[RADIOCARBON, VOL. 9, 1967, P. 477-504]

UCLA RADIOCARBON DATES VI*

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The measurements reported have been carried out during 1966 in the Isotope Laboratory of the Institute of Geophysics and Planetary Physics as a continuation of the UCLA date lists I through V. Samples were analyzed as CO_2-gas at one atm in a 7.5 L proportional counter with three energy channels. The all-solid-state unit is supplied with high voltage from a remarkably stable and interference-free battery source. Radiocarbon ages have been calculated on the basis of a 5568-yr half-life as was recommended by the Sixth International C^{14} and H^3 Dating Conference, June 1965, in Pullman, Washington. The standard for the contemporary biosphere remains as 95% of the count rate of NBS oxalic acid for radiocarbon laboratories. Background determinations have been based on CO_2 obtained from marble. The error listed is always at least a one-sigma statistical counting error. In critical cases C^{13}/C^{12} isotope ratio measurements were made to correct the dates. All samples were subjected to accepted pretreatments differing in the individual cases to exclude contamination.

All measurements have been classified in the following way:

I. Archaeologic-Historic Dates
- A. United States
- B. Mexico
- C. South America
- D. Pacific and Far East
- E. Europe
- F. Egypt
- G. Africa

II. Geophysical, Geological-Climatological and Biological Measurements
- A. C^{14} in Atmospheric Carbon Dioxide
- B. Bomb C^{14} in Human Tissues
- C. Oceanic Measurements
- D. Vegetation and Climate
- E. Geological Processes

ACKNOWLEDGMENTS

We are indebted to the National Science Foundation for Grants GP-1893 and GA-628 for continued financial support and acknowledge the competent assistance of Gönenc Ciliv (IAEA fellow), Bette L. Davis (Dept. of History), John Griffiths (Dept. of Chemistry), Deborah Y.

* Publication number 561, Institute of Geophysics and Planetary Physics, University of California, Los Angeles.

Tubbs (Dept. of Bacteriology), R. Ervin Taylor (Dept. of Anthropology), and Barbara Turring (Dept. of Psychology).

IN MEMORIAM

We wish to honor the memory of Herschel C. Smith, a dedicated amateur archeologist and good friend.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC-HISTORIC DATES

A. United States

UCLA-1079. Lake Manix artifact **14,250 ± 1000**
12,300 B.C.

Jasper encrusted by tufa from high lake terrace, N bank of Mohave River, dry Lake Manix area, California (elev 1723.5 ft; 34° 58′ N Lat, 116° 32′ W Long; Newberry Quad., Sec. 15). Identified as a tool by L. S. B. Leakey, Centre for Prehistory and Palaeontology, Nairobi, Kenya. Date (UCLA III) is based on tufa, corrected by subtracting 2500-yr virtual ages in UCLA III, and represents minimum age. Coll. 1966 by C. von Badinski, Manhattan Beach, E. L. Davis, Mus. of Man, San Diego, and T. E. King, Lawndale, California. Subm. by H. C. Smith, Isotope Foundation, Los Angeles.

Rose Spring series

Radiocarbon dates for Rose Spring site (Iny-372) (36° 3′ N Lat, 117° 58′ W Long) are important because certain projectile point types which are widely distributed in Great Basin could be sequenced here stratigraphically (Lanning, 1963). Lanning proposes the following culture periods with estimated dates as of July, 1962: Cottonwood (A.D. 1300-1900); Late Rose Spring (A.D. 500-1300); Middle Rose Spring (500 B.C.-A.D. 500); Early Rose Spring (1500-500 B.C.). Coll. by F. Riddell and J. Davis and subm. by R. F. Heizer, Univ. of California, Berkeley.

UCLA-1093A. Rose Spring **2240 ± 145**
290 B.C.

Charcoal, 60 to 64 in. depth.

UCLA-1093B. Rose Spring **2900 ± 80**
950 B.C.

Charcoal, 72 to 84 in. depth.

UCLA-1093C. Rose Spring **3520 ± 80**
1570 B.C.

Charcoal, 84 to 92 in. depth.

UCLA-1093D. Rose Spring **3580 ± 80**
1630 B.C.

Charcoal, 96 to 100 in. depth.

UCLA-1093E. Rose Spring **3900 ± 180** **1950 B.C.**

Charcoal, 108 to 120 in. depth.

Comments (R.F.H.): UCLA-1093A and B are stratigraphically Middle and Early RS, respectively, and estimated and C^{14} ages do not conflict. Samples UCLA-1093C-E come from levels below Early RS which were deficient in cultural materials. No projectile points were found below bottom of Early RS deposit at 84 in. from surface. Lanning (1963, p. 268) believes Pinto culture, known from Little Lake site 13.5 mi to S (Harrington, 1957), to have preceded Early RS. As material accompanying UCLA-1093C-E was not classifiable by projectile points, we do not know whether dates refer to Early RS or Pinto. If 1093E does mark earliest occupation of site, this would agree with other evidence indicating either re-occupation or expanding settlement in Great Basin at end of Altithermal (Baumhoff and Heizer, 1965).

Nevada series

Investigations into anthropology of prehistoric human coprolites and the question of contemporaneity of sloth and man in Gypsum Cave prompted the following measurements. Subm. by R. F. Heizer.

UCLA-1071E. Lovelock Cave **145 ± 80** **A.D. 1805**

Human coprolite from crevice, apparently used as latrine, along E edge of low original entrance to interior of Lovelock Cave (40° 10′ N Lat, 118° 30′ W Long). A large collection of human fecal material was made in 1965 and is being analyzed to determine prehistoric dietary elements and patterns. *Comment* (R. Berger): sample may be up to ca. 300 yr old when tree-ring calibrated radiocarbon dating is applied.

UCLA-1071F. Lovelock Cave **1210 ± 150** **A.D. 740**

Human coprolite from undisturbed trash inside Lovelock Cave. *Comment* (R. Berger): coprolite was analyzed for viable microorganisms common to gastro-intestinal tract with negative results (Tubbs and Berger, 1967).

Gypsum Cave Case series

The question of contemporaneity of man and ground sloth believed to exist by Harrington (1933) was re-examined to determine if an incorrect interpretation of stratigraphy had occurred. Coll. by M. R. Harrington; subm. through courtesy of B. Bryan and C. Dentzel, SW Mus., Los Angeles, by R. F. Heizer.

UCLA-1069. Gypsum Cave **2400 ± 60** **450 B.C.**

Charred greasewood sticks (6F651g, 6F651b) from a suspected torch or small open fire in passage between Rooms 4 and 5 of cave found under 18 in. of apparently undisturbed layer of sloth dung (C-221; 10,455 ± 340 yr; Libby, 1965).

UCLA-1223. Gypsum Cave **2900 ± 80**
950 B.C.

Distal end of decorated atlatl shaft (6F592) thought to be of sloth age by Harrington. 10-g fragment identified as elder (Sambucus) by R. Cockrell, Univ. of California. *Comment* (R.F.H.): it appears from above evidence that two samples of wood which appeared to M. R. Harrington, original excavator of Gypsum Cave, to be of same age as sloth dung from that site, are not contemporaneous. Sloth may have lived in cave long before it was first visited by the fire-building atlatl-using humans, and that since 2400 to 2900 yr ago disturbance of the surface deposits has been caused which effected deposition of old sloth dung above much younger cultural remains. That dates of these cultural materials from Gypsum Cave are approx. correct is also indicated by other evidence that Gypsum Cave type stone projectile points are ca. 3000 yr old in Far West.

UCLA-704. Jackknife Cave **8130 ± 105**
6180 B.C.

Charcoal from fireplace (feature K-6/1) associated with Level VIII from Jackknife Cave (10-BT-46), 7.5 mi NE of Howe, Butte County, Idaho (43° 50′ N Lat, 112° 52′ W Long). Dates from same cave are UCLA-257 and 258; UCLA III. Coll. 1963 by B. R. Butler; subm. by E. H. Swanson, Jr., Idaho St. Univ. Mus., Pocatello. *Comments* (E.H.S.): fits very well into our expectaions that high mountain country could first have been occupied following last retreat of Pinedale Stage III glaciers.

UCLA-1072. Douglas County **365 ± 135**
A.D. 1585

Charcoal from rock-lined fire pit, 43 cm below surface at 19.36S/119.06E Area C at Site DO37, 4880 ft, Douglas County, Nevada (39° 05′ N Lat, 119° 47′ W Long). Coll. 1965 by M. Suttles; subm. by W. A. Davis, Univ. of Nevada, Reno. *Comment* (W.A.D.): sample may predate introduction of small corner-and-side notched projectile points and post-date earliest occupation characterized by crude notched or stemmed basalt points which is thought to represent Martis Complex.

UCLA-1092. Little Pico Creek **3180 ± 600**
1230 B.C.

Collagen from human bones found in oldest stratum of Little Pico Creek site, SLO-175, near San Simeon, California (35° 39′ N Lat, 121° 12′ W Long). Remains in burial V, NW 90 NE 15 at 3 ft in bedrock. Coll. and subm. by D. Abrams, UCLA. *Comments* (D.A.): sample allows comparison with Chumash sites in S California and Central Valley sites.

