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Radiocarbon

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ARIZONA RADIOCARBON DATES VIII*

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INTRODUCTION

The carbon isotopic analyses reported here covers the period since the last list (Haynes *et al.*, 1967) until summer 1969. All results relating to secular C^{14} fluctuations in atmospheric CO_2 are now published separately (Damon *et al.*, 1970). Sample preparation and counting procedures remain essentially unchanged since completion of our conversion to CO_2 in 1960. All δC^{13} values are reported relative to PDB and all C^{14} dates, unless otherwise noted, are based on the 5568 year half-life, but are not corrected for C^{13} content. 0.95 NBS oxalic acid activity is our routine standard periodically monitored for isotopic fractionation.

Sample descriptions are classified as follows:

I. Geochemical Samples
II. Experimental Bone Samples
III. Geologic-Paleoclimatologic Samples
IV. Archaeologic Samples

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SAMPLE DESCRIPTIONS

I. GEOCHEMICAL SAMPLES

Sambaquis de Carnica I series, Brazil

Samples of shell and charcoal to test simultaneity of C^{14} variations in sea and air, Sambaquis de Carnica I and Carnica IA (28° 32′ S Lat,

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49° 12′ W Long), Municipio de Laguna, Santa Catarina, Brazil. Coll. 1966 by W. R. Hurt, Indiana Univ. Mus.; subm. by D. C. Grey.

A-833:1. Shell fragments — **2200 ± 500**, **250 B.C.**, $\delta C^{13} = +0.49‰$

Mound SCLL13, 1.4 cm below (b).

A-844. Charcoal — **2410 ± 110**, **460 B.C.**, $\delta C^{13} = -25.96‰$

Same location as 883:1.

A-912. Shell fragments — **3310 ± 140**, **1360 B.C.**, $\delta C^{13} = +0.68‰$

Mound SCLL13, 10.9 cm below (X).

A-914. Shell fragments — **2550 ± 110**, **600 B.C.**, $\delta C^{13} = +0.16‰$

Mound SCLL13, 5.1 cm below (A).

A-917. Shell fragments — **3210 ± 150**, **1260 B.C.**, $\delta C^{13} = +1.98‰$

Mound SCLL13, .18 cm below (X).

A-918. Charcoal — **3370 ± 150**, **1420 B.C.**, $\delta C^{13} = -23.36‰$

Mound SCLL13, 5 cm below (X).

A-919. Shell fragments — **3370 ± 110**, **1420 B.C.**

Same location as A-918.

A-956. Charcoal — **3280 ± 120**, **1330 B.C.**

Mound SCLL13A, 1.3 cm below (O.D.).

A-959. Shell — **2460 ± 110**, **510 B.C.**

Mound SCLL13A, basal. *Comment*: the Sambaquis (shell-mounds) provide paired samples of shell and charcoal which lie in a time range exhibiting rapidly changing C^{14} concentration in the atmosphere. Samples were measured to test whether the mixed ocean and the atmosphere varied synchronously. No significant differences were noted, indicating that the mixed layer of the ocean followed the atmosphere closely. Many of the charcoal samples were too small for accurate measurement. All reported values were measured at least twice and averaged.

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II. EXPERIMENTAL BONE SAMPLES

We have continued to investigate the suitability of various chemical fractions of bone for radiocarbon dating. Some results have been reported by Haynes (1968a).

A-582. Bartow Mammoth, Oklahoma **11,990 ± 170 / 10,040 B.C.**

Acid-soluble organic matter from rib of mammoth exposed in a borrow pit 11.3 km NE of Moorland, Oklahoma (36° 31′ N Lat, 99° 08′ W Long). Coll. 1964 by H. Kerr and T. Barr, Univ. of Oklahoma and subm. by A. B. Fisher, Northwestern State College, Alva, Oklahoma. *Comment*: date is geologically reasonable, but soluble bone organic matter commonly gives erroneous results (see A-806D and A-753D below).

A-584. Stein Ranch Mammoth, Montana **8890 ± 300 / 6940 B.C.**

Acid-soluble organic matter from mammoth bone exposed in arroyo wall, Stein Ranch, Park Co., Montana (45° 47′ N Lat, 110° 34′ W Long). Coll. 1963 and subm. by J. Schulte. *Comment*: bone organic matter commonly gives erroneous results (see A-806D and A-753D below).

A-587. Manhattan Mammoth, Montana **6050 ± 750 / 4100 B.C.**

Acid-soluble organic matter from jaw of mammoth in sand of 24.4 m terrace of Gallatin R. 2 mi. NW of Manhattan, Montana (45° 52′ N Lat, 111° 23′ W Long). Coll. 1963 by W. J. McMannis, Montana State College and subm. by R. Bennett, Univ. of Arizona. *Comment*: bone organic matter commonly gives erroneous results (see A806D and A-753D below).

