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# RADIOCARBON

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YALE UNIVERSITY
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# RADIOCARBON

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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 17, no. 3 must be submitted in *duplicate* before February 1, 1975, for vol 18, no. 1 before June 1, 1975.

*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 (eg, 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 BP (before present, ie, before AD 1950) and, for finite dates, in years AD/BC. 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), years, vol, and specific page (eg, 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 of 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, *eg*, chemical pretreatment, special laboratory difficulties, etc.

*Illustrations* should not be included unless absolutely essential. They should be original drawings, although photographic reproductions of line drawings are sometimes acceptable, and should accompany the manuscript in any case, if the two dimensions exceed 30cm and 23cm.

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* Suggestions to authors of the reports of the United States Geological Survey, 5th ed, Washington, DC, 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 BP the accuracy of the dates is limited, and refinements that take some but not all uncertainties into account may be misleading. The mean of three recent determinations of the half life, 5730 ± 40 yr, (**Nature,** v 195, no. 4845, p 984, 1962), is regarded as the best value presently available. Published dates in years BP, can be converted to this basis by multiplying them by 1.03.

**AD/BC dates.** As agreed at the Cambridge Conference in 1962, AD 1950 is accepted as the standard year of reference for all dates, whether BP or in the AD/BC 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 editors as well as by authors, and recent papers have used $\delta^{14}C$ as the **observed** deviation from the standard. At the New Zealand Radiocarbon Dating Conference it was recommended to use $\delta^{14}C$ only for age-corrected samples. Without an age correction, the value should then be reported as percent of modern relative to 0.95 NBS oxalic acid. (Proceedings 8th Conference on Radiocarbon Dating, Wellington, New Zealand, 1972.)

In several fields, however, age corrections are not possible. $\delta^{14}C$ and $\Delta$, uncorrected for age, have been used extensively in oceanography, and are an integral part of models and theories. For the present therefore we continue the editorial policy of using $\Delta$ notations for samples not corrected for age.

**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 US per copy.

**Publication schedule.** Beginning with Volume 15, RADIOCARBON is published in three numbers: Winter, Spring, and Summer. The next deadline is February 1, 1975. 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 now appears 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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Vol 17, No. 1 Radiocarbon 1975

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# Radiocarbon

*1975*

## INSTITUT ROYAL DU PATRIMOINE ARTISTIQUE RADIOCARBON DATES V

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Institut Royal du Patrimoine Artistique, Brussels, Belgium

This list includes the results of measurements made during 1972-73.

### SAMPLE DESCRIPTIONS

#### I. GEOLOGIC SAMPLES

**3720 ± 150**
**IRPA-137. Vlissegem** **1770 BC**

Ground water from Vlissegem, W Flanders, Belgium (51° 14′ 23″ N, 3° 07′ 03″ E), at 20m depth. Coll 1973 by W De Breuck, Univ Ghent, Belgium.

**3480 ± 220**
**IRPA-138. Adinkerke** **1530 BC**

Ground water from Adinkerke, W Flanders, Belgium (51° 04′ 25″ N, 2° 33′ 23″ E), at 25m depth. Coll 1973 by W De Breuck.

*General Comment*: $CO_2$ extraction from water samples is described in R, v 15, p 304. Dates used to study ground water formation in W Flanders.

**Wortel series**

Five samples of peat from Wortel, prov Antwerp, Belgium (51° 23′ 58″ N, 4° 47′ 24″ E). Coll 1973 by J Geys, Univ Antwerp, Belgium.

**2335 ± 125**
**IRPA-143.** **385 BC**

1m depth.

**6225 ± 260**
**IRPA-144.** **4275 BC**

3m depth.

**8215 ± 280**
**IRPA-145.** **6265 BC**

4m depth.

**9055 ± 315**
**IRPA-146** **7105 BC**

5m depth.

**9320 ± 320**
**IRPA-147.** **7370 BC**

6m depth.

*General Comment* (JG): dates used for stratigraphic study of peat formation.

**Uitbergen series**

Samples from Uitbergen, E Flanders, Belgium (51° 2′ N, 3° 58′ E). Coll 1973 by G De Moor, Univ Ghent, Belgium.

**IRPA-148.** **23,765 ± 450**
**21,815 BC**

Peat at 6.9m depth.

**IRPA-149.** **7955 ± 245**
**6005 BC**

Calcareous clay at 2m depth. No pretreatment because sample was too porous.

**IRPA-150.** **21,115 ± 450**
**19,165 BC**

Piece of wood at 7.5m depth.

*General Comment* (GdeM): dates used for stratigraphic study. Results agree with palynologic analysis.

II. ARCHAEOLOGIC SAMPLES

**IRPA-131. Kruishoutem** **4035 ± 190**
**2085 BC**

Charcoal from Kruishoutem, E Flanders, Belgium (50° 52′ N, 3° 25′ E). Coll 1972 by Y Van Wambeke, subm by M Rogge, Univ Ghent. *Comment* (MR): from cremation grave of Bell Beaker culture (De Laet and Rogge, 1972). In this country the Bell Beaker culture is the 3rd of Neolithic cultures. Dates agree with GrN-2419, -3097, -2158, and -2481 (R, 1963, v 5, p 177, 178).

**IRPA-132. Spy** **22,105 ± 500**
**20,155 BC**

Burned bones from Spy, prov Namur, Belgium (50° 28′ N, 4° 41′ E). Subm 1972 by F Twiesselman, Inst Royal Sci nat, Belgium. Collagen extraction is described by Longin (1970). *Comment*: result used to date archaeologic layer.

**IRPA-134. Ucimont** **1870 ± 90**
**AD 80**

Piece of tree trunk from Ucimont, prov Luxembourg, Belgium (49° 49′ 48″ N, 5° 3′ E). Subm 1972 by F Twiesselman. *Comment*: result used to date layers of Semois R bed.

**Pessinus series**

Two samples from Roman excavations at Pessinus, Ballihisar, Eskisehir, Turkey (39° 20′ N, 31° 35′ E). Subm by G Stoops, Geol Inst, Univ Ghent, Belgium.

**1315 ± 70**
**IRPA-135.** **AD 635**

Charcoal from upper floor of house, at 2m depth. Archaeologic date: Byzantine period.

**2020 ± 100**
**IRPA-136.** **70 BC**

Burned corns from floor of stoa (market place) covered with calcareous colluvial material. Sample was in wall of store well.

*General Comment* (GS): dates must be compared with IRPA-126, -127. IRPA-127 dates beams used to erect the stoa while IRPA-126 dates destruction by fire. Archaeologic date: 1st or 2nd century.

**1600 ± 85**
**IRPA-142.** **AD 350**

Wood from Ostende, W Flanders, Belgium (51° 12′ 14″ N, 2° 51′ 07″ E). Coll 1973 by H Thoen, Univ Ghent, Belgium. *Comment*: found on beach at low tide. Piece of a pile of wooden construction. Date used to study Roman habitation of coastal region. Archaeologic date: 1st to 3rd centuries.

### References

Dauchot-Dehon, M and Heylen, J, 1973, Institut royal du Patrimoine artistique radiocarbon dates IV: Radiocarbon, v 15, p 303-306.

De Laet, S J and Rogge, M, 1972, Une tombe à incinération de la civilisation aux gobelets campaniformes trouvée à Kruishoutem (Flandre Orientale): Helinium, v 12, no. 3, p 210-224.

Longin, R, 1970, Extraction du collagène des os fossiles pour leur datation par la méthode du carbone-14: Thesis, Fac Sci, Univ Lyon, France.

Vogel, J C and Waterbolk, H T, 1963, University of Groningen radiocarbon dates IV: Radiocarbon, v 5, p 163-202.

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# LYON NATURAL RADIOCARBON MEASUREMENTS V

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## INTRODUCTION

This list includes most of the samples measured from June 1972 to December 1973 and some other results as yet unpublished.

Chemical treatment of samples and counting technique remain as described previously (R, 1973, v 15, p 134). To improve liquid scintillation counting, a 5cm lead shield was set around the photomultipliers of the spectrometer; background was reduced from 6.2 to 3.6cpm for the 4ml samples (3ml benzene and 1ml scintillating toluene). With these counting conditions the practical limit of dating is 40,000 $^{14}C$ years.

Ages are calculated, using 1950 as reference year, and the half-life value 5570, but it has not been thought useful to adjoin the conventional ± 30 years uncertainty to this value. Statistical errors, corresponding to one standard deviation, include contemporary standard, background, and sample counts.

No age corrections were made, either from the $\delta^{13}C$ values or from the calibration tables of dendrochronology.

## ACKNOWLEDGMENTS

We thank Yvette Durand and Bertrand Leroux for chemical preparation and most routine operations. We are grateful to J Flandrin, the professors of the Dept of Geology, for their continuous support, and to A Sarazin and staff of the Nuclear Physics Institute for their help and technical assistance.

## SAMPLE DESCRIPTIONS

### I. GEOLOGIC SAMPLES

*A. Wood samples from fluvial sediments: France and Switzerland*

**Modern**

**Ly-680. Saint-Romain de Surieu, Isère** **$\delta^{14}C = -0.6\% \pm 1.4\%$**

Wood from 2.5m depth in alluvia of La Saune R, near Saint-Romain de Surieu, Isère (45° 23′ N, 4° 52′ E). Coll 1971 by G Margeriat, subm 1971 by G Montjuvent, Inst Dolomieu, Grenoble. *Comment* (GM): date of beginning of postglacial was expected. Date proves that, despite aspect of wood, alluvium of river valley may be due to a recent flood.

**780 ± 120**

**Ly-754. Les Chères, Rhône** **AD 1170**

Wood from 2m depth in low terraces of Azergue R near Les Chères, Rhône (45° 58′ N, 5° 07′ E). Coll and subm 1972 by M Mandier, Dept Geog, Univ Lyon II. *Comment* (MM): low terrace was thought to be Late Würm. Date proves it still remains in alluvial phase.

**Ventalon series, Brognon, Côte d'Or**

Fragments of big tree trunks from several depths in Ventalon quarry near Brognon, Côte d'Or (47° 24′ N, 5° 09′ E). Coll and subm 1972 by A Clair, Dir Agric Dijon, and J J Puissegur, Univ Dijon.

**Ly-694. Ventalon 1** — **2020 ± 130** / **70 BC**

**Ly-755. Ventalon 2** — **2230 ± 130** / **280 BC**

**Ly 756. Ventalon 3** — **2650 ± 120** / **700 BC**

**Ly-757. Ventalon 4** — **2300 ± 130** / **350 BC**

*General Comment* (AC & JJP): expected age: 8000 BP corresponding to Boreal sedimentation phase (Clair *et al*, 1972). Date indicates Sub-Atlantic sedimentation phase that filled ancient channels dug at end of Sub-Boreal erosion phase.

**Ly-691. Etang de Fung, La Gardette, Puy de Dôme** — **3430 ± 100** / **1480 BC**

Charred wood from boring in volcanic sands in Fung Pond near Ceyssat, Puy de Dôme (45° 46′ N, 2° 52′ E). Coll 1971 and subm 1972 by D Baudry Bureau Recherches Géol Min, Clermont-Ferrand. *Comment*: date is minimum for eruption of extinct volcano in Les Puys chain. Another date on same site: Gif-2349: 3890 ± 110 BP (R, 1974, v 16, p 72).

**Saint-Cernin de Larche series, Corrèze**

Wood from 2 layers in La Couze R alluvia, near Saint-Cernin de Larche, Corrèze (45° 6′ N, 1° 25′ E). Coll and subm by P Morin, Service Régional Aménagement des eaux du Limousin, Limoges.

**Ly-753. Saint-Cernin de Larche $S_1$** — **2560 ± 130** / **610 BC**

Elm from soil in upper layer, 2.5m depth. Coll 1972. Assoc with pottery presumed Gallo-Roman.

**Ly-752. Saint-Cernin de Larche $I_{71}$** — **2510 ± 120** / **560 BC**

Elm from either upper or lower layer. Coll 1972.

**Ly-857. Saint-Cernin de Larche $I_{71b}$** — **5570 ± 140** / **3620 BC**

Oak from lacustrine horizon in a lower layer, 7.0m depth. Coll 1973, assoc with bones.

*General Comment* (PM): Ly-752 is contemporaneous with Ly-753 and, as expected, probably is from same layer; both dates agree with assoc industry. The difference between Ly-857 and -753, if sedimentation in valley was uninterrupted and regular, gives a maximal age ca 11,000 BP for lowest layer, 14m depth. Thus valley filling probably started at beginning of postglacial.

**Ly-785. Aramon, Gard** **5950 ± 130 3000 BC**

Wood from 17m depth in boring in Rhône R alluvia near Aramon, Gard (43° 53′ N, 4° 40′ E). Coll and subm 1973 by P Deletie, Elec France, Paris. *Comment* (PD): indicates deposition rate at base of low valley of Rhône R.

**Ly-687. Vals BU 1, Glarus, Switzerland** **2480 ± 110 530 BC**

Charred wood from 1m depth in argillaceous schist "Bündner-shiefer", at Vals, Glarus, Switzerland (47° 38′ N, 9° 13′ E). Coll 1971 by W Büchi and subm 1972 by R Vivian, Inst Géog alpine, Grenoble. *Comment* (RV): date should confirm destruction of an ancient forest by fires of local legends.

*B. Wood samples from glacial sediments: France and Switzerland*

**Taillefer series, Isère**

Fragments of tree trunk exposed above today's timberline. Coll 1971 by R Dupuy and subm 1971 by R Vivian.

**Ly-586. Taillefer Brouffier V3** **Modern $\delta^{14}C = -1.8\% \pm 1.9\%$**

From shore of Brouffier lake near La Morte, Isère (45° 02′ N, 5° 53′ E).

**Ly-588. Taillefer Prévourey V6** **Modern $\delta^{14}C = +0.1\% \pm 1.4\%$**

From alt ca 2000m near Prévourey lake, Le Crau, Isère (45° 02′ N, 5° 53′ E).

**Ly-587. Taillefer Fourchu V5** **8240 ± 190 6290 BC**

From alt 2070m in basal mud of lake near Livet-Garet, Isère (45° 03′ N, 5° 56′ E).

*General Comment* (RV): date ca AD 1200 was expected for the 3 samples corresponding to the last warming phase, just preceding the "Little Ice Age". Dates show that Ly-587 is ancient and corresponds to 1st rise of timberline after glacial time. A similar warming period was previously dated in Switzerland at Gorner Glacier: Ly-298, 8160 ± 220 BP (R, 1973, v 15, p 135) and at Arolla: Ly-749, below.

**Glacier de Ferpècle series, Valais**

Wood from above present timberline near Ferpècle Glacier, Valais. Coll 1971 by F Rothlisberger and subm 1971 by R Vivian.

**2450 ± 200**
**Ly-611. Ferpècle Glacier Fe7** **500 BC**

From ancient bed of outlet river of Ferpècle Glacier at alt 1975m (46° 02′ N, 7° 42′ E).

**520 ± 200**
**Ly-612. Ferpècle Glacier Fe10** **AD 1430**

From a stump in rocks above terminal ice tongue of Ferpècle Glacier at alt 2140m (46° 02′ N, 7° 42′ E).

**5340 ± 250**
**Ly-683. Ferpècle Glacier Fe9** **3390 BC**

From bog at alt 1730m, 1m under a rockfall near Ferpècle Glacier (46° 04′ N, 7° 42′ E).

*General Comment* (RV): as with Ly-299: 6950 ± 150 BP (R, 1973, v 15, p 135) from the same glacier, dates may correspond to warming phases involving a large ice-retreat and rise of timberline.

**Arolla series, Valais**

Fragment of tree trunk from margins of Arolla Glacier, Valais. Coll 1971 by F Rothlisberger and subm 1971 by R Vivian.

**Modern**
**Ly-610. Arolla Ar3** **$\delta^{14}C = -2.8\% \pm 2.5\%$**

Tree trunk with root from gravel pit downstream from Arolla Glacier (45° 59′ N, 7° 54′ E).

**8400 ± 200**
**Ly-749. Arolla Ar4** **6450 BC**

From 10m depth in a moraine of Arolla Glacier at alt 1920m (46° 04′ N, 7° 54′ E).

*General Comment* (RV): Ly-610 shows recent postglacial burial. Ly-749 belongs to oldest warming phase previously dated at Gorner Glacier: Ly-298, 8160 ± 220 BP (R, 1973, v 15, p 135).

**4840 ± 150**
**Ly-613. Gorner Glacier Ze1** **2890 BC**

Fragment of tree trunk from Gorner Glacier near Zermatt, Valais (45° 59′ N, 7° 44′ E). Coll 1971 by F Rothlisberger and subm 1971 by R Vivian. *Comment* (RV): this 3rd warming phase (see Ly-297: 7360 ± 180 BP and Ly-298: 8160 ± 220 BP (R, 1973, v 15, p 135) may also be compared with Ly-683, above. These 2 series indicate at least 5 warming periods: ca 8000, 7000, 2500, and 500.

**Zmutt-Zermatt series, Valais**

Fragments of tree trunk from the Zmutt Glacier moraine near Zermatt, Valais (45° 59′ N, 7° 40′ E), coll 1969 by M Bezinge Grande Dixence Sté and subm 1971 by R Vivian.

**1550 ± 100**
**Ly-682. Zmutt V2** **AD 400**

On surface of moraine.

**Ly-681. Zmutt V1** **7590 ± 180**
**5640 BC**

From 5m depth in frontal moraine.

*General Comment* (RV): Ly-682 dates warmest phase of historic times. Ly-681 indicates one of oldest warm phases; both dates agree with Dansgaard's $^{18}O/^{16}O$ curves from Greenland.

**Ly-684. Mont-Miné Fe8, Valais** **Modern**
**$\delta^{14}C = +0.7\% \pm 1.4\%$**

Fragments of tree trunk from surface of moraine above Mont-Miné Glacier, Valais (46° 02′ N, 7° 42′ E). Coll 1971 by F Rothlisberger and subm 1971 by R Vivian. *Comment* (RV): younger than expected, does not indicate climatic variations.

**Ly-750. Tsidjore Nouve Tn 1b, Valais** **2940 ± 150**
**990 BC**

Fragment of tree trunk from inside moraine of Tsidjore Nouve Glacier, Valais (46° 01′ N, 7° 54′ E). Coll 1971 by F Rothlisberger and subm 1971 by R Vivian. *Comment* (RV): as for Ly-685, expected age was ca AD 1200; *ie,* just before the "Little Ice Age". But date indicates unknown period of rise of the timberline towards 3000 BP, which may be due only to local conditions.

**Ly-685. Evolène Fe II, Valais** **3360 ± 230**
**1410 BC**

Fragment of tree trunk from alt 2075m in moraine of Ferpècle Glacier near Evolène, Valais (46° 07′ N, 7° 32′ E). Coll 1971 by F Rothlisberger and subm 1971 by R Vivian. *Comment* (RV): see Ly-750, above.

**Ly-686. Furé Go 5c & 2a, Valais** **1000 ± 90**
**AD 950**

Charred wood from alt 1910m at Furé near Zermatt, Valais (45° 59° N, 7° 44′ E). Coll 1971 by F Rothlisberger and subm 1971 by R Vivian. Assoc with polished stone artifact at 120cm depth. *Comment* (RV): much younger than expected.

*C. Samples from periglacial sediments: France*

**Migennes series, Yonne**

Clayey silt with humic matter from loessic formation at Migennes, Yonne (47° 58′ N, 3° 21′ E). Coll and subm 1972 by P L Vincent and M Chateauneuf, Bureau Recherches Géol Min, Orléans, and J Evin. Outcrop had been exposed before sampling but no special precautions were taken, *ie,* no superficial scratching, and no special chemical treatment given.

**Ly-696. Limon de Migennes, Reliquat** **23,950 ± 750**
**22,000 BC**
*$\delta^{13}C = -22.5‰ \pm 0.1‰$*

**Ly-695. Limon de Migennes, Extra** **25,400 ± 600**
**23,450 BC**
$\delta^{13}C = -22.6‰ \pm 0.1‰$

25% inactive carbon.

*General Comment* (PLV & JE): good agreement between Extra and Reliquat results should prove that, despite exposure to pollution, no recent humus was in sample. Such a formation is attributed to an interstadial phase, as also suggested by malacology. However, dates correspond to a cold phase of Würm III, either the organic matter is secondary or climatic attributions are erroneous.

**Ly-769. Vautubière N 3-10, Bouches du Rhône** **31,900 +1900 −1500**
**29,950 BC**

Charcoal from Level 10 in Coudoux quarry in Vautubière valley near Lançon, Bouches du Rhône (43° 34′ N, 5° 13′ E). Coll and subm 1972 by P Ambert, Lab Géog, Univ Aix-Marseille II. *Comment* (PA): indicates beginning of Würm III, agreeing with expected age. Level 10 underlies colluvium of wind deposits attributed to coldest phase of Würm III, and overlies a similar horizon including a fauna attributed to early Würm.

*D. Peat-bog samples: France*

**Ly-795. Bramabiau 140-145, Gard** **2160 ± 120**
**210 BC**

Peat from 140 to 145cm depth in Bramabiau peat bog near Campriaux, Gard, Aigoual Massif (44° 07′ N, 3° 28′ E). Coll 1972 and subm 1973 by J L de Beaulieu, Lab Bot Hist, Univ Marseille III. *Comment* (JL de B): pollen diagram marks large decline of tree pollens just above the level; site is near a Gallo-Roman sta. As expected, date indicates deforestation occurred at beginning of Roman occupation in region.

**Ly-796. Mantals, Gard** **2820 ± 130**
**870 BC**

Peaty-clayey sand coll at 2.6m depth by "Couteau" drill in Mantals peat bog near l'Espérou, Gard, Aigoual Massif (44° 03′ N, 2° 33′ E). Coll 1972 and subm 1973 by J L de Beaulieu. *Comment* (JL de B): previous study (Firbas, 1932) attributed beginning of growth of peat bog to early Holocene. Pollen diagram and date indicate that it began at end of Sub-Boreal.

**Baïssescure 572 series, Hérault**

Peat from boring in Baïssescure peat bog, near Murat sur Vèbre, Hérault (43° 33′ N, 2° 48′ E). Coll and subm 1972 by J L de Beaulieu.

**Ly-777. Baïssescure 572, 100 to 105cm** **4720 ± 150**
**2770 BC**

Brown peat from 100 to 105cm depth, beginning of *Fagus*.

**Ly-778. Baïssescure 572, 120 to 125cm** **6010 ± 160** **4060 BC**

Brown peat from 120 to 125cm depth, maximum of *Quercus.*

**Ly-779. Baïssescure 572, 160 to 170cm** **7250 ± 190** **5300 BC**

Clayey peat from 160 to 170cm depth, *Quercus* and maximal frequency of *Corylus.*

*General Comment* (JL de B): sample coll 1967 by boring at 140cm depth gave Gif-1104: 6000 ± 250 BP (R, 1971, v 13, p 235). New dates and pollen diagram indicate hiatus in the 1967 boring and explain excessively old dates attributed to Atlantic period (de Beaulieu, 1969). The 3 agree with results from peat bogs at Lacaune in Mont de Lacaune, Tarn (de Beaulieu and Evin, 1972) and at Roudil in Montagne Noire, Tarn: Ly-583, 4220 ± 130 BP (R, 1973, v 15, p 514).

**Clapeyret 869 series, Alpes Maritimes**

Peat from Clapeyret peat-bog in Mercantour massif near Le Boréan, Alpes Maritimes (44° 09′ N, 7° 14′ E). Coll 1969 and subm 1972 by J L de Beaulieu.

**Ly-776. Clapeyret 869, 40 to 45cm** **3460 ± 120** **1510 BC**

Retreat of forest, slight rise of *Fagus.*

**Ly-774. Clapeyret 869, 60 to 65cm** **3850 ± 130** **1900 BC**

Maximum of *Abies,* and beginning of continuous curves of *Picea.*

**Ly-775. Clapeyret 869, 65 to 67.5cm** **3750 ± 140** **1800 BC**

Same as Ly-774.

**Ly-773. Clapeyret 869, 90 to 95cm** **4720 ± 140** **2770 BC**

End of continuous curve of *Ulmus* and *Tilia.*

*General Comment* (JL de B): generally agrees with expected dates. There is no other result for this period in region.

**Le Forest 972 series, Hautes Alpes**

Peat from several depths coll by "Couteau" drill in Le Forest peat bog near Saint-Etienne en Dévoluy, Hautes Alpes (44° 38′ N, 5° 57′ E). Coll and subm 1972 by J L de Beaulieu.

**Ly-782. Le Forest 972, 30 to 40cm** **8310 ± 180** **6360 BC**

30 to 40cm above reference level, beginning of *Abies.*

**Ly-781. Le Forest 972, 10 to 20cm** **9220 ± 220** **7270 BC**

10 to 20cm above reference level; maximal frequency of *Pinus.*

**Ly-780. Le Forest 972, 0 to 10cm** **10,850 ± 300**
**8900 BC**

0 to 10cm below reference level.

*General Comment* (JL de B): considering statistical range, Ly-780 agrees with attribution to Dryas III phase by sedimentology (clay with cold flora) ca 10,500 BP. Ly-781 agrees with Pre-Boreal phase attribution. Ly-782 shows an early appearance of *Abies,* at least 500 yr earlier than in other peat bog.

*E. Bone samples from open air sites: France, Switzerland, and Germany*

**Ly-722. Rue d'Ypres Lyon, Rhône** **Modern**
**$\delta^{14}C = -5.5\% \pm 4.3\%$**

Bovid bones found in Ypres St, Lyon, Rhône (45° 47′ N, 4° 51′ E). Coll by M Blazin and subm 1972 by C Guérin, Geol Dept, Univ Lyon 1. *Comment* (CG): bones were assoc with Würm loess, but date proves that they represent burial.

**Ly-651. Entrechaux, Vaucluse** **Modern**
**$\delta^{14}C = +0.9\% \pm 2.2\%$**

Mammal bones from pit in sandstone at Entrechaux, Vaucluse (44° 12′ N, 5° 08′ E). Coll and subm 1972 by M Philippe, Hist Nat Mus Lyon. 50% dead carbon added. *Comment* (MP): fairly old date or ca 2000 BP was expected due to presence of many Roman remains in region. Result remains unexplained. The scarcity of collagen preserved in bones may be due, as usual, to the acid pH of the siliceous ground.

**Ly-492. Mammouth du Garon** **3150 ± 240**
**200 BC**
*$\delta^{13}C = -3.4‰ \pm 0.1‰$*

Carbonaceous fraction of mammoth bone from Le Garon quarry near Brignais, Rhône (45° 40′ N, 4° 45′ E). Coll and subm 1971 by L David, Geol Dept, Univ Lyon 1. *Comment*: no organic matter was preserved in the bone. Date, obviously much too young, proves carbonaceous fraction of bones cannot be used for $^{14}C$ dating.

**Terrasse de Chasse sur Rhône series, Rhône**

Bone (*bison priscus*) from low terrace of Rhône R at Chasse sur Rhône (45° 35′ N, 4° 47′ E). Coll 1910 by M Mermier and subm 1971 and 1972 by C Guérin.

**Ly-723. Terrasse de Chasse sur Rhône no. 2** **12,120 ± 180**
**10,170 BC**

**Ly-653. Terrasse de Chasse sur Rhône no. 1** **14,350 ± 290**
**12,400 BC**

*General Comment* (CG): both dates agree and exclude attribution of terrace to Riss or Early Würm. Würm IV date corresponds to Quaternary (David, 1967).

**Ly-751. Mammouth de Bioley-Orjulaz, Vaud, Switzerland** **34,600 +2700 −1800**

Fragment of mammoth tusk (*Elephas primigenius*) from 40m depth at base of lowest gravels, in Bioley-Orjulaz gravel-pit, Vaud, Switzerland (46° 40′ N, 6° 35′ E). Coll and subm 1972 by M Weidmann; Geol Mus Lausanne. Ivory of tusk still contained much organic matter; at least 6% collagen: an exceptional amount for a sample so old. *Comment* (MW): gravels occur statigraphically between 2 moraines. Date validates horizon as Würm II/III interstadial (Burri *et al*, 1968).

**Ly-630. Ariendorf, Germany** **⩾31,000**

Bone of big bovine from 10m depth beneath upper loess and above a paleosol at Ariendorf near Bad-Höningen, Reinland, Germany (50° 32′ N, 7° 25′ E). Coll 1970 and subm 1972 by F Poplin, Hist Nat Mus, Paris. *Comment* (FP): upper loess is attributed to Würm. A finite age should confirm Würm III or IV.

*F. Bone samples from rock shelters and limestone caves: France*

**Ly-652. Reillanette, Drôme** **1170 ± 110**
**AD 780**

Numerous bones of microfauna from ground in cave at Reillanette, Drôme (44° 10′ N, 5° 04′ E). Coll and subm 1972 by M Philippe. *Comment* (MP): assoc with flints that might be prehistoric, but date proves recent industry and confirms that the flint cutting occurred in S E France up to the Middle Ages.

**Ly-721. Aven du Bouchas, Saint-Remèze, Ardèche** **2120 ± 160**
**170 BC**

Bones of small bovine from Le Bouchas Aven near Saint-Remèze, Ardèche (44° 20′ N, 4° 32′ E). Coll and subm by C Guérin. *Comment* (CG): bones were covered by a thick layer of calcite. Date marks growth rate of some calcic crust even though bones were in a dry part of the grotto. Organic matter well preserved in sample.

**Ly-771. Grotte multiple, Vallon Pont d'Arc, Ardèche** **2650 ± 120**
**700 BC**

Fragments of bones from "Grotte multiple" near Vallon Pont d'Arc, Ardèche (44° 13′ N, 4° 24′ E). Coll 1972 by M Cahours and subm 1972 by C Guérin. *Comment* (CG): expected age was Late Neolithic to Gallo-Roman. Date corresponds to Late Bronze Age.

**Ly-632. Abri Pailler, Vilaine, Vienne** **20,400 +2800 −2000**

Bones from Pailler rock shelter near Vilaine, Vienne (46° 36′ N, 0° 55′ E). Coll 1971 by C Lorenz and subm 1972 by C Guèrin. *Comment* (CG): expected age was Mousterian (ca 40,000 BP) but, despite large statistical margin due to scarcity of organic matter available, date refers to Würm III or Würm IV age.

**Causse de Gramat series, Lot**

Bone coll during prospecting of paleontologic sites in deep limestone caves, in Causse de Gramat region, (arid plateau in SE Massif Central). Coll 1971 by M Philippe and subm 1971 by C Guérin.

**11,840 ± 630**
**Ly-648. Le Pépin Puits 3, Caniac du Causse, Lot 9890 BC**

Lynx bones from 3rd well of Le Pépin cave near Carniac, Lot (44° 27′ N, 1° 39′ E).

**14,480 ± 400**
**Ly-649. Lespinasse, Quissac, Lot 12,530 BC**

Bones of mammals from Lespinasse cave near Quissac, Lot (44° 47′ N, 1° 44′ E).

**16,640 ± 400**
**Ly-650. La Mude, Rocamadour, Lot 14,690 BC**

Bones of mammals from La Mude cave near Rocamadour, Lot (44° 47′ N, 1° 37′ E).

*General Comment* (CG & MP): 3 dates place sites in Late Würm (Würm IV) and a Magdalenian site (Sainte-Eulalie, near Espagnac, Lot) was previously dated in same range: see 3 results of Gif lab (R, 1974, v 16, p 26-67). Fauna from Causse de Gramat region are younger than fauna from neighboring Causse de Martel region. Dates on fauna from Jaurrens, Sirejol and La Fage (Guérin & Philippe, 1971), to be pub later, are minimum for beginning of Würm III. Large discrepancy between the 2 regions may be due to a variation of hydrogeologic conditions affecting both karst systems.

*G. Shell samples from coastal sediments: Mauritania, Sénégal*

**Bangaléré series, Sénégal**

Shells from several layers in a kitchen midden in Blon de Bangaléré in Salaun R delta, Sénégal (14° 57′ N, 16° 25′ W). Coll 1972 and subm 1973 by P Elouard, Geol Dept, Univ Lyon 1.

**580 ± 125**
**Ly-815. Bangaléré Sm 22 AD 1370 BC**

*Gryphea gasar* from Level 5, E sec, 1.40m above base of kitchen midden.

**975 ± 135**
**Ly-814. Bangaléré Sm 21 AD 975 BC**

*Gryphea gasar* from Level 2, E sec, 0.40m above base.

**995 ± 155**
**Ly-817. Bangaléré Sm 24 AD 955 BC**

*Arca senelis* from Level 6, W sec, 1.90m above base.

**1650 ± 130**
**Ly-816. Bangaléré Sm 23 AD 300**

*Arca senelis* from Level 1, W sec, 0.35m above base.

*General Comment* (PE): formation of the kitchen midden continued for at least 1000 yr. Other dates from E coast of Sénégal indicating a large human occupation since High Middle Ages are confirmed.

**2150 ± 150**
**Ly-348. Kerekchet et Teintane, Ar 107, Mauritania 200 BC**
$\delta^{13}C = -0.9‰ \pm 0.1‰$

*Cardium edule* from a shallow gulf near Arguin I at Kerekchet and Teintane, Mauritania (20° 46′ N, 16° 36′ W). Coll and subm 1970 by P Elouard. *Comment* (PE): marks Post-Nouakottian regression (Taffolian).

**Baie de Saint-Jean series, Mauritania**

Shell from kitchen refuse of fishing population. Coll and subm 1971 by P Elouard.

**2640 ± 120**
**Ly-457. Cap Timris, Ar 200 690 BC**
$\delta^{13}C = +1.7‰ \pm 0.1‰$

*Arca senelis* from Timris cape (19° 23′ N, 16° 32′ W).

**2700 ± 100**
**Ly-444. Village de Saint-Jean, Ar 197 750 BC**
$\delta^{13}C = +1.8‰ \pm 0.1‰$

*Arca senelis* from Saint-Jean village (19° 38′ N, 16° 15′ W).

*General Comment* (PE): shows a human occupation in present-day desert at time of less arid climate.

**3130 ± 240**
**Ly-812. Le Cap Vert CvI, Sénégal 1180 BC**

*Patella safiana* from a fossil beach at Les Almadies near Cap Vert, Sénégal (14° 44′ N, 17° 27′ W). Coll and subm 1972 by P Elouard. *Comment* (PE): confirms age of the marine terrace previously dated eg, I-2299, 3360 ± 110 BP of T-724, 2880 ± 80 (unpub).

**3230 ± 140**
**Ly-813. Guira, Sm 7, Sénégal 1280 BC**

*Arca senelis* from a marine terrace in Bolon de Guira in Saloun R delta (14° 50′ N, 16° 30′ W). Coll and subm 1973 by P Elouard. *Comment* (PE): as expected, validates closing of shallow gulf of N Mauritania (see Ly-348, above).

**Tenioubrar series, Mauritania**

Shells from Tenioubrar sebkha, 120km N Nouakchott, Mauritania (19° 12′ N, 16° 03′ W). Coll and subm 1970 by P Elouard (Hébrard, 1973).

**2660 ± 110**
**Ly-351. Tenioubrar Nk 503 710 BC**
$\delta^{13}C = +1.2‰ \pm 0.1‰$

From lower terrace 1m above sebkha bottom.

**Ly-352. Tenioubrar Nk 514** **3450 ± 120**
**1500 BC**
$\delta^{13}C = -1.1‰ \pm 0.1‰$

From upper terrace, 2m above sebkha bottom.

*General Comment* (PE): marks 2 different regression phases of the sea in a shallow gulf that is now dry. Such phases are also found farther S, at Saint-Louis, Sénégal: I-2297 ± 100 BP (Elouard *et al,* 1967) and at Arguin: Ly-348, 2150 ± 150 (above).

**Ly-350. Nouakshott S Nk 6, Mauritania** **5510 ± 120**
**3560 ± 120**
$\delta^{13}C = 0.0‰ \pm 0.1‰$

*Arca senelis* from La Fourche quarry, 2km S Nouakchott, Mauritania (18° 58′ N, 15° 58′ W). Coll 1964 and subm 1970 by P Elouard. *Comment* (PE): dates maximum of Nouakchottian transgression and agrees perfectly with a previous date on same site: T-404, 5570 ± 120 BP (unpub).

**Nouakchottien de la Côte d'Arguin series, Mauritania**

Shells from Arguin coast, NW Mauritania. Coll and subm 1970 and 1971 by P Elouard.

**Ly-343. Les Mégarches Ar 77** **3990 ± 120**
**4040 BC**
$\delta^{13}C = +0.6‰ \pm 0.1‰$

Shells from Les Mégarches beach near Iouik (19° 52′ N, 16° 14′ W).

**Ly-445. Baie de Saint-Jean Ar 199** **4270 ± 110**
**2320 BC**
$\delta^{13}C = +0.8‰ \pm 0.1‰$

*Arca senelis* from Saint-Jean Bay (19° 28′ N, 16° 26′ W).

**Ly-442. Presqu'ile d'Iouik Ar 189** **5180 ± 150**
**3230 BC**
$\delta^{13}C = +1.4‰ \pm 0.1‰$

*Arca senelis* from Iouik Peninsula (19° 54′ N, 16° 26′ W).

**Ly 345. Cap Tafarit Ar 89** **6130 ± 150**
**4180 BC**
$\delta^{13}C = 0.1‰ \pm 0.1‰$

*Arca senelis* from foot of Tafarit Cape (20° 07′ N, 16° 15′ W).

**Ly-349. Baie de l'Etoile Ar 122** **6230 ± 130**
**4280 BC**
$\delta^{13}C = -1.1‰ \pm 0.1‰$

*Arca senelis* from l'Etoile Bay near Nouakchott (21° 02′ N, 17° 02′ W).

*General Comment* (PE): date Nouakchottian transgression either by marine deposits (Ly-442) or by kitchen midden.

**Inchirien de la Côte d'Arguin series, Mauritania**

Shells from Arguin coast, NW Mauritania. Coll and subm 1970 by P Elouard.

**Ly-443. Cap Tafarit Ar 195** **$31,400^{+2300}_{-1800}$**
**29,450 BC**
$\delta^{13}C = +1.4‰ \pm 0.1‰$

*Arca senelis* from Tafarit Cape (20° 07′ N, 16° 16′ W).

**Ly-344. Dayet-Amouré Ar 83** **⩾33,500**
$\delta^{13}C = -0.7‰ \pm 0.1‰$

*Ostrea edulis* from Dayet-Amouré depression near Tidra I (19° 45′ N, 16° 13′ W).

*General Comment* (PE): both dates mark Inchirian transgression farther than previously known and may be compared to T-536: 31,100 ± 1200 BP from Nouakchott, Mauritania and to T-464: 31,400 ± 1700 BP from Sénégal (Elouard *et al*, 1967).

**Oued Moukra series, Mauritania**

*Arca senelis* and calcic crust inside shell from Moukra oued near Ndrhomcha sebkha, Mauritania (19° 08′ N, 15° 47′ W). Coll and subm 1970 by P Elouard.

**Ly-353. Shel without calcic crust NK 517** **$28,700^{+1500}_{-1200}$**
**26,750 BC**
$\delta^{13}C = -0.6‰ \pm 0.1‰$

**Ly-354. Calcic crust, outer part, NK 518** **24,300 ± 1000**
**22,350 BC**
$\delta^{13}C = +0.6‰ \pm 0.1‰$

**Ly-354bis. Calcic crust, inner part, NK 518** **19,950 ± 550**
**18,000 BC**
$\delta^{13}C = -1.4‰ \pm 0.1‰$

Counting gas for Ly-354 came from beginning of acid treatment of calcic crust, for Ly-354bis, from end of same treatment.

**Ly-355. Gryphea gasar NK 520** **>33,100**
$\delta^{13}C = -0.9‰ \pm 0.1‰$

*General Comment* (PE): Ly-354bis agrees with another measurement on calcic crust: I-2775, 18,820 ± 350 BP (unpub) from Cap Vert Sénégal. It seems that a phase of calcic crust formation occurred ca 19,000 BP, *ie*, a change from pluvial to desert climate. Expected age of Ly-353 was Inchirian, ca 30,000 BP (Ly-355 and Ly-443, above); thus, date should be too young, either because part of crust was removed before treatment or because crust intruded into shells. Ly-354 should be same date as Ly-354bis; partial dissolution of shell may have caused difference.

## II. ARCHAEOLOGIC SAMPLES

### *A. Historic to Mesolithic periods*

**640 ± 90**
**Ly-690. Montplaisir de Gérardmer, Vosges** **AD 1310**

Wood from a pile work underlying ca 15m water in Gérardmer lake 100m offshore, near Gérardmer, Vosges (48° 04′ N, 6° 50′ E). Coll by R Douissard and subm 1971 by L Jeancolas, Tassin Rhône. *Comment* (LJ): should date 1st human sedentary occupation in this wild valley of Vosges massif where no pre- or proto-historic industry was ever found.

**1000 ± 100**
**Ly-701. Homme de Pusignan, Rhône** **AD 950**

Human bones from ancient cemetery at E Pusignan, Rhône (45° 44′ N, 5° 04′ E). Coll and subm by P Elouard, Geol Dept, Univ Lyon I. *Comment* (PE): cemetery was built according to Merovingian tradition, *ie,* AD 800. Date confirms tradition continued during Carolingian times.

**1030 ± 100**
**Ly-766. Rue de Veaugues, Cosne-sur-Loire, Nièvre** **AD 920**

Human bones from ancient cemetery in Veaugues St at Cosne-sur-Loire, Nièvre (47° 24′ N, 2° 55′ E). Coll by G Cunière and subm 1971 by A Bouthiers, Lab Zoology, Ecole Normale Supérieure, Paris. *Comment* (AB): despite numerous excavations in this cemetery, no samples were found here. Bones may either be Merovingian, AD 500 to 700, or Medieval (Bouthier, 1973). Date suggests latter.

**Ibos series, Hautes Pyrénées**

Charcoal from several sepultures in Moulin de Géline tumulus, near Ibos, Hautes-Pyrénées (43° 14′ N, 0° 11′ W). Coll 1964 by C Coquerel and subm 1972 by G Laplace.

**2460 ± 180**
**Ly-660. Ibos no. 1, sépulture latérale** **510 BC**

From sepulture in NE flank of tumulus, assoc with early La Tène industry.

**2200 ± 260**
**Ly-661. Ibos no. 2, sépulture centrale** **250 BC**

Presumed from a sepulture at bottom of tumulus and assoc with Late Bronze or Hallstatt industry, ca 700 BC.

*General Comment* (RC): Ly-660 agrees perfectly with industry and expected age. Ly-661 is obviously too young for Hallstatt or Late Bronze age but origin of sample is doubtful; it may come from another sepulture at top of tumulus, assoc with La Tène II industry consistent with date.

**1635 ± 110**
**Ly-726. Moidrey, Manche** **AD 315**

Charcoal from hearth 1m from hiding place of 350 bronze socket axes "haches à douilles" near Moidrey castle, Manche (48° 34′ N, 1°

30′ W). Coll by L Bellenger and subm 1972 by G Verron, Dir antiquités préhistoriques Normandie, Caen. *Comment* (GV): this type of "à douilles" axe is well known during transition period between Iron and Bronze ages; thus, date is ca 900 yr too young. Either recent vegetation polluted sample or hearth has no connection with hiding place.

**2790 ± 190**
**Ly-664. Vauvretin, Epervans, Saône et-Loire 840 BC**

Charcoal from hearth at Vauvretin near Epervans, Saône et Loire (45° 54′ N, 4° 53′ E). Coll 1971 and subm 1972 by L Bonnamour, Denon Mus, Chalon-sur-Saône. *Comment* (LB): assoc with rich ceramic industry of end of "Champs d'Urnes" civilization (Late Bronze, presumed IIIa) with which date agrees perfectly (Bonnamour, 1973).

**3040 ± 120**
**Ly-803. Letton de Xanthos, Ana I, Lycie, Turkey 1090 BC**

Charcoal from a beam found in a Lycian building at Letoon near Xathos, Lycia prov, Turkey (37° 30′ N, 31° 00′ E). Coll 1972 by M Metzger and subm 1972 by G Chapotat, Vienne, Rhône. *Comment* (HM): in expected range of dates, presumed 6th century BC; assoc ceramics may also be older.

**Porte-Joie series, Eure**

Samples from 2 collective sepultures (Sep I and F XIV) at Beausoleil near Porte-Joie, Eure (49° 10′ N, 1° 15′ E). Subm 1972 by G Verron.

**3040 ± 280**
**Ly-702. Porte-Joie 67, Sep I, D8 1090 BC**

Bones from bottom of no. I sepulture, Sq D8, 80cm depth. Coll 1967 by B Zago.

**4040 ± 180**
**Ly-703. Porte-Joie 68, Sep I, E13 2090 BC**

Bones from bottom of no. I sepulture, Sq E13, 60cm depth. Coll 1968 by L Bellenger.