UCLA-1088. Drake site **4600 ± 250**
2650 B.C.

Collagen from human bones heavily coated with caliche from 5 ft level in a reddish midden layer under 4 ft of black midden of Drake site No. 14 near Santa Barbara, California (34° 25′ N Lat, 119° 35′ W Long). Coll. by P. C. Orr, Santa Barbara Mus. Natl. History; subm. by P. C. Orr and R. Berger. *Comment* (R.B.): collagen was isolated in the usual manner (Berger, Horney, and Libby, 1964) and carefully treated to exclude humic acids. However the question of contamination by stable organic compounds derived from butchered marine animals is not settled and needs further clarification.

1080 ± 60
UCLA-792B. Blanchard Springs **A.D. 870**

Partially burnt cane from fire site found in one of the caves near Blanchard Springs, Arkansas (35° 58′ N Lat, 92° 11′ W Long). These caves in Ozark Natl. Forest are being developed by U. S. Forest Service. Coll. by D. E. Williams, U. S. Forest Service; subm. by E. J. Towbin, Veterans Admin., Little Rock, Arkansas.

B. Mexico

West Mexico series

An extended study of chronology of West Mexico and associated problems has resulted in a number of dating series which follow below. These have been assembled from samples originating in different West Mexican states. Specific topics based on age determinations have been discussed recently by Berger, Taylor, and Libby (1966), Long (1966), Long and Taylor (1966, 1967), Taylor and Berger (1967), and Bell (1968).

Morett series, Colima

Morett site (19° 17′ N Lat, 104° 20′ W Long) is situated S of the Rio de Cihuatlan or Marabasco, boundary between Jalisco and Colima. Series is continuation of two dates reported in UCLA II. Measurement of organic portion of sherd (soot) and wattle-and-daub (plant remnants) materials involves research into validity of such dates. For analysis materials are ground, inorganic carbon is removed by acid treatment and the organic fraction is liberated. Results to be published elsewhere. Coll. by R. J. Crabtree; subm. by C. W. Meighan and R. E. Taylor, all UCLA.

2050 ± 170
UCLA-798. Morett site **100 B.C.**

Organic portion of wattle-and-daub from Pit 2, 1.2 to 1.6 m.

2700 ± 280
UCLA-796. Morett site **750 B.C.**

Organic portion of wattle-and-daub from Pit 2, 2.2 to 2.4 m.

1695 ± 100
UCLA-910. Morett site **A.D. 255**

Organic portion of sherds from Pit 3, 1.0 to 1.2 m.

UCLA-1034. Morett site **1390 ± 80**
A.D. 560

Marine shell (*Polymesoda Egeta olivacea* Carpenter) from Pit 3, 1.0 to 1.2 m. Corrected by −240 yr for upwelling (see Berger, Taylor, and Libby, 1966).

UCLA-1035. Morett site **1240 ± 80**
A.D. 710

Marine shell (*Chione undatella* Sowerby) from Pit 3, 1.0 to 1.2 m. Corrected by −240 yr for upwelling.

UCLA-797. Morett site **1605 ± 250**
A.D. 345

Organic portion of wattle-and-daub from Pit 3, 1.4 to 1.6 m.

UCLA-790. Morett site **2000 ± 90**
50 B.C.

Charcoal from Pit 3, 3.0 to 3.2 m.

UCLA-911. Morett site **1950 ± 200**
A.D. *0* B.C

Organic portion of sherds from Pit 3, 3.0 to 3.2 m.

UCLA-799. Morett site **2695 ± 225**
745 B.C.

Organic portion of wattle-and-daub from Pit 3, 3.2 to 3.4 m.

UCLA-791. Morett site **650 ± 80**
A.D. 1300

Charcoal from Pit 4, 0.4 to 0.8 m.

UCLA-912. Morett site **1700 ± 100**
A.D. 250

Organic portion of sherds from Pit 4, 0.4 to 0.8 m.

UCLA-795. Morett site **2100 ± 230**
150 B.C.

Organic portion of sherds from Pit 4, 1.6 to 2.0 m.

UCLA-909. Morett site **2000 ± 80**
50 B.C.

Charcoal from Pit 4, 2.4 to 2.8 m.

UCLA-794. Morett site **2475 ± 190**
525 B.C.

Organic portion of wattle-and-daub from Pit 7, 2.4 to 2.6 m.

UCLA-1066. Chanchopa, Colima **1940 ± 80**
A.D. 10

Marine shell from a rifled tomb near Tecoman, Colima (19° N Lat, 104° W Long). Sample should date Kelly's Ortices-Chanchopa levels. Corrected by −240 yr for upwelling. Coll. by I. Kelly, Mexico, D. F.; subm. by C. W. Meighan and R. E. Taylor.

Jalisco series

1615 ± 100
UCLA-1032. San Sebastian, Jalisco **A.D. 335**

Bone collagen from seven human bone fragments from shaft tomb No. 1, Hacienda de San Sebastian, Municipio de Etzatlan, Jalisco (20° 40′ N Lat, 104° W Long). Tomb is on exhibit as full-scale reproduction in Los Angeles County Mus. of Nat. History. Earlier measurements in UCLA IV. Coll. 1963 by S. Long, UCLA; subm. by S. Long and R. E. Taylor.

370 ± 90
UCLA-907. Barra de Navidad, Jalisco **A.D. 1580**

Bone collagen from right tibia of human skeleton from Burial 1, Pit 5, depth 5.66 m in shell mound at Barra de Navidad, Jalisco (19° 50′ N Lat, 104° 43′ W Long). UCLA-145 (UCLA-II), charcoal at 6 m, 760 ± 70, A.D. 1190. Coll. by S. Long; subm. by S. Long and R. E. Taylor.

1000 ± 80
UCLA-1073A. Tizapan, Jalisco **A.D. 950**

Charcoal from Tizapan, Jalisco (20° 10′ N Lat, 103° W Long). Pit AR-10, 65 to 75 cm. Coll. by C. W. Meighan and L. J. Foote, UCLA; subm. by C.W. Meighan and R. E. Taylor.

4050 ± 80
UCLA-1073E. Tizapan, Jalisco **2100 B.C.**

Charcoal from Tizapan, Jalisco. Pit AR-10, 160 to 200 cm.

845 ± 90
UCLA-1073K. Tizapan, Jalisco **A.D. 1105**

Charcoal from Tizapan, Jalisco. Pit AR-10, 200 to 235 cm.

955 ± 80
UCLA-1073G. Tizapan, Jalisco **A.D. 995**

Charcoal from Tizapan, Jalisco. Pit AW-9, 240 to 249 cm. *Comment* (R. Berger): in Taylor and Berger (1967), radiocarbon ages for UCLA-1073 A-K have been compared to secular variations of atmospheric C^{14} level (Suess, 1965) resulting in somewhat more recent dates.

Nayarit series

1770 ± 80
UCLA-973. Penitas B, Nayarit **A.D. 180**

Charcoal from excavation area D-7 (Bordaz's sequence placement group 1) from Penitas A near Tuxpan, Nayarit (21° 55′ N Lat, 105° 17′ W Long). Coll. 1956 by J. Bordaz, Columbia Univ.; subm. by C. W. Meighan and R. E. Taylor.

695 ± 100
UCLA-974. Penitas B, Nayarit **A.D. 1255**

Charcoal from excavation area N8W11 (Bordaz sequence placement group 7) from Penitas A near Tuxpan, Nayarit.

UCLA-956. Amapa, Nayarit **645 ± 80**
A.D. 1305

Charcoal from Pit B-11, 40 to 60 cm, from Amapa site, Nayarit (21° 49′ N Lat, 105° 14′ W Long). Date reported here dates top of sequence. A previous date (M-1164, 700 ± 75, Michigan VIII) was derived from charcoal of Pit B-15, 4.15 to 4.25 M, and was considered intrusive from post-classic levels 2 m higher. Coll. by G. Grosscup, UCLA; subm. by C. W. Meighan and R. E. Taylor.

UCLA-964. Guasave, Sinaloa **830 ± 130**
A.D. 1120

Carbonized pitch or gum adhering to surface of remains of coiled basket found in Feature 115 at Guasave (Ekholm, 1942). Coll. by G. Ekholm, Am. Mus. of Nat History, New York; subm. by C. W. Meighan and R. E. Taylor.

Rio Balsas series

Reported are the first radiocarbon dates from a continuing study of valley of Rio Balsas (Pacific S coast). Charcoal samples obtained from locations excavated by Departmento de Monumentos Prehispanicos, Instituto Nacional de Antropologia e Historia, Mexico, D. F.; subm. by J. L. Lorenzo, INAH.

UCLA-1080E. Rio Balsas **2060 ± 80**
110 B.C.

From B 10-6, M-1, 175 m above sealevel.

UCLA-1080F. Rio Balsas **1625 ± 80**
A.D. 325

From B 10-4, M-2, 175 m above sealevel.

UCLA-1080C. Rio Balsas **2275 ± 80**
325 B.C.

From B 10-6, M-3, 175 m above sealevel.

