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RADIOCARBON

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INSTRUCTIONS TO CONTRIBUTORS

Manuscripts of radiocarbon papers should follow the recommendations in *Suggestions to Authors*, 5th ed.* All copy must be typewritten in *double space* (including the bibliography): manuscripts for vol. 12, no. 2 must be submitted in *duplicate* by January 1, 1970, and for vol. 13, no. 1 by September 1, 1970.

Description of samples, in date lists, should follow as closely as possible the style shown in this volume. Each separate entry (date or series) in a date list should be considered an *abstract*, prepared in such a way that descriptive material is distinguished from geologic or archaeologic interpretation, but description and interpretation must be both brief and informative. Date lists should therefore not be preceded by abstracts, but abstracts of the more usual form should accompany all papers (e.g. geochemical contributions) that are directed to specific problems.

Each description should include the following data, if possible in the order given:

1. Laboratory number, descriptive name (ordinarily that of the locality of collection), and the date expressed in years B.P. (before present, i.e. before A.D. 1950) and, for finite dates, in years A.D./B.C. The standard error following the date should express, within limits of $\pm$ 1σ, the laboratory's estimate of the accuracy of the radiocarbon measurement, *as judged on physicochemical (not geologic or archaeologic) grounds.*

2. Substance of which the sample is composed; if a plant or animal fossil, the scientific name if possible; otherwise the popular name; but not both. Also, where pertinent, the name of the person identifying the specimen.

3. Precise geographic location, *including latitude-longitude coordinates.*

4. Occurrence and stratigraphic position in precise terms.

5. Reference to relevant publications. Citations within a description should be to author and year, with specific pages wherever appropriate. References to published date lists should cite the journal, year, vol., and specific page (e.g., Radiocarbon, 1968, v. 10, p. 97). Full bibliographic references are listed alphabetically at the end of the manuscript, in the form recommended in *Suggestions to Authors.*

6. Date of collection and name of collector.

7. Name of person submitting the sample to the laboratory, and name and address of institution or organization with which submitter is affiliated.

8. Comment, usually comparing the date with other relevant dates, for each of which sample numbers and references must be quoted, as prescribed above. Interpretive material, summarizing the significance and implicity showing that the radiocarbon measurement was worth making, belongs here, as do technical matters, e.g. chemical pretreatment, special laboratory difficulties, etc.

Illustrations should not be included unless absolutely essential. They should be original drawings, although photographic reproductions of line drawings are sometimes acceptable, and should accompany the manuscript in any case, if the originals exceed 9 to 12 inches in size.

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* Suggestions to authors of the reports of the United States Geological Survey, 5th ed., Washington, D. C., 1958 (Government Printing Office, $1.75).

NOTICE TO READERS

Half life of C^{14}. In accordance with the decision of the Fifth Radiocarbon Dating Conference, Cambridge, 1962, **all dates published in this volume (as in previous volumes) are based on the Libby value, 5570 ± 30 yr,** for the half life. This decision was reaffirmed at the H^3 and C^{14} Conference, Pullman, Washington, 1965. Because of various uncertainties, when C^{14} measurements are expressed as dates in years B.P. the dates are arbitrary, and refinements that take some but not all uncertainties into account may be misleading. As stated in Professor Harry Godwin's letter to **Nature** (v. 195, no. 4845, p. 984, September 8, 1962), the mean of three new determinations of the half life, 5730 ± 40 yr, is regarded as the best value now obtainable. Published dates can be converted to this basis by multiplying them by 1.03.

A.D./B.C. dates. As agreed at the Cambridge Conference in 1962, A.D. 1950 is accepted as the standard year of reference for all dates, whether B.P. or in the A.D./B.C. system.

Meaning of δC^{14}. In Volume 3, 1961, we indorsed the notation Δ (Lamont VIII, 1961) for geochemically interesting measurements of C^{14} activity, corrected for isotopic fractionation in samples and in the NBS oxalic-acid standard. The value of δC^{14} that entered the calculation of Δ was defined by reference to Lamont VI, 1959, and **was corrected for age.** This fact has been lost sight of, by the editors as well as by authors, and recent papers have used δC^{14} as the **observed** deviation from the standard. This is of course the more logical and self-explanatory meaning, and cannot be abandoned now without confusion; moreover, except in tree-ring-dated material, it is rarely possible to make an age correction that is independent of the C^{14} age. In the rare instances where Δ or δC^{14} are used for samples whose age is both appreciable and known, we assume that authors will take special care to make their meaning clear; reference merely to "Δ as defined by Broecker and Olson (Lamont VIII)" is not adequate.

Radiocarbon Measurements: Comprehensive Index, 1950-1965. This index, covering all published C^{14} measurements through Volume 7 of RADIOCARBON, and incorporating revisions made by all laboratories, has been published. It is available to all subscribers to RADIOCARBON at ten dollars U.S. per copy.

Publication schedule. Volume 10 and subsequent volumes are published in two semi-annual issues, in Winter and in Summer, with deadlines for manuscripts on 1 September and 1 January. Because of the recent rise in the number of manuscripts and laboratories, our publication schedule may be slightly delayed in the future. Contributors who meet our deadlines will be given priority but not guaranteed publication in the following issue.

List of laboratories. The comprehensive list of laboratories that has appeared hitherto at the end of each issue will now appear only once a year, in the second number of each volume.

Index. Beginning with Volume 11, all dated samples now appear in index form at the end of the second number of each volume.

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Radiocarbon

1970

ANU RADIOCARBON DATE LIST IV

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The present date list describes the first stage of a co-operative study on the validity of dating secondary soil carbonates in arid and semi-arid environments of Australia. Because of the complex nature of the physical and chemical variables in a soil environment, many additional samples are being dated from stratigraphically controlled sites before final evaluation of carbonate reliability is possible.

All measurements were performed on a Beckman LS-200 liquid scintillation spectrometer following automatic cycling procedures described previously (Radiocarbon, 1969, v. 11, p. 245; Polach, 1969). In a recent paper (Geyh, 1969), auto-production of acetylene due to carbon impurities of commercial lithium metal, is reported. For our acetylene synthesis described by Polach and Stipp (1967) we use: *dry pack, low-sodium-grade lithium metal shot,* produced by Lithium Corp. of America, Inc., New York. It is free of traces of carbon and is directly suitable for C_2H_2 production if kept in an inert atmosphere. All ages are reported relative to A.D. 1950 on the basis of Libby half-life (5570 $\pm$ 30). B.C. and A.D. ages have not been calculated, for this geologic series, but δC^{13}, δC^{14}, and Δ terms in parts per (‰) are reported as in our previous date list (cf. Radiocarbon, 1969, v. 11, p. 245-262).

ACKNOWLEDGMENTS

We wish to acknowledge assistance of J. Golson, Dept. of Prehistory, A.N.U. We also thank T. A. Rafter, Dir., Inst. Nuclear Sciences, New Zealand, for allowing one of us (H.A.P.) to determine C^{13}/C^{12} ratios within the mass spectrometry section of the Institute, and G. E. Williams, Dept. of Geology, University of Adelaide, for critical reading of manuscript. J. M. B. wishes to thank J. Head, Technical Officer, Radiocarbon Lab., for tuition and supervision whilst dating his own samples.

SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Australia

A. Validity of carbonate nodule dating

Field study undertaken by J. M. Bowler. Porous, nodular, or fine-earth carbonates were selected from red calcareous and red-brown earth

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soils (Stace *et al.*, 1968) in the low-rainfall Mallee and Riverine Plain of N Victoria and from a chernozemic soil on the Keilor terrace near Melbourne (Bowler, 1969a).

Sites were selected along a transect, across Victoria, with a steep temperature and precipitation gradient. Mean annual pan evaporation ranges from ca. 150 cm near Nyah West in semi-arid Mallee to 100 cm at Melbourne whereas precipitation varies from 30 cm to 70 cm. Samples were only obtained where stratigraphic control was already available, permitting independent estimates of soil age. Samples coll. by Bowler and Polach in 1967, and recoll. by Bowler in 1968. Subm. by Dept. of Biogeography and Geomorphology.

Nyah West series

Samples obtained near Nyah West Railway Sta. (35° 20′ S Lat, 143° 23′ E Long) in cut through EW longitudinal dune. Dunes now are fixed by vegetation, but are continuous with extensive inland dune system of central Australia. Sequence of buried calcareous soils (Hills, 1939) reflects Quaternary paleoenvironments in which landscape instability and dune building alternated with stability and soil formation (Churchward, 1961). Surface of cut, weathering for ca. 50 yr, cleaned back 5 to 10 cm to permit sampling of carbonate horizons 15 cm thick.

ANU-183. $\delta C^{14} = -849.4 \pm 4.3$ **15,550 ± 230**
$\Delta = -855.7 \pm 4.1$ $\delta C^{13} = -4.9 \pm 0.2‰$

Fine earth carbonate in B_{ca} horizon, 65 cm deep in highest soil unit (Kyalite) (Churchward, 1961). Benzene, 1380 min. count.

ANU-184. $\delta C^{14} = -947.6 \pm 5.9$ **24,000 ± 900**
$\Delta = -949.7 \pm 5.6$ $\delta C^{13} = -5.1 \pm 0.2‰$

Porous nodular carbonate from 2nd soil unit (Speewa) (Churchward, 1961), 235 cm deep. Benzene, 1440 min. count.

ANU-185. $\delta C^{14} = -974.2 \pm 4.2$ **29,750 $^{+1450}_{-1200}$**
$\Delta = -975.3 \pm 4.1$ $\delta C^{13} = -4.7 \pm 0.2‰$

Porous nodular carbonate from lowest soil unit (Bymue) (Churchward, 1961), 385 cm deep. Benzene, 1560 min. count.

General Comment (J.M.B.): results are consistent with sequence of soil formation. Independent estimates of age of last period of instalibity were between 16,000 and 20,000 B.P. Soil carbonate is younger than deposit in which it formed but time relationship between deposition and pedogenesis is not clear. All 3 ages are minimum for assoc. sedimentary units. Carbonate for youngest Kyalite unit was provided by erosion of older exposed pedologic carbonates (Churchward, 1961). During translocation through profile, carbonate acquired sufficient younger atmospheric C^{14} considerably to reduce contamination by older carbon. Further

C^{14} uptake of Speewa was effectively prevented by deposition of the younger Kyalite layer (ANU-183), probably since 24,000 B.P. Low levels of C^{14} activity in all samples indicate that little atmospheric or soil CO_2 has been taken up by carbonate due to exposure to direct weathering since cut was made.

Kerang series

Samples from soil profile in quarry S of Quambatook 5 mi W of Kerang (35° 46′ S Lat, 143° 47′ E Long); 2 m calcareous red sandy clay overlie lateritized and silicified sandstone of probably Upper Tertiary age. Soil mantle being developed on materials of eolian origin of late Quaternary age.

ANU-181. $\delta C^{14} = -492.3 \pm 5.8$ **5790 ± 95**
$\Delta = -513.6 \pm 5.6$ $\delta C^{13} = -4.8 \pm 0.2‰$

Fine-earth carbonate, 10 cm deep. Benzene, 1260 min. count.

ANU-182. $\delta C^{14} = -701.6 \pm 5.1$ **10,060 ± 140**
$\Delta = -714.2 \pm 4.9$ $\delta C^{13} = -4.7 \pm 0.2‰$

Porous carbonate concretions, 60 cm deep. Benzene, 1380 min. count.

General Comment (J.M.B.): both dates are believed to be much younger than true age of carbonate organization. At this site, higher rainfall and shallow burial resulted in more rapid uptake of atmospheric carbon, as compared with dune environment to W, where horizons dated (ANU-183) are believed ca. of same age.

Echuca series

ANU-90. $\delta C^{14} = -572.8 \pm 5.0$ **7110 ± 95**
$\Delta = -587.3 \pm 4.9$ $\delta C^{13} = -8.9 \pm 0.2‰$

Carbonate concretion, 30 cm deep in levee of Kanyapella prior stream (36° 08′ S Lat, 144° 53′ E Long) (Bowler and Harford, 1966) 8.5 mi E of Echuca. Levee truncated by lake and lunette and antedates Ancestral River II phase for which an age ca. 16,000 B.P. (Bowler, 1967) is available for comparison, Benzene, 1400 min. count. *Comment* (J.M.B.): high uptake of atmospheric C^{14} as indicated during and since carbonate segregation.

ANU-135. $\delta C^{14} = -547.1 \pm 4.8$ **6700 ± 90**
$\Delta = -565.3 \pm 4.6$ $\delta C^{13} = -6.0 \pm 0.2‰$

Carbonate concretion from gravel pit in bed of prior stream of Campaspe system (Bowler and Harford, 1966) 5.5 mi NE of Rochester (36° 20′ S Lat, 144° 46′ E Long) coll. from B_{ca} horizon, 110 cm deep in red-brown earth soils typical of those developed over large region of Riverine Plain. Similar sediments and soils dated on Goulburn R. 10 mi E, indicate that these soils are older than 15,000 B.P. Coll. 1967. Benzene, 1520 min. count.

ANU-291. $\delta C^{14} = -521.9 \pm 5.7$ **6260 ± 100**
$\Delta = -541.0 \pm 5.8$ Est. $\delta C^{13} = -5.0 \pm 2.0‰$

1968 recollection of ANU-135. Benzene, 980 min. count. *Comment* (J.M.B.): high levels of C^{14} activity again indicate high percentage of soil and atmospheric C^{14} incorporated into crystal lattice after initial carbonate nodule formation. The close correspondence of ANU-135 and 291 collected in different years, in different parts of soil pit, but within same horizon indicates good consistency and reproducibility of results within site.

Shepparton series

ANU-134. $\delta C^{14} = -254.0 \pm 6.3$ **2670 ± 70**
$\Delta = -282.4 \pm 6.1$ $\delta C^{13} = -7.0 \pm 0.2‰$

Massive-carbonate concretion, 180 cm deep in profile of red-brown earth developed on prior stream sediments exposed in right bank of Goulburn R. 3 mi S of Shepparton (36° 25′ S Lat, 145° 21′ E Long). Sediments on which these soils formed have been dated at ca. 25,000 and 30,000 B.P. (Bowler, 1967). Since red-brown earth soils are not found on younger alluvium dated at ca. 5000 B.P., 8000 B.P., and 16,000 B.P., we infer age of soil formation of Shepparton series to be ca. 15,000 B.P. Coll. 1967. Benzene, 1400 min. count.

ANU-290. $\delta C^{14} = -239.7 \pm 6.8$ **2530 ± 80**
$\Delta = -270.1 \pm 7.2$ Est. $\delta C^{13} = -5.0 \pm 2.0$

1968 recollection of ANU-134. Benzene, 1100 min. count. *Comment* (J.M.B.): very high levels of C^{14} activity again reflect continuation of incorporation of atmospheric- and soil CO_2 after initial carbonate-nodule formation due to subsequent mobilization within profile, here attributed to higher rainfall. *Comment* (H.A.P.) we note that 1968 recollection of ANU-135 within Echuca series, and of ANU-134 within Shepparton series, are younger than their equivalent 1967 collections but no conclusions can be drawn from 2 determinations alone.

Keilor series

ANU-126. $\delta C^{14} = -184.5 \pm 6.5$ **2015 ± 65**
$\Delta = -222.0 \pm 6.2$ $\delta C^{13} = -2.3 \pm 0.2‰$

Carbonate nodules 8 to 10 cm diam., from Keilor terrace near Green Gully, 1 mi S of Keilor, (37° 45′ S Lat, 144° 50′ E Long) in site previously subjected to intensive stratigraphic study in connection with Late Quaternary occupation and human remains (Bowler *et al.* 1967; Bowler, 1969). Limiting ages of carbonate segregation have been reliably placed here between 6000 and 11,000 B.P. Moreover, human remains buried in B_{ca} horizon of chernozemic soil and bearing a thin encrustation of carbonate have been dated as follows: bone collagen, 6460 ± 190 B.P. (NZ-676) bone carbonate, 1781 ± 115 B.P. (NZ-675, Rafter, pers. commun.). *Comment* (H.A.P.): results from both bone and soil carbonate are in close agreement and demonstrate that here bone carbonate directly reflects carbonate environment of soil in which it is found (cf. Haynes, 1968).

General Comments (J.M.B. and H.A.P.): all samples from higher rainfall areas show high levels of C^{14} activity due to exchange between atmospheric and soil CO_2. In drier semi-arid environment, infrequent wetting has resulted in ages which are regarded as consistent with independent stratigraphic evidence and close to the actual age of carbonate organization. Circumstances necessary for segregation and migration of carbonate to form nodules or crusts, are those most suited to uptake of modern soil- and-atmosphere derived C^{14}. Where nodular carbonate has been dated in this series, ages obtained are considerably younger than independent estimates. The buried soil nodular carbonates at Kerang (ANU-182) and Nyah West (ANU-184 and 185) give minimum ages for deposition of sediment and subsequent soil formation. Age of continental dune system therefore extends beyond 30,000 B.P., an estimate consistent with independent stratigraphic evidence (Bowler, 1969). In region studied, all dates obtained from soil carbonates are younger than ages of sediment on which they were formed, demonstrating apparent independence of C^{14} levels of source carbon. This relationship can be applied to carbonate samples when more reliable dating materials are not available. While demonstrating some difficulties of carbonate dates from subhumid regions, results point to greater reliability of such materials in semiarid and arid regions.

B. Extension of carbonate nodule dating project to Quaternary geochronology of Lake Torrens area, South Australia

Lake Torrens series

Field study in Lake Torrens region of South Australia (mean annual precipitation <25 cm), by G. E. Williams, Dept. of Geol., Univ. of Adelaide. Charcoal from parent sedimentary formations has furnished an absolute chronology to which dates for authigenic soil carbonate can be related. Samples will be checked for C^{13}/C^{12} ratios by Geochron Lab., Inc., U.S.A.; in the meantime value, $\delta C^{13} = -5.0 \pm 2‰$, as derived from study by Bowler was applied. Samples coll. 1967 and 1968 by G. E. Williams; subm. by Dept. of Geophysics.

ANU-213. $\Delta = -303.9 \pm 16.8$ **2900 ± 200**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments from gravelly alluvium, near "apex" of large fan, Wilkatana Sta. (32° 07′ S Lat, 137° 57′ E Long) 30 mi N of Pt. Augusta, S.A. Benzene dilution, 1000 min. count. *Comment* (G.E.W.): Some doubt as to origin of charcoal; age is minimum for terrace.

ANU-214. $\Delta = -472.0 \pm 6.2$ **5130 ± 100**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments from gravelly alluvium near apex of Depot Creek Fan (32° 13′ S Lat, 137° 55′ E Long) 25 mi N of Pt. Augusta.

Benzene, 1000 min. count. *Comment* (G.E.W.): date more reliable than ANU-213, indicating that large segment of fan was aggraded during mid-Holocene.

ANU-215. $\Delta = -199.7 \pm 40.0$ **1790 ± 400**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments from Wilkatana Fan, youngest terrace. Benzene, 1020 min. count.

ANU-216. $\Delta = -347.6 \pm 6.5$ **3430 ± 80**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal from terrace, central area of Wilkatana Fan. Benzene, 1220 min. count.

ANU-217. $\Delta = -208.4 \pm 8.2$ **1880 ± 85**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments from Depot Creek Fan, youngest terrace. Benzene, 860 min. count.

ANU-219. $\Delta = -526.4 \pm 6.1$ **6000 ± 100**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments from terrace at base of Depot Creek Fan, which correlates with ANU-214, mid-Holocene fan segment and with alluvium locally flooring interdune corridors further N at Motpena Sta. (ANU-265). Benzene, 860 min. count. *Comment* (G.E.W.): fine earth carbonate from same formation and immediately above ANU-219 yields 6450 ± 90 B.P., ANU-224.

ANU-220. $\Delta = -163.4 \pm 8.3$ **1430 ± 80**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments from sand ridge area at base of Depot Creek Fan. Benzene, 860 min. count.

ANU-221. $\Delta = -153.4 \pm 8.1$ **1340 ± 80**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments, ca. 60 cm deep, from fan emerging from Chambers Gorge, NE Flinders Ranges (30° 58′ S Lat, 139° 17′ E Long). Benzene, 1020 min. count.

ANU-222. $\Delta = -789.1 \pm 4.4$ **12,500 ± 170**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments, 1.4 m below ANU-221, from base of clayey, silty sand, underlain by gravel. Benzene, 1000 min. count.

ANU-223. $\delta C^{14} = -612.7 \pm 5.1$ **7950 ± 110**
$\Delta = -628.2 \pm 5.1$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Carbonate nodules and tubules, from sand-ridge area at base of Wilkatana Fan. Benzene, 1020 min. count. *Comment* (G.E.W.): date for youngest calcareous soil on Lake Torrens plain. Soil correlates with that dated by ANU-224.

ANU-224. $\delta C^{14} = -533.6 \pm 4.7$ **6450 ± 90**
$\Delta = -552.2 \pm 4.9$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Fine earth carbonate from same area at base of Depot Creek Fan as ANU-223. Benzene, 1660 min. count. *Comment* (G.E.W.): compares and correlates with parent charcoal, ANU-219.

