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# UCLA RADIOCARBON DATES IV*

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The measurements reported in this list have been carried out in the Isotope Laboratory of the Institute of Geophysics and Planetary Physics during 1964. They are a continuation of the previously reported date lists UCLA I, II and III. The same counting procedure has been continued: $CO_2$ proportional counting at 1 atm of pressure in a 7.5 L counter with three energy channels. Dates have been calculated according to the recommendations of the Fifth Radiocarbon Conference, Cambridge, 1962, on the basis of a radiocarbon half-life of 5568 yr (Godwin, 1962). The modern standard for organic samples has been based on 95% of the count rate of NBS oxalic acid for radiocarbon laboratories. Background measurements are determined with $CO_2$ derived from marble. The ages of carbonate-containing substances such as shells and tufa have been calculated on the basis of estimates for the corresponding contemporary $C^{14}$ activity (Broecker and Walton, 1959), as discussed in the respective sample descriptions. New methods of sample preparation are described in context with the date listings.

All measurements have been arranged in the following manner:

I. Archaeologic-Historical Dates
   - A. United States
   - B. Mexico
   - C. South America
   - D. Pacific
   - E. Europe
   - F. Egypt
   - G. Iran and India
   - H. Africa

II. Geophysical, Geological and Biological Measurements
   - A. $C^{14}$ in Atmospheric Carbon Dioxide
   - B. Bomb Radiocarbon in Human Tissues
   - C. Plants
   - D. Oceanic Measurements
   - E. Tree Rings
   - F. Vegetation and Climate
   - G. Geological Processes

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## SAMPLE DESCRIPTIONS

### I. ARCHAEOLOGIC-HISTORIC DATES

### *A. United States*

**Bone Collagen Dating series**

A method was developed to isolate bone collagen which permits the dating of bones directly. The inorganic matrix of bones is destroyed with mild HCl treatment after general cleaning and other pre-treatments for the removal of humic acid if necessary. The procedure is described in detail elsewhere (Berger *et al.*, 1964).

**UCLA-689. Whiskey Lil** **2500 ± 80**
**550 B.C.**

Collagen from ribs of right side of cave mummy "Whiskey Lil," Western Speleological Inst., Nevada State Mus., P3b/198 from Chimney Cave, Lake Winnemucca, Nevada (40° N Lat, 119° 20′ W Long). Coll. 1955 by P. C. Orr, Western Speleological Inst., Santa Barbara, Calif. and J. W. Calhoun, Nevada State Mus., Carson City; subm. by P. C. Orr and R. Berger, UCLA.

**UCLA-690. Whiskey Lil** **2510 ± 80**
**560 B.C.**

Skin from right side of cave mummy "Whiskey Lil" as described above in UCLA-689.

**UCLA-692. Whiskey Lil** **2590 ± 80**
**640 B.C.**

Cedar matting in which mummy "Whiskey Lil" was wrapped. Matting was treated before combustion with dilute HCl. UCLA-689, 690 and 692 prove the equivalence of the materials used for dating. Another date for same material is M-437 at 2040 ± 250, Michigan II.

**UCLA-697 A. Sage Creek, Wyoming** **8750 ± 120**
**6800 B.C.**

Collagen of regular bison bones from ancient butchering ground at Horner site on Sage Creek near Cody, Wyoming (44° 25′ N Lat, 108° 57′ W Long). Coll. by G. L. Jepsen, Princeton Univ.; subm. by G. L. Jepsen at request of W. F. Libby and R. Berger, UCLA.

**UCLA-697 B. Sage Creek, Wyoming** **8840 ± 120**
**6890 B.C.**

Partially burnt bison bones from same site at Sage Creek as UCLA-697 A. Bones were treated with concentrated HCl to destroy both mineral matrix and to hydrolyze all collagen. Charred carbon pieces not attacked by acid were collected and dated. UCLA-697 A and UCLA-697 B prove equivalence of dated substances. Coll. by G. L. Jepsen; subm. by G. L. Jepsen at request of W. F. Libby and R. Berger.

**UCLA-140 B. Santa Rosa Island, California** **3970 ± 100**
**2020 B.C.**

Collagen date for a Santa Rosa Canalino from cemetery X. Site at Canada Verde, on N central coast (34° 01′ 31″ N Lat, 120° 08′ 05″ W Long), is ca. 35 ft above sealevel, covers 1200 yd in length and is ca. 30 ft deep. Several cemeteries have been found in this location. Date may be compared with UCLA-140, UCLA-II, 4260 ± 90 yr, for charcoal from same burial. Coll. by P. C. Orr; subm. by P. C. Orr at request of W. F. Libby and R. Berger.

**UCLA-685. Chillicothe, Ohio** **2180 ± 80**
**230 B.C.**

Bones from the McGraw site, a Hopewell farmstead located less than 2 mi S of Chillicothe, Ohio (39° 19′ N Lat, 83° W Long), from excavation unit B-1. Midden was ca. 2 ft below surface, covered by 2 layers of flood deposit which is characteristic overburden of entire site. Midden deposit itself represents a single, completely unmixed, cultural component. Date should be compared with UCLA-688. According to O. H. Prufer, date appears to be too early. Coll. by O. H. Prufer, Case Inst. of Tech., Cleveland, Ohio; subm. by O. H. Prufer at request of W. F. Libby and R. Berger.

**UCLA-688. Chillicothe, Ohio** **1670 ± 80**
**A.D. 280**

Charcoal from same site and location as UCLA-685. *Comment* (O.H.P.): date older than expected, but, broadly speaking, is in line with archaeological evidence.

**UCLA-705. Santa Rosa Island, California** **8000 ± 250**
**6050 B.C.**

Portion of ilium of dwarf mammoth from Santa Rosa Island, E of Canada Tecolote (34° 00′ 20″ N Lat, 120° 11′ 20″ W Long). Coll. by P. C. Orr; subm. by P. C. Orr on request of W. F. Libby and R. Berger. *Comment* (P.C.O.): $C^{14}$ date on charcoal from a burnt layer associated with the skull gives date of 12,500 ± 250, L-290-T (Lamont IV). Discrepancy between dates not understood.

In addition, UCLA-684 from Hastinapur, India, and UCLA-630 B from Broken Hill, Northern Rhodesia, Africa, were dated by the collagen method. These samples are described under their respective geographic listings.

### Shell Conchiolin Dating series

Shells also contain an organic protein constituent, conchiolin, which is present in 1-2% amounts in modern shells. The age of marine shells can be established therefore in a manner analogous to the bone collagen dating method to avoid carbonate exchange problems. However, the quantity of shells necessary for an analysis is considerably more than for bone. Details of this procedure have been discussed elsewhere (Berger *et al.*, 1964).

**UCLA-663 A. Santa Rosa Island, California** **7120 ± 120**
**5170 B.C.**

Outer carbonate layers of red abalone shells (Haliotis rufrescens) from a large pile containing several hundred shells in cemetery A, NW coast of Santa Rosa Island at Tecolote Point (34° 00′ 25″ N Lat, 120° 11′ W Long). Similar date for the same shells: L-290 D, 7070 ± 300, Lamont IV. Coll. and subm. by R. Berger, G. J. Fergusson and P. C. Orr.

**UCLA-663 B. Santa Rosa Island, California** **7230 ± 120**
**5280 B.C.**

Inner carbonate portion of UCLA-663 A.

**UCLA-663 C. Santa Rosa Island, California** **7210 ± 400**
**5260 B.C.**

Organic portion, conchiolin, of same shells dated as UCLA-663 A and B was measured. Shells contained only ~ 0.4% conchiolin based on their total weight. A correction factor equal to 250 ± 50 yr was applied to the raw date which takes into account the threshold which atmospheric carbon dioxide experiences before it enters the ocean and the upwelling characteristics of the ocean currents on the Southern California coast. The organic-based age after correction and the carbonate ages are very similar, supporting the usefulness of the conchiolin-dating method.

**UCLA-659 B. Santa Rosa Island** **6500 ± 210**
**4550 B.C.**

Conchiolin portion of red abalone shells (Haliotis rufrescens) and a few black abalone (Haliotis cracheroidi) from bottom of midden of locality 131.4 (Orr's map), NW coast of Santa Rosa Island, W of Arlington Canyon (34° 00′ 12″ N Lat, 120° 10′ 30″ W Long). Correction of 250 ± 50 yr applied. Coll. and subm. by R. Berger, G. J. Fergusson and P. C. Orr.

**UCLA-659 C. Santa Rosa Island, California** **6550 ± 120**
**4600 B.C.**

Total carbonate portion of shells used in UCLA-659 B. Carbonate and corrected organic-based ages are same as in UCLA-663 samples.

**UCLA-687. Tchefuncte, Louisiana** **2700 ± 90**
**750 B.C.**

Marine shells from OR-7 site (Tchefuncte), Louisiana sent to Chicago dating lab. in 1949. A type of smaller shell, perhaps lunarca? Conchiolin content of 0.15% permits dating of organic portion, although this measurement is the carbonate portion. Coll. and subm. by G. Quimby, Chicago Nat. History Mus.

**Falcon Hill Basketry series, Nevada**

A characteristic of Lovelock Culture deposits is their mixed and disturbed location as the result of the excavation of caches by the early occupants, and the subsequent burrowing of rodents. Consequently the relative dating of material from these sites is very difficult and reliable absolute dates have been scarce.

One possible method of dating in the Great Basin may be founded on the use of specific complexes of basketry techniques as horizon markers, similar to pottery indicators, but perhaps not as detailed.

*General Comment* (C.R.): dates of the basketry samples excavated at Falcon Hill, Nevada (40° 19′ 20″ N Lat, 119° 20′ 40″ W Long), and reported here reveal a long time span for this craft and a significant sequence of techniques which may have general application to the Great Basin. Earliest method (9550 B.P.) of finger weaving was twining. At first the stitches leaned up to the left; several thousand years later twined stiches leaned up to the right. Coiled basketry was introduced about 2500 yr ago as an added technique, followed shortly afterward by the plaited weave of Lovelock Wicker. Coll. by R. Shutler, Jr. and D. Tuohy, Nevada State Mus., Carson City: subm. by R. Shutler, Jr. and C. Rozaire, Los Angeles County Mus.

**UCLA-668. Falcon Hill** **1150 ± 100**
**A.D. 800**

Sample dates the predominate type of basketry, coiled technique, at the site (Wa-205) and associated materials, establishing temporal relationships with other sites in the Great Basin as well as with adjacent sites at Falcon Hill.

**UCLA-670. Falcon Hill** **3900 ± 100**
**1950 B.C.**

Sample from Site Wa-196, Sec. I, 16.5 in. deep, which dates the technique of plain, two-element S-twinning. It is latest occurrence of twining for Falcon Hill sites and only date for this location as of Nov. 1964.

**UCLA-671. Falcon Hill** **1610 ± 80**
**A.D. 340**

Coiled basketry technique is dated. This is only date for Site Wa-197, Test Pit 4, 12 to 14 in. deep as of Nov. 1964.

**UCLA-672. Falcon Hill** **8380 ± 120**
**6430 B.C.**

Matting from Site Wa-198, Sec. I, 54 to 60 in. deep, dates one of earliest strata as well as technique of plain, two-element Z-twining and matting.

**UCLA-673. Falcon Hill** **1190 ± 80**
**A.D. 760**

Earliest date for Lovelock Wicker in Falcon Hill sites up to Nov. 1964. Sample originated in Sec. II, along SW wall from grass foundation cache at 36 to 42 in. depth at site Wa-198.

