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U. S. GEOLOGICAL SURVEY RADIOCARBON DATES X*

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This list contains the results of measurements made during 1967 and 1968. Samples are counted in the form of acetylene gas, as previously, and ages computed on the basis of the Libby half-life, 5568 ± 30 yr. The error listed, which is always larger than the one-sigma statistical counting error commonly used, takes into account known uncertainty laboratory factors, but does not include external (field or atmospheric) variations.

Unless otherwise stated, collectors of all samples are members of the U. S. Geological Survey. The authors are indebted to Morris Drucker, who assisted in the preparation of the samples in the summer of 1967.

SAMPLE DESCRIPTIONS

A. Eastern U. S.

W-1946. Ogden Landing, Kentucky **6370 ± 250 4420 B.C.**

Carbonized wood from 400 ft S of left bank of Ohio R. at Ogden Landing (37° 12′ 55″ N Lat, 88° 56′ 16″ W Long), Bandana quad, NE Ballard Co., Kentucky; alt 300 ft. Tree trunk buried beneath 20-ft alluvial silt, sand, and clay deposited by Ohio R. Coll. 1965 and subm. by W. W. Olive. *Comment* (W.W.O.): present course of river established subsequent to drainage of Lake Paducah (Finch *et al*, 1964; Olive, 1966). Date of 21,080 ± 400 (W-1353, Radiocarbon, 1965, v. 7, p. 375) indicated for Lake Paducah sediments. Thus, Ohio R. established present course between 21,080 ± 400 and 6370 ± 250 yr ago.

W-1992. Marshall County, Kentucky **6930 ± 300 4980 B.C.**

Wood from alluvium underlying 13 ft of sandy silt, sand, and gravel in undercut bank of W Fork of Clarks R., 1.08 mi S of Hale Springs (36° 45′ N Lat, 88° 22′ 30″ W Long), Oak Level quad, Marshall Co., Kentucky. Coll. 1966 and subm. by W. W. Olive. *Comment* (W.W.O.): alluvium probably accumulated in W Fork of Clarks R., affluent of Lake Paducah (21,080 ± 400 yr, W-1353, Radiocarbon, 1965, v. 7, p. 375), shortly before or after lake was drained by major change (6370 ± 200 yr ago, W-1946, this date list) in course of Ohio R. Date suggests drainage occurred between 6930 ± 300 and 6370 ± 200 yr ago.

Calloway County series, Kentucky

Wood and peat beneath 10.5 ft gravel overlain by 1.5 ft sandy silt exposed at stream level in small, narrow, deeply incised valley 1.95 mi SE of Elm Grove Church (36° 37′ 30″ N Lat, 88° 07′ 30″ W Long), Hico quad, Calloway Co., Kentucky; alt 460 ft. Gravel is reworked higher

* Publication authorized by the Director, U.S. Geological Survey.

and older Lafayette Formation of former usage. Coll. 1966 and subm. by W. W. Olive. *Comment* (W.W.O.): amount of erosion and alluviation, assuming carbonaceous material and gravel deposited at approx. same time, within time interval indicated (between ca. 15,000 yr ago and present) supports concept that more than 1 of 4 surfaces of erosion in Jackson Purchase Region developed during Pleistocene.

W-2039. **13,280 ± 1200**
11,330 B.C.
Wood.

W-2040. **15,840 ± 700**
13,890 B.C.
Peat.

W-1789. Betterton, Maryland **1435 ± 250**
A.D. 515

Peat, commercial quality, in Big Marsh in NW corner of Betterton quadrangle (39° 21′ 37″ N Lat, 76° 06′ 20″ W Long), Maryland. From base of 12-ft peat deposit which overlies Pleistocene compact, silty, clayey, gray sand. Coll. 1965 and subm. by J. P. Minard. *Comment* (J.P.M.): bog surface slightly above tide level; sample from several feet below mean low water level. Date indicates time when sea level rose to present level and stabilized.

Boston Common series, Massachusetts

Peat and gyttja from SE corner of excavation site for underground Boston Common Garage, Boston (42° 22′ N Lat, 71° 04′ W Long), Massachusetts. Coll. 1960 and subm. by C. A. Kaye.

W-1801. **12,275 ± 350**
10,325 B.C.

Rootlets and peaty lumps from upper 3 ft of marine clay deposit and from base of overlying till over 30 ft thick in some places. *Comment* (C.A.K.): should be maximum date for ice advance responsible for till. Date agrees with that for W-991 (Radiocarbon, 1964, v. 6, p. 41, wood from same horizon).

W-1802. **11,600 ± 300**
9650 B.C.

Clay gyttja from basal ¼ in. of peat filling small kettle in till. Upper part of deposit is fibrous peat as opposed to lower, well-stratified, very clayey gyttja. *Comment* (C.A.K.): this kettle deposit lies in same till as W-1801 (see above) which was taken from base. Younger age of W-1802 confirms stratigraphic relationships within till and tends to eliminate possibility of solifluction deposit.

B. Central U. S.

W-2009. Lake Bloomington Spillway, Illinois **>40,000**

Wood chips sieved from sand lens in lowermost of 5 exposed distinct tills in Lake Bloomington Spillway, NW ¼ SW¼ NE¼ sec. 1,

T 25 N, R 2 E (40° 39.8′ N Lat, 88° 56.1′ W Long), McLean Co., Illinois. Coll. 1966 and subm. by J. P. Kempton, Illinois Geol. Survey, Urbana. *Comment* (J.P.K.): regional data suggests upper 2 tills are Woodfordian with Farmdalian soil profile on lower till; 3 lower tills are Altonian or older and contain peat dated as >34,000 (W-67, Science, 1954, v. 120, p. 470). W-2009 tends to verify >34,000 date and thus supports higher stratigraphic position for Farmdalian than previous interpretations based on wood (W-186, >31,000, Science, 1955, v. 121, p. 483) from basal till. Lowermost till may be Illinoian.