**1720 ± 320**
**Ly-704. Porte Joie 70, F XIV, P 15 AD 230**

Charcoal from no. 2 sepulture in Pit XIV, Sq R 15, 54cm depth. Coll 1970 by J Torque.

**3260 ± 190**
**Ly-705. Porte-Joie 71, F XIV, R 15 1310 BC**

Charcoal from no. 2 sepulture in Pit XIV, Sq R 15, 67cm depth. Coll 1971 by S Moller-Andersen.

*General Comment* (GV): the 2 collective sepultures, 300m from each other, seem contemporaneous and both contain "campaniform" artifacts and SOM, *ie*, Seine-Oise-Marne civilization = Late Neolithic. Expected age was 4000 BP which agrees with Ly-703. Ly-702 is polluted for unknown reasons. Dates of Pit XIV (Ly-704 and -705) correspond to hearths from base of tomb. Hearths are not Neolithic, but are assoc with destruction of site which occurred in several steps soon after last burial in sepultures.

**Ly-689. Aiguebelette no. 16, Savoie** **2710 ± 90** **760 BC**

Wood from pile work presumed from a coastal sta submerged near an islet in Aiguebelette lake near Lepin, Savoie (45° 33′ N, 5° 48′ E). Coll 1971 by C Valette and subm 1972 by R Laurent, Centre de Recherches Archeol Tresserves, Savoie. *Comment* (RL): no assoc industry in site but confirms a Late Bronze occupation of islet where bronze axes were found.

**Ly-688. Aiguebelette no. 15, Savoie** **4600 ± 120** **2650 BC**

Wood from pile foundation of coastal sta submerged in S part of Aiguebelette lake near Saint-Alban, Savoie (45° 34′ N, 5° 48′ E). Coll 1971 by C Valette and subm 1972 by R Laurent. *Comment* (RL): no assoc archeol artifacts. Sta is presumed either Late Neolithic of Chalcolithic. Date indicates 1st attribution and may be compared to Ly-20: 4150 ± 180 BP (R, 1969, v 11, p 115) from same site.

**Stations côtières du Lac de Clairvaux series, Jura**

Samples from several neighboring coastal sta in N part of Clairvaux lake near Clairvaux, Jura (46° 40′ N, 5° 46′ E). Coll 1971 and 1972 and subm 1972 by P Pétrequin, Dir antiquités préhistoriques de Franche-Comté, Besançon (Pétrequin, 1974).

**Ly-851. Clairvaux, sta La Motte aux Magnins; Level IIe** **4070 ± 140** **2120 BC**

Wood from floor assoc with Late Neolithic industry. *Comment* (PP): agrees perfectly with expected age.

**Ly-850. Clairvaux, sta La Motte aux Magnins, Level V** **4940 ± 130** **2990 BC**

Charcoal from oldest occupation level, attributed to Middle Neolithic of "Salinois" facies. *Comment* (PP): in oldest range of expected dates.

**Ly-854. Clairvaux, submerged sta no. 2, Point 10, Pile 6** **1390 ± 120** **AD 560**

Wood pile from small coastal sta submerged in center of lake. Presumed assoc archeol level now destroyed was probably Late or Middle Neolithic. *Comment* (PP): unexpected date shows it may be a pile set by High Middle age fishermen.

**Ly-853. Clairvaux, submerged sta no. 1, Point I, Pile 463** **5890 ± 140** **3940 BC**

Pile from palisade of Early Bronze or Late Neolithic village. *Comment* (PP): least 1500 yr older than previous expected age, but new excavation on site may suggest this old date. Date, which is oldest of coastal sta needs verification by other measurements.

**Ly-802. Clairvaux, submerged sta no. 3** **4450 ± 150** **2500 BC**

Pile from same sta and same level as Ly-384: 4640 ± 270 BP (R, 1973, v 15, p 143). *Comment* (PP): agrees with Ly-384 and confirms site occupation at end of Middle Neolithic and beginning Late Neolithic.

**Ly-801. Clairvaux, submerged sta no. 2, Point 68, Pile 1** **5050 ± 200** **3090 BC**

Pile from an insulated sta without assoc industry. *Comment* (PP): other date for same site: Gif-2298, 4740 ± 110 BP (R, 1974, v 16, p 57). Both dates confirm Middle Neolithic attribution of habitat. New excavation more precisely suggests beginning of Middle Neolithic in perfect agreement with date.

**Ly 852. Clairvaux, submerged sta no. 4, Pile 561** **5000 ± 130** **3050 BC**

Pile from ancient settlement now dismantled whose archeologic level was destroyed by lake erosion. *Comment* (PP): expected age was Late or Middle Neolithic. Date confirms the latter.

*General Comment* (PP): except for Ly-854, all dates are consistent and show mainly 2 occupation periods. The oldest one, ca 6000 BP, is also oldest of all coastal sta in W Europe. The youngest one, ca 4000 BP, is, on the contrary, contemporaneous with many of alpine lakes; see Aiguebelette and Le Bourget lakes sta, Savoie (R, 1971, v 13, p 57). There is no Late Bronze sta, ca 2700 BP, in Clairvaux lake but there are many in other lakes.

**Tintane cimetière series, Mauritania**

Samples from Neolithic site Tintane Cimetière, Mauritania (20° 53′ N, 16° 14′ W). Coll and subm 1971 by J P Carbonnel, Lab Géol Dynamique, Univ Paris VI.

**Ly-505. Tintane cimetière G 400 KK** **2860 ± 170** **910 BC**
$\delta^{13}C = +2.3‰ \pm 0.1‰$

Carbonate fraction of human bones from soil surface in inhumation zone "Olympe", S part of site.

**Ly-460. Tintane cimetière *Arca* G 68 H** **3530 ± 130** **1580 BC**
$\delta^{13}C = +0.5‰ \pm 0.1‰$

Shells (*arca senelis*) from surface of an insulated kitchen midden; NW part of site.

**Ly-459. Tintane cimetière *Arca* G 68 H** **3930 ± 120** **1980 BC**
$\delta^{13}C = -7.9‰ \pm 0.1‰$

Organic matter of vegetal origin included in pottery from same kitchen midden as Ly-460. Treated as charcoal.

**Ly-503. Tintane cimetière G 432 HH** **4270 ± 100**
**2320 BC**
$\delta^{13}C = +2.6‰ \pm 0.1‰$

*Cymbium* shells assoc with the kitchen midden "Olympe", S part of site.

**Ly-708. Tintane cimetière G 283 H** **6800 ± 190**
**4850 BC**

Calcic crust of roots enclosed in dune, central part of site.

*General Comment* (JPC): dates show site was occupied for at least 4000 yr. Ly-708 remains doubtful due to dating material, but may be compared with Ly-552 and -553 from Tintane Pécheur, corresponding to 1st occupation period; end of site would be marked by inhumations, Ly-505. Other measurements from site were made by other radiocarbon labs.

**Tintane pécheur series, Mauritania**

Samples from Neolithic site Tintane pécheur, 4km SW Tintane Cimetière (20° 52′ N, 16° 42′ W), from surface of a kitchen midden. Coll and subm 1971 by J P Carbonnel.

**Ly-551. Tintane pécheur *Arca* G 717** **4820 ± 140**
**2870 BC**

*Arca* shells.

**Ly-553. Tintane pécheur *Tapes* G 717** **6020 ± 150**
**4070 BC**

*Tapes* shells.

**Ly-552. Tintane pécheur Potery G 717** **6390 ± 160**
**440 BC**

Organic matter of vegetal origin included in pottery, treated as charcoal.

*General Comment* (JPC): 3 dates are contemporaneous with site at least 1st occupation of Tintane Cimetière site. Ca 6000 BP would be 1st human occupation of region.

**Chami series, Mauritania**

Samples from Neolithic village Chami, Mauritania (20° 05′ N, 16° 01′ E). Coll and subm 1970 by J P Carbonnel.

**Ly-347. Chami-Tagarit, bone, Ar 100** **Modern**
$\delta^{14}C = +2.5\% \pm 3.0\%$

**Ly-346. Chami-Tagarit, shell, Ar 100** **3570 ± 120**
**1620 BC**
$\delta^{13}C = +1.7‰ \pm 0.1‰$

*General Comment* (JPC): Ly-347 remains unexplained. Ly-346 agrees with expected value and other measurements of same material from same site by Gif lab.

**Longetraye series, Haute-Loire**

Charcoals from Sq 4E of Rock Shelter Longetraye, near Freycenet, la Cuche, Haute-Loire (44° 52′ N, 3° 55′ E). Coll and subm 1972 by

D Philibert, Lab d'Ethnol, Univ Lyon III. Excavation conditions are difficult and need continuous radiocarbon control to watch level correlation and detect any pollution of disturbance (Philibert, 1974).

**Ly-786. Longetraye Sq-4E, 20 to 30cm** — **780 ± 90** / **AD 1170**

**Ly-787. Longetraye Sq 4E, 40 to 50cm** — **5100 ± 150** / **3150 BC**

**Ly-758. Longetraye Sq 4E, 50 to 60cm** — **7430 ± 150** / **5480 BC**

**Ly-759. Longetraye Sq 4E, 60 to 70cm** — **6920 ± 160** / **4970 BC**

**Ly 760. Longetraye Sq 4E, 70 to 80cm** — **8590 ± 190** / **6640 BC**

**Ly-788. Longetraye Sq 4E, 120 to 130cm** — **5080 ± 270** / **3130 BC**

*General Comment* (DP): series must be compared to previous series from Sq D and 6E (R, 1973, v 15, p 524). Upper levels (Ly-786) also were polluted. Sequence of dates from lower level is consistent with stratigraphy from 40cm to at least 80cm deep; Sq 6E, 4E, and D correspond horizontally. At this depth assoc industries are Epipaleolithic and Mesolithic with Neolithic influence. Ly-788 indicates pollution in lowest level, which is possible in this type of site where filling material or artifacts may be pushed downward by rain water or by melting snow. See also Ly-845, below, from La Baume Loire rock shelter.

**Le Mourre Poussiou, Fos-sur-Mer series, Bouches du Rhône**

Samples from Level 2 in little rock shelter Le Mourre Poussiou, near Fos-sur-Mer, Bouches du Rhône (43° 57′ N, 4° 57′ E). Coll and subm 1972 by M Escalon de Fonton, Dir antiquités préhistoriques Provence, Marseille.

**Ly-707. Le Mourre Poussiou MP2, bone** — **6980 ± 380** / **5030 BC**

Small amount of collagen available.

**Ly-706. Le Mourre Poussiou MP2, charcoal** — **8980 ± 200** / **7030 BC**

*General Comment* (ME de F): assoc with Middle Montadian industry and attributed to Pre-Boreal climatic phase. Ly-706 seems a bit too young and agrees less with expected age than MC-591: 9780 BP from Le Ponteau neighboring site (unpub). Ly-707 suggests sub-surface disturbances were made by rodent burrows.

**Ly-770. Combe Obscure no. 5, Ardèche** — **9290 ± 350** / **7340 BC**

Charcoal from Level II in Combe Obscure grotto, at Salèlle, near Lagorce, Ardèche (44° 29′ N, 4° 08′ E). Coll and subm 1973 by G

Lhomme, Geol Dept, Univ Lyon I. *Comment* (GL): assoc with presumed Mesolithic industry (Lhomme, 1973). Date agrees with expected age and assigns level to Mesolithic or Proto-Neolithic. Other date from site: Ly-423, 6400 ± 150 BP (R, 1973, v 15, p 145) from Late Cardial Level 5.

**Ly-489. Empreinte de pied humain de Fort-Gouraud, Mauritania** **9120 ± 310**
**7170 BC**

Lacustrine clayey limestone inside footprint on ancient lake shore, near Fort-Gouraud, Mauritania (23° 43′ N, 13° 43′ E). Coll and subm 1971 by P Elouard, Geol Dept, Univ Lyon I. *Comment* (PE): ancient lake is now a sebkha and old footprints were cropped out by wind. Maximal extension of lake probably occurred during wet climatic phase, Tchadian (10,000 to 7000 BP). Though original $^{14}C$ value for this type of material is doubtful, date fits into expected range.

*B. Upper Paleolithic period*

**Ly-621. Plage de Niaux, Ariège** **4590 ± 280**
**2640 BC**

Charcoal from surface near calcified human footprint at Beach 4 in René Claste gallery of Niaux grotto, Ariège (42° 49′ N, 1° 35′ E). Coll and subm 1972 by J Clottes, Dir antiquités préhistoriques Midi-Pyrénées, Foix. On walls of grotto are paintings attributed to Magdalenian period (Clottes and Simmonet, 1972). *Comment* (JC): Gif lab made 4 other measurements on same site. There were at least 3 human passages in grotto: 1) ca 14,000 BP paintings and Ly-846, below, 2) ca 10,000 BP (possible footprints), and 3) from Neolithic period: Gif-1938 and Ly-621.

**Ly-846. Poisson de Fontanet, Ariège** **13,810 ± 740**
**11,860 BC**

Small pieces of charcoal from Fontanet grotto, near Ornolac and Ussat-les-Bains, Ariège (42° 49′ N, 1° 38′ E) from surface or rock near a salmon skeleton. Coll and subm 1973 by J Clottes. No industry younger than Magdalenian was found in grotto (Delteil *et al*, 1972). *Comment* (JC): agrees perfectly with Middle Magdalenian expected age.

**Ly-725. Abri Gay, Niveau Azilien, Poncin, Ain** **11,660 ± 240**
**9700 BC**

Bones of small rodent from azilian level, Sq L-15, of Gay rock shelter, at Poncin, Ain (46° 05′ N, 5° 24′ E). Coll and subm 1972 by R Desbrosse, Blanzy, Saône-et-Loire. Despite small size microfauna bones had normal amount (3%) of collagen. *Comment* (RD): assoc with reindeer macrofauna, lithic industry, and painted pebbles. Date marks beginning of Alleröd period as suggested by pollen analysis (Desbrosse, 1972).

**Ly-845. La Baume, Loire I, Niveau inférieur** **6970 ± 180**
**5020 BC**

Fragments of bone from lower level of basalt shelter La Baume Loire I, near Solignac-sur-Loire, Haute-Loire (44° 56′ N, 3° 54′ E).

Coll 1968 and subm 1973 by A Crémillieux, Le Monastier-sur-Gazeille, Haute-Loire. Assoc with Terminal Magdalenian or Sauveterrian industry and probably of Boreal phase or earlier (Crémillieux, 1972). *Comment* (AC): same value as Ly-539: 7100 ± 180 BP (R, 1973, v 15, p 523) from only level of neighboring rock shelter La Baume Loire III. Date, younger than expected, put level at Atlantic-Boreal limit. If no pollution occurred, date should indicate a long period of some industries as previously shown for Grotte Béraud site, near Saint-Privat d'Allier, Haute-Loire. See 4 Ly- R, v 15, p 523.

**Grottes Jean-Pierre de Saint-Thibaud de Couz series, Savoie**

Samples from 2 rock shelters 10m apart: Grotte Jean-Pierre no. 1 (JPI) and Grotte Jean-Pierre no. 2 near Saint-Thibaud de Couz, Savoie (45° 40′ N, 5° 50′ E). Coll and subm from 1969 to 1973 by A Bocquet and P Bintz, Inst Dolomieu, Grenoble. Stratigraphy of these sites was plotted in 3 separate geological secs of which one established the level correlations. There are 2 secs in JPI with respectively Latin and Greek letters for the levels and 1 little sec in JPII. Measurements were made in proportion of the excavation headings to help correlations and to date industries and climatic phases determined by pollen analysis. Although the study is incomplete; 1st results are in Table 1:

TABLE 1

| Climatic phase | Civilization | JPI S sec | JPI N sec | JPII |
|---|---|---|---|---|
| Pre-Boreal | Late Azilian | Layer 5A | | |
| End of Alleröd | Middle " | Layer 6B2 | | |
| Beginning of Alleröd | Early " | Layer 7 | Layer $\gamma$2b | |
| | | Layer 9A | Layer $\varepsilon$ | |
| Bolling or | Late Magdalenian | | Layer $\theta$ | Layer 3 |
| end of Dryas I | | Layer 9B | Layer $\lambda$ | |

Bones and charcoal were treated by usual method to eliminate all pollutants, but, as available carbon of carbonaceous earth is poor and in fine powder, all roots cannot be completely eliminated from much of the sediments. Difference between extras of $\theta$ layer indicate some roots remain after pretreatment.

TABLE 2

| Sample no. | Shelter | Geol sec | Layer | Square | Sample | $^{14}$C date |
|---|---|---|---|---|---|---|
| Ly-428 | JPI | S | 5A | I-6 | Bone splinters | 9050 ± 260<br>7100 BC<br>$\delta^{13}C = -16.0 \pm 0.1‰$ |
| Ly-596 | JPI | S | 6B2 | HI-6 | Charcoal | 10,750 ± 300<br>8800 BC |

| Sample no. | Shelter | Geol sec | Layer | Square | Sample | $^{14}$C date |
|---|---|---|---|---|---|---|
| Ly-626 | JPI | N | 2b | W-3 | Carbonaceous earth | 11,340 ± 260<br>9390 BC |
| Ly-429 | JPI | S | 7 | G-67 | Bone splinters | 11,900 ± 360<br>9950 BC |
| Ly-627 | JPI | S | 9A9B | E-5 | Carbonaceous earth | 11,700 ± 220<br>9750 BC |
| Ly-628 | JPI | N | | VW-3 | Carbonaceous earth | 8490 ± 190<br>6540 BC |
| Ly-625 | JPI | N | | VW-2 | Carbonaceaus earth reliquat | 10,470 ± 200<br>8520 BC |
| Ly-692 | JPI | N | | VW-2 | Carbonaceous earth 1st extra | 11,590 ± 330<br>9640 BC |
| Ly-693 | JPI | N | | VW-2 | Carbonaceous earth 2nd extra | 11,630 ± 240<br>9680 BC |
| Ly-829 | JPI | S | 9B | H-45 | Carbonaceous earth | 12,720 ± 230<br>10,770 BC |
| Ly-830 | JPI | N | | hearth | Carbonaceous earth | 13,070 ± 210<br>11,120 BC |
| Ly-828 | JPII | only level | | hearth | Charcoal | 12,470 ± 200<br>10,520 BC |
| Ly-390 | JPII | only level | | hearth | Charcoal | 13,300 ± 280<br>11,350 BC |

*General Comment* (AB & PB): detailed analysis of dates is not yet finished and will be tabulated with other results (sedimentology, typology, paleontology) but some observations are: 1) dates from upper levels in JPI (Layers 5A, 6B2, $\gamma$2b, and 7) are consistent and confirmed by stratigraphy, palynology, and typology; 2) same is true for oldest levels (9B, $\lambda$ and JPII) whose contemporaneity has been shown otherwise, *ie*, by joining broken flints); 3) 1000 yr difference between Ly-390 and -828 from same charcoal from JPII may be explained either by maximal statistic fluctuation or by pollution; 4) results from layer $\theta$, though a little too young, would mark 2 occupation periods during late Magdalenian time; 5) dates from middle layers, $\varepsilon$ and $\theta$, are obviously too young and disagree with stratigraphy: root pollution is likely.

**Ly-768. Gönnersdorf, Germany** **12,380 ± 230**
**10,430 BC**

Small bone pieces from habitation level of Magdalenian site Gönnersdorf, Stadtkr Neuwied, Germany (50° 27′ N, 7° 19′ E). Coll 1972 by G Bosinsky, Köln Univ and subm 1972 by F Poplin, Paris. Assoc with Magdalenian V industry; habitation ground plans covered with stone slabs and engravings on slate plaquettes. Expected age and geologic period: 13,000 BP, late Bolling or early Dryas II (Bosinsky, 1969). *Comment* (GB): Neuwied region is covered by thick layer of Bims (cinereous tuff) from volcano of Maria Laach in the Middle of Alleröd. Eruption was dated several times at ca 11,500 BP. Between Bims and Magdalenian levels are 0.30m of loess-loam deposited during a colder period with an open landscape (according to pollen-analytic results by A Leroi-Gourhan). Colder period should correspond to Dryas II; temperate oscillation with Magdalenian level should correspond to Bolling. So far, Ly-768 fits well with assumed geochronologic position.

**La Pierre aux Fées series, Cepoy, Loiret**

Samples from hearth in alluvia of Le Loing R lower terrace at La Pierre aux Fées, near Cepoy, Loiret (48° 01′ N, 2° 24′ E). Coll and subm 1973 by F Guillon and D Jagu, Paris. No industry inside hearth but near it and presumably at same level is Upper Paleolithic industry of German Hambourgian type.

**1410 ± 120**
**Ly-783. Cepoy no. 1** **AD 540**

Ashes from upper level of hearth in Zone 18.

**1970 ± 110**
**Ly-784. Cepoy no. 4** **20 BC**

Wood from same hearth.

*General Comment* (FG & DJ): proves hearth is not contemporaneous with neighboring industry. Changes of Le Loing R flow and local channeling with recent filling might explain ancient and recent deposits at same level.

**Varennes lès-Macon series, Saône-et-Loire**

Samples from 2 separate places in gravel pit in La Saône R alluvia, near Varennes-lès-Macon, Saône-et-Loire (46° 15′ N, 4° 47′ E). Coll 1967 and subm 1972 by J L Porte and J Combier, Dir antiquités préhistoriques Rhône-Alpes, Romanèche-Thorins.

**8080 ± 280**
**Ly-848. Varennes-lès-Macon no. 10** **6130 BC**

Carbonaceous earth from a hearth assoc with Azilian industry.

**11,860 ± 190**
**Ly-849. Varennes-lès-Macon no. 11** **9910 BC**

Sandy peat at same level.

*General Comment* (JC): Ly-848 seems too young for assoc industry and is probably polluted by roots. Ly-849 agrees better with expected age and indicates beginning of Alleröd.

**12,980 ± 220**
**Ly-800. Grotte d'Ebbou $C_1$, Ardèche** **11,030 BC**

Bone splinters from Level $C_1$ in Ebbou grotto, near Vallon-Pont-d'Arc, Ardèche (44° 24′ N, 4° 14′ E). Coll 1967 to 1969 by J P Thevenot and subm 1972 by J Combier. Assoc with Magdalenian industry. *Com-*

*ment* (JC): in expected range of dates. A little older than Level C in Les Deux-Avens site, Ardèche: Ly-321/322: 12,340 ± 200 BP (R, 1971, v 13, p 63). Bird fauna indicates cold climate (Combier, 1967).

**Ly-727. Enval niveau $12_e$, Puy de-Dôme** **13,700 ± 380** **11,750 BC**

Carbonaceous earth from Level $12_e$ between fallen rocks in Enval site near Vic-le-Comte, Puy-de-Dôme (45° 29′ N, 3° 04′ E). Coll 1971 and subm 1972 by Y Bourdelle, Clermont-Ferrand. *Comment* (YB): Level 12 lies 8cm under Level 12b from which came Ly-425: 13,000 ± 300 BP (R, 1973, v 15, p 149). Both dates are consistent but seem a little too old for assoc Magdalenian industry (Bourdelle, 1971).

**Grotte de Cottier series, Retournac, Haute-Loire**

Samples from 2 levels in Cottier grotto, near Retournac, Haute-Loire (45° 12′ N, 4° 01′ E). Subm 1972 by J Vincent, Issoire, Puy-de-Dôme (Virmont, 1973).

**Ly-719. Grotte de Cottier, no. 3, Niveau II** **18,550 ± 550** **16,600 BC**

Bone splinters from Level II, coll 1968. Assoc with presumed Earliest Magdalenian (Badegoulian) industry.

**Ly-662. Grotte de Cottier, no. 1, Niveau III** **11,480 ± 950** **9530 BC**

Carbonaceous earth from hearth in Sq Hb from Level III; underlies Level II and contains a poor lithic industry hardly classified. Coll 1970.

**Ly-663. Grotte de Cottier, no. 2, Niveau III** **19,880 ± 520** **17,930 BC**

Bones from several sqs of Level III. Coll 1969 and 1970.

**Ly-720. Grotte de Cottier, no. 4, Niveau III** **21,100 ± 600** **19,150 BC**

Same bones as Ly-663.

*General Comment* (JV): Ly-662 is obviously polluted and confirms risks in using such a type of sediment in certain sites (see also Longetraye and Saint-Thibaud de Couz series, this list). Bone samples, as usual, seem much more reliable. Ly-719 can possibly be Badegoulian. Ly-663 and -720 statistically overlap with $2\sigma$ criteria (average: 20,490 ± 480) and fit well between early Magdalenian value (Ly-719) and Proto-Magdalenian values of Le Blot series, Haute-Loire (Ly-564: 21,700 ± 1200 BP and Ly-565: 21,500 ± 700 BP (R, 1973, v 15, p 525). Series is also contemporaneous with Solutrean industries from other regions (see Grotte Chabot and Oullins series, below).

**Grotte Chabot series, Aiguèze, Gard**

Bones from 2 levels in Chabot grotto, near Aiguèze, Gard (44° 18′ N, 4° 32′ E). Coll 1963 and subm 1972 by J L Porte and J Combier. Assoc with lower Solutrean industry.

**Ly-697. Grotte Chabot, Niveau I** **12,000 ± 410** **10,050 BC**

Bones from Level I in red clayey sands, unconglomerated. Little collagen.

**Ly-698. Grotte Chabot, Niveau 2a** **18,200 ± 400** **16,250 BC**

Bones from upper 2cm of Level 2.

**Ly-699. Grotte Chabot, Niveau 2** **17,770 ± 400** **15,820 BC**

Bones from all 20cm of Level 2.

*General Comment* (JC): 3 dates disagree with expected ages. Ly-697 does not fit for unknown reason; but grotto was used as sheepfold for a long time and recent organic matter, may have entered bones of upper level. Ly-698 and -699 are ca 2000 yr younger than Oullins series, below, and also Solutrean from Laugerie Haute-Dordogne; see G-4466: 20,810 ± 230 BP (R, 1967, v 9, p 116).

**Grotte d'Oullins series, La Bastide de Virac, Ardèche**

Bones from 2 levels of Oullins grotto, near La Bastide de Virac, Ardèche (44° 20′ N, 4° 32′ E). Coll 1954 and 1955 and subm 1972 by J Combier. Assoc with lower Solutrean industry, end of Würm III (Combier, 1967).

**Ly-798. Grotte d'Oullins, Niveau 6** **19,360 ± 420** **17,410 BC**

**Ly-799. Grotte d'Oullins, Niveau 7** **19,710 ± 400** **17,760 BC**

*General Comment* (JC): dates are consistent with stratigraphy but expected age was 21,000 BP, relating to Lower Solutrean from Laugerie Haute. More dates from Dordogne and other regions are needed to explain discrepancy between SE and SW France.

**Ly-847. Grotte de la Tête du Lion, Bidon, Ardèche** **21,650 ± 800** **19,700 BC**

Small pieces of charcoal (*Pinus sylvestris*) from margin of Layers E and F in La Tête de Lion grotto, near Bidon, Ardèche (44° 22′ N, 4° 30′ E). Coll 1973 by P Ayroles and subm 1973 by J Combier. Wall of grotto bears paintings of "Style III" (Leroi-Gourhan's designation) attributed to Lower Solutrean or Upper Perigordian periods, presumably end of Würm IIIc. Charcoal level showed ocher traces on paleolithic soil, corresponding to paintings (Combier, 1972). *Comment* (JC): perfectly agreeing with expected age of paintings, result is 1st absolute date of paleolithic soil directly related to parietal paintings.

**Le Pré-Brun series, Villerest, Loire**

Charred bones and fine unburned bones from Le Pré-Brun open-air site at Le Saut du Perron, near Villerest, Loire (45° 58′ N, 3° 59′ E).

Coll 1962 and subm 1970 by J Combier. Expected age of assoc industry was Upper Perigordian or Magdalenian (Dupré, 1964).

**18,520 ± 500**
**Ly-391bis. Villerest no. 12 reliquat** **16,570 BC**
$\delta^{13}C = -22.4‰ \pm 0.1‰$

Organic matter from collagen preparation.

**24,900 ± 2000**
**Ly-391. Villerest no. 12 extra** **22,950 BC**

Organic matter from humus preparation, small amount available.

*General Comment*: despite poor material and large statistical range of results, dates confirm Upper Perigordian attribution of assoc industry (Combier *et al*, 1956).

**20,600 ± 1050**
**Ly-631. Spadzista St, Site B, Krakow, Poland** **18,650 BC**

Bone from open-air site in Spadzista St, Krakow, Poland (50° 05′ N, 19° 55′ E). Coll 1970 by J K Kozlowski, Inst Archeol, Univ Krakow, and subm 1972 by R Debrosse. Site is an Upper Paleolithic dwelling made by Mammoth bones at lowest part of solifluction lime overlain by last Würmian loess. Assoc with "Beryzh-Kostienki" "pointes à crans" (Kozlowski & Kubiak, 1971). *Comment* (JKK): nearly in expected range of dates: 21,000 to 23,000 BP. A little younger than GrN-6636: 23,040 ± 170 BP (unpub) from charred bones in same level and similar habitat structure. Comparable to GrN-2449: 22,860 ± 400 BP (R, 1964, v 6, p 352) from Nitra-German site assoc, with same "pointes à cran" industry and to Molodova V Level 7: MO-11: 23,000 ± 800 BP with some common "pointes à cran" types in different context (Koslowski *et al*, 1974).

**Montgaudier series, Montbron, Charente**

Bones from foot of cliff site Montgaudier, near Montbron, Charente (45° 39′ N, 0° 30′ E). Mousterian industry was found close to bones.

**1370 ± 250**
**Ly-600. Montgaudier no. 1** **AD 580**

Coll and subm 1972 by F Poplin. Much collagen preserved.

**Modern**
**Ly-700. Montgaudier no. 2** $\delta^{14}C = -2.2\% \pm 3.8\%$

Coll and subm 1972 by L Duport, Angoulème. Maximum age ($4\sigma$ criteria: 1480 BP = AD 470).

*General Comment*: Ly-700 confirms Ly-600; both samples cannot be contemporaneous with Mousterian industry.

## III. HYDROGEOLOGIC SAMPLES

**E Lyon aquifer system series, France**

Samples from wells and a spring (Bonce) in E Lyon region. Studied free ground water is 20km long, 10km wide in fluvioglacial and glacial formations of clayey sands and gravels (David, 1967). Feeding is either by meteoric waters falling on outcrop glacial deposits in E part of basin

(Bonce, Janneyrias) or by a deeper ground water in more calcareous aquifer "Molasse" (Corbas, Genas-Vurey). Sites were selected by J J Colin, Bur Recherches Géol Min, Lyon; samples coll by J Evin and G Marien.

| Water samples | No. | N Lat E Long | Colln date | | $\delta^{13}C$‰ $\pm$ 0.1 | $\delta^{14}C$% modern |
|---|---|---|---|---|---|---|
| Ly-419. Saint-Laurent de Mure | no. 1 | (45°41′, 5°07′) | Spring | 1971 | −13.6 | 84.5 ± 1.8 |
| Ly-676. Saint-Laurent de Mure | no. 2 | (45°41′, 5°07′) | Spring | 1972 | −12.3 | 83.2 ± 1.9 |
| Ly-822. Saint-Laurent de Mure | no. 3 | (45°41′, 5°07′) | Autumn | 1972 | – | 83.2 ± 1.1 |
| Ly-417. Janneyrias, usine | no. 1 | (45°42′, 5°06′) | Spring | 1971 | −12 | 94.7 ± 1.7 |
| Ly-674. Janneyrias, usine | no. 2 | (45°42′, 5°06′) | Spring | 1972 | −12.9 | 95.5 ± 1.2 |
| Ly-824. Janneyrias, usine | no. 3 | (45°42′, 5°06′) | Autumn | 1972 | – | 81.3 ± 1.0 |
| Ly-416. Saint-Bonnet, Mezely | no. 1 | (45°42′, 5°02′) | Spring | 1971 | – | 91.4 ± 0.9 |
| Ly-673. Saint-Bonnet, Mezely | no. 2 | (45°42′, 5°02′) | Spring | 1972 | −11.7 | 74.8 ± 1.0 |
| Ly-826. Saint-Bonnet, Mezely | no. 3 | (45°42′, 5°02′) | Autumn | 1972 | – | 75.4 ± 1.1 |
| Ly-855. Saine-Bonnet, Mezely | no. 4 | (45°42′, 5°02′) | Autumn | 1973 | – | 87.8 ± 0.8 |
| Ly-677. Satolas, aéroport | no. 1 | (45°43′, 5°05′) | Spring | 1972 | −11.2 | 78.2 ± 2.0 |
| Ly-678. Satolas, aéroport | no. 2 | (45°43′, 5°05′) | Spring | 1972 | – | 78.2 ± 1.1 |
| Ly-823. Satolas, aéroclub | no. 1 | (45°43′, 5°06′) | Autumn | 1972 | – | 76.3 ± 0.7 |
| Ly-418. Meyzieux, Zone industrielle | no. 1 | (45°46′, 5°05′) | Spring | 1971 | −12.6 | 85.2 ± 2.6 |
| Ly-675. Meyzieux, Zone industrielle | no. 2 | (45°46′, 5°05′) | Spring | 1972 | −12.1 | 85.1 ± 1.5 |
| Ly-825. Meyzieux, Zone industrielle | no. 3 | (45°46′, 5°05′) | Autumn | 1972 | – | 76.2 ± 1.3 |
| Ly-514. Décines, canal | no. 1 | (45°46′, 4°57′) | Spring | 1971 | − 9.3 | 99.4 ± 2.7 |
| Ly-515. Décines, canal | no. 2 | (45°46′, 4°57′) | Spring | 1971 | − 7.7 | 96.8 ± 2.5 |
| Ly-671. Décines, canal | no. 3 | (45°46′, 4°57′) | Spring | 1972 | – | 96.3 ± 4.1 |
| Ly-672. Bonce, source captée | no. 1 | (45°41′, 5°06′) | Spring | 1972 | −10.9 | 97.4 ± 2.1 |
| Ly-827. Bonce, fontaine publique | no. 3 | (45°41′, 5°06′) | Autumn | 1973 | – | 119.4 ± 1.1 |
| Ly-415. Genas-Vurey, Limnigraphe | no. 2 | (45°43′, 5°00′) | Spring | 1971 | −11.1 | 65.7 ± 1.1 |
| Ly-856. Genas-Vurey, Limnigraphe | no. 3 | (45°43′, 5°00′) | Autumn | 1973 | – | 70.1 ± 0.9 |
| Ly-679. Corbas, carrière | no. 1 | (45°41′, 4°54′) | Spring | 1972 | −12.2 | 79.0 ± 2.8 |
| Ly-821. Corbas, carrière | no. 2 | (45°41′, 4°54′) | Autumn | 1972 | – | 63.8 ± 0.9 |

*General Comment*: all $^{14}C$ activities are consistent with generally receding ground waters in region after other hydrogeologic methods were used by Colin (1971). According to Colin most waters pumped out in region come from lower aquifer (Molasse) whereas upper aquifer is weak. In fact, low $^{14}C$ activity, 65% to 80% modern is not only in well water coll in Molasse (Corbas) but also from borings in glacial formations (Satolas, Saint-Bonnet). Slightly higher values, 80% to 90%, indicate mixture of "old" (Molasse) and "young" (glacial) waters that may depend on pumping intensities. No variation of sampling yr for all wells and no detectable effects from Thermonuclear $^{14}C$ bombs. There is also no seasonal variation. Such measurements demonstrate importance of systematic $^{14}C$ surveillance of wells in regions where large amounts of waters are pumped out as in this industrial E Lyon region, especially when chemical compositions of several aquifers are the same, so that variations in water origin can be related to pumping variations.

**Eaux thermominérales d'Auvergne series, France**

Water from 2 hydrothermal regions in N and S Auvergne, France. Coll by J Evin and Bur Recherches Geol Min, Clermont-Ferrand. No treatment was done on sites to avoid pollution risks of precipitation systems. For each case 50L water were treated in the lab on gas-counting preparation bank. For the Vichy Saint-Yorre hydrothermal basin, as the free dissolved $CO_2$ concentration was very large, counting gas was obtained by stirring with an $N_2$ current. But for the less rich water of Chaudesaigues hydrothermal basin free $CO_2$ was removed as above, and, then, acid was added to get bicarbonates.

*a) Chaudesaigues region, Cantal*

Very hot waters (60 to 80°C) from 2 springs in fissured silicified micaschists at Chaudesaigues, Cantal, S Auvergne (44° 10′ N, 3° 09′ E).

| Sample no. | Sample | Temp | $\delta^{13}C$ | $^{14}C\%$ modern |
|---|---|---|---|---|
| Ly-468. | Chaudesaigues, Source du Par, $CO_2$ free | 80.5°C | −7.1‰ ± 0.1 | ⩽2.2% |
| Ly-468bis. | Chaudesaigues, Source du Par, bicarbonates | 80.5°C | −0.1‰ ± 0.1 | ⩽4.0 |
| Ly-469. | Chaudesaigues, Source du Ban, $CO_2$ free | 60.0°C | −5.6‰ ± 0.1 | ⩽2.2 |
| Ly-469bis. | Chaudesaigues, Source du Ban, bicarbonates | 60.0°C | +1.4‰ ± 0.1 | ⩽2.0 |

*b) Vichy S basin, Saint-Yorre region*

Tepid water (ca 14°C) from several springs of Saint-Yorre thermal sta Allier (46° 03′ N, 3° 50′ E).

| Sample no. | Sample | Temp | $\delta^{13}C$ | $^{14}C\%$ modern |
|---|---|---|---|---|
| Ly-467. | Saint-Yorre, artesian bore-hole (Source Royale) | 13.9°C | −4.6‰ ± 0.1 | ⩽1.5% |
| Ly-521. | Saint-Yorre, Bore-hole F 1 | 15.0°C | +0.8‰ ± 0.1 | ⩽2.0% |
| Ly-522. | Saint-Yorre, Bore-hole F 2 | 14.1°C | −4.7‰ ± 0.1 | ⩽3.5% |
| Ly-523. | Saint-Sylvestre, Source Agréable | 12.7 to 15.0°C | −4.2‰ ± 0.1 | ⩽2.0% |
| Ly-524. | Saint-Yorre, Source Parmentier | 12.6°C | −4.7‰ ± 0.1 | 4.8% ± 1.8 |

*c) Vichy N basin, Vichy region, Allier*

Hot water from several springs of Vichy thermal sta Allier (46° 10′ N, 3° 24′ E).

| Sample no. | Sample | Temp | $\delta^{13}C$ | $^{14}C$% modern |
|---|---|---|---|---|
| Ly-525. | Vichy, Source Boussange | 41.6°C | −6.9‰ ± 0.1 | ⩽3.0 |
| Ly-526. | Vichy, Source du Dôme | 65.5°C | −5.9‰ ± 0.1 | ⩽2.1 |
| Ly-527. | Vichy, Source Grande Greille | 42.5°C | −6.6‰ ± 0.1 | 4.7% ± 1.6 |
| Ly-519. | Vichy, Source Lucas | 27.7°C | −5.6‰ ± 0.1 | ⩽2.0 |
| Ly-520. | Vichy, Source Chomel | 41.8°C | −7.0‰ ± 0.1 | ⩽3.0 |

*General Comment* (JE & BRGM): almost no activity; $CO_2$ in water is from deep source and there is no atmospheric $CO_2$. Activity remains weak in Ly-524 and -527. For Parmentier spring (Ly-524) mineral water may be mixed with some meteoric water, which is less possible for Grande Grille spring (Ly-527) because all springs of N basin Vichy are similar. $\delta^{13}C$ values form regional groups and that may suggest either varying origins of $CO_2$ with basin or, rather change of primitive isotopic value according to ground crossed by thermal waters or according to temperatures. Besides $\delta^{13}C$ differences, values from Chaudesaigues demonstrate how high isotopic fractionations are according to $CO_2$ extraction.

**Lac Asal series, French territory of Afars and Issas**

Water and limestone from Lac Asal region, French territory of Afars and Issas (12° 40′ N, 42° 20′ E). Lake is −154m and is subject to strong evaporation (Degoutin, 1922). It is fed by sea water from neighboring Ghoubbet el Karab gulf, ca 12km away, through fissures of basaltic massif assoc with recent lake limestone. Hot thermomineral springs with small yields run mainly out of E shore lake. Coll and subm 1972 by P Dague, Service Geotherm, Bur Recherch Geol Min, Orléans.

| Sample no. | Sample | $^{13}C$ | $^{14}C$% modern |
|---|---|---|---|
| Ly-657. | Golfe de Goubbet el Karab 2999 | −2.1‰ ± 0.1 | 89.9% ± 2.7 |
| Ly-656. | Lac Asal 3016 | +6.6‰ ± 0.1 | 97.8% ± 30.3 |
| Ly-654. | Résurgence du Basalte 3013 | −1.4‰ ± 0.1 | 75.9% ± 2.1 |
| Ly-655. | Source chaude; Est du Lac Asal 3015 | +8.4‰ ± 0.1 | 23.0% ± 6.3 |
| Ly-658. | Calcaire lacustre CI | +5.9‰ ± 0.1 | 35.3% ± 0.9 |
| Ly-659. | Travertin TI | +7.0‰ ± 0.1 | 37.1% ± 1.1 |

*General Comment* (PD): dated to verify presumed feeding method of Asal Lake. $^{14}C$ value of lake water (Ly-656) is too inaccurate (too little $HCO_3$) but $^{13}C$ value confirms strong evaporation. As expected, resurgence from basaltic ridge (Ly-654) has a rather high $^{14}C$ content and certainly comes from gulf (Ly-657): its heavy $\delta^{13}C$ is almost similar to sea water $\delta^{13}C$ but the small difference may be due to partial dissolution of lake limestone. Water of hot spring (Ly-655) may have dissolved much more limestone (nearly same $\delta^{13}C$ and $^{14}C$ content as Ly-658 and Ly-659), or was partly mixed with lake water. More dating is needed to confirm such conclusions.

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# UNIVERSITY OF CAMBRIDGE NATURAL RADIOCARBON MEASUREMENTS XIII

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The dates presented here were calculated from measurements made at the University Radiocarbon Dating Research Laboratory mostly during 1973-74. The radioactivity of the samples was counted in gas proportional detectors, either silica lined (de Vries *et al*, 1959) or of pure copper, filled to 2 atmospheres pressure with pure carbon dioxide. The detectors were fixed in, and completely surrounded by, a plastic scintillator anticoincidence shield mounted inside a massive lead shield to protect against environmental radiation (Switsur, Hall and West, 1970). Modern sample gas was obtained from the combustion of AD 1845 to 1855 rings of an oak tree grown near Cambridge and felled in 1950. Background samples were prepared from Welsh anthracite. The contemporary sample was frequently compared with the activity of the NBS oxalic acid international standard. Age calculations were based on the $^{14}C$ half-life of 5568 years and the uncertainty stated as one standard deviation calculated from the statistical analyses of sample and standards counting rates.

Oxidation of the samples was performed in high pressure oxygen in a 'bomb' combustion unit (Switsur *et al*, 1970; Switsur, 1972; Switsur and West, 1973) followed by purification of the carbon dioxide produced. The technique was modified slightly for samples such as limnic mud deposits or gyttja which often contain excessive electronegative impurities and require more extensive purification than wood or charcoal samples. For these, a vessel containing either sodium hydroxide or ammonium hydroxide solution was placed in the combustion chamber. The carbon dioxide and acidic impurities evolved were absorbed in this as the oxidation progressed. Within a few minutes of igniting the specimen in the chamber the reaction was complete, as indicated by the fall in chamber pressure, and the excess oxygen was released. The carbon of the sample was thus converted to a carbonate solution. Initial purification of this was by precipitation as barium carbonate followed by thorough washing. Carbon dioxide was liberated with either hydrochloric or phosphoric acid and further purified suitably for the proportional counters.

As previously we have concentrated largely on determinations for our own studies with members of the Sub-department of Quaternary Research, Univ Cambridge and with archaeologists from Cambridge and other institutions.

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## SAMPLE DESCRIPTIONS

### I. GEOLOGIC SAMPLES

### *A. British Isles*

**Scottish Tree Stump series**

This continues the study of the stratigraphy of horizons of tree stumps commonly found in Scottish peat bogs (R, 1970, v 12, p 594-596). Samples coll 1966 from 3 main areas, the NW Highlands, the Cairngorm area of the E Grampians and the Galloway Hills of SW Scotland for pollen analysis by H H Birks and radiocarbon analysis by V R Switsur, both of Univ Cambridge.

**North West Highland area**

**Q-1150. Kinlochewe, Pine, 50cm** — **4447 ± 100**, **2497 BC**

Wood of *Pinus Silvestris* stump from 45 to 50cm below surface of blanket bog peat from sec exposed in ditch to base of bog, depth 125cm. Site 1km NW Kinlochewe, Wester Ross (57° 36′ N, 5° 19′ W, Nat Grid Ref 28/021628). Age is that of upper of 2 pine stump layers which were not traceable over a large area. Probably corresponds to site of Durno and McVean (1959) who carried out pollen analyses.