ANU-225. $\delta C^{14} = -956.9 \pm 3.5$ **25,600 ± 680**
$\Delta = -958.6 \pm 3.4$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Alluvial clay containing nodules and patches of authigenic carbonate, near apex of Wilkatana Fan. Small pebbles of limestone and dolomite within same alluvium, late Pleistocene fan and valley fill, on Lake Torrens Plain. Other carbonates dating same horizon are ANU-226, 227, 264, 282 and probably also ANU-127. Benzene, 1020 min. count.

ANU-226. $\delta C^{14} = -979.0 \pm 2.7$ **31,360 ± 1000**
$\Delta = -979.8 \pm 2.6$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Pebbly mudstone, containing numerous nodules of authigenic $CaCO_3$. Small pebbles of limestone occur in the alluvium, taken from apex of Depot Creek Fan. See ANU-225 for other related samples. Benzene, 1960 min. count. *Comment* (G.E.W.): anomalously great age attributed to inclusion of detrital fragments of ancient limestone, distinguishable in thin section.

ANU-227. $\delta C^{14} = -934.6 \pm 3.6$ **22,250 ± 500**
$\Delta = -937.2 \pm 3.5$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Pebbly mudstone, containing large nodules of authigenic $CaCO_3$, base of Depot Creek Fan. Small pebbles of limestone and dolomite occur in sediment. Benzene, 1000 min. count.

ANU-228. $\delta C^{14} = -944.0 \pm 3.8$ **23,500 ± 550**
$\Delta = -946.3 \pm 3.7$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Fault gouge cemented by $CaCO_3$, fault cutting Pleistocene sediments at apex of Wilkatana Fan ca. 3 m above bed of modern wash. Date correlates with ANU-225. Benzene, 860 min. count.

ANU-263A. $\Delta = -236.3 \pm 10.1$ **2160 ± 110**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Fragments of carbonized wood from base of vertical bank on N side of Hookina Creek (31° 44′ S Lat, 138° 14′ E Long) next to Hawker-Cotabena Rd. Benzene, 860 min. count. *Comment* (G.E.W.): dates youngest terrace along Hookina Creek and correlates with ANU-215 and 217 further S.

ANU-264. $\delta C^{14} = -939.6 \pm 3.6$ **22,900 ± 500**
$\Delta = -942.0 \pm 3.5$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Red clayey silt and fine sand cemented with $CaCO_3$ and gypsum with possibly limestone pebbles in alluvium. Interdune corridor in sand-ridge country W of Parachilna (31° 11′ S Lat, 138° 15′ E Long), dating *basement* soil in "Motpena" australite-strewn field.

ANU-265. $\Delta = -524.2 \pm 5.9$ **6000 ± 100**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal grains within fine sand flooring interdune corridor in sand-ridge country W of Parachilna. Correlates with ANU-214 and 219. Should date youngest australite-bearing formation in "Motpena" strewn field. Benzene, 1000 min. count.

ANU-280. $\delta C^{14} = -860.1 \pm 4.4$ **16,130 ± 250**
$\Delta = -865.7 \pm 4.2$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Carbonate cylindroids from calcareous soil within sand ridge area near Nacoona (32° 15′ S Lat, 137° 50′ E Long) ca. 20 mi N of Pt. Augusta. Benzene, 820 min. count. *Comment* (G.E.W.): soil developed within sand dunes regarded as second youngest soil on the Lake Torrens Plain. Dated elsewhere on the plain by ANU-281 and probably also ANU-100 and 132, mean value ca. 14,000 B.P.

ANU-281. $\delta C^{14} = -767.1 \pm 4.5$ **12,050 ± 160**
$\Delta = -776.4 \pm 4.4$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Carbonate cylindroids and nodules from exposed surface of old dune sands, Motpena Sta. (31° 12′ S Lat, 138° 16′ E Long) correlates with ANU-280. Benzene, 980 min. count.

ANU-282. $\delta C^{14} = -493.8 \pm 5.8$ **5800 ± 100**
$\Delta = -514.1 \pm 5.9$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Carbonate nodules from calcareous soil, 10 to 30 cm beneath inter-dune corridor, Motpena Sta. For other related dates, see ANU-225. Heavy rains cause torrential runoff over area where sample was coll. Benzene, 1000 min. count. *Comment* (H.A.P.): anomalously young age reflects atmospheric-C^{14} uptake of carbonates upon wetting.

ANU-283. $\delta C^{14} = -496.6 \pm 5.8$ **5840 ± 100**
$\Delta = -516.8 \pm 5.9$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Tubules of dense $CaCO_3$, near base of terrace on N bank of Hookina Creek, where ANU-263A was coll. High water table, with sample site subject to periodic flooding. Tubules replace plant remains. Benzene, 1000 min. count.

ANU-302. $\delta C^{14} = -797.0 \pm 4.2$ **13,140 ± 170**
$\Delta = -805.1 \pm 4.1$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Carbonate nodules, from gleyed alluvium within vertical bank of Hookina Creek above present flood plain. Interpreted as "ground water calcrete" deposited during earlier phase of high water table. Benzene, 1100 min. count. *Comment* (H.A.P.): ANU-300, charcoal not yet dated; will provide control age for parent alluvium.

General Comment (G.E.W.): 3 calcareous paleosols of late Quaternary age are developed on Lake Torrens piedmont plain, South Australia. Mean radiocarbon ages for paleosols are in correct order at ca. 7200 B.P., 14,000 B.P., and 21,400 B.P. One sample from the oldest soil, ANU-

226, 31,360 ± 1000 B.P., is anomalously old due to incorporation of dead limestone, whereas recrystallized authigenic carbonate from same paleosol, but in subchannel area subject to periodic flooding, yielded anomalously young age, ANU-282, 5800 ± 100 B.P. All other dates fall within acceptable range.

C. Dating infall of australites (tektites)

Study undertaken by J. F. Lovering, and B. Mason, Smithsonian Inst., Washington, D.C., and supplemented by stratigraphic evidence provided by G. E. Williams on occurrence and age of fall of australites. At time of fieldwork, these "ages" were reported. 1) K/Ar dating at 700,000 B.P. (Zähringer, 1963); similar K/Ar ages for tektites from Indonesia, Thailand, Indochina, and Philippines are also indicated. McDougall and Lovering (1969) provided further K/Ar data, evaluated at 860,000 yr for australites, 2) fission-track dating from 30,000 to 800,000 B.P. was interpreted as consistent with K/Ar ages, younger ages ascribed to partial annealing of fission tracks by reheating on Earth's surface (Fleischer and Price, 1964), 3) C^{14} age of charcoal believed assoc. with australites, as well as geologic evidence, indicated age between last glacial and 6000 to 7000 B.P. (Gill, 1965). Although "ages" were inconsistent, field work on geology of australite occurrences favored the "younger" radiocarbon age. Australites are being eroded out of compacted eolian sand underlying recent seif dunes in Lake Torrens and Lake Eyre regions. Calcareous samples of horizons in which or above which australites occur coll. in 1965 by Lovering and 1967 by Mason subm. by Geophysics.

ANU-28/2. $\delta C^{14} = -669.3 \pm 4.9$ **9220 ± 120**
$\Delta = -682.5 \pm 4.7$ $\delta C^{13} = -5.2 \pm 0.2‰$

Calcareous sand at base of unconsolidated red sand dune, Pine Dams "Myrtle Springs", 24 mi W of Leigh Creek (32° 26′ S Lat, 138° 01′ E Long). Australites found assoc. with this calcareous horizon. Benzene, 1340 min. determination. *Comment* (H.A.P.): age confirms earlier determination of ANU-28 (Radiocarbon, 1967, v. 9, p. 19). *Comment* (J.F.L.): perfect preservation of delicate flanges of australites in area indicates that little transport occurred prior to assoc. with dated horizon. *Comment* G.E.W.): possibly related to ANU-280, 281 and 100 which are older than ANU-28.

ANU-45. $\Delta = -51.9 \pm 13.4$ **430 ± 110**
$\delta C^{13} = -21.6 \pm 0.2‰$

Charcoal within hard "old soil" layer, 1.5 m below dune crest near Lake Peachawarrina (29° 01′ S Lat, 138° 18′ E Long). Carbonate nodules, ANU-82 derived from same horizon. Benzene, 320 min. count. *Comment* (H.A.P.): age indicative of intrusive young charcoal not related to time of formation of "old soil."

ANU-82. $\delta C^{14} = -528.2 \pm 5.5$ **6380 ± 95**
$\Delta = -548.0 \pm 5.3$ $\delta C^{13} = -4.3 \pm 0.2‰$

Carbonate nodules, Peachawarrina site, ANU-45. Benzene, 1380 min. count.

ANU-100. $\delta C^{14} = -835.0 \pm 5.0$ **14,840 ± 250**
$\Delta = -842.3 \pm 4.8$ $\delta C^{13} = -3.9 \pm 0.2‰$

Calcareous nodules from surface of bench underlying sand at Pine Dam "Myrtle Springs". Australites found loose among nodules. Benzene, 1320 min. count. *Comment* (G.E.W.): date for calcareous soil development within sand dunes. See ANU-280 for other dates for same horizon.

ANU-127. $\delta C^{14} = -916.6 \pm 3.7$ **20,310 ± 360**
$\Delta = -920.2 \pm 3.6$ $\delta C^{13} = -3.4 \pm 0.2‰$

Unusually large calcareous nodules, 2 m below bench of ANU-100, Pine Dam, believed by G. E. W. to correlate with soil developed further S on the Lake Torrens plain represented by ANU-225. Benzene, 1340 min. count.

Finke river series

S bank of Finke R., 2 mi N of Idracowra Homestead (24° 59′ S Lat, 133° 44′ E Long). Vertical cliff ca. 30 m above river level, exposing 3 carbonate horizons. Australites not found at this site, but coll. in nearby surface deposits.

ANU-128. $\delta C^{14} = -854.7 \pm 10.5$ **15,950 ± 420**
$\Delta = -864.1 \pm 10.0$ $\delta C^{13} = -3.6 \pm 0.2‰$

Carbonate nodules in 1st horizon ca. 5 m below top of Finke R. cliff. Benzene, 2760 min. count.

ANU-129. $\delta C^{14} = -950.7 \pm 3.2$ **24,560 ± 520**
$\Delta = -953.0 \pm 3.0$ $\delta C^{13} = -2.9 \pm 0.2‰$

Carbonate nodules in 2nd horizon ca. 13 m below top of Finke R. cliff. Benzene, 1360 min. count.

ANU-130. $\delta C^{14} = -985.9 \pm 3.5$ **34,320 ± 1250**
$\Delta = -986.0 \pm 2.3$ $\delta C^{13} = -3.5 \pm 0.2‰$

Large carbonate nodules in 3rd horizon ca. 23 m below top of Finke R. cliff. Benzene, 2140 min. count.

ANU-131. $\delta C^{14} = -960.5 \pm 4.0$ **26,310 ± 825**
$\Delta = -962.2 \pm 3.8$ $\delta C^{13} = -3.4 \pm 0.2‰$

Carbonate nodules from same horizon as ANU-130, coll. laterally. Benzene, 1380 min. count.

General Comment (H.A.P.): 1st series of samples coll. at lab's request to check possibility of C^{14} dating of exposed secondary soil calcretions. Results, consistent with stratigraphic position, confirmed belief that under arid conditions initial C^{14}/C^{12} ratio of formation could be preserved, and encouraged Bowler, Williams, Mason, and Lovering projects.

ANU-132. $\delta C^{14} = -780.3 \pm 6.0$ **12,540 ± 150**
$\Delta = -790.0 \pm 4.0$ $\delta C^{13} = -1.4 \pm 0.2‰$

Calcareous nodules from surface of eolian sand exposed by recent erosion of overlying dunes, Nilpena Sta. (30° 54′ S Lat, 138° 13′ E Long). Numerous australites coll. on this surface; some reported *in situ*. See ANU-280 for other dates from this soil horizon. Benzene, 2660 min. count.

ANU-193. $\delta C^{14} = -943.2 \pm 3.6$ **23,050 ± 520**
$\Delta = -945.5 \pm 3.5$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Calcareous nodules on exposed clay pan with assoc. australites, Earaheedy Sta. (25° 43′ S Lat, 121° 56′ E Long) 250 mi NE of Meekatharra. Geologic situation similar to that of Pine Dam, ANU-127, 1000 mi to SE. Benzene. 1020 min. count.

General Comments (J.F.L., B.M., and G.E.W.): well-preserved australites are common in lag flooring corridors between seif dunes in Motpena area of Lake Torrens and Pine Dam and Nilpena sites. Study of Quaternary stratigraphy indicates that late Pleistocene relict sand dunes are most likely source, supporting assumption based on uniformity of physical and chemical composition that australites fell as single shower. Radiocarbon ages of calcareous nodules from soil horizon in which australites were found, ANU-28, 100, 280, 281 scatter round 13,000 ± 3000 B.P. Varying of results could be indicative of uncertain, fluctuating amount of "dead" carbonate contamination of nodules, or that australites fell on eroded surface of eolian sediments and are assoc. with nodules of different ages at different places.

D. Quaternary lakes

Late Quaternary stratigraphy, chronology, and succession of lakes and assoc. features mainly in semiarid zone of SE Australia form part of independent study by J. M. Bowler, who coll. samples in 1968. Subm. by Dept. of Biogeog. and Geomorph.

Willandra lakes series

In W New South Wales, system of large dry lakes of area ca. 400 sq. mi, were maintained for long periods in late Quaternary by Willandra Creek (33° 00′ S Lat, 144° 23′ E Long), effluent of the Lachlan R. With climatic change near end of Pleistocene, system became inactive due to reduction in stream flow and increased evaporation. Samples obtained to establish pattern of water-level oscillations, formation of lake-shore transverse dunes (lunettes), and linear or continental dunes with which lakes are assoc.

Three stratigraphic units have been recognized within eolian sediments and soils, informally named from youngest to oldest: Zanci, Mungo, and Golgol soil-sedimentary units. In these, soil formation alternated with active eolian deposition and lunette growth. Latter can be related to fluctuating water levels within active lakes, but soils formed during dry periods. Dates are listed from oldest to youngest, reflecting sequential development.

ANU-306. $\delta C^{14} = -991.3 \pm 2.6$ **38,500 $^{+2950}_{-2150}$**

$\Delta = -991.7 \pm 2.5$ *Est.* $\delta C^{13} = -2.0 \pm 2.0‰$

Unionid shells from gypseous lacustrine sandy clay exposed in gullied terrace on Outer Arumpo Lake floor (142° 51′ S Lat, 33° 46′ E Long) 4 mi E of Arumpo Sta. homestead. 10% (outer shell surface) by weight leached away by acid. Benzene, 3000 min. count. *Comment* (J.M.B.): age indicative of early high water level in low salinity environment.

ANU-305. $\delta C^{14} = -988.0 \pm 2.7$ **35,850 $^{+2050}_{-1600}$**

$\Delta = -988.5 \pm 2.6$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Ripple marked, cross-laminated shallow-water dolomite, from soil profile on lake-shore terrace, 500 m SW from Mungo Sta. homestead, Lake Mungo (142° 54′ S Lat, 33° 48′ E Long). Benzene, 1980 min. count. *Comment* (J.M.B.): affected post-depositionally by younger carbon, indicated by recrystallization visible on thin section. Age considered minimal for deposits which relate to terminal or drying phase before 40,000 B.P. probably correlating with late phase of Golgol deposition in dune stratigraphy.

ANU-331. $\delta C^{14} = -982.3 \pm 2.7$ **32,750 ± 1250**

$\Delta = -983.1 \pm 2.6$ *Est.* $\delta C^{13} = -2.0 \pm 2.0‰$

Unionid shells from deflation surface within dune on S end of "Walls of China", E shore, Lake Mungo. 12% (outer shell surface) by weight leached away by acid. Benzene, 2000 min. count. *Comment* (J.M.B.): shells represent early low salinity, high-water facies and appear assoc. with early human occupation. If further substantiated, it represents one of earliest dated occurrences of human occupation in Australia. Current work supports this interpretation. Shells underlie horizon of calcareous argillaceous sands blown from lake floor during drying, forming upper phase of Mungo deposition. Soil formed indicates lake was dry for considerable period after 32,000 B.P.

ANU-303. $\Delta = -976.8 \pm 2.7$ **30,250 ± 950**

Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal from remains of fire in red, cross-bedded sands of Mungo unit in Sec. E of Mungo Homestead. Benzene, 2040 min. count. *Comment* (J.M.B.): estimates age of Mungo deposition during terminal phase of lacustrine activity (drying of lake). This may suggest warm-climate oscillation ca. 30,000 B.P.

ANU-304. *$\Delta = -965.0 \pm 11.2$* **26,900 $^{+3100}_{-2200}$**

Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal from fire on disconformable contact at top of Mungo Unit 2 m in gullied profile through Outer Arumpo lunette 3 mi W from Joulni Homestead. Sample was sealed beneath younger bedded Zanci deposits. Charcoal horizon had developed on Mungo sediment on which marked soil formation had already taken place. Benzene dilution, 3620 min. count. *Comment* (J.M.B.): stability necessary for pedogenesis suggests dry-lake regime in period immediately preceding 27,000 B.P. This, with previous evidence, would place Mungo dry oscillation between ca. 27,000 and 30,000 B.P.

ANU-310. *$\delta C^{14} = -943.0 \pm 3.9$* **23,350 ± 550**

$\Delta = -945.3 \pm 3.7$ *Est. $\delta C^{13} = -5.0 \pm 2.0‰$*

Tubular carbonate concretions in shallow-water sediments on E shore Lake Mungo, believed formed by precipitation around stems or roots of aquatic plants. Benzene, 1040 min. count. *Comment* (J.M.B.): represents 1st high-water stand following Mungo low-water oscillation.

ANU-311. *$\delta C^{14} = -940.4 \pm 3.6$* **23,000 ± 500**

$\Delta = -942.8 \pm 3.5$ *Est. $\delta C^{13} = -5.0 \pm 2.0‰$*

Dolomitic sandstone exposed by deflation on the floor of Lake Chibnalwood. Dolomite cements shallow-water, well-sorted medium- to fine quartz sand representing shoreline or near-shore environment and low lake level. Benzene, 1020 min. count. *Comment* (J.M.B.): age appears to correlate with end of Mungo dry oscillation and onset of next high-water phase represented by carbonates in Lake Mungo, ANU-310.

ANU-329. *$\delta C^{14} = -880.2 \pm 4.1$* **17,380 ± 280**

$\Delta = -885.0 \pm 4.0$ *Est. $\delta C^{13} = -5.0 \pm 2.0‰$*

Finely bedded calcareous sands from 1 m in gullied profile in Outer Arumpo lunette. Sample from highest or Zanci unit in lunette sequence overlying ANU-304. Benzene, 1220 min. count. *Comment* (J.M.B.): carbonate in form of pelletal aggregates and comminuted shell fragments from deflated lake floor believed to have been in near equilibrium with bicarbonate of lake waters and atmospheric C^{14} at time of drying. Age represents onset of final drying (Zanci oscillation).

ANU-321. *$\Delta = -878.0 \pm 4.0$* **16,900 ± 270**

Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal from fire remains sealed beneath Zanci sands immediately over disconformable contact with Golgol unit in Lake Garnpung lunette, Baymore Sta. Sample from basal level in Zanci unit represents early stage of Zanci deposition corresponding to onset of drying. Benzene, 1140 min. count. *Comment* (J.M.B.): agrees with ANU-329, relating same event to other parts of system.

ANU-320. $\delta C^{14} = -871.0 \pm 4.6$ **16,780 ± 290**
$\Delta = -876.1 \pm 4.5$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Calcareous sandy clay from 1.5 m in profile on crest of Chibnalwood lunette. Carbonate occurs with pelletal clay aggregates with some shell fragments and, as in ANU-329, is believed to represent deposition from lake water during terminal, drying phase of Zanci oscillation. While ANU-329 dates beginning of that event in Arumpo-Chibnalwood lakes, ANU-320 represents conclusion of dune building or final drying of lake. Benzene, 1020 min. count. *Comment* (J.M.B.): small error due to incorporation of older carbon may be present but both ANU-329 and 320 provide results consistent with field evidence and other radiocarbon analyses.

"Walls of China", Lake Mungo series

ANU-330. $\Delta = -889.2 \pm 7.2$ **17,670 ± 550**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments from base of Zanci calcareous sands 2.5 m above site of ANU-303 and 1.5 m above disconformable contact with red Mungo sands in Sec. E of Mungo Homestead. Benzene, 1280 min. count.

ANU-292. $\Delta = -875.0 \pm 9.1$ **16,700 ± 600**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal from extensive horizon developed in middle of Zanci calcareous sands on S end of Lunette. Benzene, 1040 min. count.

ANU-312. $\Delta = -872.3 \pm 6.3$ **16,530 ± 400**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal fragments from remains of fire sealed in Zanci calcareous sand ca. 6 m stratigraphically below upper limit on Sec. E from Mungo Homestead. Benzene, 1480 min. count.

ANU-319. $\delta C^{14} = -862.7 \pm 4.0$ **16,280 ± 250**
$\Delta = -868.2 \pm 4.1$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Bedded calcareous and argillaceous sand sealing ANU-312. ANU-319 represents eolian sediment deposited contemporaneously. Selected to test Hypothesis that carbonate assoc. in eolian clay aggregates in lunette was precipitated in near C^{14} equilibrium conditions with lake water and atmosphere at time of deflation. Benzene, 1140 min. count. *Comment* (J.M.B.): remarkable agreement substantiating hypothesis and validating use of calcareous sediments for dating lunettes, where organic carbon is not available. Group ANU-292, 312, and 319 represents age of basal, middle, and upper zones of Zanci unit, in consistent sequence. Start of drying est. at ca. 17,500 B.P. correlates well with that determined by ANU-329 and 321; both relate to same event in other lakes.