A-619. Kyle Mammoth, Saskatchewan **8650 ± 400 / 6700 B.C.**

$\delta C^{13} = -22.80‰$

Acid-soluble organic matter from mammoth vertebra ca. 2 m below surface at Kyle Mammoth site (EfO_a-5), Saskatchewan, Canada (50° 50′ N Lat, 108° 06′ 30″ W Long). Coll. 1964 and subm. by T. F. Kehoe, Mus. of Nat. History, Regina. *Comment*: date is significantly younger than that obtained by Canada Geol. Survey (unpub.) which is not surprising considering that this fraction commonly gives erroneous results (see A-806D and A-753D below).

Lehner mammoth bone series

Several fractions of carbon from mammoth bone from Lehner site (31° 25′ 23″ N Lat, 110° 06′ 48″ W Long) Cochise Co., Arizona, were analyzed for comparison to charcoal reliably dated at 11, 260 ± 360 B.P. (R., 1966, v. 8, p. 12.) Coll. and subm. 1966 by P. J. Mehringer and C. V. Haynes.

5610 ± 350

A-806A:3. Insoluble organic matter **3660 B.C.**

$\delta C^{13} = -16.73‰$

Grayish-brown residue after gentle treatment in 1N HCl under vacuum followed by 0.5% NaOH at room temperature. *Comment*: collagen, if present, is degraded and contaminated by younger organic residue.

7930 ± 490

A-806D. Soluble organic matter **5980 B.C.**

$\delta C^{13} = -21.50‰$

Solution from acid treatment was made basic with NaOH. Organic matter co-precipitated with hydroxides dried and pyrolized to yield CO_2. *Comment*: sample obviously contaminated.

1190 ± 90

A-806C. Secondary $CaCO_3$ **A.D. 760**

$\delta C^{13} = -3.55‰$

Initial yield of CO_2 from acid treatment of powdered bone. *Comment*: obviously secondary and apparently deposited from ground water because overlying secondary carbonates are successively older up the sec. (A-715 and A-746, R., 1969, v. 11, p. 1-14).

9980 ± 220

A-874C. CO_2 from bone apatite **8030 B.C.**

$\delta C^{13} = -1.99‰$

CO_2 from carbonyl apatite of bone, hydrolized after removal of secondary $CaCO_3$ by acetic acid under vacuum (Haynes, 1968a). *Comment*: the oldest date yet obtained from Lehner mammoth bone.

7780 ± 150

A-876C. CO_2 from tooth apatite **5830 B.C.**

$\delta C^{13} = -2.38‰$

Enamel from mammoth tooth treated in same manner as A-874C. *Comment*: exchange of apatite CO_2 with ground water CO_2 appears to be greater in tooth enamel than in bone, but variation in permeability of sedimentary matrix should also affect chemical exchange.

Hell Gap bone series

Several fractions of carbon from bison bone from Eden level of Loc. III S, Hell Gap site (42° 25′ N Lat, 104° 38′ W Long), Goshen Co., Wyoming, were analyzed for comparison with charcoal reliably dated at 8600 ± 300 B.P. (A-501, R., 1966, v. 8, p. 15). Coll. and subm. 1966 by L. Brew and H. T. Irwin.

8890 ± 110

A-753A. Collagen **6940 B.C.**

$\delta C^{13} = -15.92‰$

Bison bone from Eden occupation level at Loc. III S.

A-753D. Soluble organic matter **5430 ± 110**
3480 B.C.
$\delta C^{13} = -20.00‰$

Filtrate from collagen separation made basic to co-precipitate hydroxides and organic matter. Filter cake dried, weighed, and combusted.

A-753C$_1$. Secondary carbonate **700 ± 260**
A.D. 1250
$\delta C^{13} = -7.27‰$

First evolution of CO_2 from HCl treatment of bone.

A-753C$_2$. **6130 ± 500**
4180 B.C.
$\delta C^{13} = -9.15‰$

Second evolution of CO_2 from HCl treatment of bone.

A-753C$_3$. Bone apatite **9050 ± 160**
7100 B.C.
$\delta C^{13} = -7.56‰$

Evolution of CO_2 from HCl treatment after initial treatment of bone with acetic acid under vacuum. *Comment*: both collagen and bone apatite CO_2 appear to yield correct ages in this case.

Murray Springs bovid bone series

Several fractions of carbon from bones of a yearling bovid found in recent deposit at the Murray Springs site (31° 34′ 17″ N Lat, 110° 10′ 44″ W Long) Arizona, were analyzed as a pre-nuclear-age specimen for comparison with the Lehner mammoth bone series. From geologic evidence, specimen is 50 to 500 yr old (Haynes, 1968a). Coll. and subm. 1966 by C. V. Haynes.