**Q-1151. Kinlochewe, Pine, 80cm** — **4671 ± 80**, **2721 BC**

Wood of *Pinus Silvestris* stump from 70 to 80cm below surface as in Q-1150.

**Q-1152. Kinlochewe, Birch, 105cm** — **6974 ± 120**, **5024 BC**

Twigs (*Betula*) from layer 95 to 105cm below peat surface of site of Q-1150. These date onset of peat growth at site. With pollen diagrams of Durno & McVean, will aid correlating vegetational changes in area with other parts of Scotland.

**Q-1153. Beinn Dearg, Pine, 140cm** — **4320 ± 80**, **2370 BC**

Wood (*Pinus*) from layer 130 to 140cm below surface of blanket bog in deep haggs completely exposing sec to base at 190cm on exposed col. Site on S slope of Beinn Dearg, Dirremor, Ullapool, Wester Ross (57° 45′ N, 4° 55′ W, Nat Grid Ref 28/265775). No pollen analyses as yet.

**Q-1154. Beinn Dearg, Birch, 185cm** — **5885 ± 110**, **3935 BC**

Wood (*Betula*) from layer 180 to 185cm below surface of site of Q-1153. Dates onset of peat growth at site. Pollen analyses to be done.

**4163 ± 80**
**Q-1155. Inchnadamph, Pine, 90cm** **2213 BC**

Wood (*Pinus Silvestris*) from stump 70 to 90cm below surface of peat in sec exposed in peat haggs. Profile, obtained from Hiller peat borer, showed degraded W blanket bog containing pine at 70 to 90cm and birch at 225 to 250cm. Underlying was *Eriophorum Vaginatum* peat to 275cm and fibrous, little humified peat to base at 285cm. Site is on N side of R Loanan, 5km S of Inchnadamph, W Sutherland (58° 8′ N, 4° 58′ W, Nat Grid Ref 29/243186) and was studied by Lewis (1907). Pollen analyses to be done.

**3976 ± 100**
**Q-1156. Rogart, Pine, 50 cm** **2026 BC**

Wood (*Pinus Silvestris*) from layer 30 to 50cm below present surface of bog exposed by peat cutting. Sample obtained by Hiller peat borer and core showed 2 further wood (unid) layers at 130 to 140cm and 170 to 180cm and then *Phragmites/Sphagnum* peat with *Betula* remains to base at 395cm. Site on open moorland 5km N of Rogart, Strathfleet, E Sutherland (58° 2′ N, 4° 10′ W, Nat Grid Ref 29/735068). See Lewis (1911).

**4395 ± 90**
**Q-1157. Rannoch Moor, Pine, 75cm** **2445 BC**

Wood (*Pinus Silvestris*) from stump 60 to 75 cm below peat surface from sec exposed in peat hagg. Site on NW corner of Rannoch Moor, Argyll (56° 38′ N, 4° 50′ W, Nat Grid Ref 27/275535). One of several well-marked layers of pine remains seen widely on Rannoch Moor. See Lewis (1907). Pollen analyses to be made.

**6139 ± 110**
**Q-1158. Rannoch Moor, Pine, 100cm** **4189 BC**

Twigs (*Pinus Silvestris*) from layer 95 to 100cm below surface of peat of site of Q-1157. Dates extermination of trees by further peat growth. Pollen analyses to be made.

**1547 ± 50**
**Q-1149. Loch Morar, Birch, 90cm** **AD 403**

Branch of *Betula* wood from layer 80 to 90cm below present peat surface exposed by peat cutting, on N side of Loch Morar, W Inverness, near to Morar Lodge (56° 58′ N, 5° 46′ W, Nat Grid Ref 17/700930). Hiller borer showed no further timber layer but coarse *Carex* fen peat with wood fragments to base at 160cm. Date indicates that tree growth in this area occurred much later than in other areas studied. Pollen analysis to be made.

**1530 ± 50**
**Q-1123. Loch Morar Birch branch** **AD 420**

Check sample on birch branch from 80 to 90cm at Loch Morar, see Q-1149. Confirms sample as latest found in study of tree layers.

**Galloway area**

**5890 ± 100**
**Q-872. Cooran Lane, 105cm** **3940 BC**

Peat from depth 100 to 105cm in blanket bog, alt 260m (55° 7′ N, 4° 23′ W, Nat Grid Ref 25/480843), overlying pine stump Q-871 dated at 7471 BP. Pollen analysis indicated transition between Zones VI and VIIa.

**5912 ± 100**
**Q-1148. Cooran Lane, 115cm** **3962 BC**

Wood peat from a band between 110 to 115cm below surface of bog, apparently assoc with roots of stump Q-871 (R, 1970, v 12, p 595).

**6564 ± 120**
**Q-875. Cooran Lane Pine, Site B** **4614 BC**

Wood stump (*Pinus Silvestris*) lying in a similar position to stump of sample Q-871.

**4815 ± 80**
**Q-879. Clatteringshaws Loch, 100cm** **2865 BC**

Amorphous blanket bog peat from 95 to 100cm below surface (55° 4′ N, 4° 17′ W, Nat Grid Ref 25/5477) at level of pine pollen maximum in assoc diagram.

**6820 ± 180**
**Q-880. Clatteringshaws Loch, base** **4870 BC**

Fen wood peat from 185 to 190cm, base of the profile. Dates onset of peat growth on former mineral soil due to increased moisture of the habitat.

*General Comment*: these samples are from 13 different sites (see also R, 1970, v 12, p 594-596) and are representative of the areas studied. Radiocarbon dates indicate that conditions were suitable for tree growth on at least one site throughout most of the period from 4000 to 7500 BP, except perhaps between ca 5250 to 5750 BP from which period no samples have yet been dated. The temporal distribution is not uniform and the tree dates exhibit a bimodal character with maxima ca 4000 to 4500 BP and ca 6500 to 7500 BP. These maxima appear to have regional rather than climatic connotations (Birks & Switsur, mss in preparation).

**4393 ± 50**
**Q-1121. A Mhoine** **2443 BC**

Wood (*Pinus Silvestris*) (58° 30′ N, 4° 36′ W, Nat Grid Ref 29/487605) from stump underlying 30cm eroded surface of peat at A Mhoine, 1.5km E of Loch Hope, Sutherland, Scotland. Alt 142m above mean sea level. Coll Aug, 1972 by H H Lamb, Climatic Research Unit, Univ East Anglia. First sample of tree remains from woodland formerly growing in N coast area to be dated. *Comment*: woodland in area today is confined to few localities in valleys sheltered from winds. Confusing descriptions suggest some areas were wooded in times of the Viking earls of Orkney and later. Date agrees with others from N part of W coast at Loch Broom, Loch Sionascaig and Duartbeg where last forests close to the coast were ca 4000 yr ago. Of interest in interpretation of meteorology of warmest postglacial times.

**Q-1120. Colney Street** **14,320 ± 210** **12,370 BC**

Detritus mud with plant fragments, beetle remains and shell (mollusk) fragments erratically distributed in layer of coarse to medium gravel and sand 5.5m thick resting on gray shelly clay (Tertiary) in S face of Colney Street quarry, St Alban's Hertfordshire (51° 42′ N, 0° 20′ W, Nat Grid Ref TL/152017). Coll Nov 1971 by P L Gibbard, Sub-dept Quaternary Research, Univ Cambridge. *Comment*: dates aggradation of low terrace gravels of R Colne and, hence Weichselian history of immediate area; see Godwin (1964) for discussion of similar deposits.

**Q-1171. Glenshieldaig, Wester Ross** **1230 ± 40** **AD 720**

(*Cyperaceae-Sphagnum*) peat from 30 to 32cm below surface of bog (57° 28′ N, 5° 36′ W, Nat Grid Ref NG/844484) Glenshieldaig, Wester Ross, Scotland. Coll April 1973 by J A Lee; subm by J H Tallis, Dept Botany, Univ Manchester. *Comment* (JHT): Glenshieldaig profile is one of series of peat profiles analyzed for lead content as part of study into changes of lead pollution in recent centuries in the British Isles. Glenshieldaig is far from any known source of atmospheric lead pollution and has over all low lead content. Significant rises in lead levels appear at depths 8cm and 21cm below present day surface, which, through pollen analyses, historical records, and radiocarbon date may be dated as ca AD 1650 and ca AD 1150, respectively (Lee & Tallis, in press.)

**Hatchmere series**

Mud samples, forming part of study of vegetational history at Hatchmere, Cheshire (53° 14′ N, 2° 41′ W, Nat Grid Ref 33/554723) by H J B Birks and J E Young, Sub-dept Quaternary Research, Univ Cambridge. Samples are from floor of postglacial lake taken as a 7.5cm diam core with a square rod piston sampler. Cores were extruded 3 days after colln, wrapped in Alcan wrap, foil, and polythene and stored at 15°C for nearly a year until sampled for radiocarbon dating June 1973. Samples taken with reference to pollen analysis curve at zone boundaries to calculate sediment accumulation rates and absolute pollen influx rates. Samples id by depth in pollen diagram.

**Q-1159. Hatchmere, 722.5 to 727.5cm** **7403 ± 114** **5453 BC**

Lake mud from 722.5 to 727.5cm, level in pollen diagram at which frequencies of *Alnus* pollen rise.

**Q-1160. Hatchmere, 772.5 to 777.5cm** **8340 ± 95**
**6390 BC**

Lake mud from 772.5 to 777.5cm, level in pollen diagram at which *Pinus* pollen frequencies reach their maximum.

**Q-1161. Hatchmere, 802.5 to 807.5cm** **8776 ± 130**
**6826 BC**

Lake mud from 802.5 to 807.5cm, level in pollen diagram at which *Quercus* pollen frequencies increase.

**Q-1162. Hatchmere, 842.5 to 847.5cm** **9679 ± 140**
**7729 BC**

Lake mud from 842.5 to 847.5cm, level in pollen diagram at which frequencies of *Corylus* pollen rise.

*General Comment*: 1st 4 dates from site agree with dates for comparable pollen analytical boundaries at nearby Red Moss (Hibbert, Switsur, & West, 1971), eg, Q-917 (7460 ± 150) and Q-1159 (7403 ± 114) for the beginning of the *Alnus* pollen curve, Q-920 (8790 ± 170) and Q-1161 (8776 ± 130) for rise in *Quercus*. Sedimentation rate as calculated from these 4 dates is very constant at 5.4cm/ (radiocarbon) century, but more dates are needed before reliable sedimentation accumulation rates may be calculated to allow conversion of pollen concentration figures to absolute pollen influx rates.

**North Knapdale, Argyll series**

This series is part of a study in conjunction with L Rymer, Subdept Quaternary Research, Univ Cambridge, of the effect of Man on the landscape of North Knapdale, Argyll, Scotland. Three cores were taken, using a 7.5cm diam Livingstone piston corer, at sites within the parish. Core from Drimnagall, not fully examined, appears to have a complete late-glacial sequence. Two cores were taken from the Taynish peninsula. One was an open water core from Lochan Taynish, the other was from the fen at S end of lochan. Absolute pollen analyses from cores are being made and dates required for pollen influx calculations via sedimentation rates. Oak woods on peninsula seem to be sub-natural, and pollen diagram shows little change, with all taxa still present in the area. Samples coll Jan 1972 by L Rymer from Taynish Fen (56° 5′ N, 5° 40′ W, Nat Grid Ref 16/738854) and Lochan Taynish (56° 5′ N, 5° 40′ W, Nat Grid Ref 16/738855).

**Q-1179. Taynish Fen, LTF 805-815** **7086 ± 85**
**5136 BC**

Fen peat from 805 to 815cm.

**Q-1180. Taynish Fen, LTF 730-740** **6070 ± 120**
**4120 BC**

Fen peat from 730 to 740cm, pollen curves indicate region of Elm decline, but frequency change is small.

**Q-1181. Taynish Fen, LTF 620-630** — **4665 ± 115** — **2715 BC**

Fen peat from 620 to 630cm.

**Q-1182. Taynish Fen, LTF 405-415** — **2446 ± 80** — **496 BC**

Fen peat from 405 to 415cm.

**Q-1183. Lochan Taynish, LTW 331-351** — **4314 ± 75** — **2364 BC**

Lake mud from 331 to 351cm below sediment level at center of lake beneath 425cm water.

**Q-1184. Lochan Taynish, LTW 151-171** — **1961 ± 75** — **11 BC**

Lake mud of low organic content from 151 to 171cm below sediment surface.

*General Comment*: dates are internally consistent but difficult to correlate by stratigraphic means and pollen diagram which show little change and are not easily divisible into definitely recognizable pollen assemblage zones. Further correlation will be attempted based on radiocarbon dates.

*B. India*

**Pedogenic Carbonate series**

The pedogenic carbonate in the buried soils studied is derived predominantly from atmospheric carbon dioxide activity during soil formation so that radiocarbon concentration in a stratum reflects its time of deposition.

Buried soil of late Quaternary alluvium in Giujarat State, W India is prominently exposed in the valleys of the Narmada, Mahi and Sabarmati rivers, which cross the plain of Giujarat, cutting 30 to 40m deep, exposing the stratigraphy. A red-brown band, 3 to 4m deep, 10 to 12m below the surface of the plain, runs for > 100km. This soil contains the pedogenic carbonate, a product of weathering of the silt *in situ*. For a discussion of suitability of calcium carbonate nodules for dating see Hegde & Switsur (1973). Dating of soil carbonate is described by Rightmire (1967), Rafter (1970), Williams & Polach (1971) and Leamy & Rafter (1972).

Samples coll 1972 by K T M Hegde, M S Univ Baroda, from selected segments of the river valleys. Sites were close to villages named. Series of soil samples taken 20cm in from scraped surface at 20cm intervals, for chemical analysis. Those with maximum carbonate concentration were dated by V R Switsur.

**Q-1104. Dhegam** — **22,450 ± 550** — **20,500 BC**

On the Narmada R (73° 07′ N, 21° 46′ E).

**Q-1105. Nikora** **Modern**
On the Narmada R (73° 09′ N, 21° 48′ E).

**21,600 ± 500**
**19,650 BC**

**Q-1106. Lilod**
On the Narmada R (73° 14′ N, 21° 52′ E).

**24,500 ± 700**
**22,550 BC**

**Q-1107. Deroli**
On the Narmada R (73° 14′ N, 21° 55′ E).

**17,400 ± 500**
**15,450 BC**

**Q-1108. Sinor**
On the Narmada R (73° 20′ N, 21° 54′ E).

**22,600 ± 550**
**20,650 BC**

**Q-1109. Dabka**
On the Mahi R (72° 56′ N, 22° 15′ E).

**18,250 ± 400**
**16,300 BC**

**Q-1110. Vasad**
On the Mahi R (73° 07′ N, 22° 28′ E).

**22,150 ± 600**
**20,200 BC**

**Q-1111. Ahima**
On the Mahi R (73° 12′ N, 22° 36′ E).

**20,400 ± 550**
**18,450 BC**

**Q 1112. Pethapura**
On the Sabarmathi R (72° 41′ N, 23° 16′ E).

**21,500 ± 500**
**19,550 BC**

**Q-1113. Hirpura**
On the Sabarmathi R (72° 50′ N, 23° 11′ E).

*General Comment*: dates are later than expected and indicate approx formation time of the buried soil (except anomalous, unexplained value of Q-1105) which is representative of Quaternary alluvial stratigraphy across the Indian Sub-Continent. Dates require careful study in terms of the geochemical process proposed for carbonate formation and effect of subsequent leaching of the deposits and reprecipitation, before they should be applied to apparently assoc stone age industries, for which they might provide a useful temporal reference; see Wainwright (1964).

### *C. Africa*

**Lake Shala, Ethiopia series**

Part of a study of late Quaternary lake levels in the rift valley of S Ethiopia by A T Grove, Dept Geog, Univ Cambridge. During the past 10 yr we have learned that the high levels of the Galla lakes system were probably connected and the single large lake overflowed N into the R Awash valley. Horizontal beaches developed at different levels, the most important at 119m above Lake Shala (7° 30′ N, 38° 40′ E). Shells (*Melanoides Tuberculata*), (*Bulinus*) were coll by A T Grove, id by B W Sparks, Univ Cambridge.

**6500 ± 120**
**4550 BC**

**Q-1101. Lake Shala, 3**

Sample underlay calcrete 1m thick in sec alongside new road Mojjo to Shashamane; alt 93m above Lake Shala, a high shoreline of the lake.

**8320 ± 175**
**6370 BC**

**Q-1114. Lake Shala, 6**

Sample from shell layer 20cm thick under 1.5m sand. Alt 87m above Lake Shala, a former high shoreline of the lake.

*General Comment*: Q-1114 falls into expected range but Q-1101 is later than expected if present height above lake level is used as guide to age. Lake levels possibly fluctuated and remained as high as 90m above present level as late as 6500 BP. For further work and dates on shorelines of E African lakes, see Grove & Goudie (1971), Butzer *et al* (1972); Fontes *et al* (1973).

## II. ARCHAEOLOGIC SAMPLES

### *A. British Isles*

**Somerset Levels series, SW England**

Continuation of joint program of J M Coles, V R Switsur, and F A Hibbert in excavation, dating and stratigraphy of Somerset trackway complex. Coll July 1972 by J M Coles from Sweet Trackway Site 'F' (51° 09′ N, 2° 50′ W, Nat Grid Ref ST/422403), Shapwick Heath, Somerset.

**5140 ± 100**
**3190 BC**

**Q-1102. Sweet Track, 957**

Peat immediately underlying trackway rails.

**5103 ± 100**
**3153 BC**

**Q-1103. Sweet Track, 982**

Peat from beneath planks of track but overlying rails.

*General Comment*: dated to relate precisely underlying peat surface and 1st stages of trackway construction. Dates confirm previous results for this track (Q-962, -963, -966, -968, and Q-991) as oldest known track in Britain and agree with stratigraphic position of trackways in the peat. Dates assoc Neolithic flints, pottery and wooden objects and aid study of peat growth rate (Coles *et al*, 1973).

**4370 ± 60**
**2420 BC**

**Q-1037. Burtle Bridge Track**

Wood of trackway, overlying Q-1035 (51° 11′ N, 2° 52′ W, Nat Grid Ref ST/393426). Coll 1971 by C F Clements from multilayer track beneath 65cm peat.

**North Elmham, Norfolk series**

Continuation of study of North Elmham cistern whose construction was dated AD 831 ± 20 by combination of a series of 4 radiocarbon dates and tree ring measurements (Switsur & West, 1973; Wade-Martins *et al*, 1973). Samples from infilling of cistern (52° 45′ N, 0° 56′ E, Nat Grid

Ref TF/987215), obtained during excavations by Peter Wade-Martins, Norfolk Archaeol Unit. Historically, site is known to have been abandoned ca AD 840: radiocarbon dates help determine rate of infilling of shaft.

**956 ± 60**
**Q-1193. North Elmham, BB** **AD 994**

Twigs of hazel, birch and oak from Layer BB at base of cistern shaft, 5.6m below site datum.

**917 ± 60**
**Q-1194. North Elmham, AX** **AD 1033**

Twigs of unid wood from Layer AX near base of cistern shaft, 5.2m below site datum.

**904 ± 60**
**Q-1195. North Elmham, AG, AK** **AD 1046**

Twigs of unid wood from Layers AG to AK, 4.1 to 4.6m below site datum.

*General Comment*: dates for infilling twigs are inseparable statistically and suggest that cistern may have been used for 1½ to 2 centuries before abandonment, when it rapidly was filled with detritus. After calibration by Bristlecone Pine curve the dates appear to be, on historical evidence, approx a century late.

**Mesolithic Project**

The following 8 dates are initial results in a project begun by R M Jacobi and V R Switsur, both of Univ Cambridge, to study and date sites in the English Mesolithic. Sites range from Early to Late Mesolithic. Samples were accepted from several collectors but were very carefully selected; only those with a high probability of archaeol assoc with occupation sites were used. Contaminating substances that could have distorted results were removed by thorough physical and chemical pretreatment. This 1st series deals with sites in Pennine Range lying between 53° to 54°N.

**5850 ± 80**
**Q-788. March Hill, Marsden, Yorkshire** **3900 BC**

Burnt wood (53° 37′ N, 1° 58′ W, Nat Grid Ref SK/008128) at alt 412m from layer of burnt wood and burnt flint at base of pit 30cm deep in mineral soil, covered by stones and flint. Mesolithic flint waste surrounded pit in 15cm sand over mineral soil, all buried below 60cm peat. Excavated 1924 by F Buckley and stored in Tolson Mem Mus, Huddersfield, Yorkshire.

**8606 ± 110**
**Q-789. Warcock Hill, Marsden, Yorkshire** **6656 BC**

Burnt wood, oak and birch (53° 37 N, 1° 57′ W, Nat Grid Ref SK/032098) at alt 365m from Pit 5 dug into underlying shale and thin overlying gray sand on N side of Mesolithic workshop floor. Occurrence of peculiar gray banded flinty chert on floor and in pits suggested they were contemporary and dug during the occupation. Overlain by thin layer of peat. Excavated 1925 by F Buckley and stored in Tolson Mem Mus.

**Q-799. Dunford Bridge, W Riding, Yorkshire** **5380 ± 80**
**3430 BC**

Sandy charred wood fragments (53° 30′ N, 1° 48′ W) from 23cm depth in Mesolithic hearth in mineral soil separated by 15cm sand from intact overlying peat 1 m thick. Assoc with Mesolithic flint artifacts. Coll 1963 by J Radley, Royal Comm for Historic Monuments. See Radley *et al*, 1974.

**Q-800. Broomhead Moor, W Riding, Yorkshire** **8573 ± 110**
**6623 BC**

Small fragments of burnt wood (53° 25′ N, 1° 48′ W) with fire fractured chert stratified 7.5cm deep in sand beneath intact 1m thick blanket bog peat layer. Assoc with Mesolithic flint artifacts. Coll 1963 by J Radley. See Radley *et al*, 1974.

**Q-1116. Thorpe Common Rock Shelter (I)** **6433 ± 115**
**4483 BC**

Burnt wood (53° 18′ 30″ N, 1° 12′ 22″ W, Nat Grid Ref SK/529794) fragments (*Quercus*) id by R A Jones Univ Sheffield, from Hearth 'B' in Mesolithic occupation site at Thorpe Common Rock Shelter, 2km SE village of Thorpe Salvin, S Yorkshire. Coll Aug 1972 by P A Mellars, Univ Sheffield, partly '*in situ* and partly during sieving of material from hearth'. Hearth 'B' (Baulk 21) occupies lower part of deposits and is stratigraphically earlier than Hearth 'A'. Sample was 30cm below undisturbed surface and assoc with typical 'Geometric' industry.

**Q-1117. Thorpe Common Rock Shelter (II)** **6616 ± 220**
**4666 BC**

Burnt wood (53° 18′ 30″ N, 1° 12′ 22″ W, Nat Grid Ref SK/529794) fragments found *in situ* near base of Mesolithic deposits (Baulk 15). Coll Aug 1972 by P A Mellars. Wood id as either *Alnus* or *Corylus* by R A Jones.

**Q-1118. Thorpe Common Rock Shelter (III)** **5680 ± 150**
**3730 BC**

Bone fragments (53° 18′ 30″ N, 1° 12′ 22″ W, Nat Grid Ref SK/529794), some Red Deer (*Cervus Elaphus*), found immediately below large limestone block forming part of structure/wall at N end of site. Sample dates wall construction, unique in context of British Mesolithic, and latest occupation of the site (Baulk 15). Coll Aug 1972 by P A Mellars; id by G W Barker, Dept Ancient History, Univ Sheffield.

**Q-1127. Wetton Mill Rock Shelter, Staffordshire** **8847 ± 210**
**6897 BC**

Collagen extracted from bone fragments (53° 06′ N, 1° 51 W, Nat Grid Ref SK/096563) from Wetton Mill Minor Rock Shelter, Manifold Valley, Staffordshire. Bones chosen for proximity to Mesolithic flint artifacts. Indications are present of lengthy occupation of shelter from late glacial times to Bronze age. Coll 1967 to 1973 by J H Kelly, City Mus Hanley, Stoke on Trent, Staffordshire. See Switsur (1974c).

**The Udal series**

Excavations over 10 seasons at The Udal, 4km NE from Sollas on the Ard a' Mhorain peninsula, N Uist, Outer Hebrides (57° 38′ N, 7° 12′ W, Nat Grid Ref NF/824783) showed probable continuous occupation of area during preceding 4000 yr to ca 17th century AD. Site, Coileagan an Udail, (Sandhills of Udal), consists of 4 main dunes rising, with nearly vertical sides, 12.3m from the machair plain. Outer Hebrides machair is a plain 160km long of shell-sand forming W littoral of the Outer Isles. Despite considerable fluctuations of area in historic and prehistoric times, with its high lime content and ease of cultivation, it has been important for early settlement in Scotland as many sites indicate. At The Udal thick clay was deposited on a rock escarpment, where, in black earth, the earliest settlements took place. Subsequently, massive drifts of machair accumulated on this foundation suitable for later prehistoric settlement. On E of escarpment a large sand plateau built up, a foundation for further settlement. Erosion has left the area dispersed into isolated 'tells' and extreme sand blow in the 17th century caused final evacuation of site. Further erosion threatened the sites thus preserved in the machair. Excavations revealed at least 46 levels relative to 18 stratigraphic phases. Many artifacts were found, including shell (marine and terrestrial), bone (human, animal, and fish) with much pottery at all levels. A multi-disciplinary scientific study is being made in excavations.

The present series is part of a collaboration between I A Crawford and V R Switsur, Univ Cambridge, in determining main chronologic framework of site by radiocarbon dating. Samples of assoc pottery were coll to be dated by co-worker H McKerrell, using thermoluminescence to establish an independent absolute chronology and also a detailed comparison of the $^{14}C$ and Tl time scales over a 4000-yr period.

**1614 ± 120**
**Q-1131. The Udal (40)** **AD 336**

Collagen extracted from vertebrum of whale (*Mesoplodon Sowerbiensis*) from Level XIII which contains Norse artifacts.

**1353 ± 115**
**Q-1132. The Udal (39)** **AD 597**

Collagen extracted from bones of lamb and calf from inhumation beneath floor of building at Level $X_0$.

**3466 ± 120**
**Q 1133. The Udal (5)** **1516 BC**

Shell (unid) from Level $X_3$ containing Beaker type pottery. Date measured on $CO_2$ released from shell carbonate by dilute acid.

**3564 ± 100**
**Q-1134. The Udal (20) 1614 BC**

Collagen extracted from animal bones (unid), from Level $X_3$ contemporary with Q-1133.

**912 ± 150**
**Q-1135. The Udal (35) AD 1038**

Wood charcoal from Level $N_{IXc}$ obtained by sieving mixed materials after excavation.

**1091 ± 40**
**Q-1136. The Udal (34) AD 859**

Collagen extracted from pelvic bone of whale found in Level $N_X$, contemporary with Norse artifacts.

**1502 ± 80**
**Q-1137. The Udal (38) AD 448**

Collagen extracted from vertebrum of whale (*Balarna Glacialis*) found in Levels $N_{XI}$ and $N_{XII}$. This dates pre-Norse artifacts.

**853 ± 40**
**Q-1138. The Udal (36) AD 1097**

Wood charcoal from Level $N_{IXc}$ containing Norse artifacts.

**1271 ± 115**
**Q-1139. The Udal (37) AD 679**

Wood charcoal from Level $N_{Xb}$ assoc with pre-Norse artifacts.

*General Comment*: dates agree well with expected chronology of site and form a framework for dating other sites in Outer Hebrides and W Highlands of Scotland. For full discussion of chronology, see Crawford & Switsur, 1975. Comparison with thermoluminescence measurements will also be made.

**2602 ± 115**
**Q-761. Sands of Forvie, Aberdeenshire 652 BC**

Carbonized wood fragments (oak) from prehistoric village site (57° 18′ N, 1° 57′ W). From post hole of Hut E. Probably preserved by early waterlogging of site, which yielded much 'flat-rimmed' pottery, a widespread type of Scottish material as yet not properly dated.

**304 ± 70**
**Q-870. Holme Pierrepont, Nottinghamshire AD 1646**

Wood from brushwood layer of wooden structure of sharpened oak stakes, possibly part of flood bank. Found during gravel digging on S side of R Trent, Holme Pierrepont, Nottinghamshire (52° 57′ N, 1° 05′ W, Nat Grid Ref SK/628399), overlying gravel, covered by 1.5m silts and sands to present flood-plain surface. Excavated by M Ponsford and

A MacCormick, Nottingham Mus. Subm 1967 by H Godwin. *Comment*: confirms expected date of Medieval or later.

**835 ± 40**
**Q-1164. Ely Cathedral West Tower** **AD 1115**

Portion of timber tie, oak, embedded in 275cm thick masonry ca 36.6m above ground level in W tower of Ely cathedral, Ely, Cambridgeshire (52° 23′ 39″ N, 0° 15′ 20″ E, Nat Grid Ref TL/541802). Specimen covered by 15cm masonry. Timber may have been inserted at time of original building or later to correct chronic distress in 13th, 15th, or 18th centuries. Coll June 1973 by J Heyman, Engineering Dept, Univ Cambridge. *Comment*: conventional dates for construction of W tower bracket AD 1107 to 1189; sample age agrees.

**3250 ± 75**
**Q-1196. Denny Longbow, Falkirk** **1300 BC**

Oak wood from remains of longbow found in peat at Denny, Falkirk, Stirlingshire in 1889 (56° 1′ N, 4° 5′ W, Nat Grid Ref NS/768832) by A Frew and stored in Falkirk Mus. Sample coll by R W Feachem, Ordnance Survey; wood id by C A Dickson, Quaternary Research, Univ Cambridge. *Comment*: 1 of 5 bows from Britain; see Q-646: 4640 ± 120; Q-598: 4615 ± 120; Q-684: 3680 ± 110; Q-669: 3270 ± 110, but Denny longbow is unique in Europe, being made from oak wood. See Switsur (1974b).

**2253 ± 80**
**Q-1163. Washingborough Fen, Lincolnshire** **303 BC**

Birch wood from charred post (53° 14′ N, 0° 27′ W, Nat Grid Ref TF/042713) at junction of peat layers overlain by shelly deposit containing iron-age pottery, and human and animal bone at depth of 75cm below present surface. Coll April 1973 by J M Coles. *Comment*: precisely dates Iron age wares in area otherwise devoid of such occupation debris.

**2130 ± 40**
**Q-1173. Red Hill, Osea Road, Maldon, Essex** **180 BC**

Carbonized wood, remains of single small branch from 'Red Hill' Osea Road, Maldon (51° 43′ N, 0° 41′ E, Nat Grid Ref TL/887075), 1 of several 'Red Hills' on SE coast of England; remains of Roman or pre-Roman sites, where extensive salt making occurred. Sample presumably fuel for evaporation process. Few such sites have been explored adequately and precise age is doubtful despite range of assoc coarse pottery. Coll autumn 1972 during excavation by Colchester Archaeol Group. Subm by K de Brisay. *Comment*: site was probably used for long period and radiocarbon date is 1st independent age estimate of this industrial activity. Cf De Brisay (1973) and Switsur (1974a).

*B. Miscellaneous*

**Rio Ambi Valley, Ecuador series**

During building excavations in April 1957, on right bank of Rio Ambi, for new Otavalo electricity power sta, Imbabura Prov Ecuador (0° 15′ 55″ N, 78° 16′ 26″ W), alt 2450m, a fossilized human skeleton, in hunched semi-upright position was found by a workman, C Baca. Remains, from youngest of 4 fluvial terraces, were encased in coarse tuff cemented with calcium carbonate and stained with iron compounds from ground water. Bone cavities filled with calcium carbonate, interior of skull lined with thick adherent layer of aragonite crystals. Skeleton was in irregular cavity 65cm high by 30cm, possible a collapsed cave, at junction of alluvium and tuff ca 6m above river.

Remains may be important for Ecuadorian prehistory, but distortion of skull from overlying deposits and heavy encrustation precluded definite age decisions on anthropologic grounds. Sample coll from mus 1971; subm by D M Davies, Dept Zool, Univ College, London.

**29,023 ± 1800**
**Q-1032. Otavalo cranium, aragonite** **27,073 BC**

Aragonite crystalline deposit from interior lining of skull.

**28,012 ± 1750**
**Q-1033. Otavalo cranium, bone** **26,062 BC**

Mainly bone from crushed base of skull mixed with interstitial calcium carbonate.

*General Comment*: in each case $CO_2$ measured was evolved from sample by diluted mineral acid under reduced pressure. No collagen was recovered from remains. Dates agree with thermoluminescence date obtained by J H Fremlin, Dept Applied Radioactivity, Univ Birmingham, of 25,000 ± 3000 yr on aragonite crystals from interior of skull. This presumably dates crystal structure of the aragonite, laid down subsequently to death, and is independent of its chemical nature. Dates also agree with those of Univ Birmingham radiocarbon lab (Shotton & Williams, 1973) on similar material (Birm-331: 27,100 ± 700; 35,000 $^{+2240}_{-1770}$; Birm-332: > 36,000; Birm-360: 22,800 ± 300), but disagree with their dates on organic extract (Birm-331: 2300 ± 270; Birm-360: 2670 ± 150). Carbonate measured could be largely of magmatic origin.

**7280 ± 150**
**Q-1165. Upper Mashai peat** **5330 BC**

Peat from depth 2.5m from lowest of 5 peat layers in sec 3m deep, Mashai (29° 41′ S, 29° 5′ E) E Lesotho, Africa. Date needed to compare with others in area for stratified industrial assemblages in Lesotho. Coll 1971 by P L Carter, Dept Archaeol & Anthropol, Univ Cambridge. *Cf* Carter (1972; 1974).

**Q-1122. Csepel Island, Budapest** **4170 ± 90**
**2220 BC**

Charcoal fragments under ancient soil profile underlying dune of blown sand (47° 25′ N, 10° 5′ E) in pit 2, Hollandi St, Csepel Island, Hungary, between 2 arms of R Danube just S of Budapest, 200m from river on 4m terrace. Dated to establish beginning of Eneolithic—earliest Bronze age in E Central Europe and date for Bell Beaker culture. Coll Aug 1972 by N Kalicz. Subm by J M Coles and S J Shennan, Dept Archaeol & Anthropol, Univ Cambridge.

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[RADIOCARBON, VOL. 17, No. 1, 1975, P. 52-98]

# UNIVERSITY OF TEXAS AT AUSTIN RADIOCARBON DATES X

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This list reports $^{14}C$ measurements completed between August 1971 and November 1973. Other projects completed in that period will be reported later. Age calculations are based on $^{14}C$ half-life of 5568 yr and modern standard of 95% NBS oxalic acid, supplemented by tree rings of pre-industrial wood from a log cut in the 1850's (Tx-540; R, 1970, v 12, p 249). Deviations reported are based on counting statistics of sample, background, and modern, and are $\pm$ 1$\sigma$, except when sample count approaches either modern or background, 2$\sigma$ limits are reported. Unless noted, $^{12}C/^{13}C$ measurements were not made and results are not corrected for $^{13}C$ fractionation. The laboratory uses liquid scintillation counting of benzene, with $Li_2C_2$ and vanadium-activated catalyst in preparation; chemical yields average 90%. Three counters are employed: a Packard Tri-Carb Model 3002, and 2 Beckman LS-230 spectrometers obtained through a grant from the National Science Foundation.

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## I. GEOLOGIC SAMPLES

### *Texas*

All samples subm by C V Haynes, Dept Geol Sci, Southern Methodist Univ, Dallas, Texas, and pretreated at SMU Radiocarbon Lab (see below, under *Arizona*).

**44,360 ± 3420**
**Tx-1200. Seagoville, Texas** **42,410 BC**

Wood (5-45) from Gravel Pit B, 3.1 to 3.7m below surface of terrace, in gravel 0.6 to 0.9m below contact with overlying sand; 4km S of Seagoville, Texas (32° 36′ 05″ N, 96° 32′ 10″ W). Coll 1970 by E Williman.

**20,660 ± 350**
**Tx-889. Bois d'Arc Island, Texas** **18,710 BC**

Wood fragments from sand-clay lens in gravel channel fill, ca 4.6m below flood plain, Bois D'Arc I gravel pit, SE Dallas Co, Texas (32° 35′ 10″ N, 96° 33′ 20″ W). Coll 1969 by Slaughter & Haynes.

**Tx-890. Gifford Hill Gravel Pit, Texas** **21,540 ± 3010**
**19,590 BC**

Wood and seed pods (*Ambrosia*) from clay lens in channel sand ca 3.7m from surface, NE wall of Gifford Hill No. 2 gravel pit, on Parsons Slough, SE Dallas Co, Texas (32° 33′ 50″ N, 96° 31′ 25″ W). Coll 1969 by Slaughter & Haynes.

*Arizona*

All samples in this section (and others in this list as noted) were subm by C V Haynes, Dept Geol Sci, Southern Methodist Univ, Dallas, Texas, and were pretreated at the SMU Radiocarbon Lab before combustion and counting facilities had been installed there.

All peat and soil samples were pretreated to separate insoluble organic residues from humic acids precipitated and analyzed as sodium humates (1st humate extraction). Some samples yielded 2nd and 3rd humate extractions upon retreatment with HCl and NaOH. Where multiple humate fractions were analyzed they were within $1\sigma$ of each other in each case.

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**Murray Springs series, Arizona**

The Murray Springs site (31° 34′ N, 110° 11′ W), 11.3km E of Sierra Vista, Cochise Co, Arizona (Ariz: EE:8:25) is a buried Clovis hunting camp and kill site where artifacts assoc with mammoth, bison, and horse occur within a sequence of late Quaternary sediments. Investigations supported by Natl Geog Soc (Archaeol) and Natl Sci Found (Geol). Coll 1966 through 1971 by C V Haynes.

**Tx-1174. Bone apatite $CO_2$ 4-3** **340 ± 370**
**Modern**

Bone of early historic bison from N headcut at Pollen Profile 1, on contact between Units $G_2$ and H. *Comment* (CVH): seems less contaminated by nuclear age carbon than 5 previously dated fractions (A-819A through A-819E: R, 1971, v 13, p 5).

**Tx-1196. Insoluble soil organic matter 14-54A** **1340 ± 120**
**AD 610**

**Tx-1197. Humates 14-54B2** **1570 ± 80**
**AD 380**

Gray soil on Unit E and buried by Unit H in S wall of Curry Draw opposite Pollen Profile 6. *Comment* (CVH): older age is probably minimum for soil development.

**Tx-1046. Humates (2nd extraction) 4-28BB** **8620 ± 160**
**6670 BC**

Organic clay of lower Unit $F_3$ at M24, Trench 12.

**Tx-1173. Humates (1st extraction) 14-23B1** — **9100 ± 290** / **7150 BC**

Organic clay from base of $F_3$ channel, N headcut, at intersection with Trench 22. *Comment* (CVH): date may be too old by > 1$\sigma$ due to redeposition from Unit $F_2$.

**Tx-1234. Marl carbonate 14-51** — **10,480 ± 200** / **8530 BC**

10cm sec (32V70) of Unit E marl, 10cm below top of exposure in E end of S wall of Trench 1.

**Tx-1235. Marl carbonate 14-52** — **13,310 ± 190** / **11,360 BC**

10cm sec (33V70) of Unit E marl, 50cm below top of exposure in E end of S wall of Trench 1.

**Murray Springs Locality 1 series**

**Tx-936. Upper $G_1$ channel** — **5630 ± 130** / **3680 BC**

Humates from charcoal or decomposed wood in upper $G_1$ channel, E wall. *Comment* (CVH): date consistent with A-905A, 5750 ± 250 (R, 1971, v 13, p 34) from lower part of channel.

**Tx-937. Unit $G_3$ hearth** — **840 ± 60** / **AD 1110**

Charcoal from non-ceramic rock hearth on Unit $G_3$ on present surface. An archaeomagnetic date is also to be determined for this hearth.

**Tx-971. Unit $F_3$, caliche** — **7920 ± 150** / **5970 BC**

Hard carbonate particles in $F_3$ calcareous silt, 20cm above upper black mat, E wall. *Comment* (CVH): date is reasonable for time of secondary accumulation of $CaCO_3$.

**Tx-972. Unit $F_3$, whole rock** — **8160 ± 130** / **6210 BC**

Same as Tx-971, but whole rock. *Comment* (CVH): in conjunction with Tx-971, date suggests secondary deposition of caliche nodules.

**Murray Springs Unit $F_1$ series**

**Tx-1044. Charcoal 4-29A** — **12,600 ± 2440** / **10,650 BC**

Area 5 Clovis occupation surface, Sq K 18, 104cm W of L 18 line. *Comment* (CVH): sample very small but result is within 1$\sigma$ of other dates from Clovis occupation.

**Tx-1045. Humates 4-29B** — **10,260 ± 140** / **8310 BC**

Extracted from Tx-1044. *Comment* (CVH): probably contaminated with humates from overlying organic clay ($F_2$).

**12,940 ± 390**
**Tx-1406. Charcoal 23-15** **10,990 BC**

Charcoal, $F_1$ channel sand, Area 1, Grid Point C3S.

**11,080 ± 180**
**Tx-1413. Charcoal 23-17+18** **9130 BC**

Charcoal, $F_1$ channel sand, Area 1, Grid Point C5S.

**10,710 ± 160**
**Tx-1459. Charcoal 23-26** **8760 BC**

Charcoal, $F_1$ channel sand, 5cm below $F_2$, N wall natural exposure, S Branch Curry Draw.

**9790 ± 160**
**Tx-1460. Humates (1st extraction) 23-21b1** **7840 BC**

**9850 ± 160**
**Tx-1461. Humates (2nd extraction) 23-21b2** **7900 BC**

Humates from charcoal in clay at top of Unit $F_1$, Trench 28, N branch, Curry Draw. *Comment* (CVH): obviously contaminated by younger humates. Charcoal too small to analyze.

**10,930 ± 170**
**Tx-1462. Charcoal 23-19** **8980 BC**

From $F_1$ channel sand, Trench 28, N branch, Curry Draw.

**10,900 ± 200**
**Tx-1463. Humates 23-19b1** **8950 BC**

Humates from Tx-1462.

**Murray Springs Trench 18, Area 8 series**

**7430 ± 100**
**Tx-1178A. Insoluble organic matter** **5480 BC**

**7110 ± 140**
**Tx-1178B. Humates (1st extraction)** **5180 BC**

**6980 ± 180**
**Tx-1179. Humates (2nd extraction)** **5030 BC**

Upper of 5 clay samples (20-16A1:1, 24A70) from Unit $F_2$, Trench 18, Area 8 between spring conduits 1 and 3. *Comment* (CVH): humate fractions appear to be too young by at least $1\sigma$.

**10,260 ± 430**
**Tx-1180. Insoluble organic matter** **8310 BC**

**9410 ± 160**
**Tx-1181. Humates (1st extraction)** **7480 BC**

**9240 ± 270**
**Tx-1182. Humates (2nd extraction)** **7290 BC**

Lowest of 5 clay samples (20-20A, 28A70) in Unit $F_2$, Trench 18, Area 8 between spring conduits 1 and 3. *Comment* (CVH): humate fractions appear to be too young by as much as $2\sigma$.

**Murray Springs Trench 13 N series**

**Tx-1183. Insoluble organic matter** — **9810 ± 570** / **7860 BC**

**Tx-1184. Humates (1st extraction)** — **9570 ± 370** / **7620 BC**

**Tx-1185. Humates (2nd extraction)** — **9980 ± 360** / **8030 BC**

Lowest of 4 black organic clay layers (20-36A, 44A70) in $F_2$ at Trench 13 N. *Comment* (CVH): agreement of all 3 fractions suggests correct age, but with respect to rest of series it appears too young by as much as $2\sigma$.

**Tx-1237. Marl carbonate 20-38** — **9660 ± 150** / **7710 BC**

Middle of 3 samples (46A70) from lowest of 4 layers of $F_2$ marl, Trench 13 N.

**Tx-1238. Marl carbonate 20-39** — **9810 ± 150** / **7860 BC**

Upper of 3 samples (47A70) from lowest of 4 layers of $F_2$ marl, Trench 13 N.

**Tx-1239. Marl cabonate 20-41** — **9310 ± 150** / **7360 BC**

Lower intermediate marl (49A70) in $F_2$, Trench 13 N. *Comment on Tx-1237-1239* (CVH): marl carbonate dates show good internal consistency with stratigraphic age.

**Tx-1252. Insoluble organic matter 20-40A** — **10,480 ± 960** / **8530 BC**

**Tx-1253. Humates (1st extraction) 20-40B1** — **9560 ± 150** / **7610 BC**

Lower intermediate black clay (48A70) in $F_2$, Trench 13 N. *Comment* (CVH): humate date is probably correct within $2\sigma$.

**Tx-1247. Insoluble organic matter 20-42A** — **5050 ± 2030** / **3100 BC**

**Tx-1248. Humates 20-42B** — **9820 ± 160** / **7870 BC**

Upper intermediate black clay (50A70) in $F_2$, Trench 13 N. *Comment* (CVH): insoluble organic fraction was too small.

