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ARIZONA RADIOCARBON DATES III*

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Radiocarbon-age measurements reported here were made by the carbon dioxide gas-proportional counting method since conversion of the laboratory from the solid-carbon method. Assembly of the shield and construction of the glass system was accomplished during the summer of 1959. By January 1960, shield, anticoincidence ring, counters and electronics were set up and in operation. The first year of operation was occupied with calibration, comparison of dating with other C^{14} laboratories, and the repeating of many of the analyses previously made by the solid-carbon method. Special attention was given to dates open to question from an archaeologic point of view.

The converted C^{14} dating system is patterned after the laboratory at Lamont Geological Observatory (Broecker, 1957).

The three gas-proportional counters used have capacities of 5, 2, and 0.5 L. They are constructed of Chilean electrolytic copper with one mil tungsten center wires. The shield consists of an 8-in. thickness of black iron enclosing a 1-in. paraffin layer. A .125-in. layer of borax is placed on the counter

TABLE 1

Parameters and Performance for the University of Arizona Proportional Counters

Parameters:	5-liter counter	2-liter counter	½-liter counter	
ID of counter (in.)	5.0625	3.0625	2.0625	
Length of center wire (in.)	15.186	16.132	9.125	
Diam of center wire (mils)	1.0	1.0	1.0	
Active volume (L)	5.00	1.84	0.498	
Equivalent grams of carbon	2.27	0.84	0.22 (at 700 mm. Hg)	
Cathode area (in.^{2})	242	157	59	
Performance Characteristics:				
Filling pressure (mm. Hg)	700	700	700	1400
Operating voltage (v)	4000	3800	3600	4900
Background count (counts/min) = B	11.5	19.0	2.5	2.8
Net modern sample count rate (counts/min) = S	30.7	10.4	3.2	6.3
Figure of merit = S^2/B	82	5.7	4.2	14
Carbon dioxide plateau length (v)	600	500	700	500
slope (per 100 v)	2.5%	1%	<0.5%	0.6%
Efficiency (% of 15.3 d.p.m./gm.)	89%	81%	91%	91%
Specific background (counts/min cm^2 of counter wall)	0.0074	0.0188	0.0066	0.0074
Max measurable age (yr) (48 hr counting intervals for sample and background, background + 2 sigma)	43,000	32,000	25,000	35,000
Background ÷ meson slope (counts/min per meson count)	0.05			

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side of the paraffin layer. The shield completely surrounds the counting system and is located in the basement of a three-story building. Pertinent parameters for the counters are given in table 1.

Performance characteristics are also given in table 1. A consistent, linear background vs. meson relationship was found only for the 5-L. counter. Background was determined using gas from the combustion of anthracite coal and checked against gas obtained by the hydrolysis of Miocene limestone. Results of both methods are identical within the statistical uncertainty. Our modern wood standards, provided by Dr. Bryant Bannister of the Laboratory of Tree Ring Research, consisted of 20 rings from a piñon tree, averaging to the yr 1844. Using 95% of the NBS oxalic acid as the modern standard (as we have in all the dates listed below), our piñon dates at A.D. 1832 $\pm$ 100.

All organic samples were treated with hot 2% NaOH, when possible to do so without dissolving the sample itself, and with HCl to remove carbonate. In those cases where the carbonate fraction was dated, CO_2 was evolved by hydrolysis with 50% H_3PO_4. The calcium oxide furnace is the final step in CO_2 purification; hence, although no positive indication of radon contamination has been found in our samples, each was stored for two weeks before counting.

In addition to the random counting error, the standard deviation used for all samples includes $\pm$ 100 yr to allow for the de Vries effect and $\pm$ 80 yr to allow for possible isotopic fractionation. A mass spectrometer for C^{12}/C^{13} analyses has not been available. In those cases where the background count rate is indistinguishable from zero, 2 sigma counts/min is added to the background to set a lower limit for the age of the sample.

