ± 95**
**I-4492. Long Greek L-4-1, Mississippi** **150 B.C.**

Cypress wood from Long Creek (34° 11′ 43″ N Lat, 90° 0′ 19″ W Long), ca. 5.6km SW of Pope, SE ¼, Sec.23, T.10S, R.8W, Panola Co., Mississippi. From log at base of old channel filling, exposed at water level in right cut bank, 6m depth from top of bank. Coll. and subm. 1969 by S. C. Happ and G. S. Stanford. *Comment* (S.C.H.): date indicates approx. age of 5m flood-plain sediment, capped by dark topsoil that was at surface when country was settled ca. 1840.

**10,230 ± 150**
**I-5843. Carter-1, Ohio** **8280 B.C.**

Wood (*Picea* sp.) from peat layer in Drake Co. (40° 12′ N Lat, 84° 40′ W Long) Ansonia, Ohio. Assoc. with mastodon rib and adjacent to bones from the moose-elk (*Cervalces scotti Lydekker*), ca. 1.5m below datum plane. Coll. and subm. 1971 by R. S. Mills, Dayton Mus. Nat. Hist.

**Dry Cave series, New Mexico**

Samples from Dry Cave, Eddy Co., SE 1/4, Sec.22, T.22S, R.24E, NMPM (32° 22′ 25″ N Lat, 104° 28′ 55″ W Long), New Mexico. Alt. 1400m (Harris, 1970; Holman, 1970; Metcalf, 1970). Coll. and subm. 1971 by A. H. Harris, Univ. Texas at El Paso.

**I-6199. A.H.H. 5104** **3135 ± 165**
**1185 B.C.**

Charcoal flecks from 80 to 100cm depth, Grid A in entrance deposits. *Comment* (A.H.H.): human remains at ca. 2.75m depth and Pleistocene-Recent contact ca. 3.5m.

**I-6200. S.M.B. 94** **10,730 ± 150**
**8780 B.C.**

Collagen from *Bison* and *Equus* bones in youngest deposits in a closed sink. Assoc. with camel and microtine rodent remains.

**I-6201. Charlies Parlor** **15,030 ± 210**
**13,080 B.C.**

Bone collagen from entrance fissure ca. 7m depth. *Comment* (A.H.H.): dates opening of entrance fissure and beginning of deposition from outside cave.

**Continental shelf series, New York**

Peat from inner continental shelf S of Long Island, New York. Coll. 1968 by Alpine Geophysical Assoc. for Coastal Engineering Res. Center, U.S. Army Corps of Engineers, Washington, D.C.; subm. 1971 by N. Kumar.

**I-5880. CERC-C 73B** **7585 ± 125**
**5635 B.C.**

From peat bed 15cm thick in Core 73 (40° 44′ 36″ N Lat; 72° 45′ 22″ W Long), 1.55m below water/sediment interface.

**I-5881. CERC-C 67F** **7750 ± 125**
**5800 B.C.**

From peat bed 5cm thick in Core 67 (40° 39′ 45″ N Lat, 73° 00′ 06″ W Long), 4.5m below water/sediment interface.

*General Comment* (N.K.): peat formed in tidal marsh when sea level was −16m. Dates indicate that, during the last 7500 yr as sea level rose, the Long Island chain of barriers migrated landward at least 2.4km (Kumar and Sanders, 1970).

**I-5503. Lost Creek Dam site, Oregon** **6930 ± 115**
**4980 B.C.**

Sycamore (*Platanus racemosa*) from Lost Creek Dam site (42° 41′ N Lat, 122° 40′ W Long), NE 1/4 NW 1/4 SE 1/4, Sec.23, T.33S, R.IE, Jackson Co., Oregon. From 21m depth in gleyed boulder clay, beneath

14m Mazama pumice and 7m of cinder-ash. Coll. 1970 by R. C. Herriman, A. J. Gerig, and R. B. Parsons; subm. 1970 by R. B. Parsons, USDA Soil Conservation Serv., Corvallis, Oregon. *Comment* (R.B.P.): date is maximum for Alco soil, possible minimum for Carney-like soil, and several episodes of geomorphic interest.

*B. Canada*

**Cowichan Head series, British Columbia**

Marine shells (incl. *Nucula* and *Macoma*) from exposure ca. 26m above high-tide level in cliff face, W shore Cordova Channel (48° 34′ N Lat, 123° 22′ 30″ W Long), ca. 3.1km S of Cordova Spit, Saanich Peninsula, British Columbia. From 8.3m layer blue-gray glacio-marine clay (lowest unit of Quadra sediments). Coll. and subm. 1969 by H. D. Foster, Univ. Victoria.

**I-4452. (I) 0.2m from top of clay bed** — **33,750 ± 2000** / **31,800 B.C.**

**I-4453. (II) 0.9m from top of clay bed** — **34,900 ± 2300** / **32,950 B.C.**

*General Comment* (H.D.F.): confirms presence of Quadra intertill sediments on Saanich Peninsula. Elsewhere in area similar poorly varved glacio-marine sediments overlie Dashwood tills. If varves are annual, Dashwood Glaciation of S Vancouver I. must have terminated ca. 41,200 yr B.P. (Armstrong *et al.,* 1965; Fyles, 1963).

**I-5921. Bagotville, Quebec, Canada** — **8550 ± 140** / **6600 B.C.**

Marine shells (*Mya arenaria*) from fresh cut in terrace 1m below surface, Bagotville (Grand-Anse) (48° 19′ 10″ N Lat, 70° 50′ 25″ W Long), Chicoutimi Co., Quebec, Canada. From intertidal sand and mud overlying marine gray clay, many shells *in situ.* Coll. 1969 and subm. 1971 by J. C. Dionne, Laurentian Forest Research Center, Quebec, Canada. *Comment* (J.C.D.): date valuable for last phase of marine invasion of Lake St. Jean (LaSalle, 1965; LaSalle and Rondot, 1967).

**I-5922. Saguenay River, Quebec, Canada** — **10,400 ± 150** / **8450 B.C.**

Marine shells (*Macoma balthica*) from fresh road cut along main road between Todoussac and Chicoutimi-nord (48° 11′ 50″ N Lat, 69° 43′ 35″ W Long), Sacre-Coeur-de-Saguenay, Saguenay Co., Quebec, Canada. From marine varved clay 8m below surface. Coll. 1970 and subm. 1971 by J. C. Dionne. *Comment* (J.C.D.): postglacial marine submergence of area of Tadoussac is known to have reached 140m; hence date is minimum for marine invasion (LaSalle, 1965; LaSalle and Rondot, 1967).

*C. Ecuador*

**I-6043. El Junco 5, Galapagos Islands, Ecuador >34,000**

Organic gyttja core sample from Crater lake, El Junco, on Isla San Cristobal (Chatham) (0° 5′ S Lat, 89° 35′ W Long), Galapagos Is., Ecuador. From band of organic material 0.5m thick, 8.5m from top of 15.4m core. Red clay lies above and below organic layer. Coll. 1966 by P. A. Colinvaux; subm. 1971 by E. K. Schofield, Ohio State Univ., Columbus, Ohio. *Comment* (E.K.S.): pollen and spore content show presence of water plants not now known on islands. We postulate that these plants became extinct during 20,000 yr drought (Colinvaux, 1968; 1971; Schofield and Colinvaux, 1969).

**I-6044. Livingstone I, Galapagos Islands, Ecuador 6615 ± 110**
**4665 B.C.**

Organic gyttja (black) from Livingstone I, Bog 4, Isla Santa Cruz (0° 40′ S Lat, 91° 22′ W Long), Galapagos Is., Ecuador. From domed *Sphagnum* bog at base of crater near summit of island, depth 105 to 109cm, from 1st sec. of gyttja under 90cm *Sphagnum*. Coll. 1966 by P. A. Colinvaux; subm. 1971 by E. K. Schofield. *Comment* (E.K.S.): 1 of 4 bogs sampled in same area. Pollen and spores were counted and data is being analyzed to produce model of bog formation in an equatorial site (Colinvaux, 1968).

*D. Europe*

**I-5116. Abernethy Forest, Carn a' Chnuic 685 ± 90**
**Soil Profile III A.D. 1265**

Fine fraction of raw humus (Mor) from Abernethy Forest, Inverness-shire (57° 12′ 30″ N Lat, 3° 37′ W Long), Scotland. At H/F2 contact of podsol beneath open callunetum (heathland). Coll. 1968; subm. and pretreated 1970 by P. O'Sullivan, Dept. Geog., New Univ. Ulster, Ireland. *Comment* (P.O'S.): pollen analyses at this level indicate site supported open heath. Another date from site indicates heath was established at ca. A.D. 600 (UB-395: R., v. 13, p. 116). Sample part of study of dynamics of Scots Pine forest.

**I-5117. Abernethy Forest, Faesheallach Burn 1505 ± 150**
**soil profile A.D. 445**

Charcoal from Abernethy Forest, Inverness-shire (57° 12′ N Lat, 3° 34′ 30″ W Long), Grid Ref. NJ (38) 053143, Scotland. From mineral horizon of podsol at depth 24cm. Coll. 1969; subm. and pretreated 1970 by P. O'Sullivan. *Comment* (P.O'S.): pollen analyses of mineral horizon containing sample indicate existence of birch-dominated woodland.

**I-5069. W Preston, Kirkcudbrightshire, Scotland 1850 ± 95**
**A.D. 100**

Peat from base of low cliff N shore Solway Firth, 1km S of W Preston farm, Nat. Grid Ref. NX 952 553 (54° 53′ N Lat, 03° 38′ W Long), Kirkcudbrightshire, Scotland. From basal 5cm of 1m thick peat bed, underlain by sand. Coll. 1966 and subm. 1970 by W. G. Jardine, Univ. Glasgow, Scotland. *Comment* (W.G.J.): date is minimum for formation of lowest raised marine terrace of area.

**4000 ± 100**
**I-5513. Moss of Cree, Wigtownshire, Scotland 2050 B.C.**

Wood from Moss of Cree, 500m S of Carsenestock farm, Wigtownshire (54° 55′ N Lat, 4° 25′ W Long), Nat. Grid Ref. NX445 614, Scotland. From edge of truncated peat bog at junction of peat and underlying gray carse deposits, 8.35m above Newlyn. Coll. and subm. 1970 by W. G. Jardine. *Comment* (W.G.J.): dates local commencement of peat growth and minimum age for end of Flandrian marine transgression in Wigtown Bay area (I-5070: 4290 ± 100, unpub., for Dumfriesshire coast of Solway Firth).

**6325 ± 120**
**I-5514. Carseminnoch, Scotland 4375 B.C.**

Wood from N bank R. Cree, 500m S of Carseminnoch farm, Kirkcudbrightshire (54° 56′ N Lat, 04° 26′ W Long), Scotland. From outer layers of tree branch embedded in estuarine laminated sand and silt, 4.30m above Newlyn. Coll. 1967 and subm. 1970 by W. G. Jardine. *Comment* (W.G.J.): age agrees with Q-639, (6159 ± 120: R., v. 4, p. 60) at Newton Stewart, 3km WNW, 4.26m and BIRM-189, (6240 ± 240: R., v. 13, p. 144) at Palnure, 1km NE, 6.38m and substantiates chronology suggested by Shotton (R., v. 13, p. 144-145).

*E. Greenland*

**Erfalik series, West Greenland**

Shells (*Mya truncata*) from Erfalik, S side of entrance to Ikertoq Fjord (66° 25′ N Lat, 53° 37′ W Long) W Greenland. Coll. 1967 and subm. 1970 by A. Weidick, Geol. Survey Greenland, Copenhagen, Denmark.

**7010 ± 125**
**I-5415. No. 88962 5060 B.C.**

From shell horizon, +1.7m in 4 to 5m cliff of marine deposits. Other species include *Cardium echinatum, Tellina* sp., *Serripes groenlandicum.*

**8480 ± 130**
**I-5416. No. 88959 6530 B.C.**

From top of terrace of No. 88962, ca. +8m.

**Scoresby Sund series, East Greenland**

Shells from Scoresby Sund, East Greenland, dated to study relative sealevel changes and disappearance of some shellfish (Funder, 1971). Coll. and subm. 1970 by Svend Funder, Geol. Survey Greenland, Copenhagen, Denmark.

**21,020 ± 430**
**I-5419. Heden, Jameson Land, Scoresby Sund 19,070 B.C.**

*Mya truncata* from 50m cliff of gray marine silt (70° 46′ N Lat, 24° 07′ W Long) Heden. From +42 to 45m, some shells *in situ*. *Comment* (S.F.): area believed covered by ice during last glaciation. Older marine deposits above silt at 75m. It seems likely that great age of sample is result of mixing of interglacial material with postglacial shells. *Lab. Comment*: 62% of shell carbonate removed with acid washes before dating.

**24,300 ± 700**
**I-5419C. Resample of I-5419 22,350 B.C.**

*Lab. Comment*: 37% of shell removed with acid washes before dating.

**6650 ± 125**
**I-5420. Edge of Eielson Gletscher 4700 B.C.**

*Mya truncata, Hiatella arctica,* and *Macoma calcarea* at edge of Eielson Gletscher, Rypefjord, (71° 09′ N Lat, 27° 50′ W Long). From gray silt +30m, containing fragments of *Mytilus edulis*. *Comment* (S.F.): dates time when terminus of Eielson Gletscher was upstream from its present limit and presence of now-extinct *Mytilus* in area. *Lab. Comment*: 69% of shell removed with acid washes before analysis.

**7140 ± 130**
**I-5421. North shore of Harefjord 5190 B.C.**

*Mya truncata* from N shore (70° 57′ N Lat, 28° 09′ W Long) Harefjord. From surface of silt layer, +42 to 46m. *Comment* (S.F.): believed to date relative sea level at +50m, the local marine limit. *Lab. Comment*: 60% of shell removed with acid washes before dating.

**6450 ± 120**
**I-5422. Moraenepynt in Fønfjord 4500 B.C.**

*Mya truncata* and *Hiatella arctica* from (70° 25′ N Lat, 27° 49′ W Long) Moraenepynt. From surface of silt, +20 to 22m. Fragments of now extinct *Mytilus edulis* found in deposit. *Comment* (S.F.): probable date of marine shoreline at +25m. *Lab. Comment*: 55% of shell removed by acid washes before dating.

**6840 ± 125**
**I-5423. Elvdalen, Denmark 4890 B.C.**

*Mya truncata, Hiatella arctica, Astarte borealis,* and *Astarte elliptica* from (70° 27′ N Lat, 26° 12′ W Long) Elvdalen. From surface of silt, +1.5 to 3m. Fragments of *Mytilus edulis,* now extinct in area, were present. *Comment* (S.F.): shells may be related to a boulder shoreline at +6m. *Lab Comment*: 63% of shell removed by acid washes before dating.

**Frederick E. Hyde Fjord series, North Greenland**

Driftwood from Frederick E. Hyde Fjord, Peary Land (83° 05′ N Lat, 32° 15′ W Long), N Greenland. Wood id. by J. D. Møller, Bot. Inst., Univ. Copenhagen. Coll. 1969 by P. Dawes, subm. 1970 by A. Weidick.

**I-5591. GGU No. 100658** — **1935 ± 90**, **A.D. 15**

*Picea* sp. partially buried in gravel beach ridge +15.1m.

**I-5592. GGU No. 100659** — **4645 ± 115**, **2695 B.C.**

*Picea* sp. partially buried in gravel beach ridge + 15.1m.

**I-5593. GGU No. 100660** — **4815 ± 115**, **2865 B.C.**

*Larix* sp. partially buried in gravel beach ridge 18.5m above mean sea level.

*General Comment* (A.W.): dated for relative sea level changes.

*F. Africa*

**Nakuru Basin series, Kenya**

Charcoal and carbonate samples from S of Lake Nakuru, Kenya. Three sedimentary units (A, B, and C) deposited during large expansions of Lake Nakuru. They are separated by 2 widespread disconformities (Washbourn, 1967; Washbourn-Kamau, 1970). A prolonged period of low lake level separate Units A and B. Unit A includes evidence of 3 high lake stands. The area is type for "Gamblian Pluvial" and "Makalian and Nakuru post Pluvial" wet phases (Leaky, 1931), but relationship between climatostratigraphic divisions and lithostratigraphic units is still not clear. Coll. and subm. 1969-1970 by G. L. Isaac and Univ. Calif., Berkeley.

**I-5062. Base of Unit B** — **12,160 ± 170**, **10,210 B.C.**

Charcoal from Site GsJi 2/T, Enderit Drift near Elmenteita (0° 31′ S Lat, 36° 05′ E Long). A rubble lens of occupational debris interstratified with lacustrine deposits at base of most recent 185m high lake episode. Assoc. industry includes backed blades and very delicate obsidian awls. *Comment* (G.L.I.): date agrees closely with N-822 (R., v. 14, p. 228).

**I-5063. Lacustrine member, Unit A** — **21,030 ± 420**, **19,080 B.C.**

Lobate and botryoidal carbonate concretions 20 to 40m diam. from Makalia Bend Drift (0° 29′ 30″ S Lat, 36° 05′ 30″ E Long). Concretions may be contemporaneous with surrounding clay or secondary. Adjacent outcrops yielded "Middle Stone age" artifacts.

**I-5064. Lacustrine strata in Unit B** **3810 ± 110**
**1860 B.C.**

Lobate and branching carbonate concretions up to 25mm diam. from S of Makalia Bend (0° 29′ 30″ S Lat, 36° 05′ E Long). From poorly consolidated siltstones with hematitic laminae traceable to 153m above existing lake. Underlies Makalia ash dated at 3540 ± 120, N-821 (R., v. 14, p. 227). *Lab. Comment*: 50% of sample removed with acid washes before dating.

**I-5064C. Split of I-5064** **3400 ± 100**
**1450 B.C.**

*Lab. Comment*: 45% of sample removed with acid washes before dating. *Comment* (G.L.I.): stratum correlates with Gambles Cave high stand for Lake Nakuru but date appears too young. Carbonate concretions could be secondary emplacements.

**I-5447. East Rudolf, Kenya (ER 70-06a-0000)** **9360 ± 135**
**7410 B.C.**

Shell (*Unio, Corbicula, Melanoides*) from 8km SSE of Ileret Police Post, Marsabit Dist., E Region (04° 15′ N Lat, 36° 14′ E Long), Kenya. From ca. 2km E of present shoreline of Lake Rudolf represents stand 60m above existing lake. Coll. and subm. 1970 by G. D. Johnson, Dartmouth Coll., Hanover, New Hampshire. *Comment* (G.D.J.): air photos show continuity of deposit along NE shore. Unit correlates with number IVa Kibish Fm., Lower Omo Basin, Ethiopia (Butzer and Thurber, 1969; Leaky, 1970; Vondra, 1971).

### G. *Australia*

**Lake Callabonna series, South Australia**

Samples from SE portion of Lake Callabonna (29° 48′ S Lat, 140° 10′ E Long), S Australia. Coll. 1970 by C. Ray and R. Emry; subm. 1971 by R. H. Tedford, Am. Mus. Nat. History, N.Y.

**I-5479. SIAM 86** **>39,900**

Wood from base of laminated clay containing *Diprotodon* and other large vertebrates. Disarticulated skeletons of giant wombat (*Phascolonus*) and extinct kangaroo (*Protemnodon*) found *in situ* in immediately overlying clay (Stirling and Zietz, 1899). *Comment* (R.H.T.): date confirms NZ-205 (>40,000) from plant remains in abdominal region of *Diprotodon* skeleton and contradicts date of NZ-206 from *Diprotodon* dentine (R., 1963, v. 5, p. 143).

**I-5733. SIAM 28** **2375 ± 95**
**425 B.C.**

Bulk sample of disseminated charcoal in sand, not treated for removal of humic acids. From a succession of gypsiferous clay and sand lenses disconformably overlying *Diprotodon*-bearing clay of I-5479.

**I-5730. SIAM 25** **2080 ± 100**
**130 B.C.**

Carbonate portion of egg shell from nesting site for shore birds, same horizon as I-5733. *Lab. Comment*: outer 23% of shell removed with acid washes before dating.

## II. ARCHAEOLOGIC SAMPLES

### *A. United States*

**Nunivak Island series, Alaska**

Charcoal and wood from Nunivak I., W bank Mekoryuk R. (60° 15′ N Lat, 166° 8′ W Long), ca. 4.8km S of Mekoryuk, Alaska. Coll. and subm. 1969 and 1970 by M. Nowak (except where noted), Dept. Anthropol., Colorado College (Nowak, 1970).

**I-4485. MK2—Housepit 2, Level 1** **310 ± 95**
**A.D. 1640**

Charcoal from floor of Housepit 2, Level 1, .84 to .87m depth. *Comment* (M.N.): dates most recent of 3 recognizable occupations. Assoc. artifacts represent Norton-like culture.

**I-4486. MK2—Housepit 1, Level 8** **1925 ± 95**
**A.D. 25**

Charcoal from floor plank of Housepit 1, Level 8, 1.58m depth. *Comment* (M.N.): assoc. artifacts from Norton-like culture.

**I-4487. MK4—Housepit 2, Level 4** **670 ± 95**
**A.D. 1280**

Charcoal from floor of only house in Housepit 2, Level 4, .80 to .87m depth. *Comment* (M.N.): assoc. artifacts indicate Nukleet-like culture.

**I-4488. MK2—Housepit 1, Level 9** **2100 ± 95**
**150 B.C.**

Wood from 1 of 4 structural posts in Housepit 1, Level 9, 1.80m depth. *Comment* (M.N.): date of house probably younger due to use of driftwood in building. Assoc. with Norton-like materials.

**I-5303. MK2—Housepit 1-D, Level 2** **1360 ± 95**
**A.D. 590**

Charcoal from Housepit 1-D, Level 2, 1.35 to 1.40m depth. *Comment* (M.N.): date indicates time of change from fiber-tempered, to later sand-tempered, check-stamped pottery. Artifacts indicate Norton-like culture.

**I-5304. MK4—Housepit 6, Level 4** **955 ± 90**
**A.D. 995**

Charcoal from floor of house in Housepit 6, near hearth at 1.10m depth, Level 4. Coll. 1970 by J. Anderson. *Comment* (M.N.): dates house of Nukleet-like culture.

**9130 ± 130**
**I-6304. Ground Hog Bay—Site #2, Alaska 7180 B.C.**

Charcoal from Ground Hog Bay, Icy Strait area (58° 14′ N Lat, 135° 15′ W Long), W of Juneau, Alaska. From depression in reddish sands overlying till of terminal Wisconsin, depth 220 to 224cm below datum. Assoc. with lithic debitage. Coll. 1971 by D. Brauner; subm. 1972 by R. E. Ackerman, Washington State Univ., Pullman, Washington. *Comment* (R.E.A.): dates occupation of area in early Holocene times, soon after general glacial retreat. This is oldest dated horizon for SE Alaska (Ackerman, 1971).

**1350 ± 95**
**I-5938. Mrn—170 #2, California A.D. 600**

Adult human femur from near town of Ignacio (38° 04′ 25″ N Lat, 122° 32′ W Long), ca. 37km N of San Francisco, 0.8km N of Hamilton Air Force Base, California. From 120cm below present ground surface lying on sterile bedrock. From tightly flexed burial assoc. with *Olivella* modified saddle-type beads, red ocher, steatite ear plug, bone "wand" and large incised and perforated *Haliotis* ornaments (Burial #108-120) (Henn and Jackson, mss. in preparation). Coll. 1971 by W. Henn and T. L. Jackson; subm. 1971 by M. J. Moratto, Treganza Anthropol. Mus., San Francisco State College.

**Shantok Cove series, Connecticut**

Charcoal from Stantok Cove site (41° 28′ 50″ N Lat, 72° 4′ 38″ W Long), Fort Shantok State Park, Montville, New London Co., Connecticut. A multi-component site excavated 1967 to 1970 by field parties from New York Univ. Coll. and subm. B. Salwen, N.Y.U. Dept. Anthropol., N.Y.

**1110 ± 95**
**I-5615. Shantok Cove, base of midden A.D. 840**

From concentration of dark earth and small charcoal fragments ca. 30cm depth, at base of 15cm thick shell midden zone. Early Windsor pottery recovered in immediate vicinity.

**1035 ± 150**
**I-5616. Shantok Cove, midden A.D. 915**

From above and adjacent to 2.5cm thick ash layer, ca. 10cm above base of thick midden zone. Depth 25cm.

**845 ± 125**
**I-5617. Shantok Cove, Feature 7 A.D. 1105**

From lowest part of Feature 7, a pit, originating in mottled earth "living floor" adjacent to shell midden. Floor depth 27cm, pit extended down 27cm into sandy orange subsoil, containing ca. ¼ ceramic vessel previously unrecognized in this area. The new type, Shantok Cove Incised, has straight sides, interior brushing, exterior fabric-marking, and incised decoration in geometric patterns. This type assoc. in midden with

Early Windsor pottery. *Comment* (B.S.): date may indicate that new-type pottery continued in use longer than others.

**I-5618. Shantok Cove, Fireplace A** **1190 ± 115**
**A.D. 760**

From small hearth, marked by red burned sand in orange sand zone directly below shell midden, depth 27cm. No assoc. artifacts.

*General Comment* (B.S.): dates form consistent series of occupation of oyster-shell midden zone, marked by presence of Levanna projectile points, Early Windsor pottery types, and newly identified Shantok Cove Incised pottery. First RC dates for Early Windsor complex of S Connecticut and Long Island.

**Oahu Island series, Hawaii**

Charcoal from 14.1km from S coast of Oahu I., Hawaii; upper section of Kamana-nui Valley, Moanalua. Valley runs N-S on S side of island (Ayres, 1970). Coll. and subm. 1970 by W. S. Ayres, Bernice P. Bishop Mus., Honolulu.

**I-5269. Site 50-0A-A7-41** **445 ± 90**
**A.D. 1505**

From firepit, 22cm depth. *Comment* (W.S.A.): dates use of firepit at time preceding construction of stone shrine. Shrine consisted of small paved area with one upright stone.

**I-5270. Site 50-0A-A7-45** **<185**

From layer of scattered fragments of charcoal within layer of mixed clay and pebbly decomposing rock. Beneath superficial wall of low terrace, depth 20 to 40cm. *Comment* (W.S.A.): dates utilization of area for swidden type agriculture before low terrace was built.

**I-5271. Site 50-0A-A7-66** **335 ± 90**
**A.D. 1615**

From thin layer of charcoal and burned earth, 23cm depth. *Comment* (W.S.A.): date reflects use of firepit assoc. with walled house site.

**I-5272. Site 50-0A-A7-24** **410 ± 90**
**A.D. 1540**

From firepit, 39cm depth near suspected floor level of house structure. *Comment* (W.S.A.): date within predicted age range for use of low-walled house structure on terrace.

**Henderson Island series, Hawaii**

Charcoal from Henderson I. (24° 25′ S Lat, 128° 19′ W Long), Hawaii. Coll. 1970 and 1972; subm. 1972 by Y. H. Sinoto, Bernice P. Bishop Mus., Honolulu, Hawaii.

**I-6343. HENRC-6** **495 ± 105**
**A.D. 1455**

From Test Pit 7, 18 to 21cm depth, top Layer II. Coll. 1970.

**I-6344. HENRC-8** **790 ± 110**
**A.D. 1160**

From Test Pit 7, 50cm depth in Layer III. Coll. 1972.

*General Comment* (Y.H.S.): 1st dates on Henderson site. Evidence of Polynesian occupation prior to European discovery of island.

**Loyola Retreat series, Maryland**

Charcoal from Loyola Retreat oyster shell midden, Site 18CH58, on bank of Potomac R. between mouth of Port Tobacco R. and Popes Creek (38° 25′ 02″ N Lat, 77° 02′ W Long), Charles Co., Maryland. Coll. and subm. 1970 by W. M. Gardner and C. W. McNett, Jr., Catholic Univ. America, Washington, D.C.

**I-5246. Loyola I** **1135 ± 95**
**A.D. 815**

From lower portion of topmost of three cultural and natural levels. Assoc. with heavily shell-tempered pottery referred to as Mockley ware by R. L. Stephensen (1963).

**I-5247. Loyola II** **2440 ± 95**
**490 B.C.**

From middle of 2nd cultural and natural level. Assoc. with sand and grit-tempered, thick net-marked pottery called Popes Creek by W. H. Holmes (1903).

**I-5524. McCulley site, New York** **5730 ± 110**
**3780 B.C.**

Charcoal from McCulley site on Charlotte Creek (42° 27′ 31″ N Lat, 74° 53′ 15″ W Long), Davenport Twsp., Delaware Co., New York. Combined charcoal from 2 adjoining features in thin Archaic living floor, buried in alluvial silt below plow line. Assoc. artifacts included Otter Creek type points, end scrapers, net sinkers, hammerstones and pitted stones. Coll. 1970 by H. Hoagland and R. E. Funk; subm. 1971 by R. E. Funk, New York State Mus. and Sci. Service. *Comment* (R.E.F.): date close to age anticipated for Otter Creek Points on basis of stratigraphic data (Funk, 1965).

**I-5987. Stalag 17, Dry Cave, New Mexico** **11,880 ± 250**
**9930 B.C.**

Charcoal from Stalag 17, Dry Cave, (32° 22′ 25″ N Lat, 104° 28′ 55″ W Long), SE 1/4 Sec. 22, T.22S, R.4E, NMPM, SE New Mexico. From flecks gathered ca. 3.8 to 4.0m below surface of entrance deposits. Coll. and subm. 1971 by A. H. Harris. *Comment* (A.H.H.): assoc. with limb elements of *Camelops* (Harris, 1970).

*B. Canada*

**I-4973. Narrows site (KeNo-2), Canada** **880 ± 130**
**A.D. 1070**

Bone collagen from E end Great Slave Lake, N.W.T. (62° 47″ N Lat, 108° 56′ W Long) Canada. From buried hearth, 35cm depth, in 2nd highest terrace on old delta formation. Cultural zones lie 8m above present level of Great Slave Lake. Coll. and subm. 1969 by W. C. Noble, Dept. Anthropol., McMaster Univ., Hamilton, Ontario. *Comment* (W.C.N.): Narrows site is middle period component of Taltheilei Shale tradition, which terminates with historic Yellowknife Indians. Date complements GAK-1258, A.D. 940 (unpub.)

**1565 ± 90**
**I-5821. Waldon River (KfNt), Canada** **A.D. 385**

Charcoal from N shore McLeod Bay (62° 56′ 15″ N Lat, 110° 35′ W Long), NE Great Slave Lake, W shore of entrance of Waldon R., Canada. From buried hearth, depth 13cm from rock hollow of Area A. Coll. 1968 and subm. 1971 by W. C. Noble. *Comment* (W.C.N.): assoc. artifacts of Waldon R. complex of Taltheilei Shale tradition (Noble, 1971b).

**740 ± 160**
**I-5822. Taltheilei Point (KdNw-2), Canada** **A.D. 1210**

Charred spruce twigs and charcoal from point jutting from bay forming NW short of Talheilei Narrows (62° 35′ 45″ N Lat, 111° 32′ W Long), E Great Slave Lake, Canada. Depth 13cm on Beach 14, in series of 14 former beach terraces rising above lake. Area disturbed by erection of former Geol. Survey Canada cabins. Coll. 1968 and subm. 1971 by W. C. Noble. *Comment* (W.C.N.): much charcoal suggests forest fire rather than hearth burning. Surrounding artifacts are typologically earlier, belonging to Waldron R. complex of Taltheilei Shale tradition (Noble, 1971b).

**790 ± 120**
**I-5823. Pethei Peninsula (KdNw-4), Canada** **A.D. 1160**

Charcoal and burnt twigs from 1.3m diam. hollow, 17 to 20m above lake level on N side of rock butte of Pethei (Owl) Peninsula (62° 36′ N Lat, 111° 31′ W Long), diagonally across Taltheilei Narrows, E Slave Lake, Canada. Coll. 1968 and subm. 1971 by W. C. Noble. *Comment* (W.C.N.): dates former forest fire, date in close accord with I-5822 (this list) from Taltheilei Point (Noble, 1971b).

**410 ± 90**
**I-6514. Cleveland site (AhHb-7), Canada** **A.D. 1540**

Charcoal from Cleveland site (43° 12′ 30″ N Lat, 80° 12′ 45″ W Long), 4 acre village, overlooking Fairchild Creek, Lot 46, Con. 1 of Brantford Twp., Brant Co., Ontario, Canada. From Pit 14 within longhouse in Area E, at 23cm depth. Coll. 1971 and subm. 1972 by W. C. Noble. *Comment* (W.C.N.): first RC date of Neutral Iroquois village in SW Ontario, presence of small iron bar celt and 4 brass beads place it within early protohistoric period (Noble, 1971a).

## *C. Central and South America*

**I-6107. Maya Codex** **720 ± 130**
**A.D. 1230**

Bark paper from several unpainted pages attached to a Maya codex of unknown provenience. Coll. and subm. 1971 by M. D. Coe, Yale highest terrace on old delta formation. Cultural zones lies 8m above Univ., New Haven, Conn. *Comment* (M.D.C.): codex consists of 11 pp. of a Venus calendar which originally had 20 pp. Date congruent with painting style of codex, which is Post-Classic Maya with strong Mixtec influence. Style of day glyphs suggests it can be chronologically placed between Dresden codex and the Madrid codex, a 13th century date is highly probable. The manuscript provides new data about the gods presiding over different parts of the Venus cycle. Radiocarbon date confirms its authenticity as 4th Maya codex to survive from pre-Spanish times.

**Tlapacoya series, Mexico**

Charcoal from Zohapilco (19° 17′ 55″ N Lat, 98° 54′ 34″ W Long), Tlapacoya, Mexico. Coll. 1969 C. B. Niederberger; subm. 1970 by J. L. Lorenzo, Inst. Nac. Antropol. Historia, Moneda, Mexico.

**I-5241. Tlapacoya IV, A-14, VIIb** **2595 ± 100**
**645 B.C.**

From lakeside part of Zohapilco trench (Pit A-4), uppermost layer of clay and organic material, (Gen. Layer 7), below sandy lenses (Gen. Layers 5 and 6) (Niederberger, 1969).

**I-5242. Tlapacoya IV, AA-25, VIIIb** **2990 ± 100**
**1040 B.C.**

From hillside part of Zohaplico trench in lower middle part of thick sediment of sand with numerous stones of andesite (Gen. Layers 8 and 9).

**I-5243. Tlapacoya IV, AA-25, Vb** **3005 ± 100**
**1055 B.C.**

From hillside Zohaplico trench (Pit AA-25) with layer of sandy textured sediment (Gen. Layer 5) and clay lenses.

*General Comment* (J.L.L.): dates for I-5241 and I-5242 agree well with relative position of sediment within stratigraphic sequence and with cultural context. I-5243 is too old, does not fit sequence.

**Casita de Piedra series, Panama**

Charcoal from Casita de Piedra site, close to confluence of Rio Casita de Piedra and Rio Chiriqui (8° 47′ N Lat, 82° 17′ W Long), alt. 700m, Dist. Boquete, Prov. Chiriqui, Panama (de Sapir and Ranere, 1971).

**I-6278. #119** **6560 ± 120**
**4610 B.C.**

From lowest stratum which contained evidence of human occupation, Layer G, 130 to 140cm depth. Charcoal was scattered throughout occupation layer and not from an identifiable hearth. Coll. 1971 and subm. 1972 by A. J. Ranere, Smithsonian Tropical Research Inst., Balboa, Canal Zone. *Comment* (A.J.R.): dates earliest preceramic occupation.

**5795 ± 105**
**I-5765. #115** **3845 B.C.**

From base of Layer E, 100 to 110cm depth. Charcoal scattered in 1 x 1m excavation unit (Block 6) in level 10cm thick. Coll. 1971 and subm. 1972 by A. J. Ranere. *Comment* (A.J.R.): dates 2nd preceramic occupation.

**5680 ± 105**
**I-5764. #107 and 114 combined** **3730 B.C.**

From lowest stratum which contained evidence of human occupation, Layer G, 130 to 160cm depth, Block 5 (1 x 2m). Charcoal scattered throughout excavation unit was combined with charcoal from pit which appeared to originate in Layer G and extend below it. Coll. and subm. 1971 by A. J. Ranere. *Comment* (A.J.R.): date in closer agreement with date for Layer E (I-5675, this list) indicating that pit originated from Layer E instead of Layer G.

*D. Ireland*

**5250 ± 110**
**I-5067. Sutton Kitchen-midden, Co. Dublin** **3300 B.C.**

Charcoal from hearth in shell-midden at ca. 6m, Burrow Townland (53° 23′ N Lat, 6° 5′ W Long), Sutton, Co. Dublin, Ireland. Coll. and subm. 1970 by G. F. Mitchell, School Bot., Trinity College, Dublin. *Comment* (G.F.M.): midden contained both implements of Mesolithic type and Neolithic polished stone axes (Mitchell, 1956). Midden lay on shore storm beach, presumably thrown up at maximum of postglacial marine transgression.

**Cushendun series, Antrim, Ireland**

Charcoal and peat from Cushendun archaeol. site (55° 8′ N Lat, 6° 2′ W Long), mouth of Dun R., Cushendun, Co. Antrim, Ireland. Coll. 1934 by K. Jessen and H. L. Movius; subm. 1970 by G. F. Mitchell.

**7670 ± 140**
**I-5134. Cushendun charcoal** **5720 B.C.**

Charcoal with bone and vegetable debris embedded in brackish water sandy estuarine silt at 2.40m in beach bar; silt below charcoal horizon contained Mesolithic flint implements (Mitchell, 1955). *Comment* (G.F.M.): date corresponds with another Mesolithic site at Toome Bay, Co. Londonderry, on shore of Lough Neagh, 50km SW Cushendun. Here charcoal with assoc. Mesolithic implements in a mud that accumulated in Boreal period, Pollen Zone VIb, had $C^{14}$ age of 7680 ± 110 yr B.P. (Y-95).

**I-5135. Cushendun peat** **8410 ± 140**
**6460 B.C.**

*Phragmites* peat at 2.15m lies below beach bar of estuarine silt and gravel built up to 11.50m; silt and gravel contains Mesolithic flint implements (Movius, 1940; Jessen, 1949). *Comment* (G.F.M.): date indicates that peat formed in fresh water in Boreal period, Pollen Zone VIb, before postglacial marine transgression flooded valley.

**I-5323. Rockmarshall Midden 3, Co. Louth** **5470 ± 110**
**3520 B.C.**

Charcoal from hearth in shell midden, Rockmarshall Townland (54° 0′ N Lat, 6° 15′ W Long), near Dundalk, Co. Louth, Ireland. Assoc. with Mesolithic implements, midden on top of low morainic ridge which formed part of shoreline at maximum of postglacial marine transgression (Mitchell, 1949). Coll. and subm. 1970 by G. F. Mitchell. *Comment* (G.F.M.): early Mesolithic material in NE Ireland is dated to ca. 5700 B.C. (Y-95; I-5134, this list), Mesolithic material on Leinster coast is later (D-38; I-5067, this list).

*E. Israel*

**Ein Aqev series, Israel**

Charcoal from 150m N of spring at Ein Aqev in branch wadi S of main Nahal Zin (30° 49′ 02″ N Lat, 34° 48′ 39″ E Long), Israel. Coll. 1970 and subm. 1971 by A. E. Marks, Dept. Anthropol., Southern Methodist Univ., Dallas, Texas.

**I-5494. E 22 D31/A** **16,900 ± 250**
**14,950 B.C.**

From hearths 15 to 20cm below surface.

**I-5495. E 22 D31/B** **17,510 ± 290**
**15,560 B.C.**

From 20 to 30cm below surface.

*General Comment* (A.E.M.): site contains Levantine-Aurignacian artifacts and dates indicate terminal phase of this culture in Central Negev.

**I-5496. E 22 G7/C Nahal Horesha, Israel** **13,090 ± 200**
**11,140 B.C.**

Charcoal from E edge of Nahal Horesha (30° 30′ 50″ N Lat, 34° 34′ 40″ E Long), E of Har Harif, Israel. From small pockets of midden deposit 25 to 40cm depth. Assoc. with lithic materials of Natufian affinity. Coll. 1970 and subm. 1971 by A. E. Marks.

**Har Harif Plateau series, Israel**

Charcoal from E edge Har Harif Plateau, central Negev (30° 31′ 32″ N Lat, 34° 33′ 08″ E Long), Israel. Alt. 1000m. Coll. 1970 and subm. 1971 by A. E. Marks.

**I-5498. E 22 G12/E** **9970 ± 150**
**8020 B.C.**

From 15 to 25cm below surface of midden deposit at Abu Salem site.

**I-5499. E 22 G12/F** **10,230 ± 150**
**8280 B.C.**

From 25 to 30cm below surface of midden deposit.

**I-5500. E 22 G12/G** **10,230 ± 150**
**8280 B.C.**

From 45 to 55cm below surface of midden deposit. Assoc. artifacts: ground stone, faunal remains, and small village with oval stone walls (Marks, in press). *Lab. Comment*: humic acid pretreatment abbreviated due to sample solubility and size.

**Midrasha Sde Boker series, Israel**

Charcoal from S and SE of Midrasha Sde Boker, Israel. Coll. 1970 and subm. 1971 by A. E. Marks.

**I-5501. E 22D1/H** **8620 ± 140**
**6670 B.C.**

From S edge of present stream bed of Nahal Zin (30° 50′ 30″ N Lat, 34° 47′ 13″ E Long). From charcoal lens 60 to 63cm below surface at base of fire pit. Assoc. with points, burins, denticulates, and faunal remains. *Comment* (A.E.M.): date disagrees with Tx-1123, 6220 ± 180 (unpub.) but correlates with other dates from similar assemblages.

**I-5497. E 22D5/D** **13,170 ± 230**
**11,220 B.C.**

From remnant 20m above N edge of present stream bed of Nahal Zin (30° 50′ 29″ N Lat, 24° 46′ 36″ E Long). Scattered small pieces of charcoal recovered over 5 sq.m. Assoc. with Kebaran assemblage of geometric type and small faunal remains (Marks, in press). *Comment* (A.E.M.): date suggests temporal overlap between Natufian-like assemblages and late Kebaran. Another small sample from same site dated 13,870 ± 1730 (Tx-1121, unpub.)

*F. India*

**I-6277. Sonkh excavation, Painted Grey Ware-level, India** **2570 ± 85**
**620 B.C.**

Charcoal from Sonkh, Mathura dist. (77° 22′ N Lat, 27° 26′ E Long) India. From Level 35, Sq. So 3 I 11, 50. Representing Painted Grey Ware-level (Hartel, 1968; 1969; 1970). Coll. 1971 and subm. 1972 by H. Hartel, Mus. Indische Kunst, Berlin, Germany. *Comment* (H.H.): date fits archaeologic results.

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[RADIOCARBON, VOL. 15, NO. 2, 1973, P. 299-302]

# INSTITUTE OF GEOLOGICAL SCIENCES RADIOCARBON DATES IV

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This date list was compiled by the Institute of Geological Sciences (U.K.) incorporating data supplied under contract by E. Welin, Radioactive Dating Laboratory, Stockholm. Unless otherwise stated, age figures are in $C^{14}$ years before A.D. 1950. The half-life of $C^{14}$ is taken as 5568 years and the error, based on counting statistics of sample, background, and modern, is given as one standard deviation. Correction for $C^{13}/C^{12}$ fractionation has not been made.

**Great Harrowden series, Northamptonshire**

Peat and organic soil from alluvium at Great Harrowden, Northamptonshire (52° 22′ N Lat, 0° 35′ W Long, Grid Ref. SP 875 695). Coll. 1970 and subm. by R. J. Chandler, Imperial College, London.

**11,980 ± 145**
**IGS-C14/69. (St 3685) 10,030 B.C.**

Alluvial sequence consisting of thin basal clayey gravel overlain by 1m bed gray organic silt with a peat layer, tufa, and calcareous sand. Sample from peat in upper part of organic silt bed some 2m below ground level.

**9435 ± 610**
**IGS-C14/70. (St 3695) 7485 B.C.**

Organic soil from top of organic silt bed, some 1.5m below ground level.

**1805 ± 100**
**IGS-C14/71. (St 3694) Prah Sands, Cornwall A.D. 145**

Peat exposed on foreshore at mean high water mark (50° 06′ N Lat, 5° 23′ W Long, Grid Ref. SW 578 280). Coll. 1970 and subm. by R. T. Taylor, Inst. Geol. Sci. Peat from layer 0.20 to 0.30m thick overlain by blown sand and resting on 0.30 to 0.50m dark brown sandy loam with plant fragments and scattered, small, well-rounded, quartz and country rock pebbles. Loam rests on head (solifluxion deposits) of unknown thickness. Peat horizon appears to have formerly extended below O.D. but has been removed by marine erosion. *Comment* (R.T.T.): dates peat younger than submerged forest horizons of Cornwall and Devon coasts (Welin, Engstrand, and Waczy, 1972, p. 331). An older peat horizon described by Reid and Reid (1904) from beneath the head at this locality is no longer exposed.

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**IGS-C14/72. (St 3692) Portmellon, Cornwall** **2345 ± 100** **395 B.C.**

Peat from depth 1.5m (0.3m below O.D.) in borehole (50° 16′ N Lat, 4° 47′ W Long, Grid Ref. SX 0160 4395). Coll. 1970 and subm. by E. C. Freshney, Inst. Geol. Sci. *Comment* (E.C.F.): peat forms part of infilling of one of drowned river mouths, common along S coasts of Devon and Cornwall. Probably related to other similar deposits around coast of SW England, e.g., Prah Sands in Cornwall.

**Dunston Common series, Norfolk**

Samples from borehole on Dunston Common near Norwich, Norfolk (52° 35′ N Lat, 1° 17′ E Long, Grid Ref. TG 2270 0267). Borehole proved 4.9m gravel deposited by R. Tas, overlying grayish-blue, lignitic, laminated clay, proved to depth 16.5m without reaching base. Coll. 1969 by A. R. Clayton and subm. by E. F. P. Nickless, Inst. Geol. Sci.

**IGS-C14/73. (St. 3681)** **>40,000**

Bulk sample of lignitic clay from 8.5m below terrace gravel.

**IGS-C14/74. (St 3683)** **>40,000**

Bulk sample of lignitic clay from 11.6m below terrace gravel.

*General Comment* (E.F.P.N.): glaciation that deposited Chalky Boulder Clay in Norwich area was assigned by West (1963) to Anglian, by Straw (1965) to Wolstonian, and by Woodland (1970) to Devensian. The R. Tas dissects Chalky Boulder Clay and glacial sand and gravel. Laminated deposits containing Hoxnian flora (L. Phillips and R. G. West, pers. commun.) underlie river gravel at 4 sites in Norwich area (Cox and Nickless, 1972) of which Dunston Common is one. Mapping and evidence from other boreholes indicate that interglacial deposits rest on Chalky Boulder Clay.

**Spalding series**

Peat and marine shells from Flandrian sequence of the Fens at Spalding, Lincolnshire. Samples were obtained from site-investigation boreholes drilled along line of proposed A16 Spalding By-pass. Coll. 1969 and subm. by A. Horton, Inst. Geol. Sci.