**Tx-1241. Insoluble organic matter 20-43A** — **10,200 ± 680** / **8250 BC**

**Tx-1242. Humates (1st & 2nd extractions) 20-43B2** — **8600 ± 240** / **6650 BC**

**Tx-1243. Humates (3rd extaction) 20-43B3** — **8940 ± 210** / **6990 BC**

**Tx-1240. Marl carbonate 20-43C** **9240 ± 140**
**7290 BC**

Upper intermediate marl (51A70) in $F_2$, Trench 13 N. *Comment* (CVH): humate fractions seem to agree better with marl carbonate.

**Tx-1186. Insoluble organic matter 20-44A** **10,580 ± 3500**
**8630 BC**

**Tx-1187. Humates (1st extraction) 20-44B1** **8870 ± 140**
**6920 BC**

**Tx-1188. Humates (2nd extraction) 20-44B2** **8580 ± 240**
**6630 BC**

Highest of 4 black organic clay layers (52A70) in $F_2$ at Trench 13 N. *Comment* (CVH): considering rest of series and standard deviations, humate fractions are probably closest to correct age.

**Tx-1245. Insoluble organic matter 20-45A** **10,800 ± 1700**
**8850 BC**

**Tx-1246. Humates 20-45B** **8820 ± 250**
**6870 BC**

**Tx-1244. Marl carbonate 20-45C** **8980 ± 140**
**7030 BC**

Highest of 4 marls in $F_2$, Trench 13 N. *Comment* (CVH): humate fraction agrees best with carbonate fraction.

**Tx-1189. Insoluble organic matter 20-47A** **9640 ± 180**
**7690 BC**

**Tx-1190. Humates (1st extraction) 20-47B1** **9630 ± 310**
**7680 BC**

**Tx-1191. Humates (2nd extraction) 20-47B2** **9450 ± 180**
**7500 BC**

Lowest of 3 clay samples (55A70) in Unit $F_3$ channel at Trench 13 N. *Comment* (CVH): agreement of these 3 values indicates $F_3$ channel was cut and Unit $F_2$ was redeposited after this time.

**Tx-1249. Insoluble organic matter 20-49A** **7410 ± 610**
**5460 BC**

**Tx-1250. Humates (1st extraction) 20-49B1** **9320 ± 200**
**7870 BC**

**Tx-1251. Humates (2nd extraction) 20-49B2** **9020 ± 190**
**7070 BC**

Intermediate of 3 clay samples (57A70) in $F_3$ channel at Trench 13 N. *Comment* (CVH): humate dates are consistent with $F_3$ channel fill being redeposited from Unit $F_2$. Insoluble organic matter date may be correct within $1\sigma$.

**9200 ± 440**
**Tx-1192. Insoluble organic matter 20-50A** **7250 BC**

**8090 ± 130**
**Tx-1193. Humates (1st extraction) 20-50B1** **6140 BC**

Upper of 3 clay samples (58A70) in $F_3$ channel at Trench 13 N. *Comment* (CVH): older value probably contains redeposited $F_2$, and younger one may contain younger humates but is probably closer to true age.

**Grass Circle Trench series, Arizona**

Circular depression (31° 33′ 40″ N, 110° 10′ 05″ W) on pediment surface 1.4km S of Murray Springs, Cochise Co, Arizona, contains sediments and compound soils and supports 17ha of desert grassland within an area of Chihuahuan desert shrub. Coll 1968 by C V Haynes.

**1890 ± 130**
**Tx-1176. Insoluble soil organic matter 13-3A** **AD 60**

Upper sample from black soil, 0.3m below surface at 20+00E.

**3020 ± 90**
**Tx-1177. Humates (1st extraction) 13-3B1** **1070 BC**

Humates from Tx-1176.

**4340 ± 140**
**Tx-1175. Insoluble soil organic matter 13-2A** **2390 BC**

Lower sample from black soil, 0.6m below surface at 20+00E.

**Location 63a series, Arizona**

Humates from relict B-horizon at location 63a (79H69), 0.4km N of mouth of Horsethief Draw, 12.9km E of Sierra Vista, Cochise Co, Arizona (31° 33′ N, 110° 08′ W). Coll 1969 by C V Haynes.

**530 ± 190**
**Tx-1232. Humates 14-29B1 & 2** **AD 1420**

12.2m strath terrace.

**680 ± 240**
**Tx-1233. Humates 14-30B1** **AD 1270**

18.3m strath terrace.

**Graveyard Gulch series, Arizona**

Cochise hearths exposed in walls of Graveyard Gulch, 16km NE of Sierra Vista, Arizona (31° 38′ N, 110° 11′ W). Coll 1968 by C V Haynes.

**4810 ± 90**
**Tx-1038. Hearth #1, 3-13** **2860 BC**

Charcoal from hearth, ca 5.5m below top of 8m terrace and in lower part of red silt of Unit $G_1$.

**Tx-1048. Hearth #2, 13-15** — **5790 ± 360** — **3840 BC**

Charcoal from Cochise hearth below erosional contact truncating soil in red fill of Unit $G_1$.

**Tx-1049. Hearth #3, 13-16** — **4020 ± 80** — **2070 BC**

Charcoal from hearth above contact truncating soil in red fill.

**Lindsey Ranch series, Arizona**

Samples from Lindsey Ranch, Cochise Co, Arizona (31° 38′ 10″ N, 110° 09′ W). Coll 1968 by C V Haynes.

**Tx-970. Marl carbonate** — **7990 ± 130** — **6040 BC**

Marl from below black organic mat, on surface. *Comment* (CVH): date younger than expected, probably because of contamination by exchange.

**Tx-934. Organic residue** — **9420 ± 470** — **7470 BC**

Black organic mat from surface outcrop; black mat ($F_2$?) occurs above marl (E?) and below tan silt ($G_1$?). *Comment* (CVH): age probably minimum because of unknown content of rootlet contamination too small to be removed.

**Tx-935. Humates** — **7060 ± 310** — **5110 BC**

Humates from black organic mat (see Tx-934). *Comment* (CVH): value indicates significant contamination by younger humates.

**Cerros Negros marl series**

Samples of marl from Cerros Negros site, 6.4km SE of San Manuel, Arizona (32° 32′ N, 110° 33′ W). Coll 1968 by N M Johnson and C V Haynes. Samples listed in stratigraphic order from top to bottom of sec.

**Tx-976. Marl carbonate, 98H69** — **13,630 ± 200** — **11,680 BC**

**Tx-977. Marl carbonate, 97H69** — **12,190 ± 210** — **10,240 BC**

**Tx-975. Marl carbonate, 94H69** — **16,160 ± 210** — **14,210 BC**

**Tx-979. Marl carbonate, 89H69** — **21,190 ± 520** — **19,240 BC**

**Tx-978. Marl carbonate, 86H69** — **26,180 ± 960** — **24,230 BC**

**Tx-974. Marl carbonate, 79H69** **27,410 ± 1120**
**25,460 BC**

Very pale brown (white) clayey marl near base of sec and below erosional (?) break.

**Tx-973. Marl carbonate, 76H69** **27,060 ± 1080**
**25,110 BC**

Basal portion of sec.

*General Comment* (CVH): considering $\sigma$ values and possible contamination by exchanged $CO_2$, the series is reasonably consistent.

**Tx-1236. Curry Draw, 35V70** **10,750 ± 170**
**8800 BC**

Marl carbonate (14-53) from 1m below top of Unit E marl in headcut of S tributary of Curry Draw between Murray homesite and Tombstone aqueduct, Cochise Co, Arizona (31° 34′ 37″ N, 110° 09′ 56″ W). Coll 1970 by C V Haynes.

**Tx-933. Horsethief Draw** **2550 ± 80**
**600 BC**

Charcoal from middle of $G_{2b}$, Horsethief Draw alluvial fan, Cochise Co, Arizona (31° 32′ 30″ N, 110° 8′ 45″ W). Coll 1969 by C V Haynes. *Comment* (CVH): confirms San Pedro age of hearth and correlation to Unit $G_{2b}$ at Murray Springs.

**Tx-938. Schaldack Site Rock Hearth** **1670 ± 80**
**AD 271**

Charcoal from rock hearth on surface at Schaldack site, Cochise Co, Arizona (31° 35′ 42″ N, 110° 11′ 20″ W). Should date late San Pedro occupation. Coll 1968 by C V Haynes. *Comment* (CVH): date suggests that late San Pedro phase persisted into ceramic period but remained non-ceramic.

**Tx-939. Dubois Hearth** **1730 ± 140**
**AD 220**

Charcoal from hearth on surface S of Schaldack site, Arizona (31° 35′ 30″ N, 110° 11′ 20″ W). Archeomagnetic dating of sample from this hearth is planned. Coll 1968 by C V Haynes. *Comment* (CVH): same as with Tx-938 (above), with which date agrees.

**Tx-1037. Moson Wash, S Tributary, 3-4** **2780 ± 80**
**830 BC**

Hearth charcoal from ca 13km NE of Sierra Vista, Arizona (31° 35′ 43″ N, 110° 10′ 40″ W), 1m below top of 4m terrace, G2a/G2b(?) contact; Cochise style hearth.

**Tx-1039. Aqueduct locality, 3-14.** **1420 ± 120**
**AD 530**

Charcoal from ceramic period hearth from Unit G2b2, at Aqueduct loc, Arizona (31° 34′ 14″ N, 110° 9′ 10″ W).

**Tx-1040. East Side Arroyo, 3-15** **3580 ± 90**
**1630 BC**

Hearth charcoal from ca 1.2km S of Arizona Hwy 90 and 0.8km W of E boundary of San Rafael Grant, Arizona (31° 32′ 35″ N, 110° 7′ 15″ W), in banded reddish-brown and gray alluvium of Unit $G_{2a}$, 1.8m below top of 3m terrace.

**Tx-1041. Schaldack Wash, 3-16** **1090 ± 70**
**AD 860**

Hearth charcoal from ca 9.5km NE of Sierra Vista, Arizona, on surface between Schaldack site and Woodcutter Draw (31° 35′ 40″ N, 110° 11′ 55″ W).

**Tx-1042. Schaldack Wash, 3-17** **3380 ± 350**
**1430 BC**

Charcoal from surface hearth, same site as Tx-1041, base of reddish-brown clayey silt ($G_{2a}$?).

**Tx-1043. Boquillas North Arroyo, 3-21** **2860 ± 80**
**910 BC**

Hearth charcoal from N bank of deep arroyo ca 1.6km NW of old Boquillas rr sta, Arizona (31° 47′ N, 110° 14′ W), 1.8m below top of 4m terrace of Unit $G_2$.

**Tx-1047. Lehner Ranch 5-18B** **3770 ± 60**
**1820 BC**

Humates from red soil at top of Unit $G_2$, Trench B, Lehner Ranch, ca 6.5km NNE of Palominas, Arizona (31° 25′ 23″ N, 110° 06′ 48″ W).

**Tx-1194. Southern Pacific RR Sec 1048** **2050 ± 90**
**100 BC**

Charcoal (13-28) from occupation surface with human burial 0.9m below top of 3m terrace, 0.8km E of abandoned rr sta of Boquillas and 20.9km S of Benson, Cochise Co, Arizona (31° 47′ N, 110° 13′ W). Coll 1970 by S Haney.

**Tx-1198. Millville Relict Paleosol, Loc 59** **1590 ± 180**
**AD 360**

Humates (14-24B1), from B horizon of 0.3m red soil in roadcut on S side of Charleston rd, opposite ruins of Millville, Cochise Co, Arizona (31° 37′ N, 110° 09′ W). Coll 1969 by C V Haynes. *Comment* (CVH): residue contained no carbon. Humates probably derive from overlying soils.

**Tx-1199. Double Adobe** **8920 ± 1150**
**6970 BC**

Charcoal (15-43A) from fine gravel, coarse sand alluvium (Unit b) containing rolled mammoth bones. Ca 400m S of Double Adobe store, in W bank of Whitewater Draw, Arizona (31° 28′ N, 109° 42′ W). Coll 1970 by C V Haynes.

**Snaketown series, Arizona**

Samples from Snaketown site on Gila R CW of Chandler, Arizona (33° 10′ 45″ N, 111° 55′ 22″ W).

**Tx-888. Snaketown St-9, flood plain** **530 ± 80**
**AD 1420**

Charcoal, 7.82m below datum (65cm below surface), 26m from S end of Flood-plain Trench 1; at contact between loose, weakly laminated sand below and grayish-tan silty clay above. Dated for comparison of flood-plain deposition to age of occupation. Coll 1965 by C V Haynes.

**Tx-891. Snaketown canal** **1580 ± 60**
**AD 370**

Tufa ($CaCO_3$) from lining of Hohokam irrigation canal (Trench I) and coating pottery of types dating AD 1350 to 1400; between Units X and Y. Dated to determine apparent age and $^{14}C$ deficiency, if any. Sample was split and 2 parts prepared and counted separately: 1650 ± 80, 1510 ± 90. Average $\delta^{14}C = -178.3 \pm 4.2‰$. Coll 1969 by E W Haury. *Comment* (CVH): data suggest that there is a "fossil" component in water which could have been derived from springs.

*New Mexico*

All samples in this section were subm by C V Haynes and pretreated at Southern Methodist Univ Radiocarbon Lab as described above under *Arizona.*

**Capulin Mountain Flow series, New Mexico**

Burnt paleosol from S bank of Dry Cimarron R (CS-70-17), under basalt flow from Capulin Mt, 1.61km W of Folsom, Union Co., New Mexico (36° 51′ N, 104° 56′ W). Coll 1970 by C V Haynes.

**Tx-1268. Insoluble soil residue 17-12A** **22,360 ± 1160**
**20,410 BC**

**Tx-1269. Soil humates 17-12B2** **13,860 ± 2170**
**11,910 BC**

*Comment* (CVH): residue date should be minimum for soil, provided there was no contamination from volcanic $CO_2$.

**Folsom Site series, New Mexico**

Materials recovered from area of Folsom site arroyo (FEP70-6) near Folsom, New Mexico (36° 53′ N, 104° 04′ W). Coll 1970 & 1971 by Adrienne Anderson, Natl Park Service, and C V Haynes.

**Tx-1270. Charcoal 17-10** **4850 ± 120**
**2900 BC**

Charcoal sample (CS-70-14) from red burnt layer in Unit Qyla, ca 0.4km downstream from Folsom type site, 12.9km WNW of Folsom.

**Tx-1271. Charcoal 17-11** **6910 ± 110**
**4960 BC**

Charcoal (CS-70-16) from buried fire pit near top of Unit Qy, ca 0.4km S of Folsom type site on main draw.

**Tx-1272. Wood and charcoal 17-8** **4470 ± 90**
**2520 BC**

Charred wood and charcoal sample (CS-70-13) from upper Unit Qyla, ca 0.4km downstream from Folsom type site and 12.9km WNW of Folsom.

**Tx-1452. Charcoal 17-9** **6060 ± 500**
**4110 BC**

Charcoal sample from base of Qo2, upstream from Folsom type site, 11.3km NW of Folsom.

*California, Wyoming*

**Tx-1195. Little Lake Borrow Pit, 3C70, California** **1420 ± 70**
**AD 530**

Charcoal (19-46) from hearth lens 1.5m below surface of 2.1m terrace within alluvial fan, ca 400m NW of Little Lake Hotel, Little Lake, California (35° 50′ N, 117° 50′ W). Coll 1970 and subm by C V Haynes, and pretreated at Southern Methodist Univ Radiocarbon Lab.

**Hell Gap series, Wyoming**

Charcoal from Hell Gap site, 19.3km N of Guernsey, Wyoming (42° 25′ N, 104° 38′ W). Coll 1966 and subm by C V Haynes, and pretreated at Southern Methodist Univ Radiocarbon Lab.

**Tx-1464. Hell Gap 5-2** **290 ± 80**
**AD 1660**

Upper of two bands in loose brown silt and gravel, bands 0.3m apart in arroyo wall by gas tank.

**Tx-1465. Hell Gap 5-3** **300 ± 90**
**AD 1650**

Hearth, 10.2 to 15.2cm below top of 1.5m terrace and just under grass roots, S of Loc II.

*Missouri*

All samples subm by C V Haynes and pretreated at Southern Methodist Univ Radiocarbon Lab as described above under *Arizona*.

**Boney Springs series, Missouri**

Samples from Boney Springs site (23BE146), 4km NW of Avery and 18.1km N of Wheatland, Benton Co, Missouri (38° 06′ 20″ N, 93° 22′ 10″ W). Coll 1971 by R B McMillan and C V Haynes.

**Tx-1407. Peat humates 22-6B** **28,330 ± 3140**
**26,380 BC**

Humates from top of brown pebbly peat, Trench A, Pollen Profile I, between pollen samples +2 and +3.

**Tx-1408. Plant fragments 22-6c** **22,730 ± 590**
**20,780 BC**

From same location as Tx-1407.

**Tx-1409. Plant fragments 22-7c** **26,440 ± 1170**
**24,490 BC**

From base of brown pebbly peat, Trench A, Pollen Profile I, between pollen samples 0 and −2.

**Tx-1410. Wood 22-5** **21,380 ± 500**
**19,430 BC**

Wood fragments from upper third of olive organic clay, Trench A, 1.3m W of Pollen Profile I.

**Tx-1466. Charcoal 22-1,2,3,4** **7290 ± 1900**
**5340 BC**

Dispersed charcoal from blue clay matrix on bone bed near center of spring.

**Tx-1467. Peat 22-9AB2** **24,460 ± 10,000**
**22,510 BC**

Organic residue and humates from base of lowest peat in Trench A.

**Tx-1468. Humates 22-9B1** **27,480 ± 1950**
**25,530 BC**

From base of lowest peat in Trench A.

**Tx-1469. Wood 22-24** $\delta^{14}C = +7.50 \pm 5.3‰$

From middle of very dark brown peat, 1.75m below datum.

**Tx-1470. Humates 22-25b1** **1910 ± 80**
**AD 40**

From charcoal, middle of very dark brown-gray organic clay.

**Tx-1471. Wood 22-26** **1900 ± 80**
**AD 50**

Wood from middle of very dark brown-gray organic clay in 480 NW 515.

**Tx-1472. Wood 22-28** **1920 ± 50**
**AD 30**

Wood from pit in middle of very dark brown-gray organic clay in 480 NW 515.

**Tx-1473. Tufa carbonate 22-30c** **28,230 ± 940**
**26,280 BC**

Tufa from base of feeder just under bone bed in center of spring.

**Tx-1629. Moss 22-30a** **16,190 ± 400**
**14,240 BC**

Moss encased in pseudomorphic tufa jackets of Tx-1473.

**Tx-1474. Wood 22-8** **20,300 ± 470**
**18,350 BC**

Wood from peat at top of olive organic clay in Trench A between pollen samples +9 and +10.

**Tx-1475. Humates 22-8b1** **17,320 ± 1810**
**15,370 BC**

Humates from peat at top of olive organic clay in Trench A between pollen samples +9 and +10.

**Tx-1476. Humates 22-862** **19,550 ± 1080**
**17,600 BC**

Humates from peat (2nd extraction), sample in Tx-1475.

**Tx-1477. Wood 22-31** **16,490 ± 290**
**14,540 BC**

*Picea* wood from granular tufa in spring feeder below bone bed.

**Tx-1478. Wood 22-32** **16,540 ± 170**
**14,590 BC**

Wood from feeder wall under bone bed.

**Tx-1479. Wood 22-33** **20,710 ± 530**
**18,760 BC**

Wood (*Salix* or *Populus*) from base of olive gray clay of lower peat at base of spring feeder.

**Koch Spring series, Missouri**

Samples from Koch Spring site, 3.2km SE of Avery and 13.3km NNE of Wheatland, Hickory Co, Missouri (38° 03′ N, 93° 20′ W). Coll 1971 by C V Haynes.

**Tx-1411. Wood 22-10** **620 ± 80**
**AD 1330**

Wood fragments from Trench V-5, top of black, clayey peat.

**Tx-1412. Plant fragments 22-15** **31,880 ± 1340**
**29,930 BC**

Plant fragments from middle of brown pebbly clayey peat Trench V-1N, Pollen Profile V #10.

**Tx-1453. Wood 22-11** **640 ± 60**
**AD1310**

Wood recovered from base of peat in Trench V-5.

**Tx-1454. Wood 22-12** **840 ± 60**
**AD 1110**

Wood recovered from gray organic clay below peat in Trench V-5.

**Tx-1455. Humates 22-16B** **30,880 ± 1320**
**28,930 BC**

Humates from brown pebbly clayey peat, between samples 12 and 13, Trench 1 N, Pollen Profile V.

**Tx-1456. Wood 22-17** $\delta^{14}C = +43.88 \pm 5.7‰$

Wood from bottom 20cm of middle of dark brown clayey peat in Trench V-5, Pollen Profile VII.

**Tx-1457. Wood 22-18** **>38,000**

Wood recovered from peat, from middle of grayish brown organic clay in Trench 1 N, Pollen Profile V.

**Tx-1458. Wood 22-18B** **33,550 ± 3210**
**31,600 BC**

Humates from peat in Tx-1457.

**Jones Bog series, Missouri**

Samples from Jones Bog, 1.6km ESE of Avery School, Missouri (38° 03′ 25″ N, 93° 20′ 22″ W). Coll 1971 by C V Haynes.

**Tx-1626. Humate (2nd extraction) 22-22b2** **39,020 ± 2600**
**37,070 BC**

From base of peat exposed in W extension of backhoe trench through pond.

**Tx-1627. Humates & plant fragments, 22-21ab1** **>40,000**

From top of peat exposed by backhoe.

**Tx-1628. Wood fragments, 22-23a** **>40,000**

From olive gray sands below peat exposed by backhoe.

*General Comment* (CVH): entire peat layer is probably beyond range of radiocarbon dating.

## II. OCEANOGRAPHIC SAMPLES

### *Texas*

**Oolite Coating Series II, S Texas coast**

Samples of 2ϕ oolite (sand grains coated with concentric $CaCO_3$ coatings) from present beach sand in swash zone, shore of Azalan Bay, 3.3km NE of mouth of Cayo del Infiernillo, Laguna Madre, S Texas coast (27° 20′ 30″ N, 97° 32′ 15″ W). Dated in continuing study of time and rate of oolitic coatings. Present samples have different mineralogy and crystal orientation from those previously examined (R, 1970, v 12, p 619-620).

Oolitic coatings were removed by first calculating volume of 3N HCl necessary to dissolve desired weight of $CaCO_3$ from previously weighed sand sample. In Tx-1076 coatings were stripped serially. For complete statement of technique see Frishman (1969).

Samples coll 1969 by Frishman and Behrens; subm by E W Behrens, Univ Texas Marine Sci Inst, Port Aransas, Texas.

**Tx-1075. 2AB(2)TOT$_1$** **Modern**

$\delta^{14}C = +1.2 \pm 6.6‰$ *% modern* $= 100.2 \pm .66$

35g $CaCO_3$ (most of coatings) dissolved from 95.6 total oolite by 233ml 3N HCl. *Comment* (EWB): modern age results fortuitously from mixture of positive bomb-created carbon and negative older carbon.

**500 ± 60**

**Tx-1077. 2AB(2)TOT$_2$** **AD 1450**

$\delta^{14}C = -59.9 \pm 5.6‰$ *% modern* $= 94.00 \pm .56$

50g oolite dissolved in excess of 3N HCl. *Comment* (EWB): greater apparent age than Tx-1075, because sample includes even older material dissolved in excess acid.

**Tx-1076A. 2AB(2)a: 1st fraction** **Modern**

$\delta^{14}C = +95.6 \pm 7.1‰$ *% modern* $= 109.56 \pm .71$

Outer oolitic coatings. Total oolite in Tx-1076 = 382.5g.

**190 ± 60**

**Tx-1076B. 2AB(2)b: 2nd fraction** **AD 1760**

$\delta^{14}C = -23.0 \pm 5.7‰$ *% modern* $= 97.70 \pm .57$

**600 ± 70**

**Tx-1076C. 2AB(2)c: 3rd fraction** **AD 1350**

$\delta^{14}C = -71.4 \pm 5.5‰$ *% modern* $= 92.86 \pm .55$

**730 ± 70**

**Tx-1076D. 2AB(2)d: 4th fraction** **AD 1220**

$\delta^{14}C = -86.6 \pm 5.4‰$ *% modern* $= 91.34 \pm .54$

Inner oolitic coatings.

*General Comment* (EWB): dates very similar to, and confirm data from earlier series, showing that: 1) oolitic sands at this site, like previous site, formed in 1000 yr; 2) formation was sporadic; 3) formation was very active during past 15 yr, since nuclear weapons testing caused high positive $^{14}C$ anomalies in environment. Present samples also show that oolites of different mineralogies (one predominantly aragonite and one predominantly Mg-calcite) formed during same period, and that one type of oolite apparently does not form by alteration of the other.

### *Jamaica*

**Reef Crest series, Jamaica**

Samples of coral aragonite ($CaCO_3$) from reef crest, midway between Discovery Bay Marine Lab and Kaiser Ship Channel, Discovery Bay, Jamaica (18° 27′ 12″ N, 77° 24′ 0″ W). Coll 1970 and subm by L S Land, Dept Geol Sci, Univ Texas, Austin. Depths are below sea level.

**5300 ± 80**

**Tx-1168. Reef Crest, Hole 1** **3550 BC**

*Acropora palmata* samples n, o, p, q of 18 samples, a through r, recovered from —4.27 to —5.49m; presumably from —4.88 to —5.49m. Water depth 0.6m on low tide. Part of present reef framework.

**Tx-1169. Reef Crest, Hole 2** **5050 ± 100** **3100 BC**

*Acropora palmata* and *Montastrea annularis* samples 0 and r of 22 samples, a through r, from —1.21 to —4.27m; presumably from —3.35 to —4.27m. Last 1.21m recovered Pleistocene, thus these samples overlie Pleistocene unconformity. From present reef framework, water depth 1.21m.

**Tx-1170. Reef Crest, Hole 3** **470 ± 70** **AD 1480**

*Montastrea annularis* samples 9-12 of 28 samples, 1-12, recovered from —1.10 to —2.44m. Immediately overlying Pleistocene unconformity. Water depth 1.07m.

*General Comment* (LSL): samples record Recent rise of sea level along coast of N Jamaica, assuming that reef corals colonized Pleistocene limestone substrate as soon as it was submerged.

**Discovery Bay Core 306 series, Jamaica**

Carbonate mud samples from E-33G/70-71, Sta #16331, Core 306, Discovery Bay Harbor, Jamaica (18° 27′ 30″ N, 77° 24′ 24″ W). Recent sediment filling harbor. Coll 1971 and subm by L S Land. Depths are below sediment-water interface. For comment, see Core 420 series, below.

**Tx-1296. Core 306, 50 to 55cm** **1640 ± 80** **AD 310**

**Tx-1297. Core 306, 205 to 210cm** **2950 ± 80** **1000 BC**

**Tx-1298. Core 306, 350 to 355cm** **3510 ± 80** **1560 BC**

**Tx-1299. Core 306, 510 to 520cm** **4180 ± 90** **2230 BC**

**Discovery Bay Core 420 series, Jamaica**

$CaCO_3$ mud from R/V Eastward Sta #19498, Piston Core 420, Discovery Bay, Jamaica (18° 28′ 24″ N, 77° 25′ 36″ W). Recent carbonate sediment filling bay. Coll 1972 and subm by L S Land. Depths are below sediment-water interface.

**Tx-1567. Core 420, 700 to 710 cm** **4550 ± 80** **2600 BC**

**Tx-1568. Core 420, 900 to 910cm** **5100 ± 90** **3150 BC**

Bottom of piston core.

*General Comment on Core 306 and Core 420 series* (LSL): samples document rate of accumulation of fine-grained carbonate muds behind reef in Discovery Bay.

**Discovery Bay Core 289 series, Jamaica**

Calcite and clay from E-33G/70-71, Sta #16283, Piston Core 289, 2600m offshore, Discovery Bay, Jamaica (18° 35′ 0″ N, 77° 23′ 42″ W). Deep-sea sediment. Coll 1971 and subm by L S Land. Depths are below sediment-water interface.

**28,820 ± 1050**
**Tx-1300. Core 289, 185 to 195cm** **26,870 BC**

**32,810 ± 1720**
**Tx-1301. Core 289, 490 to 500cm** **30,860 BC**

*General Comment* (LSL): samples document rate of pelagic carbonate sedimentation in deep water off N coast of Jamaica.

**2510 ± 80**
**Tx-1125. Discovery Bay JS-296** **560 BC**

Calcite from submarine diamond core sample, 125 to 175cm below floor of dynamited quarry, near toe of *Acropora cervicornis* tongue, SW diving buoy, Discovery Bay, Jamaica (18° 28′ 06″ N, 77° 24′ 48″ W). Below Tx-930 (R, 1972, v 14, p 472). Coll 1970 and subm by L S Land. *Comment* (LSL): documents rate of reef sedimentation in deep reef frame. See also Sand Channel series and Blast Site series, below.

**Discovery Bay Sand Channel series, Jamaica**

$CaCO_3$ samples from sand channel E of Mine, SW Discovery Bay diving buoy, Jamaica (18° 28′ 06″ N, 77° 24′ 48″ W). Coll 1971 by John Gifford and L S Land; subm by L S Land. For comment, see Discovery Bay Blast Site series, below.

**530 ± 60**
**Tx-1321. JS-31** **AD 1420**

Sand, 1m below sand level, immediately overlying lithified surface. Reef sand in sand channel, recent sediment.

**860 ± 80**
**Tx-1322. JS-31aa** **AD 1090**

$CaCO_3$ (aragonite and magnesium-calcite) chips off lithified surface, 1m below level of sand channel. From reef framework, lithified.

**2240 ± 80**
**Tx-1323. JS-31n** **290 BC**

$CaCO_3$ (aragonite), 1m below lithified surface, *Diploria strigosa* head obtained by underwater diamond core drilling. Coral in recent reef framework.

**3570 ± 70**
**Tx-1324. JS-31y** **1620 BC**

$CaCO_3$ (aragonite), 2m below lithified surface, *Montastrea annularis* head obtained by underwater diamond core drilling. Coral in recent reef framework.

**50 ± 70**
**Tx-1325. JS-31ac** **Modern**

Coral (*Diochocoenia stokesii*) growing on lithified surface, 1m below level of sand channel. Recent lithified reef framework.

**Discovery Bay Blast site series, Jamaica**

Calcite and aragonite samples from JS-hole, 180ft (55m), just below drop-off, N of Pinnacle I, W of diving buoy, Discovery Bay, Jamaica (18° 28′ 06″ N, 77° 24′ 48″ W). Recent deep reef framework. Samples from ca 30cm below reef-water interface. Coll 1971 by Land and Copland; subm by L S Land.

**6870 ± 80**
**Tx-1326. JS-hole, flat slab** **4920 BC**

**1370 ± 70**
**Tx-1327. JS-hole, massive** **AD 580**

*General Comment on Tx-1125, Tx-1321-1327* (LSL): samples document rate of reef sedimentation in deep reef frame and in active sand channel (Land, L S, Carbonate productivity and growth rate of a West Indian (Jamaican) reef; 2nd internatl symposium on coral reefs, Australia, in press).

**Falmouth formation, Site #27 series, Jamaica**

$CaCO_3$ (aragonite and calcite), beside small bar, opposite quarry, 32m NNE of rd, W of Rio Bueno, Jamaica (18° 28′ 25″ N, 77° 27′ 37″ W). Falmouth formation, Pleistocene, 120,000 yr old by U/Th. Coll 1970 by Land and Copland; subm by L S Land.

**22,150 ± 550**
**Tx-1333. RB-27-8,9** **20,220 BC**

Samples 8 and 9 in diamond core, 3.35m below ground level, above water table.

**29,140 ± 1320**
**Tx-1334. RB-27-21** **27,190 BC**

Sample 21 in diamond core, 4.27m below ground level, below water table.

**Falmouth formation, Site #28 series, Jamaica**

$CaCO_3$ (aragonite & calcite), halfway between Discovery Bay and Fort Point, Jamaica, midway between Fort Point Rd and Kaiser airstrip, right side of rd (18° 28′ 25″ N, 77° 24′ 50″ W). Falmouth formation. Coll 1970 by Land and Comer; subm by L S Land.

**24,810 ± 770**
**Tx-1335. RB-28-12, 13** **22,860 BC**

Samples 12 and 13 in diamond core, 0.6m below ground level, above water table.

**Tx-1336. RB-28-38, 42** **>44,000**

Samples 38 and 42 in diamond core, between 3 and 3.9m below ground level, below water table.

*General Comment on Falmouth formation series* (LSL): since 3 of these 120,000 yr-old samples give finite $^{14}C$ ages, investigators should mistrust $^{14}C$ ages in excess of 20,000 yr unless verified by independent techniques (Land, 1973).

## III. ARCHAEOLOGIC SAMPLES

### *George C Davis site, Texas*

Samples of wood charcoal (except as noted) from George C Davis site (41 CF 19), early Caddo site, E side Neches R valley, 9.6km SW of Alto, Cherokee Co, Texas (31° 35′ N, 95° 10′ W). Dates are part of continuing dating project (for previous dates see R, 1970, v 12, p 626-629). Coll 1970, except where noted, and subm by D A Story, Dept Anthropol, Univ Texas, Austin; comments by DAS. In titles, F stands for Feature.

**George Davis, Mound C series**

Mound C is well-stratified, elaborate mortuary area with 6 stages of construction. Stage I (earliest) is large pre-mound burial pit (F134); Stages II-VI are mound construction phases, most assoc with burials. Samples listed in stratigraphic order, earliest to latest.

**1010 ± 80**
**Tx-1206. Davis Mound C, F134** **AD 940**

Stage I, pre-mound burial, offering against N wall of pit; organic material, not yet id.; possibly cane.

**1260 ± 70**
**Tx-1294. Davis Mound C, F155** **AD 690**

Stage II burial, unid. organic material assoc with skull.

**1240 ± 100**
**Tx-1295. Davis Mound C, F161** **AD 710**

Stage III burial, unid. organic material assoc with skull.

**910 ± 80**
**Tx-1203. Davis Mound C, F166** **AD 1040**

Charcoal-filled pit under washed mound fill (F162) and mound additions of Stages V and VI, otherwise stratigraphic position uncertain.

**770 ± 80**
**Tx-1231. Davis Mound C, F118** **AD 1180**

Stage IV burial, unid. organic material assoc with skull.

*General Comment*: except for Tx-1206 date on pre-mound burial pit, dates are in reasonable stratigraphic order, although Stages II (Tx-1294) and III (Tx-1295) are earlier and more similar in age than anticipated. Tx-1231 suggests that Stages V and VI are later than AD 1100 or 1200. F166 (Tx-1203) is stratigraphically earlier than Stages V and VI; date suggests it may also predate IV.

**George Davis, F125 series**

F125 is small circular structure in excavation Unit 10 in village area N of Mound B; structure has clay-lined hearth with 3 successive burnings.

**1080 ± 80**
**Tx-1202. Davis F125-82** **AD 870**

From possible roof-support pit.

**1110 ± 80**
**Tx-1204. Davis F125-1a** **AD 840**

From hearth, 1st burning.

**1030 ± 70**
**Tx-1307. Davis F125-1b** **AD 920**

From hearth, 2nd burning.

**800 ± 70**
**Tx-1308. Davis F125-1bb** **AD 1150**

Cane and possibly corn stalk fragments from hearth, 2nd burning.

**920 ± 80**
**Tx-1201. Davis F125-1c** **AD 1030**

From hearth, 3rd (final) burning.

*General Comment*: Tx-1204, -1307, -1201 form consistent but rather long stratigraphic series. Tx-1202 was thought to be same age as, or later than Tx-1201, but dates indicate it is earlier even with 1$\sigma$ agreement. Tx-1308 date on cane and possible corn is, as expected, later than Tx-1307 on woody charcoal from same provenience.

**George Davis, F139-160 series**

F139 and F160 are adjacent circular house patterns, and small charcoal-filled pits, in Excavation Unit 11 in village area S of Mound B.

**890 ± 80**
**Tx-1210. Davis F160-54** **AD 1060**

Pit N of F160 house, not clearly assoc with it or F139.

**860 ± 80**
**Tx-1211. Davis F139-21** **AD 1090**

Pit near F139 house.

**1160 ± 90**
**Tx-1212. Davis F139-1** **AD 790**

From upper part of fill in tree mold within F139 house.

**950 ± 80**
**Tx-1213. Davis F139-83** **AD 1000**

From fill of outer post of F139 house.

**670 ± 90**
**Tx-1310. Davis F139-62, cane** **AD 1280**

Charred cane from pit inside F139 house, near SW portion of outer wall of structure.

**850 ± 70**
**Tx-1313. Davis F139-62, wood charcoal** **AD 1100**
Same provenience as Tx-1310.

**880 ± 80**
**Tx-1311. Davis F136-13** **AD 1070**
Pit N of F139 & F160 houses, of uncertain assoc.

**750 ± 90**
**Tx-1312. Davis F136-6** **AD 1200**
Pit N of F139 house.

**700 ± 70**
**Tx-1314. Davis F139-84** **AD 1250**
Pit near F139 house.

**910 ± 60**
**Tx-1315. Davis F139-50** **AD 1040**
Pit or post hole inside F139 house, near SW portion of outside wall.

**810 ± 70**
**Tx-1316. Davis F139-7** **AD 1140**
Pit about 0.5m beyond outer wall of F139 house.

**760 ± 100**
**Tx-1317. Davis F139-30, wood charcoal** **AD 1190**
Pit NW of F139 house.

**570 ± 80**
**Tx-1405. Davis F139-30, corn** **AD 1380**
Same provenience as Tx-1317.

**740 ± 110**
**Tx-1318. Davis F139-90** **AD 1210**
Pit near F139 house.

**690 ± 70**
**Tx-1319. Davis F139-3** **AD 1260**
PiPt within F139 house.

**740 ± 60**
**Tx-1320. Davis F160-52** **AD 1210**
Pit near F160 house.

*General Comment*: dates indicate late village occupation, and form 2 clusters, ca AD 1000 to 1170 and ca AD 1150 to 1300. They do not tightly date structures but do suggest possibility that F139 and F160 houses are of different ages. Paired wood charcoal and corn or cane samples Tx-1310/1313 and Tx-1317/1405 differ about as expected.

**George Davis, F126 series**

F126 is group of small charcoal-filled pits and possible post, probably representing outdoor activity area, in Excavation Unit 13 in village area S of Mound B.

**Tx-1214. Davis F126-2** — **790 ± 80**
**AD 1160**

**Tx-1215. Davis F126-8** — **850 ± 90**
**AD 1100**

*General Comment*: dates are consistent with others from village.

**George Davis, F137 series**

F137 is group of small pits, probably representing outdoor activity area, in Excavation Unit 14 in village area S of Mound B.

**Tx-1208. Davis F137-16B** — **1070 ± 70**
**AD 880**

**Tx-1209. Davis F137-15** — **860 ± 80**
**AD 1090**

*General Comment*: dates suggest 2 pits relate to different times of use, although they are only 1.2m apart.

**George Davis, F146 series**

F146 is circular structure with small charcoal-filled pits inside and outside, in Excavation Unit 15 in village area W of Mound A.

**Tx-1221. Davis F146-69** — **1000 ± 80**
**AD 950**

Pit within F146.

**Tx-1222. Davis F146-71** — **1100 ± 80**
**AD 850**

Pit just outside E wall of F146.

**Tx-1223. Davis F146-164** — **1290 ± 80**
**AD 660**

Apparent post within F146.

**Tx-1224. Davis F146-62** — **980 ± 70**
**AD 970**

Pit cut into 2 outer-wall posts of F146.

*General Comment*: Tx-1224 is stratigraphically later than structure; date is appropriately later than Tx-1223, a possible interior post. Tx-1221 and Tx-1222 are from possible cooking or smudge pits. Dates suggest pits represent use of area after abandonment of structure.

**George Davis, F165 series**

F165 is probable outdoor activity area, in Excavation Unit 16S in village area N of Mound B, N of Structure 125.

**Tx-1216. Davis F165-1** — **780 ± 70**
**AD 1170**

Small charcoal-filled pit.

**Tx-1217. Davis F165-63** **1020 ± 70**
**AD 930**

Possible post.

*General Comment*: dates do not agree; possibly refer to different periods of use.

**George Davis, Borrow Pit series**

Borrow Pit is depression in terrace slope W of Mound B, probable source of some of fill used in mound construction and in pottery making. Stratified deposits within pit contained washed and discarded cultural debris.

**Tx-1207. Davis Borrow Pit, 164** **410 ± 70**
**AD 1540**

Sq N737/W1156, alt 90.94m; Stratum 1, disturbed A horizon.

**Tx-1228. Davis Borrow Pit, 61** **850 ± 60**
**AD 1100**

Test pit, Level 5 (probably Stratum 5), 140 to 160cm below surface.

**Tx-1229. Davis Borrow Pit, 44** **790 ± 240**
**AD 1160**

Same provenience as Tx-1228.

*General Comment*: Tx-1207 much too late for assoc with Caddoan occupation. Tx-1228 and -1229 agree well and fit other dates from site, although large error for Tx-1229 reduces significance.

**George Davis, Mound B1 series**

Samples from 1st phase of construction of Mound B. Charcoal scattered in fill, not assoc with cultural features.

**Tx-1225. Davis Mound B, 46** **910 ± 140**
**AD 1040**

**Tx-1226. Davis Mound B, 26** **700 ± 80**
**AD 1250**

**Tx-1227. Davis Mound B, 45** **1100 ± 70**
**AD 850**

*General Comment*: previously dated samples from pre-Mound B context (R, 1970, v 12, p 626-628) indicate mound construction began after AD 1050 or 1100. Tx-1226 fits this situation best. Tx-1225 is consistent with Tx-1226, but large error diminishes significance. Tx-1227 too early to be relevant to dating, but probably reflects mixed origin of mound fill.

**George Davis, Mound A series**

Samples coll 1960-61 by H P Newell (Newell and Krieger, 1949). Stored in paper bag for 30 yr.

**830 ± 80**
**Tx-1395. Davis Mound A, 211** **AD 1120**

Beneath Mound A, Sec 13, 6.44 to 6.84m below datum, apparently assoc with F31 structure.

**1130 ± 60**
**Tx-1399. Davis Mound A, 216** **AD 820**

Beneath Mound A, Sec 13, from post hole assoc with F31.

**710 ± 70**
**Tx-1396. Davis Mound A, 212** **AD 1240**

From Structure F9, near SE edge of Mound A, largely covered by wash from mound. Sec 19R3, 6.44m below datum.

**890 ± 60**
**Tx-1397. Davis Mound A, 213** **AD 1060**

Apparently from F9 (see Tx-1396). Sec 20R13, 25 to 38 cm below surface. Sample was split and 2 parts prepared and counted separately: 900 ± 70, 880 ± 90.

**1050 ± 70**
**Tx-1398. Davis Mound A, 214** **AD 900**

Partly covered by Mound A wash, just above floor of Structure F35. *General Comment*: Tx-1395 and -1399 from F31, structure beneath mound, do not agree. There are 3 previously dated samples from this structure: C-153, 1553 ± 175 (Libby, 1955, p 108); M-1186, 655 ± 75 (R, 1963, v 5, p 241); Tx-105, 1120 ± 90 (R, 1964, v 6, p 155). Tx-1399 and -105 agree closely and best fit general intra-site chronology as now understood, but as Tx-105 was mixture of wood charcoal and charred corn its significance is uncertain. C-153, M-1186, and Tx-1396 are felt to be far from true age of F31. Tx-1396 and -1397 from F9 do not agree. F9 and F35 (Tx-1398) do not have clear stratigraphic relationship to construction of Mound A; significance of these dates is not yet clear.

*General Comment on Davis site dates*: in general, dates fit other chronologic evidence from site and support Krieger's view (Newell and Krieger, 1949, p 193-237) that Davis is one of earliest known Caddoan sites. Village occupation may have begun in 8th or 9th century and lasted until ca AD 1300. Special burials in village beneath Mound B seem equally early and may have continued after much of village was abandoned. Mound B itself seems late, probably about same age as burial stages V and VI in Mound C. Dates from beneath Mound A not consistent and do not preclude possibility that Mound A predates Mound B.

### *Trinity Bay Estuary, Upper Texas Coast*

Samples of shell (*Rangia cuneata*) and charcoal from sites in Wallisville Reservoir area at mouth of Trinity R, E of Houston, Texas, and at Harris County Boy's School site S of Houston, subm as part of study of prehistory of upper Texas coast. In this area datable charcoal is rare in archaeologic sites but shells are abundant. L E Aten (ms in preparation), using measurements of 13 shell-charcoal sample pairs and 1 shell date assoc with historic event of known age (these dates are reported below and in R, 1970, v 12, p 263-266), obtained correlation coefficient of 0.985, and derived following regression equation:

$$A_c = .995A_a - 225.241$$

where $A_c$ = corrected age (based on predicted $^{14}C$ activity if sample were wood charcoal)

$A_a$ = apparent age (based on measured $^{14}C$ activity of shell carbonate)

Standard error of estimate of $A_c$ is 103 yr. This equation is felt to be applicable only to samples from upper reaches of Trinity Bay estuary and geochemically similar environments.