UCLA-1080A. Rio Balsas **1320 ± 80**
A.D. 630

From B 10-1, M-4, 175 m above sealevel.

UCLA-1080H. Rio Balsas **980 ± 80**
A.D. 970

From B 44-1, M-7, 190 m above sealevel.

UCLA-1080B. Rio Balsas **730 ± 80**
A.D. 1220

From B 44-2, M-6, 190 m above sealevel.

UCLA-1080G. Rio Balsas **2550 ± 80**
600 B.C.

From B 41-Plat. C, M-9, 195 m above sealevel.

1810 ± 80
UCLA-1080D. Rio Balsas **A.D. 140**

From B 54-10, M-10, 204 m above sealevel. *Comment* (J.L.L.): UCLA-1080C and 1080E are of surprising age.

130 ± 70
UCLA-1047. Mexican codex **A.D. 1820**

Codex from Mexico of doubtful age. Subm. by G. C. Kennedy, UCLA. *Comment* (R. Berger): when secular variations of atmospheric C^{14} level are considered, age appears to be either ca. A.D. 1700 or ca. A.D. 1650, post-Columbian.

550 ± 60
UCLA-1216. Idol **A.D. 1400**

Carved Aztec wooden figure of Mexican water goddess, 53 cm tall, from Art Mus., St. Louis, Missouri. One of two known to exist. To be discussed elsewhere (Nicholson and Berger, 1967). Subm. by H. B. Nicholson and R. Berger, UCLA.

C. South America

NW Argentina series

The whole archaeological chronology of Argentina is based so far on only 25 radiocarbon dates from several labs. as discussed in a review (Gonzalez, 1962). The following dates augment the pre-history of Argentina and were referred to more recently by Gonzalez (1966).

1680 ± 80
UCLA-785A. Cienaga Culture **A.D. 270**

Charcoal from Rio La Manga, Site Yi, La Cienaga, Dept. Belen, Province of Catamarca (27° 35′ S Lat, 67° W Long). Occupation level 30 to 40 cm thick at 140 cm depth in barranca of loess. Coll. 1964 by A. R. Gonzalez and M. S. Gonzalez, Univ. Nac. de la Plata, Argentina; subm. by A. R. Gonzalez. *Comment* (A.R.G.): dates for the first time the Cienaga Culture complex at original site. One of most typical cultures of early agriculture-pottery making cultures of NW Argentina.

935 ± 80
UCLA-785B. Hualfin Culture **A.D. 1015**

Basket from child's burial urn found 1952 at Quillay, Hualfin Valley, Dept. Belen, Prov. of Catamarca (27° 12′ S Lat, 66° 50′ W Long). Coll. and subm. by A. R. Gonzalez. *Comment* (A.R.G.): first sample to date Hualfin Culture.

1550 ± 60
UCLA-785C. La Rioja-San Juan Culture **A.D. 400**

Charcoal from "Volpiansky"-site, Iglesia, Dept. Iglesia, Prov. of San Juan (30° 25′ S Lat, 69° 20′ W Long). Found in barranca under typical Angualasto Culture site. Coll. and subm. by A. R. Gonzalez. *Comment* (A.R.G.): this is first date for oldest agricultural-pottery making culture of province.

D. Pacific and Far East

UCLA-1214. Buddha **820 ± 80**
A.D. 1130

Antique Amida buddha carved from wood with octagonal lotus stand, ca. 2 m tall. Coll. and subm. by Mrs. Boyd, Los Angeles. *Comment* (R. Berger): statue was dated in Japan stylistically to be of Kamakura Era (13th century) which is borne out by tree-ring calibrated radiocarbon dating.

E. Europe

European Medieval Architecture series

Dates listed below are a continuation of investigation into Aisled Medieval Timber Hall (UCLA III, IV and V) and the potential and limitations of radiocarbon dating in Middle Ages. This study will be reported on elsewhere in greater detail. For maximum dating precision δC^{13} measurements are included as well as comparison with secular variations of atmospheric C^{14} levels (Suess, 1965). Also location of oak-wood specimen in the tree affects estimate of the most probable historical age in which tree involved was used in construction. Samples coll., subm., and commented on by W. Horn, Univ. of California, Berkeley, and R. Berger.

UCLA-1048. Great Coxwell **870 ± 80**
A.D. 1080

Heartwood from Truss G, Post g, of barn at Great Coxwell, near Faringdon, Berkshire, England (51° 36′ N Lat, 1° 34′ W Long). *Comment:* sample removed from depth of ca. 40 tree-rings. Radiocarbon date corresponds to age calibrated with European oak and American trees of 740 yr. Therefore tree was felled and presumably used in construction in ca. A.D. 1250.

UCLA-1049. Great Coxwell **750 ± 60**
A.D. 1200

Sapwood from same timber as UCLA-1048. Specimen ca. 15 tree-rings inward from cambium. $\delta C^{13} = -25.2$. *Comment:* radiocarbon date corresponds to tree-ring calibrated age of 720 yr. Probable historical date for felling ca. A.D. 1245. The construction of Great Coxwell has been dated stylistically as end of first half of 13th century.

UCLA-1089. Lenham **845 ± 60**
A.D. 1105

Heartwood from center of sleeper beam below Post c of lesser barn at Lenham, near Maidstone, Kent, England (51° 13′ N Lat, 0° 38′ E Long). *Comment:* radiocarbon date corresponds to tree-ring calibrated age of 725 yr. If timber was cut from tree not much larger than the diagonal of sleeper beam, then 120 yr have to be allowed for growth before cutting. Probable historical age is ca. A.D. 1345.

670 ± 60
UCLA-1090. Lenham **A.D. 1280**

Heartwood 9 in. from center of same beam as used in UCLA-1089. $\delta C^{13} = -25.1$. *Comment:* radiocarbon date corresponds to 700 yr. Specimen secured from position ca. 30 tree-rings inward from cambium. Probable historical age ca. A.D. 1280. Historical document reports that previous barn burned in A.D. 1298. New barn (UCLA-1089, 1090) was very likely built shortly therafter. Experimental C^{14} dating can be improved by taking additional samples.

595 ± 60
UCLA-1091. Lenham **A.D. 1355**

Bark from Truss D, Post d', of greater barn at Lenham. $\delta C^{13} = -26.9$. *Comment:* radiocarbon date corresponds to a range from 550-660 yr after comparison with tree-ring calibration. Since bark is older than sapwood sample of similar thickness, 40 yr are allowed. Therefore timber was cut for construction between ca. A.D. 1330 to 1440.

610 ± 60
UCLA-1006B. Middle Littleton **A.D. 1340**

Sapwood from northern blade of first cruck truss, Truss 3, immediately above wedge of barn at Middle Littleton, NW of Evesham, Worcestershire, England (52° 10′ N Lat, 1° 50′ W Long). *Comment:* same wood was measured before as UCLA-1006 (UCLA V) and gave modern date. However since beam had carpentry mark identical to those in rest of barn, date was unacceptable. Specimen was therefore carefully decontaminated with acid and alkali treatments and measured again. It then gave the date reported now.

When all previous dates for Middle Littleton (UCLA-953, 954, 1004, 0005; UCLA V) as well as UCLA-1006B are compared with tree-ring calibration curve and age of sample in tree is considered, then the following probable historical dates are arrived at, respectively, A.D. 1265, 1255, 1265, 1240, 1265. It was on basis of this remarkable result that merit of tree-ring calibration curve became apparent. Probable historical date for construction of barn is mid-13th century (Horn, Charles, and Berger, 1966).

830 ± 60
UCLA-1075. Cressing Temple **A.D. 1120**

Heartwood from Truss A, Post a', from interior of mortice which received tenon of a lost tie-beam originally connecting Post a' with plate of western long wall. From barley barn of Cressing Temple, Witham, Essex, England (51° 50′ N Lat, 0° 36′ E Long). *Comment:* age after comparison to secular variations 730 or 790 yr; tree-ring allowance 50 yr. Probable historical date A.D. 1270 or 1210.

920 ± 60
UCLA-1076. Cressing Temple **A.D. 1030**

Sapwood from Truss E, Post e', W face immediately below springing of longitudinal brace. Barley barn. $\delta C^{13} = -23.0$. *Comment:* tree-ring calibrated age range 750 to 925 yr due to shape of calibration curve. Tree-ring allowance 10 yr. Probable historical date ca. A.D. 1200 to 1025.

950 ± 60
UCLA-1077. Cressing Temple **A.D. 1000**

Heartwood from same beam as UCLA-1076 within 2 in. of center of tree. $\delta C^{13} = -24.7$. *Comment:* corresponding age range is 850 to 925 yr; tree-ring allowance 90 yr; probable historical age range ca. A.D. 1190 to 1115. An earlier date, UCLA-646 (UCLA III), gives probable historical range of ca. A.D. 1220 to 1045.

730 ± 80
UCLA-1078. Cressing Temple **A.D. 1220**

Sapwood from Truss E, Post e', from NE edge of post in wheat barn at Cressing Temple. *Comment:* corresponding age is 710 yr; tree-ring allowance 15 yr; and probable historical date of erection ca. A.D. 1255.