**IGS-C14/75. (St 3684)** **6240 ± 120** **4290 B.C.**

Peat from depth 11.50 to 11.95m in Borehole A16-8 (52° 48′ N Lat, 0° 8′ W Long, Grid Ref. TF 2649 2324).

**IGS-C14/76. (St 3682)** **6220 ± 120** **4270 B.C.**

Silty peat from depth 10.10m in Borehole A16-11 (52° 48′ N Lat, 0° 8′ W Long, Grid Ref. TF 2527 2675).

**IGS-C14/77. (St 3659)** **1915 ± 100**
**A.D. 35**

Valves of pelecypod (*Macoma balthica*) from sand at depth 6.0 to 6.4m in Borehole A16-14 (52° 52′ N Lat, 0° 9′ W Long, Grid Ref. TF 2478 3096).

**IGS-C14/78. (St 3660 and 3664)** **Outer 1615 ± 100**
**A.D. 335**
**Inner 1555 ± 100**
**A.D. 395**

Valves of pelecypod (*Cerastoderma edule*) from sand at depth 6.0 to 6.4m in Borehole A16-14 (52° 52′ N Lat, 0° 9′ W Long, Grid Ref. TF 2478 3096).

**West Bromwich series**

Peat from deposit exposed in temporary excavation adjacent to M6 Motorway, N of Newton Lane, West Bromwich, Birmingham. Peat floors small tributary valley of R. Tame and rests upon glacial gravels (52° 32′ N Lat, 1° 58′ W Long, Grid Ref. SP 0213 9333). Coll. 1969 by A. Horton and P. J. Osborne, and subm. by A. Horton.

**IGS-C14/79. (St 3686)** **10,025 ± 100**
**8075 B.C.**

Peat, 0.41 to 0.51m above base of peat.

**IGS-C14/80. (St 3698)** **9640 ± 100**
**7690 B.C.**

Peat, 0.91m above base of peat.

**IGS-C14/81. (St 3697)** **9305 ± 110**
**7355 B.C.**

Peat, 0.97m above base of peat.

**IGS-C14/82. (St 3693)** **9540 ± 100**
**7590 B.C.**

Peat, 1.14m above base of peat.

**IGS-C14/83. (St 3688)** **9080 ± 455**
**7130 B.C.**

Peat, 1.22 to 1.32m above base of peat.

*General Comment* (A.H.): results confirm that deposit forms part of early Flandrian peat sequence representing a continuous period of peat accumulation. Previous results were obtained from base of peat and from 0.51 to 0.61m above base (Welin, Engstrand, and Vaczy, 1971, p. 28). There is no evidence that contamination or sampling error affected results for the 2 samples, IGS-C14/81 and /82.

**Empingham series, Rutland**

Samples from alluvial deposit of R. Gwash (52° 38′ N Lat, 0° 31′ W Long, Grid Ref. SK 9441 0790). Coll. 1971 by P. Horswill and subm. by R. J. Chandler, Imperial College, London.

**IGS-C14/84. (St 3689)** **1470 ± 100**
**A.D. 480**

Wood from depth 2.4m in alluvium.

**IGS-C14/85. (St 3757)** **2945 ± 240**
**995 B.C.**

Bone (*bos*) from depth 3.0m in alluvium.

**IGS-C14/86. (St 3687) Telford, Shropshire** **3685 ± 100**
**1735 B.C.**

Wood from pine tree lying horizontally in postglacial lacustrine clay, from sewer tunnel at Tweedale, Telford (52° 38′ N Lat, 2° 28′ W Long, Grid Ref. SJ 6985 0497), 5.2m below original ground level (*i.e.*, base of a colliery tip). Coll. 1970 and subm. by R. J. O. Hamblin, Inst. Geol. Sci. *Comment* (R.J.O.H.): lacustrine clay overlies undated, but probably late glacial gravel, and proves considerable development of postglacial deposits in Tweedale Valley.

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[RADIOCARBON, VOL. 15, No. 2, 1973, P. 303-306]

# INSTITUT ROYAL DU PATRIMOINE ARTISTIQUE RADIOCARBON DATES IV

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This list includes the results of datings made during 1970-71. The methods of measurements are the same as described in R., 1971, v. 13, p. 29-31.

## SAMPLE DESCRIPTIONS

### I. GEOLOGIC SAMPLES

**IRPA-97 I. Heusden-Gent** **1195 ± 75** **A.D. 755**

Peat from Heusden-Gent, E Flanders, Belgium (51° 2′ 30″ N Lat, 3° 45′ 30″ E Long), at 4m alt. Coll. 1970 by C. Verbruggen, Univ. Ghent, Belgium. No NaOH pretreatment.

**IRPA-97 II. Uitbergen** **1585 ± 80** **A.D. 365**

Peat from Uitbergen, E Flanders, Belgium (51° 0′ 40″ N Lat, 31° 57′ 48″ E Long), at 3.5m alt. Coll. 1970 by C. Verbruggen. No NaOH pretreatment.

*General Comment* (C.V.): control of palynologic dates, used for study of Sub-Boreal—Sub-Atlantic peat formation.

**IRPA-108. Lubefu** **23,780 ± 535** **21,830 B.C.**

Clay with small pieces of plant material, from Lubefu valley, Zaïre (4° 35′ S Lat, 24° 15′ E Long). Coll. 1941 by P. Snock and subm. 1970 by J. Lepersonne, Mus. royal de l'Afrique centrale, Tervuren, Belgium. *Comment* (J.L.): date resolves interesting geologic and stratigraphic problem for prehistorians.

**IRPA-122. Villa Angostura** **1600 ± 90** **A.D. 350**

Charcoal from Villa Angostura, Neuquen, Argentina (40° 39′ 40″ S Lat, 71° 42′ 40″ W Long), at 950m alt., in volcanic ash. Coll. 1968 by H. Laya and subm. 1970 by W. DeBreuck, Lab. Geol., Univ. Ghent, Belgium.

**IRPA-123. Puerto Varas** **25,320 ± 570** **23,370 B.C.**

Charcoal from Puerto Varas, Llanquihue, Chili (41° 19′ S Lat, 73° 01′ W Long), at 50m alt., in volcanic ash. Coll. 1970 by R. Langohr and subm. 1970 by W. DeBreuck.

**IRPA-124. Puerto Varas** **24,830 ± 560** **22,880 B.C.**

Wood from Puerto Varas, Llanquihue, Chili (41° 19′ S Lat, 73° 01′ W Long), at 50m alt. Coll. 1970 by R. Langohr and subm. 1970 by W. DeBreuck.

*General Comment* (W.DeB.): dates are very interesting because there are no geologic data about these countries; dates used for study of last ice period and volcanic ash.

II. WATER SAMPLE

This laboratory has begun dating water samples. Our method is based on those used in other laboratories (Broecker, 1959; Berger, 1965). $CO_2$ is extracted from water in a continuous flow extraction apparatus that consists of a 5-necked flask of 3 L. In the 1st is placed a heat exchanger, in the 2nd a funnel with concentrated sulfuric acid, in the 3rd a thermometer, in the 4th is introduced a stream of carrier gas $N_2$, $CO_2$ is removed through the 5th. The flask is heated in an electric muffle oven to ca. 80° to 90°C. Water in the tank is forced into the flask in continuous flow through $N_2$ over-pressure; the waste water is run through the heat exchanger, against incoming water, preheating it and is removed by a peristaltic pump. The rate of peristaltic pumping and the pressure of $N_2$ in the tank are regulated so that water level in the flask is always the same. Water is acidified in the flask, at a PH between 1 and 3 (Thymol Blue indicator). $CO_2$ is removed with the stream of carrier gas $N_2$ in 2 bubblers with silver nitrate and then in 2 with sulfochromic acid. The recovery of $CO_2$ is ca. 90%. Purified $CO_2$ is transformed to methane and counted. All $CO_2$ is removed from 50 L water after 4 hr. Water quantity is variable and depends on $CO_2$ present. In our case 50 L was enough.

**4125 ± 125**
**IRPA-30. Vlissegem** **2170 B.C.**

Ground water from Vlissegem, W Flanders, Belgium (51° 14′ 23″ N Lat, 3° 07′ 03″ E Long). Coll. 1972 by W. DeBreuck.

III. ARCHAEOLOGIC SAMPLES

**11,350 ± 340**
**IRPA-92. Buvuma** **9400 B.C.**

Charcoal from Buvuma I., Uganda (0° 15′ N Lat, 33° 20′ W Long), at 1162m alt. and 0.80 to 0.90m depth. Coll. 1968 and subm. 1970 by F. Van Noten, Mus. royal de l'Afrique centrale, Tervuren, Belgium. *Comment* (F.V.N.): sample from cave 28.5m above level of Lake Victoria at SW end of Buvuma I. At depth ca. 0.50m, uncontaminated Late Stone age artifacts (made of white vein quartz) were found. The excavation was carried out in spits of 0.10m; radiocarbon samples could be taken from each spit. Confirms dates of Groningen lab.

**Meer series**

Two pieces of charcoal from Upper Paleolithic (Tjongerian) site, near Meer, prov. Antwerp, Belgium (51° 27′ N Lat, 4° 45′ E Long). Coll. 1968 and subm. 1970 by F. Van Noten (1967).

**IRPA-93 I. Meer II-2** **7080 ± 290**
**5130 B.C.**

**IRPA-93 II. Meer II-3** **8025 ± 315**
**6075 B.C.**

*General Comment*: dates are much younger than archaeologic sites but confirm dates of Groningen lab. (GrN-4960, -4961, -5706).

**IRPA-106 II. Kamoa** **760 ± 40**
**A.D. 1190**

Charcoal from Kamoa, Katanga, Zaïre (10° 24′ 54″ S Lat, 25° 9′ 19″ E Long), at 1030m alt. Coll. 1970 by D. Cahen, Mus. royal de l'Afrique centrale, Tervuren, Belgium. *Comment* (D.C.): sample from Iron age oven (underlayer). Archaeol. date: 5th to 15th centuries.

**Pessinus series**

Samples from Roman excavations at Pessinus, Eskisehir, Turkey. Coll. 1970-71 by G. Stoops, Geol. Inst., Univ. Ghent, Belgium.

**Group I**

Calcareous rock from Istikhal Băge near Ballihisar (39° 24′ N Lat, 21° 26′ E Long). Samples from stratified deposit in water channel; 3 from lower part, 1 from upper. Pretreatment with HCl 1% until 40% weight loss.

**IRPA-121.** **2105 ± 110**
**155 B.C.**

From 0 to 5mm depth, measured upward.

**IRPA-120.** **1920 ± 100**
**A.D. 30**

From 5 to 17mm depth, measured upward.

**IRPA-119.** **1790 ± 95**
**A.D. 160**

From 17 to 39mm depth, measured upward.

**IRPA-118.** **2075 ± 105**
**125 B.C.**

From 2 to 7mm depth, measured downward. The 1st mm was removed to avoid contamination by algae. Date is too old but contamination by granite and marble is possible.

**Group II**

Charcoal from Ballihisar (39° 22′ N Lat, 31° 38′ E Long). Samples from foundation of Roman temple.

**1730 ± 120**
**IRPA-126.** **A.D. 220**

Charcoal from a fire near burned tiles and plaster. Because upper layer of fire has a colluvial origin, contamination by roots is possible.

**2170 ± 110**
**IRPA-127.** **95 B.C.**

Charcoal from calcareous ground between W wall tower and temple foundations. No contamination.

*General Comment*: results of 2 groups are used to date Pessinus sites.

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# INSTITUTO VENEZOLANO DE INVESTIGACIONES CIENTIFICAS NATURAL RADIOCARBON MEASUREMENTS VII

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The samples reported in this date list were processed during 1970. After preliminary sample treatments including carbonates and rootlet removal, a complete benzene synthesis was made. This liquid serves as the solvent in a liquid scintillation spectrometer, using a modified 4cc counting vessel; 2.42g of carbon are counted with a 64% efficiency. The background is constant at 6.8 cpm.

Ages are calculated for a $C^{14}$ half-life of 5568 years, using 95% of the activity of the NBS oxalic acid as the modern reference and commercial petroleum-derived benzene for background determinations. Errors are the standard deviations based on the random nature of the radioactive disintegration process. The reference year A.D. 1950 is in "Before Present" ages.

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## SAMPLE DESCRIPTIONS

### I. GROUND WATER SAMPLES

These samples represent the continuation of the annual sampling of deep ground wells S of Maracaibo. This deposit is fossil (Tamers, 1967), but represents the only source of fresh water for the urban center. Radiocarbon dates were run in order to verify that the brackish waters of the Lake of Maracaibo have not begun to infiltrate the major portion of the aquifer. Samples consist of total extracted carbonates. Coll. and subm. by members of Radiocarbon Lab., I.V.I.C.

**Maracaibo Wells**

| | | Collection (day/month/yr) | $C^{14}$ (% of modern) |
|---|---|---|---|
| IVIC-836. | Campo 1, Pozo 28 (10° 33′ N Lat, 71° 42.5′ W Long) | 2/9/70 | 26.0 ± 0.4 |
| IVIC-837. | Campo 1, Pozo 23 (10° 32′ N Lat, 71° 43′ W Long) | 2/9/70 | 22.2 ± 0.4 |
| IVIC-838. | Campo 2, Pozo 2 (10° 30′ N Lat, 71° 48′ W Long) | 2/9/70 | 25.3 ± 0.4 |
| IVIC-839. | Campo 2, Pozo 6 (10° 30′ N Lat, 71° 48′ W Long) | 2/9/70 | 28.8 ± 0.4 |

| | | Collection (day/month/yr) | $C^{14}$ (% of modern) |
|---|---|---|---|
| IVIC-840. | Campo 3, Pozo 1 (10° 30′ N Lat, 71° 43′ W Long) | 2/9/70 | 31.9 ± 0.45 |
| IVIC-841. | La Cañada (10° 25′ N Lat, 71° 41′ W Long) | 2/9/70 | 6.1 ± 0.3 |

*Comment*: the main municipal wells still show no indication of modern water infiltration. Radiocarbon content is essentially the same as in 1966 when the sampling was initiated. The La Cañada radiocarbon concentration is significantly higher in recent years, but seems to be due to an infiltration of slightly younger water from inland deposits rather than lake infiltration.

## II. ARCHAEOLOGIC SAMPLES

### *A. Venezuela*

**1660 ± 70**
**IVIC-777. El Cuartel** **A.D. 290**

Charcoal, S-1, near naval base of Carupano, Venezuela (10° 4′ N Lat, 63° 45′ W Long), from Cuts 7 and 9, Level 7, 120 to 140cm below surface. Assoc. with pottery and lithic artifacts, related to Ronquín style of Lower Orinoco. Coll. 1969 and subm. by M. Sanoja, Univ. Central de Venezuela, Caracas. Estimated age: A.D. 200 to 200 B.C. *Comment* (M.S.): date correlates well with others obtained by Rouse and Cruxent (1963) for similar sites near Carupano, suggesting that by that time the area was intensively occupied by a homogeneous aboriginal population.

**670 ± 70**
**IVIC-778. El Guamo** **A.D. 1280**

Charcoal and wood, T-1, from bank of Zulia R., near Orope Caño, state of Táchira, Venezuela (8° 24′ N Lat, 72° 36′ W Long). From Cut 3, Sec. D, Level 6, 100 to 120cm below surface. Coll. March 1967 and subm. by M. Sanoja. Assoc. with pottery, textile-impressed sherds, and lithic artifacts. Sample should be after Caño Grande period and beginning of red/white painted and incised pottery of the SW bank of Lake Maracaibo. Estimated age A.D. 600 to 1000. *Comment* (M.S.): according to series for SW coast of Lake Maracaibo, date is acceptable.

**IVIC-779. Caño Grande** **>34,550**

Amorphous material (asphalt ?), Z-5, with high carbon content, from Caño Grande, near village of Encontrados, state of Zulia, Venezuela (9° 2′ N Lat, 72° 46′ W Long). From Cut 2, Level 6, 100 to 120cm below surface. Assoc. with pottery, lithic artifacts, and bones. Site appears to represent one of most ancient of SW coast of Lake Maracaibo. Coll. 1968 and subm. by M. Sanoja. Estimated age: A.D. 400 to 600. *Comment* (M.S.): obviously, date does not belong to Caño Grande phase cultural context and should be discarded.

**IVIC-780. El Danto** **900 ± 70**
**A.D. 1050**

Charcoal, Z-23, from El Danto Caño, 8 to 10km from Escalante R., Bolivar Dist., state of Zulia, Venezuela (8° 24′ N Lat, 72° 36′ W Long). From Cut 1, Level 4, 60 to 80cm below surface. Assoc. with pottery, lithic artifacts, animal bones and terrestrial snail shells. Many characteristics of pottery here also occur in that of El Guamo and other sites of SW and NW coasts of Lake Maracaibo. Coll. 1970 and subm. by M. Sanoja. Estimated date: A.D. 400 to 1000. *Comment* (M.S.): according to series for archaeologic sites of area, date is acceptable.

**IVIC-882. Muaco tierra** **10,490 ± 100**
**8540 B.C.**

Earth, with carbonates and rootlet removal pretreatment, from ca. 1m below surface of Muaco site, state of Falcón, Venezuela (11° 45′ N Lat, 69° 15′ W Long). Assoc. with Pleistocene animal bones previously dated (non-carbonate fraction) at 9030 ± 240 B.P. (IVIC-488: R., 1969, v. 11, p. 406), and 14,300 ± 500 B.P. (M-1068: R., 1962, v. 4, p. 200), presumably on total bone. Coll. 1970 and subm. by J. Cruxent, I.V.I.C. *Comment* (J.C.): date slightly younger than Taima-taima, 11,000 to 15,000 B.P. (Tamers, 1971), which is possible and agrees with previous I.V.I.C. date of Muaco bones.

*B. Trinidad*

**Banwari Trace series**

Charcoal from top of small hill, 2.5km W Penal on S bank of old Oropuche Lagoon, Trinidad (10° 10′ N Lat, 61′ 28′ W Long). Assoc. with bone and stone implements, possibly similar to those of Ortoire complex. Shell tools absent. Samples expected to indicate antiquity of Meso-Indian period in Trinidad. Coll. 1969 (IVIC-783, -784) and 1970 (IVIC-887-891) by P. Harris, Trinidad and Tobago Hist. Soc., Pointe-à-Pièrre. Subm. by J. Cruxent.

**IVIC-784. Banwari Trace A-1** **2550 ± 100**
**600 B.C.**

Excavation A, 0 to 25cm below surface. Sample might be contaminated by modern material due to cultivation in region.

**IVIC-783. Banwari Trace A-2** **5650 ± 100**
**3700 B.C.**

Excavation A, 25 to 50cm below surface.

**IVIC-887. Banwari Trace A-3** **6170 ± 90**
**4220 B.C.**

Excavation A, 50 to 75cm below surface.

**IVIC-890. Banwari Trace A-4** **6100 ± 90**
**4150 B.C.**

Excavation A, 75 to 100cm below surface.

**6190 ± 100**
**IVIC-891. Banwari Trace A-5** **4240 B.C.**

Excavation A, 100 to 125cm below surface.

**6780 ± 70**
**IVIC-889. Banwari Trace A-6** **4830 B.C.**

Excavation A, 125 to 150cm below surface.

**7180 ± 80**
**IVIC-888. Banwari Trace A-8** **5250 B.C.**

Excavation A, 175 to 200cm below surface.

*General Comment*: these are the oldest dates for man in the Caribbean Is. and supports arguments of Cruxent and Rouse (1969) for early habitation of the West Indies.

**1260 ± 100**
**IVIC-785. Guayaguayare C-1** **A.D. 690**

Charcoal, from 4.5km SW of Guayaguayare, Trinidad (10° 7′ N Lat, 61° 4′ W Long), 0 to 25cm below surface. Assoc. with stones, bones, shells, and pottery. Pottery styles similar to that of Erin (Trinidad) and Caloriguy (Grenada). Coll. 1969 by P. Harris and subm. by J. Cruxent. Estimated age: 1000 to 1300 B.P.

**1720 ± 90**
**IVIC-786. Guayaguayare C-2** **A.D. 230**

Charcoal, same excavation as IVIC-785, 25 to 50cm below surface. Coll. same time and assoc. with similar artifacts. *Comment* (P.H.): dates are reasonable.

*C. Chile*

**Caleta Huelen series**

Various cultural materials from pre-Columbian cemetery on bank of mouth of Loa R., dividing Tarapaca and Antofagasta provs. in N Chile (21° 25′ S Lat, 70° 65′ W Long). Coll. 1968 and subm. by L. Nuñez, Univ. Chile, Antofagasta.

**2030 ± 80**
**IVIC-788. Caleta Huelen 7** **80 B.C.**

Coiled basketry and other vegetable fibers, well preserved, from undisturbed Tomb 1 containing flexed adult body covered with marine bird feathers, from 65cm below surface. Assoc. with bottle- and bell-shaped ceramic vessels with polished surfaces, copper ore, basketry, cord, cotton, wool, quartz knives. Artifacts related to 1st agricultural settlements in Tarapaca Valley, Caserones sec. *Comment* (L.N.): estimated date: at least A.D. 100 since sample is from population whose artifacts are old. Date is consistent with archaeologic evidence.

**2000 ± 70**
**IVIC-789. Caleta Huelen 10** **50 B.C.**

Crude wool cloth from Tomb 1 of CaH-10 cemetery, tumulos sec., S bank, covering body of small child. Assoc. with bottle-shaped striated ceramic vessels, slightly polished, with cucurbitaceous forms. Also present were net sacks of vegetable fibers, wool, coiled basketry, and Quisco fishhooks. This is 1st date for a late agricultural-ceramic settlement with Quisco fishhooks. *Comment* (L.N.): date is reasonable and expected; it confirms IVIC-788.

**IVIC-790. Caleta Huelen 10A** **2320 ± 80**
**370 B.C.**

Charred wood, from Tomb 7, Sec. A of CaH-10A cemetery on S bank, 43cm below surface of undisturbed tomb containing flexed adult body. Assoc. with wool bundle covered with vegetable fiber matting, a bone harpoon, coiled basketry, shells, cloth sack, wool cloth, perforated stone. *Comment* (L.N.): date older than expected. This population was buried on side of CaH-10 tomb area. Field evidence must be reexamined in light of radiocarbon result.

**IVIC-791. Caleta Huelen 43** **1130 ± 80**
**A.D. 820**

Human flesh from flexed adult body, naturally mummified by climatic factors; from undisturbed Tomb 10, 63cm depth, on N bank of river. From cemetery of 210 graves of only settlement on N bank of Loa R. Assoc. with a separate style of ceramics, back packs, sticks for agricultural use, crude wool cloth, sack with maize, leather sandals. Population had a balanced agricultural-maritime economy. Estimated date: A.D. 0 to 300. *Comment* (L.N.): date is very unexpected, but possible, due to fact that tomb was on edge of cemetery. Sample from central burial area is needed to determine true age of site. But present sample might date end of occupation.

**IVIC-792. Pica 8** **950 ± 70**
**A.D. 1000**

Human flesh and digested vegetable from adult body, mummified by climatic factors in undisturbed Tomb 7, Sec. G, 76cm depth, in Pica cemetery, San Andres de Pica oasis, Tarapaca prov., Chile (20° 31′ S Lat, 69° 23′ W Long). Assoc. with Charcollo type ceramics with irregular red bands and thick woven textiles with Tiahuanaco designs. Previous dates for site were 310 ± 110 B.P. and 220 ± 80 B.P. on maize cobs (IVIC-172 and IVIC-174: R., 1966, v. 8, p. 208) and 930± 90 B.P. on cloth (IVIC-173: R., 1966, v. 8, p. 208). Maize cob dates were unacceptable, but cloth radiocarbon result was reasonable. Present sample should resolve ambiguity of earlier dates. Sec. G presents conclusive altiplano characteristics. Coll. 1967 and subm. by L. Nuñez. This is 1st date for Tiahuanaco influence in N Chile. *Comment* (L.N.): date confirms that Pica complex is dated ca. A.D. 1000. Maize cob dates are invalidated.

**IVIC-844. Bellavista A** **3870 ± 80**
**1920 B.C.**

Charcoal, Bell. I. 70, from Sq. A-3, bottom Level 4, in Bellavista farm, 6km NE Concepción, Chile (36° 47′ S Lat, 73° 2′ W Long). Assoc.

with lithic industry consisting of projectile points, fishing weights, polishers. Coll. 1970 and subm. by Z. Seguel, Univ. Concepción, Chile. This is 1st date for central-S zone of Chile. Estimated age: 3000 to 3500 B.C. *Comment*: see IVIC-845.

**3330 ± 80**
**IVIC-845. Bellavista B** **1380 B.C.**

Charcoal, Bell. I. 70, from Sq. B-2, Level 3, of same site as IVIC-844. Assoc. with projectile points, fishing net weights, other lithic artifacts. Settlement of marine fishermen-collectors without ceramics. Coll. 1969 and subm. by Z. Seguel. *Comment* (Z.S.): dates establish existence of this early preceramic society. Site is presently far from actual sea coast and indicates one of last pulsations of sea level in this sector.

**810 ± 100**
**IVIC-846. Tubul 1** **A.D. 1140**

Charcoal, Tub. I. 70, from SE sec., Sq. B-2, Level 3, of excavation NW mouths of Raqui and Tubul R., behind Tubul cove (37° 14′ S Lat, 73° 27′ W Long). Assoc. with ceramics and funerary structures. Estimated date: A.D. 1450 to 1500. *Comment* (Z.S.): date earlier than expected, but it is reasonable to believe that these ceramic techniques were present considerably before Inca penetration into Chile.

**4020 ± 110**
**IVIC-875. Conanoxa 4** **2070 B.C.**

Charcoal, Cxa. W-a No. 4, of fluvial terrace W Conanoxa, Camarones Valley, Tarapaca Prov., Chile (19° 2′ S Lat, 69° 59′ W Long). Assoc. with cultural materials typical of pre-agricultural culture of Conanoxa. Previous dates on dried excrement and charcoal from site were 3740 ± 130 B.P. and 1150 ± 95 B.P., respectively (IVIC-175 and IVIC-176: R., 1966, v. 8, p. 208-209). Material from floor of House 3, S wall, Sq. A. Coll. 1967 and subm. by V. Schiappacasse and H. Niemeyer, Santiago, Chile. *Comment*: see IVIC-876.

**3970 ± 120**
**IVIC-876. Conanoxa 5** **2020 B.C.**

Charcoal, Cxa. W-a No. 5, from same site as IVIC-875. From floor of House 1, S wall, Sq. A. Same cultural material as previous sample. *Comment*: dates confirm antiquity of Conanoxa pre-agricultural settlement and invalidate possible significance of IVIC-176.

*D. Mexico*

**Cueva del Texcal series**

Charcoal from +2100m, NW Manuel Avila Camacho dam, on bank of reservoir, Puebla municipality, state of Puebla, Mexico (18° 55′ N Lat, 98° 8′ W Long). Settlement showed both ceramic and preceramic cultures. Coll. by members of Natl. Inst. Archeol. History (INAH) in Mexico City and subm. by J. Lorenzo.

**IVIC-813. Cueva del Texcal 1** **390 ± 70**
**A.D. 1560**

From Sq. A-12, Level II. Coll. 1964 by R. Reyna. Assoc. with ceramic and pre-ceramic cultures. *Comment* (J.L.): assoc. with late postglacial ceramics of Puebla Valley (A.D. 1200 to 1520) and Venta Salada phase of Tehuacan Valley (A.D. 700 to 1520).

**IVIC-814. Cueva del Texcal 2** **580 ± 70**
**A.D. 1370**

From Sq. A-12, Level III. Coll. 1964 by A. Arbide. Assoc. preceramic material. *Comment* (J.L.): see IVIC-813.

**IVIC-815. Cueva del Texcal 3** **210 ± 60**
**A.D. 1740**

From Sq. CC-17, Level III. Coll. 1964 by A. Arbide. Assoc. with preceramic material. *Comment* (J.L.): cultural material found with sample was same type as for Texcal 1 and 2; dates are too recent.

**IVIC-816. Cueva del Texcal 4** **7320 ± 280**
**5370 B.C.**

Very small sample from Sq. A-18, Level VI. Coll. 1965 by L. Mirambell. Assoc. with preceramic material. *Comment* (J.L.): date acceptable since Levels IV and V produced material corresponding to Coxcatlan phase of Tehuacan Valley. In lower levels, artifacts are of El Riego del Valle de Tehuacan phase, oldest of Texcal cave. Coxcatalan dates 5000 to 3500 B.C. and El Riego from 6500 to 5000 B.C.

**IVIC-818. Cueva del Texcal 6** **1980 ± 70**
**30 B.C.**

From Sq. A-19, Level IV. Coll. 1965 by L. Mirambell. Assoc. with preceramic material. *Comment*: intermediate date between Venta Salada and Coxcatlan phases.

**IVIC-833. Tlatilco 4** **2920 ± 80**
**970 B.C.**

Zea maize from Trench 4, Pit 17, Tlatilco site, Naucalpan de Juárez municipality, state of Mexico, Mexico (19° 29′ N Lat, 99° 14′ W Long), +2276m. Coll. 1968 and subm. by R. García Moll, Mus. Nacl. Antropol., INAH. *Comment* (R.G.M.): sample assoc. with ceramics similar to that described by Piña Chán (1958). Date excludes Transitional Tlatilco phase corresponding to Medium Preclassical of central Alitplano of Mexico. This would have dated A.D. 1500 to 900.

*E. Ecuador*

**IVIC-855. Subibaja** **950 ± 70**
**A.D. 1000**

Charcoal from Trench 1, Level 6, in excavation on slope of Chanduy hills, near San Rafael, Santa Elena peninsula, Ecuador (2° 21′ S Lat, 80° 38′ W Long). Assoc. with Guangala ceramics, frogware type, comales, and graters. Sample should determine period of frogware-type ceramics in Guangala culture. Coll. 1970 and subm. by J. Marcos, Guayaquil, Ecuador. Estimated date: A.D. 500 to 600.

**1180 ± 70**
**IVIC-883. Loma del Guasango Torcido** **A.D. 770**

Human bones, with carbonate removal pretreatment, from Tomb 43, on Loma del Guasango Torcido, Chanduy Valley, Santa Elena peninsula, Ecuador (2° 22′ S Lat, 80° 40′ W Long). Assoc. with Chanduy red band, Guasango finger paint, and early frogware-type ceramics. Coll. 1970 and subm. by J. Marcos. Estimated date: A.D. 500.

*F. Argentina*

**1910 ± 60**
**IVIC-859. Manos Pintadas 1** **A.D. 40**

Charcoal from a rock shelter in Cañadon de las Manos Pintadas, General Sarmiemto municipality, Chubut prov., Argentina (45° 28′ S Lat, 69° 42′ W Long). From Trench 1, 60cm below surface. Coll. 1970 by C. Gradin, Ethnol. Mus. Buenos Aires, and subm. by J. Cruxent, IVIC. Estimated date: 1500 B.P.

**3330 ± 70**
**IVIC-860. Manos Pintadas 2** **1380 B.C.**

Charcoal from same site as IVIC-859. From Trench II, 183cm below surface. Coll. 1970 by C. Gradin and subm. by J. Cruxent. Estimated date: 5000 B.P.

**750 ± 70**
**IVIC-862. Quimili Paso 24** **A.D. 1200**

Charcoal from Site 2, Sq. 1, Level 4, 45 to 60cm below surface, on side of dry bed of Maillín Llanura stream, Santiago del Estero prov., Argentina (28° 45′ S Lat, 63° 10′ W Long). This level presented a concentration of basketry remains and animal bones. Coll. 1968 and subm. by A. Lorandi, Nat. Sci. Mus., La Plata, Argentina. These are 1st dates for Santiago del Estero region. Estimated date: A.D. 1000 to 1400. *Comment* (A.L.): date agrees with archaeol. evidence.

**1140 ± 60**
**IVIC-863. Quimili Paso 31** **A.D. 810**

Charcoal from same site as IVIC-862, Sq. 2, Level 2, 15 to 25cm below surface. Assoc. with ceramic vase, basketry, animal bones, some charred. Coll. same time as previous sample. Estimated date: A.D. 1000 to 1400. *Comment* (A.L.): 390-yr difference between IVIC-862 and -863 is excessive; order of ages is inconsistent with depth. Errors of dates must be considered; an average value for Site 2: ca. 1000 B.P.

**450 ± 70**
**IVIC-864. Quimili Paso 43** **A.D. 1500**

Charcoal from Site 3, Sq. 1, Level 4, 45 to 60cm below surface. On side of Maillín Llanura stream dry bed, Santiago del Estero prov., Argentina (28° 45′ S Lat, 63° 10′ W Long). Assoc. with late period basketry and animal bones. Site 3 expected to date later than Site 2. Coll. 1968 by M. Klark and subm. by A. Lorandi. *Comment* (A.L.): ages of Sites 2 and 3 should differ by only ca. 100 yr.

### III. SOIL SAMPLES

This is a continuation of the program of dating soil materials in Venezuela. The pretreatment method for removal of rootlets and carbonates (Herrera and Tamers, 1971) is a modification of the method developed in Bonn (Scharpenseel *et al.*, 1968).

**IVIC-781. Calicata 4** **1810 ± 60**
**A.D. 140**

Earth, buried Horizon $A_{1b}$, at 148 to 154cm below surface; 0.44% non-rootlet, non-carbonate carbon content.

**IVIC-782. Calicata 5** **1920 ± 70**
**A.D. 30**

Earth, buried Horizon $A_{1b}$, at 230 to 260cm below surface, 1.4% non-rootlet, non-carbonate carbon content; soil is Vertisol, covering ancient Ultisol. These 2 samples from pit near Mantecal, state of Apure, Venezuela (7° 34′ N Lat, 69° 9′ W Long). Coll. 1970 by R. Schargel, M.O.P., Guanare, and subm. by R. Herrera, IVIC. Calicata is part of study of rate of soil profile formation under tropical conditions. *Comment*: dates are statistically indistinguishable, which was unexpected due to almost 1m soil separating samples.

**Tierra Pipe series**

Samples, from A-C horizon type soil, from hill in IVIC, Altos de Pipe, state of Miranda, Venezuela (10° 23′ N Lat, 66° 58′ W Long). Other dates from this series previously published (R., 1970, v. 12, p. 524; R., 1971, v. 13, p. 39-41). Samples at same depth were regularly younger and of higher non-rootlet, non-carbonate carbon content, proceeding down hill. Intense cloud-forest vegetation and steep slope make sampling difficult. Profiles studied cover range in alt. from 1745m to 1450m over horizontal distance of only 800m. A preliminary description of results was published previously (Herrera and Tamers, 1971). Coll. 1970 and subm. by R. Herrera and M. Tamers. Pipe 6 is ca. 200 horizontal m downhill from Pipe 4 and is almost at foot of hill. Pipes 7 and 8, separated by ca. 100m, are ca. 100m downhill from summit. Pipe 9 was taken close to sampling area of Pipe 1, but on opposite side of road.

**IVIC-794. Pipe 6, 20 to 35cm** **112.7 ± 0.8 % modern**

1.5% non-rootlet, non-carbonate carbon content.

**IVIC-795. Pipe 6, 35 to 50cm** **107.8 ± 0.8 % modern**

1.2% non-rootlet, non-carbonate carbon content.

**IVIC-796. Pipe 6, 50 to 65cm** **123.8 ± 0.9 % modern**

0.81% non-rootlet, non-carbonate carbon content.

**IVIC-797. Pipe 6, 0.65 to 0.80m** **162.8 ± 0.9 % modern**
0.24% non-rootlet, non-carbonate carbon content.

**IVIC-798. Pipe 6, 0.80 to 1.00m** **114.9 ± 0.8 % modern**
0.14% non-rootlet, non-carbonate carbon content.

**IVIC-802. Pipe 7, 0.30 to 0.45m** **101.4 ± 0.9 % modern**
2.7% non-rootlet, non-carbonate carbon content.

**IVIC-803. Pipe 7, 0.45 to 0.60m** **116.2 ± 0.8 % modern**
3.3% non-rootlet, non-carbonate carbon content.

**IVIC-804. Pipe 7, 0.60 to 0.75m** **135.2 ± 0.8 % modern**
1.1% non-rootlet, non-carbonate carbon content.

**IVIC-805. Pipe 7, 0.75 to 0.90m** **225.5 ± 1.4 % modern**
0.38% non-rootlet, non-carbonate carbon content.

**IVIC-806. Pipe 7, 0.90 to 1.05m** **223.9 ± 1.6 % modern**
0.18% non-rootlet, non-carbonate carbon content.

**IVIC-809. Pipe 8, 0.50 to 0.65m** **111.9 ± 0.3 % modern**
2.2% non-rootlet, non-carbonate carbon content.

**IVIC-810. Pipe 8, 0.65 to 0.80m** **105.8 ± 0.8 % modern**
1.5% non-rootlet, non-carbonate carbon content.

**IVIC-811. Pipe 8, 0.80 to 0.95m** **113.6 ± 0.7 % modern**
0.63% non-rootlet, noncarbonate carbon content.

**2540 ± 80**
**IVIC-866. Pipe 9, 0.20 to 0.35m** **590 B.C.**
0.87% non-rootlet, non-carbonate carbon content.

**4090 ± 70**
**IVIC-867. Pipe 9, 0.35 to 0.50m** **2140 B.C.**
0.60% non-rootlet, non-carbonate carbon content.

**4860 ± 70**
**IVIC-868. Pipe 9, 0.50 to 0.65m** **2910 B.C.**
0.46% non-rootlet, non-carbonate carbon content.

**5220 ± 80**
**IVIC-869. Pipe 9, 0.65 to 0.80m** **3270 B.C.**
0.33% non-rootlet, non-carbonate carbon content.

**4750 ± 90**
**IVIC-870. Pipe 9, 0.80 to 0.95m** **2800 B.C.**
0.36% non-rootlet, non-carbonate carbon content.

**6450 ± 90**
**IVIC-871. Pipe 9, 0.95 to 1.10m** **4500 B.C.**
0.35% non-rootlet, non-carbonate carbon content.

**IVIC-872. Pipe 9, 1.10 to 1.25m** **6990 ± 90**
**5040 B.C.**

0.33% non-rootlet, non-carbonate carbon content.

*General Comment*: Pipe 9 series agrees with previous measurements. Pipe 6 profile is modern, but this was expected since general tendency seen for hill slope was decreasing ages as foot was approached. Modern dates for Pipe 7 and Pipe 8 profiles were unexpected. There is no evidence for artificial radiocarbon contamination; in any case, $C^{14}$ contents are all within range of post-1952 nuclear weapon contamination in Venezuela (IVIC-805 and -806 are a little high, but still possible). Most reasonable explanation is that in this area, soil was rejuvenated by infiltration of younger material from surface layers. Bonn lab. (Scharpenseel and Pietig, 1969) showed that samples of a fossil chernozem horizon were composed of equivalent of 50% modern material, at depth ca. 1.4 m. This Scharpenseel-Pietig effect would account for modern Pipe 7 and Pipe 8 samples. But, it is not clear why effect should be so large in this particular area; further study is needed.

## IV. GEOLOGIC SAMPLES

**IVIC-847. Laguna Brava** **14,900 ± 210**
**12,950 B.C.**

Diatomite-lacustrine sediments, with rootlet, carbonates removal pretreatment, No. MER-40-1, from edge of Laguna Brava, near Páramo de La Negra, between States of Mérida and Tachira, Venezuela (8° 25′ N Lat, 71° 50′ W Long). Coll. 1970, ca. 3m below lake base, and subm. by N. Muñoz, Dept. Geol., Univ. Central Venezuela, Caracas. *Comment* (N.M.): date agrees with pollen analyses on same sample, placing layer in late glacial, when climate began to improve.

**IVIC-857. Guanoco 1** $\mathbf{30{,}740^{+1360}_{-1170}}$
**28,790 B.C.**

**IVIC-858. Guanoco 2** $\mathbf{27{,}460^{+1040}_{-920}}$

Asphalt (IVIC-857 semi-solid and IVIC-858 more liquid) from Guanoco Lake, State of Sucre, Venezuela (10° 11′ N Lat, 62° 54′ W Long). Deposit represents largest surface of asphalt in world (ca. 350h). Coll. 1970 and subm. by D. Raynaud and M. Tamers. *Comment*: ages are statistically indistinguishable. Detection of radiocarbon activity was unexpected, as it is generally believed that asphalt originates completely from petroleum. Real ages might indicate that modern carbon plays a role in asphalt formation. Situation described fully in Raynaud and Tamers, 1971.

**Mucubají series**

Soil samples, fluvial-glacial, from headwaters of Santo Domingo R., in Morrena Victoria Valley, ca. 2.5 km NE Mucubají, State of Mérida, Venezuela (8° 48.7′ N Lat, 70° 48.3′ W Long). Previous date for soil was 5470 ± 80 B.P. (IVIC-722, R., 1971, v. 13, p. 43). Coll. 1970 and subm. by C. Schubert, IVIC. Site described in Schubert and Sifontes (1970). Samples subm. to rootlet, carbonate removal pretreatment.

**IVIC-764. Mucubají CS-29** — **450 ± 70**, **A.D. 1500**

0 to 50cm below surface.

**IVIC-763. Mucubají CS-28** — **3920 ± 90**, **1970 B.C.**

50 to 75cm below surface.

**IVIC-762. Mucubají CS-27** — **5800 ± 80**, **3850 B.C.**

75 to 100cm below surface.

**IVIC-766. Mucubají CS-31** — **5360 ± 90**, **3410 B.C.**

Ca. 50cm below surface.

**IVIC-767. Mucubají CS-32** — **5590 ± 100**, **3640 B.C.**

Ca. 75cm below surface.

**IVIC-765. Mucubají CS-30** — **8790 ± 120**, **6840 B.C.**

Ca. 100cm below surface.

*General Comment* (C.S.): confirms antiquity of IVIC-722. Older date of IVIC-765 is reasonable.

## V. SAMPLES OF KNOWN AGE

| | | | |
|---|---|---|---|
| IVIC-678. | Hojas de Guama, | 29 Dec., 1969 | 154.2 ± 1.1 % modern |
| IVIC-703. | " | 30 Jan., 1970 | 156.9 ± 1.1 % modern |
| IVIC-720. | " | 28 Feb., 1970 | 152.6 ± 1.0 % modern |
| IVIC-725. | " | 31 Mar., 1970 | 150.6 ± 0.9 % modern |
| IVIC-747. | " | 30 Apr., 1970 | 151.9 ± 1.1 % modern |
| IVIC-776. | " | 29 May, 1970 | 153.9 ± 1.0 % modern |
| IVIC-819. | " | 30 June, 1970 | 150.2 ± 1.0 % modern |
| IVIC-826. | " | 31 July, 1970 | 150.1 ± 1.0 % modern |
| IVIC-835. | " | 31 Aug., 1970 | 148.3 ± 1.1 % modern |
| IVIC-854. | " | 30 Sept., 1970 | 143.3 ± 1.1 % modern |
| IVIC-873. | " | 2 Nov., 1970 | 145.2 ± 1.0 % modern |
| IVIC-884. | " | 30 Nov., 1970 | 149.3 ± 1.0 % modern |

Green leaves from Guama trees (*Inga Fastuosa*) in Altos de Pipe, state of Miranda, Venezuela (10° 23′ N Lat, 66° 58′ W Long). Modern plant samples have been coll. here since 1964; results are reported in previous IVIC date lists. Coll. and subm. by members of Radiocarbon Lab., IVIC. *Comment*: activity fairly constant throughout year, but a little lower on average from 1969 (R., 1970, v. 12, p. 522).

**Oyster shell series**

This type of sample is common in Venezuelan archaeologic excavations (Rouse and Cruxent, 1963) and an attempt was made to determine whether errors here would be as large as those found on deep-water marine shells (Taylor and Berger, 1967). Since no pre-nuclear-weapon-testing Venezuelan oyster shells were available, a comparison of the oyster and shell of modern samples should give information at least concerning possible errors caused by isotope effect in shell dates. The oysters were purchased at various locations near Caracas, but came from region of Chichiriviche, State of Falcon, Venezuela (10° 4′ N Lat, 68° 16′ W Long). Coll. and subm. by members of Radiocarbon Lab.

**IVIC-822. Oysters, 19 July, 1970** **137.3 ± 0.9 % modern**

**IVIC-823. Oyster shells, 19 July, 1970** **142.5 ± 0.9 % modern**

Shells of IVIC-822 oysters.

**IVIC-824. Oysters, 24 July, 1970** **139.3 ± 0.9 % modern**

**IVIC-825. Oyster shells, 24 July, 1970** **143.8 ± 0.9 % modern**

Shells of IVIC-824 oysters.

**IVIC-827. Oysters, 2 August, 1970** **142.1 ± 0.9 % modern**

**IVIC-828. Oyster shells, 2 August, 1970** **141.5 ± 0.9 % modern**

Shells of IVIC-827 oysters.

*General Comment*: radiocarbon concentrations of oyster-shell pairs are statistically indistinguishable, therefore, there would be no isotope-effect error in oyster-shell dates. Absolute values, nevertheless, are lower than contemporary plant material at this time in Venezuela. This could have been caused either by tendency of dilution of contamination in ocean waters coming from S hemisphere, by uncontaminated modern waters near the surface or by dilution by deeper waters of non-modern age. More samples of this kind in future years could clarify this question.

## VI. EXTRATERRESTRIAL SAMPLES

**IVIC-821. Allende meteorite** **71.0 ± 4.2 dpm/kg**

Type III carbonaceous chondrite, fell 1:05 CST, 8 Feb. 1969, near Parral, state of Chihuahua, Mexico (27° 6′ N Lat, 105° 12′ W Long), At least 2 tons were recovered; 149g from surface taken for radiocarbon analysis. Chemical and mineralogic analyses have been pub. (Clarke *et al.*, 1970). Sample sent by R. Clarke, Smithsonian Inst., Washington, D.C. Carbon extracted by heating at ca. 1000°C for 2 days in oxygen stream with polyethylene plastic used as carrier. *Comment*: radiocarbon content is close to average value, 85dpm/kg, of other "fall" stone meteorites measured (Tamers, 1963). This is surprising due to largeness of

Allende. Since it is improbable that sample was exactly on surface of large body, we suspect that Allende reached the earth's atmosphere as colln. of smaller stones more or less uniformly irradiated for a long period by cosmic radiation. Allende represents largest stony meteorite fall in areal extent, pieces spreading over 300km$^2$.

**IVIC-842. Lost City meteorite** **40.8 ± 5.1 dpm/kg**

Type H-5 olivine-bronzite chondrite, fell evening of 3 Jan. 1970 near Lost City, Oklahoma (36° 0′ N Lat, 95° 6′ W Long) (Clarke, Jarosewich, and Nelen, 1971). Stony meteorite weighed 17.5kg; 94g from center sent by R. Clarke for radiocarbon analysis. Sample heated at 1000°C for 2 days in oxygen stream with polyethylene plastic carrier. *Comment*: radiocarbon content a little on low side, but still within normal range and reasonable compared with $O^{16}$ (p,3p) $C^{14}$ cross-section data. Low value could be because sample came from inner portion of meteorite.