Except where noted, all samples coll 1969 and subm by L E Aten, Texas Archeol Survey, Univ Texas, Austin. Comments by LEA. In comments, "corrected age" refers to age $A_c$ above.

**1110 ± 50**

**Tx-953. 41 CH 170, 1** **AD 840**

Shell from hearth adjacent to main shell lens, site 41 CH 170, 2.6km SE of Cove, Texas, in marsh E of Old River Lake (29° 49′ N, 94° 47′ W). Site had no diagnostic artifacts. *Comment*: corrected date AD 1071, indicating occupation during Round Lake period.

**1650 ± 70**

**Tx-1050. 41 CH 9, 1** **AD 300**

Shell from Site 41 CH 9, 2.25km E of Trinity R, 1.9km S of Interstate Hwy 10 (29° 48′ N, 94° 43′ W). From buried natural clam bed in nearshore estuarine (Turtle Bay) facies underlying beach ridge on which site was established; should date maximum age of beach ridge. *Comment*: corrected date: AD 533. Earliest occupation on this beach ridge was during Mayes Island period (AD 350 to 600). Present date indicates relatively short interval between shoreline progradation, beach-ridge formation, and establishment of occupation, probably directly on bay front.

**1560 ± 80**

**Tx-1051. 41 CH 24, #3** **AD 390**

Shell from base of midden, S corner Unit A, Site 41 CH 24, N bank of Lost R, 1.6km upstream from Interstate Hwy 10 bridge (29° 51′ N, 94° 47′ W). Immediately overlies levee sand of Channel Stage 3; should give minimum age of that stage and initial occupation of site. *Comment*: corrected date: AD 623. Ceramics indicate initial occupation during Round Lake period, not earlier than AD 950. Date, however, should (and does) agree with Tx-1057 (below), reinforcing interpretation of assoc with immediately post-Stage 3 events. Perhaps sparse occupation earlier than Round Lake period escaped detection in test excavation.

**1510 ± 80**
**Tx-1057. 41 CH 165, #1** **AD 440**

Shell, 25cm below surface at base of shell midden in Site 41 CH 165, exposed in wave-cut bank along E shore of Old River Lake, 1.6km S of Interstate Hwy 10 (29° 49′ N, 94° 47′ W). Immediately overlies backswamp facies probably assoc with Channel Stage 3; age should be minimum for that stage. *Comment*: corrected date, AD 673, correlates well with Tx-1051, above, indicating that Channel Stage 3 was terminated by 1st half of 7th century AD.

**3270 ± 80**
**Tx-1058. 41 CH 172, #2** **1320 BC**

Shell, 15cm above base of buried shell midden, Site 41 CH 172, 0.3km W of Lost R, 0.4km N of Interstate Hwy 10 (29° 50′ N, 94° 48′ W). Midden overlies levee sand from adjacent distributary channel of unknown origin. *Comment*: corrected date 1078 BC. Site is oldest yet discovered in alluvial deposits of lower Trinity R. Age is minimum for assoc abandoned channel segment that antedates Channel Stage 1.

**41 CH 36 series**

Charcoal and shell from Unit A, Site 41 CH 36, shell midden on N shore of Old River Lake immediately W of mouth of Round Lake Bayou (29° 48′ N, 94° 46′ W).

**1100 ± 70**
**Tx-946A. 41 CH 36/3, shell** **AD 850**

**720 ± 90**
**Tx-946B. 41 CH 36/3, charcoal** **AD 1230**

From hearth in SE corner, depth 81 to 85cm. Assoc with Round Lake period ceramics. *Comment*: corrected date for Tx-946A, AD 1081.

**1300 ± 70**
**Tx-947A. 41 CH 36/4, shell** **AD 650**

**1120 ± 110**
**Tx-947B. 41 CH 36/4, charcoal** **AD 830**

Shell taken from E wall of excavation, 165cm depth; charcoal scattered through fill, depth 160 to 170cm. Samples assoc with Turtle Bay ceramics. *Comment*: corrected date of Tx-947A, AD 882.

**1470 ± 70**
**Tx-948. 41 CH 36/5, shell** **AD 480**

From base of midden, depth 195cm, immediately overlying levee sand probably from Trinity R Channel Stage 3. Age should be minimum for abandonment of that channel stage. *Comment*: corrected date AD 713.

**41 CH 46 series**

Charcoal and shell from hearth in SW corner Unit A, 40 to 42cm depth, at Site 41 CH 46, NW shore Round Lake, 3.2km ESE of Cove, Texas (29° 49′ N, 94° 46′ W). Ceramics indicate hearth was at stratigraphic contact between Mayes Island period and either Round Lake or Old River period.

**Tx-949A. 41 CH 46/1, shell** **1740 ± 70**
**AD 210**

**Tx-949B. 41 CH 46/1, charcoal** **1120 ± 70**
**AD 830**

*Comment*: corrected date of Tx-949A, AD 444, compatible with current estimates for Mayes Island period; Tx-949B is at lower limit of current estimates of age for Round Lake period.

**41 CH 98 series**

Charcoal and shell from lower shell zone, S wall Unit A, Site 41 CH 98, 0.4km SE of Cove Point on W bank Cotton's Bayou (28° 48′ N, 94° 48′ W). Shell zone is at base of midden, overlying marsh clay. Assoc with initial occupation of site during Mayes Island period.

**Tx-951B. 41 CH 98/5, shell** **1310 ± 60**
**AD 640**

**Tx-951A. 41 CH 98/5, charcoal** **1060 ± 90**
**AD 890**

*Comment*: corrected date of Tx-951B, AD 872. However, Mayes Island period is AD 350 to 600; thus both dates are much too young. On all objects at this level of midden there was considerable $CaCO_3$ encrustation, presumably derived from higher (younger) shell deposits; this might be source of contaminants.

**41 CH 57 series**

Shell from Site 41 CH 57, 0.8km N of Trinity R at Wallisville (29° 50′ N, 94° 45′ W). Coll 1970 by W L Fullen; subm by L E Aten.

**Tx-1113. 41 CH 57, 1** **3670 ± 90**
**1720 BC**

From base of Shell Zone 2, preceramic component underlying and stratigraphically separated from historic occupation at site. Near middle of E wall Sq S24.5/E70. Should fall between Tx-397 (2540 ± 110; R, 1970, v 12, p 264) and Tx-969 (3670 ± 80; this list). *Comment*: corrected date, 1476 BC, reasonable for early shell middens in this area and identical to Tx-969 from site on opposite side of Galveston Bay.

**Tx-1114. 41 CH 57, 2** **5570 ± 100**
**3620 BC**

In NW quad Sq S79-E71, from top of thin compact shell lens containing post molds and with subrectangular outline; no habitation refuse. Lens is presumed to be sub-floor of European structure, ca 1756. *Comment*: evidence exists that *Rangia cuneata* shells deposited in physical contact with Beaumont formation will yield unusually old dates, eg, O-912 (Ring, 1961, p 318), Tx-642-644, -654 (R, 1970, v 12, p 275). This appears to be problem with Tx-1114 as well.

**Harris County Boys' School series**

Samples from Sites 41 HR 80 and 41 HR 85 at Harris County Boys' School, 0.7km N of Clear Lake on E bank of Mud Lake, S of Houston, Texas (29° 34′ N, 95° 04′ W).

**640 ± 130**
**Tx-1059. 41 HR 80, Burial 1** **AD 1310**

Human bone from Burial 1, Sqs N-98, N-99, M-98, 20cm below surface, Site 41 HR 80. Cultural assoc uncertain but probably Turtle Bay period. Coll 1968 by R M Gramley.

**2140 ± 380**
**Tx-1060. 41 HR 80, Burial 2** **190 BC**

Human bone from Burial 2, Sq M-98, 17.5cm below surface, Site 41 HR 80. Probably later than Burial 1 (Tx-1059, above), but same cultural assoc. Coll 1968 by R M Gramley.

*General Comment*: dates do not agree with age of Turtle Bay period (AD 600 to 950), and Tx-1060 is older than Clear Lake period (AD 100 to 350), into which midden the burials are intrusive. Also, dates do not agree with each other, and relationship is reverse of probable stratigraphic relationship. No archaeologic explanation is apparent for these discrepancies.

**2170 ± 180**
**Tx-968A. 41 HR 85/1, charcoal** **220 BC**

Charcoal fragments from throughout midden of Level 2, depth 10 to 25cm, Site 41 HR 35, assoc with Goose Creek Plain and Tchefuncte Plain ceramics; earliest ceramics at site. *Comment*: since Level 2 spans preceramic-ceramic transition and charcoal is from throughout level we would expect date to be earlier than AD 100, time of 1st appearance of ceramics in this area (Aten, ms in preparation).

**1500 ± 70**
**Tx-968B. 41 HR 85/1, shell** **AD 450**

Shells from bulk matrix Sample #2A from N wall of Test Pit 2, Site 41 HR 85, in upper part of Level 2, 10 to 25cm depth. *Comment*: corrected date: AD 683, late relative to Tx-968A but consistent with ceramics of still later date immediately above in Level 1, and with observation that middens on upland bluffs around Galveston Bay accumulated very slowly.

**3670 ± 80**
**Tx-969. 41 HR 85/2, shell** **1720 BC**

Shells (*Rangia*) from bulk matrix Sample #4 from N wall of Test Pit 2, Site 41 HR 85, 65 to 70cm depth. Preceramic level. *Comment*: corrected date: 1476 BC. Appropriately earlier than Tx-968A & B, above, which are higher stratigraphically. Agrees with Tx-1113 (this list), preceramic component on opposite side of Galveston Bay.

*Brazos Delta area, Texas Coast*

All samples subm and commented on by L E Aten.

**41 BO 15 series**

Shell (*Rangia cuneata*) and charcoal from Site 41 BO 15, N shore Shy Pond, 1.25km N of airport at Lake Jackson, Brazoria Co, Texas (29° 03′ N, 95° 27′ W). Assocs were mainly Goose Creek Plain pottery.

**860 ± 50**

**Tx-1116A. 41 BO 15/1, shell** **AD 1090**

From top of shell zone between Trenches 2 and 4. Coll 1970 by D Hamilton.

**180 ± 60**

**Tx-1116B. 41 BO 15/1, charcoal** **AD 1770**

From top of shell zone from Trenches 2 and 4, and between Trenches 5 and 2. Coll 1957 by T R Hester.

*General Comment*: 1st shell-charcoal pair dated in study of shell dates in area; no correction of shell dates yet feasible (see also Tx-1259A & B, below). Archaeologic estimate of date of assemblage AD 1350 to 1500; if this is correct, Tx-1116B on charcoal is too young.

**Dow-Cleaver site series**

Shells (*Rangia cuneata*) from Site 41 BO 35, SW part of Dow Chemical Co Plant B, N side Brazos R, ca 3km WNW of city limits of Freeport, Brazoria Co, Texas (28° 58′ N, 95° 25′ W). Coll 1970 by L E Aten. Samples listed in stratigraphic order, most recent first.

**1680 ± 70**

**Tx-1167. Dow-Cleaver 5; Zone 1** **AD 270**

From throughout Sq E-48 in Shell Zone 1, uppermost shell zone, buried by ca 10cm sterile overburden. Mandible of pig (*Sus scrofa*) found in zone; no evidence of intrusion. No other evidence of European contact. Native pottery assemblage (Goose Creek Plain, Goose Creek Incised, San Jacinto Plain, and plain and incised bone-tempered) unlike those in lower zones.

**1330 ± 50**

**Tx-1205. Dow-Cleaver 6; Zone 1** **AD 620**

From Test Pit 1, Shell Zone 1; dated to check Tx-1167 (above) which seems too early.

**1830 ± 80**

**Tx-1117. Dow-Cleaver 3; Zone 2B** **AD 120**

Shell Zone 2B in trench wall between D49 and E49. Goose Creek Plain pottery; earliest appearance in site of San Jacinto Plain pottery and arrowpoints.

**2360 ± 60**
**Tx-1066. Dow-Cleaver 1; Zone 3A** **410 BC**

Shell Zone 3A between D49 and E49; upper part of earliest ceramic zone; Goose Creek Plain ceramics.

**1250 ± 70**
**Tx-1115. Dow-Cleaver 4; Zone 3B** **AD 700**

Shell Zone 3B, SE quad Unit E44; Goose Creek Plain ceramics.

**2370 ± 80**
**Tx-1067. Dow-Cleaver 2; Zone 4** **420 BC**

Shell Zone 4, from walls and floor of NW quad of Unit E47. Preceramic.

*General Comment*: samples apparently affected by 2 sources of contamination with old carbon: 1) ancient carbon in delta waters, from carbonate rock of interior Texas through which Brazos R flows; 2) chemical wastes discharged by large chemical plant adjacent to site. For detailed discussion, see Aten (1971, p 47-50).

**41 BO 50 series**

Paired samples of charcoal and shell (*Rangia cuneata*) from Sq 1, Zone 2 in Site 41 BO 50, N shore of S bend of L Jackson, 3.6km N of center of city of Lake Jackson, Brazoria Co, Texas (29° 03′ N, 95° 28′ 30″ W).

**1650 ± 90**
**Tx-1259A. 41 BO 50, 1A; charcoal** **AD 300**

**1870 ± 70**
**Tx-1259B. 41 BO 50, 1B; shell** **AD 80**

*Comment*: dated as part of study of shell/charcoal dating relationship in area. Tx-1259A not unreasonable but indicates that previous estimates for introduction of sandy paste ceramics and arrow points into area may be too recent (Aten, 1971, p 50-54).

*Sabine Lake Area, Texas-Louisiana Coast*

**2020 ± 110**
**Tx-1230. Conway D/1, Louisiana** **70 BC**

Shell (*Rangia cuneata*) from buried midden exposed in cut bank of Conway Bayou, ca 0.8km upstream from its confluence with Sabine R in Calcasieu Parish, Louisiana (30° 04′ N, 93° 42′ W). Site has mostly Tchefuncte period ceramics; some Marksville-influenced ceramics appear late. Sample assoc with Tchefuncte Plain vessel, stratigraphically about midway in Tchefuncte deposits. Coll 1971 by C N Bollich; subm by L E Aten. *Comment* (LEA): no basis yet for appraising dates on *Rangia cuneata* in this drainage. Relatively low $HCO_3$ values measured today (Hahl and Ratzlaff, 1970) may indicate negligible addition of non-radioactive carbon from geologic ancient deposits; if true, no correction would be necessary for shell dates here. Present date is entirely compatible with current estimates of age of this cultural context (Gagliano, 1967, p 11).

*Other Texas Samples*

**540 ± 70**
**Tx-1306. George L Keith site, Texas** **AD 1410**

Charcoal fragments from George L Keith site (41 TT 11), E edge Hart Creek flood plain 1.5km E of Mt Pleasant, Texas (33° 09′ N, 94° 56′ W). From different lenses and zones of mound fill, ca 102.6 to 106m elev, exposed in fresh cut in S wall, E end of trench excavated in 1934 by Goldschmidt (1935, p 97-99). Charcoal appears to derive from pre-existing midden deposits incorporated into mound fill; date should indicate time at or after which middle 3rd of mound was built. No stratigraphic breaks observed; no diagnostic artifacts assoc. Coll 1971 and subm by K M Brown, Dept Anthropol, Northwestern Univ, Evanston, Illinois. *Comment* (KMB): premound and mound construction phases appear to be Sanders focus, similar to other Sanders components S of Red R. Date somewhat later than expected, and suggests construction of large platform mounds relatively late in this area. Overlap with early end of $^{14}C$ date range for Whelan complex (see comments, Harroun site series, R, 1966, v 8, p 461-462) may also indicate rather rapid cultural change in area ca AD 1300 to 1400.

**Loeve-Fox series, central Texas**

Wood charcoal samples from Loeve-Fox site (41 WM 230), left bank San Gabriel R, 8km NNE of Taylor, Williamson Co, Texas, in Laneport Reservoir basin (30° 39′ 25″ N, 97° 24′ 58″ W). Coll 1972 and subm by E R Prewitt, Texas Archeol Survey, Univ Texas, Austin.

**850 ± 100**
**Tx-1765. Loeve-Fox 13c** **AD 1100**

Feature 4, hearth, N895/W990, 46 to 61cm below surface. Overlain by unstemmed arrowpoints, underlain by Darl points. *Comment* (ERP): dates transition from dart points to arrowpoints.

**1600 ± 110**
**Tx-1766. Loeve-Fox 8** **AD 350**

**1480 ± 170**
**Tx-1767. Loeve-Fox 3** **AD 470**

Tx-1766 and -1767 from Feature 8, midden zone, N1060/W990, 76 to 81.5cm below surface. Large error due to small size of samples. *Comment* (ERP): dates agree. Feature 8 has Darl points assoc; above are Scallorn points, below are Ensor, Fairland, Montell. Dates support previous estimates of beginning date for terminal Archaic in central Texas.

**Walker #2 series, Texas**

Charcoal samples from 2 rock-lined cooking pits at Walker #2 site (41 CK 137; Shafer, 1971, p 113-127), 8km SW of Silver, Coke Co, W central Texas, on 1st terrace of Colorado R, in basin of Robert Lee Reservoir (32° 05′ N, 100° 40′ W). No artifact assoc. Coll 1969 and subm by H J Shafer, Texas Archeol Salvage Project, Univ Texas, Austin.

**110 ± 140**
**Tx-892. Walker #2, Feature 4** **Modern**

From Feature 4, a cooking pit. Presence of some uncharred wood, not decayed, suggests recent age.

**240 ± 70**
**Tx-893. Walker #2, Feature 5** **AD 1710**

From Feature 5, a cooking pit.

*General Comment* (HJS): cooking pits are foreign to the Plains except for those of Dismal River aspect (Apache, ca AD 1675-1725) NW of this location. Tx-893 agrees with Dismal River date and reinforces suggestion that pits were made by Apache.

**Northgate Site series, Texas**

Charcoal from House #1 (Feature 183), Northgate site (41 EP 6), 11.3km N of downtown El Paso, 0.4km NW of intersection of Diane Rd and Dyer St, Ft Bliss military reservation, Texas (31° 52′ 57″ N, 106° 25′ 39″ W). Southern Jornada branch occupation. Coll 1972 and subm by L E Aten.

**1220 ± 130**
**Tx-1450. Northgate #8** **AD 730**

Roof beam#I, lying on floor of house.

**1200 ± 70**
**Tx-1451. Northgate #10** **AD 750**

Roof Beam #III, lying on floor of house.

*General Comment* (LEA): samples are from undisturbed context; assoc ceramics were El Paso Brown and Mimbres Classic Black-on-White. Assoc house structure was probably of jacal construction over excavated house-pit ca 15cm deep. Thus, dates suggest an earlier brownware-Mimbres Black-on-white assemblage than was previously thought.

*Arkansas*

**Hazel site series, Arkansas**

Samples of charcoal (except where otherwise noted) from Hazel site, on Little R near Marked Tree, Poinsett Co, NE Arkansas (35° 32′ N, 90° 24′ W). Three developmental stages of St Francis Valley Mississippian sequence are present: Group I, Early Mississippi; Group II, Middle Mississippi, like Lawhorn site (Moselage, 1962); Group III, Late Mississippi, like Parkin phase. Coll 1933 by J Durham; subm by M Zinke, Univ Arkansas Mus, Fayetteville.

**1120 ± 70**
**Tx-700A. Hazel 933A, charcoal** **AD 830**

**660 ± 70**
**Tx-700B. Hazel 933A, corncobs** **AD 1290**

**860 ± 70**
**Tx-844. Hazel 933B, charcoal** **AD 1090**

**760 ± 60**
**Tx-878A. Hazel 933C, charcoal** **AD 1190**

**420 ± 60**
**Tx-878B. Hazel 933C, corncobs** **AD 1530**

Tx-700, -844, -878 are from same field sample, from Trench 5, Level II; Group 1. *Comment* (SV, Jr, & EMD): discrepancy between corn and wood in Tx-700 is greater than what we usually found; with Tx-878 discrepancy is within usual range. In view of Tx-844, true $^{14}C$ age is probably ca 800 yr.

**870 ± 100**
**Tx-845. Hazel 400** **AD 1080**

Trench 5, Level III; Group I.

**840 ± 80**
**Tx-704. Hazel 950** **AD 1110**

Trench 5, Level V; Group II.

**690 ± 70**
**Tx-705. Hazel 1039** **AD 1260**

Burial 490, Burial Cluster 7; Group II.

**470 ± 70**
**Tx-851. Hazel 445c** **AD 1480**

**690 ± 70**
**Tx-876. Hazel 445h** **AD 1260**

Tx-851 and -876 are from Burial 455; Tx-851 was 33cm deeper than Tx-876. Burial Cluster 10; Group II.

**370 ± 180**
**Tx-846. Hazel 868** **AD 1580**

Trench 5, Level VII; Group III.

**370 ± 70**
**Tx-847. Hazel 972** **AD 1580**

Trench 5, Level VII; Group III.

**600 ± 90**
**Tx-848. Hazel 897A** **AD 1350**

**500 ± 80**
**Tx-877. Hazel 897B** **AD 1450**

Tx-848 and -877 are from same field sample, from Trench 5, Level VII; Group III.

**410 ± 70**
**Tx-849. Hazel 460** **AD 1540**

1m W of Burial 460, 54cm deep; Group III.

**Tx-850. Hazel 1052-473** **490 ± 70**
**AD 1460**

94cm deep; Group III.

*General Comment* (MZ): Group I appears to date ca AD 1100 to 1200; Group II, AD 1200 to 1300; Group III, AD 1400 to 1600.

**Tx-1541. Dillard 57, Arkansas** **560 ± 50**
**AD 1390**

Wood charcoal from post of burned structure covered by small conical mound, on large ovate temple mound, at Dillard Mound site (3CL25), 9km NW of Gurdon, Arkansas, on W bank Terre Noir Creek (34° 00′ N, 93° 11′ W). Gibson aspect Caddo site. Coll 1964 by J A Scholtz and subm by J C Weber, Arkansas Archeol Survey, Henderson State Coll, Arkadelphia, Arkansas. *Comment* (JCW): date indicates mound building was still practiced among E Caddo in 14th century.

**Paw Paw site series, Arkansas**

Wood charcoal (except as noted) from area 4 of Paw Paw site (3OU22), stratified site ca 30km SE of Camden, Arkansas, on old channel of Ouachita R (33° 28′ 30″ N, 92° 43′ 30″ W). Area 4 had 8 strata and 4 recognized cultural manifestations: Stratum 1 (highest), Plaquemine; Strata 2 and 4, late and early Coles Creek, respectively; Stratum 6, Paw Paw phase, earliest ceramic, assignable to Baytown and Lowland Fourche Maline; Stratum 8, Tom's Brook Archaic. Coll 1971, subm and commented on by J C Weber.

**Tx-1542. Paw Paw 549, Stratum 1** **740 ± 50**
**AD 1210**

W25N31, Feature 26, pit originating in Stratum 1 and extending into Stratum 3.

**Tx-1548. Paw Paw 437 & 542, Stratum 1** **870 ± 60**
**AD 1080**

W23N29, W23N31, S halves, bottom of Stratum 1.

*Comment on Tx-1542, -1548*: dates support archaeologic estimate of age of Plaquemine.

**Tx-1543. Paw Paw 444, Stratum 2** **990 ± 40**
**AD 960**

W23N29, S half.

**Tx-1544. Paw Paw 564, Stratum 2** **1170 ± 50**
**AD 780**

W23N31, S half.

*Comment on Tx-1543, -1544*: assoc with sherds of Coles Creek Incised, varieties Hardy and Blakely; dates support archaeologic estimate of AD 800 to 1000 for this occupation.

**Tx-1545. Paw Paw 580-1, Stratum 4** **1110 ± 40**
**AD 840**

W23N31, S half.

**950 ± 40**
**Tx-1546. Paw Paw 580-2, Stratum 4** **AD 1000**

W23N31, S half.

*Comment on Tx-1545, -1546*: assoc with sherds of Coles Creek Incised varieties Campbellsville, Hunt, and Stoner, indicating date of AD 600 to 800. Dates more recent, and stratigraphically out of order with Tx-1543, -1544 from Stratum 2 (above). No explanation apparent.

**1490 ± 40**
**Tx-1547. Paw Paw 597, Stratum 6** **AD 460**

W25N31, S half.

**1290 ± 60**
**Tx-1552. Paw Paw 594, Stratum 6** **AD 660**

W25N31, S half.

*Comment on Tx-1547, -1552*: absence of Coles Creek Incised sherds makes Tx-1552 seem late; Tx-1547 supports archaeologic estimate of AD 200 to 500 for Stratum 6.

**3450 ± 140**
**Tx-1549. Paw Paw 432, 438, 607, Stratum 8** **1500 BC**

Carbonized nut hulls, W21N29, 160 to 250cm below surface.

**6640 ± 70**
**Tx-1550. Paw Paw 331, 384, 615, Stratum 8** **4690 BC**

Carbonized nut hulls, Area 2, E7N44 and E7N46; 100 to 130cm below surface.

*Comment on Tx-1549, -1550*: Tx-1550 supports previous estimates of 5000 to 3000 BC for Tom's Brook Archaic. Tx-1549 is anomalous.

**Hays Mound series, Arkansas**

Samples of wood charcoal (except cane charcoal where noted) from 4 successive building stages of Hays Mound, 8km S of Okolona, SW Arkansas on E bank Little Missouri R (33° 56′ N, 93° 19′ W). Stages are numbered Zero Mound to 3rd Mound, earliest to latest. Ceramic cross-dating suggests AD 1000 to 1200. Coll 1971 and subm and commented on by J C Weber.

**770 ± 60**
**Tx-1534. Hays 193, Zero Mound** **AD 1180**

House construction element, E104N94.

**1030 ± 50**
**Tx-1535. Hays 205, Zero Mound** **AD 920**

House construction post, E106N94.

**750 ± 40**
**Tx-1536. Hays 184, Zero Mound** **AD 1200**

House construction post, E104N92.

*Comment on Zero Mound dates*: Tx-1535 much earlier than anticipated and inconsistent with other 2 dates, which support each other.

**Tx-1538. Hays 138-1, First Mound** **760 ± 50**
**AD 1190**

House construction element, E102N92-94-96, E104N92-94-96.

**Tx-1539. Hays 138-2, First Mound** **930 ± 50**
**AD 1020**

As with Tx-1538.

**Tx-1540. Hays 138-3, First Mound** **740 ± 50**
**AD 1210**

As with Tx-1538.

*Comment on First Mound dates*: Tx-1538 and -1540 are consistent with each other and with Zero Mound dates (above); Tx-1539 seems falsely early.

**Tx-1529. Hays 115, Second Mound** **780 ± 50**
**AD 1170**

From ash lens, E100N100.

**Tx-1530. Hays 118, Second Mound** **810 ± 50**
**AD 1140**

As with Tx-1529.

**Tx-1531. Hays 123, Second Mound** **950 ± 60**
**AD 1000**

From ash lens, E98N100.

*Comment on Second Mound dates*: Tx-1529 and -1530 agree within 1$\sigma$ with dates from Zero and First Mounds (above). Material seems to be firewood rather than house construction elements. Tx-1531 is too early to be consistent.

**Tx-1528. Hays 083, Third Mound** **690 ± 50**
**AD 1260**

Surface of Third Mound, E90N92.

**Tx-1532. Hays 231-1, 234-1, Third Mound** **540 ± 60**
**AD 1410**

Surface of 3rd mound, E94N98, E96N98.

**Tx-1533. Hays 234-2, Third Mound** **550 ± 50**
**AD 1400**

Cane charcoal; same location as Tx-1532.

**Tx-1537. Hays 231-2, Third Mound** **520 ± 50**
**AD 1430**

Cane charcoal, same location as Tx-1532.

*Comment on Third Mound dates*: continuity of ceramics within site does not indicate appreciable time lapse between 2nd and 3rd mounds, so that Tx-1528 appears most likely correct date in light of dates from earlier stages. Cane charcoal dates Tx-1533, -1537 may be late due to fractionation during photosynthesis (Bender, 1968), although these dates agree with wood charcoal Tx-1532.

**Crenshaw site series, Arkansas**

Wood charcoal samples (except as noted) from Crenshaw site (3MI6) W side Red R 29km NE of Texarkana, SW Arkansas (33° 28′ N, 93° 45′ W). Late component, in Area 1, is early Caddoan; earlier component, in Area 4 and Mound F, is late Fourche Maline. Coll 1968, 1969, subm and commented on by Frank Schambach, Arkansas Archaeol Survey, Southern State Coll, Magnolia, Arkansas.

**850 ± 50**
**Tx-1351. Crenshaw 370-a** **AD 1100**

Area 1 midden; from distinct layer at bottom of Feature 11, pit hearth. *Comment*: too recent compared with Tx-1352 and Tx-1353 from same feature, and with rest of series.

**950 ± 50**
**Tx-1352. Crenshaw 378-a** **AD 1000**

Area 1 midden; Feature 11, higher layer than Tx-1351.

**940 ± 50**
**Tx-1353. Crenshaw 378-b** **AD 1010**

Same as Tx-1352, but small particles of charcoal, twigs, and bark.

**520 ± 60**
**Tx-1355. Crenshaw 596** **AD 1430**

Deer bone; Area 1, Feature 6, ash-laden floor. *Comment*: does not fit with rest of Area 1 features.

**960 ± 60**
**Tx-1356. Crenshaw 599** **AD 990**

Area 1, Feature 6, charcoal scattered throughout house floor.

**790 ± 270**
**Tx-1359. Crenshaw 597** **AD 1160**

Deer bone; Area 1, Feature 6, a house, from beneath floor. Large error due to small sample size. *Comment*: see Tx-1361, below.

**970 ± 60**
**Tx-1360. Crenshaw 298-a** **AD 980**

Area 1, Feature 9, pit hearth.

**830 ± 70**
**Tx-1698. Crenshaw 298-b** **AD 1120**

Same as Tx-1360, but pine cone fragments. *Comment*: experimental run to check isotopic fractionation in pine cones; 140 to 170 yr more recent than wood charcoal in same context.

**790 ± 70**
**Tx-1361. Crenshaw 598** **AD 1160**

Deer antler; Area 1, Feature 1, pile of antler assoc with floor of Feature 6. *Comment*: date agrees with age of Feature 6 (Tx-1359, above) as expected.

**Tx-1354. Crenshaw 421-a** **1060 ± 60**
**AD 890**

Area 4 midden, Feature 12, pit hearth. *Comment*: substantially more recent than estimated range, AD 600 to 800, for late Fourche Maline occupation.

**Tx-1358. Crenshaw 421-b** **890 ± 50**
**AD 1060**

Same as Tx-1354, but bark, twigs, and pine cone fragments. *Comment*: see Tx-1698, above.

**Tx-1357. Crenshaw 595-a** **1050 ± 70**
**AD 900**

Mound F, midden layer above clay cap over mass grave under mound.

*General Comment*: Caddo culture began in this area between late Fourche Maline and early Caddo occupations of this site, dates for which overlap in 10th century. Area 1 dates agree with those from other early Caddo sites, such as Davis (R, 1970, v 12, p 626-629, and present date list) and Harlan (*ibid*, p 254-258). Deer bone and antler from Area 1 are more recent than other samples, possibly reflecting fractionation in grasses eaten by deer.

*Nevada, Utah, Alabama*

**Thompson Site series, Nevada**

Charcoal from Thompson site (26WA1435), E side of Steamboat Creek, 2km SSE of junction Hwys 17 and 395, S of Reno, Nevada (39° 23′ N, 119° 43′ W). Site has 5 stratigraphic units, D (lowest) through H. In F1 (lower part Unit F), is midden ("Steamboat component") with lanceolate projectile points, chipped stone drills, manos, metates. Soil III, a structural and weak textural B horizon, later than Steamboat component, is developed in F2, upper part of F. Unit G, overlying F, is eolian deposit with artifacts and features suggesting dates during last 300 to 500 yr. Coll 1971 by R Elston and J O Davis; subm by Robert Elston, Nevada Archeol Survey, Univ of Nevada, Reno.

**Tx-1390. Thompson, 28** **330 ± 60**
**AD 1620**

From hearth, Feature 1, on unconformity between Soil III and Unit G. No direct cultural assoc.

**Tx-1391. Thompson, 2** **3480 ± 110**
**1530 BC**

Composite sample, particles scattered through Unit F, both F1 and F2.

*General Comment* (RE&JOD): dates indicate Steamboat component is early phase of Early Martis complex (Elston, 1971) and that local rate of clay accumulation and structural development in Soil B horizons is more than twice that of regional estimates in current literature (Birkeland, 1965; Mock, 1972). Dates bracket period of weathering during which weak textural and moderate structural B horizon formed.

**Dust Devil Cave series, Utah**

Samples from Stratum IV (except as noted), Dust Devil Cave (NA 7613), 12km NE of summit of Navajo Mt, San Juan Co, S Utah (37° 07′ N, 110° 47′ W). Site has 2 major cultural strata: Stratum IV (lower) with Desha complex materials; Stratum VI with Basketmaker II and Pueblo II-III materials. BMII occupation has $^{14}C$ date of 1820 ± 80 (Tx-452; R, 1970, v 12, p 276). Earlier work at site reported in Lindsay *et al*, 1968, p 102-121. Coll 1970, subm and commented on by J R Ambler, Dept Anthropol, Northern Arizona Univ, Flagstaff, Arizona. Samples are listed in stratigraphic order, top to bottom.

**Tx-1260. Dust Devil IV, 1** — **6840 ± 130** / **4890 BC**

Sandal fragments, Sq F9, top of stratum.

**Tx-1261. Dust Devil IV, 2** — **6740 ± 110** / **4790 BC**

Charcoal from Hearth 35, Sq F9, top of stratum.

*Comment on Tx-1260, -1261*: dates agree, indicate Desha complex lasted 200 yr later than 7000 BP indicated by Sand Dune Cave dates (Tx-447, -448, -454; R, 1970, v 12, p 276-277).

**Tx-1262. Dust Devil IV, 3** — **7630 ± 120** / **5680 BC**

Human fecal material, Sq B7, middle portion of stratum. *Comment*: in terms of stratigraphic position, consistent with other dates in series.

**Tx-1263. Dust Devil IV, 4** — **7340 ± 100** / **5390 BC**

Charcoal from concentration in Sq G8, middle part of stratum. Sample split and 2 parts prepared and counted separately: 7460 ± 120, 7210 ± 170. *Comment*: inconsistent stratigraphically with Tx-1264, but consistent with series as a whole.

**Tx-1264. Dust Devil IV, 5** — **7250 ± 110** / **5300 BC**

Charcoal from Hearth 37, Sq F9, bottom of stratum. *Comment*: earliest Desha complex, unless Tx-1265, -1266 are Desha.

**Tx-1265. Dust Devil IV, 6** — **8370 ± 110** / **6420 BC**

Charcoal from Hearth 32, Sq F8, bottom of stratum. Sample was split and 2 parts prepared and counted separately: 8380 ± 130, 8360 ± 180.

**Tx-1266. Dust Devil IV, 7** — **8830 ± 160** / **6880 BC**

Yucca leaves from Feature 17, yucca-lined pit, within Stratum III but dug from surface at base of Stratum IV.

*Comment on Tx-1265, -1266*: beginning of cave occupation; either earliest Desha complex (before Tx-1264) or a separate, earlier occupation.

**9600 ± 150**
**Tx-1267. Dust Devil III, 8** **7650 BC**

Leaves of Gambel's Oak and hackberry, Sq F8, Stratum III. Leaves blew into site before Desha complex occupation. Should provide *terminus post quem* for that occupation. *Comment*: with Tx-1266, indicates 800-yr hiatus between deposition of stratum III and beginning of occupation.

**Winston County Shelter #23 series, Alabama**

Fragmentary human bones from burial in Square 25, 91 cm depth, Winston County Bluff Shelter #23, 18km NE of Jasper, Alabama (34° 00′ N, 87° 15′ W). Burial was assoc with fireplace, and appeared disturbed. Also assoc were projectile points of early Archaic types. Coll and subm by Karen Joines, Samford Univ, Birmingham, Alabama.

**4850 ± 60**
**Tx-1614A. Winston #23, apatite** **2900 BC**

**2650 ± 550**
**Tx-1614B. Winston #23, collagen** **700 BC**

*General Comment* (KJ): apatite date agrees closely with archaeologic estimate of site age; (SV, EMD) collagen evidently affected by recent organic carbon.

*Mexico, Peru*

**Fábrica San José series, Oaxaca, Mexico**

Wood charcoal from Fábrica San José site, 13km NNE of Oaxaca, Mexico (17° 11′ 03″ N, 96° 40′ 20″ W). Site is one of few Middle Formative sites in piedmont zone of Valley of Oaxaca. Coll 1972 by R D Drennan and subm by D M Varner, Texas Memorial Mus, Univ Texas, Austin.

**2460 ± 80**
**Tx-1699. Fábrica San José #21** **510 BC**

Layer of ash and charcoal in basin-shaped hearth. Ceramics are Monte Alban IA phase.

**2670 ± 60**
**Tx-1700. Fábrica San José #14** **720 BC**

In layer of burned daub immediately above house floor. Ceramics are Monte Alban IA phase.

**3110 ± 80**
**Tx-1701. Fábrica San José #26** **1160 BC**

Layer of ash and charcoal in bottom of basin-shaped hearth in packed sand house floor. Sealed under later house floor. Ceramics in both floors are early Guadalupe phase.

**Tx-1702. Fábrica San José #22** **2350 ± 20**
**400 BC**

Layer of ash and charcoal in bottom of basin-shaped hearth. Ceramics are Monte Alban I phase.

*General Comment* (DMV): dates clarify beginning and duration of Guadalupe and Monte Alban IA phases during which settlement patterns shifted from valley floor alone to piedmont zone as well.

**Pashash series, Peru**

Charcoal samples from Pashash site, 2km SW of Cabana, Prov de Pallasca, Ancash, Peru (8° 24′ S, 78° 03′ W). Coll 1969 & 1971, subm and commented on by Terence Grieder, Dept Art, Univ Texas, Austin.

**Tx-940. Pashash A** **1500 ± 90**
**AD 450**

NE corner El Caseron; Cut 3, Level 2, 80 to 100cm. Assoc with richest level of Huaylas, or Recuay, pottery. Dates domestic construction after colossal fortification walls. *Comment*: date plausible, and agrees with Tx-942 (below) as it should, but in reverse sequence with Tx-943 (below) suggesting redeposition of slope wash on small structures flanking El Caseron.

**Tx-941. Pashash B** **1490 ± 70**
**AD 460**

From cut in Huaylas house W of La Capilla; Cut 4, Level 1, 40cm below surface. Burned roof beams of next-to-last house construction at this spot. Early Huaylas pottery, before resist was common. This sample should date a conquest of the site. A final building phase follows it. *Comment*: in proper sequence with Tx-944, -1322.

**Tx-942. Pashash C** **1580 ± 70**
**AD 370**

NE corner El Caseron; Cut 3, Level 2, lower part, ca 130 to 150cm. Assoc with beginning of richest sample of classic Huaylas or Recuay pottery and houses after building of colossal fortification walls. Dates resist pottery decoration and Huaylas pottery style. *Comment*: see Tx-941, above.

**Tx-943. Pashash D** **1380 ± 100**
**AD 570**

NE corner El Caseron; Cut 3, Level 4, 200 to 235cm. Dates beginning of later walls, later than colossal fortification walls. Before major period of resist painting on pottery, although resist was in use. *Comment*: see Tx-941, above.

**Tx-944. Pashash E** **1640 ± 80**
**AD 310**

Cut 4 (see Tx-941, above) 80cm below surface, under Floor 2. Dates 1st floor in this house laid down in Huaylas (Recuay) times; end of Chavinoid pottery and beginning of Huaylas (Recuay) style. Dates beginning of houses; post-dates colossal fortification walls. Should be oldest sample of this series (but site has prior occupations). *Comment*: appropriately early relative to other dates in series, but surprisingly late for end of Chavinoid. See also Tx-1332, below.

**Tx-1329. Pashash F** — **1400 ± 60** / **AD 550**

Cut 10, Level 4, against top of S wall of La Capilla hill inside chamber. Dates offering of stone pedestal bowls, Recuay effigy pottery, copper bells, and megalithic revetment wall.

**Tx-1330. Pashash G** — **420 ± 80** / **AD 1530**

Cut 7, 50cm W of La Portada, Level 4, 180cm deep. Dates Recuay ceramics.

**Tx-1331. Pashash H** — **1110 ± 270** / **AD 840**

Cut 9, top of La Capilla hill, against N wall, Level 2, 35cm below stone floor. Dates red-on-white ceramics. *Comment*: fill must be mixed; date too recent for red-on-white, even at early end of 1$\sigma$ range.

**Tx-1332. Pashash I** — **1610 ± 170** / **AD 340**

Cut 9 (see Tx-1331), Level 3. Dates initial occupation with pre-Recuay, red-on-white, and terminal Chavin ceramics. *Comment*: agrees with Tx-944 above, but—like that date—surprisingly late for terminal Chavin.

*Ecuador*

Samples coll 1970 (except as noted) and subm by R E Bell, Dept Anthropol, Univ Oklahoma, Norman.

**Alangasi Mastodon Locality series, Ecuador**

Wood from Alangasi Mastodon Locality, just N of Alangasi, Ecuador (0° 18′ S, 8° 1′ W). A mastodon skeleton with evidence of burning and assoc obsidian flakes and pottery sherds was found here in the 1920's (Uhle, 1928). Precise location of mastodon skeleton no longer certain; believed to have been in same stratigraphic unit as these samples —Late Cangagua, volcanic ash deposit of widespread occurrence around Mt Ilalo. Tx-1126-1130 from Site #1, 5m or more deep in side of gully; Tx-1131 from Site #2, about 60m downstream from Site #1, 8 to 10m deep. Errors are 2$\sigma$.

**Tx-1126. Alangasi 1, A** — **>38,000**

**Tx-1127. Alangasi 1, B** — **>40,000**

**Tx-1128. Alangasi 1, C** — **36,750 ± 2540** / **34,800 BC**

**Tx-1129. Alangasi 1, D** — **>40,000**

**Tx-1130. Alangasi 1, E** **39,560 ± 7200** **37,610 BC**

**Tx-1131. Alangasi 2** **39,100 ± 6820** **37,150 BC**

*General Comment* (REB): dates older than expected for mastodon and much too old for artifacts, but will help in using Late Cangagua as time marker in area. Mastodon either not contemporary with cangagua or not in primary assoc with artifacts, or both. Mastodon discovery evidently needs reevaluation.

**Shobschi Cave series, Ecuador**

Charcoal from preceramic horizon, Shobschi Cave, near Sigsig, Prov Azuay, Ecuador (3° 2′ S, 78° 57′ W). Coll 1968 by G Reinosa Hermida.

**Tx-1132. Shobschi, A** **8480 ± 200** **6530 BC**

From 10cm below surface.

**Tx-1133. Shobschi, B** **10,010 ± 430** **8060 BC**

From 20cm below surface.

*General Comment* (REB): dates indicate Shobschi is important preceramic site and merits further excavation. Cultural deposit continues below older sample.

**Santi Lucia series, Ecuador**

Charcoal scraped from pottery vessels from graves exposed by weathering at Santa Lucia site (ED-16), near Tumbaco, Ecuador (0° 15′ S, 78° 26′ W). Vessels are of typical Panzaleo ware, common and widespread in Highland area around Quito.

**Tx-1134. Santa Lucia, Burial #1** **2060 ± 110** **110 BC**

**Tx-1135. Santa Lucia, Burial #2** **2170 ± 100** **220 BC**

*General Comment* (REB): these are 1st dates for Panzaleo ceramics, and will provide initial point of reference in study of ceramic sequence in area.

**Tx-1136. Rubia Cocha #2, Ecuador** **170 ± 70** **AD 1780**

Charcoal from buried fireplace exposed in side of ditch cut, 10 to 25cm below surface, in Rubia Cocha #2 site (ED-4), near Tumbaco (0° 15′ S, 78° 28′ W). Field evidence not certain whether fireplace was assoc with Panzaleo ceramics or with preceramic occupation, or represented recent charcoal preparation subsequently covered by colluvium. *Comment* (REB): sample evidently from recent charcoal industry.