Sample descriptions are classified as follows:

I Samples of geologic-palynologic interest.
II Samples of archaeologic interest.
III Archaeologic samples of known age for check purposes.
IV Modern organic material.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A-213. Chuska Mountains, New Mexico **>28,000**

Organic material from 7.25 to 7.35-m level in lake-sediment core taken from Deadman Lake, Chuska Mountains (36° 15′ N Lat, 108° 55′ Long). Coll. 1958 and subm. by H. E. Wright, Jr., Univ. of Minnesota, Minneapolis, Minnesota. *Comment*: pollen at this level, high Artemisia and spruce, probably represents Pleistocene glacio-pluvial phase with subalpine vegetation in the Chuska Mountains (Bent, 1960).

A-231. Tramway Cave, Arizona **12,900 ± 1500**

Impure bat guano from 80-in. level in Tramway Cave, lower Granite Gorge, Grand Canyon of the Colorado River (36° 10′ N Lat, 113° 57′ W Long). Coll. 1958 by P. S. Martin and B. C. Arms; subm. by P. S. Martin, Geochronology Labs., Univ. of Arizona, Tucson, Arizona. *Comment*: impurity is silicic, probably silt and clay. Dilution with dead CO_2 was necessary to fill the counter. Sample was barren of pollen. Bones of the Mexican *Tadarida brasiliensis* were found. B. E. Sabels has made emission spectrographic analyses of trace elements from this site.

Parque Vicente Lachner series, Costa Rica

Peat samples from a bog core at altitude 2400 m in Cordillera de Talamanca (9° 43′ N Lat, 83° 56′ W Long). Coll. 1959 by P. S. Martin and J. Valerio; subm. by P. S. Martin. Pollen analyses by P. S. Martin.

A-234. 2.50-2.75 m **8080 ± 170**

Pollen in top 2.75 m is predominantly oak, reflecting a warm or post-glacial climate.

A-235. 3.75-4.25 m **20,750 ± 540**

Pollen was dominated by grasses and Umbelliferae when apparently colder conditions prevailed.

A-236. 5.50-5.75 m **>36,000**

The 5.5- to 7.0-m zone also showed a dominance of oak; below 7 m, colder flora again indicated.

II. ARCHAEOLOGIC SAMPLES

Point of Pines series, Arizona

Wood, charcoal and finely divided organic matter from an alluvial site on the San Carlos Indian Reservation (33° 22′ 30″ N Lat, 110° 45′ W Long), Graham Co. Coll. and subm. by E. W. Haury, Director, Arizona State Mus., during two field seasons at the Univ. of Arizona Archaeol. Field School camp (Haury, 1957).

A-28. Pit 3, Bed C-2 **1900 ± 160**

Finely divided organic matter associated with cremations in Pit 3, Bed

C-2. Coll. 1955. Sample is a recombustion of the solid carbon previously dated 2515 ± 300 (Wise and Shutler, 1958, p. 73).

A-20, A-23. Pit 3, Bed C-2 **2100 ± 150**

Two samples of charcoal were combined to obtain sufficient carbon for analysis. Coll. 1955. *Comment*: other dates from this bed are A-28: 1900 ± 160 (this paper) and M-462: 1140 ± 300 (Haury, 1957). M-462 was a small sample, less reliable than the other Michigan dates. On physical evidence and local archaeological pattern, Haury judges Layer C to be of pre-pottery age, hence before A.D. 1.

A-50 bis. Pit 8, Bed C-3 **2730 ± 150**

Wet, charred wood. Coll. 1956. *Comment*: Pit 8 is intrusive into the lower Bed C-3 and hence older than Pit 3. Sample is a recombustion of the solid carbon previously dated 3250 ± 200 (A-50), and 3025 ± 200 (A-52, a recount of A-50) (Wise and Shutler, 1958, p. 73).

A-51 bis. Bed C-3 **3190 ± 160**

Wood, rotten and wet, from Bed C-3, the deposit into which Pit 8 was cut. Coll. 1956. A recombustion of the solid carbon previously dated 3380 ± 200 (Wise and Shutler, 1958, p. 73). Other Arizona solid-carbon dates for this bed, previously published (Wise and Shutler, idem), are: A-48, 2150 ± 200; A-49, 2610 ± 200; and A-53, a recount of A-49, 2080 ± 200.