Dating of Cressing Temple barns has been discussed in detail by Berger and Horn (1967). Barley barn was raised around A.D. 1200 based on evidence of very similar time spans of UCLA-1076, 1077, and 646, and UCLA-1075 at A.D. 1210 or 1270. Also, trees used in construction are on the order of 100 yr or so in age, a time span which just disappears into the plateau of the calibration curve. Cressing Temple barley barn is oldest extant medieval English barn known.

490 ± 60
UCLA-1083. Nettlestead **A.D. 1460**

Sample from sapwood/heartwood interface of sleeper beam of manor barn at Nettlestead, Kent, England (51° 11′ N Lat, 0° 26′ E Long). $\delta C^{13} = -24.0$. *Comment:* radiocarbon age corresponds to 530 yr; tree-ring allowance 20 yr; probable historical age ca. A.D. 1440.

350 ± 60
UCLA-1085A. Nettlestead **A.D. 1600**

Sapwood from cut-off end of sleeper beam, same as UCLA-1083. $\delta C^{13} = -24.4$. *Comment:* radiocarbon age corresponds to 350 or 500 yr due to reversal of calibration curve; tree-ring allowance 5 yr; probable historical age ca. A.D. 1605 or 1455.

535 ± 60
UCLA-1085B. Nettlestead **A.D. 1415**

Heartwood from same sample as UCLA-1085A. $C^{13} = -24.2$. *Comment:* radiocarbon age is identical with tree-ring calibrated age; tree-ring allowance 50 yr; probable historical age ca. A.D. 1465.

Accordingly barn was raised in mid-15th century (Horn, Born, and Berger, 1967).

610 ± 80
UCLA-1084. Nettlestead **A.D. 1340**

Heartwood from shake in ceiling beam of manor house. $\delta C^{13} = -24.4$. *Comment:* tree-ring calibrated age is 600 to 700 yr; tree-ring allowance 40 yr; probable historical age 14th century.

270 ± 80
UCLA-1060. Bredon **A.D. 1680**

Sapwood from Truss I, Post i', SW edge of Bredon tithe barn, near Tewkesbury, Worcestershire, England (52° 1′ N Lat, 2° 8′ W Long). $\delta C^{13} = -24.7$. *Comment:* due to reversal of calibration curve, radiocarbon age corresponds to either 325 or 410 to 475 B.P. Tree-ring allowance 15 yr. Probable historical age A.D. 1640 or 1555 to 1490.

845 ± 60
UCLA-1061. Bredon **A.D. 1105**

Sapwood next to heartwood from Truss D, Post d, same barn as UCLA-1060. $\delta C^{13} = -26.0$. *Comment:* radiocarbon age corresponds to 725 or 800 yr. Tree-ring allowance 25 yr. Probable historical date A.D. 1250 or 1175. Another timber (UCLA-577A; UCLA IV) was assayed earlier. Its probable age is 750 to 900 yr. Bredon is likely to be mid-13th century but requires additional work.

670 ± 60
UCLA-1057. Little Wymondley **A.D. 1280**

Sapwood from E face of Truss H, Post h′, of barn at Little Wymondley (51° 44′ N Lat, 0° 18′ W Long). $\delta C^{13} = -24.4$. *Comment:* radiocarbon age corresponds to 700 yr; tree-ring allowance 15 yr; probable historical age ca. A.D. 1265.

350 ± 60
UCLA-1058. Little Wymondley **A.D. 1600**

Heartwood, 2 to 3 in. inward from waney edge of Truss G, Post g′, same barn as UCLA-1057. $\delta C^{13} = -23.8$. *Comment:* radiocarbon age either 350 or 500 yr due to reversal of calibration curve. Tree-ring allowance 25 yr. Probable historical age ca. A.D. 1625 or 1475.

610 ± 80
UCLA-1055. Drayton-St. Leonard **A.D. 1340**

Heartwood 3 to 3.5 in. inward from edge of tree, Truss A, Post a, tithe barn at Drayton-St. Leonard, near Dorchester, Oxonshire, England (51° 40′ N Lat, 1° 7′ W Long). $\delta C^{13} = -22.7$. *Comment:* radiocarbon age corresponds to 600 to 670 yr. Tree-ring allowance 35 yr. Probable historical age ca. A.D. 1385 to 1315.

525 ± 80
UCLA-1056. Drayton-St. Leonard **A.D. 1425**

Sapwood from same post as UCLA-1055. $\delta C^{13} = -22.3$. *Comment:* radiocarbon age equivalent of 540 yr. Tree-ring allowance 10 yr. Probable historical age ca A.D. 1420. Earlier date (UCLA-578; UCLA IV) corresponds to probably early 14th century.

670 ± 60
UCLA-1050. Harmondsworth **A.D. 1280**

Heartwood, 3 in. inward from edge of tree, from Truss K, Post k, of tithe barn at Harmondsworth, Middlesex, England (51° 27′ N Lat, 0°

24′ W Long). $\delta C^{13} = -26.0$. *Comment:* C^{14} age corresponds to 690 yr. Tree-ring allowance ca. 40 yr. Probable historical date ca. A.D. 1300.

555 ± 60
UCLA-1051. Harmondsworth **A.D. 1395**

Sapwood from same post as UCLA-1050. $\delta C^{13} = -26.0$. *Comment:* radiocarbon age equivalent to age span of 550 to 670 yr. Tree-ring allowance 15 yr. Probable historical age ca. A.D. 1415 to 1295. Earlier date (UCLA-575; UCLA IV) suggests end of 13th century. Therefore Harmondsworth was probably constructed at turn of 13/14th century.

620 ± 60
UCLA-1036. Ter Doest **A.D. 1330**

Heartwood from base block under Truss G, Post g', of barn of Abbey of Ter Doest near Bruges, Belgium (51° 16′ N Lat, 3° 12′ E Long). *Comment:* radiocarbon age corresponds to 670 yr. Tree-ring allowance 90 yr. Probable historical age ca. A.D. 1370.

565 ± 60
UCLA-1038. Ter Doest **A.D. 1385**

Sapwood from same block as UCLA-1036. $\delta C^{13} = -25.1$. *Comment:* radiocarbon date commensurate with age of 550 to 650 yr. Tree-ring allowance 15 yr. Probable historical date ca. A.D. 1415 to 1315. Earlier dates (UCLA-568A and B) suggest 13th century origin for Ter Doest. Base block chosen here for sampling may be not representative of age of barn due to its location.

970 ± 60
UCLA-1094. Nurstead Court **A.D. 980**

Heartwood from edge of tie beam of Truss B, Post b′, of Nurstead Court near Chatham, Kent, England (51° 22′ N Lat, 0° 30′ E Long). $\delta C^{13} = -24.7$. *Comments:* radiocarbon age corresponds to 900 to 950 yr ago. Uncertainty of location of wood sample with reference to cambium necessitates additional analyses to establish historical age.

F. Egypt

Ancient Egypt and radiocarbon dating have been discussed from the egyptologist's point of view by Smith (1964). Observed disparities, but also similarities, of historical and radiocarbon chronologies especially in Old Kingdom are based on measurements of several labs. (Arizona IV, V and VI; British Museum I and III; Chicago; Groningen III; Pennsylvania III; Tata Institute V, unpub.; UCLA II, IV and V; and Uppsala I). In order to minimize errors due to inadequate sample selection or collection, a plan was developed by I.E.S. Edwards (British Mus., London) to obtain the best historically dated material directly from Egypt. With archaeological cooperation of W. B. Emery (Univ. College, London), G. T. Martin (Corpus Christi College, Cambridge) secured samples dated below after consultation as to the best dateable material with R. Berger.

Sample material obtained was divided among several radiocarbon labs. for independent dating (Arizona, British Museum, La Jolla and UCLA).

All UCLA samples were treated first in dilute hydrochloric acid to remove inorganic carbon, washed in water, treated with dilute sodium hydroxide for removal of humic acids, washed in acidic water to counter atmospheric CO_2 absorption during the alkali immersion, washed in distilled water, and dried. All samples were dated after complete Rn decay. C^{13}/C^{12} data by H. Craig, La Jolla.

A more detailed analysis of the following results, especially with respect to major historical chronologies, will be published elsewhere.

Middle Kingdom series

3500 ± 60

UCLA-1212. Dynasty XII **1550 B.C.**

Plant remains of reed matting used as bonding between mud-brick courses, N boundary wall of pyramid of Senusret II at El-Lahun (Fayum), Egypt (29° 13′ N Lat, 30° 59′ E Long). $\delta C^{13} = -10.00‰$. Average of two measurements: 3230 and 3290 yr. *Comment* (R.B.): using half-life of 5730 yr, age is 3605 yr or 1655 B.C. According to G. T. Martin, sample is archaeologically sealed to reign of Senusret II (1897-1877 B.C.). However Senusret III (Sesostris III), XII dynasty, funerary boat dates 3750 B.P. or 1800 B.C. based on half-life 5730 yr (UCLA-900, UCLA-IV).