**Stobi series, Yugoslavia**

Charcoal (except where noted) from Stobi, Hellenistic and Roman site at junction of Crna R with Vardar R, S of Titov Veles, Macedonia, Yugoslavia (41° 33′ N, 21° 59′ E). As noted, most samples were split and check-dated by this lab and Rudjer Bošković lab at Zagreb; Zagreb dates pub in R, 1973, v 15, p 438-439. Most samples also were split by us and the 2 parts prepared and dated separately; in these cases individual dates are given. Except where noted, samples coll 1971 by hand, stored in polyethylene bags. Coll and subm by J R Wiseman, Dept Classics, Boston Univ, Boston, Mass, and E M Davis. Comments by EMD; for more extended discussion, see Davis *et al*, 1973.

**1600 ± 60**
**Tx-1339. Stobi R-71-3; Episcopal Basilica AD 350**

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. Date is average: 1610 ± 100, 1550 ± 100. Same sample as Z-207, 1611 ± 69. *Comment*: agrees closely with Z-207, and with archaeologic date of ca AD 400 for construction of building; early for late 6th century date of destruction.

**1660 ± 130**
**Tx-1340. Stobi R-71-13; Episcopal Basilica AD 290**

Wood; Episcopal Basilica, S Stairway, E extension 5; W of Wall 9, S of Wall 2, E of Wall 5; alt 144.39 to 144.69m. Below destruction fill, above latest floor; relates to latest use of basilica. *Comment*: within 1$\sigma$ of archaeologic date of building construction.

**1540 ± 70**
**Tx-1347. Stobi R-71-37; Episcopal Basilica AD 410**

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. Date is average: 1490 ± 70, 1580 ± 70. Same sample as Z-205, 1619 ± 66. *Comment*: agrees with Z-205, and with archaeologic date of building construction.

**1680 ± 70**
**Tx-1348. Stobi R-71-38; Episcopal Basilica AD 270**

Episcopal Basilica, Baptistry; from deposit above NE and NW parts of mosaic floor encircling piscina; alt 143.15 to 143.39m. Same sample as Z-211, 1759 ± 61. *Comment*: agrees well with Z-211; earlier than archaeologic date of building construction.

*General Comment on Tx-1339, -1340, -1347, -1348*: later part of date ranges mostly agree with AD 400 construction date of Episcopal Basilica, but as a group dates suggest early to middle 4th century rather than late 4th to early 5th. Presumably we are dating inner rings of beams.

**1760 ± 40**
**Tx-1341. Stobi R-17-14A; W Cemetery** **AD 190**

W Cemetery, S trench, N & E parts; from zone resting on Wall 8, alt 148.97 to 149.22m, with abundant pottery of 1st and 2nd centuries AD. Stored damp in polyethylene bag for 3 weeks, then dried. Date is average: 1680 ± 70, 1770 ± 70. Same sample as Z-216, 1779 ± 66. *Comment*: agrees with Z-216 and with ceramic date.

**2060 ± 120**
**Tx-1154. Stobi MF-70-44; W Cem, Grave 21** **110 BC**

Vegetal materials from W part Grave 21; part of burial offering including terracotta figurines and bas reliefs, unguentaria, pottery. Archaeologic date 30 BC to AD 40. Coll 1970. *Comment*: see below, Tx-1342.

**1810 ± 60**
**Tx-1342. Stobi R-71-15; W Cem, Grave 21** **AD 140**

Nuts from E part of same grave as Tx-1154. Wrapped in tissue, placed in polyethylene bag; tissue removed 3 weeks later. Date is average: 1770 ± 80, 1850 ± 90. Same sample as Z-213, 1836 ± 48. *Comment*: Tx-1342 and Z-213 agree but are a little later than archaeologic date, whereas Tx-1154 is anomalously early.

**1810 ± 70**
**Tx-1344. Stobi R-71-34; W Cem, Grave 82** **AD 140**

Fill of Grave 82, archaeologic date early 1st century AD. Date is average: 1810 ± 100, 1810 ± 100. Same sample as Z-210, 1883 ± 72. *Comment*: agrees with Z-210 and with archaeologic date.

**1640 ± 50**
**Tx-1345. Stobi R-71-35; W Cem, Grave 57** **AD 310**

Fill of Grave 57, probably 1st century AD. Date is average: 1600 ± 70, 1670 ± 70. Same sample as Z-206, 1877 ± 65. *Comment*: does not agree with Z-206 or with archaeologic date; reason for discrepancy not apparent.

**1620 ± 50**
**Tx-1343. Stobi R-71-33; Fuller's House** **AD 330**

House of the Fuller; charred beam in destruction layer on highest of 4 floors; final destruction of building; alt 149.19 to 149.66m. Ceramics late 4th century AD. Coll by hand into tray, moist; transferred to polyethylene bag, left open for 6 weeks in basement lab. Date is average: 1650 ± 60, 1590 ± 70. Same sample as Z-212, 1769 ± 69. *Comment*: does not agree with Z-212: late part of range agrees with ceramic date.

**1530 ± 50**
**Tx-1346. Stobi R-71-36; Acropolis** **AD 420**

Acropolis, Trench 1, from destruction debris in Room 4; probably roof beam. Should date end of last occupation in this part of site. Ceramics and coins indicate 5th or possible 6th century AD. Date is average: 1540 ± 70, 1520 ± 70. Same sample as Z-215, 1619 ± 65. *Comment*: agrees with Z-215 and with archaeologic date.

**130 ± 40**

**Tx-1349. Stobi R-71-23; bridge** **AD 1820**

Bridge Access; wood from transverse slot in pavement leading up from Pier I, W abutment pier of former bridge across Crna R. Should date bridge construction. No archaeologic date for bridge; stratigraphically later than flood-plain terrace-fill, which is later than ruins of wall built no later than 5th century AD. Coll with trowel and forceps. Date is average: 130 ± 60, 120 ± 60. *Comment*: date indicates bridge is Turkish, not Roman.

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[RADIOCARBON, VOL. 17, No. 1, 1975, P. 99-111]

# UNIVERSITY OF GEORGIA RADIOCARBON DATES IV

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The following list of dates is compiled from samples prepared since publication of our last date list (R, 1974, v 16, p 131-141). The counting equipment and operating procedures are the same. Ages are quoted with a $1\sigma$ counting error which includes statistical variation of the sample count as well as for background and standard, using AD 1950 as the reference year and 95% NBS oxalic acid for $^{14}C$ dating as the standard. The half-life value used is 5570 years.

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## SAMPLE DESCRIPTIONS

### GEOLOGIC SAMPLES

*Georgia*

**Okefenokee Swamp site series**

Core samples from various locations in the Okefenokee Swamp in SE Georgia.

**1875 ± 60**
**UGa-498. Sap Prairie** **AD 75**

Sap Prairie site (30° 37′ 10″ N, 82° 24′ 20″ W). Sandy peat at depth 175 to 186cm.

**2115 ± 95**
**UGa-497. Sap Prairie** **165 BC**

Sap Prairie site (30° 37′ 10″ N, 82° 24′ 20″ W). Wood at depth 193 to 196cm.

**6060 ± 110**
**UGa-499. Gannet Lake Trail** **4110 BC**

Gannet Lake Trail site (30° 39′ 50″ N, 82° 14′ 10″ W). Peaty sand, depth 405 to 430cm.

**6235 ± 105**
**UGa-485. Gannet Lake Trail** **4285 BC**

Gannet Lake Trail site (30° 39′ 50″ N, 82° 14′ 10″ W). Peaty sand at depth 379 to 386cm.

**3910 ± 85**
**UGa-503. Chesser 3B** **1960 BC**

Chesser 3B site (30° 42′ 10″ N, 82° 11′ 50″ W). Sandy peat at depth 191 to 201cm.

**UGa-507. Chesser 5** **4310 ± 80**
**2360 BC**

Chesser 5 site (30° 42′ 40″ N, 82° 11′ 10″ W). Sandy peat at depth 165 to 175cm.

**UGa-508. DJC #1** **3990 ± 70**
**2040 BC**

DJC #1 site (30° 43′ 50″ N, 82° 10′ 30″ W). Sandy peat at depth 170 to 180cm.

**UGa-513. Mizzel Prairie #2** **4385 ± 95**
**2435 BC**

Mizzel Prairie #2 site (30° 45′ 40″ N, 82° 10′ 10″ W). Peaty sand at depth 188 to 198cm.

**UGa-514. Chase Prairie** **6490 ± 80**
**4540 BC**

Chase Prairie site (30° 48′ 20″ N, 82° 14′ 40″ W). Sandy peat at depth 277 to 287cm.

**UGa-520. Chase Prairie 2B** **5140 ± 100**
**3190 BC**

Chase Prairie 2B site (30° 49′ 40″ N, 82° 14′ 40″ W). Sandy peat at depth 259 to 267cm.

**UGa-521. Territory Prairie** **6640 ± 95**
**4690 BC**

Territory Prairie site (30° 51′ 40″ N, 82° 12′ 0″ W). Peaty sand at depth 361 to 374cm.

**UGa-522. Trout Lake** **2130 ± 60**
**180 BC**

Trout Lake site (30° 57′ 50″ N, 82° 9′ 20″ W). Peat at depth 211 to 216cm.

**UGa-523. Trout Lake** **3730 ± 175**
**1780 BC**

Trout Lake site (30° 57′ 50″ N, 82° 9′ 20″ W). Wood at depth 218 to 226cm.

**UGa-524. Mixons Hammock** **4650 ± 110**
**2700 BC**

Mixons Hammock site (30° 49′ 20″ N, 82° 22′ 50″ W). Sandy, clayey peat at depth 193 to 209cm.

**UGa-538. Boat Trail** **6610 ± 90**
**4660 BC**

Boat Trail site (30° 50′ 30″ N, 82° 20′ 40″ W). Sandy peat at depth 165 to 173cm.

**UGa-539. Floyds Prairie** **6145 ± 80**
**4195 BC**

Floyds Prairie site (30° 52′ 40″ N, 82° 18′ 0″ W). Sandy peat at depth 250 to 262cm.

**6325 ± 140**
**UGa-540. 10 Min to Minnie's Lake** **4375 BC**

10 Min to Minnie's Lake site (30° 51′ 20″ N, 82° 19′ 40″ W). Sandy peat at depth 287 to 295cm.

**5840 ± 115**
**UGa-541. Middle Fork** **3890 BC**

Middle Fork site (30° 54′ 0″ N, 82° 17′ 0″ W). Sandy peat at depth 336 to 346cm.

**2635 ± 85**
**UGa-496. Dinner Pond** **685 BC**

Dinner Pond site (30° 58′ 40″ N, 82° 17′ 0″ W). Peaty sand at depth 79 to 89cm.

**2950 ± 160**
**UGa-542. Dinner Pond** **1000 BC**

Dinner Pond site (30° 58′ 40″ N, 82° 17′ 0″ W). Wood at depth 104cm.

**2775 ± 70**
**UGa-543. Green River Run** **825 BC**

Green River Run site (31° 2′ 39″ N, 82° 17′ 10″ W). Sandy peat at depth 84 to 91cm.

**6585 ± 160**
**UGa-494. Floyd's Prairie Canoe Trail** **4635 BC**

Floyd's Prairie Canoe Trail site (30° 51′ 50″ N, 82° 16′ 30″ W). Peaty sand at depth 310 to 315cm.

*General Comment*: all samples were taken from 7.5cm cores to determine age and rate of peat deposition in Okefenokee Swamp-Marsh system. The dates of the basal peats suggest that swamp did not start forming or accumulating on sandy subsurface until ca 6500 BP. Dates agree well with proposed swamp-marsh formation and results are further discussed in Cohen (1973). Samples coll and subm by A D Cohen, Dept Geol, Southern Illinois Univ, Carbondale.

## ARCHAEOLOGIC SAMPLES

### *Alabama*

**605 ± 60**
**UGa-695. Clarke County** **AD 1345**

Cypress wood sample cut from gunwale of dugout canoe from E bank, Lower Tombigbee R ca .4km SE of Peavy's Landing (31° 36′ 15″ N, 88° 04′ 15″ W). Coll by R L Grimes and J J Mason, Frankville, Alabama. Subm by N R Stowe, Dept Soc & Anthropol, Univ South Alabama, Mobile.

**585 ± 60**
**UGa-564. Laddel site, Feature 26** **AD 1365**

Wood charcoal from burned roof or wall timber of Mississippian type house. Laddel site 1-Wx-1, Wilcox Co, (32° 5′ N, 87° 14′ 21″ W) on 2nd or 3rd terrace of Alabama R, seldom flooded. Site is in level field, plowed by draft animals for ca 60 yr. Sample is 20 to 25cm below plow zone. Excavated by J W Cottier, Field Dir, Miller's Ferry Lock and Dam Archaeol Proj. *Comment* (CTS, Jr): structure assoc with ceramics of so-called Burial Urn complex of central Alabama. This material is almost definitely post-Mississippian-climax (Moundville phase), but prior to full contact with Europeans ca AD 1700. Structure estimated to be built between AD 1500 and AD 1700. Subm and coll by C T Sheldon, Jr, Dept Soc Anthropol, West Georgia College, Carrollton.

**Jefferson County series #1**

Jefferson Co site 1-Je-33, 15.5km W of Birmingham, Alabama (87° N, 33° W).

**UGa-609. Charcoal, Feature 3** **1005 ± 60** **AD 945**

Bell-shaped pit underlying plow zone. One charred corn cob in pit, along with clay-tempered loop handle and plain, incised, and zone punctated pottery.

**UGa-610. Charcoal, Feature 9A** **995 ± 65** **AD 955**

Large pit underlying plow zone.

**UGa-611. Charcoal, Feature 36** **945 ± 70** **AD 1005**

Large bell-shaped pit underlying plow zone. Clay-grit tempered pottery discoidal in pit.

**UGa-612. Charcoal, Feature 5** **945 ± 70** **AD 1005**

Small basin-shaped pit underlying plow zone. Plain clay-grit tempered pottery and acorn husks found in pit. Coll by Ned Jenkins, and subm by D L DeJarnette, as part of West Jefferson Steam Plant Salvage Proj, Univ Alabama, Moundville.

*General Comment* (DLDeJ): site is a single component terminal Woodland.

**Jefferson County series #2**

Jefferson Co site 1-Je-32, 15.5km NW of Birmingham, Alabama (33° 38′ N, 87° 4′ W).

**UGa-633. Charcoal, Feature 30** **1050 ± 60** **AD 900**

Large basin shaped pit—originated at base of Plow zone. Pit fill contained 5 Wheeler check-stamped sherds.

**UGa-625. Charcoal, Feature 20** **890 ± 60** **AD 1060**

Sample from straight sided, flat-bottomed pit that originated at base of plow zone.

**UGa-624. Charcoal, Feature 8** **985 ± 65**
**AD 965**

Bell-shaped pit that originated at base of plow zone. Clay tempered loop handle found in pit fill.

**UGa-626. Charcoal, Feature 13** **1565 ± 635**
**AD 385**

Basin-shaped pit, containing fire hearth, originating at base of plow zone. One steatite potsherd found in pit fill. Coll by Ned Jenkins, and subm by D L DeJarnette.

**Jefferson County series #3**

Jefferson Co site 1-Je-31, 15.5km W of Birmingham, Alabama (33° 38′ N, 87° 4′ W).

**UGa-650. Wood charcoal, Feature 11** **1360 ± 70**
**AD 590**

Sample from refuse pit which originated at base of plow zone. Plain clay-grit pottery. Also in this feature was a large sherd of Autauga check-stamped, a Central Alabama type dated by Dickens at AD 920.

**UGa-651. Wood charcoal, Feature 10** (A) **3850 ± 70**
**1900 BC**

**UGa-651R.** (B) **2340 ± 85**
**390 BC**

Sample from refuse pit that originated at base of plow zone. Plain clay-grit pottery. Also found was sherd of Autauga Pinched, a central Alabama type dated by Dickens at AD 920. *Comment*: separate determinations on charcoal from this pit indicate mixing of components.

**Uga-652. Wood charcoal, Feature 12** **1075 ± 70**
**AD 875**

Sample from refuse pit originating at base of plow zone. Much mussel shell also in pit. Plain clay-grit tempered pottery; 2 large loop handles.

**UGa-649. Wood charcoal, Feature 4** **890 ± 75**
**AD 1060**

Sample from refuse pit that originated at base of plow zone. Plain clay-grit tempered pottery, large loop handles. Also in pit was part of shell-tempered pipe and part of clay-grit tempered pipe. Coll and subm by D L DeJarnette.

*Arkansas*

**Blanchard Springs Caverns series**

Caverns 13km NW of Mt View, Stone Co, (35° 58′ N, 92° 11′ W).

**UGa-691. Charcoal** **965 ± 90**
**AD 985**

From floor of cavern ca 180m SE of Indian skeleton.

**UGa-692. Charred wood** **1005 ± 60**
**AD 945**

From floor of cavern ca 30m NW of Indian skeleton.

**UGa-693. Charred wood** **1725 ± 60**
**AD 225**

From floor of cavern ca 140m NW of Indian skeleton.

**UGa-694. Charred wood** **1005 ± 70**
**AD 945**

From floor of cavern ca 140m NW of Indian skeleton.

*General Comment*: in 1955 an Indian skeleton was found by spelunkers in Blanchard Springs Caverns. In 1966 a $^{14}C$ date of 1080 ± 60 (UCLA-792B, Berger and Libby, 1967) was obtained on some partially buried cane from cavern 229m NW of skeleton. No Indian artifacts were ever reported from Blanchard Springs Caverns. Subm and comment by Daniel Wolfman, Arkansas Archaeol Survey, Arkansas Polytech College.

### *California*

*Sierra Nevada*

These determinations represent continuing effort to accurately bracket the ages of volcanic-ash eruptions within the Mono-Inyo Crater chain of E-central California that deposited rhyolitic ash found in surficial deposits of Sierra Nevada region. Coll in 1972 and subm by S H Wood, Cal Tech, Pasadena.

**UGa-449. Devil's Post Pile National Monument** **3375 ± 140**
**1455 BC**

Charcoal, 2.8m deep in 3.7m sec of dark yellowish-brown loamy soil exposed in gully ca 20m W of rd to Reds Meadow, 0.3km S of Starkweather Lake (37° 39′ 32″ N, 119° 04′ 18″ W). Four volcanic ash layers occur in this sec. This dated charcoal layer immediately underlies 3rd deepest volcanic ash layer and dates maximum age.

**West Fork of Long Meadow Creek series**

West Fork site, Sierra Nevada (36° 58′ 47″ N, 119° 0′ 49″ W).

**UGa-450. Wood** **1210 ± 55**
**AD 740**

Outer wood from 0.5m diam, white fir stump *in situ* buried 0.6m beneath surface of a recently dissected meadow, 1.2h.

**UGa-451. Wood** **1175 ± 65**
**AD 785**

Outer wood from 0.5m diam white fir log buried 0.45m beneath meadow surface.

*General Comment*: UGa-450 and -451 bracket age of fine rhyolitic ash deposited directly on stump. Another, more recent tephra layer of fine white lapilli and ash occurs 0.25m above log, UGa-451. Age of this layer was estimated by Wood (1972) as 600 to 900 yr. These 2 tephra layers are widespread in central and S Sierra, and are uppermost 2 layers in Devil's Post Pile sec of UGa-449, where most recent layer is coarse pumice surface deposit. Preliminary trace element "fingerpainting" of this most recent tephra layer indicates a possible source from lapilli-rimmed crater partially covered by rhyolite dome S of Deadman Creek in Inyo Crater group analyzed by Jack and Carmichael (1968) and described by Huber and Rinehart (1967). The second deepest layer ca 1200 BP, correlates to Mono Crater group based on very low strontium content, and is same ash found in East Meadow and Tuolumne Meadows, Yosemite, by Wood (1972).

**UGa-604. Wood** **3320 ± 85** **1370 BC**

Fir log, 0.2m diam buried 3.1m.

**UGa-605. Wood** **3770 ± 65** **1820 BC**

Fir log, 0.1m diam buried 5.8m.

**UGa-602. Heartwood from Lower Cabin Meadow, Sierra Natl Forest** **760 ± 60** **AD 1190**

Heartwood comprised of 12 growth rings 40 to 52 yr older than outermost growth ring of fir log, 0.4m diam, buried 0.3m and resting directly on rhyolitic tephra, 2cm thick.

**UGa-603. Pine log** **710 ± 60** **AD 1240**

The 20-yr growth ring interval 150 to 170 yr older than outermost growth ring of pine log, 0.2m diam, buried in a volcanic mudflow, exposed on N wall of S-most explosion pit of Inyo Crater Lakes, Inyo Natl Forest, California.

**UGa-621. Wood Upper Cabin Meadow on Laurel Creek** **8960 ± 90** **7010 BC**

Pine wood buried 3.05m in basal paleosol of Upper Cabin Meadow on Laurel Creek, Sierra Natl Forest.

**Boggy Meadow site series**

Kings Canyon National Park (36° 43′ 30″ N, 119° 30′ W).

**UGa-620. Wood** **8705 ± 95** **6755 BC**

Wood from stump, 0.07m diam, rooted in basal paleosol, buried 6.1m in Boggy Meadow.

**UGa-623. Charcoal** **10,185 ± 105** **8235 BC**

Pieces of organic soil containing charcoal buried 6.7m in Boggy Meadow, Sugarloaf Valley.

**UGa-622. Wood** **9855 ± 100**
**7905 BC**

Heartwood from pine stump, 1m diam, buried 3.1m in Exchequer Meadow, Sierra Natl Forest.

**East Meadow series**

Wood and charcoal from several secs alluvial and organic fill exposed in gullies that dissected this 6.1h meadow, 2.5km E of Aspen Valley, Yosemite Natl Park, California (37° 50′ N, 119° 44′ 30″ W). Coll 1972 and subm by S H Wood.

**UGa-447. Charcoal** **9020 ± 270**
**7070 BC**

Charcoal from the "O" horizon of paleosol with O, A, C profile developed upon granitic bedrock. Paleosol was buried 7.5m beneath meadow surface.

**UGa-452. Wood** **9480 ± 90**
**7530 BC**

Wood from pine stump, 0.3m diam, *in situ*, rooted in mucky soil extending laterally to basal paleosol of UGa-447. Sample was buried 10m beneath meadow surface.

**UGa-448. Wood** **2830 ± 65**
**880 BC**

Wood from root mass *in situ* of fir stump, 1m diam, truncated and buried 2.5m beneath meadow surface.

*General Comment*: dates, with I-6049 (unpub) establish chronology for 3 depositional units that comprise sub-meadow stratigraphy described by Wood (1973).

*Florida*

**Drummond Point series**

Samples from small shell midden, offshore in salt marsh at Drummond Point 8-Na-34, Amelia I, Florida (30° 32′ N, 81° 28′ W).

**UGa-512. Oyster shell** **915 ± 60**
**AD 1035**

**UGa-546. Charcoal** **845 ± 140**
**AD 1105**

Coll and subm by E T Hemmings, Florida State Mus, Gainesville, Florida.

*General Comment* (ETH): midden lacks evidence of typical household refuse; believed to be a specialized mollusk processing sta for a St Johns II village ca 1km S (Hemmings *et al*, 1973).

**St John's site series**

Site 8-Vo-139 is one of St John's R complex of prehistoric and preceramic aboriginal habitation, S-most Volusia Co, (28° 34′ N, 80° 57′ W) at Brevard Co border (Rouse, 1951).

**4360 ± 75**
**UGa-409. Clam shell** **2410 BC**

From 7.6cm streak of humus, 2.7m below surface. *Comment* (ASD, Jr): date is younger than expected, geologically.

**3955 ± 65**
**UGa-462. Snail shell** **2005 BC**

From 0.75 to 0.9m depth at interface between Ceramic and Preceramic secs. Coll by A S Dooley, Jr and C F Knoderer and subm by ASD, Jr, Brevard Comm College, Cocoa.

*South Carolina*

**Spanish Mount site series**

Edisto I, Charleston Co, South Carolina (32° 30′ N, 80° 19′ W). Site 38-Ch-62, samples are from slightly different locations at base of Spanish Mount shell mound.

**3820 ± 185**
**UGa-583. Charcoal** **1870 BC**

**4170 ± 350**
**UGa-584. Charcoal** **2220 BC**

*General Comment*: results agree well with expected date. Samples assoc with burnt shell and Early Woodland ceramics. Coll by D R Sutherland and subm by R L Stephenson, Inst Archaeol & Anthropol, Univ South Carolina, Columbia.

*Indiana*

**Farrand site series**

Site 12-Vi-64, Vigo Co, Indiana (39° 19′ 00″ N, 87° 32′ 24″ W). Multi-component, non-stratified village site with Late Woodland Albee complex, and Havana, Albee and Vincinnes cultural debris.

**1205 ± 85**
**UGa-536. Charcoal, Feature 25** **AD 745**

Pit, 1m diam and 0.75m deep, containing nut fragments, charcoal, bone and flint, with lens of ashes.

**1130 ± 115**
**UGa-537. Charcoal, Feature 39** **AD 820**

Pit, 1.1m diam and 0.6m deep, containing charcoal, ashes, carbonized nut fragments, bone and flint debris, some shell, and heat-cracked stone.

**810 ± 75**
**UGa-656. Charcoal, Feature 61** **AD 1140**

Pit, 1.15m diam by 1.45m depth, with expanded lower third; pit contained remains of maize, beans, grass fiber lining, mammal, bird, fish and mussel, along with trianguloid points and shell-tempered sherds. Stench caps and ash lens present.

**845 ± 100**
**UGa-657. Charcoal, Feature 74** **AD 1105**

Pit, 0.9m diam and 1.4m deep, containing maize, beans, nuts, mammal and fish bones, turtle, shell-tempered sherds, mud dauber nests, and obsidian flake removed. Subm and comment by R E Pace, Indiana State Univ, Dept Anthropol, Terre Haute.

**Monroe-Daughtery site series**

Site 12-Su-13, Sullivan Co, Indiana (39° 07′ 39″ N, 87° 38′ 11″ W). Single component, non-stratified, Late LaMotte culture village site. Samples from shallow basin-shaped cooking pit containing Embarrass Cordmarked ceramics. Site discussed by McMichael and Coffing (1970), Clouse *et al* (1971), and Brashear *et al* (1972).

**1490 ± 105**
**UGa-533. Charcoal, Feature 7** **AD 460**

Sample was removed by trowel from pit, 135cm diam and 145cm deep, containing Embarrass Cordmarked (83%) and Embarrass Simple Stamped (15%) ceramics.

**1560 ± 70**
**UGa-534. Charcoal Feature 8** **AD 390**

Sample removed by trowel from pit, 125cm diam and 140cm deep, containing Embarrass Cordmarked (92%) and Embarrass Simple Stamped (4%) ceramics.

**2480 ± 110**
**UGa-535. Charcoal, Feature 3** **530 BC**

Sample removed by trowel from pit, 84cm diam and 40cm deep, containing Embarrass Cordmarked ceramics.

**1450 ± 95**
**UGa-654. Charcoal and Nuts, Feature 20** **AD 500**

Sample from cooking pit.

**1715 ± 85**
**UGa-655. Charcoal and nuts, Feature 50** **AD 235**

Sample from refuse pit within large circular house pattern. Subm and comment by R E Pace.

*General Comment*: pits contained charred nut fragments, charcoal, bone, shell, flint and heated stone debris. Pit of Feature 7 had intrusion of an osage orange tree root in upper half of pit.

**1810 ± 135**
**UGa-660. Leonard site, 12-Po-20** **AD 140**

Charcoal from multi-component, non-stratified village site, Late Woodland and Mississippian, (39° 19′ 00″ N, 87° 32′ 24″ W). Sample removed from refuse pit at depth 0.6m. Site discussed by Henn (1971). Comm and subm by R E Pace.

*Massachusetts*

**Green Hill site series**

Site M-35-NW, on a Kame Terrace along Neponset R, Milton, Massachusetts (42° 13′ N, 71° 8′ W).

**UGa-500. Charcoal** **7875 ± 230**
**5925 BC**

Sample from Feature 5, bowl-shaped pit.

**UGa-580. Charcoal** **7950 ± 95**
**6000 BC**

Sample from Feature 13, bowl-shaped pit in possible lodge floor.

*General Comment* (RAP): dates indicate Early Archaic site. Coll and subm by R A Parker and R W McCurdy, South Shore Chapter, Massachusetts Archaeol Soc.

*Mississippi*

**UGa-680. Coleman Mound site, 22-Lo-507** **685 ± 105**
**AD 1265**

Charcoal from undisturbed hearth in Logan Co, Mississippi (33° 20′ N, 88° 20′ W) found at base of final construction phase of this moderately large, flat-topped mound at depth 75 to 90cm. Sample should date Mississippian cultural period occupation of central Tombigbee Valley. No village site was found immediately contiguous with mound, but a single shell-tempered sherd was discovered in fill of final building stage of mound, above hearth from which sample was taken. Coll, subm, and comment by M D Rucker, Dept Anthropol, Mississippi State Univ, Mississippi State.

**Vaughn Mound site series**

Vaughn Mound site, 22-Lo-538, Logan Co, Mississippi (33° 25′ N, 88° 25′ W).

**UGa-681. Charcoal** **1595 ± 70**
**AD 355**

Sample from excavations in Test Sq D, at depth 42cm within undisturbed fill of trash pit containing many homogenous ceramics. Sample ca 20cm below plow zone and no rootlets or other contaminating agents were apparent. Preponderant ceramic type present in pit was rather large, undecorated, "paste-tempered" jar form with slightly outflaring rims and slightly constricted necks. One large sherd from rim of tecomate (or incurvate rim form) bears incised decorations much like those found on Marksville Incised, var Yokena, described and illustrated by Greengo from Yazoo Basin. A late Marksville or early Baytown date is expected.

**UGa-682. Charcoal** **1285 ± 90**
**AD 665**

Sample from Test Pit D within fill of same trash pit as UGa-681, but at depth 52cm. Coll ca 35cm below plow zone in apparently undisturbed context. Date should be consistent with that of UGa-681. Late

Marksville or early Baytown date expected, but possibly later since Marksville-like sherd described in connection with UGa-681 contained some finely crushed shell as a tempering agent.

**UGa-688. Bone** **5040 ± 85** **3090 BC**

Sample consists of human bone, left femur and humerus, encountered in Test Pit C at depth 137cm, and designated "Burial 3/73". This burial, with at least 2 others, was covered by a small mound of earth containing midden debris, but no artifacts were found assoc with this or any other of these burials. Adult specimen from this burial was recovered from well within an Archaic Period deposit and should date to somewhere within that period.

**UGa-689. Bone** **5835 ± 95** **3885 BC**

Sample subm consists of human bone, left femur and humerus, adult specimen, from burial excavated in Test Pit B at depth 160cm and designated "Burial 6/73". This was only burial recovered from Test Pit B, but was also covered by a small earthen mound containing some midden debris. No mortuary accompaniments were present. Like UGa-688, this burial was recovered from deep in Archaic period deposit and date should reflect this. Coll, subm, and comment by M D Rucker.

*Tennessee*

**Higgs site series**

Loudon Co site, 40-Ld-45, (35° 45′ 22″ N, 84° 22′ 15′ W). Site discussed by McCollough and Faulkner (1973).

**UGa-517. Wood charcoal, Feature 11** **2850 ± 85** **900 BC**

Bottom (primary) fill of Feature 11, a large hemispheric cooking pit; matrix of charcoal overlaid by secondary fill comprising dark brown loam. Point of origin of feature 0.5m below present surface (base of Level III); feature excavated into yellow-brown clayey loam of Level IV; sample depth 0.7m below present surface. Feature 11 is central hearth assoc with Late Archaic timber shelter and living floor. To date Late Archaic shelter complex. Feature contains domestic sunflower and *chenopodium sp* seed.

**UGa-547. Same as UGa-517** **2970 ± 155** **1020 BC**

**UGa-515. Wood charcoal, Feature 18** **2355 ± 85** **405 BC**

Fill of Feature 18 (shallow basin-shaped firepit); matrix of loose dark brown sandy loam, very friable; fill also includes several large burned quartzite cobbles. Point of origin of feature 1.0m below present surface base of Level II midden. *Comment*: to date Level II midden, early phase of Early Woodland occupation of Site 40-Ld-45, and adjoining Early Woodland house at same horizon.

**UGa-548. Wood charcoal, Feature 17** **1475 ± 165**
**AD 475**

Fill of Feature 17 (elliptical basin-shaped firepit containing abundant charred wood, no artifacts); matrix of loose dark brown sandy loam, very friable; point of origin of feature 0.6m below present surface —top of Level II midden. *Comment*: to date Level II midden, late phase of Early Woodland occupation of Site 40-Ld-45, and furnish *terminus ante quem* for adjoining Early Woodland house at slightly lower horizon. Subm and coll by M C R McCollough, Univ Tennessee, Dept Anthropol, Knoxville, Tennessee.

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# UNIVERSITY OF MIAMI RADIOCARBON DATES II

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The following list of dates are selected from geologic and archaeologic samples measured in late 1973. The laboratory procedures and techniques are the same as indicated in R, 1974, v 16, p 402-408, where sample is synthesized to benzene and counted for 24 hours in either a Beckman LS-100-C or Packard 2311 liquid scintillation spectrometer. Ages are calculated relative to 0.95 x NBS oxalic acid using a $^{14}C$ half-life of 5568 years. The quoted error is $1\sigma$, which includes only the counting uncertainties of the background, modern standard, and sample. Sample descriptions and comments were written in collaboration with collectors and submitters.

ACKNOWLEDGMENTS

We are grateful to D Evans of the Department of Biology for use of his spectrometer as a supplement to our own counter.

## CHECK SAMPLES

### Interlaboratory cross checks

| UM sample | UM date | Other sample | Other date | Reference | Sample material |
|---|---|---|---|---|---|
| *UM-182/a | 10,538 ± 145 | | | | |
| 182/b | 10,125 ± 119 | | | | |
| 182/c | 9446 ± 110 | A-1250 | 10,150 ± 480 | unpub | wood |
| 182/d | 10,379 ± 108 | | | | |
| 182/e | 10,724 ± 173 | | | | |

* Complete reruns of the same sample.

Ages of check samples determined in this laboratory indicate satisfactory agreement with results of other laboratories. Reproducibility, as indicated by multiple runs, is satisfactory.

## SAMPLE DESCRIPTIONS

### I. ARCHAEOLOGIC SAMPLES

### *A. United States*

**Maximo Park shell midden series**

Shells from a series of kitchen middens, Maximo Park, S of St Petersburg, Florida (27° 42′ 30″ N, 82° 41′ 00″ W), to determine environmental utilization patterns of peoples who constructed midden and number of their cultures. Radiocarbon analyzed and artifacts identified to establish age range for habitation. Coll 1973 by J R Williams, Dept Anthropol, Univ South Florida, Tampa, Florida; subm 1973 by M Andrejko.

*General Comment* (JRW): inhabitants of Tampa Bay middens during Archaic period are currently without distinct cultural names. Early inhabitants were efficient users of Tampa Bay eco-system; there are no signs of ecological disturbances.

**976 ± 70**
**UM-143. Shell Midden A, RC-1** **AD 974**

Charcoal from 72cm beneath surface.

**4148 ± 90**
**UM-150. Shell Midden A, RC-17A** **2198 BC**

*Ostrea equestris* shells from 105 to 110cm beneath surface.

**2130 ± 105**
**UM-151. Shell Midden A, RC-17B** **180 BC**

Calcareous concretion found in a possible fire pit, from 105 to 110cm beneath surface.

**4022 ± 122**
**UM-149. Shell Midden A, RC-15A** **2072 BC**

*Aequipecten irradians concentricus* shells from 115 to 120cm beneath surface.

**3977 ± 118**
**UM-144. Shell Midden B, RC-9A** **2027 BC**

*Ostrea equestris* shells from 75 to 80cm beneath surface.

**3875 ± 90**
**UM-145. Shell Midden B, RC-9B** **1925 BC**

*Aequipecten irradians concentricus* shells from 75 to 80cm beneath surface. *Comment*: *cf* UM-144.

**3822 ± 100**
**UM-147. Shell Midden B, RC-12** **1872 BC**

*Aequipecten irradians concentricus* shells from 80cm beneath surface. *Comment*: duplicate runs of sample gave 3852 ± 92 BP and 3793 ± 108 BP.

**3822 ± 80**
**UM-148. Shell Midden B, RC-14B** **1872 BC**

*Aequipecten irradians concentricus* shells from 100cm beneath surface. *Comment*: duplicate runs of sample gave 3879 ± 86 BP and 3765 ± 80 BP.

**3827 ± 80**
**UM-146. Shell Midden B, RC-11** **1877 BC**

*Strombus alatus* shells from 105cm beneath surface.

*B. British Honduras*

**1010 ± 50**
**UM-122. San Jose, C4** **AD 940**

Fragment of Sapote wood from a cross beam in principal Palace Building of Mayan site in San Jose, British Honduras (17° 30′ 12″ N, 88° 55′ 00″ W). Sample used to cross-date pottery from same structure. Coll 1967 and subm 1973 by H C Ball, Inst Maya Studies, Miami, Florida. *Comment* (HCB): pottery assoc with structure id as San Jose V, or AD 987 (Thompson, 1939).

*C. Guatemala*

**UM-124. Kinal Lintel** **1320 ± 73**
**AD 630**

Fragment of wooden lintel from East Temple, Main Plaza, Mayan site of Kinal, Guatemala (17° 42′ N, 89° 14′ W). Sample used to cross-date pottery and artifacts from same site. Coll 1964 and subm 1973 by H C Ball. *Comment* (HCB): pottery sherds from site correspond to both Tzakol phase, AD 300 to 650 and Tepeuh phase, AD 650 to 1000. Kinal architecture is similar to other sites in area that date near middle of Classic period, ca AD 500 to 700 (Graham, 1967).

*E. China*

**UM-170. Goddess Kuan Yin** **162 ± 50**
**AD 1788**

Wood cored from Buddhist sculpture, from Temple, Shenhsi, China (ca 35° 00′ N, 110° 00′ E). Coll and subm 1973 by L R Rick, Jr, Key Biscayne, Florida. *Comment* (LRR): sculpture is gesso covered wood, 1.2m high, carved from a single block. Represents Kuan Yin, China's Bodhisattva Goddess of Mercy. Iconographically comparable only to 5th and 6th century stone. Kuan Yin is shown in Lubor Hajek's "Chinese Art" pls 137-145, Naprstek Mus, Prague, Czechoslovakia. If sculpture was dated from 6th to 8th century, it would be oldest Buddhist sculpture in wood extant today. *Comment*: $^{14}C$ date is average of 3 separate runs of sample, 135 ± 65 BP; 195 ± 65 BP; 155 ± 60 BP.

## II. GEOLOGIC SAMPLES

*A. Tunisia*

**Lake Tunis series**

Red algae and mollusk shells cored from center of Lake Tunis, Tunisia (36° 45′ N, 10° 15′ E). Dates help establish sedimentation rate of lagoonal deposits in lake. Coll 1972 by F Kerr; subm 1973 by O H Pilkey, Duke Univ, Durham, North Carolina.

**UM-160. Lake Tunis, RC-1** **2520 ± 95**
**570 BC**

Sample from 60 to 70cm beneath lake bottom.

**UM-156. Lake Tunis, RC-2** **3130 ± 105**
**1180 BC**

Sample from 220cm beneath lake bottom.

*B. United States*

**UM-155. Continental rise pelagic mud** **9710 ± 155**
**7760 BC**

Core interval 110 to 114cm, Continental rise, 3500m off North Carolina coast (33° 40′ 18″ N, 75° 04′ 30″ W). Coll and subm 1973 by O H Pilkey. *Comment* (OHP): sample is from a pelagic sequence, overlying a sharp drop in $CaCO_3$ found in most rise cores from this area. Date probably represents a point at which sea level rose over edge of shelf and caused a sudden reduction in sedimentation rate. Hence higher $CaCO_3$ content.

**UM-158. Surf City beach shell** **7845 ± 135**
**5895 BC**

Composite, loose shell material from beach, Surf City, North Carolina (34° 24′ N, 77° 38′ W). Sample from hightide line. Coll 1973 by Piotrowski; subm 1973 by O H Pilkey. *Comment* (OHP): date reinforces conclusion that Surf City beach is composed of basically relict shell material.

**UM-159. Plum Island beach shell** **420 ± 75**
**AD 1530**

Composite, loose shell material from beach on Plum Island, Massachusetts (42° 45 N, 70° 47′ W). Coll 1973 by Piotrowski; subm 1973 by O H Pilkey. *Comment* (OHP): sample from hightide line. Plum Island beach is basically recent shell material.

**Platt Shoals series**

Samples dated to establish evolution of Platt Shoals complex, Platt Shoals, North Carolina. Coll 1973 by P C Sears; subm 1973 by W L Stubblefield, NOAA, Miami, Florida.

**UM-117. Platt Shoals PGL** **4400 ± 160**
**2450 BC**

Shell hash cored 4m beneath water and sediment interface, inner crest of Platt Shoals (35° 45′ 06″ N, 75° 26′ 30″ W).

**UM-118. Platt Shoals P1M** **5618 ± 100**
**3668 BC**

Shell hash cored 3m beneath water and sediment interface, outer ridge of Platt Shoals (35° 45′ 06″ N, 75° 19′ 18″ W).

**Atlantic City series**

Samples cored 48km SE of Atlantic City, New Jersey. Coll 1972 by D J Swift; subm 1973 by W L Stubblefield.

**UM-103. Atlantic City 1B-V2** **29,700 ± 650**
**27,750 BC**

Shells from 83cm beneath surface (39° 04′ 54″ N, 73° 55′ 00″ W). *Comment* (WLS): sample from littoral deposit of early Holocene. Date brackets top of Pleistocene and establishes sedimentation rate during Holocene.

**UM-104. Atlantic City 1B-V2** **32,150 ± 600**
**30,200 BC**

Shells from 215cm beneath surface, same core as UM-103.

**UM-134. Atlantic City 1B-156** **10,050 ± 170**
**8100 BC**

Shells from scoured trough of ridge and swale topography (39° 05′ N, 73° 55′ W). *Comment* (WLS): dated to help establish scouring action.

**UM-105. Atlantic City 1B-V3** **10,950 ± 360**
**9000 BC**

Shells from 8cm beneath surface (39° 06′ N, 73° 49′ W). *Comment* (WLS): dates from core establish Pleistocene contact and amount of sand movement above underlying clay contact. Sample from lower littoral zone of early Holocene.

**UM-133. Atlantic City 1B-V3** **22,035 ± 665**
**20,085 BC**

Shells from 150cm beneath surface, same core as UM-105.

**UM-106. Atlantic City 1B-V3** **25,300 +1040 −1200**

Shells from 250cm beneath surface, same core as UM-105.

**UM-107. Atlantic City 1B-V3** **>36,600**

Shells from 370cm beneath surface, same core as UM-105.

**UM-108. Atlantic City 1B-V4** **<500**

Shells from 60cm beneath surface (39° 07′ N, 73° 51′ W). *Comment* (WLS): dates from core determine sedimentation rate of sand during Holocene and sand movement in ridge and swale topography.

**UM-109. Atlantic City 1B-V4** **3760 ± 70**
**1810 BC**

Shells from 125cm beneath surface, same core as UM-108.

*C. Haiti*

**Caicos-Hispaniola Basin series**

Cores from Caicos-Hispaniola Basin, N of Haiti, dated to determine frequency of turbidity currents and their affects on basin sedimentation. A yellow pelagic layer at intervals ranging from 118 to 187cm within core and a gray turbidite layer ranging from 42 to 125cm within core, were dated. Coll 1972 by Bennetts; subm 1973 by O H Pilkey.

*General Comment* (OHP): sedimentation rate of yellow pelagic layer is 2.5 to 4cm/1000 yr. Source area of gray turbidite layer is W side of basin near Great Inagua Island, Bahamas. Gray turbidite overlies yellow pelagic; inversion of dates indicates tectonic disturbances basically from Puerto Rican Trench and Hispaniola volcanic activity.

**UM-163. Caicos-Hispaniola Basin, core 19253** **12,855 ± 145**
**10,905 BC**

Yellow pelagic mud from 118 to 122cm beneath surface (21° 02′ 12″ N, 72° 28′ 30″ W).

**UM-162. Caicos-Hispaniola Basin, core 21414** **16,580 ± 190**
**14,630 BC**

Gray turbidiate from 52 to 60cm beneath surface (20° 39′ 12″ N, 72° 44′ 12″ W).

**UM-164. Caicos-Hispaniola Basin, core 21423** **16,400 ± 320**
**14,450 BC**

Gray turbidite from 120 to 125cm beneath surface (20° 32′ 00″ N, 71° 56′ 00″ W). *Comment*: duplicate run other side of core, UM-172, gave 16,780 ± 780 BP.

**UM-165. Caicos-Hispaniola Basin, core 21418** **13,110 ± 200**
**11,160 BC**

Yellow pelagic mud from 183 to 187cm beneath surface (20° 47′ 12″ N, 72° 14′ 30″ W). *Comment*: duplicate run on other side of core, UM-173, gave 14,010 ± 195 BP.