**UCLA-674. Falcon Hill** **2440 ± 100**
**490 B.C.**

Earliest date for coiled technique in Falcon Hill excavations reported up to Nov. 1964. Sample coll. from site Wa-200 at Area 2, 42 to 48 in. depth.

**UCLA-675. Falcon Hill** **9540 ± 120**
**7590 B.C.**

Twined basketry from Site Wa-198, Sec. II, 84 to 90 in. depth, is earliest date for basketry from Falcon Hill. Sample may be fragment of open-work burden basket made by the plain, two-element Z-twined technique.

**UCLA-677. Falcon Hill** **580 ± 80**
**A.D. 1370**

Latest date for basketry and Lovelock Wicker in particular from Falcon Hill sites; is only date up to Nov. 1964 for Site Wa-202 from depth of 18 to 24 in.

**UCLA-741 A. Marble Canyon, Arizona** **4095 ± 100**
**2145 B.C.**

Split willow (*Salix* sp.) twig figurines from Site Ariz. C:5:3(ASC), Stanton's Cave (36° 30′ N Lat, 111° 52′ W Long), alt 2785 ft, on Colorado River at mile 31.2 below U.S.G.S. gauging station at Lees Ferry, Arizona. Samples from surface of cave interior under large rock fall; treated with dilute HCl to remove carbonate from rock. Coll. 1963 and subm. 1964 by R. C. Euler, Univ.

of Utah, Salt Lake City. *Comment* (R.C.E.): no other cultural material is found in association with the figurines and their makers remain unknown. Date, however, corroborates and extends those obtained by Schwartz *et al.* (1958) of 3530 ± 300 (M-563) and 3100 ± 110 (A-47) for similar figurines.

**UCLA-741 B. Walnut Canyon, Arizona** **3500 ± 100**
**1550 B.C.**

Wood (probably *Salix* sp.) from split-twig figurines from cave in N wall of Walnut Canyon just W of Walnut Canyon Nat. Monument (35° 10′ N Lat, 111° 30′ W Long). Samples NA5607.6, NA5607.15, NA5607.16, NA5607.20, NA5607.24, NA5607.25 combined. Coll. 1963 and subm. by A. P. Olson, Mus. of Northern Arizona, Flagstaff. *Comment* (A.P.O.): other dates on similar figurines: 3530 ± 300 B.P. (M-563, Michigan II); 3100 ± 110 B.P. (A-47, Arizona I); 3880 ± 90 B.P. (SI-86, Smithsonian Institution II); 4095 ± 100 (UCLA-741 A, UCLA IV).

**Hopewell, McGraw series, Ohio**

Hopewell Culture of eastern United States is one of the most interesting cultural evolutions since it encompasses activities of a prehistoric society on verge of entering period of a "Hochkultur." Hopewell is usually fitted into Middle Woodland Period within a time span from 150 B.C. to A.D. 500. It is characterized by extensive burial complexes in Ohio, Illinois and Indiana (Prufer, 1963).

Present samples were collected from a Hopewell sheet midden located 2 mi S of Chillicothe, Ohio (39° 19′ N Lat, 83° W Long). It is a culturally homogenerous midden with only a single archaeological occupation, sealed off by an average of 2 ft of flood deposit composed of two distinct layers. Coll. and subm. by O. H. Prufer, Case Inst. of Tech., Cleveland, Ohio. *Comment* (O.H.P.): ceramic affiliation indicates late classic Hopewell occupation. Two races of corn were found in the midden, the first time in Hopewell under unimpeachable circumstances.

**UCLA-679 A. McGraw site** **1810 ± 80**
**A.D. 140**

Charcoal from excavation unit D-1. Age greater than expected may be due to use of an old tree.

**UCLA-679 B. McGraw site** **1760 ± 80**
**A.D. 190**

Charcoal from excavation unit D-1. Similar to UCLA-679 A, this charcoal may be derived from an old tree.

**UCLA-679 C. McGraw site** **1510 ± 80**
**A.D. 440**

Charcoal from excavation unit C-1. *Comment* (O.H.P.): date appears to be the most acceptable since it can be compared to similar dates: OWU-61, 1469 ± 65 and OWU-62, 1515 ± 166 (Ohio Wesleyan I). Russell Brown Mound number 3 in Ross County, Ohio, is archaeologically very closely related and yielded the following ages: UCLA-246 A, 1335 ± 70; UCLA-246 B, 1360 ± 70 and UCLA-246 C, 1520 ± 80 (UCLA II).

**UCLA-740. San Luis Dam, California** **>36,000**

Sample was removed from what appeared to be a fire hearth, which included charcoal, burnt orange earth, and burnt fragmentary small mammal bones. "Fire hearth" appeared at ca. 85 ft from present surface in the upstream cut-off trench in blue clay at San Luis Dam axis, Merced County, California (37° 01′ N Lat, 120° 52′ W Long). Horse, camel, mammoth and sycamore tree remains, some of which were in partial articulation or original position, occurred in general association at depths above and below "fire hearth" level. A direct association was, however, not observed. Nearby from a large clod of blue clay a broken and polished bone was recovered after exposure by heavy earth-moving equipment. Bone could have served as a tool. Preliminary tests and observations strongly suggest a non-cultural origin of the fire site. Charcoal is probably carbonaceous material of natural origin similar to that observed at Tule Springs, Nevada, discussed by S. F. Cook (1964).

The present age determination will serve as a reference point in future research. Coll. by F. A. Riddell, State of Calif., Div. of Beaches and Parks, Sacramento; subm. by F. A. Riddell and C. W. Meighan, UCLA.

**UCLA-680. Malaga Cove II, California** **1170 ± 100**
**A.D. 780**

Marine shells from Malage Cove II, Pit I, 12 to 24 in. depth (33° 48′ 23″ N Lat, 118° 23′ 32″ W Long). Dates stratigraphic layer for this sample (Los Angeles Southwest Mus., 1951). Coll. and subm. by W. J. Wallace, Calif. State College, Long Beach, T. Blackburn and S. Long, UCLA.

**UCLA-681. Malaga Cove II, California** **1800 ± 100**
**A.D. 150**

Marine shells from Malage Cove II, Pit I, 36 to 48 in. depth. Dates stratigraphic layer of this sample. Coll. and subm. by W. J. Wallace, T. Blackburn and S. Long.

**UCLA-752. Pintwater Cave, Nevada** **3255 ± 80**
**1305 B.C.**

Twigs collected in Pintwater Cave, Nevada (36° 47.4′ N Lat, 115° 34.3′ W Long), at alt 4200 ft from Pit 53-54N/68-69E at 3 to 6 in. depth. Sample removed from pocket of soil, contains points of "Basketmaker" and "Amargosa" type, whose age is established with this date. Coll. and subm. by C. Rozaire.

**Santa Rosa Island series, California**

A field trip was undertaken on 23 Sept. 1963 to Santa Rosa Island by R. Berger, G. J. Fergusson, and P. C. Orr to secure shell samples for the shell chonchiolin dating series described earlier (UCLA-663 and 659). Additional samples were taken which together with future specimens will describe Santa Rosa Island completely. We would like to acknowledge the assistance and cooperation of Mr. Al Vail, owner of Santa Rosa, and Mr. H. C. Smith, whose aircraft made the 14 hr tour possible .

**UCLA-659 A. Santa Rosa Island, California** **2260 ± 100**
**310 B.C.**

Fine charcoal from beneath broken, burnt rock, formerly an Indian sweat-

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house or temescal. Large amounts of charcoal have been exposed here from 1946 to present. Remains are located on NW coast of Santa Rosa Island, W side of Arlington Canyon known as locality 131.4 on Orr's map (34° 00′ 12″ N Lat. 120° 10′ 30″ W Long). *Comment* (P.C.O.): similar date 2590 ± 350, CT-40 (unpublished Cal Tech date) run on large pieces of charcoal.

**UCLA-660. Santa Rosa Island, California** **6350 ± 130**
**4400 B.C.**

Small shell fragments from lowest black midden, 6 ft below sand dune midden at Survey Point (locality 131.5 on Orr's map) from NW coast of Santa Rosa Island (34° 00′ 25″ N Lat, 120° 10′ 50″ W Long).

**UCLA-661. Santa Rosa Island, California** **11,900 ± 200**
**9950 B.C.**

Charcoal from an investigation of fire sites located in face of sea cliff at Tecolote Point, Santa Rosa Island, California (34° 0′ 25″ N Lat, 120° 10′ 55″ W Long), 6 ft below surface.

**UCLA-662. Santa Rosa Island, California** **7600 ± 400**
**5650 B.C.**

Charcoal from fine buff silts immediately above gravel level at estimated depth of 24 ft from grass roots exposed in Canada Verde, N central interior at road crossing of Smith Highway in Canada Verde on Santa Rosa Island, California (34° 00′ 15″ N Lat, 120° 06′ 25″ W Long). Sample is part of a program to estimate deposition rates on Santa Rosa.

**Humboldt Bay series, California**

Samples were collected during excavations to begin establishment of a chronology for various inhabitants of Humboldt Bay area (approx. 40° 51′ N Lat, 124° 10′ W Long). Coll. by J. A. Hamm, Arcata, Calif.; subm. by R. W. Becking, Humboldt State College, Arcata, Calif.

**UCLA-622. Krei site, California** **515 ± 80**
**A.D. 1435**

Mussel shells (*Mytilus californianus*) from deposit at bottom of mound called site No. 1 or the Krei site.

**UCLA-643. Yurok site, California** **550 ± 60**
**A.D. 1400**

Charcoal, partially from redwood, *Sequoia sempervirens*, from large Indian village site, No. 2, Yurok Indians, from just above virgin sand at depth ca. 6 ft.

**UCLA-733 A. Yurok site, California** **700 ± 80**
**A.D. 1250**

Shell fragments, #14, from same site No. 2 of Yurok Indians, from depth 6 ft. Should date oldest part of village.

**UCLA-733 B. Yurok site, California** **935 ± 100**
**A.D. 1015**

Wood from Yurok Indian site No. 2, from 6 ft depth, #13. Should date oldest part of village.

*B. Mexico*

**Teotihuacan series, Mexico**

Charcoal from remains of Teotihuacan site, 25 mi NE of Mexico City (19° 44′ N Lat, 98° 52′ W Long). Teotihuacan is the type site for the culture following the Preclassic phase in Central Mexico, and comprised an urbanized area covering ca. 9 sq mi. It was on open ground and had no city walls. Large temples and palaces formed nucleus of the city, with densely clustered buildings in the residential section. Streets and plazas were paved with lime plaster and there was a complete underground system of drainage. The city was violently destroyed, presumably by fire, and was never rebuilt. Coll. 1962-63 by Ignacio Bernal; subm. by Bernal through R. F. Heizer, Univ. of California, Berkeley.

**UCLA-609. Teotihuacan 1** **1800 ± 80**
**A.D. 150**

Calle de Los Muertos, Building 18, Room 1. Charcoal from roof found on top of floor.

**UCLA-610. Teotihuacan 2** **1750 ± 80**
**A.D. 200**

Plaza de la Luna, Palace 3. Door beam of porch of S room, E facade.

**UCLA-611. Teotihuacan 3** **1700 ± 80**
**A.D. 250**

Plaza de la Luna, Palace 3, Room 1.

**UCLA-612. Teotihuacan 4** **1750 ± 80**
**A.D. 200**

Plaza de la Luna, Zone 2, Palace 3. From room which communicates big stair with the S of W facade.

**UCLA-613. Teotihuacan 5** **1290 ± 80**
**A.D. 660**

Plaza of Pyramid of Sun, Zone 5-B, Str. I. Fireplace in NE corner of Patio 1, charcoal on floor.