A-819A. Collagen **103.5 ± 3.0% Modern**
$\delta C^{13} = -13.90‰$

A-819B. Humates **102.4 ± 2.8% Modern**

A-819C. Secondary carbonate **124.9 ± 4.6% Modern**

A-819D. Soluble organic matter **100.9 ± 2.4% Modern**
$\delta C^{13} = -12.35‰$

A-819E. Fulvic acids **98.8 ± 6.7% Modern**

Comment: because a nuclear age is precluded by the geologic occurrence, the yearling is believed to have lived within a few yr of A.D. 1700 when there was a 2.5% increase in atmospheric C^{14} budget (Damon, Long, and Grey, 1966).

A-988. Hurley Mammoth site, Arizona **21,210 ± 770**
19,260 B.C.
$\delta C^{13} = -20.98‰$

CO_2 from bone apatite from *Mammuthus columbi*(?), Hurley site (31° 37′ N Lat, 110° 12′ W Long), Cochise Co., Arizona. Coll. 1967 by

E. T. Hemmings; subm. by C. V. Haynes. *Comment* (C.V.H.): bones occurred in mudstone of Unit D dated 29,000 ± 2000 B.P. (A-896A) at Murray Springs (this list). Contamination by exchanged CO_2 is likely.

III. GEOLOGIC-PALEOCLIMATOLOGIC SAMPLES

Hell Gap series, Wyoming

Hell Gap site (42° 24′ 35″ N Lat, 104° 38′ 25″ W Long), Goshen Co., Wyoming is a multiple component early man site where artifacts and bones of extinct bison occur within a sequence of late Quaternary sediments (Irwin, 1967). Investigations supported by Natl. Geog. Soc. Coll. 1965 and subm. by C. V. Haynes, H. T. Irwin, and C. Irwin-Williams.

A-748A. Insoluble soil residue — **9250 ± 500 / 7300 B.C.**

Gray silt soil immediately below Folsom level at Loc. I. Residue after removal of carbonates and humates. *Comment*: date indicates presence of contaminants, probably vegetable remains.

A-755A. Insoluble soil residue — **6450 ± 300 / 4500 B.C.**

$\delta C^{13} = -23.23‰$

CCa-horizon of truncated silt soil at Loc. II. Residue after removal of carbonate (A-755C) and humates (A-755B). Soil underlies a buried fire pit dated 5740 ± 230 (A-498, R., 1966, v. 8, p. 15).

A-755B. Humates — **8050 ± 400 / 6100 B.C.**

Base-soluble fraction from A-755.

A-755C. Carbonates — **1420 ± 300 / A.D. 530**

Carbonate CO_2 from A-755. *Comment*: all fractions show some degree of contamination from overlying soil roots.

A-754B. Soil humates — **6110 ± 120 / 4160 B.C.**

$\delta C^{13} = -23.59‰$

Base-soluble fraction of B-horizon of late "Altithermal" soil at Loc. II. Soil overlies a buried fire pit dated 5740 ± 230 (A-498, R., 1966, v. 8, p. 15). *Comment*: either soil was contaminated by older humic acids or fire pit was dug after development of B-horizon. Stratigraphic level from which pit was dug is not known because bulldozer removed strata immediately overlying it.

Gilcrease Spring mound series, Las Vegas Valley, Nevada

Gilcrease Spring No. 4 (36° 17′ 47″ N Lat, 115° 28′ W Long) is a silt mound 3.66 m high and 30.5 m diam. that has been dry since early 1920's, when it was damp. It was dissected by dulldozer trench in 1963 in order to investigate the stratigraphy (R., 1966, v. 8, p. 8-9). Analyses

of fossil pollen and plant macrofossils (Mehringer, 1967) augmented stratigraphic and geochronologic studies (Haynes, 1967a). Coll. 1965 and subm. by P. J. Mehringer and C. V. Haynes, Univ. of Arizona, and D. R. Tuohy, Nevada State Mus.

A-709A. Peat **9090 ± 210**
7140 B.C.
$\delta C^{13} = -29.69‰$

A-709B. Humates **9910 ± 500**
7960 B.C.

A-709A A. Carbonized grape vine (*Vitis* sp.), hand-picked from A-709 **9160 ± 170**
7210 B.C.

Insoluble organic residues (A and AA) and humates (B) extracted from spring laid clayey peat at Pollen Profile VI, 84.4 to 96.5 cm below local datum. *Comment*: A-709A A is considered most reliable material and was run as a check on A-709A and A-709B. Data indicate humates may be slightly contaminated from ancient ground water.