ANU-266. $\delta C^{14} = -846.2 \pm 4.0$ **15,400 ± 210**
$\Delta = -853.3 \pm 3.9$ *Est.* $\delta C^{13} = -2.0 \pm 2.0‰$

Unionid shells from trench excavated through lake shore sediments in inner W margin of Lake Garnpung lunette, Golgol Sta. Benzene, 1020 min. count. *Comment* (J.M.B.): age of youngest shells exposed in sediments, consistent with final drying. Lake Garnpung, on upstream end of system, probably received fresh-water inflow from waning discharge of Willandra Creek after Lakes Mungo and Chibnalwood had dried. Final drying in Lake Chibnalwood ca. 16,780 (ANU-320) occurs before that in Lake Garnpung represented by ANU-266.

ANU-293. $\Delta = -848.1 \pm 15.5$ **15,140 ± 850**
Est. $\delta C^{13} = -24.0 \pm 2.0‰$

Charcoal from fire remains in sand overlying Zanci high-water level gravel in gully sec. through E edge of Lake Mungo, Joulni Sta. Benzene, 1040 min. count. *Comment* (J.M.B.): postdates final drying of lake, confirming interpretation based on dune stratigraphy as in ANU-312 and 292.

Soil carbonate series

Following experiences in soil-carbonate dating described earlier (this date list) 3 samples were selected to answer specific stratigraphic problems and test field hypotheses rather than further to test reliability of materials.

ANU-268. $\delta C^{14} = -940.0 \pm 3.6$ **22,950 ± 500**
$\Delta = -942.4 \pm 3.5$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Hard carbonate concretions in red calcareous Golgol soil in Garnpung lunette at site of excavation on Golgol Sta. Benzene, 1020 min. count.

ANU-270. $\delta C^{14} = -972.2 \pm 2.7$ **29,100 ± 800**
$\Delta = -973.3 \pm 2.6$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Hard carbonate concretions in red calcareous Golgol soil in "Walls of China", in Sec. E of Zanci Sta. Homestead. Benzene, 2020 min. count. *Comment* (J.M.B.): based on conclusions drawn from soil-carbonate project, ages of these samples are younger than sediments in which they occur. Age of Golgol deposition is older than 30,000 B.P.

ANU-269. $\delta C^{14} = -715.0 \pm 4.7$ **10,400 ± 140**
$\Delta = -726.4 \pm 4.6$ *Est.* $\delta C^{13} = -5.0 \pm 2.0‰$

Soft carbonate concretions from a 2nd B_{ca} horizon apparently underlying that represented by ANU-270 analyzed to determine if 2 soil-sedimentary units were present where only one had been suspected. Benzene, 1020 min. count. *Comment* (J.M.B.): young age indicates carbonate segregation later than that of main Golgol B_{ca} represented by ANU-268 and 270. Re-examination of field evidence revealed pedogenetic carbonate from Zanci unit had been leached down into underlying Golgol on steep slope from which Zanci was later eroded. In this way, younger, soft carbonate appeared low in Sec. as if stratigraphically underlying hard Golgol calcrete.

General Comment (J.M.B.): in view of variety of materials used and range of soil and sedimentary environments represented, agreement between C^{14} results and field evidence is better than anticipated. Use of calcareous lunette sediments to date lunette building and lake drying is particularly significant. Excellent agreement between dates from contemporary organic carbon (ANU-312) and lake-derived inorganic carbon (ANU-319) needs further testing in other sites, but results suggest new approach to dating of formation of calcareous lunettes across South Australia and dating of climatic changes. *Caution*: before lunette sediments can be used thus, field and micropedologic analyses must establish sample has not been affected by secondary carbonate. If such evidence is present, younger C^{14} from soil—and atmospheric CO_2 will be incorporated.

Each stratigraphic unit in dunes represents water-level oscillation with cyclic variation from high-water to low-water phase, controlled by variations of climate. Series established high-water phase from before 40,000 B.P., until some time after 33,000 B.P. Lowering of water levels and increased salinity followed, probably ca. 31,000 B.P., and at least some lakes remained dry for several thousand yrs corresponding to Mungo dry oscillation. Start of following wet phase begins ca. 25,000 B.P. This Zanci wet phase lasted until near 17,500 B.P. when, due to change in hydrologic budget, lake levels began to fluctuate and salinities increased, continuing until ca. 15,500 B.P., when discharge was insufficient to balance water lost by evaporation. Apart from occasional floods, system has remained inactive throughout the last 15,000 yr.

Sequence demonstrates effects of late Pleistocene cold phase equivalent to late-glacial climates of Northern Hemisphere, and provides 1st detailed chronology of late Quaternary environmental changes in the semiarid zone in South Australia.

Lake Keilambete series

To check climatic sequence, a deep-water lake was selected in W Victoria for comparison. Lake Keilambete near Terang (38° 10′ S Lat, 142° 53′ E Long) is volcanic, crater lake or maar, circular in plan, with rim diam. ca. 1.4 mi. Lake has small catchment area, limits of which are defined by crater rim. No streams discharge into it and groundwater increment is small compared to volume of water involved in direct precipitation, run-off from crater slopes, and evaporation. Fluctuations in water level apparent from both strandline features and from facies changes within core through lake sediment are therefore believed to directly reflect climatic variations. Salinity of present water is near 60,000 ppm and is currently increasing annually due to falling water levels.

Maar lies in Miocene marine limestone which outcrops on margin of lake. Possibility of large limestone dilution error in lacustrine carbonates precipitated from lake waters in such an environment required evaluation before carbonates could be used for dating.

In shoreline stratigraphy, lacustrine limestone alternates with dark, calcareous, and organic rich lake muds. Initially, sequence of radiocarbon analyses of organic carbon in muds representing deep water facies was obtained through Inst. of Phys. and Chem. Research (RIKEN) Radiocarbon Lab., Tokyo. These provided basis for control of ages of shallow-water lacustrine limestones with which muds alternate. Three carbonate samples were analyzed to check reliability against those derived from organic carbon. Bowler has subsequently continued this project in co-operation with T. Hamada, RIKEN Lab, using contemporaneous organic and inorganic samples from cores from lake-floor sediment. In this latter series some additional 25 samples have been analyzed results of which will be reported separately.

ANU-197. $\delta C^{14} = -116.0 \pm 7.4$ **1450 ± 70**
$\Delta = -165.5 \pm 7.0$ $\delta C^{13} = +3.0 \pm 0.2‰$

Lithified slabby lacustrine limestone overlying eroded tree remains recently emerged during falling water levels. Tree dated at 1890 ± 115 (N-390, Hamada, pers. commun.). Sample represents warm shallow water deposition during moderately low stand in lake level. Benzene, 1120 min. count.

ANU-198. $\delta C^{14} = -362.0 \pm 6.4$ **4080 ± 90**
$\Delta = -398.1 \pm 6.2$ $\delta C^{13} = +3.3 \pm 0.2‰$

Lithified, slabby lacustrine limestone stratigraphically underlying tree remains and rich organic lacustrine muds in which trees grew. Muds have been dated by organic carbon at 3820 ± 120 (N-388, Hamada, pers. commun.). Sample rests on lower organic rich lacustrine muds dated at 8690 ± 165 (N-389, Hamada, pers. commun.). Benzene, 1020 min. count.

ANU-199. $\delta C^{14} = -919.7 \pm 3.6$ **20,500 ± 400**
$\Delta = -922.2 \pm 3.6$ $\delta C^{13} = -9.2 \pm 0.2‰$

Soft white lacustrine marl disconformably underlying lacustrine muds represented by N-389. Disconformity separating ANU-199 from younger samples assoc. with a buried soil; evidence of drying period between 20,500 and 9000 B.P. Benzene, 1020 min. count.

General Comment (J.M.B. and H.A.P.): 3 samples dated are consistent with ages established by analyses of organic carbon, lending confidence to use of inorganic carbon in a saline, hard-water environment despite close contact with Tertiary limestone. In those samples, errors due to limestone dilution, if present, remain small. Results indicate lacustrine limestones were precipitated directly from lake water in which level of C^{14} activity was near equilibrium with atmospheric C^{14} levels at that time, a conclusion vindicated by more comprehensive analyses carried out by the RIKEN Lab.

General Comment (H.A.P.): our approach to problem of dating carconates (shell, coral, lake sediments, secondary soil calcretions, ground water concretions) was one of relating derived radiocarbon ages to ages based on organic materials from same horizons, supported by stratigraphic and geomorphic evidence, rather than physico-chemical argument (Ingerson and Pearson, 1964). Carbon-isotope data presented here and in Radiocarbon, 1969, v. 11, p. 245, indicate that δC^{13} values are not always recognizably displaced from initial values while C^{14} migrates into recrystallizing carbonate (cf. Chappell, J. and Polach, H. A., 1969, Recrystallization processes in late Quaternary corals in light of isotope data: ms. on file). On completion of study, results will be further discussed independently by Bowler and Polach, and Williams and Polach.

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UNIVERSITY OF BONN NATURAL RADIOCARBON MEASUREMENTS III

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The laboratory has continued to concentrate on soil and water dating, using the benzene method as outlined in Scharpenseel and Pietig (1969a).

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SAMPLE DESCRIPTIONS

I. GROUND WATER SAMPLES

A. Cologne 07 sand aquifer

After 2 yr, a 3rd repetition of radiocarbon measurements was made on same wells of the Cologne 07 sand aquifer, reported previously (Radiocarbon, 1968, v. 10, p. 8-28 and Radiocarbon, 1969, v. 11, p. 3-14). This is a continuing study of subterranean water movement (Tamers, Balke, and Scharpenseel, 1969) based on nuclear-weapon-produced excesses of C^{14}, whose variation over the past decade is measured, Radiocarbon, 1969, v. 11, p. 10-13. Carbonates were extracted by the method of Tamers (1967). Tritium concentrations are also measured. Samples coll. 1969 and subm. by members of Radiocarbon Dating Lab.

Sample	C^{14} age uncorrected	C^{14} age, corrected according to Tamers (1967)
BONN-572. Ingendorf (51° 1′ N Lat, 6° 44′ E Long)	1070 ± 60	Modern
BONN-573. Widdersdorf (50° 58′ N Lat, 6° 50′ E Long)	6540 ± 45	5290 ± 415
BONN-574. Dansweiler (50° 57′ N Lat, 6° 46′ E Long)	11,120 ± 120	9870 ± 415
BONN-575. Königsdorf (50° 56′ N Lat, 6° 46′ E Long)	6825 ± 90	5435 ± 465

Sample	C^{14} age uncorrected	C^{14} age, corrected according to Tamers (1967)
BONN-576. Glessen (50° 58′ N Lat, 6° 45′ E Long)	1510 ± 70	260 ± 415 (Modern)
BONN-577. Synthern (50° 58′ N Lat, 6° 47′ E Long)	1735 ± 50	390 ± 445 (Modern)
BONN-578. Buschbell (50° 56′ N Lat, 6° 48′ E Long)	6440 ± 65	5640 ± 330

Comment: movement of water fairly slow, compared to distance of piezometric tubes from which samples are taken. For more reliable flow speed measurement another series of radiocarbon and tritium results must be produced 2 or 3 yr later. Preliminary estimate of flow velocity is aggravated by apparent artificial disturbances of flow direction.

B. Netherrhine series

Samples are dated in support of thesis work (Balke, 1969) on distribution, flow velocity, and recharge of ground water aquifers in the Netherrhine. Samples coll. 1969 and subm. by K. D. Balke, Geol. Landesamt Northrhine Westfalia, Krefeld, and members of Radiocarbon Dating Lab.

BONN-225. Etgendorf 230 7/4 — 10,100 ± 95
(50° 59′ N Lat, 6° 33′ E Long) — 8150 B.C.

BONN-226. Etgendorf 230 7/3 — 14,200 ± 100
(50° 59′ N Lat, 6° 33′ E Long) — 12,250 B.C.

BONN-227. Etgendorf 230 7/2 — 4200 ± 60
(50° 59′ N Lat, 6° 33′ E Long) — 2250 B.C.

BONN-228. Etgendorf 230 7/1 — 4720 ± 80
(50° 59′ N Lat, 6° 33′ E Long) — 2770 B.C.

BONN-516. Margaretenhof — 1530 ± 70
(50° 57′ N Lat, 6° 25′ E Long) — A.D. 420

BONN-517. B 32 Rheinbraun — 4020 ± 50
(50° 58′ N Lat, 6° 37′ E Long) — 2070 B.C.

BONN-518. MT 36 — 970 ± 60
(50° 52′ N Lat, 6° 44′ E Long) — A.D. 980

BONN-519. Oberembt — 2800 ± 80
(50° 57′ N Lat, 6° 30′ E Long) — 850 B.C.

BONN-520. Pegel 4.141, 4 Blatzheim — 2640 ± 80
(50° 51′ N Lat, 6° 36′ E Long) — 690 B.C.

Comment: dates help to confirm identity of aquifers feeding different wells. BONN-227, -228, and -517 as well as BONN-516, -518 and BONN-519, -520 belong together. BONN-226 overlies -225 and was expected to be younger. Dates BONN-225, -226 indicate, that aquifer from BONN-225 must have lateral connection with younger water resources, or BONN-226 is alimented by older fossil water reserves.

C. Landesbad Aachen wells

Wells belong to area of medical bathing resort. Identity of new wells with those already exploited is confirmed by chemical analysis and C^{14} dating. Samples coll. 1968 and subm. by Prof. Schuler, Landesbad Aachen.

BONN-509. Landesbad Aachen-Burscheidt, Quelle A — 14,200 ± 205
(50° 47′ N Lat, 6° 4′ E Long) — 12,250 B.C.

BONN-510. Landesbad Aachen-Burscheidt, Quelle D — 11,570 ± 90
(50° 47′ N Lat, 6° 4′ E Long) — 9620 B.C.

BONN-511. Landesbad Aachen-Burscheidt, Tiefenquelle — 17,140 ± 225
(50° 47′ N Lat, 6° 4′ E Long) — 15,190 B.C.

D. HOAG/Ruhrchemie/RWW series

Samples stem from aquifer of limited extent. Industries with increasing water consumption need information on extent of recharge. Also tritium concentrations are measured. Samples coll. 1968 and subm. by members of Radiocarbon Dating Lab. B.P. dates are after bicarbonate correction according to Tamers (1967).

BONN-513. Brunnen IV, Franz Haniel (HOAG) — 11,290 ± 155
(51° 33′ N Lat, 6° 53′ E Long) — 9340 B.C.
9650 ± 570 B.P.

BONN-514. RWW, Rhein, Westf. Wasserwerke — 4490 ± 80
(51° 32′ N Lat, 6° 49′ E Long) — 2540 B.C.
2875 ± 540 B.P.

BONN-515. Ruhrchemie — 9370 ± 100
(51° 31′ N Lat, 6° 48′ E Long) — 7420 B.C.
7640 ± 590 B.P.

Comment: increase in age from E to W. As presumed, some recharge from E fringes. Abrupt drop in age of BONN-514 due to past break-in of younger water through demolished pit mouth.

E. Venezuela water sample, Meachiche

A portion of the sample was previously dated at 10,730 ± 120 B.P. (Tamers, 1966; IVIC-218). Coll. 1966 and subm. by M. A. Tamers, IVIC, Caracas, as check sample.

BONN-512. Meachiche, Venezuela **10,480 ± 140**
8530 B.C.
(11° 20′ N Lat, 69° 34′ W Long)

Comment: agrees with Venezuela IVIC measurement within 1σ error range.

F. Tunisia series

As a 1st sample series within 3-yr project of dating some of Tunisia's subterranean water reserves, carbonates of 76 wells were collected. C^{14} ages are indicated, uncorrected and corrected for dead carbonate-C contibution (Tamers, 1967). In all samples also tritium concentrations are measured. Samples coll. 1968 and subm. by H. W. Scharpenseel and H. Gewehr, Inst. für Bodenkunde, Bonn Univ., J. Ohling, HER-Economic Cooperation Project, Tunis.

	Measured age	Corrected age
BONN-229. Kairouan II (35° 40′ N Lat, 10° 05′ E Long)	14,090 ± 150 12,140 B.C.	12,470 ± 540 10,520 B.C.
BONN-230. Kairouan III (35° 40′ N Lat, 10° 5′ E Long)	24,300 ± 500 22,350 B.C.	21,820 ± 830 19,870 B.C.
BONN-231. El Grine V (35° 36′ N Lat, 9° 52′ E Long)	5570 ± 50 3620 B.C.	3380 ± 720 1430 B.C.
BONN-232. El Grine II (35° 36′ N Lat, 9° 52′ E Long)	3070 ± 50 1120 B.C.	1310 ± 560 A.D. 640
BONN-233. El Haouareb (35° 34′ N Lat, 9° 45′ E Long)	5030 ± 40 3080 B.C.	2930 ± 700 980 B.C.
BONN-234. Bled Sbitha (35° 31′ N Lat, 9° 49′ E Long)	5590 ± 60 3640 B.C.	3630 ± 650 1680 B.C.
BONN-235. Sidi Ali Ben Salem (35° 33′ N Lat, 9° 54′ E Long)	8460 ± 50 6510 B.C.	6140 ± 770 4190 B.C.
BONN-236. Zafrana IV (35° 32′ N Lat, 10° 4′ E Long)	22,490 ± 370 20,540 B.C.	21,150 ± 450 19,200 B.C.
BONN-237. Puit Zafrana IV (35° 31′ N Lat, 10° 4′ E Long)	3160 ± 75 1210 B.C.	Modern
BONN-238. Sidi Amor Ben Hadjla (35° 23′ N Lat, 10° 2′ E Long)	21,390 ± 150 19,440 B.C.	19,860 ± 510 17,910 B.C.
BONN-239. Bir Boussari (35° 23′ N Lat, 9° 55′ E Long)	9790 ± 140 7840 B.C.	8450 ± 440 6500 B.C.
BONN-240. Bir Djedid (35° 24′ N Lat, 9° 56′ E Long)	7805 ± 105 5855 B.C.	6400 ± 480 4450 B.C.

	Measured age	Corrected age
BONN-241. Puit Boussari (35° 23′ N Lat, 9° 56′ E Long)	1100 ± 30 A.D. 850	Modern
BONN-242. Zafrana 4 (35° 30′ N Lat, 10° 8′ E Long)	13,830 ± 80 11,880 B.C.	12,530 ± 430 10,580 B.C.
BONN-243. Ain El Bell (35° 31′ N Lat, 10° 12′ E Long)	2370 ± 50 420 B.C.	980 ± 480 A.D. 970
BONN-244. Draa el Oust (35° 40′ N Lat, 10° 10′ E Long)	21,240 ± 310 19,290 B.C.	20,190 ± 350 18,240 B.C.
BONN-245. Bir Naceur Chaffra (35° 41′ N Lat, 10° 10′ E Long)	14,320 ± 135 12,370 B.C.	12,930 ± 480 10,980 B.C.
BONN-246. Puit Service Foret (35° 26′ N Lat, 9° 50′ E Long)	3940 ± 30 1990 B.C.	2170 ± 580 220 B.C.
BONN-247. Draa Chouk (35° 45′ N Lat, 10° 08′ E Long)	29,260 ± 370 27,310 B.C.	27,960 ± 430 26,010 B.C.
BONN-248. El Goutass I (35° 37′ N Lat, 9° 56′ E Long)	9245 ± 40 7295 B.C.	7905 ± 450 5955 B.C.
BONN-249. Kairouan IIb (35° 39′ N Lat, 10° 6′ E Long)	13,550 ± 150 11,600 B.C.	12,250 ± 430 10,300 B.C.
BONN-250. Puits Membetch III (35° 37′ N Lat, 9° 55′ E Long)	4000 ± 40 2050 B.C.	2230 ± 590 280 B.C.
BONN-251. Bir Romani I (35° 38′ N Lat, 10° 6′ E Long)	4790 ± 90 2840 B.C.	3400 ± 460 1450 B.C.
BONN-252. Bir Hadj Sadok (35° 24′ N Lat, 9° 53° E Long)	6200 ± 60 4250 B.C.	4570 ± 540 2620 B.C.
BONN-253. El Khadra (35° 29′ N Lat, 10° 1′ E Long)	6530 ± 80 4580 B.C.	5090 ± 480 3140 B.C.
BONN-254. Zafrana III (35° 27′ N Lat, 10° 4′ E Long)	15,620 ± 80 13,670 B.C.	14,380 ± 415 12,430 B.C.
BONN-255. Sidi Ahmed (35° 25′ N Lat, 10° 5′ E Long)	11,470 ± 90 9520 B.C.	10,030 ± 480 8080 B.C.
BONN-256. Pavillier (35° 25′ N Lat, 9° 51′ E Long)	4200 ± 80 2250 B.C.	2130 ± 690 180 B.C.
BONN-257. Draa Tammar I (35° 45′ N Lat, 10° 5′ E Long)	16,230 ± 430 14,280 B.C.	14,980 ± 420 13,030 B.C.
BONN-258. Draa Tammar II (35° 43′ N Lat, 10° 5′ E Long)	19,850 ± 110 17,900 B.C.	18,550 ± 430 16,600 B.C.