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# MONACO RADIOCARBON MEASUREMENTS IV

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The following list of dates includes most of the samples processed from 1968 to 1972. Proportional counting is used and the counting gas is $CO_2$ at constant filling pressure of 740mmHg at 22°C (Thommeret *et al.*, 1969). Samples are counted at least twice on two different counters and errors quoted are averages of standard deviations obtained on each counting.

In 1970 the installations were entirely rebuilt and 3 quartz-lined proportional counters of 1.2L were constructed in the laboratory and are now in use. Counting results are periodically punched on tape and the dates calculated with the help of a small calculator.

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## SAMPLE DESCRIPTIONS

### I. GEOLOGIC SAMPLES

### *A. France*

**Continental shelf of Roussillon, Pyrénées Orientales**

Between Bear Cape (42° 31′ 00″ N Lat, 3° 08′ 20″ E Long) and Leucate Cape (42° 55′ 10″ N Lat, 3° 03′ 30″ E Long), the continental shelf (down to −120m) is spotted with Quaternary remnants. Some are crowned with large coral concretions that are covered by more recent sediment. Invasion of post-Würm sea shaped marine terraces and deposited layers of sand. Many cores 5 to 10m long, coll. from 1965 to 1970 and subm. by A. Monaco, Centre Recherches Séd. Marine, UER Sci., Perpignan, Pyrénées Orientales.

**MC-468. Core CLK 3, 155 to 175cm** **≥35,000**

Shell (*Cyprina islandica*) 155 to 175cm in Core CLK 3 (42° 55′ 35″ N Lat, 3° 29′ 00″ E Long), water depth 95m.

**MC-469. Core CLK 3, 330 to 350cm** **≥35,000**

Shell (*Cyprina islandica*) in deepest sandy to gravelly horizon, 330 to 350cm in core.

**MC-465. Core F 123, 210 to 230cm** **≥35,000**

Mixed marine shells (*Cyprina islandica, Turritella, Mytilus sp.*) in Core F 123 (42° 35′ 40″ N Lat, 3° 17′ 00″ E Long), 210 to 220cm in core, water depth 82m.

**MC-331. Core S 11, 250 to 300cm** **≥35,000**

Shelly sand, heterogeneous horizon, 250 to 300cm in Core S 11

(42° 41′ 30″ N Lat, 3° 16′ 15″ E Long), water depth 90m. *Comment* (A.M.): stratigraphically equivalent to MC-468 and MC-469.

**27,200 ± 1000**
**25,250 B.C.**

**MC-250. Core C 29**

Shell fragments (*Chlamys sp.*) included in siliceous eolian-sand matrix appearing as pebbles in several levels of Core C 29 (42° 43′ 10″ N Lat, 3° 7′ 35″ E Long) near outcropping rock of littoral zone, water depth 47m. *Comment* (A.M.): if the organisms, during their life, became embedded in the sandy matrix, age of gritty sediment agrees with paleogeographic data deduced from cores and seismic records.

**23,800 ± 1000**
**21,850 B.C.**

**MC-467. Core F 129, 510 to 540cm**

Mixed marine shells (*Venus, Turritella, Mytilus*) from whole sandy lower part, 510 to 540cm in Core F 129 (42° 31′ 40″ N Lat, 3° 13′ 00″ E Long), water depth 78m. *Comment* (A.M.): medium- to coarse-grained sand horizon pertains to facies called "offshore sands" or "Würm relict sands."

**18,300 ± 750**
**16,350 B.C.**

**MC-330. Core S 9, 50cm**

Shelly sand from depth 50cm in Core S 9 (42° 40′ 10″ N Lat, 3° 26′ 40″ E Long), water depth 90m. *Comment* (A.M.): dates gravelly sand horizon marking late Würm regression at outer border of Continental slope.

**12,900 ± 200**
**10,950 B.C.**

**MC-334. Core S 17, 400 to 450cm**

Shelly sand in 450cm long Core S 17 (42° 36′ 50″ N Lat, 3° 12′ 15″ E Long), 400 to 450cm in core, water depth 72m. *Comment* (A.M.): should date horizon of −70m submarine terrace shaped during postglacial transgression.

**10,500 ± 150**
**8550 B.C.**

**MC-335. Core S 19, 850cm**

Shelly sand from lower sand horizon in Core S 19, 850cm long. (42° 49′ 30″ N Lat, 3° 12′ 50″ E Long), water depth 60m. *Comment* (A.M.): could be same age as terrace at −55m.

**8400 ± 150**
**6450 B.C.**

**MC-466. Core F 128, 860 to 878cm**

Mixed shells (*Chlamys, Cardium, Venus*) in Core F 128 (all sand) (42° 31′ 10″ N Lat, 3° 9′ 00″ E Long), 860 to 878cm in core, water depth 40m. *Comment* (A.M.): date corresponds to stand of sea level characterized by bulky sand that projects through silt mantle in places (Bear and Leucate Capes).

**6000 ± 100**
**4050 B.C.**

**MC-332. Core S 13, 230 to 300cm**

Silty, shelly sand in Core S 13, 250cm long (42° 37′ 22″ N Lat, 3°

07′ 50″ E Long), 120 to 235cm in core, water depth 38m. *Comment* (A.M.): Flandrian silty facies.

**MC-303. Core C 29, 340 to 350cm** **1350 ± 60 A.D. 600**

Tiny lamellibranch and gasteropod shells in Core C 29 (42° 43′ 10″ N Lat, 3° 7′ 35″ E Long), 340 to 350cm in core, water depth 47m. *Comment* (A.M.): possible reworking of sediment in vicinity of Roche Lannier, an outcropping reef.

**MC-304. Dredging 5** $\delta C^{14}‰ = +13 \pm 10$

Lamellibranchs (*Pecten, Anomya*) form a dredged superficial deposit (42° 41′ 40″ N Lat, 3° 7′ 45″ E Long), water depth 45m, near Roche Lannier.

*General Comment* (A.M.): due to complexity of Quaternary stratigraphy and paleogeography shaped by eustatic sea levels on Roussillon continental shelf, interpretation of dates requires a large set of various analyses (Monaco, 1971; Monaco and Thommeret, 1969; Monaco *et al.*, 1972).

**Saint-Nazaire shore-pond sediment series**

Shells from various cores from coastal lake of Saint-Nazaire, coll. and subm. by F. Gadel, Centre Recherches Séd. Marine, UER Sci., Perpignan.

**MC-397. Saint-Nazaire 1** **2750 ± 90 800 B.C.**

Shells (*Cardium*) in a transition shell layer, from depth 235cm in Core CM (42° 39′ 3″ N Lat, 3° 15′ E Long). Coll. 1967.

**MC-396. Saint-Nazaire 2** **4360 ± 90 2410 B.C.**

Shells (*Cardium*) in a transition shell layer, from 380cm in same core as MC-397.

**MC-517. Saint-Nazaire 3** **2870 ± 90 920 B.C.**

Shells (*Cardium*) from depth 205 to 220cm in Core CH (42° 39′ 40″ N Lat, 3° 1′ 20″ E Long). Coll. 1968.

**MC-518. Saint-Nazaire 4** **4300 ± 70 2350 B.C.**

Shells (*Cardium*) from depth 370 to 390cm in same core as MC-517.

**MC-519. Saint-Nazaire 5** **3670 ± 80 1720 B.C.**

Marine shells of lagoonal ooze in Core CD (42° 41′ 10″ N Lat, 3° 0′ 10″ E Long), from depth 186 to 200cm. Coll. 1967.

**MC-417. Saint-Nazaire 6** **4800 ± 150 2850 B.C.**

Marine shells in silty Core CK (42° 40′ 40″ N Lat, 3° 30′ E Long), depth 50cm in core. Coll. 1968.

*General Comment* (F.G.): in central part of Saint-Nazaire shore-pond, sedimentation rates in recent layers are from 75 to 80cm/millennium (CH and CK cores) in comparison to 90 to 110cm for deeper oozes in same cores, suggesting quieter conditions for former deposits. In N part of lagoon a slower rate (40cm/millennium in Cores CD and CJ) was found despite fluvial supplies. This may be explained by temporary summer uncovering periods inducing compaction of dry sediment followed by wind erosion.

**Golfe du Lion α core series**

Piston core 19m long, coll. 1969 on continental shelf of Golfe du Lion (43° 13′ 25″ N Lat, 4° 10′ 45″ E Long), water depth 88m, by O. V. Terebel for CFP and subm. by F. Gadel.

**MC-413. Golfe du Lion α core 7.00m** — **7780 ± 100**; **5830 B.C.**

Shells (*Turritella*) in gray silt at 7.00m below surface sediment.

**MC-414. Golfe du Lion α core 12.80m** — **12,240 ± 180**; **10,290 B.C.**

Serpulid calcareous tubes at core depth 12.80m.

**MC-415. Golfe du Lion α core 17.50m** — **25,300 ± 800**; **23,350 B.C.**

Shell fragments at core depth 17.50m.

*General Comment* (F.G.): since 12,000 B.P. sedimentation rate in this place is 1m/millennium. Before 12,000 B.P., sedimentation rate was 35 to 40cm/millennium; but compaction must be considered.

**Bages-Sigean shore-pond sediment series**

**MC-515. Bages-Sigean E 3** — **1250 ± 70**; **A.D. 700**

Mixed marine shells (*Rissoa, Lucina, Cardium*) from depth 80 to 90cm in silt, Sta. E, water depth 1m (43° 6′ 20″ N Lat, 3° 0′ E Long). Coll. 1968 by G. Cahet, Lab. Arago, Banyuls sur Mer, Pyrénées Orientales.

**MC-516. Bages-Sigean C 3** — **650 ± 60**; **A.D. 1300**

Mixed marine shells (*Rissoa, Lucina, Cardium*) from depth 80 to 90cm in sediment, Sta. C, water depth 2m (43° 5′ 25″ N Lat, 2° 59′ 29″ E Long). Coll. 1968 by G. Cahet.

*General Comment* (F.G.): sedimentation rate depends on position in lagoon and water depth. Rates near shore at Sta. C, which is influenced by fluvial supplies from the Berre R., are twice as great as in the shallow water of Sta. E.

**Continental shelf of Provence**

Between Rhône delta and S shore of Massif des Maures at depths from 200 to 300m are found, as fossils, North Atlantic shell species, now extinct in the Mediterranean. Cores and dredging from continental slope or from canyon rims yielded shells of these species, subm. 1967 to 1971 by C. Froget, Lab. Géol. Marine, Univ. Marseille-Luminy (Blanc, Froget, and Gien, 1967).

**Provence Core B 11-67 series**

Piston core of silty sand, coll. and subm. 1967, in upper part of continental slope (43° 08′ 40″ N Lat, 5° 25′ 30″ E Long) S of Bec de Sormiou, water depth 90m.

**MC-243. Core B 11-67, 210cm** — **13,050 ± 300** / **11,100 B.C.**

Shells (*Cyprina islandica*), 210cm in core.

**MC-242. Core B 11-67, 250cm** — **12,170 ± 300** / **10,220 B.C.**

Shells (*Cyprina islandica*), 250cm in core.

*General Comment* (C.F.): ages do not agree with depth in sediment. Reworking is a possible explanation.

**Provence shelf Core series**

Sandy and silty piston core (42° 58′ 49″ N Lat, 3° 58′ 26″ E Long) in S of delta of Rhône R., water depth 96m.

**MC-356. Provence shelf Core, 90cm** — **10,350 ± 200** / **8400 B.C.**

Shell (*Cyprina islandica*), 90cm in core.

**MC-357. Provence shelf Core, 230cm** — **21,300 ± 700** / **19,350 B.C.**

Shell (*Cyprina islandica*), 230cm in core.

**Provence continental shelf dredging series**

**MC-348. Dredging R 30** — **12,200 ± 300** / **10,250 B.C.**

Shells (*Venus casina*) dredged Sept. 1966 (42° 58′ 10″ N Lat, 5° 42′ 30″ E Long), water depth 250m, on the E border of Plateau des Blauquières.

**MC-245 A. Dredging S of Bandol, Var** — **13,140 ± 160** / **11,190 B.C.**

Shells (*Venus casina*) dredged Sept. 1966 (42° 58′ 15″ N Lat, 5° 41′ 30″ E Long), water depth ca. 250m.

**MC-245 B. Dredging S of Bandol** — **12,470 ± 190** / **10,520 B.C.**

Shells (*Glycimeris glycimeris*) from same dredging as MC-245.

**MC-244. Dredging Cassidaigne, Bouches du Rhône** — **13,095 ± 300** / **11,145 B.C.**

Shells (*Cyprina islandica*) dredged Oct. 1967 (43° 07′ 30″ N Lat, 5° 26″ 10″ E Long), water depth from 300 to 150m on W rim of Canyon de Cassidaigne.

**MC-246 A. Dredging Cassidaigne CF 86** **6400 ± 100**
**4450 B.C.**

Shells (*Venus casina*) dredged April 1967 (43° 05′ 00″ N Lat, 5° 31′ 00″ E Long), water depth from 250 to 200m on E rim of Canyon de Cassidaigne, sample deeply worm-pitted.

**MC-246 B. Dredging Cassidaigne CF 86** **6970 ± 100**
**5020 B.C.**

Uncorroded shell (*Venus casina*). *Comment*: no significant age difference between corroded and non-corroded shells.

**MC-247. Dredging Cassidaigne CF 16** **9600 ± 100**
**7650 B.C.**

Calcareous tubes of shell-worm (*Ditrupa arietina*) dredged (43° 01′ 15″ N Lat, 5° 30′ 10″ E Long), water depth from 240 to 220m on E edge of Canyon de Cassidaigne.

**MC-248. Dredging Cassidaigne R 178** **5600 ± 100**
**3650 B.C.**

Shells of unid. large oysters, supposedly of Tertiary age dredged 1966 (43° 07″ 30″ N Lat, 5° 29′ 00″ E Long), water depth from 600 to 500m. *Comment* (C.F.): quoted age is probably correct, though estimated age was much greater. Oysters were attached to sandstone block dated 27,900 B.P. (MC-434).

**MC-358. Dredging Cassidaigne F 5** **10,000 ± 150**
**8050 B.C.**

Shells (*Modiolus modiolus*) dredged Jan. 1967 (43° 06′ 10″ N Lat, 05° 27′ 20″ E Long), water depth from 250 to 150m, on W rim of Canyon de Cassidaigne.

**MC-359. Dredging Cassidaigne F 4** **⩾35,000**

Shell (*Cyprina islandica*). Coll. March 1969 in same zone as Dredging F 5, water depth ca. 345m. Shell all pitted and bored by worms.

**MC-360. Dredging Cassidaigne F 3** **11,000 ± 200**
**9050 B.C.**

Shell (*Panopea norvegica*) dredged Aug. 1967 (43° 05′ N Lat, 5° 30′ 50″ E Long), water depth from 350 to 150m.

**MC-361. Dredging Cassidaigne F 2** **9800 ± 200**
**7850 B.C.**

Shell (*Buccinum undatum*). Coll. March 1968 (43° 06′ 40″ N Lat, 5° 32′ E Long).

**MC-362. Dredging Cassidaigne F 1** **$\delta C^{14}‰ = +21 \pm 8$**

Shells (*Venus casina*) coll. alive May 1969 (43° 07′ N Lat, 5° 32′ 30″ E Long) in dredging of same zone as F 4 (MC-359) and F 5 (MC-358), water depth ca. 135m on E edge of Canyon de Cassidaigne.

*General Comment* (C.F.): North Atlantic species of shells cored or dredged in top part of continental slope (Plateau des Blauquières, top of Canyon de Cassidaigne) at depth from 300 to 200m and dated as Würm are also found as shell accumulations, dated from 13,000 to 10,000 B.P., corresponding to milder postglacial climate (Dryas I, Allerød, Dryas II) that induced their extinction. At that time, sea level was 80m lower than at present. Some species (*Venus casina, Glycimeris glycimeris, Ditrupa arietina*), always present in the Mediterranean, survived these climatic changes up to the present, although they are found at unusual depth. *Venus casina,* coll. alive is relic of these populations (Froget *et al.,* 1972).

**Provence continental shelf Core D 11-67 series**

Piston core 370cm long coll. 1967 (43° 04′ 30″ N Lat, 5° 22′ E Long) water depth 140m on ridge of continental shelf, S of Marseille, Bouches du Rhône, subm. by C. Froget.

**MC-351. Core D 11-67, 0 to 11cm** — **16,200 ± 360** — **14,250 B.C.**

Free calcareous algae.

**MC-352. Core D 11-67, 22 to 35cm** — **16,100 ± 360** — **14,150 B.C.**

Free calcareous algae.

**MC-439. Core D 11-67, 40 to 50cm** — **19,350 ± 700** — **17,400 B.C.**

Calcareous algae.

**MC-438. Core D 11-67, 50 to 60m** — **27,700 ± 1500** — **25,750 B.C.**

Calcareous algae.

**MC-437. Core D 11-67, 70 to 80cm** — **27,200 ± 1500** — **25,250 B.C.**

Mixed sample of polychaete worm tubes (*Salmacina*) and bryozoan tubes (*Hippodiplosia fascialis* P).

**MC-436. Core D 11-67, 80 to 90cm** — **30,700 ± 1800** — **28,750 B.C.**

Coarse calcareous sand, grain-size fraction > 0.5mm.

**MC-435. Core D 11-67, 90 to 100cm** — **30,300 ± 1800** — **28,350 B.C.**

Bryozoans.

**MC-353. Core D 11-67, 120 to 130cm** — **28,000 ± 1700** — **26,050 B.C.**

Calcareous sand, grain-size fraction > 2mm.

**MC-355. Core D 11-67, 340 to 350cm** — **29,300 ± 1600** — **27,350 B.C.**

Bryozoans (*Hippodiplosia fascialis*).

*General Comment* (C.F.): dating technique probably reaches its limit at core depth 1m. Thus, calculated sedimentation rate is poor and variable: ca. 12cm/1000 yr from 0 to 50cm and 2 to 3cm/1000 yr from 40 to 60cm. Results agree with pteropod distributions in core: N Atlantic pteropod (*Spiratella retroversa*) is only species found at core depths > 40cm.

**Golfe du Lion Piston Core 9-68 series**

Piston core 1850cm long, coll. Sept. 1968 (43° 13′ 25″ N Lat, 4° 10′ 45″ E Long), water depth 88m, ca. 50km SE Montpellier. Sandy silt, mostly from Rhône Delta, with shell debris. Subm. 1971 by C. Froget.

**MC-428. Core 9-68, 300cm** — **6900 ± 150**, **4950 B.C.**

Unid. shell fragments.

**MC-429. Core 9-68, 700cm** — **7700 ± 140**, **5750 B.C.**

Unid. shell fragments.

**MC-430. Core 9-68, 1500cm** — **19,000 ± 250**, **17,050 B.C.**

Shell fragments (*Cyprina islandica*).

**MC-431. Core 9-68, 1700cm** — **31,500 ± 3000**, **29,550 B.C.**

Shell fragments (*Cyprina islandica*).

**MC-432. Core 9-68, 1800cm** — **13,300 ± 250**, **11,350 B.C.**

Unid. shell fragments.

*General Comment* (C.F.): compared to Core D 11-67, sedimentation rate is much higher (ca. 1m/1000 yr) from 300 to 1500cm. The 1700cm level (MC-431) appears older than surrounding ones: 1500cm (MC-430) and 1800cm (MC-432) suggesting reworking. Appearance of N Atlantic pteropod (*Spiratella retroversa*), 900cm, agrees with age in core.

**Provence littoral zone consolidated formations**

**MC-347. Saint-Cyr-les-Lecques, Var** — **⩾35,000**

Shells (*Patella ferruginea*) from fossil beach of cemented sand and pebbles covered by consolidated dune sand formation (43° 10′ 20″ N Lat, 5° 41′ 40″ E Long), alt. +3m. Coll. and subm. 1969 by C. Froget.

**MC-433. Cavalaire, Var** — **24,400 ± 1000**, **22,450 B.C.**

Fragments of dredged shelly sandstone (43° 06′ 30″ N Lat, 6° 33′ 30″ E Long), water depth 220m, S of Cap Cavalaire. Coll. and subm. 1969 by C. Froget. *Comment*: dates a submarine lithification.

**MC-434. Cassidaigne, Bouches du Rhône** — **27,900 ± 1100**, **25,950 B.C.**

Unid. shell fragments extracted from dredged sandstone cobbles (43° 07′ N Lat, 5° 31′ E Long), water depth from 400 to 350m, in Canyon de Cassidaigne. Coll. and subm. 1969 by C. Froget. *Comment* (C.F.): dates a submarine lithification.

**MC-349. Isle of Riou 1** — **1200 ± 130**, **A.D. 750**

Calcareous, slightly cemented algae from sea floor, −18m, Plateau des Chèvres (43° 11′ 10″ N Lat, 5° 24′ 30″ E Long) near Isle of Riou, Bouches du Rhône. Coll. and subm. 1969 by C. Froget.

**MC-350. Isle of Riou 2** **1300 ± 130**
**A.D. 650**

Calcareous algae from area of MC-349, water depth 15m. Coll. and subm. 1969 by C. Froget. *Comment* (C.F.): dates for submarine rocks (MC-454, -434, -349, -350) vary from 1200 to 27,900 yr B.P. and confirm a submarine medium of consolidation if their present depth is considered. They aid study of diagenesis of carbonaceous sediment in this medium.

**Isle of Riou Cardial site series, Bouches du Rhône**

Marine shells from open-air habitat, nearly destroyed by removal of sand from a 19th century sand pit (43° 10′ 50″ N Lat, 5° 23′ E Long), alt. ca. +25m in NW Isle of Riou, near Marseille. Rough early cardial pottery and poor lithic industry remains: milling stones cut in Quaternary sandstone blocks not found on island. Coll. and subm. by C. Froget.

**MC-440. Isle of Riou Cardial Site 1** **7600 ± 100**
**5650 B.C.**

Shells (*Patella caerulea*).

**MC-441. Isle of Riou Cardial Site 2** **7400 ± 100**
**5450 B.C.**

Shells (*Patella lusitanica*).

*General Comment* (C.F.): dates agree with pottery for early cardial campsite. At that time sea level was ca. 20m lower than at present and island was connected to land (Courtin and Froget, 1970).

**Cap Ragnon cave, Bouches du Rhône**

Shells from early cardial Neolithic habitat in cave of Cap Ragnon, Le Rove, NW coast, bay of Marseille (43° 21′ N Lat, 5° 16′ E Long). Coll. 1970 and subm. 1971 by J. Courtin, CNRS, Marseille.

**MC-500 A.** **7970 ± 130**
**6020 B.C.**

Shells (*Patella caerulea*).

**MC-500 B.** **7650 ± 150**
**5700 B.C.**

Shells (*Trococochlea turbinata*).

*Comment*: dates agree with others of cardial site in Ile Riou (MC-440: 7600 B.P.; MC-441: 7400 B.P.).

**Grotte des Trémies, Cassis, Bouches du Rhône**

Large submarine cave (43° 12′ 12″ N Lat, 5° 30′ 42″ E Long), at base of overhanging cliff. In midst of cave at −18m a 50cm diam. well, cored with a sucking pump in Versilian sediment 5m thick, stopped at −24m depth on large blocks and hard cryoclastic sediments of Würm age. Samples coll. and subm. 1970 by E. Bonifay, lab. Géol. Marine, Univ. Marseille-Luminy.

**MC-377 A. Grotte des Trémies, 50 to 100cm** — **1290 ± 90 / A.D. 660**

Coral (*Corallium rubrum*), 50 to 100cm in core.

**MC-377 B. Grotte des Trémies, 50 to 100cm** — **1200 ± 70 / A.D. 750**

Opercula of *Turbo opercularis.*

**MC-378 A. Grotte des Trémies, 100 to 150cm** — **1980 ± 90 / 30 B.C.**

Coral (*Corallium rubrum*).

**MC-378 B. Grotte des Trémies, 100 to 150cm** — **2040 ± 80 / 90 B.C.**

Opercula of *Turbo.*

**MC-379. Grotte des Trémies, 150 to 200cm** — **2730 ± 80 / 780 B.C.**

Opercula of *Turbo.*

**MC-380. Grotte des Trémies, 200 to 250cm** — **4050 ± 100 / 2100 B.C.**

Opercula of *Turbo.*

**MC-381. Grotte des Trémies, 250 to 300cm** — **4760 ± 100 / 2810 B.C.**

Opercula of *Turbo.*

**MC-382. Grotte des Trémies, 300 to 350cm** — **4820 ± 100 / 2870 B.C.**

Opercula of *Turbo.*

**MC-383. Grotte des Trémies, 350 to 400cm** — **5520 ± 100 / 3570 B.C.**

Opercula of *Turbo.*

**MC-384. Grotte des Trémies, 400 to 450cm** — **5720 ± 100 / 3770 B.C.**

Opercula of *Turbo.*

**MC-385. Grotte des Trémies, 450 to 500cm** — **5730 ± 100 / 3780 B.C.**

Opercula of *Turbo.*

*General Comment* (E.B., J.T.): in Grotte des Trémies Versilian sedimentation begins ca. 5800 B.P. (–23m). First appearance of coral (200 to 250cm) only begins after complete submergence of cave, *i.e.*, –7m sea level ca. 4000 B.P. (MC-380). Reduced sedimentation rate above –7m sea level should indicate a longer stand of sea at that level (Bonifay *et al.*, 1971).

**MC-329. Golfe de Frejus, Var** — **11,800 ± 200 / 9850 B.C.**

Lamellibranch shells (*Cardium glaucum*) in upper silty sand 43 to 51cm in Core DRA P 20 (43° 23′ N Lat, 6° 45′ 42″ E Long), 3km offshore Saint Aygulf, Var. Core from top of continental slope, water depth 100m.

Coll. and subm. 1967 by G. Bellaiche, Centre de Recherches Géodynamiques, Villefranche-sur-Mer. *Comment* (G.B.): silty sand corresponding to an acoustic-reflection layer detected throughout Gulf by "mud penetrator," was deposited, as supposed, at end of Würm IV, more precisely during Dryas (Bellaiche *et al.*, 1969).

**MC-314. Saint Tropez, Var** **11,700 ± 100**
**9750 B.C.**

Shells (*Venus casina*) from a shelly sand 315 to 320cm in Core DRA P 71 (43° 18′ N Lat, 6° 40′ E Long), water depth 100m. Coll. and subm. 1967 by G. Bellaiche. *Comment* (G.B.): structure and age of sandy layer dated in DRA P 20 (MC-329) from lower Argens Valley are very similar to this layer from top of canyon of Saint Tropez (Bellaiche, 1971).

**MC-315. Open-sea core DRA P 5** **⩾30,000**

Fraction > 40μ shelly sand from 610 to 615cm, in Core CAP P 5 (42° 58′ N Lat, 6° 48′ E Long), water depth 2500m. Abyssal plain of Isle of Levant. Coll. and subm. 1967 by G. Bellaiche.

**Grotte du Corail, Villefranche-sur-Mer**

Grotte du Corail, a submarine cave, (43° 41′ 30″ N Lat, 7° 18′ 30″ E Long), in bay of Villefranche, Alpes Maritimes, at foot of Mont Boron, opens at ca. –26m. Silty sediment of floor of cave, manually cored down to bedrock by divers, yielded many shell remains. Core 69 coll. and subm. 1969; Core 70 coll. and subm. 1970 by H. De Lumley, Fac. Sci., Marseille.

**Grotte du Corail Core 69 series**

**MC-371. Grotte du Corail C 69, 35cm** **3150 ± 80**
**1200 B.C.**

Lamellibranch and gastropod shells, level 35cm in core, water depth (absolute level) 22.75m.

**MC-370. Grotte du Corail C 69, 120cm** **5040 ± 100**
**3090 B.C.**

Madreporeans, water depth 23.60m.

**MC-369. Grotte du Corail C 69, 160cm** **5650 ± 80**
**3700 B.C.**

Madreporeans, water depth 24m.

**MC-368. Grotte du Corail C 69, 200cm** **5850 ± 70**
**3900 B.C.**

Lamellibranch shells, water depth 24.40m.

**MC-367. Grotte du Corail, C 69, 250cm** **6100 ± 100**
**4150 B.C.**

Lamellibranch shells, water depth 24.90m.

**MC-366. Grotte du Corail C 69, 310cm** **5650 ± 100**
**3700 B.C.**

Lamellibranch and gastropod shells, water depth 25.50m. Difficulties encountered in coring disturbed the sampling.

6080 ± 100
**MC-365. Grotte du Corail C 69, 350cm** 4130 B.C.

Lamellibranch shells, water depth 25.90m. Same remark as for MC-366.

**Grotte du Corail Core 70 series**

3060 ± 60
**MC-449. Grotte du Corail C 70, 50cm** 1110 B.C.

Opercula of *Turbo* and lamellibranch shells, depth 50cm in core, water depth (absolute level) 21.10m.

3800 ± 90
**MC-450. Grotte du Corail C 70, 100cm** 1850 B.C.

Opercula of *Turbo*, water depth 21.60m.

4750 ± 100
**MC-452. Grotte du Corail C 70, 150cm** 2800 B.C.

Opercula of *Turbo* and lamellibranch shells, water depth 22.10m.

4930 ± 100
**MC-454. Grotte du Corail C 70, 200cm** 2980 B.C.

Lamellibranch shells and corals (*Corallium rubrum*), water depth 22.60m.

5670 ± 110
**MC-456. Grotte du Corail C 70, 250cm** 3720 B.C.

Opercula of *Turbo* and *Arca* sp. shells, water depth 23.10m.

7150 ± 130
**MC-458. Grotte du Corail C 70, 300cm** 5200 B.C.

Fraction of shelly sand > 0.75mm, water depth 23.60m.

*General Comment* (H.L.): cave was filled by silty submarine sediment from 6080 (middle Atlantic) to 3060 B.P. (end of Boreal). Results show that sea level was already higher than −26m (floor of cave) ca. 6100 B.P.

**Grotte du Mérou, Core M 70 series, Villefranche-sur-Mer**

Submarine cave (43° 41′ 30″ N Lat, 7° 19′ 13″ E Long) on W cliff of Cap Ferrat in bay of Villefranche. Opening ca. −26m. Many similarities with Grotte du Corail in same bay. Sediment Coring M 70 by free divers yielded many shells, subm. 1971 by H. de Lumley.

1900 ± 70
**MC-443. Grotte du Mérou M 70, 70cm** A.D. 50

Opercula of *Turbo*, depth 70cm in core, water depth 24.80m.

3030 ± 80
**MC-444. Grotte du Mérou M 70, 100cm** 1080 B.C.

Opercula of *Turbo*, water depth 25.10m.

5860 ± 100
**MC-446. Grotte du Mérou M 70, 120cm** 3910 B.C.

Lamellibranch shells and opercula of *Turbo*, water depth 25.30m.

**MC-447. Grotte du Mérou M 70, 150cm** **6050 ± 100**
**4100 B.C.**

Lamellibranch and gastropod shells, water depth 25.60m.

**MC-448. Grotte du Mérou M 70, 170cm** **5320 ± 110**
**3370 B.C.**

Gastropod shells, water depth 25.80m.

*General Comment* (H.L.): disturbed chronology of sediments probably results from difficulties in manual coring. Chronology of filling similar to Grotte du Corail; same conclusion applies.

**Grotte Huet series, Golfe Juan**

Submarine cave opening at −30m on cliff wall of submerged reef le Secanion (43° 32′ 29″ N Lat, 7° 6′ 7″ E Long) offshore Juan les Pins, Alpes Maritimes. At base of cave, 18m from entrance, continental deposits hardened in breccia and covered with flowstone dated older to younger Dryas 14,690 B.P. (Ly-403) and 10,500 B.P. (Ly-404) by J. Evin. Free divers manually cored silty marine sediments beneath porch of cave and found many shells; subm. 1972 by H. de Lumley.

**MC-535. Grotte Huet 3 C, 50cm** **2670 ± 90**
**720 B.C.**

Gastropod shells, water depth 27.50m.

**MC-538. Grotte Huet 9 C, 160cm** **3810 ± 70**
**1860 B.C.**

Lamellibranch shells and opercula of *Turbo,* water depth 28.60m.

**MC-539. Grotte Huet 11 C, 200cm** **4340 ± 100**
**2390 B.C.**

Lamellibranch shells, water depth 29m.

**MC-543. Grotte Huet 25 C, 270cm** **4900 ± 100**
**2950 B.C.**

Gastropod and lamellibranch shells, water depth 29.70m.

**MC-544. Grotte Huet 26 C, 280cm** **5000 ± 100**
**3050 B.C.**

Gastropod and lamellibranch shells, water depth 29.80m.

**MC-545. Grotte Huet 27 C, 300cm** **5480 ± 100**
**3530 B.C.**

Gastropod and lamellibranch shells, water depth 30m.

**MC-546. Grotte Huet 28 C, 315cm** **6050 ± 130**
**4100 B.C.**

Gastropod and lamellibranch shells, water depth 30.15m.

*General Comment* (H.L.): invasion of Flandrian sea in cave occurred during Preboreal or Boreal.

*B. Other Countries*

**Capo Mele series, Ligurian Sea, Italy**

Calcareous organic matter from Core DRA P 10 (43° 55′ N Lat, 8° 14′ E Long) in Ligurian Sea, offshore Capo Mele, water depth 284m. Coll. and subm. 1968 by C. Vergnaud-Grazzini, Lab. Géol. Dynamique, Fac. Sci., Paris.

**MC-249A. Capo Mele 1** — **18,300 ± 300** / **16,350 B.C.**

Tests of Madreporeans (*Retepora cellulosa*) in top of sediment.

**MC-249B. Capo Mele 2** — **16,800 ± 500** / **14,850 B.C.**

Serpulid tubes from same horizon as MC-249 A. Diluted sample, 48% inactive gas.

**MC-286. Capo Mele 3** — **27,400 ± 1100** / **25,450 B.C.**

Mixed marine shells, 415 to 420cm in core.

**MC-288. Capo Mele 4** — **⩾35,000**

Lamellibranch shells and serpulid tubes at base of core (depth > 480cm).

*General Comment* (C.V.G.): mean paleotemperature of sea surface (+9°C) recorded on foraminiferal species from whole core, lower ca. 10°C from mean present surface temperature, indicates complete deposit of sediment during cold Würm III and agrees with dates (Vergnaud-Grazzini *et al.*, 1970).

**MC-336. Lignano Beach, North Adriatic Sea, Italy** — **3200 ± 90** / **1250 B.C.**

Marine shells of submerged beach offshore Lignano barrier (45° 42′ N Lat, 13° 14′ E Long), water depth not > 10m. May date old coastline. Coll. 1967 and subm. 1969 by A. Stefanon, Ist. Biol. Mare, Venezia, Italy.

**Mar Menor series, Murcia, Spain**

Marine shells (mostly *Cardium*) of Cores M 6, M 45, M 47, M 61, in coastal lake Mar Menor, Prov. Murcia, Spain. Coll. 1969 and subm. 1971 by J. Simonneau, Centre Recherches Séd. Marine, UER Sci. Perpignan, Pyrénées Orientales.

**MC-470. Mar Menor M 6, 66 to 119cm** — **3600 ± 80** / **1650 B.C.**

Shells (*Cerithium vulgatum*) Core M 6 (37° 40′ 22″ N Lat, 0° 53′ 30″ E Long), 66 to 119cm in core.

**MC-471. Mar Menor M 45, 20 to 35cm** — $\delta C^{14}‰ = +99 \pm 15$

Shells (*Cardium*) Core M 45, (37° 40′ N Lat, 2° 56′ 35″ E Long).

**MC-472. Mar Menor M 45, 35 to 55cm** — $\delta C^{14}‰ = +40 \pm 8$

**MC-473. Mar Menor M 45, 70 to 91cm** **1420 ± 80**
**A.D. 530**

**MC-474. Mar Menor M 45, 125 to 149cm** **2200 ± 100**
**250 B.C.**

**MC-475. Mar Menor M 45, 149 to 180cm** **2700 ± 100**
**750 B.C.**

**MC-476. Mar Menor M 47, 0 to 24cm** $\delta C^{14}‰ = +7 \pm 7$

Shells (*Cardium*), Core M 47 (37° 40′ N Lat, 0° 55′ 26″ E Long).

**MC-477. Mar Menor M 47, 70 to 90cm** **635 ± 60**
**A.D. 1315**

**MC-478. Mar Menor M 47, 90 to 113cm** **2300 ± 90**
**350 B.C.**

**MC-480. Mar Menor M 61, 20 to 40cm** **60 ± 60**
**A.D. 1890**

Shells (*Cardium*), Core M 61 (37° 43 ′23″ N Lat, 0° 53′ 16″ E Long).

**MC-481. Mar Menor M 61, 89 to 147cm** **1600 ± 80**
**A.D. 350**

Mixed marine shells.

**MC-363. Bay of Dumbea, New Caledonia** **4690 ± 90**
**2740 B.C.**

Coral at base of 260cm long Core 9 (22° 13′ 30″ S Lat, 166° 22′ 40″ E Long), water depth 15m Bay of Dumbea. Coll. 1968 and subm. 1970 by J. Launay, ORSTOM, Nouméa, New Caledonia. *Comment* (J.L.): although sample was cored in hard coral reef surface, beneath 260cm of sediment, no conclusion can be drawn about sea level. A mean rate of 50cm/millennium can be assessed at the site for accumulation of Dumbea R. sediments (Launay, 1971).

## II. ARCHAEOLOGIC SAMPLES

### *A. France*

**Abri de Saint Mitre No. 3 series, Basses Alpes**

Charcoal from several hearths in No. 3 shelter of Saint Mitre (43° 53′ N Lat, 5° 39′ E Long). Coll. and subm. by A. Calvet, CEA, Cadarache, Bouches du Rhône.

**MC-263. Abri de Saint Mitre No. 3, 1** **6400 ± 100**
**4450 B.C.**

Layer Y 10, Hearth 3.

**MC-264. Abri de Saint Mitre No. 3, 2** **6700 ± 130**
**4750 B.C.**

Layer Z 8/9, elliptical Hearth 3: 2x1m covered with 10cm thick stone layer.

**MC-265. Abri de Saint Mitre No. 3, 3** **6100 ± 120**
**4150 B.C.**

Layer Y 11, Hearth 6.

*General Comment* (A.C.): date, 4000 B.C. (MC-202) for Hearth F 4 in same shelter suggests continuous human occupation for at least 750 yr. Dates agree with Cardial pottery sherds (Calvet and Guilaine, 1970).

**Shelter of Font-Juvénal series, Conques, Aude**

Charcoal from archaeologic layers of rich stratigraphic sequence in rock shelter of Font-Juvénal (43° 17′ 46″ N Lat, 2° 20′ 54″ E Long), Conques, Aude. Coll. and subm. 1971 by J. Guilaine, CNRS, Carcassonne, Aude.

**MC-490. Font-Juvénal, C 2 b** **4400 ± 100**
**2450 B.C.**

Charcoal from Layer C 2 b (H 6, H 7), with Campaniform vases of Pyrenean design.

**MC-491. Font-Juvénal, C 3** **4200 ± 90**
**2250 B.C.**

Charcoal from Layer C 3 (H 7). Verazian level, characterized by late Neolithic "pastoral" facies as found in W Languedoc, France.

**MC-492. Font-Juvénal C 4** **3620 ± 90**
**1670 B.C.**

Charcoal from hearth in Layer C 4 (H 6). Verazian level.

**MC-493. Font-Juvénal, C 5** **4490 ± 80**
**2540 B.C.**

Charcoal from Layer C 5 (H 7). Two cultural groups present in same layer: Gourgasian (awry point) and Ferrières (incised chevron adorned pottery).

**MC-494. Font-Juvénal, C 12** **4570 ± 90**
**2620 B.C.**

Charcoal from Layer C 6 (H 7). Transitional level above Upper Chassean facies.

**MC-495. Font-Juvénal, C 7 a** **4860 ± 90**
**2910 B.C.**

Charcoal from Layer C 7 a (H 7). Upper Chassean facies.

**MC-496. Font-Juvénal, C 8** **4800 ± 150**
**2850 B.C.**

Charcoal from Layer C 8 (H 6). Upper Chassean facies.

**MC-497. Font-Juvénal, C 10** **5350 ± 100**
**3400 B.C.**

Charcoal from base of Layer C 10 (H 8). Furniture pertains to classical Chassean culture of Languedoc, similar to La Madeleine type: engraved ornaments on plates and clear-silex tools.

**MC-498. Font-Juvénal, C 11** **5540 ± 100**
**3590 B.C.**

Charcoal from hearth in Layer C 11 (H 8). Chassean horizon with smooth pottery, anterior to typical "Languedocian" facies.

**MC-499. Font-Juvénal, C 12** **5850 ± 100**
**3900 B.C.**

Charcoal from Layer C 12 (H 8). Epicardial industry anterior to older Chassean.

*General Comment* (J.G.): chronologic sequence yields dates for several Languedocian civilizations at site: Chassean, Gourgasian, Ferrières, Vérazian, Campaniform.

*B. Italy*

**MC-402. Grotte des Enfants, Grimaldi** **12,200 ± 400**
**10,250 B.C.**

Shells (*Monodonta turbinata*) from burial level of female skeleton, Hearth B, Grotte des Enfants (43° 47′ 00″ N Lat, 7° 32′ 20″ E Long), Grimaldi, near Vintimiglia, Italy. Coll. by E. Rivière and subm. 1971 by L. Barral, Mus. Anthropol. Monaco. *Comment*: age agrees with Mesolithic industry and with fauna colder than present (*Cervus elaphus, Rangifer tarandus* . . .).

*C. Lebanon*

**Ksar'Aqil series**

Bones and terrestrial shells from shelter cave of Ksar'Aqil (33° 55′ N Lat, 35° 37′ E Long) Antelias, 10km from Beirut, Lebanon. Coll. 1970 and subm. by J. Tixier, Mus. Hist. Nat., Inst. Paleontol. Humaine, Paris (Braidwood *et al.*, 1951; Tixier, 1970).

**MC-411. Ksar'Aqil, I 4, IV-VII** **14,100 ± 500**
**12,150 B.C.**

Bones from Layer C, 350 to 355cm. *Comment*: organic fraction. Agrees with relative chronology.

**MC-410. Ksar'Aqil, J 8-9, 3b medium** **24,400 ± 900**
**22,450 B.C.**

Terrestrial shells (*Helix* sp.) from Layer 3b, 280 to 290cm. *Comment*: carbonate fraction. Diasagrees with expected date and should be rejected.

*D. Algeria*

**Medjez II series, Saint Arnaud, Sétif**

Charcoal from large snailery of El Eulma, Sétif, E Algeria (36° 08′ N Lat, 5° 40′ E Long). Continuous stratigraphic layers 365cm thick showing evolution of lithic and bone tools throughout more than 2000 yr of Upper Capsian civilization. Coll. and subm. 1969 by G. Camps, LAPEMO, Aix en Provence, France, (Camps *et al.*, 1968).

**MC-318. Medjez II, 10, 100 to 125cm** **7030 ± 120**
**5080 B.C.**

**MC-319. Medjez II, 11, 125 to 150cm** **7570 ± 160**
**5620 B.C.**

**MC-320. Medjez II, 12, 150 to 175cm** **8230 ± 130**
**6280 B.C.**

**MC-321. Medjez, II, 13, 175 to 200cm** **7280 ± 140**
**5330 B.C.**

**MC-322. Medjez II, 14, 200 to 225cm** **7610 ± 140**
**5660 B.C.**

**MC-323. Medjez II, 15, 225 to 250cm** **7280 ± 120**
**5330 B.C.**

**MC-325. Medjez II, 17, 275 to 300cm** **7860 ± 120**
**5910 B.C.**

**MC-326. Medjez II, 18, 300 to 325cm** **8550 ± 150**
**6600 B.C.**

**MC-327. Medjez II, 19, 325 to 350cm** **8860 ± 150**
**6910 B.C.**

*General Comment* (G.C.): complete chronology of site, rich in Microlithic industry, should characterize a regional facies of Upper Capsian: "Setifian." Cf. R., 1972, v. 14, p. 292, (Camps-Fabrer, 1968).

**MC-281. Rabah 11, Ouled Djellal, Batna** **7920 ± 100**
**5970 B.C.**

Terrestrial shells (*Helix* sp.) from 10 to 20cm from terrace bordering Oued Djedi near Ouled Djellal, Batna (34° 26′ N Lat, 5° 8′ E Long). Coll. and subm. 1968 by G. Camps.

**MC-283. Rabah 4, Ouled Djellal, Batna** **9180 ± 130**
**7230 B.C.**

Terrestrial shells (*Helix*) from 30 to 40cm in same place as MC-281. *Comment*: date too old to match this Upper Capsian site.

**MC-285. El Mermouta, Ouled Djellal, Batna** **8410 ± 130**
**6460 B.C.**

Terrestrial shells (*Helix*) from Neolithic settlement on border of Oued Djedi near Ouled Djellal, Batna (34° 35′ N Lat, 5° 21′ E Long). Coll. and subm. 1968 by G. Camps. *Comment* (G.C.): industry is characterized by small and short stone triangles similar to those from Rabah site.

**MC-328. Botma si Mamar, Ouled Djellal, Batna** **6880 ± 100**
**4930 B.C.**

Terrestrial shells (*Helix*) from Neolithic settlement near Ouled Djellal, Batna (34° 22′ N Lat, 4° 53′ E Long). Coll. and subm. 1969 by G. Camps (Grébenart, 1970).

**MC-280. Safiet Bou Rhenan, Messad, Médéa** **7220 ± 100**
**5270 B.C.**

Terrestrial shells (*Helix*) from Neolithic settlement near Messad, Médéa (34° 11′ N Lat, 3° 31′ E Long). Coll. and subm. 1968 by G. Camps. *Comment* (G.C.): MC-328 and MC-280 pertain to peculiar Neolithic facies different from Capsian tradition (Grébenart, 1970).

**MC-279. Aïn Guettara, Oasis** **5950 ± 100**
**4000 B.C.**

Charcoal from Neolithic settlement of Capsian tradition, S border of Tademaït Plateau, Oasis (28° 02′ N Lat, 3° 06′ E Long). Coll. and subm. by G. Camps. *Comment* (G.C.): agrees with Gif-1223: 3980 B.C., unpub.

**MC-399. Bouh Behl, Oasis** **6290 ± 120**
**4340 B.C.**

Fragments of ostrich eggs in layers of Hadjarian campsite, Bouh Behl, Oasis (31° 48′ N Lat, 5° 14′ E Long). Lithic industry with geometrical microliths. No pottery. Coll. and subm. 1971 by G. Camps. *Comment*: agrees with dates from Protoneolithic facies.