**UM-160. Caicos-Hispaniola Basin, core 21417** **20,520 ± 305**
**18,570 BC**

Gray turbidite from 42 to 51cm beneath surface (20° 46′ 30″ N, 72° 32′ 00″ W).

**UM-169. Caicos-Hispaniola Basin, core 21417** **15,925 ± 235**
**13,975 BC**

Yellow pelagic mud from 140 to 146cm beneath surface, same core as UM-160. *Comment*: duplicate run on other side of core, UM-171, gave 15,565 ± 440 BP.

*D. Bahamas*

**Berry Islands series**

Four series of marine-derived carbonates dated. Samples represent intertidal beachrock, beachsand, and eolian dune deposits selected from emergent portions of islands. Dates provide temporal framework for interpretation of Holocene sea-level history of Berry Is. Place names used in description of islands derived from Berry Is Ed 1, Scale 1:25,000; contour interval 6.1m, Lands and Surveys Dept, Nassau, Bahamas. Coll and subm 1972 by D Pasley, RSMAS, Univ Miami.

**Interior Bank, Island series**

Lithified, well-sorted oolitic pelleted calcarenite from back beach and beach-rock ridges.

**UM-6. "Bushes," 8-1A** **1030 ± 100**
**AD 920**

Sample from back beach dune on N side of island, NE of Rum Cay, alt 1.5m above MSL (25° 27′ 47″ N, 78° 00′ 45″ W).

**UM-7. South Stirrup Cay, 8-3** **1785 ± 100**
**AD 165**

Sample from back beach dune on SE corner of island, alt 1m above MSL (25° 25′ 42″ N, 77° 55′ 30″ W).

**UM-8. "Bushes," P-4** **1340 ± 180**
**AD 610**

Sample from beach-rock ridge on beach, SW side of island, NE of Rum Cay (25° 27′ 46″ N, 78° 00′ 45.3″ W).

**Bank-edge Island series**

**UM-5. Chub Cay, 7-1A** — **2465 ± 75** **515 BC**

Whole rock sample of lithified oolitic-pelletoidal calcarenite from exposure on S side of boat channel leading to Chub Cay Marina, Crown Colony Club, 80m S of marina, alt MSL (25° 34′ 31″ N, 77° 54′ 42″ W).

**UM-95. Chub Cay, 73-129-A** — **2135 ± 65** **185 BC**

Pelecypod shells, same location as UM-5.

**UM-10. Holmes Cay, P-10** — **4010 ± 60** **2060 BC**

Lithified, well-sorted oolitic-pelletoidal calcarenite exposed in leeward dipping beds of single eolianite ridge parallel to seaward side, S end of island, alt 4m above MSL (25° 36′ 58″ N, 77° 44′ 00″ W).

**UM-44. Haines Cay, 72-806-5A** — **5535 ± 95** **3585 BC**

Lithified pelletoidal-oolitic calcarenite from windward–dipping eolianite bed on seafacing bluff, extreme N part of island, alt 2m above MSL (25° 44′ 22″ N, 77° 49′ 06″ W).

**UM-54. Haines Cay, 72-806-5B** — **2680 ± 60** **730 BC**

Poorly lithified, well-sorted pelletoid skeletal calcarenite forming beachdune ridge ca 11m high. Crest ca 30m W of seaward lithified ridge (samples UM-44 and -94), alt 2.5m above MSL (25° 44′ 22″ N, 77° 49′ 06″ W).

**UM-94. Hawks Nest, 72-806-4A; 1&2** — **5170 ± 150** **3220 BC**

Lithified pelleted oolitic calcarenite from windward-dipping eolianite bed of farthest-seaward dune ridge, alt 1.5m above MSL (25° 44′ 42″ N, 77° 49′ 02″ W).

**UM-97. Little Harbour Cay, 72-721-1A4** — **4295 ± 90** **2345 BC**

Holocene pelletoidal oolitic eolianite from backset beds dipping 35°N 300°W, seaward side of island, 3.5m above MSL (25° 34′ 44″ N, 77° 43′ 04″ W).

**UM-81. Great Harbour Cay, 73-129-B3** — **1170 ± 65** **AD 780**

Well-sorted unconsolidated pelletoidal sand from incipient dune located at nodal point of beach (25° 45′ 50″ N, 77° 51′ 00″ W).

**UM-84. Great Harbour Cay, 73-122-B3** — **290 ± 100** **AD 1660**

Well-sorted pelletoidal and skeletal sand from pocket beach, base of Pleistocene section. Sample from upper beach covered only during high tide (25° 48′ 33″ N, 77° 52′ 58″ W). *Comment* (DP): sand probably deposited as a result of annual longshore depositional regime commencing when prevailing winds are from SE.

**2500 ± 75**
**UM-96. Frazers Hog Cay, 72-126-C3** **550 BC**

Oolitic beach sand from base of Holocene eolianite along strandline, S side of island (25° 24′ 30″ N, 77° 51′ 13″ W).

**2165 ± 90**
**UM-85. Frazers Hog Cay, 73-125-E** **215 BC**

Oolitic beach sand from base of Holocene eolianites along strandline, NW side of island (25° 26′ 25″ N, 77° 49′ 38″ W).

**2445 ± 65**
**UM-80. Frazers Hog Cay, 73-126-C2** **495 BC**

Oolitic limestone lithified from shallow windward- (N90°E) dipping bed, alt 2.4m above MSL (25° 24′ 30″ N, 77° 51′ 13″ W).

**Suger Beach Cove Holocene dune series**

Vertical sequence of whole rock samples from an eroded lithified eolianite Holocene dune, 11.1m high, cave area, seaward side of island. Part of a series of seaward fronting dunes (25° 47′ 30″ N, 77° 52′ 37″ W).

**4880 ± 105**
**UM-91. Sugar Beach Cove, 72-805-1A2** **2930 BC**

Pelleted skeletal calcarenite, alt 0.3m above MSL.

**5195 ± 125**
**UM-92. Sugar Beach Cove, 72-805-1A5** **3245 BC**

Pelleted limestone from well-sorted cross-bedded zone, 2.5m above MSL.

**5550 ± 85**
**UM-93. Sugar Beach Cove, 72-805-1A7** **3600 BC**

Pelleted limestone from highest accessible alt, 4.9m above MSL.

**1060 ± 80**
**UM-88. Sugar Beach Cove, 72-805-1A8** **AD 890**

Oolitic beach sand from front of cliff base. *Comment* (DP): represents reworked, lithified Holocene sediments derived from receding coastal dunes mixed with recently formed sediments.

**4975 ± 80**
**UM-89. Sugar Beach Cove** **3025 BC**

Pelleted skeletal calcarenite from base of dune face, alt MSL.

*General Comment* (DP): $^{14}C$ ages exhibit a reversed trend in order of superposition.

**Clubhouse series**

Traverse with dates of Holocene depositional sequence starting with beach on E side of island across lithified dunes on W side.

**1530 ± 80**
**UM-90. Great Harbour Cay, 72-807-1A AD 420**

Unconsolidated abraded skeletal sand mixed with pelletoid sand, from upper beach, alt ca MSL (25° 44′ 53″ N, 77° 51′ 48″ W).

**1330 ± 85**
**UM-45. Great Harbour Cay, 72-807-1C AD 620**

Oolitic pelletoidal calcarenite, poorly lithified, from dune ridge 70m E of Great Harbour Dr, approx alt 3m above MSL (25° 44′ 53″ N, 77° 50′ 53″ W). *Comment* (DP): no evidence of beach facies bubbles, burrows, or beach bedding appear in sample.

**2010 ± 95**
**UM-55. Great Harbour Cay, 72-807-1D 60 BC**

Oolitic pelletoidal calcarenite, poorly lithified, well-sorted, from exposed road cut through dune ridge on N side of Royal Palm Dr, alt ca 3.5m above MSL (25° 44′ 52″ N, 77° 50′ 57″ W).

**1765 ± 75**
**UM-56. Great Harbour Cay, 72-807-1E AD 185**

Oolitic pelletoidal calcarenite, poorly lithified, well sorted, from N side of Royal Palm Dr, 79m E of Pinta Dr, alt ca 4m above MSL (25° 44′ 05″ N, 77° 51′ 07″ W).

**1955 ± 70**
**UM-79. Great Harbour Cay, 73-124-B 5 BC**

Oolitic pelletoidal calcarenite, well sorted, from sandy lens 3.2m below apex of highest (15.2m) dune in dune field. Exposure on N side of Royal Palm Dr, Great Harbour Cay Golf Club House, alt ca 9m above MSL (25° 44′ 43″ N, 77° 51′ 19″ W).

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# UNIVERSITY OF WISCONSIN RADIOCARBON DATES XII

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Procedures and equipment of the laboratory have been described in previous date lists. Wood, charcoal, and peat samples are pretreated with dilute NaOH and dilute $H_3PO_4$ before conversion to the counting gas methane; marls and lake cores are treated with acid only. Very calcareous materials are treated with HCl instead of $H_3PO_4$.

The dates reported have been calculated using 5568 as the half-life of $^{14}C$, with 1950 as the reference year. The standard deviation quoted includes only the $1\sigma$ of the counting statistics of background, sample, and standard counts. The $\delta^{13}C$ values for the $CO_2$ samples prepared by thermal decomposition of NBS oxalic acid vary from $-19.2$ to $-20.4‰$ (compared to the PDB standard) and are corrected to $-19‰$ (Craig, 1961). The dated samples for which $\delta^{13}C$ values are reported have been corrected to $-25.0‰$.

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## I. ARCHAEOLOGIC SAMPLES

### *A. Illinois*

**Divers site series (11MO28)**

Excavations at Divers site, Monroe Co, Illinois (38° 27′ 42″ N, 90° 15′ 25″ W) July 1972 by Glen Freimuth, Univ Illinois, Urbana. Site is Mississippian variant in Lundsford-Pulcher area of American Bottom. Subm by D A Baerreis. A date, AD 1105, WIS-334 (R, 1970, v 12, p 340) was reported from earlier excavation.

**1045 ± 55**
**WIS-625. Divers site (11MO28)** **AD 905**

Charcoal from bottom of Feature 76, large refuse pit. Late Woodland vessel from bottom of pit.

**945 ± 55**
**WIS-627. Divers site (11MO28)** **AD 1005**

Acorns from Feature 66, pit, superimposed on Feature 85, wall trench structure. Acorns from pit floated into wall trenches.

**900 ± 55**
**WIS-637. Divers site (11MO28)** **AD 1050**

Additional sample identical with WIS-627. Date repeated because of possible contaminant in reagent used in 1st preparation.

**Spoon River Culture series**

Archaeologists working with Spoon River culture in central Illinois R valley found the 18 radiocarbon dates available as of 1967 (Hall, 1967) too ambiguous to be of value. Because of our continuing interest in effects of neo-Atlantic/Pacific climatic discontinuity (Baerreis and Bryson, 1965) on culture, we made use of improved techniques and larger sample selections, hoping to simplify this problem. Carefully selected samples from 5 sites, Eveland, Orendorf, Cooper, Crable, and Larson, covering all except the latest known period of occupation, were dated. The series is internally consistent, except for those attributable to the late Larson phase (Conrad and Harn, ms in preparation), indicated in comments below on individual samples. Wood samples id by L A Conrad.

**Eveland site (11F900)**

Charcoal from Eveland site, Fulton Co, Illinois (40° 20′ N, 90° 10′ W) coll 1958 to 1960 by W L Wittry and J R Caldwell, Illinois State Mus; subm by L A Conrad, Univ Wisconsin-Madison. Site seems to have functioned as some type of outpost for the Ramey state which centered on Cahokia. Mississippian ceramics from site are clearly part of shell tempered component of Stirling phase assemblage at Cahokia as described by Fowler and Hall (1972) which dates between AD 1050 and 1150. The presence of Sepo ware (Harn, 1973) of indigenous Late Woodland people and Mississippian-Woodland hybrid types suggest an amalgamation of 2 ethnic groups at site. The 6 dates derived for the site by 2 different laboratories (Hall, 1967 and Crane and Griffin, 1960; 1972) ranged from AD 930 to 1300 with no discernable patterning. The current series was run in hopes of eliminating the ambiguity.

**WIS-652. Eveland site (11F900)** **865 ± 50**
**AD 1085**
$\delta^{13}C = -26.6‰$

Charred wood (*Carya* sp) from log, Level g, House 2, NE corner.

**WIS-653. Eveland site (11F900)** **895 ± 55**
**AD 1055**
$\delta^{13}C = -25.8‰$

Charcoal (*Carya* sp) from House 4, Log E.

**WIS-654. Eveland site (11F900)** **820 ± 50**
**AD 1130**
$\delta^{13}C = -25.9‰$

Charcoal, hickory nuts, from floor of S room of House 6, cross-shaped structure.

*General Comment* (LAC): dates agree perfectly with those from Cahokia.

**Orendorf site series (11F1284)**

Excavations in 1972 at Middle Mississippian Orendorf site in Fulton Co, Illinois (40° 29′ N, 90° 57′ W) were supervised by L A Conrad;

subm by L A Conrad. Site was temple town with major occupation predating Larson site. Other dates were previously reported (R, 1973, v 15, p 613-614).

**800 ± 55**
**WIS-649. Orendorf site (11F1284)** **AD 1150**
$\delta^{13}C = -25.8‰$

Charcoal (*Quercus* sp) 10 to 15 outer rings from disturbed fill of trench dug in early 1930s. Collectors' notes mention cutting through logs. Profile cut in 1969 demonstrated that logs were part of mortuary structure on low platform. Date should be representative of period when Orendorf functioned as administrative center.

**865 ± 55**
**WIS-683. Orendorf site (11F1284)** **AD 1085**
$\delta^{13}C = -25.4‰$

Charcoal from Feature 257. Date is inconsistent with most of series, earlier than expected, but consistent with date for WIS-607, Structure 9, with which Feature 257 was assoc.

**845 ± 65**
**WIS-692. Orendorf site (11F1284)** **AD 1105**
$\delta^{13}C = -26.3‰$

*Juglans* sp, 10 rings from near outside of Log 98, Structure 10, normal pretreatment.

**810 ± 45**
**WIS-693. Orendorf site (11F1284)** **AD 1140**
$\delta^{13}C = -26.8‰$

Same as WIS-692, acid pretreatment only.

**770 ± 55**
**WIS-695. Orendorf site (11F1284)** **AD 1180**
$\delta^{13}C = -9.3‰$

*Zea mays* from fill of aboriginal pit, Feature 231, overlain by ca 45.7cm of midden.

**Larson site series (11F1109)**

Charcoal from Larson site, Fulton Co, Illinois (40° 21′ N, 90° 8′ W). Coll 1970 by A D Harn, Dickson Mounds Branch, Illinois State Mus, Lewistown, Illinois; subm by D A Baerreis. Site is Spoon R temple town thought occupied after desertion of Orendorf and before occupation of Crable site. Ceramic assemblage at site is appropriate to fully developed Larson phase between AD 1250 and 1350, (Harn, 1970).

**765 ± 55**
**WIS-655. Larson site (11F1109)** **AD 1185**
$\delta^{13}C = -26.7‰$

Charcoal (*Carya* sp) from Feature 140, storage refuse pit in House 77. Sample and WIS-689 representative of latest occupation of site.

**WIS-689. Larson site (11F1109)**
**760 ± 55**
**AD 1190**
$\delta^{13}C = -27.3‰$

Charcoal (*Quercus* sp) from Feature 140.

**WIS-659. Larson site (11F1109)**
**835 ± 60**
**AD 1115**
$\delta^{13}C = -26.3‰$

Charcoal (*Fraxinus* sp) from Feature 52, storage pit along E wall of House 55. Sample from wall or roof timbers that fell into open pit. Sample and WIS-688 representative of earliest Spoon R occupation of site.

**WIS-688. Larson site (11F1109)**
**815 ± 55**
**AD 1135**
$\delta^{13}C = -27.6‰$

Charred *Ostrya virginiana* from floor of House 55.

*General Comment* (LAC): dates, as with all late Larson phase dates, are too early to be consistent with remainder of Spoon R series. Site series is internally very consistent.

**Charles W Cooper site (11F47)**

Excavations at site in Fulton Co, Illinois (40° 24′ 10″ N, 90° 3′ 30″ W) undertaken by L A Conrad, summer 1971. These are 1st dates on Charles W Cooper site, only known Oneota village in central Illinois R valley. Site seems to be source of Oneota elements at Crable site (Smith, 1951).

**WIS-639. Charles W Cooper site (11F47)**
**565 ± 55**
**AD 1385**
$\delta^{13}C = -26.3‰$

Charcoal (*Ostrya virginiana*) from floor of Feature 30, 61cm below surface. Prepared clay floor of Feature 30, burned house with basin-shaped floor and single post construction, covered several Spoon River and Bold Counselor (Oneota) pits.

**WIS-645. Charles W Cooper site (11F47)**
**555 ± 55**
**AD 1395**
$\delta^{13}C = -27.1‰$

Charcoal (*Quercus* sp) from Feature 30.

**Crable site (11F891)**

Charcoal from Crable site, Kerton Township, Fulton Co, Illinois (40° 11′ N, 90° 13′ W). Coll 1969 and 1970 by R L Hall, Univ Illinois at Chicago Circle; subm by L A Conrad. Site is temple town of Middle Mississippi culture exhibiting evidence of interaction with Oneota culture to N and W. Previous dates from site have been reported as 600, 620, and 530 BP, M-550, -553, and -554, respectively, on charcoal (Crane & Griffin, 1959) and 1150 BP, M-556, on mussel shell (Crane & Griffin, 1958).

**WIS-648. Crable site (11F891)** **565 ± 55**
**AD 1385**
$\delta^{13}C = -25.7‰$

Sample, 10 rings of carbonized wooden poles (*Quercus* sp) from House F14, Sq 790L 260. From stratum of debris at 0.4 to 0.6m below present surface. House stratigraphically above House F117.

**WIS-644. Crable site (11F891)** **515 ± 60**
**AD 1435**
$\delta^{13}C = -25.8‰$

10 annual rings of carbonized poles (*Fraxinus* sp) from House F117. Sample 86.4cm below present surface.

**WIS-610. Maey's site (11MO233)** **1225 ± 65**
**AD 725**
$\delta^{13}C = -26.4‰$

Charred wood (*Gymnocladus dioicus*), id by L A Conrad, coll from Feature 2 of Maey's site Monroe Co, Illinois (38° 13′ 10″ N, 90° 17′ 50″ W) in 1972 by J W Porter; subm by D A Baerreis. Sample from debris 40 to 90 cm below plow zone in bell-shaped pit in center of test unit S100-102E 64-66.

*B. Iowa*

**Chan-Ya-Ta site (13BV1)**

Charcoal from Chan-Ya-Ta site in Buena Vista Co, Iowa (42° 54′ N, 90° 16′ W) coll 1972 by J A Tiffany, Univ. Wisconsin-Madison; subm by D A Baerreis. Site is single component, fortified Mill Creek site located on peninsular knoll near Brooke's Creek in Buena Vista Co, Iowa. Site was partially excavated in late 1930's by F L Van Voorhis, whose work was summarized by Hurt (1953). Seriation of ceramics recovered suggests that Chan-Ya-Ta belongs in late, Early Little Sioux phase which agrees with radiocarbon dates obtained.

**WIS-671. Chan-Ya-Ta site (13BV1)** **995 ± 55**
**AD 995**

Charcoal from Sq H-27, house fill.

**WIS-673. Chan-Ya-Ta site (13BV1)** **940 ± 55**
**AD 1010**

Charcoal from Sq H-27, house fill.

**WIS-685. Chan-Ya-Ta site (13BV1)** **890 ± 60**
**AD 1060**

Charcoal from Sq H-27, house floor.

**WIS-630. Sparks site (13BN121)** **1670 ± 55**
**AD 280**

Charcoal from Sparks site, Boone Co, Iowa (42° 2′ 0″ N, 56° 56′ 30″ W). Coll 1970 by David Gradwohl, Iowa State Univ; subm by D A Baerreis. Catalogue no. 2933 from Feature 13 and Catalogue no. 2716 from Feature 6, both feature storage pits or basins. Date of 1600 BP from this site was previously reported (R, 1973, v 15, p 232).

*C. Minnesota*

**Smith site (21KC3)**

Excavations in July 1972 at Smith site, also called "Grand Mound site", in Koochiching Co, Minnesota (48° 31′ N, 93° 43′ W) supervised by Edward Lugenbeal, Univ Wisconsin-Madison; subm by J B Stoltman. Portions of Smith site are deeply stratified containing at least 5 distinct cultural strata. The most intensive occupation appears to have been the latest major occupation of the site by people making "Blackduck" pottery (Evans, 1961).

**885 ± 60**
**WIS-611. Smith site (21KC3)** **AD 1065**
$\delta^{13}C = -25.9‰$

Charcoal from Level 4, main occupation level of Blackduck Late Woodland village. Level 4 is 30 to 40cm below ground level.

**670 ± 55**
**WIS-612. Smith site (21KC3)** **AD 1280**
$\delta^{13}C = -26.1‰$

Charcoal from Level 3, Feature 18. Sample should date late stages of Blackduck occupation of site.

**850 ± 50**
**WIS-613. Smith site (21KC3)** **AD 1100**
$\delta^{13}C = -25.3‰$

Charcoal from Feature 17, Level 4.

**775 ± 55**
**WIS-614. Smith site (21KC3)** **AD 1175**
$\delta^{13}C = -25.5‰$

Charcoal from Feature 17, from bottom of Level 3, sand, with very few cultural remains, and from top of Level 4.

**840 ± 55**
**WIS-615. Smith site (21KC3)** **AD 1110**
$\delta^{13}C = -25.1‰$

Charcoal from Feature 18, Level 4.

**1020 ± 65**
**WIS-616. Smith site (21KC3)** **AD 930**
$\delta^{13}C = -26.5‰$

Charcoal from Feature 16, Level 6, NW and SE quads, and Level 7, NW quad, and Feature 11, Level 4. Sample is from lowest Blackduck levels in Features 11 and 16.

**1385 ± 60**
**WIS-622. Smith site (21KC3)** **AD 565**
$\delta^{13}C = -23.4‰$

Bones of mammal, fish, bird, from Feature 16, Level 7, SE quad, from stratum containing latest Middle Woodland "Laurel culture" occupation of site.

**WIS-631. Smith site (21KC3)** **1470 ± 60**
**AD 480**
*$\delta^{13}C = -23.7‰$*

Miscellaneous fragments of bone from Feature 18, Level 8. Sample stratigraphically below major Laurel horizon at site.

**WIS-638. Smith site (21KC3)** **1190 ± 55**
**AD 760**
*$\delta^{13}C = -23.5‰$*

Charcoal from Feature 16 and bone from Feature 18, Level 6.

*D. South Dakota*

**Swanson site, South Dakota (39BR16)**

Since dates from Swanson site (43° 54′ N, 99° 20′ W) previously reported (R, 1973, v 15, p 236-237; 618-619) were erratic and suggested contamination during lengthy storage in museum, more samples were obtained through the courtesy of J S Sigstad, Univ South Dakota and W R Wood, Univ Missouri. These samples were first extracted with petroleum ether, then with acetone before the usual base and acid treatment, and were found to have been treated with varying amounts of paraffin. Those in which no paraffin was detectable, WIS-657 and -660, produced dates that agree well with assays of the same samples reported previously (R, 1973, v 15, p 236-237). Extraction with organic solvents thus produced no change in dates except when paraffin contamination was removed.

**WIS-650. Swanson site (39BR16)** **1100 ± 65**
**AD 850**
*$\delta^{13}C = -22.3‰$*

*Juniperus virginiana*, id by L A Conrad, from House 2, Post D.

**WIS-651. Swanson site (39BR16)** **955 ± 60**
**AD 995**
*$\delta^{13}C = -21.6‰$*

*Juniperus virginiana* from House 1, Post 2, exterior rings.

**WIS-657. Swanson site (39BR16)** **1130 ± 60**
**AD 820**
*$\delta^{13}C = -22.5‰$*

Wood from inner rings of Post 2, House 1.

**WIS-660. Swanson site (39BR16)** **935 ± 55**
**AD 1015**
*$\delta^{13}C = -23.0‰$*

*Juniperus virginiana* from Post C, House 2, outer rings.

*E. Wisconsin*

**Hilgen Spring Park site (47OZ7)**

Charcoal from Mound 2, Hilgen Spring Park site, Cedarburg, Wisconsin (43° 17′ 30″ N, 87° 58′ 30″ W). Coll 1968 by H Van Langen; subm by T F Kehoe, Milwaukee Public Mus, Milwaukee, Wisconsin.

**WIS-643. Hilgen Spring Park site (47OZ7)** **2475 ± 65**
**525 BC**
$\delta^{13}C = -26.1‰$

Charcoal from Feature 6, fire-pit, 1.22m diam intruding from mound fill into red sub-soil layer.

**WIS-647. Hilgen Spring Park site (47OZ7)** **2790 ± 65**
**840 BC**

Charcoal from Feature 5, from fire hearth of limestone on surface of cleared mound floor. *Comment* (TFK): date of 2410 BP, WIS-354 (R, 1970, v 12, p 337), from Mound 1 was reported earlier in error from Mound 2. These mounds are no longer considered of Effigy Mound culture. Mound 1 construction and Feature 6 of Mound 2 are considered contemporaneous with earlier Mound 2 construction (Kehoe & Kehoe, 1973).

*F. Venezuela*

**Caño Caroni Barinas series**

Excavations at Rancho Corozal, Dist Barinas, State of Barinas, Venezuela on N bank of Caroni R (08° 11.5′ N, 68° 43.5′ E) directed by Alberta Zucchi, January 1972; subm by W M Denevan, Univ Wisconsin-Madison. Archaeologic site is small pre-Columbian village in gallery forest. Assoc ceramics belong to various phases of Arauquinoid series of Central Orinoco region. Sites occur in general region of relic, raised agricultural fields.

**WIS-602. Caño Caroni, Barinas** **745 ± 50**
**AD 1205**

Charcoal from Trench D, Pit 1, 0.50 to 0.75m deep.

**WIS-617. Caño Caroni, Barinas** **535 ± 55**
**AD 1415**

Charcoal from Trench D, Pit 2, 0.25 to 0.50m deep.

**WIS-619. Caño Caroni, Barinas** **610 ± 50**
**AD 1340**

Charcoal from Trench D, Pit 2, 0.50 to 0.75m deep.

**WIS-621. Caño Caroni, Barinas** **1970 ± 55**
**20 BC**

Charcoal from Trench D, Pit 3, 0.50 to 0.75m deep.

**WIS-620. Caño Caroni, Barinas** **695 ± 50**
**AD 1255**

Charcoal from Trench D, Pit 3, 0.75 to 1.00m deep.

*G. Russia*

**WIS-475. Kokorevo I site** **15,410 ± 130**
**13,460 BC**

Charcoal from Kokorevo I (Zabochka) on Yenisii R near village of Kokorevo, Novoselovskii Dist, Krasnoyarsk Terr, USSR. Sample from cultural layer 2, 2.60m deep. Coll and subm by Z A Abramova, Inst

Archaeol, Acad Sci, USSR. Date, 13,300 ± 50, GIN-91 (R, 1968, v 10, p 435) was reported on charcoal from site.

## II. GEOLOGIC SAMPLES

### *A. Illinois*

**WIS-635. Cahokia site** **920 ± 50**
**AD 1030**

Small charcoal fragments from matrix of dark clay and sand 110 to 130cm deep from 2m sec of soil accumulated in borrow pit at Cahokia site, St Clair Co, Illinois (38° 39′ N, 90° 04′ W). Coll 1972 by R L Hall; subm by A M Swain, Univ Wisconsin-Madison. Date will help determine time scale for pollen diagram and deposition rate of sediment in pit.

### *B. Michigan*

**Wintergreen Lake**

Core coll from ice surface of lake February 1972 by R E Bailey, Central Michigan Univ, Mt Pleasant, Michigan, from Wintergreen Lake, Kalamazoo Co, Michigan (42° 24′ N, 85° 23′ 30″ W). Subm by Thompson Webb, III, Univ Wisconsin-Madison and Brown Univ, Providence, Rhode Island. Core depths represent depth from ice surface of lake; true age of 680 to 685cm level is AD 1820, time of land clearance in area of lake marked by ragweed increase. Lake is currently eutrophic.

**WIS-668. Wintergreen Lake** **3375 ± 60**
**1425 BC**

Heavy black organic gyttja from 846 to 855cm depth.

**WIS-670. Wintergreen Lake** **8945 ± 90**
**6995 BC**

Heavy black organic gyttja from 1116 to 1125cm depth. This level dates beginning of mixed hardwood pollen assemblage marked by abundance of oak.

**WIS-672. Wintergreen Lake** **11,425 ± 110**
**9475 BC**

Marly gyttja from 1226 to 1235cm depth. This level dates spruce-fir pollen assemblage in lake.

**WIS-676. Wintergreen Lake** **13,195 ± 125**
**11,245 BC**

Marly gyttja containing plant macrofossils from 1291 to 1295cm depth. Sample dates period just prior to levels in sediment where pollen becomes abundant.

**Green Lake**

Core, 380cm long, coll March 1972 from Green Lake, Antrim Co, Michigan (44° 53′ N, 85° 07′ W) by R E Bailey. Lake is presently hard water; samples were very calcareous and required lengthy acid treatment to remove carbonate. Carbonate content of lake raises uncertainty in sample ages (Deevey *et al*, 1954; Donner *et al*, 1971). Sample depths are from mud-water interface. Subm by Thompson Webb, III.

**4215 ± 65**
**WIS-669. Green Lake** **2265 BC**

Black organic gyttja from 75.5 to 84.5cm depth. Dates change from pine assembly zone to mixed hard wood assemblage.

**11,845 ± 115**
**WIS-664. Green Lake** **9895 BC**

Marl and marly gyttja, 235.5 to 244.5cm depth. Dates change from spruce-herb pollen assemblage to pine assemblage.

**15,215 ± 155**
**WIS-663. Green Lake** **13,265 BC**

Marl with clay and silt fraction from 375.5 to 389.5cm depth. Dates early spruce-herb pollen assemblage near time when basin began accepting pollen.

*C. Minnesota*

**Lake of the Clouds**

Pollen diagram by Craig (1972) was made from 2 separate cores, H and A, of lake sediment. Dating for last 9400 yr of diagram was provided by varve counts from Core H. Pollen record prior to 9400 BP is from Core A of which only portion is varved. Chronology for Core A is provided by dates below. Core A-5 coll by H E Wright, Jr, Univ Minnesota, in winter 1969 from Lake of the Clouds, Lake Co, Minnesota (48° 00′ N, 91° 07′ W); subm by A M Swain.

**9075 ± 90**
**WIS-677. Lake of the Clouds** **7125 BC**

Lake sediments and algal gyttja from 479 to 486cm in Core A-5.

**9140 ± 90**
**WIS-681. Lake of the Clouds** **7190 BC**

Lake sediments, algal gyttja with silt and clay from 510 to 517cm sec in Core A-5. Dates beginning of Pollen Zone LC-2, marked by rise in *Picea* pollen and decline in herb pollen. Also dates rise in pollen concentration from 1000 to 5000 grains/ml.

**Kylen Lake**

Core 10cm diam, coll November 1970 by H E Wright, Jr, from Kylen Lake, St Louis Co, Minnesota (47° 20′ N, 91° 48′ W); subm by A M Swain. Sample depths measured from water surface.

**8410 ± 85**
**WIS-694. Kylen Lake** **6460 BC**

Organic lake mud (gyttja) from 750 to 753cm depth.

**8575 ± 80**
**WIS-690. Kylen Lake** **6620 BC**
$\delta^{13}C = -34.1‰$

Organic lake mud, from 800 to 803cm depth.

**10,055 ± 100**
**WIS-684. Kylen Lake** **8105 BC**

Organic lake mud, base of pure gyttja, from 850 to 853cm depth.

**WIS-679. Kylen Lake** **10,430 ± 100**
**8480 BC**

Silty gyttja from 880 to 883cm depth.

**WIS-682. Kylen Lake** **12,390 ± 120**
**10,440 BC**

Organic silt, spruce pollen zone, from 900 to 907cm depth.

*D. Wisconsin*

**Seidel Lake**

Three lake cores, 180[1] and 180[2], both 5.1cm diam, and 180[3], 10.2cm diam, were coll and subm 1970 by H E Wright, Jr, from Seidel Lake, Kewaunee Co, Wisconsin (44° 27′ N, 87° 31′ W). Earlier date, WIS-462, 12,360 BP, on sample from 1417 to 1442cm depth of 5.08cm core was previously reported (R, 1971, v 13, p 480). Initial pollen work was done at this site by West (1961). All samples were very calcareous and required lengthy acid treatment.

**WIS-640. Seidel Lake** **10,225 ± 85**
**8275 BC**

Sample from 1264 to 1269cm below water surface, Core 180[1]. Level marks major fall in spruce pollen and rise in pine pollen (jack pine or red pine) stratigraphically similar to WIS-646 of adjacent Core 180[2].

**WIS-680. Seidel Lake** **8680 ± 90**
**6730 BC**

Sample from 1260 to 1270cm below water surface, Core 180[2]. Level marks maximum of white pine pollen in early post-glacial vegetational history of E Wisconsin.

**WIS-642. Seidel Lake** **9225 ± 80**
**7275 BC**

Sample from 1315 to 1320cm below water surface, Core 180[2]. Level marks initial increase in white pine pollen, assoc with immigration of white pine into E Wisconsin.

**WIS-646. Seidel Lake** **10,440 ± 95**
**8490 BC**

Sample from 1363 to 1368cm depth of Core 180[2], base of gyttja. Level marks fall of spruce pollen and rise of pine pollen.

**WIS-641. Seidel Lake** **11,620 ± 110**
**9670 BC**

Sample from 1418 to 1421cm depth below water surface in Core 180[3]. Sample overlies level of WIS-462, which spanned 30cm of a 5.1cm core. Dates gradual transition from spruce-herb pollen assemblages to spruce-alder-fir assemblage. Pollen change indicates probable transition from spruce parkland to spruce forest in late glacial history of E Wisconsin.

**WIS-626. East Blue Mounds Creek site** **10,480 ± 100**
**8530 BC**

Column, 3m length, coll from valley floor site on E branch of Blue Mounds Creek, Iowa Co, Wisconsin (43° 03′ N, 89° 47′ W) by A M Davis, November 1972; subm by A M Davis and G H Dury, Univ Wisconsin-Madison. Post-settlement alluvium of 64cm is underlain by 97cm of sapric peat containing numerous spruce remnants in base from which sample (*Picea*) was taken at 145cm depth. Peat is underlain by gray marl, grading downward into dolomite and chert rubble referred by Dury (1964) to periglacial activity at approx time of last local glacial maximum. WIS-661, below, West Blue Mounds Creek site, probably dates same episode.

**West Blue Mounds Creek site**

Core, 4.2m of peat, gyttja, and marl, from peat bog in W branch of Blue Mounds Creek, Iowa Co, Wisconsin (43° 5′ N, 89° 52′ W). Coll and subm by A M Davis. At 4.2m, marl overlay rubble of chert and dolomite considered periglacial in origin.

**WIS-661. West Blue Mounds Creek site** **10,485 ± 100**
**8535 BC**

Woody peat, organic layer at 3.15 to 3.17m level, immediately overlying 80cm marl base devoid of pollen. Assoc pollen spectrum shows predominance of spruce indicative of cool late-glacial climates. Wood remnants are also spruce.

**WIS-658. West Blue Mounds Creek site** **9580 ± 95**
**7630 BC**

Spruce from peat and spruce litter layer, 2.65 to 2.67m level. Layer appears to represent final destruction of late-glacial boreal forest. It is overlain by gyttja with pollen assemblage dominated by oak, pine, and non-arboreal pollen.

**WIS-662. West Blue Mounds Creek site** **7335 ± 80**
**5385 BC**

Gyttja at 2.02 to 2.12m level. Layer corresponds with high level of non-arboreal pollen in core.

**WIS-656. West Blue Mounds Creek site** **4235 ± 65**
**2285 BC**

Sedge peat from 85 to 88cm level of core. Pollen assemblage shows decrease in oak, increase in pine.

**Warner Creek, Wisconsin**

Part of a continuing study of paleohydrologic episodes of the Driftless area of SW Wisconsin (Knox, 1972). Samples coll to represent common stratigraphic occurrences in Driftless area. Samples coll July 1973 by J C Knox, Univ Wisconsin-Madison and W C Johnson during stratigraphic study of N bank of Warner Creek, Vernon Co, Wisconsin (43° 38′ N, 90° 32′ W).

**WIS-665. Warner Creek** **5800 ± 70**
**3850 BC**

Wood (*Ulmus americana*), id by R Miller, Forest Prods Lab, Madison, from 1.7m below ground within gleyed sand stratum overlying gravel-cobble. Sample burial is probably result of valley aggradation response to middle Holocene climatic change.

**WIS-675. Warner Creek** **5170 ± 70**
**3220 BC**

Hardwood charcoal included in compact clay from 1.0 to 1.1m depth. Clay separates gray silty clay above from underlying brown, sandy silt.

**Brush Creek, Wisconsin**

Samples coll and subm July and August 1973 during stratigraphic studies of bank of Brush Creek, Monroe Co, Wisconsin, in Whitestown Township (43° 43′ N, 90° 37′ W) and Jefferson Township (43° 44′ N, 90° 41′ W) by W C Johnson.

**WIS-678. Brush Creek** **2715 ± 55**
**765 BC**

Wood (white oak group), id by R Miller, 185 to 200cm deep in gleyed sand layer overlying cobble/gravel in excavation in Jefferson Township.

**WIS-674. Brush Creek** **5055 ± 65**
**3105 BC**

Log (white oak group), id by R Miller, 225 to 260cm deep in gravel and cobble in same site as WIS-678, above.

**WIS-666. Brush Creek** **4440 ± 65**
**2490 BC**

Wood (*Tsuga canadensis*), id by R Miller, 2.5m deep within gleyed sand immediately overlying gravel-cobble horizon in Whitestown site.

**WIS-667. Little Platte River** **3070 ± 55**
**1120 BC**

Wood (white oak group), id by R Miller, from base of left bank of Little Platte R, 285 to 295cm deep in sandy silt, Grant Co, Wisconsin (42° 42′ N, 90° 34′ W). Coll and subm by J C Knox. Sample overlay gravel, cobble layer; silt over gravel is common stratigraphic occurrence in Driftless area stream channel banks.

**WIS-507. Point Beach site** **12,060 ± 120**
**10,110 BC**

Log from eroding bank of bluff overlooking Lake Michigan in Two Creeks Township, Manitowoc Co, Wisconsin (44° 19′ N, 87° 32′ W) coll 1972 and subm by Dan Sullivan, Wisconsin Electric Power. Date is within range of Two Creeks wood.

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# US GEOLOGICAL SURVEY, WATER RESOURCES DIVISION, RADIOCARBON MEASUREMENTS I

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The Water Resources Division of the US Geological Survey has operated a low-level tritium laboratory since the late 1950's. In 1970, $^{14}C$-measuring facilities were added to that laboratory to provide analyses of ground water and other carbonates, primarily for research and field projects of the Division.

$^{14}C$ analyses are made by liquid scintillation counting of benzene synthesized from sample carbonate by the reactions:

$$CO_3^{=} \xrightarrow{H+} CO_2 \xrightarrow{Li} Li_2C_2 \xrightarrow{H_2O} C_2H_2 \xrightarrow{\text{catalyst}} C_6H_6$$

The $C_2H_2$ is produced by the method of Guntz (1896, 1898), more recently described by Barker (1953) and Hubbs and Bien (1967). To make $Li_2C_2$, we use about twice the stoichiometric amount of Li and add $CO_2$ at pressures of $< 15$cm Hg to keep the temperature of the reaction relatively low (dull red heat). After $CO_2$ is added, the mixture is held at the same temperature while open to a vacuum for ca 1 hr. With samples of normal size, ca 3ml $C_6H_6$, $C_2H_2$ yields are consistently above 90%. The $C_2H_2$ is purified and dried by passing it over NaOH pellets and glass beads coated with 85% $H_3PO_4$. It is then catalytically polymerized to $C_6H_6$. The catalyst used is a commercial petroleum cracking catalyst, requiring only drying before use. The polymerization yields generally exceed 85% and the $C_6H_6$ is free of impurities that might cause quenching (Fraser *et al*, 1974). The method has been described in detail by Noakes, Kim, and Stipp (1966) and, more recently, by Fontes (1971).

The $C_6H_6$ is counted on a Picker Nuclear Liquemat 220* liquid scintillation counter with photomultiplier tubes selected for optimum $^{14}C$ sensitivity. The absence of quenching is vertified for each sample by the external standard channels ratio method. Samples through WRD-156 were counted in low-potassium glass vials, which held 4ml, 3ml sample benzene and 1ml toluene + scintillator. This arrangement had a background of ca 4.0cpm and a net modern count, 0.95 x NBS oxalic acid, 3ml $C_6H_6$, of ca 21cpm. Samples following WRD-156 were counted in a 4ml capacity Teflon vial, identical to design "A" of Calf and Polach (1974). This vial, with 3ml sample benzene and 1ml toluene + scintillator, had a background count of ca 4.0cpm and a net modern count of 24cpm.

* Products are named for identification only and do not imply endorsement by US Geological Survey.

Results are based on a modern of 0.95 x NBS oxalic acid, and $^{14}C$ half-life of 5568 years. Errors are based on counting statistics and are $\pm 1\sigma$, except for those samples whose counts approach either modern or background for which $2\sigma$ limits are reported. Ground-water analyses are described at the beginning of that section.

Unless otherwise identified, collectors and submitters are USGS, WRD, personnel from the office specified.

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We are grateful to Meyer Rubin and Sam Valastro for providing check samples and other assistance in establishing this laboratory, and to T A Wyerman for his invaluable assistance in optimizing the counting procedure. $^{13}C$ analyses were made by C T Rightmire.

## SAMPLE DESCRIPTIONS

### I. CHECK SAMPLES

| Sample no. | Age (yr) | Other lab no. | Age (yr) | Reference |
|---|---|---|---|---|
| WRD-27 | 2330 ± 100 | W-2051 | 2200 ± 250 | M Rubin, 1971, pers commun |
| WRD-28 | 8950 ± 150 | W-568 | 9000 ± 400 | R, 1960, v 2, p 165 |
| WRD-29 | 31,000 ± 2350 | W-2043 | 28,000 ± 1000 | R, 1970, v 12, p 319 |
| WRD-63 | 3960 ± 100 | Tx-966 | 4050 ± 80 | R, 1972, v 14, p 467 |

See also WRD-1, Washington series, and WRD-197-200, -203, -205, Southern Great Basin, Nevada and California series.

### II. GROUND-WATER SAMPLES

Ground-water carbonate for $^{14}C$ analysis is collected in the field by direct precipitation of $SrCO_3$ from 100L of sample. The procedure is similar to that used by the IAEA (B Payne, 1970, written commun). In the laboratory, the wet precipitate is poured into a flask and $CO_2$ evolved with acid. Samples containing a large amount of sulfide precipitated with the carbonate are oxidized with $H_2O_2$ to prevent $H_2S$ formation when acid is added.

Separate samples for determination of $\delta^{13}C$ of dissolved carbonate are obtained by adding an $NH_4OH \cdot SrCl_2$ solution to 1L of sample in the field (Gleason, Friedman, & Hanshaw, 1969). $\delta^{13}C$ values, reported below relative to PDB, are for these samples.

Tritium analyses are made on most samples collected for $^{14}C$. Results are used to determine whether any admixture of recent water from faulty well construction, sampling technique, or natural water flow paths is likely to have effected the $^{14}C$ content of the water.

For $^{14}C$ samples, field measurements of alkalinity and pH are made, and laboratory analyses of 10 or more common dissolved constituents are made. From these data, distribution of dissolved species and degree of saturation of water related to several minerals are calculated using the computer program WATEQ (Truesdell and Jones, 1973). Values of total dissolved carbonate content,

$$(C_{total} = H_2CO_3 + HCO_3^- + CO_3^= + CaHCO_3^- + MgHCO_3^- + \text{etc}),$$

reported below are from this program.

It is well known that the measured $^{14}C$ content of a ground-water carbonate depends on more than just the age of the water. Various schemes have been proposed to adjust measured $^{14}C$ values to calculate ages, eg, papers from IAEA (1967, 1970, 1974). Our experience has been that no one scheme is universally satisfactory. Instead, we examine each series, using geochemical, stable isotope, conventional hydrologic, and any other available data to discern extent of processes, other than radioactive decay, which affect measured $^{14}C$ content. In some series, no ages are given because no unambiguous geochemical interpretation of the system could be made or because the wells sampled produced mixtures of waters from within the hydrologic system. Where ages are reported, comments describe $^{14}C$ adjustment procedure and geochemical information used.