	Measured age	Corrected age
BONN-259. El Goutass III (35° 37′ N Lat, 10° 1′ E Long)	9660 ± 70 7710 B.C.	7860 ± 600 5910 B.C.
BONN-260. Sidi Amor Ben Hadjla I (35° 23′ N Lat, 10° 3′ E Long)	11,260 ± 100 9310 B.C.	10,520 ± 245 8570 B.C.
BONN-261. Sbiba 11 (35° 31′ N Lat, 9° 4′ E Long)	2600 ± 70 650 B.C.	Modern
BONN-262. Sbiba 12 (35° 31′ N Lat, 9° 3′ E Long)	7170 ± 80 5220 B.C.	4410 ± 920 2460 B.C.
BONN-263. Sbiba 5 (35° 31′ N Lat, 9° 2′ E Long)	3110 ± 80 2160 B.C.	1340 ± 580 A.D. 610
BONN-264. Kasserine 14 (35° 8′ N Lat, 8° 50′ E Long)	3960 ± 40 2010 B.C.	2570 ± 460 620 B.C.
BONN-265. Ain Alouche (35° 10′ N Lat, 8° 48′ E Long)	9250 ± 90 7300 B.C.	5650 ± 1200 3700 B.C.
BONN-266. Kasserine 11 (35° 9′ N Lat, 8° 48′ E Long)	10,470 ± 150 8520 B.C.	8750 ± 570 6800 B.C.
BONN-267. Kasserine 12 (35° 9′ N Lat, 8° 48′ E Long)	13,820 ± 70 11,870 B.C.	12,090 ± 575 10,140 B.C.
BONN-268. Tozeur Gare (33° 55′ N Lat, 8° 8′ E Long)	8280 ± 180 6330 B.C.	6380 ± 630 4430 B.C.
BONN-269. Sebaa Biar (34° 0′ N Lat, 8° 14′ E Long)	16,450 ± 240 14,500 B.C.	14,250 ± 730 12,300 B.C.
BONN-270. Seddada (34° 1′ N Lat, 8° 17′ E Long)	18,490 ± 430 16,540 B.C.	16,730 ± 590 14,780 B.C.
BONN-271. Puits Haffa (33° 55′ N Lat, 8° 8′ E Long	133.5 ± 0.4% Modern	Modern
BONN-272. Nefta 3 (33° 52′ N Lat, 7° 52′ E Long)	11,050 ± 175 9100 B.C.	9470 ± 530 7520 B.C.
BONN-273. El Hamma 8 (34° 0′ N Lat, 8° 10′ E Long)	13,880 ± 100 11,930 B.C.	12,030 ± 610 10,080 B.C.
BONN-274. Gouifla (34° 13′ N Lat, 8° 12′ E Long)	14,970 ± 560 13,020 B.C.	13,290 ± 560 11,340 B.C.
BONN-275. Mnagaa (Gafsa) (34° 24′ N Lat, 8° 48′ E Long)	10,370 ± 60 8420 B.C.	9690 ± 230 7740 B.C.
BONN-276. Sidi Mansour (34° 25′ N Lat, 8° 48′ E Long)	12,680 ± 100 10,730 B.C.	11,190 ± 490 9240 B.C.

	Measured age	Corrected age
BONN-277. El Guettar (34° 20′ N Lat, 8° 54′ E Long)	14,900 ± 150 12,950 B.C.	13,320 ± 530 11,370 B.C.
BONN-278. Seftimi 1 (33° 48′ N Lat, 9° 0′ E Long)	17,210 ± 460 15,260 B.C.	16,260 ± 320 14,310 B.C.
BONN-279. Tombar 3 (33° 44′ N Lat, 8° 53′ E Long)	12,550 ± 90 10,600 B.C.	9670 ± 820 7720 B.C.
BONN-280. Douz (33° 26′ N Lat, 9° 1′ E Long)	9960 ± 60 8010 B.C.	9010 ± 315 7060 B.C.
BONN-281. Chenchou (33° 54′ N Lat, 9° 52′ E Long)	12,110 ± 100 10,160 B.C.	10,860 ± 420 8910 B.C.
BONN-282. Gabés ICN 3 (33′ 59′ N Lat, 10° 2′ E Long)	13,170 ± 350 11,220 B.C.	12,020 ± 380 10,070 B.C.
BONN-283. Mareth I b (33° 37′ N Lat, 9° 50′ E Long)	11,620 ± 80 9670 B.C.	10,620 ± 330 8670 B.C.
BONN-284. Dakhlet et Bibane (30° 26′ N Lat, 9° 53′ E Long)	14,520 ± 80 12,570 B.C.	13,080 ± 480 11,130 B.C.
BONN-285. Tiaret SP 3 (30° 58′ N Lat, 10° 8′ E Long)	16,140 ± 200 14,190 B.C.	14,840 ± 430 12,890 B.C.
BONN-286. Bir Oulet Lorzet (31° 46′ N Lat, 10° 20′ E Long)	10,950 ± 60 9000 B.C.	9950 ± 330 8000 B.C.
BONN-287. Fort Saint (30° 45′ N Lat, 9° 32′ E Long)	13,060 ± 150 11,110 B.C.	11,620 ± 480 9670 B.C.
BONN-288. Zarzis (33° 29′ N Lat, 11° 4′ E Long)	10,830 ± 100 8880 B.C.	8230 ± 860 6280 B.C.
BONN-289. Qualegh (Djerba) (33° 53′ N Lat, 10° 59′ E Long)	2870 ± 90 920 B.C.	740 ± 710 A.D. 1210
BONN-290. El Djazira (Djerba) (33° 51′ N Lat, 10° 58′ E Long)	21,330 ± 160 19,380 B.C.	19,430 ± 630 17,480 B.C.
BONN-291. Sfax Siap (34° 43′ N Lat, 10° 46′ E Long)	23,900 ± 250 21,950 B.C.	20,880 ± 1005 18,930 B.C.
BONN-292. Oued Sohil (36° 31′ N Lat, 10° 42′ E Long)	10,920 ± 130 8970 B.C.	9670 ± 420 7720 B.C.
BONN-293. Oued Sidi Youssef (36° 46′ N Lat, 10° 6′ E Long)	103.5 ± 0.7% Modern	Modern
BONN-294. Taffeloun (36° 41′ N Lat, 10° 53′ E Long)	4540 ± 60 2590 B.C.	3240 ± 450 1290 B.C.

	Measured age	Corrected age
BONN-295. Dar Chichou 9447 (36° 58′ N Lat, 10° 57′ E Long)	17,300 ± 220 15,350 B.C.	16,590 ± 220 14,640 B.C.
BONN-296. Dar Chichou 8303 (37° 0′ N Lat, 10° 27′ E Long)	13,620 ± 170 11,670 B.C.	12,280 ± 445 10,330 B.C.
BONN-297. Ain Tahouna 2 (36° 15′ N Lat, 9° 11′ E Long)	7230 ± 75 5280 B.C.	5770 ± 490 3820 B.C.
BONN-298. Tabarka 1 (36° 55′ N Lat, 8° 39′ E Long)	1240 ± 70 A.D. 710	380 ± 350 A.D. 1570
BONN-299. Bulla Regia (36° 33′ N Lat, 8° 45′ E Long)	950 ± 60 A.D. 1000	Modern
BONN-300. Ain Beida (36° 13′ N Lat, 8° 56′ E Long)	3990 ± 100 2040 B.C.	2050 ± 640 100 B.C.
BONN-501. Le Kef 4 (36° 9′ N Lat, 8° 42′ E Long)	2100 ± 30 150 B.C.	770 ± 440 A.D. 1180
BONN-502. Bled Abida (36° 0′ N Lat, 8° 46′ E Long)	7950 ± 60 6000 B.C.	6010 ± 650 4060 B.C.
BONN-503. Ebba Ksour (35° 59′ N Lat, 8° 49′ E Long)	15,520 ± 120 13,570 B.C.	13,920 ± 530 11,970 B.C.
BONN-521. S. Amor Sidi Bou Hadjla (35° 22′ N Lat, 10° 4′ E Long)	16,700 ± 120 14,750 B.C.	15,500 ± 380 13,550 B.C.

Comment: BONN-229-260 and BONN-521 are from Kairouan area, captured in the Quaternary and Pliocene, BONN-261-267 from the Sbiba-Kasserine zone in Miocene sandstone and limestone, BONN-268-277, N of Schott el Djerid in Mio-Pliocene, BONN-278-287, E of Djerid and extreme S in Cretaceous (esp. Cenomanian and Turonian), BONN 288-290 at Djerba I. and neighboring Zarzis in Oligo-Miocene and Plio-Quaternary, BONN-292-296 on Cap Bon Peninsula in Pliocene (esp. Astian and Plaisancian), and BONN-297-300 as well as BONN-501-503 from Medjerdah valley in Campanian, Quaternary, Eocene and Jurassic. Samples came from water holes and from wells, both artesian and ordinary. After 2nd and 3rd yr results of sample series are available, aquifers with modern recharge and those with "fossil" water only (without alimentation) will be listed, to assist systematic water management. Further isochrones will be drawn to connect wells of equal age and chemical composition.

II. SOIL SAMPLES

Soil samples were freed from roots and organic debris as already described in Radiocarbon, 1968, v. 10, p. 8-28; 1969, v. 11, p. 3-14. Carbon analysis was carried out by method of Rauterberg and Kremkus (1951). Fractionation of soil organic matter followed the basic procedure by Flaig, Scheffer, and Klamroth (1955) in slight modification (Scharpenseel, Ronzani, and Pietig, 1968).

A. Chernozem and Steppe soils

Organic material of fossil A horizon (fA) in B horizon of Parabraunerde (hapludalf) in wall of clay pit.

BONN-403. Parabraunerde with fossil chernozem Lantershofen, 0.8% C, A_p 10 to 20 cm — 60 ± 30; A.D. 1890

BONN-404. Parabraunerde with fossil chernozem Lantershofen, 0.8% C, A_1 25 to 30 cm — 980 ± 60; A.D. 970

BONN-405. Parabraunerde with fossil chernozem Lantershofen, 1.8% C, fAB_{t1} 45 to 55 cm — 3550 ± 50; 1600 B.C.

BONN-406. Parabraunerde with fossil chernozem Lantershofen, 0.8% C, fAB_{t2} 55 to 75 cm — 5110 ± 80; 3160 B.C.

BONN-407. Parabraunerde with fossil chernozem Lantershofen, 0.7% C, fAB_{t3} 75 to 95 cm — 5530 ± 90; 3580 B.C.

BONN-408. Charcoal under disturbed chernozem humus (fossil) in Parabraunerde Lantershofen, 60 to 65 cm — 1340 ± 60; A.D. 610

BONN-409. Humic horizon at 150 to 170 cm, containing charcoal, bones, and pieces of brick, Lantershofen — 1500 ± 60; A.D. 450

Samples belong to different genetic horizons of Parabraunerde (hapludalf) profile on Würm loess with fA material of chernozem in present day B_t (B_2) horizon., clay pit Lantershofen (50° 33.5′ N Lat, 7° 7′ E Long). Coll. 1968 and subm. by E. Kopp and H. W. Scharpenseel. *Comment*: BONN-403 -407 indicate presence of fossil A horizon within B_t (B_2) horizon of profile, maximum age 5530 yr, such as observed in modern chernozems (BONN-105, BONN-112, BONN-113). Charcoal of BONN-408 and BONN-409 are too young to be in undisturbed position.

Fossil chernozem (paleudoll) buried under trachyt pumice.

BONN-411. Ochtendung, direct. Plaidt, Sample Michelsberg I, under disturbed trachyt pumice (fine roots), 0.5% C, 120 to 140 cm — 5850 ± 70; 3900 B.C.

BONN-412. Same location, 0.3% C, 140 to 160 cm — 6990 ± 80; 5040 B.C.

BONN-413. Between Ochtendung and Plaidt, Sample Michelsberg II. Under slope cover of half-weathered pumice, few fine roots penetrate, upper 15 cm in 3 to 4 m depth, 0.6% C — 10,580 ± 100; 8630 B.C.

BONN-414.	Same location, lower 15 cm, 0.4% C	10,060 ± 100 8110 B.C.
BONN-415.	3 Km S Ochtendung, in direction of Koblenz, digging deeper at fresh cut in trachyt pumice cover, 0.3% C, 260 to 275 cm	10,020 ± 90 8070 B.C.
BONN-416.	Same location, 0.3% C, 275 to 290 cm	10,230 ± 120 8280 B.C.

Samples are from slightly darker fossil chernozem A horizon, forming upper layer of Würm loess. On top cover of trachyt pumice. Samples BONN-411-414 Michelsberg, between Ochtendung and Plaidt (Rhineland Pfalz) (50° 21′ N Lat, 7° 19′ E Long), Samples 415-416 in fresh pumice pit 3 km S Ochtendung, next to road in direction of Koblenz (50° 20′ N Lat, 7° 18′ E Long). Coll. 1968 and subm. by E. Kopp and H. W. Scharpenseel. *Comment*: samples underlie layer of trachyt pumice, spread in its present position by Allerød volcanism. Estimated minimum age: 10 to 11,000 yr. Few visible deep-reaching roots cause slight rejuvenation. Ages are about twice as high as BONN-407, whose origin is in same humic horizon in unburied site. With necessary caution correction factor for rejuvenation in recent German chernozem profiles could be estimated to be ca. 2.

Fossil chernozem fA in Parabraunerde (hapludalf) B_t (B_2) horizon.

BONN-417.	Degraded fossil chernozem in Parabraunerde, E rim, clay pit Muddersheim, Rhineland, 1.34% C, A_h, 0 to 30 cm	540 ± 60 A.D. 1410
BONN-418.	Same location, 0.58% C, A_1, 30 to 70 cm	750 ± 50 A.D. 1200
BONN-419.	Same location, 0.54% C, fAB_{t1}, 70 to 90 cm	1600 ± 50 A.D. 350
BONN-420.	Same location, 0.43% C, fAB_{t2}, 90 to 120 cm	2660 ± 50 710 B.C.
BONN-421.	Same location, 0.48% C, fAB_v, 120 to 165 cm	3700 ± 60 1750 B.C.

Samples of Parabraunerde profile (hapludalf) in Würm loess with darker B horizons, Muddersheim/Rhineland, "Muddersheimer Kumm", E fringe of clay pit (50° 45′ N Lat, 6° 39′ E Long). Coll. 1968 and subm. by G. Strunk-Lichtenberg of the Institute (Strunk-Lichtenberg, 1968). *Comment*: in B_{t1} horizon fragment of string ceramics found and archeologically dated to 3000 to 3500 B.C. This again would indicate a rejuvenation factor for B_{t1} horizon of ca. 2 (see preceding series). Dark color and abrupt step up of age in B_t (B_2) horizon (Bonn-419-421) suggests humic material of fossil chernozem (fA) in argillic and B_v horizon.

Humic matter containing Würm loess with buried fossil steppe soils.

BONN-422. Fossil steppe soil, Quarry Schäferkalkwerke (50° 19′ N Lat, 8° 4′ E Long) 0.3% C, 560 to 585 cm — 21,430 ± 220; 19,480 B.C.

BONN-423. Fossil steppe soil, Gravel Pit E Weilbach (50° 3′ N Lat, 8° 6′ E Long) 0.2% C, 640 to 680 cm — 23,100 ± 300; 21,150 B.C.

BONN-424. Fossil steppe soil, Gravel Pit E Weilbach (50° 3′ N Lat, 8° 6′ E Long) 0.2% C, 580 to 620 cm — 17,950 ± 375; 16,000 B.C.

BONN-425. Fossil steppe soil, Gravel Pit SO Weilbach (50° 3′ N Lat, 8° 6′ E Long) 0.4% C, 340 to 360 cm — 19,680 ± 180; 17,730 B.C.

BONN-426. Fossil steppe soil, Tilery OB 45 Hanau-Rossdorf, (50° 11′ N Lat, 8° 15′ E Long) 0.4% C, 350 to 370 cm — 17,000 ± 570; 15,050 B.C.

BONN-427. Fossil steppe soil, Dyckerhoff-Quarry, Wiesbaden, (50° 3′ N Lat, 8° 17′ E Long) 0.4% C, 600 to 690 cm — 25,000 ± 700; 2350 B.C.

BONN-428. Fossil steppe soil, Dyckerhoff-Quarry Wiesbaden, (50° 3′ N Lat, 8° 17′ E Long) 0.2% C, 470 to 530 cm — 20,720 ± 520; 18,770 B.C.

BONN-429. Fossil steppe soil, Dyckerhoff-Quarry, Wiesbaden, (50° 3′ N Lat, 8° 17′ E Long) 0.4% C, 400 to 440 cm — 23,770 ± 470; 21,820 B.C.

BONN-430. Fossil steppe soil, Dyckerhoff-Quarry, Wiesbaden, (50° 3′ N Lat, 8° 17′ E Long) 0.2% C, 230 to 270 cm — 20,550 ± 180; 18,600 B.C.

BONN-431. Fossil steppe soil, Tilery Wallertheim (49° 2′ N Lat, 8° 3′ E Long) 0.5% N, 300 cm — 21,380 ± 490; 19,430 B.C.

Samples of layered fossil soils, taken in various spots of dark steppe soil area Rhine-Pfalz and Rhine-Hessen. Samples serve to elucidate questions of Quarternary stratigraphy and chronology of fossil steppe soil formations. Coll. 1968 and subm. by A. Semmel, Hessisches Landesamt für Bodenforschung, Wiesbaden. *Comment*: samples BONN-422-431 were expected to stem from Old Würm with ages beyond 35,000 yr. Further samples will be measured.

Various horizons of soil profiles from Boehmen and Maehren (Czechoslovakia). Scrutiny of different dark soils, such as chernozems (hapludoll) on loess and marl, pseudogley chernozem (haplaquoll), smonitza (vertisol)-like chernozems.

BONN-437.	(Boehmen, chernozem lessivé, Griserde from loess, Kozojedy, Jicin Dist., (50° 19′ N Lat, 15° 21′ E Long) 1.5% C, A_p, 0 to 20 cm	1210 ± 50 A.D. 740
BONN-438.	Same location, 1.3% C, A_hA_1, 25 to 45 cm	3390 ± 80 1440 B.C.
BONN-439.	Same location, 0.7% C, B_{th}, 50 to 70 cm	4020 ± 70 2070 B.C.
BONN-440.	Same location, 0.6% C, B_t/C, 80 to 90 cm	4150 ± 90 2200 B.C.
BONN-441.	Boehmen, chernozem lessivé, Griserde from loess, Smiuce, Hradec Kralové Dist., Tilery (50° 15′ N Lat, 15° 23′ E Long), 0.5% C, B_{th} C, 80 to 90 cm	4020 ± 60 2070 B.C.
BONN-442.	Boehmen, typic chernozem from loess, Brazdim, Prahoviphod Dist. Tilery, (50° 11′ N Lat, 14° 35′ E Long), 22% C, A_p, 5 to 30 cm	1210 ± 60 A.D. 740
BONN-443.	Same location, 1.5% C, A_h, 35 to 50 cm	2260 ± 70 310 B.C.
BONN-444.	Same location, 1.4% C, A_h/C_{Ca}, 55 to 65 cm	3430 ± 65 1480 B.C.
BONN-445.	Boehman, Smonitza (vertisol) from tertiary marly clay, Prunevor, Choumtov Dist., slightly slopy, (50° 24′ N Lat, 13° 17′ E Long), 3.7% C, A_h, 5 to 30 cm	2050 ± 70 100 B.C.
BONN-446.	Same location, 1.7% C, A_h, 35 to 50 cm	3800 ± 80 1850 B.C.
BONN-447.	Same location, 1.6% C, A_h/C_{Ca}, 55 to 65 cm	6370 ± 65 4420 B.C.
BONN-485.	Chernozem from Cretaceous marl, Zezelice I, Königrätz Dist. (50° 8′ N Lat, 15° 21′ E Long) 1.8% C, A_h, 0 to 30 cm	118.9 ± 0.3% Modern
BONN-486.	Same location, 1.1% C, A_h, 30 to 45 cm	1120 ± 60 A.D. 830
BONN-487.	Same location, 0.5% C, A/C_c, 45 to 60 cm	1460 ± 110 A.D. 490
BONN-488.	Pseudogley chernozem from cretaceous marl Zozelice II, Königrätz Dist. (50° 8′ N Lat, 15° 21′ E Long) 2.1% C, A_h, 0 to 30 cm	550 ± 60 A.D. 1400

BONN-489. Same location, 1.5% C, A_h, 35 to 50 cm — 1950 ± 70

BONN-490. Same location, 1.1% C, A_h/C_c, 50 to 60 cm — 1270 ± 65 A.D. 680

BONN-491. Chernozem-Griserde from loess, lessivé Maehren, Brnicko, Olmütz Dist. (49° 47′ N Lat, 17° 7′ E Long) 1.8% C, A_p, 0 to 20 cm — 1080 ± 65 A.D. 870

BONN-492. Same location, 1.6% C, A_h/A_1, 20 to 35 cm — 1410 ± 65 A.D. 540

BONN-493. Same location, 1.4% C, B_{th1}, 35 to 52 cm — 3130 ± 75 1180 B.C.

BONN-494. Same location, 1.1% C, B_{th2}, 52 to 62 cm — 2950 ± 75 1000 B.C.

