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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 21, no. 1 must be submitted in *duplicate* before September 1, 1978, for vol 21, no. 2 before January 1, 1979.

General or technical articles should follow the recommendations above and the editorial style of the *American Journal of Science.*

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). The standard error following the date should express, within limits of $\pm$ 1σ, the laboratory's estimate of the accuracy of the radiocarbon measurement, *as judged on physico-chemical (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 may 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. Calendar estimates, reported in AD/BC may be included, citing the specific calibration curve used to obtain the estimate.

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 9th International Conference on Radiocarbon Dating, Los Angeles/La Jolla, 1976. Because of various uncertainties, when ^{14}C measurements are expressed as dates in years BP the accuracy of the dates is limited, and refinements that take some but not all uncertainties into account may be misleading. The mean of three recent determinations of the half life, 5730 ± 40 yr, (**Nature,** v 195, no. 4845, p 984, 1962), is regarded as the best value presently available. Published dates in years BP, can be converted to this basis by multiplying them by 1.03.

AD/BC Dates. In accordance with the decision of the Ninth International Radiocarbon Conference, Los Angeles and San Diego, 1976, the designation of AD/BC, obtained by subtracting AD 1950 from conventional BP determinations is discontinued in Radiocarbon.

Authors or submitters may include calendar estimates as a comment, and report these estimates as AD/BC, citing the specific calibration curve used to obtain the estimate.

Meaning of $\delta^{14}C$. In Volume 3, 1961, we endorsed the notation Δ (Lamont VIII, 1961) for geochemical measurements of ^{14}C activity, corrected for isotopic fractionation in samples and in the NBS oxalic-acid standard. The value of $\delta^{14}C$ that entered the calculation of Δ was defined by reference to Lamont VI, 1959, and **was corrected for age.** This fact has been lost sight of, by editors as well as by authors, and recent papers have used $\delta^{14}C$ 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). The Ninth International Radiocarbon Conference, Los Angeles and San Diego, 1976, recommended that the reference standard, 0.95 times NBS oxalic acid activity, be normalized to $\delta^{13}C = -19‰$.

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

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

Radiocarbon Measurements: Comprehensive Index, 1950-1965. This index, 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 $10.00 US per copy.

Publication schedule. Beginning with Volume 15, RADIOCARBON has been published in three numbers: Winter, Spring, and Summer. The next deadline is September 1, 1978. Contributors who meet our deadlines will be given priority but publication is not guaranteed 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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EDITORIAL STATEMENT TO CONTRIBUTORS

Since its inception, the basic purpose of Radiocarbon has been the publication of compilations of ^{14}C dates produced by various laboratories. These lists are extremely useful for the dissemination of basic ^{14}C information.

The editors have recently agreed to an expanded role for the Journal. In addition to date lists, the editors will now consider technical or interpretative articles on all aspects of ^{14}C. In general, the type of material presented at International Radiocarbon conferences is appropriate for inclusion in Radiocarbon. Articles containing scientific knowledge based on ^{14}C data broadens the scope of the Journal.

All correspondence and manuscripts should be sent to the Managing Editor, Radiocarbon, Box 2161, Yale Station, New Haven, Connecticut 06520.

The Editors

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[RADIOCARBON, VOL. 20, NO. 2, 1978, P. 169-170]

Radiocarbon

1978

A PROCEDURE FOR THE PREPARATION OF BENZENE FROM ^{14}C NBS OXALIC ACID STANDARD

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Sutherland, Australia, 2232

ABSTRACT. A simple procedure for the conversion of ^{14}C NBS oxalic acid standard to benzene without direct combustion or wet oxidation is reported. Fractionation in the synthesized benzene was not detected.

INTRODUCTION

The direct combustion or wet oxidation of ^{14}C NBS oxalic acid standard to carbon dioxide is the accepted technique used by most radiocarbon dating laboratories. Fractionation during these oxidations has been reported by many investigators. Grey and others (1969) reported $\delta^{13}C$ values of $+61.5‰$ for the last 0.6 percent fraction of carbon dioxide prepared from oxalic acid, and Polach and Krueger (1972) have established experimentally that $\delta^{13}C$ values range from $-50‰$ to $+54‰$ for significant proportions of the carbon dioxide resulting from permanganate oxidation of oxalic acid. This fractionation could be of serious consequence to laboratories without access to mass spectrometric $\delta^{13}C$ value determinations, because the error in ^{14}C activity of oxalic acid, based on an assumed $-19‰$ $\delta^{13}C$, may lead to systematic errors in age determinations.

Recently, Valastro, Land, and Varela (1977) have reported an improved procedure for wet oxidation of the ^{14}C NBS oxalic standard. They also showed that negligible fractionation occurs when carbon dioxide and acetylene are converted to benzene, the counting liquid used by all radiocarbon dating laboratories with liquid scintillation facilities.

To overcome difficulties associated with these oxidation procedures, a technique in which lithium oxalate is converted to benzene, in very high yield, is reported.

PROCEDURE

For the preparation of approx 6 g benzene, 33.0 g ^{14}C NBS oxalic acid standard $(COOH)_2 \cdot 2\ H_2O$ is dissolved in 70 ml boiling distilled water. To this solution is carefully added a solution of lithium hydroxide prepared by reacting 3.62 g dry-packed lithium metal shot 4 to 16 mesh (weighed in a glove box flushed with dry nitrogen) with 125 ml carbon dioxide free water in an atmosphere of nitrogen. This latter solution can also be prepared by dissolving 12.5 g L.R. lithium hydroxide in 125 ml water.

The resulting solution is evaporated to dryness in a rotary evaporator and finally dried at 120°C. The yield of lithium oxalate is theoretical (26.7 g). This is mixed with 20 g dry-packed lithium metal in a stainless steel reaction vessel. Initially a vacuum is applied, but when the temperature reaches 100°C, the valve to the vacuum pump is closed, and the mixture reacted at 700°C and finally to 900°C using the method reported by Polach and Stipp (1967).

$$(COO\ Li)_2 + 8\ Li \rightarrow Li_2C_2 + 4\ Li_2O.$$

The lithium carbide is hydrolyzed with tritium free water, and the resulting acetylene, after purifying by passing over glass beads coated with saturated sodium hydroxide solution and 85 percent phosphoric acid, is polymerized at 5°C to benzene using vanadium-activated silica–alumina catalyst (Noakes, Kim, and Akers, 1967). When polymerization is complete, the benzene is removed from the catalyst by heating to about 150°C under vacuum and collecting the benzene in a small liquid nitrogen cooled trap. The recovered yield of benzene is greater than 95 percent. The purity of the benzene has been reported by Fraser and others (1974). The carbon dioxide obtained from three batches of benzene by burning the benzene in oxygen had an average $\delta^{13}C$ of $-19.6 \pm 0.4‰$.

CONCLUSION

The procedure outlined in this technical note gives benzene with the same isotopic concentration as ^{14}C NBS oxalic acid. This technique should prove particularly valuable for laboratories equipped with liquid scintillation spectrometers but without access to mass spectrometer δ^{13} value determinations.

The procedure is easily carried out and eliminates many of the difficulties associated with direct combustion or wet oxidation techniques.

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[RADIOCARBON, VOL. 20, No. 2, 1978, P. 171-191]

ARIZONA RADIOCARBON DATES IX: CARBON ISOTOPE DATING OF PACKRAT MIDDENS

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INTRODUCTION

The carbon isotope analyses reported here include all radiocarbon dates run on packrat middens in the United States and Mexico by the Arizona radiocarbon laboratory through October 1977. All samples described below report dates by CO_2 (0.5 or 2.0L) counting. Age calculations are based on a ^{14}C half-life of 5568 years, using 0.949 NBS oxalic acid as the modern value. Errors, based on counting statistics, are quoted to $\pm$ 1δ; infinite ages quoted to $-$ 2δ.

Sample collectors and submitters are unless otherwise stated: Kenneth L Cole (KLC), Austin Long (AL), Paul S Martin (PSM), Jim I Mead (JIM), W Geoffery Spaulding (WGS), Robert S Thompson (RST) and Thomas R Van Devender (TRV), Department of Geosciences, University of Arizona, Tucson; Arthur M Phillips, III (AMP), Museum of Northern Arizona, Flagstaff, Arizona; and Benjamin L Everitt (BLE), Utah Geological Survey, Salt Lake City, Utah.

Packrats (*Neotoma* spp) collect a variety of materials, including seeds, twigs and bones for food and constructional components in their houses and dens. These materials are collected within the home-range of the packrat, which is usually less than 100m from the den (Stones and Hayward, 1968). Periodic "cleaning" of the house or den by the packrat produces a midden of discarded waste material. Repeated trampling and urination on this midden may convert it into a hard, urine-cemented (indurated) mass. The analyses of ancient packrat middens preserved in dry rock crevices or caves have provided important information about past biotic communities (Wells, 1976; Van Devender, 1977).

An indurated midden is very hard, and a hammer and chisel are usually required to remove the sample from its shelter. If the midden is stratified, its layers are separated and considered different units. In the Laboratory of Paleoenvironmental Studies, a 1 to 2kg portion of each stratified midden unit is brushed to remove loose debris and placed in a 4L container of water. After the cementing urine has been soaked free, the water is decanted through fine screens, leaving the midden debris for analysis. This material is then dried and the floral and faunal fossils removed by hand-picking. Generally, 5 to 10g of material to be radiocarbon dated are selected from the midden unit sample, and observable extraneous material is removed. In previous years, only a cold water wash was used to remove the urine, but for the past 3 yr an additional 30min warm water wash in an ultrasonic cleaner has been used. Preparatory to com-

* Laboratory of Paleoenvironmental Studies
** Laboratory of Isotope Geochemistry

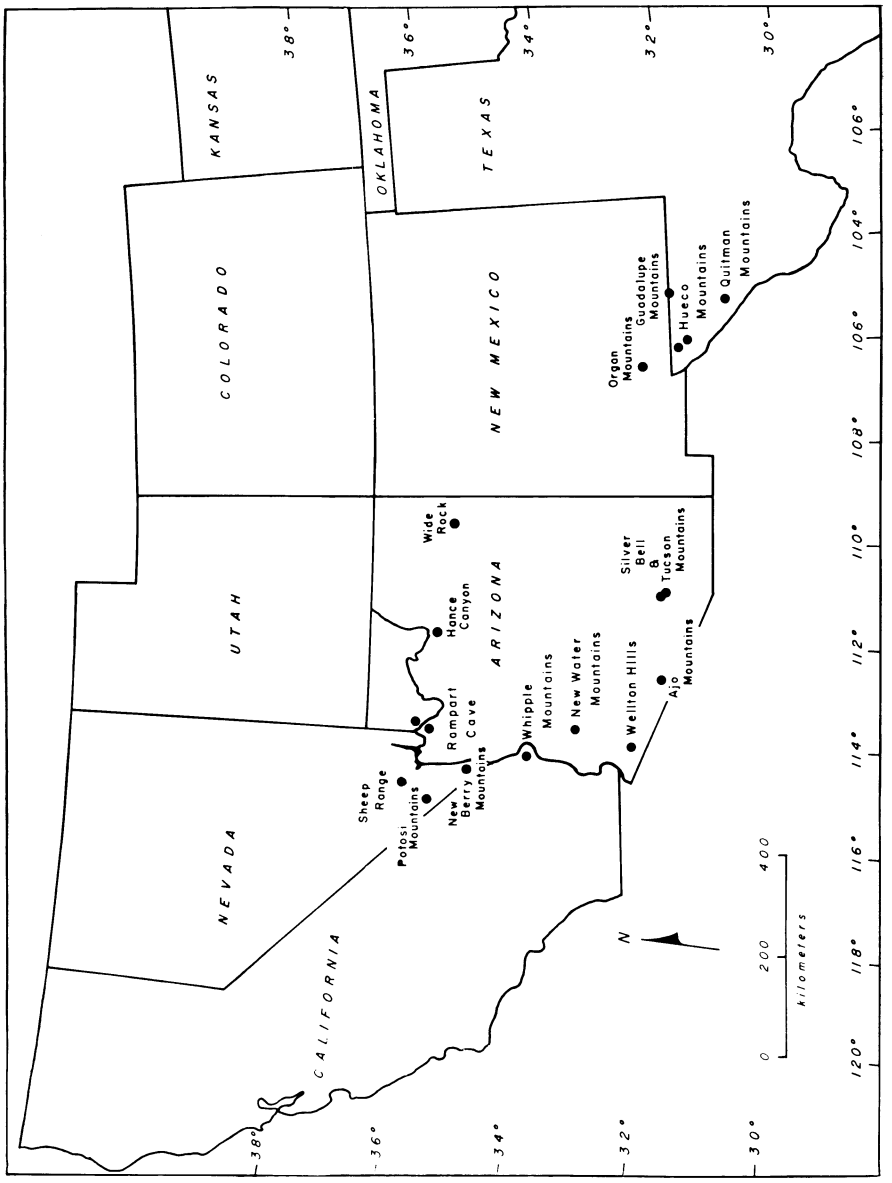

Figure 1. Locality map of packrat midden series mentioned in text.

bustion in the ^{14}C laboratory, the plant fragments are treated in hot 2% NaOH, then in hot 1N HCl for ca 15min each. Finally the samples are rinsed in water and dried overnight.

There has been much debate concerning the best sampling procedure for radiocarbon dates from packrat middens (Wells, 1976). We believe that, in general, it is best to date a fossil species that no longer occurs in the area at present (extralocal). This method provides us with an average radiocarbon date directly on this extralocal species. A single midden unit may contain upward of 35 plant taxa. At lower alts, *Juniperus* usually has been the dominant taxa by weight and number, whereas, at higher alts, the dominant taxa usually are *Pinus* spp and *Picea*. Mixed in with these dominants are other less dominant extralocal and local taxa. The most abundant taxon is usually selected for radiocarbon dating because it is extralocal and because it provides the required minimum weight for a datable sample. We feel that obtaining a date on a thin bulk sample does not show direct assoc with the contents of the remaining larger portion of the midden sample. Preferably 2 radiocarbon dates should be run on each midden unit, with 1 date on an extralocal species and the other date on a local species or a bulk sample of the entire unit. Bulk midden samples may, on the one hand, represent a shorter length of time, but on the other hand, seem prone to contamination with younger urine and plant fragments. Indeed, there may be no one sampling procedure which will provide accurate dates for all middens.

The radiocarbon samples are organized by their present biogeographic or physiographic region: Colorado Plateau, Grand Canyon, Mohave Desert, Sonoran Desert or Chihuahuan Desert. Under each division, further subdivision is determined by mountain range, canyon or cave. All samples are from indurated middens unless otherwise stated.

ACKNOWLEDGMENTS

We thank Tom Van Devender, Paul Martin, Geoff Spaulding, Ken Cole, and Art Phillips for their comments and discussions about packrat middens. We also appreciate the help of the numerous additional collectors cited within the paper. Larry Arnold helped analyze the samples in the laboratory. Financial support was supplied by the National Science Foundation to P S Martin (DEB75-13944), T R Van Devender (DEB76-19784) and to P E Damon and A Long (EAR74-13362 AO2). The ^{14}C laboratory is also supported in part by the State of Arizona. University of Arizona, Department of Geosciences Contribution No. 809.

SAMPLE DESCRIPTIONS

Colorado Plateau

Wide Rock Series

Two samples from Wide Rock, WdR, an isolated butte in Canyon de Chelly at 2100m alt (36° 05′ N, 109° 20′ W), Navajo Co, Arizona. The indurated midden (15 by 1 by 0.76m) contains 4 levels (Schmutz *et al,* 1976). Coll by Arthur Dennis; subm by Jeff Zauderer.

General Comment: with such a large midden of many levels, the 2 dates should be considered exploratory in nature.

A-1536. WdR Level 2, 45 cm **1930 ± 80**

Juniperus osteosperma twigs.

A-1537. WdR Level 4, 76 cm **6210 ± 90**

Neotoma dung.

Grand Canyon

Middens were recovered from numerous canyons within the Grand Canyon. Canyons are referenced to their Colorado R mile location, following the conventional usage of miles (Hamblin & Rigby, 1968).

Horseshoe Mesa

One sample from Crystal Forest Cave, Horseshoe Mesa, S of Colorado R Mile 77, Grand Canyon (36° 01′ N, 111° 58′ W), Coconino Co, Arizona. Coll by KLC 1976; subm by KLC and PSM.

A-1805. Horseshoe Mesa 7a, 1424m alt **13,540 ± 170**
$\delta^{13}C = -22.4‰$

Juniperus sp twigs.

Hance Canyon series

Two samples from Bida Cave, Hance Canyon, S of Colorado R Mile 77.5, Grand Canyon (36° 00′ N, 111° 57′ W), Coconino Co, Arizona. Coll by KLC 1976; subm by KLC and PSM.

A-1789. Bida Cave 2, 1424m alt **14,200 ± 470**
$\delta^{13}C = -23.3‰$

Pseudotsuga menziesii and *Abies concolor* needles.

A-1790. Bida Cave 2c, 1424m alt **13,780 ± 240**
$\delta^{13}C = -24.7‰$

Plant and midden debris.

Shinumo Creek series

Two samples from N of Colorado R Mile 107.6, Grand Canyon (36° 14′ N, 112° 21′ W), Cononino Co, Arizona (Van Devender & Mead, 1976; Cole and Van Devender, 1976; Van Devender *et al,* 1977). Midden not in Shinumo Creek but closer to Bass Rapids. Coll by PSM, JIM and J E King 1969 and 1976; subm by PSM, JIM, and TRV.

General Comment: Shinumo Creek samples represent 2 different samples from the same large midden.

A-1321. SC 1, 730m alt **13,660 ± 160**
$\delta^{13}C = -22.5‰$

Juniperus sp twigs.

A-1444. SC 1, 730m alt **12,070 ± 600**

Opuntia cf *whipplei* spines.

Peach Springs Wash series

Sample from Peach Springs Wash (PSW), 11km S of Diamond Creek at confluence with Colorado R Mile 225.6, Grand Canyon, Mohave Co, Arizona.

A-1454. PSW 1, 885m alt **12,040 ± 250**

Juniperus sp twigs (35° 47′ N, 113° 30′ W) (Van Devender & Mead, 1976; Cole and Van Devender, 1976; Van Devender *et al,* 1977). Coll by TRV and JIM 1973; subm by TRV and JIM.

A-1718. Cave of the Early Morning Light, 1300m alt **16,580 ± 460**

$\delta^{13}C = -21.5‰$

Juniperus sp twigs (35° 42′ 45″ N, 113° 23′ 20″ W). Coll by Don Davis 1976; subm by TRV and PSM.

Vulture Canyon series

Samples from Vulture Canyon (VC), S of Colorado R Mile 274.5, Grand Canyon (36° 06′ N, 113° 56′ W), Mohave Co, Arizona. Samples are from numerous isolated rock crevice middens throughout predominantly limestone canyon and from Vulture Cave (Phillips & Van Devender, 1974; Cole & Van Devender, 1976; Phillips, 1977; Van Devender *et al,* 1977; Mead & Phillips, ms in prep). Coll by AMP, JIM, TRV, and PSM 1972 to 1976; subm by AMP, JIM, TRV, and PSM.

A-1316. VC 1, 540m alt **12,770 ± 440**

$\delta^{13}C = -22.3‰$

Juniperus sp twigs. *Comment*: VC 1 = Columbine Falls 1.

A-1564. VC 8 Vulture Cave, 645m alt **13,820 ± 220**

Juniperus sp twigs. *Comment*: youngest dated midden in cave. Sample dates only a single small unit within extremely complex, stratified midden. Date not representative of entire midden.

A-1566. VC 4, 495m alt **10,610 ± 320**

$\delta^{13}C = -19.8‰$

Juniperus sp seeds and twigs.

A-1567. VC 2b, 460m alt **10,250 ± 290**

$\delta^{13}C = -22.4‰$

Juniperus sp twigs.

A-1568. VC 12, 675m alt **8540 ± 180**

$\delta^{13}C = -21.8‰$

Fraxinus anomala seeds and twigs.

A-1579. VC 5, 620m alt **13,400 ± 390**

$\delta^{13}C = -22.0‰$

Juniperus sp twigs.

A-1587. VC 14, 645m alt **11,870 ± 190**
$\delta^{13}C = -20.7‰$

Juniperus sp seeds and twigs.

A-1603. VC 6 Vulture Cave, 645m alt **17,610 ± 290**
$\delta^{13}C = -22.0‰$

Juniperus sp twigs.

A-1604. VC 7 Vulture Cave, 645m alt **22,720 ± 610**
$\delta^{13}C = -21.8‰$

Juniperus sp twigs.

A-1605. VC 9 Vulture Cave, 645m alt **29,810 ± 1980**
$\delta^{13}C = -21.8‰$

Juniperus sp twigs. *Comment*: oldest dated midden from cave.

A-1606. VC 10 Vulture Cave, 645m alt **19,050 ± 390**
$\delta^{13}C = -21.8‰$

Juniperus sp twigs.

A-1607. VC 13 Vulture Cave, 645m alt **15,130 ± 210**
$\delta^{13}C = -23.0‰$

Juniperus sp twigs. *Comment*: unindurated floor midden covered by ca 5cm eolian silt.

A-1608. VC 15 Vulture Cave, 645m alt **15,260 ± 270**
$\delta^{13}C = -23.0‰$

Juniperus sp twigs. *Comment*: apparent indurated extension of unindurated midden (see A-1607).

Rampart Cave Series

Samples from Rampart Cave (RC), S of Colorado R Mile 274.5, 535m alt, Grand Canyon (36° 06′ N, 113° 56′ W), Mohave Co, Arizona. Cave contains 145cm stratified sloth dung and unindurated packrat middens (Rat Layer). Indurated middens occur along cave wall and in excavated pits (Martin *et al,* 1961; Long & Martin, 1974; Long *et al,* 1974; Phillips & Van Devender, 1974; Cole & Van Devender, 1976; Van Devender *et al,* 1977; Van Devender, 1977). Coll by AMP, TVD, PSM, and AL 1972 to 1976; subm by AMP, TRV, and PSM.

A-1208. Rat Layer 71cm **16,700 ± 900**
$\delta^{13}C = -8.5‰$

Neotoma dung from Ray Layer. *Comment*: date is minimum for layer; unindurated.

A-1209. Rat Layer 96 cm **23,540 ± 460**

Neotoma dung at base of layer. *Comment*: date is maximum for layer; unindurated.

A-1325. RC St 45 **13,170 ± 310**
$\delta^{13}C = -21.3‰$

Juniperus sp seeds and twigs.

A-1350. RC Pit B Original **12,600 ± 260**
$\delta^{13}C = -22.7‰$

Juniperus sp twigs.

A-1356. RC Rat Layer **18,890 ± 500**
Fraxinus anomala seeds and twigs. *Comment*: unindurated.

A-1421. RC Roof Crack **13,510 ± 190**
Juniperus sp twigs.

A-1450. RC St 50 **9770 ± 160**
$\delta^{13}C = -22.0‰$

Juniperus sp twigs.

A-1451. RC St 50 **9520 ± 400**
Fraxinus anomala twigs and seeds.

A-1452. RC St 50 **9520 ± 330**
$\delta^{13}C = -11.9‰$

Single *Agave utahensis* leaf fragment.

A-1453. RC St 50 **11,140 ± 250**
Nothrotheriops shastense dung. *Comment*: A-1450 and -1453 are on different midden constituents from same unit sample. Three are within 1σ, whereas A-1453 represents incorporation of older material into a younger midden.

A-1535. RC St 35 **12,230 ± 350**
Juniperus sp and *Fraxinus anomala* seeds and twigs.

A-1569. RC Pit B Front **16,330 ± 270**
$\delta^{13}C = -21.4‰$

Juniperus sp twigs.

A-1570. RC Rat Layer **14,810 ± 220**
$\delta^{13}C = -20.6‰$

Juniperus sp single twig.

A-1791. RC Rat Layer **26,300 ± 760**
$\delta^{13}C = -21.2‰$

Equus sp (small) hoof. Subm by TRV and KLC 1977; coll by AMP 1974.

Needle-Eye Canyon

One sample has been taken from Needle-Eye Canyon (NC), N of Colorado R Mile 276.5, Grand Canyon (36° 06′ N, 113° 56′ W), Mohave Co, Arizona (Phillips, 1977; Van Devender *et al,* 1977; Van Devender, 1977). Coll by AMP, TRV, and PSM 1973; subm by AMP, PSM, and TRV.

A-1618. NC 1, 550m alt **9720 ± 260**
$\delta^{13}C = -23.0‰$

Juniperus sp twigs.

Window Rock Canyon series

Window Rock Canyon (WR), N of Colorado R Mile 275.2, Grand Canyon (36° 06′ N, 113° 56′ W), Mohave Co, Arizona (Cole & Van Devender, 1976; Phillips, 1977; Van Devender *et al,* 1977). Coll by TRV and PSM 1973; subm by TRV and PSM.

General Comment: assoc with *Agave, Yucca,* and *Vitis.*

A-1314. WR 1 level 1h, 465m alt **11,310 ± 380**
$\delta^{13}C = -23.5‰$

Juniperus sp twigs.

A-1352. WR 2c, 465m alt **10,250 ± 220**
$\delta^{13}C = -23.1‰$

Juniperus sp twigs.

Desert Almond Canyon series

Formerly Emergy Falls Canyon (Phillips & Van Devender, 1974; Cole & Van Devender, 1976; Van Devender *et al,* 1977), Desert Almond Canyon (DA) is N of Colorado R Mile 276.5, Grand Canyon (36° 06′ N, 113° 56′ W), Mohave Co, Arizona. Samples are from isolated middens in limestone shelters within canyon (Phillips, 1977; Van Devender, 1977). Coll by AMP, TRV, and PSM 1973; subm by AMP, PSM, and TRV.

A-1380. DA 1a,b, 490m alt **10,100 ± 200**
$\delta^{13}C = -24.6‰$

Nolina microcarpa leaves.

A-1422. DA 3b, 520m alt **11,190 ± 150**
$\delta^{13}C = -22.6‰$

Juniperus sp twigs.

A-1423. DA 4, 585m alt **11,990 ± 490**

Juniperus sp twigs.

A-1426. DA 2a, 490m alt **10,930 ± 460**
$\delta^{13}C = -23.4‰$

Nolina microcarpa, Prunus fasciculata, and *Fraxinus anomala* leaves and twigs.

A-1427. DA 6a,b, 570m alt **10,910 ± 450**
$\delta^{13}C = -21.6‰$

Nolina microcarpa and *Fraxinus anomala* leaves and twigs.

A-1428. DA 7b, 560m alt **9650 ± 360**
$\delta^{13}C = -21.9‰$

Juniperus sp twigs.

A-1456. DA 5a,b, 565m alt **10,450 ± 420**

Mortonia scarbella, Juniperus sp, and *Fraxinus anomala* leaves and twigs.

A-1469. DA 7a, 560m alt **8560 ± 260**

Juniperus sp twigs.

A-1547. DA 8, 575m alt **8850 ± 150**

Nolina microcarpa leaves.

A-1720. DA 10a, 635m alt **12,650 ± 380**
$\delta^{13}C = -21.7‰$

Juniperus sp twigs.

Muav Gate Canyon

Muav Gate Canyon (MG) is N of Colorado R Mile 275.2, Grand Canyon (36° 06′ N, 113° 56′ W), Mohave Co, Arizona (Cole & Van Devender, 1976; Phillips, 1977; Van Devender *et al,* 1977). Coll by TRV and PSM 1973; subm by PSM and TRV.

A-1455. MG 1, 440m alt **12,430 ± 550**

Juniperus sp twigs.

Iceberg Canyon

One sample from Iceberg Canyon (IC) S of Colorado R Mile 287.2 (36° 11′ N, 114° 03′ W), Mohave Co, Arizona (Phillips, 1977). Coll by TRV and WGS 1973; subm by AMP, TRV, and PSM.

A-1322. IC 1, 425m alt **11,010 ± 400**
$\delta^{13}C = -21.9‰$

Juniperus sp twigs.

Mohave Desert

Sheep Range series

Samples are from an elevational transect of the Sheep Range (36° 29′ N, 115° 15′ W), Clark Co, Nevada (Spaulding, 1977). Coll by WGS 1972 to 1975; subm by WGS and PSM.

A-1379. Long Canyon Saddle 1, 1700m alt **30,400 ± 1500**

Juniperus osteosperma twigs. *Comment*: Long Canyon Saddle 1 = Fleharty Canyon Saddle 1.

A-1531. Canyon Two top layer, 1740m alt **3310 ± 100**

Juniperus osteosperma twigs and seeds. *Comment*: assoc with *Yucca brevifolia and Opuntia basilaris.*

A-1532. Canyon Two bottom layer, 1740m alt **1990 ± 70**

Juniperus osteosperma twigs. *Comment*: assoc with *Yucca brevifolia* and *Opuntia basilaris.*

A-1642. Spires 2, 2030m alt **>26,000**
$\delta^{13}C = -21.5‰$

Pinus longaeva and *P flexilis* needles.

A-1643. Tire Wash 1, 1750m alt **>34,000**
$\delta^{13}C = -21.4‰$

Juniperus osteosperma twigs.

A-1656. Tire Wash 2, 1790m alt **25,000 ± 710**
$\delta^{13}C = -22.0‰$

Juniperus osteosperma twigs.

A-1665. Spires 1, 2060m alt **3460 ± 150**
$\delta^{13}C = -11.7‰$

Yucca baccata leaf.

A-1669. South Crest Level 3, 1970m alt **25,200 ± 900**
$\delta^{13}C = -21.2‰$

Juniperus osteosperma twigs.

A-1670. Spires 3, 2000m alt **9540 ± 130**
$\delta^{13}C = -22.6‰$

Juniperus osteosperma twigs.

A-1725. Willow Wash 1a, 1560m alt **22,420 ± 720**
$\delta^{13}C = -21.3‰$

Juniperus osteosperma seeds and twigs.

A-1740. Willow Wash 5, 1570m alt **>31,000**
$\delta^{13}C = -21.7‰$

Juniperus osteosperma seeds and twigs.

Potosi Mountain

One sample from a limestone cave at N end of Potosi Mt in the Spring Range, (PM) (36° 00′ N, 115° 30′ W), Clark Co, Nevada. Coll by RST and JIM 1976; subm by JIM, RST, and PSM.

A-1778. PM $2c_2$, 1830m alt **14,450 ± 250**
$\delta^{13}C = -22.4‰$

Abies concolor needles.

Newberry Mountains

Two samples from Newberry Mts (35° 16′ N, 114° 37′ W), Clark Co, Nevada (Leskinen, 1975). Coll by P H Leskinen 1970; subm by P H Leskinen.

A-1017. Site 3, 850m alt **9500 ± 240**

Quercus dunnii acorns. *Comment* (PHL): species is not known to be living now in Nevada.

A-1136. Site 4, 850m alt **15,000 ± 1600**
$\delta^{13}C = -23.1‰$

Juniperus osteosperma twigs. *Comment* (PHL): species no longer grows in Newberry Mts.

Sonoran Desert

Escondito Canyon

A modern midden from Escondito Canyon (29° 40′ N, 112° 31′ W), Sonora, Mexico. Coll by PSM and Mary Kay O'Rourke 1975; subm by PSM and O'Rourke.

A-1674. Escondito Canyon 1, 70m alt **320 ± 65**
$\delta^{13}C = -21.9‰$

Jatropha sp seeds.

Tucson Mountains series

Three samples from isolated middens in rock crevices in Tucson Mts (TM) (32° 19′ N, 111° 12′ W) Pima Co, Arizona (Van Devender, 1973; Petit, 1974; Cole & Van Devender, 1976; King & Van Devender, 1977; Van Devender & Mead, in press).

A-994. TM 3, 700m alt **21,000 ± 700**
$\delta^{13}C = -19.1‰$

Neotoma dung. Coll by P J Mehringer and P E Damon 1967; subm by Mehringer and Damon. *Comment*: TM 3 = Contzen Pass 1.

A-1195. TM 1, 890m alt **12,430 ± 400**
$\delta^{13}C = -22.6‰$

Juniperus sp twigs. Coll by TRV and K B Moodie 1970; subm by PSM and TRV.

A-1235. TM 2, 700m alt **2720 ± 100**

Neotoma dung and plant debris. Coll by TRV and J E King 1971; subm by PSM, TRV, and King.

Silver Bell Mountains series

Four samples from 3 middens on Wolcott Peak (WP) in Silver Bell Mts (32° 27′ N, 111° 28′ W) Pima Co, Arizona. All middens from 860m alt (Van Devender, 1973; Cole & Van Devender, 1976; Van Devender & Mead, in press).

General Comment: *Juniperus* presently does not grow in these mts.

A-1216. WP 2 **5020 ± 80**
$\delta^{13}C = -22.7‰$

Juniperus sp twigs and plant debris. Coll by TRV, K B Moodie 1971; subm by Moodie. *Comment*: WP 2 = Sawtooth 2.

A-1236. WP 4 **5350 ± 100**
$\delta^{13}C = -20.7‰$

Plant debris. Coll by TRV and K B Moodie 1971; subm by TRV.

A-1286. WP 2 **14,550 ± 800**
$\delta^{13}C = -19.6‰$

Juniperus osteosperma twigs. Coll by PSM, TRV, and K B Moodie 1971; subm by TRV. *Comment*: this sample and A-1216 indicate that some intermixing from 2 different midden units has occurred.

A-1287. WP 5 **12,130 ± 500**
$\delta^{13}C = -21.8‰$

Juniperus osteosperma twigs. Coll by PSM, TRV, and K B Moodie 1971; subm by TRV.

Ajo Mountain series

A single multilayered midden from a rock shelter on Montezuma's Head (MH) in the Ajo Mts (32° 07′ N, 112° 42′ W) at 975m alt, Pima Co, Arizona. Coll by TRV and PSM 1976; subm by TRV and PSM.

A-1695. MH 1a **20,490 ± 510**
$\delta^{13}C = -22.4‰$

Juniperus sp twigs.

A-1696. MH 1b **21,840 ± 650**
$\delta^{13}C = -21.4‰$

Pinus monophylla needles.

A-1697. MH 1c **17,830 ± 870**
$\delta^{13}C = -20.9‰$

Pinus monophylla needles and *Juniperus* sp twigs.

A-1698. MH 1d **13,500 ± 390**
$\delta^{13}C = -22.9‰$

Juniperus sp twigs.

Wellton Hills series

This series of Holocene samples was taken from small rock crevices in the Wellton Hills (WH) (32° 36′ N, 114° 07′ W) Yuma Co, Arizona (Van Devender, 1973; Cole & Van Devender, 1976; Van Devender & Mead, in press). Coll by TRV 1973; subm by TRV and PSM.

A-1364. WH 5a, 175m alt **8150 ± 260**
$\delta^{13}C = -21.6‰$

Ephedra nevadensis twigs.

A-1365. WH 5a, 175m alt **6600 ± 370**
$\delta^{13}C = -11.2‰$

Larrea divaricata twigs and leaves. *Comment*: surface contamination by local species.

A-1399. WH 2b top, 160m alt **8750 ± 320**
Ephedra nevadensis twigs.

A-1400. WH 2b top, 160m alt **7950 ± 370**
Larrea divaricata twigs and leaves. *Comment*: surface contamination by local species.

A-1406. WH 1, 160m alt **10,750 ± 400**
Ephedra nevadensis twigs.

A-1407. WH 1, 160m alt **10,580 ± 550**
Larrea divaricata twigs and leaves. *Comment* (TRV): oldest date on *Larrea*.

Kofa Mountain series

Three midden samples from rock crevices in Kofa Mts, Yuma Co, Arizona. Burro Canyon at (33° 24′ N, 114° 01′ W), 860m alt. Brass Cap Point at (33° 26′ N, 114° 05′ W), 550m alt (Van Devender, 1973; Lanner & Van Devender, 1974; King & Van Devender, 1977; Van Devender & Mead, in press).

A-1315. Burro Canyon 1, Level 1 **14,400 ± 330**
$\delta^{13}C = -21.6‰$

Juniperus osteosperma twigs. Coll by A Gottesfeld 1971; subm by PSM and TRV.

A-1357. Burro Canyon 1, Level 6 **13,400 ± 250**
$\delta^{13}C = -21.6‰$

Juniperus sp twigs. Coll by TRV 1972; subm by PSM and TRV.

A-1328. Brass Cap Point 1 **11,450 ± 400**
$\delta^{13}C = -17.6‰$

Yucca brevifolia leaves. Coll by TRV 1972; subm by PSM and TRV.

New Water Mountains series

This series of midden samples from rock crevices in New Water Mts (NW) (33° 36′ N, 113° 55′ W) Yuma Co, Arizona (Van Devender, 1973; Lanner & Van Devender, 1974; Petit, 1974; Cole & Van Devender, 1976; King & Van Devender, 1977; Van Devender, 1977; Van Devender & Mead, in press).

A-1284. NW 2, 615m alt **7870 ± 750**
$\delta^{13}C = -12.5‰$

Juniperus osteosperma seeds and twigs. Coll by W VanAsdall, L J Reynolds, and R W Sherwin 1971; subm by TRV.

A-1285. NW 4, 615m alt **10,880 ± 900**
$\delta^{13}C = -20.5‰$

Juniperus osteosperma twigs. Coll by W VanAsdall, L J Reynolds, and R W Sherwin 1971; subm by PSM and TRV.

A-1295. NW 7, 605m alt **11,000 ± 510**
$\delta^{13}C = -20.4‰$

Juniperus sp twigs. Coll by J E King and TRV 1971; subm by PSM and TRV.

A-1296. NW 7, 605m alt **2710 ± 280**
$\delta^{13}C = -17.0‰$

Larrea divaricata twigs and leaves. Coll by J King and TRV 1971; subm by PSM and TRV.

A-1353. NW 2, 615m alt **11,060 ± 390**

Juniperus sp whole seeds and twigs. Coll by W VanAsdall and L J Reynolds 1971; subm by PSM and TRV.

A-1445. NW 2, 615m alt **12,090 ± 570**
$\delta^{13}C = -21.6‰$

Quercus turbinella leaves. Coll by W VanAsdall and L J Reynolds 1971; subm by PSM and TRV.

Artillery Mountain series

Three middens were sampled from 2 rock shelters in Artillery Mts (A), Mohave Co, Arizona. A 1 and 3 at (34° 20′ N, 113° 35′ W), 615m alt. A 2 at (34° 20′ N, 113° 38′ W), 725m alt (Van Devender & King, 1971; Van Devender, 1973; Lanner & Van Devender, 1974; King & Van Devender, 1977; Van Devender & Mead, in press). Coll by TRV, PSM, K B Moodie, and J E King 1969 and 1970; subm by TRV and PSM.

A-1099. A 1 **10,250 ± 200**

Juniperus sp twigs.

A-1100. A 3 **>30,000**

Juniperus osteosperma twigs.

A-1101. A 2 **18,320 ± 400**

Juniperus osteosperma and *J. monosperma* twigs.

A-1103. A 2 **1840 ± 200**
$\delta^{13}C = -13.0‰$

Pinus monophylla needles. *Comment*: 1st run produced insufficient gas volume for a count. A 2nd run produced a very young age on very little gas and may be in error.

Whipple Mountains series

These middens are from rock crevices and a small cave in the Whipple Mts area of San Bernardino Co, California. The Falling Arches

(FA) and Tunnel Ridge (TR) samples are at (34° 13′ N, 114° 22′ W). The Redtail Peak (RP) samples are at (34° 16′ N, 114° 25′ W) and the Whipple Mt proper (WM) samples are from (34° 14′ N, 114° 22′ W) (Cole & Van Devender, 1976; King & Van Devender, 1977; Van Devender, 1977; Van Devender & Mead, in press). Redtail Peak samples coll by TRV, JIM, and AMP 1974; subm by PSM and TRV.

A-1548. FA 1, 320m alt **11,650 ± 190**

Juniperus sp twigs. Coll by PSM, TRV, and Paul Johnson 1974; subm by PSM and TRV.

A-1470. TR 2, 365m alt **10,330 ± 300**

$\delta^{13}C = -19.6‰$

Juniperus sp twigs. Coll by AL and W B Bull 1973; subm by AL and Bull.

A-1550. TR 5, 365m alt **12,670 ± 260**

Yucca brevifolia leaves. Coll by PSM, TRV, JIM, AMP and W B Bull 1974; subm by PSM and TRV.

A-1582. TR 5a, 365m alt **12,330 ± 350**

$\delta^{13}C = -21.0‰$

Juniperus sp twigs. Coll by TRV and AMP 1974; subm by TRV and PSM.

A-1580. RP 1, 520m alt **8910 ± 380**

$\delta^{13}C = -20.6‰$

Juniperus californica twigs. *Comment*: assoc with *Yucca brevifolia, Yucca whipplei,* and *Nolina bigelovii.*

A-1616. RP 10a, 490m alt **10,840 ± 170**

$\delta^{13}C = -19.5‰$

Nolina bigelovii leaves.

A-1620. RP 3, 510m alt **10,030 ± 160**

$\delta^{13}C = -20.0‰$

Juniperus sp twigs.

A-1621. RP 8, 495m alt **11,520 ± 160**

$\delta^{13}C = -20.2‰$

Juniperus sp twigs.

A-1650. RP 11, 520m alt **13,810 ± 270**

$\delta^{13}C = -20.5‰$

Juniperus sp twigs.

A-1655. RP 6, 495m alt **9600 ± 170**

$\delta^{13}C = -19.7‰$

Juniperus sp twigs.

A-1661. RP 5, 510m alt **10,880 ± 180**
$\delta^{13}C = -19.3‰$

Juniperus sp twigs.

A-1662. RP 5, 510m alt **10,360 ± 350**
$\delta^{13}C = -21.5‰$

Midden debris with *Nolina bigelovii, Juniperus* sp, *Amsinckia tessellata, Ephedra nevadensis,* and *Salvia mohavensis.*

A-1663. RP 5, 510m alt **9600 ± 160**
$\delta^{13}C = -23.2‰$

Nolina bigelovii leaves.