**MC-400. El Hadjar, dismantled, Oasis** **8050 ± 100**
**6100 B.C.**

Fragments of ostrich eggs at Neolithic settlement, El Hadjar, Oasis (31° 32′ N Lat, 4° 47′ 30″ E Long). Industry lacking pottery (Hadjarian). Coll. by G. Aumassip and subm. by G. Camps. *Comment* (G.C.): date appears very old compared to charcoal from adjoining Epipalaeolithic site (Gif-880: 7300 ± 170, R., 1972, v. 14, p. 293) but different stratigraphic position.

**MC-398. El Hadjar, Oasis** **6670 ± 100**
**4720 B.C.**

Fragments of ostrich eggs, aceramic Neolithic. Coll. by G. Aumassip and subm. by G. Camps.

**MC-401. Khellal, Oasis** **7750 ± 100**
**5800 B.C.**

Fragments of ostrich eggs in Saharian campsite of Khellal, Oasis (30° 31′ N Lat, 5° 53′ E Long). Coll. by G. Aumassip and subm. 1971 by G. Camps. *Comment*: only one lithic industry which is poorly typed.

**Ahaggar series**

Charcoal from hearths in various sites of Ahaggar area in Central Sahara (Maitre, 1969). Coll. 1964 to 1967 and subm. by J. P. Maitre, LAPEMO, Aix en Provence, France.

**MC-483. Ahaggar, Timidouin, 155-30** **6050 ± 120**
**4100 B.C.**

Charcoal, 15 to 30cm in Timidouin site (24° 20′ N Lat, 5° 35′ E Long), Tefedest, ca. 300km N Tamanrasset, alt. 1800m.

**MC-484. Ahaggar, Timidouin, 155-32** **8100 ± 130**
**6150 B.C.**

Charcoal, 30 to 60cm in same site as MC-483. *Comment*: dates of MC-483 and MC-484 appear rather old in comparison with ceramics.

**MC-485. Ahaggar, Ideles I, 20 to 50cm** **6050 ± 100**
**4100 B.C.**

Charcoal, 20 to 50cm from small cave of Ideles (23° 52′ N Lat, 5° 55′ E Long) Arechchoum, 200km N NE Tamanrasset, alt. 1450m.

**MC-486. Ahaggar, Ideles, 25 to 40cm** **5300 ± 110**
**3350 B.C.**

Charcoal, 25 to 40cm in cave of Ideles.

**MC-488. Ahaggar, Tin Amenser** **6500 ± 250**
**4550 B.C.**

Charcoal, 20 to 70cm in Tin Amenser site (22° 55′ N Lat, 5° 06′ E Long) Afedafeda, ca. 40km NW Tamanrasset, alt. 1400m. *Comment*: further excavation is expected at site.

**MC-487. Ahaggar, Tamanrasset II** **3900 ± 100**
**1950 B.C.**

Charcoal, 45 to 50cm level in Tamanrasset site (22° 50′ N Lat, 5° 28′ E Long) Oua-Helledjen, 16km NW Tamanrasset, alt. 1470m. Neolithic industry and remains of Mediterranean flora. *Comment*: although too young to agree with ceramics and palynology, date compares with Gif-357: 3330 B.P. (R., 1970, v. 12, p. 437).

**MC-489. Ahaggar, Tadjard Todjdjet** **4320 ± 100**
**2370 B.C.**

Charcoal, 0 to 20cm level in Tadjard Todjdjet site (22° 45′ N Lat, 5° 30′ E Long) Oua-Helledjen 5km W Tamanrasset, alt. 1350m. *Comment*: date confirms late Neolithic as expected.

*General Comment*: sites dated in Ahaggar Mts. correspond to Neolithic of Sudan tradition which began early 6th millennium and ended late 1000 B.C., with full development during 4th millennium B.C. (Camps *et al.*, 1968).

**Aïn Dokkara series, Tebessa**

Terrestrial shells (*Helix*) and charcoal from "Escargotière du Chacal" a large snail-shell deposit of Aïn Dokkara, Tebessa, NE Algeria (35° 20′ N Lat, 8° 16′ E Long). Coll. 1968 by C. Roubet and subm. by L. Balout, Inst. Paleontol. Humaine, Paris. Two sections dated: 1) Aïn Dokkara S sec., cut 1949, 130cm thick, at base of which a human Capsian skeleton was unearthed by L. Balout; 2) Aïn Dokkara N sec. parallel 25cm to N trench of 1951.

**MC-337. Aïn Dokkara, S sec. 30 to 60cm** **7485 ± 100**
**5535 B.C.**

*Helix* shells, S section 1949, layer 30 to 60cm.

**MC-338. Aïn Dokkara, S sec. 90 to 110cm** **7990 ± 100**
**6040 B.C.**

*Helix* shells.

**MC-339. Aïn Dokkara, S sec. 110 to 130cm** **8530 ± 120**
**6580 B.C.**

**MC-340. Aïn Dokkara, S sec., 90 to 120cm** **7090 ± 100**
**5140 B.C.**

Charcoal.

**MC-372. Aïn Dokkara N sec., 20cm** **7260 ± 120**
**5310 B.C.**

*Helix* shells, section parallel 25cm S to N trench of 1951.

**MC-373. Aïn Dokkara, N sec., 20 to 40cm** **7280 ± 120**
**5330 B.C.**

*Helix* shells.

**MC-374. Aïn Dokkara, N sec., 40 to 60cm** **7570 ± 120**
**5620 B.C.**

*Helix* shells.

**MC-375. Aïn Dokkara, N sec., 60 to 80cm** **8030 ± 120**
**6080 B.C.**

*Helix* shells.

**MC-376. Aïn Dokkara, N sec., 80 to 100cm** **8345 ± 120**
**6395 B.C.**

*Helix* shells.

*General Comment* (L.B.): imperceptible evolution of industry through 1300 yr occupation of this typical Capsian site (Balout and Roubet, 1970).

*E. Cambodia*

**Laang Spean series**

Laang Spean cave (12° 51′ N Lat, 102° 55′ E Long) in Battambang dist., 28km from B., Cambodia, a Neolithic settlement dug in Permian limestone. Charcoal from 3 out of 9 principal layers in 2 borings 140cm long. Coll. and subm. 1968 by R. and C. Mourer, Univ. Phnom Penh.

**MC-270. Laang Spean, CRS** **1200 ± 70**
**A.D. 750**

Charcoal from central boring in upper red layer, 2 to 10cm with sherds of ornated and shaped stone flakes.

**MC-271. Laang Spean, CRa** **1120 ± 60**
**A.D. 830**

Charcoal from entrance boring. Upper red layer, 2 to 15cm.

**MC-272. Laang Spean, CRb** **2450 ± 90**
**500 B.C.**

Charcoal from entrance boring. Red layer, 15 to 30cm.

**4000 ± 90**
**MC-269. Laang Spean, CRM** **2050 B.C.**

Charcoal from central boring. Red layer, 12 to 30cm. Pottery assoc. with crude industry of hoabinian type, using large tools and atypical stone flakes.

**3970 ± 90**
**MC-274. Laang Spean CRc** **2020 B.C.**

Charcoal from entrance boring. Lower red layer under 30cm.

**6240 ± 70**
**MC-273. Laang Spean, CN** **4290 B.C.**

Charcoal from central boring. Black layer, 30 to 50cm with burnt bones, crude tools and few pottery sherds.

*General Comment* (C.M., R.M.): uninterrupted occupation of cave from 5th millennium to 9th century. Ceramics in black layer dated 4290 B.C. (MC-273) shows that Neolithic in SE Asia is older than formerly supposed (Mourer *et al.*, 1970).

## III. MISCELLANEOUS SAMPLES

**200 ± 30**
**MC-418. Paper** **A.D. 1750**

Cloth paper from old Archives dated 1749. Coll. and subm. 1970 by J. Thommeret. *Comment*: test of accuracy for recent samples.

### Atmospheric radiocarbon activity series, Monaco

This series of $C^{14}$ content measured in atmospheric $CO_2$ periodically coll. on roof of Mus. Océanog. Monaco (43° 43′ N Lat, 7° 25′ E Long) alt. 80m, is continuation of previous results (R., 1966, v. 8, p. 290-291; R., 1969, v. 11, p. 127-128).

| Sample no. | Coll. date | $\delta C^{14}$‰ |
|---|---|---|
| MC-261. | Aug. 1968 | +593 ± 15 |
| MC-310. | Feb. 1969 | +507 ± 15 |
| MC-311. | May 1969 | +512 ± 15 |
| MC-312. | Aug. 1969 | +502 ± 15 |
| MC-313. | Nov. 1969 | +502 ± 15 |
| MC-390. | April 1970 | +550 ± 15 |
| MC-391. | Aug. 1970 | +590 ± 15 |
| MC-392. | Nov. 1970 | +500 ± 15 |
| MC-393. | March 1971 | +515 ± 15 |
| MC-394. | July 1971 | +490 ± 10 |
| MC-395. | Nov. 1971 | +542 ± 10 |
| MC-547. | April 1972 | +480 ± 10 |
| MC-548. | Aug. 1972 | +500 ± 10 |

**Seawater series**

This series continues the list of previous results (R., 1969, v. 11, p. 128).

**MC-267. Seawater 2000m** $\delta C^{14}‰ = +\mathbf{20} \pm \mathbf{7}$

Coll. May 1968, 20km S Monaco.

**MC-419. Seawater 1700m** $\delta C^{14}‰ = +\mathbf{19} \pm \mathbf{7}$

Coll. June 1971, 20km S Monaco.

**MC-550. Seawater 2500m** $\delta C^{14}‰ = -\mathbf{50} \pm \mathbf{10}$

Coll. June 1972, 30km S Monaco.

**Correction**

In previous list of seawater measurements (*ibid.*, above) values given as $C^{14}\%$ should be $\delta C^{14}‰$.

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# NATIONAL TAIWAN UNIVERSITY RADIOCARBON MEASUREMENTS II

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The $C^{14}$ dates given below have been obtained by counting $CO_2$ at 2 atm pressure in a 1 L proportional counter. Details of procedure are given in our previous list (R., 1970, v. 12, p. 187-192). Radiocarbon dates in this list are based on 95% of activity of NBS oxalic acid as the modern standard and were calculated using 5570 yr as the half-life of $C^{14}$. Errors quoted with the dates are standard deviation originating from the statistical nature of radioactive disintegration process. Results obtained during 1970 and 1971 are described here.

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## SAMPLE DESCRIPTIONS

### I. GEOLOGIC SAMPLES

*A. Japan*

**1370 ± 40**
**NTU-124. Hirogami** **A.D. 580**

Bogwood from landslide area, Hirogami, Niigata, Japan (37° 20′ N Lat, 139° 00′ E Long), at 0m depth. Coll. and subm. 1969 by S. Yamaguchi, Disaster Prevention Inst., Kyoto Univ. *Comment* (S.Y.): date approximates landslide (Yamaguchi and Lin, 1971).

*B. China*

**Hwalien series**

Shell and coral of coral reef from Hwalien harbor, Taiwan (23° 59′ N Lat, 121° 32′ E Long). Coll. 1951 and subm. 1971 by C. C. Lin, Dept. Geol., Natl. Taiwan Univ.

**1512 ± 45**
**NTU-159. Hwalien 1** **A.D. 438**

Coral, at +3m, 2.5m depth.

**1052 ± 32**
**NTU-166. Hwalien 2** **A.D. 898**

Shell, at +3m, 1m depth.

*General Comment* (C.C.L.): dates coral reef overlying Milun Formation (Lin, 1969) unconformably and is overlain by the Chara-Melanoides Clay

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and Sand Member of the Peipin Formation (Lin, 1969). Dates are geologically reasonable.

**Hengchun series**

Coral of coral reef from Wangsa village, Hengchun, Taiwan (22° 03′ N Lat, 120° 45′ E Long), at +35m. Coll. and subm. 1971 by C. C. Lin.

**NTU-161. Hengchun 1** **>30,000**

Ca. 1m depth.

**NTU-162. Hengchun 2** **>30,000**

Ca. 1.5m depth.

**NTU-163. Hengchun 3** **>30,000**

Ca. 3m depth.

*General Comment* (C.C.L.): dates are minimum for isolated Pleistocene emerged coral reef, overlain by laterite soil (with gravel), and underlain by Plio-Pleistocene arenaceous limestone of Maopitou Formation (Lin, 1967). Dates are expected.

**Taitung series**

Coral and shell of emerged coral reef from Taitung area. Coll. 1960 and subm. 1970 by C. C. Lin.

**3820 ± 115**
**NTU-150. Taitung 1** **1870 B.C.**

Coral from Tanman, Changpin, Taitung, Taiwan (23° 13′ N Lat, 121° 24′ E Long), at +20m, 0.5m depth.

**6132 ± 184**
**NTU-151. Taitung 2** **4182 B.C.**

Coral from Chiwen village, Taitung, Taiwan (23° 08′ N Lat, 121° 23′ E Long), at +35m, ca. 0.5m depth.

**1643 ± 49**
**NTU-152. Taitung 3** **A.D. 307**

Coral from Chiten village, Taitung, Taiwan (23° 07′ N Lat, 121° 22′ E Long), at +20m, ca. 0.5m depth.

**1950 ± 59**
**NTU-153. Taitung 4** **A.D. 0**

Coral from Chengkung, Taitung, Taiwan (23° 06′ N Lat, 121° 22′ E Long), at ca. +35m, ca. 1.5m depth.

**3221 ± 97**
**NTU-154. Taitung 5** **1271 B.C.**

Coral from Chengkung, Taitung, Taiwan (23° 06′ N Lat, 121° 22′ E Long), at ca. +15m, ca. 2m depth.

**NTU-158. Taitung 6** **9234 ± 277**
**7284 B.C.**

Coral from Fukang valley, Taitung, Taiwan (22° 48′ N Lat, 121° 11′ E Long), at +15m, ca. 2m depth.

**NTU-165. Taitung 7** **2349 ± 70**
**399 B.C.**

Shell from Chiwen village, Taitung, Taiwan (23° 08′ N Lat, 121° 23′ E Long), at +35m, ca. 0.5m depth. *Comment* (C.C.L.): younger than expected.

*General Comment* (C.C.L.): samples expected to date emerged coral reefs. Except for NTU-165, dates are acceptable.

## II. ARCHAEOLOGIC SAMPLES

### *China*

**Changpin series**

**NTU-125. Changpin 4** **>15,000**

Charcoal from LHVI (Sung, 1969) cave, Changpin, Taitung, Taiwan (23° 24′ N Lat, 121° 25′ E Long), at +100m, ca. 3.35m to 3.55m depth. Coll. and subm. 1970 by W. H. Sung, Dept. Archaeol. and Anthropol., Natl. Taiwan Univ. *Comment* (W.H.S.): this sample was obtained from geologically and culturally earlier horizon of Changpin culture. Four $C^{14}$ dates, NTU-69-71 (Hsu *et al.*, 1970) and Y-2638 (Sung, 1969) of the latest phase of this culture range from 5000 to 6000 yr B.P. Thus, present date not only agrees with above-mentioned dates but also with estimate of W. H. Sung (1969), that earlier phase of Changpin culture must go back to Pleistocene.

## III. GEOPHYSICAL SAMPLES

### *$C^{14}$ in Atmospheric Carbon Dioxide*

**Atmospheric radiocarbon activity series, Taipei**

$C^{14}$ content in ground level atmospheric $CO_2$ is monitored monthly at Taipei, Taiwan (25° 02′ N Lat, 121° 32′ E Long). The following list contains exposure time at NaOH solutions to air and per cent increase of $C^{14}$ above 95% NBS oxalic acid. Data are graphed in Fig. 1. The statistical error is less than 1%.

| Sample no. | Exposure time | $\delta C^{14}$, % |
|---|---|---|
| NTU-113 | 15 Jan. – 20 Jan. 1968 | +56.6 |
| NTU-114 | 15 Feb. – 21 Feb. 1968 | +59.5 |
| NTU-115 | 15 Mar. – 20 Mar. 1968 | +61.0 |
| NTU-116 | 15 Apr. – 21 Apr. 1968 | +56.0 |
| NTU-117 | 18 May – 23 May 1968 | +49.9 |
| NTU-118 | 16 June – 22 June 1968 | +55.5 |
| NTU-119 | 15 July 1968 | +55.9 |

| Sample no. | Exposure time | $\delta C^{14}$, % |
|---|---|---|
| NTU-120 | 20 Sept. – 25 Sept. 1968 | +55.6 |
| NTU-121 | 18 Oct. – 22 Oct. 1968 | +53.5 |
| NTU-122 | 15 Nov. – 20 Nov. 1968 | +55.0 |
| NTU-123 | 17 Dec. – 22 Dec. 1968 | +54.7 |
| NTU-126 | 15 Jan. – 21 Jan. 1969 | +51.2 |
| NTU-127 | 15 Feb. – 21 Feb. 1969 | +47.2 |
| NTU-128 | 16 Mar. – 21 Mar. 1969 | +52.7 |
| NTU-129 | 16 Apr. – 21 Apr. 1969 | +43.7 |
| NTU-130 | 16 May – 21 May 1969 | +67.7 |
| NTU-131 | 17 June – 21 June 1969 | +54.2 |
| NTU-132 | 15 Aug. – 21 Aug. 1969 | +49.4 |
| NTU-133 | 15 Sept. – 21 Sept. 1969 | +50.7 |
| NTU-134 | 15 Oct. – 21 Oct. 1969 | +40.0 |
| NTU-135 | 15 Nov. – 20 Nov. 1969 | +54.1 |
| NTU-136 | 15 Dec. – 20 Dec. 1969 | +74.7 |
| NTU-137 | 15 Jan. – 20 Jan. 1970 | +52.4 |
| NTU-138 | 14 Feb. – 18 Feb. 1970 | +55.7 |
| NTU-139 | 15 Mar. – 21 Mar. 1970 | +55.9 |
| NTU-140 | 15 Apr. – 20 Apr. 1970 | +56.4 |
| NTU-141 | 15 May – 21 May 1970 | +55.7 |
| NTU-142 | 15 June – 21 June 1970 | +56.2 |
| NTU-143 | 15 July – 20 July 1970 | +55.0 |
| NTU-144 | 15 Aug. – 20 Aug. 1970 | +45.7 |
| NTU-145 | 14 Sept. – 21 Sept. 1970 | +52.6 |
| NTU-146 | 14 Oct. – 20 Oct. 1970 | +49.8 |
| NTU-147 | 15 Nov. – 20 Nov. 1970 | +44.7 |
| NTU-148 | 14 Dec. – 20 Dec. 1970 | +48.9 |

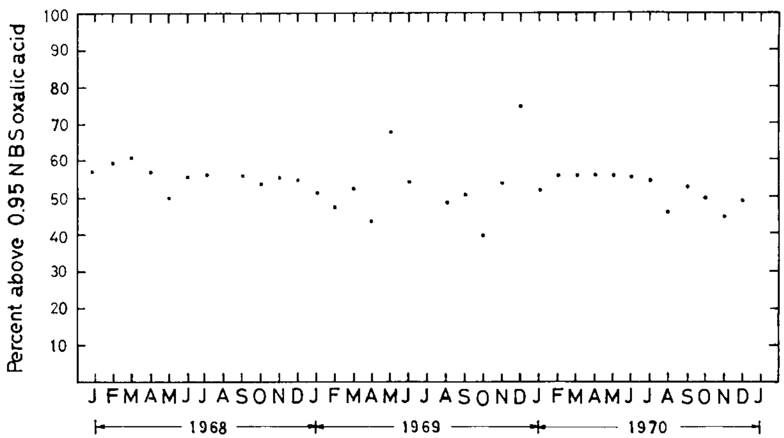


Fig. 1. $C^{14}$ enrichment over NBS standard of atmospheric $CO_2$ during 1968 to 1970 at Taipei, Taiwan 25° 02′ N Lat, 121° 31′ E Long).

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# OHIO WESLEYAN UNIVERSITY NATURAL RADIOCARBON MEASUREMENTS V

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## INTRODUCTION

The following list of determinations is compiled from samples prepared since publication of our last date list (R., 1969, v. 11, p. 137-149) and includes sample measurements through July, 1970. The Radiocarbon Laboratory was dismantled and transported to Halifax, Nova Scotia, where it will resume operation as the Dalhousie University Radiocarbon Dating Laboratory.

Equipment and operating procedures for samples reported in this date list are the same as described earlier (R., 1964, v. 6, p. 340). Unless noted otherwise, all samples are pretreated with hot 2% NaOH and 10% HCl. Samples of archaeologic charcoal are subjected to an additional pretreatment to remove rootlet cellulose following the Haynes method (1966). Purity of sample $CO_2$ and $CH_4$ is checked with a gas chromatograph. Methane samples are stored for one month to permit decay of radon prior to counting.

Ages are quoted with a $1\sigma$ counting error which includes statistical variation of sample count as well as that for background and contemporary standard. The half-life value is 5568 yr, and reference year is 1950.

## ACKNOWLEDGMENTS

It is a special pleasure for the authors to acknowledge the advice and assistance of George H. Crowl in interpretation of geologic samples, and to George W. Burns for numerous identifications of wood samples, not only in this report, but through the years of operation of the laboratory.

Thanks are also due to William C. Hart for technical assistance in the operation and maintenance of the laboratory. The support of the National Science Foundation (GB-7485) is gratefully acknowledged.

## SAMPLE DESCRIPTIONS

### I. GEOCHEMICAL SAMPLES

**OWU-333. Plant opal #3** **$\delta C^{14} = 105.72 \pm 1.60\%$**

Opal phytoliths extracts from surface horizon (0 to 18cm) of well-drained Brunizem soil (Warsaw silt loam) from terrace along Mad River Valley, W-central Ohio. Previous samples, OWU-317 (R., 1969, v. 9, p. 140) and I-2277 indicated that level of oxidation pretreatment was controlling factor in determining sample age. OWU-333 was pretreated with boiling 1N chromic acid, ground, and then retreated with chromic acid. Coll. and subm. by L. P. Wilding. *Comment* (J.G.O.): not signifi-

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cantly different from OWU-317, despite increased rigor of oxidation pretreatment.

**Sample Contamination Series I**

First of a series of tests to determine penetrability of charcoal samples to rootlets, and possibility of contamination of archaeologic and geologic samples in the root zone of plants.

Four clay pots 20cm diam., 15cm soil depth, vol of soil 1800cm$^3$ were filled with a uniform mixture of screened (3.2mm mesh) soil, consisting of 50% sand, 50% Perlite by volume. Two of the pots included a layer of spruce wood charcoal (40g) of known age (OWU-398). All 4 pots were planted to a uniform density (ca. 200 seeds) with wheat (*Triticum* sp.) and placed in Dept. of Botany greenhouse on 3 March, 1969. After 6 weeks' growth, plants were harvested by clipping, and charcoal was hand-picked from root mass surrounding charcoal. Small rootlets were hand-picked from charcoal under a low power dissecting microscope. Results are shown in Table 1. *Comment* (J.G.O.): results indicate that the small pore space of gymnosperm tracheids (average 7$\mu$) were not significantly invaded by rootlets, and confirm that carbonized charcoal is unavailable to angiosperm plants. Future experiments will include the use of ring-porous angiosperm wood (e.g., Oak, *Quercus* spp.), and limiting water such that the charcoal may provide a "reservoir" of water for plant growth. Previous studies on archaeologic samples, e.g. OWU-92 (R., 1965, v. 7, p. 172) show that rootlet penetration of archaeologic samples is a serious source of error.

TABLE 1
Sample Contamination Series I

| Sample no. | Material | Age |
|---|---|---|
| OWU-398 | Indiana spruce-charcoal | 17,030 ± 550 |
| OWU-399 | Pot 1 + 2 Wheat (*Triticum* sp.) (+ Indiana wood charcoal) | $\delta C^{14} = 158 \pm 2.4\%$ |
| OWU-400 | Pot 3 + 4 Wheat (*Triticum* sp.) (no charcoal) | $\delta C^{14} = 158 \pm .69\%$ |
| OWU-401 | Indiana spruce charcoal, rootlets hand picked from Pots 1 and 2 | 16,870 ± 820 |

**OWU-455. Modern Scirpus seeds** **$\delta C^{14} = 171.8 \pm 4.5\%$**

Contemporary sample of *Scirpus robustus* seeds coll. 5 Dec., 1968 in Death Valley Nat. Monument (35° 41′ N Lat, 116° 25′ W Long) and subm. by P. J. Mehringer. *Comment* (J.G.O.): previous sample of hand-picked Scirpus seeds from 58 to 64cm in Core IV in archaeologic context gave C$^{14}$ measurement of $\delta C^{14} = 103.8 \pm 3.8\%$ (OWU-320). Similar sample by Isotopes, Inc. dated I-3766, 4740 ± 110, additional sample was run to check for possible isotopic fractionation by *Scirpus*. Since OWU-455 is not significantly different from winter, 1968 atmospheric levels of $C^{14}$, it is concluded that small sample size (0.22g seeds) and large sample dilution precluded accurate determination.

II. GEOLOGIC SAMPLES

**OWU-321. Akron mastodon** **13,695 ± 460** **11,745 B.C.**

Spruce wood, new sample, id. by G. W. Burns, assoc. with partial skeleton of mastodon excavated during building construction near Akron, Ohio (40° 2′ N Lat, 81° 38′ W Long). Coll. and subm. by J. D. Speth. *Comment* (J.G.O.): sample run to test discrepancy between previous determinations from site (OWU-190, R., 1969, v. 11, p. 137) and M-1971, which showed 13,300 ± 600 yr B.P. Although all determinations are within 2$\sigma$, new date closely agrees with Michigan determination.

**OWU-334. Tashmoo Beach wood** **370 ± 105** **A.D. 1580**

Red Maple stump, id. by G. W. Burns, ca. 20m offshore from mean high-water mark off NW coast of Martha's Vineyard, Massachusetts, with root crown ca. 120cm below mean high tide (41° 26 N Lat, 70° 38′ W Long). Coll. and subm. by J.G.O.

**OWU-335. Tashmoo Beach peat** **700 ± 110** **A.D. 1250**

Fibrous woody peat in which OWU-334 was rooted. Pollen analysis shows typical red-maple-swamp assoc. of red maple (Acer), willow (Salix), Ericaceae, sedge, fern and *Sphagnum* spore (Ogden, 1961). *Comment* (J.G.O.): at present, nearest red-maple assoc. is 0.5km inland from sample site. Because of swift tides and exposed location subject to storms, the sea level that killed the tree was probably 20 to 30cm below level of root crown, and that preservation was due to regression of a barrier beach over site.

**OWU-336. Grane Langsø, Denmark** **3830 ± 205** **1880 B.C.**

Core sample, Sec. 8, 157-164cm depth, from Grane Langsø, Denmark (52° 2′ N Lat, 9° 27′ E Long). Detritus gyttja, with small plant fragments. Coll. and subm. by M. Whiteside. *Comment* (M.W.): pollen and other data indicate that radiocarbon dates (OWU-336, and I.U. 58, 164 to 171cm depth) for sediments 157 to 171cm are too old. I attribute older dates to redeposition in benthos of older lake sediments exposed along lake margin during Sub-Boreal time (Whiteside, 1970, p. 109).

**Lake Erie series**

Part of systematic sediment sampling operation by Ohio Geol. Survey, W of Middle Bass I. Coll. by C. E. Herdendorf and subm. by C. E. H. and J. L. Forsyth.

**OWU-318-bis. Station WR-31J** **4270 ± 210** **2320 B.C.**

Rerun of OWU-318, originally dated 4335 ± 135. *Comment*

(J.G.O.): similarity of 2 determinations confirms probability that sample represents flooding of 13m level below present surface of Lake Erie (see R., 1969, v. 11, p. 141).

**9940 ± 315**
**OWU-350. Station WR-33J** **7490 B.C.**

Continuation of samples previously reported (R., 1969, v. 11, p. 141). Sample from 1.9m below base in 11m water.

**5087 ± 175**
**OWU-351. Station W-34J** **3147 B.C.**

Sample from 2.8m below base in 11.2m water. *Comment* (J.L.F.): all samples (OWU-318/318-bis; -319; -350; -351) come from approx. same level (−13m) below surface of Lake Erie. Stratigraphic uniformity suggests that a past near-surface position was maintained from ca. 9000 (OWU-350) to ca. 4000 (OWU-31) yr B.P. I interpret uniformity of depth of these 4 samples, throughout this time to represent a lowering of the lake level during the Xerothermic Interval, a lowering that just balanced over all postglacial isostatic rise of lake level evident before and following this time (cf. Lewis, 1969, fig. 12). With return of moister climate, lake level apparently rose rapidly (7.6m in 500 yr) in response to both climatic and isostatic changes. Return to more normal lake-level rise is documented from Point Pelee Pond (Lewis, 1969) and from Terwilliger's Pond, on S Bass I. (OWU-275, Ogden and Hay, 1969).

**7590 ± 200**
**OWU-394. Mt. Gilead Beaver site** **5640 B.C.**

Beaver-gnawed wood from commercial peat excavation, 1.07m below surface near Mt. Gilead, Ohio (40° 30′ N Lat, 83° 52′ W Long). Wood (crushed) tentatively id. as Ash (*Fraxinus*) by G. W. Burns. Coll. and subm. by G. H. Crowl.

**19,850 ± 765**
**OWU-452. Southwest Columbus** **17,900 B.C.**

Spruce wood, id. by G. W. Burns, from Intersection I-71/I-270 in SW Columbus, Ohio (39° 53′ 30″ N Lat, 83° 2′ 10″ W Long). Coll. by G. H. Crowl and W. D. Sevon, subm. by G. H. Crowl. *Comment* (G.H.C.): sample relates to same late Wisconsin events as OWU-256/257 (R., 1969, v. 11, p. 139), and OWU-488, this list. Dates are consistent with last major ice advance in region.

**10,890 ± 275**
**OWU-487. Cleveland (Lake Wayne) Beach** **8940 B.C.**

Unid. wood fragments in channel sand, below foreslope beach gravel at depth 3.7m below present lake level. Recovered from building excavation between Euclid and Chester Aves. (41° 30′ 8″ N Lat, 81° 47′ 29″ W Long). Relevant dates; I-2917 (wood, Euclid Ave.) 11,200 ± 170. Coll. by T. Lewis and subm. by R. P. Goldthwait.

**OWU-488. Reeseville Moraine buried silt** **19,303 ± 1080**
**17,353 B.C.**

Charcoal fragments in silt from Core B-9 at depth 14m in test coring for Interstate Bridge FAY-71-0205, Fayette Co., Ohio (39° 36′ 18″ N Lat, 83° 38′ 3″ W Long). Relevant dates: OWU-256, same place, within 3cm depth, 17,340 ± 390, OWU-257, 19,735 ± 475 (R., 1969, v. 11, p. 139).

**OWU-489. Alaskan Hypsithermal Forest** **2520 ± 90**
**570 B.C.**

Spruce wood, id. by G. W. Burns, from Hypsithermal deposit, Wachusett Inlet (off Muir), Burroughs Glacier (E), Glacier Bay Monument (58° 57′ 49″ N Lat, 136° 13′ 24″ W Long). Relevant dates: I-22, 1.6km E, same stratigraphy, 2735 ± 160, I-1610, 5km N, same stratigraphy, 2100 ± 115. Coll. by R. P. Goldthwait and D. Mickelson. Subm. by R. P. Goldthwait.

**OWU-490. Collins Creek (Bull Run)** **19,535 ± 655**
**17,585 B.C.**

Spruce wood, id. by G. W. Burns. N Bank, Sec. 2, in Till 4, 30 to 90cm above bedrock. Wood fragments for this determination from 30cm below contact with Till 3. Coll. and subm. by R. P. Goldthwait.

## III. GEOLOGIC SAMPLES—LAKE AND BOG SEDIMENTATION

### Little Round Lake series

Samples from 1.26m sediment core, in Little Round Lake (44° 48′ N Lat, 76° 41′ W Long), near Sharbot Lake is SE Ontario. Lake watershed is just S of divide between Ottawa R. drainage to U and Lake Ontario drainage to S. Pollen evidence (Ogden, unpub.) indicates that plant succession had proceeded to a closed Boreal forest by the time the lake basin began to record local pollen rain. Coll. and subm. by J. Terasmae.

**OWU-322. GSC:LRL-1; 0 to 4cm** **715 ± 240**
**A.D. 1235**

Homogeneous flocculent algal gyttja.

**OWU-323. GSC:LRL-1; 10 to 14cm** **965 ± 310**
**A.D. 985**

Homogeneous flocculent algal gyttja.

**OWU-324. GSC:LRL-1; 20 to 25cm** **55 ± 220**
**A.D. 1895**

Homogeneous black-green algal gyttja.

**OWU-325. GSC:LRL-1; 30 to 35cm** **750 ± 175**
**A.D. 1200**

Homogeneous black-green algal gyttja.

**OWU-326. GSC:LRL-1; 50 to 55cm** **865 ± 155**
**A.D. 1085**

Homogeneous black-green algal gyttja.

**OWU-327. GSC:LRL-1; 60 to 75cm** **2090 ± 255**
**140 B.C.**

Black-green algal gyttja, trace of banding.

**OWU-328. GSC:LRL-1; 100 to 105cm** **2740 ± 250**
**790 B.C.**

Brownish-black indistinct banded algal gyttja.

**OWU-329. GSC:LRL-1; 120 to 125cm** **2795 ± 190**
**845 B.C.**

Brownish-black indistinct coarsely banded algal gyttja.

**Saylorsburg, Pennsylvania series**

As part of a geologic and biogeographic study of late Pleistocene history of SE Pennsylvania by Pennsylvania Geol. Survey, a series of cores were obtained from 3 lakes in general area of Saylorsburg, Pennsylvania (41° 3′ N Lat, 75° 7′ W Long). The lakes differ in alt., and distance from late Wisconsin ice front. Pollen stratigraphic studies will be reported elsewhere. Coll. by J. G. Ogden, III, G. H. Crowl, W. D. Sevon, and W. C. Hart. Subm. by J. G. Ogden.

**Leaps Bog**

**OWU-413. Core LPBG-1: 710-720cm** **9560 ± 210**
**7610 B.C.**

Decomposed forest peat (detritus gyttja) at contact with clay, 10cm thick, overlying rock.

**OWU-414. Core LPBG-2: 700-712cm** **9900 ± 215**
**7950 B.C.**

Decomposed woody peat (detritus gyttja) from 2nd core a few m S of LPBG-1, which struck rock at 730cm.

**OWU-415. Core LPBG-2: 712-719cm** **12,520 ± 825**
**10,570 B.C.**

Decomposed woody peat (detritus gyttja) at clay contact. Stratigraphy similar to OWU-413. Small sample diluted with dead methane to fill counter. *Comment* (J.G.O.): due to small sample size, 25% of counter filling, date may not be reliable.

**Echo Lake**

**OWU-416. Core Echo-1: 15-25cm** **680 ± 120**
**A.D. 1273**

Flocculent green algal gyttja.

**OWU-417. Core Echo-1: 40-50cm** **235 ± 85**
**A.D. 1717**

Dark green flocculent algal gyttja. At *Ambrosia* pollen rise.

**OWU-418. Core Echo-1: 145-155cm** **640 ± 130**
**A.D. 1310**

Green algal gyttja, some plant fragments.

**OWU-419. Core Echo-1: 245-255cm** **1860 ± 135** **A.D. 88**

Homogeneous green algal gyttja.

**OWU-420. Core Echo-1: 345-355cm** **2385 ± 160** **435 B.C.**

Homogeneous green algal gyttja.

**OWU-433. Core Echo-2: 50-60cm** **735 ± 120** **A.D. 1217**

Homogeneous green algal gyttja.

**OWU-434. Core Echo-2: 70-80cm** **1280 ± 135** **A.D. 670**

Homogeneous green algal gyttja.

**Saylors Lake**

**OWU-437. Core SYL-1: 5-15cm** $\delta C^{14} = $ **102.8 + 2.4%**

Green algal flocculent gyttja.

**OWU-438. Core SYL-1: 25-30cm** $\delta C^{14} = $ **11.6 + 2.0%**

Flocculent green algal gyttja.

**OWU-439. Core SYL-1: 50-60cm** **535 ± 155** **A.D. 1415**

Homogeneous algal gyttja.

**OWU-440. Core SYL-1: 70-80cm** **250 ± 130** **A.D. 1700**

Homogeneous algal gyttja. Field notes indicate possibility that borer may have opened prematurely, which would cause inclusion of younger material.

**OWU-441. Core SYL-1: 120-130cm** **1290 ± 175** **A.D. 660**

Homogeneous green algal gyttja.

**OWU-443. Core SYL-1: 240-250cm** **3235 ± 155** **1285 B.C.**

Homogeneous green algal gyttja.

**OWU-444. Core SYL-1: 340-350cm** **4800 ± 145** **2850 B.C.**

Homogeneous green algal gyttja.

*General Comment* (J.G.O.): all cores bottomed on rock, in gravel or coarse sand. As pollen stratigraphy is determined, additional dates will be run on critical horizons. From present evidence, it would appear that lower portion of valley NW of Delaware Water Gap was not ice-free until 12,000 to 13,000 yr ago.

**Fayetteville Green Lake series**

Meromictic lake, presumably formed as a plunge pool (Hutchinson, 1957), in Green Lakes State Park, Fayetteville, New York (43° 01′ N Lat, 76° 00′ W Long). Lake has been subject of intensive limnologic, geologic

TABLE 2
Fayetteville Green Lake, Series A
(Ekman dredge surface sample)

| Depth mm | Sample no. | Sediment composition | Total bands | Marl age Sample A | Organic age Sample B |
|---|---|---|---|---|---|
| 0-2.8 | OWU-345* | Gray marl band—homog | 1 | 5690 ± 150 | — |
| 2.8-6.9 | OWU-346 | 8 thin white marl bands | 9 | 3870 ± 130 | 2570 ± 315** |
| (6.9-12.0) | | 3 gray marl bands | 13 | | |
| 12.0-14.3 | OWU-347 | 4 thin white marl bands | 17 | 4255 ± 120 | — |
| 14.3-16.3 | OWU-348 | Solid gray marl band | 18 | 4975 ± 130 | — |
| (16.3-20.0) | | Gray marl band | 19 | | |
| 20.0-25.2 | OWU-349 | 8 thin white bands | 27 | 5315 ± 140 | 2290 ± 365** |

* Mean age (OWU 345-349) 4820 ± 90
** Insufficient carbon, diluted with "dead" methane

TABLE 3
Fayetteville Green Lake, Series B
Core FAY-I

| Depth cm | Sample no. | Sediment type | Marl age | Corrected age* |
|---|---|---|---|---|
| 0-15 | OWU-352A | Fine greenish laminated marl gyttja | 5620 ± 140 | 800 ± 165 |
| 40-51 | OWU-353A | Fine greenish laminated marl gyttja 2 turbidites | 6390 ± 155 | 1570 ± 180 |
| 54-56 | OWU-354A | Single marl turbidite | 5520 ± 180 | 700 ± 200 |
| 61.5-63.5 | OWU-355A | Fine grained laminated marl gyttja | 4075 ± 150 | — |
| 90-93 | OWU-356A | Fine grained laminated marl gyttja | 6500 ± 190 | 1680 ± 210 |
| 94-96.5 | OWU-357A | Base of large marl turbidite | 6410 ± 180 | 1590 ± 200 |
| 121-124 | OWU-358A | Fine grained greenish laminated marl gyttja | 8135 ± 275 | 3315 ± 290 |
| 125.5-128 | OWU-359A | Fine grained greenish laminated marl gyttja | 8790 ± 230 | 3970 ± 245 |
| 138-142 | OWU-360A | Fine grained greenish laminated marl gyttja | 8420 ± 210 | 3600 ± 230 |
| End of Core Slug 1 | | | | |
| 145-148 | OWU-361A | Fine grained greenish laminated marl gyttja | 8270 ± 190 | 3450 ± 210 |
| 148-160 | OWU-362A | Marl turbidite | 9255 ± 210 | 4435 ± 230 |
| 160-191 | OWU-363A | Fine grained laminated marl gyttja | 9145 ± 225 | 4325 ± 240 |
| 160-191 | OWU-363B | Fine grained organic | | 1220 ± 200 (63% sample) |
| 191-212 | OWU-364A | Homogeneous marl gyttja | 9365 ± 225 | 4545 ± 240 |
| 191-212 | OWU-364B | Organic | | 4022 ± 560 (32% sample) |
| 287-292 | OWU-365A | Homogeneous marl gyttja | 9930 ± 240 | 5110 ± 255 |

* Marl ages corrected by subtraction 4820 yr (Mean of OWU-345–349).

and geochemical investigations in recent years. Distinct rhythmites are apparently continuously recorded in sediment stratigraphy, and possibly annual. Narrow bands of rhythmites are separated by thicker, coarse bands (turbidites) which apparently reflect turbidity currents and possible redeposition in basin. Two series of samples are reported here to test possibility of annual deposition, and stratigraphic inversion due to turbidity currents.

In Series A, an Ekman dredge (15cm × 15cm) sample was carefully dried and sectioned with a fine saw. Thickness and sequence of bands were recorded as samples were removed by scraping for dating. Total thickness of dried sample was 30mm and contained 35 rhythmites. Dates are based on marl fractions from phosphoric acid hydrolysis. Two samples (OWU-346B and -349B) yielded a small amount of organic material which was burned and diluted with dead methane to bring the samples up to counter pressure. Because of the large dilutions (40% and 50% sample, respectively), these dates are considered less reliable. Samples were run in sequence, and data were pooled to provide a composite date (OWU-349C to estimate correction for carbonate dilution on core samples (Series B).

Series B includes dates from 2 core slugs (1.51m and 1.45m long) from a core 7.28m long. Additional samples from deeper parts of this core are available and may be processed in future. Except for OWU-363B and -346B, all dates are on marl treated with phosphoric acid. The 2 samples noted were burned and diluted with dead methane to operating counter pressure (63% and 32% sample, respectively), and are considered to be less reliable for this reason.

An age correction value (R., 1969, v. 11, p. 144) calculated from the mean value of Series A (OWU-345-349) was applied to all dates as an estimate of the contribution of Paleozoic carbonate to sediment sample ages. *Comment* (J.G.O.): surprisingly old age of surface samples (Series A) indicates that there is relatively little exchange with atmospheric $CO_2$ from this lake. Phytoplankton productivity must be largely restricted to recirculation within the lake waters in the absence of substantial influx of carbonate-rich runoff into the lake. Both series indicate that turbidity currents and assoc. redeposition from older deposits in the lake play a dominant role in the stratigraphy of the sediments, making close-interval sampling of doubtful value for chronologic inferences.

**OWU-467. Charles Lake, Indiana** **8765 ± 295**
**6815 B.C.**

Lake located ca. 9km E of Wyerton, Ontario (44° 45′ N, 81° 1′ W). Sample from Core CL-8:13.01-13.15m at spruce pollen decline. Coll. and subm. by R. E. Bailey. *Comment* (R.E.B.): date is acceptable for spruce pollen decline and compares well with other sites in Northern Georgian Bay areas and Bruce Peninsula (Terasmae, 1967).

**Rockyhock Bay series**

Rockyhock Bay, Chowan Co. N. Carolina (36° 10′ 6″ N Lat, 76° 40′ W Long). A former Carolina Bay now peat filled and forested. Coll. and subm. by D. H. Whitehead.

**OWU-468. RB-66-2-B: 1.54-1.58m** — **6655 ± 170**, **4705 B.C.**

Fibrous gel-mud, no carbonates present, pollen spectra dominated by oak, cypress, hickory, black gum.

**OWU-469. RB-66-9-C: 2.10-2.14m** — **5810 ± 145**, **3860 B.C.**

Gel-mud, no carbonates present. Pollen dominated by oak.

**OWU-470. RB-66-9-E: 2.52-2.58m** — **9135 ± 305**, **7185 B.C.**

Olive, mottled lake silt. Pollen dominated by pine.

**OWU-471. RB-66-10-E: 3.41-3.48m** — **14,300 ± 505**, **12,350 B.C.**

Olive, mottled lake silt. Spruce and pine pollen dominant.

**OWU-472. RB-66-1-F: 3.66-3.73m** — **13,385 ± 495**, **11,445 B.C.**

Olive mottled silt. Sample contained small fragments of crushed wood. Tentatively id. as diffuse-porous angiosperm, id. by G. W. Burns. Spruce and pine pollen dominant.

**OWU-473. RB-66-11-A: 4.05-4.10m** — **25,020 ± 1215**, **23,070 B.C.**

Brown organic clay, no carbonates present. Pine, oak, cypress pollen dominant.

**Berry Pond series**

Berry Pond, Berkshire Co., Massachusetts (42° 30′ 20″ N Lat, 73° 19′ 08″ W Long). AH. 600m, surface area 3.9ha. Coll. and subm. by D. H. Whitehead.

**OWU-474. BP-68-33-B: 1.53-1.58m** — **995 ± 135**, **A.D. 995**

Algal gyttja, no marl carbonates present. Pollen evidence indicates C3/C2 zone boundary.

**OWU-475. BP-68-34-B: 2.53-2.57m** — **2720 ± 150**, **770 B.C.**

Algal gyttja, middle of Pollen Zone C2.

**OWU-476. BP-68-35-B: 3.53-3.57m** — **2665 ± 115**, **715 B.C.**

Algal gyttja, lower portions of Pollen Zone C2.

**OWU-477. BP-68-36-B: 4.53-4.57m** — **4800 ± 200**, **2850 B.C.**

Algal gyttja, below C2/C1 pollen zone boundary.

**OWU-478. BP-68-37-B: 5.53-5.57m** **5400 ± 155**
**3450 B.C.**

Algal gyttja. Pollen Zone C1.

**OWU-479. BP-68-38-B: 6.46-6.50m** **7825 ± 295**
**5875 B.C.**

Algal gyttja. Upper pine pollen zone.

**OWU-480. BP-68-39-D: 7.16-7.20m** **9235 ± 230**
**7285 B.C.**

Algal gyttja. Border of pine/spruce pollen zones.

**OWU-481. BP-68-39-C: 7.50-7.55m** **12,680 ± 480**
**10,730 B.C.**

Clay-gyttja. Spruce pollen zone.

**Round Lake series**

Lake located 8km SSW of Knox, Indiana (41° 14′ N, 86° 38′ W), Starke Co., Indiana. Coll. by D. H. Whitehead and R. E. Bailey and subm. by R. E. B. *Laboratory Comment* (J.G.O.): samples accessioned as received but presented here in reverse order to preserve stratigraphic and chronologic sequence.

**OWU-486. RL-69-19-A: 150.5-154.5cm** **655 ± 95**
**A.D. 1295**

Detritus gyttja (Dy).

**OWU-485. RL-69-21-A: 345.5-350.5m** **3390 ± 125**
**1440 B.C.**

Detritus gyttja (Dy).

**OWU-484. RL-69-23-A: 520.5-524.5cm** **3610 ± 170**
**1660 B.C.**

Marly gyttja.

**OWU-483. RL-69-26-A: 870.5-874.5cm** **9345 ± 235**
**7395 B.C.**

Dark brown gyttja.