A-710A. Peat **10,200 ± 400**
8250 B.C.
$\delta C^{13} = -27.57‰$

A-710B. Humates **10,500 ± 170**
8550 B.C.

Insoluble organic residue (A) and humates (B) extracted from spring laid clayey peat at Pollen Profile VI, 1.22 to 1.42 m below datum. *Comment*: dates are not significantly different.

A-953. Carson Slough, Nevada **3550 ± 300**
1600 B.C.

Scirpus sp. seeds from 1.25 to 1.35 m below floor of commercial peat mine stripped of ca. 0.5 m of peat, Carson Slough (36° 29′ N Lat, 116° 21′ W Long) near Ash Meadows, Nevada. Coll. and subm. 1967 by P. J. Mehringer, Jr.

Warm Sulphur Springs series, California

Sediment core samples from playa-edge springs (36° 7′ N Lat, 117° 13′ W Long) were taken for pollen analyses and radiocarbon dating in order to determine the geochronology of lake level fluctuations. Coll. and subm. 1966-1967 by P. J. Mehringer, Jr.

A-848. Organic silt **99.8 ± 4.4% Modern**
Core II, 128 to 132 cm depth.

A-849A A. Coarse (>2 mm) organic matter **110.4 ± 2.4% Modern**
Core II, 71 to 77 cm depth.

A-849A. Fine (<2 mm) organic matter **107.1 ± 4.5% Modern**

Core II, 71 to 77 cm depth.

A-849B. Humates **100.9 ± 1.5% Modern**

Core II, 71 to 77 cm depth.

3450 ± 500

A-952. Seeds and charcoal **1500 B.C.**

Seed fragments (*Scirpus* sp.) and small pieces of charcoal hand-picked from 4 in. core secs. 66 to 78 cm depth. *Comment* (P.J.M., Jr.): A-848 and A-849 indicate that desert salt marsh cores contain modern contaminants not removed by routine mechanical methods. On the basis of the pollen chronology and stratigraphy, A-952 agrees well with other dated fossil seeds from salt marsh deposits of the Death Valley region: A-953, A-1064, A-1069, and I-3766 (last three unpub.).

San Pedro Valley series, Arizona

With the collaboration of archaeologists, paleontologists, and geologists, the Quaternary geochronology of upper San Pedro Valley, Cochise Co., Arizona, has been under investigation for over 40 yr (Gidley, 1922; Antevs, 1955; Lance, 1960; Gray, 1967). A radiocarbon-based chronology is being established by dating archaeologic sites and fossil localities buried in alluvium of the valley and its tributaries (Haynes, 1968b).

2520 ± 140

A-902. Moson site, Arizona **570 B.C.**

$\delta C^{13} = -26.02‰$

Charcoal from rock-filled fire pit buried in silt 1.2 m below surface of 4.6 m terrace of Moson Wash (31° 36′ 13″ N Lat, 110° 10′ 25″ W Long). Assoc. with Cochise artifacts. Coll. and subm. 1967 by E. T. Hemmings and C. V. Haynes. *Comment*: date applies to occupation during end of period of aggradation.

3350 ± 150

A-903. Hereford Dairy Ranch, Arizona **1400 B.C.**

Charcoal from rock-filled hearth buried in silty sand 1.2 m below top of 5.5 m terrace of unnamed tributary arroyo (31° 25′ N Lat, 110° 05′ 38″ W Long). Coll. and subm. 1967 by C. V., Elizabeth, and Lisa Haynes. *Comment*: dates late stage of Unit G_{2a} deposition.

3760 ± 100

A-904. Wiek Ranch, Arizona **1810 B.C.**

Charcoal from rock-filled hearth buried under 1 m silt on ancient erosional slope ca. 15 m above San Pedro R. Coll. and subm. 1966 by D. F. Libbey. *Comment*: dates early stage of deposition of Unit G_{2a}.

A-940B. Moson black mat, Arizona **4820 ± 250**
2870 B.C.
$\delta C^{13} = -21.43‰$

Dark brownish-gray organic clay within Unit G_1 of 4.6 m terrace at Moson site. Coll. and subm. 1967 by C. V. Haynes. *Comment*: dates middle of Unit G_1 deposition.

A-879. Murray Springs Pollen Profile 1, Arizona **5500 ± 400**
3550 B.C.
$\delta C^{13} = -26.67‰$

Partially decomposed wood from lower part of Unit G_1 (Unit B of Mehringer *et al.*, 1967) at Pollen Loc. 1 (31° 34′ 28″ N Lat, 110° 10′ 7″ W Long). Coll. and subm. 1967 by C. V. Haynes, C. F. Hickox, Jr., and P. S. Martin. *Comment*: date is consistent with stratigraphic position between A-697B and A-696 (R., 1967, v. 9, p. 5; Mehringer *et al.*, 1967).