**UCLA-614. Teotihuacan 6** **1580 ± 80**
**A.D. 370**

Plaza de la Luna, Zone 3, Building 14.

**UCLA-615. Teotihuacan 7** **1780 ± 80**
**A.D. 170**

Calle de los Muertos, Zone 7, Building 4. Sample from top of floor.

**UCLA-616. Teotihuacan 8** **1750 ± 80**
**A.D. 200**

Calle de los Muertos, Zone 7, Building 4, Room 2, fill. Sample from floor.

**UCLA-617. Teotihuacan 9** **1900 ± 80**
**A.D. 50**

Plaza de la Luna, Palace 3. Door beam of room on N side of open patio.

**UCLA-618. Teotihuacan 10** **1800 ± 80**
**A.D. 150**

Plaza de la Luna, Building 13, W side near to W Balustrade.

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**UCLA-620. Teotihuacan 12** **1660 ± 80**
**A.D. 290**

Zone 2, Palace 3. Room that communicates big stair to the S of W facade.

*General Comment* (J.A.B. and R.F.H.): all 11 samples came from late structures on or near N half of Street of the Dead, ceremonial heart of the city. Space does not permit review of previous dates from Teotihuacan, many of which are interpretive problems. In the following discussion a chronology being worked out by F. Müller, W. T. Sanders, R. F. Millon, and J. A. Bennyhoff is utilized, with the following phases: Teotihuacan I (Tzacualli): A.D. 1-100; Teo I-II (Apetlac): 100-150; Teo II (Miccaotli): 150-250; Teo II-III (Early, Late Tlaminilolpa): 250-450; Teo III (Early, Late Xolalpan): 450-650; Teo IV (Metepec): 650-750.

It was hoped that series would date destruction of the city, tentatively placed at A.D. 750. However, only UCLA-613 (A.D. 580-740) may have bearing on this event (though A.D. 660 is *early* Phase IV). Age of remaining 10 dates indicates the probability that beams from which samples derive were reused in later structures. Palacio 3 (represented by 6 dates ranging from A.D. 50-290) can be assigned stylistically to Phase IV, and ceramics of this phase were found on floors. However, it is built over several earlier structures, the beams of which had been removed. Similar reuse can be inferred for the other 4 buildings represented in the samples, since all feature superimposed construction.

If reuse of beams is accepted, these 11 dates reflect period of intensive building: 8 fall between A.D. 150-250, thus spanning Phase II, and support general view that Street of the Dead was first laid out during this phase. UCLA-620 (A.D. 290) and UCLA-614 (A.D. 370) probably represent beams originally used in superimposed construction of Phase II-III. UCLA-617 (A.D. 50) might represent a salvaged Phase I beam, or merely reflect age of a tree cut during Phase II.

## La Venta series, Tabasco, Mexico

Two samples reported here are importantly connected with series of nine samples dated in 1957 at Michigan (M-528 to M-536, Michigan II). In Sept. 1955, when P. Drucker returned to Washington following the Smithsonian-National Geographic-Univ. of California excavation of the La Venta site (18° 10′ N Lat, 94° 05′ W Long), he parted two of the nine wood charcoal samples and sent these two to USGS Radiocarbon Lab. for age determination. They were never run, but their moieties were dated in 1957 by the Univ. Memorial-Phoenix Project, Radiocarbon Lab. at Univ. of Michigan, and reported as samples M-531 and M-533 (Michigan II). In Sept. 1964, M. Rubin of USGS Lab. returned the two samples submitted by Drucker in 1955 and these were sent by R. F. Heizer to W. F. Libby and R. Berger for dating and are here reported as UCLA-902 and UCLA-903.

**UCLA-902. La Venta, Mexico** **2940 ± 80**
**990 B.C.**

UCLA-902 is one half of sample M-531. M-531 yielded date of 2560 ± 300 yr in 1957; UCLA-902 in 1964 is 2940 ± 80 yr. The two dates on the same sample barely coincide, the first Σ range of M-531 being 2860-2260 yr

B.P., that of UCLA-902 being 3020-2860 yr B.P. If we take 2860 B.P. (910 B.C.) as true age and as dating Phase I constructions at La Venta (Drucker *et al.*, 1957; 1959:264-267), this is in reasonable, though not exact, agreement with our earlier averaging of five Phase I $C^{14}$ dates (M-529, M-531, M-532, M-534, M-535) at 2700 ± 134 B.P. or 750 ± 134 B.C. (Michigan II).

### UCLA-903. La Venta, Mexico — 2460 ± 80 / 510 B.C.

Sample is one half of original batch of wood charcoal from which M-533 was run in 1957. M-533 gave age of 2130 ± 300 B.P. (180 ± 300 B.C.). Range within the first Σ of M-533 is 2430-1830 B.P.; that of UCLA-903 is 2540-2380 B.P. The two ages are reasonably close, there being a 50 yr overlap. UCLA-903 refers archaeologically to a point in time not long after abandonment of La Venta site (early Post-Phase IV in site sequence as explained by Drucker *et al.*, 1957; 1959), and whose date was calculated at 309 B.C. on basis of simple arithmetic averaging of M-528 (2400 ± 250 B.P.) and M-533. UCLA-903 is somewhat closer in age to M-528 (2400 ± 300 B.P.), also collected from post occupation drift sands covering La Venta ceremonial site.
*General Comment* (R.F.H.): generally speaking, UCLA-902/M-531 and UCLA-903/M-533 are sufficiently conformable—in view of the 7 yr difference in lab. determination, undoubted changes in instrumentation, and methods for calculating ages—to support the earlier conclusion that the *floruit* of the La Venta site took place ca. 800-400 B.C. As firm dates, UCLA-902 and UCLA-903 are probably preferable to M-531 and M-533 since more precise lab. methods and a lesser margin of error are involved.

## Jalisco-Nayarit series, Mexico

Three shell samples were obtained from tomb near hill El Arenal on Hacienda de San Sebastian, Municipio de Etzatlan, Jalisco, Mexico (20° 40′ N Lat, 104° 00′ W Long). This is the first Jalisco tomb from which the provenience has been established. From private collection given to Los Angeles County Mus.

### UCLA-593 A. Conch shell — 2090 ± 100 / 140 B.C.

Part of conch shell from Caribbean, T52. Shell carbonate was dated. No correction applied to date.

### UCLA-593 B. Shell amulet — 2230 ± 100 / 280 B.C.

Small shells, T60. Age computed on basis that Pacific Ocean water off West Mexico due to upwelling is about –1% $C^{14}$ or –80 yr with respect to 0.95 NBS oxalic acid. Shell carbonate was dated.

### UCLA-593 C. Murex shell — 1710 ± 100 / A.D. 240

Murex nigritus Philippi from Pacific Coast, 92 mm long, 60 mm high, mouth hole 12 mm, side hole 3.5 mm. Age computed on basis of surface ocean water being in this region approx. –1% $C^{14}$ or –80 yr with respect to 0.95 NBS oxalic acid. Shell carbonate was dated.

**UCLA-789. Teponaztl** **110 ± 80**
**A.D. 1840**

Mexican drum carved from log perhaps 75 ± 20 yr old as judged from diam and tree rings. Reportedly from state of Guerrero, Mexico. Dating analysis was run to establish whether drum was stylistically just simple or perhaps quite old. Subm. by G. C. Kennedy, UCLA.

*C. South America*

**Casma Valley series, Peru**

Two shell samples were excavated in 1956 from stratified refuse in Casma Valley, Peru (9° 30′ S Lat, 78° 15′ W Long) (Collier, 1962). Deposit contains pottery from two earliest ceramic styles in this locality: Cahuachuco style, estimated to date 1200-1000 B.C., and Gualaño style, 1000-800 B.C. Both the initial handling of the samples and a re-assessment after dating rule out sample switching either in Chicago or at UCLA. Coll. and subm. by Donald Collier, Chicago Nat. History Mus. *Comment* (D.C.): dates reported here are opposite of expected ages based on stratigraphy.

**UCLA-729 A. Shells** **3400 ± 100**
**1450 B.C.**

From Level 5, 250 to 375 cm depth, 2 limpet shells, *Fissurella maxima* Sowerby, and one *Concholepas peruviana* Lamarck.

**UCLA-729 B. Shells** **2640 ± 90**
**690 B.C.**

From Level 7, 400 to 470 cm depth, 9 clam shells, *Aulocomya atar* (Molina), one *Semele flavescens* (Gould), and one *Crepidula dilatata* Sowerby.

**UCLA-683. Cerro los Chivateros** **10,430 ± 160**
**8480 B.C.**

Wood fragments from Level 2 of excavation at PV 46-27, Cerro los Chivateros, lower Chillon Valley, Peru (11° 56′ 30″ S Lat, 77° 8′ W Long). Deposit consists of salt-impregnated, indurated soil, and is not a normal occupation deposit. Wood thought to be contemporary with lithic workshop debris, among which they were found, containing artifacts of Chivateros I Phase. Both wood and workshop debris were sealed in by induration of soil before deposition of overlying soft stratum, Level 1, which contains mixture of Chivateros I and II artifacts and a few Pampilla points. Coll. and subm. by E. P. Lanning, Columbia Univ., New York. *Comment* (E.P.L.): date somewhat more recent than expected.

*D. Pacific*

**Southern New Hebrides series**

Analyses obtained from excavations in S New Hebrides is expected to supplement the work carried out in New Caledonia and Fiji and present a fuller picture of the S Melanesian cultures from which Polynesian cultures are derived. Present research suggests that New Caledonia was occupied by 800 B.C. and Fiji by at least 46 B.C. Present dates from New Hebrides are part of a more extensive chronological investigation of oceanic migrations. Coll. and subm. by R. Shutler, Jr.

### UCLA-693. Aneityum, New Hebrides

**470 ± 80**
**A.D. 1480**

Charcoal sample from Pit 4, 54 to 60 in. depth, coll. 21 December 1963, associated with human refuge from AT rockshelter No. 1, Ano-onu-pul, Aneityum, S New Hebrides (20° 10′ 2″ S Lat, 169° 42′ E Long). Age indicates one of earliest dates of occupation from this island.

### UCLA-734. Tanna, New Hebrides

**2370 ± 90**
**420 B.C.**

Charcoal from cave on Tanna, S New Hebrides, pit 10, 108 to 126 in. depth (19° 34′ S Lat, 169° 16′ E Long). Coll. 25 March 1964 from bottom of deepest pit excavated on site and should date earliest occupation of this Tanna site, if not S New Hebrides.

*E. Europe*

**European Medieval Architecture series**

Series of wood samples was collected in England, France and Belgium in a study of the Aisled Medieval Timber Hall. Some originate from monuments that can be dated either by documentary or by stylistic evidence. This permits a modern assessment of these structures whether or not timber work is original, and what original architectural design really was. In addition, timber samples were secured from monuments of uncertain or controversial date for correct placement into chronology. Extensive analysis of this study will be published at future date. Samples coll., subm., and commented on by W. W. Horn, Univ. of Calif., Berkeley.

### UCLA-566 A. Leicester Castle

**1070 ± 60**
**A.D. 880**

The aisled hall of Leicester Castle, Leicester, Leicestershire (52° 34′ N Lat, 1° 7′ W Long), was built ca. A.D. 1150 to judge by scalloped capitals of its original eastern gable wall which survives. $C^{14}$ date taken from one of the posts supporting roof of hall (post C of truss C), also from ca. A.D. 1150 according to scalloped capital, suggests that post was cut from heartwood of a tree which at time of felling had age of 300-400 yr.