3500 ± 60

UCLA-1211. Dynasties XI-XII **1550 B.C.**

Two dowels from fragment of wood bearing part of coffin text. From debris outside Tomb 386, on S side. Tomb was owned by Overseer of Soldiers, Intef, a contemporary of Neb-hepet-re Mentu-hotep I of XI dynasty. Excavated March 1966 by Deutsches Archäologisches Institut at Thebes, Asasif (25° 41′ N Lat, 32° 40′ E Long). $\delta C^{13} = -25.36‰$. Average of two measurements: 3480 and 3515 yr. *Comment* (R.B.): according to G. T. Martin, sample was found outside the tomb and can therefore not be assigned with certainty to XI dynasty. Probability is, though, that it formed part of funerary equipment of Intef or his family. Age using half-life of 5730 is 3605 yr or 1655 B.C.

Old Kingdom series

4010 ± 60

UCLA-1208. Dynasty IV **2060 B.C.**

Flax cloth from small, undisturbed mastaba between Tombs 3508 and 3510 (both dated on architectural grounds to Dynasty III) from Archaic Cemetery, Sakkara (29° 51′ N Lat, 31° 14′ E Long). $\delta C^{13} =$ 25.62‰.

Excavated by W. B. Emery, 1964. Average of two measurements: 3980 and 4050 yr. *Comment* (R.B.): age computed with half-life of 5730 yr is 4130 yr or 2180 B.C. G.T. Martin dates sample tentatively to Dynasty IV.

UCLA-1207. Dynasty III **4050 ± 60**
2100 B.C.

Remains of reed matting used as bonding between mud-brick courses of S side of superstructure, Tomb 3075-5 (Kha-bau-Sokar, official, III dynasty), from Sakkara. δC^{13} = 23.12‰. Average of two measurements: 4040 and 4000 yr. *Comment* (R.B.): age computed with 5730 yr half-life is 4170 yr or 2220 B.C. G. T. Martin reports sample was archaeologically sealed, III dynasty.

UCLA-1206. Dynasty III **3965 ± 60**
2015 B.C.

Wood from plank (238 x 38 x 5.5 cm) built into super-structure of Tomb 3510 and subsequently sealed on all sides by brickwork of tomb. Excavated 1964 by W. B. Emery, Egypt Exploration Soc. at Sakkara in Archaic Cemetery. δC^{13} = −25.36‰.

Average of two measurements: 3940 and 4000 yr. *Comment* (R.B.): age based on 5730 yr half-life is 4085 yr or 2135 B.C. G. T. Martin feels certain that sample is definitely III dynasty.

UCLA-1205. Dynasty III **4055 ± 60**
2105 B.C.

Remains of reed-matting used as bonding between mud-brick courses of W side of entrance stairway, Tomb 3030, at Sakkara, Archaic Cemetery. Excavated by C. M. Firth. δC^{13} = 23.36‰. Average of two measurements: 4030 and 4030 yr. *Comment* (R.B.): age based on 5730 yr half-life is 4175 yr or 2225 B.C. G. T. Martin dates tomb on architectural grounds firmly to early III dynasty.

UCLA-1204. Dynasty II **4190 ± 60**
2240 B.C.

Remains of reed-matting used as bonding between mud-brick courses of W side of superstructure, Tomb 3046 (Emery, 1961), Archaic Cemetery, Sakkara. δC^{13} = 23.05‰. Average of two measurements: 4200 and 4120 yr. *Comment* (R.B.): age computed with 5730 yr half-life is 4315 yr or 2365 B.C. G. T. Martin reports that tomb involved is securely dated to II dynasty.

UCLA-1203. Dynasty I **4140 ± 60**
2190 B.C.

Remains of reed-matting used as bonding between mud-brick courses of inner enclosure wall, W side, Tomb 3505 (Ka'a) from Archaic Cemetery, Sakkara (Emery, 1958). δC^{13} = −22.71‰. Average of three measurements: 4130, 4070, and 4120 yr. *Comment* (R.B.): age based on 5730 yr half-life is 4265 yr or 2315 B.C. W. B. Emery carefully went over his old excavations with G. T. Martin to identify tombs of I dynasty correctly. Present sample came from tomb at end of I dynasty.

UCLA-1202. Dynasty I **4235 ± 60**
2285 B.C.

Remains of reed-matting used as bonding between mud-brick courses of S side of superstructure of Tomb 3035 belonging to Hemaka at Sakkara in Archaic Cemetery (Emery, 1938). $\delta C^{13} = 21.95‰$.

Average of two measurements: 4160 and 4215 yr. *Comment* (R.B.): age based on 5730 yr half-life is 4360 yr or 2410 B.C. Sample was archaeologically sealed, mid-I dynasty, the time of Udimu. Slab of wood from roof beam of tomb of Hemaka was dated at 4883 ± 200 (C-267; Libby, 1965), 5568 yr half-life.

4290 ± 60
2340 B.C.

UCLA-1201. Dynasty I

Remains of reed-matting used as bonding between mud-brick courses of N side of superstructure of Tomb 3503 (Mer-Neit) at Archaic Cemetery, Sakkara (Emery, 1954). $\delta C^{13} = 22.36‰$. Average of two measurements: 4230 and 4270 yr. *Comment* (R.B.): age is 4420 yr or 2470 B.C. based on 5730 yr half-life. Sample was archaeologically sealed, ca. early-I dynasty according to G. T. Martin.

4500 ± 60
2550 B.C.

UCLA-1200. Dynasty I

Remains of reed-matting used as bonding between mud-brick courses of W side of superstructure, Tomb 3357 (Hor-Aha) at Archaic Cemetery, Sakkara (Emery, 1939). $\delta C^{13} = 22.65‰$. Average of three measurements: 4490, 4460, and 4430 yr. *Comment* (R.B.): age computed with half-life of 5730 yr is 4635 yr or 2685 B.C. G. T. Martin is certain about sample which has been archaeologically sealed from beginning I dynasty.

General Comment (R.B. and W.F.L.): technically, the preceding samples were checked repeatedly against standards. UCLA-900, Sesostris III, in 1964 (UCLA IV) gave 3640 ± 80. It was remeasured after this series and found to be 3610 ± 80.

Several authors have discussed secular variations in C^{14} level of atmosphere (Damon, Long and Grey, 1966; DeVries, 1958; Kigoshi and Hasegawa, 1965; Libby, 1963; Lingenfelter, 1963; Stuiver, 1961, 1965; Stuiver and Suess, 1966; Suess, 1965; Willis, Tauber and Münnich, 1960; Wood and Libby, 1964). Our series shows these variations, if Egyptian history of the first twelve dynasties is assumed to be correct, to exist to an apparently intensified degree during Middle and Old Kingdom as compared with last two millennia where history is certainly firmer. If changing C^{14} concentration is responsible, relatively rapid changes must have occurred in I to XII dynasties. Presently, however, a discrepancy exists of as much as ca. 200 yr between the two major historical chronologies of Hayes (1962) and Helck (1956).

G. Africa

165 ± 80
A.D. 1785

UCLA-1086. Statue

Metal-covered wooden statue from Gold Coast area, Africa. Coll. and subm. by Mrs. Hilburg, Los Angeles. *Comment* (R.B.): when secular variations of atmospheric C^{14} content are considered, statue may be as early as 17th century, remarkably well-preserved for tropics.

II. GEOPHYSICAL, GEOLOGICAL-CLIMATOLOGICAL AND BIOLOGICAL MEASUREMENTS

A. C^{14} in Atmospheric Carbon Dioxide

Atmospheric Radiocarbon Activity series, California

This series is continuation of data published in UCLA IV and V. C^{14} content in ground level atmospheric CO_2 is monitored monthly at China Lake, California (35° 37′ N Lat, 117° 41′ W Long). Samples are collected with cooperation of Gilbert Plain, Acting Head, Research Dept., Naval Ordnance Test Station, China Lake, California.

The following list contains exposure times of NaOH solutions to air and percent increase of C^{14} above reference level of 1890 or 0.95 NBS oxalic acid. Data are graphed in Fig 1.

Sample no.	Exposure time	δ^1C^4,%
UCLA-1130.	25 Dec. – 1 Jan. 1966	+ 71.6%
UCLA-1132.	28 Jan. – 4 Feb. 1966	+ 70.4%
UCLA-1133.	26 Feb. – 5 Mar. 1966	+ 69.1%
UCLA-1137.	27 Mar. – 3 Apr. 1966	+ 69.9%
UCLA-1138.	28 Apr. – 5 May 1966	+ 69.2%
UCLA-1143.	28 May – 4 June 1966	+ 72.2%
UCLA-1145.	28 June – 5 July 1966	+ 73.0%
UCLA-1147.	29 July – 5 Aug. 1966	+ 66.6%
UCLA-1148.	27 Aug. – 3 Sept. 1966	+ 72.3%
UCLA-1151.	28 Sept. – 5 Oct. 1966	+ 70.4%
UCLA-1153.	29 Oct. – 5 Nov. 1966	+ 67.2%

Inspection of Fig. 1 shows that a small spring-summer rise is still discernible, but tendency of atmospheric C^{14} level is toward further decrease.