BONN-495. Same location, 0.8% C, B_t/C, 62 to 72 cm — 4055 ± 80 2105 B.C.

BONN-496. Chernozem from sand loess, Maehren (48° 45′ N Lat, 16° 53′ E Long) 1.3% C, A_p, 0 to 25 cm — 440 ± 50 A.D. 1510

BONN-497. Same location, 1.2% C, A_h, 25 to 45 cm — 1560 ± 60 A.D. 390

BONN-498. Same location, 0.6% C, A_h/C, 45 to 55 cm — 3610 ± 75 1660 B.C.

BONN-499. Same location, 0.5% C, A_h/C, 55 to 65 cm — 3210 ± 75 1260 B.C.

BONN-500. Chernozem from loess, typic, Maehren, Bilorice, Bilorice Dist. (48° 51′ N Lat, 16° 54′ E Long) 2.3% C, A_p, 0 to 25 cm — 450 ± 60 A.D. 1500

BONN-601. Same location, 2.6% C, A_h, 25 to 40 cm — 1610 ± 60 A.D. 340

BONN-602. Same location, 1.3% C, A_h/C_c, 40 to 55 cm — 1700 ± 65 A.D. 250

BONN-603. Same location, 0.7% C, C_c, 55 to 65 cm — 2450 ± 70 500 B.C.

BONN-604. Chernozem, vertisol-like, Tegel Maehren, Pole, Brünn-Dist. (49° 14′ N Lat, 16° 37′ E Long) 2.9% C, A_p, 0 to 35 cm — 117.4 ± 0.8% Modern

BONN-605. Same location, 1.7% C, $A_{h,c}$, 35 to 50 cm — 2940 ± 65; 990 B.C.

BONN-606. Same location, 1.5% C, $A_{h,c}$, 50 to 70 cm — 3690 ± 70; 1740 B.C.

BONN-607. Same location, 0.9% C, A/C_c, 70 to 80 cm — 4070 ± 70; 2120 B.C.

Samples BONN-437-447 as well as BONN-485-500 and BONN-601-607 from various great soil groups of Udolls in plains and slightly rolling areas of Czechoslovakia. Coll. and subm. 1968 by D. Nemécek Sec. of Soil Sci., Research Center for Plant Prod., Prague. *Comment*: except for vertisol-like chernozem (BONN-447) maximum age in deepest layers of A horizons lags behind maximum ages found in N boundary area of Western German "Feuchtschwarzerden", Brunswick region (BONN-32, BONN-105, BONN-113), but comply very well with maximum ages obtained for Hildesheim pseudogley chernozems (BONN-119, BONN-127). Vertisol-like profile, Tegel, (BONN-604-607) shows fairly low age gradient, reflecting homogenizing effect of longterm recycling self-mulching principle, which is an intrinsic property of these soils. Work is in progress on buried fossil horizons of Czechoslovakia, that merge elsewhere into recent profile, to produce correction factor for rejuvenation (*cf*. BONN-403-416).

Deep plowed degraded chernozem on young Würm Loess WIII, Florsheim (Hessen) on middle terrace of Main R.

BONN-453. Florsheim (Hessen), 0.6% C, RM, 30 to 40 cm — 990 ± 40; A.D. 960

BONN-454. Same location, 0.4% C, A_h, 50 to 60 cm — 3360 ± 80; 1410 B.C.

Samples coll. 1968 and subm. by H. Zakosek, Hessisches Landesamt für Bodenforschung, Wiesbaden (50° 17.5′ N Lat, 8° 58′ E Long). *Comment*: age of deeper sample is about average so far measured at this depth in chernozem samples of Germany.

Several forms of Russian chernozem (hapl-, vermudoll) on Würm loess.

BONN-455. Deep chernozem from loess, Orel (52.5° N Lat, 36.2° E Long) 4.5% C, A_p, 10 to 20 cm — 1020 ± 70; A.D. 930

BONN-456. Same location, 2.3% C, A_h, 50 to 60 cm — 2680 ± 70; 730 B.C.

BONN-457. Same location, 1.0% C, AC, 110 to 120 cm — 4720 ± 60; 2770 B.C.

BONN-460. Typical chernozem from loess, Charkov (50° N Lat, 36° 12′ E Long) 3.3% C, A_p, 10 to 20 cm — 1190 ± 60, A.D. 760

BONN-461. Same location, 2.8% C, A_h, 50 to 60 cm — 2650 ± 70, 700 B.C.

BONN-462. Same location, 0.7% C, AC, 110 to 120 cm — 5920 ± 140, 3970 B.C.

BONN-464. S chernozem from loess, Zaparoskje (49° N Lat, 35° E Long) 2.0% C, A_p, 10 to 20 cm — 940 ± 90, A.D. 1010

BONN-466. Same location, 1.0% C, AC, 110 to 120 cm — 3270 ± 80, 1320 B.C.

BONN-468. Chestnut soil from loess, Askania Nova (46° 30′ N Lat, 34° E Long) 2.0% C, A_p, 10 to 20 cm — 1010 ± 60, A.D. 940

BONN-469. Same location, 1.2% C, A_h, 50 to 60 cm — 1580 ± 90, A.D. 370

BONN-470. Same location, 0.7% C, AC, 110 to 120 cm — 2710 ± 70, 760 B.C.

Samples coll. 1967 and subm. by H. Zakosek. *Comment*: although Russian chernozems have developed deeper A horizons, age of these samples is about the same as in deepest humus layer of West German chernozems (BONN-105, -112) indicating similar period of origin (Scharpenseel and Pietig, 1969 b).

B. Vertisol

Deepest humus containing layer of Tunesian Vertisols.

BONN-433. Vertisol, Béja **2920 ± 40** **970 B.C.**

(36° 55′ N Lat, 8° 39′ E Long) 0.5% C, AC, 60 to 85 cm. Slightly vertic dark xerert soil on calcareous loam, 2 km W Béja. Coll. 1968 and subm. by H. W. Scharpenseel.

BONN-434. Vertisol Zouarine **3680 ± 65** **1730 B.C.**

Near Ebba Ksour (35° 59′ N Lat, 8° 49′ E Long) 0.6% C, AC, 140 to 170 cm. Grumustert Zouarine, 30 km SW Le Kef. Sample taken from maximum penetration depth of cracks. Coll. 1968 and subm. by H. W. Scharpenseel. *Comment*: both ages of BONN-433 and -434 were expected to be higher. Homogenizing effect of self mulching, vertic principle seems to be cause.

C. Parabraunerde (hapludalf)

Parabraunerde (hapludalf) or refilled and recultivated brown coal pit.

BONN-436. Parabraunerde Bergheim **730 ± 50**
A.D. 1220

(50° 56′ N Lat, 6° 43′ E Long) 0.3% C, A_p, 15 to 25 cm. Sample is mixture of raw loess and former Parabraunerde, flooded by hydraulic transport on top of refilled brown coal pit and re-used for crop production for ca. 10 yr. Coll. 1967 and subm. by E. Schulze, Inst. of Agron., Bonn Univ. *Comment*: humus produced in 10 yr after recultivation was expected to contain all bomb carbon. Extracts of humic matter were planned to be fractioned for relative age determination of humic matter fractions with reference to bomb carbon distribution curve of last 10 yr. Influence of residual humus however too high for fraction dating by bomb carbon measurement.

D. Buried organic matter

Organic matter–containing loam for dating age of soil formation along slight grade.

BONN-448. W. Eddersheim, humus loam **8300 ± 120**
6350 B.C.

(50° 2′ N Lat, 8° 28′ E Long) 0.6% C

Sample from W Eddersheim (Hessen) coll. and subm. by A. Semmel. *Comment*: BONN-448 complies well with age expectations from 7 to 10,000 yr.

Humus-containing sand with charcoal, fireplace.

BONN-608a. Fireplace Amalienhof, 60 cm deep, charcoal only **2530 ± 70**
580 B.C.

BONN-608b. Same location humus sand without charcoal, 1.9% C **2350 ± 80**
400 B.C.

Fireplace Amalienhof, Berlin-Brandenburg (52° 31′ N Lat, 30° 9′ E Long). Coll. and subm. 1968 by U. Schwertmann, Inst. für Bodenkunde, Tech. Univ. Berlin. *Comment*: fireplace is cut by clay strings. Age determination allows conclusion on clay migration. BONN-608 a, b are less than estimated 4000 yr. Pure charcoal is ca. 180 yr older than mixture of humus and charcoal powder.

BONN-609. Buried humus A_h, Heiligensee Forest, 0.6% C, 210 m **760 ± 60**
A.D. 1190

Humus under dune sand in Heiligensee Forest, Berlin-Brandenburg (52° 36′ N Lat, 30° 56′ E Long). Coll. and subm. by U. Schwertmann. *Comment*: humus 210 m under dune sand. BONN-609 indicates age of dune formation and time span for recent soil development.

Sandy humus, fossil organic matter.

BONN-449. Sandy humus, Kevo, N Finlandia, 75 to 80 cm **2350 ± 70**
400 B.C.

Sample from 75 to 80 cm depth at entrance of seismologic tunnel to Research Sta. Kevo, Finlandia (69° 46′ N Lat, 27° 3′ E Long). Coll. and subm. 1968 by A. Semmel. *Comment*: BONN-449 indicates age of soil formation with some rejuvenation by penetrating roots.

Fossil A horizon of humus silty sand.

BONN-432. Fossil A horizon, Spitzbergen, 50 to 60 cm **3040 ± 80** **1090 B.C.**

Fossil horizon at 50 to 60 cm depth, Hohenstaufen Plateau, Barents I, SE Spitzbergen (no exact coordinates measured). Coll. and subm. 1968 by A. Semmel. *Comment*: sample indicates age and speed of soil formation under cold climate conditions. BONN-432 agrees with estimates.

E. Bones in loess

Bone relics in loess, Michelsberg.

BONN-763. Bone-collagen, Michelsberg, 5 m **10,800 ± 100** **8850 B.C.**

Bones in loess deposit under trachyt pumice of Allerød volcanism, 5 m deep, from Michelsberg, between Ochtendung and Plaidt, Rhineland Pfalz (50° 21′ N Lat, 7° 19′ E Long). Coll. and subm. 1969 by E. Kopp of the Inst. and H. Remy, Inst. of Paleontol., Bonn Univ. *Comment*: sample of individual bones, mostly from mole, treated with HCl to separate collagen. Age, 10,800, is younger than expected, since sample originates from loess underlying BONN-413-416. Since bones are in undisturbed position, their later emplacement seems highly improbable.

F. Soil organic matter fractions

Soil organic matter fractions are dated for information on eventual time sequence of fractions formation. In previous work Münnich, (1957) good agreement was found between total-, cellulose-, and humic matter-carbon. Two samples: St-554 A, St-554 B (Radiocarbon 1963, v. 5, p. 221) showed an age gradient from humic acid via humine and humus coal. When testing decay of young organic masses in soil on basis of bomb carbon levels, Nakhla and Delibrias (1967) found development of humine to occur faster than that of humic acid. Paul *et al.* (1964), when testing organic matter fractions of chernozem, obtained younger age for fulvic acids, and equal age within error range or humic acid and humine fractions.

BONN-6 A. Söllingen-chernozem, total organic substance (52° 5′ N Lat, 10° 58.5′ E Long), AC, 60 to 80 cm 2100 ± 80 150 B.C.

BONN-6 B. Same location, only humic acid extract 2240 ± 80 290 B.C.

BONN-138. Podzol Scherpenseel, brown humic acid fraction (50° 56.5′ N Lat, 6° 0.5′ E Long), B_h, 50 to 70 cm 2060 ± 60 110 B.C.

BONN-139. Same location, gray humic acid fraction 1720 ± 60 A.D. 230

BONN-366.	Podzol Scherpenseel, fulvic acid fraction, N rim of gravel pit, (50° 56.5′ N Lat, 6°, 0.5′ E Long) A_h, 20 to 30 cm	2930 ± 40 980 B.C.
BONN-367.	Same location, hymatomelanic acid fraction	1580 ± 80 A.D. 370
BONN-368.	Same location, brown humic acid fraction	2530 ± 60 A.D. 580
BONN-369.	Same location, gray humic acid fraction	2980 ± 70 1030 B.C.
BONN-370.	Same location, humine fraction	2850 ± 70 900 B.C.
BONN-360.	Kalkarer Moor, fulvic acid fraction, near Euskirchen, Rhineland, W marginal area (50° 36′ N Lat, 6° 40′ E Long), O horizon, 80 cm	4270 ± 80 2320 B.C.
BONN-361.	Same location, hymatomelanic acid fraction	4510 ± 80 2560 B.C.
BONN-362.	Same location, brown humic acid fraction	5380 ± 80 3430 B.C.
BONN-363.	Same location, gray humic acid fraction	5970 ± 40 4020 B.C.
BONN-364.	Same location, humine fraction	3490 ± 70 1540 B.C.
BONN-365.	Same location, humus coal fraction	4460 ± 80 2510 B.C.
BONN-397.	Pseudogley chernozem, fulvic acid fraction, Adlum near Hildesheim, lowest part of S_wA, 80 cm (52° 15′ N Lat, 10° 3′ E Long)	1800 ± 60 A.D. 150
BONN-398.	Same location, hymatomelanic acid fraction	1390 ± 70 A.D. 560
BONN-399.	Same location, brown + gray humic acid fraction	4890 ± 50 2940 B.C.
BONN-401.	Same location, humine fraction	2980 ± 70 1030 B.C.
BONN-402.	Same location, humus coal fraction	2810 ± 60 860 B.C.

Fractions are taken from pseudogley chernozem, low moor and podzol -organic matter samples. Coll. 1967, fractions separated and subm. by H. W. Scharpenseel and C. Ronzani of the Inst. *Comment*: BONN-6A and BONN-6B, chernozem in total and chernozem humic acid extract are of equal age within error range. From podzol samples BONN-138 and BONN-139, brown humic acid is slightly older than gray humic acid, that occurs in podzol only in scanty amounts and is untypic. Podzol fractions 366-370 are not very different, except for the hymatomelanic acid fraction, that might be contaminated by extraction with modern ethanol. In podzol, interconversions between humic and fulvic acid are most likely occuring. Low moor and pseudogley chernozem fractions show highest age in humic acids. In such profiles, strongly influenced by moisture excess, humine and humus coal fractions are unspecific and contain various residual organic materials of non-humine or non-humus coal character. Fraction results of additional terrestric, non-hydromorphous soil materials are forthcoming.

III. ARCHAEOLOGIC SAMPLES

A. West Germany

BONN-450. Oak wood, Wallerfangen, 3 — 260 ± 60 A.D. 1690

BONN-451. Same location, 4 — 210 ± 50 A.D. 1740

BONN-452. Same location, 5 — Modern

BONN-657. Same location, trough-rest of wood in 25 m deep copper mine — 150 ± 50 A.D. 1800

BONN-658. Same location, rest of ladder pole, wood in copper mine — 230 ± 60 A.D. 1720

BONN-659. Same location, wood in copper mine — 360 ± 60 A.D. 1590

Oak wood, Wallerfangen, Saargebiet, W Germany. Samples found in water, containing copper, in Buntsandstone, St. Barbara village, Blauwald Dist. Continuation of BONN-435 (Radiocarbon, 1969, v. 11, p. 9) (49° 22′ N Lat, 6° 43′ E Long). Coll. and subm. by H. Conrad, Bergbaumus., Bochum. *Comment*: dates primitive copper mining in this area, "Pingenbau." Expected ages from 1st to 3rd centuries A.D. are ruled out.

B. Cyprus

Wooden pieces of antique Cypric mine, Cyprus, Apliki.

BONN-677. Wood from Cyprus copper mine — **2380 ± 60 430 B.C.**

BONN-678. Wood, same location — **2280 ± 60 330 B.C.**

Cyprus samples (35° N Lat, 33° E Long), nearby Cypric-Roman ceramics found. Coll. 1968 by Kortan, Cyprus Mine Corp., and subm.

by H. Conrad. *Comment*: estimated age: 100 to 200 A.D., *i.e.*, 300 to 500 yr younger than BONN-677 and BONN-678.

IV. MODERN SAMPLES

Grass from Röttgen, 8 km SW Bonn, Rhineland.

BONN-385.	Grass, Röttgen, January, 1968	152.8 ± 0.6% Modern
BONN-386.	Grass, Röttgen, February, 1968	152.0 ± 0.7% Modern
BONN-387.	Grass, Röttgen, March, 1968	159.0 ± 0.9% Modern
BONN-388.	Grass, Röttgen, April, 1968	157.8 ± 0.9% Modern
BONN-389.	Grass, Röttgen, May, 1968	150.7 ± 0.7% Modern
BONN-390.	Grass, Röttgen, June, 1968	158.7 ± 0.8% Modern
BONN-391.	Grass, Röttgen, July, 1968	156.2 ± 0.6% Modern
BONN-392.	Grass, Röttgen, August, 1968	161.0 ± 0.9% Modern
BONN-393.	Grass, Röttgen, September, 1968	156.0 ± 0.4% Modern
BONN-394.	Grass, Röttgen, October, 1968	146.9 ± 0.7% Modern
BONN-395.	Grass, Röttgen, November, 1968	146.2 ± 0.8% Modern
BONN-396.	Grass, Röttgen, December, 1968	151.1 ± 0.6% Modern

Samples were taken monthly to observe fluctuations of bomb carbon level and as extension of bomb carbon-curve (Radiocarbon, 1969, v. 11, p. 13). Samples were taken exclusively from same meadow area within few m² (50° 41′ N Lat, 7° 5.5′ E Long). Coll. and subm. 1968 by H. W. Scharpenseel. *Comment*: among fluctuations, highest activity found in August, lowest in October and November.

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FREIBERG RADIOCARBON MEASUREMENTS I

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INTRODUCTION

This list reports the first age determinations carried out by the Freiberg Radiocarbon Dating Laboratory. The preparation of samples and radiocarbon dates were done by the first two authors, who constructed the apparatus; sample descriptions and interpretations of dates were made by the third author.

After careful selection, all organic samples, unless noted otherwise, were boiled in a water bath at the neutral point. Samples were burnt in a stream of oxygen and the released CO_2 purified following the modified method of de Vries (1956). The measurements are made with a proportional counter (active volume: 0.708 l; total volume: 0.757 l) filled with purified CO_2 to a pressure of 3 atm at 24°C. The tube is made of electrolytic copper with brass ends and teflon insulators, glued in place with araldite. The shielding consists of walls of 30 cm iron, 15 cm paraffin with boric acid, 32 commercial G. M. counters (cosmic-ray type VA-Z-232, VEB Vakutronik Dresden) arranged in a double ring, and a stainless steel vessel providing a 4.5 cm layer of Hg. The counting apparatus is installed in an underground laboratory covered by 2 m brick. At present the anticoincidence background count is (3.99 $\pm$ 0.04) cpm and the net contemporary value (95% NBS oxalic acid) is (13.42 $\pm$ 0.08) cpm. As substandard, we use tree-rings from A.D. 1816 to 1822 of an oak tree 200 years old. Activity, when corrected for age, coincides with 0.95 times the activity of NBS oxalic acid. Each sample was measured twice, more than 14 days apart, for a period of 24 hours or, if necessary, of 48 hours.

Dates are based on the Libby half-life value, 5570 $\pm$ 30 yr. Errors given together with the following results of our measurements include: the standard deviation calculated from the statistical uncertainties of the counting rates of an unknown sample, background, contemporary standard, and inaccuracy of the half-life value. Calculated errors less than 100 years are rounded off to 100 years. Mass spectrometric C^{13} measurements of some samples indicate no considerable deviations; therefore, for the following samples no correction for C^{13} content was made. Details of our apparatus, sample preparation, and measuring procedure will be published elsewhere.

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CHECK SAMPLES

Freiberg laboratory Sample no.	Age (yr)	Other laboratories Sample no.	Age (yr)	References	Sample material
Fr-39	10,925 ± 220	Bln-206	11,839 ± 200	unpubl.	peat
Fr-40	5155 ± 100	Bln-54	5140 ± 80	Radiocarbon, 1964, v. 6, p. 310	wood
		Bln-71	5200 ± 100	*ibid.*	
		KN-191	5290 ± 120	Radiocarbon, 1966, v. 8, p. 244	
		H-1749/ 1201	5030 ± 80	*ibid.*	
Fr-41	28,730 ± 1280	Bln-101a	27,800 ± 600	*ibid.*, p. 43	gyttja

Ages of check samples determined in this laboratory indicate satisfactory agreement with the results of other laboratories.

SAMPLE DESCRIPTIONS

Radiocarbon age measurements were carried through at two important sections of the Late Pleistocene and Holocene eras from the N area of the German uplands. Both sections allow a closely differentiated subdivision of the Eemian interglacial, the Weichselian glacial and the Holocene, permitting interpretation of the development of climate and environment in the former regions of Weichselian periglacial events.

A. Section of the Aschersleben Lake

A sediment series 25 m thick from the basin of the Aschersleben lake in the NE foreland of the Harz Mts. (51° 50′ N Lat, 11° 25′ E Long) was exposed by open-cast mining. The series includes 11 cycles of sedimentation. Each cycle is composed of 3 parts:

1) lower part: fluviatile deposits (gravels and sands)
2) middle part: limnic and telmatic deposits (gyttja and peat)
3) upper part: solifluction deposits with frost structures (cryoturbatic involutions).