### UCLA-566 C. Leicester Castle

**400 ± 60**
**A.D. 1550**

Sample was obtained from part of roof plate (over post D and C) which was badly worm-eaten. Position of this plate under a Norman tie-beam of A.D. 990 (UCLA-566 D) and A.D. 970 (UCLA-566 F) makes it unlikely that it is so late. Further tests on a better preserved portion are needed to establish date.

### UCLA-566 D. Leicester Castle

**960 ± 80**
**A.D. 990**

Dates one of principal tie-beams of the hall (truss D). Beam must have been part of original structure of A.D. 1150.

### UCLA-566 F. Leicester Castle

**980 ± 60**
**A.D. 970**

Another measurement of same beam used in preceding sample, UCLA-566 D.

**UCLA-566 E. Leicester Hall** **590 ± 60**
**A.D. 1360**

Date indicates late medieval replacement of principal rafter of truss E.

**UCLA-566 G. Leicester Hall** **450 ± 60**
**A.D. 1500**

Measurement proves that elbow brace connecting tie-beam with principal rafter of truss D is not part of original Norman timber frame. As it is a waney edge, it dates the time just prior to cutting the tree and points to a restoration of upper portion of truss E around A.D. 1500.

**UCLA-567 B. Frocester Tithe Barn** **200 ± 80**
**A.D. 1750**

Located 5 mi W of city of Stroud (51° 44′ N Lat, 2° 19′ W Long), erection of this structure is attested by a reliable contemporary source and ascribed to period of Abbot John de Gamache (A.D. 1284-1306). One of the cruck blades was dated; obviously a replacement.

**UCLA-567 C. Frocester Tithe Barn** **400 ± 60**
**A.D. 1550**

Waney edge with bark from one of the wind braces. Must have been replaced.

**UCLA-568 A. Ter Doest** **815 ± 80**
**A.D. 1135**

Barn of the Abbey of Ter Doest near Bruges, Belgium (51° 16′ N Lat, 3° 12′ E Long), can be dated on basis of stylistic analysis of decorations of its brick walls to about A.D. 1250-1275 (in agreement with anticipated age). Sample was heartwood from main post to left of center door along W range of posts. As expected, sample is older than UCLA-568 B (Horn and Born, 1964).

**UCLA-568 B. Ter Doest** **690 ± 80**
**A.D. 1260**

Waney edge of northernmost tie-beam over S aisle provides age in agreement with stylistic analysis.

**UCLA-570. Parcay-Meslay** **735 ± 80**
**A.D. 1215**

Wood from one of the main posts. History ascribes this barn of Abbey Grange of Parcay-Meslay, near Tours, France (47° 28′ N Lat, 0° 21′ W Long), to time of Abbot Hugue de Rochecourbon (A.D. 1211-1227), in agreement with measurement (Horn, 1957).

**UCLA-572. Méréville** **490 ± 80**
**A.D. 1460**

Timber from one of outer posts of market hall of Méréville, Seine-et-Oise, France (48° 17′ N Lat, 2° 13′ E Long). Smaller outer posts were often cut from trees with diam not much larger than desired thickness of post. Date in agreement with historical erection of building by Etienne le Fevre, Vicomte de Méréville (1456-1472).

**UCLA-574 A. Great Coxwell** **805 ± 80**
**A.D. 1145**

Tie-beam from W aisle of barn at Great Coxwell, near Faringdon, Berkshire, England (51° 36′ N Lat, 1° 34′ W Long). Beam presumably cut from heartwood of a tree several hundred yr old at felling. Barn can be dated into first half of 13th century by profiles and details of masonry as well as design of timber frame (Horn and Born, 1964).

**UCLA-575. Harmondsworth** **720 ± 80**
**A.D. 1230**

Timber from great tithe barn of Harmondsworth, Middlesex, England (51° 27′ N Lat, 0° 24′ W Long). Measurement suggests 13th century origin (Horn, 1957).

**UCLA-576. Lenham** **700 ± 80**
**A.D. 1250**

Wood from rafter of Barn B at Lenham, near Maidstone, Kent, England (51° 13′ N Lat, 0° 38′ W Long). A 13th century document mentions destruction of the church and its subsidiary buildings by fire in A.D. 1298. In order to shelter the harvest, barns had to be rebuilt immediately; date supports this.

**UCLA-577 A. Bredon** **945 ± 80**
**A.D. 1005**

Timber from one of main posts of tithe barn of Bredon, near Tewkesbury, Worcestershire, England (52° 1′ N Lat, 2° 8′ W Long), located in N range to left of E transept. Structure is ascribed to 14th century and needs additional investigation.

**UCLA-578. Drayton-St. Leonard** **675 ± 80**
**A.D. 1275**

Wood from tithe barn of Drayton-St. Leonard, near Dorchester, Oxonshire, England (51° 40′ N Lat, 1° 7′ W Long). Additional dating required for this structure.

**UCLA-579. Lower Peover** **1120 ± 80**
**A.D. 830**

Wood from church at Lower Peover, near Northwich, Cheshire, England (53° 16′ N Lat, 2° 36′ W Long). Building suggests a 14th century origin while present date may indicate the re-use of large timber (Horn, 1962).

**UCLA-580. Salisbury** **910 ± 80**
**A.D. 1040**

Timber from tenon of brace lodged in mortice of tie-beam of the Deanery in Salisbury, Wiltshire, England (51° 4′ N Lat, 1° 18′ W Long). Historical evidence suggesting construction date around A.D. 1300 may be conservative. Sample received from J. T. Smith, Senior Investigator, Royal Comm. on Ancient and Hist. Monuments.

**UCLA-581 A. Salisbury** **835 ± 80**
**A.D. 1115**

Wood from arch brace, behind hammer beam, truss 2, from hall behind a shop in Winchester St., Salisbury, Wiltshire, England (51° 4′ N Lat, 1° 18′ W Long). Suggested construction date of 14-15th century may also be too conservative. Wood received from J. T. Smith.

**Byzantine Architectural Sculpture series**

The great church of Santa Sophia in Istanbul, Turkey (41° N Lat, 29° E Long), is a focal point of interest in Byzantine architecture. Unfortunately, it has been impossible until recently to determine unequivocally dates of parts of the building and decorations. No records of rebuilding or reconstruction exist prior to 1927. Since Santa Sophia was dedicated in A.D. 548 by Emperor Justinian, there exists a blank time span of 1379 yr. Extensive rebuilding was conducted in early 8th century, again in the 13th, in the mid-15th, and later in the 1860's. Coll., subm., and commented on by C. D. Sheppard, Univ. of Minnesota, Minneapolis.

**UCLA-562. Santa Sophia** **1480 ± 70**
**A.D. 470**

Wood from a strut and its encasing box located in W Gallery of Royal Loge. Date indicates that strut was part of original construction of building and was never removed.

**UCLA-563. Santa Sophia** **1120 ± 70**
**A.D. 830**

Wood from same location as UCLA-562. Date gives an important fix for decorative motifs of encasing box. No other examples dated in early 9th century in Istanbul or in Byzantine world. Motifs are closely related to decorative repertory of Ommayad period in Syria. Traces of this style of ornament have been located on 6th century monuments in Istanbul but not until late 10th, early 11th century is this decoration found again on Byzantine monuments, and then very emphatically. It has been assumed that the latter represent a revival of 6th century Justinianic monuments or a possible provincial Persian influence in metropolitan Byzantium. Significant date of UCLA-563 proves that style has continuous presence in Byzantium.

**UCLA-564. Santa Sophia** **1540 ± 70**
**A.D. 410**

Wood from central portal, left valve. Confirms expected date of structure.

**UCLA-565. Santa Sophia** **180 ± 70**
**A.D. 1770**

Wood from lowest sill of complete valve. Confirms expected date of structure.

**UCLA-786. Statue of Saint** **215 ± 80**
**A.D. 1735**

Half-length bust of female saint brought to United States in 1951 from Europe. European experts disputed claim that it might be original Leonardo da Vinci (Porcella and Porcella, 1963). $C^{14}$ date confirms their suspicions and places origin into 18th century. Coll. and subm. by Florian Bajonski, 1526 N. Oakley Blvd., Chicago 22, Illinois.

**UCLA-793. Megillah of Esther** **660 ± 80**
**A.D. 1290**

Medieval manuscript of book of Esther is written in Hebrew and illustrated in gothic style. In opinion of Prof. Adolph Goldschmidt (Univ. of Berlin), the parchment scroll stems from second half of 14th century; this is essentially corroborated by $C^{14}$ analysis. Coll. and subm. by Felix Guggenheim, 725 Roxbury Dr., Beverly Hills, California.

### *F. Egypt*

**Buhen series, Sudan**

Site consisting of domestic and workshop buildings of the Old Kingdom (2160 B.C.-3100 B.C.) was discovered in 1961 at Buhen near border of Egypt and Sudan on W bank of Nile (21° 51′ N Lat, 31° 17′ E Long). In 1962 excavations were conducted there by W. B. Emery, London Univ. College, under auspices of Egypt Exploration Soc. An abundance of Old Kingdom pottery, inscribed jar seals and ostraka were found, some of which bore names of IV Dynasty kings Krafre and Menkaure and V Dynasty kings Userkaf, Sahure and Suserre. Several results from site have been published in Arizona Radiocarbon Dates IV (1963). Dynastic dates are based on Hayes (1962). Coll. by W. B. Emery and subm. by I. E. S. Edwards, British Mus., London.

**UCLA-665. Buhen** **3990 ± 80**
**2040 B.C.**

Charcoal from Pit 1, Level 1. For archaeological reasons sample should be contemporaneous with IV Dynasty (2500 B.C.-2620 B.C.).

**UCLA-666. Buhen** **4090 ± 80**
**2140 B.C.**

Charcoal from Pit 2, Level 1. Should also be contemporaneous with IV Dynasty (2500 B.C.-2620 B.C.).

**UCLA-667. Buhen** **3970 ± 80**
**2020 B.C.**

Charcoal from Pit 1, Level 2. Archaeologically sample should be archaic.

Since sample ages by $C^{14}$ dating are younger than they should be on archaeological grounds, $C^{13}$ mass spectrometric measurements were carried out through courtesy of W. R. Eckelmann, Jersey Production Research Co., Tulsa, Oklahoma.

| | $\delta C^{13}$ |
|---|---|
| UCLA-665. | –25.75 |
| UCLA-666. | –26.04 |
| UCLA-667. | –25.87 |

$\delta C^{13}$ is expressed as the per mil difference of the sample from the Chicago PDB standard. Results do not indicate any abnormality in samples analyzed.

**UCLA-739. Tarkhan II linen** **4265 ± 80**
**2315 B.C.**

Since wood and charcoal dating cannot be as accurate as a date derived from a plant such as flax growing only one year, some linen was obtained upon request by W. F. Libby from the British Mus., through the courtesy of I. E. S. Edwards. This was found by W. M. Flinders Petrie in the mastaba 2050 at Tarkhan near Cairo, Egypt (29° 40′ N Lat, 31° 13′ E Long), described by Petrie in Tarkhan II, 1914, and considered to be of I Dynasty. Petrie writes in Tarkhan II, p. 6:

> The later history of this mastaba was curious. It had been completely cleared of sand between the walls, except at the north end. Large quantities of straw, and of twigs for fuel, had been stored in it, much as the Egyptian now stores fuel in pits on the desert. Afterwards these deposits were covered with blown sand. The central pit had been entirely rifled, and from it were dragged out a great pile of linen cloth of various qualities, and . . .