A-1664. RP 5, 510m alt **10,540 ± 140**
$\delta^{13}C = -22.2‰$

Neotoma dung.

A-1666. RP 5, 510m alt **12,960 ± 210**
$\delta^{13}C = -21.3‰$

Pinus monophylla wood.

A-1668. RP 1, Sample 2, 520m alt **9160 ± 170**
$\delta^{13}C = -20.2‰$

Juniperus sp twigs.

A-1538. WM 2, 520m alt **9980 ± 180**

Juniperus sp twigs. Coll by TRV, PSM, JIM, AMP, and W B Bull 1974; subm by PSM and TRV. *Comment*: midden on cave floor. Assoc sp include *Yucca baccata* and *Nolina bigelovii.*

A-1551. WM 3, 515m alt **9920 ± 130**

Nolina bigelovii leaves. Coll by PSM, TRV, JIM, AMP, and W B Bull 1974; subm by PSM and TRV.

A-1615. WM 1, 520m alt **10,430 ± 170**
$\delta^{13}C = -22.4‰$

Juniperus sp twigs. Coll by TRV and PSM, 1974; subm by PSM and TRV.

Chihuahuan Desert

A-1581. Shafter 1 b, 1310m alt **15,670 ± 230**
$\delta^{13}C = -20.4‰$

Juniperus monosperma twigs. Rock crevice midden in Livingston Hills, Chinati Mts (29° 47′ N, 104° 22′ W) Presidio Co, Texas (Van Devender *et al,* in press). Coll by R D Worthington and E Freeman 1973; subm by PSM and TRV.

A-1612. Quitman Mountain 1, 1430m alt **10,910 ± 170**
$\delta^{13}C = -22.0‰$

Juniperus cf *monosperma* twigs. Rock crevice midden in Quitman Mts (31° 07′ N, 105° 23′ W) Hudspeth Co, Texas (Van Devender & Wiseman, in press). Coll by TRV 1975; subm by PSM and TRV.

A-1623. Steeruwitz Hills 1 Unit P4, 1430m alt **18,060 ± 1320**
$\delta^{13}C = -25.1‰$

Juniperus sp twigs. Rock crevice midden in Sierra Diablo (31° 07′ N, 105° 09′ W) Hudspeth Co, Texas. Coll by TRV and D R Frost 1975; subm by PSM and TRV.

Guadalupe Mountains series

Three middens from Guadalupe Mts (31° 54′ N, 104° 50′ W) Culberson Co, Texas, were sampled from 3 limestone caves. One sample is from previously excavated Williams Cave. Coll by TRV, AMP, WGS, and JIM 1974; subm by PSM and TRV. The other 2 samples are from 2 sloth caves (Van Devender & Everitt, 1977; Van Devender *et al,* 1977; Van Devender *et al,* in press). Coll by TRV and WGS 1974; subm by PSM and TRV.

General Comment: *Picea* dates document late Pleistocene occurrence of spruce which no longer grows in Texas (TRV).

A-1540. William's Cave 2, 1495m alt **12,040 ± 210**

Juniperus sp twigs. *Comment*: assoc with *Pinus edulis, Rhus,* and *Quercus.*

A-1539. Cave-09, 2000m alt **13,000 ± 730**

Picea sp needles. *Comment*: needles from unindurated floor-fill midden.

A-1549. Cave-08, 2000m alt **13,060 ± 280**

Picea sp needles.

Rocky Arroyo series

Rocky Arroyo (RA) (32° 27′ N, 104° 28′ W) at 1130m alt, Eddy Co, New Mexico. Coll by TRV 1975; subm by TRV and PSM.

A-1648. RA 1 **10,560 ± 150**
$\delta^{13}C = -23.5‰$

Juniperus sp twigs.

A-1657. RA 2 **2940 ± 190**
$\delta^{13}C = -11.0‰$

Agave lecheguilla leaves.

Hueco Mountains series

This large mt mass has been sampled for packrat middens at numerous localities within the range. Hueco Mts Site 1 (31° 42′ N, 105° 58′ W), at 1280m alt, Hudspeth Co, Texas (Van Devender, 1977; Van Devender & Wiseman, in press).

A-1613. Hueco Mountains 1a **9370 ± 130**
$\delta^{13}C = -12.6‰$

Yucca torrey leaves. Coll by TRV, BLE and R D Worthington 1975; subm by TRV.

A-1614. Hueco Mountains 1b **8150 ± 170**
$\delta^{13}C = -21.2‰$

Juniperus sp twigs. Coll by R D Worthington 1975; subm TRV.

Hueco Tanks State Park (31° 55′ N, 106° 02′ W) at 1420m alt, El Paso Co, Texas.

A-1624. Hueco Tanks State Park 1 **13,500 ± 250**
$\delta^{13}C = -23.2‰$

Juniperus sp twigs. Coll by D H Riskind 1974; subm by TRV.

A-1647. Hueco Tanks State Park 2 **9380 ± 270**
$\delta^{13}C = -10.1‰$

Opuntia phaeacantha and *O violacea* seeds. Coll by TRV and BLE 1975; subm by TRV.

Navar Ranch (NR) (31° 53′ N, 102° 09′ W) El Paso Co, Texas (Van Devender, 1977). Coll by TRV and BLE 1975; subm by TRV.

A-1644. NR 1b, 1340m alt **>34,000**
$\delta^{13}C = -21.8‰$

Juniperus sp twigs.

A-1645. NR 3 Pine B, 1370m alt **16,240 ± 430**
$\delta^{13}C = -21.5‰$

Juniperus sp twigs.

A-1646. NR 5, 1330m alt **11,360 ± 330**
$\delta^{13}C = -25.2‰$

Quercus pungens (acorn) fragments.

A-1649. NR 4c, 1370m alt **8920 ± 370**
$\delta^{13}C = -24.1‰$

Quercus pungens (acorn) fragments. *Comment*: unindurated floor midden.

A-1651. NR 4c, 1370m alt **11,410 ± 220**
$\delta^{13}C = -9.8‰$

Opuntia imbricata stems.

A-1652. NR 3a top, 1370m alt **10,750 ± 600**

Quercus pungens acorn fragments.

A-1719. NR 1b, 1340m alt **>33,000**
$\delta^{13}C = -23.1‰$

Gorpherus agassizi dung. *Comment*: dung incorporated in midden.

Picture Cave (PC) (31° 53′ N, 106° 08′ W) at 1430m alt, El Paso Co, Texas. Coll by TRV, BLE, and Deborah Goldberg 1975; subm by TRV.

A-1699. PC 1d **12,030 ± 210**
$\delta^{13}C = -22.1‰$

Juniperus sp twigs.

A-1706. PC 1a **1530 ± 120**
$\delta^{13}C = -10.6‰$

Opuntia phaeacantha and *O violacea* seeds.

Tank Trap Wash (TTW) at (31° 53′ N, 106° 09′ W) 1340m alt, El Paso Co, Texas (Van Devender, 1977). Coll by TRV, BLE, and Deborah Goldberg 1975; subm by TRV.

A-1707. TTW 1, Level 2b **>34,000**
$\delta^{13}C = -23.0‰$

Cercocarpus breviflorus wood.

A-1708. TTW 1, Level 4 **>34,000**
$\delta^{13}C = -20.0‰$

Juniperus sp wood.

A-1709. TTW 1, Level 3 **>34,000**
$\delta^{13}C = -21.8‰$

Juniperus sp twigs.

A-1710. TTW 1, Level 5 **19,670 ± 1150**
$\delta^{13}C = -21.4‰$

Pinus edulis needles, seeds, and cone scales.

A-1721. TTW 1, Level 2a **>33,000**
$\delta^{13}C = -22.3‰$

Juniperus sp twigs.

A-1722. TTW 2 **21,200 ± 990**
$\delta^{13}C = -22.1‰$

Juniperus sp twigs.

A-1723. TTW 1, Level 1, top **>35,000**
$\delta^{13}C = -22.8‰$

Juniperus sp twigs.

Organ Mountains series

Bishops Cap (BC) is a limestone hill at S end of Organ Mts (32° 11′ N, 106° 36′ W) at 1465m alt Doña Ana Co, New Mexico (Van Devender & Everitt, 1977; Van Devender *et al,* 1977).

A-1571. BC 1 **10,650 ± 170**
$\delta^{13}C = -21.6‰$

Juniperus sp seeds and twigs.

A-1572. BC 2 **10,780 ± 240**
$\delta^{13}C = -20.4‰$

Juniperus sp seeds and twigs.

A-1573. BC 3 **10,260 ± 250**
$\delta^{13}C = -21.2‰$

Juniperus sp seeds and twigs.

Shelter Cave in Bishops Cap was first excavated in 1930 and is now known to contain dried sloth dung. A midden sample was removed from a crevice within the cave (32° 11′ N, 106° 36′ W) Doña Ana Co, New Mexico. Coll by California Inst Technol 1930; subm by PSM, TRV, and Los Angeles Co Mus.

A-1729. Shelter Cave, 1400m alt **11,850 ± 380**
$\delta^{13}C = -21.6‰$

Midden debris with *Juniperus* sp twigs and *Opuntia imbricata*. *Comment*: no cave provenience given for midden (LACM 1010, N-6-11), midden debris attached to *Gopherus agassizi* scute.

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ANTWERP UNIVERSITY RADIOCARBON DATES III

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The following list contains most of the measurements made during 1977, since our last list (R, 1977, v 19, p 383-388). The laboratory procedures used were those outlined in the previous date lists (R, 1976, v 18, p 151-160; R, 1977, *op cit*). Dates are calculated using ^{14}C half-life of 5568 yr and errors are reported as one-standard deviation. The collagen extraction follows Longin (1970).

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Belgium

ANTW-227. Leffinge 2 **3570 ± 60**

Peat from layer 120cm below surface (51° 8′ 40″ N, 2° 52′ 15″ E). Coll Aug 1976 by R Paepe. *Comment* (RV): age corresponds roughly with expected age, and indicates peat growth halted at end of Sub-boreal.

Lampernisse series

ANTW-245. Lampernisse B68, 225-230 **4050 ± 180**

Wood and peat from layer 220cm thick. Sample from 225 to 230cm below surface (51° 02′ 10″ N, 2° 45′ 10″ E). Coll June 1975 by C Baeteman. *Comment* (RV): submitter expected a date of 4200 BP, because sample was taken in lower half of layer, which began to develop at Atlanticum-Sub-Boreal transition.

ANTW-244. Lampernisse B68, 490-514 **5590 ± 80**

Clayey peat sample from 490 to 514cm below surface (51° 02′ 10″ N, 2° 45′ 10″ E). Coll June 1975 by C Baeteman. *Comment* (RV): Atlantic age was expected, because layer was included in Calais layer, underlying Holland peat.

ANTW-248. Lampernisse B71, 84 **2040 ± 60**

Peat from layer 200cm thick at 84cm below surface (51° 01′ 52″ N, 2° 45′ 50″ E). Coll 1975 by C Baeteman. *Comment* (RV): from sample belonging to top of Holland peat, we coll data of arrested peat development, which probably ranged from end of Sub-Boreal to 4th century AD.

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ANTW-249. Lampernisse B71, 280 4640 ± 65

Peat from layer 200cm thick at 280cm below surface (51° 01′ 52″ N, 2° 45′ 50″ E). Coll 1975 by C Baeteman. *Comment* (RV): dates beginning of peat formation in Belgian coastal plain and confirms opinion that peat development started at Atlantic-Sub-Boreal transition.

ANTW-250. Lampernisse B71, 370 5100 ± 140

Peat at 370cm below surface of layer 30cm thick (51° 01′ 52″ N, 2° 45′ 50″ E). Coll June 1975 by C Baeteman. *Comment* (RV): date of top of peat layer, included in Calais layer, reveals that peat formation stopped in last phase of Atlantic period, as expected.

ANTW-251. Lampernisse B71, 400 5310 ± 190

Peat at 400cm below surface of layer 30cm thick (51° 01′ 52″ N, 2° 45′ 50″ E). Coll June 1975 by C Baeteman. *Comment* (RV): date of base of peat layer included in Calais layer, reveals that peat formation began in Atlantic period, as expected. According to dates ANTW-250 and -251, peat growth occurred quickly, mean rate being ca 1.4mm yr^{-1}.

ANTW-214. Lampernisse 93a, Point 189 3110 ± 80

Wood from a pine trunk lying horizontally in peat layer of Belgian coastal plain 170cm below surface (51° 01′ 20″ N, 2° 49′ 50″ E). The trunk contained 89 annual rings and was divided into 3 secs for determination. Coll 1951 by R Vanhoorne.

TABLE 1

Description	Date yr BP	Recalculated date		$x-\bar{x}$	$(x-\bar{x})^2$
Outer 17 rings	3040 ± 50	(3040-9) ± 50	3031 ± 50	83	6889
Intermediate 27 rings	3150 ± 60	(3150-31) ± 60	3119 ± 60	5	25
Inner 45 rings	3260 ± 55	(3260-67) ± 55	3193 ± 55	79	6241

Comment (RV&MVS): assuming that each date can be related to central ring of each sec, we can recalculate the results in function of the outermost annual ring (Table 1). With recalculated dates the error of chemistry can be rechecked (R, 1976, v 18, p 151-152).

$$\text{mean value} = \bar{X} = \frac{\Sigma X}{n} = 3114 \text{ yr}$$

$$\text{one standard deviation: } s = \sqrt{\frac{(x-\bar{x})^2}{n-1}} = 81 \text{ yr}$$

$$\text{error}^2_{\text{measured}} = \text{error}^2_{\text{chemistry}} + \text{error}^2_{\text{counting}} \quad \text{(Wyld, 1970)}$$

$$\text{error}_{\text{chemistry}} = \sqrt{\text{error}^2_{\text{measured}} - \text{error}^2_{\text{counting}}}$$

mean error due to counting statistics alone: 55 yr

$$\text{error}_{\text{chemistry}} = \sqrt{81^2 - 55^2} = 59 \text{ yr}$$

which implies a reduction of 54%

Date fits well with peat age deducted from pollen diagram (Stockmans & Vanhoorne, 1954, p 136), in which end of Sub-Boreal is indicated between 170 to 160cm below surface. No *Fagus* was found at 1.70m, while 10cm higher, *Fagus* appears, for 1st time in pollen diagram, continuing its presence to top of peat in an uninterrupted curve, attaining 30% at top.

Zandvoorde series

ANTW-228. Zandvoorde 9 **3000 ± 55**

Peat from layer 150cm thick, at 450cm below surface (51° 12′ 30″ N, 2° 58′ 30″ E). Coll Aug 1976 by C Baeteman. *Comment* (RV): date reveals that peat growth halted at very end of Sub-Boreal, i.e. 500 years later than at Leffinge (ANTW-227).

ANTW-Zandvoorde 11 **6750 ± 125**

Peat layer 950cm below surface (51° 12′ 30″ N, 2° 58′ 30″ E). Coll Aug 1976 by C Baeteman. *Comment* (RV): date reveals that peat, embedded in Calais layer, developed in Atlantic period, which corresponds with opinion that Calais layer was deposited by Calais transgression in Atlantic period.

Paal series

ANTW-254. Paal 1-C, 60-65 **9400 ± 200**

Peat, 60 to 65cm below surface (51° 03′ 34″ N, 05° 09′ 41″ E). Coll Sept 1975 by L Beyens & R Vanhoorne. *Comment* (LB): date agrees with Pre-Boreal age, indicated by pollen analysis. Vegetation type was a *Betula-Pinus* forest.

ANTW-255. Paal 1-C, 85-90 **10,120 ± 155**

Peat, 85 to 90cm below surface (51° 03′ 34″ N, 05° 09′ 41″ E). Coll Sept 1975 by L Beyens & R Vanhoorne. *Comment* (LB): no pollen was found in sample. Palynologic analysis of sec between 80 and 70cm points to younger Dryas period.

Wortel series

Peat layer 0 to 435cm below surface (4° 47′ 36″ N, 51° 23′ 52″ E). Coll Feb 1977 by L Beyens, C Verbruggen, and M Van Strydonck.

ANTW-261. Wortel 1, 85-95 **3990 ± 130**

Sample from 85 to 95cm below surface.

ANTW-262. Wortel 1, 125-140 **4680 ± 75**

Sample from 135 to 140cm below surface.

ANTW-263. Wortel 1, 185-190 **5980 ± 80**

Sample from 185 to 190cm below surface.

ANTW-264. Wortel 1, 275-280 **7950 ± 95**

Sample from 275 to 280cm below surface.

ANTW-265. Wortel 1, 355-360 **9060 ± 115**

Sample from 355 to 360cm below surface.

General Comment (LB): date of ANTW-261 confirms Sub-Boreal age. At 80cm pollen diagram shows 1st appearance of *Cerealia*. No typical Atlantic sequence is present: maximum 15% mixed oak forest, probably caused by over-representation of *Alnus* and *Betula,* due to ecologic conditions. ANTW-262 date is difficult to confirm but should be early Sub-Boreal age. ANTW-263 indicates Atlantic age. ANTW-265 date fits well in pollen diagram: 70% *Pinus* and expansion of *Corylus* reveals a Boreal age. Elements of mixed oak forest appears in very small quantities.

Bergen-Bruggen series

Peat layer 100 to 330cm below surface (51° 26′ 23″ N, 4° 45′ 47″ E). Coll June 1977 by L Beyens, C Verbruggen, and M Van Strydonck.

ANTW-271. Bergen-Bruggen, 195 **7060 ± 90**

Wood, embedded in peat 195cm below surface.

ANTW-274. Bergen-Bruggen, 210-230 **8420 ± 110**

Peat, 210 to 230cm below surface.

ANTW-275. Bergen-Bruggen, 230-250 **8850 ± 120**

Peat, 230 to 250cm below surface.

ANTW-272. Bergen-Bruggen, 250-270 **9510 ± 175**

Peat, 250 to 270cm below surface.

ANTW-276. Bergen-Bruggen, 270-290 **9390 ± 100**

Peat, 270 to 290cm below surface.

ANTW-270. Bergen-Bruggen, 290-310 **9510 ± 200**

Peat, 290 to 310cm below surface.

ANTW-273. Bergen-Bruggen, 310-330 **10,230 ± 320**

Peat, 310 to 330cm below surface.

General Comment (LB): dates seem acceptable in light of present knowledge of Wortel-1 peat sec. ANTW-272 date is slightly too old, but can still fit in series when error is considered. Pollen analysis of sec is under study.

ANTW-204. Rijkevorsel R/2 **1100 ± 240**

Soil, 45 to 55cm below surface (51° 20′ 39″ N, 4° 45′ 34″ E). Coll May 1976 by J Maes. *Comment* (CV & MVS): extracted humic acid was dated, indicating beginning of formation of soil plagging.

Deinze series

ANTW-241. Deinze-market place **860 ± 50**

Sample from infilled ditch at market place of Deinze, 120cm below surface (50° 59′ 18″ N, 3° 3′ 53″ E). Coll 1976 by C Verbruggen. *Com-*

ment (CV): date agrees with pollen analysis of adjoining buried soil surface.

ANTW-256. Deinze 3 **6380 ± 135**

Wood, 700cm below surface (50° 59′ 32″ N, 3° 32′ 32″ E). Coll 1977 by C Verbruggen.

ANTW-257. Deinze 2 **5870 ± 90**

Peat, 640 to 660cm below surface (50° 59′ 32″ N, 3° 32′ 32″ E). Coll 1977 by C Verbruggen.

ANTW-258. Deinze 1 **7360 ± 80**

Shells, 610 to 640cm below surface (50° 59′ 32″ N, 3° 32′ 32″ E). Coll 1977 by C Verbruggen.

General Comment (CV & MVS): pollen analysis, showing Atlantic spectra, confirms dates of Deinze 2 and 3. The date of Deinze 1 is too old, as expected (Thommeret, 1976; Keith & Anderson, 1964; Broecker, 1964).

ANTW-201. Mammoth tusk, Dendermonde **29,880 ± 930**

Collagen extract of a mammoth tusk 1000cm below surface in coarse sand (51° 02′ 08″ N, 04° 05′ 18″ E). Coll 1970 by H De Potter. *Comment* (RV): age is younger than expected, because sediments bearing mammalia bones were placed (De Moor, 1974) at beginning of Pleniglacial A (72,000 to 60,500 BP). However, environmental conditions of end of Denekamp interstadial, corresponding with obtained date, were favorable to proliferation of mammoth.

Ipenrooi-Hoogstraten series

ANTW-209. Ipenrooi 2′, 60-70 **7880 ± 85**

Peat from layer 60 to 70cm below surface (51° 29′ 50″ N, 4° 45′ 14″ E). Coll Oct 1975 by J Janssens & R Vanhoorne. *Comment* (RV): date is 3500 years too young because pollen diagram reveals pine phase of Alleröd, characterized by dominance of pine over birch in a woody landscape, in which no thermophilous trees were growing. Rejuvenation is certainly due to contamination by younger plant material, observable in microscopic secs of the wood, perforated by later growing water plant roots.

ANTW-208. Ipenrooi 2′, 105 **9130 ± 25**

Peat from layer 105cm below surface (51° 29′ 50″ N, 4° 45′ 14″ E). Coll Oct 1975 by J Janssens and R Vanhoorne. *Comment* (RV): date does not correspond with age deduced from pollen diagram. Palynoflora indicates open birch wood without thermophilous trees existing at beginning of Alleröd; date ca 11,800 yr BP was expected.

ANTW-246. Wambeek B2/25 **6520 ± 100**

Peat with clay and lime 450cm below surface (50° 51′ 30″ N, 4° 10′ 00″ E). Coll Feb 1977 by W Huybrechts. *Comment* (RV): scarcity of

pollen grains in sediment prevents confirmation of date of 1st half of Atlantic period. But palynoflora indicates a woody landscape, in which *Pinus, Alnus, Betula,* and *Corylus* were growing.

ANTW-247. St-Martens Bodegem B2/28 11,240 ± 90

Peat in clay and lime 460cm below surface (50° 51′ 30″ N, 2° 13′ 00″ E). Coll Feb 1977 by W Huybrechts. *Comment* (RV): palynoflora, containing 40% of arboreal pollen, points to open park landscape in which *Betula* was dominant. *Salix, Corylus,* and *Pinus* completed the forest vegetation. Based on the opinion that 2nd half of Alleröd was characterized by dense *Pinus-Betula* wood, date seems to be ca 200 yr too young.

ANTW-285. Ruisbroek 233 P1-μ8 4440 ± 80

Peat and wood at 247cm below surface (51° 05′ 00″ N, 4° 21′ 16″ E). Coll 1973 by J Geys. *Comment* (RV): Sub-Boreal date corresponds with expectations of submitter. Pollen spectrum shows dominance of *Quercetum mixtum* with high percentages of *Alnus* and ca 10% *Corylus.* Only few *Ericales* and *Gramineae* have been found. *Fagus* was totally absent. Therefore it is hard to conclude on basis of pollen-analysis that peat layer was deposited in Atlanticum or Sub-Boreal.

B. Scotland

Cairngorm Estate series

ANTW-220. Site 10, Sample 15 6210 ± 120

Trunk from pine stump from eroded blanket bog between Allt a′ Choire Chais and Caochan Dubh a′ Chadha; alt, +570m (57° 08′ 09″ N, 3° 40′ 44″ W). Coll 1975 by L Beyens and D K Ferguson. *Comment* (DKF): growth was slow in 1st 30 yr, growth rings averaging no more than 0.7mm/yr. Thereafter girth increased fairly rapidly (average growth ring: 1.85mm) and after 45 yr, trunk diam was 8cm. Age determination is based on cross-sec covering complete time span.

ANTW-221. Site 11, Sample 16 4150 ± 70

Trunk from pine stump in eroded blanket bog above Coachan Dubh a′ Chadha; alt, +545m (57° 08′ 13″ N, 3° 40′ 51″ W). Coll 1975 by L Beyens and D K Ferguson. *Comment* (DKF): tree just managed to survive, for growth rings averaged 0.3mm/yr in 1st 70 yr. Between 65 to 75 yr, a number of wider growth rings of up to 2mm are present, but thereafter, width decreases again. The tree lived at least 90 yr. Age determination is based on cross-sec covering complete time span.

ANTW-222. Site 22-1, Sample 17 1190 ± 55

Root from pine stump 30cm from surface of accumulation of peat 1.5m thick overlying river gravel Caochan Dugh a′ Chadha; alt, +530m (57° 08′ 13″ N, 3° 41′ 11″ W). Coll 1975 by L Beyens and D K Ferguson. Comment (DKF): although pine disappeared from surrounding slopes

thousands of yr previously, this sheltered valley above tree-line was able to support a number of individual trees up to the present.

ANTW-236. Site 22-2, Sample 18 **5690 ± 60**

Root from pine stump at base of accumulation of peat 1.5m thick overlying river gravel Caochan Dubh a′ Chadha; alt, +530m (57° 08′ 13″ N, 3° 41′ 11″ W). Coll 1975 by L Beyens and D K Ferguson. *Comment* (DKF): date indicates Dubh a′ Chadha stream was already in existence in Atlantic times.

ANTW-259. Site 12-1, Sample 19 **3940 ± 95**

Trunk from pine stump in eroded blanket bog 2.5 to 3m thick above Caochan Dubh a′ Chadha, alt, +560m (57° 08′ 23″ N, 3° 41′ 11″ W). Coll 1975 by L Beyens and D K Ferguson. *Comment* (DKF): stump, 14cm in diam excluding bark, underlain by 40cm peat. While growth was slow (growth rings frequently no more than 0.3mm wide and, at most, 1.8mm wide) tree lived at least 160 yr. Age determination is based on cross-sec covering complete time span.

ANTW-269. Site 12-2, Sample 20 **4450 ± 140**

Root from pine stump in eroded blanket bog 2.5 to 3m thick above Caochan Dubh a′ Chadha; alt, +560m (57° 08′ 23″ N, 3° 41′ 11″ W). Coll 1975 by L Beyens and D K Ferguson. *Comment* (DKF): while stump was underlain by 75cm peat, age is younger than ANTW-259. Trunk 16cm in diam excluding bark.

ANTW-277. Site 3, Sample 21 **3940 ± 60**

Root from pine stump overlain by 80cm blanket bog between Creagan Dubh and Allt Clais a′ Mhèirlich; alt, +660m (57° 08′ 38″ N, 3° 38′ 40″ W). Coll 1975 by D K Ferguson, J and P D'hondt. *Comment* (DKF): age based on wood between 60th and 145th growth rings. Evidence for fire in form of charcoal was found 60 to 80cm below surface.

ANTW-278. Site 19, Sample 22 **2670 ± 65**

Root from pine stump from eroded blanket bog between Allt Ban and Allt na Ciste; alt, +485m (57° 09′ 12″ N, 3° 39′ 15″ W). Coll 1975 by L Beyens and D K Ferguson. *Comment* (DKF): relatively old age from site no more than 15m above present tree-line could indicate tree-line did not extend above 470m in recent past. More age determinations are required to confirm this supposition.

C. France

ANTW-225. Loon Plage **2440 ± 50**

Wood in marine sands 1600cm below surface (51° 00′ 32″ N, 2° 10′ 30″ E). Coll Oct 1976 by R Vanhoorne. *Comment* (RV): date with opinion that marine sands containing some wood and peat were deposited during Flandrian transgression.

ANTW-243. Pont des Grenouilles 1890 ± 80

Peat from top of layer 110 to 120cm below surface (51° N, 2° 16′ E). Coll 1977 by J Sommé. *Comment* (RV): peat layer from French coastal plain, covered by marine sands with shells (*Cardium edule*) overlain by a layer with Medieval pottery and a skeleton of *Bovideae*. Date, pointing to a Sub-Atlantic age, agrees with pollen diagram characterized by continuous *Fagus* curve.

D. Malaysia

ANTW-266. Dengkil Log 11/1, Sample 1 1945 ± 110

Wood, at 700cm below surface (2° 53′ 30″ N, 101° 43′ E). Coll Feb 1977 by B C Batchelor.

ANTW-282. Dengkil Log 11/1, Sample 2 1700 ± 95

Wood, at 700cm below surface (2° 53′ 30″ N, 101° 43′ E). Coll Feb 1977 by B C Batchelor.

ANTW-283. Lombong Sharikat Galian Gangganegara No. 2, Sample G G 25 8670 ± 200

Wood, from layer 100 to 500cm below surface (40° 23′ 45″ N, 100° 35′ 55″ E). Coll 1977 by B C Batchelor.

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US GEOLOGICAL SURVEY, DENVER, COLORADO RADIOCARBON DATES II*

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INTRODUCTION

This list includes all measurements made between 1969 and 1973 that represent natural samples. Physical and chemical treatment of samples and counting technique remain as previously reported (R, 1973, v 15, p 469-478). Calculations of dates are made with the radiocarbon half-life of 5568 ± 30 years; plus or minus numbers quoted herein are the standard errors for the counting of radioactive disintegrations.

The $\delta^{13}C$ values reported in Tables 1 and 2 are based on Craig PDB limestone standard (Craig, 1957) and were determined by Teledyne Isotopes, Inc, Westwood Laboratories (R, 1968, v 11, p 53-105). The total alkalinity as bicarbonate values reported in Tables 1 and 2 were determined using techniques described by Brown and others (1970). All dates reported in this list are from water samples collected by members of the US Geological Survey.

ACKNOWLEDGMENTS

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DE-680795. Test Hole UAe-2 **8400 ± 250**

Sample coll Dec 21, 1967 from Test Hole UAe-2, 6.3km NW of Base Camp, Amchitka I, Alaska (51° 24′ 59″ N, 179° 10′ 54″ E). Hole drilled to 1,846.8m and cased to 83.5m below lsd. Alt of lsd 39.46m above msl. Static water was 5.6m above msl.

DE-680896. Hole UE-18r **20,500 ± 950**

Sample coll Jan 31, 1968 from Hole UE-18r, NW of Mercury, Buckboard Mesa, Nevada Test Site, Nye Co, Nevada (38° 35′ 10″ N, 116° 11′ 29″ W). Hole drilled to 1525m and cased to 497m below lsd. Alt of lsd 1698m above msl. *Comment* (RLE): interval swabbed was 496.5m to 601.7m below lsd.

DE-680900. Hole UE-18r **20,200 ± 1200**

Sample coll Feb 2, 1968 from Hole UE-18r (38° 35′ 10″ N, 116° 11′ 29″ W). *Comment* (RLE): interval swabbed was 852.2m to 913.2m below lsd. Static water level was 418.2m below lsd.

DE-681208. Test Hole Superior No. 1 **24,100 ± 1050**

Sample coll June 3, 1968 from Superior No. 1 Test Hole, SW of

* Publication authorized by the Director, US Geological Survey.

TABLE 1
Summary of δC^{13} and alkalinity for water sources in Colorado

Sample no.	Date	δC^{13} (‰ PDB)	Total alkalinity as bicarbonate (mg/l)
DE-681208	6/3/68	+2.7	—
DE-690038	6/21/68	+2.7	43,600
DE-690263	7/20/68	+3.6	3,870
DE-690278	8/8/68	+3.0	8,060
DE-690282	8/12/68	+2.8	>8,060
DE-690500	10/14/68	−3.1	530
DE-690625	10/30/68	+3.3	21,400
DE-690734	11/7/68	−5.8	490
DE-723015	1/26/72	—	22,700

Meeker, Rio Blanco Co, Colorado (40° 03′ 01″ N, 108° 16′ 50″ W). Alt of lsd 1882m above msl.

DE-690038. Well CH-4-PC >30,000

Sample coll June 21, 1968 from Well CH-4-PC, SW of Meeker, Rio Blanco Co, Colorado (40° 03′ 01″ N, 108° 16′ 50″ W). Well drilled and cased to 291m below lsd in 1968. Well yields 1.5m³/min at 25.0°C. Alt of lsd is 1882m above msl and static water level was 190m below lsd.

DE-690117. Base Camp Well 16,100 ± 1350

Sample coll July 13, 1968 from Base Camp well 16km E of Warm Springs, Hot Creek Valley, Nevada (38° 18′ 20″ N, 116° 16′ 55″ W). Well drilled and cased to 90.5m into Valley fill. Well yields >0.2m³/min at 17°C. Alt of lsd is 585m above msl and static well was 24.4m below lsd.

DE-690198. Well UAE3 1700 ± 140

Sample coll July 22, 1968 from UAE-3, Zone 3, 21km NW of Base Camp, Amchitka I, Alaska (51° 32′ 17″ N, −178° 50′ 03″ E). The zone sampled was from 1703.0 to 1748.2m below lsd. Yield 0.075m³/min. Alt of lsd is 146.91m above msl.

DE-690263. Well CH-6PC 26,500 ± 1100

Sample coll July 20, 1968 from Well CH6PC, Piceance Creek Basin, Rio Blanco Co, Colorado (40° 03′ 02″ N, 108° 14′ 50″ W). The well drilled to 183.8m below lsd during 1968. Yield was 1.17m³/min at 16.0°C. Alt of lsd is 1821m above msl.

DE-690278. Well CH7PC 27,100 ± 1100

Sample coll Aug 8, 1968 from Well CH7PC, Piceance Creek Basin, Rio Blanco Co, Colorado (40° 03′ 49″ N, 108° 18′ 15″ W). The well drilled to 426.7m and cased to 343.8m during 1968. The zone sampled was from 426.7m below lsd. Yield was 0.76m³/min at 25.6°C. Alt of lsd is 1951m above msl.

TABLE 2
Summary of δC^{13} and alkalinity for water sources in Nevada

Sample no.	Date	δC^{13} (‰ PDB)	Total alkalinity as bicarbonate (mg/l)
DE-680896	1/31/68	−6.4	—
DE-680900	2/2/68	−5.0	—
DE-690117	7/13/68	−8.3	—
DE-690386	9/12/68	−11.6	240
DE-690390	9/13/68	−9.1	240
DE-690392	9/13/68	−9.4	1350
DE-690473	10/3/68	−11.8	—
DE-690832	12/15/68	−8.7	250
DE-690855	12/15/68	−7.4	150
DE-690856	12/8/68	−6.8	260
DE-690857	12/8/68	−8.3	290
DE-690858	12/16/68	−5.9	330
DE-690859	12/8/68	−7.2	230
DE-690860	12/17/68	−7.7	240
DE-690884	2/9/65	−12.3	190
DE-690885	2/17/65	11.6	310
DE-690886	2/9/65	−9.8	250
DE-690918	2/9/65	−7.1	250
DE-690919	2/26/65	−8.3	230
DE-690920	2/9/65	−5.5	580
DE-690921	2/11/65	−16.9	190
DE-690922	2/9/65	−11.7	180
DE-690923	2/27/65	−7.0	300
DE-700257	9/4/69	—	180
DE-700258	9/4/69	—	510
DE-700260	9/9/69	—	120
DE-700261	9/9/69	—	280
DE-700262	9/11/69	—	280
DE-700414	9/28/69	—	300
DE-700415	9/28/69	—	290
DE-700467	9/26/69	—	910
DE-700471	9/28/69	—	870
DE-700508	10/10/69	—	870
DE-700653	11/3/69	−2.0	910
DE-700657	11/8/69	−6.0	290
DE-711558	10/26/70	−7.0	—

DE-690282. Well CH-7PC **21,800 ± 1800**

Sample coll Aug 12, 1968 from Well CH-7PC (40° 05′ 49″ N, 108° 18′ 15″ W). The zone sampled was 566.9m below lsd. Yield was 1.06m³/min at 25°C.

DE-690386. Big Loui Spring **2500 ± 100**

Sample coll Aug 12, 1968 from Big Loui Spring, 47.8km NW of Currant, Railroad Valley, Nye Co, Nevada (39° 00′ 55″ N, 115° 49′ 10″ W). The water level was 1914.1m above msl.

DE-690390. Crows Nest Flowing Well **18,300 ± 810**

Sample coll Sept 13, 1968 from Flowing well at Crows Nest, 48.3km S of Currant, Railroad Valley, Nye Co, Nevada (38° 21′ 20″ N, 115° 40′ 10″ W). The water level was 1450.8m above msl.

DE-690392. Freds Well **15,400 ± 700**

Sample coll Sept 13, 1968 from Freds Well, 4.0km E of Warm Springs, Hot Creek Valley, Nevada (37° 57′ 50″ N, 116° 03′ 00″ W). Well was dug and cased to 33.5m below lsd. Well yields 0.04m³/min at 17.0°C from valley fill. Alt of lsd 1508.8m above msl and static water level was 24.4m below lsd.

DE-690473. Well HTH-23 **7000 ± 890**

Sample coll Oct 3, 1968 from Well HTH-23, 49.9km NE of Warm Springs, Little Smokey Valley, Nye Co, Nevada (38° 30′ 23″ N, 116° 01′ 22″ W). Well drilled to 750.1m and cased to 378.9m below lsd in 1968. Well yields 1.3m³/min at 16.0°C from Tertiary volcanic rocks. Alt of lsd 1766.4m above msl and static water level was 143.1m below lsd. The zone sampled was between 378.9m and 750.1m below lsd.

DE-690500. Well TOSCO-1 **22,500 ± 1200**

Sample coll Oct 14, 1968 from Well TOSCO-1, SW of Meeker, Rio Blanco Co, Colorado (36° 46′ 28″ N, 108° 10′ 27″ W). Well drilled to 315.6m and cased to 64.9m below lsd in 1968. Well yields 0.11m³/min at 25.0°C from Green River Formation. Alt of lsd is 2048m above msl.

DE-690625. Well CH-7-PC **29,700 ± 1200**

Sample coll Oct 30, 1968 from Well CH-7-PC (40° 03′ 49″ N, 108° 18′ 15″ W). Well drilled to 605m below lsd and cased to 344m during 1968. Yield was 1.1m³/min at 27°C. Alt of lsd is 1951m above msl.

DE-690734. Oldland Spring **9000 ± 300**

Sample coll Nov 7, 1968 Oldland Spring, SW of Meeker, Colorado (39° 44′ 51″ N, 108° 10″ 06″ W). Spring yields 1.2m³/min at 10.0°C. Alt of lsd is 2100.1m above msl.

DE-690832. Indian Springs Well No. 1 **10,500 ± 350**

Sample coll Dec 15, 1968 from Indian Springs Sewage Co, Inc, Well No. 1, Indian Springs, Clark Co, Nevada (36° 33′ 30″ N, 115° 39′ 40″ W). The well was drilled to 179.8m and cased to 167.6m below land surface datum during 1963. The discharge rate measured 3.785m³/min at 22°C from fractured limestone. Alt of lsd 975.3m above msl and static water level was 16.5m below lsd.

DE-690855. Well 15S/50-18cdc **17,200 ± 600**

Sample coll Dec 15, 1968 from Well 15S/50-18cdc, Lathrop Wells, Nye Co, Nevada (36° 38′ 32″ N, 116° 23′ 48″ W). Well was drilled and cased to total depth. Well yields 0.08m³/min at 25.0°C from carbonate rocks. Alt of lsd 810.8m above msl and static water level was 105.8m below lsd.

DE-690856. Well 19S/60-09aba **11,000 ± 250**

Sample coll Dec 8, 1968 from Well 19S/60-09aba, Tule Springs Park, Clark Co, Nevada (36° 19′ 14″ N, 115° 15′ 55″ W). Well drilled and

cased to ca 91.4m below lsd. Well yields 2.8m³/min from carbonate rocks. Alt of lsd 749.8m above msl and static water level was 22.9m below lsd.

DE-690857. Corn Creek Springs **14,300 ± 500**

Sample coll Dec 8, 1968 from Corn Creek Springs, Corn Creek Ranger Sta, Clark Co, Nevada (36° 26′ 22″ N, 115° 19′ 24″ W). The spring yields 0.2m³/min at alt 890.0m above msl.

DE-690858. Well No. 1 **10,000 ± 250**

Sample coll Dec 16, 1968 from Well No. 1, Nuclear Engineering Co, 29km NW of Lathrop Wells, Nye Co, Nevada (36° 46′ 00″ N, 116° 41′ 30″ W). Well drilled to 175.3m and cased to 174.6m below lsd in 1961. Well yields 0.04m³/min from valley fill. Alt of lsd 849.8m above msl and static water level was 92.1m below lsd.

DE-690859. Indian Springs **15,700 ± 500**

Sample coll Dec 8, 1968 from Indian Springs, Indian Springs, Clark Co, Nevada (36° 33′ 30″ N, 115° 39′ 40″ W). The spring yields 1.7m³/min at alt 975.6m above msl from carbonate rocks.

DE-690860. Well 20S/61-18c **12,900 ± 350**

Sample coll Dec 17, 1968 from Well 20S/61-18c, North Las Vegas Airport, Clark Co, Nevada (36° 12′ 20″ N, 115° 11′ 40″ W). Well drilled and cased to 152.4m below lsd. Well yields 1.3m³/min from valley fill. Alt of lsd 670.6m above msl and static water level was 39.6m below lsd.

DE-690884. Well 2 (USGS Test Well 2) **15,500 ± 780**

Sample coll Feb 9, 1965 from Well 2 (USGS Test Well 2), 31.2km N of Mercury at Yucca Flat, Nevada Test Site, Nye Co, Nevada (37° 09′ 58″ N, 116° 05′ 15″ W). Well drilled and cased to 1043.0m below lsd in 1962. Well yields 0.5m³/min from carbonate rocks. Alt of lsd 1362.5m above msl and static water level was 736.4m below lsd.

DE-690885. Cold Creek Spring **350 ± 30**

Sample coll Feb 17, 1965 from Cold Creek Spring, 20.9km SSW of Indian Springs, Clark Co, Nevada (36° 24′ 40″ N, 115° 44′ 19″ W). Spring discharges 2.6m³/min at 10.0°C from Paleozoic limestone at alt 1900m above msl.