B. Bomb C^{14} in Human Tissues

This is continuation of measurements reported in UCLA IV and V. Radiocarbon activity is expressed as percent increase over 1890 level of wood or 0.95 NBS oxalic acid.

Protein series

UCLA-848. Brain **δC^{14} + 47.1%**

Total brain protein from 62 yr old Australian male. Congestive cardiac failure. Died 25 Sept. 1965. Coll. by W. P. Freeman, Univ. of Melbourne. G. V. Alexander and J. F. Mead (UCLA) cooperated in preparation of UCLA-848-850.

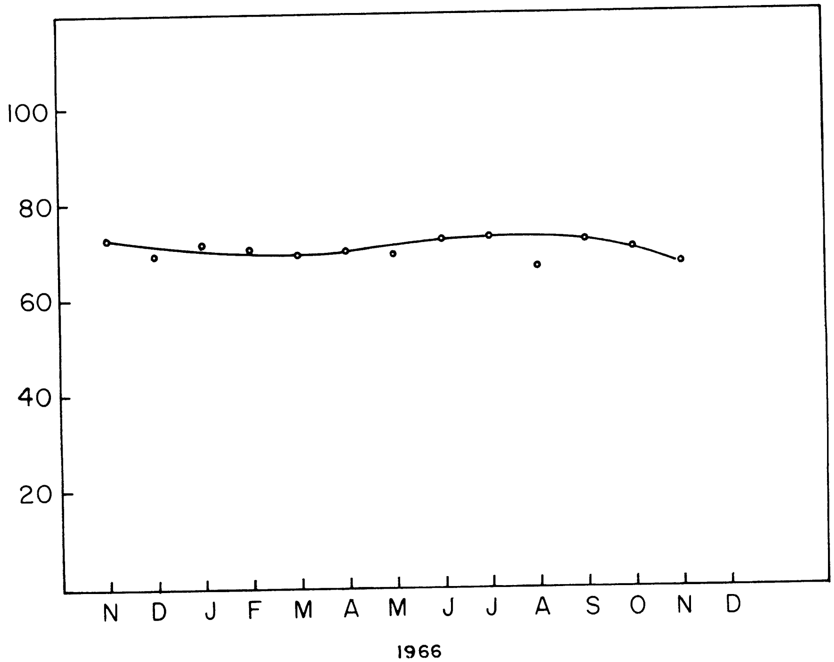

Fig. 1. C^{14} enrichment in percent over NBS standard of atmospheric CO_2 during 1966 at China Lake, California (35° 37′ N Lat, 117° 41′ W Long).

UCLA-849. Liver δC^{14} **+ 44.3%**

Liver protein; same as UCLA-848.

UCLA-850. Heart δC^{14} **+ 46.4%**

Heart protein; same as UCLA-848.

Collagen series

It was established earlier that collagen turns over hardly at all or very slowly in old persons (Libby *et al.*, 1964; Berger *et al.*, 1966). Aim of this study is to assess rate of decrease of metabolic activity of collagen with increasing age of a person. Coll. by J. F. Ross, UCLA; subm. by R. Berger.

UCLA-852. Cartilage δC^{14} **+ 66.2%**

From 3 yr old. Autopsy date: 7 Dec. 1965.

UCLA-853. Cartilage δC^{14} **+ 48.6%**

From 8 yr old. Pulmonary embolism. Autopsy date: 2 Jan. 1966.

UCLA-854. Cartilage δC^{14} **+ 41.0%**

From 9 yr old. Chronic renal failure. Autopsy date: 15 Dec. 1965.

UCLA-855. Cartilage **δC^{14} + 29.4%**

From 25 yr old. Systemic lupus erythrematosis. Autopsy date: 20 Dec. 1965.

UCLA-856. Liver-Control **δC^{14} + 88.8%**

From 3 yr old. Autopsy date: 14 Dec. 1965.

C. Oceanic Measurements

Seawater series

A continuation of seawater C^{14} measurements from southern California coast (see UCLA IV and V). Radiocarbon activity expressed as previously. Measurements are part of program to study CO_2 transfer from atmosphere to ocean. See Fig. 2.

UCLA-1120. Seawater **δC^{14} + 14.9%**

From beach off Sunset Blvd., Pacific Palisades. Coll. 22 Dec. 1965 by R. Staudenmayer and J. Griffiths, UCLA.

UCLA-1127. Seawater **δC^{14} + 17.3%**

Same water as UCLA-1120. Water was exposed at China Lake, California (see Atmospheric Radiocarbon Activity series, this date list) in a plastic 50-gal drum to air for 17 days. Bubbling rate 200 L/hr.

UCLA-1129. Seawater **δC^{14} + 15.1%**

From beach at Sunset Blvd., Pacific Palisades. Coll. 8 Jan. 1966 by R. Staudenmayer and J. Griffiths.

UCLA-1128. Seawater **δC^{14} + 22.7%**

Same as UCLA-1129. Exposed similarly to UCLA-1127 for 68 days to air at China Lake, California.

UCLA-1134. Seawater **δC^{14} + 15.4%**

From beach at Sunset Blvd., Pacific Palisades. Coll. 12 April 1966.

UCLA-1135. Seawater **δC^{14} + 47.0%**

Same water as UCLA-1134. Exposed for 14 days at China Lake similarly to UCLA-1127, but with addition of 100 mg carbonic anhydrase. Enzyme was added to study its effect of promoting CO_2 exchange. It appears reasonable to suspect presence of very minute but effective concentrations of carbonic anhydrase in high-productivity areas of ocean released by organisms and of considerable importance in exchange mechanism.

UCLA-1139. Seawater **δC^{14} + 29.6%**

From beach at Sunset Blvd., Pacific Palisades. Coll. 12 May 1966.

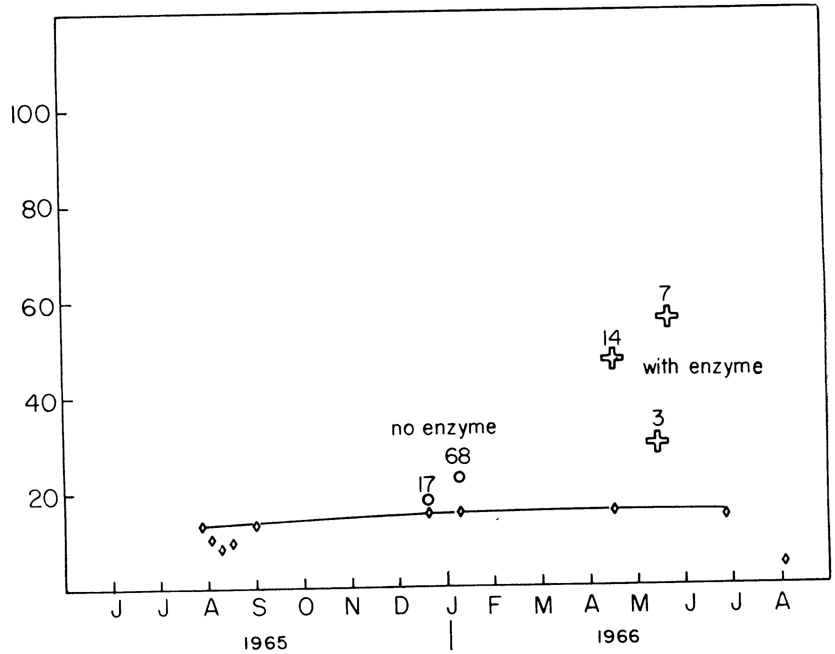

Fig. 2. C^{14} enrichment, in percent, of ocean water during 1965-66 at Los Angeles area beaches. Diamonds are direct measurements; their scatter is due to changing upwelling along the coast. However, it appears that C^{14} activity in surface ocean water is leveling off. Circles denote samples through which air has been bubbled for number of days stated. Crosses are samples containing carbonic anhydrase in the sea water and exposed to air for period marked.

Exposed for 3 days to air at UCLA with addition of 100 mg of carbonic anhydrase to 50 gal of seawater.

UCLA-1141. Seawater **δC^{14} + 55.3%**

From beach at Sunset Blvd., Pacific Palisades. Coll. 20 May 1966. Exposed for 7 days to air at UCLA with addition of 100 mg of carbonic anhydrase to 50 gal of seawater.

UCLA-1144. Seawater **δC^{14} + 14.0%**

From beach at Sunset Blvd., Pacific Palisades. Coll. 28 June 1966.

UCLA-1146. Seawater **δC^{14} + 4.0%**

From Marineland, Palos Verdes. Coll. 4 Aug. 1966.

Contemporary Marine Shell series

Continuation of investigation into C^{14} concentration of marine shells in different oceanic environments (UCLA V; Berger, Taylor and Libby, 1966). Subm. by R. E. Taylor and R. Berger.

UCLA-1037. Shell δC^{14} + 10.1%

Strombus raninus Gmelin shell from Tortugas, Florida, 15 fms, coll. 1911. Obtained through courtesy of J. Rosewater, Smithsonian Inst., Washington.

UCLA-1081. Shell δC^{14} + 9.9%

Livona pica Lium shell from cable station Puntade los Colorados, 10 mi S of Cienfuegos, Cuba. Coll. by W. J. Clench and C. Goodrich, 10 Dec. 1927.