The I Dynasty according to Hayes (1962), does not have historically clearly established time span. Beginning of III Dynasty is thought to be near 2700 B.C., and duration of first two dynasties varies in time estimate from 295 yr to 453 yr, with 415 yr the estimate by Hayes. Presumably the first dynasty should then be dated around 3000 B.C. or 5000 yr ago. When the new half-life of 5730 yr is applied to the linen, age is 4390 ± 80 B.P. or 2440 B.C.

**Zoser's Pyramid Intrusion I series, Saqqara, Egypt**

Four samples were collected on 29 March 1964 by R. F. Heizer and Dr. Rachid Noweir from the partially destroyed mud brick structure apparently enclosed at midpoint of the lower mastaba over which was built Zoser's Step Pyramid of Saqqara, Egypt (29° 50′ N Lat, 31° 15′ E Long). No published account was known of this inclusion in the mastaba, and it appeared that this element, 5 m long and 2.5 m high, was an original part of the construction. Mastaba is exposed at base of S side of the pyramid permitting intrusion of graves in recent times. On vertical exposure of S edge of mastaba (see photo in Lauer, 1962, text vol. Pl. IV. top), the mud brick structure occurred at the point marked by the second "a" in the word "mastaba" shown in Lauer (1962, plates vol., Pl. II). Samples are consistent in their age and bear no relation to original construction of mastaba or overlying pyramid. They are clearly intrusions dating from Roman or Byzantine (Coptic) periods. Coll., subm., and commented on by R. F. Heizer.

**UCLA-742. Substructure under Zoser's Pyramid** **1540 ± 80**
**A.D. 410**

Palm leaf.

**UCLA-743. Substructure under Zoser's Pyramid** **1910 ± 80**
**A.D. 40**

Wood.

**UCLA-744. Substructure under Zoser's Pyramid** **1430 ± 110**
**A.D. 520**

Roots.

**UCLA-753. Substructure under Zoser's Pyramid** **1800 ± 80**
**A.D. 150**

Textile.

**UCLA-751. Zoser's Pyramid Intrusion II** **4060 ± 80**
**2110 B.C.**

Acacia wood from Zoser Step Pyramid at Saqqara near Cairo, Egypt (29° 50′ N Lat, 31° 15′ E Long). Wood obtained from J. Arnold, Univ. of

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Calif., San Diego, and originates from J.-P. Lauer, 1961. Zoser was second king of III Dynasty (75 yr duration) which places Zoser at ca. 2670 B.C.

Before exploratory and possibly archaeological explorations of the Saites about 2000 yr after erection of the pyramid, other men had carried out narrow tunnellings under the pyramid. Lauer thinks that these first transgressors operated after fall of the Old Kingdom or during First Intermediate Period which, according to chronology of Hayes (1962), falls around 2160 B.C. It appears, therefore, likely that wood analyzed here was not part of original construction but was placed into pyramid during First Intermediate Period. Subm. and comments by R. Berger.

**UCLA-900. Sesostris III** **3640 ± 80**
**1690 B.C.**

For a fixed date in Egyptian Middle Kingdom, the seventh year of reign of Sesostris III of XII Dynasty falls on a recorded helical rising of the star Sirius. This occurred on 16 August of the 365-day civil calendar which places the year in question between 1876 B.C. and 1864 B.C., probably 1872 B.C. (Hayes, 1962). Since there exists no similar astronomical correlation for any earlier period in Egyptian history, this crucial year is the anchor point for all recorded history extending back to King Menes, founder of I Dynasty.

According to Manetho, Sesostris III reigned for 48 yr (Gardiner, 1961) which places his year of death at 1872 + 7 - 48 = 1831 B.C. The Turin Canon in column 5 lines 23 and 25 records for Sesostris' reign 13, perhaps 19, and 30 yr respectively. However the papyrus is torn and missing, so that these numbers may be larger (Gardiner, 1959).

Sample analyzed here is a deck board from funerary boat of Sesostris III obtained in 1948 from Chicago Mus. of Nat. History at request of W. F. Libby. Since it appears likely that boat would be the original, sample should be reliable for historic date $C^{14}$ comparison.

When the new half-life of 5730 ± 40 yr is applied and age based on the half-life of 5568 yr is multiplied by 1.03, 3750 B.P. or 1800 B.C. is calculated. This is in agreement with latest historical estimate. Sample had been analyzed by solid carbon counting method in the original Chicago lab. as C-81 with an average age from three measurements of 3621 ± 180 yr. Subm. and comments by R. Berger.

### *G. Iran and India*

**Deh Luran Valley series, Iran**

The following samples were collected from two sites, Tepe Sabz and Ali Kosh, in Deh Luran Valley of SW Iran (32° 15′ to 32° 30′ N Lat, 47° 8′ to 47° 24′ E Long), during autumn of 1963.

This series will date, in one small area, the sequence of developing agriculture from its incipience through the use of irrigation and development of fully effective commercial production. The cultural sequence is already well established on the basis of artifacts and seeds from each of the components. Radiocarbon dates will give the first firm chronology for this range, and the sequence of artifacts will serve as an internal check on the dates.

Because the valley soil is composed of limestone, all samples were treated with dilute HCl. In the general area bitumen is found in the soil, but samples appear to be free from it. Coll. by F. Hole, Rice Univ., Houston, Texas, and J. Neely, Univ. of Arizona, Tucson; subm. by F. Hole.

**UCLA-750 A. Tepe Sabz** **6070 ± 100**
**4120 B.C.**

Charcoal from Sq. 14, 270 to 280 cm below surface (H14/270-80).

**UCLA-750 B. Tepe Sabz** **6925 ± 200**
**4975 B.C.**

Charcoal from Sq. 25, 860 cm below surface (H25/860).

**UCLA-750 C. Tepe Sabz** **9050 ± 160**
**7100 B.C.**

Charcoal from Sq. 29, 1000 to 1020 cm below surface (H29/1000-1020). *Comment* (F.H.): sample at least 1000 yr too old on basis of cultural context. Expected date 5500-6000 B.C.

**UCLA-750 D. Ali Kosh** **9900 ± 200**
**7950 B.C.**

Charcoal from Sq. 76, 680 cm below surface (A 76/680).

**Painted Gray Ware series, India**

A joint expedition by Univ. of Rajasthan, India, and UCLA excavated in January 1964 a site at Noh near Bharatpur, Rajasthan, about 30 mi from Agra (27° 10′ N Lat, 78° 00′ E Long). Charcoal samples listed here originated in a stratified layer at bottom of a hill associated with painted gray ware under 6 ft of earth cover. This pottery type is generally considered to date from 600-1000 B.C., although more recent theories suggest 600-800 B.C. Coll., subm. and comments by J. L. Davidson, UCLA.

**UCLA-703 A. Noh, India** **2480 ± 250**
**530 B.C.**

Sample H, Tr. A XXII-XXIV. This date and the following support the newer theory and will be useful in placing the painted gray ware culture within a specific time limit.

**UCLA-703 B. Noh, India** **2690 ± 220**
**740 B.C.**

Sample E, Tr. A XXII-XXIV. See comments for UCLA-703A.

**UCLA-684. Hastinapur, India** **1800 ± 100**
**A.D. 150**

Human bones dated by the collagen method from site near Hastinapur (29° 9′ N Lat, 78° 3′ E Long), on left bank of Ganga River in District of Meerut, India. Site was excavated in 1950-52 and 1962 by B. B. Lal and is discussed in Tata Institute Radiocarbon Date List II. According to D. Lal, Tata Inst., UCLA-684 is to be compared with charcoal (TF-90) at 2270 ± 100. This raises possibility of an intrusive burial. Subm. by D. Lal at request of W. F. Libby and R. Berger.

*II. Africa*

**Dar-es-Soltan Cave series, Rabat, Morocco**

The cave of Dar-es-Soltan is a few kilometers S of Rabat (33° 59′ N Lat, 7° 2′ W Long) in Morocco. Excavated by A. Ruhlmann in the 1940's. Occupation deposit to depth of 8.80 m filled the cave and rested on beach deposit of the last marine regression. Two Aterian occupation levels were found in the limon rouge that composed the lower 5 m of cave fill. Older layer that contained hearths and a lower Aterian industry was 0.3 in. thick and occurred in couche I at depth of 7.55 m. Younger (Upper) Aterian layer, also containing hearths, occurred at approx. depth of 5 m. At 3.75 m shell midden 1.60 in. thick was found overlying the yellow, sandy cave earth which contained an Ibero-Maurusian industry of Neolithic affinities. Coll. by C. Arambourg, Inst. de Paleontologie Humaine, Paris, E. Ennouchi, Univ. of Rabat, J. D. Clark, Univ. of California, Berkeley, and G. Isaac, Centre for Prehistory and Paleontology, Nairobi, Kenya. Subm. by J. D. Clark.

**UCLA-678 A. Dar-es-Soltan** **>30,000 yr**

Charocal from red/purple layer said to be the Lower Aterian horizon. Occurs in flecks and small fragments in a broad zone, not in intense concentration.

**UCLA-678 B. Dar-es-Soltan** **>27,000 yr**

Charcoal from gray/brown level said to be Upper Aterian layer.

**UCLA-678 C. Dar-es-Soltan** **1710 ± 400**
**A.D. 240**

Charcoal from basal level of dark gray shell midden.

*General Comment* (J.D.C.): these are first dates obtained from samples directly associated with Aterian culture and though there were insufficient samples to provide for absolute determinations, results indicate satisfactorily the lower range for the Aterian in Morocco. If there is no contamination, UCLA-678 C indicates that the Neolithic may have persisted into Roman times on some parts of the Moroccan coast. It is more probable that sample is contaminated by later occupation during Roman times.

**Lunda Province series, NE Angola**

These samples dating upwards from a time early in the last, or Gamblian Pluvial, fall mostly into 3 groups and compliment those obtained earlier. See UCLA-168 to UCLA-172 (UCLA II) and C-580 and C-581 (Libby, 1955).

a) Early Gamblian sediments

**UCLA-709 A. Mufo Mine** **>40,000 yr**

Wood from large tree trunk under 3 ft of ferricrete and gravel exposed by mining operations in base of the 3 to 4 m aggradation terrace of Luembe River (7° 31′ S Lat, 21° 25′ E Long).

**UCLA-709 B. Mufo Mine** **>40,000 yr**

Wood from tree trunk in ferricrete and gravel at basal level of the 3 to

4 m terrace now exposed in bed of Luembe River by mining operations. *General Comment* (J.D.C.): gravel contains derived Acheulian and earlier artifacts together with lower Lupemban/Sangoan tools believed to be contemporary with beginning of aggradation of this terrace. Agrees well with result from UCLA-168, a sample obtained nearer flank of the valley and confirms age of the lower Lupemban/Sangoan culture in S part of Congo basin.

b) Samples buried by redeposited sands on the interfluves

**UCLA-714. Matafari, Dundo** **2160 ± 80**
**210 B.C.**

Charcoal from buried surface at depth of 80 cm in redistributed orange-colored sand on upper flank of Luachimo River. Coll. by J. V. Martins, Angola Diamond Co., Dundo; subm. by J. D. Clark. *Comment* (J.D.C.): on this surface occur Lupembo-Tshitolian and/or Lower Tshitolian tools and waste. Sample therefore expected to give age for this surface comparable to that of UCLA-172. Present sample is either intrusive or contaminated since it should date the terminal Pleistocene.