W-1969. Fairview locality, Iowa **>35,000**

Wood logs, branches, and twigs in organic clay ca. ½ mi NE of Fairview, South Dakota, in NE ¼ SW ¼ NW ¼ NE ¼ sec. 14, T 97 N, R 48 W (43° 13′ 30″ N Lat, 96° 31′ 06″ W Long), Sioux Co., Iowa. Wood exhumed during road construction from peaty clay beneath 15 ft of Wisconsinan loess and 50-ft Illinoian till. Coll. 1966 by F. V. Steece and Clarence Vander Laan; subm. by F. V. Steece, South Dakota Geol. Survey, Sci. Center, Univ. South Dakota, Vermillion. *Comment* (F.V.S.): stratigraphic evidence suggests Illinoian age for overlying till (Steece, 1965). Wood must be considerably older than 35,000 yr.

W-1889. Cheboygan County, Michigan **12,570 ± 500**
10,620 B.C.

Bryophyte bed, predominantly *Calliergon turgescens* (Th. Jens.) Kindbg. and *Drepanocladus intermedius* (Lindb.) Warnst., from Munro Twp., center sec. 4, T 37 N, R 3 W, (45° 38′ N Lat, 84° 41′ W Long), Cheboygan Co., Michigan; alt 740 ft. Underlain by glacial outwash; overlain by fine sand and silt, red, clayey till, probably Valders, and sand and gravel assoc. with nearby shoreline of Glacial Lake Algonquin. Coll. 1965 by Robert Zahner; subm. by W. R. Farrand, Univ. of Michigan. *Comment* (W.R.F.): indicates bryophyte probably assoc. with low-water interval of Glacial Lake Arkona just prior to Glacial Lake Whittlesey. Transition to Lake Whittlesey and assoc. Port Huron advance has been dated 12,800 ± 250 (Y-240, Science, 1957, v. 126, p. 912), 12,920 ± 400 (W-430, Science, 1958, v. 127, p. 1477), and 13,600 ± 500 (W-33, Science, 1954, v. 120, p. 469).

W-1973. Kotiranta Lake, Minnesota **16,150 ± 550**
14,200 B.C.

Moss-rich organic silt from Kotiranta Lake, small bog lake, 6 mi W of Cloquet, sec. 23, T 49 N, R 18 W (46° 42′ 32″ N Lat, 92° 35′ W Long), Carlton Co., Minnesota. From base (930 to 935 cm) of lake sediment atop outwash of Nickerson glacial phase of Superior lobe; pollen and seed analysis indicates tundra. Coll. 1966 and subm. by H. E. Wright, Jr., Limnological Research Center, Univ. Minnesota, Minneapolis. *Comment* (H.E.W.): W-1762 (Radiocarbon, 1967, v. 9, p. 508), from slightly higher stratigraphic level, is 13,480 ± 350. However, W-1973 seems too old because Nickerson phase of Superior lobe is correlated on good geo-

morphic evidence with Pine City phase of Grantsburg lobe and Bemis phase of Des Moines lobe which are no more than 14,000 yr old (Wright and Ruhe, 1965).

W-1966. Waubay, South Dakota **>31,000**

Wood cuttings from 155 to 170 ft in test hole at Waubay, SW ¼ SE ¼ SE ¼ NW ¼ sec. 34, T 122 N, R 54 W (45° 20′ 00″ N Lat, 97° 17′ 42″ W Long), Day Co., South Dakota. Wood in sand and gravel lying 60 ft below 95-ft late Wisconsinan drift and 60-ft early Wisconsinan drift. Coll. 1966 by Lloyd Helseth; subm. by F. V. Steece. *Comment* (F.V.S.): supports conclusion that wood enclosing drift is early Wisconsinan or older; compares well with dated wood, >30,000 yr (W-115, Science, 1955, v. 121, p. 484), early Wisconsinan drift in Brookings Co., South Dakota.

C. Western U. S.

W-1890. N Searles Valley, California **13,650 ± 500**
11,700 B.C.

Tufa, probably aragonite, from base of Field Unit B, late Wisconsinan age, in N Searles Valley (35° 50.4′ N Lat, 117° 18.8′ W Long), California. Overlain by 0-to 2-ft white lake silt, 0-to 2-ft sandy alluvium with developed soil, and tufa of Unit C dated as 13,830 ± 500 (W-1893, this date list). Coll. 1966 and subm. by G. I. Smith. *Comment* (G.I.S.): date is 5000 to 8000 yr younger than anticipated; mapped as older than W-1894 (9070 ± 300), W-1905 (19,150 ± 600), and W-14,950 ± 500) (this date list).

W-1893. N Searles Valley, California **13,830 ± 500**
11,880 B.C.

Tufa, probably aragonite, from base of Field Unit C, N Searles Valley (35° 50.4′ N Lat, 117° 18.8′ W Long), California. Nodular tufa overlying 2-ft alluvial (?) unit with soil thought characteristic of period 12,500 to 15,000 yr ago. Coll. 1966 and subm. by G. I. Smith. *Comment* (G.I.S.): correlative units in S part of basin yield repeated dates of ca. 12,000 yr, although one is 13,300 ± 500. Date of 13,650 ± 500 (W-1890, this date list) on tufa from unit 3 ft lower in sec. is 5000 to 8000 yr younger than expected; possibly old carbonate released during recrystallization of unit was added to this unit during recrystallization to produce intermediate age.

W-1894. N Searles Valley, California **9070 ± 300**
7120 B.C.

Ostracod shells from greenish marl of Field Unit B, N Searles Valley (35° 52.7′ N Lat, 117° W Long), California. Coll. 1966 and subm. by G. I. Smith. *Comment* (G.I.S.): date younger than probability. Subsequent study of ostracods by I. G. Sohn indicates shells have been altered, destroyed, or replaced after burial.

14,950 ± 500
13,000 B.C.

W-1904. SW Searles Valley, California

Aragonitic oolites from Field Unit B, SW Searles Valley (35° 35.7′ N Lat, 117° 22.8′ W Long), California. From 3 ft above base of unit 6- to 8-ft thick, overlain (unconformably?) by Field Unit C which contains oolites dated as 11,020 ± 400 (W-1679, Radiocarbon, 1967, v. 9, p. 516) to 11,820 ± 400 yr (W-1680, *ibid.*). Coll. 1965 and subm. by G. I. Smith. *Comment* (G.I.S.): date probably too young though not in conflict with any C-14 or stratigraphic data (Smith, 1962).

19,150 ± 600
17,200 B.C.