**OWU-482. RL-69-27-A: 955.5-050.5cm** **9415 ± 230**
**7465 B.C.**

Gyttja. *Comment* (R. E. Bailey): OWU-484 is consistent with pollen data and implies Xerothermic Interval in profile. Large maximum of *Cephalanthus* pollen and NAP (non-tree pollen) rise to 20-30% immediately above this zone, together with closely similar date of OWU-485, located 1.8m further up core implies possibility of rapid sedimentation due to lowering of lake level, as suggested by Ogden (1967). OWU-482 is at spruce pollen maximum and is consistent with other unpublished sites in Indiana by Bailey and by Williams. Stratigraphy and age similar to sequence at Silver Lake, Ohio (Ogden, 1966). Overlying OWU-483 may be due to rapid sedimentation.

**Minard Lake, Nova Scotia series**

Minard Lake, Queen's Co. Nova Scotia (44° 26′ N Lat, 65° 10′ W

Long). Small, shallow lake, 1.09ha in drumlin field near location of old ice divide of former South Mountain ice cap (Hickox, 1962; Prest and Grant, 1969). Sec. from 7.87m water. It was hoped that sediments would date dissipation of this ice cap. Coll. and subm. by J. Railton.

**OWU-496. MY-1: 0.5cm** **$\delta C^{14} = 108.03 + 4.30\%$**

Flocculent algal gyttja. *Betula-Pinus-Picea* dominants. AP-84%, Shrub-10% and Herb-6%.

**2370 ± 165**
**OWU-497. MY-1: 115-120cm** **420 B.C.**

Algal gyttja. *Betula-Pinus-Picea* dominants. AP-90%, Shrub-10% and Herb-3%.

**2980 ± 260**
**OWU-498. MY-1: 244-249cm** **1030 B.C.**

Algal gyttja. *Pinus-Betula-Picea* dominants. AP-79% Shrub-12% and Herb-9%.

**5735 ± 220**
**OWU-499. MY-1: 354-359cm** **3785 B.C.**

Gyttja with some clay. *Betula-Myrica-Pinus* dominants. AP-62%, Shrub-28% and Herb-10%. *Comment* (J.R.): sec. 541cm long with pollen-depositional hiatus from 370 to 395cm and 405 to 530cm. Dominants at 540cm were *Myrica-Betula-Poaceae* with AP-32%, Shrub-37%, Herb-25% and Crumpled-6%. Dates appear too young and do not agree with pollen stratigraphy.

**Oak Hill Lake, Nova Scotia series**

Oak Hill Lake, Lunenburg Co. Nova Scotia (44° 23′ N Lat, 64° 34′ W Long). Small lake, 0.80ha, elongated in EW direction in a drumlin field and has 3 basins. Core from deepest basin through 6.12m water. Dated to estimate time of recession of South Mountain ice cap (Hickox, 1962) from its S periphery. Coll. and subm. by J. Railton.

**1005 ± 135**
**OWU-501. O-1: 0-7.5cm** **A.D. 945**

Flocculent algal gyttja. *Betula-Picea-Pinus* dominants. AP-78%, Shrubs-14% and Herbs-8%.

**4905 ± 225**
**OWU-502. O-1: 150-155cm** **2955 B.C.**

Gyttja. *Pinus-Tsuga-Betula* dominants. AP-89%, Shrubs-7% and Herbs-4%.

**6230 ± 235**
**OWU-503. O-1: 225-230cm** **4280 B.C.**

Gyttja. *Pinus-Picea-Betula* dominants. AP-94%, Shrubs-4%, and Herbs-2%.

**OWU-504. 0-1: 300-305cm** **8675 ± 835**
**6724 B.C.**

Gyttja with some clay. *Pinus-Picea-Betula* dominants. AP-84%, Shrubs-14% and Herbs-2%.

**OWU-505. 0-1: 355-360cm** **8250 ± 365**
**6300 B.C.**

Transition from clay gyttja to clay with faint laminations of organic material. (*Lab note*: small sample, diluted with dead methane to operating counter pressure). *Myrica-Poaceae-Polypodiaceae* dominants. AP-15%, Shrubs-34% and Herbs-51%. *Comment* (J.R.): dates appear too young when compared with pollen stratigraphy. From 365 to 405cm there was a pollen-depositional hiatus. AP increased at 410 to 425cm along with some mesophytic species. Latter zone appears to be a pollen stratigraphic equivalent of the G-zone (Livingstone, 1968).

### IV. MARINE SEDIMENTATION SAMPLES

**Black Sea series**

In Spring 1969, the Wood's Hole Oceanographic Inst. sent a team of scientists on *R/V Atlantis II* into the Black Sea for detailed geochemical, geologic, geophysical, and biologic studies. The Black Sea is the world's largest anoxic basin and an estimation of the sedimentation rates from radiocarbon dates is essential to an interpretation of the stratigraphy of the sediments. Two Kasten cores (15 × 15 × 400cm) were selected for sampling. Both cores were recovered from the central basin in more than 2000m water. Only the radiocarbon dates are reported here, as detailed mineralogic and stratigraphic analyses will be reported by the Wood's Hole Oceanographic Inst. Coll. and subm. by D. A. Ross.

**OWU-456. Black Sea marl:** **1410 ± 105**
**1464-K, 45-51cm** **A.D. 539**

Core 1464-K (43° 00′ N Lat, 35° 28′ E Long). $CO_2$ generated by phosphoric acid hydrolysis. Sample size 150g. Sediment laminated calcareous, marly with ca. 100 bands 1mm thick.

**OWU-457. Black Sea marl:** **880 ± 90**
**1464-K, 74-79.5cm** **A.D. 1069**

$CO_2$ generated by phosphoric acid hydrolysis. Sample size 200g. Sediment banded calcareous ooze, 75 to 100 bands in 5.5cm sample.

**OWU-458. Black Sea marl:** **2135 ± 110**
**1464-L, 114.5-117cm** **185 B.C.**

$CO_2$ generated by phosphoric acid hydrolysis, 150g sample. Sediment banded calcareous ooze, 30 to 50 laminae in 7.5cm.

**OWU-460. Black Sea marl:** **2180 ± 150**
**1464-K, 322-325cm** **320 B.C.**

$CO_2$ generated by phosphoric acid hydrolysis, 140g sample. Banded calcareous ooze, 35 to 50 laminae in 3cm.

**OWU-461. Black Sea marl: 1464-K, 372-277cm** **6740 ± 150**
**4790 B.C.**

Sample contained calcareous ooze/clay bands 2 to 5mm wide, indistinct. $CO_2$ generated by phosphoric acid hydrolysis.

**OWU-462. Black Sea marl: 1462-K, 5-12cm** **$\delta C^{14} = 100.11 + 1.26\%$**

Core (43° 00′ N Lat, 33° 00′ E Long), $CO_2$ generated by acid hydrolysis. Sample size 200g. Finely banded calcareous sediment with alternating light and dark laminae-top of core homogeneous gray-blue silty clay, laminae continuous to 23.5cm then blocky silt/clay to 52.5cm laminated to 71cm.

**2040 ± 150**
**OWU-463. Black Sea marl: 1462-K, 63.5-71cm** **90 B.C.**

$CO_2$ generated by acid hydrolysis. Sample size 200g. Coarse 1 to 2mm laminae above contact with homogeneous blue-gray silty clay (71 to 100cm in core sec.). *Comments* (J.G.O.): large amounts of sulfide made sample preparation extremely difficult. Despite pyrolysis at 500°C in a stream of Nitrogen in attempt to distill elemental sulfur from samples, several methane reactors were poisoned and no organic carbon samples were successfully prepared. (D.A.R.): except for 1 date (OWU-457), results of determinations on cores 1464K and 1462K are consistent with stratigraphy and ages of other sediment cores from Black Sea basin. A more detailed description is given in Ross *et al.* (1970).

## V. ARCHAEOLOGIC SAMPLES

**1735 ± 170**
**OWU-330. Phillips Mound No. 2, Ohio** **A.D. 215**

Charcoal sample from Sq. 30; 38cm below mound surface (40° 5′ 38″ N Lat, 83° 2′ 33″ W Long). Assoc. with deposits of cremated bones in same square plane (35′ profile). Wood id. as probably ash or hickory by G. W. Burns. Coll. and subm. by R. S. Baby. *Comment* (R.S.B.): date represents construction of earth mound over site of abandoned Hopewell house and is acceptable. Although several centuries later than the date for Phillip Mound No. 1 (OWU-146: 356 B.C. ± 536) it is still within the Hopewell range. May represent slightly later Hopewell component.

**2630 ± 115**
**OWU-331. James Mound, Ohio** **680 B.C.**

Post hole in Sqs. 20L4 and 20L5 on L4, N-S line (40° 13′ 15″ N Lat, 82° 57′ 24″ W Long). Ring-porous angiosperm wood with narrow rays, probably ash or hickory, id. by G. W. Burns. Coll. and subm. by R. S. Baby. *Comment* (R.S.B.): date is acceptable. Sample from post mold of house pattern typical of Early Adena architecture. Most artifacts from mound fill are also Early Adena.

**OWU-323. Mound City, Ohio** **$\delta C^{14} = 106.38\% + 1.83\%$**

Mound 23 Fl. Wood charcoal (oak, id. by G. W. Burns) from large post in SE corner of house pattern, Fl, Posthole #20 (39° 22′ 35″ N Lat, 83° 00′ 15″ W Long). Numerous rootlets hand-picked followed by Haynes (1966) treatment. *Comment* (R.S.B.): although sample obtained from post mold of Hopewell charnel house, obviously contaminated by modern disturbance, probably by Camp Sherman. Date is not acceptable.

**OWU-397. Incinerator Village site** **$\delta C^{14} = 154.60 + 4.94\%$**

Fort Ancient House site, storage pit charcoal, near Dayton, Ohio (39° 43′ N Lat, 83° 14′ W Long). Charcoal fragments id. by G. W. Burns as ring-porous angiosperm (not oak). Coll. by C. Smith and subm. by R. S. Baby. *Comment* (J.G.O.): 2 preparations of this sample indicate post-1950 A.D. age for charcoal. Date is not acceptable. Apparently sample contaminated either while it was in the ground or during coll. process.

**OWU-448A. Sq. D-1, Feature 13** **$\delta C^{14} = 101.8 + 1.71\%$**

Area 2, Group 1, D.13, 1.37m depth. Wood charcoal fragments probably Hickory, id. by G. W. Burns.

**OWU-448B. Sq. D-1, Feature 13** **555 ± 100**
**A.D. 1395**

Area 2, Group 1, D.13, 45 to 60cm depth. Wood charcoal fragments id. as hickory and ash by G. W. Burns.

**OWU-450. Sq. C-1, Feature 12** **$\delta C^{14} = 107.50 + 3.20\%$**

Area 2, Group 1, 100 to 115cm. Unidentifiable wood charcoal fragments assoc. with pottery.

**OWU-451. Sq. B-2, Feature 4** **$\delta C^{14} = 129.39 + 4.26\%$**

Composite sample of small charcoaled wood fragments including elm, id. by G. W. Burns, from 30, 35, and 40cm depths.

**OWU-464. La Moreaux Mound, D1-16** **1955 ± 125**
**5 B.C.**

Ash wood charcoal id. by G. W. Burns, from Sq. 45-L2 (A:50L2(s) 4-80 (40° 12′ 40″ N Lat, 82° 57′ 28″ W Long). La Moreaux mound covered an irregular post hole pattern that may represent a series of screens and scaffolds rather formal house pattern. Sample yielding date came from charred log near center of mound and 26.8cm below surface of 1m high structure. Date corresponds with Middle to Late Adena artifacts scattered through mound fill. Coll. and subm. by R. S. Baby.

**OWU-465. Bagley Mound, DL17** **745 ± 135**
**A.D. 1205**

Hickory wood charcoal id. by G. W. Burns from Sq. 35R1 (40° 10′ 26″ N Lat, 82° 58′ 12″ W Long). Sample included burnt bark of log. Bagley mound ca. 3km SW of La Moreaux mound, was also built by Adena Indians over irregular post hole pattern. Should be contemporaneous with or slightly earlier than La Moreaux site judging from artifacts recovered and unpaired post hole pattern of house discovered 120m N mound. Therefore, A.D. 1205 is not acceptable. Apparently charred log from which sample was taken was contaminated, possibly by a relic collector's excavation trench nearby.

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[RADIOCARBON, VOL. 15, NO. 2, 1973, P. 367-381]

# UNIVERSITY OF PENNSYLVANIA RADIOCARBON DATES XV

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## INTRODUCTION

This date list includes most of the archaeologic and geologic samples dated in this laboratory since publication of our last date list (R., v. 12, p. 577-589), as well as some samples which had previously been dated, but lacked the sample information necessary for publication. Known-age samples, completed in this time period, will be reported elsewhere. The B.P. ages are based upon A.D. 1950, and have been calculated with the half-life value of 5568 yr. All samples were counted at least twice for periods of not less than 1000 minutes each. Errors quoted for each sample are derived from the measurement of the sample, the background, and of several counts of our mid-19th century standard oak sample, but do not include the half-life error. All samples were pretreated with 3N HCl, and some, where noted, were given additional pretreatment with 2% NaOH for the removal of possible humic acid contaminants.

Our mid-19th century calibration samples have an average age of 126 yr. When corrected for this age, they have $C^{14}$ contents equal to 95% of the NBS oxalic acid standard. The average $C^{13}$ relationship between the oak standards and the NBS limestone standard #20 is $-25.7 \pm 1.3‰$ as measured on the University of Pennsylvania mass spectrograph. Where $\delta C^{13}$ is reported and the results accordingly corrected for isotopic fractionation, the $C^{13}$ relationship has been measured with respect to the oak standard.

The MASCA corrected dates, appearing in the sample comments, have been arrived at by applying appropriate correction factors to dates calculated with the 5730 half-life. The MASCA correction factors are based on the $C^{14}$ dating of almost 200 tree-ring dated sequoias and bristlecone pines. In this date list the corrections used are those published by Ralph (1971, p. 1-48). It is anticipated that these correction factors will become more precise as more tree-ring dated samples are processed. It is hoped that composite plots of calibration curves and lists of correction factors, based upon the work of the laboratories of Univ. of Arizona (Damon *et al.*, 1970, p. 615-618), Univ. of California, San Diego, La Jolla (Seuss, 1970, p. 303-311) and Univ. of Pennsylvania (Ralph and Michael, 1970, p. 619-623)—more than 500 dates in all—will be agreed upon in the future.

I wish to thank John Hedrick and Ray Costa for their careful work in the processing of these samples.

# SAMPLE DESCRIPTIONS

## I. ARCHAEOLOGIC SAMPLES

### *A. Mediterranean*

*1. Italy*

**Cosa series**

Samples from harbor area at Cosa, Ansedonia, Italy (42° 24′ N Lat, 11° 17′ E Long). Coll. and subm. 1969 by J. D. Lewis and A. M. McCann, Am. Acad. in Rome, Italy (Brown, 1951).

**303 ± 36**
**P-1594. COH-69-W1** **A.D. 1647**

Wood from rib of ship's hull resting in shallow rock shore along coast of Ansedonia, within confines of harbor. *Comment*: MASCA corrected date = A.D. 1588.

**2020 ± 44**
**P-1722. PC-69-W22a** **70 B.C.**

Wood from cofferdam of Roman dock *in situ*, buried under 1m earth and mud at W end of Lago di Burano, a narrow lagoon running parallel to the sea just behind the sand dunes. The W end is believed to be location of an inner harbor connected by a ship-canal to the sea and protected at the seaward end by a large stone and masonry constructed breakwater. For another date for this cofferdam, see I-3968, 1925 ± 85 (R., 1970, v. 12, p. 122). *Comment*: MASCA corrected date = 70 B.C.

**2462 ± 71**
**P-1723. Roman Forum, Italy** **512 B.C.**

Carbonized wood and perhaps thatch from debris of burnt hut or huts, buried in pit, sealed across top by thin layer of clay in Area (2), Stratum VI pit of the Regia in the Roman Forum, Rome, Italy (41° 54′ N Lat, 12° 27′ E Long). Coll. 1969 and subm. by F. E. Brown, Am. Acad. in Rome, Italy. *Comment*: MASCA corrected date = 636 B.C.

**2588 ± 47**
**P-1756. Populonia, Italy** **638 B.C.**

Wood, U-16, from underwater, harbor area at Populonia, Italy (43° 00′ 00″ N Lat, 1° 52′ 30″ E Long). Coll. July 1970 and subm. by A. M. McCann, Univ. California at Berkeley. Sample from plank buried in sand, ca. 0.3m under present surface, found ca. 100m N of N end of modern W jetty of harbor in ca. 13.5m water. Harbor area of Populonia has been dredged in modern times and large gouges in sea floor occur, for depth of up to 1.8m. Sample, and ancient pottery of 5th century B.C. and later, were found surrounded by weeds in one of these pockets. *Comment*: MASCA corrected date = 816 B.C.

**Straits of Messina series**

Wood, *Pinus* (*halepensis*), id. by B. F. Kukachka, Forest Prods. Lab., U.S. Dept. Agric., Madison, Wisconsin, from shipwreck in Straits of

Messina, Italy (38° 14′ N Lat, 15° 39′ E Long). Samples from depth 35m in sandy area of sea-bottom, partly resting on bedrock. Estimated date of shipwreck: ca. 300 B.C. Samples coll. and subm. by D. I. Owens, Univ. Mus., Univ. Pennsylvania, Philadelphia.

**P-1728. Straits of Messina** **1541 ± 40**
**A.D. 409**

Two smaller pieces of wood (less riddled by shipworms) of 3 subm. 1970, from ship's timbers. *Comment*: MASCA corrected date = A.D. 333 (D.I.O.) wood of sample could well have come from another ancient shipwreck in immediate vicinity and swept into area by swift currents in Straits. Close proximity of ancient shipwrecks of different periods, sometimes overlapping one another, is now well documented by Univ. Mus. excavations led by G. F. Bass, Yassi Ada, Turkey (P-1395, R., 1970, v. 12, p. 581).

**P-1755. Straits of Messina** **2360 ± 50**
**410 B.C.**

Outer sec. of remaining larger piece of wood from ship's timbers, subm. 1970. *Comment*: MASCA corrected date = 531 B.C.

**P-1814. Straits of Messina** **2277 ± 42**
**327 B.C.**

Object #7, piece of ship's timbers, subm. 1971. *Comment*: MASCA corrected date = 446 B.C.

2. *Greece*

**Sesklo series**

Sesklo is a high prehistoric mound (acropolis), 8km W of Volos, capital of Thessaly, Greece (39° 23′ N Lat, 22° 49′ E Long). New excavations of Archaeol. Soc. Athens dir. by D. R. Theocharis, Ephor of Antiquities for Thessaly. Samples coll. 1963, 1968 and subm. by D. R. Theocharis, Archaeol. Mus., Volos, Greece.

**P-1671. S.68.37, Late Neolithic** **5622 ± 80**
**3672 B.C.**

Very fine dark soil, Sample S.68.37, from Sq. E 3, Late Neolithic (Dimini period). *Comment*: MASCA corrected date = 4372 B.C.

**P-1672. S.68.79, Middle Neolithic** **6504 ± 85**
**4554 B.C.**

Fine dark soil, Sample S.68.79, from Rm. 12, Middle Neolithic (later phase).

**P-1674. S.68.132, Middle Neolithic** **6964 ± 92**
**5014 B.C.**

Charcoal, Sample S.68.132, from wooden column, Middle Neolithic.

**P-1675. S.68.156, Middle Neolithic** **6694 ± 87**
**4744 B.C.**

Charcoal, Sample S.68.156, from wooden column, Middle Neolithic.

**P-1676. S.68.126, Middle Neolithic Floor** **6317 ± 84** **4367 B.C.**

Fine dark soil containing rootlets, Sample S.68.126, Middle Neolithic Floor. *Comment*: as many rootlets as possible removed by hand.

**P-1677. S.68.36, Middle Neolithic** **6741 ± 103** **4791 B.C.**

Charcoal, Sample S.68.36, from House 50, deep sounding, Middle Neolithic. *Comment*: undersized sample, 95%.

**P-1678. S.68.98, Earliest Pottery Neolithic** **7427 ± 78** **5477 B.C.**

Charcoal and fine dark soil, Sample S.68.98, from Trench 63, W, Earliest Pottery Neolithic.

**P-1679. S.63.122, Earliest Pottery Neolithic** **7611 ± 83** **5661 B.C.**

Charcoal and fine dark soil, Sample S.63.122, from depth 3.88m, Earliest Pottery Neolithic.

**P-1680. S.63.124A, Pre-Pottery Neolithic** **7300 ± 93** **5350 B.C.**

Charcoal and soil, Sample S.63.124A, from Sq. B 1, depth 4.10 to 4.20m, Pre-Pottery Neolithic.

**P-1681. S.63.124B, Pre-Pottery Neolithic** **7755 ± 97** **5805 B.C.**

Charcoal and soil, Sample S.63.124B, from Sq. 1 to Δ1, Pre-Pottery Neolithic.

**P-1682. S.63.121, Pre-Pottery Neolithic** **7483 ± 72** **5533 B.C.**

Charcoal and soil, Sample S.63.121, from Sq. B, depth 4.32m, Pre-Pottery Neolithic.

*General Comment*: this series, with exception of P-1671, is beyond range of MASCA correction factors now available (May, 1972).

*B. Near East*

*1. Iraq*

**P-1466. Khafajah, Sin Temple I** **5983 ± 73** **4033 B.C.**

Khafajah is a large mound complex on E bank of Diyala R., 16km NE of junction with Tigris in Iraq (33° 20′ N Lat, 44° 3′ E Long). The Sin Temple was excavated to its deepest level, dated by its excavators as Protoliterate C. Sample consisted of dark brown soil containing rootlets, from base of wall stubs still standing on N edge of pit excavated 1937-38 to ground-water level (now silted in with flood deposits). Alt. and position indicate Sin I walls (Delougaz and Lloyd, 1942, Fig. 3, Wall d). Excavators could expose only a very small area and established plan by tunnelling. Sample coll. 1955 and subm. 1968 by F. R. Matson, Pennsylvania State Univ., Univ. Park, Pennsylvania. *Comments*: NaOH pretreatment. MASCA corrected date = 4963 B.C. Comment by Matson based on uncorrected date calculated with 5730 half-life. (F.R.M.): date is almost a millennium early for Protoliterate C. Contamination from possible inclusion of bitumen and from frequent flooding of pit by Diyala R. since excavation must be considered. Cf. P-530, 4672 ± 74 (R., 1963, v. 5, p. 85).

**P-1468. Gasur (Nuzi)** **4002 ± 61**
**2052 B.C.**

Gasur, the Akkadian city found beneath the Hurrian city of Nuzi, 17.7km SW of Kirkuk, Iraq (35° 22′ N Lat, 44° 15′ E Long). Sample coll. 1955 from S wall of Pit L-4 from a dark soil band 10 to 12cm thick, 1.7m below base of a *libn* structure that could be traced in pit walls, and probably from above Pavement V (Starr, 1939, I, p. 21, II, plan no. 5) and subm. 1968 by F. R. Matson, Pennsylvania State Univ., Univ. Park, Pennsylvania. *Comments*: NaOH pretreatment. MASCA corrected date = 2673 B.C. Comment by Matson based on uncorrected date calculated with 5730 half-life. (F.R.M.): date is quite satisfactory for Akkadian period of occupation of Gasur, which has been surmised from study of clay tablets with Akkadian texts found on Pavements V and IV.

**Tepe Gawra series**

Tepe Gawra is a large mound ca. 32km NNE of Mosul, Iraq (36° 33′ N Lat, 43° 15′ E Long). It was excavated by Univ. Mus., Univ. Pennsylvania, 1931 to 1938 under direction of E. A. Speiser, and in some seasons under Charles Bache. Level XIX was the earliest excavated over an extended area. Level XX, which was tested, was of the Halaf period. Level XIX-XVII, in terms of pottery, represent early phase of N Ubaid period; levels XIIA-XII are terminal N Ubaid (Tobler, 1950, p. 4). Samples for P-1494-1496 (cf.) were from NW face of sounding in Sqs. 3-5, G-K, on either side of the "intrusive pit" (Tobler, 1950, pls. XVIII-XX, XLIII-XLV) after the face had been extensively cleaned. Samples coll. 1954 and subm. 1968 by F. R. Matson, Pennsylvania State Univ., Univ. Park, Pennsylvania.

**P-1497. Level XII** **5787 ± 72**
**3837 B.C.**

Sample, mostly soil (3% C) from a dark band in scarp face at S corner of Rm. 81, 15cm below Level XIA, the top of the scarp (Tobler, pls. VIII, XXVIIIb). *Comment*: NaOH pretreatment. MASCA corrected date = 4761 B.C.

**P-1496. Level XVII** **5991 ± 72**
**4041 B.C.**

Sample, mostly soil (2.45% C) from top of cleaned face of strat. cut, just E of "intrusive pit," containing some rootlets. From debris between Levels XVII and XVI. *Comment*: NaOH pretreatment. MASCA corrected date = 4971 B.C.

**P-1495. Level XVIII** **6420 ± 61**
**4470 B.C.**

Sample, mostly soil, (1.75% C) from ashy dark soil band, 43 to 63cm above P-1494 (cf.). *Comment*: NaOH pretreatment.

**P-1494. Level XIX** **7002 ± 82**
**5052 B.C.**

Sample, mostly soil (1.75% C) from dark soil band at exterior base W wall, Rm. 44, Level XIX (Tobler, 1950, pl. XX). *Comment*: NaOH pretreatment.

*General Comments*: P-1491 and -1495 are beyond range of MASCA correction factors now available (May, 1972). The following comment by Matson was based on uncorrected date calculated with the 5730 half-life. (F.R.M.): Samples P-1494-1497 show time range of N Ubaid period at Tepe Gawra—about a millennium. These 4 samples are internally consistent. Overlap between early Ubaid, later Halaf (cf. P-1487), and late Hassuna (cf. P-1499) strengthen the suggestion that Halaf is an intrusive culture in N Mesopotamia where Ubaid gradually succeeds Hassuna-Samarra in many village areas.

**P-1498. Tell Uqair** **6599 ± 107**
**4649 B.C.**
$\delta C^{13} = +38.9‰$

Tell Uqair is a mound ca. 80.5km S of Baghdad, midway between Tigris and Euphrates R. in Iraq (32° 57′ N Lat, 44° 38′ E Long). At site was evidence of occupation ranging from an Ubaid settlement into Early Dynastic times. Sample consisted of shells from excavation dump to NW of the deep Ubaid sounding. A few shells were included from NE dump. Faud Safar thought shells probably came from debris of House A, late in the Tell Uqair sequence. He had found a "heavy deposit of fresh water mussels" in House A (Lloyd and Safar, 1943, p. 149, pl. VIb). Sample coll. 1955 and subm. 1968 by F. R. Matson. *Comments*: sample undersized, 85.20%. MASCA corrected date = 4927 B.C. The following comment by Matson was based on uncorrected date calculated with the 5730 half-life. (F.R.M.): mass spectrometer corrected date is consistent with estimates of early Ubaid in S Mesopotamia. Compare P-1494, 7002 ± 82 (cf.) and H-138-123, 6070 ± 160 (Science, 1957, v. 126, p. 198).

**P-1499. Gird Ali Agha** **6927 ± 63**
**4977 B.C.**

Gird Ali Agha is a small mound on left bank of Greater Zab R., Iraq (36° 27′ N Lat, 43° 48′ E Long) (Braidwood and Howe, 1960, p. 26). This Hassuna period site in NE Iraq helps link upper levels of Jarmo with Hassuna in a cultural sequence. Sample is hearth material of ash and charcoal (2.65% C) from Operation I, Sec. B, Sq. 3, Feature 6 to 7, under Floor 3. Coll. 1954 and subm. 1968 by F. R. Matson. *Comments*: NaOH pretreatment. Date is beyond range of MASCA correction factors now available (May, 1972). (F.R.M.): date falls at upper end of date range from Hassuna period sites. Cf. K-960, -972, -981 (R., 1968, v. 10, p. 323), P-855, -857 (R., 1965, v. 7, p. 190), TK-23, -24 (R., 1969, v. 11, p. 513), W-623 and -660 (R., v. 2, p. 183).

**Banahilk series**

Banahilk is a small Halaf period site in Kurdistan, 1.6km SW of village of Diyana, Iraq (36° 40′ N Lat, 44° 45′ E Long) tested in 1955 by P. J. Watson (Braidwood and Howe, 1960, p. 23, 33-35. Watson's site report in press). Site is at E edge of distribution of Halaf-style pottery villages. Samples coll. 1954 and subm. 1968 by F. R. Matson.

**P-1501. Trench D II** — **6309 ± 78**, **4359 B.C.**

Black hearth material from top level of Halaf deposits, Trench D II, 1.3m below surface.

**P-1502. Trench D I** — **6752 ± 85**, **4802 B.C.**

Charcoal from hearth in Trench D I, Floor 6, 2.2m below surface, beneath Feature 1.

**P-1504. Trench D I** — **6854 ± 72**, **4904 B.C.**, $\delta C^{13} = +7.3‰$

*Helix* shells from same locus as P-1502. *Comment*: (F.R.M.): this mass spectrometer corrected date agrees with charcoal date from same hearth (P-1502, 6752 ± 85).

*General Comments*: this series is beyond range of MASCA correction factors now available (May, 1972). (F.R.M.): dates indicate time span for middle Halaf period near its E periphery. See comments for P-1487 (cf.).

2. *Syria*

**P-1487. Tell Chagar Bazar** — **6665 ± 77**, **4715 B.C.**

Sample, mostly soil or ash (2.1% C) from Tell Chagar Bazar, on Khabur R. near N-central border of Syria (36° 51′ N Lat, 41° 7′ E Long). A "Prehistoric Pit" was dug to determine main period of occupation (Mallowan, 1936, p. 7). An ash level near base of still exposed, but weathered S face of pit, 11.3m below surface, was estimated to correspond to Levels 11-12, in which initial extensive appearance of Halaf ware at site was found. Sample coll. 1955 and subm. 1968 by F. R. Matson. *Comments*: NaOH pretreatment. Date is beyond range of MASCA correction factors now available (May, 1972). (F.R.M.): date falls well within estimates for Halaf Period. It is later than those obtained from Tell Halaf: GrN-2660, 7570 ± 35 (R., 1964, v. 6, p. 355) and Arpachiyah: P-584, 7027 ± 83; and P-585, 8064 ± 78 (R., 1965, v. 7, p. 188). It is earlier than one Banahilk date (P-1501, cf.) from upper Halafian debris, but agrees well with 2 others from Banahilk (P-1502, -1504, cf.). Dates confirm excavator's suggestion that Halaf "ware entered Chagar Bazar later than it entered the Nineveh region" (Mallowan, 1936, p. 10). A "very late- or post-Halafian" date (6465 ± 100, Braidwood *et al.*, 1971, p. 1240) from Groningen Lab. has recently been cited for Gerikihaciyan, a Halafian site excavated by Watson in SE Turkey. Two other samples are being processed.

*3. Turkey*

**P-1473. Tell Judaidah, Phase G** **4782 ± 60**
**2832 B.C.**

Tell Judaidah is large mound in Amuq, Plain of Antioch, 1.5km SE of Rihaniyah, Turkey (36° 16′ N Lat, 36° 35′ E Long). Phase G is equated with Late Protoliterate-Early Dynastic period in Mesopotamia, with EB II in Palestine, and with Dynasty I of Egypt (Watson, 1965, p. 75-77). Sample from ash level with bits of charcoal (3.2% C) in Cut JK-3 at basal Phase G just below base of circular mud brick wall. Coll. 1955 and subm. 1968 by F. R. Matson (Braidwood and Braidwood, 1960). *Comments*: NaOH pretreatment. MASCA corrected date = 3676 B.C. Following comment based on uncorrected date calculated with 5730 half-life. (F.R.M.): date agrees very well with archaeol. established correlations.

*4. Iran*

**Dinkha Tepe series**

Dinkha Tepe (36° 59′ 51″ N Lat, 45° 10′ 41″ E Long) is in Ushnu Valley, W. Azerbaijan, Iran. Samples coll. 1968 by Hasanlu Project, jointly sponsored by Univ. Mus., Univ. of Pennsylvania, Metropolitan Mus. Art New York City, and Archaeol. Service Iran, subm. by excavation director, R. H. Dyson, Jr., Univ. Mus., Univ. Pennsylvania, Philadelphia, Pennsylvania. Remains of 4 major occupations have been uncovered: Dinkha I (Islamic); Dinkha II (Iron Age II equal to Hasanlu IV, ca. 1000 to 800 B.C.); Dinkha III (Iron Age I equal to Hasanlu V, ca. 1350 to 1000 B.C. and Dinkha IV (Bronze age equal in part to Hasanlu VI, ca. ?1900 to ?1350 B.C.). Chronology based on earlier radiocarbon dates for Hasanlu and studies of relative chronology (Dyson, 1965; Ralph, 1959; Stuckenrath, 1963; Stuckenrath *et al.*, 1966).

**Dinkha IV**

**P-1690. Di-68-S.7, B9/10a** **3539 ± 59**
**1589 B.C.**

Charcoal from Op. B9/10a, St. 2A, Area 5 (Field Sample # 3), N edge of central Mound. *Comment*: MASCA corrected date = 1895 B.C.

**P-1692. Di-68-S.11AI, B9/10a** **3576 ± 70**
**1626 B.C.**

Charcoal from Op. B9/10a, St. 7 (Field Sample #14) at level of Wall K and hearth of Area 11, N edge of central mound. *Comment*: MASCA corrected date = 1933 B.C.

**P-1720. Di-68-S.9, B9/10a** **3395 ± 68**
**1445 B.C.**

Charcoal from Op. B9/10a, St. 3, Area 4 (Field Sample #11), N edge of central mound. *Comment*: MASCA corrected date = 1747 B.C.

**P-1721. Di-68-S.11A and 11BII, B9/10a** **3458 ± 66**
**1508 B.C.**

Two samples of charcoal from Op. B9/10a, St. 7, Di-68-S.11A (Field Sample #15) in SW corner of Wall K and Di-68-S.11BII (Field Sample #13) at level of Wall K and Hearth 11, N edge of central mound. *Comment*: NaOH pretreatment. MASCA corrected date = 1812 B.C. (R.H.D.): these 2 combined samples represent deepest stratified carbon above virgin soil at site.

**P-1693. Di-68-S.5A and B, G10h** **3353 ± 65**
**1403 B.C.**

Charcoal and soil, Op. G10h, St. 5e, Area 2, from single black lens 50cm below and sealed by Wall O, E edge of central mound. *Comment*: NaOH pretreatment. MASCA corrected date = 1704 B.C.

*General Comment*: for additional dates from Dinkha IV, see P-1231, -1232, -1450, -1452, -1233, -1430, -1552, and -1429/31 (R., 1970, v. 12, p. 578-579).

*C. Africa*

*1. Cameroon*

**Pouss series**

Pouss is Iron age mound in Logone Valley, N Cameroon (10° 51′ N Lat, 15° 4′ E Long). Samples coll. 1969 by Frank Bartell; subm. by N. C. David, Univ. Mus., Univ. Pennsylvania, Philadelphia, Pennsylvania.

**P-1765. Stratigraphic Units 1 and 2** **199 ± 43**
**A.D. 1751**

Charcoal containing rootlets from strat. Units 1 and 2. *Comment*: rootlets removed by hand. NaOH pretreatment. MASCA corrected date = A.D. 1638.

**P-1766. Strat. Units 3 and 4** **550 ± 29**
**A.D. 1400**

Charcoal containing many rootlets from strat. Units 3 and 4. *Comment*: rootlet pretreatment (Haynes, 1966; Lowdon *et al.*, 1970, p. 474). MASCA corrected date = A.D. 1383.

**P-1773. Strat. Units 3 and 4** **607 ± 49**
**A.D. 1343**

Portion of same sample as P-1766. *Comment*: rootlets removed by hand and sample given regular HCl and NaOH pretreatment. MASCA corrected date = A.D. 1324.

**P-1767. Strat. Units 15 and 16** **889 ± 35**
**A.D. 1061**

Charcoal and soil containing rootlets from strat. Units 15 and 16. *Comment*: rootlets removed by hand. NaOH pretreatment. MASCA corrected date = A.D. 1034.

*General Comment* (N.C.D.): Pouss is S-most mound of any size on left bank of Logone R. Preliminary typologic analysis suggests that materials represent impoverished S facies of Sao civilization. P-1767 was from lowest horizons of occupation, though burials occur 1m below at depth 5.75m.

**Sumpa Cave series**

Sumpa Cave is in Benue Valley, N Cameroon (9° 18′ N Lat, 13° 31′ E Long), only known site in area containing Neolithic phase. Samples coll. 1969 by Frank Bartell; subm. by N. C. David.

**P-1635. C:2 and A:2** **347 ± 41**
**A.D. 1603**

Charcoal, Sample C:2 and A:2, from strat. Unit 1b. *Comment*: NaOH pretreatment. MASCA corrected date = A.D. 1542.

**P-1636. C:4** **102 ± 39**
**A.D. 1848**

Charcoal, Sample C:4 from strat. Unit 2b. *Comment*: MASCA corrected date = A.D. 1794.

**P-1637. C:6 and D:3** **346 ± 51**
**A.D. 1604**

Charcoal, Samples C:6 and D:3 from strat. Unit 3. *Comment*: NaOH pretreatment. MASCA corrected date = A.D. 1543.

**P-1638. C:8, C:7, A:5, and A:6** **704 ± 42**
**A.D. 1246**

Charcoal, Samples C:8, C:7, A:5, and A:6 from strat. Units 4 and 5. *Comment*: MASCA corrected date = A.D. 1224.

*General Comment* (N.C.D.): deposits were extensively disturbed by burrowing animals and cave was used until very recently as a stall for sheep and goats. Dates are valueless. Preliminary typologic analyses suggest that both P-1637 and -1638 should fall within 1st 2 millennia B.C.

**Douloumi series**

Douloumi is Iron age mound with ca. 4m cultural stratigraphy, on Lake Douloumi in N Cameroon (9° 12′ N Lat, 13° 39′ E Long). Sample coll. 1969 by Frank Bartell; subm. by N. C. David.

**1089 ± 41**
**P-1761. Strat. Units 5, 6, and 7** **A.D. 861**

Charcoal, burnt bone, and soil from strat. Units 5, 6, and 7 of Iron age assemblage. *Comment*: MASCA corrected date = A.D. 878.

**1074 ± 47**
**P-1763. Strat. Units 17 and 18** **A.D. 876**

Charcoal, soil, and rootlets from strat. Units 17 and 18 of Iron age assemblage. *Comment*: rootlets removed by hand. NaOH pretreatment. MASCA corrected date = A.D. 894.

**1412 ± 50**
**P-1764. Strat. Units 20 and 21** **A.D. 538**

Charcoal, burnt bone, soil, and rootlets from strat. Units 20 and 21 of Iron age assemblage. *Comment*: rootlets removed by hand. MASCA corrected date = A.D. 546.

*General Comment* (N.C.D.): P-1764 comes from lowest horizons of occupation and represents earliest, but surprisingly late, Iron age occupation so far found in area. P-1761, 1.75m above P-1763 in strat. appears too old. A date in 1st millennium A.D. was expected.

**Be series**

Be, an Iron age mound with 7m cultural material, unoccupied since A.D. 1839, Fulani conquest of the Nyam-nyam village, is in the Mayo Kebbi Valley, N Cameroon (9° 18′ N Lat, 13° 40′ E Long). Samples coll. 1969 and subm. by N. C. David.

**Pit A**

**258 ± 39**
**P-1744. Strat. Units 7 and 8** **A.D. 1692**

Charcoal and soil from arbitrary strat. Units 7 and 8. *Comment*: NaOH pretreatment. MASCA corrected date = A.D. 1634.

**410 ± 36**
**P-1557. Strat. Unit 12** **A.D. 1540**

Charcoal from arbitrary strat. Unit 12. *Comment*: MASCA corrected date = A.D. 1458.

**832 ± 49**
**P-1746. Strat. Unit 25** **A.D. 1118**

Charcoal and soil from arbitrary strat. Unit 25. *Comment*: NaOH pretreatment. MASCA corrected date = A.D. 1093.

**507 ± 36**
**P-1747. Strat. Unit 30** **A.D. 1443**

Charcoal and soil from arbitrary strat. Unit 30. *Comment*: NaOH pretreatment. Undersized sample (89%), therefore not as reliable. MASCA corrected date = A.D. 1427.

**902 ± 41**

**P-1748. Strat. Unit 34** **A.D. 1048**

Charcoal and soil from arbitrary strat. Unit 34. *Comment*: NaOH pretreatment. MASCA corrected date = A.D. 1021.

**1106 ± 33**

**P-1684. Strat. Unit. 38** **A.D. 844**

Charcoal and soil from arbitrary strat. Unit 38, lowest occupational horizon. *Comment*: NaOH pretreatment. MASCA corrected date = A.D. 860.

*General Comment* (N.C.D.): radiocarbon dates suggest average rate of accumulation of 7mm/yr, and with exception of undersized Sample P-1747, may be considered satisfactory.

**Be Pit B**

**275 ± 53**

**P-1750. Strat. Units 6 to 10** **A.D. 1675**

Charcoal and soil from strat. Unit 6 to 10. *Comments*: MASCA corrected date = A.D. 1616. (N.C.D.): date appears too young, but is made up of 6 sub-samples from zone > 1m deep. Expected date: ca. A.D. 1000.

**1014 ± 48**

**P-1753. Strat. Units 19 to 22** **A.D. 936**

Charcoal with many rootlets from Units 19 to 22. *Comments*: rootlets removed by hand. MASCA corrected date = A.D. 956. (N.C.D.): sample corresponds well with stratigraphically equivalent P-1684 from Pit A.

*D. Arctic*

*1. Alaska*

**Unalakleet series**

Unalakleet Old Village consists of 200 to 300 house pits on older beach ridge now ca. 4km from coastline of Norton Sound, Alaska (64° N Lat, 161° E Long). Samples coll. 1968, 1969 and subm. 1969 by Bruce Lutz, Univ. Mus., Univ. Pennsylvania, Philadelphia, Pennsylvania (1969).

**1556 ± 48**

**P-1530. Ipiutak house** **A.D. 394**

Charcoal from within floor of Ipiutak house, coll. 1968. *Comment*: MASCA corrected date = A.D. 297.

**1810 ± 40**

**P-1772. Ipiutak house** **A.D. 140**

Charcoal from W hearth of Ipiutak house (house had 2 hearths), coll. 1969. *Comment*: NaOH pretreatment. P-1530 was obtained near hearth. MASCA corrected date = A.D. 135.

**1976 ± 50**

**P-1531. House 2** **26 B.C.**

Charcoal from hearth on floor of House 2, coll. 1968. *Comment*: on typologic grounds (*i.e.*, presence of burins), should be earlier than Cape

Denbigh Norton, P-13, 2213 ± 110 (R., 1961, v. 3, p. 11). MASCA corrected date = 86 B.C.

**2091 ± 50**
**P-1532. House 3** **141 B.C.**

Charcoal from hearth at bottom of floor midden of House 3. *Comment*: same as for P-1531. MASCA corrected date = 204 B.C.

**2140 ± 47**
**P-1771. House 120** **190 B.C.**

Charcoal from hearth on floor of House 120. *Comment*: rootlet pretreatment (Haynes, 1966; Lowdon *et al.*, 1970). MASCA corrected date = 304 B.C.

## II. GEOLOGIC SAMPLES

### *A. North America*

*1. United States*

**Island Field, Delaware series**

*Spartina alterniflora* marsh peat or plant fragments embedded in marsh mud at Island Field Archaeol. Site, S Bowers, Delaware (39° 3′ N Lat, 75° 23′ W Long). Samples are from different peat horizons within a marshy sequence, building upwards and advancing landward for the past 3 to 5000 yr. Coll. 1968, 1969 by J. C. Kraft, Univ. Delaware, Newark, Delaware; subm. by R. A. Thomas.

**1592 ± 45**
**P-1687. JCK DH 1-68** **2 B.C.**

JCK DH 1-68, 2.13m to 2.64m. *Comment*: NaOH pretreatment.. MASCA corrected date = 61 B.C.

**1950 ± 55**
**P-1686. JCK DH-1-69** **A.D. 1 to 1 B.C.**

JCK DH 1-69, Core 1, 4.57m to 4.88m. *Comment*: NaOH pretreatment. MASCA corrected date = 59 B.C.

**2999 ± 59**
**P-1688. JCK DH-1-69** **1049 B.C.**

JCK DH 1-69, Core 3, 6.10m to 6.40m. *Comment*: NaOH pretreatment. MASCA corrected date = 1289 B.C.

**3314 ± 63**
**P-1685. JCK, DH 5-69** **1364 B.C.**

JCK, DH 5-69, 6.60m to 6.86m. *Comment*: NaOH pretreatment. MASCA corrected date = 1664 B.C.

**2153 ± 69**
**P-1669. JCK Core 11** **183 B.C.**

JCK Core 11, Part 2-69, 2.24m to 2.57m. *Comment*: NaOH pretreatment. MASCA corrected date = 298 B.C.

**Corrections**

R., 1969, v. 11, p. 152: P-1434 should be 4285 ± 62 (2335 B.C.), published correctly in R., 1971, v. 13, p. 371, but not designated as a correction.

R., 1971, v. 13, p. 365; P-1392 should be P-1394.

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# UNIVERSITY OF ROME CARBON-14 DATES XI

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During the last few years, we have set up the benzene scintillation method in our laboratory. $C^{14}$ activity measurements are now carried out with both liquid scintillation and $CO_2$-proportional counters. Chemical apparatus for benzene synthesis and a liquid scintillation spectrometer for low-level counting were built and are described below.

After standard pretreatment, carbon is converted to $CO_2$ by combustion or acid treatment and then synthesized to liquid benzene in a closed system for ca. 8 hours. The combustion line was set up after Broecker *et al.* (1959), connected with a benzene synthesizing line designed as suggested by Noakes *et al.* (1963; 1965; 1967), as well as with new designs and operating features (Alessio *et al.*, 1970b).

Converting a sample to $CO_2$ requires 90 to 120 min., yielding from 95% to 98% $CO_2$. For the conversion of $CO_2$ into $C_6H_6$, Table 1 shows reactions, time, and yields.

TABLE 1
Benzene synthesis

| Reactions | Yields (%) | Time (min.) |
|---|---|---|
| a) $\begin{cases} 2\,CO_2 + 10\,Li \longrightarrow Li_2C_2 + 4\,Li_2O \\ 2\,C + 2\,Li \longrightarrow Li_2C_2 \end{cases}$ | | 60-90 |
| b) $Li_2C_2 + 2\,H_2O \longrightarrow C_2H_2 + 2\,LiOH$ | 98-100 | 20-30 |
| c) $3\,C_2H_2 \xrightarrow{\text{catalyst}} C_6H_6$ | 98-100 | 180-240 |

a) In synthesis of $Li_2C_2$ metallic lithium pellets are used, in 10% > stoichiometrically required quantity. The metal is slowly brought to melting (ca. 600°C), completed in 15-20 min.; subsequently the temperature rises to ca. 800°C and lithium assumes an orange-red color. It was found that, keeping the temperature at ca. 800°C for > 15-20 min. after the total disappearance of $CO_2$, the $C_6H_6$ yield is further raised to ca. 95% (Polach and Stipp, 1967).