A-26 bis. Bed C-3 **2490 ± 170**

A-26B. Bed C-3 **2900 ± 150**

Organic material directly above bones in Cremation 36, Bed C-3. Coll. 1955. *Comment*: Cremation 36 is intrusive into Bed D, but is considered belonging to Bed C-3 time. A-26B was treated from original sample material, and as it contained considerable rootlets which were carefully picked out, the age may still be slightly young. Sample previously dated (solid carbon) 3280 ± 200 (A-26) (Wise and Shutler, 1958, p. 73). However, the solid carbon from A-26 bis was reconverted to CO_2 (A-26) and determined in our counters as reported above.

A-27 bis. Pit 6, Bed D **3190 ± 150**

Charred, water logged pine branch. Coll. 1955. Sample from Pit 6, which is intrusive into Bed D-1 (immediately below C-3) but appears to represent time of pre-C-3 and post-D-1. A recombustion of the solid-carbon sample A-27 dated 3070 ± 150 (Wise and Shutler, 1958, p. 73).

A-25 bis. Pit 1, Bed D-1 **2700 ± 160**

A-25B. Pit 1, Bed D-1 **2440 ± 160**

Wood from Pit 1, Layer D-1. Coll. 1955. Wood was red and appeared to have been partly replaced by silica and limonite. A-25 bis is a recombustion of solid carbon. A-25B is the original sample prepared by us. *Comment*: A-25 bis and A-25B are statistically in agreement with each other, and both are in

agreement with the Michigan date on the same sample, 2600 ± 250 (M-461; Haury, 1957, p. 23). On stratigraphic grounds, however, this date cannot be accepted, as the wood lies below Bed C-3 and is older than Pit 6. Perhaps the discrepancy is linked with the intense replacement features on the sample. There are four other dates from the same bed: L-432B, 2200 ± 140 (same as M-540; Broecker, 1959); M-541, 2530 ± 250; M-540, 2400 ± 200 (Haury, 1957, p. 23); and A-29 bis, 2430 ± 150 (this paper). Although it is difficult to imagine contamination causing fortuitous agreement of all the D-1 layer dates, it is even more difficult to reconcile young ages with the cultural assemblage in D-1 and the older dates above it.

A-29 bis. Bed D-1 **2430 ± 150**

Scattered charcoal fragments in D-1 layer composed of moist, dark gray clay. Coll. 1955. *Comment*: a recombustion of the solid-carbon sample earlier dated 4400 ± 150 (A-29; Wise and Shutler, 1958, p. 73). Neither date can be accepted as the age of the D-1 layer, for reasons mentioned above (A-25 bis). The differences are also consistent in comparing A-19, 4310 ± 160 (Wise and Shutler, 1958, p. 73) with M-541, 2530 ± 250 which is the sample run by both laboratories (Haury, 1957, p. 23). Another Arizona solid-carbon date, also questionable, is that of A-21 and A-22 (combined): 3980 ± 160 (Wise and Shutler, 1958, p. 73). In light of the above, it can be said only that the D-1 layer must be older than 3200 yr.

Lehner Ranch series, Arizona

Lehner mammoth site (31° 25′ 23″ N Lat, 110° 06′ 48″ W Long), Cochise County, Arizona. ARIZ:EE:12:1. Lehner site is an elephant-kill site in which Clovis fluted points were found in association with charcoal from fires, bones of nine immature mammoths, and remains of horse, bison and tapir. For description of site and fossils, see Haury *et al.*, 1959. Coll. 1956 by W. W. Wasley; subm. by E. W. Haury.

A-33 bis. Layer K, above bone bed **10,410 ± 190**

Carbonaceous material from black swamp soil above hearths, bone bed and artifacts. *Comment*: solid-carbon date for this sample is 7133 ± 350 (Wise and Shutler, 1958, p. 73). The present sample is from CO_2 converted from the solid carbon.