Gray-Seff locality series, Arizona

Dark-colored organic clayey silt at this loc. (31° 59′ 30″ N Lat, 110° 19′ 15″ W Long) overlies clayey sand containing Rancholabrean vertebrate fossils and is separated from an overlying brownish-gray silt by an erosional unconformity. Paleo-Indian artifacts found on surface appear to have come from basal contact of the "black mat." Cochise artifacts on the surface come from the grayish-brown silt. Coll. and subm. 1967 by I. Zarins, D. L. Livingston, and C. V. Haynes.

A-970A. Organic residue **7800 ± 600**
5850 B.C.

Insoluble organic residue after repeated decantation to remove floating matter and acid-base treatment. *Comment*: excessively young date suggests that removal of contaminant vegetable matter from modern soil by flotation and decantation was incomplete.

A-970B. Humates **10,150 ± 600**
8200 B.C.
$\delta C^{13} = -23.64‰$

Base-soluble organic matter precipitated in acid. *Comment*: date is minimal and comparable to similar samples from the Murray Springs site (this list).

Murray Springs series, Arizona

Murray Springs site (31° 34′ 15″ N Lat, 110° 10′ 38″ W Long), San Pedro Valley, Cochise Co., Arizona (Ariz: EE:8:25) is a buried Clovis hunting camp and kill site where artifacts assoc. with mammoth, bison, and horse occur within a sequence of late Quaternary sediments. Investigations supported by Natl. Geog. Soc. (Archaeol.) and Natl. Sci. Foundation (Geol.). Coll. 1967-1968 and subm. by C. V. Haynes.

A-896A. Organic clay — **29,000 ± 2000**, **27,050 B.C.**, $\delta C^{13} = -25.92‰$

A-896B. Humates — **19,200 ± 1600**, **17,250 B.C.**, $\delta C^{13} = -24.97‰$

Organic, laminated lacustrine clay in Unit D, 80 cm below base of Unit F_2 ("black mat"). Acid insoluble residue (A) and base-soluble organic matter precipitated in acid (B). Coll. and subm. 1966 by C. V. Haynes and P. J. Mehringer, Jr. *Comment*: dates existence of pond or lake and a pluvial climate.

A-897. Marl — **21,200 ± 500**, **19,250 B.C.**, $\delta C^{13} = -4.38‰$

Clayey $CaCO_3$ from near base of Unit E (Pollen Sample #1) at Pollen Profile 6. Coll. and subm. 1966 by P. J. Mehringer, G. Batchelder, and C. V. Haynes. *Comment*: dates early part of carbonate phase of lacustrine deposition.

A-905A. Charcoal — **5750 ± 250**, **3800 B.C.**, $\delta C^{13} = -16.56‰$

A-905B. Humates — **5520 ± 200**, **3570 B.C.**, $\delta C^{13} = -11.38‰$

Average 5640 ± 200
3690 B.C.

Charcoal from below gray wet-meadow soil in Unit G_1 at Loc. 1. Coll. and subm. 1966 by L. D. Agenbroad and C. V. Haynes. *Comment*: date is consistent with those from Unit G_1 at Pollen Loc. 1 (Mehringer *et al.*, 1967).

Murray Springs "black mat" series, Arizona

Black organic layer (Unit F_2) bifurcates at Loc. 1 (31° 34′ 15″ N Lat, 110° 10′ 38″ W Long) into an upper (F_{2c}) and lower (F_{2a}) layer separated by ca. 35 cm of soft marl (F_{2b}). Organic samples separated into insoluble organic residue (A) and humates (B). Listed in stratigraphic order. Coll. and subm. 1967 by B. Walton and C. V. Haynes.

A-969A. Organic residue, F_{2c} — **8900 ± 400**, **6950 B.C.**

A-969B. Humates, F_{2c} — **9270 ± 800**, **7320 B.C.**, $\delta C^{13} = -25.63‰$

A-977. $CaCO_3$, F_{2b} — **10,250 ± 170**, **8300 B.C.**

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10,360 ± 90

A-989B. Humates, F_{2a} **8410 B.C.**

$\delta C^{13} = -25.11‰$

Comment: dates suggest >1000 yr was required to deposit sequence. Date, 11,230 ± 340 (A-805, R., 1967, v. 9, p. 11) for top of underlying Unit (F_1) indicates more time was required to form black organic layers than carbonate layer.

2630 ± 150

A-730. Fairbank, Arizona **680 B.C.**

Charcoal from rock-lined hearth 3 m below top of 4.6 m alluvial terrace of the San Pedro R. at Fairbank bridge (31 °43′ N Lat, 110° 12′ W Long). Coll. 1965 and subm. by C. V. Haynes, N. M. Johnson, and P. J. Mehringer, Univ. of Arizona. *Comment*: dates erosional contact between 2 alluvial units.