Reaction completed, all traces of radon are removed by keeping the reactor bottom under vacuum at ca. 600°C for 30 min. The lithium carbide synthesis reaction is quantitative and fairly fast: not > 90 min. is required to convert 10 L $CO_2$.

b) Distilled water is made to flow at ca. 200 ml/min. over lithium carbide at room temperature, at the same time cooling the bottom of reaction chamber, reaction being exothermic. Acetylene is frozen in liquid nitrogen; water vapor, ammonia compounds, and hydrogen are suitably removed.

c) For trimerization of acetylene to benzene, a catalyst developed by Noakes *et al.* (1967) was used initially, consisting of 20% $V_2O_5$ on a silica-alumina support with a minimum specific surface of 200 $m^2/g$. Immediately before use, the catalyst was activated at ca. 300°C under rotary pump vacuum for 2 hours, while cycling reaction was carried out at 13 ± 1°C, for at this temperature reaction kinetics were faster (Alessio *et al.*, 1970b). This catalyst could be reactivated several times by heating to ca. 300°C under vacuum for 2 hours, with yields always > 90% and high reaction kinetics.

At present our laboratory uses the KC-Perlkatalysator Neu catalyst, Kaly-Chemie A. G., Hannover. This product is activated to ca. 350°C for 15-20 min., while the temperature of acetylene to benzene trimerization begins at ca. 50°C, allowing reaction to proceed spontaneously. It was found that 100g of this non-regenerative catalyst is sufficient to produce up to 5.5ml benzene and all gas-chromatographic analyses of samples have always shown a degree of purity from 99.5 to 100%.

In a pyrex counting vial 4.5ml liquid is introduced, containing 2ml sample benzene and 2.5ml NE 216 liquid scintillator produced by Nuclear Enterprises Ltd. The cylindrical vial, ca. 1/3 as high as its diam., is inserted coaxially into a light pipe, to the ends of which are connected 2 photomultipliers operating in coincidence.

An anti-coincidence shield is formed by a plastic scintillator enclosing a light pipe and connected with a 3rd photomultiplier operating in anti-coincidence with the first two. The scintillation spectrometer is in a room at 18°C and is protected against soft component of cosmic radiation by a 20cm iron and 15cm lead shield. Data are recorded by an electronic unit incorporating coincidence circuits with 7 ns resolution times. Each activity measurement lasts ca. 24 hours, with regularity checks at 30-min. intervals. Background is 6.47 ± 0.04cpm, the net modern activity 13.43 ± 0.08cpm, and the figure of merit $E^2/B = 580$.

This list includes age measurements of check samples and of new series of Italian geologic and historic samples made by the liquid scintillation method.

As in dating with $CO_2$-proportional counters in preceding lists, "modern standard" is wood grown near Rome from 1949 to 1953, whose activity was repeatedly checked with 95% of the activity of NBS oxalic acid. Errors quoted are 1$\sigma$ statistical error. Ages were calculated using the Libby half-life of 5568 yr, with 1950 as the standard year of reference.

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## SAMPLE DESCRIPTIONS

### I. CHECK SAMPLES

The liquid scintillation method was checked, using for benzene synthesis $CO_2$ obtained from various samples dated with the proportional counter. Ages obtained from both methods agree satisfactorily and are compared in Table 2.

TABLE 2
Check samples

| Sample | $C^{14}$ age liquid scintillation method | $C^{14}$ age $CO_2$-proportional counting method | References |
|---|---|---|---|
| R-716 | 28,500 ± 2000 | 27,800 ± 800 | R., 1971, v. 13, p. 404 |
| R-578 | 12,650 ± 250 | 11,820 ± 120 | R., 1971, v. 13, p. 406 |
| R-703 | 5000 ± 70 | 4360 ± 50 | R., 1971, v. 13, p. 407 |
| R-706 | 11,500 ± 200 | 11,800 ± 100 | R., 1971, v. 13, p. 407 |
| R-594 | 8480 ± 200 | 8400 ± 70 | R., 1971, v. 13, p. 409 |
| R-595 | 5850 ± 160 | 5880 ± 50 | R., 1971, v. 13, p. 409 |
| R-375 | 3230 ± 100 | 3360 ± 50 | R., 1973, v. 15, p. 165 |
| R-375$\alpha$ | 3840 ± 80 | 3160 ± 50 | R., 1973, v. 15, p. 165 |
| R-831A$\alpha$ | 1730 ± 90 | 1710 ± 50 | R., 1973, v. 15, p. 169 |
| R-834$\alpha$ | 1650 ± 90 | 1700 ± 50 | R., 1973, v. 15, p. 169 |
| R-836$\alpha$ | 1760 ± 100 | 1680 ± 50 | R., 1973, v. 15, p. 169 |
| R-823 | 16,400 ± 400 | 16,390 ± 180 | R., 1973, v. 15, p. 173 |
| R-825 | 15,900 ± 300 | 15,090 ± 140 | R., 1973, v. 15, p. 173 |
| R-707 | 3600 ± 90 | 3650 ± 50 | R., 1973, v. 15, p. 175 |

### II. GEOLOGIC SAMPLES

*Italy*

**5570 ± 120**
**R-241. Ghiacciaio del Rutor** **3620 B.C.**

**5950 ± 130**
**R-241$\alpha$. Ghiacciaio del Rutor** **4000 B.C.**

Brown-blackish peat with leaf remains (*Cyperaceae, Bryophyta*), and detritus with no wood, in terminal moraine of W branch of Rutor Glacier near confluence with E branch, 250m S Rutor Lake, Upper Valley Dora di la Thuile R., Valle d'Aosta, Piedmont (45° 39′ 53″ N Lat, 6° 57′ 24″ E Long) at +2515m; coordinate system U.T.M. 32 TLR 42905910. Coll. 1958 by L. Peretti, and subm. 1966 by G. Charrier, both of Ist. Giacim. Min., Politecnico Turin. Peat is believed to come from an ancient peat bog, later covered and reworked by glacier, at foot of a high rocky shelf, at +2776m. Peat therefore provides evidence of a Rutor glacier terminal margin a few hundred m behind present one and glaciated area diminished > 2km², corresponding to a major Holocene anathermic phase (Peretti, 1964). Pollen analysis of peat shows: *Pinus*, several species, (57.45%), *Abies* (34.44%), *Tilia* (2.75%) (Charrier, 1964). *Comment*: R-241 was pretreated with 10% HCl; R-241$\alpha$ was given additional leaching with 6% $NH_4OH$. R-241$\alpha$ date, indicating the climax of postglacial climatic optimum (Atlantic), substantially agrees well with pollen analysis showing predominance of *Abies* assoc. with *Pinus* and with characteristic mixed forest components (*Tilia*). Radiometric data, therefore, rule out other controversial reference to anathermic climatic phases of Late Holocene (Sub-Atlantic).

Other peat bogs and lacustrine deposits dated in various areas of the Alps to establish a chronology of postglacial climatic events (see: R., 1964, v. 6, p. 85-87; 1968, v. 10, p. 359-360; v. 12, p. 610-611).

**Lago di Tenno series**

Well-preserved trunks *in situ* on bottom of Tenno Lake, 4.5km N Tenno, prov. Trento, Trentino (45° 56′ N Lat, 10° 49′ E Long) at +570m. Coll. 1970 by Gruppo Sommozzatori di Riva del Garda and subm. by B. Bagolini, Mus. Tridentino Sci. Nat., Trento.

Trunks belong to submerged forest covering ca. 1/5 lake bottom on W side. Over 70 trees have been mapped by Mus. and are being id. by F. Pedrotti, Ist. Bot., Univ. Camerino. Samples dated with and without acid pretreatment (A-labelled samples): no carbonate present.

**790 ± 70**
**R-793. Lago di Tenno A** **A.D. 1160**

**1190 ± 80**
**R-793A. Lago di Tenno A** **A.D. 760**

Well-preserved, small trunk *in situ*. *Comment*: 2 dates do not agree well.

**570 ± 70**
**R-794. Lago di Tenno B** **A.D. 1380**

**630 ± 70**
**R-794A. Lago di Tenno B** **A.D. 1320**

Well-preserved, very small trunk or branch *in situ*. *Comment*: 2 dates agree.

**1000 ± 70**
**R-795. Lago di Tenno C28** **A.D. 950**

**940 ± 70**
**R-795A. Lago di Tenno C28** **A.D. 1010**

Well-preserved wood, ca. 25cm diam. trunk *in situ*. *Comment*: 2 dates agree.

*General Comment*: $C^{14}$ dates, in particular R-794 ages, seem to confirm traditional belief that Tenno Lake basin was formed by a landslide ca. A.D. 1400 (Battisti, 1898; Tomasi, 1963; Untergasser, 1935; Venzo, 1935).

**Pontelagoscuro series**

In 1970, a water prospecting test, 60cm diam. and ca. 40m deep, was drilled by dry cable-tool method along Natl. Hwy. No. 16 about mid-way between Pontelagoscuro and Ferrara, Emilia (44° 51′ 58″ N Lat, 11° 36′ 00″ E Long) at +8.50m. Drill core was preserved for study. Later, at same location, a 3.5m diam. and 40m deep well was driven to trap aquifers located at depths 11 to 36m; 2 levels were found, 30.10 and 34.90m deep, rich in vegetable remains and 1 level, 35.70m deep, with abundant, large wood fragments. Coll. 1970 by drilling staff and subm. 1970 by M. Bondesan, Ist. Geol., Univ. Ferrara.

**32,500 ± 2000**
**R-862. Pontelagoscuro 1 30,550 B.C.**

Vegetable remains, mainly small wood fragments, fairly well-preserved, from coarse sand level, 30.10m deep. *Comment*: sample pretreated with 10% HCl only because, despite slight darkening, test with 0.2N NaOH did not disclose humic material.

**35,000 ± 3000**
**R-863α. Pontelagoscuro 2 33,050 B.C.**

Vegetable remains, mainly small darkened wood fragments, found in coarse clayey sand 34.90m deep. *Comment*: sample was pretreated with 10% HCl and given additional leaching with 0.2N NaOH.

**27,500 ± 1000**
**R-864. Pontelagoscuro 3 25,550 B.C.**

Fragment of well-preserved wood, 35cm long and 3cm diam., found in coarse clayey sand rich in large wood fragments, 37.70m deep. *Comment*: sample pretreated with 10% HCl only, as alkaline treatment was not considered necessary.

*General Comment*: as supposed, $C^{14}$ dates indicate Würm age. However, dates cannot yet be fully interpreted since lithologic and paleontologic study of core has barely started; sedimentary environment and origin of dated materials have not yet been determined. In the area only known stratigraphy is from deep natural-gas prospecting well (Selli, 1945-46).

## III. HISTORIC SAMPLES

### *Italy*

**2100 ± 90**
**R-913. S. Andrea, Orvieto 150 B.C.**

Humic acids from brown earthy layer in archeol. excavations of a sacred area underlying St. Andrea's Church, Orvieto, Umbria. Coll. 1970 by M. P. Rossignani, and subm. 1971 by M. Cagiano de Azevedo, both of Ist. Archeol., Univ. Cattolica, Milan. *Comment*: layer containing scarce small bone fragments and charcoal appears as a final fire level indicating last stage of use of a sacred area of Villanovan-Etruscan age with superimposed foundations of a Palaeochristian basilica (Cagiano de Azevedo, 1972). Bones and charcoal being insufficient, humic acids of layer judged uncontaminated by more recent carbon were dated; results are merely suggestive although they agree with expected archaeol. age.

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# SMITHSONIAN INSTITUTION RADIOCARBON MEASUREMENTS VIII*

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## INTRODUCTION

This list includes samples completed to July, 1972. All samples are counted for at least 2500 min., and $X^2$ analyses are made on 100-min. print-outs. Errors quoted are $1\sigma$, derived from sample, background, and NBS oxalic acid standard measurements, adjusted where appropriate for small-sample dilution.

Shell samples are pretreated with 1N HCl to remove outer portion, and sample $CO_2$ is evolved using 50% $H_3PO_4$. Except where noted, all other samples are pretreated with hot 2% NaOH and 2N HCl. $CO_2$ is converted to $CH_4$ in a static bomb reactor with ruthenium metal catalyst, using $H_2$ generated from "dead" $H_2O$. Radon is extracted from $CH_4$ by passing it through charcoal at −30°C, following the technique of H. W. Krueger of Geochron Laboratories.

## SAMPLE DESCRIPTIONS

### I. GEOLOGIC AND PALEONTOLOGIC SAMPLES

**Alboran Basin series, W Mediterranean**

Samples from several localities on sediment surface in Alboran Basin, W Mediterranean. Coll. 1970 and 1971 and subm. by D. J. Stanley, Smithsonian Inst.

**13,430 ± 360**
**SI-664. Xaven Bank, 300m** **11,480 B.C.**

Coarse carbonate sands, 90% shell, dredged from 300m water depth, 0 to 30cm sediment depth, on Xaven Bank (33° 26′ N Lat, 4° 15′ 42″ W Long).

**11,605 ± 235**
**SI-665. Xaven Bank, 234m** **9655 B.C.**

Coarse calcareous sand, 90% shell, dredged from 234m water depth, 0 to 30cm sediment depth, on Xaven Bank (35° 25′ 30″ N Lat, 4° 22′ 12″ W Long).

**3840 ± 120**
**SI-666. W Alboran Ridge, 86m** **1890 B.C.**

Coarse brown carbonate sand, 90% shell, Shipek grab sample from 86m water depth, 0 to 20cm sediment depth, on W Alboran Ridge (35° 34′ N Lat, 3° 33′ E Long).

**6605 ± 180**
**SI-667. Alboran Ridge, 97m** **4655 B.C.**

Coarse calcareous sand, 90% shell, Shipek grab sample from 97m

* Published with the approval of the Secretary of the Smithsonian Institution.

water depth, 0 to 20cm sediment depth, on Alboran Ridge (36° 00′ 05″ N Lat, 2° 50′ 48″ E Long).

**SI-668. E Gibraltar Strait, 823m** **9400 ± 185**
**7450 B.C.**

Coarse calcareous sand, 90% shell, from 823m water depth, 0 to 20cm sediment depth, in E Gibraltar Strait (35° 57′ 48″ N Lat, 5° 23′ 24″ E Long).

**SI-884. Algal ball, 50m** **295 ± 45**
**A.D. 1655**

Algal ball on sediment surface, 50m water depth, in Alboran Sea (33° 55′ N Lat, 3° 00′ W Long).

**SI-885. Algal ball, 30m** **101.5% modern**

Algal ball on sediment surface at 30m water depth in Alboran Sea (36° 00′ N Lat, 3° 00′ W Long).

**SI-886. Calcareous algae, 50m** **11,385 ± 145**
**9435 B.C.**

Calcareous algae from sediment surface, 50m water depth on Xaven Bank (35° 25′ N Lat, 4° 00′ W Long).

**Alboran split series, W Mediterranean**

Three portions of a single sample, water depth 50m, on sediment surface in Alboran Basin (35° 10′ N Lat, 3° 10′ W Long), W Mediterranean. Sample was sorted by shell varieties, and each portion dated. Coll. 1970 and subm. by D. J. Stanley.

**SI-881. Alboran gastropods** **6590 ± 280**
**4640 B.C.**

**SI-883. Alboran coralline algae** **6930 ± 240**
**4980 B.C.**

**SI-882. Alboran ectoprocts** **3085 ± 160**
**1135 B.C.**

*General Comment*: while dates for gastropods and coralline algae agree (340 ± 370 = 0.9$\sigma$), date for ectoprocts differs significantly (3675 ± 245 = 15$\sigma$) from average age of other fractions (6760 ± 185 yr). Difference casts some doubt upon reliability of ages obtained on undifferentiated shell samples in these and other series.

**Mediterranean core series**

Foraminifera from sphincter cores in W Alboran Basin, Mediterranean. Coll. 1969 and subm. by D. J. Stanley (Huang, Stanley, and Stuckenrath, 1972).

W Alboran Core 92 (35° 42′ N Lat, 4° 15′ W Long)

**SI-669. Core 92, 340 to 360cm** **11,280 ± 230**
**9330 B.C.**

From pelagic clay beneath upper sand layer.

**SI-670. Core 92, 558 to 578cm** **14,620 ± 410** **12,670 B.C.**

From pelagic clay beneath lower sand layer.

**SI-671. Core 92, 710 to 730cm** **15,780 ± 470** **13,830 B.C.**

From gray pelagic clay, lowest part of core.

W Alboran Core 95 (35° 39′ 12″ N Lat, 4° 08′ 42″ W Long)

**SI-672. Core 95, 50 to 70cm** **2835 ± 155** **885 B.C.**

From yellow-brown pelagic clay near sediment surface.

**SI-673. Core 95, 295 to 315cm** **8275 ± 195** **6325 B.C.**

In gray pelagic clay beneath upper sand layer. *Comment*: small sample, diluted.

**SI-674. Core 95, 420 to 440cm** **9560 ± 250** **7610 B.C.**

From gray pelagic clay in upper part of bioturbated layer. *Comment*: small sample, diluted.

**SI-675. Core 95, 490 to 510cm** **10,780 ± 270** **8830 B.C.**

From gray pelagic clay beneath bioturbated layer.

**SI-676. Core 95, 680 to 700cm** **13,895 ± 345** **11,945 B.C.**

From gray pelagic clay, deepest part of core. *Comment*: small sample, diluted.

W Alboran Core 107 (36° 03′ N Lat, 4° 25′ W Long)

**SI-677. Core 107, 0 to 20cm** **725 ± 105** **A.D. 1225**

From yellow-brown pelagic clay near sediment surface.

**SI-678. Core 107, 450 to 470cm** **19,055 ± 695** **17,105 B.C.**

From gray pelagic clay above turbidite layer.

**Ward Hunt Ice Shelf series, Ellesmere I., Canada**

Shells, id. by Joseph Rosewater, from Ward Hunt I. (83° N Lat, 74° W Long), N.W.T., Canada. Samples are part of study to determine formation and growth of the ice shelf with climatic change, and to establish a rebound curve for N coast of Ellesmere I. Coll. 1960 by J. B. Lyons; subm. by J. E. Mielke, (Lyons and Mielke, mss. in preparation).

**SI-718. Ward Hunt I., 38m** **7755 ± 150** **5805 B.C.**

*Hiatella arctica* Linné from emerged beach at +38m, N side Ward Hunt I. *Comment*: cf. L-248A: 7200 ± 200 (Science, 1956, v. 124, p. 162).

**SI-720. Ward Hunt I., 5m** **5950 ± 155**
**4000 B.C.**

*Hiatella arctica* Linné from emerged beach at +5m, E side Ward Hunt I.

**SI-721. NE Ward Hunt I., basement ice** **6815 ± 190**
**4865 B.C.**

*Astarte* and *Vermetus* from basement ice at junction with moat ice near ridge and trough system 1.6km NNE of NE tip of Ward Hunt I.

**SI-722. SE Ward Hunt I., ice thrust** **3990 ± 130**
**2040 B.C.**

*Hiatella arctica* Linné, *Astarte,* and *Vermetus* in ice thrust structures at SE end Ward Hunt I.

**SI-723. Camp Creek ice rise** **4775 ± 120**
**2825 B.C.**

*Hiatella arctica* Linné found beneath Camp Creek ice rise from till being uncovered by ablation.

**SI-724. Rambow Hill** **5735 ± 110**
**3785 B.C.**

*Hiatella arctica* Linné from area between Rambow Hill and Camp Creek ice rise, +10m.

**SI-725. Camp Creek** **7045 ± 190**
**5095 B.C.**

*Hiatella arctica* Linné, *Astarte,* and *Vermetus* from 0.8km above mouth of Camp Creek, +30m.

**SI-727. Ellesmere I., basement ice** **3680 ± 100**
**1730 B.C.**

*Hiatella arctica* Linné and *Astarte* from basement ice near moat near Ellesmere I., S edge of ice shelf.

**Ward Hunt I. series, N.W.T.**

Shell and sponge material from ice-thrust structures on SE shore of Ward Hunt I. (83° 04′ N Lat, 74° 05′ W Long), N.W.T. Age may represent time of extinction due to brackish- or fresh-water poisoning of marine bottom fauna beneath original Ward Hunt Ice Shelf. Coll. 1969 and subm. by J. E. Mielke.

**SI-638. Shell** **3645 ± 120**
**1695 B.C.**

*Astarte, Hiatella arctica* Linné, and *Limatula.*

**SI-719-A. Sponge, carbonate fraction** **13,200 ± 440**
**11,250 B.C.**

Calcilutite assoc. with siliceous sponge material.

**SI-719-B. Sponge, organic fraction** **3400 ± 140**
**1450 B.C.**

Organic fraction of same sponge as SI-719-A, above. *Comment*: cf. L-284: 400 ± 150 (Science, 1956, v. 124, p. 162).

**Lake "A", Ellesmere I., N.W.T.**

Two samples of saline water from bottom of unnamed lake in raised fiord on N coast Ellesmere I. (83° N Lat, 75° 20′ W Long), N.W.T. This is the density stratified lake, 16km SW of Ward Hunt I., discussed by Hattersley-Smith *et al.* (1970). Dates entrapment of seawater by isostatic rebound. Present sill alt. is 5m. Coll. 1969 and subm. by J. E. Mielke.

**SI-730.** **4590 ± 150**
**2640 B.C.**

**SI-731.** **4315 ± 140**
**2365 B.C.**

**SI-729. Lake "C", Ellesmere I., N.W.T.** **4590 ± 155**
**2640 B.C.**

Unnamed density stratified lake in emerged fiord on N coast Ellesmere I. (82° 52′ N Lat, 78° W Long). This is Lake "C" discussed by Hattersley-Smith *et al.* (1970), S of Bromley I. in Taconite Inlet. Age of seawater dates entrapment. Coll. 1969 and subm. by J. E. Mielke.

**Blake Plain Core C-4 series, W Atlantic**

Fine carbonates in turbidite layers from Core C-4 (26° 27′ N Lat, 75° 53′ W Long), in Blake Plain sediments, W Atlantic. Coll. 1971 and subm. by J. W. Pierce, Smithsonian Inst.

**SI-957. Blake Plain C-4, 129 to 145cm** **25,365 ± 2370**
**23,415 B.C.**
$\delta C^{13} = -1.26‰$

Fine carbonates, 129 to 145cm sediment depth, Core C-4. *Comment*: small sample, diluted.

**SI-958. Blake Plain C-4, 215 to 231cm** **31,365 ± 2040**
**29,415 B.C.**
$\delta C^{13} = +3.0‰$

Fine carbonates, 215 to 231cm sediment depth, Core C-4. *Comment*: small sample, diluted.

**SI-959. Blake Plain C-4, 315 to 340cm** **>40,800**
$\delta C^{13} = +1.26‰$

Fine carbonates, 315 to 340cm sediment depth, Core C-4. *Comment*: small sample, diluted.

**Blake Plain Core C-6 series, W Atlantic**

Fine carbonates in turbidite layers from Core C-6 (26° 05′ N Lat, 75° 46′ 30″ W Long), in Blake Plain sediments, W Atlantic. Coll. 1971 and subm. by J. W. Pierce.

**SI-960. Blake Plain C-6, 908 to 920cm** **>39,700**
$\delta C^{13} = -2.4‰$

Fine carbonates, 908 to 920cm sediment depth, Core C-6.

**SI-961. Blake Plain C-6, 987 to 998cm** **>42,500**
$\delta C^{13} = -1.7‰$

Fine carbonates, 987 to 998cm sediment depth, Core C-6.

**Blake Plain Core C-19 series, W Atlantic**

Fine carbonates in turbidite layers from Core C-19 (25° 35′ N Lat, 77° 01′ W Long), in Blake Plain sediments, W Atlantic. Coll. 1971 and subm. by J. W. Pierce.

**4130 ± 100**
**SI-962. Blake Plain C-19, 90 to 105cm** **2180 B.C.**
$\delta C^{13} = +1.9‰$

Fine carbonates, 90 to 105cm sediment depth, Core C-19.

**7170 ± 60**
**SI-963. Blake Plain C-19, 236 to 246cm** **5220 B.C.**
$\delta C^{13} = -1.26‰$

Fine carbonates, 236 to 246cm sediment depth, Core C-19.

**15,995 ± 210**
**SI-964. Blake Plain C-19, 328 to 338cm** **14,045 B.C.**
$\delta C^{13} = -1.1‰$

Fine carbonates, 328 to 338cm sediment depth, Core C-19.

**North Carolina shelf series**

Mollusks, id. by Blake Blackwelder, picked from samples of cemented sandstone and magnesium calcite from break of continental shelf off coast of N Carolina. Samples coll. at depths 30m or greater, and have temperate affinities. Coll. 1967 and subm. by I. G. Macintyre, Smithsonian Inst. (Milliman and Emery, 1968; Macintyre and Milliman, 1970).

**15,105 ± 310**
**SI-1095. N Carolina Shelf 7845** **13,155 B.C.**

Fragments of *Busycou* sp. and *Mactra* sp., Site 7845 (34° 06′ 30″ N Lat, 76° 15′ 30″ W Long), 73 to 74m water depth.

**11,190 ± 185**
**SI-1096. N Carolina Shelf 7848** **9240 B.C.**

Fragments of *Columbella mercatoria* Linné, *Glycermeris pectinata* Gmelin, *Colubraria lanceolata* Meuke, *Cuprarea spurca acicularis* Gmelin, *Glycermeris americania* DeFrance, *Olivella* sp. cf. *O. mutica* Say, *Fasciolaria* sp., *Prunum spicinum* Menke, and *Vernericardia perplana* Conrad, Site 7848 (34° 09′ 06″ N Lat, 76° 11′ W Long), at 68 to 95m water depth.

**22,265 ± 980**
**SI-1097. N Carolina Shelf 8085** **20,315 B.C.**

Fragments of *Trivis pediculus* Linné, *Astarte nana* Dall, *Turritella exoleta* Linné, *Glycermeris pectinata* Gmelin, *Glycermeris americania* DeFrance, *Vernericardia perplana* Conrad, *Turbo castaneus* Gmelin, *Nassarius ambiguus* Pulteney, and *Prunum aspicium* Menke, Site 8085 (34° 03′ 33″ N Lat, 76° 15′ 53″ W Long), at 92 to 102m water depth.

**SI-1098. N Carolina Shelf 8200** **12,365 ± 270**
**10,415 B.C.**

Fragments of *Glycermeris pectinata* Gmelin, *Olivella* sp., cf. *O. Mutica* Say, *Astarte nana* Dall, *Nassarius ambiguus* Pulteney, *Trivia* sp. cf. *T. pediculus* Linné (worn), *Cypraea* sp. (juvenile), *Pitar* (juvenile), *Cylichna* sp., *Busycon* sp., *Prunum aspicinum* Menke, *Vernericardia tridentata* Say, *Vernericardia perplana* Conrad, and *Turbo castaneus* Gmelin, Site 8200 (33° 58′ 24″ N Lat, 76° 22′ 24″ W Long), at 99 to 108m water depth.

**SI-1099. N Carolina Shelf 2737** **12,485 ± 210**
**10,535 B.C.**

Fragments of *Glycermeris pectinata* Gmelin, *Astarte nana* Dall, *Olivella* sp. cf. *O. mutica* Say, *Vernericardia tridentata* Say, *Cylichna* sp., and *Nassarius ambiguus* Pulteney, Site 2737 (34° 01′ 24″ N Lat, 76° 17′ 54″ W Long), at 88 to 89m water depth.

**Secas Island series, Panama**

Calcareous corals (*Pocilliopora* sp.), id. by P. W. Glynn, from 2 adjacent sites on coral reef in Secas I. (7° 57′ N Lat, 82° 01′ W Long), Panama. Samples dated to estimate rate of accretion of coral reef for comparison with predation attrition rates. Coll. 1971 and subm. by P. W. Glynn, Smithsonian Trop. Res. Inst.

**Secas sequence 1**

**SI-893. Secas-1, 0.5m** **Modern**

Apparent age: 25 ± 150.

**SI-894. Secas-1, 1.0m** **Modern**

Apparent age: 50 ± 105.

**SI-895. Secas-1, 2.0m** **400 ± 70**
**A.D. 1550**

**SI-896. Secas-1, 2.7m** **130 ± 85**
**A.D. 1820**

**Secas sequence 2**

**SI-897. Secas-2, 0.3m** **101.4% modern**

**SI-898. Secas-2, 0.6m** **105.1% modern**

**SI-899. Secas-2, 0.9m** **104.6% modern**

**SI-900. Secas-2, 1.2m** **610 ± 110**
**A.D. 1340**

**SI-901. Secas-2, 1.5m** **285 ± 110**
**A.D. 1665**

**SI-902. Secas-2, 1.7m** **400 ± 65**
**A.D. 1550**

**SI-1049. Mt. Katahdin bog, Maine** **7070 ± 90**
**5120 B.C.**

Organic material from bottom sediment of 3 adjacent cores of bog on E slope Mt. Katahdin (45° 55′ N Lat, 68° 53′ W Long), 100m W of Halfway Rock, 100m N of Roaring Brook Trail, Maine. Bog surface +700m. Cone of *Picea mariana*, id. by R. B. Davis, from bottom of 3rd core, 8.8m below bog surface. Coll. 1971 and subm. by H. W. Borns Jr., Univ. Maine. *Comment*: NaOH-soluble portion, SI-1049A: 6700 ± 155.

**SI-1048. Norse Pond, Maine** **12,175 ± 120**
**10,225 B.C.**

*Mytilus* fragments from 4.35 to 4.5m below sediment surface in Norse Pond (42° 30′ N Lat, 67° 07′ W Long), Maine. Sample believed to represent offlap of sea during emergence of land. Coll. 1971 and subm. by R. B. Davis, Univ. Maine.

**SI-970. Madison Dunes, Maine** **245 ± 60**
**A.D. 1705**

Charred wood from 2cm bed of charred organic matter in buried soil, developed on and overlain by fine-grained eolian sand, 4m below sparsely vegetated top surface at Madison Dunes (44° 47′ N Lat, 69° 47′ W Long), 6km E of Madison, Maine. Sample dated to determine if this period of dune activity was a recent reactivation. Coll. 1971 by J. B. McKeon; subm. by H. W. Borns, Jr.

**Orton Ranch series, SE Alaska**

Samples from vicinity of Orton Ranch (55° 36′ N Lat, 131° 35′ W Long), on Naha R., Revillagigedo I., SE Alaska. Id. by Joseph Rosewater. Coll. 1971 and subm. by Robert Stuckenrath.

**SI-905. Orton Ranch Shell Bed 1** **8420 ± 130**
**6470 B.C.**

*Saxidomus nuttalli* Conrad from bed of Naha R. at Orton Ranch, est. at +10m. Living examples are found intertidally from S Alaska to California.

**SI-906. Orton Ranch Shell Bed 2** **7230 ± 115**
**5280 B.C.**

*Cardium cilliatum* Fabricius from same shell bed as SI-905, above. Living examples are distributed circumpolarly.

**SI-911. Orton Ranch, 35cm** **575 ± 80**
**A.D. 1375**

Charred wood from 35cm below surface in test pit beside Naha R. shell bed, land surface 2.7m above R. Sample from 10cm band of fine gray-brown sand, below 25cm brown loam, and overlying coarse gray pebbly sand.

**SI-912. Orton Ranch, 40cm** **995 ± 80**
**A.D. 955**

Twigs from 40cm below surface in upper part of coarse gray pebbly sand underlying SI-911, above, and overlying brown peat.

**SI-913. Orton Ranch, 75cm** **1660 ± 100**
**A.D. 290**

Twigs from brown peat, 75cm below surface, underlying coarse gray pebbly sand of SI-912, above. Peat grades into gray clay and local water table 30cm below sampling point.

**Karta Bay series, SE Alaska**

Shell samples from SE tip of Sandy Point (55° 31′ N Lat, 132° 30′ W Long), at junction of Karta Bay and Twelvemile Arm, Kasaan Bay, Prince of Wales I., SE Alaska. Coll. 1971 and subm. by Robert Stuckenrath.

**SI-914. Karta Bay, 1m** **500 ± 45**
**A.D. 1450**

Shell fragments from bed at +1m, overlain by 10cm forest soil.

**SI-915. Karta Bay, modern intertidal** **Modern**

Shell fragments from intertidal Zone 30 E of site of SI-914, above, as modern control. Apparent age: 35 ± 150.

**Extinction series, Alaska**

Samples from specimens of extinct mammals in collns. of Am. Mus. Nat. Hist., New York. Coll. by O. W. Geist; subm. and id. by R. D. Guthrie, Univ. Alaska.

**SI-837. Fairbanks Creek Bison I** **20,445 ± 885**
**18,945 B.C.**

*Bison* horn sheath (1042) from Fairbanks Cr. (65° 04′ N Lat, 147° 10′ W Long), Fairbanks Co., Alaska. Coll. 1952.

**SI-838. Fairbanks Creek Bison II** **17,170 ± 840**
**15,220 B.C.**

*Bison* horn sheath (1014) from Fairbanks Cr., same locality as SI-837, above. Coll. 1952.

**SI-843. Fairbanks Bison** **31,980 ± 4490**
**30,030 B.C.**

*Bison preoccidentalis* horn sheath (30530) from unknown site near Fairbanks, Alaska. *Comment*: small sample, diluted.

**SI-839. Cripple Creek Bison I** **21,065 ± 1365**
**19,115 B.C.**

*Bison* horn sheath (4037) from Cripple Cr. (64° 49′ N Lat, 148° 01′ W Long), Alaska. Coll. 1947. *Comment*: small sample, diluted.

**SI-840. Cripple Creek Bison II** **>39,000**

*Bison* horn sheath (4038) from Cripple Cr., same locality as SI-839, above. Coll. 1947.

**SI-842. Cripple Creek Bison III** **29,295 ± 2440**
**27,345 B.C.**

*Bison* horn sheath (46928) from Cripple Cr., same locality as SI-839 and SI-840, above. Coll. 1940. *Comment*: small sample, diluted.

**SI-841. Manley Hot Springs bison** **18,000 ± 200**
**16,050 B.C.**

*Bison* horn sheath (4002) from Manley Hot Springs (65° N Lat, 149° W Long), Alaska. Coll. 1948.

**SI-844. Little Eldorado Cr. bison** **>35,000**

*Bison* horn sheath (46890) from Little Eldorado Cr. (65° 06′ N Lat, 147° 41′ W Long), Alaska. Coll. 1938.

**SI-845. Goldstream bison** **5340 ± 110**
**3390 B.C.**

Horn sheath of *Bison preoccidentalis* (46884) from Goldstream area (64° 57′ N Lat, 147° 35′ W Long), Alaska. Coll. 1939. *Comment*: date obviously does not represent *Bison preoccidentalis*.

**SI-850. Upper Cleary Cr. symbos** **25,090 ± 1070**
**23,140 B.C.**

*Symbos* horn sheath (A-235-1002) from Upper Cleary Cr. (65° 05′ N Lat, 147° 20′ W Long), Alaska. Coll. 1939. *Comment*: small sample, diluted.

**SI-851. Dome Cr. symbos** **17,695 ± 445**
**15,745 B.C.**

*Symbos* horn sheath (A-651-3006) from Dome Cr., Fairbanks Co., Alaska, exact site unknown. Coll. 1952.

*General Comment*: all samples were pretreated with cold 2% NaOH followed by cold 2N HCl.

**SI-852. Chester Cr. bison, Alaska** **470 ± 90**
**A.D. 1480**

Horn sheath of *Bison occidentalis*, id. by R. D. Guthrie, from exposure 3m downstream from Chester Cr. Bridge along Campbell Airstrip Rd. (61° N Lat, 150° W Long), Anchorage, Alaska. Coll. 1969 by Frederick Hadley-West; subm. by R. D. Guthrie. *Comment*: pretreated with cold 2% NaOH and cold 2N HCl. Date obviously does not represent *Bison occidentalis*.

**Natazhat Glacier series, Yukon Terr.**

Samples from deposit between 2 tills at terminus of Natazhat Glacier (60° 36′ N Lat, 140° 54′ W Long), 48km SW of Koidern, Yukon Terr. Bed, 1.1m thick, lies above modern timberlane, and provides key stratigraphic horizon for area, dating glacier retreat and higher treeline. Coll. 1970 and subm. by G. H. Denton, Univ. Maine.

**SI-1100. Natazhat Glacier, bed base** **3050 ± 55**
**1100 B.C.**
$\delta C^{13} = -24.5‰$

Wood, probably white spruce, id. by B. F. Kukachka, from base of forest bed deposit.

**SI-1101. Natazhat Glacier, peat** **2675 ± 85**
**725 B.C.**

Organic silt and peat from base of forest bed deposit.

**SI-1102. Natazhat Glacier, bed top** **3060 ± 50**
**1110 B.C.**

Wood, probably white spruce, from top of forest bed deposit.

**SI-1103. Capps, White R. Valley, Alaska** **11,100 ± 120**
**9150 B.C.**

Organic silt from base of peat bog in Capps sec. at confluence of White R. and North Fork Cr. (60° 45′ N Lat, 141° 35′ W Long), Alaska. Bog, 12m deep, rests on Macauley till; date is minimum for recession of Late Wisconsin (Macauley) ice from White R. valley. Coll. 1970 and subm. by G. H. Denton. *Comment*: NaOH-soluble portion was dated 8220 ± 145 ($\delta C^{13} = -25.0‰$).

**SI-903. Prudhoe Bay wood, Alaska** **>43,300**

Larch (*Larix*, id. by B. F. Kukachka) brought to surface from depth 183m in drilling operations at Prudhoe Bay area (69° 30′ N Lat, 146° 30′ W Long), Sec. 1, Twp. 1, Range 12E, Alaska. Coll. 1971 by B. P. Alaska, Inc.; subm. by E. S. Rogers, Natl. Geog. Soc., Washington, D.C. *Comment* (B.F.K.): rings shown by specimen are broader than those in Pleistocene specimens, suggesting more equitable growth conditions.

## II. ARCHAEOLOGIC SAMPLES

### *A. Iran*

**Tepe Ganj Dareh series, Iran**

Charcoal from Level E at Tepe Ganj Dareh (34° 15′ N Lat, 47° 30′ E Long), near Qeysevand in Kermanshah, Iran. Assoc. with faunal remains, early Neolithic flint artifacts, and occasional clay figurines, but no solid architecture. Coll. 1971 and subm. by P.E.L. Smith, Univ. Montreal (Young and Smith, 1966; Smith, 1970).

**SI-922. Level E, 6.7 to 6.8m** **8570 ± 210**
**6620 B.C.**

Charcoal from depth 6.7 to 6.8m in zone immediately below living floor at 6.55m.

**SI-923. Level E, 7.5 to 7.6m** **8625 ± 195**
**6675 B.C.**

Charcoal from depth 7.5 to 7.6m, from top zone of large fire pit at base of mound, dug into virgin soil, and partially filled with stones covering an accumulation of ash and charcoal.

**SI-924. Level E, 7.6 to 7.8m** **8640 ± 90**
**6690 B.C.**

Charcoal from depth 7.6 to 7.8m, from lower zone of same firepit as SI-923, above.

**SI-925. Level E, below 7.6m** **8385 ± 75**
**6435 B.C.**

Charcoal from firepit, just above virgin soil at base of mound, 7.6m depth.

*General Comment*: cf. other dates from Level E, GaK-807: 10,400 ± 150 and GaK-994: 8910 ± 170 (R., 1967, v. 9, p. 61); and P-1484: 8968 ± 100, P-1485: 9239 ± 196, and P-1486: 8888 ± 98 (R., 1970, v. 12, p. 579).

*B. Turkey*

**St. Sophia series, Istanbul**

Portions of structural and decorative timbers from St. Sophia (41° 00′ 16″ N Lat, 28° 59′ 04″ E Long), Istanbul, Turkey, dated to determine times of repair. Coll. 1969 and subm. by R. L. Van Nice, Dumbarton Oaks, Washington, D.C.

**SI-778. SW pier** **85 ± 55**
**A.D. 1865**

Wood from decorated box surrounding timber in partition joining SW pier and buttress in S gallery.

**SI-779. S gallery** **195 ± 50**
**A.D. 1755**

Wood from decorated box surrounding built-in strut in arch spanning small opening above secondary columns, S gallery.

**SI-781. SW secondary pier** **1545 ± 85**
**A.D. 405**

Decorated box surrounding timber connecting SW secondary pier and coupled columns, W side, N end.

**SI-782. Timber, SW secondary pier** **1320 ± 80**
**A.D. 630**

Working timber connecting SW secondary pier and coupled columns, N end.

*General Comment*: outer surfaces were removed to avoid possible contamination by varnish and pigeon droppings. SI-778 and SI-779 may represent replacements with old wood during renovations of A.D. 1847 to 1849. SI-781 and SI-782 may represent initial construction of A.D. 532 to 537, or early repairs.

*C. British Isles*

**Dun Ailinne series, Ireland**

Charcoal from stratified hill fort at Dun Ailinne (53° 13′ N Lat, 6° 35′ W Long), Knockaulin Townland, Kilcullen, Co. Kildare, Ireland. Coll. 1969 and subm. by Bernard Wailes, Univ. Mus., Philadelphia.

**SI-977. Dun Ailinne 1** **2165 ± 70** **215 B.C.**

Charcoal from 1 of last 3 Iron age levels.

**SI-979. Dun Ailinne 3** **1950 ± 80** **1 B.C.**

Charcoal, occupation material from 1 of last 3 Iron age levels.

**SI-981. Dun Ailinne 5** **2490 ± 85** **540 B.C.**

Charcoal from occupation in 1 of last 3 Iron age levels.

**SI-986. Dun Ailinne 10** **2075 ± 80** **125 B.C.**

Charcoal from fill of Feature 36, Iron age Phases 4, 5, and 6.

**SI-987. Dun Ailinne 11** **1855 ± 50** **A.D. 95**

Charcoal from fill of Feature 33, Iron age Phases 4, 5, and 6.

**SI-985. Dun Ailinne 9** **1755 ± 90** **A.D. 195**

Charcoal from fill of Trench A, Iron age Phases 3 and 4.

**SI-978. Dun Ailinne 2** **1930 ± 85** **A.D. 20**

Charcoal from fill of Trench B, Iron age Phases 3 or 4. Expected to be contemporary with SI-980, below.

**SI-980. Dun Ailinne 4** **1900 ± 85** **A.D. 50**

Charcoal from fill of Trench A, Iron age Phases 3 and 4.

**SI-983. Dun Ailinne 7** **2370 ± 85** **420 B.C.**

Charcoal from occupation contemporary with Iron age Phases 2, 3, and 4.

**SI-984. Dun Ailinne 8** **2200 ± 50** **250 B.C.**

Charcoal from fill of Feature 60, Iron age Phases 2 and 3.

**SI-982. Dun Ailinne 6** **3220 ± 55** **1270 B.C.**

Charcoal from shallow pit, assoc. with sherds of food vessel of Late Neolithic or Early Bronze age.

**Silbury Hill series, England**

Fractions of cut sod buried in course of secondary construction of Silbury Hill (51° 25′ N Lat, 1° 52′ W Long), England. Samples dated to determine feasibility of dating prehistoric earthworks by dating sod or turf buried during construction. Coll. 1969 by Bernard Wailes; subm. by Robert Stuckenrath.

**4675 ± 110**
**SI-910-A. Silbury Hill sod, 2mm** **2725 B.C.**

Organic matter from sod, retained on 2mm screen.

**5995 ± 185**
**SI-910-AH. Silbury Hill, 2mm NaOH** **4045 B.C.**

NaOH-soluble portion of SI-910-A, above.

**4315 ± 110**
**SI-910-B. Silbury Hill sod, 1 to 2mm** **2365 B.C.**

Organic matter from sod, retained on 1mm screen, passed by 2mm screen.

**4570 ± 120**
**SI-910-C. Silbury Hill sod, 0.5 to 1mm** **2620 B.C.**

Organic matter from sod, retained on 0.5mm screen, passed by 1mm screen.

**4465 ± 130**
**SI-910-CH. Silbury Hill, 0.5-1mm, NaOH** **2515 B.C.**

NaOH-soluble portion of SI-910-C, above.

**4530 ± 110**
**SI-910-D. Silbury Hill, <0.5mm** **2580 B.C.**

Organic matter from sod passed by 0.5mm screen. *Comment*: sample impossible to filter after boiling in 2% NaOH; reacidified and date is for whole sample.

*General Comment*: no explanation is offered for SI-910-AH; excluding this date, average age of series is 4510 ± 50 yr.

*E. Labrador-Newfoundland*

**2200 ± 120**
**SI-875. Red Rock Point, Labrador** **250 B.C.**

Charcoal from hearth 0 to 8cm below surface in Dorset Site GeBk-2, Red Rock Point 2 (54° 41′ 30″ N Lat, 57° 44′ W Long), Labrador. Assoc. with one of the later Dorset tool assemblages in Hamilton Inlet area. Coll. 1969 and subm. by W. W. Fitzhugh, Smithsonian Inst. (Fitzhugh, 1972).

**4810 ± 115**
**SI-877. Sandy Cove 4, Labrador** **2860 B.C.**

Charcoal from hearth in Site GcBk-4, Sandy Cove 4 (54° 18′ N Lat, 57° 45′ W Long), Labrador. Hearth, 15cm below surface, was overlain by sterile sandy layer. Assoc. with Sandy Cove complex materials, stemmed points, quartz knives, ground slate tools, and red ocher—all characteristic of early subdivision of Maritime Archaic in central Labrador. Coll. 1969 by S. L. Cox; subm. by W. W. Fitzhugh (Fitzhugh, 1972). *Comment* (W.W.F.): 1st date for early Maritime Archaic Sandy Cove complex in Hamilton Inlet. Date agrees with geologic estimate based on emergence of 14m terrace on which Sandy Cove sites were found. Cf. dates for Maritime Archaic at Saglek, N Labrador, 4530 ± 105 and 3890 ± 110 (written commun., J. A. Tuck, Mem. Univ., St. Johns, Newfoundland.

**Hound Pond 4 series, Labrador**

Charcoal from hearths in Site GcBi-18, Hound Pond 4 (54° 27′ 30″ N Lat, 57° 28′ W Long), Groswater Bay, Hamilton Inlet, Labrador, +12m. Samples from cultural zone in leached gray sand beneath 20 to 30cm peat layer. Present surface vegetation is tundra with permafrost, but believed to have been spruce forest. Assoc. with lanceolate biface of red quartzite, assymetric knives, and ground slate celt. Coll. 1971 and subm. by W. W. Fitzhugh (1972).

**SI-927. Hound Pond 4, Pit 1** — **3195 ± 120** — **1245 B.C.**

**SI-928. Hound Pond 4, Pit 3** — **3095 ± 105** — **1145 B.C.**

*General Comment* (W.W.F.): dates confirm age estimates of Charles complex in Lake Melville, and indicate a camp site here considerably above active beach line, unusual in sites found thus far in Hamilton Inlet area.