Individual cycles are separated from each other by evidence of denudation. Some of the middle parts originated during periods of thermal oscillation. Other cycles, however, belong to adjacent cold periods. The lowest cycle includes the Eemian interglacial, the upper one the Holocene period. The intermediate 9 cycles represent climatic oscillations during the Weichselian glacial. The following parts of the Weichselian glacial period may be discerned (Mania, 1967 a-d; Mania and Stechemesser, 1969 b):

a) relative moist early glacial period with 5 thermal oscillations (interstadials), 1st 2 of which can be equated with Amersfoort and Brörup interstadials (Andersen, 1961; Andersen, de Vries, and Zagwijn, 1960; Zagwijn, 1961), whereas the 5th interstadial belongs to period of Stillfried-B complex (Fink, 1964) and of the Denekamp interstadial (van der Hammen *et al.,* 1967)

b) pronouncedly dry and cold high glacial period with at least 2 thermal oscillations (1 interstadial, 1 interval; a sect. from Geisel valley near Halle shows that at the end of high glacial period 2 more slight oscillations must have taken place: "Mücheln" intervals 1 and 2; they could not be identified in sect. of Aschersleben lake);

c) moist late glacial period with Bölling and Alleröd interstadials (according to palynologic investigations by Müller, 1953).

Coll. 1966 by D. Mania and H. Stechemesser (open pit Königsaue, Georg mine near Königsaue).

1750 ± 100
Fr-45. Königsaue 9 **A.D. 200**

Timber from wooden wall from depth 4.2 m, open pit Königsaue. Up to the 18th century permanently in region of subsoil water. *Comment*: archaeologic dating (ceramic objects found) to 1st to 2nd centuries confirmed (Frühe Römische Kaiserzeit) by C^{14} dates.

8640 ± 125
Fr-32. Königsaue 8 **6510 B.C.**

Peat from depth 1 m, 11th cycle, shore of lake S of vineyard (W of Königsaue). Numerous recent roots were hand picked. *Comment*: sample belongs to Boreal period and dates beginning of marginal peat formation of Aschersleben lake.

10,490 ± 240
Fr-44. Königsaue 7 **8540 B.C.**

Moss peat from depth 2 m, 10th cycle, Georg mine. *Comment*: date is consistent with estimated classification Pleistocene/Holocene transition (late Dryas period).

12,520 ± 180
Fr-25. Königsaue 6 **10,570 B.C.**

Wood (*Salix*) from depth 3.5 m from sands of base of 10th cycle, Georg mine. Geologic and palynologic investigations indicate early Dryas period. *Comment*: former examination confirms this age: H 77/54 = 12,300 ± 260 (Naturwissenschaften, 1955, v. 42, p. 409).

Fr-24. Königsaue 5 **12,890 ± 190**
10,940 B.C.

Calcareous gyttja from depth 4 m, 9th cycle, Georg mine. With numerous plant remains. According to geologic and palynologic investigations determined as Bölling interstadial. *Comment*: determination compatible with 2 previous radiocarbon datings from base of Bölling gyttja: H 88/74 = 13,250 ± 280, H 106/89 = 12,700 ± 320 (*ibid.*, above).

Fr-23. Königsaue 4 **25,000 ± 750**
23,050 B.C.

Wood (polar shrubs—*Salix*) from depth 7 m, from fine sands within sandy gyttja of 7th cycle, Georg mine. According to geologic and malacologic investigations determined as high glacial period. *Comment*: date nearly corresponds with values attached to period of Brandenburg stage (Cepek, 1965).

Fr-22. Königsaue 3 **32,500 ± 2600**
30,550 B.C.

Wood from sandy peat from depth 9 m, middle part of 6th cycle, Georg mine. According to geologic and palynologic investigations (small woods with *Pinus silvestris, Pinus cembra, Betula, Picea*) last interstadial before high glacial period. *Comment*: date indicates beginning of interstadial. Since duration is estimated to involve several millennia, high glacial period, assumed as pronouncedly cold and dry, must begin between 28,000 and 25,000 B.C. with stadial after this thermal oscillation. Following this warm interval, border of Scandinavian glacier extends farthest to S (Brandenburg stage).

Fr-19. Königsaue 2 **>40,000**

Wood (*Pinus*) from sandy peat from depth 11.5 m, middle part of 5th cycle, Georg mine. Fourth interstadial of early glacial period. *Comment*: this interstadial possibly represents Hengelo interstadial (van der Hammen *et al.*, 1967).

Fr-17. Königsaue 1 **>40,000**

Herbaceous remains (chiefly grasses) from clay-gyttja of depth 12 m, medium part of 5th cycle, open-cast mine Königsaue. Fourth interstadial of early glacial period. *Comment*: like previous date (Fr-19), this belongs to 1st upper sedimentary cycle reaching as far as limit of 40,000 yr.

B. Section from Grosskröbitz-Plinz, district Jena, Germany (GDR)

Section is from E highlands of Thuringia (50° 50′ N Lat, 11° 30′ E Long). The filling of a valley 12 m thick, mainly consisting of paludal lime, peat, and gyttja, was cut and exposed by recent erosion. Greatest part is Holocene. However, at some places a subdeposit of late glacial series which divided by Bölling and Alleröd deposits is recognized. Holocene series begins with peat containing numerous remains of *Pinus*. Higher up it is gradually replaced by paludal and fluviatile limes. While basal peat extends into pre-Boreal period (mainly pine forest), thin seams of peat with remains of deciduous trees (probably *Quercus*), in paludal limes belong to Boreal age (Mania and Stechemesser, 1969 a). Coll. 1966 by D. Mania and H. Stechemesser.

8340 ± 125
Fr-38. Plinz 1 **6390 B.C.**

Fragments of deciduous trees from layer of peat, 5 cm thick, embedded in paludal lime, interpreted as of Boreal age, at depth 6.5 m, 1 m above basal peat. *Comment*: Boreal age is confirmed.

8660 ± 125
Fr-36. Plinz 2 **6710 B.C.**

Fragments of deciduous trees from humus zone in paludal lime, 5 cm above basal peat, at depth 7.5 m. *Comment*: horizon in beginning of Boreal period.

9290 ± 125
Fr-37. Plinz 3 **7340 B.C.**

Calcareous peat (base peat) from depth 8 m. Recent roots removed by hand picking. Treatment with 20% HCl for 3 hr. *Comment*: result confirms interpretation as pre-Boreal. Dates of Fr-36 and Fr-37 indicate pre-Boreal/Boreal transition, which coincides with marked change of sedimentation.

9500 ± 135
Fr-35. Plinz 4 **7550 B.C.**

Cones and wood (*Pinus silvestris*) from lowest zone of basal peat, interpreted as pre-Boreal, depth 8.5 m. *Comment*: mid-pre-Boreal age is confirmed. Ca. 10 cm below peat sample a clay horizon begins, according to geologic and malacologic observations, belonging to Pleistocene/Holocene boundary. Comparable dates exist from Alperstedt Ried in Thuringian basin (Lange, 1965), Bln-242, 9975 ± 160 and from Lower Lusatia (Cepek, 1965), Bln-99, 9905 ± 200 (Radiocarbon, 1966, v. 8, p. 40).

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GEOLOGICAL SURVEY OF CANADA RADIOCARBON DATES IX

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INTRODUCTION

Both the 2-L counter, described in GSC I (Radiocarbon, 1962, v. 4, p. 13-26), and the 5-L counter (GSC IV, Radiocarbon, 1965, v. 7, p. 24-46) were operated routinely during the past year. Approximately half the determinations reported were obtained from each counter. The 2-L counter was operated at 2 atm except for August and September, 1968, when it was operated for the first time at 1 atm. This allowed for the counting of most small samples without the necessity of mixing with dead gas. The 5-L counter was operated at 1 atm, except for the same period when it was operated at 4 atm. Carbon dioxide is used as the counting gas, and both counters are of the proportional type.

All age calculations are carried out monthly by a C.D.C. 3100 computer and are based on a C^{14} half-life of 5568 ± 30 yr and 0.95 of the activity of the NBS oxalic-acid standard. Ages are quoted in years before 1950. Age errors include: counting errors of sample, background, and standard; error in the half-life of C^{14}; and an error term to account for the average variation of $\pm$ 1.5% in the C^{14} concentration of the biosphere during the past 1100 yr. The error assigned to an age is always a minimum of $\pm$ 100 yr. Finite ages are based on the 2σ criterion and "Infinite" ages on the 4σ criterion (Radiocarbon, 1962, v. 4, p. 13-26). Unless otherwise stated in the sample descriptions all ages are based on two 1-day counts.

One change has been made in the purification technique described in GSC VIII (Radiocarbon, 1969, v. 11, p. 22-42). The hot (400°C) Pt. asbestos – Ag wool furnace was removed from the purification line in order to test its effect on the purity of the CO_2 gas. Since there was no detectable change in the gas purity this furnace was not re-installed in the purification line.

Average background and standard counting rates over the past 12 months are listed in Tables 1 and 2 respectively.

With respect to the 2-L counter operating at 1 atm, the August background is the average of 4 individual daily counts. One background result was omitted for statistical reasons. The September background is the average of 6 individual daily counts. For this 2 month period, 5 different background preparations were counted. At an operating pressure of 2 atm, the 2-L monthly backgrounds are the average of 4 individual daily counts. From a total of 42 background determinations (October 1967 to July 1968 inclusive) 2 were omitted for statistical reasons. During this 10-month period, 11 different background preparations were used.

* The introductory part of this paper has been prepared by the first author, who operates the laboratory. The date list has been compiled by the second author from descriptions of samples and interpretations of dates by the collectors.

TABLE 1

Monthly Background (c/m) for Period, Oct. 1, 1967 to Sept. 30, 1968

Month	2-L counter (2 atm)	5-L counter (1 atm)
October 1967	1.188 ± .036	2.122 ± .032
November	1.220 ± .020	2.122 ± .038
December	1.200 ± .023	2.157 ± .043
January 1968	1.180 ± .024	2.154 ± .027
February	1.184 ± .024	2.176 ± .024
March	1.162 ± .019	2.177 ± .039
April	1.182 ± .036	2.162 ± .044
May	1.154 ± .031	2.061 ± .032
June	1.131 ± .019	2.099 ± .026
July	1.121 ± .018	2.115 ± .022
August	1.012 ± .016*	2.775 ± .021**
September	1.079 ± .016*	

* 2-L counter operating at 1 atm.
** 5-L counter operating at 4 atm.

The 5-L counter was operated at 4 atm during August and September. The background for this 2 month period is the average of 12 individual daily counts. No background results had to be omitted, and 4 different preparations were used. At 1 atm, the 5-L counter monthly backgrounds are the average of 4 individual daily counts. None were omitted, and 9 different background preparations were used.

TABLE 2

Monthly Standard, N_o*, (c/m) for Period, Oct. 1, 1967 to Sept. 30, 1968

Month	2-L counter (2 atm)	5-L counter (1 atm)
October 1967	19.984 ± .109	29.153 ± .129
November	19.943 ± .097	28.877 ± .121
December	20.130 ± .158	28.925 ± .127
January 1968	19.999 ± .097	28.953 ± .097
February	20.103 ± .196	28.747 ± .122
March	19.977 ± .119	28.704 ± .123
April	19.895 ± .106	29.035 ± .124
May	20.006 ± .099	28.767 ± .192
June	20.071 ± .083	29.136 ± .114
July	19.980 ± .094	28.955 ± .114
August	9.732 ± .056**	111.719 ± .158†
September	9.668 ± .096**	

* $N_o = 0.95$ x net counting rate of the NBS oxalic-acid standard.
** 2-L counter operating at 1 atm.
† 5-L counter operating at 4 atm.

For the 2-L counter operating at 1 atm, the August and September average monthly standard counting rates are each the average of 4 daily counts. No counts were omitted. All 8 counts were carried out using the same oxalic-acid preparation. The monthly standards at 2 atm are the averages of 3 individual daily counts. No counts were omitted, and 6 different oxalic-acid preparations were used.

At 4 atm, the 5-L standard counting rate is made up of the average of 6 individual daily counts. No counts were omitted and the same oxalic-acid preparation was used for all determinations. At 1 atm the 5-L standard counting rates consist of the monthly average of 3 individual daily counts. Seven oxalic-acid preparations were used, and 1 result was omitted for statistical reasons.

A comparison of ages obtained on the same sample at different counter pressures is shown in Table 3. All determinations were carried out in the 5-L counter and all samples were given the same acid and base pretreatment, except for GSC-993 and GSC-1002 where the base treatment was omitted.

TABLE 3*

Comparison of ages at different pressures in 5-L counter

Sample no.	Length of count (days)	Pressure (atm)	Age (yr. B.P.)
GSC-629**	3	1	>41,000
GSC-629-2	5	4	40,200 ± 480
GSC-993	3	1	>37,000
GSC-993-2	4	4	46,400 ± 940
GSC-1002	1	1	>40,000
GSC-1002-2	5	4	>48,000
GSC-1019	2	1	>40,000
GSC-1019-2	5	4	52,200 ± 1760

* Detailed descriptions of samples GSC-629, 993, and 1019 are deferred to a later date list.

** GSC-629 was prepared from wood only whereas GSC-629-2 was prepared from wood plus plant detritus. Presence of material younger than the wood could account for the fact that the high pressure age appears younger than the low pressure age.

Table 4 illustrates the effects of different pretreatment methods on bone samples. The samples were originally treated with dilute HCl to remove carbonates (Radiocarbon, 1969, v. 11, p. 22-42). From the results obtained it would appear that the amount of base treatment does not affect significantly the final ages obtained for these samples from an Arctic environment.* However, contamination of bones by soil organics can occur (Berger and Libby, 1966), and, therefore, some amount of base treatment is essential.

* These 3 samples were coll. near Cape Storm, Ellesmere I. All 3 bones were imbedded in sand and gravel of raised beaches; they have been subjected to freezing for much of the year, and to intermittent wetting during the summer.

TABLE 4

Tests on bone contamination by varying pretreatment*

Sample no.	Base treatment (0.1 N NaOH)	Uncorrected age (yr B.P.)	δC^{13} ‰	Corrected age (yr B.P.)
GSC-979	none	5460 ± 140	−16.1	5600 ± 140
GSC-979-2	1 hour	5270 ± 140		
GSC-980	none	830 ± 140	−15.8	980 ± 140
GSC-980-2	1 hour	930 ± 140	−23.7	940 ± 140
GSC-1021	≈24 hours	4360 ± 140	−16.3	4490 ± 140
GSC-1021-2	1 hour	4440 ± 140	−15.9	4580 ± 140

* Detailed descriptions of these samples are deferred to a later date list.

Table 5 illustrates further results obtained from different fractions of the same sample or of related samples.

TABLE 5*

Tests for C^{14} Contamination

Sample no.	Fraction	Age (yr B.P.)
A. Marl and Organic Detritus		
GSC-657	Inorganic (marl)	13,200 ± 170
	Organic	13,800 ± 170
GSC-662	Gyttja (immediately *below* GSC-657)	11,200 ± 200
GSC-675	Inorganic (marl)	12,100 ± 170
	Organic	11,500 ± 180
GSC-875	Inorganic (marl)	8540 ± 140
	Organic	8310 ± 150
GSC-1027	Inorganic (marl, 253-259 cm depth)	33,900 ± 1250
GSC-1023	Organic (left after marl at 289-295 cm depth treated with H_3PO_4)	11,500 ± 160
B. Peat		
GSC-879	less soluble**	4700 ± 130
	more soluble	4830 ± 160

* Detailed descriptions of all samples appear in this date list except for GSC-879, 1023, and 1027, deferred to a later list.

** Degree of solubility refers to solubility in 2% NaOH.

From the results obtained so far (cf. also Radiocarbon: 1963, v. 5, p. 39-55; 1965, v. 7, p. 24-46; 1968, v. 10, p. 207-245) it is not possible to generalize regarding the validity of marl dates. The data listed in Table

5 show that the age of marl can be younger than, similar to, or older than that of the included organic material. In two localities the dates on gyttja *below* the marl samples give an indication of how much in error dates on *both* marl and included organic material can be (cf. GSC-657 and GSC-662, New Brunswick; GSC-1023 and GSC-1027, Ontario). Further investigation of this problem is planned.

All samples with an age of less than 5000 yr are now being submitted to Isotopes, Inc. for C^{13}/C^{12} determinations in order to evaluate, and correct for, effects of carbon isotope fractionation. The 5000 yr cut-off point is purely arbitrary and may be revised in the future. The results obtained so far have shown that all bone and soil samples are subject to fractionation, as well as many peat samples and some wood samples. Corrections ranged as follows: bones (+20 to +150 yr); soils (−30 to +100 yr); peats (−40 to +110 yr); wood (−80 to +70 yr); charcoal (0 to +20 yr). In the future C^{13}/C^{12} determinations will be carried out on all bone and soil samples, regardless of age. In this date list, where δC^{13} measurements are available, a correction for isotopic fractionation has been applied to each date, and the δC^{13} value reported. Related to the PDB standard, normal values are taken to be −25.0‰ for wood, other terrestrial organic material, and bones (terrestrial and marine) and 0.0‰ for marine shells.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Eastern Canada

GSC-868. Cox's Cove, Newfoundland **12,600 ± 170**
10,650 B.C.

Marine shells and shell fragments (mostly *Hiatella arctica, Mya truncata, Serripes groenlandicus,* and *Macoma calcarea*) from gray and red silty clay at alt 120 to 130 ft in roadcut ca. 0.5 mi SW of town of Cox's Cove, Middle Arm, Newfoundland (49° 07′ N Lat, 58° 05′ W Long). Shell-bearing clay overlain by ca. 5 to 10 ft red clay and 3 ft sand which grades shoreward into cobble gravel to marine limit at ca. 165 ft. Coll. 1967 by V. K. Prest.* *Comment* (V.K.P.): date believed to refer to sea level close to marine limit established following retreat of Newfoundland Ice Cap from W coastal area (Brookes, 1969). Marine limit corresponds closely with that determined by Flint (1940) at Cornerbrook, 12 mi SE.

* All persons referred to as collectors or submitters of samples or otherwise cited as sources of data are with the Geological Survey of Canada unless otherwise specified.

GSC-937. Rocky Point, Port au Port Bay, Newfoundland **13,200 ± 220**
11,250 B.C.
$\delta C^{13} = +1.9‰$

Fragments of marine shells (mainly *Mya arenaria*) from exposure ca. 200 yds N of Rocky Pt., W side of Port au Port Bay, Newfoundland (48° 39.1′ N Lat, 58° 57.4 W Long); 12 ft above present beach in marine clay (ca. 6 ft thick band overlies bedrock) with abundant interspersed boulders (ice rafted). Coll. 1966 by J. M. Shearer, Memorial Univ., St. John's; now at Dalhousie Univ., Halifax. *Comment* (J.M.S.): date is probably close to time of deglaciation of area (Brookes, 1969). Sample mixed with dead gas for counting. Date based on one 3-day count.

GSC-887. Gilbert Cove, Nova Scotia **>39,000**

Marine shells (*Mercenaria mercenaria*, id. by A. H. Clarke, Jr., Natl. Mus. of Canada, Ottawa) from trench cut in gray clay beneath sand and gravel, 200 yds inland from present shore of Gilbert Cove, St. Mary's Bay, Nova Scotia (44° 29′ 10″ N Lat, 65° 57′ 10″ W Long) at alt ca. 45 ft. Shelly clay was covered by sand and gravel before excavation. Coll. 1967 by J. Welsted, Brandon Univ., Brandon, Manitoba. *Comment* (J.W.): date provides evidence that at one stage, over 39,000 yr ago, SW Nova Scotia coast stood ca. 50 ft lower, relative to sea level, than at present. A similar date, >38,000 (GSC-695; Radiocarbon, 1968, v. 10, p. 211), was obtained on shells coll. by D. R. Grant from stony clay near Cape St. Mary, ca. 30 mi S of Gilbert Cove along W coast of Nova Scotia. Two fractions were dated after removal of outer 20% of shell:

outer fraction, (21-60% leach) two 1-day counts	>38,000
inner fraction, (61-100% leach) one 3-day count	>39,000

Recent submergence series, Nova Scotia and New Brunswick

The following 17 dates, part of a series, deal with recent submergence in Nova Scotia and New Brunswick. Materials dated are freshwater peat, sedge (brackish water) peat, salt marsh peat, stumps from submerged forests, and marine shells. Coll. 1966, 1967, 1968 by D. R. Grant at widely separated localities to trace history of relative sea level movements. Samples are from natural intertidal exposures unless otherwise noted. *Elevations are referred to higher high water spring tides.*

1040 ± 130
GSC-910. Great Tancook Island, Nova Scotia **A.D. 910**
$\delta C^{13} = -25.4‰$

Stump rooted in till at −6.0 ft, overlain by sedge peat grading onto salt marsh peat, at head of Southeast Cove, Great Tancook I. (44° 26.9′ N Lat, 64° 10.3′ W Long).

1470 ± 130
GSC-731. Hawk Point, Nova Scotia, peat **A.D. 480**

Freshwater peat from extensive submerged bog at Hawk Point, 1 mi S of Lower Clark's Harbour, Cape Sable I. (43° 25.0′ N Lat, 65° 36.8′

W Long). Grab sample taken underwater at –20 ft, ca. 4 ft below wave-planed bog surface.