W-1905. W Searles Valley, California

Greenish laminated lake marl containing calcite and aragonite from W edge of Searles Valley (35° 38.8′ N Lat, 117° 23′ W Long), California. Coll. 1966 and subm. by G. I. Smith. *Comment* (G.I.S.): date agrees with other data for Searles Valley (Smith, 1962).

Trinidad series, Colorado

Pinon or Juniper charcoal from peublo structure near Sopris (37° 08′ N Lat, 104° 34′ W Long), 5 mi W of Trinidad, Colorado. From fallen roof debris on floor level at site dated by pottery as A.D. 1150 to 1250. Coll. 1963 and subm. by G. R. Baker, Otero Jr. College, La Junta, Colorado. *Comment* (G.R.B.): date falls within 50 yr of known ages for assoc. Pueblo Santa Fe Black-on-white sherds.

1030 ± 250
A.D. 920

W-1906. TC 1

1000 ± 250
A.D. 950

W-1910. TC 3

11,500 ± 300
9550 B.C.

W-1753. Sun River Canyon, Montana

Dark gray clay, enclosing mammoth bones, from center of NE ¼ sec. 13, T 21 N, R 8 W, (47° 36′ N Lat, 112° 50′ W Long), Barr Creek Quadrangle, Lewis and Clark County, Montana. Clay horizon underlies ca. 20 ft colluvium and alluvium which, upstream, contain Mount Mazama ash and overlie colluvium on Pinedale till. Coll. 1965 and subm. by R. J. Mudge and M. R. Mudge. *Comment* (M.R.M.): dates last appearance of *Mammuthus* cf. *M.* (*Parelephas*) *columbi* in N America.

>34,000

W-1808. The Dalles, Oregon

Carbonaceous silt from E face, S end, of borrow pit cut below terrace on W side of Fifteenmile Creek valley, SE corner of NE ¼ NW ¼ sec. 33, T 2 N, R 14 E (45° 35′ N Lat, 121° 10′ W Long), ca. ½ mi NE of Petersburg School and 3 mi ENE of The Dalles, Oregon; alt 440 ft. Fissile silt with carbonaceous and peaty laminae in glaciofluvial gravel built southward into Fifteenmile Creek valley when Columbia R. overflowed 600-ft divide to N. Gravel largely from The Dalles Formation and Columbia R. Basalt in wind gap to N. Coll. 1966 and subm. by

R. C. Newcomb. *Comment* (R.C.N.): confirms earlier date (W-1656, >30,000) on same material. However, remote possibility that carbonaceous material represents hunks of peaty silt eroded from The Dalles Formation.

W-1822. Jayton, Texas **11,830**
δC^{14}—770.4

Water from USGS test hole in Permian lower Whitehorse Group and Pease River Group, 6 mi N of Jayton (33° 13′ N Lat, 100° 33′ W Long), Kent County, Texas, from 169 to 298 ft; temp. 74° F. Coll. 1965 by Pete Stevens; subm. by Bruce Hanshaw. *Comment* (B.H.): very concentrated brine thought to be connate water, but date and stable isotope data indicate otherwise.

W-1743. University of Utah campus, Salt Lake City **19,840 ± 1000**
17,890 B.C.

Organic material from excavation on Univ. of Utah campus (40° 48′ N Lat, 111° 54′ W Long). Mostly bark from tree buried in fan material beneath lake beds of last high rise to Bonneville level. Coll. 1965 and subm. by A. J. Eardley, Dept. of Geol., Univ. of Utah, Salt Lake City, Utah. *Comment*: date agrees with others for Lake Bonneville history.

W-2000. Black Rock Canyon, Utah **12,860 ± 400**
10,910 B.C.

Gastropoda from Provo sand deposit of Lake Bonneville, Black Rock Canyon, T 1 S, R 3 W, sec. 19 (ca. 41° N Lat, 112° W Long), Salt Lake Co., Utah; alt 4671.19 ft. Coll. 1964 by J. H. Madsen, Jr.; subm. by R. G. Smith, Univ. Kansas, Mus. Nat. History, Lawrence. *Comment* (G.R.S.): dates assoc. trout, chubs, and sculpins of Provo age.

W-1892. Sand Point, Seattle Washington **18,920 ± 600**
16,970 B.C.

Wood from Sand Point dist. (47° 42′ N Lat, 122° 17′ W Long), Seattle, Washington; alt 67 ft, in tunnel at point approx. below 44th Ave. NE and NE 86th St. From middle of thick, bouldery sand and gravel underlying Lawton Clay Member of Vashon Drift; overlying pumiceous, nonglacial formation older than Olympia Interglaciation. Coll. 1966 by E. R. McMaster; subm. by D. R. Mullineaux. *Comment* (D.R.M.): date indicates gravel was deposited during Olympia Interglaciation, and that its upper part cannot represent pre-Vashon glaciation of lowland. Sand and gravel in lowland may have resulted from glacier advances in Cascade Range during Evans Creek Stade of Fraser Glaciation.

W-1979. Seattle, Washington **>42,000**

Cedar branch from excavation for First Natl. Bank building, between 3rd and 4th Aves. and Spring and Madison Sts., NW ¼ SW ¼ SW ¼ sec 32, T 25 N, R 4E (47° 36′ 20″ N Lat, 122° 19′ 55″ W Long),

Seattle S quad, King Co., Washington. From fine-grained alluvium and colluvium overlain by Lawton Clay Member of Vashon Drift unconformably overlying oxidized sand and gravel. Coll. 1966 and subm. by H. H. Waldron. *Comment* (H.H.W.): sample ca. 1000 ft SE of and from about same alt. as W-1387 (20,640 ± 600) and UW-55 (21,200 ± 300, Radiocarbon, 1966, v. 8, p. 500), but believed 15 to 20 ft lower stratigraphically. May represent older part of Olympia Interglaciation.

W-1982. Maplewood, Washington **>42,000**

Peat from vicinity of type sec. of Kitsap Formation, Maplewood, NW ¼ SE ¼ sec. 16, T 22 N, R 2 E (47° 23′ 45″ N Lat, 122° 33′ W Long), Pierce Co., Washington. Coll. 1963 and subm. by D. R. Crandell, H. H. Waldron, and D. R. Mullineaux. *Comment*: sec. appears to occupy old valley in Salmon Springs Drift filled during Kitsap (Olympia, late Pleistocene) time.