A-42. Bone layer **11,240 ± 190**

Charcoal from hearth in sand layer, bone bed. Date was obtained from the original sample. Other dates on this stratum are: 11,180 ± 140 (K-554, dated by Copenhagen Lab.; Haury *et al*, 1959, p. 24) and 11,290 ± 500 (M-811; Michigan IV, 1959). *Comment*: earlier Arizona dates on this site, from solid carbon, are: A-30, 8330 ± 450; A-31, 6877 ± 450 and recounted, 6356 ± 450; A-32, 7022 ± 450; A-34, 7205 ± 450; and A-40A, 12,000 ± 450, rerun as A-40B, 10,900 ± 450 (Wise and Shutler, 1958). In light of the more recent CO_2 determinations, A-40 can be accepted but the younger dates from the Lehner site must be rejected.

Double Adobe Site series, Arizona

ARIZ:FF:10:1, 2.1 km N of Double Adobe, Cochise County, Arizona (31° 29′ N Lat, 109° 43′ W Long). A Cochise culture site. For pollen analysis see Martin *et al.* (1961).

A-192A. Carbonate fraction **7560 ± 260**

A-192B. Total soil organic fraction **4960 ± 300**

Soil sample is blue clay 250-260 cm below surface from face of arroyo cut. Coll. 1958 by P. S. Martin and B. C. Arms; subm. by P. S. Martin. *Comment*: the carbonate date may be greater than the time of sedimentation due to formation from carbon with less than modern activity, or younger due to postdepositional cementation. The soil organic age must represent a minimum age because of possible contamination after sedimentation. The pollen at this stratum, according to Martin, indicates a maximum of moisture-dependent plants; but according to Sayles and Antevs (1941), the Chiricahua stage is of altithermal (warm, dry) age.

A-184C. Charcoal **8240 ± 960**

A-184E. Earth **7030 ± 260**

A-184C is pure charcoal hand picked from sand. A-184E is the soil fraction with organic content minus the hand-picked charcoal. Sample was taken from 320 cm below surface, S bank of Whitewater Draw. Coll. 1958 by P. S. Martin and J. Schoenwetter; subm. by P. S. Martin. Site is of Cazador type. *Comment*: on pollen evidence Martin correlates sample with his Zone VI and on the basis of archaeologic context and older Univ. of Chicago dates, places the age between 8000 and 9000 yr. A Univ. of Chicago date from approximately the same horizon (C-216, W. F. Libby, 1955) is 7756 ± 370. The charcoal date is considered closer to the true age, as the total soil organic sample is possibly contaminated with post-charcoal humus.

A-188C. Charcoal **8270 ± 250**

A-188E. Earth **8260 ± 160**

A-188C is pure charcoal hand picked from soil matrix. A-188E is the total soil with visible but minute specks of charcoal. The sample represents the 0 to 10 cm level below the bench surface. Coll. 1959 and subm. by P. S. Martin. *Comment*: as does A-184, this sample should also date Martin's Zone VI, which shows generally high Compositae and low chenopod-amaranth pollen. Due to the agreement of these two fractions, and in light of the agreement with A-184C, these three dates are believed to represent the time of Pollen Zone VI.

A-67 bis. Charred wood **9350 ± 160**

Sample is from Trench no. 2, E end, in river sand, associated with artifacts of the Sulphur Spring stage, the earliest stage of the Cochise Culture. Coll. 1957 and subm. by E. B. Sayles, Arizona State Mus., Tucson. *Comment*: sample is a recombustion of a solid-carbon sample dated 8200 ± 260 (Wise and Shutler, 1958).