12,000 ± 300

A-854. Cerros Negros site, Arizona **10,050 B.C.**

Marl from top of sedimentary sec. at Cerros Negros fossil loc. (32° 32′ N Lat, 110° 33′ W Long), Arizona. Coll. and subm. 1966 by L. D. Agenbroad (1967), Univ. of Arizona. *Comment*: date is approx. for end of lacustrine deposition.

Coyote Draw series, Arizona

Charcoal samples from an arroyo (32° 35′ 43″ N Lat, 110° 30′ 15″ W Long) tributary to San Pedro R. were coll. at several levels in late Holocene alluvium of 3.7 m terrace. Coll. and subm. 1966 by L. D. Agenbroad and C. V. Haynes. *Comment*: dates indicate period of general aggradation 1000-3500 yr ago with brief erosional episode shortly before 2300 yr ago.

1360 ± 190

A-861. Charred log **A.D. 590**

Buried 1.4 m below top of 3.7 m terrace.

2270 ± 150

A-862. Charcoal **320 B.C.**

Aboriginal rock-filled hearth 1.7 m below top of 3.7 m terrace and on a buried erosion surface.

3210 ± 240

A-866. Charred twigs **1260 B.C.**

Layer of burned vegetation 3 m below top of 3.7 m terrace.

Malawi, Africa series

Under Natl. Sci. Foundation sponsorship archaeologic, paleontologic, and geologic investigations were conducted in NW Malawi to determine Quaternary paleoecology of area in relation to Lake Nyasa history.

10,170 ± 140

A-782A:2. Ngara Court **8220 B.C.**

Charcoal entrapped in pumiceous tuff exposed at Ngara Court on right bank of Songwe R. (9° 36′ S Lat, 33° 48′ E Long). Coll. and subm. 1966 by J. D. Clark, J. E. Mawby, and C. V. Haynes. *Comment*: re-collected for comparison with A-782B (R., 1967, v. 9, p. 7).

Charcoal from 4 levels of archaeologic test trench excavated at Mbande Court (9° 56′ S Lat, 33° 54′ E Long). Coll. 1965 by A. Van Eggers; subm. 1966 by J. D. Clark, Univ. of California, Berkeley.

4290 ± 100

A-783. 76 to 91 cm below surface **2340 B.C.**

3480 ± 90

A-784. 91 to 107 cm below surface **1530 B.C.**

$\delta C^{13} = -25.67‰$

2370 ± 120

A-785. 107 to 122 cm below surface **420 B.C.**

Comment: A-783 and A-785 were possibly mislabeled which seems even more likely considering these results.

Rungwe volcanic ash series, Tanzania

Late Quaternary ash deposits of Rungwe volcano, S Tanzania, are separated by 3 paleosols containing flecks of charcoal apparently burned during fall of hot pumiceous ash that buried soil. Coll. and subm. 1966 by C. V. Haynes and J. D. Clark. *Comment*: last explosive phases of Rungwe volcano occurred during Holocene. Samples listed in stratigraphic order.

2800 ± 400

A-893. Charcoal **850 B.C.**

$\delta C^{13} = -24.10‰$

Upper buried soil exposed in mud-brick pit (8° 59′ S Lat, 33° 39′ E Long) at intersection of Mbeya-Tukuyu rd. and new Elton Plateau rd. near Ikoma.

3200 ± 100

A-892. Charcoal **1250 B.C.**

Intermediate buried soil exposed in mud-brick pit (8° 58′ S Lat, 33° 38′ E Long) in Isionje Village.

3920 ± 80

A-895. Charcoal **1970 B.C.**

$\delta C^{13} = -23.86‰$

Top of lower buried soil exposed in road-metal pit (9° 00′ S Lat, 33° 40′ E Long) ca. 2 mi E of Ikoma on Elton Plateau rd.

7510 ± 150

A-894. Charcoal **5560 B.C.**

Middle of lower buried soil exposed in same pit as A-895.

Lake Rukwa series, Tanzania

Late Quaternary sediments of pluvial Lake Rukwa are exposed by Songwe R. gorge (8° 42′ S Lat, 33° 02′ E Long) S of Galula. Lacustrine sediments contain pumice and ash transported from Rungwe-Ngozi volcanic field. Coll. and subm. 1966 by C. V. Haynes and J. D. Clark. *Comment*: high pluvial stand of ancient Lake Rukwa occurred during early Holocene when Rungwe-Ngozi volcanic field was intensely active.

A-944. Clam shells **8060 ± 120**
6110 B.C.
$\delta C^{13} = -1.36‰$

Near top of lacustrine sand and tuffaceous mudstone exposed near road S of Galula.