**UCLA-686. Copal** **2830 ± 80**
**880 B.C.**

Resin (Copal) stems from depth of 90 cm in Kalahari sand, Camissombo Plain, NE Angola (8° 9′ S Lat, 21° 41′ E Long). Coll. by J. V. Martins; subm. by J. D. Clark. *Comment* (J.D.C.): fossil resin is found in upper level of Kalahari sands on the treeless grass plain at several localities (Chanas of the highest interfluves). Occurs unassociated with cultural materials, but it seemed unlikely that the tree-cover or other vegetation were more recent than late Pleistocene. It is more likely that resin is recent and was brought by man onto the chanas for use as a mastic. Unsuccessful attempts have been made to identify pollen in these resins. But samples of modern resin will, it is hoped, permit identification of the fossil resin. If resin was found to come from a tree still growing in protected localities on the chanas, it would indicate appreciable destruction of woodland savannah there sometime after 9th century B.C., possibly as result of human activity, which might be associated with occupation by Iron age immigrants in the early years of the present era.

c) Samples dating fine grain sediments of Post Pleistocene age

These samples represent one or more phases of aggradation, the earliest of which may be comparable with the Nakuran Wet Phase of East Africa. Also indicates that the stream courses were aggrading during time of early Iron Age occupation in S. Congo basin.

**UCLA-710. Chambuage Mine** **2080 ± 80**
**130 B.C.**

Chambuage Mine is a tributary stream of Luashimo River (15° 10′ S Lat, 45° E Long). Charcoal sample from black clay layer under 12 ft of buff/orange colluvial sands and overlying bedded alluvial sand and stream gravel. Coll. and subm. by J. D. Clark. *Comment* (J.D.C.): Fresh Lupembo-Tshitolian and/or Lower Tshitolian implements underlie the clay layer. It was believed that sample would date to Makalian Wet Phase of E. Africa, but it is younger and belongs to one or more phases of stream cutting and filling, perhaps equivalent to Nakuran Phase of E. Africa.

**UCLA-711. Mucuquesse 3 Mine** **1330 ± 80**
**A.D. 620**

Mucuquesse 3 Mine is a tributary stream of Luembe River (7° 38′ S Lat. 21° 22′ E Long). Wood from alluvial bedded and buff colored sands lying on stream gravels and covered by 8 ft of orange/red redistributed colluvial sands. Coll. and subm. by J. D. Clark. *Comment* (J.D.C.): bored stones from mine are probably derived from same deposit and might be Late Stone or Early Iron Age.

**UCLA-712. Tchibaba Mine** **880 ± 80**
**A.D. 1070**

This is a tributary stream of Luachimo River at 23° 50′ S Lat, 44° 10′ E Long. Wood from alluvial yellow sands overlying creek gravels and overlain by gray clays and 8 ft of orange/red colored sands. Coll. and subm. by J. D. Clark. *Comment* (J.D.C.): Lupembo-Tshitolian and/or Lower Tshitolian artifacts rest on lower stream gravel and must long antedate aggradation of overlying sediments, the age of which is compatible with presence of potsherd and iron artifacts which occur in some of these late stream sediments. Compare with UCLA-170.

d) Samples associated with pottery-using cultures (presumably Early Iron Age)

**UCLA-715. Marrhura** **800 ± 80**
**A.D. 1150**

Charcoal from Marrhura (Mahuha), Tshikapa River (7° 36′ S Lat, 20° 28′ E Long), obtained from excavations in a buried land surface, depth 1.45 m. in alluvial sediments. On surface is a late Tshitolian industry associated with numerous potsherds. Coll. by J. Janmart and J. Redinha, 1943, Angola Diamond Co., Dundo; subm. by J. D. Clark. *Comment* (J.D.C.): pottery is of texture comparable to that of early Channelled Ware of Rhodesia and Zambia. Age of sample is compatible.

**UCLA-717. Ricoco II** **1010 ± 80**
**A.D. 940**

Charcoal from Ricoco II rock-shelter, Dundo (7° 28′ S Lat, 20° 51′ E Long), excavated from occupation floor associated with pottery similar to that found at UCLA-716 and buried by ca. 4 ft of sterile red clay sand. Coll. by J. V. Martins; subm. by J. D. Clark. *Comment* (J.D.C.): result agrees with estimated age.

**UCLA-716. Dundo Air Field** **1190 ± 80**
**A.D. 760**

Charcoal excavated from old land surface covered by redistributed red sand and associated with Early Iron Age pottery believed to antedate A.D. 1100 (7° 22′ S Lat, 20° 30′ E Long). Pottery belongs to a tradition not previously recorded from Angola or Rhodesia and is same as that found at Ricoco shelter, UCLA-717. Coll. and subm. by J. D. Clark. *Comment* (J.D.C.): result in agreement with estimated age.

**UCLA-718. Museque Cave** **465 ± 80**
**A.D. 1485**

Charcoal from Museque Cave, Alto Tchicapa (10° 50′ S Lat, 19° 10′ E Long), obtained from 20 to 48 cm depth in guano and associated with pottery believed to date to later Iron Age, i.e., post A.D. 1100. Coll. by J. V. Martins; subm. by J. D. Clark. *Comment* (J.D.C.): result in agreement with estimated age.

*General Comment* (J.D.C.): samples show that lower Lupemban/Sangoan culture is of approx. same date in Congo basin as it is at Kalambo Falls (see Kalambo Falls series, Groningen V) and in Rhodesia (see Pomongwe Cave series, S. Rhodesia I). As at Kalambo, pollen indicates climate was cooler and vegetation more open than at present.

UCLA-686 may indicate that the high plains had been repopulated by savannah woodland species after close of the Pleistocene during a return to warmer climatic conditions. Treeless grass lands that exist today on higher interfluves may largely be man-made. Courses of smaller streams had become filled with red colluvial sand during terminal Pleistocene (see UCLA-172, UCLA II, C-580 and C-581, Libby, 1955). But sometime prior to second millenium B.C., downcutting had reexposed older stream gravels. This was followed during earlier half of first millenium A.D. by aggradation of clays, sands and fine gravels. These incorporate wood and other vegetable remains as well as cultural material such as bored stones, some pottery and iron objects. Contemporary sites on the plateau, Dundo Air Field, and in the valleys, Mahura and Ricoco II, yield evidence of Iron Age occupation from 7th century onwards.

**UCLA-630. Broken Hill Man** **>9000**

Animal bones dated by collagen method said to come from bone cave at Broken Hill, N. Rhodesia (14° 30′ S Lat, 28° 20′ E Long), which yielded *Homo rhodesiensis* (Woodward, 1921). Date is composite of several bones. Sample obtained and subm. by J. D. Clark.

## II. GEOPHYSICAL, GEOLOGICAL AND BIOLOGICAL MEASUREMENTS

### *A. $C^{14}$ in Atmospheric Carbon Dioxide*

**Atmospheric Radiocarbon Activity series, California**

The $C^{14}$ content in atmospheric $CO_2$ is monitored monthly at a China Lake, California location (35° 37′ N Lat, 117° 41′ W Long). For each collection, 2 L of 2N carbonate-free NaOH are poured into a plastic tray which is allowed to stand for about a week. Evaporation losses are made up with distilled water. The tray is protected from heavy rainfall which might cause overflowing. The tray is placed outdoors to permit free air circulation, away from any fossil fuel burning and any animal hazard.

Samples are collected with the cooperation of Gilbert Plain, Acting Head, Research Dept., Naval Ordnance Test Station, China Lake, California.

The following list contains the exposure times of the NaOH solutions to

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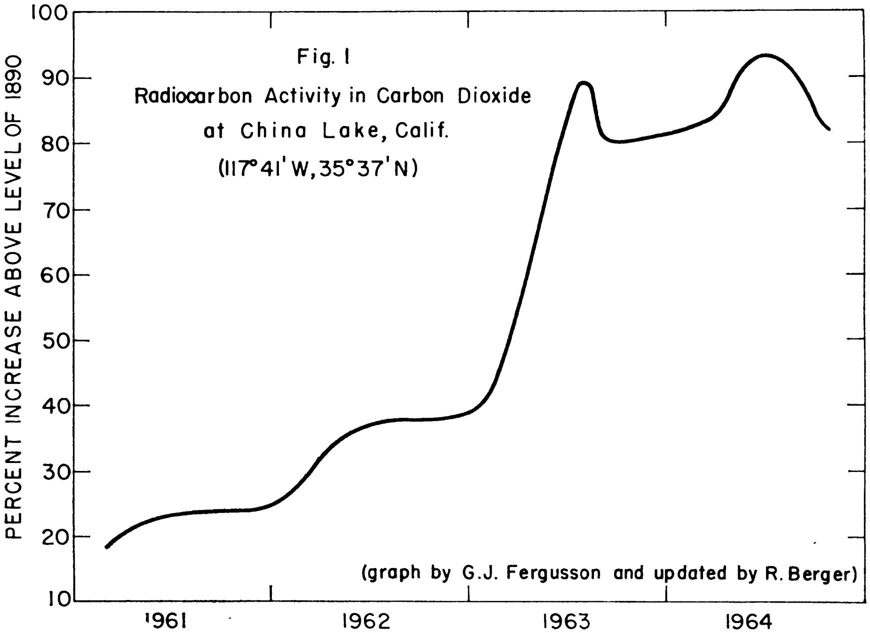


air and the percent increase of $C^{14}$ above the reference level of 1890 or 0.95 NBS oxalic acid.

| | | |
|---|---|---|
| **UCLA-466.** | **28 Sept.—5 Oct. 1963** | **+79.4%** |
| **UCLA-467.** | **26 Oct.—2 Nov. 1963** | **+83.1%** |
| **UCLA-468.** | **30 Nov.—7 Dec. 1963** | **+80.6%** |
| **UCLA-472.** | **28 Dec.—4 Jan. 1964** | **+80.5%** |
| **UCLA-473.** | **1 Feb.—8 Feb. 1964** | **+83.4%** |
| **UCLA-474.** | **29 Feb.—7 Mar. 1964** | **+81.5%** |
| **UCLA-478.** | **28 Mar.—4 April 1964** | **+83.2%** |
| **UCLA-479.** | **25 April—2 May 1964** | **+86.8%** |
| **UCLA-480.** | **30 May—6 June 1964** | **+92.3%** |
| **UCLA-484.** | **27 June—4 July 1964** | **+92.7%** |
| **UCLA-485.** | **29 July—5 Aug. 1964** | **+83.7%** |
| **UCLA-491.** | **29 Aug.—1 Sept. 1964** | **+87.8%** |
| **UCLA-492.** | **26 Sept.—3 Oct. 1964** | **+83.4%** |
| **UCLA-493.** | **31 Oct.—7 Nov. 1964** | **+81.9%** |

**Atmospheric Radiocarbon Activity series, Aircraft Collections**

During October 1963 to November 1964, an additional number of samples was run as a continuation of an aircraft $CO_2$ collection program whose results were published in part by Fergusson (1963) on upper tropospheric $C^{14}$ levels. The $CO_2$ was collected by high-volume samplers using Linde molecular sieves as described in detail elsewhere by Fergusson (1963). The results encompassing the measurements reported here will be published separately.

The authors acknowledge the cooperation of Edwards Air Force Base, California.

The following list contains flight altitude, date of collection and flight boundaries within the continental United States and the Caribbean. Radiocarbon activity is expressed in percent above the 1890 level.

**UCLA-455.** **+91%**

33,000 ft on 8 July 1963 from 35° N Lat, to 43° N Lat.

**UCLA-456.** **+244%**

35,000 ft on 10 July 1963 from 43° N Lat to 35° N Lat.

**UCLA-460 A.** **+71%**

29,000 ft on 28 August 1963 near 16° N Lat.

**UCLA-460 B.** **+71%**

29,000 ft on 28 August 1963 near 16° N Lat.

**UCLA-460 D.** **+70%**

29,000 ft on 29 August 1963 near 16° N Lat.