GSC-899. Hawk Point, Nova Scotia, wood **1230 ± 130**
A.D. 720
$\delta C^{13} = -24.0‰$

Stump at –11.0 ft, rooted in till, at Hawk Point, 1 mi S of Lower Clark's Harbour Cape Sable I. (43° 24.8′ N Lat, 65° 36.9′ W Long). Stump from forest zone assoc. with peat dated as GSC-731 and at same level as salt marsh peat outcropping on beach slope.

GSC-918. Double Island, Nova Scotia **1010 ± 130**
A.D. 940
$\delta C^{13} = -23.4‰$

Stump rooted in thin humus over till at –5.5 ft, overlain by few in. sedge peat buried by high tide salt marsh peat; E side of tombolo on Double I. in Pubnico Harbour (43° 40.1′ N Lat, 65° 47.5′ W Long).

GSC-1046. Chebogue Point, Nova Scotia **3330 ± 140**
1380 B.C.
$\delta C^{13} = -18.1‰$

Sedge peat from bore hole through salt marsh sediment; 19.7 to 21.3 ft below marsh surface and–3.9 ft below datum; 0.3 mi NNE of Chebogue Point, Nova Scotia (43° 44.4′ N Lat, 66° 07.0′ W Long).

GSC-900. Church Point, Nova Scotia **5060 ± 130**
3110 B.C.

Stump rooted in till at –12.0 ft at Church Point, 0.2 mi N of lighthouse, E side St. Mary's Bay (44° 20.1′ N Lat, 66° 07.4′ W Long), assoc. with extensive offshore peat bog and overlain by *Spartina alterniflora* peat.

GSC-1052. Brighton, Nova Scotia **1320 ± 130**
A.D. 630
$\delta C^{13} = -21.4‰$

Corms of *Scirpus* sp., intermediate between freshwater peat below and salt marsh above, –10.0 ft below datum; 0.3 mi WSW of Brighton, Nova Scotia (44° 32.9′ N Lat, 65° 51.9′ W Long).

GSC-997. Head of St. Mary's Bay, Nova Scotia **760 ± 130**
A.D. 1190
$\delta C^{13} = -22.6‰$

Rhizomes of *Scirpus* sp. at –8.0 ft; from top of 3 in. sedge peat over till, under 6 ft high tide salt marsh peat, 5 mi SW of Digby at head of St. Mary's Bay (44° 34.77′ N Lat, 65° 51.4′ W Long).

GSC-972. Grand Pré, Nova Scotia, –29 ft **3820 ± 130**
1870 B.C.
$\delta C^{13} = -24.1‰$

Stump at –29 ft, rooted in till, exposed by erosion of formerly overlying salt marsh wedge. Site is opposite Boot I., 2 mi NE of Grand Pré, Minas Basin (45° 08.25′ N Lat, 64° 17.14′ W Long).

GSC-1054. Grand Pré, Nova Scotia, –27 ft **3480 ± 140**
1530 B.C.
$\delta C^{13} = -22.9‰$

Stump at –27.0 ft, rooted in till, exposed by erosion of formerly overlying salt marsh. Location as above.

GSC-757. Saint's Rest, Nova Scotia, wood **8180 ± 150**
6230 B.C.

Wood from stump at –8 ft overlying few in. of humus on till, and overlain by salt marsh peat; near lighthouse at Saint's Rest, mouth of Bass R., Cobequid Bay, Minas Basin (45° 23.9′ N Lat, 63° 47.9′ W Long).

GSC-922. Saint's Rest, Nova Scotia, salt marsh peat **1260 ± 140**
A.D. 690
$\delta C^{13} = -20.5‰$

Basal *Spartina patens* salt marsh peat at –9.8 ft overlying 26 ft freshwater peat and stumps. Location as above.

GSC-957. Highland Village, Nova Scotia, –17 ft **2070 ± 130**
120 B.C.
$\delta C^{13} = -25.4‰$

Stump at –17.0 ft, rooted in till and overlain by few in. freshwater peat at Highland Village school, Cobequid Bay, Minas Basin (45° 23.5′ N Lat, 63° 39.00′ W Long). Stumps exposed by erosion of overlying salt marsh wedge.

GSC-1045. Highland Village, Nova Scotia, –12 ft **1750 ± 130**
A.D. 200
$\delta C^{13} = -26.8‰$

Stump at –12.0 ft, rooted in till and overlain by sedge (brackish water) peat and salt marsh peat. Location as above.

GSC-973. Lyon Head, Nova Scotia **1210 ± 140**
A.D. 740
$\delta C^{13} = -25.0‰$

Stumps at –6.0 ft, rooted in till and overlain by salt marsh peat at Lyon Head, 5 mi W of Truro, on N side Cobequid Bay, Minas Basin (45° 21.8′ N Lat, 63° 24.2′ W Long).

GSC-1032. Amherst Marsh, Nova Scotia **980 ± 140**
A.D. 970
$\delta C^{13} = -26.4‰$

Sedge peat and humus over till at –10.6 ft, from borehole 190 to 200 cm below surface of salt marsh 2 mi W of Amherst, Cumberland Basin, Bay of Fundy (45° 49.15′ N Lat, 64° 15.00′ W Long).

GSC-930. Fort Beauséjour, New Brunswick, –39 ft **4040 ± 130**
2090 B.C.
$\delta C^{13} = -23.1‰$

Stump at –39 ft from submerged forest covering several acres on till surface underlying 36 ft of high tide salt marsh sediment, 1 mi SW of fort on NE shore of Cumberland Basin, Bay of Fundy (45° 51.1′ N Lat, 64° 18.1′ W Long).

GSC-975. Fort Beauséjour, New Brunswick, −31 ft **3520 ± 140**
1570 B.C.
$\delta C^{13} = -25.4‰$

Stump at −31 ft, rooted in till and overlain, successively, by sedge peat and 28-ft-high tide salt marsh sediment. Location as bove.

GSC-1030. Fort Beauséjour, New Brunswick, −20.3 ft **1760 ± 140**
A.D. 190
$\delta C^{13} = -1.5‰$

Shells (*Mya arenaria*) intact and in growth position at −20.3 ft (17.3 ft below marsh surface, midway between top and bottom of sec. of salt marsh peat nearly 40 ft thick). Location as above.

GSC-967. Cape Spear, New Brunswick **930 ± 130**
A.D. 1020
$\delta C^{13} = -25.1‰$

Stump at −4.0 ft, rooted in till, overlain by few in. of sedge peat grading into salt marsh peat, 0.5 mi NE of Cape Spear on N shore Baie Verte, Northumberland Strait (46° 05.42′ N Lat, 63° 47.80′ W Long). *General Comment* (D.R.G.): except for GSC-731 which has been displaced by compaction, and for GSC-757 and GSC-900 which show age anomalies due to erosion, most ages indicate 2 distinct submergence rates for area (Grant, 1968, 1969). This is borne out by few previous datings (Lyon and Harrison, 1960; Frankel and Crowl, 1961; Harrison and Lyon, 1963) and by corroborative evidence. For Atlantic coast and Gulf of St. Lawrence, high tide datum has been rising at 0.5 ft/100 yr, much like rates for New England (cf. data summarized by Scholl and Stuiver, 1967) and presumably reflecting same crustal subsidence. In contrast, Fundy embayment has been submerging at almost 1 ft/100 yr, believed largely because of progressive tidal amplification. Samples GSC-922 and GSC-1030 mixed with dead gas for counting. Dates GSC-910, 731, 899, 900, 972, 957, 930, and 975 each based on one 3-day count. NaOH-leach omitted from pretreatment of GSC-1032 and 1046. GSC-1032 dated in 2-L counter at 1 atm.

GSC-1089. Fort Beauséjour, New Brunswick **4120 ± 130**
2170 B.C.
$\delta C^{13} = -21.6‰$

Wood from *in situ* white pine stump (id. by Wood Technology Dept., Univ. of New Brunswick Forestry Faculty) in Tantramar Marsh, S of Fort Beauséjour, New Brunswick (45° 50′ 48″ N Lat, 64° 17′ 42″ W Long). Top of stump 13.72 ft *below mean sea level*, top of present marsh 20.74 ft *above mean sea level* (cf ref. datum for other samples from Fort Beauséjour, this list). Roots of stump imbedded in undisturbed soil profile, a podzol corresponding to soils of Tormentine catena formed on reddish brown till. Stump is one of many exposed at low water on medium or lower tides; surface of marsh is inundated during spring tides. Coll. 1968 by K. Langmaid, Canada Dept. Agric., Fredericton. *Comment* (W.B., Jr.): date in accord with GSC-930, 4040 ± 130, this list. Date based on one 3-day count.

640 ± 130
GSC-602. Sackville, New Brunswick **A.D. 1310**

Birch stump from White Birch Marsh, New Brunswick (45° 57′ N Lat, 64° 20′ W Long). Till, on which podzol or gleyed podzol soil of Tormentine series and upright tree stumps occur, is overlain by 1 ft of salt marsh mud. Podzol soil and top of till 18.7 ft above mean sea level; ground surface is at 19.7 ft. Area now protected from high tides by dikes and aboideaux. Coll. 1960 by K. Langmaid. *Comment* (H. A. Lee): dates buried podzol soil and contained trees.

13,200 ± 200
GSC-965. Sheldon Point, New Brunswick **11,250 B.C.**

Marine shells (*Macoma calcarea, Mya truncata* and *Hiatella arctica*) coll. ca. 20 ft above high-tide level in slumped cliff face ca. 0.5 mi W of Sheldon Point, W of Saint John harbor, New Brunswick (45° 13′ 30″ N Lat, 66° 06′ 20″ W Long). Shells were concentrated in black layers in red clay forming cliffs. Inland, clay interdigitates with gravel. Coll. 1967 by J. Welsted. *Comments* (J.W.): shelly clay was probably deposited around margin of delta formed soon after deglaciation. Date agrees with I(GSC)-7, 13,325 ± 500 (Radiocarbon, 1961, v. 3, p. 50); shells coll. 1958 nearby by H. A. Lee. Sample mixed with dead gas for counting.

13,000 ± 240
GSC-882. Pennfield, New Brunswick **11,050 B.C.**

Marine pelecypod shells (*Portlandia* sp.) from shallow excavation for reservoir at toe of terraced, emerged delta on distal side of a major moraine, 1 mi SW of Pennfield P.O., New Brunswick (45° 05′ 50″ N Lat, 66° 45′ 15″ W Long) at alt ca. 130 ft. Coll. 1967 by N. R. Gadd. *Comment* (N.R.G.): intact shells, many with periostracum, suggest no transport. Shells occur in bottomset beds, but terracing of delta foreset face suggests they may relate to some time during marine regression, not to time delta top formed. Date is minimum for formation of delta topsets at ca. 250 ft, considered probable marine maximum for area, and for formation of moraine along N margin of delta. Moraine-delta relationships and apparent level of marine submergence at Pennfield are similar to those of Pineo Ridge in morainic systems between Cherryfield and Lubec, Maine (Borns, 1967). Date is compatible with ones in similar materials near Saint John, New Brunswick: I(GSC)-7, (13,325 ± 500; Radiocarbon, 1961, v. 3, p. 50) and GSC-965 (13,200 ± 200, this list). Marine submergence of coastal Maine and Fundy coast of New Brunswick occurred a minimum of 13,000 yr B.P.; however, relationship of moraines and deltas to marine levels and to one another is not established clearly. Correlation suggested for features between Cherryfield and Saint John

(Borns, 1967) requires further study. Sample mixed with dead gas for counting.

12,300 ± 160
GSC-886. Benson Corner, New Brunswick **10,350 B.C.**

Marine pelecypod shells (*Mytilus edulis*) from silt between glaciofluvial and beach gravel in wave-modified kame 0.6 mi S of Benson Corner, on W side of rd. along W side of Oak Bay, ca. 3 mi N of St. Croix R., New Brunswick (45° 12′ 35″ N Lat, 67° 12′ W Long), alt ca. 85 ft. Coll. 1967 by N. R. Gadd. *Comment* (N.R.G.): abundant *M. edulis* suggests shallow water, perhaps near limit of marine submergence (ca. 100 ft). Date is identical with GSC-795 (12,300 ± 160; Gadd, 1968; Radiocarbon, 1968, v. 10, p. 212), on similar material and at similar alt from E side of St. Croix estuary a few mi S. Two dates are minimum for recession, from St. Croix estuary and from Passamaquoddy Bay to S, of persisting glacial lobe after deglaciation of adjacent coastal areas of Maine and New Brunswick; cf. GSC-882 (13,000 ± 240, this list; Gadd, 1969) from area where marine limit is ca. 250 ft. Outermost 50% of shell leached in pretreatment. Date based on one 3-day count.

David Lake series, New Brunswick

Gyttja and marl from newly opened trench of Grand Falls Peat Co., Ltd., in drained David Lake, ca. 12 mi S of Grand Falls near California settlement, New Brunswick (46° 54′ N Lat, 67° 47′ W Long). Gravel outwash from Grand Falls Moraine is overlain successively by freshwater clay, gyttja, marl, gyttja, peat, and lake sediments (Tibbetts and Kirkpatrick, 1964). Coll. 1965 by R. E. Kirkpatrick, Grand Falls, and H. A. Lee.

9150 ± 150
GSC-661. David Lake, upper gyttja **7200 B.C.**

Gyttja above marl, at depth ca. 1 ft, near one end of trench.

13,800 ± 170
GSC-657. David Lake, marl **11,850 B.C.**

Sample from base of marl, estimated depth 3 to 4 ft below original surface of lake sediments (now stripped), in main trench. Two determinations were made; cf. Radiocarbon, 1968, v. 10, p. 209, and Table 5, this list:

inorganic portion (one 3-day count)	13,200 ± 170
organic portion, left after sample dissolved in H_3PO_4 (one 3-day count)	13,800 ± 170

11,200 ± 200
GSC-662. David Lake, lower gyttja **9250 B.C.**

Gyttja immediately below marl used for GSC-657.

General Comment (H.A.L.): marl and gyttja dated to check reliability of dates on marl in area where this material is widespread. Gyttja dates are in correct order; marl apparently contains older carbonate as well as older organic material. Cf. GSC-675, 11,500 ± 180, this list. NaOH-leach omitted from pretreatment of both GSC-661 and GSC-662. GSC-662 mixed with dead gas for counting.

11,500 ± 180
GSC-675. Siegas, New Brunswick, marl-gyttja **9550 B.C.**

Marl, aquatic shells and gyttja, at ca. 5 ft depth in road cut for new route of Trans-Canada Hwy. at Siegas Agric. Experiment Sta. (47° 12′ N Lat, 67° 57′ W Long); from small bog in depression of calcareous slate. Marly deposit is overlain and underlain by peat. Coll. 1965 by H. A. Lee from fresh exposure. Two determinations were made; cf. Radiocarbon, 1968, v. 10, p. 209, and Table 5, this list:

inorganic portion	12,100 ± 170
organic portion (left after sample dissolved in H_3PO_4	11,500 ± 180

Comment (H.A.L.): sample was intended to check validity of date on marl containing aquatic shells vs. gyttja; agreement between organic and inorganic portions is only fair; cf. GSC-18 (9820 ± 130; Radiocarbon, 1962, v. 4, p. 16), a date on wood within gravel along Siegas R.

9180 ± 180
GSC-856. Rivière Caouette, Quebec **7230 B.C.**

Charcoal fragments enclosed in oxidized pebbly, silty-clay, 4 to 6 ft below original surface in cut on N side of Domtar Newsprint Rd. 7a, NW side of Rivière Caouette, 200 ft NE of junction of this river with tributary from Lac Caouette, Quebec (45° 47.25′ N Lat, 70° 29.5′ W Long). Coll. 1967 by W. W. Shilts, Syracuse Univ., Syracuse, New York. *Comment* (W.W.S.): enclosing material originally thought to be till, but later excavations revealed it to overlie texturally distinct lodgment till with strong NW fabric. Striae 100 ft from coll. site are at 130°. Pebbly silt now is thought to be colluvium deposited soon after denudation by forest fires. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

590 ± 140
GSC-908. Rivière Chaudière, Quebec **A.D. 1360**
$\delta C^{13} = -29.7‰$

Wood fragment from laminated lake silt, E face of artificial channel cut for Rivière Chaudière through E end of Gayhurst Dam, 400 ft downstream from dam, Quebec (45° 45′ N Lat, 70° 47.5′ W Long). Sample, 12 ft above river, surrounded by undisturbed laminae. Silt is overlain locally by fluvial gravel and by till. Coll. 1967 by W. W. Shilts. *Comment* (W.W.S.): significance of date unknown; artificial channel is 5 yr old. Sample mixed with dead gas for counting.

GSC-936. L'Avenir, Quebec **12,000 ± 230**
10,050 B.C.

Marine pelecypod shells (*Macoma balthica* 90%, *Hiatella arctica* 8%, *Mya* sp. 1%, *Yoldia* sp. 1%), coll. in gravel pit from 8 to 12 ft depth in pebbly gravel and sand 2 mi NNW of L'Avenir, Quebec (45° 47′ N Lat, 72° 16′ W Long), alt ca. 400 ft. Coll. 1967 by B. C. McDonald. *Comment* (B.C.M.): from same site as GSC-505, 11,880 ± 180, (Radiocarbon, 1967, v. 9, p. 159) but redated because GSC-505 was older than other Champlain Sea shell dates (cf. Gadd, 1964; McDonald, 1968). GSC-936 was hand-picked to avoid secondary carbonate, and outermost 50% of shells was removed by leaching. Date supports initial determination and indicates that Champlain Sea was in existence by ca. 12,000 B.P. (cf. GSC-475-2, 11,500 ± 160, this list).

GSC-475-2. Ste-Christine, Quebec **11,500 ± 160**
9550 B.C.

Marine pelecypod shells (mostly *Hiatella arctica*, but fragments of *Macoma* sp., *Yoldia* sp., and *Mytilus edulis*) from silt 5 ft below surface, in bottom of small, unnamed stream, 0.5 mi SW of village of Ste-Christine, Quebec (45° 36′ N Lat, 72° 26′ 30″ W Long), alt ca. 475 ft. Shell site is 0.25 mi NW along gently sloping marine plain from beach at 510 ft. Marine limit marked by adjacent beach at 540 ft (165 m). Coll. 1965 by B. C. McDonald. *Comment* (B.C.M.): specimens of *Hiatella, Macoma,* and *Yoldia* were found articulated and in growth position, so shells probably not reworked. Shells are among highest on SE shore of Champlain Sea; they are probably related to sea-level stand at 510 ft or 540 ft. Date should indicate age of early phase of marine invasion of St. Lawrence Lowlands. Sample redated to check on possible discrepancy between GSC-475 (11,530 ± 160) and GSC-505 (11,880 ± 180, both in Radiocarbon, 1967, v. 9, p. 159-160); cf. also GSC-936, 12,000 ± 230, this list. Date agrees with original determination. One preparation was made, after outermost 50% removed by leaching (compared to normal 20% for GSC-475), and counted first in 5-L counter, then in 2-L counter:

5-L counter, one 1-day count	11,300 ± 170
2-L counter, one 3-day count	11,500 ± 160

GSC-951. Lac-Saint-Jean, Québec **8630 ± 160**
6680 B.C.

Marine shells (*Hiatella arctica*) from stony, silty clay overlying esker gravel, alt ca. 110 m, 3.4 mi SE of St-Félicien, Québec (48° 36′ 55″ N Lat, 72° 23′ 30″ W Long); many shells whole and paired. Coll. 1967 by J. C. Dionne, Dept. of Forestry and Rural Development, Québec. *Comment* (J.C.D.): date is minimum for Laflamme Gulf submergence in W part of Lac-Saint-Jean area, but is significantly younger than dates on marine shells from E Lac-Saint-Jean; e.g., 10,250 ± 350 (Gif-424) on shells at alt 113 m in sandy beaches at Metabetchouan, 20 mi SE of St-Félicien (Lasalle and Rondot, 1967; cf. also Lasalle, 1965, 1966; Radiocarbon, 1966, v. 8, p. 102). Pretreatment involved leaching of only outermost 10% of shell.

3960 ± 130
GSC-1022. Chacoura slide, Quebec **2010 B.C.**
$\delta C^{13} = -25.9‰$

Hemlock wood (id. by T. W. Anderson, Univ. of Waterloo, Waterloo, Ontario) 6 to 8 ft below top of "flow-slide" on E bank of Rivière Chacoura, 3 mi N of Quebec Rte. 2 at Louiseville, Quebec (46° 18′ N Lat, 72° 56′ 30″ W Long). Alluvium overlying wood and peat is underlain by undisturbed gray marine clay (cf. Gadd and Karrow, 1960). Coll. 1966 by P. F. Karrow, Univ. of Waterloo, Waterloo. *Comment* (P.F.K.): date, oldest for a "flow-slide" in Quebec, is maximum for slide. Geomorphic evidence suggests presence of slides of substantially greater age. GSC-550 (1140 ± 150, Radiocarbon, 1967, v. 9, p. 160), dates a similar "flow-slide" near Ottawa, Ontario.