DE-690886. Well Army-1 **18,000 ± 1000**

Sample coll Feb 9, 1965 from Well Army-1, 4.0km W of junction of Mercury Hwy and US 95, Nevada Test Site, Nye Co, Nevada (36° 35′ 30″ N, 116° 02′ 14″ W). Well drilled to 593.1m and cased to 414.5m below lsd and yields 1.7m³/min at 30.5°C from Paleozoic limestone. Alt of lsd is 961.3m above msl and static water level was 239.3m below lsd.

DE-690918. Well Army-1 **18,500 ± 400**

Sample coll Feb 9, 1965 from Well Army-1 (36° 35′ 30″ N, 116° 02′ 14″ W).

DE-690919. Indian Springs **16,500 ± 700**

Sample coll Feb 26, 1965 from Indian Springs, Indian Springs, Clark Co, Nevada (36° 33′ 30″ N, 115° 39′ 40″ W).

DE-690920. Well C-1 **18,200 ± 650**

Sample coll Feb 9, 1965 from Well C-1, 30km N of Mercury, Yucca Flat, Nevada Test Site, Nye Co, Nevada (36° 55′ 07″ N, 116° 00′ 34″ W). Well drilled and cased to 503m below lsd during 1962 into Paleozoic carbonates. Alt of lsd is 1195m and static water level was 470m below lsd.

DE-690921. Well 2 (USGS Test Well 2) **14,900 ± 450**

Sample coll Feb 9, 1965 from Well 2 (USGS Test Well 2) (37° 09′ 58″ N, 116° 05′ 15″ W). Well drilled and cased to 1043m below lsd during 1961 and into Paleozoic carbonates. Alt of lsd is 1362m above msl and static water level was 626m below lsd.

DE-690922. Well 5B **13,600 ± 550**

Sample coll Feb 9, 1965 from Well 5B, N of Mercury at Frenchman Flat, Nevada Test Site, Nye Co, Nevada (36° 48′ 05″ N, 115° 58′ 08″ W). Well drilled and cased to 274.3m below lsd in valley fill in 1951. Alt of lsd is 94.25m above msl and static water level was 208.2m below lsd.

DE-609023. Fairbanks Spring **17,800 ± 600**

Sample coll Feb 27, 1965 from NE spring orifice, Fairbanks Spring, 17.7km SSE of Lathrop Wells, Amargosa Desert, Nye Co, Nevada (36° 29′ 30″ N, 116° 20′ 30″ W). The total spring discharge was 6.5m^3/min at 27.0°C at alt 694.9m above msl from valley fill.

DE-700006. Well WASP A-1 **8300 ± 300**

Sample coll June 10, 1969 from Well WASP A-1, Internatl Nuclear Corp, 37km NW of Pinedale, Sublette Co, Wyoming (43° 03′ 38″ N, 110° 13′ 43″ W). Well drilled to 1082.7m and cased to 562.1m below lsd in 1969. Alt of lsd is 2372m above msl.

DE-700007. Well WASP A-1 **11,900 ± 450**

Sample coll June 19, 1969 from Well WASP A-1, Wyoming (43° 03′ 38″ N, 110° 13′ 43″ W).

DE-700112. WASP Water Well **3500 ± 200**

Sample coll July 30, 1969 from WASP Water Well, Internatl Nuclear Corp, 37km NW of Pinedale, Sublette Co, Wyoming (43° 03′ 35″ N, 110° 13′ 46″ W). Well drilled and cased to 22.9m below lsd in Wasatch Formation. Alt of lsd 2379m above msl.

DE-700114. Well 30-108-05bbb **14,200 ± 400**

Sample coll Aug 1, 1969 from Well 30-108-05bbb, El Paso Natural Gas Co, 32.2km SE of Pinedale, Sublette Co, Wyoming (42° 35′ 59′ N, 109° 44′ 48″ W). Well drilled and cased to 762.3m below lsd in Tertiary sediments in 1969. Alt of lsd is 2151.9m above msl and static water level was 29.9m below lsd.

DE-700132. Well 30-108-05bbb **25,100 ± 2000**

Sample coll Aug 28, 1969 from Well 30-108-05bbb, El Paso Natural Gas Co, 32.2km SE of Pinedale, Sublette Co, Wyoming (42° 35′ 59″ N, 109° 44′ 48″ W). Well drilled and cased to 762.3m below lsd into Tertiary sediments. Alt of lsd is 2151.9m above msl.

DE-700257. Well Watertown No. 3 **120% ± 2%**

Sample coll Sept 4, 1969 from Well Watertown No. 3, 61.1km SW of Crystal Springs, Groom Lake, Lincoln Co, Nevada (37° 15′ 39″ N, 115° 50′ 03″ W). Well drilled to 113.1m and cased to 111.6m below lsd in 1959. Yield was 1.0m^3/min at 24.5°C from valley fill. Alt of lsd is 1322.5m above msl and static water level was 32.6m below lsd.

DE-700258. Well Watertown No. 4. **168% ± 2%**

Sample coll Sept 4, 1969 from Well Watertown No. 4, 61.1km SW of Crystal Springs, Groom Lake, Lincoln Co, Nevada (37° 15′ 35″ N, 115° 50′ 16″ W). Well drilled and cased to 165.2m below lsd in valley fill. Yield was 0.97m^3/min at 35.5°C. Alt of lsd is 1355.5m above msl and static water level was 34.7m below lsd.

DE-700260. Amargosa Observation Well **850 ± 140**

Sample coll Sept 9, 1969 from Well 50-290, Amargosa Observation Hole, 27.4km SW of Mercury, Amargosa Desert, Nye Co, Nevada (36° 32′ 12″ N, 116° 13′ 36″ W). Well drilled and cased 189.0m below lsd into valley fill in 1966. Alt of lsd is 732.9m and static water level was 13.3m below lsd.

DE-700261. Amargosa Tracer Well No. 2 **12,900 ± 550**

Sample coll Sept 9, 1968 from Amargosa Tracer Well No. 2, Amargosa Valley, Nye Co, Nevada (36° 32′ 11″ N, 116° 13′ 39″ W). Well drilled to 252.4m and cased to 200.9m below lsd in 1966 and yields 3.4m^3/min at 31.0°C. Alt of lsd is 731.6m above msl and static water level was 11.9m below lsd.

DE-700262. Well U3CN-5 **9100 ± 300**

Sample coll Sept 11, 1969 from Well U3CN-5, Yucca Flat, Nevada Test Site, Nye Co, Nevada (37° 03′ 34″ N, 116° 01′ 21″ W). Well drilled to 922.3m and cased to 863.2m below lsd in 1966. Well yields 0.2m^3/min from Paleozoic carbonates. Alt of lsd is 1222.9m above msl.

DE-700414. Fairbanks Spring **14,400 ± 600**

Sample coll Sept 28, 1969 from NW spring orifice, Fairbanks Spring, 17.7km SSE of Lathrop Wells, Amargosa Desert, Nye Co, Nevada (36° 29′ 30″ N, 116° 20′ 30″ W).

DE-700415. Amargosa Tracer Well No. 2 **8300 ± 350**

Sample coll Sept 28, 1969 from Amargosa Tracer Well No. 2, (36° 32′ 11″ N, 116° 13′ 39″ W).

DE-700467. Well UE 15j **16,800 ± 850**

Sample coll Sept 26, 1969 from Well UE 15j, 58.8km SW of Crystal Springs, Groom Lake, Nye Co, Nevada (37° 12′ 01″ N, 115° 57′ 36″ W). Well drilled 318.5m below lsd in Paleozoic clastic rocks in 1969. Alt of lsd is 1451.8m above msl.

DE-700471. Well UE 15j-A5 **12,400 ± 430**

Sample coll Sept 28, 1969 from Well UE 15j-A5, 38.4km SW of Crystal Springs, Groom Lake, Nye Co, Nevada (37° 11′ 58″ N, 115° 57′ 47″ W). Well drilled 151.9km below lsd in Paleozoic clastic rock in 1969. Alt of lsd is 1454.5m above msl. *Comment* (LJS): water sample taken during well development.

DE-700508. Well UE 15j-A5 **18,300 ± 1300**

Sample coll Oct 10, 1969 from Well UE 15j-A5 (37° 11′ 58″ N, 115° 57′ 47″ W). *Comment* (LJS): water sample taken during well development.

DE-700653. Well UE 15J-A5 **28,400 ± 3300**

Sample coll Nov 3, 1969 from Well UE 15j-A5 (37° 11′ 58″ N, 115° 57′ 47″ W).

DE-700657. Amargosa Tracer Well No. 2 **24,600 ± 1800**

Sample coll Nov 8, 1969 from Amargosa Tracer Well No. 2 (36° 32′ 11″ N, 116° 13′ 39″ W).

DE-700678. Well 30-108-05bbb **9100 ± 250**

Sample coll Nov 25, 1969 from Well 30-108-05bbb, El Paso Natural Gas Co, 32.2km SE of Pinedale, Sublette Co, Wyoming (42° 35′ 59″ N, 109° 44′ 48″ W). Well drilled to 2176.3m and cased to 755.3m below lsd into Tertiary sediments. Alt of lsd is 2152.7m above msl.

DE-711558. Six Mile Well **4800 ± 150**

Sample coll Oct 26, 1970 from Six Mile Well, 5.7km E of Hot Creek Ranch, Hot Creek Valley, Nye Co, Nevada (38° 30′ 15″ N, 116° 13′ 15″ W). Well drilled and cased 47.2m below lsd in 1948. Well yields 0.01m^3/min at 14.0°C from valley fill. Alt of lsd is 1676.4m above msl and static water level was 34.0m below lsd.

DE-711928. Test Hole 4S **10,800 ± 450**

Sample coll Dec 30, 1970 from Test Hole 4S, located NE of Lyons, Rice Co, Kansas (38° 21′ 45″ N, 98° 21′ 45″ W). Interval sampled was 18.3 to 38.4m below lsd with producing interval determined to be 19.2 to 22.9m below lsd in sandstone. Alt of lsd is 522.1m above msl and static water level was 9.81m below lsd. *Comment* (LJS): 8.18m^3 water pumped before sample colln.

DE-711980. Test Hole 3S **18,900 ± 1050**

Sample coll Jan 14, 1971 from Test Hole 3S, NE of Lyons, Rice Co, Kansas (38° 22′ 36″ N, 98° 11′ 30″ W). Interval sampled was 24.4 to

45.7m below lsd with producing intervals determined to be 27.4 to 29.2m and 33.5 to 38.7m below lsd in sandstone. Alt of lsd is 528.2m above msl and static water level was 13.60m below lsd. *Comment* (LJS): 10.2m^3 water pumped before sample colln.

DE-711981. Test Hole 3S **13,400 ± 650**

Sample coll Jan 16, 1971 from Test Hole 3S (38° 22′ 36″ N, 98° 11′ 30″ W). Sampling interval was 66.1 to 96.0m below lsd with producing interval determined to be 87.2 to 90.8m below lsd in dolomite and gypsum. Static water level was 30.38m below lsd. *Comment* (LJS): 1.42m^3 water pumped before sample colln.

DE-711982. Test Hole 1S **19,100 ± 1300**

Sample coll Jan 19, 1971 from Test Hole 1S, NE of Lyons, Rice Co, Kansas (38° 22′ 33″ N, 98° 10′ 28″ W). Sampling interval was 30.8m to 39.6m below lsd with producing intervals determined to be 33.5 to 34.7m and 35.7 to 38.4m below lsd in sandstone. Alt of lsd is 532.5m above msl and static water level was 19.2m below lsd. *Comment* (LJS): 6.96m^3 water pumped before sample colln.

DE-711983. Test Hole 1S **16,000 ± 600**

Sample coll Jan 21, 1971 from Test Hole 1S (38° 22′ 33″ N, 98° 10′ 28″ W). Sampling interval was 80.2 to 96.3m below lsd with producing interval determined 90.2 to 90.8m and 91.1 to 96.3m below lsd in dolomite and gypsum. Static water level was 32.85m below lsd. *Comment* (LJS): 0.85m^3 water pumped before sample colln.

DE-712665. Well 30-108-05b **21,100 ± 950**

Sample coll May 19, 1971 from Well 30-108-05b, El Paso Natural Gas Co, 32.2km SE of Pinedale, Sublette Co, Wyoming (42° 35′ 57″ N, 109° 44′ 49″ W). Well drilled and cased to 1585m below lsd in Wasatch Formation during 1971 and yields 0.2m^3/min at 21°C. Alt of lsd is 2152.5m above msl and static water level was 31.27m below lsd. *Comment* (LJS): water sampled from 944.9m below lsd.

DE-712666. Well 30-108-05b **>30,000**

Sample coll May 22, 1971 from Well 30-108-05b (42° 35′ 57″ N, 109° 44′ 49″ W). *Comment* (LJS): water sampled from 1555m below lsd.

DE-721105. Well HTH-1 **10,600 ± 450**

Sample coll Aug 27, 1971 from Well HTH-1, 1.2km N of Cannikan, Amchitka I, Alaska (51° 28′ 54″ N, −179° 06′ 47″ E). Well drilled and cased to 235m below lsd into Tertiary volcanics during 1971. Alt of lsd is 50.1m above msl. *Comment* (LJS): zone sampled 183m to 235m below lsd.

DE-721106. Well HTH-1 **23,200 ± 1400**

Sample coll Aug 30, 1971 from Well HTH-1 (51° 28′ 54″ N, −179° 06′ 47″ E). Well drilled and cased to 279m below lsd into Tertiary vol-

canics during 1971. Alt of lsd is 50.1m above msl. *Comment* (LJS): zone sampled 227m to 279m below lsd.

DE-721628. Well RB-D-01 **24,900 ± 1200**

Sample coll Oct 16, 1971 from Well RB-D-01, CER Geonuclear Corp, W of Rio Blanco, Rio Blanco Co, Colorado (39° 47′ 37″ N, 108° 21′ 59″ W). Well drilled to 503.2m and cased to 496.8m below lsd in 1971. Well yields 2.4m³/min at 17.0°C from Green River Formation. Alt of lsd is 2020.8m above msl and static water level was 18.3m below lsd. *Comment* (LJS): water sample from 74.8m to 257.6m below lsd.

DE-721630. Well RB-D-01 **24,700 ± 900**

Sample coll Oct 23, 1971 from Well RB-D-01 (39° 47′ 37″ N, 108° 21′ 59″ W). *Comment* (LJS): water sample from 496.8m to 503.2m below lsd at 25°C and well yielded 0.4m³/min.

DE-723014. Well TG71-1 **26,700 ± 1000**

Sample coll Jan 21, 1972 from Well TG71-1, W of Rio Blanco, Rio Blanco Co, Colorado (39° 47′ 38″ N, 108° 13′ 43″ W). Well drilled to 604.7m and cased to 38.7m below lsd in 1972. Well yields 0.04m³/min at 15.0°C from the Green River Formation. Alt of lsd is 2030m above msl and static water level was 9.6m below lsd. *Comment* (LJS): water sample from 38.7m to 444.4m below lsd and yield was 0.02m³/min at 13°C.

DE-723015. Well TG71-1 **>30,000**

Sample coll Jan 26, 1972 from Well TG-71-1 (39° 47′ 38″ N, 108° 13′ 43″ W). *Comment* (LJS): water sample from 38.7m to 604.7m below lsd and yield was 0.05m³/min at 14.0°C.

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UNIVERSITY OF PENNSYLVANIA RADIOCARBON DATES XX

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INTRODUCTION

In this date list we have included most of the archaeologic samples dated in this laboratory since publication of our last date list (R, 1977, v 19, p 188-228).

The BP ages are based on AD 1950, and have been calculated with the half-life value of 5568 yr. An asterisk (*) before an AD/BC date indicates a date that has been calculated with the half-life value of 5730 yr and then corrected by means of MASCA correction factors. For further explanation see Univ of Pennsylvania Dates XVI (R, 1974, v 16, p 198-218) and Ralph *et al,* 1973, p 1-20.

All samples were counted at least twice for periods of not less than 1000 min each. Errors quoted for each sample include the statistical counting uncertainties in the measurement of the sample, the background, and the running mean of several counts of our mid- 19th century oak sample, but do not include any additional errors associated with the correction factors.

In addition to our 2 8L counters, a small 1L counter is employed for counting undersized samples. Larger errors associated with these dates are a direct result of small sample size and the consequently reduced number of counts. Samples counted in the small counter have been so noted. We continue to use pure CO_2 in the proportional counters.

All samples were pretreated with 3N HCL, and some, where noted, were given additional pretreatment with 2% NaOH for the removal of possible humic acid contaminants.

Our mid-19th century calibration samples have an average age of 141 years. When corrected for this age, they have ^{14}C contents equal to 95% of the NBS oxalic standard.

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SAMPLE DESCRIPTIONS

ARCHAEOLOGIC SAMPLES

A. Mediterranean

1. Aegean Bronze Age

Most of the following samples have chronologic significance for dating Bronze age remains in various parts of the Aegean. Betancourt and Weinstein (ms in preparation; 1976; hereafter PB-GW) analyzed these and other radiocarbon dates to study patterns of Aegean chronology. They have noted that major discrepancies between ^{14}C dates (using MASCA correction factors) and dates based on traditional systems are particularly pronounced for the Late Helladic I/Late Minoan IA and the Late Minoan II periods, while ^{14}C dates from later stages of the Aegean Bronze age show more exact correlations. Reasons for these inconsistencies have not yet been satisfactorily resolved, and some revision of heretofore accepted traditional chronology may possibly be in order.

Crete

Knossos, Unexplored Mansion series

Samples are from Late Minoan II destruction level of "Unexplored Mansion" at Knossos, Crete (35° 20′ N, 25° 09′ E). Samples lay some 2m below top of surviving walls in debris, including charcoal and sherds, all overlain by 3m of later occupational deposition ending in 3rd century BC. Initial and perhaps incomplete construction of bldg dates to Late Minoan IA period (conventionally ca 1550 to 1500 BC), then followed by levelling of interior and eventual completion of structure in Late Minoan II period (conventionally ca 1450 to 1425 BC). Minor fire damage and subsequent repairs preceded final LM II destruction. For other Knossos dates, see R, 1963, v 5, p 104-105; R, 1969, v 11, p 157-159, 279-280; R, 1977, v 19, p 145, and Palace series below. Coll 1972, subm 1973 by M R Popham, Linacre Coll, Oxford Univ, Oxford.

General Comments: wood id by R C Koeppen, Forest Prods Lab, US Dept Agric, Madison, Wisconsin. (MRP, PB-GW): re-use of timber beams may explain unusually early dates displayed by all samples in series.

P-2045. Sample 1 **3320 ± 50** / *** 1680 ± 60 BC**

Charred softwood (probably *Cupressus sempervirens*) from basement Rm 21, portion of either beam or wall cupboard. *Comment*: NaOH pretreatment.

4240 ± 70

P-2048. Sample 4 *** 2970 ± 70 BC**

Charred softwood (probably *Cupressus sempervirens*) from basement Rm 21; portion of either roof beam or wall cupboard. *Comment*: NaOH pretreatment.

3460 ± 50

P-2048-A. Sample 4 *** 1950-1920 ± 60 BC**

Portion of P-2048, above. *Comment*: NaOH pretreatment. Date unexpectedly inconsistent with P-2048.

3820 ± 50

P-2046. Sample 2 *** 2330-2210 ± 50 BC**

Charred resin, id by R C Koeppen, although subm as burnt wood. Found in doorway between basement Rms 33 and 21, from part of either roof beam or wall cupboard. *Comment*: NaOH pretreatment.

3930 ± 70

P-2047. Sample 3 *** 2550 ± 70 BC**

Charred wood from basement Rm 31, probably portion of roof beam.

Knossos, Palace series

Samples from trial soundings in palace of Knossos, Crete (35° 20′ N, 25° 09′ E). Unless otherwise stated, coll 1973, subm 1974 by W M S Hood, Oxford Univ, Oxford.

2310 ± 70

P-2512. Sample 15 *** 430 ± 170 BC**

Charcoal, Knossos Survey Provisional No. 326, from base of kiln used for burning gypsum. Coll 1976 and subm by W M S Hood. *Comments*: NaOH pretreatment. Sample counted in small counter. (WMSH): although no archaeol evidence relevant to date of this kiln exists, it may be of Roman period.

3440 ± 90

P-2444. Sample 9, 10, 11, and 14 *** 1910-1780 ± 90 BC**

Provenience L.I. 9, in Levels 5, 6, 10, and 13. From Middle Minoan IIIB deposit, in drain filled with burned debris and complete vases. *Comment* (WMSH): expected date ca 1550 BC.

3060 ± 60

P-2441. Sample 1 *** 1400-1380 ± 60 BC**

Wood charcoal, Provenience C V 3, from remaining sec of floor in S Terrace basements originally excavated by Sir Arthur Evans in 1900-1901. *Comment* (WMSH): sample recovered ca 5cm below old excavation surface. Presumably dates final destruction of palace early in Late Minoan IIIA or within 1st half of Late Minoan IIIB, ca 1400 to 1250 BC.

3720 ± 220

P-2442. Sample 4 *** 2180 ± 230 BC**

Wood charcoal, Provenience D.VII.14, Level 10, from Middle Minoan IB destruction level. *Comment*: sample counted in small counter. Large uncertainty allows agreement with expected date, ca 1900 BC.

3890 ± 70

P-2443. Sample 5 *** 2480-2440 ± 70 BC**

Wood charcoal, Provenience D.VII.14, Level II, from Middle Minoan IB destruction level.

Pyrgos series

Pyrgos, near village of Myrtos, Crete (35° 00′ N, 25° 36′ E), is multiphase Minoan habitation site, which yielded remains from Early Minoan II to Late Minoan IB periods (Catling, 1974). Relation between LM IB destruction of Pyrgos and any volcanic activity uncertain, although trace levels of pyroclastic materials were recovered from site (Cadogan *et al,* 1972). Unless otherwise stated, Samples P-2113, -2116 coll 1970 by Mrs. Henry Hankey, subm 1972 by Gerald Cadogan, Univ Cincinnati, Cincinnati, Ohio; Samples P-2339, -2353 coll 1973 by Jill Carington-Smith, subm 1975 by Gerald Cadogan.

3320 ± 60

P-2113. Sample 3, MP/70 *** 1680 ± 60 BC**

Bitter vetch, id as *Vicia ervilia* by Jane Renfrew, from E Storeroom 9 of "country house" destroyed by fire in LM IB period. Sample represents contents of broken pithos found 0.5 to 0.7m below modern surface. *Comments*: NaOH pretreatment. (PB-GW): date is not only early, but archaeologically predates earlier LM IA dates from Thera.

3320 ± 60

P-2114. Sample 4, MP/70 *** 1690 ± 60 BC**

Hulled 6-row barley, id by Jane Renfrew, from E Storeroom 9 of "country house" destroyed by fire in LM IB period. *Comments*: NaOH pretreatment. (PG-GW): this date, like P-2113 above, is unexpectedly early.

3350 ± 60

P-2115. Sample 2, MP/70 *** 1710-1690 ± 60 BC**

Portion of carbonized beam, perhaps cypress, from paved Corridor 7 leading to Storerooms 8 and 9, Balk J5-J6, Level 2, in LM IB destruction deposit. Coll 1971. *Comments*: NaOH pretreatment. (PB-GW): re-use of older wood perhaps explains anomalously early date, which agrees with 2 Pyrgos dates from short-lived samples (see P-2113 and -2114, above).

3440 ± 60

P-2116. Sample 1, MP/70 *** 1910-1780 ± 60 BC**

Portion of carbonized beam, perhaps cypress, 0.16 to 0.20m diam. From house courtyard, Level 6 (W), in LM IB destruction deposit. *Com-*

ments: NaOH pretreatment. (PB-GW): re-use of older wood perhaps explains anomalously early date. (GC): date is, however, properly older than short-loved samples P-2113 and -2114 above.

3560 ± 60

P-2343. Sample 5, MP/73 *** 2080 ± 60 BC**

Wood from Trench G6/H6, Level 8, Basket 4257, Pyrgos Period IV. From "country house" of LM IB destruction which produced P-2113 and -2116, above. *Comment* (GC): sample should provide a check for P-2113 and -2116, and seems to confirm 1st group of dates for LM IB destruction.

3410 ± 70

P-2344-A. Sample 6, MP/73 *** 1870-1770 ± 80 BC**

Charcoal from Trench H7/J7, Level 3, LM IB destruction of "country house". *Comments*: NaOH pretreatment. (GC): sample should provide a check for P-2113 and -2116. (PB-GW): early date agrees with P-2113 and -2114, above.

3670 ± 230

P-2341. Sample 3, MP/73 *** 2150 ± 240 BC**

Charcoal from Trench EO 1, Level 6, Basket 3334, Pyrgos Period III. *Comments*: sample counted in small counter. (GC): should date construction of large Middle Minoan cistern on N slope of hill.

3430 ± 70

P-2347. Sample 9, MP/73 *** 1900-1780 ± 70 BC**

Charcoal from S and E of Trench Z3, Level 2, Basket 3633, Pyrgos Periods ? IId/III. *Comments* (GC): presumably dates to some point in Middle Minoan sequence.

3770 ± 370

P-2350. Sample 12, MP/73 *** 2180 ± 380 BC**

Charcoal from Trench Z4, Level 15, Basket 3237, Pyrgos Period II. *Comments*: sample counted in small counter. (GC): sample seems to belong to destruction level of mostly MM date.

3790 ± 300

P-2351. Sample 13, MP/73 *** 2290-2190 ± 300 BC**

Charcoal from Trench Z4, Level 14, Basket 3235, late Pyrgos Period II. *Comments*: sample counted in small counter. (GC): sample perhaps from posthole, and seems to belong to destruction level of mostly MM date.

5590 ± 350

P-2339. Sample 1, MP/73 *** 4470 ± 360 BC**

Charcoal from NE corner of Trench A3, Level 10 (14), Basket 3785, Pyrgos Period IIC. Assoc with Floor W of "funeral drive", roadway constituting part of Early Minoan III/Middle Minoan IB funerary complex. *Comment*: sample counted in small counter.

3560 ± 200

P-2340. Sample 2, MP/73 *** 2070 ± 210 BC**

Charcoal from S and E part of Trench B2, Level 3, Basket 3379, Pyrgos Period ? III. *Comments*: sample counted in small counter. (GC): period uncertain, but either EM II/MM IA or elsewhere in MM sequence.

3700 ± 230

P-2348. Sample 10, MP/73 *** 2160 ± 240 BC**

Charcoal from Trench Z3, Level 11, Basket 3644, Pyrgos Period I/IIa. *Comments*: sample counted in small counter. (GC): presumably dates to EM II to EM III/MM IA period, earliest date for traces at Pyrgos.

3990 ± 70

P-2349. Sample 11, MP/73 *** 2600 ± 70 BC**

Charcoal from Trench Z3, Level 11, Basket 3644, Pyrgos Period I/IIa. *Comment* (GC): possibly from EM II destruction debris overlain by rd and courtyard belonging to EM III/MM IA funerary complex.

4390 ± 280

P-2353. Sample 15, MP/73 *** 3160 ± 280 BC**

Charcoal from Trench Z4, Level 23, Basket 3261, Pyrgos Period ? IIb. Sample found below Floor VIII, earliest excavated floor, and below funerary complex rd. *Comments*: sample counted in small counter. (GC): probably belongs to EM II destruction level.

Cyclades

Akrotiri Series II

Akrotiri, on I. of Thera (Santorini), Cyclades, Greece (36° 16′ N, 25° 27′ E), is multiphase settlement overwhelmed by volcanic eruption in Late Cycladic I (Late Minoan IA) period. Earliest remains at site are of Middle Cycladic date. For discussion of problems assoc with this and an earlier series (I) of Akrotiri dates (R, 1977, v 19, p 191-193), see Betancourt and Weinstein (ms in preparation; 1976), Michael (1976), and Pichler and Friedrich (1976). All samples from pithoi in Rm 5, Ground Floor of W House. Coll and subm 1976 by Christos Doumas, Rhodes Mus, Rhodes.

General Comment (CD): samples should date final destruction of site, conventionally placed at ca 1500 BC. (PB-GW): this 2nd series of dates is inconsistent both internally and with 1st series of Akrotiri dates. But it does suggest an early trend despite its wide range.

3370 ± 70

P-2559. Sample 1976.7 *** 1750-1710 ± 70 BC**

Grain from pithos *pi* 1, *delta* 2.

3980 ± 70

P-2560. Sample 1976.1 *** 2590 ± 70 BC**

Grain from pithos *pi* 2, *delta* 1.

3800 ± 50

P-2561. Sample 1976.2 *** 2290-2190 ± 60 BC**

Grain from pithos *pi* 3, *delta* 1.

2890 ± 190

P-2562. Sample 1976.3 *** 1180-1160 ± 190 BC**

Organic matter from pithos *pi* 3, *delta* 1. *Comment*: sample counted in small counter.

3180 ± 190

P-2563. Sample 1976.4 *** 1550-1510 ± 200 BC**

Organic matter from pithos *pi* 16, *delta* 3. *Comment*: sample counted in small counter.

3050 ± 190

P-2564. Sample 1976.5 *** 1390-1370 ± 200 BC**

Organic matter from pithos *pi* 9, *delta* 3. *Comment*: sample counted in small counter.

3310 ± 60

P-2565. Sample 1976.6 *** 1680-1660 ± 60 BC**

Grain from pithos *pi* 5, *delta* 2.

2830 ± 180

P-2566. Sample 1976.8 *** 1100-1030 ± 190 BC**

Organic matter from pithos *pi* 9, *delta* 2. *Comment*: sample counted in small counter.

Ayia Irini series

Ayia Irini, in bay of Ayios Nikolaos, Kea, Cyclades, Greece (37° 42′ N, 24° 18′ E), is stratified site which, so far, yielded remains dating from Neolithic into Late Helladic IIIC periods (Caskey, 1971; 1972). Previous dates for samples from Ayia Irini are reported in R, 1969, v 11, p 156-157. Samples coll 1963 to 1967, subm 1977 by John Caskey, Univ Cincinnati, Ohio.

3230 ± 60

P-2576. Sample 3, Field No. G-7.32 *** 1600-1570 ± 60 BC**

Charcoal from Rm IX in Area G, Cut 8, Ayia Irini Period H (LM IB), conventionally ca 1500 to 1450 BC. *Comments*: NaOH pretreatment. (PB-GW): date barely falls within extreme upper limit of traditional chronology.

3320 ± 60

P-2579. Sample 6, Field No. A-3.642 *** 1690 ± 70 BC**

Charcoal from Rm I in Area A, Cuts 24 to 29, Ayia Irini Period H (LM IB). *Comments* (JC): sample may in fact be earlier, as some LM IA sherds in possible assoc. (PB-GW): although anomalously early, date agrees with short-lived samples P-2113 and -2114 from Pyrgos (above).

3820 ± 70

P-2574. Sample 1, Field No. B-6.97 *** 2330-2210 ± 70 BC**

Charcoal from Rm XV in Area B, Cuts 15, 16, & 17, Ayia Irini Period G (LM IA, conventionally ca 1550-1500 BC). *Comments*: NaOH pretreatment. (PB-GW): date is too early, but may be partly explained by possible re-use of wood.

2920 ± 230

P-2578. Sample 5, Field No. M-76.7 *** 1210-1170 ± 240 BC**

Charcoal from Area M, Trenches 6/8 (ca .34m below sea level, necessitating a pump for excavation), Ayia Irini Period G (LM IA, conventionally ca 1550-1500 BC). *Comments*: sample counted in small counter. (JLC): possible contamination from percolating ground water caused by being below sea level.

3350 ± 60

P-2575. Sample 2, Field No. G-6.20 *** 1710-1690 ± 70 BC**

Charcoal from Rm VII in Area G, Cuts 8 & 9, Ayia Irini Period F (MM IIB/MM III). *Comments*: NaOH pretreatment. (PB-GW): date falls well within traditionally acceptable range.

3420 ± 60

P-2581. Sample 8, Field No. J-1.178 *** 1850-1770 ± 70 BC**

Charcoal from Area J, Trench 4, Cuts 7, 8 & 9, Ayia Irini Period F (MM IIB/MM III). *Comment*: (PB-GW) date fits upper limit of traditional chronology.

3500 ± 60

P-2577. Sample 4, Field No. E-8.26 *** 2040-2020 ± 70 BC**

Charcoal from Rm C.XVII, Area E, Cut 9, Ayia Irini Period D (early phases of Middle Bronze age).

3460 ± 60

P-2580. Sample 7, Field No. C-3.498 *** 1950-1920 ± 70 BC**

Charcoal from Rm XIII, Area C, N ash layer, Ayia Irini Period D (early phases of Middle Bronze age).

Greece

4060 ± 60

P-2474. Lake Vouliagmeni *** 2800-2690 ± 60 BC**

Sample 2B, charcoal from Trench AI, Level 5E, Lake Vouliagmeni, Perakhora, Greece (38° 02′ N, 22° 53′ E). Sample from thick destruction level of final phase of Early Bronze II period bldg. Coll 1972, subm 1975 by John Fossey, McGill Univ, Montreal. Unpub dates for portions of same sample: DIC-448, 3900 ± 65; LJ-3604, 3740 ± 40. Other unpub dates from same destruction level elsewhere on site: DIC-452, 3880 ± 185: DIC-453, 4330 ± 210. Other unpub dates from deposits immediately overlying this destruction: DIC-449, 4270 ± 200; DIC-451, 4010 ± 105 (personal commun).

2. Cyprus

Kalavasos-Tenta series

Tenta, 2.25 km SSE of Kalavasos village, Laconia prov, Cyprus (34° 45′ N, 33° 18′ E), is stratified habitation site yielding evidence of Neolithic IA (aceramic) and Neolithic II period settlements (ca 6000-4000 BC) (Dikaios, 1953; 1960; 1962). Ceramic material may also indicate Neolithic IB occupation at Tenta, which would constitute most detailed Neolithic sequence from Cyprus. Earlier phase at site is represented by Sqs G 12A and F 11D, while later phase perhaps is represented by Sq F 10B. Samples coll 1976 and subm by Ian Todd, Brandeis Univ, Waltham, Massachusetts.

5630 ± 260

P-2549. Sample 1 ***4490 ± 270 BC**

Charcoal from Sq G 12A, Deposit 4.3, overlying natural layer, presumably soft "havara" form of bedrock. *Comments*: sample counted in small counter. (IT): expected date earliest in series. Unexpectedly late date may be due to sample contamination from humic acids.

P-2548. Sample 3 **8350 ± 200**

Charcoal from Sq G 12A, Deposit 6.3, small hearth containing burnt flints, in open area, from early phase of occupation at site. *Comments*: NaOH pretreatment. Uncorrected date calculated with 5730 half-life = 6650 ± 200 BC. (IT): expected date, later than P-2549, above, and earlier than P-2550, below.

P-2550. Sample 2 **7180 ± 90**

Charcoal from Sq G 12A, Deposit 5.5, small hearth containing burnt flints, in open area. *Comments*: uncorrected date calculated with 5730 half-life is 5450 ± 100 BC. (IT): expected date later than P-2549, above.

P-2551. Sample 4 **7140 ± 90**

Charcoal from Sq G 12A, Deposit 6.3, a different part of source deposit for P-2548, above. *Comments*: uncorrected date calculated with 5730 half-life is 5400 ± 100 BC. Difference between P-2548 and -2551 could be explained by absence of NaOH pretreatment for P-2551. (IT): sample should be contemporary with P-2548, above.

P-2552. Sample 5 **7250 ± 100**

Charcoal from Sq F 11D, Deposit 3.5, ashy deposit in open area near 2 circular stone structures. *Comments*: NaOH pretreatment. Uncorrected date calculated with 5730 half-life = 5520 ± 100 BC. (IT): sample postdates main occupation of stone structures, and should be later than P-2548-2551, above, while earlier than P-2555, below.

P-2553. Sample 6 **7110 ± 90**

Charcoal from Sq F 11D, Deposit 3.5, ashy deposit in open area near 2 circular stone structures. *Comments*: NaOH pretreatment. Uncorrected date calculated with 5730 half-life = 5730 ± 100 BC.

P-2555. Sample 7 **7430 ± 90**

Charcoal from Sq F 11D, Deposit 3.7, W of circular structure in NE corner of sq in open area. *Comments*: uncorrected date calculated with 5730 half-life is 5700 ± 90 BC. (IT): should date occupation of structure.

P-2554. Sample 8 **8480 ± 110**

Charcoal from Sq F 10B, from hearth between 2 ring walls of structure, in open work area surrounding inner circular stone structure. *Comments*: NaOH pretreatment. Uncorrected date calculated with 5730 half-life = 6780 ± 110 BC. (IT): dates occupation of structure and assoc outer ring wall. Sample possibly later than other samples in series, but its stratigraphic position relative to remains in Sqs F 11D and G 12A is not yet clear.

B. Near East

1. Iran

Hasanlu Tepe Series IV

Settlement mound of Hasanlu (37° 02′ N, 45° 28′ E) S of Lake Urmia and NW of town of Nagadeh in Solduz Valley, W Azerbaijan, Iran (Dyson, 1972; 1974; ms in preparation). Samples coll 1966 to 1974 and subm 1966 to 1975 by Robert H Dyson, Jr, Univ Mus, Univ Pennsylvania. For 3 previous series of ^{14}C dates from Hasanlu, see R, 1959, v 1, p 49-50; R, 1963, v 5, p 85-89; and R, 1966, v 8, p 349-350.

General Comment (RHD): working chronology for Hasanlu periods relevant to most of samples submitted is as follows: Hasanlu IIIA: ca 600 to 300 BC; Hasanlu IIIB: ca 780 to 600 BC; Hasanlu IVA: ca 800 BC; Hasanlu IVB: ca 1100 to 800 BC; Hasanlu IVC: ca 1250 to 1100 BC; Hasanlu V: ca 1450 to 1250 BC.

2350 ± 260

P-2153. HAS-72-C14-S1: Period IIIA *** 460-440 ± 270 BC**

Charcoal, Provenience BB-CC-32. From Balk E of Burned Bldg II, in large pit with layered refill cut down from Period IIIB/IVA. *Comments*: NaOH pretreatment. Sample counted in small counter. (RHD): dates to Period IIIA.

2360 ± 60

P-2377. HAS-72-Ca4-S18: Period IIIA *** 470-440 ± 60 BC**

Charcoal and ash, Provenience Z21 (2) /1/ C14 S1. From kiln built over thin burned stratum resting on pavement assoc with curved Wall A in Z21. For date for pavement, see P-399, 2521 ± 54 (R, 1963, v 5, p 88). *Comments*: NaOH pretreatment. (RHD): dates, as expected, to Period IIIA.

2530 ± 50

P-1881. HAS-70-C14-S32: Period IIIB/IVA *** 780 ± 50 BC**

Wood charcoal, Provenience CC-32. From Pit 5, Balk E of Burned Bldg II. This pit was cut down from IIIB/IVA surface. *Comment* (RHD): dates to Period IIIB/IVA.

2450 ± 50

P-2157. HAS-72-C14-S6: Period IIIB/IVA * 720-660 ± 50 BC

Charcoal, from W Gate Sec A-B, 5-2A, on W slope of Citadel Mound. Sample provenience was pit dug into stratum slightly above stratum of P-2159 (below), and was assoc with curved Wall A and pavement of Z21 and wall of Y20. Samples P-2382 (below) and P-399 (R, 1963, v 5, p 88) are from same complex. *Comment* (RHD): it is still undecided whether apparently late 8th century date should be considered Period IVA or Period IIIB.

P-2382. HAS-74-C14-S92: 2440 ± 60
Period IIIB/IVA *710-530 ± 60 BC

Charcoal, from Provenience Y20 (4) with Wall A, W slope of Citadel Mound. Wall A directly underlies Fortification Wall I (Period IIIA or later), and relates stratigraphically to Wall A and pavement of Z21 (see P-2377, above). *Comment* (RHD): expected date same as P-2157, above, and P-399 (R, 1963, v 5, p 88). Period either IVA or IIIB.

2630 ± 60

P-2159. HAS-72-C14-S7: Period IVA * 840-820 ± 60 BC

Charcoal, S-3A, from W Gate, Sec A-B, W slope of Citadel Mound. Sample provenience was pit dug into redeposited Period IV debris which also underlay curved Wall A and pavement (see P-2382 and -2377, above). *Comment* (RHD): dates of P-399, -2157, and -2382 suggest curved wall complex dates to late 8th century BC. Thin stratum separates P-2159 from this group, which is later. Date suggests Period IVA, at end of 9th or beginning of 8th century BC.

2540 ± 50

P-2380. HAS-74-C14-S91: Period IVA * 790 ± 50 BC

Charred reeds, Provenience W32 P26 C14 S22b. From Burned Bldg IV-V debris cut into by stratified refuse pit. Sample from Lenses 7 through 10 at base of pit. *Comment* (RHD): pit was cut from surface dating to Period IIIB/IV. Date appears to favor Period IVA.

2480 ± 70

P-2381. HAS-74-C14-Period IVA * 740 ± 70 BC

Charred reeds (?) Provenience W32 P26 C14 S22a, from upper Lenses 1 through 6 in same pit as P-2380, above. *Comments*: sample undersized (90.94%) in 8L counter, resulting in slightly larger uncertainty than most samples in series. (RHD): date appears to favor Period IVA.

2600 ± 50

P-2383. HAS-74-C14-S95: Period IVA * 810 ± 50 BC

Charcoal, Provenience V22 (4) */1/*, stone paving on NW Citadel Mound. From paved structure overlying N wall of Burned Bldg VI (Periods IVC and B), and underlying walls of IIIB date attached to Fortification Wall II (Urartian). *Comment*: NaOH pretreatment. (RHD): date expected to be Period IVA.

2830 ± 60

P-1230. HAS-66-C14-S1: Period IVB *** 1100-1030 ± 60 BC**

Charcoal, Provenience AA 30, Wall H. From N wall of anteroom of Burned Bldg II. Sample was sealed in layer between 1st and 2nd brick course during reconstruction of bldg. *Comment* (RHD): date should relate to rebuilding activity at beginning of Period IVB.