A-945. Oyster shells **9740 ± 130**
7790 B.C.
$\delta C^{13} = -2.05‰$

In mudstone overlain by nodular carbonate zone near top of 41 m sec. of fluvio-lacustrine ash beds S of Galula.

A-946. Nara River, Tanzania **>24,600**
$\delta C^{13} = +1.70‰$

Lacustrine marl from Nara R. sec. (8° 57′ S Lat, 33° 14′ E Long) near Mbeya Lime works, S Tanzania. Upper of 2 marl layers below calcareous paleosol. Coll. and subm. 1966 by C. V. Haynes and J. D. Clark.

IV. ARCHAEOLOGIC SAMPLES

Rodgers shelter series, Missouri

NSF sponsored excavations of Rodgers Rock Shelter (38° 05′ 30″ N Lat, 93° 20′ 40″ W Long) Benton Co., Missouri, have revealed an unusually complete stratigraphic sequence of buried Archaic cultural levels in ancient sediments of Pomme de Terre R. Coll. and subm. 1966 by W. R. Wood and R. B. McMillan (1967), Univ. of Missouri.

A-867. Charcoal **430 ± 100**
A.D. 1520
$\delta C^{13} = -25.26‰$

Scattered flecks of charcoal from ca. 60 cm below top of 3.7 m terrace (coordinates 174NW120, 5.84 m below datum).

A-868A. Charcoal **8100 ± 300**
6150 B.C.
$\delta C^{13} = -24.59‰$

Charred log from uppermost level of Stratum I and 2 m below surface of 8 to 9 m terrace.

9010 ± 190
A-868B. Humates **7060 B.C.**
$\delta C^{13} = -25.07‰$

Base soluble organic matter extracted from A-868A and analyzed to evaluate potential of humic acids to contaminate samples. *Comment*: ancient humic acids in ground water are indicated.

10,150 ± 500
A-744. Olsen-Chubbuck site, Colorado **8200 B.C.**

Collagen extracted from hooves of extinct bison (*Occidentalis*) killed by early man at the Olsen-Chubbuck site in SE Colorado (38° 41′ 15″ N Lat, 102° 31′ 45″ W Long). Coll. 1960 and subm. by J. B. Wheat, Univ. of Colorado. *Comment* (C.V.H.): on basis of existing stratigraphic evidence, date appears 1000 yr too early (Haynes, 1967b), but may be correct if recent interpretation of Eden and Scottsbluff complex and redefinition as Firstview complex (Wheat, pers. commun.) is correct.

Armijo site, New Mexico

Charcoal from Test Trench 5, lowest San Jose level, Pollen Zone IV, on top of yellow silt (35° 25′ 30″ N Lat, 106° 55′ 47″ W Long) analyzed to compare insoluble and base soluble fractions. Coll. and subm. 1966 by C. V. Haynes and C. Irwin-Williams.

7630 ± 140
A-809A. Charcoal **5680 B.C.**
$\delta C^{13} = -18.28‰$

6770 ± 220
A-809B. Humates **4820 B.C.**
$\delta C^{13} = -18.06‰$

3920 ± 80
A-812. Pithouse 4, Northern Arizona **1340 B.C.**

Charcoal flecks from sand of floor of pre-ceramic Pithouse 4 (35° 14′ N Lat, 109° 22′ W Long) N Arizona. Coll. and subm. by G. J. Gumerman (1966).

A-578. Borax Lake, California **Modern**
$\delta C^{13} = -25.1‰$

Charcoal from rodent hole at Borax Lake site (38° 59′ 00″ N Lat, 122° 39′ 46″ W Long) in Trench I. Analysis to determine if rodents have brought up material from lower levels. Coll. 1964 and subm. by C. V. Haynes. *Comment*: age indicates modern charcoal intruded Unit E via rodent activity.

Tlapacoya site series, Mexico

Excavations in deposits of volcanic ash, beach gravel, and peat (19° 18′ 30″ N Lat, 98° 54′ 30″ W Long) related to ancient Lake Chalco were sponsored by Inst. Nac. Antropol. Hist. (INAH), Mexico. In addition

to finding fossil wood and bones of extinct animals, past presence of early man is suggested (Mirambell, 1967; Haynes, 1967c). Coll. 1966 by C. V. Haynes and J. M. and Elizabeth Goodliffe; subm. 1966 by J. L. Lorenzo, dir. INAH.

A-790A. Charred log, Layer XII — **22,400 ± 2600 / 20,450 B.C.**

A-793. Wood, middle of lower peat layer — **24,500 ± 900 / 22,550 B.C.**

A-794B. Base soluble organic matter extracted from finely divided charcoal in lens between A-790A and A-793 — **24,200 ± 400 / 22,250 B.C.**

Comment: purified charcoal (A-794A) from A-794B yielded insufficient CO_2 for analysis.