A-68 bis. Hereford, Arizona **1800 ± 140**

Charcoal from ARIZ:EE:12:2 Cochise County (31° 20′ N Lat, 110° 10′ W Long), ca. ¼ mi S of Hereford, Fort Huachuca Road. Coll. by E. B. Sayles and E. Antevs; subm. by E. B. Sayles, Arizona State Mus., Tucson. Sample is from erosion channel of San Pedro River, associated with artifacts tentatively identified with Chiricahua stage of Cochise culture. *Comment*: solid-carbon date is 2850 ± 200 (Wise and Shutler, 1958, p. 73). Both numbers are younger than what is generally considered Chiricahua culture time, particularly the CO_2 date, which is probably closer to the correct number. It is possible that rootlets or other modern contamination may have brought the number toward the present.

A-69 bis. Murray Springs, Arizona **8270 ± 260**

Carbonaceous earth from ARIZ:EE:8:13 Cochise County (31° 30′ N Lat, 110° 10′ W Long), ca. one mi W of Lewis Spring on San Pedro River. Coll. 1956 and subm. by E. B. Sayles. Sample coll. ca. 500 ft NE of old ranch house at the forks of drainage, ca. 3 ft below the surface. The carbonaceous earth is overlain by fine silt in which Cochise-type artifacts occur and is above clay containing elephant bones. *Comment*: solid-carbon date on this material is 8250 ± 200 (Wise and Shutler, 1958).

A-70 bis. San Simon, Arizona **6920 ± 160**

Carbonaceous material coll. San Simon Creek (32° 20′ N Lat, 109° 10′ W Long), ca. ¼ mi N of Railroad Bridge E of San Simon in erosion channel. Coll. 1956 by E. B. Sayles and E. Antevs; subm. by E. B. Sayles. *Comment*: solid-carbon age is 7000 ± 265 (Wise and Shutler, 1958), in good agreement with the present number. Probably of Chiricahua stage.

Matty Canyon series, Arizona

Decayed plant material from two Cienega strata in wall of Matty Canyon Creek (31° 51′ N Lat, 110° 35′ W Long), Sec. 17, T 19 S, R 17 E, Pima County, Arizona. Coll. 1957 and subm. by D. Shutler, Jr., Univ. of Arizona and F. W. Eddy, Ariz. State Mus., Tucson. Samples were taken 60 ft NW of MC-5 (Unit 3) (Eddy, 1958).

A-88 bis. Upper stratum **2010 ± 150**

Sample no. 6. *Comment*: this is a recumbustion of the solid-carbon sample. Arizona solid-carbon date is 2860 ± 210. Another date is 1850 ± 70 (Shell Laboratory No. 5664-7, private communication).

A-92. Lower stratum **2220 ± 150**

Sample no. 8. *Comment*: burned from original sample. The volatile and nonvolatile fractions were coll. separately and gave identical results. Another date from this same stratum: 2470 ± 100 (Shell Laboratory No. 5665-10, private communication).

Topanga Canyon series, California

Charcoal specimens from Topanga Canyon site (34° 5′ 40″ Lat, 118° 35′ 20″ W Long), $4LAn_2$ fire pits. Coll. 1957 and subm. by K. L. Johnson, Dept.

of Anthropol. and Soc., UCLA. This site is believed to represent a very early tool assemblage in southern California. No stratigraphy was noted; midden is homogeneous throughout and averaged 25 in. from ground surface to sterile sandstone base (Treganza and Bierman, 1958).

A-94. 14 to 30 in. depth **2450 ± 150**

Sample is composite from Feature 1, Fire Pits K3 and L3; Feature 5, Fire Pit K5; and Feature 3, Pit K4. *Comment*: a solid-carbon date was obtained on this sample (A-94) in 1958 of 2500 yr (unpub.). Our more recent 2450 ± 150 (above) was on CO_2 reconverted from the solid carbon of 1958.

A-197. 15 to 24 in. depth **2700 ± 150**

Sample from Feature 3, Fire Pit K4.