**UCLA-461.** **+78%**

26,000 ft on 30 August 1963 from 18° N to 28° N Lat.

**UCLA-462.** **+75%**

35,000 ft on 31 August 1963 from 28° N Lat to 35° N Lat.

**UCLA-464 A.** **+85%**

31,000 ft on 13 September 1963 between 35° N Lat and 48° N Lat.

**UCLA-464 B.** **+86%**

37,000 ft on 13 September 1963 between 35° N Lat, and 48° N Lat.

**UCLA-464 C.** **+138%**

41,000 ft on 13 September 1963 between 35° N Lat and 48° N Lat.

**UCLA-464 D.** **+130%**

43,000 ft on 13 September 1963 between 35° N Lat and 48° N Lat.

**UCLA-465.** **+78%**

33,000 ft on 10 October 1963 between 35° N Lat and 42° N Lat.

**UCLA-469 B.** **+93%**

35,000 ft on 25 October 1963 between 35° N Lat and 48° N Lat, N sector.

**UCLA-469 C.** **+82%**

39,000 ft on 25 October 1963 between 48° N Lat and 35° N Lat, N sector.

**UCLA-469 D.** **+63%**

39,000 ft on 25 October 1963 between 48° N Lat and 35° N Lat, S sector.

**UCLA-470.** **+240%**

35,000 ft on 20 December 1964 from 35° N Lat to 46° N Lat.

**UCLA-471.** **+287%**

39,000 ft on 20 December 1964 from 42° N Lat to 35° N Lat.

### Atmospheric Radiocarbon Activity series, Galapagos Islands

During the Galapagos International Scientific Project organized by the Univ. of California, C. E. Palmer, UCLA, collected $CO_2$ during the middle of February 1964 by the same method used for the California monitoring. Samples were taken at the Darwin Research Station on Santa Cruz Island (0° 45′ S Lat, 90° 19′ W Long).

The atmospheric radioactivity at Galapagos in February 1964 is that of about April-May 1963 at China Lake (see graph of Atmospheric Radiocarbon Activity series, Calif.), which supports an approximately one-year transfer time between the N and S hemisphere.

The measurements are expressed in percent increase above the reference level of 1890.

| | |
|---|---|
| **UCLA-476/1.** | **+56.2%** |
| **UCLA-476/2.** | **+58.4%** |
| **UCLA-476/3.** | **+57.7%** |
| **UCLA-476/4.** | **+57.9%** |
| **UCLA-476/5.** | **+57.9%** |
| **UCLA-476/6.** | **+57.0%** |

## *B. Bomb Radiocarbon in Human Tissues*

The increase in $C^{14}$ concentration in atmospheric carbon dioxide provides now and in the future the unique opportunity to use it as a tracer in all living organisms connected to photosynthesis. This opportunity will be lost when atmospheric $C^{14}$ will have equilibrated with the oceans.

For the first time it is possible to perform $C^{14}$ tracer experiments directly on man himself. This is discussed by Libby *et al.*, 1964.

The major conclusions of this paper are threefold: there is a certain relationship between atmospheric $C^{14}$ and human tissues; the human brain incorporates radiocarbon as rapidly as many other body tissues; and cartilage in old persons is metabolically quite inert.

The processing of the samples necessitated the absorption of the crude $CO_2$ obtained from the combustion of tissues in 4 N NaOH. Carbon dioxide was then liberated with HCl and purified in the usual manner. This procedure proved adequate in obtaining pure $CO_2$ suitable for proportional counting.

In the following list of measurements the $C^{14}$ concentration is expressed in terms of the percent increase over the level of 1890 or 95% of the count rate of NBS oxalic acid.

**UCLA-800. Brain** **+41.0%**

Total brain protein of 73-yr-old Los Angeles resident.

**UCLA-801. Brain** **+41.0%**
Total brain lipids of 73-yr-old Los Angeles resident.

**UCLA-802. Heart** **+40.7%**
Heart protein of 73-yr-old Los Angeles resident.

**UCLA-803. Liver** **+40.2%**
Liver protein of 73-yr-old Los Angeles resident.

**UCLA-804. Cartilage** **–0.6%**
Cartilage of 73-yr-old Los Angeles resident.

**UCLA-805. Cartilage** **+0.3%**
Cartilage of 74-yr-old Los Angeles resident.

**UCLA-806. Brain** **+35.0%**
Brain white matter from 74-yr-old Los Angeles resident.

**UCLA-810. Liver** **+41.1%**
Liver protein from 74-yr-old Los Angeles resident.

**UCLA-811. Heart** **+36.4%**
Heart protein from 74-yr-old Los Angeles resident.

**UCLA-817. Brain** **+25.3%**
Lipids from brain white matter of 73-yr-old Los Angeles resident.

**UCLA-818. Brain** **+35.1%**
Protein from brain white matter of 73-yr-old Los Angeles resident.

**UCLA-819. Brain** **+31.9%**
Lipids from brain white matter of 74-yr-old Los Angeles resident.

**UCLA-820. Brain** **+32.3%**
Protein from brain white matter of 74-yr-old Los Angeles resident.

**UCLA-808. Blood plasma protein** **+55.9%**
Coll. 8 January 1964 from Los Angeles resident; same blood as UCLA-809.

**UCLA-809. Erythrocyte protein** **+35.4%**
Coll. 8 January 1964 from Los Angeles resident; same blood as UCLA-808.

**UCLA-812. Erythrocyte protein** **+26.2%**
Coll. 8 January 1964 from Los Angeles resident; same blood as UCLA-813.

**UCLA-813. Blood plasma protein** **+46.4%**
Coll. 8 January 1964 from Los Angeles resident; same blood as UCLA-812.

**UCLA-814. Blood plasma protein** **+23.4%**
Coll. 9 August 1962 from Los Angeles resident.

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**UCLA-815. Blood plasma protein** **+23.8%**

Coll. 10 August 1962 from Los Angeles resident.

**UCLA-816. Blood plasma protein** **+33.4%**

Coll. 11 September 1963 from Los Angeles resident.

**UCLA-821. Blood plasma protein** **+54.2%**

Coll. 28 June 1964 from Los Angeles resident; same blood as UCLA-822.

**UCLA-822. Erythrocyte protein** **+53.5%**

Coll. 28 June 1964 from Los Angeles resident; same blood as UCLA-821.

**UCLA-823. Blood plasma protein** **+57.0%**

Coll. 18 June 1964 from resident of Melbourne, Australia, who had been in United States for 14 days. Same blood as UCLA-824.

**UCLA-824. Erythrocyte protein** **+13.7%**

Coll. 18 June 1964 from resident of Melbourne, Australia, who had been in United States for 14 days. Same blood as UCLA-823.

**UCLA-826. Blood plasma protein** **+35.7%**

Coll. 9 September 1964 from resident of Melbourne newly arrived in Los Angeles by air with 3-day stopover in Hawaii. Same blood as UCLA-827.

**UCLA-827. Erythrocyte protein** **+32.3%**

Same blood as used in UCLA-826.

### *C. Plants*

**High Altitude Vegetation series**

The rise in $C^{14}$ activity is also reflected in plants. The following plants were collected to determine whether or not specimens growing at the highest vegetation zones would contain more $C^{14}$ than plants at lower levels, and to measure $C^{14}$ concentration in oceanic plants in the upwelling current off the S California coast.

**UCLA-486. Mt. Whitney** **+72.0%**

Mustard, *Draba lemmonii* Wats., from 14,200 ft level of Mt. Whitney (36° 34′ 45″ N Lat, 118° 7′ 30″ W Long). These specimens of the highest vegetation were coll. 9 August 1964 by B. R. Nevius and R. Berger, UCLA.

**UCLA-487. Mt. Whitney** **+90.0%**

Sky piot, *Polemonium eximium* Greene, from 14,000 ft level of Mt. Whitney. Coll. 9 August 1964 by B. R. Nevius and R. Berger.

**Seaweed and fish series**

**UCLA-481. La Jolla** **+4.3%**

Seaweed leaves, *Macrocystis pyrifera*, new growth from kelp beds off Scripps Inst. of Oceanography, La Jolla, Caliofrnia (32° 52′ N Lat, 117° 15′ W Long). Coll. 11 June 1964 by R. Lasker, USDA-Univ. of California, San Diego and R. Berger.

**UCLA-482. La Jolla** **+2.1%**

Seaweed hold-fast, *Macrocystis pyrifera*, from kelp beds off Scripps Inst. of Oceanography, La Jolla, California. Coll. 11 June 1964 by R. Lasker and R. Berger.

**UCLA-483. Ensenada** **+1.1%**

Sardine collected from fertile ocean area off Ensenada, Mexico (32° N Lat, 117° W Long), where sardines are present all year. Two-yr-old fish, caught beginning of June 1964. Coll. by R. Lasker and R. Berger.

### *D. Oceanic Measurements*

A series of 50 gal (190 L) sea water samples was collected in February 1964 off Baja California, Mexico, to check into level of $C^{14}$ concentration in surface sea water of an area of minimum productivity around 24° N Lat, 118° W Long.

Carbon dioxide was liberated from the sea water in a continuous-flow extraction apparatus that consists of a vertical Pyrex column supplied with an immersion heater which brings the sea water to ca. 70-80° while being acidified with sulfuric acid. The waste sea water is run through a heat exchanger against incoming sea water, preheating it and thereby reducing the power requirement of the immersion heater. Carbon dioxide is removed by cycling a stream of carrier gas ($N_2$ or He) through the hot sea water and three in-line wash towers containing 4N sodium hydroxide. The recovery of carbon dioxide is 90% or better. Three peristaltic pumps are used to assure independence and safe operation of the sea water-, acid- and $CO_2/N_2$-cycles.

The following list of sea water measurements expresses the $C^{14}$ concentration in terms of percent increase over the level of 1890 or 95% of the count rate of NBS oxalic acid.

Samples pertaining to this series are also UCLA-481, UCLA-482 and UCLA-483 in the plant section of this date list.

Coll. by J. D. Isaacs, on board "Alexander Agassiz," Univ. of California, San Diego. The tritium measurements were carried out by J. Leventhal, UCLA, Chemistry Dept.

**UCLA-475/1. Sea water, Baja California** **+6.0%**

From 26° 01′ N Lat, 114° 27′ W Long. Tritium content 22 ± 7 T.U.

**UCLA-475/2. Sea water, Baja California** **+8.7%**

From 25° 58′ N Lat, 114° 31.5′ W Long. Tritium content 31 ± 2 T.U.

**UCLA-475/3. Sea water, Baja California** **+7.6%**

From 25° 55.5′ N Lat, 114° 36.2′ W Long. Tritium content 55 ± 5 T.U.

**UCLA-475/4. Sea water, Baja California** **+12.1%**

From 24° 09.5′ N Lat, 117° 56.2′ W Long. Probable contamination of leaky barrel. Tritium content 39 ± 2 T.U.

**UCLA-475/5. Sea water, Baja California** **+6.2%**

From 24° 08′ N Lat, 118° 02′ W Long.

**UCLA-475/6. Sea water, Baja California** **+6.9%**

From 24° 05.8′ N Lat, 118° 07′ W Long.

### *E. Tree Rings*

On 30 June 1908 at $0^h$ $17^m$ $11^s$ U.T., the Tunguska Meteorite fell in the Podkamenaia Tunguska River, Siberia (60° 55′ N Lat, 101° 57′ E Long). Details of the massive fall phenomena have been discussed by Krinov (1963). No trace of the meteorite body has ever been found and the fall has been explained as a small comet consisting of frozen gases colliding with the earth (Whipple, 1930).