Mount Rainier series, Washington

Wood from mudflows in Mt. Rainier area, Washington. Coll. 1966 and 1967 and subm. by D. R. Crandell. *Comment* (D.R.C.): series dated to establish age of large mudflows in valleys W of Mt. Rainier volcano. Mudflows were caused by massive slides of hydrothermally altered rock from volcano, probably triggered by volcanic explosions or earthquakes.

W-1971. **1110 ± 250**
A.D. 840

Log embedded in mudflow exposed in N bank of S. Puyallup R. at Wonderland Trail bridge (46° 49′ N Lat, 121° 52′ W Long), Mt. Rainier Natl. Park, Washington. *Comment* (D.R.C.): mudflow is younger than bomb-bearing lahar in same valley that was hot during movement and dated 2350 ± 250 (W-1587, Radiocarbon, 1967, v. 9, p. 521); older than series of 3 mudflows.

W-1972. **2710 ± 250**
760 B.C.

Log embedded in mudflow exposed in S bank of Mowich R. ca. 20 mi W of Mt. Rainier, in NE ¼ SE ¼ sec. 3, T 16 N, R 6 E (46° 54′ N Lat, 122° 02′ W Long), Pierce Co., Washington. *Comment* (D.R.C.): W-566 (Radiocarbon, 1960, v. 2, p. 163), from same mudflow on N side of Mowich R., dated 2170 ± 200 yr. Mudflow correlates with one of W-2114 (this date list).

W-2113. **1050 ± 350**
A.D. 900

Log embedded in lower of 2 mudflows in N bank of Puyallup R. ca. 20 mi W of Mt. Rainier, at E edge sec. 33, T 17 N, R 6 E (46° 55′ N Lat, 122° 02′ 30″ W Long), Pierce Co., Washington. *Comment* (D.R.C.): overlying mudflow is Electron, dated as 530 ± 200 yr (W-565, Radiocarbon, 1960, v. 2, p. 163). Both mudflows lie within valley cut into older mudflow from Mt. Rainier, dated at 2710 ± 250 (this date list).

W-2114. **2610 ± 350**
660 B.C.

Log from lowest of 4 mudflows exposed in N bank Tahoma Creek, 1.25 mi upstream from Tahoma Creek campground (46° 48′ N Lat, 121° 52′ W Long), Mt. Rainier Natl. Park, Washington. *Comment* (D.R.C.): lowest mudflow overlies pyroclastic Layer Y from Mt. St. Helens volcano, bracketed by radiocarbon dates ca. 3000 and 3500 (Crandell *et al.*, 1962). W-2114 is from largest Holocene mudflow on W side of Mt. Rainier; it temporarily filled 3 valleys to as much as 1000 ft, and extends at least 25 mi down one valley (Crandell and Mullineaux, 1967).

W-1944. Yellowstone National Park, Wyoming **8310 ± 300**
6360 B.C.

Charcoal from carbon layer exposed continuously for 80 ft at Bear Creek, 300 yd SW of Turbid Lake, Canyon Village quad (44° 30′ N Lat, 110° 15′ W Long), Yellowstone Natl. Park, Wyoming. Charcoal horizon overlies Pinedale till; underlies younger till according to some geologists, explosion breccia by others. Coll. 1966 by J. D. Love and J. M. Good; subm. by J. D. Love. *Comment* (J.D.L.): date is minimum for underlying till and maximum for overlying deposit whether explosion breccia or till.

W-1999. Yellowstone Lake, Wyoming **620 ± 250**
A.D. 1330

Charred wood in alluvial fan 2½ mi SW of Rock Point (44° 28′ N Lat, 110° 27′ 30″ W Long), Yellowstone Lake, Yellowstone Natl. Park, Wyoming. In weakly developed sandy humic soil in 1-ft bed of colluvium overlying sandy gravel of alluvial fan graded to 10-ft lake terrace; overlain by 8-ft sandy gravelly colluvium on which another weak humic soil is formed. Coll. 1966 and subm. by G. M. Richmond. *Comment* (G.M.R.): indicates volume and rapidity of recent colluvium, possibly related to extensive destruction of vegetation by forest fires; similar degree of recent fan development is shown in W-2010 (this date list).

W-2003. Signal Hills, Wyoming **3100 ± 250**
1150 B.C.

Charcoal from lower foot of 5-ft Signal Hills fine alluvium, 1.3 mi SW of Grizzly Peak (44° 27.2′ N Lat, 110° 11.5′ W Long), Eagle Peak quad, Yellowstone Natl. Park, Wyoming. Alluvium accumulated in meadow area behind Pinedale lateral moraines. Coll. 1966 by K. L. Pierce; subm. by G. M. Richmond. *Comment* (G.M.R.): alluvium postdates impounding moraines by ca. 10,000 yr, and also postdates altithermal. Abundant charcoal suggests assoc. with forest fires.

W-2004. Mammoth Hot Springs, Wyoming **>32,000**

Travertine from base of New Highland terrace, Mammoth Hot Springs (44° 58′ N Lat, 110° 43′ W Long), Yellowstone Natl. Park, Wyoming. Spring water (eruption temp. 74°C., temp. at travertine coll.

point ca. 25°C) flows as thin stream over travertine apron for ca. 50 ft. Coll. 1967 and subm. by Irving Friedman. *Comment* (I.F.): sample coll. to check for atmospheric CO_2 exchange; data does not indicate increase in activity of travertine.

550 ± 250

W-2008. Yellowstone National Park, Wyoming **A.D. 1400**

Wood from base of 5-ft sec. of lake beds overlying alluvial gravel 1 mi up Middle Creek from E entrance to Yellowstone Natl. Park (110° 01′ N Lat, 44° 29′ W Long), Wyoming; alt 7000 ft. Lake apparently formed by debris avalanching onto fan at downstream edge of deposits. Coll. 1966 by K. L. Pierce; subm. by G. M. Richmond. *Comment* (G.M.R.): indicates large-scale debris avalanching is still occurring in area and is not restricted to local movements in cirques or at high alts.