A-193. Whitewater Draw, Arizona **3860 ± 200**

Soil from pithouse of San Pedro stage on W bank of Whitewater Draw, 2.8 mi NW of McNeal generating plant (31° 32′ N Lat, 104° 43′ W Long). Sample taken 105 cm below surface, on floor of pithouse. Coll. 1958 by P. S. Martin and B. C. Arms; subm. by P. S. Martin. *Comment*: sample should date both the age of the San Pedro pithouse and the younger high-composite pollen zone, Martin's Zone II (Martin, *et al.*, 1961). This date should be minimal for time of sedimentation, and its does not seem likely that it could be as young as the generally accepted San Pedro age, i.e., ca. 2000 to 3000 yr.

A-203. Ventana Cave, Arizona **11,300 ± 1200**

A-203C. Carbonate Fraction **31.7% Modern**

Small amount of charcoal in Bed 5-B (lower member of volcanic debris layer (32° 20′ N Lat, 112° 14′ W Long). The charcoal was hand picked from the matrix, which was a pond deposit. Coll. 1960 by J. D. Hayden; subm. by J. D. Hayden and E. W. Haury. *Comment*: other dating of Bed 5 has been by inference only, through association with extinct fauna found in this bed. The 11,300 yr date is believed to be near the true age as it is consistent with association of extinct fauna, including bison, horse, tapir and four-pronged antelope, described by E. H. Colbert (Haury, 1950, p. 126-147). Dilution with dead CO_2 was necessary to fill the counter. The carbonate cementation in this pond deposit appears to be post-charcoal; a sample (A-203C) of the carbonate gave 31.7% of the C^{14} content of modern wood.

A-203. Charcoal **11,300 ± 1200**

A-203C. Carbonate fraction **00,000 ± 000**

McEuen Cave series, Arizona

McEuen Cave, ARIZ:W:13:6 (33° 09′ N Lat, 110° 58′ W Long), ca. 12 mi NNE of Geronimo, Arizona. Coll. 1934 by Byron Cummings; subm. by E. W. Haury. *Comment*: McEuen Cave has produced a wealth of material, much of which resembles Basketmaker and some of which is probably late. Much of the material is unique.

A-247. Cloth woven from yucca **2500 ± 160**

Material well preserved, dyes still on cloth.

A-257. Wood **2200 ± 145**

Yucca or agave stalk and one piece of wood which are cradle fragments. These are presumed to be about the same age as A-247, but could be slightly younger.

A-258. Yucca cord **2200 ± 145**

Specimen associated with the same burial that produced A-247, and judged to be about the same age.

A-226. Casas Grandes Site, Chihuahua, Mexico **750 ± 160**

Wood from main rim of upright viga, Room 21c-8 N (30° 30′ N Lat, 107° 45′ W Long), CHIH: 9:1—Amerind Foundation Survey System, Specimen no. CG (D)-118. Coll. 1959 by C. C. DiPeso, Director, Amerind Foundation, Inc., Dragoon, Arizona; subm. by Bryant Bannister, Lab. of Tree Ring Research, Univ. of Arizona, Tucson. *Comment*: sample is cut from wood beam section which has been cross-dated into Casas Grandes "floating" tree-ring chronology.

A-243. Los Molinos Lake, Argentina **903 ± 150**

Charcoal from refuse heap at Desembocadura Rio San Pedro site, Lago del Dique Rio Los Molinos (64.5° S Lat, 32.2° W Long). Pcia. de Cordoba, Rep. Argentina. Sample 101-B3, depth 20-40 cm. Coll. 1960 by E. Berbarian and J. A. Perez; subm. by A. R. Gonzalez, Director, Inst. of Anthropol., Univ. of Córdoba, Argentina. *Comment*: the associated material belongs to the protohistoric Comechingon-Sanaviron culture of Sierras Centrales. This is the first date of the ceramic culture of the Sierras.

Puna de Jujuy series, Argentina

Pozuelo site (64.9° S Lat, 22.4° W Long), Puna de Jujuy, Jujuy Province, Argentina. Coll. 1960 and subm. by A. R. Gonzalez. *Comment*: the associated archaeological material belongs to a recently discovered phase of the Puna culture, the Pozuelo Phase. Both samples are from a humus and refuse layer, Mound no. 1, Stratigraphic Test no. 1.