The question has been raised if perhaps there were any nculear reactions involved in the collision process. Since some nuclear reactions liberate neutrons which in turn produce $C^{14}$ in the atmosphere, a search was begun for variations in the $C^{14}$ content of the biosphere in the form of tree rings before and after 1908. The tree rings were obtained from the Hitchcock tree, a 300-yr-old Douglas fir (*Pseudotsuga taxifolia*) which fell in the winter of 1952 in an unsurveyed area (35° 15′ N Lat, 111° 45′ W Long) of the Santa Catalina Mountains ca. 30 mi from Tucson, Arizona. This tree was secured by the Lab. of Tree Ring Research, Univ. of Arizona, Tucson, which generously forwarded a portion to C. Cowan, Catholic Univ. of America, Washington, D. C., who isolated tree ring sections by growth yr and submitted them to this lab. upon request of W. F. Libby.

The following list contains the percent deviation of the tree rings from the reference level of 1890 or the count rate of 0.95 NBS oxalic acid, and $C^{13}$ mass spectrometric determinations expressed in per mil deviation from the Chicago PDB standard provided by R. McIver and W. Sackett of the Jersey Production Research Co., Tulsa, Oklahoma. A more specific interpretation of the events surrounding the Tunguska Meteorite will appear elsewhere.

| | yr | $\delta C^{14}$, ‰ | $\delta C^{13}$, ‰ |
|---|---|---|---|
| **UCLA-769.** | **1873** | **0** | **–22.3** |
| **UCLA-768.** | **1873** | **–0.72** | **–23.0** |
| **UCLA-767.** | **1883** | **–0.31** | **–22.9** |
| **UCLA-766.** | **1888** | **–1.64** | **–22.2** |
| **UCLA-765.** | **1893** | **–3.75** | **—** |
| **UCLA-782.** | **1894** | **–1.26** | **—** |
| **UCLA-763.** | **1898** | **–0.48** | **–22.9** |
| **UCLA-760.** | **1903** | **–0.28** | **–23.1** |
| **UCLA-761.** | **1908** | **–1.07** | **—** |
| **UCLA-774.** | **1909** | **+0.26** | **–22.6** |
| **UCLA-780.** | **1910** | **–0.70** | **–22.2** |
| **UCLA-762.** | **1913** | **–0.81** | **–22.6** |
| **UCLA-764.** | **1918** | **–1.20** | **–22.4** |
| **UCLA-770.** | **1923** | **–0.63** | **–23.0** |
| **UCLA-771.** | **1928** | **–2.40** | **–22.4** |
| **UCLA-772.** | **1933** | **–1.50** | **–22.0** |

Additional tree ring samples were measured that were obtained at UCLA from an oak tree cut in 1964 NW of Los Angeles in the Simi Valley (34° 12′ N Lat, 118° 48′ W Long). Coll. by L. Wood at the request of W. F. Libby.

| | | | |
|---|---|---|---|
| **UCLA-778.** | **1908** | **–0.96** | **—** |
| **UCLA-776.** | **1909** | **+0.17** | **–24.8** |
| **UCLA-779.** | **1910** | **–1.50** | **–24.5** |

*F. Vegetation and Climate*

**Neotoma Midden series, SW States**

The following list is a continuation of sample analyses similar to those of the Frenchman Flat series, Nevada (UCLA III). The remains of recognizable, abandoned packrat middens are dated, which together with a botanical analysis of plant remains permits an estimate of the flora and climatological conditions at the time of deposition. A more detailed report is found in a paper by Wells and Jorgensen (1964). Coll. and subm. by P. V. Wells, Univ. of Kansas, Lawrence.

**UCLA-755. Pyramid Peak** **11,600 ± 160**
**9650 B.C.**

Deposit No. 7 from Pyramid Peak, Funeral Mountains, California (36° 23′ N Lat, 116° 36′ W Long), alt ca. 4200 ft, containing much *Juniperus osteosperma*. Current vegetation is Larrea, Coleogyne and other desert shrubs. Sample analysis implies downward displacement of existing vegetation zones by ca. 2000 ft and lateral displacement of ca. 50 mi.

**UCLA-756. Turtle Mountains** **13,900 ± 200**
**11,950 B.C.**

Deposit No. 8 from Turtle Mountains, California, alt ca. 2400 ft (34° 24′ N Lat, 114° 46′ W Long). Contains much *Pinus monophylla* and *Juniperus osteosperma*. Current vegetation is Larrea, palo verde, ocotillo and other desert shrubs. Change in vegetation implies a downward displacement of ca. 1000 ft and a lateral displacement of ca. 20 mi.

**UCLA-757. Negro Butte** **9140 ± 140**
**7190 B.C.**

Sample No. 9 from Negro Butte, Lucerne Valley, California, alt ca. 3500 ft (34° 29′ N Lat, 116° 49′ W Long). Deposit contains much *Juniperus osteosperma* and Purshia. Current vegetation is Larrea, Grayia and other desert shrubs. A downward displacement of 800 ft and a lateral displacement of ca. 11 mi is indicated.

**UCLA-758. Burro Mesa** **18,750 ± 360**
**16,800 B.C.**

No. 10 from Burro Mesa, Texas, at alt 3900 ft (29° 13′ N Lat, 103° 23′ W Long). Deposit contains much *Pinus edulis*, Juniperus and Berberis. Current vegetation is Larrea, ocotillo and other desert shrubs. This implies a downward and lateral displacement of 1000 ft and 3 mi respectively.

**UCLA-759. Newberry Cave** **7400 ± 100**
**5450 B.C.**

Sample No. 11 from Newberry Cave, California at alt ca. 2200 ft (34° 49′

N Lat, 116° 40′ W Long). Human artifacts are found together with Larrea and *Haplopappus cuneatus*. Current vegetation includes Larrea, but no *Haplopappus cuneatus*. A downward displacement of less than 1000 ft but within the same vegetation zone is apparent.

### Pintwater Cave Amberat series, California

In many dry western caves the ceilings, walls and floors are coated with a black, amorphous, carbonaceous material which has been explained as smoke from campfires, rat or bat excrement, or humic acid escaping through the rocks. This material has been described by Orr (1957) and called Amberat due to its amber-like appearance and odor of rats.

Samples of this material were found in 1964 on the floor of Pintwater Cave, Nevada (36° 47.4′ N Lat, 115° 33.3′ W Long), at alt 4200 ft. It was then analyzed for its water-soluble and water-insoluble components and a pollen analysis begun. Coll. and subm. by W. F. Libby and H. C. Smith, H. C. Smith Construction Co., Los Angeles, California.

**UCLA-727 A. Amberat I** — **16,100 ± 300**<br>**14,150 B.C.**

Dates the total material.

**UCLA-727 B. Amberat I** — **16,100 ± 300**<br>**14,150 B.C.**

Insoluble cellulose portion in the form of rat feces.

**UCLA-727 C. Amberat I** — **16,200 ± 300**<br>**14,250 B.C.**

Water soluble portion.

**UCLA-787 A. Amberat II** — **15,540 ± 280**<br>**13,590 B.C.**

Total material from different sample than used in UCLA-727 A,B,C.

**UCLA-787 B. Amberat II** — **14,870 ± 280**<br>**12,920 B.C.**

Insoluble cellulose fraction in the form of rat feces.

### Sequoia series, California

An exploratory study trying to explain the distribution of *Sequoia gigantea* in California was begun. Wood samples are from the Sequoia and Kings Canyon Natl. Parks (37° N Lat, 119° W Long). Coll. and subm. by R. J. Hartesveldt, San Jose State College, California.

**UCLA-655. Sequoia** — **770 ± 80**<br>**A.D. 1180**

Outer portion from heavily burnt sequoia stump along trail between Hazelwood Picnic Area and Circle Meadow, Giant Forest, Sequoia Natl. Park. Base 15 ft diam.

**UCLA-656. Sequoia** — **2100 ± 100**<br>**150 B.C.**

Outer portion from heavily burnt sequoia stump on W edge of Circle Meadow, Giant Forest, Sequoia Natl. Park. Base 12 ft diam.

**UCLA-657. Sequoia** **Modern <200**

Outer portion from heavily burnt sequoia stump in Buena Vista Grove. Kings Canyon Natl. Park. Base 28 ft diam.

*G. Geologic Processes*

**Luedtke's Marsh series, Wisconsin**

This thesis problem is a paleoecological study of the gastropod fauna of the postglacial deposits of Luedtke's Marsh, Waushara County, Wisconsin (44° 3′ N Lat, 89° 23′ W Long). Dates reported here are part of an investigation of gastropod populations, sediment types, and pollen, as correlated with the advances and retreats of the continental ice sheet.

Dates compare favorably with those obtained from similar sections in Minnesota and confirm preliminary interpretations of the skeleton pollen diagram for the Luedtke's Marsh section. A comprehensive report of this study will appear elsewhere. Coll., subm., and comments by R. A. Park, Univ. of Wisconsin, Madison.

**UCLA-631. Luedtke's Marsh** **11,600 ± 300**
**9650 B.C.**

Wood from base of lake deposit (S3-30), but from a different location as UCLA-632, indicating time of start of sedimentation.

**UCLA-632 A. Luedtke's Marsh** **13,700 ± 300**
**11,750 B.C.**

Carbonate fraction of organic marl 4 ft above base of lake deposit (S3-20), but from different location than UCLA-631. This relatively "old" date requires additional study.

**UCLA-632 B. Luedtke's Marsh** **12,800 ± 400**
**10,850 B.C.**

Organic fraction of marl 4 ft above base of lake deposit.

**UCLA-633 A. Luedtke's Marsh** **11,000 ± 400**
**9050 B.C.**

Carbonate fraction of fine detrital gyttja (S3-11). *Comment*: the average difference between carbonate and the organic portion for UCLA-632 and UCLA- 634 is ca. 1100 yr which would correspond to a $C^{14}$ depletion in carbonate, relative to organic matter, of ca. 14%. This figure may be used to estimate the age of the organic fraction of UCLA-633 as 9900 yr.

**UCLA-634 A. Luedtke's Marsh** **5140 ± 120**
**3190 B.C.**

Carbonate fraction dating the termination of lake deposition.

**UCLA-634 B. Luedtke's Marsh** **3880 ± 120**
**1930 B.C.**

Organic fraction dating the termination of lake deposition.

**UCLA-775. Mugu Lagoon, California** **<100**

Date is from shells of the scallop *Pecten* (*Plagioctenium*) *circularis*, found buried undisturbed below salt marsh at depth of 75 cm in Mugu Lagoon. Ventura County, California (34° 05′ 30″ N Lat, 119° 04′ W Long). Coll. and

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subm. by J. E. Warme, UCLA. *Comment* (J.E.W.): a probable date of <100 yr indicates rapid sedimentation rate for the lagoonal environment on the order of 1 m/100 yr.

### UCLA-781. Ballona Gap, California

**3420 ± 90**
**1470 B.C.**

Peat sample was collected for an assessment of the geological reasons leading to the disastrous break of the Baldwin Hills reservoir in the City of Los Angeles in 1963. The peat originated from a 18 ft thick bed 10 and 15 ft below the surface, about 200 ft N of Santa Barbara Ave and 250 ft N 20° W of the corner of Coliseum Street (34° 1′ 6″ N Lat, 118° 20′ 42″ Long, elev. 105 ft). Coll. by U. S. Grant IV, E. E. Wyckoff and S. H. Mayeda, June 5, 1964; subm. by U. S. Grant IV, emeritus, UCLA. *Comment* (U.S.G.): age of the peat sample may approximate the date of the last substantial diastrophic movement along the Inglewood fault causing the ponding of the ancient Los Angeles river and subsequent marsh formation.

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