440 ± 250

W-2010. Escarpment Creek, Wyoming **A.D. 1510**

Fibrous vegetable material, underlying 10 ft of alluvium, near edge of Escarpment Creek fan (44° 09.1′ N Lat, 110° 05.6′ W Long), Two Ocean Pass quad, Yellowstone Natl. Park, Wyoming. Coll. 1966 by K. L. Pierce; subm. by G. M. Richmond. *Comment* (G.M.R.): indicates significant, essentially contemporaneous deposition at edge of fan; previously, it was not known whether last major alluviation on this and similar fans was late Pleistocene or Holocene.

W-2012. Solution Creek, Wyoming **>38,000**

Fibrous vegetable mat in compact lake sediments, truncated and overlain by Pinedale kame sand and gravel, 1800 ft from mouth of Solution Creek (44° 23′ N Lat, 110° 30′ W Long), Frank Island quad, Yellowstone Natl. Park, Wyoming. Coll. 1966 by K. L. Pierce; subm. by G. M. Richmond. *Comment* (G.M.R.): indicates lake sediments do not represent pre-glacial Pinedale lake, but older lake of probable Bull Lake age.

D. Alaska

Pinguk River series, Alaska

Peat deposit with wood in old filled lake, exposed, in cutbank on N side of Pinguk R. (65° 40′ N Lat, 167° W Long), Teller (D-5) quad, Alaska. Peat underlain by sheet of clear ice over shingled York Glaciation outwash; overlain by 18-in.-thick bluish clay buried by modern tundra. Coll. 1965 and subm. by C. L. Sainsbury.

10,880 ± 300

W-1776. **8930 B.C.**

Peat from zone 2- to 3-ft thick. *Comment* (C.L.S.): gives minimum age for retreat of York glaciers, also probable age of beginning of Mint River Glaciation. Blue clay, interpreted as partly loess of Mint River Glaciation, fills thaw lake developed in tundra growing on outwash of York Glaciation.

W-1823. **3760 ± 250**
1810 B.C.

Wood from upper part of peat deposit (W-1776, see above). *Comment* (C.L.S.): wood must represent shrub (or willow?) vegetation growing either on old tundra prior to clay deposition or around thaw lake developed on tundra.

W-1984. California River, Alaska **>37,000**

Deciduous tree from top of marine gravel sequence, California River Teller (C-3) quad (65° 24′ N Lat, 166° 36′ 30″ W Long), Seward Peninsula, Alaska. Coll. 1966 and subm. by C. L. Sainsbury. *Comment* (C.L.S.): indicates marine gravels, filling old cut in California R. are pre-Wisconsinan, rather than post-Wisconsinan.

Fourth of July Creek series, Alaska

Spruce from old peat zone overlying auriferous gravels, upper end of gold placer workings, Fourth of July Creek (66° 07′ N Lat, 142° W Long), Charley R. (B-1) quad, E-central Alaska. Coll. 1966 and subm. by C. L. Sainsbury. *Comment* (C.L.S.): compares with W-1944 (this date list) from same general area. Indicates modern tundra and peat cover with deciduous trees started to form over auiferous gravels ca. 5200 yr B.P. in this part of Alaska.

W-1987. **2200 ± 250**
250 B.C.

Spruce from near top of peat zone.

W-1996. **5280 ± 250**
3330 B.C.

Spruce (?) from near base of peat zone.

Coal Creek series, Alaska

Spruce from old peat zone beneath modern tundra and spruce cover in W bank of Coal Creek, along sliver of undredged ground below airfield (65° 22′ N Lat, 143° 12′ W Long), Charley R. (A-5) quad, E-central Alaska. Coll. 1966 and subm. by C. L. Sainsbury. *Comment* (C.L.S.): compares well with W-1987 and W-1996 (this date list) from same general area. Dates peat accumulation on Coal Creek.

W-1994. **4310 ± 250**
2360 B.C.

Spruce from base of old peat zone.

W-1997. **3090 ± 250**
1140 B.C.

Spruce (?) from top of old peat zone.

W-1998. Breving Mission, Alaska **400 ± 250**
A.D. 1550

Deciduous tree from buried igloo exposed in beach cut at site of old Eskimo camp on Breving Lagoon (65° 22′ N Lat, 166° 45′ W Long), ca. 4 mi W of Breving Mission, Teller (B-4) quad, Seward Peninsula,

Alaska. Coll. 1966 and subm. by C. L. Sainsbury. *Comment* (C.L.S.): site was probably a bird-shooting camp of Eskimos now at Breving Mission and Teller.

6930 ± 250
4980 B.C.

W-1657. Nabesna Road, Alaska

Organic silt from S side of Nabesna Rd. at about mi 73.6 (62° 37.6′ N Lat, 143° 43.3′ W Long), in meander scar area, Nabesna (C-6) Quadrangle, Alaska; alt 2460 ft. In 1-in. organic zone within silty sand and sand units comprising deposition within meander scar incised beneath surface of proglacial-lake sediments. Coll. 1963 and subm. by H. R. Schmoll. *Comment* (H.R.S.): date indicates alluviation represented by meander scars and deposition therein occurred during glacial event equivalent to Cochrane glaciation in midcontinent N America and Tanya glaciation of Cook Inlet region.

9700 ± 350
7750 B.C.

W-1800. Nome Coast, Alaska

Peaty mud from 0 to 4 ft below sediment in 55 to 60 ft of water off mouth of Hastings Creek (64° 30′ N Lat, 165° 18′ W Long), ca. 9 mi E of Nome, Seward Peninsula, Alaska. Sample is from widespread zone of black compact sediment that apparently represents subaerial nonmarine bog soil. Soil overlain by less than 4 ft of fluid, uncompacted recent marine mud. Coll. August, 1965 by Wendell Gayman and Andrew Stancioff; subm. by D. M. Hopkins. *Comment* (D.M.H.): date is minimum for sea level rise to −60 ft in N Bering Sea.

3555 ± 250
1605 B.C.