2750 ± 50

P-2160. HAS-72-C14-S8: Period IVB *** 990-940 ± 50 BC**

Charcoal, Provenience S22 (10) */13/* S5, NW Citadel Mound. Sample from posthole penetrating floor of Bldg II in Period V. *Comment* (RHD): apparently intrusive from overlying Period IVB level.

2830 ± 50

P-2374. HAS-72-C14-S15: Period IVB *** 1100-1030 ± 50 BC**

Charcoal, Provenience V31 W(2) */4/* C14 S2. From upper collapse of Burned Bldg IVE, columned hall. Bldg was reconstructed at start of Period IVB, following fire. *Comments*: NaOH pretreatment. (RHD): dates to Period IVB.

2820 ± 50

P-2376. HAS-72-C14-S17: Period IVB *** 1080-1030 ± 50 BC**

Charcoal, Provenience Y31 (3) */3/* C14 S2. From upper collapse of Burned Bldg V, over bench in NW corner of columned hall. Bldg was partially reconstructed at start of Period IVB after damaged by fire. *Comments*: NaOH pretreatment. (RHD): dates, as expected, to Period IVB.

P-2384-A. HAS-74-C14-S69A: Period IVB **2770 ± 50** *** 1010-950 ± 60 BC**

Charcoal, Provenience V22 W(3) */5/*. From S end Rm of Burned Bldg VII. Stratigraphically precedes structure of P-2383, above. *Comments*: NaOH pretreatment. (RHD): dates as expected to Period IVB.

P-2394. HAS-74-C14-S93: Periods IVB/IVC **2880 ± 60** *** 1110 ± 60 BC**

Charcoal, Provenience V19 */2/*. From fill between Walls K and J on W slope of Citadel Mound. On lower slope, Wall K was overlain by Period IVB road system, but remained in use on upper slope. *Comment* (RHD): dates as expected to end of Period IVC or start of Period IVB.

2950 ± 50

P-2375. HAS-72-C14-S16: Period IVC *** 1270-1240 ± 50 BC**

Charred wood, Provenience W30 C14 S2. Sample was portion of column from E portico of Burned Bldg IV. Portico was built at start of Period IVB. *Comments*: NaOH pretreatment. (RHD): either an older tree used for column, or Period IVC wood re-used in Period IVB.

2990 ± 170

P-2378. HAS-72-C14-S19: Period IVC * 1290 ± 170 BC

Charcoal, from Provenience S22 (8)/*11*/ C14 S2 on NW Citadel Mound. Sample taken from stratum underlying Period IVB remains and overlying Bldg II of Period V. *Comments*: sample counted in small counter. (RHD): appears to date to start of Period IV. Sample overlies P-2161, below.

2980 ± 40

P-2385. HAS-74-C14-S32A: Period IVC * 1300-1270 ± 50 BC

Charred wood, Provenience X32 (5) */3/* C14 S6. Sample was portion of door frame from N door to columned hall of Burned Bldg V. *Comments*: NaOH pretreatment. (RHD): may belong to original structure of Period IVC which was partially renovated at start of Period IVB. Slightly older than expected for Period IVC.

3000 ± 60

P-2389. HAS-74-C14-S14A: Period IVC * 1300 ± 60 BC

Charred wood, Provenience V31 E(3) */2/* C14 S8A. Sample was portion of roof beam in columned hall of Burned Bldg IVE. *Comments*: NaOH pretreatment. (RHD): appears to be Period IVC beam re-used in reconstruction of bldg at start of Period IVB.

3110 ± 60

P-2155. HAS-72-C14-S3: Period V * 1480-1460 ± 60 BC

Charcoal, Provenience V31 (5). From bench on S side of columned hall of Burned Bldg IVE. Sample sealed with debris inside plastered bench. *Comments*: sample undersized, 88.99%. (RHD): apparently Period V debris from under Burned Bldg IVE was swept up and used as fill for bldg bench in Period IV.

3020 ± 50

P-2156. HAS-72-C14-S4: Period V * 1360-1310 ± 50 BC

Charcoal, Provenience DD 30 */1/* (5) C14-2. From structure against S wall of Burned Bldg II, preceding its construction. *Comment* (RHD): dates to end of Period V but survived through Period IVB (see P-2392, below).

3010 ± 50

P-2161. HAS-72-C14-S9: Period V * 1360-1300 ± 50 BC

Charcoal, Provenience S22 (8a) */11/* S6. From stratum overlying Period V Bldg II, and underlying Period IVB stratum, on NW Citadel Mound. *Comments*: NaOH pretreatment. (RHD): dates to later Period V.

3130 ± 60

P-2390. HAS-74-C14-S84A: Period V * 1500 ± 60 BC

Charcoal, Provenience V31 E TTI (5) */7/* C14 S26. From structure beneath columned hall of Burned Bldg IVE. *Comment* (RHD): dates as expected to Period V.

2950 ± 50

P2391-A. HAS-72-C14-S13: Period V * 1260-1220 ± 50 BC

Charcoal, Provenience Z29 (10A) */1/ /4/* C14 S3A. From structure beneath Rm 6 of Burned Bldg IE (Period IVB) and an underlying foundation (Period IVC ?), between Wall J and S balk of Z29. *Comments*: NaOH pretreatment. (RHD): according to pottery, dates to Period V.

2950 ± 60

P-2392. HAS-72-C14-S20: Period V * 1260-1220 ± 60 BC

Charred wood, Provenience DD30 (5) */4/* C14 S5. From structure against S wall of Burned Bldg II, preceding its construction. *Comments*: NaOH pretreatment. (RHD): this structure probably originates in Period V (see P-2156, above), but survived through Period IVB.

3000 ± 60

P-2393. HAS-74-C14-S83A: Period V * 1300 ± 60 BC

Charcoal, Provenience V31 TT1 (5) */8/*, Lot 32, C14 S24. Sample recovered from beneath columned hall of Burned Bldg IVE, between Walls C and E of 2 adjoining structures. *Comments*: NaOH pretreatment. (RHD): dates, as expected, to Period V.

3970 ± 50

P-2163. HAS-72-C14-S11: Period VII * 2580 ± 50 BC

Barley grain, Provenience U22 (20) */12/* S5A. Sample recovered from deep sounding in Area U22, on NW Citadel Mound. *Comments*: NaOH pretreatment. (RHD): deposit dates to end of Period VII.

Shahr-i Sokhta series

Shahr-i Sokhta, 59km SSW of Zabol, Sistan prov, Iran (30° 44′ N, 61° 30′ E) is settlement site with 4-period sequence (I-IV) divided into 11 phases (0-10). Period I and Phase 10 are oldest. For other dates from this site, see R, 1977, v 19, p 204-207; R, 1973, v 15, p 593-594. Samples coll 1972 and subm 1976 by Maurizio Tozi, Sem Studi Asiatici, Inst Univ Orientale, Napoli.

General Comment: in sample titles 1st no. represents sec, 2nd no., cut, 3rd no., rm, and last no., layer. Thus XDX.5.CCLXXXV.0 is equivalent to Sec XDX, Cut 5, Rm CCLXXXV, and Layer, none cited.

4530 ± 60

P-2545. XEU.3.0.1 * 3350 ± 60 BC

Sample 1, charcoal from horizontal lens of charcoal 8cm beneath Cut 3, in possible aeolian deposit of loose soil. Relevant assemblage Buff Ware of Periods II-III. *Comments*: NaOH pretreatment. (MT): dates to Period III (?), Phase 5.

4060 ± 70

P-2544. EWK.3.DX.2 * 2800-2690 ± 70 BC

Sample 8, charcoal from sq hearth of latest stratum predating "large upper structure". Relevant assemblage pottery of Phase IId of "House of

Stairs". *Comments*: NaOH pretreatment. (MT): sample should also date stratum of pottery beneath foundations of Rm D. Dates to Period II, Phase 5.

P-2542. EWK.8.DVII.4 **3990 ± 60**
*** 2600 ± 60 BC**

Sample 10, charcoal on deposit of clay covering side of Rm, itself directly above clay fill. Relevant assemblage Buff Ware of later Period II, and Gray Ware with close affinities to Rana Ghundai III a-b. *Comments*: NaOH pretreatment. (MT): this deposit of smashed bricks and clay probably later than underlying pottery, and contemporary with or slightly earlier than hearth from which P-2544 (below) came. Dates to Period II, Phases 6-5.

P-2546. EWK.8DV.4 **4170 ± 70**
*** 2910 ± 70 BC**

Sample 11, charcoal from container set against S wall. Relevant assemblage Polychrome and grit-tempered wares. *Comments*: NaOH pretreatment. (MT): container was probably not fireplace. Charcoal may possibly come from later filling (Cuts 3 to 7). Dates to Period II, Phases 7-6.

P-2541. XDX.5.CCLXXXV.3 **4080 ± 70**
*** 2820-2700 ± 70 BC**

Sample 13, charcoal from partially burned log, in earthen fill within rm of "House of Buttresses". Relevant assemblage pear-shaped beakers and conical bowls. *Comments*: NaOH pretreatment. (MT): may date to final destruction of "House of Buttresses". Dates to Period II, Phase 7.

P-2543. XDV.24.XX.0 **4200 ± 60**
*** 2940-2920 ± 60 BC**

Sample 5, charcoal from lens in silty soil between floors dating to Period I. Relevant assemblage Buff Ware. *Comments*: NaOH pretreatment. (MT): dates to Period I, Phases 9 to 10.

Tall-i-Malyan series

Tall-i-Malyan, Fars prov, 46km N of Shiraz, Iran (30° 3′ N, 52° 25′ E), is stratified settlement mound, ca 150 ha, occupied during 3rd millennium and 2nd millennium BC. On inscriptional evidence site was id with ancient Elamite capital of Anshan (Sumner, 1973b). For other dates, see R, 1973, v 15, p 594. Samples coll 1972, 1974, subm by William Sumner, Ohio State Univ, Columbus, and R H Dyson, Jr.

P-2059. Sample 136 **12,550 ± 150**

Portion of carbonized reed mat from Operation B1, Feature 27, Area 43. Sample contemporary with Operation B, Bldg Level II, where proto-Elamite tablets and sealings were discovered. *Comments*: NaOH pretreatment. Possible bitumen contamination may explain anomalous date.

3170 ± 50

P-2060. Sample 22 *** 1540-1500 ± 60 BC**

Charcoal from Operation EE 41, Lot 29. Sample from bldg containing neo-Elamite tablets. *Comment*: NaOH pretreatment.

3060 ± 60

P-2061. Sample 14 *** 1400-1380 ± 60 BC**

Charcoal from Operation EE 41, Lot 17. Sample found in bldg containing neo-Elamite tablets.

3560 ± 60

P-2062. Samples 77 and 78 *** 2070 ± 60 BC**

Charcoal from Operation C, Area 20, Lot 56, from well containing Kaftari period artifacts, and assoc with Bldg Level I of Operation C. *Comment*: NaOH pretreatment.

3430 ± 60

P-2063. Sample 52 *** 1900-1780 ± 60 BC**

Charcoal from Operation C, Area 16, Lot 34, assoc with refuse deposit of Bldg Level I. *Comment*: NaOH pretreatment.

1690 ± 50

P-2185. Sample 1 *** AD 270 ± 50**

Charcoal from Operation X-65, Area 5, Stratum 3, Lot 19. Sample provenience 150cm from E balk, next to Wall H, in fill above leveled surface of collapsed kiln, sealed by construction of wall E (Sumner, 1973a).

4370 ± 60

P-2187. Sample 227 *** 3150 ± 60 BC**

Charcoal from Operation B, Lot 63, Banesh period. For another date of same sample, see TUNC-31, 4671 ± 88, R, 1975, v 15, p 594.

2980 ± 60

P-2330. Sample 52a *** 1300-1270 ± 60 BC**

MF 1249a, wood charcoal from Operation DD 43, Area 14, Lot 43. Sample is portion of roof beam from Middle Elamite bldg. *Comment*: NaOH pretreatment.

2830 ± 60

P-2331. Sample 18 *** 1100-1030 ± 70 BC**

MF 1390A, reed charcoal from Operation CC 43, Area 5, Lot 17, in middle Elamite bldg. *Comment*: NaOH pretreatment.

2950 ± 60

P-2332. Sample 68 *** 1270-1240 ± 70 BC**

MF 1254, reed charcoal from Operation DD 43, Area 15, Lot 49, in Middle Elamite bldg. *Comment*: NaOH pretreatment.

4150 ± 250

P-2333. Sample 40 *** 2900-2800 ± 250 BC**

Charcoal from Operation U 168, Lot 61, Banesh period. *Comment*: NaOH pretreatment. Sample counted in small counter.

4460 ± 70

P-2334. Sample 303 *** 3310-3210 ± 80 BC**

Charcoal from Operation ABC-N, Area 80, Lot 143, Bldg Level IV, Banesh period. *Comment*: NaOH pretreatment.

4390 ± 90

P-2335. Sample 158 *** 3160 ± 90 BC**

MF 1388, charcoal from Operation ABC-N, Area 3, Lot 90, between Bldg Levels II and III, Banesh period. *Comment*: NaOH pretreatment.

4630 ± 260

P-2336. Sample 346 *** 3450-3390 ± 270 BC**

Charcoal from Operation ABC-N, Pit 84. Sample provenience Bldg Level IV, Banesh period. *Comment*: NaOH pretreatment. Sample counted in small counter.

2. Israel

3740 ± 230

P-2572. Tell Qiri (Hazorea) *** 2180 ± 230 BC**

Charcoal from Loc 834, Level 61.40, at stratified habitation mound of Tell Qiri (Hazorea), (32° 38′ N, 35° 6′ E). Site revealed remains extending from Chalcolithic into Roman periods with Iron age remains particularly prominent (Ben-Tor 1975; 1976). Coll 1976 and subm by Amnon Ben-Tor, Inst Archaeol, Hebrew Univ Jerusalem. *Comment*: sample counted in small counter.

3. Jordan

3770 ± 60

P-2573. Bab-Edh-Dhra *** 2180 ± 60 BC**

Olive stones from ash pit, Phase 3, Area X, of Early Bronze age site of Bab-Edh-Dhra, S Ghor, Jordan (31° 15′ N, 35° 33′ E). Sample from earliest habitation Level E of walled town, of Early Bronze IV A date, ca 2300-2200 BC (see Schaub, 1973). For other dates from same site see R, 1970, v 12, p 179. Coll 1975 by R Thomas Schaub, Indiana Univ Pennsylvania; subm 1976 by James Weinstein, Univ Mus, Univ Pennsylvania.

C. SW Asia

1. Pakistan

4630 ± 300

P-2476. Jhukar *** 3450-3390 ± 310 BC**

Charcoal from oven in Trench C IV, Layer 15, Mound A, of Harrapan period site of Jhukar, Larkana dist, Sind prov, Pakistan (37° 33′ N, 68° 8′ E). For site survey, see Majumdar (1934). Coll 1974 by M Rafique Mughal, subm 1976 by Dept Archaeol & Mus, Govt Pakistan, Karachi. *Comment*: sample counted in small counter.

Loebanr III series

Loebanr III is small settlement site (34° 52′ N, 72° 23′ E) in Swat valley, Pakistan. Cultural horizon of site can probably be ascribed to

Period IV in sequence of protohistoric cultures of Swat valley, and shows close relationship with Neolithic Phase II of Burzahom in Kashmir (Stacul, 1976). For other dates related to Period IV from site of Aligrama (Stacul & Tusa, 1975), see P-2151, 3010 ± 60, and P-2152, 3350 ± 40 (both R, 1977, v 19, p 214). Samples coll 1976 and subm 1977 by Giorgio Stacul, Inst Storia Antica, Univ Trieste, Italy.

3280 ± 90

P-2583. Sample 1 *** 1650 ± 90 BC**

Charcoal from Pit 1, Layer 5. *Comment*: NaOH pretreatment. Sample undersized (91.8%) when placed in 8L counter, accounting for larger uncertainty than other samples in series.

3140 ± 60

P-2584. Sample 2 *** 1500 ± 60 BC**

Charcoal from Pit 1, Layer 6.

3250 ± 60

P-2585. Sample 3 *** 1640-1600 ± 60 BC**

Charcoal from Pit 1, Layer 7.

3360 ± 60

P-2586. Sample 4 *** 1730-1690 ± 60 BC**

Charcoal from Pit 2, Layer 5. *Comment*: NaOH pretreatment.

2. Sri Lanka (Ceylon)

Kantarodai series

Charcoal from site of Kantarodai, Jaffna, Sri Lanka (10° 0′ N, 80° 1′ E). Site contains complex stratified sequence covering pre-Anuradhapura period and, in its middle phase, displays close connections with Arikamedu in S India. One Roman carnelian seal was recovered from Trench A, in Rouletted Ware strata. Samples coll 1970 by Bennet Bronson, Field Mus Nat Hist, Univ Chicago, Chicago, Illinois, and Mohammed Mauro, Univ Pennsylvania, and subm 1976 by Bennet Bronson.

General Comment (BB): although overall time span indicated by radiocarbon dates seems reasonable, stratigraphic order suggested by certain dates is problematic, particularly very young date of Sample P-2526.

2350 ± 200

P-2529. Sample 6, Lot 7 *** 460-444 ± 210 BC**

Stratum III, Trench X, from late pre-Rouletted Ware context (2nd phase), at depth of 76 to 79cm. *Comment*: sample counted in small counter.

2020 ± 50

P-2521. Sample 4, Lot 13 *** 100-10 ± 50 BC**

From Refuse Pit 4, Stratum IV, Trench A, assoc with Rouletted Ware (3rd phase), at depth 55 to 59cm.

2290 ± 50

P-2518. Sample 5, Lot 13 *** 420 ± 50 BC**

From Refuse Pit 4, Stratum IV, Trench A, assoc with Rouletted Ware (3rd phase), at depth 55 to 59cm. *Comment*: NaOH pretreatment.

2250 ± 50

P-2517. Sample 12, Lot 16 *** 410 ± 50 BC**

Stratum IV or V, Trench X, Phase 1 or 2. *Comment*: NaOH pretreatment.

2250 ± 60

P-2514. Sample 1, Lot 8 *** 410 ± 60 BC**

From surface of Stratum V, Trench B, underlying Rouletted Ware strata (3rd phase), at depth of 72 to 81cm.

2180 ± 60

P-2520. Sample 8, Lot 21 *** 390-270 ± 60 BC**

Pit 6, Stratum V, Trench A, Rouletted Ware context (Phase 3), at depth 85 to 92cm.

2340 ± 50

P-2524. Sample 9, Lot 22 *** 440 ± 50 BC**

Stratum VI, Trench A, pre-Rouletted Ware context (Late Phase 2), outside pit containing P-2520, above, at depth 90 to 96cm.

2990 ± 60

P-2515. Sample 2, Lot 10 *** 1290 ± 60 BC**

From Stratum VI, Trench B, late pre-Rouletted Ware context (2nd Phase), at depth 91 to 98cm.

2070 ± 60

P-2516. Sample 3, Lot 12 *** 130 ± 60 BC**

From Stratum VI, Trench B, at depth 125 to 130cm. *Comment*: NaOH pretreatment.

2110 ± 60

P-2522. Sample 7, Lot 21 *** 200-170 ± 60 BC**

Lower part of Stratum VII, Trench B, assoc with Phase 2 ceramics, at depth 125 to 225cm.

2060 ± 50

P-2523. Sample 16, Lot 27 *** 140-120 ± 60 BC**

Stratum VIII, Trench B, assoc with Phase I pottery, at base of stone "wall", within sherd pavement, at depth 280cm.

2730 ± 220

P-2525. Sample 16, Lot 28 *** 980-940 ± 220 BC**

Stratum VIII, Trench B, in Phase 1 context, at depth 290cm. *Comment*: sample counted in small counter.

2290 ± 60

P-2519. Sample 17, Lot 30 *** 420 ± 60 BC**

Stratum IX, Trench B, in early Phase 1 context, at depth 315cm. Assoc pottery stylistically undefinable. *Comment*: NaOH preteatment.

2090 ± 50

P-2526. Sample 18, Lot 31 *** 190-140 ± 50 BC**

Stratum X, Trench B, at depth 390 to 395cm, in Phase I context lacking pottery, overlying naturally deposited layer of small stones. *Comment* (BB): deepest and presumably earliest sample from site.

2370 ± 60

P-2528. Sample 19 *** 480 ± 60 BC**

Lot 35, Stratum XI, Trench B, at depth 345 to 350cm, in presumably Phase 1 context, assoc with worn sherds and some bones.

D. United States

B Lawrence I Rockshelter series

B Lawrence I Rockshelter (47-Ve-154), in Kickapoo Valley, Vernon Co, Wisconsin (43° 36′ N, 90° 37′ W), Amerindian shelter site with 6 cultural levels (VI, oldest, to I, most recent) interleaved with mostly sterile strata. All cultural levels but Level I are aceramic. Of some 450 sites retrieved through salvage archaeol in Kickapoo Valley, only B Lawrence I Rockshelter yielded sufficient material for ^{14}C dating. Dates from this site will establish chronologic framework for entire valley. All samples coll 1974 by John Halsey, subm 1976 by Barbara Mead, both, State Hist Soc Wisconsin, Madison.

1080 ± 60

P-2462. Sq 7Ø, Level I *** AD 910 ± 60**

Wood, charcoal, and nutshell (id as *Carya ovata* by B Mead) from midden deposits in Sq 7Ø, middle of cultural Level I. Assoc with triangular and side-notched triangular points, and smoothed over cord-marked ceramics, at depth of 28.3cm. *Comment* (BM): projectile points are usually considered to be Late Woodland, while ceramics considered to be Middle Woodland.

880 ± 60

P-2463. Sq 6Ø, Level I *** AD 1080 ± 60**

Wood charcoal from closely compacted hearths, assoc with triangular and side-notched triangular points, and smoothed-over cord marked ceramics, at depth 57cm. *Comment* (BM): see above.

1840 ± 50

P-2464. Sq 6A, Level II *** AD 110-130 ± 50**

Wood charcoal from log in midden deposit, assoc with Durst Stemmed points, at depth 75.9cm. *Comments*: NaOH pretreatment.

3040 ± 250

P-2465. Sqs 1Ø, 4Ø, Level III *** 1370-1340 ± 260 BC**

Wood charcoal from hearth, Feature 13, assoc as P-2466, below, at depth 176.8cm. *Comments*: NaOH pretreatment. Sample counted in small counter.

P-2466. Sq 5A, Level III **2570 ± 70**
*** 800 ± 70 BC**

Wood charcoal from hearth, Feature 112, assoc with Durst Stemmed projectile points Late Archaic), at depth 191.1cm. *Comment* (BM): NaOH pretreatment; no Durst point components have yet been dated in Wisconsin.

P-2467. Sq 3A, Level IV **3090 ± 250**
*** 1450-1400 ± 260 BC**

Wood charcoal from hearth, Feature 78, assoc as P-2468, above, at depth 226.5cm. *Comment*: sample counted in small counter.

P-2468. Sq 5A, Level IV **3150 ± 260**
*** 1500 ± 260 BC**

Wood charcoal from pit, Feature 117, assoc with Raddatz Side-Notched projectile points (Middle Archaic) and large straight stemmed projectile points, at depth 226.5cm. *Comment*: sample counted in small counter.

P-2469. Sq 6C, Level V **3500 ± 70**
*** 2040-2020 ± 70 BC**

Wood charcoal from midden deposit, assoc with Raddatz Side-Notched and large straight stemmed projectile points, at depth 229.2cm. *Comment*: NaOH pretreatment.

P-2475. Elephant Hill, Vermont **39 ± 38**

Fragment of log from S side of passageway leading into structure on Theodore Fouck property, Elephant Hill, NE of S Royalton, Vermont (43° 49′ N, 72° 30′ W). Log lay between 2 capstones and other stones which served as posts framing this passageway. Coll 1976 and subm by Vincent Malmström, Dartmouth Coll, Hanover, New Hampshire. *Comments*: age precedes nuclear bomb tests of last decade, but more precise date cannot be estimated (VM). Structures similar to this one are common in N New England; their origins have been subject of persistent controversy.

E. Guatemala

Quiriqua series

Quirigua is Lowland Mayan site of Classic period, Dept Izabal, Guatemala (15° 16′ N, 89° 03′ W). Samples coll 1975 and 1976; subm 1976 by Robert Sharer, Univ Mus, Univ Pennsylvania.

P-2534. Ref No. 8L/4-1 **1140 ± 50**
*** AD 830-850 ± 50**

Fragments of carbonized wood, 0.66 to 0.69m below ground surface, on threshold of Str 2C-3, Loc 026. Assoc with "ROK" stair. *Comments*: NaOH pretreatment. (RS): expected date in Late Classic-Early Post-classic periods, ca AD 700 to 1000, although precise stratigraphic relation to other samples in series is uncertain.

1490 ± 50

P-2532. Ref No. 8L/5-1 *** AD 490-530 ± 50**

Fragments of carbonized wood, 0.54 to 0.64m below ground surface, on surface of "BEAN" floor, Loc 026. Assoc with floor. *Comment* (RS): expected date in Late Classic or Early Postclassic periods, ca AD 700 to 1000.

1150 ± 50

P-2533. Ref No. 6G/6-2 *** AD 830-850 ± 50**

Fragments of carbonized wood, 0.98 below ground surface, in N-S trench below "HAZ" layer, among interstices of "SAL" paving *lajas,* and assoc with "SAL" pavement. *Comments*: NaOH pretreatment. (RS): expected date in Late Classic period, ca AD 600 to 900.

1130 ± 180

P-2535. Ref No. 6I/15-1 *** AD 860-880 ± 180**

Fragments of carbonized wood, 2.78m below ground surface at N base and inside corner of assoc buried Acropolis structure "RAT". *Comments*: sample counted in small counter. (RS): expected date later than P-2533, above, but still within Late Classic period, ca AD 600 to 900.

1400 ± 50

P-2536. Ref No. 6I/27-1 *** AD 590 ± 50**

Fragments of carbonized wood, 3.08m below ground surface, in fill NE of and below "TOM" structure. Fill appears to predate this structure. *Comments*: NaOH pretreatment. (RC): expected date earlier than P-2535, above, but still within Late Classic period, ca AD 600 to 900.

1580 ± 190

P-2537. Ref Nos. 13N/18-2, 13N/18-3 *** AD 400 ± 190**

Fragments of carbonized wood, 1.2 to 1.4m below ground surface, toward base of pit beyond N end of Structure 3C-2, Loc 029. *Comments*: NaOH pretreatment. Sample counted in small counter. (RS): expected date Late Classic period, ca AD 600 to 900, although precise stratigraphic relation to other samples in series is uncertain.

4660 ± 270

P-2531. Ref Nos. 6L/11-1, 6L/11-2 *** 3470-3400 ± 280 BC**

Fragments of carbonized wood, 4.32m below ground surface along N facade in axial trench of "PINA" structure on Acropolis. Assoc with fill predating "SANDIA" floor. *Comments*: sample counted in small counter. (RS): presumed dated to Late Classic period, ca AD 600 to 900, although difficult to assess age relative to other samples in series.

1100 ± 170

P-2538. Ref No. 6F/17-2 *** AD 890 ± 170**

Fragments of carbonized wood, 0.06 to 1.05m below ground surface, W of "BOM" wall in fill of sub-"BOT" floor on Acropolis. Fill apparently predates "BOT" floor. *Comments*: sample counted in small coun-

ter. (RS): expected date in Late Classic period, ca AD 600 to 900, although precise stratigraphic relationship to other samples in series is uncertain.

F. Japan

Hamanasuno series

Hamanasuno is single component Early Jomon site with slight traces of Middle Jomon horizon (41° 50′ N, 141° 00′ E) Minamikayabe, Japan (Hurley, 1974). Radiocarbon and thermoluminescence dates from site have aided construction of chronology for Early Jomon period (Hurley *et al,* ms in preparation). Samples coll 1975 by William Hurley, Univ Toronto, Ontario, Canada; subm 1976 by William Hurley and Gary Crawford, Univ North Carolina, Chapel Hill.

4430 ± 90

P-2459. House 31, Pits 2, 3, and 5 *** 3180 ± 100 BC**

Charcoal, composed of deciduous hardwoods, combined from Pits 2, 3, and 5 in House 31. *Comments*: NaOH pretreatment. Sample was undersized (63%) for 8L counter. Date is average, weighted by uncertainties of 3 counts in 8L counter and 1 count in 1L counter. Counts are statistically consistent for quoted age and uncertainty.

4960 ± 350

P-2460. House 30a, Level X3 *** 3750 ± 360 BC**

Charcoal from House 30a, Grid G25-25, Subsquare 0, Level X3 house floor. *Comments*: NaOH pretreatment. Sample counted in small counter.

5420 ± 330

P-2470. House 30a, Level X3 *** 4360 ± 340 BC**

Charcoal from floor. *Comment*: sample counted in small counter.

4650 ± 330

P-2461. House 32, Pits 6, 7, and 8 *** 3470-3400 ± 340 BC**

Charcoal combined from Pits 6, 7, and 8, wc-6. *Comment*: sample counted in small counter.

5680 ± 380

P-2471. Grids G 28-23, G 29-23 *** 4550 ± 390 BC**

Charcoal found between grids G 28-23 and G 29-23, Level XI, adjacent to Pithouse 33. *Comment*: sample counted in small counter.

4950 ± 310

P-2472. House 27 *** 3740 ± 320 BC**

Charcoal from floor. *Comment*: sample counted in small counter.

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Corrections

1. R, 1977, v 19, p 214: 2nd sample numbered P-2151, 3350 ± 40, should have been numbered P-2152.

2. R, 1977, v 19, p 194: P-2403, Nuraghe Genna Maria, Villanovaforru, Sardinia. MASCA corrected date should be * 1210-1100 ± 50 BC.

[RADIOCARBON, VOL. 20, NO. 2, 1978, P. 234-244]

PHYSICAL RESEARCH LABORATORY RADIOCARBON DATE LIST III

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Presented below are dates from some important archaeologic and Quaternary sites. All dates are based on τ 1/2 = 5568 yr; to convert the radiocarbon dates for archaeologic samples into AD/BC scale, 1950 has been used as base as per the resolution passed at the Ninth International Radiocarbon Conference, San Diego, 1976. The dates are not corrected for ^{13}C fractionation. All the dates older than 10,000 yr have been given with 2σ errors. Due to uncertainty about the contribution of the biogenic carbon in caliche ($CaCO_3$) samples, the dates represent apparent and not true ages.

Samples were converted to methane for measuring ^{14}C activity in gas proportional counters. Detailed techniques were described earlier (R, 1971, v 13, p 442-449). All archaeologic samples were given NaOH pretreatment.

General Comment: many dates on Pacific Ocean sediments (PRL-284-286, PRL-326-329, PRL-332, PRL-344-346, PRL-348-357, and PRL-360-372) were obtained to determine sedimentation rates. ^{14}C dates on caliche formations of Rajasthan were measured to date climatic changes depicted by sedimentary profiles. Wherever possible measurements were based on CO_2 evolved from outer (a), middle (b), and core (c) fractions of the same nodule which enabled a study of the growth rates of caliche nodules. The ^{14}C dated pollen sequence from Toshmaidan (PRL-2B-5, PRL-7, PRL-9-10 and PRL-12) indicates that deglaciation in Kashmir valley started ca 15,000 yr ago. The Ramtirth Ware, a newly discovered Deccan Chalcolithic culture, has been dated to 3500 yr BP (PRL-382-384).

I. ARCHAEOLOGIC SAMPLES

Aligrama series, Pakistan

Aligrama (34° 49′ N, 72° 19′ E), Dist Swat, Pakistan; subm by Sebastiano Tusa, ISMEO, Rome, Italy. *Comment*: samples were measured to date Swat culture deposits (Stacul & Tusa, 1975, p 291-321).

PRL-243. Swat culture Vth period **2900 ± 110**
Charcoal, Loc Tr E, Layer 9, depth 4.5m.

PRL-244. Swat culture Vth period **2660 ± 130**
Charcoal, Loc Tr F, Area 3, Layer 4, depth 2.5m.

PRL-246. Swat culture Vth period **3080 ± 170**
Charcoal, Loc Tr F, Area 4, Layer 7, depth 5.5m.

Apegaon series, Maharashtra

Apegaon, a Chalcolithic site, Dist Aurangabad; subm by S B Deo, Deccan Coll, Poona. *Comment*: site has yielded a new ceramic viz Ramtirth Ware, different from the other Chalcolithic (Jorwe and Malwa) wares of the Deccan.

PRL-382. Chalcolithic deposit **3450 ± 100**

Charcoal, Loc Tr XII-XVI, Layer 4, depth 1.3m.

PRL-383. Chalcolithic deposit **3450 ± 100**

Charcoal, Loc Tr XII-XVI, Layer 5, depth 1.5m.

PRL-384. Chalcolithic deposit **3520 ± 100**

Charcoal, Loc Tr XII-XVI, Layer 6.

PRL-283. Besnagar, India, Northern Black Polished (NBP) Ware deposit **2200 ± 130**

Charcoal from Besnagar (23° 30′ N, 77° 45′ E), Dist Vidisha, Loc Tr BSN-VI, Layer 11, depth 4.1m; subm by Dir Gen Archaeol, New Delhi.

Bhalukpung series, Arunachal Pradesh

Bhalukpung (27° 30′ N, 92° 20′ E), Dist Kameng, subm by B M Das, Dibrugarh Univ, Assam.

PRL-287. Terrace deposit **1130 ± 100**

Carbonized rice, Tr 1, Loc Dezenling, Layer 2, depth .3 to 1m; sender's Sample S/B/1.

PRL-288. Terrace deposit **650 ± 80**

Charcoal, Tr 1, Loc Dezenling, Layer 2, depth .3 to 1m; sender's Sample S/B/2.

Bhimbetka series, Madhya Pradesh

Bhimbetka (22° 65′ N, 77° 57′ E), Dist Raisen, subm by V N Misra, Deccan Coll, Poona. *Comment*: dates show scatter indicating probably admixture due to recent fire-building activity at site.

PRL-306. Cave deposit **2820 ± 110**

Charcoal, Tr F, Loc 1 & 2, Layer 1, depth .46 to .5m; sender's Sample BTK-IIIF-13-1976-1.

PRL-310. Cave deposit **2320 ± 100**

Charcoal, Tr F, Loc 1 & 2, Layer 2, depth .5 to .55m; sender's Sample BTK-IIIF-13-1976-2.

PRL-311. Cave deposit **1060 ± 80**

Charcoal, Tr F, Loc 1 & 2, Layer 2, depth .56 to .6m; sender's Sample IIIF-13-1976-3.

PRL-314. Cave deposit, burial **630 ± 100**

Charcoal, Tr E, Loc 2, Layer 2, depth .61 to .65m; sender's Sample BTK-IIIF-13-1976-8.

PRL-315. Cave deposit **1760 ± 180**

Charcoal, Tr F, Loc 1 & 2, Layer 2, depth .61 to .65m; sender's Sample BTK-IIIF-13-1976-4.

PRL-316. Cave deposit **1930 ± 100**

Charcoal, Tr F, Loc 2, Layer 2, depth .66 to .7m; sender's Sample BTK-IIIF-13-1976-5.

PRL-317. Cave deposit **2490 ± 100**

Charcoal, Tr E, Loc 2, Layer 2, depth .66 to .7m; sender's Sample BTK-IIIF-13-1976-9.

PRL-318. Cave deposit **3560 ± 100**

Charcoal, Tr E, Loc 1, Layer 3, depth .71 to .75m; sender's Sample BTK-IIIF-13-1976-7.

PRL-321. Cave deposit **370 ± 130**

Charcoal, Tr E, Loc 2, Layer 3, depth 1.06 to 1.1m; sender's Sample BTR-IIIF-13-1976-11.

PRL-325. Ganwaria, India, Painted Grey Ware (PGW) deposit **4610 ± 110**

Ganwaria (27° 26′ N, 83° 7′ E), Dist Basti, Loc Tr XA1 Qd2, Rm 17, Layer 15, depth 7m; subm by Dir Gen Archaeol, New Delhi, sender's Sample 15. *Comment*: date represents old charcoal and has no relevance to cultural levels.

PRL-253. Hatti, India, Old gold mining **2630 ± 150**

Charred wood from ancient shaft at Hatti, Dist Raichur, subm by Dir Gen Archaeol, New Delhi; sender's Sample 2/75/MSC.

PRL-252. Ingaladhal, India, Old copper working **1680 ± 100**

Wood from ancient shaft at Ingaladhal, Dist Chitradurga, subm by Dir Gen Archaeol, New Delhi; sender's Sample 1/75/MSC.

Jodhpura series, India

Jodhpura (27° 31′ N, 76° 5′ E) Dist Jaipur, subm by Dir Archaeol & Mus, Jaipur.

PRL-272. Painted Grey Ware (PGW) deposit **2670 ± 150**

Charcoal, Loc Tr D, Layer 12, depth 1.97m; sender's Sample JRA 3/75.

PRL-273. PGW deposit **2310 ± 140**

Charcoal, Loc Tr E, Layer 8, depth 2.5m; sender's Sample JRA 4/75.

PRL-274. PGW deposit **2250 ± 110**

Charcoal, Loc Tr D, Layer 12, depth 2.9m; sender's Sample JRA 5/75.

PRL-275. Black-and-Red Ware (BRW) deposit (?) **4360 ± 160**

Charcoal, Loc Tr D, Layer 13, depth 2.87m; sender's Sample JRA 6/75.

PRL-277. Ocher Color Pottery (OCP) deposit (?) **2610 ± 110**

Charcoal, Loc Tr D, Layer 14, depth 1.94m; sender's Sample JRA 9/75.

PRL-278. OCP deposit **4060 ± 170**

Charcoal, Loc Tr D, Layer 14, depth 3m; sender's Sample 12/75.

PRL-254. Kalyadi, India, Old copper working **310 ± 80**

Wood from an ancient shaft at Kalyadi, Dist Hassan, subm by Dir Gen Archaeol, New Delhi; sender's Sample 3/75/MSC.

Mitathal series, Haryana

Mitathal (28° 50′ N, 76° 10′ E), Dist Bhiwani, subm by Suraj Bhan, Ind Inst Adv Studies, Simla.

PRL-290. Late Siswal culture (?) **3820 ± 130**

Charcoal, Loc Tr MTL-1, Layer 17, depth 2.95m; sender's Sample 10.

PRL-291. Harappa culture **3600 ± 110**

Charcoal, Loc Tr MTL-1, pit sealed by Layer 10, depth 2.6m; sender's Sample 11.

PRL-292. Harappa culture **4210 ± 210**

Charcoal, Loc Tr MTL-2, pit sealed by Layer 4; sender's Sample 15.

Mathura series, Uttar Pradesh

Mathura (27° 28′ N, 77° 42′ E), Dist Mathura, subm by Dir Gen Archaeol, New Delhi.

PRL-333. Northern Black Polished Ware (NBP) deposit **2490 ± 140**

Charcoal, Tr MTR-8, Loc B1 Qd2, Pit 3 sealed by Layer 5, depth 3.18m; sender's Sample 1.

PRL-334. NBP deposit **2600 ± 150**

Charcoal, Tr MTR-10, Loc A1 Qd4, Layer 9, depth 1.45m; sender's Sample 3.

PRL-336. NBP deposit **2540 ± 90**

Charcoal, Tr MTR-8, Loc B1 Qd2, Layer 6, depth 3m; sender's Sample 5.

PRL-337. NBP deposit **2340 ± 100**

Charcoal, Tr MTR-11, Loc Trial Trench (TT), Pit 5 sealed by Layer 20, depth 5.45m; sender's Sample 6.

PRL-338. NBP deposit **2280 ± 100**

Charcoal, Tr MTR-11, Loc TT, Layer 18, depth 4.7m; sender's Sample 7.

PRL-339. NBP deposit **2380 ± 100**

Charcoal, Tr MTR-8, Loc B1 Qd3, Pit 2 sealed by Layer 3; sender's Sample 8.

PRL-340. PGW-NBP overlap (?) **2390 ± 150**

Charcoal, Tr MTR-8, Loc A1 Qd4, Layer 11, depth 4.2m; sender's Sample 9.

PRL-342. PGW-NBP overlap (?) **2180 ± 160**

Charcoal, Tr MTR-8, Loc B1 Qd2, Pit 8 sealed by Layer 8, depth 3.6m; sender's Sample 11.

PRL-343. NBP deposit **2150 ± 100**

Charcoal, Tr MTR-11, Loc TT, Layer 18, depth 4.2m; sender's Sample 12.

Piprahwa series, Uttar Pradesh

Piprahwa (27° 26′ N, 83° 7′ E), Dist Basti, subm by Dir Gen Archaeol, New Delhi.

PRL-322. Sunga-Kushana deposit **2250 ± 100**

Charred rice, NW corner room of E Monastery, Layer 2, depth 1.65m; sender's Sample 10.

PRL-323. Pre-Mauryan deposit **2290 ± 100**

Charcoal, Room 2, E Monastery, Layer 8, depth 4.1m; sender's Sample 13.

PRL-324. Pre-Mauryan deposit **2170 ± 130**

Charcoal, Tr ZA2 Qd3, Layer 8, depth 4.2m; sender's Sample 14.

Pirak series, Pakistan

Pirak (29° 30′ N, 67° 54′ E) a Chalcolithic site, Dist Kachi, subm by J F Jarrige, Mus Guimet, Paris.

PRL-388. Chalcolithic deposit **2730 ± 110**

Charcoal, Tr PKC 3G, Loc CXIII, Layer 2, depth 1.1m.

PRL-389. Chalcolithic deposit **2590 ± 100**

Charcoal, Tr PKC 2F, Loc CVII, Layer 7, depth 1.6m.

PRL-390. Chalcolithic deposit **2730 ± 100**

Charcoal, PKA 3G, Loc LXXVII, Layer 21W, depth 3m.

PRL-391. Chalcolithic deposit **2730 ± 100**

Charcoal, Tr PKA 3I, Layer 42N, depth 10m.