D. Vegetation and Climate

Gatun Basin, Panama series

The following measurements are on vegetation and climate of Gatun Basin, Panama, since 12,000 yr ago with special reference to eustatic sealevel changes. Subm. by E. S. Barghoorn, Harvard, for Ph.D. thesis of Alexandra Bartlett, 1967.

UCLA-1019. Gatun **5980 ± 80**
4030 B.C.

Peat from 9 ft depth below mean sealevel of Panama Canal Company Core TDS-8, coll. from core Dec. 1962 (9° 10′ N Lat, 79° 56′ W Long).

UCLA-1020. Gatun **1275 ± 80**
A.D. 675

Lignitic clay, 13 ft, Core SL-48, coll. from core Jan. 1962 (9° 11′ N Lat, 79° 55′ W Long).

UCLA-1021. Gatun **2180 ± 80**
230 B.C.

Lignitic clay, 15 ft, same core as UCLA-1020 (9° 11′ N Lat, 79° 55′ W Long).

UCLA-1022. Gatun **3340 ± 80**
1390 B.C.

Mineral peat, 19 ft, Core TRS-4, coll. from core Dec. 1962 (9° 11′ N Lat, 79° 57′ W Long).

UCLA-1023. Gatun **4200 ± 80**
2250 B.C.

Peat, 26 ft, Core TDS-2, coll. from core Jan. 1962 (9° 11′ N Lat, 79° 57′ W Long).

UCLA-1024. Gatun **4850 ± 80**
2900 B.C.

Peat, 34 ft, same core as UCLA-1023 (9° 11′ N Lat 79° 57′ W Long).

UCLA-1025. Gatun **35,500 ± 2500**
33,550 B.C.

Clay, 162 ft, Core SL-103, coll. from core Dec. 1962 (9° 16′ N Lat, 79° 52′ W Long).

General Comment (R.B.): other measurements in this series are UCLA-183-186 (UCLA-II). According to Mrs. Bartlett, *Rhizophora* (Mangrove) pollen are present througout most of the column indicating deposition close to sealevel. Maize pollen in samples from 21 to 31 ft are the oldest and only known occurrence of fossil corn pollen in Panama. Correlation of samples and their dates fits very well to eustatic sealevel rise since ca. 12,000 yr ago.

Bristlecone Pine Timberline series

A study of timberline recession of *Pinus aristata* during last several thousand yr as function of climatic changes (La Marche and Mooney, 1967). Coll. and subm. by V. C. La Marche, U. S. Geol. Survey, Menlo Park, California and H. A. Mooney, UCLA.

UCLA-1070A. Bristlecone Pine **4000 ± 80**
2050 B.C.

Remnant of fallen tree above contemporary treeline at 11,900 ft in White Mountains, California (37° 30′ N Lat, 118° 15′ W Long). Coll. 8 July 1965. Resinous wood was dated.

UCLA-1070B. Bristlecone Pine **2540 ± 80**
590 B.C.

Wood from dead, erect stub above contemporary treeline in White Mountains, California, at 11,400 ft.

UCLA-1070C. Bristlecone Pine **2350 ± 80**
400 B.C.

Wood from fallen tree above contemporary treeline in Snake Range, Nevada (38° 30′ N Lat, 114° 15′ W Long). Coll. 13 August 1965.

UCLA-1070D. Bristlecone Pine **2240 ± 80**
290 B.C.

Wood from outer edge of fallen tree above contemporary treeline in Snake Range, Nevada. Coll. 13 August 1965.

UCLA-1070E. Bristlecone Pine **3130 ± 80**
1180 B.C.

Same tree as UCLA-1070D except inside of tree.

UCLA-1070F. Bristlecone Pine **840 ± 80**
A.D. 1110

Wood from dead, erect stub above contemporary treeline at 11,400 ft in White Mountains. Coll. 8 July 1965.

UCLA-1070G. Bristlecone Pine **3565 ± 80**
1615 B.C.

Remnant of fallen tree above contemporary treeline in White Mountains, California, at 11,500 ft. Coll. 8 July 1965.

UCLA-1070H. Bristlecone Pine **3910 ± 80**
1960 B.C.

Same tree as UCLA-1070A, but resin extracted. *Comment* (V.C.L.): dates indicate that bristlecone pines advanced to maximum post-glacial altitude in the Altithermal.

Neotoma Midden series, SW States

Series is part of dating program begun with UCLA III, IV, and V to use macrofossil plants of packrat middens to infer environmental conditions at time of deposition. Results of studies have been published by Wells (1966) and Wells and Berger (1967). Coll. and subm. by P. V. Wells, Univ. of California, Berkeley.

UCLA-1039. Chihuahuan Desert **11,560 ± 140**
9610 B.C.

From cave in Maravellas Canyon, 2000 ft alt. Contains juniper, live-oak, and pinyon pine.

UCLA-1040. Chihuahuan Desert **12,550 ± 130**
10,600 B.C.

Same location as UCLA-1039, base of deposit. Contains juniper.

UCLA-1041. Chihuahuan Desert **12,000 ± 150**
10,050 B.C.

Same location as UCLA-1039, left side of tunnel. Contains juniper.

UCLA-1042. Chihuahuan Desert **13,350 ± 170**
11,400 B.C.

Same location as UCLA-1039, right side of tunnel. Contains juniper.

UCLA-1043. Chihuahuan Desert **14,800 ± 180**
12,850 B.C.

From shelter W of cave (UCLA-1039). Contains juniper.

UCLA-1044. Chihuahuan Desert **> 40,000**

From location in Dead Horse Mountains at 2800 ft. Below center of deposit. Contains juniper.

UCLA-1045. Chihuahuan Desert **20,000 ± 390**
18,050 B.C.

Same as UCLA-1044 except upper part of deposit. Contains juniper.

UCLA-1046. Chihuahuan Desert **16,250 ± 240**
14,300 B.C.

Same location as UCLA-1044 except ledge side at 2700 ft. Contains juniper.

UCLA-1062. Chihuahuan Desert **4200 ± 80**
2250 B.C.

From Maravellas Canyon, 2000 ft alt. Ocotillo layer.

UCLA-1063. Turtle Mountains **19,500 ± 380**
17,550 B.C.

Site at 2750 ft elev in Turtle Mountains, California. Contains *Juniperus, Opuntia,* and *Pinus monophylla.*

UCLA-1064. Spotted Range **8420 ± 100**
6470 B.C.

Site at 6000 ft in Spotted Range, Nevada. Contains *Juniperus osteosperma, Cercocarpus intricatus, Acer glabrum.*

E. Geologic Processes

UCLA-1131. Pismo Beach, California **> 40,000**

Miocene carbonate-containing rock at the shore, constantly being wetted by ocean spray. Rock was analyzed to determine if process of dolomitization could be observed at that California location (35° 8′ 30″ N Lat, 120° 39′ W Long). Coll. and subm. by C. A. Hall, UCLA.

UCLA-1150. Camp Nelson, California **8.88% of modern**

Tufa containing plant impressions from mountain stream at Camp Nelson, California (36° 4′ N Lat, 118° 22′ W Long). Exploratory date to see if paleobotany should be investigated. Subm. by D. I. Axelrod, UCLA. *Comment* (R.B.): measurement is expressed in percent of modern as location has to be checked to be certain that date is meaningful.

Beeri sulfur mine series

Continuation of earlier measurement (UCLA-1007; UCLA V) from Beeri sulfur quarries, Israel, 9 km S of Gaza (31° 28′ N Lat, 34° 29′ E Long) on origin of sulfur deposit (Kaplan and Nissenbaum, 1966). Coll. and subm. by I. R. Kaplan and A. Nissenbaum, UCLA.

UCLA-1067. Beeri sulfur quarries, Israel **$\Delta = -980 \pm 175$**
$\delta C^{14} = -97.6\%$

NaOH-extract of organics found in sandstone of quarries. $\delta C^{13} = -77.3$ to -82.7 although latter value is more acceptable. Apparent age is 31,2000 ± 3500 yr.

UCLA-1068. Beeri sulfur quarries, Israel **$\delta C^{14} = -96.3\%$**
$\delta C^{13} = -85.5\%$

Benzene extract of same material as UCLA-1067. Apparent age is 20,000 ± 620 yr. *Comment* (R.B.): origin and implications of Beeri sulfur deposit in a lagunal environment are discussed in detail by Nissenbaum and Kaplan (1967).

References

Date lists:

Arizona IV	Damon, Long and Sigalove, 1963
Arizona V	Damon, Haynes and Long, 1964
Arizona VI	Haynes, Damon and Grey, 1966
British Museum I	Barker and Mackey, 1959
British Museum III	Barker and Mackey, 1961
Chicago	Libby, 1955
Groningen III	DeVries and Barendsen, 1958
Michigan VIII	Crane and Griffin, 1963
Pennsylvania III	Ralph, 1959
UCLA I	Fergusson and Libby, 1962
UCLA II	Fergusson and Libby, 1963
UCLA III	Fergusson and Libby, 1964
UCLA IV	Berger, Fergusson and Libby, 1965
UCLA V	Berger and Libby, 1966
Uppsala I	Olsson, 1959

Barker, H. and Mackey, C. J., 1959, British Museum natural radiocarbon measurements I: Radiocarbon, v. 1, p. 81.