## *A. United States*

### South-Central Washington series

Samples were part of study of characteristics of regional ground-water flow in an 11,600sq km area including the Pasco Basin and surrounding areas, S-central Washington. All wells draw water from basalt of Columbia River Group or from interbed zones in basalt sequence. The well numbers give Township/Range-Section-sequential letter and number. Samples coll and subm by A M LaSala, Jr and G C Doty, Richland, Washington. *Comment*: $^{14}C$ data are accordant with regional flow pattern suggested by hydrologic information (LaSala, Doty & Pearson, 1973). General range of values similar to those reported from Pullman-Moscow Basin, Washington (Crosby & Chatters, 1965). Errors reported to submitter incorrectly and pub (LaSala, Doty & Pearson, 1973).

### Fresno and Kings Co, San Joaquin Valley, California series

Extensive use of ground water for irrigation in the San Joaquin Valley has led to many studies of the ground-water hydrology of the region. A tritium study (Haskell, Leventhal, & Bianchi, 1966), based on 1963 sampling of wells along 2 traverses on W side, suggested flow rates much greater than those estimated by conventional hydrologic methods (Poland, 1973). Consequently, in 1966-1968, and 1970, the USGS sampled and tested tritium content of well waters along the same 2 traverses to resolve the contradiction. The 1970 sampling was expanded to include wells 8 to 13km SE, analyzed for both T and $^{14}C$ (results listed below). Well numbers give Township/Range-Section-sequential letter and and number. Coll Aug 1970 by Raoul LeBlanc; subm by J F Poland, Sacramento, California.

TABLE 1
South-Central Washington series

| Sample no. | Well no. | Date coll | Land surface alt (m) | Well depth (m) | Total dissolved carbonate (mM/L) | $\delta^{13}C$ ‰ | Tritium TU ± 1σ | $^{14}C$ % modern ± 1σ |
|---|---|---|---|---|---|---|---|---|
| WRD-100 | 5/28-5D1 | 10/18/71 | | | | −15.4 | <1.1 | 10.4 ± 0.3 |
| WRD-102 | 5/28-6R2 | 9/24/71 | | | | −16.2 | 4.2 ± 0.5 | 5.7 ± 0.4 |
| WRD- 55 | 6/23-11P1 | 10/21/70 | 311 | 272 | 3.44 | −16.0 | <1.7 | 3.4 ± 0.4 |
| WRD- 57 | 6/23-15J1 | 10/22/70 | 320 | 193 | 3.39 | −15.8 | <1.2 | 3.8 ± 0.4 |
| WRD-101 | 6/29-8M1 | 10/19/71 | | | | | 3.9 ± 0.4 | 82.9 ± 0.7 |
| WRD-103 | 7/32-36Q1 | 9/20/71 | | | | −14.8 | 1.1 ± 0.5 | 8.4 ± 0.4 |
| WRD- 60 | 8/24-2Q1 | 9/28/70 | 196 | 227 | 4.38 | −13.1 | 49.0 ± 2.7 | 56.8 ± 0.7 |
| WRD- 58 | 8/29-22A1 | 11/17/70 | 232 | 244 | 3.15 | | 8.1 ± 0.5 | 10.5 ± 1.3 |
| WRD- 40 | 8/31-34H1 | 9/9/70 | 139 | 117 | 2.34 | − 7.4 | <0.8 | 1.8 ± 0.6 |
| WRD- 53 | 9/23-23G1 | 10/7/70 | 243 | 350 | 4.10 | −13.9 | 53.8 ± 2.9 | 67.8 ± 0.5* |
| WRD- 52 | 9/26-27K1 | 10/12/70 | 449 | 204 | 2.61 | −11.5 | <1.5 | 14.6 ± 0.4 |
| WRD- 41 | 9/30-18H1 | 8/28/70 | 125 | 315 | 4.92 | − 7.7 | <1.0 | <0.6 |
| WRD- 54 | 10/22-25F1 | 10/6/70 | 227 | 480 | 2.79 | −13.0 | <2.1 | 18.9 ± 0.6 |
| WRD- 56 | 11/24-14N1 | 11/13/70 | 872 | 124 | 1.92 | −12.4 | 0.8 ± 0.3 | 38.7 ± 0.7 |

TABLE 1 (Continued)

| Sample no. | Well no. | Date coll | Land surface alt (m) | Well depth (m) | Total dissolved carbonate (mM/L) | $\delta^{13}C$ ‰ | Tritium TU ± 1σ | $^{14}C$ % modern ± 1σ |
|---|---|---|---|---|---|---|---|---|
| WRD- 51 | 11/26-34R1 | 11/19/70 | 369 | 305 | 2.85 | | <1.9 | 1.7 ± 0.7 |
| WRD- 61 | 11/30-11C1 | 12/14/70 | 213 | 187 | 3.60 | −10.9 | 100 ± 5 | 89.6 ± 1.4 |
| WRD- 42 | 12/23-28Q1 | 9/21/70 | 670 | Spring | 2.16 | −12.9 | 1.7 ± 0.3 | 97.2 ± 1.2 |
| WRD- 43 | 12/24-20N1 | 9/11/70 | 323 | 366 | 2.80 | −15.1 | <0.8 | 10.2 ± 0.5 |
| WRD- 44 | 12/28-24N1 | 9/15/70 | 131 | 230 | 2.93 | −15.7 | 2.8 ± 0.4 | 5.1 ± 0.9 |
| WRD- 45 | 13/24-25E1 | 8/27/70 | 282 | 237 | 3.06 | −13.1 | <0.9 | 13.6 ± 0.8 |
| WRD- 46 | 13/25-30G1 | 8/27/70 | 255 | 338 | 3.07 | −11.8 | <0.7 | 6.1 ± 0.7 |
| WRD- 46a | 13/25-30G1 | 9/8/70 | 255 | 338 | 2.99 | −12.2 | <0.7 | 7.4 ± 0.5 |
| WRD- 1 | 13/26-35H1 | 5/7/69 | 175 | 164-189 | 3.59 | −14.3 | 2.2 ± 0.3 | 12.0 ± 0.8** |
| WRD- 2 | 13/26-35H1 | 5/10/69 | 175 | 111-151 | 3.17 | −14.2 | — | 14.2 ± 0.7 |
| WRD- 59 | 13/28-13N1 | 11/10/70 | 290 | 341 | 3.00 | −16.8 | <1.1 | <0.8 |
| WRD-105 | 14/25-1D1 | 10/8/71 | | | | −13.8 | <2.3 | 8.0 ± 0.5 |
| WRD- 48 | 14/31-36J1 | 9/24/70 | 259 | 335 | 2.66 | −11.6 | <0.8 | 6.4 ± 0.5 |
| WRD-104 | 15/28-15D1 | 10/6/71 | | | | −12.5 | <0.8 | 7.3 ± 0.2 |
| WRD- 50 | 15/29-3J1 | 10/27/70 | 334 | 276 | 3.02 | −11.3 | <1.8 | 3.4 ± 0.3 |
| WRD-171 | 21/31-10M1 | 7/11/72 | | (shallow) | | | <1.1 | 45.2 ± 0.3 |
| WRD-172 | 21/31-10M1 | 9/13/72 | | (deep) | | | <1.3 | 15.2 ± 0.4 |

* Originally and incorrectly reported to AML as 63.2 ± 0.5% modern.
** Also analyzed as Tx-894; % modern = 13.4 ± 0.4 (S Valastro, 1970, written commun).

| Sample no. | Well no. | Tritium TU ± 1σ | $\delta^{13}C$ ‰ | $^{14}C$ % modern ± 1σ |
|---|---|---|---|---|
| WRD-87 | 17S/20E-31F1 | 1.0 ± 0.4 | — | 14.8 ± 0.9 |
| WRD-88 | 18S/17E-13N2 | <0.8 | −22.9 | 3.2 ± 0.4 |
| WRD-97 | 18S/19E-31G2 | <0.7 | − 4.8 | 1.0 ± 0.2 |
| WRD-98 | 18S/17E-31Q1 | — | −28.2 | 1.2 ± 0.4 |
| WRD-99 | 19S/18E-10N1 | <0.7 | − 8.2 | 2.6 ± 0.1 |

*Comment* (FJP): wells normally produce water from several horizons and adjusted ages of resulting mixture cannot be made. Generally low T and $^{14}C$ contents suggest rapid flow rate estimated from previous T work is incorrect (Poland, 1973).

**Southern Great Basin, Nevada and California series**

Samples are from 4 groups of moderately hot (25° to 39°C) springs discharging, at valley level, from a regional carbonate rock aquifer system from an area > 11,600km. Samples were coll May and June 1973 to evaluate utility of environmental isotopes for definition of a hydrogeologically complex ground-water flow system. The hydrogeology and hydrochemistry of the region were described by Winograd (1971); $\delta^{13}C$ and $^{14}C$ analyses are in progress. Tritium content of all sources was <1 TU. Coll and subm by I J Winograd, Reston, Virginia.
*Comment* (IJW): agreement in $^{14}C$ content between spring pairs in Pahranagat Valley, Death Valley, and Muddy R areas was expected due to mean identity of water chemistry. The wide divergence (1.8 to 11.6% modern) of the 3 springs at Ash Meadows was a surprise, in view of similar water chemistry and $^{13}C$ content. Differences may reflect mixing of water from 2 sources or extreme hydrodynamic dispersion in a heterogeneous fractured aquifer.

Two orifices exist at Fairbanks Spring. WRD-197 was of SW orifice, as was DE-670293 (R, 1973, v 15, p 470); DE-670294 was of NE orifice. Grove *et al* (1969) do not describe which orifice they sampled.

**Arkansas Hot Springs series**

Following are from hot and cold wells and springs in vicinity of Hot Springs, Arkansas, which are part of the hydrologic system including the Arkansas Hot Springs. Sampling was part of geochemical and hydrologic study for management of Hot Springs National Park. Pearson, Bedinger, and Jones (1972) described preliminary results (WRD-146-156), and a final report on the work, including all basic data, is made by Bedinger *et al* (1973). Coll and subm Feb 1972 (WRD-146-156) and Sept 1972 (WRD-164-170) by M S Bedinger, Little Rock, Arkansas, and F J P. *Comment*: carbonate geochemistry of this system is as straightforward as any we have encountered. Adjustment of measured $^{14}C$ values by

TABLE 2

Southern Great Basin, Nevada and California, series

| Area | Sample no. | Name | Location | Total dissolved carbonate (mM/L) | $\delta^{13}C$ ‰ | $^{14}C$ % modern ± 1σ | Other $^{14}C$ samples: Sample no. | Other $^{14}C$ samples: % modern ± 1σ |
|---|---|---|---|---|---|---|---|---|
| Pahranagat Valley, Nevada | WRD-196 | Hiko Spring | SE¼,sec14,T4S,R60E | 4.92 | −7.0 | 6.5 ± 0.3 | | |
| | WRD-203 | Ash Spring | NW¼,sec6,T6S,R61E | 4.65 | −6.7 | 5.8 ± 0.3 | 118 | 6.3 ± 1.2* |
| Spring Mts, Nevada | WRD-200 | Indian Spring | NW¼,sec16,T16S,R56E | 4.27 | −7.8 | 8.8 ± 0.4 | W-1841 | 11.0** |
| | | | | | | | DE-670347 | 18.6 ± 1.7† |
| Ash Meadows, Nevada | WRD-197 | Fairbanks Spring | NE¼,sec9,T17S,R50E | 5.44 | −4.8 | 1.8 ± 0.2 | W-1858 | 6.9** |
| | | | | | | | DE-670293 | 5.1 ± 0.8† |
| | | | | | | | DE-670294 | 2.4 ± 0.8† |
| | WRD-198 | Crystal Pool | NE¼,sec3,T18S,R50E | 5.34 | −5.5 | 11.6 ± 0.7 | DE-670298 | 10.8 ± 1.3† |
| | WRD-199 | Big Spring | NE¼,sec19,T18S,R51E | 5.60 | −5.4 | 3.9 ± 0.3 | DE-670303 | 3.0 ± 1.3† |
| Death Valley, California | WRD-201 | Nevares Spring | NE¼,sec36,T28N,R1E | 6.20 | −5.5 | 4.8 ± 0.3 | | |
| | WRD-204 | Texas Spring | NE¼,sec23,T27N,R1E | 5.75 | −5.0 | 5.6 ± 0.3 | | |
| Muddy R (near Moapa), Nevada | WRD-205 | Muddy (Warm) Spring | NE¼,sec16,T14S,R65E | 5.00 | −6.7 | 8.7 ± 0.3 | 119 | 8.8 ± 1.3* |
| | WRD-202 | Pederson's Warm Spring | NE¼,sec21,T14S,R65E | 4.82 | −6.8 | 9.0 ± 0.4 | | |

* Mifflin (1968). Sample no. is Spring no. in Appendix Table 5. Lab source of $^{14}C$ analyses not given.
** Grove *et al* 1969, Table 1; errors not reported.
† R, 1973, v 15, p 470.

TABLE 3
Arkansas Hot Springs series

| Sample no. | Local* well (W-) or spring (S-) no. | Location | Total dissolved carbonate (mM/L) | Calcium + magnesium + strontium (mM/L) | $\delta^{13}C$ ‰ | Tritium TU ± 1σ | $^{14}C$ % modern ± 1σ | Adjusted age yr BP |
|---|---|---|---|---|---|---|---|---|
| | | Cold Wells and Springs | | | | | | |
| WRD-168 | W-19 | NW¼,SW¼,NE¼,Sec23,T2S,R19W | 1.44 | 0.01 | −22.5 | 41.8 ± 2.0 | 101.7 ± 1.6 | 0 |
| WRD-166 | W-20 | SE¼,NW¼,NW¼,Sec26,T2S,R19W | 0.88 | 0.01 | −23.7 | 85.3 ± 1.6 | 98.9 ± 1.5 | 0 |
| WRD-170 | W-16 | NE¼,NE¼,SW¼,Sec14,T2S,R19W | 1.85 | 0.21 | −23.6 | 27.7 ± 1.6 | 111.8 ± 1.3 | 0 |
| WRD-165 | S-11 | NW¼,SW¼,NE¼,Sec32,T2S,R18W | 2.78 | 1.06 | −13.8 | 1.5 ± 0.8 | 39.5 ± 0.8 | 3730 |
| WRD-164 | W-21 | NW¼,SW¼,SW¼,Sec27,T2S,R19W | 3.05 | 1.26 | −14.4 | 1.3 ± 0.4 | 35.5 ± 0.5 | 4130 |
| WRD-167 | S-7 | NE¼,NW¼,SE¼,Sec31,T2S,R18W | 3.49 | 1.15 | −15.8 | 0.7 ± 0.6 | 37.3 ± 0.4 | 4840 |
| WRD-150 | W-26 | NE¼,NW¼,SE¼,Sec32,T2S,R19W | 3.85 | 1.34 | −14.3 | 2.8 ± 0.5 | 31.2 ± 0.5 | 6070 |
| WRD-156 | W-25 | NE¼,NW¼SE¼,Sec32,T2S,R19W | 3.94 | 1.72 | −13.8 | 1.2 ± 0.8 | 23.7 ± 0.3 | 7180 |
| WRD-155 | S-5 | SE¼,NW¼,SE¼,Sec22,T2S,R19W | 4.06 | 1.79 | −14.9 | 3.1 ± 0.6 | 22.2 ± 0.3 | 7620 |
| WRD-169 | W-12 | SE¼,NE¼,NW¼,Sec13,T2S,R19W | 3.88 | 1.45 | −15.5 | 0.9 ± 0.5 | 21.2 ± 0.4 | 8940 |
| WRD-149 | W-24 | SE¼,NW¼,NE¼,Sec32,T2S,R19W | 4.15 | 1.80 | −13.3 | 1.5 ± 0.4 | 19.4 ± 0.3 | 8850 |
| | | Hot Springs | | | | | | |
| WRD-152 | No. 17 | All within: NW¼,SE¼,Sec33,T2S,R19W | 2.70 | 1.29 | −14.1 | 3.0 ± 0.5 | 36.9 ± 0.5 | |
| WRD-153 | No. 23 | | 2.74 | 1.29 | −14.2 | 0.7 ± 0.8 | 35.1 ± 0.6 | |
| WRD-146 | No. 46 | | 3.18 | 1.32 | −14.8 | 3.1 ± 0.6 | 35.6 ± 0.7 | |
| WRD-151 | No. 48 | | 2.97 | 1.31 | −14.3 | 0.7 ± 0.4 | 38.7 ± 0.7 | |
| WRD-154 | Collecting reservoir | | 2.97 | 1.32 | −14.4 | 1.0 ± 0.7 | 30.4 ± 0.6 | |
| WRD-148 | No. 49 | | 3.07 | 1.30 | −16.1 | 0.9 ± 0.4 | 36.8 ± 0.9 | |
| | Average Hot Springs | | | | −14.6 | | 35.6 | 4430 |

* **Bedinger *et al*, 1973.**

almost any conventional method using $\delta^{13}C$ or water chemistry (Ingerson and Pearson, 1964; Pearson and Hanshaw, 1970; Tamers, 1967; Wendt *et al,* 1967) gives essentially the same results. In preliminary report (Pearson, Bedinger, and Jones, 1972), all ages adjusted using:

$$^{14}C_{adj} = {}^{14}C_{meas} \times \frac{-23}{\delta^{13}C_{meas}} .$$

Here and in the final report (Bedinger *et al,* 1973), cold wells and springs were adjusted using:

$$^{14}C_{adj} = {}^{14}C_{meas} \div 1 - \left(\frac{C_{alkaline\ earth}}{C_{total}}\right) .$$

Variable $CO_2$ outgassing among Hot Springs gives unreliable $C_{total}$ values, so adjustment was made only for average of hot springs using:

$$^{14}C_{adj} = {}^{14}C_{meas} \times \frac{-24}{\delta^{13}C_{sample}} .$$

Adjusted ages and other geochemical data provide tests of assumptions made in digital models of water and heat flow in the Hot Springs system. Results show that the age of Hot Springs water is due largely to residence time in cold-water portion of the flow system rather than to an extended period in the zone of heating.

**Edwards Aquifer, Texas, series**

Following are from wells in the Edwards and assoc limestones aquifer in the San Antonio area, Texas (Garza, 1966; Petitt and George, 1956). The part of the Edwards studied is on the down-thrown, coastal side of the Balcones fault zone, near which, the Edwards supplies huge amounts of oxidizing $Ca\text{-}HCO_3$ water for irrigation and municipal supply, including that of the City of San Antonio. It discharges in springs used for recreation NE of San Antonio. Down dip (toward coast) there is a zone of rapid transition to water of a $Ca\text{-}SO_4$ to Na-Cl type, reducing enough to contain $H_2S$. These results are 1st of a series coll as part of comprehensive study of hydrology of the Edwards. Well numbers are those used by Texas Water Development Board (Rettman, 1969). Samples WRD-71-86 coll July, 1970 and WRD-110-129 coll July, 1971 by F J P, M B, and Paul Rettman. Subm by F J P. *Comment*: initial results agree with previous hydrologic concept of rapid water movement through oxidized part and relatively much slower movement in reducing part of aquifer. Detailed interpretation must await further geochemical work.

**Southeast Florida series**

Following results are from study of the use of deep saline aquifers for injection of liquid wastes and constitute a vertical section of hydrogeologic framework in SE Florida, near Miami. Study is to determine sources and relative ages of native fluids, degree of vertical hydraulic interconnection or separation, and whether saline water is residual from past sea-water intrusions or from recent influx of "moden" sea-water from adjacent Straits of Florida as part of an active ground-water circulation system.

Preston sample coll April 1972 by F W Meyer; Kendale samples coll July 1971 through March 1972 during drilling by D J McKenzie. Subm by M I Kaufman.

| Sample no. | Name | Lat, Long, aquifer, & depth | $^{14}C$ % modern ± 1σ |
|---|---|---|---|
| WRD-159 | Preston Well | 25° 49′ 46″ N, 80° 17′ 15″ W | 97.5 ± 0.5 |
| | Field, S1476 | Biscayne Aquifer | |
| | | Depth 32.6m | |
| | Kendale Lakes | 25° 41′ 24″ N, 80° 24′ 53″ W | |
| | Test Well | Floridan Aquifer | |
| WRD-162 | | Depth 393.2m | 5.6 ± 0.7 |
| WRD-157 | | Depth 586.4m | 4.3 ± 0.8 |

*Comment* (MIK): results indicate effective vertical hydraulic separation between Biscayne aquifer (modern) and upper Floridan aquifer (≅5% modern). Although not definitive, age of upper Floridan waters and the extremely small amounts of $^{14}C$ from greater depths suggest a residual rather than a recent origin. Additional $^{14}C$ data is planned from future wells.

### Northwest Florida series

**WRD-160. Pensacola South Monitor Well** **<2.0% modern**

From lower Floridan aquifer, depth 483m, (30° 34′ 17″ N, 87° 14′ 17″ W). Part of study of use of deep saline aquifers for injection of liquid wastes. Represents native aquifer water from injection horizon 2.4km S of industrial waste injection system in NW Florida, near Pensacola. Fresh water occurs within this aquifer ca 32.2km upgradient. Dated to determine relative age of aquifer water. Coll Nov 1971 by L Slack and M I Kaufman. Subm by Kaufman. *Comment* (MIK): results suggestive of lethargic flow system and relatively old waters near injection site. Additional $^{14}C$ data is planned for overlying and upgradient waters to evaluate hydraulic separation and rates of ground-water movement.

TABLE 4
Edwards Aquifer, Texas, series

| Sample no. | Well no. | Total dissolved carbonate (mM/L) | $\delta^{13}C$ ‰ | Tritium TU ± 1σ | $^{14}C$ % modern ± 1σ |
|---|---|---|---|---|---|
| WRD-111 | 8-1900* | 3.76 | − 4.9 | 30.5 ± 2.2 | 116.0 ± 1.1 |
| WRD-110 | 8-1950* | 3.48 | − 9.3 | 28.3 ± 1.6 | 118.0 ± 1.1 |
| WRD-119 | YP-69-50-101 | 4.90 | −11.5 | 21.0 ± 1.5 | 72.5 ± 0.6 |
| WRD-115 | YP-69-45-401 | 4.66 | − 8.5 | 11.7 ± 0.8 | 65.6 ± 0.7 |
| WRD-114 | TD-69-47-302 | 4.62 | − 8.4 | 2.4 ± 0.3 | 62.4 ± 0.6 |
| WRD-117 | TD-68-42-806 | 4.05 | − 5.7 | <0.8 | 24.5 ± 0.6 |
| WRD-118 | AY-68-35-904 | 4.49 | − 8.5 | 1.9 ± 0.7 | 59.9 ± 1.0 |
| WRD-112 | AY-68-36-102 | 5.36 | − 8.9 | 13.9 ± 0.8 | 73.6 ± 0.6 |
| WRD-116 | DX-68-23-301 | 5.30 | − 9.2 | 6.7 ± 0.4 | 65.1 ± 0.6 |
| WRD- 72 | AY-68-29-109 | 6.98 | −10.8 | 5.4 ± 0.4 | 73.8 ± 0.7 |
| WRD- 75 | AY-68-37-104 | 4.83 | − 8.6 | 4.4 ± 0.3** | 83.6 ± 1.1 |
| WRD- 85 | TD-69-40-901 | 4.95 | − 9.6 | 11.5 ± 1.2 | 52.2 ± 0.7 |
| WRD- 86 | AY-68-37-701 | 4.50 | − 8.1 | <0.7 | 55.6 ± 0.7 |
| WRD- 77 | TD-68-41-801 | 4.60 | − 6.2 | <0.8** | 5.8 ± 0.4 |
| WRD-122 | AY-68-43-809 | 4.44 | − 5.3 | — | 34.2 ± 0.6 |
| WRD-125 | AY-68-43-703 | 4.42 | — | — | 22.8 ± 0.6 |
| WRD-124 | AY-68-44-210 | 4.46 | − 5.4 | <1.0 | 32.0 ± 0.4 |
| WRD-121 | AY-68-38-101 | 4.10 | − 4.3 | — | 21.0 ± 0.6 |
| WRD-123 | KX-68-30-601 | 5.14 | − 3.3 | <1.8 | <1.4 |
| WRD- 84 | AY-68-45-802 | 5.44 | − 3.2 | — | <1.0 |
| WRD-129 | AY-68-45-802 | 4.81 | − 6.9 | — | <1.1 |
| WRD-128 | AY-68-45-101 | 5.20 | − 3.1 | — | <2.2 |
| WRD-127 | AY-68-38-301 | 6.55 | − 4.0 | — | <1.2 |
| WRD- 78 | AL-68-50-201 | 4.44 | − 2.9 | — | 2.7 ± 0.4 |
| WRD- 80 | AY-68-43-702 | 4.87 | − 4.7 | — | 22.3 ± 0.6 |
| WRD- 82 | AY-68-37-702 | 7.18 | 0.0 | <0.6 | 3.9 ± 0.6 |
| WRD- 71 | AY-68-45-301 | 5.13 | − 4.6 | — | <2.4 |

* Stream samples.
** Coll in spring, 1968.

*B. Pakistan*

**Punjab series**

Samples are part of study to determine if salty ground water in irrigated doabs of upper Indus Plains, Punjab, Pakistan, is residual from conditions existing prior to irrigation or is currently being formed by evaporation of irrigation water. For details of study, see Seaber *et al* (1974).

Coll Feb and March 1971 by Ata and Gafar, WASID Lab, Govt Pakistan, and W Back, R Cherry, and P Seaber. Subm by C T Rightmire, Reston, Virginia.

| Sample no. | Name | Lat (N) | Long (E) | $\delta^{13}C$ ‰ | Alkalinity (mM/L) | $^{14}C$ % modern $\pm 1\sigma$ |
|---|---|---|---|---|---|---|
| WRD- 91 | Kurala | 31°41′ | 72°58′ | − 5.8 | 4.21 | 78.6 ± 1.2 |
| WRD- 92 | Thatta Khushi | 31°11′ | 72°14′ | −19.7 | 5.44 | 68.1 ± 1.0 |
| WRD- 93 | Shorkot Road hand pump | 30°47′ | 72°15′ | — | 2.69 | 58.7 ± 1.1 |
| WRD- 94 | Kamalia | 30°47′ | 72°35′ | − 8.9 | 5.19 | 72.8 ± 0.9 |
| WRD-106 | Gojra | 31°10′ | 72°41′ | −10.5 | 5.05 | 70.5 ± 0.6 |
| WRD-107 | Lyallpur | 31°24′ | 73°06′ | − 6.6 | 11.61 | 82.5 ± 0.7 |
| WRD-108 | Test well, ZW-357 | 31°38′ | 73°55′ | — | 6.17 | 69.2 ± 0.7 |
| WRD-109 | Toba Tek Singh | 30°59′ | 72°29′ | − 6.0 | 4.38 | 97.3 ± 0.8 |

*Comment* (CTR): due to lack of vertical control and possible mixing within wells, results of these $^{14}C$ determinations cannot be interpreted within regional hydrologic framework.

*C. Kenya*

**North Eastern Province series**

A body of fresh ground water underlies drainageways of Ewaso Ngiro R and Lagh Dera for ca 200km SE and E of Habaswein and is a major natural resource of arid North Eastern Prov. Samples coll to elucidate recharge mechanisms and perhaps flow rate to help plan use of this fresh water. Samples coll May, 1973 by F J P and W V Swarzenski, and Simon Wanuki, Water Dept, Govt Kenya. *Comment*: higher measured $^{14}C$ values are assoc with fresher water body, but correlation is not strict between $^{14}C$ and salinity. Samples fall into several groups; members of each show a striking correspondence between measured $^{14}C$ contents and $(C_{tot})^{-1}$ values. Our hypothesis to account for this correspondence is that each of the $^{14}C$-$C_{tot}$ groups represents a single recharge event. The different $^{14}C$ contents within each group are due to additions of varying amounts of $^{14}C$ free carbonate—by aquifer carbonate solution or mixing with older water—to water from a single recharge event.

Because of lack of general knowledge about arid-region carbonate chemistry and samples to show chemical and isotopic variations with depth in the aquifer, we do not assign absolute ages to these waters. It is probable, though, that recharge events recurred at intervals of a few milennia. Details of study are given by Pearson and Swarzenski (1974).

TABLE 5
North Eastern Province series

| Sample no. | Well no. C– | Lat | Long | Chloride (mg/L) | Total dissolved carbonate (mM/L) | $\delta^{13}C$ ‰ | $^{14}C$ % modern ± 1σ |
|---|---|---|---|---|---|---|---|
| WRD-184 | 3788 | 0°26′N | 40°01′E | 40 | 7.1 | −12.6 | 38.4 ± 0.5 |
| WRD-183 | 3715 | 0°30′N | 39°51′E | 64 | 7.2 | −13.8 | 39.4 ± 0.5 |
| WRD-182 | 3727 | 0°38′N | 39°42′E | 50 | 8.2 | −11.6 | 37.9 ± 0.5 |
| WRD-194 | 2685 | 0°21′N | 40°52′E | 142 | 6.0 | −12.7 | 48.4 ± 0.5 |
| WRD-177 | 3655 | 1°02′N | 39°27′E | 100 | 9.8 | −10.6 | 58.2 ± 0.6 |
| WRD-193 | 3831 | 0°02′S | 40°27′E | 82 | 9.5 | −11.5 | 12.8 ± 0.3 |
| WRD-178 | 3218 | 1°02′N | 39°29′E | 67 | 10.9 | −11.1 | 57.6 ± 0.5 |
| WRD-195 | 3821 | 0°14′N | 40°21′E | 256 | 7.4 | −13.4 | 42.1 ± 0.5 |
| WRD-181 | 3792 | 0°46′N | 39°37′E | 140 | 10.2 | −10.5 | 64.1 ± 1.4 |
| WRD-187 | 3685 | 0°51′N | 39°34′E | 109 | 10.0 | — | 87.7 ± 0.7 |
| WRD-180 | 3753 | 0°52′N | 39°27′E | 130 | 12.8 | − 9.8 | 52.4 ± 0.5 |
| WRD-188 | 3751 | 0°28′N | 39°44′E | 278 | 9.9 | −11.4 | 18.6 ± 0.3 |
| WRD-189 | 3752 | 0°39′N | 39°35′E | 182 | 13.0 | − 9.6 | 21.0 ± 0.3 |
| WRD-192 | 3726 | 0°37′N | 40°01′E | 150 | 18.2 | −11.9 | 35.0 ± 0.4 |
| WRD-185 | 3893 | 1°28′N | 39°16′E | 576 | 8.5 | − 9.5 | 2.8 ± 0.1 |
| WRD-191 | 3769 | 0°55′N | 39°53′E | 816 | 11.1 | −10.5 | 13.3 ± 0.4 |
| WRD-190 | 3804 | 0°42′N | 39°28′E | 2700 | 31.0 | −10.6 | 7.3 ± 0.3 |
| WRD-179 | 3822 | 1°02′N | 39°06′E | 2240 | 55.2 | − 8.0 | 6.7 ± 0.2 |
| WRD-186 | 3830 | 1°12′N | 39°15′E | 2720 | 38.7 | − 8.9 | 28.9 ± 0.4 |
| WRD-176 | 3770 | 0°01′S | 40°00′E | 3650 | 22.4 | − 9.4 | 4.4 ± 0.3 |

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# RUDJER BOŠKOVIĆ INSTITUTE RADIOCARBON MEASUREMENTS III

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The following list contains dates of samples measured since our previous list (R, 1973, v 15, p 435-441). 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.

Before combustion, wood and charcoal were treated with 4% HCl. Samples of soil with high percentage of limestone were treated with 50% HCl. Samples containing recent carbon (mold, rootlets) were boiled in 4% NaOH. The counting method is essentially the same as described in R, 1971, v 13, p 135-140. Sample descriptions were prepared with collectors and submitters. The errors quoted correspond to 1$\sigma$ variation of sample net counting rate and do not include the uncertainty in $^{14}C$ 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 was subtracted from the radiocarbon age (Münnich and Vogel, 1959).

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## I. ARCHAEOLOGIC SAMPLES

### Selevac series

Charred grain (*Triticum* sp) from a baked earth receptacle that rested on lowest occupation floor, underlying several occupation levels and overlying ashy layer devoid of artifacts, in Sonda S-VII at Selevac, loc "Staro Selo", near Smederevska Palanka (44° 30′ N, 20° 53′ E), N Serbia. Site spans most of Serbian Middle and Late Neolithic sequence. Figurine found in receptacle, the only artifact, is diagnostic of Vinča "A" at type site. Coll 1970 by Radovan Milošević and Vojislav Novaković, Nat Mus Smederevska Palanka, and subm by A McPherron, Univ Pittsburgh.

**Z-233A. Selevac** — **6113 ± 80** / **4163 BC**

Whole unbroken grains treated with 4% HCl and 4% NaOH.

**Z-233B. Selevac** — **6152 ± 90** / **4202 BC**

Whole unbroken grains without chemical treatment; mean value of 2 measurements.

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**6366 ± 100**
**4416 BC**

**Z-233. Selevac**

Rest of sample, treated with 4% HCl and 4% NaOH. *Comments* (DS): while both samples gave very close dates, whole-grains samples are regarded as more reliable; (AM): date confirms early position of occupation level in Vinča sequence.

**283 ± 60**
**AD 1667**

**Z-234. Varaždinske toplice**

Fragments of wood from draw-well 2m below surface (46° 14′ N, 14° 05′ E). Sample coll 1973 by Marcel Gorenc, Archaeol Mus, Zagreb.

**1533 ± 75**
**AD 417**

**Z-269. Varaždinske toplice**

Fragments of charred wood, remains of rafter from NW capitol of early Roman imperial settlement Aquae Jasae (46° 14′ N, 14° 05′ E). Coll 1973 and subm by Marcel Gorenc.

**430 ± 60**
**AD 1520**

**Z-236. Hutovo Blato**

Fragment of wooden boat (*Quercus*) 11m below surface, spring Desilo, Hutovo Blato (43° 3′ N, 17° 45′ E) near Čapljina, Hercegovina. Coll 1972 and subm by Vukosava Atanacković-Salčić, Inst Protection Cultural Monuments, Regional Center, Mostar.

**Hrvatska Dubica series**

Fragments of wooden boat from muddy bed of Una R near Hrvatska Dubica (45° 11′ N, 16° 49′ E) Croatia. Coll 1973 and subm by Members Regional Inst Protection Cultural Monuments, Zagreb.

**541 ± 60**
**AD 1409**

**Z-251. Hrvatska Dubica I**

**417 ± 60**
**AD 1533**

**Z-255. Hrvatska Dubica II**

**1759 ± 55**
**AD 191**

**Z-256. Bosanska Gradiška**

Fragment of wooden boat from sandy bed of Jablanica R NW of Bosanska Gradiška (45° 7′ 30″ N, 17° 11′ 30″ E). Coll 1973 and subm by Drago Malešević, Bosanska Gradiška.

**320 ± 60**
**AD 1630**

**Z-257. Dubrovnik, Knežev dvor**

Wooden pillar from foundation of Duke's Palace (Knežev Dvor). Found during restoration of palace. Date important for chronology of building.

**194 ± 60**
**AD 1756**

**Z-260. Lopar**

Charcoal from hearth, Lopar (44° 51′ N, 14° 43′ E) on Rab I. Coll 1972 and subm by Vjeko Legac, Rab.

**Z-261. Maslovare** **1944 ± 83**
**AD 6**

Charcoal from layer in Illyrian iron melting-furnace in Blagaj near Bosanski Novi (45° 0′ N, 16° 25′ E). Depth: 2m below dross layer in gray clay. Coll 1973 and subm by Djuro Basler, Regional Mus, Sarajevo. *Comment* (Dj B): expected age: 70 BC to AD 50.

**Vlasac series**

Charcoal from archaeol excavation of Mesolithic settlement Vlasac (44° 32′ N, 22° 3′ E) near Donji Milanovac. Settlement discovered during construction of Djerdap hydro-electric power plant. Coll 1970 and subm by Dragoslav Srejović and Zagorka Letica, Fac Arts & Sci, Archaeol Dept, Belgrade.

**Z-262. Vlasac I** **7000 ± 90**
**5050 BC**

Charcoal from hearth, House I, Sonda A, Level XXVI, depth 4.1m below surface, oldest horizon. *Comment* (DS): dates agree with expected period (Mesolithic, 7-6th millennium BC).

**Z-264. Vlasac I** **6335 ± 92**
**4385 BC**

Charcoal from Burial 54, Quad A/17, Level XI.

**Z-267. Vlasac II** **7559 ± 93**
**5609 BC**

Charcoal below Hearth 16. *Comment* (DS): expected age: end of Mesolithic, 7-6th millennium BC.

**Z-268. Vlasac ?** **6713 ± 909**
**4763 BC**

Charcoal from Burial 11, Quad a/6, Level VII.

**Z-270. Vela Svitnja** **317 ± 65**
**AD 1579**

Fragments of charred wood (*Pinus*) from sand at depth 35m, Vela Svitnja, Vis bay (43° 04′ N, 16° 12′ E), Vis I. Coll 1973 and subm by Nenad Cambi, Archaeol Mus, Split.

**Z-283. Ščitarjevo** **1949 ± 77**
**AD 1**

Charcoal from cult fireplace in burial place, Block 7, depth 1m, in Roman municipality Andautonia near Zagreb (45° 46′ N, 16° 00′ E). Coll 1973 and subm by Branka Vikić and Marcel Gorenc, Archaeol Mus, Zagreb.

**Nin series, Croatia**

Fragments of wooden ship from sea under muddy sand at 2m depth at Ždrijac, port of Nin (44° 15′ N, 15° 15′ E). Coll 1973 and subm by Zdenko Brusić and Božidar Vilhar, Archaeol Mus, Zadar.

**961 ± 64**
**Z-296. Nin I** **AD 989**

Hull fragments.

**937 ± 71**
**Z-297. Nin II** **AD 1013**

Hull fragments of same ship.

**1177 ± 80**
**Z-298. Nin III** **AD 773**

Fragments of wooden rib from same ship.

**Z-299. Slavonski Brod** **>35,000**

Fragments of wood assoc with steppe elephant (*parelephas trogontherii*) skull from Glogovica channel near Slavonski Brod (45° 10′ N, 18° 02′ 30″ E). Coll 1973 and subm by Mirko Malez, Yugoslav Acad Sci, Zagreb.

**2735 ± 100**
**Z-306. Hruševje** **785 BC**

Fragments of driftwood, Hruševje near Postojna (45° 46′ N, 14° 07′ 15″ E). Date determines period of accumulation of driftwood in Nanošca creek valley. Coll 1973 and subm by Alojz Šercelj, Slov Acad Sci & Arts, Ljubljana.

**7150 ± 100**
**Z-307. Loče** **5200 BC**

Fragments of driftwood, Loče near Slovenska Bistrica (46° 22′ 45″ N, 15° 33′ 30″ E). Date determines period of accumulation of driftwood in Ložnica creek valley. Coll 1973 and subm by Alojz Šercelj.

**Ljubljansko Barje series**

Wood fragments from ash (*Fraxinus*) pilings of pile houses from Ljubljansko Barje peat bog (45° 58′ N, 14° 32′ E), Slovenia. Potsherds, estimated age, 3800 yr old, assoc with fragments.

**4633 ± 117**
**Z-278. Ljubljansko Barje** **2683 BC**

**4345 ± 113**
**Z-305. Veliki Mah No. 1** **2395 BC**

**4964 ± 99**
**Z-314. Maharski prekop** **3104 BC**

**4701 ± 104**
**Z-315. Maharski prekop** **2751 BC**

**Kaptol series**

Charcoal from rectangular charcoal-filled trench in prehistoric Barrow I in Kaptol village near Požega (45° 26′ N, 17° 44′ E). Results important for chronology of Early Iron age of Požega Valley. Coll 1973 and subm by Vera Vejvoda and Ivan Mirnik, Archaeol Mus, Zagreb.

**Z-316. Kaptol 1** **2626 ± 90**
**676 BC**

**Z-317. Kaptol 2** **2294 ± 97**
**644 BC**

II. GEOLOGIC SAMPLES

**Grapa series, Slovenia**

Calcite from stalagmite, Grapa Cave (46° 49′ N, 14° 09′ E) near Belsko. Coll 1972 and subm by France Habe, Slovenian Acad Sci & Arts, Postojna. Samples date periods of growth of sinter.

**Z-231. Grapa** **6380 ± 100**
**4430 BC**

Calcite from stalagmitic core, entrance gallery.

**Z-231/I. Grapa** **3330 ± 80**
**1380 BC**

Calcite from same stalagmite, 0 to 4mm below surface.

**Z-231/II. Grapa** **4300 ± 90**
**2350 BC**

Calcite from same stalagmite, 7 to 12mm below surface.

**Z-231/IV. Grapa** **2201 ± 63**
**251 BC**

Calcite from tip of same stalagmite.

**Z-232/I. Grapa** **3942 ± 80**
**1992 BC**

Calcite from stalagmite grown on clay in N gallery, 0 to 10mm below surface.

**Z-232/II. Grapa** **6252 ± 100**
**4302 BC**

Calcite from same stalagmitic core.

**Z-227. Grapa** **2410 ± 78**
**460 BC**

Calcite from stalagmite from N gallery. *Comment* (FH): expected period: Holocene.

**Rastuša series**

Calcite from stalactite from top of Rastuša cave near Teslić (44° 41′ 48″ N, 17° 48′ 20″ E). This stratum is sterile, but next layer contains bones of cave bear (*Ursus spelaeus*). Coll 1972 and subm by Mirko Malez, Yugoslav Acad Sci, Zagreb. *Comment* (MM): expected period: Pre-Boreal.

**Z-238/I. Rastuša** **9808 ± 124**
**7858 BC**

Calcite from core of stalactite.

**Z-238/II. Rastuša** **9412 ± 126**
**7462 BC**

Calcite from same stalactite 0 to 2cm below surface.

**Buško Blato series**

Speleothems from caves discovered during construction of dam, Orlovac hydroelectric plant (43° 40′ N, 16° 59′ E). Dates helped to establish chronology of cave formation, growth of speleothems and tectonic changes. Coll 1972 and subm by Srećko Božičević, Inst Geol, Zagreb.

**Z-239/I. Buško Blato 1** **1857 ± 74**
**AD 93**

Base of submerged stalagmite, Sec 8, of interest for dating formation of sandy layer in stalagmite. Calcite below sand.

**Z-239/II. Buško Blato 1** **1828 ± 62**
**AD 122**

Calcite above sand.

**Z-240/I. Buško Blato 2** **1821 ± 66**
**AD 129**

Calcite from core, submerged stalagmite, Sec 8, near siphon.

**Z-240/II. Buško Blato 2** **Modern**

Calcite from tip of same stalagmite.

**Z-241. Buško Blato 3** **2763 ± 78**
**813 BC**

Calcite from tip, submerged stalagmite, Sec 8.

**Z-243. Buško Blato 5** **1349 ± 74**
**AD 601**

Calcite from core of base of broken stalagmite from great hall, Sec 8, grown on a calcite block.

**Z-244/I. Buško Blato 6** **3776 ± 84**
**1826 BC**

Calcite from stalagmite from Great Hall beneath block with stalagmite Z-243, Sec 8. Calcite from core of base of stalagmite.

**Z-244/II. Buško Blato 6** **2886 ± 64**
**934 BC**

Calcite from same stalagmite 0 to 5cm below surface.

**Z-245. Buško Blato 7** **312 ± 70**
**AD 1638**

Calcite from outer layer of stalagmite grown on a block under rock in right canal, Sec 8.

**Z-246/I. Buško Blato 8** **2481 ± 77**
**531 BC**

Calcite from stalagmite grown on a block under inclined rock, Sec 17. Calcite from base of stalagmite.

**Z-246/II. Buško Blato 8** **659 ± 70**
**AD 1291**

Calcite from tip of same stalagmite.

**Z-247. Buško Blato 11** **3382 ± 78**
**1432 BC**

Calcite from base of stalagmite grown on muddy ground behind block with stalagmite Z-246, Sec 17.

**Z-248/I. Buško Blato 9** **2041 ± 64**
**91 BC**

Calcite from stalagmite grown on calcite block, Sec 17. Calcite from base of stalagmite.

**Z-248/II. Buško Blato 9** **1970 ± 79**
**20 BC**

Calcite from tip of same stalagmite.

**Z-249/I. Buško Blato 12** **>30,000**

Calcite from fragment of speleothem 10cm thick, Sec 27. Core of speleothem.

**Z-249/II. Buško Blato 12** **20,990 ± 405**
**19,040 BC**

Outer part of speleothem. Sample mixed with dead gas for counting.

**Z-250. Buško Blato 13** **1945 ± 94**
**AD 5**

Calcite from base of broken stalagmite grown on calcite crust 0 to 6mm below surface. Sample mixed with dead gas for counting.

**Z-279. Ciganske Jame** **4790 ± 120**
**2840 BC**

Speleothem from cave Ciganske Jame near Kočevje (45° 39′ N, 14° 53′ E). Coll 1973 by Mitja Brodar and subm by Alojz Šercelj, both of Slovenian Acad Sci & Arts, Ljubljana.

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