A-244. Charcoal from 100-150 cm depth **810 ± 150**

A-245. Charcoal and charred bone from 60-100 cm depth **820 ± 150**

A-246. Sümeg, Hungary **4520 ± 160**

Charcoal from alluvial sediment of a prehistoric flint mine cut into a marl-like limestone (47° N Lat, 17° 15′ E Long). Depth 2-3 m below the recent surface. The sediment containing the charcoal is an early postglacial soil. Coll. 1960 by L. Vértes, Hungarian Natl. Mus., Hist. Mus., Budapest; subm. by Dr. Marija Gimbutas, Peabody Mus. of Archaeol. and Ethnol., Harvard Univ. *Comment*: date establishes Central Europe's richest flint mine as belong-

ing to the Neolithic Period. Details will be published by Dr. Vértes in the Acta Archaeoligica Hungaricae.

III. CHECK SAMPLES

A-66 bis. Marseille, France **2160 ± 150**

Cedar wood from the ship of Maarko Sestios. Subm. 1955 by F. L. Lallemand, Office Français de Recherches sous Marines, Marseille (43° 15′ N Lat, 5° 20′ E Long). It is thought that the ship sank off the island of Grand Conglone, near Marseille, about the middle of the second century B.C. *Comment*: the solid-carbon date (A-66) was 2295 ± 110, well within standard deviation of the CO_2 date and both near the expected age.

A-81 bis. Groningen, Netherlands **1080 ± 140**

Wood from St. Walburg church in Groningen (53° 12′ N Lat, 6° 36′ E Long), Netherlands. This sample has been used as a standard for interlaboratory comparison. Subm. by Hl. de Vries, Univ. of Groningen, Netherlands. *Comment*: the solid-carbon date was 900 ± 160 (Shutler and Damon, 1959, p. 62). Groningen dates this at 1125 (de Vries, 1954), an average of nine measurements. Uppsala dates this at 1095 ± 70 (Olsson, 1959, p. 100). The Lamont date on this is 1250 ± 150 (L-292, Olson and Broecker, 1959). Others are T-29, 1050 ± 100 (Nydal and Sigmond, 1957) and H-8-7, 1245 ± 130 (Münnich, 1957).

A-207. Kumma Site, Sudan **3160 ± 160**

Wood taken from timber near base of E wall of Kumma (21° 30′ N Lat, 30° 58′ E Long), an Egyptian middle-kingdom fortress on the Nile constructed during the 12th dynasty. Coll. 1960 and subm. by W. Y. Adams, P. O. Box 131, Wadi Halfa, Sudan. *Comment*: there are hieroglyphic texts to associate the building of this fortress with the Pharaoh Sesostris (= Senusret) III. His reign, determined astronomically, began 1887 B.C. and ended at 1849 B.C. This sample was taken from a location near the base of the E wall of the fortress. Although the C^{14} age fell well below the Egyptological age of 3809 B.P. to 3847 B.P., the discrepancy is in the same direction and of about the same order as other C^{14} dates from similar sites.

A-219. Zoser's Tomb, Sakkara, Egypt **4240 ± 150**

Acacia wood, Zoser's Tomb, Sakkara, Egypt (29° 50′ N Lat, 31° 8′ E Long). Coll. 1931 by Prentice Duell; subm. by Bryant Bannister. *Comment*: from 3rd dynasty of Egypt, 3000-2800 B.C. Previously dated by J. R. Arnold and W. F. Libby (1951) at 3979 ± 350 yr by solid-carbon method. See A-207 above.

A-220. El Borshen Tomb, Egypt **3840 ± 150**

Wood from large plank taken from El Borsheh Tomb (27° 45′ N Lat, 30° 53′ E Long), 12th dynasty. Coll. 1932 by E. W. Haury; subm. by Bryant Bannister. *Comment*: from 12th dynasty of Egypt, 2000 B.C. Relationship of the wood sample to the growth pattern of the tree is not definitely known. Curvature of rings indicates that the wood is not early growth.