W-1803. Anchorage area, Alaska

Carbonized peat from trench on S Oceanview Drive, extending S, 0.15 mi E of John's Rd., SW ¼ NE ¼ sec 30, T 12 N, R 3 W (61° 06.2′ N Lat, 149° 52.3′ W Long), Anchorage area, Alaska. From 1-in. organic bed overlain by sand with ash bed, and underlain by sand, (with ash), silt, and gravel. Coll. 1965 by Ernest Dobrovolny and H. R. Schmoll; subm. by Ernest Dobrovolny. *Comment*: date is approx. for deposition of both ash beds, probably equivalent to upper rather than lower group of ash beds at Campbell Creek sec. (W-1807, this date list). Date minimum for underlying alluvium.

34,000 ± 2000
32,050 B.C.

W-1804. Anchorage area, Alaska

Wood fragments from Potter Hill r.r. cut exposure along Alaska R.R. near intersection of Seward Hwy. and DeArmoun Rd., NW ¼ NE ¼ sec. 32, T 12 N, R 3 W (61° 5.05′ N Lat, 149° 50.07′ W Long), Anchorage area, Alaska. Wood from organic zone overlain by silt, gravel, sand, and a diamicton. Coll. 1965 by Ernest Dobrovolny and H. R. Schmoll; subm. by Ernest Dobrovolny. *Comment*: indicates overlying diamicton and assoc. deposits are of Naptowne (late Wisconsinan) rather than Knik (early Wisconsinan) age as previously thought. Ice of Naptowne age must have fronted in water at and W of this site.

W-1806. Anchorage area, Alaska **>38,000**

Wood fragments from Moose Point Lodge site, on NE side of abandoned segment of Glenn Hwy., along N side of Eagle R., NW ¼ NW ¼ sec. 13, T 14 N, R 2 W, (61° 18.6′ N Lat, 149° 34.0′ W Long), Anchorage area, Alaska. Organic material, in silt, overlain by gravel and underlain by oxidized sand. Coll. 1965 by Ernest Dobrovolny and H. R. Schmoll; subm. by Ernest Dobrovolny. *Comment*: organic zones which record episode of fluctuating lacustrine or marine environment in Eagle R. valley presumably correlate with peat underlying Naptowne outwash gravel ca. 3 mi downstream (W-535, >38,000, Radiocarbon, 1960, v. 2, p. 164), and represent deposition prior to Naptowne Glaciation, rather than during it as at Potter Hill (W-1804, this date list).

W-1807. Anchorage area, Alaska **5960 ± 250**
4010 B.C.

Charcoal from N side of S Fork Campbell Creek just upstream from power line crossing, SW ¼ NW ¼ sec. 7, T 12 N, R 2 W (61° 08.8′ N Lat, 149° 42.5′ W Long), Anchorage area, Alaska. Overlain by 2 ash horizons interbedded with sand and organic material; underlain by interbedded gravel and diamicton, and bedrock. Coll. 1965 by Ernest Dobrovolny and H. R. Schmoll; subm. by Ernest Dobrovolny. *Comment*: closely dates lower ash in this sequence and indicates lower ash beds here are older than 2 found in lowland, as at Oceanview Drive (W-1803, this date list).

W-1983. Glacier Bay, Alaska **1840 ± 250**
A.D. 110

Log embedded in lake clays in stream valley heading SW between Favorite Fjord and Geikie Inlet, Mt. Fairweather (C-2) quad (59° N Lat, 137° 30′ W Long), Glacier Bay area, Alaska. E drainage probably ponded by ice advance or gravel deposition in main part of Glacier Bay. Coll. 1966 and subm. by A. T. Ovenshine. *Comment*: though lake beds similar to Van Horn Formation of Haselton (1966) at Muir Inlet, this lake probably not synchronous with lake dated at 4000 B.P. by Goldthwait in Muir Inlet.

W-1993. Sagavanirktok River, Alaska **8400 ± 300**
6450 B.C.

Cottonwood log (*Populus* sp.) from 20 ft below surface in sandy terrace gravel, 2.4 mi S 15° W of VABM Sussie, sec. 22, T 2 N, R 13 E (69° 31′ N Lat, 148″ 52′ W Long), Sagavanirktok quad, N Alaska. Coll. 1965 by M. D. Mangus; subm. by R. L. Detterman. *Comment* (R.L.D.): dates tree from far N of present tree line. Good correlation with dates given by McCulloch and Hopkins (1966).

W-1819. Lower Chitina Valley, Alaska **200 ± 200**
A.D. 1750

Outer rings from spruce (?) log 0.9 mi NNE of McCarthy (61° 26′ 46″ N Lat, 142° 54′ 37″ W Long), McCarthy (B-6) Quadrangle, Alaska; alt 1400 ft. Wood from mass of sediment, overturned by glacial shearing.

Coll. 1962 and subm. by L. A. Yehle. *Comment* (L.A.Y.): dates most recent advance of Kennicott glacier near valley axis and at present terminus.

200 ± 200
A.D. 1750

W-1820. Lower Chitina Valley, Alaska

Wood in basal sector of kame adjacent to Root Glacier, 1.7 mi NW of Kennicott (61° 30′ 32″ N Lat, 142° 54′ 02″ W Long), McCarthy (C-6) Quadrangle, Alaska; alt 2100 ft. Coll. 1962 and subm. by L. A. Yehle. *Comment*: dates activity of Root Glacier.

10,240 ± 300
8290 B.C.

W-1826. Auke Lake, Alaska

Shells in emerged terrace sediment at 138 ft between Auke Lake and Montana Creek in Mendenhall Valley, NW ¼ NW ¼ sec. 24, T 40 S, R 65 E (58° 23′ 36″ N Lat, 134° 37′ 03″ W Long), Juneau (B-2) Quadrangle, Alaska. Shells, mostly clams and oysters, accumulated on eroded delta and were covered by till or marine diamicton. Coll. 1965 and subm. by R. D. Miller. *Comment* (R.D.M.): dates marine delta.

10,640 ± 300
8690 B.C.

W-1827. Mendenhall Peninsula, Alaska

Shells in stony marine clay and diamicton from N end Mendenhall Peninsula, along Glacier Hwy. just SE of junction of Fritz Cove Rd., SE ¼ SE ¼ sec. 23, T 40 S, R 65 E (58° 23′ 12″ N Lat, 134° 37′ 59″ W Long), Juneau (B-2) Quadrangle, Alaska. Shells from 6-ft zone within diamicton overlying glacially striated bedrock. Coll. 1965 and subm. by R. D. Miller. *Comment* (R.D.M.): date relates deposition of diamicton to that of delta (W-1829, this date list) and beach (W-1826, this date list).