PRL-298. Zawar, India, lead workings **Modern**

Carbon from lead smelting retort coll at Zawar (24° 21′ N, 73° 41′ E), Dist Udaipur; subm by G P Deshmukh, Geol Survey, Jaipur.

II. QUATERNARY SAMPLES

PRL-385. Admiralty Bay, Antarctica, morainic deposit **>40,000**

Wood from a crag slope at Admiralty Bay (62° S, 64° W) Antarctica, subm by E Anati, Centro Camuno Studi Prehist, Capo Di Ponte, Italy.

PRL-146. Andada, India, river terrace deposit **$31{,}830^{+4010}_{-2660}$**

Lime-caliche from Upper Terrace on Narmada R near Andada, Broach Dist, depth 3m; subm by N Bedi, Geol Survey India, Ahmedabad; sender's Sample GSI/NB/3.

PRL-42. Bombay High, India, continental shelf **$11{,}120^{+320}_{-300}$**

Shelf sediment from 0.4m-long drill core off Bombay. Subm by B S Venkatachala, Palynol Lab, Dehra Dun. Sender's Sample V2/H-1-1/P.

Chirai series, Rajasthan

Chirai, Jodhpur Dist; subm by D P Agrawal, PRL, Ahmedabad. *Comment*: samples measured to study caliche formation.

PRL-377. Caliche **$27{,}820^{+2690}_{-2010}$**

Caliche from exposed sec at Chirai, depth 1.65m; sender's Sample C-22.

PRL-378. Caliche **$21{,}550^{+640}_{-600}$**

Caliche from exposed sec at Chirai, depth 1.3m; sender's Sample C-23.

PRL-379. Caliche **$22{,}350^{+690}_{-640}$**

Caliche from exposed sec at Chirai, depth 1.15m, sender's Sample C-24.

PRL-262. Chotila, India, miliolite deposit **$15{,}820^{+590}_{-640}$**

Miliolite from hillslope near Chotila, Surendranagar Dist, depth 0.1m; subm by B Roy, PRL, Ahmedabad. *Comment*: sample measured to date inland miliolite.

PRL-191. Dungarpur, India, miliolite deposit $19{,}780^{+850}_{-950}$

Miliolite from Dungarpur, Junagarh Dist, depth 12.3m; subm by D P Agrawal, PRL, Ahmedabad. *Comment*: sample measured to date miliolite formation.

Gudlai Nadi series, Rajasthan

Gudlai Nadi, Jodhpur Dist; subm by D P Agrawal, PRL, Ahmedabad. *Comment*: samples measured to study caliche formation.

PRL-373. Caliche $11{,}730^{+450}_{-430}$

Caliche from exposed sec of Gudlai Nadi R; horizon D, depth 0.5m; sender's Sample C-20.

PRL-374. Caliche

a) $14{,}960^{+220}_{-210}$

b) $22{,}910^{+1050}_{-930}$

c) $18{,}310^{+580}_{-540}$

Caliche from exposed sec on Gudlai Nadi R from horizon C, depth 1.4m; sender's Sample C-19.

PRL-375. Caliche $26{,}450^{+3190}_{-2280}$

Caliche from exposed sec on Gudlai Nadi R; depth 1.8m; sender's Sample C-18.

PRL-376. Caliche >40,000

Caliche from exposed sec on Gudlai Nadi R; depth 3.2m; sender's Sample C-17.

PRL-263. Junagarh, India, miliolite deposit $33{,}750^{+3250}_{-5540}$

Miliolite from dune at base of Girnar Hill, Junagarh Dist; subm by B Roy, PRL, Ahmedabad.

PRL-236. Kolara, India, terrace deposit 6640 ± 260

Peaty clay with wood fragments from river terrace near Kolara (22° 30′ N, 88° 30′ E), Howrah Dist; depth 6.65m; subm by H P Gupta, Birbal Sahni Inst Palaebot, Lucknow. *Comment*: dated to study possible submergence of forest in Bengal Basin.

Little Rann of Kutch series, Gujarat

Little Rann of Kutch, Surendranagar Dist; subm by R S Kathiara, Geol Survey, Ahmedabad. *Comment*: samples measured to study sedimentation rate.

PRL-299. Silt deposit 6220 ± 110

Wood from a brine well, depth 2.1m; sender's Sample RSK/49/4A.

PRL-300. Silt deposit **6160 ± 110**

Wood from a brine well, depth 2.2m; sender's Sample RSK/41/4A.

PRL-301. Silt deposit **8240 ± 140**

Wood from a brine well, depth 4.1m; sender's Sample RSK/10/5A.

PRL-302. Silt deposit **7560 ± 140**

Wood from a brine well, depth 4.5m, sender's Sample RSK/24/4A.

PRL-296. Naini Tal, India, talus deposit **540 ± 100**

Wood from drill hole DH1, depth 61m at Naini Tal (29° 23′ N, 79° 27′ E); subm by Dir Engg Geol Dn (East), Geol Survey India, Lucknow; sender's Sample 1. *Comment*: sample dated to study landslide history.

Naliasar series, Rajasthan

Naliasar, Jaipur Dist; subm by D P Agrawal, PRL, Ahmedabad. *Comment*: samples measured to study caliche formation.

a) $12{,}750^{+290}_{-280}$

PRL-358. Caliche **b) $15{,}570^{+370}_{-360}$**

Caliche from lake basin, depth 0.05m; sender's Sample C-1.

a) $15{,}550^{+590}_{-550}$

PRL-359. Caliche **b) $20{,}000^{+920}_{-820}$**

c) $22{,}320^{+700}_{-640}$

Caliche from lake basin, depth 0.1m; sender's Sample C-2.

PRL-293. Nandipalli, India, fluvial deposit **$23{,}670^{+640}_{-690}$**

Shells from clayey silt deposit resting on Middle Paleolithic tool-bearing gravel on Sagileru R at Nandipalli, Cuddapah Dist; subm by K Thimma Reddy.

Navunda series, Karnataka

Navunda village (13° 45′ N, 74° 38′ E), South Canara Dist; subm by P S N Murty, Nat Min Dev Corp Ltd, Mangalore. *Comment*: samples measured to study lignite stratigraphy.

PRL-103. Lignite deposit **>40,000**

Lignite from a well 6m deep and 1.5m below water level.

PRL-132. Lignitized wood deposit **$38{,}295^{+5330}_{-3145}$**

Fragments of lignitized wood 9.4m below surface and 1.2m below water level. *Comment*: finite age probably due to contamination.

PRL-216. Odador, India, coastal aeolinite **9390 ± 140**

Limestone from semi-consolidated aeolinite 1.5km SE of Odador (21° 34′ N, 69° 40′ E), Junagarh Dist, alt +8m; subm by U B Mathur, Geol Survey India; sender's Sample MM 14. *Comment*: sample measured to date Late Quaternary coastal aeolinite.

Pacific Ocean sediment series

Box cores of calcareous sediments from Ontong Java Plateau (4° 50′ N to 0° 07′ N, 155° 52′ E to 163° 42′ E), water depth 1597 to 4441m. Coll by W H Berger, subm by D Lal, PRL, Ahmedabad. *Comment*: samples measured to study sedimentation rate.

Sample	Core no.	Core depth (mm)	^{14}C age
PRL-360	ERDC 88 BX 2	0 to 5	3060 ± 150
PRL-363	"	50 to 60	5410 ± 110
PRL-362	"	140 to 180	11,370 ± 230
PRL-361	"	230 to 260	$17{,}460^{+440}_{-420}$
PRL-364	ERDC 102 BX 2	0-5	7900 ± 160
PRL-366	"	5-10	7930 ± 190
PRL-367	"	10-15	4450 ± 110
PRL-368	"	15-20	8360 ± 170
PRL-369	"	30-40	5010 ± 100
PRL-370	"	60-80	6370 ± 100
PRL-371	"	120-150	10,570 ± 180
PRL-372	"	180-230	$14{,}470^{+320}_{-310}$
PRL-365	"	270-310	$22{,}050^{+560}_{-520}$
PRL-284	ERDC 123 BX 2	0-3	2310 ± 180
PRL-285	"	6.5-10.5	2810 ± 110
PRL-286	"	15.5-21	3150 ± 140
PRL-326	"	31-41	3470 ± 120
PRL-327	"	51-61	3540 ± 150
PRL-346	"	61-71	3650 ± 110
PRL-328	"	81-91	4960 ± 160
PRL-329	"	121-141	6550 ± 120
PRL-345	"	181-201	9110 ± 130
PRL-344	"	261-291	12,240 ± 270
PRL-332	"	321-361	$14{,}500^{+300}_{-310}$

Sample	Core no.	Core depth (mm)	^{14}C age
PRL-348	ERDC 141 BX 2	0-5	5790 ± 170
PRL-349	"	5-10	6310 ± 170
PRL-350	"	10-15	6800 ± 120
PRL-351	"	15-20	6940 ± 150
PRL-352	"	30-40	8560 ± 140
PRL-353	"	60-80	$12{,}510\ ^{+\ 270}_{-\ 260}$
PRL-354	"	140-180	$28{,}730\ ^{+\ 1540}_{-\ 1290}$
PRL-356	"	220-260	$37{,}800\ ^{+\ 5870}_{-\ 3350}$
PRL-357	"	340-370	>40,000

PRL-120. Pandiya Tivu, India, coastal sediment **2070 ± 100**

Coral from Pandya Tivu (78° 13′ E, 8° 45′ N), alt +3m; subm by A V N Sarma, Temple Univ, Philadelphia, Pennsylvania. *Comment*: sample measured to study sea-level changes on east coast of India.

PRL-145. Panetha, India, terrace deposit **6470 ± 180**

Pedocal with caliche from upper terrace on Narmada R near Panetha, Broach Dist, depth 2.5m; subm by N Bedi, Geol Survey, India, Ahmedabad, sender's Sample GSI/NB/2.

PRL-30. Prabhas Patan, India, oyster shell bed **$20{,}825^{+670}_{-540}$**

Shells from oyster bed on Hiran R, Junagarh Dist; subm by D P Agrawal. *Comment*: bed yielded Middle Paleolithic tools.

Sankhu, Nepal

Sankhu (27° 43′ N, 88° 28′ E), Kathmandu Dist, subm by Vishnu Mittre, Birbal Sahni Inst Paleobot, Lucknow. *Comment*: samples were measured to date pollen sequence.

PRL-192. Carbonaceous clay deposit **$16{,}900^{+1010}_{-\ 900}$**

Peaty Clay II from exposed sec, depth 11.3m, sender's Sample Sankhu Boudh 1.

PRL-193. Carbonaceous clay deposit **>40,000**

Peaty Clay III from exposed sec, depth 13.75m, sender's Sample Sankhu Boudh 2.

PRL-194. Carbonaceous clay deposit **>40,000**

Peaty Clay III from exposed sec, depth 14.15m, sender's Sample Sankhu Boudh 3.

PRL-195. Carbonaceous clay deposit >40,000

Peaty Clay III from exposed sec, depth 14.45m, sender's Sample Sankhu Boudh 4.

PRL-196. Carbonaceous clay deposit >40,000

Peaty Clay III from exposed sec, depth 14.75m, sender's Sample 5.

Toshmaidan series, Jammu & Kashmir

Toshmaidan (33° 56′ N, 73° 31′ E), Srinagar Dist; subm by G Singh, Australian Natl Univ, Canberra and D P Agrawal, PRL, Ahmedabad. *Comment*: samples were measured to date pollen sequence in a bog (Singh & Agrawal, 1976, p 232).

Sample no.	Serial no.	Depth (m)	Sample	Sieve fraction (m)	Pollen stage	Date
PRL-2B	II	.15 to .35	Peat	420	g	2790 ± 160
PRL-3	III	.5 to .7	Peat	420	d	9650 ± 245
PRL-4B	IV	.75 to .90	Peat	420	d	10,005 $^{+340}_{-380}$
PRL-5	V	1.25 to 1.4	Peat	420	d	11,360 $^{+585}_{-600}$
PRL-7	VII	2.05 to 2.2	Fine organic mud	—	c	13,980 $^{+520}_{-565}$
PRL-9	IX	2.8 to 2.95	Clay mud	—	c	15,250 $^{+760}_{-820}$
PRL-10	X	3.17 to 3.27	Clay mud	—	a-b	14,760 $^{+1015}_{-925}$
PRL-12	XII	3.37 to 3.5	Blue-gray Lacustrine clay	—	a-b	13,830 $^{+900}_{-785}$

Tso-Kar series, Jammu & Kashmir

Tso-Kar (33° 20′ N, 78° E) Ladakh Dist, subm by M Krishnamurthy, Geol Survey, India, Lucknow. *Comment*: samples measured to date paleoclimatic events.

PRL-259. Lacustrine deposit 7490 ± 190

Gastropod shells from lacustrine deposits at Tso-Kar, depth 2m.

PRL-261. Lacustrine deposit 4840 ± 170

Carbon precipitate from lake sediment, depth .6m.

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[RADIOCARBON, VOL. 20, NO. 2, 1978, P. 245-273]

UNIVERSITY OF TEXAS AT AUSTIN RADIOCARBON DATES XII

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This list reports certain ^{14}C measurements completed by November 1977; other projects completed by this time will be reported later. Age calculations are based on ^{14}C half-life of 5568yr 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 that when sample count approaches either modern or background, 2σ limits are reported. Unless noted, $^{12}C/^{13}C$ measurements were not made and results are not corrected for ^{13}C fractionation. Our laboratory uses liquid scintillation counting of benzene, with Li_2C_2 and vanadium-activated catalyst in preparation; chemical yields range between 95% and 99%. Three counters are employed: a Packard Tri-Carb Model 3002 and 2 Beckman LS320 spectrometers obtained through a grant from the National Science Foundation.

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I. GEOLOGIC AND OCEANOGRAPHIC SAMPLES

Texas

Aransas Pass series, Texas

Shell samples from vicinity of Aransas pass, S coast of Texas. Subm to establish sea-level curve and growth of tidal delta. Coll 1974 by M Munson and subm by Michael Amdurer, Dept Geol, Columbia Univ, New York. In titles, depth in m below sea level follows sample no.

Tx-2310A. Aransas 5E,10.4m; white shell **6320 ± 210**

Mulinia Lateralis shell, Site 5E, 10.4m depth, from washdown rig boring on E Harbor I, 10km ESE of city of Aransas Pass (27° 51′ 36″ N, 97° 03′ 30″ W). At Holocene-Pleistocene boundary, base of barrier-island sand facies. This and Tx-2310B, -2310C (below) subm to examine effect of preservation and shell color on ^{14}C age.

Tx-2310B. Aransas 5E,10.4m; black shell **9740 ± 140**

All types of shell, from same sample as Tx-2310A.

Tx-2310C. Aransas 5E,10.4m; echinoids 7260 ± 150

Echinoid fragments (*Mellita* sp); from same sample as Tx-2310A. *Comment* (MA): black shells (Tx-2310B) were thought to be reworked; date relative to Tx-2310A verifies this. Echinoids (Tx-2310C) also were probably reworked since *Mellita* inhabits quiet lower shore face sandy bottoms where molluscan genera in sample do not occur. Disparities in these 3 dates show danger of dating whole samples without first removing pieces that may be reworked. Tx-2310A date is felt to be most nearly accurate; correlates with pub dates for initial sand deposition beneath Matagorda and St Joseph I (Wilkinson, 1973; Shepard and Moore, 1955).

Tx-2311. Aransas 2J,7m 5530 ± 90

From 7m depth, 8km ESE of city of Aransas Pass (27° 52′ 54″ N, 97° 03′ 06″ W), 2.5 to 3m above Holocene-Pleistocene contact, within lower open-bay mud facies. *Comment* (MA): slightly older than expected. May result from mixed sample that included echinoid fragments; see comment on Tx-2310, above.

Tx-2312. Aransas 2F,5.8m 4950 ± 60

From 5.8m depth, W Harbor I, 6km ESE of city of Aransas Pass (27° 53′ 06″ N, 97° 04′ 24″ W); just above Holocene-Pleistocene boundary, at base of open-bay mud facies. *Comment* (MA): dates initial Holocene deposition here; about as expected.

Tx-2313. Aransas D,2.1m 3410 ± 70

Chione and *Cerithium,* 2.1m depth, W Redfish Bay, NW of Harbor I, 3km E of city of Aransas Pass (27° 54′ 36″ N, 97° 07′ 06″ W). At Holocene-Pleistocene boundary, just above soil zone, base of grass-flat facies. *Comment* (MA): dates development of facies and indicates deposition rate of 2400mm/1000yr for open-bay mud facies.

Tx-2333. Aransas 5E,5.8m 4840 ± 70

Same site as Tx-2310 (above); 5.8m depth, top of barrier island sand lens. *Comment* (MA): dated to ascertain deposition rate of this unit (3100mm/1000yr). Correlative with Tx-2312 (above), 3km distant; agreement of date indicates synchroneity of deposition over this distance.

Tx-2334. Aransas G,2.7m 2180 ± 50

From 2.7m depth, Harbor I, 5km E of city of Aransas Pass (27° 53′ 54″ N, 97° 05′ 06″ W). Above Holocene-Pleistocene boundary, lower Holocene tidal delta, grass-flat facies. *Comments* (MA): date much younger than expected; we have no dates at this site shallower than this, though Tx-2312 (above) is nearby (2km), shallower, and considerably older. (SV,Jr): anomaly may result from leak in recovery system in lab.

Tx-1769. Flower Garden Bank Reef, Texas 4160 ± 110

Fossil *(Amphistegina gibbosa)* foraminifera from 60m below sea level, crest of W bank Flower Garden Bank reef, Gulf of Mexico, S of

Galveston I, Texas (27° 52′ N, 93° 49′ W). Subm to obtain chronology of Holocene sea level fluctuations in open Gulf based on assumption that *Amphistegina* is restricted to shallow water. Coll 1970 on Oceanography Cruise #70-A-13/25 and subm by C Lindau, Dept Oceanog, Texas A&M Univ, College Station, Texas. *Comment* (CL): agrees well with comparable sample TAMU-184, 4200 ± 150 (Lindau, written commun); however, dating did not provide indication of sea level transgression.

Central Texas Flood Deposit series

Samples from creek sites in central Texas, subm to establish age of flood deposits and frequency of flooding on small streams. Coll 1976 and subm by P C Patton, Dept Earth & Environmental Sci, Wesleyan Univ, Middletown, Connecticut.

Tx-2348A. PP BC#1, total organic **710 ± 60**

Tx-2348B. PP BC#1, humic fraction **770 ± 90**

Tx-2348C. PP BC#1, residue **370 ± 40**

Humus from upper soil #1, 50 to 60cm depth, Bleiders Creek, 500m upstream from Guadalupe R, 1.6km N of New Braunfels (29° 44′ N, 98° 08′ W).

Tx-2349A. PP BC#2, total organic **1000 ± 60**

Tx-2349B. PP BC#2, humic fraction **790 ± 150**

Tx-2349C. PP BC#2, residue **890 ± 60**

Humus from buried soil #1, 80 to 90cm depth, Bleiders Creek, same locality as Tx-2348, above.

Tx-2350A. PP EC#1, total organic **1300 ± 60**

Tx-2350B. PP EC#1, humic fraction **950 ± 70**

Tx-2350C. PP EC#1, residue **710 ± 50**

Humus from buried soil #1, 130 to 150cm depth, Elm Creek, 400m upstream from Guadalupe R, 6.4km N of New Braunfels (29° 45′ N, 98° 06′ W).

Tx-2351. PP CC#1 **610 ± 90**

Charcoal from alluvium, 50cm depth, Cibolo Creek, 1.6km downstream from Curry Creek Rd at Gosser Ranch, 16km SE of Boerne (29° 44′ N, 98° 37′ W).

General Comment (PCP): Tx-2348-2350 date recurrence of floods in area. Tx-2351 proves that sediment deposition is related to present hydraulic regime of stream and places maximum time limit on incipient soil formation on deposit.

Little Bahama Bank, West Indies

Jet core slurry samples from sites on Little Bahama Bank, 19km W of Walker's Cay, Bahama I, West Indies. Subm to reconstruct sea level flooding history of Little Bahama Bank. Coll 1975 and subm by A C Hine, Dept of Geol, Univ South Carolina, Columbia.

Tx-2267. Little Bahama, C-4 7521 I-9 **2460 ± 50**

Carbonate bioclastic sand, 1 to 2m beneath sediment/water interface, back reef seagrass beds (27° 16′ 30″ N, 78° 35′ 36″ W).

Lily Bank series

From Lily Bank site C-2 7521, NE margin of Little Bahama Bank (27° 14′ 48″ N, 78° 37′ 30″ W). Numbers in titles are depths beneath sediment/water interface.

Tx-2263. Lily Bank, 0-1.0m **1660 ± 60**

Oolitic sand.

Tx-2265. Lily Bank, 3.9-4.5m **2590 ± 50**

Carbonate bioclastic sand, 1.5 to 2.1m above bedrock. More ooids than in Tx-2264 (below); ooid shoal is nearer core site.

Tx-2264. Lily Bank, 4.5-5.0m **2780 ± 60**

Carbonate shell fragments, 1 to 1.5m above bedrock.

Tx-2266. Lily Bank, 6.0-6.1m **25,220 ± 630**

Carbonate rock fragments, from bedrock limestone beneath sediment.

General Comment (ACH): dates provide deposition rate prior to oolite shoal development and indicate upper limit for oolite shoal development. Sequence corresponds reasonably well with slowing of Holocene sea level rise.

Maine

Peat samples from cores in salt water estuary marshes in S Maine. Coll 1972 and subm by B S Timson, Maine State Dept Conservation, Augusta, Maine.

Tx-1645. Ogunquit R Estuary, Maine **730 ± 220**

Base of Core 1-5B, 80cm below marsh surface, above Pleistocene level, Ogunquit R estuary, by Furbish Rd (43° 16′ 50″ N, 70° 35′ 15″ W).

Wells Marsh series, Maine

Samples from Core 4-10, taken at approx high tide level on Webhannet estuary marsh, 0.4km E of Mile Rd in Wells, Maine (43° 19′ 30″ N, 70° 34′ 05″ W). Numbers in titles are depths below marsh surface.

Tx-1640. Wells BT-1, 20 to 23cm **1290 ± 110**

Tx-1641. Wells BT-2, 55 to 58cm **2340 ± 250**

Tx-1642. Wells BT-3, 80 to 83cm **2630 ± 190**

Tx-1643. Wells BT-4, 102 to 107cm **2860 ± 150**

General Comment on Tx-1645 and Wells Marsh series (BST): dates corroborate previous dating (Hussey, 1959) of formation of estuary lagoon, and define formation of Wells and Ogunquit barrier beaches ca 900 BC; previously thought to be much earlier (Hussey, 1970).

Utah, Idaho, Nevada

Fillmore Caliche series, Utah

Samples of caliche from lava flow near Fillmore, Utah. Coll 1970 and subm by F M Bullard, Dept Geol Sci, Univ Texas, Austin.

Tx-1304. Fillmore Caliche, 13 **11,460 ± 170**

From roadcut of jeep rd to crater, near N margin of Tabernacle flow, 17.7km SW of Fillmore (38° 56′ N, 112° 31′ W); in basin of extinct Lake Bonneville. Lava flow occurred before lake disappeared. *Comment* (FMB): dates volcanic activity in this area and contributes to our knowledge of history of Lake Bonneville.

Tx-1305. Fillmore Caliche, 14 **3600 ± 90**

From lava in and around entrance to Cold Tunnel (dug in one of more recent lava flows), 11.3km W of Fillmore (38° 59′ N, 112° 28′ W). Roots from tunnel gave date of 660 ± 70 (Tx-1166; R, 1972, v 14, p 470), but may have been contaminated by more recent material. *Comment* (FMB): date obviously much too young; sample was contaminated or was made of rootlets that grew on flow at much later date.

Tx-1418. Aberdeen, Idaho 15 **>44,000**

Wood from 2.5cm layer of shell and slimy wood beneath 24cm of hard lava in Snake River Plain; coll from well drilled through lava, Bruce Beck home, 1.2km NE of Aberdeen, Idaho (42° 56′ N, 112° 51′ W). Coll 1971 by James Papadakis and subm by F M Bullard. *Comment* (FMB): date gives age for this particular lava flow, but relation of this flow to others in Snake River lava plain is not known.

Tx-1736. Crystal Ice Cave 1001, Idaho **2170 ± 90**

Charred root projecting beneath lava flow at entrance to Crystal Ice Cave (Kings Bowl on some maps), 29km W of Aberdeen, Idaho (42° 56′ N, 113° 15′ W). Same sample as X-1001, 2130 ± 130 (5730 half-life; Prinz, 1970, p 946, citing Edwin Olson). Same loc and possibly same plant as Tx-1164, 2090 ± 470, and Tx-1165, 2360 ± 150 (R, 1972, v 14, p 470). Coll 1967 by E H Swanson Jr and subm by F M Bullard. *Comment* (FMB): lava flow, which buried roots, issued from Great Rift during final phase of volcanic activity in this area; sample dates last activity from Great Rift.

Arco Caliche series, Idaho

Caliche samples from lava flows near Arco, Idaho. Coll 1970 and subm by F M Bullard.

Tx-1302. Arco Caliche, 11 **14,260 ± 230**

From Snake R lava blocks along rd to Minodoka, 12km S of Arco (43° 30′ N, 113° 17′ W). Lava at Craters of the Moon rests on this lava surface. *Comment* (FMB): date should be maximum for Craters of the Moon lavas; how much younger those lavas are at this point has not been determined.

Tx-1303. Arco Caliche, 12 **3840 ± 130**

From road cut on "old" rd to Arco, Lava Creek flow, 8km NE of headquarters of Craters of the Moon National Monument (43° 32′ N, 113° 30′ W). *Comment* (FMB): Lava Creek flow is believed to be first lava to issue from Great Rift; date marks beginning of volcanic activity on Great Rift.

Pyramid Island series, Nevada

Samples from shore of Pyramid Lake, Nevada, 20.1km N of Nixon (39° 59′ N, 119° 30′ W). Coll 1976 and subm by J O Davis, Nevada Archaeol Surv, Univ Nevada, Reno.

Tx-2542. Pyramid I, JOD 27/3/76-F **33,650 ± 1720**

Compressed wood from shore scarp of Pyramid Lake, ca 500m SE of Pyramid I, 2m above water level, 43cm above base of clay of Lower Member of Sehoo Fm, alt 1158.2m; 25cm above Marble Bluff ash bed; ca 180cm below Timber Lake ash bed.

Tx-2596. Pyramid I, JOD 1/12/76-A **29,000 ± 980**

Black sulphurous clay, ca 500m SW of Pyramid I, near stake 30m S, 40cm above water level, 60cm below Timber Lake ash bed, ca 145cm above Marble Bluff ash bed.

Popcorn Rocks series, Nevada

Wood samples from wave-cut scarp at present shore, SW side of mouth of Truckee R, S extremity of Pyramid Lake (31° 51′ N, 119° 28′ W). Coll 1975 and subm by J O Davis.

Tx-2338. Popcorn Rocks, JOD 8/6/75-E **24,480 ± 430**

Juniperus sp from sulphurous clay (Lower Member of Sehoo Fm) conformably 10cm above Wono Bed of volcanic ash 5 to 10cm thick (Davis, 1977a). *Lab Comment*: sample counted 72hr.

Tx-2563. Popcorn Rocks, JOD 29/5/76-A **11,490 ± 130**

From top of same clay depositional unit as Tx-2338 (above), 50 to 100cm above Wono bed.

General Comment on Pyramid Island and Popcorn Rocks series (JOD): dates show Lower Member of Sehoo Fm (Lake Lahontan) deposited from ca 35,000 BP to ca 11,500 BP. Thus Lower Sehoo spans, rather than follows, Farmdalian Substage. Suggests most of Broecker's dates (Broecker & Orr, 1958; Broecker and Kaufman, 1956) are from end of, or later

than, Early Sehoo. Dates provide time control for series of ash layers in homotaxial succession in clay at several localities near Pyramid Lake and Fallon (Davis, 1977a;b;c). Marble Bluff bed may be unnamed St Helens ash ca 35,000 BP (W-2653, -2661; R, 1977, v 19, p 340-341).

Tx-2398. Rodgers Dam, Nevada **Modern**

Wood roots and rootlets (sp unid) from exposure in E bank of Humbolt R, 50m S of Rodgers Dam, 3.2km NE of Lovelock, Nevada (40° 12′ N, 118° 26′ W); in sandy alluvium over hackly organic-rich clay. Stratigraphic assignment uncertain. Coll 1975 and subm by J O Davis. *Comment* (JOD): although sample is modern, deposit appears much older. Suspect modern root grew laterally from river bank into older deposit.

Tx-2399. Weber Dam, Nevada **2000 ± 60**

Charcoal and soil from possible hearth 4m below surface in small alluvial fan truncated by road cut, W side Walker R, 1.25km SSW of Weber Dam, Mineral Co, Nevada (39° 02′ N, 118° 52′ W). Fan was graded to lowest terrace of Walker R. Sample underlies 2 layers of rhyolitic tephra (Salt Wells member; Davis, 1977a,b) correlated with tephra in "Turupah Fm" near Fallon. *Comment* (JOD): date supports tephra correlation that "Turupah Fm" near Fallon is late Fallon in age. Suggests Salt Wells Member correlates with Mono Basin tephra described by Wood (1977). Dates latest aggradational episode on Walker River.

II. ARCHAEOLOGIC SAMPLES

Wallisville Reservoir, Texas

Samples from sites in Wallisville Reservoir Basin, Trinity F estuary, E of Houston, Texas. Previous dates from this basin are in R, 1970, v 12, p 263-266; 1975, v 17, p 76-80. Sites and dates below are discussed in Dillehay, 1975.

Wallisville miscellaneous series, Texas

Rangia cuneata shell samples, coll 1973 and subm by T D Dillehay, Texas Archaeol Survey, Univ of Texas, Austin.

Tx-1891. 41CH46/1 **1070 ± 70**

Test Pit 1, hearth area at 50cm depth, level 4; 41CH46, 2km SE of Interstate Hwy 10 at crossing of Trinity R on NW shore of Round Lake (29° 49′ N, 94° 46′ W). Transitional between Wallisville Plain and early Goose Creek Plain. *Comment* (TDD): date fits relatively well with previous Goose Creek Plain date of 1330 ± 50 (Tx-1205; R, 1975, v 17, p 81).

Tx-1892. 41CH32/1 **2880 ± 110**

Test Pit 1, Area A, Level 8, Site 41CH32, 1.8km NE of Interstate Hwy 10 crossing of Trinity R (29° 50′ 55″ N, 94° 45′ 40″ W). From dense shell lens, assoc with bone fragments and coarse sandy-paste plainware ceramics. Level 8 exclusively contained Goose Creek Plain. *Comment* (TDD): date is unexpectedly early.

Tx-1893. 41CH32/2 **1870 ± 80**

Test Pit 2, Area B, Level 9, Site 41CH32 (see Tx-1892, above). Earliest ceramic level, assoc with early sandy paste and grog-tempered wates (San Jacinto Plain). *Comment* (TDD): date indicates beginning of manufacture of San Jacinto Plain in area.

Tx-1894. 41CH47/1 **1480 ± 80**

Test Pit 1, Level 2, Site 41CH47, 12.8km NE of Anahuac, 3.2km S of Interstate Hwy 10 and 1.8km W of Trinity R in Mayes Marsh (29° 50′ 00″ N, 94° 45′ 85″ W). Stratum between Goose Creek and Wallisville Plain ceramic types; assoc with early Goose Creek sherd and large mammal bones. *Comment* (TDD): date agrees with evidence for transition from Wallisville Plain to Goose Creek Plain (Ambler, 1967, p 74-76).

Tx-1895. 41CH47/2 **2230 ± 110**

Test Pit 1, Level 7, Site 41CH47 (see Tx-1894, above). Assoc with lithic debitage, no ceramics. *Comment* (TDD): agrees well with previous preceramic date of 2370 ± 80 (Tx-1067; R, 1975, v 17, p 82).

Wallisville 41CH110 series, Texas

Shell samples from Site 41CH110, 0.8km N of Interstate Hwy 10 (29° 50′ 32″ N, 94° 46′ 33″ W). Subm to supplement stratigraphic evidence in area where little is known about post-AD 800 sequence. Coll 1972 and subm by K Gilmore, Texas Archaeol Survey, Univ Texas, Austin.

Tx-2022. 41CH110/1 **500 ± 60**

N116 W102, SESE; upper shell zone.

Tx-2023. 41CH110/2 **390 ± 50**

N116 W102, NENE; 2nd shell zone.

Tx-2024. 41CH110/3 **800 ± 80**

N116 W102, SESE; 3rd shell zone.

Tx-2025. 41CH110/4 **760 ± 60**

N116 W102, NESE; 4th shell zone.

Tx-2026. 41CH110/5 **410 ± 60**

N116 W102, NESW; 10 to 20cm below surface.

Tx-2027. 41CH110/7 **740 ± 70**

N116 W110, NESW; 20 to 30cm below surface.

Tx-2029. 41CH110/8 **880 ± 60**

N116 W102, SWNE; 30 to 40cm below surface.

Tx-2030. 41CH110/9 **560 ± 50**

N116 W102, SWNE; 40 to 50cm below surface.

Tx-2031. 41CH110/10 **620 ± 60**

N114 W112, NESE; shell zone.

General comment (KG): with adjustment in shell dates by 150 to 250yr for established difference from charcoal samples in this area (R, 1975, v 17, p 76-77), these dates are consistent with early historic context of glass trade beads found in uppermost zones. Reversal of dates by depth, especially Tx-2030, may indicate shifting of occupation zones by physical processes subsequent to deposition.

Cooper Reservoir, Texas

Charcoal samples from sites in Cooper Reservoir basin on S Sulphur R, Delta and Hopkins Cos, NE Texas. Sites (except for Arnold site) are described in Hyatt *et al,* 1974. All samples coll by R D Hyatt and subm by Hyatt and R E Larson, Dept Anthropol, Southern Methodist Univ, Dallas, Texas.

Tx-1961. Lawson D **2080 ± 60**

Charcoal from hearth, Sq 9, 25cm level, Lawson site (X41HP7), 5.6km SE of Cooper, 200m S of S Sulphur R, 1.6km downstream from confluence with Moore Creek (33° 19′ 26″ N, 95° 38′ 53″ W). Coll 1972.

Tx-1962. Cox E **1110 ± 120**

Charcoal from Cox site (X41HP37), 6.2km SE of Cooper, 370m E of S Sulphur E, 0.4km downstream from confluence with Moore Creek (33° 18′ 52″ N, 95° 38′ 21″ W). Sq 145, 12 to 19cm level, stratum containing early Caddoan ceramics. Coll 1973.

Thomas site series

Charcoal from Thomas site (X41DT68), 4.8km SE of Cooper, 1.6km NE of Harper's Crossing, 91m N of S Sulphur R (33° 19′ 17″ N, 95° 38′ 38″ W). Coll 1972.

Tx-1958. Thomas A **1220 ± 350**

Sq 88, 25 to 30cm level, assoc with fire-cracked rock, lithic debris, Alto focus ceramics.

Tx-1959. Thomas B **1180 ± 220**

Sq 88, 85 to 92 cm level, Archaic, assoc with ash, fire-cracked rock, lithic debris.

Arnold site series

Charcoal from Arnold site (X41HP34), 7.7km S of Cooper, 0.6km SW of S Sulphur R (33° 18′ N, 95° 40′ W). Cultural remains are Gibson aspect Caddoan, possibly Alto focus. Coll 1974.

Tx-2041. Arnold 130-9 **970 ± 90**

Sq 130, 42.5cm.

Tx-2042. Arnold 161-7 **1410 ± 920**
Sq 161, 31cm. Large error due to small sample size.

Tx-2043. Arnold 115-10 **1010 ± 90**
Sq 115, 50cm.

Tx-2044. Arnold 219-6 **680 ± 100**
Sq 219, 27cm, near burial.

Tx-2045. Arnold 177-5 **730 ± 210**
Sq 177, 20 to 25cm, near skull of burial, Feature 177A.

Tx-2046. Arnold 72-5 **1690 ± 160**
Sq 72, 24cm.

Tx-2047. Arnold 145-11 **1040 ± 360**
Sq 145, 52cm.

Tx-2048. Arnold 117-6 **830 ± 110**
Sq 177, 25.5cm.

Tx-2049. Arnold 129-7 **510 ± 90**
Sq 129, 34.5cm.

General Comment on Cooper Reservoir dates (REL): dates are close to what was expected, except for Tx-2049 which is a bit more recent than anticipated.

Other Texas Samples

Steadman site series, Texas

Charcoal in soil from Steadman site (41FS2) 16km NW of Noodle, Texas (32° 41′ 30″ N, 100° 09′ 00″ W). Sample is from large feature which is either assoc with a Folsom component or is of later origin. Coll 1970 and subm by C D Tunnell, State Archaeologist, Texas State Hist Comm, Austin.

Tx-1171. Steadman #2 **2200 ± 110**
Test Pit #9, Profile 1 in SW corner.

Tx-1172. Steadman #1 **2150 ± 90**
Test Pit #9, depth 22cm.

General Comment (CDT): feature is evidently of much later origin than Folsom component.

Tx-1928. Hogge Bridge, Texas **950 ± 70**

Charcoal from Hogge Bridge site (41COL1; Stephenson, 1952), E fork Trinity R, ca 5km NE of Wylie, Texas; ca 60km SE of Hogge Bridge crossing (33° 02′ 45″ N, 96° 30′ 00″ W). From Trench Sec A-2, 30 to 45cm below ground surface, in midden next to main pit structure, ca 12.2m SE of pit rim; assoc with Wylie focus material. Coll 1951 by R L Stephen-

son; subm by W S Marmaduke, Dept Anthropol, Univ Texas, Austin. *Comment* (WSM): supports estimated age of AD 1000 for Wylie focus (Marmaduke, 1975).

Sister Grove Creek series, Texas

Charcoal from Sister Grove Creek site (X41COL36), W bank of Sister Grove Creek, 800m S of Hwy 380, 9.6km W of Farmersville, N Texas (33° 09′ N, 96° 26′ W). Subm to establish age of Wylie focus ceremonial pit and assoc features. Coll 1974 and subm by M J Lynott, Archaeol Research Prog, Southern Methodist Univ, Dallas, Texas.

Tx-2033. Sister Grove Creek 226 **360 ± 70**

Hearth in pit, 48N/20E; should date use of ceremonial pit.

Tx-2034. Sister Grove Creek 227 **970 ± 200**

Hearth from lowest level in pit, 39N/27E; should date construction of ceremonial pit.

Tx-2036. Sister Grove Creek 229 **570 ± 80**

From concentration of oxidized clay and fire-cracked rocks, 54N/24E; should date use of ceremonial pit.

Tx-2037. Sister Grove Creek 238 **770 ± 70**

Hearth in ceremonial pit, 42-44N/18-20E; should date use of pit.

Tx-2038. Sister Grove Creek 241 **1000 ± 240**

Hearth in pit, 45N/28E; should date use of ceremonial pit.

Tx-2039. Sister Grove Creek 242 **620 ± 80**

Trash pit, 90-95S/55-60E; outside ceremonial pit.

Tx-2040. Sister Grove Creek 246 **790 ± 90**

Burial, 86S/52E; ca 100m S of ceremonial pit.

General Comment (MJL): dates (discussed in Lynott, 1975, p 69-70) indicate Wylie focus occupation occurred earlier than previously estimated. Dates agree with bone dates from same site (*ibid,* p. 70).

Hopewell School series, Texas

Charcoal from Hopewell School site (X41SV30), on first terrace 10m above Squaw Creek, 6.5km NE of Glen Rose, ca 70km SW of Fort Worth, Texas (32° 17′ 30″ N, 97° 45′ 20″ W). Late Edwards Plateau Archaic occupation, mixed component. Coll 1974 and subm by J G Gallagher, Archaeol Research Program, Southern Methodist Univ, Dallas, Texas.

Tx-2050. Hopewell School 389-9 **50 ± 60**

Hearth, Block C, Sq 389, Feature A.

Tx-2051. Hopewell School 360-73 **190 ± 60**

From within skeleton soil, Block C, Sq 360, Feature A.

Tx-2052. Hopewell School 360-72 **200 ± 60**

Same provenience as Tx-2051, above.

Tx-2064. Hopewell School 2208-1 **560 ± 110**

From bone and shell midden, Block BB, Sq 2208, Level 1.

General Comment (PGG): dates too recent for Edwards Plateau Archaic. For detailed discussion see Gallagher and Bearden, 1976, p 81-82.

Northlake series, Texas

Charcoal from Northlake site (X41DL8), 0.3km S of Ledbetter Rd on Leslie dairy farm, SE of Coppell, Dallas Co, Texas (32° 56′ N, 97° 57′ W). Assoc with Carrollton and Elam focus materials of Archaic stage, and pottery; possibly disturbed. Coll 1972, 1974 and subm by T R Hays, Inst Appl Sci, N Texas State Univ, Denton, Texas.

Tx-2066. Northlake 4 **1000 ± 100**

Level 3, A&B; ceramic level.

Tx-2123. Northlake 2 **Modern**

Level 6; lowest level, aceramic.

Tx-2308. Northlake 3 **1130 ± 170**

Level 6; aceramic.

General Comment (TRH): Tx-2066 and -2308 place levels in correct chronologic position and indicate site has not been disturbed. Dates also indicate when pottery first appeared in area, and provide estimate of length of occupation. No explanation apparent for Tx-2123, anomalous modern date.