Snaketown series, Arizona

Wood charcoal and charred corn from a Hohokam village site (33° 11′ 12″ N Lat, 111° 55′ 18″ W Long) in Pinal Co. Coll. 1964 and 1965; subm. by E. W. Haury. See Gladwin *et al.* (1937) and Haury (1966). Final report on Snaketown is currently in preparation which will include a discussion by Haynes and Long of the radiocarbon dating.

A-598. No. 4 — **220 ± 110 / A.D. 1730**

Charcoal from 10D: Crematorium 1, Sacaton phase.

A-603. No. 9 — **1010 ± 100 / A.D. 940**

Charcoal from 10F: House 1, Sacaton phase.

A-604. No. 10 — **1050 ± 100 / A.D. 900**

Charcoal from 10F: House 1, Sacaton phase.

A-817. No. 69 — **1310 ± 180 / A.D. 640**

Charcoal from Hearth under crematory floor Mound 38, Gila Butte phase. *Comment*: A-817 and A-601 (this list) agree with SI-190 (R., 1967, v. 9, p 375).

A-601. No. 7 — **1370 ± 130 / A.D. 580**

Charcoal from 9E: Pit 6, fill, Gila Butte phase.

A-741-1. No. 46 — **1430 ± 110 / A.D. 520**

Charcoal from 11F: Pit 33, Level 3, Gila Butte-Snaketown Transition phase.

A-731. No. 25 — **1240 ± 160 / A.D. 710**

Charcoal from 11F: Md. 40, Tier 1, Level 6, Snaketown phase.

1340 ± 100

A-734. No. 31A **A.D. 610**

Charcoal from 15E: House 1, Snaketown phase.

1050 ± 100

A-596. No. 2 **A.D. 900**

Charcoal from 10D: Strat. Test 1, Level 4, Sweetwater-Snaketown Transition phase. *Comment*: agrees with SI-187 (R., 1967, v. 9, p. 375).

920 ± 120

A-599. No. 5A **A.D. 1030**

Burnt corn from 9E: House 2, Sweetwater phase. *Comment*: agrees with SI-188 (R., 1967, v. 9, p. 375), but not with GX-328, 1580 ± 105 (unpub.) or WSU-418, 2990 ± 210 (unpub.). A reasonable correction of +250 yr on this corn (R., 1969, v. 11, p. 391-393) brings A-599 and SI-188 into agreement with SI-189 (R., 1967, v. 9, p. 375).

1350 ± 80

A-786. No. 61 **A.D. 600**

Charcoal from 5G: House 12, Sub-floor pit, Estrella phase.

1510 ± 90

A-742. No. 57 **A.D. 440**

Charcoal from 10G: Test 4, Level 6, Estrella phase.

1540 ± 90

A-814. No. 65 **A.D. 410**

Charcoal from 11F: Pit 42, Test 3, Levels 7, 8; Estrella phase.

1640 ± 250

A-743. No. 58 **A.D. 310**

Charcoal from 10G: Test 4, Level 6, Estrella phase.

1810 ± 300

A-771. No. 59 **A.D. 140**

Charcoal from 11F: House 12, Sub-floor pit, Vahki-Estrella Transition phase.

1150 ± 120

A-815. No. 66 **A.D. 800**

Charcoal from 6G: House 2, Sub-floor test, Levels 3, 4; Vahki(?) phase.

1240 ± 110

A-735. No. 41 **A.D. 710**

Charcoal from 11F: Md. 40 Tier 12, Level 9, Early Pioneer phase.

900 ± 120

A-788. No. 63 **A.D. 1050**

Burnt corn from 7H: House 1, Vahki (?) phase. *Comment*: an estimated isotopic fraction correction would increase age by 250 yr (R., 1969, v. 11, p. 391-393).

A-689. No. 16 **1030 ± 120**
A.D. 920

Charcoal from 8E: Crematorium 1, Vahki (?) phase.

A-818. No. 72 **1400 ± 120**
A.D. 550

Charcoal from 11F, Pit 42, Test 2, Level 8, Vahki phase.

A-1072. No. 17 **1540 ± 70**
A.D. 410
$\delta C^{13} = -24.73‰$

Charcoal from 8E: Crematorium 1, Early Pioneer phase.

A-816. No. 68 **1710 ± 110**
A.D. 240

Charcoal from 6G: House 2, Sub-floor test, Levels 5, 6; Vahki phase.

A-873. No. 52 **1890 ± 220**
A.D. 60

Charcoal from 11I: Roasting Pit 1. *Comment* on Vahki phase samples: GX-329, 2375 ± 110 (unpub.) does not agree with Arizona data.

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