10,880 ± 340
8930 B.C.

W-1829. Calhoun Road, Juneau, Alaska

Barnacle fragments from foreset beds in gravel pit near Calhoun Rd., N side Gold Creek, SE ¼ NW ¼ sec. 23, T 41 S, R 67 E (58° 18′ 12″ N Lat, 134° 25′ 05″ W Long), Juneau, Alaska. Gravels from one of highest deltas along Gastineau Channel trough; barnacle horizon at alt 186 to 188 ft. Coll. 1965 and subm. by R. D. Miller. *Comment* (R.D.M.): dates delta and helps correlate deposits on both sides of Gastineau Channel which may have been differentially uplifted.

Auke Bay series, Alaska

Shells from diamicton within delta exposed in gravel pit, N side Glacier Hwy., 500 ft E of entrance to Auke Bay ferry terminal, SW ¼ SE ¼ sec. 21, T 40 S, R 65 E, (58° 22′ 59″ N Lat, 134° 41′ 00″ W Long), Juneau (B-3) quad, Alaska. Coll. 1965 and subm. by R. D. Miller. *Comment* (R.D.M.): delta seems to be graded to a surface 500 ft above sea level.

12,730 ± 500
10,780 B.C.

W-1830.

Barnacles, in life position.

W-1831. **12,880 ± 500**
10,930 B.C.

Shells, whole and fragments.

W-1832. Mendenhall Peninsula, Alaska **7210 ± 300**
5260 B.C.

Peat in shallow road cut along Engineers Cutoff in Mendenhall Peninsula saddle, SE ¼ NW ¼ sec. 35, T 40 S, R 65 E (58° 21′ 29″ N Lat, 134° 38′ 11″ W Long), Juneau (B-2) Quadrangle, Alaska; alt 180 ft. Overlies water-deposited gravel on diamicton or marine till. Coll. 1965 and subm. by R. D. Miller. *Comment* (R.D.M.): dates a marine terrace at 180 ft.

W-1835. Sunny Point, Alaska **9400 ± 300**
7450 B.C.

Pelecypods from shelly beach sediment Sunny Point, N side Gastineau Channel, NW ¼ SW ¼ sec. 33, T 40 S, R 65 E (58° 21′ 28″ N Lat, 134° 31′ 52″ W Long), Juneau (B-2) Quadrangle, Alaska; alt 28 to 30 ft. Beach overlies stony marine silt and clay and underlies peat. Coll. 1965 and subm. by R. D. Miller. *Comment* (R.D.M.): provides age of shoreline at 28 ft level.

W-1839. Auke Bay, Alaska **12,300 ± 350**
10,350 B.C.

Shells from sand layer in deltaic sequence of sands, gravel, and diamicton in cut on N side of Glacier Hwy., Auke Bay area, 1550 ft E of entrance to ferry landing, SE ¼ SE ¼ sec. 21, T 40 S, R 65 E (58° 22′ 59″ N Lat, 134° 40′ 40″ W Long), Juneau (B-2) quad, Alaska. Deltaic deposits from water flowing SE between bedrock ridges and Auke Mt.; sequence includes W-1830 and W-1831 (this date list). Coll. 1965 and subm. by R. D. Miller. *Comment* (R.D.M.: dates marine terrace at 62 ft along Auke Bay.

W-1947. Juneau area, Alaska **860 ± 250**
A.D. 1090

Wood from tree, sheared and buried by outwash, rooted in carbonaceous muck layer in E bank Mendenhall R. at W end of rd. for Richards Subdivision, NE ¼ NE ¼ SE ¼ sec. 24, T 40 S, R 65 E (58° 23′ 56″ N Lat, 134″ 35′ 24° W Long), Juneau (B-2) quad, Alaska. Coll. 1966 and subm. by R. D. Miller. *Comment* (R.D.M.): dates rapid burial of tree by Mendenhall Glacier outwash.

W-1953. Douglas Island, Alaska **<200**

Wood fragments in peaty bed overlying gravel, NW of town of Douglas along Lawson Creek, NE ¼ SE ¼ SW ¼ sec. 26, T 41 S, R 67 E (58° 18′ 22″ N Lat, 134° 14′ 53″ W Long), Douglas Is., Juneau (B-2) quad, Alaska. Wood below modern soil zone with podzolic leached zone, and overlies deltaic gravel; stream cross-bedding in upper gravel sug-

gests last phases of deltaic deposition. Coll. 1966 and subm. by R. D. Miller. *Comment* (R.D.M.): sample younger than expected; probably not part of delta cycle.

3400 ± 250
1450 B.C.

W-1955. Admiralty Island, Alaska

Peat from bedded peat layer along unnamed tributary of Bear Creek, on the NE side of Robert Barron Peak, Mansfield Peninsula, NE ¼ NW ¼ sec. 8, T 42 S, R 65 E (58° 14′ 51″ N Lat, 134° 49′ 14″ W Long), Admiralty Is., Juneau (A-3) quad, Alaska. Peat within shelly, sandy, clayey diamicton containing stones and boulders. Coll. 1966 and subm. by R. D. Miller. *Comment* (R.D.M.): peat in highest known marine deposit in area; age critical for determination of rate of uplift and detection of possible tectonic movement between Admiralty Is. and Douglas and mainland.

E. Miscellaneous

10,000 ± 350
8050 B.C.

W-1815. Mid-Atlantic Ridge, Atlantic Ocean

Coral branches exposed in area of low rate of sediment deposition, Chain Cruise 43, Sta. 113, Mid-Atlantic Ridge (42° 40.9′ N Lat, 29° 01.9′ W Long); water depth 2300 m. Coral heavily Mn-stained with highest concentrations in rough areas, edges, pits, etc. Coll. 1963 by Richard Pratt; subm. by F. T. Manheim. *Comment* (F.T.M.): indicates very slow Mn-deposition rate (see also W-1813, W-1814, this date list).