Tx-2124. Palmetto Bend 41JK91/C4, Texas **2400 ± 90**

Charcoal from hearth, Feature 2, bottom of natural level 7, 3x3m unit, Site 41JK91, 2nd terrace W bank Navidad R, 11.2km SE of Edna, Jackson Co, Texas, in Palmetto Bend Reservoir basin (28° 53′ 18″ N, 96° 34′ 58″ W). Assoc with Abasolo point and other Archaic material. Coll 1974 by Jackson and McGuff and subm by D S Dibble, Texas Archaeol Survey, Univ Texas, Austin. *Comment* (W B Fawcett & P R McGuff): date agrees with dates for Archaic stage (pre-AD 1000) in other parts of Texas coast (see comment, R, 1970, v 12, p 265).

Tx-2482. Hop Hill, Texas **230 ± 70**

Charcoal from postulated fire hearth in Hop Hill site (41GL21), ca 26.5km E of Fredericksburg, 300m S of Pedernales R, central Texas (30° 14′ N, 98° 36′ W). From Zone #2, 1000E/101N, Strata 2-1, 14cm depth, believed to be Twin Sisters substage, central Texas Archaic. Coll 1976 and subm by J D Gunn, Center for Archaeol Research, Univ Texas, San Antonio. *Comment* (JDG): date indicates sample is intrusive root, charred in recent burning of vegetation.

Tx-2539. San Gabriel 41WM53, Texas **1620 ± 70**

Charcoal from Site 41WM53, on N fork of San Gabriel R, ca 7km NW of Georgetown, central Texas (30° 39′ N, 97° 43′ W); Area E, Test Sq D, Level 5, assoc with Bulverde points. Coll 1976 and subm by T R Hays, Inst Appl Sci, North Texas State Univ, Denton, Texas. *Comment* (TRH): date agrees fairly well with geol interpretation but is later than expected in terms of projectile point chronology for central Texas.

Tx-2675. Loeve site WM-CS-1, Texas **8500 ± 130**

Charcoal from hearth exposed in stream bank ca 4m below present surface in Loeve site (41WM133), 6.3km downstream from Hwy 95 on left bank of San Gabriel R, central Texas (30° 39′ 35″ N, 97° 24′ 30″ W). Early Archaic component. Coll 1977 and subm by E P Baxter, Anthropol Research Labs, Texas A&M Univ, College Station, Texas. *Comment* (EPB): date is appropriate for central Texas Archaic. Previous dates from site (Tx-802, 7000 ± 160, and Tx-805, 6900 ± 110; R, 1970, v 12, p 633) were from hearth believed to be stratigraphically higher; dates support this relationship. This is earliest date from San Gabriel R basin.

Chayah site series, Texas

Carbonized nuts and wood from Chayah site (41NA44), single-component late prehistoric Caddoan site ca 22.5km W of Nacogdoches, E Texas, on FM 225 (31° 36′ N, 94° 52′ W). From Area M, assoc with Patton Engraved pottery, a type often found elsewhere in this area with European trade goods. Coll 1976 and subm by J E Corbin, Dept Sociol, Stephen F Austin State Univ, Nacogdoches, Texas.

Tx-2639. Chayah 215 **1110 ± 70**

N62-W197, SU #9, 30 to 40cm.

Tx-2640. Chayah 425 **420 ± 80**

N62-W195, SU #5, 30 to 40cm.

Tx-2799. Chayah 420 **630 ± 50**

N60-W195, SU #1, 40 to 50 cm.

Tx-2800. Chayah 210 **670 ± 140**

Another part of same sample as Tx-2639, above.

General Comment (JEC): except for Tx-2640, dates do not pertain to occupation of site, which on total archaeol evidence dates from 350 ± 100BP. Samples represent all carbonized plant material coll on fine screen from excavation units indicated. Evidently this method of collecting samples from a sandy, gopher-disturbed site cannot be expected to produce valid results. Tx-2639 and Tx-2800, different parts of same sample, emphasize this problem.

Hinds Cave series, Texas

Charcoal from Hinds Cave (41VV456; Shafer and Bryant, 1977), W side of Still Canyon, 3.2km above confluence with Pecos R, Val Verde Co,

SW Texas (29° 53′ 30″ N, 101° 26′ 12″ W). All samples from early Archaic context. Coll 1975 and subm by H J Shafer, Archaeol Research Lab, Texas A&M Univ, College Station, Texas.

Tx-2314. Hinds Cave 1 **8280 ± 80**

Unit D-2, Level 7, 100 to 101cm depth, white ash lens. *Comment* (HJS): dates hitherto undated sandal forms and other perishable material contained in lens; is earliest date thus far for this cave occupation.

Tx-2315. Hinds Cave 2 **7220 ± 60**

Trench B-E, Level 4, 60 to 80cm depth, coprolite lens. *Comment* (HJS): provides date for latrine area which yielded "Early Barbed" dart point.

Tx-2316. Hinds Cave 3 **6750 ± 100**

Unit C, Level 10, possible remains of rock-lined pit. *Comment* (HJS): dates one of series of deep cultural lenses in Area C of cave. "Early Barbed" dart points in assoc deposits.

Tx-2466. Baker Cave C, Texas **9020 ± 150**

Charcoal from hearth in Zone 1 (Golondrina point horizon) in Baker Cave (41VV213; Word and Douglas, 1970), midway between Comstock and Juno, SW Texas, on dry tributary of Devils R (29° 59′ N, 101° 06′ W). Coll 1976 and subm by T R Hester, Center for Archaeol Research, Univ Texas, San Antonio. *Comment* (TRH): date agrees with Tx-128, 8910 ± 140, and Tx-129, 9030 ± 230, from same stratum in site (R, 1965, v 7, p 305, where stratum is called "Zone 8;" it is "Zone I" in Word and Douglas, 1970). Faunal and floral assoc indicate somewhat more mesic climate, with xeric conditions beginning ca 7500 BP (Hester, 1978).

Other States

Shallow Lake Site series, Arkansas

Fragments of burned log supports from floor of Structure 1 beneath Mound C, Shallow Lake site (3UN52), early Caddoan site 0.8km W of Shallow Lake, Lapoile Creek drainage, Arkansas (33° 08′ N, 92° 10′ W). Coll 1975 (except as noted) and subm by P Stacy, Arkansas Archaeol Survey, Univ Arkansas at Monticello.

Tx-2623. Shallow Lake 75-379-20 **660 ± 80**

Center of Sq 10.

Tx-2624. Shallow Lake 75-379-25 **470 ± 130**

Sq 6M.

Tx-2625. Shallow Lake 75-379-28 **720 ± 60**

Sq 7.

Tx-2626. Shallow Lake 75-379-30 **650 ± 60**

SE quad of Sq 5.

Tx-2627. Shallow Lake 72-531-60 **1890 ± 390**

Test pit 10, top of midden. Coll 1972 by J Lischka.

General Comment (PS): Tx-2623, -2626 support archaeo-magnetic date of AD 1302 ± 23 from central hearth of Structure 1 (Stacy, written commun); they are slightly later than ceramic estimate of AD 1100-1200. Tx-2624 slightly later, but not significantly so. Tx-2627 is anomalous; presumably relevant to midden beneath structure, not to structure.

Tx-2190. Perry Ranch Bison, Oklahoma **7030 ± 190**

Apatite fraction of *Bison antiquus* bone from Perry Ranch site (34JK81), on Turkey Creek, tributary of Salt Fork of Red R, SW Oklahoma (34° 40′ N, 99° 40′ W). Assoc with Plainview point. Coll 1974 and subm by R S Saunders, Oklahoma Archaeol Survey, Univ Oklahoma, Norman. *Comment* (RSS): date indicates later portion of Plainview time range as now understood.

Tx-2408. Waurika 1, Oklahoma **630 ± 100**

Charcoal from Waurika site (34St26), N bank of Beaver Creek, Stephens Co, S central Oklahoma (34° 19′ N, 98° 07′ W). Sample eroding from creek bank, 2m below surface, assoc with lithic debitage. Coll 1976 by S Hall and subm by T R Hays, Inst Appl Sci, N Texas State Univ, Denton, Texas. *Comment* (TRH): dates alluvial deposit and may be related to cultural material. Other sites in area have been subjected to severe erosional activity and are not in primary context.

Tx-2816. Mahaffey, Oklahoma **1920 ± 70**

Charcoal from Feature 3, trash pit, 50cm depth, in Mahaffey site (Ch-1), McCurtain focus (late Caddoan) site on peninsula on E side Hugo Lake, Choctaw Co, Oklahoma (34° 02′ 50″ N, 95° 23′ 45″ W). Coll 1977 and subm by G Perino, Mus of the Red River, Idabel, Oklahoma. *Comment* (GP): date >1000yr too old for McCurtain focus, reason for discrepancy unknown; assocs with McCurtain pottery were good.

Tx-2285. X29ED13, 0-0-19, New Mexico **5810 ± 290**

Charcoal from buried hearth in alluvium, exposed in arroyo cut 65 to 75 cm below surface, site X29ED13, 9km S of McMillan Dam, E side of Pecos R, 6.6km SE of Seven Rivers, Eddy Co, New Mexico (32° 32′ 50″ N, 104° 22′ 30″ W). Coll 1975 and subm by J G Gallagher, Archaeol Research Prog, Southern Methodist Univ, Dallas, Texas. *Comment* (JGG): date refers to diffuse occupation represented only by lithic debris and hearth.

Tx-2717. M-362/V1-6c, New Mexico **1250 ± 330**

Charcoal from earth in 2 early Mogollon vessels containing shell jewelry, site M-362/V1-6c, New Mexico, ca 96km NNE of El Paso, Texas (32° 30′ 36″ N, 105° 45′ 30″ W). Coll 1975 and subm by W Wooldridge, Texas Archaeol Survey, Univ Texas, Austin. *Comment* (WW): date con-

sistent with typologic features of vessels, although pre-AD 1000 was expected.

Placitas Arroyo series, Mexico

Charcoal from 3 early Mogollon sedentary sites, in Placitas Arroyo subwatershed, 5km SW of Hatch, New Mexico (32° 40′ N, 107° 09′ W). Subm to establish date for shift to sedentism in this region. Coll 1976 and subm by E P Morenon, Inst Appl Sci, North Texas State Univ, Denton, Texas.

Tx-2613. Placitas Arroyo 2, 272 **1690 ± 70**

Site 2, burned post in Pithouse 1; Mogollon 1.

Tx-2614. Placitas Arroyo 2, 297 **1260 ± 70**

Site 2, from hearth in magnetometer-defined anomaly; assoc with Mesilla phase artifaces but in unsealed context near surface.

Tx-2615. Placitas Arroyo 2, 448 **1440 ± 70**

Site 2, burned post in subfloor pit, Pithouse 1; Mogollon 1.

Tx-2616. Placitas Arroyo 2, 453 **1540 ± 70**

Site 2, burned post in Pithouse 1; Mogollon 1.

Tx-2618. Placitas Arroyo 5, 124 **2030 ± 80**

Site 5, possible hearth within a paleosol, assoc with Hueco to Mesilla phase artifacts but in unsealed context near surface.

Tx-2619. Placitas Arroyo 8, 262 **1750 ± 60**

Site 8, burned roof post from Pithouse 2; Mogollon 1.

Tx-2620. Placitas Arroyo 8, 333/528 **900 ± 70**

Site 8, carbonized wood from subfloor pit in Pithouse 2; Mogollon 1. *Comment* (EPM): context apparently well-sealed, but sample may be intrusive tree root since wood was carbonized rather than burned. Trees are rare on these sites today, being mainly confined to arroyo bottoms.

Tx-2621. Placitas Arroyo 8, 473 **1580 ± 70**

Site 8, burned roof fall from Pithouse 4; Mogollon 1.

Tx-2622. Placitas Arroyo 8, 556 **1720 ± 70**

Site 8, post from Pithouse 4; Mogollon 1.

General Comment (EPM): by 2000 BP (Tx-2618), horticulturists were using Placitas Arroyo at open-air sites. Later, tight cluster of dates for pithouses from Sites 2 & 8 shows sedentary Mogollon 1 village in use ca 1700 to 1500 BP. This is unusually early for Jornada branch of Mogollon, but agrees with recent evidence from Mogollon Rim to W. At Site 2, Mesilla phase follows Mogollon 1; Tx-2614 date agrees with traditional age estimate of Mesilla phase.

Tx-2128. Lehner site A, Arizona **10,160 ± 140**

Charcoal from upper portion of Unit F_2, Lehner site (Ariz:EE:12:1), W side of San Pedro R, Cochise Co, Arizona (31° 25′ 23″ N, 110° 06′ 48″ W). Coll 1974 by N Ajeman and subm by C V Haynes, Dept Anthropol, Univ Arizona, Tucson. *Comment* (CVH): sample slightly above Clovis surface; dates post-Clovis occupation of site.

Tx-2541. Last Supper Cave, Nevada **8960 ± 190**

Charcoal from Last Supper Cave (26Hu102), N side of canyon overlooking Hell Creek, 2.5km from confluence with Virgin Creek, Nevada (41° 44′ N, 119° 10′ W). From "shell stratum" below Mazama ash, assoc with Parman series and Cougar Mt projectile points. Coll 1974 and subm by J O Davis, Nevada Archaeol Survey, Univ Nevada, Reno. *Comment* (JOD): date is significantly older than WSU-1706, 8260 ± 90 (J O Davis, written commun), on another part of same sample. Generally agrees with dates on pelecypod shells from same stratum: LSU-120, 8790 ± 350 (T Layton, written commun) and WSU-1431, 8630 ± 195 (R, 1976, v 18, p 145). All these dates are significantly younger than 10 dates on Lake Mohave points from Smith Creek Cave, which are ca 9300 to 11,700 BP (R, 1977, v 19, p 318-319). Apparently Lake Mohave, Parman, and Cougar Mt points span at least 2000yr, from ca 10,500 to 8500 BP.

Tx-2714. Kachina Cave, Nevada **1350 ± 70**

Charcoal from pine nut cache in juniper-bark-lined pit, Kachina Cave (26WP69), N side Smith Creek Canyon, ca 29km N of US Hwy 50 crossing of Nevada-Utah border (39° 21′ N, 114° 06′ W). Feature 2, Unit C-10, 30cm BD. Coll 1971 and subm by D R Tuohy, Dept Anthropol, Nevada State Mus, Carson City. *Comment* (DRT): dates earliest use of pine nuts by inhabitants of Smith Creek caves; adds to chronology of Baker phase. Previous Kachina Cave dates are in R, 1977, v 19, p 319.

Wortham Shelter series, Wyoming

Wood from 2 arrowshaft fragments, surface of woodrat midden, Sq D1, Wortham Shelter (48BH730) E side Bighorn Canyon, N end of Little Mt Plateau, Wyoming, 0.6km S of Montana state line (44° 59′ 30″ N, 100° 14′ 00″ W). Assoc with Avonlea style arrowpoints. Coll 1975 and subm by J W Greer, Dept Anthropol, Univ Missouri, Columbia.

Tx-2715. Wortham, Lot 9, 1 **1230 ± 90**

Tx-2716. Wortham, Lot 9, 2 **1230 ± 70**

General Comment (JWG): dates agree with previous estimates of Avonlea phase materials in Montana and Canada.

Mexico, Belize

Monte Albán series, Mexico

Charcoal from Monte Albán (B86-91), immediately SW of Oaxaca City, Mexico (17° 02′ N, 96° 47′ W). Subm to define chronology of Monte

Albán ceramic sequence. Coll 1972-73 by M C Winter and subm by D M Varner, Dept Anthropol, California State Univ at Fresno.

Tx-1814. Monte Albán MA72/2 **1350 ± 80**

Feature 20; assoc with late Period I ceramics. *Comment* (MCW): see Tx-1816, below.

Tx-1815. Monte Albán MA72/3 **1210 ± 100**

Feature 19, assoc with Period IIIB ceramics. *Comment* (MCW): date indicates contemporaneity with Period IV at site of Lambityeco in Valley of Oaxaca. Relation between Periods IIIB and IV remains to be clarified in terms of ceramics as well as chronology. Tx-1814-1816 probably date latest occupation at residential area excavated at Monte Albán in 1972 and 1973.

Tx-1816. Monte Albán MA72/4 **1230 ± 80**

Feature 20, 96.8 to 96.9cm depth; assoc with early Period III ceramics. *Comment* (MCW): this date and Tx-1814, above, suggest that midden deposit, Feature 20, was laid down in Period IIIB (Tx-1815) and that dated charcoal does not correspond in time with late Period I and early Period II sherds that occurred in deposit.

Tx-1918. Monte Albán MA72/45.5 **1560 ± 100**

Feature 45, 93.45cm depth, NE bottom; assoc with Period I/II ceramics. *Comment* (MCW): date is several centuries too late for late Period I context; no evident reason.

Tx-1919. Monte Albán MA73B/69.9 **2470 ± 50**

Feature 69, 92.68 to 92.58cm depth, Level IA; assoc with early Period I ceramics. *Comment* (MCW): see Tx-1921, below.

Tx-1920. Monte Albán MA73/73.7 **1790 ± 70**

Center of Feature 73, 91.26cm depth; assoc with Period II ceramics. *Comment* (MCW): date consistent with Period II context.

Tx-1921. Monte Albán MA73B/77.9 **2530 ± 50**

Feature 77, 93.0 to 42.0cm depth, Quads NW, SW; assoc with Period I ceramics. *Comment* (MCW): this date and Tx-1919, above, appear to date initial occupation of residential area excavated at Monte Albán in 1972 and 1973.

Tx-2402. Blue Creek #1, Belize **1420 ± 60**

Charcoal from Blue Creek site, on 92m rise W of village of Blue Creek, N Belize (17° 50′ N, 88° 55′ W). From Burial #1 in trench through Mound B-1; late Classic. Coll 1976 and subm by M B Nievens, Univ de las Americas, Puebla, Puebla, Mexico. *Comment* (MBN): date slightly earlier than pottery assocs suggest, but not impossible. Date is one of few clues for placing site in chronologic sequence.

Tx-2403. El Pozito #1, Belize **1860 ± 60**

Charcoal from El Pozito site, SW of Orange Walk, midway between villages of Guinea Grass and August Pine Ridge, N Belize (18° 00′ N, 88° 40′ W). From chamber fill of Mound B-VIII, alt 98.58m; assoc with late Chicanel ceramics. Coll 1976 and subm by M B Nievens. *Comment* (MBN): date confirms estimate by ceramics and dates construction of earliest architecture at site.

Venezuela, Ecuador

Campoma series, Venezuela

Charcoal assoc with pottery from Campoma site (Wagner, 1972a,b), near E shore Lake Campoma, 8km NE of Cariaco, Dist Ribero, Estado Sucre, E Venezuela (10° 30′ N, 63° 35′ W). Coll 1971 and subm by E Wagner, Dept Antropol, IVIC, Caracas, Venezuela. Each sample was broken into 3 parts which were prepared and counted separately. Individual dates are given; final date is average. Figures after title denote trench no. and level.

Tx-1433. Campoma EW1, C-3, 0.0-0.25m **700 ± 50**

700 ± 70; 650 ± 110; 760 ± 80.

Tx-1434. Campoma EW3: D-3, 0.50-0.75m **720 ± 40**

700 ± 70; 800 ± 70; 670 ± 70.

Tx-1435. Campoma EW4: D-1, 0.25-0.50m **750 ± 40**

740 ± 70; 770 ± 80; 750 ± 80.

General Comment (EW): dates fit well into expected protohistoric Period IV (AD 1000 to 1500) occupation of regional chronology. Previously, chronology was based entirely on stylistic comparisons.

El Jobal series, Venezuela

Charcoal from El Jobal site (Wagner, 1973a;b), ca 5km SE of Aqua Viva, Dist Valera, Estado Trujillo, W Venezuela (9° 30′ N, 70° 37′ W). Coll 1972 and subm by E Wagner. Figures after title denote trench no. and level.

Tx-1576. El Jobal EW1-1: B-2, 0.25-0.50m **1530 ± 50**

Tx-1577. El Jobal EW3-1: B-2, 0.75-1.00m **1680 ± 70**

Tx-1578. El Jobal EW4-1: B-2, 1.00-1.25m **1670 ± 70**

Tx-1579. El Jobal EW6.1: B-1, 0.25-0.50m **1520 ± 50**

General Comment (EW): dates are consistent. Closely related pottery belonging to Betijoque style (Cruxent & Rouse, 1958, p 148) from nearly Los Tiestos site not adequately dated yet, due to lack of organic material. Present dates place El Jobal and Betijoque in Period III (AD 300 to 1000) of regional chronology, which fits well into W Venezuelan chronology.

Lagunillas U-52 series, Venezuela

Samples from Lagunillas U-52 site (Wagner, 1974; 1976), ca 2km E of Lagunillas, Estado Zulia, ca 200m from Shell Oil Wells 1951 and 2093 (10° 10′ N, 71° 20′ W). Formerly part of Lake Maracaibo but not under water since dam built in 1939. Coll 1974 and subm by E Wagner.

Tx-1945. Lagunillas 6 **1170 ± 60**

Rotted wood pole fragment from Trench A, in vertical position, depth of upper part of pole ca 1m.

Tx-1946. Lagunillas 7 **1280 ± 60**

Peat (turba), Test Trench 2, ca 1.5m depth. Could date draining of lake.

Tx-1947. Lagunillas 8 **1310 ± 50**

Rotted wood pole fragment from Test Trench 1, in vertical position, ca 2m depth.

Tx-1948. Lagunillas 9 **2430 ± 60**

Charcoal fragments in earth from Trench A, 0.30 to 1.10m depth.

Tx-1949. Lagunillas 10 **2390 ± 60**

Charcoal from Trench A, 0.30 to 1.10m depth.

Tx-1950. Lagunillas 11 **2160 ± 80**

Charcoal from Trench 1, 1.30 to 1.50m depth.

Tx-1951. Lagunillas 12 **2330 ± 70**

Charcoal from Trench B, 0.10 to 0.25m depth.

General Comment on Tx-1945—Tx-1951 (EW): Tx-1948-1951 were assoc with pottery of newly established Lagunillas phase (Wagner & Tarble de Ruíz, 1975). Dates are consistent and agree with expected ages, and with related material from Venezuela and Colombia. Tx-1945-47 are more recent and may date draining of lake.

Tx-2272. Lagunillas 13 **300 ± 70**

Wood fragments 100m S of Trenches A & B, from upper portion of pole protruding ca 1m above ground.

Tx-2273. Lagunillas 14 **400 ± 50**

Same as Tx-2272, above; 0.5m above ground.

General Comment on Tx-2272, -23 (EW): dates fit well into expected early historic period (after AD 1500), and confirm information provided by historic sources. Assoc pottery very different from Lagunillas phase pottery.

Bachaquero series, Venezuela

Samples from Trench E, Bachaquero site E, between towns of Bachaquero and Lagunillas near "La curva del Indio", Pueblo Viejo,

on Rd GG-82, near Oil Well 1737, Estado Zulia, Venezuela (10° 00′ N, 71° 10′ W). Assoc with Dabajuroid ceramics; subm to confirm relative dating of Dabajuro IV and V of regional chronology. Coll 1974 and subm by E Wagner.

Tx-2270. Bachaquero 1, bone apatite **550 ± 70**

Mammal bones, 0.15 to 0.25m depth.

Tx-2271. Bachaquero 2, snail shells **420 ± 50**

Depth 0.25 to 0.50m.

General Comment (EW): dates confirm relative date for Dabajuro as belonging to Periods IV and V of regional chronology, AD 1000 to after AD 1500.

El Diluvio series, Venezuela

Charcoal from sites near Hacienda El Diluvio, Dist Perija, Estado Zulia, Venezuela (10° 37′ N, 72° 23′ W). Assoc with pottery and stone tools related to Rancho Pueblo of Dabajuroid tradition. Subm to confirm regional chronology. Coll 1976 and subm by E Wagner.

Tx-2409. El Diluvio 1, DIL-1 **7410 ± 440**

Trench 1, level 0.25 to 0.50m, El Diluvio Site 1, E bank of R Palmar, 350m from main building of hacienda.

Tx-2410. El Diluvio 2, DIL-2 **1240 ± 170**

Trench 8B, level 0 to 0.25m, El Diluvio Site 2, in sugar cane field next to main bldg of hacienda.

Tx-2411. El Diluvio 2, DIL-3 **9850 ± 250**

Same location as Tx-2410, level 0.25 to 0.50m.

Tx-2412. El Diluvio, DIL-4 **3490 ± 240**

Same location as Tx-2410; Trench 9B, level 0.25 to 0.50m.

Tx-2413. El Diluvio 2, DIL-5 **8800 ± 100**

Same location as Tx-2410; Trench 10B, level 0.20m.

General Comment (EW): Tx-2409, -2411, -2413 seem too old and probably consisted of a mixture of charcoal (from recently cut trees) and coal (from Tertiary coal deposits common in Perija region). Dates for Tx-2410 and -2412 are reasonable. Additional dates are needed to refine and confirm regional chronology.

Alangasi Mastodon Locality series, Ecuador

Samples of wood from Alangasi Mastodon Locality, near Alangasi, Ecuador (0° 17′ S, 78° 24′ W). Samples are from trees buried in Late Cangagua, volcanic ash deposit of widespread occurrence around Mt Ilalo. Tx-1126-1130 from Site 1, 5m or more deep in side of quebrada; Tx-1131 from Site 2, ca 60m downstream from Site 1, 8 to 10m deep.

Coll 1970 and subm by R E Bell, Dept Anthropol, Univ Oklahoma, Norman.

Tx-1126. Alangasi Site 1, A **>38,000**

Tx-1127. Alangasi Site 1, B **>40,000**

Tx-1128. Alangasi Site 1, C **36,750 ± 2540**

Tx-1129. Alangasi Site 1, D **>40,000**

Tx-1130. Alangasi Site 1, E **39,560 ± 7200**

Tx-1131. Alangasi Site 2 **39,100 ± 6820**

General Comment (REB): dates are older than expected, but can be used to date Alangasi cangagua deposit. Whether they date mastodon remains is uncertain; either mastodon was not contained within cangagua and represents later time period, or was in cangagua and exposure by erosion aroused interest and attention of later prehistoric peoples.

Shobschi Cave series, Ecuador

Charcoal from preceramic horizon, Shobschi Cave, near Sigsig, Prov Azuay, Ecuador (3° 03′ S, 78° 48′ W). Coll 1968 by G Reinosa Hermida and subm by R E Bell.

Tx-1132. Shobschi A **8480 ± 200**

From 10cm below surface.

Tx-1133. Shobschi B **10,010 ± 430**

From 20cm below surface.

General Comment (REB): dates indicate that Shobschi represents important preceramic site; since depth of deposit exceeds that for oldest charcoal sample, greater antiquity can be expected for lower levels.

Santa Lucia series, Ecuador

Charcoal scraped from pottery vessels of Panzaleo ware from graves in Santa Lucia site (ED-16), near Tumbaco, Ecuador (0° 14′ S, 78° 23′ W). Coll 1970 and subm by R E Bell.

Tx-1134. Santa Lucia, Burial #1 **2060 ± 110**

Tx-1135. Santa Lucia, Burial #2 **2170 ± 100**

General Comment (REB): these are 1st radiocarbon dates for Panzaleo ceramics of highland area, which are common and widespread around Quito. Dates provide starting point for reliable chronologic sequence of ceramics in this region.

Tx-1136. Rubia Cocha #2, Ecuador **170 ± 70**

Charcoal from buried fireplace exposed in side of ditch, 10 to 35cm below surface, in Rubia Cocha #2 site (ED-4), near Tumbaco, Ecuador (0° 14′ S, 78° 23′ W). Field evidence not certain whether fireplace was

assoc with Panzaleo ceramics, with preceramic occupation, or represented recent charcoal preparation subsequently covered by collovium. Coll 1970 and subm by R E Bell. *Comment* (REB): date is clearly recent and apparently derived from charcoal industry of past few decades; does not contribute to dating of Panzaleo ceramics.

Peru

Gramalote series

Samples of epiphyte *Tillandsia* from stratigraphic cut in Gramalote site (H6168B; Pozorski, 1976, Ch IV), Initial Period site 150m from Pacific shore in Moche Valley, N coast of Peru (8° 06′ 04″ S, 79° 06′ 54″ W). Natural levels numbered from top to bottom. Coll 1973, 1974 and subm by T Pozorski, Dept Anthropol, Univ Texas, Austin.

Tx-1929A. Gramalote 128, charcoal **3070 ± 90**

Tx-1929B. Gramalote 128, wood **3250 ± 120**
From Natural Level 3.

Tx-1930A. Gramalote 129, charcoal **3050 ± 110**

Tx-1930B. Gramalote 129, wood **3540 ± 80**
From Natural Level 2.

Tx-1931A. Gramalote 130, charcoal **3530 ± 130**

Tx-1931B. Gramalote 130, wood **3280 ± 60**
From Natural Level 1.

General Comment (TP): although not in stratigraphic order, dates coincide well with early occupation of Caballo Muerto complex (Tx-1938, below), supporting relative-chronologic evidence of artifacts and subsistence remains.

Padre Aban series

Samples of *Tillandsia,* except as noted, from Padre Aban site (H64326410), preceramic site 200m from Pacific shore, Moche Valley, Peru (8° 04′ 27″ S, 79° 06′ 25″ W). Natural levels numbered from top to bottom. Coll 1973, 1974 and subm by T Pozorski.

Tx-1933. Padre Aban 64 **3850 ± 210**
From Natural Level 5.

Tx-1934. Padre Aban 63 **3930 ± 120**
From Natural Level 7.

Tx-1935. Padre Aban 64 **3670 ± 260**
Grama grass, from Natural Level 5.

Tx-1936. Padre Aban 66 **5420 ± 140**
From Natural Level 3.

General Comment (TP): Tx-1933 and -1934 are consistent with evidence that site is preceramic and without textiles, antedating Caballo Muerto, below, and Gramalote, above. Tx-1935 may be too young; Tx-1936 is much too old.

Caballo Muerto series

Samples of charred cane *(Gynerium sagittatum),* except as noted, from sites in Caballo Muerto complex (Pozorski, 1976), 18km to 20km inland from Trujillo, Moche Valley, Peru (8° 05′ S, 78° 56′ W). Chavin-Cupisnique horizon. Coll 1973, 1974 and subm by T Pozorski.

Tx-1937. Herederos Chica 197 **3040 ± 60**

Cut 2, 550 to 575cm depth, in small cobble and adobe mound, Huaca Herederos Chica site (K498586), ca 20km from Pacific coast.

Tx-1938. Herederos Chica 145 **3450 ± 70**

Same as Tx-1937, Cut 1, 400 to 420cm depth.

General Comment on Tx-1937, -1938 (TP): dates apply to Phase I of complex. Tx-1938 supports archaeol evidence, whereas Tx-1937 is inconsistent (too young) with archaeol data.

Tx-1939. Guavalito 41 **2390 ± 70**

From Huaca Guavalito (K482582), Cut 1, just above sealed floor of 2nd construction phase, in corridor W of colonnade. Phase 3 of complex. *Comment* (TP): agrees well with archaeol evidence for sequence.

Tx-1972. Huaca de los Reyes 105 **3310 ± 80**

First construction phase of Huaca de los Reyes (K4462), 18km inland from coast; Phase 2 of complex. Probable roofing material found on floor of 1st construction phase, Mound F, Cut 47.

Tx-1973. Huaca de los Reyes 106 **3140 ± 60**

Same provenience as Tx-1972.

Tx-1974. Huaca de los Reyes 289 **3680 ± 80**

Same provenience as Tx-1972, -1973; pieces of cane post burned *in situ* within bench floor.

Tx-2180. Huaca de los Reyes 438 **2800 ± 60**

Pieces of cane post in floor N of S bench, on top of Mound F, 1st construction phase, Cut 47.

General Comment on Tx-1972-1974, -2180 (TP): all dates apply to Phase 2 of Caballo Muerto complex. Tx-1972, -1973 are consistent with relative dating by archaeol evidence; Tx-1974 seems early; Tx-2180 is inconsistently late.

Tx-2181. Huaca de los Reyes 173 **1560 ± 120**

Junco grass (*Cyperus* sp) near floor along S face of 3rd N pillar, Cut 15, Mound B. *Comment* (TP): late date, relative to others of series, led to

re-examination of field records. Context is found to be dubious; date presumably not applicable to Phase 2 of complex.

Huancayo Alto series

Charcoal from various residential, administrative and industrial zones within Huancayo Alto site (PV-46-2), at Km 56 in Chillon Valley, central coast of Peru (11° 42′ S, 76° 50′ W). Late Intermediate period through Late Horizon. Coll 1974 and subm by T D Dillehay, Dept Anthropol, Univ Texas, Austin.

Tx-2002. Huancayo Alto 1 **320 ± 60**
Room 1, Unit 3, level 40cm, directly below Floor 2.

Tx-2003. Huancayo Alto 2 **1650 ± 170**
Stone-lined Terrace #2, Test pit 1, Level 1.

Tx-2004. Huancayo Alto 3 **2880 ± 80**
Storage Unit 1, Level 2.

Tx-2005. Huancayo Alto 4 **1740 ± 70**
Storage Unit 2, Level 2.

Tx-2006. Huancayo Alto 5 **580 ± 100**
Drying Terrace #1, Level 4.

Tx-2007. Huancayo Alto 6 **1250 ± 180**
Drying Terrace #2, Test pit 2, Level 3.

Tx-2008. Huancayo Alto 7 **1220 ± 60**
Drying Terrace #3, Test pit 1, Level 2.

Tx-2009. Huancayo Alto 8 **620 ± 60**
Room 3, level 65cm, fill at base of Floor 4.

General Comment on Tx-2002-2009 (TDD): dates confirm initial and secondary construction phases (ca 1000 to 500 BC and AD 200 to 500) and subsequent periods of occupation (AD 500 to 1650) indicated by assoc architecture and ceramics: Chavín-like, Maranga, Chancay Black-on-White, Inca. Tx-2004-2008 are from large drying terrace and storage facility area; this is earliest known complex of this kind peripheral to a central Andean urban site.

Tx-2070. Huancayo Alto 11 $\delta^{14}C = +29.4 \pm 2.4‰$
Platform, Level 2, Test Pit 1.

Tx-2071. Huancayo Alto 12 $\delta^{14}C = +19.7 \pm 2.9‰$
Room 3, Level 3.

Tx-2072. Huancayo Alto 13 **Modern**
Room 3, level 115cm.

General Comment on Tx-2070-2072 (TDD): dates show disturbance resulting from use of prehistoric floors by shepherds, though there was no field evidence of disturbance.

Tx-2376. Huancayo Alto 14 **610 ± 70**
Drying Terrace #1, Level 3.

Tx-2377. Huancayo Alto 15 **560 ± 50**
Terrace 1, Level 2.

Tx-2397. Huancayo Alto 16 **1840 ± 50**
Storage Unit 3, Level 1.

General Comment on Tx-2376, -2377, -2397 (TDD): dates confirm other dates in this list for drying and storage zones within site. Tx-2377 is from residential stone-lined terrace zone peripheral to main site area; these terraces are assoc with some highland ceramics, which suggests coastal-highland co-residence at site.

Quives series

Charcoal samples from Quives site (PV-46-3), at junction of Chillon and Arahuay Rs in upper Chillon Valley, central coast of Peru (11° 38′ S, 76° 46′ W). Assoc with pre-Incaic and early Colonial materials. Coll 1974 and subm by T D Dillehay.

Tx-2068. Quives 3 **2710 ± 70**
Test Pit 1, Rm 1, Level 2; pre-Incaic.

Tx-2069. Quives 4 **Modern**

General Comment (TDD): dates confirm ceramic evidence for occupation from ca 500BC to AD 1650. Tx-2069 suggests occupation continued into post-Colonial times.

Monterrico Grande Oeste 1 series

Charcoal from tomb and living floor within residential zone of Monterrico Grande Oeste 1 site, at Km 8 E of Lima on N bank of Rimac R, central coast of Peru (12° 10′ S, 76° 85′ W). Middle Horizon through Late Horizon. Coll 1974 by A S Millones and subm by T D Dillehay.

Tx-2369. Monterrico Grande Oeste 1/1 **Modern**
Area D, Sec 4, Quad 89, Level 2. *Comment* (ASM): date shows disturbance resulting from partial destruction by modern residents.

Tx-2370. Monterrico Grande Oeste 1/2 **780 ± 60**
Area 3, Sec 2, Floor A, Level 2, 1m depth, Quad 416, Burial 9. *Comment* (ASM): date confirms period of occupation (ca AD 500-1000) indicated by assoc architecture and ceramics of Huancho culture.

Mummy Bundle series

Specimens from prehistoric mummy bundles, central and S coast of Peru. Subm by J M Vreeland, Dept Anthropol, Univ Texas, Austin.

Tx-2448. Paracas Necropolis 226; X-5 **1860 ± 60**

Cotton cloth fragments from Mummy Bundle #226, Grand Necropolis of Cerro Colorado, Dpto Pisco, 250km S of Lima, Peru (13° 55′ S, 76° 15′ W). Paracas phase, Nazca culture. Bundle coll 1927 by T Mejía Xesspe; dissected and sample coll 1976 by Vreeland. Sample taken from bottom internal part of bundle isolated from environment, although moisture, mold, or insects could have affected it. *Comment* (JMV): according to current evidence, date is appropriate; falls at end of Paracas phase.

Tx-2449. Rinconada 60; X-2 **700 ± 50**

Oxidized cotton cloth fragments and organic remains from Mummy Bundle #60, from Rinconada Alta, La Molina, Rimac Valley, ca 5km E of Lima, Peru (12° 10′ S, 76° 55′ W). From internal portion of bundle, adjacent to body. Huancho phase cultural assoc. Bundle coll 1972 by A Sandoval M; dissected and sample coll 1975 by Vreeland. *Comment* (JMV): no other dates available for comparison; agrees with stratigraphic assignment to middle of Central Coast Huancho phase (ca AD 900-1532).

Tx-2450. Huaca de la Universidad **710 ± 60**

Cotton fiber from mummy bundle recovered in salvage operation during destruction of Huaca de la Universidad pyramid in downtown Lima, Peru (12° 10′ S, 76° 55′ W). One of largest prehistoric mummy bundles reported, containing largest known prehistoric single-web textile. Cultural assoc probably Epigonal. Bundle coll ca 1970 by T Mejía Xesspe; opened and sample coll 1974 by Vreeland. *Comment* (JMV): 1st date for material from this pyramid. Stylistic features support date, at end of Central Coast Epigonal.

La Galgada series

Charcoal and maguey wood from La Galgada site, Pallasca Prov, Peru, 1km S of La Galgada, E bank of Chuquicara R (8° 12′ S, 78° 10′ W). Dated to check archaeol evidence for preceramic date of very advanced architecture. Coll 1976 by Grieder and Bueno and subm by T Grieder, Dept Art, Unit Texas, Austin.

Tx-2463. La Galgada, 1 **3740 ± 90**

Wood charcoal from midden, base of massive wall, N Gallery, Mound B.

Tx-2464. La Galgada, 2 **3440 ± 80**

Maguey wood from shaft wall leading to tomb built into temple after all floors had been constructed, S Gallery, Mound B; Phase 5 of construction.

General Comment (TG): dates confirm preceramic period suggested by textiles, and indicate time lapse between end of temple bldg period (Tx-2463) and construction of shaft tombs (Tx-2464).

Italy, Egypt, Sudan

Pizzica Series II, Italy

Charred wood samples from Pizzica site, 3km NW of Metaponto Scalo, Pizzica Pontanelle area, S Italy (40° 23′ N, 16° 35′ E). Previous dates from site in R, 1977, v 19, p 323. Coll 1976 and subm by J C Carter, Dept Classics, Univ Texas, Austin.

Tx-2468. Pizzica PZ.76.293SS **2520 ± 90**

From beam in upper level of deposit of gray pottery, NS trench, Area Beta, Level 2.

Tx-2538. Pizzica PZ.76.140SS **2410 ± 120**

From below fallen roof tiles, probably from roof beams of tile factory. Sq A′12, W of Wall Beta W, N of rectangular structure, Level 2.

General Comment (JCC): ceramic evidence suggests 200 BC at earliest; thus dates are inconsistent with archaeol evidence. Since samples were from large beams, probably inner rings of old trees were being dated.

Tx-2340. El Khatara, Egypt **4970 ± 70**

Charcoal from El Khatara site (75/3A), Badarian midden, N bank of wadi 1km N of Danfiq, Egypt (25° 58′ N, 32° 40′ E). From Sq 2, Level 4, 75 to 100cm depth; subm to help date beginning of Egyptian Predynastic. Coll 1975 and subm by T R Hays, Inst Appl Sci, North Texas State Univ, Denton, Texas. *Comment* (TRH): date agrees with other dates from site (4780 ± 70 to 5030 ± 100: SMU-303, -351, -353, -355, -360; Hayes, written commun). All these dates are younger than most of Libby's Predynastic dates (4720 ± 310 to 6391 ± 180: C-457, -550, -551, -810-814; Libby, 1955, p 77-79).

Tx-2465. "Southtown," Egypt **4920 ± 90**

Charcoal from Petrie's "Southtown," N side of Wadi Ibeidalla, W of Nag Arab Turk, Egypt (25° 58′ N, 32° 40′ E), 15cm below surface in Gerzean culture midden. Coll 1976 and subm by T R Hays. *Comment* (TRH): date agrees with Libby's Gerzean dates (Libby, 1955, p 77-79).

Tx-1155. Dibeira West, Sudan **6540 ± 110**

Ostrich egg shell from deflated surface of Dibiera-Jer formation, partially *in situ,* Dibeira West site (DiW-5), Wadi Halfa, N Sudan (22° 05′ N, 31° 21′ E). Assoc with distinctive pottery with complex punctate and rocker-stamp decoration found at early Neolithic sites in Sudan, Ethiopia, Libya, Chad. Coll 1964 by A E Marks and subm by J L Shiner, Dept Anthropol, Southern Methodist Univ, Dallas, Texas. *Comment* (JLS): date indicates early Sudanese Neolithic; this widespread ceramic style appears to date from 4500 to 3500 BC. Sudanese Neolithic appears to be at least as early as Egyptian Neolithic.