IV. MODERN ORGANIC SAMPLES

A-241. Tucson, Arizona — Modern

Wood (root) collected at 175ft depth from American Smelting and Refining Co. Mission Unit open pit mine (31° 56′ N Lat, 111° 04′ W Long). Coll. 1960 by W. S. Phillips; subm. by F. H. Tschirley, U. S. Dept. of Agric., Tucson. Determination was made to establish if root found at this depth was modern. *Comment*: this is believed to be the deepest known penetration of a living root.

REFERENCES

Date lists:

Arizona II	Shutler and Damon, 1959
Lamont V	Olson and Broecker, 1959
Michigan IV	Crane and Griffin
Uppsala I	Olsson, 1959

Arnold, J. R., and Libby, W. F., 1951, Radiocarbon dates: Science, v. 113, p. 111-120.

Bent, A. M., 1960, Pollen analysis from Deadman Lake, Chuska Mtns., New Mexico: M. S. thesis, Minnesota Univ.

Crane, H. R., and Griffin, J. B., 1959, University of Michigan radiocarbon dates IV: Am. Jour. Sci. Radioc. Supp., v. 1, p. 173-198.

Eddy, F. W., 1958, A sequence of cultural and alluvial deposits in the Cienega Creek Basin, southeastern Arizona: M. S. thesis, Arizona Univ.

Haury, E. W., 1950, Stratigraphy and archaeology of Ventana Cave: Albuquerque, New Mexico Univ. Press; Tucson, Arizona Univ. Press.

———— 1957, An alluvial site on the San Carlos Indian Reservation, Arizona: Amer. Antiquity, v. 23, p. 2-27.

———— 1958, Two fossil elephant kill sites in the American Southwest: Arizona Univ. Program in Geochronology, Contr. 4, Internat. Cong. Americanists, 32nd, Copenhagen 1956, Proc., p. 433-440.

Haury, E. W., Sayles, E. B., Wasley, W. W., Antevs, E., and Lance, J. F., 1959, The Lehner mammoth site: Am. Antiquity, v. 25, p. 1-42.

Libby, W. F., 1955, Radiocarbon dating 2d ed.: Chicago, Univ. Chicago Press, ix, 175 p.

Martin, P. S., Schoenwetter, J., and Arms, B. C., 1961, Southwestern palynology and prehistory—the last 10,000 years: Arizona Univ. Contr. 50, Program in Geochronology.

Münnich, K. O., 1957, Heidelberg natural radiocarbon measurements I: Science, v. 126, p. 194-199.

Nydal, R., and Sigmond, R. S., 1957, Radiocarbon dating in Trondheim: Appl. Sci. Research, sec. B, v. 6, p. 393-400.

Olson, E. A., and Broecker, W. S., 1959, Lamont natural radiocarbon measurements V: Am. Jour. Sci. Radioc. Supp., v. 1, p. 1-28.

Olsson, Ingrid, 1959, Uppsala natural radiocarbon measurements I: Am. Jour. Sci. Radioc. Supp., v. 1, p. 87-102.

Sayles, E. B., and Antevs, Ernst, 1941, The Cochise culture: Lancaster, Pa., Lancaster Press, Inc., 81 p.

Shutler, Dick, Jr., and Damon, P. E., 1959, University of Arizona radiocarbon dates II: Am. Jour. Sci. Radioc. Supp., v. 1, p. 59-62.

Treganza, A. E., and Bierman, A., 1958, The Topanga culture: Final report on excavations, 1948: California Univ. Anthropol. Rec. 20:2.

Vries, Hl. de, and Barendsen, G. W., 1954, Measurements of age by the carbon-14 technique: Nature, v. 174, p. 1138-1141.

Wise, E. N., and Shutler, Dick, Jr., 1958, University of Arizona radiocarbon dates: Science, v. 127, p. 72-74.

Wright, H. E., Jr., 1956, Origin of the Chuska sandstone, Arizona-New Mexico: A structural and petrographic study of a Tertiary eolian sediment: Geol. Soc. America Bull., v. 67, p. 413-434.