**Rattler Bight 1 series, Labrador**

Rattlers Bight 1 (54° 27′ N Lat, 57° 26′ W Long), Groswater Bay, Hamilton Inlet, Labrador, is a large summer occupation site, +6.7m of Rattlers Bight phase of Maritime Archaic in central Labrador. There is also a small Dorset component in one area of site. Coll. 1971 and subm. by W. W. Fitzhugh (1972).

**SI-929. Rattlers Bight, Hearth 2** — **4525 ± 155** — **2575 B.C.**

Charcoal from Hearth 2, from cultural zone beneath large slab cooking rock, 28cm below surface, at N end of site. Assoc. with chipped Ramah chert stemmed points, ground slate tools, burned animal bone, and red ocher. *Comment* (W.W.F.): earliest date for this site, and represents an occupation earlier than elsewhere on site. It dates a phase transitional between Sandy Cove complex (SI-877, above) and Rattlers Bight phase of Maritime Archaic. Lower portion of hearth is believed to have been used soon after emergence of the tombolo terrace on which site is located.

**SI-932. Rattlers Bight hearth** — **3890 ± 145** — **1940 B.C.**

Charcoal from beneath rotting slab of hearth rock, beneath peaty level, and 12 to 18cm below surface, +5.5m. This is lowest alt. for Maritime Archaic materials found at site, and should be terminal date for occupation since water-worn artifacts were found below this level. Assoc. with ground red slate knife and Ramah chert tools of Rattlers Bight phase.

**SI-930. Rattlers Bight Dorset** **2720 ± 125**
**770 B.C.**

Hearth charcoal from Dorset component within area of Maritime Archaic occupation. Scattered charcoal beneath small slab rock 16cm below surface. Assoc. Dorset materials are typical of early Dorset found in Groswater Bay. *Comment* (W.W.F.): Maritime Archaic materials were found in this square, and the fact that this date is several hundred yr earlier than date for Dorset components elsewhere in site (SI-931, below) suggests some contamination of sample by admixture with earlier Maritime Archaic material.

**SI-931. Rattlers Bight Dorset 2** **2255 ± 55**
**305 B.C.**

Hearth charcoal from Dorset component, from lower level of peaty zone. Maritime Archaic materials appeared in this square, but only in sandy soil levels below peaty Dorset zone.

**SI-1105. Rattlers Bight Shell 1** **2310 ± 50**
**360 B.C.**

Green sea urchin, *Hiatella arctica, Balanus balanus, Mytilus edulis, Lacuna vinta* Montague, *Littorina obtusata,* and *Acmaea testudinalis,* id. by W. W. Fitzhugh, from within extensively frost-worked beach deposit, 0 to 0.5m thick, +4m.

**SI-1106. Rattlers Bight Shell 2** **2545 ± 55**
**595 B.C.**

Green sea urchin, *Pyramidella fusca, Aporrhais occidentalis, Mytilus edulis, Balanus balanus, Littorina obtusata,* and *Hiatella arctica,* id. by W. W. Fitzhugh, from within extensively frost-worked beach deposit, 0 to 0.5m thick, +5m.

**SI-1104. Grenfell Mission shell, Labrador** **5610 ± 115**
**3660 B.C.**

*Mytilus edulis,* id. by Wesley Blake, from shell lens in 10cm clay-shell matrix 30 to 40cm below surface in front of hospital at Internatl. Grenfell Mission, 140m NE of North West R. (53° 31′ 30″ N Lat, 60° 08′ 40″ W Long), Labrador. Beach sands and sand-cobble mixtures lie both above and below sample horizon, believed extensive. Horizon lies at +4.9m in Lake Melville. Coll 1968 and subm. by W. W. Fitzhugh (Fitzhugh, 1972). *Comments*: sample cleaned and pretreated at Geological Survey of Canada Lab. (W.W.F.): date seems far too old for this alt.

*F. New Brunswick*

**Cow Point series, New Brunswick**

Charcoal samples from Site B1Dn-2, Cow Point (45° 52′ 30″ N Lat, 66° 11′ W Long), near hwy. between Grand Lake and Maquapit Lake, New Brunswick. Assoc. with late Laurentian Archaic material in burial complex. Coll. 1970 and subm. by David Sanger, Univ. Maine.

**SI-988. Cow Point, Burial 4** **3630 ± 135**
**1680 B.C.**

Charcoal. *Comment*: small sample, diluted.

**SI-989. Cow Point, Burial 13** **3835 ± 115**
**1885 B.C.**

Charcoal.

*G. United States*

**SI-789. Eddington Bend, Maine** **3430 ± 145**
**1480 B.C.**

Charcoal from gray crematory fill, 140cm below surface, at Eddington Bend site (44° 49′ 30″ N Lat, 68° 42′ W Long), Penobscot Co., Maine. This is a middle to late Archaic cemetery under later habitation site. Coll. 1970 and subm. by D. R. Snow, SUNY, Albany. *Comment* (D.R.S.): dates near end of Moorehead complex; see M-90: 3350 ± 400 (Science, 1956, v. 124, p. 668); and Byers (1959).

**Indian I. series, Maine**

Charcoal from Indian I. site (44° 57′ N Lat, 68° 39′ W Long), Penobscot Co., Maine. Coll. 1970 and subm. by D. R. Snow.

**SI-790. Indian I., 32** **1600 ± 115**
**A.D. 350**

Charcoal from Feature 32, 70cm below surface, from hearth assoc. with dentate rocker-stamped pottery and a medicine bundle containing shark teeth, rolled copper beads, human deciduous teeth, and red ocher.

**SI-791. Indian I., 30** **155 ± 100**
**A.D. 1795**

Charcoal from Feature 30, burned post mold assumed part of Penobscot Indian stockade, destroyed by English in A.D. 1723. Assoc. with fragments of white kaolin pipe.

**Hathaway site series, Maine**

Charcoal samples from Hathaway site (45° 11′ N Lat, 68° 35′ W Long), Penobscot Co., Maine. Site initially excavated by W. H. Moorehead in 1912; later excavations indicate site assoc. with a cemetery. Coll. 1969 and subm. by D. R. Snow (Byers, 1959; Snow, 1969).

**SI-878. Hathaway, Burial 40** **5165 ± 185**
**3215 B.C.**

Charcoal from Burial 40, 30cm below surface, assoc. with red ocher, gouges, and a plummet.

**SI-880. Hathaway, hearth** **102.4% modern**

Charcoal from small hearth 24cm below surface. *Comment* (D.R.S.): age suggests contamination by remains of 19th century lumber camp.

**SI-887. Hathaway, ossuary** **3355 ± 125**
**1405 B.C.**

Charcoal from possible ossuary, 40cm below surface, assoc. with shattered artifacts and burned bone.

**SI-888. Hathaway, Feature III** **3620 ± 150**
**1670 B.C.**

Charcoal from Feature III, burial pit, assoc. with red ocher and tooth enamel.

**SI-889. Hathaway, Feature VI** **2920 ± 135**
**970 B.C.**

Charcoal from Feature VI, burial pit assoc. with red ocher and tooth enamel.

**SI-890. Hathaway, Feature VII** **3840 ± 155**
**1890 B.C.**

Charcoal from Feature VII, burial pit assoc. with red ocher and tooth enamel.

*General Comment* (D.R.S.): SI-878 is oldest radiocarbon date for Moorehead complex, and supports Y-2624: 5000 ± 140 from same site. Burial 40, with Burials 1-17, form earlier Archaic component of site. SI-887 from a possible ossuary dates the later Archaic component. SI-888 is stratigraphically the oldest of 3 burial pits, SI-889 is stratigraphically the youngest, and SI-890 is between SI-888 and SI-889. All 3 pits are assigned to the later Archaic component of site.

**Healy Lake series, Alaska**

Charcoal samples from Village site (64° 00′ N Lat, 144° 30′ W Long), on Healy Lake in central Alaska. Coll. 1970 and subm. by J. P. Cook, Univ. Alaska.

**SI-737. Chindadn complex, 30 to 36cm** **10,150 ± 210**
**8200 B.C.**

**SI-738. Chindadn complex, 46 to 48cm** **8210 ± 155**
**6260 B.C.**

**SI-739. Chindadn complex, 51 to 58cm** **10,040 ± 210**
**8090 B.C.**

**SI-742. Sag Bluffs I, Alaska** **955 ± 125**
**A.D. 1095**

Charcoal from stone-lined hearth, 14cm below surface at Sag Bluffs I site (69° 27′ N Lat, 149° 29′ W Long), N Slope, Alaska. Coll. 1970 by D. E. Derry; subm. by J. P. Cook. Assoc. with stemmed points and flakes of possible Kavik or Ekseavik affinities.

**Gallagher Flint sta. series, Alaska**

Charcoal from Gallagher Flint Sta. (68° 44′ N Lat, 148° 58′ W Long), in drainage of Sagavanirktok R., N Slope, Alaska. Upper stratigraphic level is a thin black-brown organic soil, 1 to 8cm thick. Directly under this surface organic layer is a blanket of loess, 20 to 30cm deep, deposited sometime after Banded Mountain-Siruk Cr. stage of Itkillik glaciation. Coll. 1971 by James Dixon; subm. by J. P. Cook.

**SI-972. Gallagher, Hearth 1** **2920 ± 155**
**970 B.C.**

Charcoal from Hearth 1, Loc. II. Hearth lay on a few flat stones, partially in surface organic layer and in upper loess. Assoc. with unground burins, burin spalls, drills, end blade, side blades, stemmed points, and unifacial knife. Artifacts appear to bear strong relationship to Choris. *Comment*: nitration pretreatment for removal of roots. Additional portion was given standard NaOH and HCl pretreatment, SI-972-A: 2125 ± 70.

**SI-973. Gallagher, Hearth 1, A** **3280 ± 155**
**1330 B.C.**

Charcoal from same hearth as SI-972, above. *Comment*: small sample, diluted. Nitration pretreatment for removal of roots. Additional portion was given standard NaOH and HCl pretreatment, SI-973-A: 905 ± 35.

**SI-974. Gallagher, Loc. I** **10,540 ± 150**
**8590 B.C.**

Charcoal from Loc. I in loess deposit, 20 to 25cm below surface. No apparent hearth, but assoc. with unifacial core and blade industry. No type core recognized, but artifacts show possible cultural connections with Anangula types. *Comment*: nitration pretreatment for removal of roots.

**SI-975. Gallagher, Loc. I-A** **2620 ± 175**
**670 B.C.**

Charcoal from Loc. I-A, intrusive upon locality I, 3 to 9cm below surface, no apparent hearth. Assoc. with end blade fragment, drill, and 2 bifacial point fragments, probably post-Choris affinities. Notable lack of burins and spalls. *Comment*: small sample, diluted.

**Akun I. series, Aleutians**

Samples from 2 adjacent sites on Akun I. (54° 08′ N Lat, 165° 38′ W Long), Aleutian Is. Coll. 1971 and subm. by C. G. and J. A. Turner, Arizona State Univ.

**SI-965. Chulka matting** **570 ± 65**
**A.D. 1380**

Carbonized beach grass matting from burned pithouse roof. Assoc. with prehistoric Aleut hunting and cooking tools; no Russian material found at this level. *Comment*: sample from block of midden which may have slumped out of original position.

**SI-966. Chulka Level 3** **820 ± 60**
**A.D. 1130**

Charcoal from wood fire, originated as driftwood since no trees grow at site now. Assoc. with food refuse in trash midden, with mixed bone and stone tools.

**1170 ± 90**
**SI-967. Chulka Level 4** **A.D. 780**

Charcoal from wood fire, originated as driftwood. Assoc. with prehistoric Aleut hunting and cooking tools. Human burial in this stratum showed no evidence of Russian or American trade goods.

**3105 ± 55**
**SI-968. Islelo** **1155 B.C.**

Charcoal from wood fire on Islelo site, separated from Chulka midden by shallow channel 95m wide. Assoc. with bifacial knives, unretouched flakes, no bone tools.

**Izembek series, Alaska**

Izembek, Site IZM-3 (55° 10′ N Lat, 162° 58′ W Long), is a single component, extended occupation Eskimo house site within Izembek Nat. Wildlife Refuge, near Cold Bay on tip of Alaskan Peninsula. Coll. 1971 and subm. by A. P. McCartney, Univ. Arkansas.

**1005 ± 105**
**SI-916. Izembek, House 1 hearth** **A.D. 945**

Charcoal from hearth area of House 1.

**390 ± 95**
**SI-917. Izembek, House 1 fill** **A.D. 1560**

Charcoal from fill, 15cm above floor of House 1. *Comment* (A.P.M.): ground squirrel burrows in fill may account for anomalously young age.

**1235 ± 105**
**SI-918. Izembek, House 2 fill** **A.D. 715**

Whale bone from fill of House 2, 40cm below surface. *Comment*: date determined on collagen fraction extracted in 8% HCl wash, prolonged heating at pH = 3, and centrifugation after Longin (1971). Age at least 300 yr older than expected.

**905 ± 50**
**SI-919. Izembek, House 2 floor** **A.D. 1045**

Charcoal from floor of House 2, 75cm below surface.

**925 ± 95**
**SI-920. Izembek, House 2** **A.D. 1025**

Charcoal from House 2, 40cm below surface.

**760 ± 90**
**SI-921. Izembek, House 1** **A.D. 1190**

Charcoal from House 1, 45cm below surface.

*H. Cuba*

**Mogote de la Cueva series, Cuba**

Charcoal from occupation and burial site (22° 44′ 18″ N Lat, 83° 30′ 31″ W Long), Pinar del Rio, Cuba. Assoc. with typical Ciboney-

Cayo Redondo cultural material in Burial Cave 2. Coll. 1966 by J. M. Guarch; subm. by Clifford Evans (Osgood, 1942).

**1620 ± 150**
**SI-424. Trench 1, 35cm** **A.D. 330**

**650 ± 200**
**SI-425. Trench 1, 1.25m** **A.D. 1300**

**Residuario Funche series, Cuba**

Charcoal from Midden 1, 50m diam., 2.5m high, 10m from mouth of Cueva Funche R., (21° 54′ 12″ N Lat, 84° 20′ W Long), Pinar del Rio, Cuba. Assoc. with typical Ciboney-Guayabo Blanco cultural materials, including crude hammerstones, flint chips, shell vessels and gouges, and very crude ceremonial stones. Coll. 1966 by J. M. Guarch; subm. by Clifford Evans (Rouse, 1942).

**2070 ± 150**
**SI-426. Block II, Sec. A, 0.5m** **120 B.C.**

**2510 ± 200**
**SI-427. Block II, Sec. D, 0.55m** **560 B.C.**

**3110 ± 200**
**SI-428. Block III, Sec. A, 1.4m** **1160 B.C.**

**4000 ± 150**
**SI-429. Block III, Sec. A, 1.72m** **2050 B.C.**

*I. Ecuador*

**Quijos Valley series, Ecuador**

Samples from group of adjacent sites related to Cosanga ceramic phase in Quijos Valley (0° 30′ S Lat, 77° 50′ W Long), Napo Prov., Ecuador. Coll. 1967 and 1968 by P. I. Porras, C. Univ. Quito; subm. by Clifford Evans (Porras, Evans, and Meggers, ms. in preparation).

**690 ± 80**
**SI-589. Borja-Minda, 0 to 10cm** **A.D. 1260**

Charcoal from 0 to 10cm below surface in Borja-minda, Site BO-1.

**2390 ± 165**
**SI-690. Borja-Minda, 30 to 40cm** **440 B.C.**

Charcoal from 30 to 40cm below surface. *Comment*: small sample; NaOH pretreatment omitted; diluted.

**140 ± 100**
**SI-591. Borja-Minda, 50cm** **A.D. 1810**

Charcoal from 50cm below surface.

**450 ± 90**
**SI-594. Borja-Minda, 70 to 80cm** **A.D. 1500**

Charcoal from 70 to 80cm below surface.

**SI-590. Mamallacta, 10 to 20cm** **860 ± 100**
**A.D. 1090**

Carbonized material adhering to potsherds at 10 to 20cm below surface in Mamallacta, Site BA-7.

**SI-685. Mamallacta, 20 to 30cm** **3445 ± 140**
**1495 B.C.**

Charred material scraped from potsherds 20 to 30cm below surface.

**SI-686. Mamallacta, 40 to 50cm** **2615 ± 100**
**665 B.C.**

Charred material scraped from potsherds 40 to 50cm below surface.

**SI-592. Mamallacta, 50 to 60cm** **1600 ± 100**
**A.D. 350**

Carbonized material adhering to potsherds 50 to 60cm below surface.

**SI-593. Mamallacta, 60 to 70cm** **2140 ± 120**
**190 B.C.**

Carbonized material adhering to potsherds 60 to 70cm below surface.

**SI-684. Banco Samana, 0 to 10cm** **1455 ± 170**
**A.D. 495**

Charred material from inner surface of pot 0 to 10cm below surface at Banco Samana, Site BA-4. *Comment*: very small sample; NaOH pretreatment omitted; diluted.

**SI-687. Banco Samana, 30 to 40cm** **1985 ± 170**
**35 B.C.**

Charred material from potsherds 30 to 40cm below surface.

**SI-595. Nacimba-1, 40 to 50cm** **140 ± 80**
**A.D. 1810**

Charred material from potsherds 40 to 50cm below surface at Nacimba-1, Site BA-6.

**SI-596. Baeza Centro, 50 to 60cm** **Modern**

Charcoal from 50 to 60cm below surface at Baeza Centro, Site BA-2.

*General Comment* (C.E.): inconsistency of dates with seriated sequence of pottery types is unexplainable. Recent and modern samples from 40 to 50cm depth in middle of refuse may be because modern occupants of region charred points of fence posts before driving them into the ground. The charred point may leave modern charcoal in the older refuse; remainder posts then rot away, leaving no evidence of disturbance in heavy tropical rainforest.

*J. Peru*

**Pacompampa series, Peru**

Charcoal samples representative of Formative period at Pacompampa, Site PI-14 (6° 20′ S Lat, 79° 01′ W Long), Cajamarca, Peru. Coll. 1970 by H. Rosas La Noire; subm. by Clifford Evans.

**SI-792. Pacompampa, 40cm** — **2765 ± 135** / **815 B.C.**

Charcoal, 30 to 45cm below surface. *Comment*: small sample, diluted.

**SI-793. Pacompampa, 65cm** — **2855 ± 95** / **905 B.C.**

Charcoal, 65cm below surface.

**SI-794. Pacompampa, 1m** — **2385 ± 155** / **435 B.C.**

Charcoal, 90cm to 1.5m below surface. *Comment* (C.E.): too recent; sample excavated at later period after cut was left open, with possible contamination from above.

**Pandanche series, Peru**

Charcoal, representative of Formative period at Pandanche, Site P2-B (6° 20′ S Lat, 79° 01′ W Long), Cajamarca, Peru. Coll. 1969 by Hermilio Rosas and Ruth Shady; subm. by Clifford Evans.

**SI-795. Pandanche, 52cm** — **2185 ± 160** / **235 B.C.**

Charcoal, 45 to 60cm level. *Comment*: small sample, NaOH pretreatment omitted; diluted.

**SI-796. Pandanche, 1.58m** — **2725 ± 150** / **775 B.C.**

Charcoal, 1.5 to 1.65m level. *Comment*: small sample, NaOH pretreatment omitted; diluted.

**SI-797. Pandanche, 1.75m** — **2875 ± 150** / **925 B.C.**

Charcoal, 1.65 to 1.8m level. *Comment*: small sample, NaOH pretreatment omitted; diluted.

**SI-798. Alenya Formative, Peru** — **345 ± 90** / **A.D. 1605**

Charcoal from Formative period site at Alenya, B2 (5° 37′ 05″ S Lat, 78° 30′ W Long), Amazonas, Peru. Coll. 1969 by Hermilio Rosas; subm. by Clifford Evans. *Comment* (C.E.): too young; mixture unexplained.

*K. Brazil*

**do Caju series, Brazil**

Charcoal from do Caju site (21° 45′ S Lat, 41° 18′ W Long), Mun. Campos, Rio de Janeiro, Brazil. Assoc. with ceramics of Mucuri phase, Una tradition. Coll. 1968 by O. F. Dias and J. C. Oliveira, Inst. Arq. Brazil; subm. by Clifford Evans.

**SI-704. do Caju, 10 to 20 cm** — **720 ± 95** / **A.D. 1230**

Charcoal from 10 to 20cm below surface. *Comment*: small sample, NaOH pretreatment omitted.

**SI-705. do Caju, 20 to 30cm** **1430 ± 65**
**A.D. 520**

Charcoal from 20 to 30cm below surface.

**Sambaqui do Ury series, Brazil**

Charcoal from partially destroyed shell mound, Sambaqui do Ury (22° 21′ S Lat, 41° 49′ W Long), Mun. Macaé, Rio de Janeiro, Brazil. This is a non-ceramic midden in which samples are assoc. with Macaé phase quartz artifacts. Coll. 1968 by O. F. Dias; subm. by Clifford Evans.

**SI-710. Sambaqui do Ury, 100cm** **3635 ± 135**
**1685 B.C.**

Charcoal, 100cm below surface.

**SI-711. Sambaqui do Ury, 120cm** **3975 ± 160**
**2025 B.C.**

Charcoal, 120cm below surface.

**Pedra Grande series, Brazil**

Pedra Grande, RS-SM-7 (29° 33′ S Lat, 54° 15′ W Long), a preceramic rock shelter in Mun. São Pedro do Sul, Rio Grande do Sul, Brazil. Petroglyphs pecked or engraved on rock walls, stylistically are believed, later than those of Abrigo do Canhemborá. Coll. 1971 by J. P. Brochado; subm. by Clifford Evans.

**SI-1002. Pedra Grande, 4** **605 ± 40**
**A.D. 1345**

Charcoal from refuse in Level 4, 30 to 40cm below surface, below Tupiguarani sherd level. Assoc. with retouched flakes and chopping tools. *Comment* (C.E.): date is reasonable for Tupiguarani level, but too recent for preceramic horizon, and mixture is assumed.

**SI-1003. Pedra Grande, 7** **800 ± 40**
**A.D. 1150**

Charcoal from refuse in Level 7, 60 to 70cm below surface, and assoc. with retouched flakes, chopping tools, and projectile points. *Comment* (C.E.): date is reasonable for Tupiguarani level, but too recent for preceramic horizon; mixture is assumed.

**SI-1004. Pedra Grande, 8** **2795 ± 55**
**845 B.C.**

Charcoal from hearth in Level 8, 70 to 80cm below surface, and lowest level in this rock shelter. Assoc. with flakes and artifacts of preceramic Canhemborá phase.

**Abrigo do Canhemborá series, Brazil**

Abrigo do Canhemborá, RS-MJ-14 (29° 25′ S Lat, 53° 15′ W Long), is preceramic rock shelter in Mun. Nova Palma, Rio Grande do Sul, Brazil. Rock shelter contains zoomorphic petroglyphs pecked or engraved on rock walls, stylistically believed older than those of Pedra Grande rock shelter, and are rare in S Brazil. Coll. 1971 by J. P. Brochado; subm. by Clifford Evans.

**SI-1000. Abrigo do Canhemborá, 5** — **1165 ± 35**, **A.D. 785**

Charcoal from Level 5, 40 to 50cm below surface.

**SI-1001. Abrigo do Canhemborá, 7** — **2945 ± 85**, **995 B.C.**

Charcoal from Level 7, 60 to 70cm below surface, and assoc. with Altoparanense bifaces and flakes, and zoomorphic petroglyphs.

*General Comment* (C.E.): dates are too recent.

**Guarata ceramic series, Brazil**

Charcoal assoc. with Guaratã phase of Tupiguarani Corrugated ceramic tradition in 3 adjacent sites, Mun. de Restinga Seca, Rio Grande do Sul, Brazil. Coll. 1969 by J. P. Brochado; subm. by Clifford Evans.

**SI-999. J. Cantarelli** — **Modern**

Charcoal from House A in J. B. Cantarelli Tupiguarani village (29° 49′ 26″ S Lat, 53° 23′ W Long), RS-MJ-42.

**SI-819. J. B. Cantarelli, 20 to 50cm** — **Modern**

Charcoal from Levels 1 and 2, 20 to 50cm below surface, assoc. with sherds of corrugated jar in House A.

**SI-815. J. B. Cantarelli, 60cm** — **A.D. 1820**

Charcoal from Level 2, 60cm below surface, House A.

**SI-997. Silva Cantarelli, 20cm** — **Modern**

Charcoal from 20cm below surface, House C, Silva Cantarelli Tupiguarani village, RS-MJ-47-C (29° 51′ S Lat, 53° 22′ 48″ W Long).

**SI-816. Silva Cantarelli, 20 to 30cm** — **530 ± 120**, **A.D. 1420**

Charcoal under Urns 1 and 2, Burial 1, 20 to 30cm below surface.

**SI-998. Dal Pra** — **Modern**

Charcoal from bottom of post hole in House B of Dal Pra, a large Tupiguarani village, RS-MJ-50 (29° 41′ 21″ S Lat, 53° 33′ W Long).

**SI-818. Dal Pra, 20 to 40cm** — **345 ± 105**, **A.D. 1605**

Charcoal found near burial urns, 20 to 40cm below surface, 50m ENE of House B.

**SI-817. Dal Pra, 40 to 50cm** — **110 ± 100**, **A.D. 1840**

Charcoal from interior of posthole in remains of House B.

*General Comment* (C.E.): all dates are too recent.

**SI-812. Mangueira Nova-1, Brazil** **950 ± 80**
**A.D. 1000**

Charcoal from 120 to 135cm below surface, assoc. with ceramics of Guatambu phase, Taquara tradition in Mangueira Nova-1, RS-P-27 (28° 36′ S Lat, 50° 06′ W Long), Mun. Bom Jesus, Rio Grande do Sul, Brazil. Coll. 1969 by E. T. Miller; subm. by Clifford Evans.

**SI-813. Fazenda Carvalho-2, Brazil** **1810 ± 85**
**A.D. 140**

Charcoal from 15 to 20cm below surface, assoc. with ceramics of Guatambu phase, Taquara tradition, in Fazenda Carvalho-2, RS-P-12 (28° 29′ 48″ S Lat, 49° 50′ 49″ W Long), Mun. Bom Jesus, Rio Grande do Sul, Brazil. Coll. 1969 by E. T. Miller; subm. by Clifford Evans.

**SI-804. Morro da Flecha-1, Brazil** **575 ± 80**
**A.D. 1375**

Charcoal from 15 to 20cm below surface, assoc. with lithic artifacts of preceramic Camuri phase in Morro da Flecha-1, RS-S-308 (29° 26′ 30″ S Lat, 50° 24′ W Long), Mun. São Francisco de Paula, Rio Grande do Sul, Brazil. Coll. 1966 by E. T. Miller; subm. by Clifford Evans. *Comment* (C.E.): too recent. Small sample, pretreated in cold 2% NaOH.

**Bugres-1 series, Brazil**

Charcoal from Bugres-1, RS-A-2 (29° 18′ S Lat, 50° 21′ W Long), Mun. São Francisco de Paula, Rio Grande do Sul, Brazil. Samples are from excavated pit house, assoc. with ceramics of Taquara phase, Taquara tradition. Coll. 1966 by E. T. Miller; subm. by Clifford Evans.

**SI-805. Bugres-1, 53 to 59cm** **1515 ± 105**
**A.D. 435**

*Comment*: small sample, pretreated with cold 2% NaOH.

**SI-806. Bugres-1, 65 to 70cm** **1385 ± 95**
**A.D. 565**

**SI-808. Bugres-1, 75 to 77cm** **970 ± 95**
**A.D. 980**

*Comments*: small sample, NaOH pretreatment omitted. (C.E.): too recent.

**SI-707. Parizinho, Brazil** **3935 ± 60**
**1985 B.C.**

Charcoal assoc. with ceramics of Irapua phase of Tupiguarani Painted tradition in Parizinho, RS-VZ-45 (27° 19′ S Lat, 53° 44′ W Long), Mun. Tenete Portela, Rio Grande do Sul, Brazil. Coll. 1968 by Eurico Miller; subm. by Clifford Evans. *Comments*: small sample, NaOH pretreatment omitted. (C.E.): too old.

**SI-708. Linha Uruguai Sul, Brazil** **1220 ± 120**
**A.D. 730**

Charcoal assoc. with ceramics of Irapua phase of Tupiguarani

Painted tradition in Linha Uruguai Sul, RS-VZ-4 (27° 49′ S Lat, 55° 03′ W Long), Mun. Pôrto Lucena, Rio Grande do Sul, Brazil. Coll. 1968 by Eurico Miller; subm. by Clifford Evans.

**675 ± 50**
**SI-799. Barro do Turvo, Brazil** **A.D. 1275**

Charcoal from Barro do Turvo 3, RS-VZ-52 (27° 18′ S Lat, 54° 06′ W Long), Mun. Tres Passos, Rio Grande do Sul, Brazil. Assoc. with stone tools 30 to 35cm below surface in non-ceramic Caaguaçu phase, last preceramic phase of area. Coll. 1968 by Eurico Miller; subm. by Clifford Evans. *Comment* (C.E.): too recent.

**3525 ± 145**
**SI-800. Porto das Laranjeiras, Brazil** **1575 B.C.**

Charcoal from Porto da Laranjeiras, RS-IJ-62 (29° 00′ S Lat, 56° 25′ W Long), Mun. Itaqui, Rio Grande do Sul, Brazil. Assoc. with Itaqui phase Altoparaense biface and bones of Pleistocene fauna 2.3 to 2.35m below surface in same horizon as bone of SI-801, below. Coll. 1968 by Eurico Miller; subm. by Clifford Evans. *Comment*: very small sample, NaOH pretreatment omitted; diluted.

**12,770 ± 220**
**SI-801. Lageado dos Fosseis, Brazil** **10,820 B.C.**

Bone of *Paramilodon*, id. by E. Miller, from RS-I-50 (29° 35′ S Lat, 55° 42′ W Long), Mun. Alegrete, Rio Grande do Sul, Brazil. Assoc. with Ibicui phase lithic artifacts in horizon containing extinct Pleistocene fauna. *Comment*: sample leached in 50% acetic acid under vacuum before $CO_2$ evolution with HCl. Small sample, diluted.

**Parizinho series, Brazil**

Charcoal from 2 adjacent sites in Mun. Tenete Portela, Rio Grande do Sul, Brazil, assoc. with ceramics of Taquarucu phase of Taquara tradition. Coll. 1968 by Eurico Miller; subm. by Clifford Evans.

**830 ± 60**
**SI-598. Parazinho-1** **A.D. 1120**

Charcoal from 20 to 30cm below surface at Parazinho 1 (28° 18′ S Lat, 53° 44′ W Long).

**160 ± 70**
**SI-599. Parazinho-2** **A.D. 1790**

Charcoal from 10 to 20cm below surface at Parazinho 2 (28° 18′ S Lat, 53° 45′ W Long).

**400 ± 100**
**SI-600. Boa Vista-2, Brazil** **A.D. 1550**

Charcoal from 20 to 25cm below surface, assoc. with ceramics of Taquara phase of Taquara tradition in Boa Vista-2 (27° 46′ S Lat, 54° 58′ W Long), Mun. Pôrto Lucena, Rio Grande do Sul, Brazil. Coll. 1968 by Eurico Miller; subm. by Clifford Evans. *Comment* (C.E.): too recent.

**SI-601. Tres Arvores, Brazil** **1300 ± 70** **A.D. 650**

Charcoal from 65 to 70cm below surface, assoc. with ceramics of Taquara phase of Taquara tradition in Tres Arvores (28° 10′ S Lat, 52° 29′ W Long), Mun. Passo Fundo, Rio Grande do Sul, Brazil. Coll. 1968 by Eurico Miller; subm. by Clifford Evans.

**SI-607. Fazenda Sao Marcos, Brazil** **1520 ± 90** **A.D. 430**

Charcoal from hearth 1m below surface in subterranean Pithouse B, RS-40 (29° 10′ S Lat, 51° 12′ W Long), Mun. Caxias do Sul, Rio Grande do Sul, Brazil. Assoc. with Caxias phase ceramics, possible equivalent of Taquara phase of Taquara tradition. Coll. 1966 by P. I. Schmitz; subm. by Clifford Evans.

**Caxias do Sul series, Brazil**

Charcoal samples from a complex of pithouses and mounds at RS-127 (29° 15′ S Lat, 51° W Long), Mun. Caxias do Sul, Rio Grande do Sul, Brazil. Coll. 1968 by P. I. Schmitz; subm. by Clifford Evans.

**SI-604. Mound 1, 55cm** **630 ± 70** **A.D. 1320**

Charcoal, 55cm below surface in level of red burned soil, assoc. with stone flakes and Taquara tradition ceramics.

**SI-602. Mound 1, 80 to 100cm** **1140 ± 40** **A.D. 810**

Charcoal 80 to 100cm below surface in dark soil level, assoc. with a few sherds of Taquara tradition and stone flakes.

**SI-603. Pithouse A** **1480 ± 70** **A.D. 470**

Charcoal from base of hearth on original floor of Pithouse A, 80 to 100cm below surface, assoc. with ceramics of Taquara tradition.

**SI-606. Pithouse B** **840 ± 60** **A.D. 1110**

Charcoal from level of black soil under reddened dirt in Pithouse B, assoc. with Taquara tradition ceramics.

**SI-605. Pithouse B, 80 to 100cm** **1330 ± 100** **A.D. 620**

Charcoal from floor of pithouse at site of large burned tree, assoc. with Taquara tradition ceramics. Pithouse cut into decomposed basalt. *General Comment* (C.E.): site belongs to Caxias phase (possible equivalent to Taquara phase) of Taquara tradition.

**Itapiranga series, Brazil**

Itapiranga, SC-U-6 (27° 12′ S Lat, 53° 25′ W Long), Mun. Itapiranga, Santa Catarina, Brazil, is a stratified site. The upper 1m contains ceramics of Tupiguarani tradition, and remaining 7.3m contains preceramic Altoparanense tools. Coll. 1968 by J. A. Rohr; subm. by Clifford Evans.

**7145 ± 120**
**SI-993. Itapiranga, 5m** **5195 B.C.**

Charcoal from hearth in red clay, 5m below surface, assoc. with percussion-made flake tools.

**8095 ± 90**
**SI-994. Itapiranga, 6m** **6145 B.C.**

Charcoal from hearth in red clay, 6m below surface, assoc. with percussion-made flake tools.

**8640 ± 95**
**SI-995. Itapiranga, 7.3m** **6690 B.C.**

Charcoal from hearth in red clay, 7.3m below surface, assoc. with percussion-made flake tools.

**Itá series, Brazil**

Charcoal from Itá, SC-VP-38 (27° 16′ 15″ S Lat, 52° 30′ 30″ W Long), Mun. Itá, Santa Catarina, Brazil. Coll. 1969 by W. F. Piazza; subm. by Clifford Evans.

**590 ± 100**
**SI-826. Itá, 0 to 15cm** **A.D. 1360**

Charcoal from 0 to 15cm below surface, assoc. with ceramics of Ita phase, Tupiguarani Corrugated tradition.

**5930 ± 140**
**SI-827. Itá, 3.5m** **3980 B.C.**

Charcoal from 3.5m below surface, assoc. with artifacts of preceramic Tamanduá phase.

**975 ± 95**
**SI-825. Pinheiro Preto II, Brazil** **A.D. 975**

Charcoal from Pinheiro Preto II, SC-VP-35 (27° 16′ S Lat, 52° 10′ 30″ W Long), Mun. Concordia, Santa Catarina, Brazil. Assoc. with ceramics of Xaxim phase, Taquara tradition, 0 to 20cm below surface. Coll. 1969 by W. F. Piazza; subm. by Clifford Evans.

**330 ± 90**
**SI-597. Vacas Gordas, Brazil** **A.D. 1620**

Charcoal from 60cm below surface at Vacas Gordas, SC-CL-10 (28° 08′ S Lat, 49° 40′ W Long), Mun. Urubici, Santa Catarina, Brazil. Assoc. with Xaxim phase of Taquara tradition. Coll. 1967 by W. F. Piazza; subm. by Clifford Evans. *Comment*: (C.E.): too recent.

**Passo da Cadeia series, Brazil**

Charcoal samples from Passo da Cadeia, SC-CL (28° 29′ S Lat, 50° 05′ 40″ W Long), Mun. Sao Joaquim, Santa Catarina, Brazil. Coll. 1969 by E. T. Miller; subm. by Clifford Evans.

**1085 ± 80**
**SI-810. Passo da Cadeia, 55 to 60cm** **A.D. 865**

Charcoal assoc. with ceramics of Guatumbu phase, Taquara tradition, 55 to 60cm below surface.

**1920 ± 50**
**SI-811. Passo da Cadeia, 120 to 140cm** **A.D. 30**

Charcoal from 120 to 140cm below surface, assoc. with lithic materials.

**Rio Iguaçu series, Brazil**

Charcoal samples from 3 adjacent sites along Iguaçu R., Mun. Bituruna, Parana, Brazil. Coll. by Igor Chmyz; subm. by Clifford Evans.

**3110 ± 140**
**SI-802. R. Iguaçu, PR-UV-4** **1160 B.C.**

Charcoal from 50 to 60cm below surface, assoc. with preceramic lithic Iguaçu phase materials (26° 00′ S Lat, 51° 00′ W Long). Coll. 1968.

**1035 ± 90**
**SI-803. R. Iguaçu, PR-UV-3** **A.D. 915**

Charcoal from 35 to 45cm below surface, assoc. with preceramic lithic Iguaçu phase materials (26° 00′ S Lat, 51° 00′ W Long). Coll. 1962. *Comment* (C.E.): too recent.

**605 ± 120**
**SI-691. R. Iguaçu, PR-UV-12, 40-60** **A.D. 1345**

Charcoal from 40 to 60cm below surface, assoc. with subterranean house complex.

**810 ± 90**
**SI-892. R. Iguaçu, PR-UV-12, 60-80** **A.D. 1140**

Charcoal from 60 to 80cm below surface.

**255 ± 100**
**SI-692. R. Iguaçu, PR-UV-12, 80-100** **A.D. 1695**

Charcoal from 80 to 100cm below surface. *Comment*: too recent in terms of stratigraphic position.

**Rio Ivai, PR-FL-5 series, Brazil**

Charcoal from PR-FL-5 (23° 30′ S Lat, 52° 30′ W Long), Mun. Paraiso do Norte, Paraná, Brazil, representing Umuarama phase of Tupiguarani Painted ceramic tradition. Coll. 1968 by Igor Chmyz; subm. by Clifford Evans.

**300 ± 115**
**SI-693. R. Ivai, 60 to 80cm** **A.D. 1650**

**470 ± 100**
**SI-694. R. Ivai, 80 to 100cm** **A.D. 1480**

*General Comment* (C.E.): both dates are too recent.

**Rio Ivai, Condor phase series, Brazil**

Charcoal from 4 adjacent sites (23° 30′ S Lat, 52° 30′ W Long), Mun. Indianópolis and Mirador, Paraná, Brazil. Sites represent painted Condor phase of Tupiguarani Painted ceramic tradition. Coll. 1968 by Igor Chmyz; subm. by Clifford Evans.

**SI-695. PR-ST-1, 0 to 10cm** — **1065 ± 95**, **A.D. 885**

**SI-696. PR-ST-1, 10 to 20cm** — **610 ± 120**, **A.D. 1340**

**SI-697. PR-QN-2, 15 to 30cm** — **540 ± 60**, **A.D. 1410**

**SI-698. PR-FL-13, 0 to 20cm** — **135 ± 120**, **A.D. 1815**

*Comment* (C.E.): too recent.

**SI-699. PR-FL-15, 0 to 20cm** — **590 ± 70**, **A.D. 1360**

**SI-700. PR-FL-23, Tamboara, Brazil** — **560 ± 60**, **A.D. 1390**

Charcoal from Site PR-FL-23 (23° 30′ S Lat, 52° 20′ W Long), on R. Ivai, Mun. Doutor, Paraná, Brazil. Assoc. with ceramics of Tamboara phase of Tupiguarani Corrugated tradition, 2 to 20cm below surface. Coll. 1968 by Igor Chmyz; subm. by Clifford Evans.

**SI-701. Jaboticaba, Brazil** — **225 ± 55**, **A.D. 1725**

Charcoal from Jaboticaba, RS-VZ-41 (27° 10′ S Lat, 53° 44′ W Long), Mun. Tenente Portela, Rio Grande do Sul, Brazil. Assoc. with ceramics of Comandai phase of Tupiguarani Corrugated tradition. Coll. 1967 by Eurico Miller; subm. by Clifford Evans. *Comment* (C.E.): too recent.

**SI-702. Ilha Comandai, Brazil** — **215 ± 105**, **A.D. 1735**

Charcoal from Ilha Comandai, RS-VZ-12 (27° 48′ S Lat, 55° 06′ W Long), Mun. Pôrto Lucena, Rio Grande do Sul, Brazil. Assoc. with ceramics of Comandai phase of Tupiguarani Corrugated tradition. Coll. 1968 by Eurico Miller; subm. by Clifford Evans. *Comment* (C.E.): too recent.

**Sambaqui do Rio S. Joao series, Brazil**

Sambaqui do Rio S. Joao (25° 30′ S Lat, 49° 30′ W Long), shell mound site in Mun. de Antonina, Paraná, Brazil, built on a barrier reef and boulder sand. The surface shows humus underlain by oyster shell; below these are burned oyster shell and gray boulder sand, a compact stratum of oyster shell, and *Modiolus Brasiliensis,* id. by J. W. Rauth. Coll. 1967 by J. W. Rauth; subm. by Clifford Evans.

**SI-1020. Humus stratum, 0 to 0.25m** **Modern**

Charcoal from topmost humus layer, 0 to 0.25m from surface, assoc. with stone scrapers and human burial.

**4070 ± 105**
**SI-1021. Oyster stratum, 0.75 to 1m** **2120 B.C.**

Charcoal from upper layer of oyster shell, 0.75 to 1m below surface, from hearth.

**4960 ± 110**
**SI-1022. Oyster stratum, 1.25 to 1.5m** **3010 B.C.**

Charcoal from lower portion of compacted oyster shell, 1.25 to 1.5m below surface.

**4810 ± 100**
**SI-1023. Bottom level, 1.5 to 2m** **2860 B.C.**

Charcoal from bottom level, overlying boulder sand terrace, assoc. with *Modiulus Brasiliensis,* 1.5 to 2m below surface.

**4665 ± 90**
**SI-1024. Bottom level, 1.75m** **2115 B.C.**

Charcoal from 2nd trench, unknown distance from SI-1023, above, 1.75m below surface in lowest stratum overlying boulder sand terrace and barrier reef.

**Sambaqui do Godo series, Brazil**

Sambaqui do Godo (30° 26′ S Lat, 49° 30′ W Long), preceramic shell mound in Mun. de Antonina, Paraná, Brazil. Coll. 1968 by J. W. Rauth; subm. by Clifford Evans.

**3815 ± 50**
**SI-1025. do Godo, 50 to 75cm** **1865 B.C.**

Charcoal from 50 to 75cm below surface, assoc. with human bones and lithic artifacts.

**2980 ± 130**
**SI-1026. do Godo, 1 to 1.25m** **1030 B.C.**

Charcoal from 1 to 1.25m below surface, assoc. with lithic artifacts. *Comment*: small sample, diluted.

**3000 ± 90**
**SI-1027. do Godo, 1.5 to 2m** **1050 B.C.**

Charcoal from 1.5 to 2m below surface, assoc. with fish bones and lithic artifacts.

**3365 ± 85**
**SI-1028. do Godo, 2.25 to 2.5m** **1415 B.C.**

Charcoal from 2.25 to 2.5m below surface, assoc. with fish and animal bones and lithic artifacts.

**3300 ± 95**
**SI-1028-A. do Godo, 2.25 to 2.5m, A** **1350 B.C.**

Oyster shell from same sample as SI-1028, above.

**SI-1029. do Godo, 2.5 to 3m** **4740 ± 95** **2790 B.C.**

Charcoal from 2.5 to 3m below surface at base of mound, mixed with sandy clay.

**SI-709. Rio Paranapanema, Brazil** **908 ± 100** **A.D. 970**

Charcoal, assoc. with ceramics of Cambará phase of Tupiguarani Painted tradition from Rio Paranapanema, SP-AS-14 (22° 50′ S Lat, 51° 10′ W Long), Mun. Iepê, Sao Paulo, Brazil. Coll. 1968 by Igor Chmyz; subm. by Clifford Evans. *Comment*: small sample, no NaOH pretreatment.

**SI-1009. Rio Itarare, Brazil** **1195 ± 80** **A.D. 775**

Charcoal and charred nut shells from 10 to 20cm below surface, Site SP-BA-7 (23° 30′ S Lat, 49° 30′ W Long), Sao Paulo, Brazil. Assoc. with ceramics of Cambara phase of Tupiguarani tradition. Coll. 1965 by Igor Chmyz; subm. by Clifford Evans.

**SI-933. Barreiro, Brazil** **6620 ± 175** **4670 B.C.**

Charcoal assoc. with lithic artifacts of Antas phase in preceramic site at Barreiro, RS-A-8 (28° 48′ S Lat, 50° 29′ 24″ W Long), Mun. Bom Jesus, Rio Grande do Sul, Brazil. Coll. 1969 by E. T. Miller; subm. by Clifford Evans.

**SI-828. Morro H, Brazil** **1055 ± 80** **A.D. 895**

Charcoal from 30cm below surface in single ceramic level of Cricaré phase of Tupiguarani Painted tradition at Morro H, Site 17 (20° 05′ S Lat, 40° 14′ W Long), Mun. Pium, Espirito Santo, Brazil. Coll. 1968 by Celso Perota; subm. by Clifford Evans.

**SI-829. Estrada I, Brazil** **170 ± 75** **A.D. 1780**

Charcoal from 20cm below surface in single cultural level of Itaunas phase of Aratu ceramic tradition at Estrada I, Site 22 (20° 50′ S Lat, 40° 44′ W Long), Mun. Serra, Espirito Santo, Brazil. Coll. 1969 by Celso Perota; subm. by Clifford Evans.

**SI-830. Campus, Brazil** **240 ± 70** **A.D. 1710**

Charcoal from 45 to 60cm below surface, assoc. with lithic and bone assemblage and Neobrasilian ceramic tradition in Campus, Site Cu-02 (20° 16′ S Lat, 40° 17′ W Long), Mun. Vitória, Espirito Santo, Brazil. Coll. 1969 by Celso Perota; subm. by Clifford Evans.

**SI-831. Campus 1, Brazil** **1435 ± 80** **A.D. 515**

Charcoal from 10cm below surface, assoc. with lithic and bone assemblage of Potiri phase of non-ceramic tradition in Campus-1, Cu-01

(20° 16′ S Lat, 40° 17′ W Long), Mun. Vitória, Espirito Santo, Brazil. Coll. 1969 by Celso Perota; subm. by Clifford Evans.