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[RADIOCARBON, VOL. 20, No. 2, 1978, P. 274-282]

UNIVERSITY OF MIAMI RADIOCARBON DATES XII

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The following radiocarbon dates are a partial list of samples measured since March 1977. The techniques used are the same as reported in R, v 16, p 402-408, and modified in R, v 18, p 210-220, with the following exception. A third liquid scintillation counter (Beckman LS-100) has been added and the shortened, low-K glass-counting vials have been replaced with teflon vials of Noakes (1975) design. Backgrounds on the counters were thus reduced from 9.1 cpm, 8.8 cpm and 4.9 cpm to 3.8 cpm, 3.5 cpm and 2.8 cpm, respectively, with an attendant small increase in efficiency.

Dates are calculated using the Libby half-life of 5568 years, with no correction factors included, although it is now the policy of this laboratory to routinely measure $^{13}C/^{12}C$ ratios. Errors are reported as one standard deviation which includes only the combined uncertainties on the modern, background and sample measurements.

ACKNOWLEDGMENTS

A computer program was developed by Peter Canter for ^{14}C calculations.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Bahamas

Exuma Sound series

Carbonate ooze cored from 1723m below sea level on basin floor of Exuma Sound (24° 25.6′ N, 76° 18.6′ W), adjacent to the Bahama platform, coll to establish sedimentation rates for comparison with results from Tongue of the Ocean (Lynts *et al,* 1973). Coll and subm 1977 by P D Crevello, RSMAS, Miami, Florida.

UM-1171.	**GS7103-001: 0 to 5cm**	**1675 ± 110**
UM-1172.	**GS7103-001: 2 to 6cm**	**4670 ± 90**
UM-1173.	**GS7103-001: 25 to 29cm**	**8995 ± 145**
UM-1174.	**GS7103-001: 46 to 50cm**	**15,420 ± 250**
UM-1175.	**GS7103-001: 115 to 119cm**	**33,055 $^{+850}_{-955}$**
UM-1176.	**GS7103-001: 172 to 176cm**	**>36,820**
UM-1177.	**GS7103-001: 252 to 256cm**	**>36,815**
UM-1178.	**GS7103-001: 322 to 326cm**	**>34,090**

B. Martinique, West Indies

Mt Pelée series

Charcoal from pyroclastic surge sediments near Mt Pelée, Martinique, West Indies. Dates used to determine frequency of cyclic eruptions on Mt Pelée. Coll and subm by A L Smith and M J Roobol, Univ Puerto Rico, Mayaguez, Puerto Rico.

PM-1027. Pelée 513 **<170**

Sample from small quarry coast rd immediately N of R Claire (14° 46′ 24″ N, 61° 12′ 12″ W).

UM-1028. Pelée 338 **1845 ± 70**

Sample from small gully infill 45.5m from Falaise Bridge (14° 49′ 46″ N, 61° 6′ 04″ W).

UM-1029. Pelée 438 **765 ± 95**

Sample from quarry at mouth of R Seche (14° 45′ 36″ N, 16° 11′ 40″ W).

UM-1030. Pelée 537A **4500 ± 75**

Sample from rd cut between Point la Mare and Qtr de la Charmouse (14° 47′ 18″ N, 61° 13′ 46″ W).

UM-1031. Pelée 553 **7745 ± 135**

Sample from S W edge of Morne Rouge (14° 46′ 04″ N, 61° 08′ 30″ W).

UM-1032. Pelée 378 **7365 ± 105**

Sample from upper part of R des Pares, W Mt Pelée (14° 46′ 15″ N, 61° 10′ W).

UM-1033. Pelée 547 **1900 ± 60**

Sample from rd cut S of Carbet (14° 41′ 30″ N, 61° 10′ 00″ W).

UM-1034. Pelée 180 **3150 ± 65**

Sample from lowest part of R Claire (14° 46′ 12″ N, 61° 12′ 00″ W).

UM-1035. Pelée 44 **535 ± 80**

Sample from lower R Claire (14° 46′ 36″ N, 61° 11′ 36″ W).

UM-1036. Pelée 508.1 **4375 ± 90**

Sample from S bank of R des Pares (14° 45′ 16″ N, 61° 10′ 44″ W).

UM-1037. Pelée 402 **545 ± 60**

Sample from S bank of R des Pares (14° 45′ 16″ N, 61° 10′ 44″ W).

UM-1038. Pelée 405 **5250 ± 90**

Sample from S bank of R des Pares (14° 45′ 16″ N, 61° 10′ 44″ W).

UM-1039. Pelée 537 **1625 ± 75**

Sample from crystal-pumice groundsurge deposit at Morne Callabase (14° 47′ 50″ N, 61° 8′ 42″ W).

UM-1040. Pelée 562 **1625 ± 75**

Sample dates ash hurricane deposits at quarry S of r at La Falaise bridge (14° 49′ 46″ N, 61° 06′ 04″ W).

UM-1085. Pelée Arch **1280 ± 290**

Sample from Fond Brule Le Lorrain.

UM-1086. Pelée 8 **2550 ± 75**

Sample from La Falaise Quarry (14° 49′ 42″ N, 61° 6′ 12″ W).

UM-1087. Palée 96 **1800 ± 95**

Sample from pumic flow at La Falaise Quarry (14° 49′ 42″ N, 61° 6′ 12″ W).

UM-1088. Pelée 216 **4990 ± 100**

Sample from Qobeide Quarry (14° 45′ 24″ N, 61° 8′ 46″ W).

UM-1089. Pelée 515 **2470 ± 125**

Sample from pumice flow at quarry at mouth of R Capot (14° 50′ 20″ N, 61° 05′ 40″ W).

UM-1090. Pelée 574 **2260 ± 110**

Sample from lithic groundsurge deposit at rd cut 2km inland from Vivé (14° 29′ 44″ N, 61° 05′ 32″ W).

C. United States

Sandy Bank series

Samples from cores on Sandy Bank, W Florida, between (25° 04′ 39″ N, 81° 02′ 03″ W) and (25° 01′ 39″ N, 81° 00′ 06″ W). Coll 1976 and subm 1977 by K Mukherji, Concordia Univ, Montreal, Quebec.

General Comment (KM): dates stratigraphic sequence and local buried geomorphic features for West Florida Bay.

UM-1121. M5-1 **5000 ± 110**

Peat from 227 to 233cm depth.

UM-1122. M2-4 **5490 ± 120**

Peat from 222 to 225cm depth.

UM-1123. M21-7 **5150 ± 100**

Peat from 195 to 205cm depth.

UM-1124. M6-12 **3425 ± 75**

Mixed *Transenella*-rich ekeletal material from 193 to 233cm depth. *Comment* (KM): correlated with lowermost Packstone unit (*Anomalocardia*).

UM-1125. M4-13 **4290 ± 85**

Coarse *Pseudocyrena-* and *Anomalocardia*-rich skeletal material from 230 to 233cm depth. *Comment* (KM): correlated with lowermost transgressive sequence.

UM-1126. M23-8 **2385 ± 80**

Transenella-rich skeletal material from 144 to 168cm depth. *Comment* (KM): correlated with lowermost *Anomalocardia* Packstone unit.

UM-1127. M5-2 **2615 ± 70**

Mixed *Transenella*-rich skeletal material from 167 to 186cm depth. *Comment* (KM): correlated with lowermost Packstone unit.

UM-1128. M10-10 **2600 ± 65**

Transenella-rich skeletal material from 111 to 116cm depth. *Comment* (KM): correlated with upper part of lowermost Packstone unit.

UM-1129. M16-9 **2645 ± 70**

Mixed *Transenella*-rich skeletal material from 83 to 111cm depth. *Comment* (KM): correlated with basal Packstone unit.

UM-1130. M20-6 **1790 ± 60**

Mixed *Tellina-, Cardita-,* and *Chione*-rich skeletal material from 83 to 93cm depth. *Comment* (KM): correlated with basal Packstone unit.

UM-1131. M19-5 **1130 ± 70**

Transenella-, Bulla-, and *Cerithium*-rich coarse, skeletal material from 34 to 47cm depth. *Comment* (KM): correlated with uppermost Packstone unit.

UM-1132. M10-11 **1250 ± 70**

Tellina- and *Chione*-rich skeletal material from 62 to 80cm depth. *Comment* (KM): correlated with uppermost Packstone unit.

UM-1133. M5-3 **2150 ± 55**

Mixed *Transenella*-rich coarse, skeletal material from 143 to 153cm depth. *Comment* (KM): correlated with uppermost Packstone unit.

Lower Alsea River Valley, Lincoln Co, Oregon

UM-1119. CLEV(A)/D-228(QL)/421-433 **4180 ± 70**

Woody peat from open-sided, spiral drill bit auger on flood basin of coastal flood plain on Lower Alsea R Valley, Lincoln Co, Oregon (44° 24′ 30″ N, 123° 57′ 18″ W). Coll April 1977 and subm May 1977 by J J Feiereisen, Univ Oregon, Eugene, Oregon.

Lower Siuslaw River Valley, Lane Co, Oregon

UM-1120. CLEV(S)/D-25(QL)/538-553 **3250 ± 70**

Woody peat from open-sided, spiral drill bit auger on flood basin of coastal flood plain on Lower Siuslaw R Valley, Lane Co, Oregon (44° 00′

50″ N, 123° 56′ 03″ W). Coll April 1977 and subm May 1977 by J J Feiereisen.

Ft Lauderdale reef series

Samples cored from 2 of 3 parallel reefs on continental shelf near Ft Lauderdale (26° 06′ 41″ N, 80° 04′ 55″ W). Outermost reef designated 3R (15.2m below sea level) and 2nd reef 2R (10.5m below sea level). Studies were made to determine if reefs are being destroyed by nearby dredging and to evaluate past reef accumulation rates. Coll July 1977 by Bill Raymond and subm Aug 1977 by D E Britt Assoc, Ft Lauderdale, Florida.

UM-1162. 3R-1 **3815 ± 95**
Coral from surface.

UM-1163. 3R-2 **7855 ± 120**
Coral from 76.2cm depth.

UM-1164. 3R-3 **8025 ± 95**
Coral at maximum core depth, 162.5cm.

UM-1165. 2R-4 **3615 ± 95**
Coral from 50.8cm depth.

UM-1166. 2R-5 **4460 ± 100**
Coral (*A Palmata*).

UM-1167. 2R-6 **7520 ± 110**
Coral from 345.5cm depth.

Florida Savannahs series

Peat samples cored on Florida Savannahs area in S Florida (27° 30′ N, 80° 20′ W). Coll and subm 1977 by P Gleason, Flood Control Division, Florida, and P Canter, Univ Miami, Coral Gables, Florida.

General Comment (PC): dates indicate initiation of peat deposition in Florida Savannahs.

UM-960. S-3 **2650 ± 75**
Basal peat from 83.1 to 99.6cm depth.

UM-961. S-5 **5000 ± 135**
Basal peat from 170.9 to 191.8cm depth.

UM-962A. S-1 **3025 ± 90**
Basal peat from 150.9 to 165.9cm depth.

UM-962B. S-1 **2595 ± 105**
Basal peat from 150.9 to 165.9cm depth.

UM-963. S-4 **1445 ± 85**

Basal peat from 78.7 to 97.3 cm depth.

UM-964. S-2 **1565 ± 95**

Basal peat from 68.6 to 85.3cm depth.

Woodside series

Coral and shell samples from sites on coastal plain in North and South Carolina. Coll March 1977 and subm May 1977 by V A Zullo, Univ North Carolina. *Comment* (VZ): dates used for correlation of Pleistocene marine deposits in SE North Carolina.

UM-1137. 6-Mercenaria **>34,265**

Shell material from Waccamau Formation at sea level (34° 25′ N, 77° 38′ 15″ W).

UM-1138. 6-coral **>32,280**

Coral from Waccamau Formation at sea level (34° 25′ N, 77° 38′ 15″ W).

UM-1139. 42-coral **38,410 $^{+3155}_{-5270}$**

Coral *(Septastrea crassa)* from Waccamau Formation at sea level (33° 52′ 30″ N, 78° 35′ W).

UM-1140. 42-Mercenaria **>32,550**

Shell material from Waccamau Formation at sea level (33° 52′ 30″ N, 78° 35′ W).

UM-1141. 39-Mercenaria **31,810 $^{+745}_{-825}$**

Shell material from Canepatch Formation 60cm above sea level (33° 40′ 30″ N, 78° 55′ 05″ W).

UM-1142. 46-Mercenaria **39,040 $^{+1645}_{-2070}$**

Shell material from beach rock 2.5m above sea level (34° 05′ N, 77° 55′ W).

II. ARCHAEOLOGIC SAMPLES

A. Mexico

Cacaxtla series

Cacaxtla (19° 24′ N, 90° 57′ W) in state of Tlaxcala, Mexico is site where wood and stucco structures with murals were uncovered. Murals indicate influence of several cultures including Theoihuacanos and Mayas. Sample coll 1976 by Diana Lopez de Monna, Inst Natl Antropol e Hist, de Pueblo, Tlaxcala and subm by Joaquin Ruiz, Univ Miami, Coral Gables. Comments by Ruiz.

UM-1020. B-6 Level II **1205 ± 75**

Wood from door frame of room where most significant murals were found. *Comment*: since wood appears to have been painted at same time as murals, this dates painting of murals.

UM-1041. 0'2 Level II **1180 ± 65**

Charcoal from a ritual fire. *Comment*: fire is believed to have been burned when Cacaxtla was abandoned.

UM-1042. Ditch 12 Level X **1350 ± 90**

Charcoal from a ritual fire. *Comment*: representative of occupation in Classic period. Consistent with pottery of sampling site.

UM-1043. Ditch 8 Level XVIII **1220 ± 70**

Charcoal from ditch which indicates occupational level of Classic period.

UM-1044. A4 Level II **1450 ± 110**

Charcoal from ritual fires in front of murals. *Comment*: sample was misinterpreted since fire was thought to be from time of Cacaxtla's abandonment and yet predates murals.

UM-1045. Ditch 14 Level IV **1755 ± 100**

Charcoal coll from deep level. *Comment*: dates time of Classical occupation of Cacalaxtla.

UM-1046. Ditch 3 Level VII **1745 ± 120**

Charcoal from early Classic period.

UM-1047. Ditch 9 Level II **1640 ± 120**

Charcoal from Level II. *Comment*: from occupational level of murals but predates them, indicating another probable misassociation.

B. Florida

Little Salt Spring series, Florida

Samples from slough leading to Little Salt Spring, extreme S of Sarasota Co (27° 04′ 29″ N, 82° 13′ 59″ W). Coll 1977 and subm by C J Clausen, Little Salt Spring Research Facility, North Port, Florida, unless otherwise indicated. Comments by Clausen.

UM-1099. GDF-043 **7465 ± 100**

Apparent myrtle branch, compressed by ground pressure, was removed from position in direct assoc with Burial 1, Test 2. *Comment*: should date several Late Archaic horizon primary interments with well-preserved wood, bone, shell, and stone artifacts. Ceremonial burials suggested by use of aromatic flora such as bay and myrtle. Coll 1977 by L N Wood, Jr, General Development Foundation, Inc, North Port, Florida.

UM-1100. GDF-047 **8145 ± 115**

Wood and peat-like material from within portion of Burial 2 next to femur along back of thigh.

UM-1101. GDF-048 **9100 ± 95**

Peat from underlying extensive zone of freshwater marl below similar heavily organic zone containing Archaic burials (same stratigraphic column).

UM-1156. GDF-048 **8820 ± 120**

Duplicate run of UM-1101.

UM-1102. GDF-046 **6180 ± 95**

Carbonate fraction of fragmentary human skeletal material including both radii, both ulnas, one humerus, skull fragments and femur.

UC-1103. GDF-046 **5850 ± 70**

Organic fraction of UM-1102.

UM-1157. GDF-064 **6830 ± 155**

Portion of oak tool found with Archaic period extended burials.

UM-1158. GDF-077 **13,360 ± 205**

Calcitic marl from middle portion of marl layer beneath Burials 1 and 2. *Comment*: age for this position in stratigraphic column would indicate shallow water site of marl formation was fed by water flowing through Miocene carbonates.

Alderman Site series

Charcoal from twigs and small branches from shell midden in Volusia Co, Florida (28° 44′ N, 81° 02′ W). Coll 1977 and subm by M C Stewart, Behavioral Sci Dept, Rollins Coll, Winter Park, Florida. Comments by Stewart.

UM-1152. Ald-TP3-CS10 **2425 ± 210**

Comment: should correlate culture within St John's II in absence of mortuary pottery or significant amounts of trade sherds.

UM-1153. Ald-TP2-CS5 **1090 ± 100**

Comment: use for correlation of culture as UM-1152.

UM-1154. Ald-TP1-CS3 **1190 ± 125**

Comment: dates postmolds as contemporary with UM-1153.

UM-1155. Palmer-Taylor site SE18 **6060 ± 105**

Conch shell from shell midden Seminole Co, Florida (28° 41′ N, 81° 02′ W) used for verification of projectile point, possibly Culbreath found 43cm below surface. Coll 1976 and subm by M C Stewart.

Captiva Island series

Oyster shells from shell mounds on property of South Seas Plantation on Captiva I., Florida (26° 30′ N, 82° 13′ W) for comparison with dates from Wightman site, Sanibel, Florida (UM-729-736, UM-860-872, UM-919-924, R, 1977, v 19, pp 453-455). Mound is ca 3m above bay water. Coll 1977 by Lee High, Dept Geol, Oberlin College. Subm by C J Wilson, Sanibel, Florida.

UM-1169. Surface **1060 ± 110**

UM-1170. 46cm **1065 ± 65**

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[RADIOCARBON, VOL. 20, NO. 2, 1978, P. 283-312]

U S GEOLOGICAL SURVEY, RESTON, VIRGINIA, RADIOCARBON DATES XIV

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This list contains the results of some measurements made between 1966 and 1975, and includes some earlier unpublished dates. Samples are counted in the form of acetylene gas, as previously, and ages computed on the basis of the Libby half-life, 5568 ± 30 years. The dates have not been corrected for fractionation by making a ^{13}C measurement. The error listed, always larger than the one-sigma statistical counting error commonly used, takes into account possible fractionation in the laboratory and in nature and variability experienced with replicate samples. We thank Linda Wilt for helping in the preparation of the manuscript and Charles Oman for his technical assistance.

Unless otherwise stated, collectors of all samples are members of the U S Geological Survey.

A. Eastern United States

Louisville series, Kentucky and Indiana

Wood samples coll and subm 1972 by R C Kepferle.

W-2905. **2840 ± 250**

Carbonized tree limb, N bank Ohio R, 270m below mouth of Silver Creek (38° 17′ 16″ N, 85° 47′ 41″ W), Floyd Co, Indiana. *Comment* (RCK): inclined beds containing sample may have slumped to sampled position along bank of Ohio. Massive till-like deposit between inclined beds and horizontally bedded New Albany Shale (Devonian) bedrock may be the gouge along sole of slump. Thus, exposure is not evidence of glaciation. Beech, hickory, and walnut fruits assoc with sampled wood indicate deciduous forest that has more similarities to present flora than does conifer assoc of W-2907 (Kepferle, 1974a).

W-2907. **19,450 ± 700**

Knotty conifer wood lying sub-parallel to horizontally bedded sediments, in gully draining loess pit E of Illinois Central tracks from Johnsontown (38° 06′ 59″ N, 85° 51′ 03″ W), Jefferson Co, Kentucky. *Comment* (RCK): precludes any designation except Wisconsin age for overlying loess, contrary to Browne and McDonald (1960, p 171), and in support of Ray (1974), who finds no evidence for sediments of Illinoian age in area, and reported a similar age for nearby deposits, 18,530 ± 500, W-520 (R, 1960, v 2, p 147), (Kepferle, 1974b).

B. Central United States

W-2426. Iowa Point, Kansas **18,200 ± 500**

Wood *(Picea)* from dolomitic loess, at base of Peoria Loess, overlain by Brady soil zone and Bignell Loess, underlain by "Gilman Canyon

Loess" (Frye & Leonard, 1949; 1952; Frye *et al*, 1949), Iowa Point limestone quarry #2, Doniphan Co (39° 55′ 15″ N, 95° 13′ 45″ W). Coll and subm 1969 by Fred Caspall, Western Illinois Univ, Macomb, Illinois. *Comment* (FC): first date from base of Peoria Loess in NE Kansas. Stratigraphic relationships suggest date of 16,000 to 20,000 BP for initial deposition of loess. Age agrees and dates probability of boreal forest in NE Kansas prior to and possibly during deposition of Peoria Loess.

Camel Rock series, New Mexico

Charcoal coll after discovery of Clovis biface or preforms in arroyo floor below Pueblo occupation site, dated at AD 1175 to 1250. Two charcoal samples from exposures on N wall of arroyo, 0.5km W of US Hwy 64, in 3rd major arroyo N of Camel Rock (35° 40′ N, 105° 55′ W), Santa Fe Co. Coll 1973 and subm by H Warren, Mus New Mexico, Santa Fe, and G O Bachman.

W-2943. **2810 ± 250**

Depth 3m below top of "high terrace".

W-2942. **2600 ± 250**

Depth 4.5m below top of "high terrace".

General Comment (GOB & HW): we speculate that charcoal horizon was occupational level from which Clovis artifacts had weathered. Dates are consistent with Archaic cultural material.

W-2899. Cat Tail Creek, North Dakota **6850 ± 250**

Wood fragments from sand interval in valley fill, 7.5m deep in test hole, Cat Tail Creek valley (46° 08′ N, 100° 35′ W), Emmons Co. Coll 1972 and subm by C A Armstrong. *Comment* (CAA): apparently small stream has not eroded laterally to any great extent during last few thousand yr.

North Redwood series, Minnesota

Wood from roadcut, W side of Hwy 19, near North Redwood, in Minnesota R Valley (44° 40′ N, 94° 55′ W). Coll 1970 and subm by H E Wright, Univ Minnesota, Minneapolis.

W-2722. **>41,000**

Wood from sand beneath Wadena-lobe "Granite Falls" till, which underlies Des Moines lobe "New Ulm" till.

W-2723. **>41,000**

Wood from base of clay deposit beneath sand containing W-2722.

General Comment (HEW): dates indicate that till may be pre-Wisconsin or early Wisconsin, although a main Wisconsin correlation is not completely ruled out.

C. Western United States

W-2608. Flathead Lake, Montana >43,000

Lignite, depth 165m, in soil overlying Bull Lake Till I and overlain by Pinedale Till, Mission moraine, Flathead Lake (47° 26′ 10″ N, 114° 11′ 00″ W). Coll 1970 and subm by D G Smith, Univ Calgary, Calgary 44, Alberta, Canada. *Comment* (DGS): suggests that sample may be early Bull Lake. This is only date available for end moraines that mark S limit of Cordilleran ice lobes in Rocky Mtn trench.

Gallatin Natl Forest series, Montana

Organic samples from Jarrett (24SW651) archaeol site, N terrace Main Boulder R, 8km W and 40km S of McLeod, Gallatin Natl Forest (45° 21′ N, 110° 13′ W). Coll 1972 and subm by L B Davis, Montana State Univ, Bozeman.

W-2886. 320 ± 200

Charcoal from hearth, depth 40 to 60cm. *Comment* (LBD): sample was split and dated at 340 ± 100, RL-762, independently. Dates Old Woman's phase affiliation for intrusive hearth into Pelican Lake phase component (1000 BC to AD 200).

W-2885. 4630 ± 250

Charcoal and ash, roasting pit, depth 155cm. *Comment* (LBD): dates roasting pit assoc with large side-notched dart points attributable to complex at Mummy Cave, and Early Middle Prehistoric period manifestation for which a local chronology remains to be firmly established; complex tentatively dated 5500 to 3500 BC.

Snake River series, Idaho

Shells, freshwater sp, from borrow pit, excavated in Michaud Gravel (Trimble & Carr, 1961), alt 1326 to 1329m, 0.8km E of Schiller (42° 53′ N, 112° 39′ W). Coll 1969 and subm by H E Malde.

W-2512. >29,000

Whole clam shells.

W-2514. >33,000

Snail shells.

General Comment (HEM): Michaud Gravel forms delta possibly deposited during maximum discharge of Bonneville flood. The next younger deposit, Aberdeen terrace that was incised in Michaud Gravel as flood waned, yielded shells dated 29,700 ± 1000, W-731 (R, 1960, v 2, p 159) (Malde, 1968, p 10).

W-2408. Soap Lake, Washington 320 ± 200

Sagebrush, rooted in lake bottom at depth 2.3m below present lake surface, N end Soap Lake, Grant Co (47° 23′ N, 119° 30′ W). Coll 1968

by Janet Low, Diane Egan, and P B Egan; subm by W T Edmondson. *Comment* (WTE): date suggests that lake has risen at least 4.5m in the few centuries since plants were killed by rising lake water.

W-2452. **280 ± 200**

Complete re-run of W-2408.

Puget Lowland series, Washington

Peat interbedded in nonglacial detrital sediments, Auburn borrow pit, Puget Lowlands (47° 10′ N, 122° 15′ W). Coll 1973 by Kurt Othberg, Western Washington State Coll, Bellingham, Washington; subm by S Grommé.

W-3011. **>45,000**

Uppermost 5cm.

W-3012. **>45,000**

Lowermost 5cm.

General Comments (KO): dates assoc with exposure of silt in which measured paleomagnetic polarities are reversed (Othberg, 1973), and place nonglacial sediments and paleomagnetic reversal at >45,000 yr BP. Reversal may be pre-Wisconsin. However, there is no indication that these sediments are older than those of Brunhes Normal Magnetic Epoch. (SG): reversed magnetized silts are too old to represent proposed Laschamp geomagnetic polarity event, but very likely represent Blake polarity event at roughly 110,000 yr.

Port Angeles series, Washington

Wood from glacial deposits, Port Angeles area. Coll and subm 1955 and 1957 by P D Snavely, Jr.

W-2410. **>40,000**

Seacliff, W of mouth, McDonald Creek (48° 07′ 00″ N, 123° 14′ 30″ W), near Carlsburg.

W-2409. **>42,000**

Roadcut, SW end, Ediz Hook (48° 07′ 30″ N, 123° 28′ 00″ W).

W-391. **>38,000**

Quarry, SE end, Ediz Hook, E side of rd (48° 07′ 32″ N, 123° 28′ 15″ W).

General Comment (PDS): dates are too old for Vashon Drift; wood was reworked from older Pleistocene unit.

W-2474. Chesaw, Washington **9000 ± 900**

Wood in coarse sand, depth 1.5m in well excavation, home of John Thorpe, Chesaw (48° 58′ N, 119° 05′ W). Coll 1969 by John Thorpe and Madilane Perry; subm by R Fryxell, Washington State Univ, Pullman.

Comment (RF): unit dated is overlain by blue clay and soil; provides limiting date for deglaciation of area.

W-2425. Underwood Heights, Washington >40,000

Wood from diamicton (possibly a lahar), Columbia R, alt 105m, Underwood Heights (45° 45′ N, 121° 30′ W). Coll 1968 and subm by R Fryxell, Washington State Univ.

Marmes Rockshelter series, Washington

Shells and charcoal from Marmes Rockshelter site, Palouse area (46° 50′ N, 118° 20′ W). Coll 1968 by R Fryxell, and M Rubin; subm by R Fryxell. Stratigraphy (Fryxell & Cook, 1964) contains unique sequence of human remains, artifacts, fossil animal bones, as well as geol record for much of Holocene.

W-2213. 7980 ± 300

Freshwater mussel shells from fossil stream bank midden site. Sample lies on surface of bank buried by ashfall at Mazama.

W-2207. 9010 ± 300

Shells, Unit I-II.

W-2208. 8700 ± 300

Charcoal, Unit I-II.

W-2209. 9820 ± 300

Mussel shells, just above contact of gravels and shells with flood plain silt. *Comment* (RF): gives upper limiting date on Marmes level. *Comment* (MR): compares well with age of 9970 ± 110, Y-2481 (Minze Stuiver, written commun, 11/5/68) for same sample.

W-2210. 9540 ± 300

Shells from lens of shell midden, Unit III. *Comment* (MR): agrees with date of 9200 ± 110, Y-2482 (Minze Stuiver, written commun, 11/5/68) for same sample.

W-2212. 9840 ± 300

Charcoal, 3rd, 4th and 5th A horizon.

W-2218. 10,130 ± 300

Charcoal, 3rd and 4th A horizon.

General Comment (RF): dates 1st human occupation of Marmes rockshelter ca 10,000 yr BP. Deposits overlying Marmes layers, which contain bones and artifacts, date between 8000 and 10,000 yr BP.

W-2777. Newberry Craters, Oregon 1390 ± 200

Charcoal from pumice layer, exposed in roadcut, Newberry Craters (43° 45′ N, 121° 15′ W). Coll and subm 1972 by Irving Friedman. *Comment* (IF): pumice layer underlies "Big Obsidian" flow and overlies

pumice dated at 1720 ± 250, W-2168 (R, 1978, v 20, p 143); age is minimum for flow. Date consistent with that of 1270 ± 60, Tx-245 (R, 1966, v 8, p 459) from charcoal sampled nearby.

W-390. Neskowin, Oregon **1730 ± 160**

Spruce stumps, just below MSL, S of Proposal Rock, Neskowin (45° 05′ N, 124° 00′ W). Coll and subm 1955 by P D Snavely, Jr. *Comment* (PDS): stumps are part of drowned forest along Oregon coast. Because area does not appear to be one of local subsidence or landslides, drowning was probably due to eustatic rise in sea level.

W-1916. Newport, Oregon **2770 ± 350**

Shell fragments in pebbly gravel, capping 30m terrace at Jump-Off-Joe, Newport (44° 38′ 46″ N, 124° 03′ 40″ W), coastal Oregon. Coll 1966 and subm by P D Snavely, Jr. *Comment* (PDS): shells are 7.5m above wood dated at >38,000, W-646 (R, 1960, v 2, p 161). Age of 2770 ± 350 is much too young for 30m marine terrace. Basalt pebbles and shell material probably are from Holocene beach gravels which were used to surface an old wagon rd on terrace. Gravels were buried by eolian sands and now appear to be in stratigraphic sequence at Jump-Off-Joe.

W-2926. Port Orford, Oregon **1370 ± 250**

Shells, depth 5.1cm in box core, water depth 26m, 3.2 km S of Port Orford (42° 50′ N, 124° 25′ W). Coll 1971 and subm by H E Clifton. *Comment* (HEC): date clearly confirms that deposit is not relict, but a relatively recent storm deposit.

W-2981. Minaret Summit, California **1040 ± 250**

Partially charred wood, base of pumice lapilli bed, underlain by till, E wall pumice quarry, end of dirt rd, S from Devils Postpile rd at Minaret Summit (37° 39′ 05″ N, 119° 03′ 20″ W). Coll 1973 by R Koeppen and R A Bailey; subm by R A Bailey. *Comment*: this date and 920 ± 80, UCLA-908 (R, 1966, v 8, p 494) relate to age of basal tephra layers from Inyo crater (Wood, 1977).

W-1431. Inyo Crater, California **650 ± 200**

Wood, projecting into S crater from NE wall, underlain by pumice, Inyo Crater Lakes (37° 40′ N, 119° 05′ W). Coll 1961 by E C Rockwell; subm by C D Rinehart. *Comment* (CDR): pumice represents youngest extrusive material in area (Rinehart & Huber, 1965; Wood, 1977).

W-2624. Lopez Canyon, California **<200**

Wood from rubble exposed in exploratory trench across buried fault scarp that predates February 9, 1971, California faulting in Lopez Canyon (34° 17′ 47″ N, 118° 23′ 58″ W). Coll and subm 1971 by M G Bonilla. *Comment* (MGB): age is approx for formation of pre-1971 scarp (Bonilla, 1973).

San Francisco series, California

Two organic samples nearby and adjacent to bones of human skeleton found during excavation for Civic Center Sta of San Francisco Bay Area Rapid Transit Dist (BART), San Francisco (37° 46.8′ N, 122° 24.45′ W). First remains found by workmen, 1969; remainder dug out by Winfield Henn and Michael Mannion, of Treganza Anthropol Mus San Francisco State Coll, San Francisco; subm by Julius Schlocker.

W-2733. **2070 ± 250**

Peat, 90m W of and 2.7m above skeleton at base of dune deposit. *Comment* (JS): peat formed from plant debris in marsh near sea-level near shore of San Francisco Bay. Marsh was subsequently buried by at least 14.6m dune sand. Site is near pre-1850 shoreline; later filling by man moved shore 2.4km E. Data gives rate of subsidence and/or compaction of ca 0.25cm/yr.

W-2463. **4900 ± 250**

Organic clay clinging to hip bone of skeleton, alt 7.8m below MSL, depth 21.9m, N side of Market St, 36.9m S of centerline of Fulton St. *Comment* (JS): oldest date for human occupation in Bay area (Henn *et al,* 1972).

W-2764. Point Ano Nuevo, California **>43,000**

Shells *(Macoma inquinata)* from lowest exposed terrace, 0.8km NE of Ano Nuevo Point (37° 10′ N, 122° 25′ W), near Santa Cruz. Coll 1970 and subm by W O Addicott. *Comment* (WOA): same sample gave Th/U age of 16,000 ± 2000 yr (Bradley & Addicott, 1968). However, studies seem to confirm an older age.

W-2412. San Nicolas I., California **2070 ± 200**

Abalone shells *(Haliotis cracherodii)* from unexposed middle part of black sooty shell layer, atop wind-eroded dune, 52.5m W of Triangulation Sta, North Head 2, alt 168m, San Nicolas I. (33° 15′ N, 119° 30′ W). Coll 1957 and subm by J G Vedder. *Comment* (JGV): date is maximum for vegetation development on Holocene deposits on I.

Borrego Mountain series, California

Shells, N wall of Trench #2 across the 1968 Coyote Creek fault surface rupture (33° 06′ N, 116° 03′ W). Coll 1971 and subm by M M Clark.

W-2602. **5620 ± 300**

Shells from shelly bed, 1m below surface on upthrown (W) side of this dominantly strike-slip fault. Same bed could not be found across fault and is presumably deeper in sec.

W-2604. **5410 ± 300**

Shells from deepest bed exposed on downthrown side of fault. This bed is 1.9m deeper than bed of W-2602.

General Comment (MMC): data indicate at least 1.9m vertical separation caused by fault movement at this place during last 5400 yr (Clark *et al,* 1972). Parallel trench across fault, excavated 1977 ca 25m NW by R V Sharp and M G Bonilla, shows 3 to 4m vertical fault separation of bed that is possibly same as that of W-2602.

Santa Cruz series, California

Organic sediment samples from drill holes in sag ponds in valley controlled by San Andreas fault, N of Pajaro Gap, Santa Cruz Co (36° 55′ N, 121° 45′ W). Coll and subm 1971 by A M Sarna-Wojcicki.

W-2784. **680 ± 200**
Organic mud, depth 1.1m.

W-2782. **900 ± 200**
Organic mud, depth 1.3m.

W-2811. **3410 ± 250**
Organic clay, depth 2.2m.

W-2812. **3415 ± 250**
Organic clay, depth 2.3m.

W-2789. **3860 ± 500**
Organic clay, depth 4.4m.

W-2787. **3200 ± 500**
Organic clay, depth 4.5m.

W-2785. **3470 ± 500**
Organic mud, depth 5.0m.

W-2786. **3850 ± 500**
Organic mud, depth 5.1m.

General Comment (AMS): lower dates indicate rapid alluviation over short period of time, on the order of 100 to several hundred yr, followed by long period of nondeposition or erosion, lasting until ca 1000 to 1500 yr BP, followed by period of slower alluviation until present. Periods of alluviation may represent deformation of thalweg of valley by prehistoric seismic events, with formation of sag, which was then rapidly filled by alluvium.

W-2457. San Benito, California **1740 ± 250**

Organic clay, sag pond, depth 1.6 to 1.9m, San Benito Co (36° 30′ N, 120° 50′ W). Coll and subm 1969 by Andrei M Sarna-Wojcicki. *Comment* (AMS): age falls within estimate obtained from erosion-deposition rates.

W-2461. Orchard Peak, California **13,060 ± 400**

Plant material, sag pond, depth 7.5 to 8.4m, 13.5m E of earth dam, Twisslemann's Ranch, Orchard Peak quad, S of Cholame Valley (35° 45′

N, 120° 15′ W). Coll and subm 1969 by Andrei M Sarna-Wojcicki. *Comment* (AMS): dates sag pond depression that was completely filled by sediment and more recently re-excavated by erosion.

W-2616. Glendale, Nevada >45,000

Carbonaceous mudstone, near top of exposed lacustrine sequence of gypsiferous and limy mudstone containing brimstone deposits, off Hwy I-15 overpass across Union Pacific RR track, SW of Glendale (36° 39′ 10″ N, 114° 34′ 45″ W), N end of North Muddy Mts. Date will help to determine origin of sulfur deposits. Coll 1968 and subm by F G Poole. *Comment* (FGP): unit sampled also contains abundant plant fragments and some snails.

Oak City, series, Utah

Marl and shell samples from Oak City area, Millard Co. Subm by D J Varnes and Richard Van Horn.

W-2968. 5770 ± 250

Clam shells in silty alluvium, bank of Sevier R (39° 25′ 42″ N, 112° 27′ 03″ W). Coll 1973 by D J Varnes. *Comment* (DJV): indicates that alluvium is post-Lake Bonneville, although it is lithologically identical with known pre-Lake Bonneville alluvium.

W-931. 12,560 ± 400

Light-gray silty marl containing fragments of black pumiceous ash, alt 1527m, overlain by Bonneville bench, underlain by 1.5m gravel overlying sand and clay lake deposits, Gilbert's Leamington sec, at mouth of valley cut through Canyon Range by Sevier R, at foot of quartzite ridge, N of Sevier R (39° 32′ 47″ N, 112° 15′ 29″ W). Coll 1957 by D J Varnes. *Comment* (DJV): although very thin, this marl is probably equivalent to Gilbert's "White Marl" and is within Bonneville Formation of Lake Bonneville Group.

W-2378. 13,060 ± 350

Gastropod shells with fragments of pelecypod shells, 15.2km NE of Delta towards Lynndyl (39° 25′ 50″ N, 112° 26′ 53″ W). Coll 1969 by D J Varnes and Richard Van Horn. *Comment* (DJV): material is believed to be lacustrine and to have been deposited during last rise of Lake Bonneville above 1425m.

W-2969. 16,510 ± 350

Gastropods from gravelly sand, Big Gully (39° 26′ 43″ N, 112° 23′ 59″ W). Coll 1973 by D J Varnes. *Comment* (DJV): youngest date yet obtained from sec at Big Gully. Sample was coll ca 1m above "White Marl" horizon, which has many dates in the range 17,000 to 18,000, (Broecker & Kaufman, 1965).

W-924. **18,200 ± 500**

Light gray marl at base of Lake Bonneville Group enclosing a bed of black volcanic ash, lower Sevier R Delta (39° 24′ 31″ N, 112° 27′ 52″ W). Coll 1957 by D J Varnes.

W-946. **15,900 ± 400**

Complete re-run of W-924. *Comment* (DJV): dates for material at base of Lake Bonneville Group are much too young and indicate exchange of carbon isotopes, possibly by ground water.

W-2967. **19,910 ± 600**

Gastropods from silty sand, 0.6m below base of upper Alpine blocky clay (39° 30′ 55″ N, 112° 20′ 56″ W). Coll 1973 by D J Varnes and J C Liddicoat, Univ California, Santa Cruz. *Comment* (DJV): date appears too young, being separated from an overlying basaltic ash, dated at 18,200, W-924, by an unconformity and 11.4m fine-grained lacustrine deposits. Isotope exchange by ground water is possible. Similar gastropod material was dated by U-Th method at 40,000, L-1005C (W S Broecker, written commun, 6/27/66).

W-2966. **20,140 ± 400**

Gastropods from gravel at base of Lake Bonneville Group, bank Sevier R (39° 24′ 50″ N, 112° 27′ 01″ W). Coll 1973 by D J Varnes. *Comment* (DJV): previously obtained material on bank near this horizon ranges from 14,000 to 18,200 (W-946, -924: this list; L-711B, -774F: Kaufman & Broecker, 1965), but on opposite bank dates >32,000 (L-711A: Kaufman & Broecker, 1965) by ^{14}C, and 140,000 (L-1005A: W S Broecker, written commun, 6/27/66) and 108,000 ± 23,000 (L-711A: Kaufman & Broecker, 1965) by U-Th. This analysis confirms exchange of carbon isotopes by ground water contamination.

W-923. **20,000 ± 500**

White marl from middle of highest white marl bed overlying volcanic ash, in marl pit near rd from Oak City to Lynndyl (39° 25′ 47″ N, 112° 20′ 03″ W). Coll 1949 by Richard Van Horn. *Comment* (DJV): probably equivalent to Gilbert's "White Marl" in Bonneville Formation of Lake Bonneville Group.

W-927. **>35,000**

Light-gray silty, clayey marl, near top of sec of Alpine Formation, Lake Bonneville Group, at Big Gully (39° 26′ 49″ N, 112° 24′ 05″ W). Coll 1949 by Richard Van Horn. *Comment* (DJV): date agrees with stratigraphic assignment.

W-2553. Fountain Creek, Colorado **<200**

Wood, possibly at contact of Pierre Shale and Verdos Alluvium, Fountain Creek, Colorado Springs, El Paso Co (38° 47′ 49″ N, 104° 49′

15″ W). Coll 1970 by Joseph Alley; subm by G R Scott. *Comment* (GRS): apparently this was from modern channel cut into Verdos Alluvium.

Ophir Valley series, Colorado

Well-preserved wood, lying on bedding planes in goethite deposit built up by precipitation from springs and seeps, dated as part of study of geochemical kinetics of iron spring deposit (Hanshaw & Spiker, 1972), Ophir Valley, San Juan Mts, San Miguel Co. Coll and subm 1971 by B B Hanshaw and E Spiker.