———— 1961, British Museum natural radiocarbon measurements III: Radiocarbon, v. 3, p. 39.

Bartlett, A., 1967, Chronological studies of the Gatun Basin of Panama: a history of vegetation, climate and sealevel changes during the last 12,0000 yr.: Ph.D. dissertation, Harvard Univ.

Baumhoff, M. A. and Heizer, R. F., 1965, Postglacial climate and archaeology in the desert west; *in* The Quarternary of the United States, ed. H. E. Wright and D. G. Frey: Princeton, Princeton Univ. Press, p. 697.

Bell, B., 1968, The archaeology of Nayarit, Jalisco and Colima; *in* Handbook of Middle American Indians, general ed. R. Wauchope: Austin, Univ. of Texas Press, in press.

Berger, R., Fergusson, G. J., and Libby, W. F., 1965, UCLA radiocarbon dates IV: Radiocarbon, v. 7, p. 336.

Berger, R. and Horn, W., 1967, The construction date of the barns of Cressing Temple, Essex, in the light of radiocarbon analysis: Jour. Soc. Architectural Historians, in press.

Berger, R., Horney, A. G., and Libby, W. F., 1964, Radiocarbon dating of bone and shell from their organic components: Science, v. 144, p. 999.

Berger, R. and Libby, W. F., 1966, UCLA radiocarbon dates V: Radiocarbon, v. 8, p. 467.

Berger, R., Libby, W. F., Alexander, G. V., Mead, J. F., and Ross, J. F., 1966, Atmospheric bomb radiocarbon as a tracer in human beings; *in* Advances in tracer methodology, ed. S. Rothchild: New York, Plenum Press, p. 321.

Berger, R., Taylor, R. E., and Libby, W. F., 1966, Radiocarbon content of marine shells from the California and Mexican west coast: Science, v. 153, p. 864.

Crane, H. R. and Griffin, J. B., 1963, University of Michigan radiocarbon dates VIII: Radiocarbon, v. 5, p. 228.

Damon, P, E., Haynes, C. V., and Long, A., 1964, Arizona radiocarbon dates V: Radiocarbon, v. 6, p. 91.

Damon, P. E., Long, A., and Grey, D. C., 1966, Fluctuation of atmospheric carbon-14 during the last six millenia: Jour. Geophys. Res., v. 71, p. 1055.

Damon, P. E., Long, A., and Sigalove, J. J., 1963, Arizona radiocarbon dates IV: Radiocarbon, v. 5, p. 283.

DeVries, H., 1958, Variations in concentration of radiocarbon with time and location on earth: Koninkl. Ned. Akad. Wetensch. Prodc. B61, p. 94.

DeVries, H. and Barendsen, G. W., 1958, Groningen radiocarbon dates III: Science, v. 128, p. 1550.

Ekholm, G. F., 1942, Excavations at Guasave, Sinoloa, Mexico: Anthropological Papers of Am. Mus. of Nat. History, v. 38, pt. 2.

Fergusson, G. J. and Libby, W. F., 1962, UCLA radiocarbon dates I: Radiocarbon, v. 4, p. 109.

——— 1963, UCLA radiocarbon dates II: Radiocarbon, v. 5, p. 1.

——— 1964, UCLA radiocarbon dates III: Radiocarbon, v. 6, p. 318.

Gonzalez, A. R., 1962, Nuevas fechas de la cronologia arqueologica Argentina obtenidas por el metodo de radiocarbon: Revista del Instituto de Antropologia, Universidad Nacional de Cordoba, v. 1, p. 303.

——— 1966, Paper presented at 37th Internat. Cong. of Americanists, La Plata, Agentina.

Harrington, M. R., 1933, Gypsum Ceva, Nevada: Southwest Mus. Papers, no. 8.

——— 1957, A Pinto site at Little Lake, California: Southwest Mus. Papers, no. 17.

Hayes, W. C., 1962, Egypt—to the end of twentieth dynasty; *in* W. C. Hayes, M. B. Rowton and F. H. Stubbings, Chronology: Cambridge Ancient History Fascicles: Cambridge, Cambridge Univ. Press, general eds. I. E. S. Edwards, C. J. Gadd and N. G. L. Hammond, p. 1-23.

Haynes, C. V., Damon, P. E., and Grey, D. C., 1966, Arizona radiocarbon dates VI: Radiocarbon, v. 8, p. 1.

Helck, W., 1956, Untersuchungen zu Manetho und den ägyptischen Königslisten: Berlin, Akademie Verlag.

Horn, W., Born, E., and Berger, R., 1967, A victim of fire: the 15th century manor barn of Nettlestead, Kent: Aachener Kunstblätter, in press.

Horn, W., Charles, F. W. B., and Berger, R., 1966, The cruck-built barn of Middle Littleton, Worcestershire: Jour. Soc. Architectural Historians, v. 25, p. 221.

Kaplan, I. R. and Nissenbaum, A., 1966, Anomalous carbon-isotope ratios in nonvolatile organic material: Science, v. 153, p. 744.

Kigoshi, K. and Hasegawa, H., 1965, Secular variations of atmospheric radiocarbon concentration and its dependence on geomagnetism: Jour. Geophys. Res., v. 71, p. 1065.

La Marche, V. C. and Mooney, H. A., 1967, Altithermal timberline advance in Western United States: Nature, v. 213, p. 980.

Lanning, E. P., 1963, Archaeology of the Rose Spring Site, Iny-372: Univ. of California Publications in American Archaeology and Ethnology, v. 49, no. 3, p. 237.

Libby, W. F., 1955, Radiocarbon dating: Chicago, Univ. of Chicago Press. New paperback edition with notes added, 1965.

——— 1963, Accuracy of radiocarbon dates: Science, v. 140, p. 278.

Libby, W. F., Berger, R., Mead, J. F., Alexander, G. V., and Ross, J. F., 1964, Replacement rates for human tissues from atmospheric radiocarbon: Science, v. 146, p. 1170.

Lingenfelter, R. E., 1963, Production of carbon-14 by cosmic- ray neutrons: Revs. Geophys., v. 1, p. 1.

Long, S. V., 1966, An application of the direct historical approach to West Mexican archaeology: Ph.D. dissertation, Univ. of California, Los Angeles.

Long, S. V. and Taylor, R. E., 1966, Chronology of a West Mexican shaft-tomb: Nature, v. 212, p. 651.

——— 1966, Suggested revision for West Mexican archaeological sequences: Science, v. 154, p. 1456.

Nicholson, H. B. and Berger, R., 1966, Two Aztec wood idols: Manuscript on file, Inst. of Geophysics and Dept. of Anthropology, UCLA.

Nissenbaum, A. and Kaplan, I. R., 1967, Origin of the Beeri (Israel) sulfur deposit: Chemical Geology, v. 1, p. 295.

Olsson, I., 1959, Uppsala natural radiocarbon measurements I: Radiocarbon, v. 1, p. 87.

Ralph, E. K., 1959, University of Pennsylvania radiocarbon dates III: Radiocarbon, v. 1, p. 45.

Smith, H. S.,1964, Egypt and C^{14} dating: Am. Antiquity, v. 38, p. 32.

Stuiver, M., 1961, Variations in radiocarbon concentration and sunspot activity: Jour. Geophys. Res., v. 66, p. 273.

———— 1965, Carbon-14 content of 18th and 19th century wood: variations correlated with sunspot activity: Science, v. 149, p. 533.

Stuiver, M. and Suess, H. E., 1966, On the relationship between radiocarbon dates and true sample ages: Radiocarbon, v. 8, p. 534.

Suess, H. E., 1965, Secular variations of the cosmic-ray-produced carbon-14 in the atmosphere and their interpretations: Jour. Geophys. Res., v. 70, p. 5937.

Taylor, R. E. and Berger, R., 1967, Radiocarbon dates from Tizapan El Alto, Jalisco: *in* Excavations at Tizapan, C. W. Meighan and L. Foote: monograph, in press.

Tubbs, D. Y. and Berger, R., 1967, The viability of pathogens in ancient human coprolites: Univ. of California, Berkeley, Archaeol. Survey report No. 70.

Wells, P. V., 1966, Late Pleistocene vegetation and degree of pluvial climate change in the Chihuahuan desert: Science, v. 153, p. 970.

Wells, P. V. and Berger, R., 1967, Late Pleistocene history of woodland vegetation in the Mohave desert: Science, v. 155, p. 1640.

Willis, E. H., Tauber, T., and Münnich, K. O., 1960, Variations in the atmospheric radiocarbon concentration over the past 1300 years: Radiocarbon, v. 2, p. 1.

Wood, L. and Libby, W. F., 1964, Geophysical implications of radiocarbon date discrepancies; *in* Isotopic and Cosmic Chemistry, eds. Craig, Miller and Wasserberg: Amsterdam, North-Holland Pub. Co., p. 205.