**SI-832. Tucun, Brazil** **560 ± 70**
**A.D. 1390**

Charcoal assoc. with ceramics of Tucun phase of Tupiguarani Painted tradition in Tucun, ES-VI-20 (20° 16′ S Lat, 40° 22′ W Long), Mun. Cariacica, Espirito Santo, Brazil. Coll. 1970 by Celso Perota; subm. by Clifford Evans.

**SI-833. Campus-3, Brazil** **110 ± 40**
**A.D. 1840**

Charcoal assoc. with ceramics of Tucun phase of Tupiguarani Painted tradition in Campus 3, ES-VI-11 (20° 17′ S Lat, 40° 08′ W Long), Mun. Vitória, Espirito Santo, Brazil. Coll. 1969 by Celso Perota; subm. by Clifford Evans. *Comment* (C.E.): too recent.

**SI-834. Belem 3, Brazil** **220 ± 75**
**A.D. 1730**

Charcoal assoc. with ceramics of Itaúnas phase of Aratu tradition in Belem 3, ES-LI-14 (18° 34′ S Lat, 39° 44′ W Long), Mun. Conceição da Barra, Espirito Santo, Brazil. Coll. 1968 by Celso Perota; subm. by Clifford Evans.

**SI-835. Fazenda Salvador I, Brazil** **Modern**

Charcoal assoc. with ceramics of Itaúnas phase of Aratu tradition in Fazenda Salvador I, ES-LI-4 (18° 21′ S Lat, 39° 47′ W Long), Mun. São Mateus, Espirito Santo, Brazil. Coll. 1969 by Celso Perota; subm. by Clifford Evans. *Comment* (C.E.): too recent.

**SI-836. Vale, Brazil** **605 ± 70**
**A.D. 1345**

Charcoal assoc. with ceramics of Jacareipe phase of Aratu tradition in Vale, ES-VI-18 (20° 16′ S Lat, 40° 15′ W Long), Mun. Vitória, Espirito Santo, Brazil. Coll. 1970 by Celso Perota; subm. by Clifford Evans.

**SI-820. Cariri, Brazil** **305 ± 65**
**A.D. 1645**

Charcoal from 0 to 20cm below surface, assoc. with ceramics of Itapicuru phase of Tupiguarani Painted tradition at Cariri, BA-19 (13° 45′ 05″ S Lat, 41° 15′ W Long), Mun. Ituacu, Bahia, Brazil. Coll. 1967 by Valentin Calderon; subm. by Clifford Evans.

**SI-821. Joaquim Guilherme, Brazil** **550 ± 95**
**A.D. 1400**

Charcoal assoc. with Itapicuru phase ceramics of Tupiguarani Painted tradition, 0 to 20cm below surface at Joaquim Guilherme site, BA-26 (13° 45′ 45″ S Lat, 41° 15′ W Long), Mun. Ituacu, Bahia, Brazil. Coll. 1967 by Valentin Calderon; subm. by Clifford Evans.

**Raposo series, Brazil**

Charcoal assoc. with ceramics of Jeragua phase at Raposo, MG-GV-

19 (21° 10′ S Lat, 45° 15′ W Long), Mun. Nepomuceno, Minas Gerais, Brazil. Coll. 1969 by O. F. Dias; subm. by Clifford Evans.

**SI-822. Raposo, 0 to 10cm** **885 ± 90**
**A.D. 1065**

**SI-824. Raposo, 20 to 30cm** **855 ± 70**
**A.D. 1095**

**SI-823. Primavera, Brazil** **95 ± 100**
**A.D. 1855**

Charcoal 30cm below surface, assoc. with ceramics in black earth at Primavera, MG-GV-39 (21° 05′ S Lat, 45° 50′ 30″ W Long), Mun. Campo do Meio, Minas Gerais, Brazil. Coll. 1969 by O. F. Dias; subm. by Clifford Evans. *Comment* (C.E.): too recent.

**SI-1010. R. Iguaçu, PR-UV-11, Brazil** **680 ± 70**
**A.D. 1270**

Charcoal and wood from 30 to 40cm below surface at Pr-UV-11 on R. Iguaçu (26° 00′ S Lat, 51° 30′ W Long), Parana, Brazil. Assoc. with non-Tupiguarani ceramics in subterranean houses and small mounds. Coll. 1966 by Igor Chmyz; subm. by Clifford Evans.

**SI-1015. R. Iguaçu, PR-UV-16, Brazil** **500 ± 45**
**A.D. 1450**

Charcoal from 40 to 50cm below surface, assoc. with Tupiguarani ceramics at PR-UV-16 (26° 10′ S Lat, 51° 00′ W Long), Parana, Brazil. Coll. 1968 by Igor Chmyz; subm. by Clifford Evans.

**SI-1011. R. Ivai, PR-FL-21, Brazil** **1490 ± 45**
**A.D. 460**

Charcoal from 0 to 20cm below surface, assoc. with ceramics of Tamboara phase of Tupiguarani tradition at PR-FL-21 on R. Ivai (23° 30′ S Lat, 52° 20′ W Long), Parana, Brazil. Coll. 1967 by Igor Chmyz; subm. by Clifford Evans.

**SI-1012. R. Ivai, PR-KA-2, Brazil** **Modern**

Charcoal from 0 to 20cm below surface with ceramics of Caloré phase of Tupiguarani tradition at PR-KA-2 on R. Ivai (23° 40′ S Lat, 51° 30′ W Long), Parana, Brazil. Coll. 1967 by Igor Chmyz; subm. by Clifford Evans.

**SI-1014. R. Ivai, PR-QN-1, Brazil** **5380 ± 110**
**3430 B.C.**

Charcoal, 90 to 100cm below surface with lithic artifacts of non-ceramic Ivai complex at PR-QN-1 on R. Ivai (23° 30′ S Lat, 52° 30′ W Long), Parana, Brazil. Coll. 1967 by Igor Chmyz; subm. by Clifford Evans.

**Rio Parana series, Brazil**

Charcoal from Site MT-IV-1 on R. Parana (23° 30′ S Lat, 52° 30′ W Long), Mato Grosso, Brazil, assoc. with Tupiguarani ceramics. Coll. 1967 by Igor Chmyz; subm. by Clifford Evans.

**260 ± 70**
**SI-1016. MT-IV-1, urn** **A.D. 1690**

Charcoal, part of urn contents.

**475 ± 45**
**SI-1017. MT-IV-1, 20 to 40cm** **A.D. 1475**

**180 ± 60**
**SI-1018. MT-IV-1, 60 to 80cm** **A.D. 1770**

Charcoal from 60 to 80cm below surface.

*General Comment* (C.E.): dates do not correspond to seriated order of stratigraphic excavations. Of this series, and SI-1019, below, only SI-1017 agrees with other dates from phases representing Corrugated sub-tradition of Tupiguarani ceramic tradition in S Brazil.

**110 ± 60**
**SI-1019. R. Parana, MT-IV-2, Brazil** **A.D. 1840**

Charcoal from 20 to 40cm below surface, assoc. with Tupiguarani ceramics at MT-IV-2 on R. Parana (22° 40′ S Lat, 53° 20′ W Long), Mato Grosso, Brazil. Coll. 1967 by Igor Chmyz; subm. by Clifford Evans. *Comment* (C.E.): too recent. See general comment for Rio Parana series, above.

**Tuteceta series, Brazil**

Potsherds containing ashes of siliceous bark as temper from Tuteceta (11° 10′ S Lat, 53° 25′ W Long), on R. Suia-missu, Upper Xingu, Matto Grosso, Brazil. Sherds are Diauarum phase of Incised and Punctate tradition. Coll. 1966 by M. F. Simoes; subm. by Clifford Evans.

**1390 ± 140**
**SI-712. Tuteceta, 10 to 20cm** **A.D. 560**

Sherds from 10 to 20cm below surface. *Comments*: small sample, NaOH pretreatment omitted. (C.E.): too old.

**830 ± 75**
**SI-713. Tuteceta, 20 to 30cm** **A.D.1120**

Sherds from 20 to 30cm below surface.

**Diauarum series, Brazil**

Charcoal and potsherds containing ash of siliceous bark as temper from Diauarum (11° 12′ S Lat, 53° 30′ W Long), on R. Xingu, Upper Xingu, Matto Grosso, Brazil. Ceramics are Diauarum phase of Incised and Punctate tradition. Coll. 1966 by M. F. Simoes; subm. by Clifford Evans.

**1470 ± 135**
**SI-714. Diauarum sherds, 30 to 40cm** **A.D. 480**

Sherds from 30 to 40cm below surface. *Comments*: small sample, NaOH pretreatment omitted. (C.E.): too old.

**SI-716. Diauarum, 55cm** **830 ± 90**
**A.D. 1120**

Charcoal in burned soil, 55cm below surface.

**SI-717. Diauarum, 18cm** **2095 ± 65**
**145 B.C.**

Charcoal in burned soil, 18cm below surface. *Comments* (C.E.): too old.

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# VIENNA RADIUM INSTITUTE RADIOCARBON DATES IV

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Measurements have continued with the same proportional counter system, the same procedure in sample pretreatment, methane preparation and measurement, and the same age calculation using a half-life of 5568 ± 30 yr as described previously (R., 1970, v. 12, p. 298-318).

Uncertainties quoted are single standard deviations originating from the statistical nature of radioactive decay including standard, sample, background, and half-life. No $C^{13}/C^{12}$ ratios were measured.

The following list presents most samples of our work in the last year. Sample descriptions have been prepared in cooperation with submitters.

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## SAMPLE DESCRIPTIONS

### I. GEOLOGY, GEOGRAPHY, SOIL SCIENCE, AND FORESTRY

### *A. Austria*

**Klopeinersee-Kleinsee series, Kärnten**

Sediment from Lake Klopeinersee (46° 36′ N Lat, 14° 35′ E Long), Carinthia, and from neighboring Lake Kleinsee from similar depths below ground near shore outside of lakes. Coll. 1971 by H. Löffler; subm. by A. Preisinger, Inst. f. Min. u. Kristallog., Univ. Vienna.

*General Comments* (A.P.): similar sample ages could support hypothesis of a former unit of both lakes and later separation. (H.F.): no humic acid separation was used due to small sample sizes. Different ages cannot be explained by unequal contents of younger humic acids as can be seen by calculation: for 9000-yr-old sample, an admixture of ca. 67% recent material would be necessary to get a fictitious age of 2000 yr.

**VRI-294. Kleinsee** **2140 ± 730**
**190 B.C.**

Peat-like lake sediment with calcite admixture from depth 3.14m below soil, E side of lake. *Comment* (H.F.): large statistical uncertainty is due to small sample size.

**VRI-295. Klopeinersee** **9190 ± 230**
**7240 B.C.**

Peat-like lake sediment with calcite admixture from depth 3.50m below soil, 10m from shore E of lake.

**Rax series, N.Ö.**

Peat from dried pond, regularly water-filled up to 50 yr ago, at plateau of Mt. Rax near former shelter "Alte Seehütte" (47° 42′ 30″ N Lat, 15° 44′ 15″ E Long), Lower Austria, alt. 1650m. Coll. 1968 by K. Zukrigl and K. H. Ballik; subm. by F. Kral, Inst. f. Waldbau, Hochschule f. Bodenkultur, Vienna.

*General Comment* (K.Z.): pollen diagram suggests mixing down to 40cm depth, presumably by cattle.

**VRI-227. Alte Seehütte, 45 to 55cm** **Recent**

Peat from depth 45 to 55cm. *Comments* (K.Z.): according to pollen diagram sample covers time immediately after beginning of pasture clearing. Plentiful recent rootlets. (H.F.): clearly influenced by bomb produced $C^{14}$; 108% modern.

**VRI-228. Alte Seehütte, 80 to 90cm** **Recent**

Peat from depth 80 to 90cm. *Comment* (K.Z.): according to pollen diagram sample covers time before pasture clearing. Pollen of grain observed. No recent rootlets observed in macrostructure.

**Mt. Dachstein series, O.Ö.**

Organic samples and calcium carbonate sinter from cave Dachstein-Mammuthöhle (37° 32′ 10″ N Lat, 13° 42′ 39″ E Long), O.Ö. Coll. and subm. by R. Seemann, Mineralog.-Petrograph. Inst., Univ. Vienna.

*General Comment* (R.S.): should help date cave pyrite and iron ore in Nördliche Kalkalpen (Seemann, 1970).

**VRI-255. Sinter MaP 5** **>36,000**

Calcium carbonate sinter with limonite, quartz, and clay from layer of pyrite conglomerate in cave. Coll. 1970. *Comment* (H.F.): date based on assumption of recent value 85% modern (Münnich and Vogel, 1959).

**2230 ± 80**
**VRI-257. Sample MaP 45** **280 B.C.**

Carbonic substance in clay-calcic cave sediment. Coll. 1971.

**VRI-284. Rostocker Hütte-43,** **1600 ± 70**
**Venediger Gruppe, Osttirol** **A.D. 350**

Peat from depth 43cm of undisturbed peat profile 130 to 160cm thick, covered by series of loamy-sandy sediments 30 to 50cm thick. Site near shelter Rostocker Hütte (47° 03′ 19″ N Lat, 12° 18′ 07″ E Long), alt. 2200m, Simonykees glacier (Patzelt, 1967), Venediger Group, E-Tyrol. Coll. 1971 and subm. by G. Patzelt, Geog. Inst., Univ. Innsbruck. *Comment* (G.P.): part of series from 2 profiles 5m apart. VRI-54 (base; R., 1970, v. 12, p. 304), VRI-179 (depth 90cm; R., 1971, v. 13, p. 132, see Correction: R., 1972, v. 14, p. 504) and VRI-284 from peat layer, Profile R-II; VRI-178 (depth 35cm; R., 1971, v. 13, p. 131) and VRI-243 (depth 42 cm; R., 1972, v. 14, p. 502) from sediment layer, Profile R-III. Sample dates drift-in of sediments by advancing Simonykees, and palynologically detected glacier maximum.

**Badgastein series, Salzburg**

Hydrothermal wart sinter (wart-shaped sinter) of organic genesis (Grabherr, 1949); Scheminzky and Grabherr, 1951) from former thermal watercourse discovered by slope slide of Kirchbachlehne (Scheminzky, 1968) in Badgastein (47° 07′ N Lat, 13° 08′ E Long), Salzburg. Coll. 1967 and subm. by F. Scheminzky, Forschungsinst. Gastein.

*General Comment* (H.F.): date based on study (Felber, 1972) of $C^{14}$ concentration in recent wart sinters (VRI-219, -274, -275) that were shown to equal that of atmospheric $C^{14}$ and not that of water (VRI-218, -335) that sinters grew from. This is different from common limestone encrustations of inorganic genesis, of which recent $C^{14}$ concentration equals that of water (Münnich and Vogel, 1959).

**VRI-146. Kirchbachlehne** **7460 ± 110** **5510 B.C.**

Wart sinter.

**VRI-218. Fledermaus-Spring X/3** **27.1 ± 1.1% modern**

Barium carbonate precipitated from bicarbonate in thermal water (37°C; Mutschlechner, 1963) of Spring X, Fledermausquelle, Badgastein, immediately from Outlet X/3. Precipitated 1970 by H. Felber. *Comment* (H.F.): agrees with measurements of Florkowski and Job, 1969, on Springs I/23-24 (Franz-Josef-adit) and IX/8-12 (Elisabeth-adit), Badgastein.

**VRI-335. Fledermaus-adit, pond** **36.2 ± 1.8% modern**

Barium carbonate precipitated from bicarbonate of thermal water from localized spring outlets X/1,2,4,5 and several diffuse outlets on rock walls in ca. 12m long Fledermaus-adit, Badgastein. Water from ca. 25cm deep pond on base of adit collecting these spring waters. During transfer to pond, and on its surface (ca. $2m^2$), carbon exchanges between water and atmosphere. From inflows of 5.8L/min and pond volume of 530L (both determined by G. Mutschlechner) an average sojourn time for water in pond of ca. 90 min follows. Precipitated 1972 by G. Mutschlechner. *Comment* (H.F.): $C^{14}$ concentration in pond raised by exchange by ca. 30% compared with water taken immediately from spring outlet X/3 (VRI-218).

**VRI-219. Fledermaus-adit, sinter** **120.1 ± 1.2% modern**

Wart sinter on gneiss rock along littoral zone of pond (VRI-335) in Fledermaus-adit, Badgastein. Growth period of sinter: 1930 to 1970. Coll. 1970 by G. Mutschlechner. *Comment* (H.F.): atmospheric $C^{14}$ concentration influenced by atomic bomb explosions (Felber, 1972).

**VRI-274. Franz-Josef-adit, Sinter 1** **100.0 ± 0.9% modern**

Wart sinter from border of basin of Spring I/2, Franz-Josef-adit, Badgastein. Thermal water stopped 1929/30 nearly completely when N adit was driven in, opening new springs. Growth period of sinter: 1855/56 to 1929/30. Coll. 1971 by G. Mutschlechner and F. Scheminzky. *Comment* (H.F.): atmospheric $C^{14}$ concentration. Proves growth stopped before atomic bomb era.

**VRI-275. Franz-Josef-adit, Sinter 2 100.5 ± 1.1% modern**

Wart sinter from walled roof of Franz-Josef-adit, 19m behind opening. Sinter fallen down and picked up from bottom. Beginning of growth after 1855, end unknown. Coll. 1971 by G. Mutschlechner. *Comment* (H.F.): atmospheric $C^{14}$ concentration. Growth stop before atomic bomb era.

**Baumkirchen series, Tirol**

Fossil wood from banded silt and clay in pit Baumkirchen (Fliri *et al.*, 1970, 1971) (47° 18′ 25″ N Lat, 11° 34′ 19″ E Long), Inn Valley, Tyrol. Subm. by F. Fliri, Geog. Inst., Univ. Innsbruck.

**25,500 ± 600**
**VRI-273. Find No. 18 23,550 B.C.**

Wood (prob. *Pinus silvestris,* det. by H. Hilscher); find No. 18 from 661m level in W part of pit. Coll. 1971 by F. Fliri. *Comment* (F.F.): date too young compared with VRI-173, -193, -226 (R., 1971, v. 13, p. 130; 1972, v. 14, p. 500; Fliri *et al.*, 1971) from same level.

**28,300 ± 1000**
**VRI-334. Find No. 22 26,350 B.C.**

Wood (*Alnus viridis,* determined by H. Hilscher), from 667m level, in undisturbed banded silt and clay. Coll. 1971 by E. Hellriegl. *Comment* (F.F.): date according to VRI-161, -173, -193, -226 (R., 1971, v. 13, p. 130 and R., 1972, v. 14, p. 500).

**11,300 ± 170**
**VRI-338. Find No. 23 9350 B.C.**

Stem wood, ca. 25cm diam, 80 rings at alt. 776m in blueish gray clay colluvium colored by intrusion of organic substance. Site overlies undisturbed clay of primary sedimentation, and is overlain by 3m slightly weathered slopewash clay, and by 1m gravel. Coll. 1972 by F. Fliri. *Comment* (F.F.): date according to VRI-94 (R., 1970, v. 12, p. 309) and VRI-194 (R., 1972, v. 14, p. 500).

**VRI-270. Baumkirchener Tal, Tirol <450**

Wood (*Alnus incana*) in slopewash silt on surface of banded silt and clay deposit of Baumkirchen (47° 18′ 18″ N Lat, 11° 33′ 25″ E Long), Tyrol, 1250m W of clay pit. Coll. 1971 and subm. by F. Fliri. *Comment* (F.F.): Alleröd was expected (VRI-94; R., 1970, v. 12, p. 309; VRI-194, R., 1972, v. 14, p. 500) or young age. Date proves latter.

**VRI-307. Breitenbach, Tirol** **7390 ± 120**
**5440 B.C.**

Wood from oldest soil of alluvial cone Heuberg near Breitenbach am Inn (47° 29′ N Lat, 11° 58′ E Long), Tyrol. Soil covered by periglacial colluvium and main mass of alluvial cone with several soils embedded. Coll. 1971 and subm. by F. Mayr, Dépt Géol., Univ. Montréal, Canada. *Comment* (F.M.): new trial to determine age of 1st plant growth after retreat of Würm glacier. Sample younger than hoped.

**Gurgler Zirbenwaldmoor series, Tirol**

Cyperaceae peat from different depths of bog Zirbenwaldmoor (46° 51′ 20″ N Lat, 11° 01′ E Long), Obergurgl, Ötztal, Tyrol. Coll. 1970 and subm. by S. Bortenschlager, Inst. f. Botan. Systematik u. Geobot., Univ. Innsbruck.

*General Comment* (S.B.): geochronologic determination of palynologically determined climate fluctuations.

**VRI-216. 288 to 295cm** **8600 ± 150**
**6650 B.C.**

*Comment* (S.B.): date agrees with studies in Venediger area.

**VRI-217. 325cm to rock** **8540 ± 130**
**6590 B.C.**

*Comment* (S.B.): date too young; sample supposedly contaminated by water intrusion in depth 3m. Water could not be removed by continuous pumping at 900L/min. Sample coll. under water.

**VRI-236. Hopfgarten, Tirol** **>36,000**

Driftwood found with Schieferkohle in uppermost layer of alluvial sands and lacustrine silt overlain by Inn-eisstromnetz till. Sediment rests on gravel of Hall Valley fill. Site 20m below present surface, alt. 730m. Hopfgarten (47° 26′ 32″ N Lat, 12° 08′ 36″ E Long), Tyrol. Coll. 1970 and subm. by F. Mayr. *Comment* (F.M.): expected result.

**VRI-271. Imst, Tirol** **10,580 ± 140**
**8630 B.C.**

Wood (*Pinus silvestris*) in slopewash silt on surface of banded silt and clay, 1st find in pit of Imst (47° 11′ 45″ N Lat, 10° 45′ 12″ E Long), Oberinntal, Tyrol. Coll. 1970 by F. Fliri and H. Heuberger; subm. by F. Fliri. *Comment* (F.F.): expected date.

**VRI-309. Kufstein, Tirol** **Recent**

Wood (*Picea*) found in Pendling cave, Cut II, depth 40cm, with cave-bear bones; near Kufstein (47° 34′ 20″ N Lat, 12° 06′ 40″ E Long), Tyrol, alt. 1484m. Coll. 1971 and subm. by W. Kneussl, Solbad Hall i.T. *Comment* (H.F.): wood not contemporaneous with bones.

**VRI-301. Mils, Tirol** **<850**

Wood (root of *Pinus*) ca. 0.5m above base of Würm ground moraine ca. 7m thick. Gravel pit N of Mils near Solbad Hall (47° 18′ 21″ N Lat, 11° 31′ 48″ E Long), Tyrol. Coll. 1971 by H. Crepaz; subm. by F. Fliri. *Comment* (F.F.): sample covered by ca. 6m till. If primary deposition in moraine, onset of last great advance of Würm glaciation in Inn Valley is dated by sample. Date proves young vegetation also suggested by absence of pressure marks.

**VRI-240. Moetz-Klammbach, Tirol** **7950 ± 160**
**6000 B.C.**

Plant chaff in thin lens half-way up bluffs facing last houses in Klammbachgraben, 1.5km N Moetz (47° 17′ 42″ N Lat, 10° 57′ 18″ E Long), Inn Valley, Tyrol, alt. 705m. High bluffs, 15m, expose structure of late glacial valley fill: gravel followed by sand interbedded with several layers of banded silt. Coll. 1970 and subm. by F. Mayr. *Comment* (F.M.): sediment sequence indicates rapid changes from alluvial fan to alluvial plain to lake and vice versa. Moraines and ice-marginal terraces near Moetz support conclusion that valley fill and lakes were caused by Oetz Valley glacier advance (Steinach I ?).

**VRI-231. Roppen North 3, Tirol** **Recent**

Needles (*Pinus* and *Larix*) from exposure by bulldozer near forest road, alt. 900m, SSE above Roppen (47° 13′ N Lat, 10° 50′ E Long), mouth of Oetz Valley, Tyrol. Samples found upon buried soil of Roppen beneath block of Wetterstein dolomite in left lateral moraine (distal side) of former Oetz Valley glacier (moraine of Tschirgant landslide). Coll. 1970 and subm. by H. Heuberger, Geog. Inst., Univ. Innsbruck. *Comment* (H.H.): submitter hoped to date soil of Roppen formed between 2 late glacial advances of Oetz Valley glacier, not later than Alleröd as H.H. supposes.

**VRI-239. Trins, Tirol** **8970 ± 140**
**7020 B.C.**

Charcoal, conifer wood, id. by H. Hilscher, 10m below surface of steep (20°) alluvial cone burying N branch of Type-Gschnitz-Moraine, 2km upstream from terminus. Irregular and oversteepened bedding of debris indicates deposition on ice. Site, few meters above ground moraine, near Trins, (47° 04′ 19″ N Lat, 11° 23′ 40″ E Long), alt. 1240m, Tyrol. Coll. 1970 and subm. by F. Mayr. *Comment* (F.M.): sample perhaps somewhat younger than Type-Gschnitz-Moraine. But time-lag should be short, since retreat of Gschnitz glacier and melting of buried ice on steep S slope may not have taken too long.

**Sellrain Tal series, Tirol**

Samples from vicinity of St. Sigmund, Sellrain Tal, Tyrol; subm. by I. Neuwinger, Forstliche Bundesversuchsanstalt, Imst.

*General Comment* (I.N.): dates provide chronology for forest history.

**VRI-278. Paidaer Sonnberg** **930 ± 190**
**A.D. 1020**

Amorphous charcoal from burning horizon ca. 50cm below recent

A-horizon of iron-humus-podsol changed by use as pasture land. Undersized sample. Paidaer Sonnberg (47° 13′ N Lat, 11° 07′ E Long), 1950m. Coll. by G. Heiss.

**1680 ± 110**
**VRI-279. Haggener Sonnberg 1** **A.D. 270**

Charcoal from burning horizon 60cm below $O_f$ of iron-podsol on block heap. Haggener Sonnberg (47° 13′ N Lat, 11° 05′ 30″ E Long), ca. 1950m. Coll. by G. Heiss.

**VRI-280. Haggener Sonnberg 2** **Recent**

Root (*Pinus cembra*) ca. 20cm below recent A-horizon of iron-podsol changed by use as pasture land. Haggener Sonnberg (47° 12′ 20″ N Lat, 11° 06′ E Long), ca. 1800m. Coll. by W. Hensler.

**Untermieming series, Tirol**

Material from area gravel pit Untermieming (47° 17′ 50″ N Lat, 10° 58′ 39″ E Long), near Telfs, Inn Valley, Tyrol. Coll. 1970 and subm. by F. Mayr.

**VRI-237. Untermieming-See I** **Recent**

Wood from buried pine stumps, upright, 1 to 3m tall, 110 to 120m NNE of entry to pit, 5 to 7m below surface of alluvial cone. Unlike today, trees rooted in lenses of loamy sand only. Heartwood perfectly preserved; outer parts of stumps moldy. *Comment* (F.M.): submitter hoped for evaluation of long-range activity of an alpine alluvial cone.

**VRI-238. Untermieming-See II** **Recent**

Charcoal at base of fine sands overlying foot of alluvial cone near entry of pit. Sands form terrace ca. 2m high. *Comment* (F.M.): submitter hoped to date birth of lake at "See" and activity of alluvial cone, together with VRI-237.

**800 ± 80**
**VRI-327. Donau, Wien** **A.D. 1150**

Wood, −6 to −7m in canal shaft near crossing Mitterweg-Weissenböckstrasse, Vienna 11 (48° 10′ N Lat, 34° 27′ E Long). Coll. 1971 by Plachy; subm. by J. Fink, Geog. Inst., Univ. Vienna. *Comment* (J.F.): sample embedded between alluvial sediments and gravel zone of Prater terrace. Dates Prater terrace in this area and fine sediment accumulation by R. Danube.

*B. Germany, Greece*

**Törwang series, Bayern, Germany**

Samples from basin of Törwang in area of Samerberg-Gritschen (47° 44′ 53″ N Lat, 12° 11′ 53″ E Long), Bavaria, alt. 1630m. Coll. 1970 and subm. by F. Mayr.

*General Comment* (F.M.): in late glacial for ca. 1000 yr, basin had ice-dammed lake (moraines at Kirchwald, above Nussdorf). Waning of lake means end of piedmont glaciation in Inn R. basin of Bavaria.

**VRI-232. Samerberg-Gritschen I** **12,560 ± 190**
**10,610 B.C.**

Dwarf willow wood (e.g., *Salix herbacea*) from 1 to 3cm thick soil horizon 1.5m below present surface. *Comment* (F.M.): 1st late glacial vegetation in basin of Törwang.

**VRI-233. Samerberg-Gritschen II** **12,560 ± 190**
**10,610 B.C.**

Moss peat from 1 to 2cm thick peat band 30cm above dwarf willow horizon (VRI-232) separated by sand and colluvium. *Comment* (F.M.): short peat growth following last short expansion of Inn glacier.

**VRI-234. Samerberg-Gritschen III** **5420 ± 100**
**3470 B.C.**

Wood from root-stock (presumably *Juniperus* sp.) with strongly reduced parenchyma, id. by H. Hilscher, 0.5 to 0.7m below present surface. Sample from cluster of old and young root-stocks, tops of which were found 1m above oldest soil (VRI-232). Mud flows buried plants while growing and frost action disturbed bedding and thin soil as soon as plants died. *Comment* (F.M.): root-stocks date 1st settlement of Törwang basin by alpine dwarf shrubs. Suggested by VRI-232, submitter expected older age.

**VRI-326. Driskos, Greece** **27,000 ± 800**
**25,050 B.C.**

Pieces of fossil wood in undisturbed primary sedimentation in weathered siltstone of mud flow sealing slope to R. Arachthos, near Driskos (39° 40′ 40″ N Lat, 21° 00′ 00″ E Long), NE Greece. Sample from 40m below surface, 126m behind entrance of horizontal adit, alt. 430m. Coll. 1971 and subm. by G. Riedmüller, Inst. f. Bodenkde., Hochschule f. Bodenkultur, Vienna. *Comment* (G.R.): wood dates mud flow.

## II. ARCHAEOLOGIC SAMPLES

### *A. Austria*

**Attersee series, O.Ö.**

Wooden piles from bottom of Lake Attersee at depth 3 to 4m, Sta. Misling III, Gde. Unterach am Attersee (47° 49′ N Lat, 13° 30′ E Long), Upper Austria. Coll. 1970 and subm. by H. Offenberger, Bundesdenkmalamt, Vienna. Wood determined by J. Kisser.

*General Comment* (H.O.): no artifacts; possibly remnants of Neolithic settlement. Dates refute supposition.

**VRI-251. Misling III/1** **<400**

Hard wood (*Picea abies*) pile consisting of 5 rings. N part of Sta.

**VRI-252. Misling III/2** **<400**

Hard wood (*Abies alba*) pile consisting of 18 rings. Middle part of Sta.

**VRI-253. Misling III/3** **<450**

Hard wood (*Picea abies*) pile consisting of 7 rings. S part of Sta.

**Mondsee series, O.Ö.**

Wood piles from bottom of Lake Mondsee at depth 2 to 5m, Gde. Innerschwand, Mooswinkl (47° 48′ 50″ N Lat, 13° 23′ 40″ E Long), Upper Austria. Coll. 1970 and subm. by H. Offenberger. Wood determined by J. Kisser.

*General Comment* (H.O.): no artifacts; possibly remnants of Neolithic settlement.

**VRI-249. Mooswinkl 1** **<220**

Hard wood (*Picea abies*).

**4560 ± 100**
**VRI-250. Mooswinkl 2** **2610 B.C.**

Soft kneadable wood (probably *Populus*). *Comment* (H.O.): part of Neolithic lake dwelling.

**350 ± 110**
**VRI-254. Pichl-Auhof, Mondsee, O.Ö.** **A.D. 1600**

Wooden pile (*Picea abies*) from bottom of Lake Mondsee at depth 1 to 2m, Gde. Innerschwand, Pichl-Auhof (47° 48′ 55″ N Lat, 13° 24′ 15″ E Long), O.Ö. Coll. 1970 and subm. by H. Offenberger. *Comment* (H.O.): date disagrees with supposition of prehistoric settlement remnants.

*B. Turkey*

**2300 ± 90**
**VRI-222. Ephesos, Turkey** **350 B.C.**

Charred wood found together with fragments of ceramics and bones 10m below level (contact with underground water) beside place of archaic sacrifice of altar of temple of Diana (Artemis) in Ephesos (Bammer, 1966-67; Vetters, 1971) (37° 57′ N Lat, 27° 20′ 10″ E Long), Turkey. Coll. 1969 and subm. by A. Bammer, Österr. Archäolog. Inst., Univ. Vienna. *Comment* (A.B.): dating by ceramics points to middle of 6th century B.C. Origin of discrepancy unknown.

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# RUDJER BOŠKOVIĆ INSTITUTE RADIOCARBON MEASUREMENTS II

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The present list contains dates of samples measured since our previous list (R., 1971, v. 13, p. 135-140). As before, age calculations are based on the Libby half-life 5568 ± 30 yr, and reported in years before 1950. The modern standard is 0.950 of the activity of NBS oxalic acid, giving a net counting rate of 21.68cpm. The background count is measured by a series of inactive samples such as marble, anthracite, petroleum coke, and old natural methane. Background count of these samples give a mean value of 6.05cpm. It is observed that marble always gives the highest value of background count while natural methane gives the lowest. Results, however, are within ± 1 $\sigma$ of the mean value.

The reduction of nearly 3cpm in background count with respect to previous values listed in R., 1971, v. 13, p. 135-140 is obtained by adding a 10cm layer of low background lead (Mežice, Yugoslavia) around the guard counter and by increasing the gas pressure in the guard counter from 0.9 to 2atm. Also, an electronic shield consisting of a steel cabinet containing the counters, the preamplifiers, and the lead shield eliminated background variations caused by electric noise.

Before combustion, wood and charcoal were treated with 4% HCl and 4% NaOH. The counting method is essentially the same as described in R., 1971, v. 13, p. 135-140, using a 1.1L proportional counter at 3atm $CH_4$ pressure. Sample descriptions were prepared in collaboration with collectors and submitters. The errors quoted correspond to 1$\sigma$ variation of sample net counting rate and do not include the uncertainty in $C^{14}$ half-life. Data are not corrected for isotopic fractionation. The recent activity of speleothems (dripstones) is assumed to be 85% of modern samples; therefore 1305 yr has been subtracted from the radiocarbon age (Münnich and Vogel, 1959).

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## SAMPLE DESCRIPTIONS

### ARCHAEOLOGIC SAMPLES

### *A. Yugoslavia*

**281 ± 67**
**Z-164. Kupa near Karlovac** **A.D. 1669**

Fragment of wooden boat from muddy bed of Kupa R. near Karlovac (44° 50′ N Lat, 15° 23′ E Long), Croatia. Coll. 1970 and subm. by S. Janjić, Mus. Karlovac.

**95 ± 79**
**Z-204. Osor** **A.D. 1855**

Fragment of beam from sea near Osor, Cres I., Adriatic Sea (44° 40′ N Lat, 14° 20′ E Long). Coll. 1971 and subm. by V. Uranija, Mus. Zadar.

**2106 ± 69**
**Z-221. Punta sv. Ivana** **156 B.C.**

Wood from sand, 25m deep in sea, probably part of wooden ship, W of Viganj on Pelješac Peninsula (42° 59′ N Lat, 17° 6′ E Long), SE Croatia. Coll. 1971 and subm. by Ž. Rapanić, Archaeol. Mus., Split.

**1021 ± 65**
**Z-223. Bribir** **A.D. 929**

Wood from coffin containing human skeleton, found in Bribir near Skradin (43° 56′ N Lat, 15° 51′ E Long), S Croatia. Coll. 1972 and subm. by S. Gunjača, Inst. Natl. Archaeol., Split.

**237 ± 63**
**Z-224. Vučedol** **A.D. 1713**

Fragment of wooden boat (*Quercus*) from muddy bed of Danube R. 3km downstream from Vukovar (45° 20′ N Lat, 19° 00′ E Long), NW Croatia. Coll. 1972 and subm. by H. Malinar, Croatian Inst. Restoration, Zagreb.

**2386 ± 58**
**Z-217. Prozor** **A.D. 436**

Fragment of charred wooden board covering grave No. 44 at 80cm depth near Otočac (44° 50′ N Lat, 15° 10′ E Long), Lika, Croatia. Site was settlement of Japods, an Illyrian tribe. Buckle ornamented with amber found in same grave indicates late Iron period. Coll. 1971 and subm. by R. Dreksler, Archaeol. Mus., Zagreb.

**Bezdanjača series**

Wood and speleothems from Bezdanjača cave, Brakusova Draga near Vrhovine (44° 50′ N Lat, 15° 23′ E Long), Lika, Croatia. Cave is 1km long and 42 to 300m deep. Served as necropolis to Protojapodes. Wood subm. by R. Dreksler and H. Malinar and speleothem by M. Malez, Yugoslav Acad. Sci., Zagreb. Ceramics indicate middle Bronze age (1500 to 1300 B.C.), or late Bronze age (1300 to 1200 B.C.). Some wooden samples are sticks of circular or semicircular sec. (branchlets) ca. 20cm long found around fireplaces and probably served as torches; others are more or less flat, dressed sticks ca. 20cm long with sharpened and partly burned tips, found close to skeletons and probably served in funeral rites. Analysis of wooden sticks made by B. Petrić and V. Ščukanec, Fac. Forestry, Univ. Zagreb.

**Z-174. Bezdanjača 1** — **3351 ± 77**; **1401 B.C.**

Ceremonial torches from niche of main gallery of cave 72m from entrance.

**Z-186/I. Bezdanjača 2** — **2986 ± 75**; **1036 B.C.**

Decayed short sticks (*Corylus* spp. *Betulaceae, Fraxinus* spp. *Oleaceae*) from Grave 21, Block 24. *Comment*: date suggests contamination with recent organic matter.

**Z-186/II. Bezdanjača 3** — **3299 ± 61**; **1349 B.C.**

Ceremonial torches (*Pinus sylvestris*), Grave 21, Block 24.

**Z-191/I. Bezdanjača 4** — **2229 ± 75**; **279 B.C.**

Stalagmite core deposited on pottery in Grave 21, Block 24 at same place as Z-186/II.

**Z-191/II. Bezdanjača 5** — **1275 ± 70**; **A.D. 675**

Outside layer of stalagmite deposited on pottery.

**Z-219. Bezdanjača 6** — **3060 ± 58**; **1110 B.C.**

Partly burned wooden sticks, Grave 19, Block 23.

**Z-220. Bezdanjača 7** — **2867 ± 75**; **917 B.C.**

Wooden construction near fireplace, Block 1.

**St. Donat series**

Wooden beams (*Quercus*) from gallery floor in St. Donat church, Zadar, SE Croatia (44° 5′ N Lat, 15° 15′ E Long). Only well-preserved beams with 110 to 120 tree rings which could be easily counted were drilled out, each containing 10 to 20 tree rings as indicated below. Samples subm. 1970 by Ksenija Radulić, Inst. Preservation Cultural Monuments, Zadar. B. Bersa and C. Iveković think St. Donat church was erected in 6th century, V. de Ponte and K. Bulić believe in the 9th century (Petricioli, 1962).

**Z-177. St. Donat** — **1389 ± 60**

Tree rings 0 to 20.

**Z-178. St. Donat** **1400 ± 62**

Tree rings 0 to 10.

**Z-178/I. St. Donat** **1302 ± 67**

Tree rings 90 to 100.

*General Comment*: based on mean value estimated by weighted means of the 3 samples, trees were in cut A.D. 695 ± 55. It was assumed that 30 ± 10 tree rings of sapwood were cut away during shaping of beams. This would be earliest date that beams could be used for construction of gallery floor. However, the possibility exists that wood was stored for some years or that it was used in another building and built into St. Donat church afterwards.

**Stobi series**

Charcoal (except at noted) from Stobi, at junction of Crna R. with Vardar R., S of Titov Veles, Macedonia, (41° 33′ N Lat, 21° 59′ E Long). Site dates from late Roman times and earlier. Except where noted, samples were coll. by hand and put in polyethylene bags for storage. Coll. 1971 and subm. by J. R. Wiseman and E. M. Davis, Stobi Excavations, Naroden Muzej, Titov Veles, Yugoslavia, and Classics Dept., Univ. Texas, Austin. Many of these samples are also being dated by Univ. Texas lab. Dates will be discussed elsewhere, (Wiseman and Mano-Zissi, in press).

**1611 ± 69**

**Z-207. Stobi R-71-3** **A.D. 339**

Episcopal basilica, S stairway, W extension; above Steps 2, 3, 4 of S stairway, alt. 146.89 to 147.39m. Later than final destruction of building.

**1779 ± 66**

**Z-216. Stobi R-71-14A** **A.D. 171**

W cemetery, S trench, N and E parts; from zone resting on Wall 8, alt. 148.97 to 149.22m, with abundant pottery of 1st and 2nd centuries A.D. Stored damp in polyethylene bag for 3 weeks, then dried.

**1836 ± 68**

**Z-213. Stobi R-71-15** **A.D. 114**

Nuts; W cemetery, S trench, from fill in E end of Grave 21, assoc. with bulbous unguentarium, probably 1st century A.D. Wrapped in tissue, placed in polyethylene bag: tissue removed 3 weeks later.

**1769 ± 69**

**Z-212. Stobi R-71-33** **A.D. 153**

House of the Fuller; charred beam in destruction layer on highest of 4 floors, final destruction of building; alt. 149.25 to 149.66m. Ceramics late 4th century. Coll. by hand into tray, moist; transferred to polyethylene bag, left open for 6 weeks in basement lab.

**Z-210. Stobi R-71-34** **1883 ± 72**
**A.D. 67**

W cemetery, fill of Grave 82, from early history of cemetery.

**Z-206. Stobi R-71-35** **1877 ± 65**
**A.D. 73**

W cemetery, fill of Grave 57, early in history of cemetery, A.D. 150 or earlier.

**Z-215. Stobi R-71-36** **1619 ± 65**
**A.D. 331**

Acropolis, Trench 1, from destruction debris in Room 4; probably a roof beam. Should date end of last occupation in this part of site. Ceramics and coins indicate 5th or possibly 6th century A.D.

**Z-205. Stobi R-71-37** **1619 ± 66**
**A.D. 331**

Episcopal basilica, S stairway, NE area of E Ext. 5; from Wall #5 to and beyond Wall #13. Burned timber from final layer of destruction fill in this area above latest earth floor; alt. 143.37 to 143.98m.

**Z-211. Stobi R-71-38** **1759 ± 61**
**A.D. 191**

Episcopal basilica, baptistry; from deposit above NE and NW parts of mosaic floor encircling piscina. Alt. 143.15 to 143.39m.

*B. Paleolithic and Mesolithic of Central and Eastern Europe*

**Z-188. Strmica** **33,540 ± 1830**
**31,190 B.C.**

Bone collagen from Strmica (44° 10′ N Lat, 16° 20′ E Long), 12km N of Knin, SE Croatia, in valley of Butišnica R. Coll. 1971 and subm. M. Malez, Yugoslav Acad. Sci., Zagreb.

**Z-189. Velika Pećina Cave, Layer *g*** **27,300 ± 1200**
**25,350 B.C.**

Charcoal from hearth in Layer *g* from Velika Pećina Cave near Veliki Goranec (46° 17′ 10″ N Lat, 16° 02′ 22″ E Long) near Ravna Gora, NW Croatia. Layer contains bones and teeth of Pleistocene animals and flint and bone artifacts of Aurignacian industry. Coll. 1970 and subm. by M. Malez. *Comment* (M.M.): results agree well with earlier analysis of layers *e* (GrN-4980) and *c* (GrN-4990) (Malez and Vogel, 1970).

**Z-190. Mali Bukovac** **257 ± 59**
**A.D. 1693**

Soil with charcoal pieces in Layer *a* from Mali Bukovac rock shelter on Sleme near Lokve (45° 21′ N Lat, 12° 25′ E Long), Gorski Kotar, W Croatia. Layer contains bones of recent animals. Coll. 1970 and subm. by M. Malez. *Comment* (M.M.): date as expected.

**Z-193. Šandalja** **20,750 ± 400**
**18,800 B.C.**

Charcoal grains mixed with clay in Layer c/d from cave in Šandalja limestone quarry, (44° 52′ 57″ N Lat, 13° 53′ 48″ E Long), 4km E of Pula, Istra, W Croatia. Layer contains teeth and bones of Pleistocene animals and flint artifacts attributed to Gravettian culture. Coll. 1970 and subm. by M. Malez. *Comment*: dates agree well with results of Layer *b* GrN-4978: 12,320 ± 100, and Layer *e* GrN-5013: 23,450 ± 180 (R., 1972, v. 14, p. 66), of same site.

**Z-195. Podosojna Cave** **2833 ± 72**
**883 B.C.**

Charcoal grains mixed with soil from Layer *d* in Podosojna Cave SE of Detani village near Mošćenička Draga (45° 15′ N Lat, 14° 14′ E Long) Istra, W Croatia. Layer contains prehistoric ceramics. Coll. 1970 by J. Radovčić, Yugoslav Acad. Science, Zagreb, subm. by M. Malez. *Comment* (M.M.): expected age ~ 4000 yr.

**Z-196. Medvjedja pećina** **25,745 ± 670**
**23,795 B.C.**

Fragment of speleothem; part of Layer *b* from Bukovac cave on Sleme near Lokve (45° 20′ 30″ N Lat, 12° 25′ 17″ E Long) Gorski Kotar. Coll. 1971 and subm. by M. Malez. *Comment* (M.M.): date as expected.

**Z-198. Podosojna** **6470 ± 95**
**4250 B.C.**

Charcoal grains mixed with soil under Layer *f*(g) in Podosojna Cave SE of village Detani near Mošćenička Draga (45° 15′ N Lat, 14° 14′ E Long) Istra. Layer contains prehistoric ceramics. Coll. 1970 and subm. by J. Radovčić.

**Veternica series**

Veternica Cave is 700m N of Gornji Stenjevec near Zagreb (45° 50′ 36″ N Lat, 13° 32′ 24″ E Long), NW Croatia. Four samples are from 2 vertical profiles of compact speleothem forming Layer *c*. Distance between profiles is ca. 8m. Sample Z-194 is from top, and Z-201 from bottom of 1st profile of speleothem, 70cm thick here, and forms uppermost layer in this region of cave. Sample Z-218/II is from top, Z-218/I from bottom of 2nd profile of the same speleothem, which is here only 10cm thick and covered with 40cm thick Layers *a* and *b*. Coll. 1971 and subm. by M. Malez.

**Z-194. Veternica 1** **4655 ± 90**
**2705 B.C.**

Fragment of speleothem (Layer *c*, top). *Comment* (M.M.): expected age: 3000 to 5000 B.C.

**Z-201. Veternica 2** **12,355 ± 180**
**10,405 B.C.**

Fragment of speleothem (Layer *c*, bottom).

**Z-218/I. Veternica 3** **11,095 ± 150**
**9145 B.C.**

Fragment of speleothem (Layer *c*, bottom).

**Z-218/II. Veternica 4** **4495 ± 80**
**2545 B.C.**

Fragment of speleothem (Layer *c*, top).

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