W-2414. **2990 ± 250**
5m above base of deposit.

W-2711. **4880 ± 250**

W-2716. **5730 ± 250**

W-2712. **5970 ± 250**
6.1m below W-2711.

W-2713. **6310 ± 250**
0.5m below W-2712.

W-2714. **6300 ± 250**
0.3m below W-2713.

W-2710. **7100 ± 250**

W-2717. **7240 ± 250**
1.8m below W-2716.

W-2420. **8250 ± 300**
7.3m below top of deposit, 10m above base.

General Comment (BBH & ES): ages of wood from different stratigraphic levels indicate that rates of accumulation are between 0.6 and 1.6mm/yr, average being 0.9mm/yr. Markers placed in seeps developed 2mm crust of goethite in 2yr, showing that deposit is still growing at same rate. Apparently, deposit began to develop soon after retreat of most recent mt glaciers.

Teton Park series, Wyoming

Shell and organic samples from Teton Park, Teton Co (Love *et al,* 1965; Love & Taylor, 1962). Coll 1963 and 1969 and subm by J D Love.

W-2428. **370 ± 200**

Charred wood fragments in soil horizon overlain and underlain by till, W base South Park Cemetery Hill (43° 22′ 30″ N, 110° 45′ W). *Comment* (JDL): young age is probably result of slump or solifluction that put till over young soil.

W-2429. **1570 ± 200**

Charcoal fragments in light-brown silt, roadcut S side of Gros Ventre USFS rd, 60m W of junction of Sohare oil well rd (43° 30′ N, 110° 15′ W). *Comment* (JDL): age is minimum for Dibble Racetrack terrace, maximum for 24m post-terrace downcutting by Gros Ventre R, and minimum for major landslide directly overlain by charcoal layer (Bailey, 1971, p 90).

W-2432. **4120 ± 200**

Shells *(Helix)* embedded in organic dark-gray silt, roadcut, N side USFS Gros Ventre R rd, N of Lower Slide Lake scenic turnout (43° 37′ 30″ N, 110° 30′ W). *Comment* (JDL): represents land snail unit indicating lake margin had filled up, (Bailey, 1971, p 67, fig 45).

W-2458. **3790 ± 250**

Organic silt and charcoal, 1.5m above base of deposit, 2.7m below W-2432. *Comment* (JDL): represents lacustrine environment.

General Comment (JDL): dates are minimum for landslide resulting in lake where sediment accumulated. Slightly subdued features of slide would be expected in slide of this age. Ages also indicate how rapidly Gros Ventre R excavated 45m of valley in post-lake time.

W-2479. **5000 ± 650**

Snail shells embedded in loess, from roadcut, E side of Fish and Wildlife Service dugway rd in National Elk Refuge (43° 30′ N, 110° 37′ 30″ W). *Comment* (JDL): age is much younger than expected. Either age or stratigraphic correlation with widespread 15,000 yr old loess is invalid. Suggest recollection and redating.

W-1556. **14,800 ± 400**

Shells, from upper of 2 shell beds, N of Jackson (43° 32′ 32″ N, 110° 42′ 35″ W). *Comment* (JDL): date is maximum for folding and faulting in upper loess, (Love *et al,* 1965, p 40).

W-1558. **>33,000**

Shells, from lower shell bed, 20m below W-1556. *Comment* (JDL): this is from same location as W-1556, but from below old till, (Love *et al,* 1965, p 40).

W-1560. **19,100 ± 600**

Shells in loess from upthrown block of large Holocene fault system, N of Jackson (43° 32′ 40″ N, 110° 44′ 25″ W). *Comment* (JDL): age of offset loess dates fault movement which, here, is 60m in post-loess time (Love *et al,* 1965, p 40).

W-2453. **>45,000**

Carbon chunks intermixed with pumice fragments and sand, upper part of 15m hwy cut, 60m S of target range turnoff (43° 22′ 30″ N, 110°

37′ 30″ W). *Comment* (JDL): infinite age indicates that Bailey Creek slide, placer gold accumulation to 120m thickness, and destruction of slide lake, all took place >45,000 yr ago. Date is valuable for chronology of later events along Snake R, especially cutting of terraces and stabilization of old lake-triggered slides.

W-1684. Pelican Valley, Wyoming **7550 ± 350**

Wood in Pelican Valley lacustrine sequence, Yellowstone Natl Park (44° 36′ N, 110° 14′ 50″ W). Coll and subm 1965 by J D Love. *Comment* (JDL): sequence overlies youngest glacial deposit in area, is at least 60m thick, widespread, and is involved in tectonics that destroyed at least half of ancestral Yellowstone Lake.

W-2928. Rainbow Springs, Wyoming **>45,000**

Oil that bubbled up in probe hole 1.2m deep in oily swamp, originating from bluish-gray tuffaceous lacustrine claystone containing oil-secreting alga *Botryococcus* and Pleistocene or Holocene diatoms and pollen, Rainbow Springs (Love & Good, 1970). Coll and subm 1963 by J D Love.

Yellowstone Natl Park series, Wyoming

Series is part of study of surficial geol history of Yellowstone Natl Park area (Richmond 1975; 1976; 1977; Pierce *et al*, 1976).

W-2766. **540 ± 250**

Wood from landslide-dammed lake silt, 3m above river level in Grand Canyon of Yellowstone R (44° 45′ 48″ N, 110° 23′ 35″ W), Tower Junction quad. Coll and subm 1971 by G M Richmond. *Comment* (GMR): dates large blockslide of Eocene rock that dammed canyon at N end Sevenmile Hole.

W-2735. **2430 ± 250**

Wood from lake silt in escarpment of 12m terrace, W side Grand Canyon of Yellowstone R at site of 1971 landslide, 8 km below Lower Falls and ca 1.6km upstream from foot of Sevenmile Hole Trail (44° 44′ 25″ N, 110° 25′ 19″ W), Canyon Village quad. Coll and subm 1971 by G M Richmond. *Comment* (GMR): approx dates large post-Pinedale landslide of hydrothermally altered rhyolite that blocked Yellowstone R and formed lake in canyon.

W-2487. **2850 ± 600**

Wood from base of peat lobe on slope adjacent to meadow along small tributary to Raven Creek, 2.4km SE from top of Pelican Cone (44° 38′ 10″ N, 110° 10′ W), Pelican Cone quad. Coll 1967 and subm by G M Richmond.

W-2581. **3480 ± 300**

Complete re-run of W-2487. *Comment* (GMR): minimum age for movement of peat lobe on slope.

W-2734. **3500 ± 250**

Peaty organic material, 2 to 7cm thick, beneath colluvium overlain by forest fire debris and surface dune sand. Deposit rests on Squaw Lake hydrothermal explosion debris in bluff on Yellowstone Lake, 0.2km E of Squaw Lake picnic area (44° 33′ 15″ N, 114° 15′ 00″ W), Canyon Village quad (Richmond, 1973b). Coll and subm 1971 by G M Richmond.

W-2497. **4950 ± 400**

Humic silt, on gravel of 5m stream terrace along Pelican Creek, ca 90m upstream from horse bridge (44° 34′ 30″ N, 110° 15′ 30″ W), Canyon Village quad. Coll 1967 and subm by G M Richmond.

W-2580. **5900 ± 300**

Willow twigs from boggy sand layer beneath gravel of 5m stream terrace at same locality as W-2497. Coll 1967 and subm by G M Richmond. *Comment* (GMR): overlying gravel is probably related to lake terrace 12 to 14m above Yellowstone Lake. This date and 4950 ± 400 from W-2497 bracket age of gravel.

W-2765. **5750 ± 300**

Charcoal from base of thick colluvium, exposed in gully, N slope Conant Basin, Teton Natl Forest, S of Yellowstone Natl Park (44° 02′ N, 110° 54′ W), Grassy Lake Reservoir quad. Coll 1968 and subm by G M Richmond.

W-3190. **7530 ± 250**

Wood from dark peaty deposit 30cm thick, beneath 7.3m pebbly lake sand with diatomaceous silt layers, in bluff of Yellowstone Lake, mouth of Solution Creek (44° 24′ 20″ N, 110° 30′ W), Frank Island quad. Coll 1974 and subm by G M Richmond.

W-3187. **7890 ± 250**

Charcoal from brownish sandy peat 15cm thick, same locality as W-3190, but 1m below. Coll 1974 and subm by G M Richmond.

W-2486. **8000 ± 500**

Peaty silt, overlain by hydrothermal explosion debris from crater at Turbid Lake, at right angle bend of Sedge Creek, 1.6km NE of Turbid Lake (44° 34′ N, 110° 15′ W), Pelican Cone quad. Coll 1967 and subm by G M Richmond. *Comment* (GMR): charcoal beneath explosion debris, 1.6km to SW, was dated at 8310 ± 300, W-1944 (R, 1969, v 11, p 217). Approx date for instantaneous explosion.

W-2748. **8820 ± 300**

Wood, depth 71 to 79cm below top of sandy bog deposit overlying Pinedale Till and outwash in bluff of Yellowstone R, upstream from Yellowstone Lake and immediately downstream from confluence of Monument Creek (44° 14′ 05″ N, 110° 08′ W), Two Ocean Pass quad. Coll 1970 and subm by G M Richmond.

W-2738. **10,720 ± 350**

Charcoal, 1.34km above ash from Glacier Peak, 2.4m above lake level, in bluff of Yellowstone Lake immediately E of Squaw Lake picnic area, N end of lake (44° 33′ 10″ N, 110° 19′ 20″ W), Canyon Village quad. Coll 1970 and subm by G M Richmond.

W-2736. **10,900 ± 350**

Carbonized wood from mudflow unit, overlying Pinedale Till and recessional gravel, and overlain by lake silt, same location as W-2735. *Comment* (GMR): postdates Pinedale deglaciation of this part of Grand Canyon of Yellowstone R and predates landslide assoc with overlying lake beds from which W-2735 was coll.

W-2767. **11,600 ± 350**

Twigs and peat, depth 310 to 315cm below surface at base of sandy bog deposit overlying Pinedale Till and outwash gravel, same location as W-2748. Coll 1970 and subm by G M Richmond. *Comment* (GMR): date is minimum for deglaciation and end of outwash deposition along Yellowstone R above Yellowstone Lake.

W-2894. **13,650 ± 600**

Thin organic-rich lake silt, at base of finely laminated lake sand, overlying varved silt. Organic silt, 10m to E, is overlain and folded into distal deposit of hydrothermal explosion breccia from craters in Mary Bay, "Squaw Point" on Yellowstone Lake at Squaw Lake picnic area (44° 33′ 10″ N, 110° 19′ 30″ W) Canyon Village quad. Coll and subm 1972 by G M Richmond. *Comment* (GMR): organic silt and explosion breccia underlie ash from Glacier Peak (ca 12,000 yr BP). Dates hydrothermal explosions in Mary Bay and approx end of deposition of varved silts.

W-2739. **14,130 ± 375**

Thin lenticular bryophyte mattes from lake silt, same locality as W-3190. Coll 1970 and subm by G M Richmond. *Comment* (GMR): dates opening of this part of Yellowstone Lake during recession of Pinedale glacier.

W-3183. **14,490 ± 350**

Re-run of W-2739. Recoll 1974 and subm by G M Richmond.

W-2895. **17,460 ± 500**

Black humic clay lenses, 5cm thick, disconformably overlying involuted reddish-brown clayey loess, and overlain by brown loess and solifluction layer of basalt blocks, 0.8km E of Warm R Bridge, along forest rd E of Warm R Campground, 7.2km W of Yellowstone Natl Park (44° 15′ 55″ N, 111° 16′ 30″ W), Hatchery Butte quad, Idaho. Coll and subm 1972 by G M Richmond. *Comment* (GMR): locality is beyond outer limit of Pinedale glaciers.

W-2896. **17,480 ± 500**

Dark organic silt, 50cm thick in uppermost part of loess, overlain by 45cm reddish-brown soluflucted loess beneath 1m slabby black vitrophyric tuff fragments in sandy matrix, cut on W side Fish Creek Rd at rd level, 0.4km S of junction of Fish Creek Rd with Snow Creek Rd near Horsefly Spring, 5.6km W of Yellowstone Natl Park (44° 10′ 50″ N, 111° 10′ 05″ W), Warm River Butte quad, Idaho. Coll and subm 1972 by G M Richmond. *Comment* (GMR): locality is beyond outer limit of Pinedale glaciers.

W-2582. **>29,000**

Humic lake sediments with thin bryophyte mattes, in lower part of sediments dipping gently N, same locality as, and disconformably overlying W-2739, -3183, -3187, and -3190. Coll and subm 1968 by G M Richmond. *Comment* (GMR): though no till is present, deposit is believed to pre-date Pinedale Glaciation. *Comment* (MR): although sample gave finite age of ca 29,000 yr, we believe that material is contaminated by an indeterminate amount of modern carbon that cannot be removed. Therefore minimum age is quoted. See discussion by Pierce *et al* (1976).

W-2955. **>40,000**

Laminated silty clay containing thin lenticular bryophyte mattes gently dipping downstream, disconformably overlain by sand and gravel deposited during stagnation of Pinedale glacier, E bluff Solution Creek, ca 1.7km above its entrance into W thumb Yellowstone Lake (44° 23′ 40″ N, 110° 30′ W), Frank Island quad (Richmond & Waldrop, 1975). Coll and subm 1973 by G M Richmond. *Comment* (GMR): W-2955, and -2012, >38,000 (R, 1969, v 11, p 218) were derived from same bryophyte matte horizon. Dated horizon dips 3° N and disappears downstream beneath successively younger similarly dipping beds that extend to locality dated by W-2582.

W-2197. **>42,000**

Wood in lake silt, S side Beaverdam Creek, near junction with Rocky Creek (44° 20′ N, 110° 10′ W), Eagle Peak quad (Richmond & Pierce, 1972; Richmond, 1974; Richmond, 1973b). Coll 1967 and subm by G M Richmond. *Comment* (GMR): wood is from lake silt that grades up through sand into 12m gravel overlain by peaty sand, dated by ^{14}C enrichment method as 68,300 ± 2200 (Grootes, 1977), higher lake silt, proglacial gravel and Pinedale Till.

W-2411. **>45,000**

Organic layer in laminated silt along Trappers Creek, overlain by 6m gravel, underlain by 12m gravel and by older till, lake sediments, and gravel (45° 1.62′ N, 110° 5.88′ W), Eagle Peak quad. Coll 1966 by K L Pierce; subm by G M Richmond.

W-2264. **>42,000**

Wood and plant debris from laminated clayey silt deposit lying disconformably beneath gray Pinedale Till, containing small pebbles of obsidian, S side Teton Natl Forest, immediately S of Yellowstone Natl Park (44° 07′ 30″ N, 110° 49′ W), Grassy Lake Reservoir quad (Richmond, 1973a; Richmond & Waldrop, 1975). Coll and subm 1968 by G M Richmond. *Comment* (GMR): laminated silt grades downward into lake sand, underlain to W by older pink till that contains no obsidian.

W-2780. Cub Creek, Yellowstone Natl Park, Wyoming **14,360 ± 400**

Organic silt from piston core, depth 7.0 to 7.3m, alt 2485m, 3.2km E of Yellowstone Lake on rd to E entrance of Yellowstone Natl Park (44° 30′ N, 110° 15′ W). Coll 1970 and subm by H E Wright, Jr, Univ Minnesota, Minneapolis. *Comment* (HEW): material dated is in herb pollen zone, indicating late glacial alpine vegetation before spread of sub-alpine forests; it is combination of 8cm directly above volcanic ash and 16cm directly below. Date gives reasonable minimal time for withdrawal of Pinedale ice from this part of Yellowstone Plateau. This and other ash dates, as well as pollen stratigraphy, are discussed by Waddington and Wright, Jr (1974).

D. Mexico

La Malinche series, Mexico

Series is part of study of volcanic ash and lapilli at Valsequillo archaeol sites, Puebla, Mexico. Area is surrounded by 3 major volcanoes: Popocatepetl, Iztaccihuatl, and La Malinche (LM). Chronology of volcanic ejecta in basin deposits that contain archaeol sites is useful in studies of regional archaeol, paleontol, and geol.

The S and W flanks of L M, alt 4450m, N of Puebla are mantled by surficial deposits that include at least 10 layers of volcanic ash and pumice lapilli. These are intercalated with buried soils, alluvial fan material and mudflows. See also Heine (1971). Field relations indicate that layers of ash and pumice represent airfalls (locally ash flows) from explosive eruptions indigenous to LM. The latest ash, a blanket of lithic volcanic sand 6m thick, overlies fossil soil developed on moraine that extends along W flank of mt at 3800m alt (just below treeline—3900 to 3950m); ash is, in turn, succeeded by small moraine at 4100m alt on NW side. Thus, all but 1 of the id volcanic layers are older than 2 episodes of glaciation, and all volcanic layers that contain pumice are older than any recognized glaciation. Older of the moraines on LM is regarded as late Pleistocene on basis of its geomorphic similarity to an upper Pleistocene moraine in Iztaccihuatl (White, 1962), and younger moraine is probably early Holocene.

Sequence of ash and pumice lapilli on LM is divided into 2 parts separated by minor unconformity. None of these volcanic layers has yet been id in beds of ash and pumice at Valsequillo, and probably the layers

equivalent to those at Valsequillo are still deeply buried on LM. Organic sediment and charcoal samples coll 1966 and 1968 and subm by H E Malde.

W-1912. **5750 ± 280**

Humus soil, 40cm thick, on pumice near treeline, buried by airfall of lithic volcanic sand equivalent to that of W-1909, NW flank LM, alt 3850m, 0.5km WSW of Cerro Chi Chi (19° 15′ N, 98° 03′ W).

W-1923. **7450 ± 250**

Humus soil, 35cm thick, on pumice 500m below treeline, buried by airfall of lithic volcanic sand equivalent to that of W-1909, W flank LM, alt 3420, near spring in Barranca Apache, 3km E of Tlaloca (19° 14′ N, 98° 04′ W).

W-1909. **8240 ± 300**

Humus soil, 40cm thick, on moraine, buried by airfall of lithic volcanic sand, W flank LM, alt 3800m, head of Barranca Apache, 4km E of Tlaloca, 1.6km SW of W-1912 (19° 14′ N, 98° 03′ W).

General Comment (HEM): development of this soil ended as consequence of sudden burial by lithic volcanic sand. Date is maximum (ca 5700 BP) for younger moraine on LM, not covered by sand, alt 4100m. Because soil must have begun to form when ice that built older moraine retreated, age of this soil closely approximates end of this glacial advance (ca 8200 BP) although glacial maximum was necessarily somewhat older. This is consistent with known regional glacial history (White, 1962). As applied to age of Valsequillo S of Puebla, date for this soil is minimum for any LM pumice deposits that may be id as airfalls in Valsequillo because all pumice eruptions from LM are stratigraphically below this soil.

W-1908. **23,940 ± 1000**

Humus soil 75cm thick, buried conformably by 50cm unsorted stony debris, then by 7cm laminated pumice lapilli, and by massive ash flow at least 8m thick, W flank LM, Barranca Angostura, alt 2700m, 2.2km SW of Tlaloca (19° 13′ N, 98° 06′ W).

W-1911. **25,920 ± 1000**

Humus soil 1.5m thick, buried conformably by lm unsorted stony debris, then by 10cm laminated pumice lapilli, and by massive ash flow at least 18m thick, W flank LM, Barranca San Jose Xotanacatla, alt 2450m, 6km ENE of San Cosme Mazatecoxco (19° 12′ N, 98° 08′ W).

W-2570. **24,300 ± 1000**

Charcoal, lower part of humus soil, same location and horizon as W-1911.

W-2571. **26,100 ± 600**

Soil humates, extracted from soil in lab of Vance Haynes (SMU), same location and horizon as W-1911.

General Comment (HEM): dates indicate soil is ca 25,000 yr old. Development of this soil must have ended as consequence of sudden burial by overlying stony debris, possibly an airfall of lithic fragments resulting from nonmagnetic explosion of LM, followed by laminated lapilli and ash flow. If volcanic layer equivalent to this ashflow is missing at Valsequillo because Valsequillo deposits are older, dates imply that Valsequillo archaeol site provides earliest known signs of man in New World.

W-1927. **8110 ± 300**

Charcoal in soil 50cm thick correlated with soil of W-1911, buried conformably by 10cm laminated pumice lapilli and by massive ashflow at least 18m thick (layer of stony debris found at other exposures between soil and laminated lapilli is lacking here), W flank LM, Barranca San José Xotanacatla, alt 2500m, 7.5km ENE of San Cosme Mazatecoxco (19° 12′ N, 98° 07′ W). *Comment* (HEM): because other dates for this soil substantially agree (W-1911, -1908 -2570, -2571), and indicate age 3 times as old as this charcoal, charcoal is probably not indigenous but represents carbonized roots of plants that grew more recently.

W-1913. **17,350 ± 550**

Humus soil, 15cm thick, below 2.5m pumice that unconformably underlies W-1911, same location as W-1911. *Comment* (HEM): date is discounted because sample was below W-1911 but is dated as younger. Sample is evidently contaminated.

W-1925. **17,650 ± 550**

Humus soil, 45cm thick, developed on stony layer and overlain by 20cm lithic volcanic sand and then by 1.5m pumice, W flank LM, Barranca Angostura, alt 3000m, 1.5km SE of Tlaloca (19° 13′ N, 98° 05′ W). *Comment* (HEM): significance of date in chronology of volcanic deposits on LM is uncertain, pending petrographic study of overlying sand and pumice.

Valsequillo barranca series, Mexico

Barrancas (deep arroyos) that debouch along embayed N shore Valsequillo Reservoir are partly filled with compact, gravelly alluvium, now dissected. This alluvial fill is at grade with alluvial formation ca 30m thick (known locally as Valsequillo gravel) widely exposed around reservoir, although barranca deposits and typical Valsqeuillo at reservoir are nowhere in contact. On basis of unpub geol mapping by Malde, 1964-1966, and on incomplete petrographic study by V Steen-McIntyre of several intercalated beds of volcanic ash and lapilli, barranca alluvium and Valsequillo appear correlative. Barranca deposits probably represent alluvium that filled tributaries of large valley where typical Valsequillo was deposited concurrently. Radiocarbon analyses from barranca deposits, therefore, are believed to apply to Valsequillo, which has not yet yielded material suitable for direct radiocarbon dating. Selected bone samples from these alluvial gravels were also dated by uranium-series method

(Szabo *et al,* 1969). However, archaeologically, several uranium-series dates are much too old. Samples of freshwater clams, freshwater snails, and land snails from alluvium, Puebla, Mexico. Coll 1966 by J Reynolds and C E Ray, US Natl Mus, Washington, D C; subm by H E Malde.

W-1974. **Modern**

Living snails, *Holospira,* Barranca de Caulapan, 425m S of rd to Valsequillo Presa, 8km on rd ESE from San Francisco Totimehuacan (18° 57′ N, 98° 08′ W). Coll 1964 by H E Malde. *Comment* (HEM): control sample for modern standard.

W-1896. **9150 ± 500**

Shells, 23m above W-1898, Barranca de Caulapan. *Comment* (HEM): dates upper limit for alluvium.

W-1895. **21,850 ± 850**

Shells, 10m above W-1898, Barranca de Caulapan, 8m above W-1975. *Comment* (HEM): from same bed immediately adjacent to sample, C Irwin-Williams and J Armenta found *in situ* a chert flake, possibly an artifact, which may be oldest directly dated record of man in New World.

W-1975. **>29,000**

Shells from gravelly sand in gravel above base of compact alluvial fill, 2m above W-1898, Barranca de Caulapan.

W-2189. **30,600 ± 1000**

Shells from gravelly sand near base of compact alluvial fill, 50m upstream from W-1898, Barranca de Caulapan.

W-1898. **>35,000**

Shells, at base alluvial fill, Barranca de Caulapan.

General Comment (HEM): alluvial fill rises to form well-defined terrace at grade with surface of Valsequillo deposits preserved in isolated outcroppings where barranca joins reservoir. Dates indicate alluvium began to accumulate at least 35,000 yr ago, changed from gravel to fine-grained material ca 20,000 yr ago, and culminated ca 9000 yr ago.

W-1899. **>35,000**

Shells, at base of alluvium, 8m above Rio Atepitzingo, 10m N of bridge, 1500 ESE of San Francisco Totimehuacan (18° 58′ N, 98° 10′ W). *Comment* (HEM): indicates assoc fossils and possible artifacts (Aveleyra, 1962, p 44) are at least as old as late Pleistocene. Unpub mapping and drilling by H E Malde demonstrates that alluvium at Rio Atepitzingo connects in subsurface with that along Rio Alsesca upstream from village of Totimehuacan.

W-1901. **>35,000**

Shells, near base of alluvial fill, Barranca de Xochiac, 1250m E of San Pedro Zacachimalpa (18° 56′ N, 98° 09′ W). *Comment* (HEM): sug-

gests all fossils and possible artifacts near base of alluvium are at least as old as late Pleistocene (Armenta, 1959; Lorenzo, 1960).

W-1897. **20,780 ± 800**

Shells, 2 to 3m below top of well-exposed alluvium at least 8m thick, 45km ESE of Puebla, W edge Santa Isabel Tlanepantla, 300m upstream from cemetery (18° 51′ N, 97° 54′ W). *Comment* (HEM): suggests local fauna from Barranca de Santa Isabel Tlanepantla is closely contemporaneous with local faunas from Valsequillo barrancas. Date helps estimate age of inferred widespread fauna in this prov of Mexico.

W-1980. Puente del Negro, Mexico **4350 ± 250**

Charcoal at base of fine volcanic ash bed, E side Rio San Francisco, depth 329 cm, 200m NNE of Puente del Negro, Pueblo (19° 04′ N, 98° 12′ W), Mexico. Coll 1966 by P S Martin; subm by H E Malde. *Comment* (HEM): dates white ash marker.

W-1995. Rio Frio, Mexico **>40,000**

Carbonized wood in ash flow, exposed borrow pit, 200m SE of Rio Frio junction on Mexico City-Puebla Toll Rd, alt 2970m, (19° 20′ 55″ N, 98° 40′ 00″ W), Mexico. Coll 1966 by V Steen-McIntyre and H E Malde; subm by H E Malde. *Comment* (HEM): ash flow rests on fresh lava above pumice layers and intercalated buried soils that conform closely to existing topography. Overlying volcanic ash probably represents airfalls from Popocatepetl.

E. Pacific Islands

Jarvis Island series, Pacific Ocean

Coral samples from Jarvis I. (00° 23′ S, 160° 01′ W), Southern Line Is, Central Pacific Ocean. Coll 1968 by J I Tracey, Jr and S O Schlanger; subm by J I Tracey, Jr.

W-2315. **1810 ± 250**

Aragonite coral boulder, cemented in rubble, base of conglomerate at MLW, N coast of I.

W-2314. **2270 ± 250**

Aragonite coral cobble from top of cemented rubble, 1.5m above reef flat, MSL, N coast of I.

General Comment (JIT): dates compare with others for cemented rubble in Micronesia (Shepard *et al,* 1967; Curray *et al,* 1970). These corals are ca 2000 yr younger than corals from emergent reefs within Jarvis I. (W-2317, -2318) and are slightly younger than dolomitized lagoonal mud 2530 ± 250, W-2287 (R, 1978, v 20), (US Geol Survey, 1970; Schlanger & Tracey, 1970).

W-2317. **3980 ± 250**

Aragonite coral from microatoll in growth position, 1.2m above

W-2318. **3950 ± 250**

Aragonite coral from microatoll, 15m S of W-2317, same alt.

General Comment (JIT): date growing lagoon reefs of Jarvis that are now emergent. Age can be compared with dates of similar emergent reefs on Malden I. and on Starbuck I. (Tracey, 1972).

Starbuck Island series, Pacific Ocean

Calcium carbonate samples from present reef flats and from shell facies of emergent lagoon reefs within Starbuck I. (05° 38′ S, 155° 55′ W), Southern Line Is, Central Pacific Ocean. Reefs are formed almost entirely of articulated *Tridacna* in growth position. Coll 1968 by J I Tracey, Jr and S O Schlanger; subm by J I Tracey, Jr.

W-2381. **1230 ± 200**

Aragonite shells (*Tridacna*) *in situ* in coral microatoll on N reef flat, alt 0.3m above highest presently living coral on outer reef flat.

W-2383. **1980 ± 200**

Aragonite coral from emergent coral head, *in situ,* same locality and alt as W-2381.

General Comment (JIT): samples from slightly emergent flat on present reef.

W-2390. **1820 ± 200**

Aragonite coral (*Porites*) from large microatoll, overlying emergent shell reef, alt 1.5m above MSL, center of I.

W-2385. **2690 ± 250**

Aragonite (*Tridacna*) same location and alt as W-2390.

W-2451. **2940 ± 250**

Complete re-run of W-2385.

General Comment (JIT): same ages were expected since both shells and coral were on flat top of reef ridge.

W-2566. **2000 ± 250**

Algal reef rock (*Lithophyllum*) from present reef flat, 0.3m above MLW, same alt as living algal margin 15m seaward, N reef. *Comment* (JIT): suggests present living margin is thin veneer on older reef at same level, or possibly that margin has grown seaward 15m in 2000 yr, leaving behind relict uneroded parts of old margin.

Malden Island series, Pacific Ocean

Calcium carbonate samples formed at or just below former low

W-2329. **3550 ± 250**

Aragonite oolite crust on emergent lagoon floor 1m above MSL. *Comment* (JIT): oolite crust is much younger than emergent reefs of Malden I. but is close to ages of emergent reefs of Jarvis I. It is older, but in same range, as emergent reefs of Starbuck I., suggesting that though Malden reefs grew >27,000 to 38,000 yr ago, a resubmergence 3000 to 4000 yr ago led to ooid formation on Malden shoals.

W-2334. **>38,000**

Shells (*Tridacna*) *in situ,* encrustate reef rock, 1.3m above MSL.

W-2356. **>27,000**

Calcite and aragonite, encrustate reef rock, 0.9m above MSL.

W-2358. **>29,000**

Aragonite coral, from cemented rubbly layer overlying algal reef rock, 1.1m above MSL.

W-2359. **>32,000**

Shells (*Tridacna*) *in situ,* in coralline algal reef rock, 1m above MSL.

General Comment (JIT): emergent reefs of Malden I. are not in 1500 to 4000 yr range of most low (1 to 2m) emergent Pacific reefs. They are probably equivalent to emergent reefs or feo of Tuamotu Is, 120,000 yr range, (Veeh, 1966) but are remarkably uneroded. Reef structures are better preserved than most Holocene emergent reefs (Tracey, 1972).

Fanning Island series, Pacific Ocean

Coralline algae (*Lithophyllum*) 0.8km S of English Harbor, Fanning I. (03° 00′ N, 159° 00′ W), Line Is, Central Pacific Ocean. Coll 1968 by J I Tracey, Jr and S O Schlanger; subm by J I Tracey, Jr.

W-2568. **2200 ± 250**

Algal reef rock at beach line, midtide level, top of truncated reef flat.

W-2569. **<200**

Living algal reef rock, 15m seaward of W-2568.

General Comment (JIT): living algal margin of reef, which contains well-developed spurs and grooves, is at same level as top of adjacent truncated reef. Date of 2200 yr for truncated reef indicates that present algal margin (W-2569) is thin veneer on older reef, or possibly that present margin grew 15m seaward in 2000 yr.

W-2539. Enderbury Island, Pacific Ocean **2630 ± 250**

Aragonite shells (*Tridacna*) *in situ* in microatoll, small dry lagoon, 1m above MSL, Enderbury I. (03° 00′ S, 171° 00′ W), Phoenix Is, Central Pacific Ocean. Coll 1969 by Harold Rehder, Smithsonian Inst, Washington, D C; subm by J I Tracey, Jr. *Comment* (JIT): representative of lagoon reef ridges in dry lagoon at center of I. and indicates sea level was at least 1m higher relative to Enderbury I. 2600 yr BP.

W-2564. Vatia Bay, American Samoa Is, Pacific Ocean 250 ± 200

Coral *in situ* in large reef block containing USGS benchmark, 1m above MSL, on reef flat E side of Vatia Bay (14° 14.9′ S, 170° 40.1′ W), American Samoa, Central Pacific Ocean. Coll 1968 by J I Tracey, Jr and S O Schlanger; subm by J I Tracey, Jr. *Comment* (JIT): reef block contains large corals as much as 1m across in upright position, and was called remnant of reef from higher 1.5m stand of sea by Stearns (1944, p 1308). The block, however, is near present reef edge, and comparably large coral knolls are visible nearby at depths of 5 to 8m. Date indicates block was tossed upright upon reef by storm waves, and is not relict of eustatic sea stand.

Midway Island series, Pacific Ocean

Limestone and coral samples from reefs of Midway I., Hawaiian Is. Coll 1965 and subm by J I Tracey, Jr (Gross *et al,* 1969; Ladd *et al,* 1967; 1970). Samples were used to date emergent reefs for comparison with other Pacific Is.

W-1851. <200

Living coralline algae (*Lithophyllum*) from living reef margin, E reef (28° 15′ N, 177° 19′ W).

W-1956. 1230 ± 250

Detrital reef limestone, from emergent ledge, 0.6m above MLLW, E reef (28° 15′ N, 177° 19′ W).

W-1846. 2090 ± 200

Encrustate reef limestone, from emergent reef rock, 0.8m above MLLW, N reef (28° 17′ N, 177° 22′ W).

W-1962. 2220 ± 250

Detrital reef limestone, from truncated platform near reef edge, 0.6m above MLLW, W reef (28° 14′ N, 177° 25′ W).

W-1954. 2420 ± 300

Encrustate reef limestone, from emergent ledge near reef margin, 0.6m above MLLW, E reef (28° 15′ N, 177° 19′ W) (Stearns, 1974, p 796).

Bikini Atoll series, Pacific Ocean

Carbonate samples from Bikini Atoll, Central Pacific Ocean (Emery *et al,* 1954). Coll 1946, 1947 and subm by J I Tracey, Jr.

W-1848. <200

Living calcarous alga (*Lithophyllum*) from present reef margin (11° 37′ N, 165° 33′ E) near S end of Bikini I. *Comment* (JIT): control sample for comparison with Holocene reef limestone samples.

W-1845. **640 ± 180**

Coralline alga (*Lithophyllum*) from eroded algal reef rock 30m behind reef margin, 0.9m above MLLW (11° 37′ N, 165° 33′ E). *Comment* (JIT): limestone is part of algal margin at same alt as present living margin (W-1848) but 0.6m higher than present reef flat (Emery *et al,* 1954, pl 39; Tracey & Ladd, 1974). It possibly formed under conditions similar to present (same sea level) but died as outer parts of margin grew and cut it off from continual surf.

W-1948. **4050 ± 300**

Reef limestone, chiefly aragonitic coral, from eroded hummocky surface of reef rock at MSL (11° 36′ 25″ N, 165° 33′ 14″ E), S end of Bikini I., (Emery *et al,* 1954, p 162; Tracey & Ladd, 1974). *Comment* (JIT): dates eroded top of reef underlying Bikini I.

W-1950. **5750 ± 300**

Reef limestone of coralline algae (high Mg calcite), depth 4.6m, 2.1m below MLW, Drill Hole 3, (11° 36′ 25″ N, 165° 33′ 12″ E), SE end of Bikini I., (Emery *et al,* 1954, p 83, 255; Tracey & Ladd, 1974). *General Comment* (JIT): this date, W-1948 for reef rock at Bikini, and W-1850 at Eniwetok indicate that sea level in N Marshall Is region was within 2m of present levels 6000 yr ago, and attained present level by 4000 yr ago.

W-1850. Eniwetok Atoll, Pacific Ocean **6220 ± 200**

Aragonite coral in coral-algal reef rocks, depth 3.1m, 2.1m below MLLW, from hole drilled on rubble groin on reef flat, 60m off E coast of Engebi I. (11° 39′ 55″ N, 162° 15′ 05″ E), Eniwetok Atoll, Central Pacific Ocean (Ladd & Schlanger, 1960, p 884-889; Tracey & Ladd, 1974). Coll 1950 by H S Ladd; subm by J I Tracey, Jr. *Comment* (JIT): sample is higher but older than those reported by Thurber *et al* (1965), and suggests sea level at Eniwetok at 6000 yr BP was no more than 2m below present levels.

W-1952. Kure Island, Pacific Ocean **1480 ± 250**

Encrustate reef limestone, emergent, eroded platform at reef edge, 0.6m above MLLW, N reef of Kure I. (28° 27′ N, 178° 20′ W), Hawaiian Is, Pacific Ocean. Coll 1965 and subm by J I Tracey, Jr. *Comment* (JIT): dates emergent reef of Kure for comparison with Midway and other Pacific islands, (Gross *et al,* 1969; Stearns, 1974).

Easter Island series, Pacific Ocean

Charcoals from Rano Raraku volcano quarry (Mazière, 1968, p 138), Easter I. (27° S, 109° W). Subm by Harmon Craig, Scripps Inst Oceanog, La Jolla, California.

W-2509. **<200**

Excavated site in "stone-cutters' working place", S side quarry, depth 0.6m. Coll 1963 by Francis Mazière, SIO.

W-2511. **<200**

Charcoal from series of charcoal hearths with convex-up shape, depth 1m, at site of Thor Heyerdahl's cutting of modern tiki from quarry face. Coll by Harmon Craig on SIO Carrousel Expedition.

General Comment (HC): dates ostensibly indicate that statue carving on Easter I. may have continued until very recent times, even after legendary "Poike ditch fire" and disastrous war, dated by Heyerdahl as ca 333 yr BP. But soil from which samples were coll is completely filled with grass roots; thus dates should be regarded as lower limits (*ie* they could be older), validity of which depends on degree to which rootlets were successfully removed from samples. *Comment* (MR): all visible rootlets were removed prior to burning sample, but decomposed intruded rootlets may be significant source of young organic carbon.

F. Miscellaneous Samples

W-2575. Santa Maria Island, Azores **>30,000**

Marine bivalves from emerged encrusting algal limestone reef, along S shore of I., from Priaia to Prainha, 1.8m above MHW, Santa Maria I. (36° 57.3′ N, 25° 06.7′ W). Coll and subm 1967 by W S Newman, Queens Coll, Flushing, New York. *Comment* (WSN): date, with 29,950 ± 1200 yr (I-5666) for encrusting algal limestone is probably evidence that relative sea level prior to classical Wisconsin was higher than present.

W-2442. Monrovia, Liberia **<200**

Carbonaceous silica-rich sand, depth 0 to 1m, 5 to 7.5m above MSL, Brewerville VOA site, 12km N of Monrovia (06° 26′ 37″ N, 10° 49′ 15″ W). Coll and subm 1969 by Sam Rosenblum. *Comment* (SR): sand represents tidal-lagoon environment which suggests a ca 6m relative fall of sea level during ≤200 yr, a rather rapid rate. Evidence for uplift and/or sea level drop as noted in Ghana, 1500km E, was reported in 1940. There terraces are as much as +36m to −18m and similar silica sand is noted near seacoast.

Coastal Liberia series

Wood and charcoal dated to establish chronology for late Pleistocene and Holocene events in coastal area of Liberia. Coll 1968-70 and subm by W L Coonrad.

W-2957. **960 ± 200**

Charcoal fragments in sparse midden zone, depth 0.9 to 1.2m, beach cut bank (06° 31′ N, 10° 57′ W). *Comment* (WLC): local subsidence causing beach erosion is apparently very recent although apparently not documented historically. Date was referred to Creighton Gabel, Boston Univ, African Studies Center, Brookline, Massachusetts. *Comment* (CG): test excavations produced abundant pottery and charcoal. Date agrees very well with 1 obtained by us at same depth, 865 ± 155 (GX-3308), indicating initial occupation of site took place in 9th or 10th century AD.

W-2953. **4210 ± 250**

Charcoal fragments found buried with earthenware pots and iron implements, depth 0.9m, cut bank on SE side of Po R behind rock outcropping at beach-river intersec (06° 30′ 25″ N, 10° 55′ 30″ W). *Comment* (WLC): age is surprisingly old, but, if accurate, is significant in indicating that both iron and pottery were produced and utilized in Liberia earlier than previously known. *Comment* (CG): site was investigated by us. Extensive recent disturbance was noted, and no pottery or iron was seen. Date is far earlier than any presently accepted for early Iron age in West Africa or any other part of continent.

W-2952. **6620 ± 250**

Wood fragments, beach at Kabiki at mouth of Cavalla R (04° 21′ 42″ N, 07° 32′ W). *Comment* (WLC): age suggests approx equivalence with Bushrod I. clay age of 6160 ± 600, W-2238 (R, 1978, v 20, p 154; Blade, 1970, p 8). Both samples eroded from offshore deposits thought to be located at MSL, indicating lower sea level along this part of African coast 6000 to 7000 yr ago.

W-2958. **8400 ± 300**

Wood fragments, coll from dredge spoil, depth −10.5 to −13.5m Monrovia Freeport harbor (06° 21′ N, 10° 48′ W). *Comment* (WLC): suggests deeply incised buried river channels crossing present coastal boundary and that beach placers possibly developed 10,000 yr ago are now located far offshore.

W-2962. **12,120 ± 350**

Wood embedded in Edina Sandstone, cropping out at back edge of modern beach (06° 30′ 40″ N, 10° 56′ 25″ W). *Comment* (WLC): appears anomalously young. The Edina SS is unconformably overlain by unconsolidated deposits dated at 6000 yr, W-2238 (R, 1978, v 20, p 154) to 10,000 yr, St-1106 (R, 1965, v 7, p 273; White, 1969).

W-2447. Kumba, Liberia **3160 ± 200**

Wood cut from log buried by stream gravels, 2100m NW of Kumba (07° 39′ 46″ N, 10° 35′ 18″ W), Liberia. Coll 1968 and subm by J F Seitz. *Comment* (JFS): dates radical change in stream regimen. Logs were deposited when streams ran on beds of weathered bedrock; later, gravel was deposited.

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