Atlantic Ocean series

Freshwater peat, wood, and shells coll. from continental shelf off NE United States to establish generalized rates of sea-level rise. *Comment*: freshwater peats on continental shelf reinforce belief that during glacial ages shelves emerged. Data on postglacial low sea levels are provided by radiocarbon dates on shells of commercial oyster, *Crassostrea virginica* (Gmelin) that generally lives in estuaries and lagoons in zone between high tide and depth of several m. Oyster-shell and peat data seem to indicate postglacial subsidence of shelf off NE United States relative to most other shelves of world (Emery *et al.*, 1967).

8620 ± 300
6670 B.C.

W-1735. SE of Nantucket

Peat from surface of sea floor (41° 02.2′ N Lat, 69° 30.6′ W Long) depth 20 to 27m. Coll. 1965 by Capt. Norman Lepire; subm. K. O. Emery, Woods Hole Oceanog. Inst., Woods Hole, Massachusetts.

10,630 ± 300
8680 B.C.

W-1736. SE of Nantucket

Wood fragments from peat from surface of sea floor (41° 05.6′ N Lat, 69° 41.5′ W Long) depth 40m. Coll. 1965 by Capt. Norman Lepire; subm. by K. O. Emery.

W-1737. **11,090 ± 300**
9140 B.C.

Peat matrix of Sample W-1736 above.

W-1981. Nantucket Shoals, Massachusetts **7130 ± 300**
5360 B.C.

Crassostrea virginica shell from surface of sea floor (40° 59′ N Lat, 69° 44′ W Long) depth 45m. Coll. 1966 by R. L. Wigley; subm. by K. O. Emery.

W-2001. Great South Channel, Georges Bank **1320 ± 250**
A.D. 630

Conifer wood from surface of sea floor (50° 59.8′ N Lat, 69° 00.7′ W Long) depth 82m. Coll. 1964 and subm. by K. O. Emery. *Comment* (K.O.E.): date too recent for wood to be in place.

W-2013. Near Woods Hole, Massachusetts **9300 ± 250**
7350 B.C.

Crassostrea virginica shell from surface of sea floor (41° 18′ N Lat, 71° 00′ W Long) depth 34m. Coll. 1967 by K. O. Emery and R. L. Wigley; subm. by K. O. Emery. *Comment* (K.O.E.): establishes time sea entered Vineyard Sound.

W-2014. Near Virginia coast **13,500 ± 350**
11,550 B.C.

Fresh-water peat from surface of sea floor (37° 38′ N Lat, 74° 30′ W Long) depth 64 to 68m. Coll. 1967 by Tim Furtado; subm. by K. O. Emery.

Blake Plateau series, Atlantic Ocean

Coral coll. from Blake Plateau and Mid-Atlantic Ridge (W-1815, this date list) to determine rate of Mn deposition on coral. W-1813 is living coral with no Mn staining, sampled to establish "age" of living coral; W-1814 is brownish-purplish Mn-stained coral. Coll. 1965 by Richard Pratt; subm. by F. T. Manheim. *Comment* (F.T.M.): 0.03 Mn layer in conjunction with age indicates very slow rate of deposition, less than 0.01 mm/1000 yr.

W-1813. **300 ± 450**
A.D. 1650

Dendrophyllum living in area of strong currents, Gosnold Sta. 2477, Blake Plateau (31° 00.5′ N Lat, 79° 19.4′ W Long); water depth 684m.

W-1814. **13,720 ± 450**
11,770 B.C.

Brownish-purplish Mn-stained coral branches from exposed corals in area of low deposition of detritus, Gosnold Sta. 2439, Blake Plateau (28° 39.5′ N Lat, 79° 26.0′ W Long); water depth 828m.

7380 ± 250
5430 B.C.

W-1874. Eferding, Austria

Carbonaceous material from Nieder terrace fill at Eferding, (48° 19′ N Lat, 14° 03′ E Long), on Danube R. near Linz, Austria. Coll. 1965 and subm. by H. Kohl, Hirschgasse 19, Linz, Austria. *Comment*: dates Nieder terrace fill in Danube Basin and ties fill into glacial sequence.

370 ± 150
A.D. 1580

W-1788. Dominica Island, British West Indies

Dacryodes excelsa heartwood from virgin forest tree, stem diameter 46 in., in Gleau Gommier forest, Dominica Is. (15° 24′ N Lat, 61° 20′ W Long), B.W.I.. These trees, with no annual growth rings, are dominant species of climax forest in Dominica (rainfall 250 in.) and in Puerto Rico. Coll. 1965 and subm. by H. T. Odum, Puerto Rico Nuclear Center, Caparra Heights Sta., San Juan, Puerto Rico. *Comment* (H.T.O.): crowns of trees are small; this might indicate slow growth rate. However, date implies very rapid growth for a few hundred yr.

Ifalik Atoll series, Caroline Islands

Emerged reef limestone (2 ft above reef level) off S end Falarik Is., (7° 15′ N Lat, 144° 27′ E Long), Ifalik Atoll, Caroline Is. Coll. 1953 and subm. by J. I. Tracey, Jr. *Comment* (J.I.T.): dates formation of emerged reef, now eroded, formed when relative sea level was ca. +1 to 2m. Detrital limestone must represent more recent storms.

2140 ± 200
190 B.C.

W-1842.

Reef limestone, 90% coralline algae, 10% coral, *in situ*.

360 ± 250
A.D. 1590

W-1959.

Detrital limestone.

Lake Waiau series, Hawaii

Lake sediment, largely volcanic ash and planktonic debris, from Alpine Lake Waiau (19° 49′ N Lat, 155° 29′ W Long), Mauna Kea, Hawaii; alt 3970m. Coll. 1966 and subm. by A. H. Woodcock, Inst. Geophysics, Univ. Hawaii, Honolulu. *Comment* (A.H.W.): dates agree well with W-1833 and W-1834 (Radiocarbon, 1967, v. 9, p. 527) and I-2633-5, and I-2637 in presenting pattern of age increasing with depth in lake sediment. Pattern helps date ash layers deposited from nearby eruptions, as well as other events reflected in sediment strata.

5500 ± 500
3550 B.C.

W-1941.

Sample from ca. 1.8m below lake bottom.

4180 ± 600
2230 B.C.

W-1968.

Sample from ca. 1.55m below lake bottom.

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