6750 ± 140
GSC-985. Place Victoria, Montreal, Quebec **4800 B.C.**

Silty gyttja with freshwater molluscs from excavation for subway sta. at SW corner of Beaver Hall Hill and Vitre Sts., Montreal, Quebec (45° 29′ 40″ N Lat, 73° 33′ 50″ W Long), alt ca. 30 ft. Sandy peat and gyttja are enclosed in silt and sand beds overlying sand and gravel on bedrock. Sample 16.5 ft below ground. Coll. 1966 by J. A. Elson and Q. H. J. Gwyn, McGill Univ., Montreal; subm. by J. Terasmae. *Comment* (J.A.E.): sediments accumulated in shallow lake formed when St. Lawrence R. abandoned a channel now in St. Vitre-Craig St. area of old Montreal. Date is maximum for present course of river at Montreal. NaOH-leach omitted from sample pretreatment. Date based on one 4-day count.

11,600 ± 150
GSC-842. Meach Lake, Gatineau Park, Quebec **9650 B.C.**

Shells (*Hiatella arctica* and *Macoma balthica*) at alt 557 ft, 0.5 mi E of S end of Meach Lake, Gatineau Park, Quebec (45° 30′ 30″ N Lat, 75° 51′ 30″ W Long), from pit exposure in sand 40 ft thick overlying silt. Marine limit believed slightly higher than top of sand at 590 ft. Coll. 1967 by J. T. Buckley. *Comment* (J.T.B.): date is minimum for deglaciation of Gatineau R. valley; probably relates to time when Champlain Sea stood at ca. 600 ft at Meach Lake (cf. Buckley, 1968; Gadd, 1964). Outermost 50% of shells leached. Date based on one 4-day count.

11,300 ± 180
GSC-982. Mahon Lake, Quebec **9350 B.C.**

Marine shells (*Macoma* sp.) from fine gravel in stream-bed cut in silty clay, alt 508 to 525 ft, 0.75 mi S of Mahon Lake and ca. 2.5 mi NNE of Ste-Cécile de Masham, Quebec (45° 40′ N Lat, 76° 01′ 15″ W Long). Shells believed to derive from gravel at alt 550 to 600 ft. Coll. 1967 by J. T. Buckley. *Comment* (J.T.B.): date accords with GSC-842 (11,600 ±

150, this list), coll. at 557 ft ca. 12.5 mi to SE. Only outermost 10% of small (12 g) sample leached. Sample mixed with dead gas for counting. Date based on one 3-day count.

Twin Elm series, Ontario

Marine brown algae (kelp) and shells from Orr Unsworth Ltd. gravel pit 12 mi SE of Ottawa center, and ca. 3.5 mi NE of Richmond, in Nepean township. Pit is at SW corner of Moodie Drive and road to Twin Elm, Ontario (45° 14′ N Lat, 75° 47′ W Long). Sands washed from morainic ridge during Champlain Sea episode contain layer of marine algae. Marine shells occur in layer below algal bed and scattered through sand above it (Mott, 1968). Coll. 1965 and 1966 by R. J. Mott, J. Terasmae, and T. W. Anderson.

10,880 ± 160
GSC-588. Twin Elm, lower shells 8930 B.C.

Abundant shells (*Macoma balthica*) formed a layer 3 to 4 in. thick in gently dipping gray, unoxidized and unleached lower sands below water table. This is lowest sample dated.

10,800 ± 150
GSC-570. Twin Elm, kelp 8850 B.C.

Marine brown algae (kelp) formed 2 layers up to 3 in. thick, or several thin layers near top of lower sands; layer is ca. 30 to 35 ft below original ground level.

10,620 ± 200
GSC-587. Twin Elm, upper shells 8670 B.C.

Marine shells, (mainly *Macoma balthica*), dispersed throughout upper, steeply bedded, leached sands.

General Comment (R.J.M.): date on kelp corroborates dates on marine shells and substantiates validity of previous Champlain Sea shell and bone dates from Ottawa area; cf. L-604A (10,700 ± 200) and L-604B (10,550 ± 200; both in Radiocarbon, 1961, v. 3, p. 150) and GSC-454 (10,420 ± 150; Radiocarbon, 1966, v. 8, p. 103). NaOH-leach omitted from pretreatment of GSC-570; date based on one 3-day count. For GSC-587 outer 50% of shells removed before dating; sample mixed with dead gas for counting.

11,800 ± 210
GSC-1013. Maitland, Ontario 9850 B.C.

Marine shells (*Macoma balthica*) from shallow gravel at Brockville Chemical Works 2 mi NE of Maitland, Ontario (44° 40′ N Lat, 75° 36′ W Long). Gravel occurs as beach or bar deposits of Champlain Sea along crest of long till ridge, alt 340 ft (65 ft below theoretical marine limit). Coll. 1967 by E. P. Henderson. *Comment* (E.P.H.): date suggests gravels near Maitland may be oldest deposits so far assoc. with W parts of Champlain Sea (Henderson, 1969). Previously a shell sample N of Ottawa near Meach Lake dated 11,600 ± 150 yr (GSC-842, this list; Buckley, 1968) was oldest date obtained from W Champlain Sea materials. When coll., shells nearest yet found to alt of Champlain Sea water plane at its maximum W extension. Subsquently a few marine shell fragments have been found at Yule Sta., 19 mi NW, only 35 ft below marine limit. Only outermost 5% of shells leached due to small sample size (7.0 g). Sample mixed with dead gas for counting. Date based on one 4-day count in 2-L counter at 1 atm.

10,800 ± 180
GSC-1028. Arthur, Ontario **8850 B.C.**

Marly gyttja coll. with piston sampler from base of peat sequence, depth 638 to 643 cm in Wylde Lake Bog, ca. 8 mi NE of Arthur, Ontario (43° 54′ 15″ N Lat, 80° 24′ 30″ W Long), at alt <1600 ft. Coll. 1968 by T. W. Anderson. *Comment* (T.W.A.): pollen from sample shows date represents time for spruce decline and jackpine invasion; it agrees closely with date on spruce decline for bog near Heidelberg (GSC-1006, 10,700 ± 160, this list). NaOH-leach omitted from sample pretreatment. Date based on one 3-day count.

10,700 ± 160
GSC-1006. Heidelberg, Ontario **8750 B.C.**

Gyttja coll. with Hiller sampler from base (220 to 230 cm depth) of organic material in peat-gyttja sediment sequence in bog 1.7 mi S of Heidelberg and 2 mi NE of Erbsville, Ontario (43° 29′ 35″ N Lat, 80° 37′ 02″ W Long). Coll. 1967 by B. A. Sreenivasa and T. W. Anderson, Univ. of Waterloo, Waterloo. *Comment* (B.A.S.): date is minimum for Cary Drift on top of Waterloo morainic complex and provides age for spruce decline and pine rise in pollen profile. It accords with date of 11,950 ± 350, I(GSC)-29 (Radiocarbon, 1961, v. 3, p. 49; Karrow *et al.*, 1961; Karrow, 1963), on basal gyttja from Crieff Kettle Bog, on Galt moraine ca. 14 mi S, which relates to spruce maximum on pollen diagram by J. Terasmae. A similar date (GSC-1028, 10,800 ± 180, this list) has been obtained for spruce decline at Wylde Lake Bog. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date basd on one 3-day count.

Plum Point series, Ontario

Samples of driftwood and peat balls from buried beach deposit 20 ft deep in gravel pit on Lake Erie shore 0.5 mi NE of Plum Point, Ontario (42° 36′ 45″ N Lat, 81° 23′ 30″ W Long). Beach gravel overlies, successively, glaciofluvial gravel and Port Talbot Interstadial deposits, and is overlain, successively, by Catfish Creek Drift, Port Stanley Drift, and late-Wisconsin glaciolacustrine sediments. Coll. 1967 by F. Mayr; subm. by A. Dreimanis, both of Univ. of Western Ontario, London.

GSC-770. Plum Point, Ontario, driftwood **>40,000**

Comment (A.D.): sample coll. to date beach deposit believed of Plum Point Interstadial age (24,000 to 28,000 yr, Dreimanis *et al.*, 1966), but date indicates wood probably is reworked Port Talbot Interstadial material in spite of its fresh appearance. Pretreatment (by A.D.) included boiling in NaOH solution. Port Talbot wood usually produces a strong brown humic stain, so only wood with little brown staining was submitted. Date based on one 3-day count.

GSC-993-2. Plum Point, Ontario, peat ball **46,400 ± 940** **44,450 B.C.**

Comment (A.D.): peat ball is probably reworked from Port Talbot II Interstadial deposits. Pollen content of peat (5 samples investigated by A. A. Berti, Univ. of Western Ontario) resembles closely that of Port Talbot II beds: main pollen are spruce (49 to 57%) and jackpine (36 to 44%). Date is in good agreement with other finite Port Talbot Interstadial dates from Plum Point—Port Talbot area, ranging from 42,000 to 48,000 yr B.P. (Dreimanis *et al.*, 1966 and 2 unpub. Groningen dates). Two determinations were made:

GSC-993 (NaOH-leach omitted from sample pretreatment; one 3-day count in 2-L counter)	>37,000
GSC-933-2 (one 3-day count and one 1-day count in 5-L counter at 4 atm)	46,400 ± 940

GSC-994. Port Glasgow, Ontario **18,500 ± 200** **16,550 B.C.**

Plant detritus from beach or nearshore sand, at 11 ft depth, in Lake Erie bluff at Port Glasgow, Ontario (42° 30′ 35″ N Lat, 81° 36′ 30″ W Long). Sand overlies Port Stanley Till; plant detritus was concentrated in depressions in till surface. Coll. 1967 by F. Mayr; subm. by A. Dreimanis. *Comment* (A.D.): as plant detritus occurs 70 ft above Lake Erie level and ca. 75 ft below Lake Warren level, it was believed to belong to transitional phase between Lake Warren and Early Lake Erie, or to low level phase assoc. with Lake Arkona. Date obtained is improbable as ice margin was in S Ohio then (Goldthwait *et al.*, 1965); admixture of some old plant remains, most probably from Port Talbot Interstadial deposits, is suggested. NaOH-leach omitted from sample pretreatment. Date based on one 3-day count.

The Albany Forks series, Ontario

Gyttja and peat from 2 localities near The Albany Forks, Ontario. Coll. 1967 with Davis piston sampler by J. Terasmae and R. J. Mott.

GSC-831. The Albany Forks, 520 ft **7140 ± 170** **5190 B.C.**

Gyttja and peat from 412 cm below bog surface, overlying silty clay, alt ca. 520 ft, 22 mi NNW of The Albany Forks (51° 23′ N Lat, 84° 31′ W Long).

GSC-885. The Albany Forks, 550 ft **5820 ± 150** **3870 B.C.**

Gyttja and peat from 450 cm below surface, overlying sand and gravel, near small lake ca. 30 mi NW of The Albany Forks (51° 28′ N Lat, 84° 48′ W Long), at alt ca. 550 ft. Lake is on one of numerous curving features of unknown origin which transect, and are higher than, parallel shorelines in area (highest at ca. 520 ft alt).

General Comment (B. G. Craig): GSC-831 is ca. 50 ft above marine limit and provides minimum date for deglaciation of region and beginning of accumulation of organic sediment; cf. GSC-487 (7660 ± 140) and GSC-309 (7150 ± 140; both in Radiocarbon, 1966, v. 8, p. 105-106), GSC-624 (7380 ± 140; Radiocarbon, 1967, v. 9, p. 162), and GSC-670 (7560 ± 180; Radiocarbon, 1968, v. 10, p. 215), other similar dates relating to draining of Glacial Lake Barlow-Ojibway. For summaries of ages on oldest marine shells in area see Craig (1969). NaOH-leach omitted from pretreatment of both samples. GSC-885 mixed with dead gas for counting.

GSC-1011. Severn River, Ontario **>41,000**

Peat from NW bank of Severn R., ca. 5.5 mi upstream from confluence with Fawn R. (55° 18′ N Lat, 88° 26′ W Long), at alt ca. 200 ft, 13 ft above river level. Peat occurred as lenses 6 in. long in clayey sand within 10-ft thick unit of stratified sediments underlying 20 ft of till. Wood fragments as long as 0.75 in. were assoc. with peat. Coll. 1967 by B. C. McDonald. *Comment* (B.C.M.): peat, probably of interglacial age, is probably correlative with Missinaibi beds dated at >53,000 (Gro-1435; Terasmae and Hughes, 1960a). Other dates on Missinaibi beds are cited by Terasmae (1958) and McDonald (1969); cf. also GSC-892, >37,000, this list. NaOH-leach omitted from sample pretreatment. Date based on one 4-day count.

Hudson Bay Lowland series, Ontario and Manitoba

Marine pelecypod shells from 7 localities S and W of Hudson Bay, Ontario and Manitoba.

7540 ± 140
GSC-915. Kabinakagami River, Ontario **5590 B.C.**

Whole shells (*Hiatella arctica*), many paired, in silty clay from river bank sec., alt ca. 325 ft, ca. 50 to 75 ft below marine limit on Kabinakagami R., ca. 15 mi S of Kenogami R., Ontario (50° 13′ N Lat, 84° 14′ W Long). Coll. 1967 by B. C. McDonald.

7760 ± 160
GSC-897. Nagagami River, Ontario **5810 B.C.**

Whole shells (*Hiatella arctica*), many paired, in silt from river bank sec., alt ca. 345 ft, ca. 50 to 75 ft below marine limit, on Nagagami R., ca. 14 mi S of Kenogami R., Ontario (50° 13′ N Lat, 84° 18′ W Long). Coll. 1967 by Q. H. J. Gwyn.

7720 ± 140
GSC-880. Kapiskau River, Ontario **5770 B.C.**

Marine pelecypod shells (*Macoma calcarea*), many paired, in clayey silt in river bank, alt 400 ft, ca. 100 ft below marine limit, on Kapiskau

R., 32 mi SE of Mississa Lake, Ontario (51° 56′ N Lat, 84° 32′ W Long). Coll. 1967 by B. G. Craig.

GSC-872. Ekwan River, Ontario **7220 ± 140**
5270 B.C.

Whole shells and fragments (*Mya truncata*) in sand and silt from river bank, alt ca. 400 ft, ca. 125 ft, ca. 125 ft below marine limit, on Ekwan R., Ontario (53° 32′ N Lat, 86° 03′ W Long). Coll. 1967 by L. M. Cumming.

GSC-877. Fawn River, Ontario **7400 ± 140**
5450 B.C.

Marine pelecypod shells (*Hiatella arctica*), many paired, in sand from river bank, alt ca. 450 ft, ca. 50 ft below marine limit, on Fawn R., 14 mi above mouth of Fat R., Ontario (54° 29′ N Lat, 88° 16′ W Long). Coll. 1967 by B. C. McDonald.

GSC-896. 'Old Beach' Creek, Manitoba **8530 ± 220**
6580 B.C.

Marine pelecypod shell fragments (mainly *Hiatella arctica* and *Macoma* sp.) in beach sand, river bank, alt 410 ft, ca. 35 ft below marine limit, on Old Beach Creek 52 mi S of mouth of Kaskattama R., Manitoba (56° 18′ N Lat, 90° 24′ W Long). Coll. 1967 by B. G. Craig and B. C. McDonald.

GSC-878. Hayes River, Manitoba **7570 ± 140**
5620 B.C.

Marine pelecypod shells (*Hiatella arctica*) in living position in silty clay of river bank, alt ca. 375 ft, 25 to 50 ft below marine limit, on Hayes R., 2 mi above mouth of Fox R., Manitoba (56° 02′ 20″ N Lat, 93° 17′ W Long). Coll. 1967 by M. C. McDonald. *General Comment* (B.G.C.): this series comprises dates on several shell collections near marine limit across Hudson Bay Lowland to determine time of deglaciation and marine invasion. Along with I(GSC)-14 (7875 ± 200; Terasmae and Hughes, 1960b), I(GSC)-8 (6975 ± 250; Lee, 1959) and GSC-289 (6830 ± 170; Craig, 1965b), present series indicates that samples from SW of James Bay (ca. 7900 to 7400 B.P.) are clearly older than those from W and NW of Hudson Bay (ca. 6900 to 6600 B.P.; Craig, 1969). Age of GSC-896 (8530 ± 220) is not compatible with rest of series; as shells are found throughout area in deposits that predate Tyrrell Sea deposits it is assumed that this coll. is both redeposited and contaminated (cf. also GX-1063, 8010 ± 95, on shells 50 mi SW of Churchill; Wagner, 1967). For GSC-896 only outermost 10% of shells removed by leaching; sample mixed with dead gas for counting. Dates for GSC-897, 880, 877, and 878 each based on one 3-day count. Dates for GSC-915, 872, and 896 each based on one 4-day count.

B. Western Canada

GSC-892. Echoing River, Manitoba **>37,000**

Wood from bank of unnamed tributary of Echoing R., 22.4 mi NNE of confluence of Echoing and Sturgeon Rivers (55° 50′ 30″ N Lat, 91°

15′ W Long), at alt ca. 400 ft, 28.5 ft above stream level. Coll. 1967 by B. G. Craig. Wood enclosed in laminated organic-rich silt overlying 3 in. peat and is part of sequence of stratified sediments at least 17 ft thick underlying 18 ft till. *Comment* (B. C. McDonald): wood is probably part of widely exposed unit in Hudson Bay Lowland that has been interpreted as being of interglacial age; cf. GSC-1011 (>41,000, this list), GSC-83 (>35,000; Radiocarbon, 1963, v. 5, p. 45; McDonald, 1969).

5050 ± 180
GSC-984. Morden, Manitoba **3100 B.C.**

Wood fragments retrieved by sidewall sampler, 19 to 20 ft depth, from drill hole 2 mi E and 2.5 mi N of Morden, Manitoba, SW12-23-3-5 WP (49° 15′ N Lat, 98° 00′ W Long). Sample from base of 20 ft-thick clay-rich silt and fine sand unit overlying lacustrine clays. Coll. 1967 by J. E. Wyder. *Comment* (J.E.W.): sample dated to obtain age between 2 phases (I and II) of Lake Agassiz. Young date may represent, instead, earliest flooding of Lake Agassiz plain by postglacial Red R. Sample mixed with dead gas for counting. Date based on one 4-day count.

Rossendale series, Manitoba

Alluvial and lacustrine silt and clay containing plant detritus and shells underlie an Assiniboine Valley terrace at 1050 ft level ca. 4 mi S of Rossendale, Manitoba, NE ¼ LSD9 sec. 17, tp. 9, rge. 9 W1 (49° 45′ N Lat, 98° 39′ W Long). Samples from fresh roadcut and adjacent gully exposing a total of ca. 70 ft of sediment below terrace surface. Coll. 1966 and 1967 by R. W. Klassen.

10,600 ± 150
GSC-902. Rossendale, plant detritus **8650 B.C.**

Plant detritus from lowest silty unit containing organic material, ca. 60 ft below terrace surface.

10,000 ± 150
GSC-870. Rossendale, lower wood **8050 B.C.**

Wood from base of clay unit, ca. 28 ft below terrace surface.

9700 ± 140
GSC-797. Rossendale, upper wood **7750 B.C.**

Wood from clayey silt unit, ca. 16 ft below terrace surface.

10,920 ± 150
GSC-689. Rossendale, freshwater clams **8970 B.C.**

Freshwater clam shells from old exposure of same unit as GSC-797, at depths from 5 to 15 ft below terrace surface. Two determinations were made after removal of outer 20% of shells:

outer fraction (21 to 60% leach), two 1-day counts	10,720 ± 160
inner fraction (61 to 100% leach), one 3-day count	10,920 ± 150

General Comment (R.W.K.): wood and plant detritus dates record fluctuations in level of Lake Agassiz subsequent to initial drop in level of Lake

Agassiz I. Dates on wood and plant detritus are internally consistent and indicate that shell date is 1000 yr too old; younger terrace ca. 10 mi up-valley and 70 ft lower contains shells of similar age (GSC-492, 10,670 ± 160; Klassen, 1967; Radiocarbon, 1967, v. 9, p. 166). Date for GSC-797 based on one 4-day count.

GSC-987. Bliss Gravel Pit, Fort Qu'Appelle, Saskatchewan **>30,000**

Aquatic and terrestrial mollusc shells from Bliss Gravel Pit on SW side of Fort Qu'Appelle, Saskatchewan in sec. 18, tp. 21, rge. 13, W 2nd mer. (50° 46′ N Lat, 103° 48′ W Long), alt ca. 1615 ft. Shells from gravel and sand beds, 50 ft thick, containing abundant vertebrate fossils; overlain by thick drift including 2 tills and underlain by one or more tills. The intertill deposit is thought to be of Sangamon age. Coll. 1967 by E. Khan, Punjab Univ., Chandigarh, India and A. M. Stalker. *Comment*: only outermost 5% removed due to small sample size (ca. 7 g). Sample mixed with dead gas for counting. Date based on one 4-day count.

GSC-1041. Kenaston No. 2, Saskatchewan **38,000 ± 560**
36,050 B.C.

Wood in gyttja 19 to 23 ft below surface under one till in drill hole Kenaston No. 2, SW11-24-29-3-W3, Saskatchewan (50° 30′ N Lat, 106° 18′ W Long). Coll. 1945 by S. C. Collins; subm. by E. A. Christiansen, Saskatchewan Research Council, Saskatoon. Another wood sample from drill hole was dated at >30,000 (S-166). *Comment* (E.A.C.): wood is overlain by Battleford Formation, a thin till occurring in W-central Saskatchewan (Christiansen 1968a, 1968b). Hiatus prior to deposition of this till began at least 38,000 yr ago. Dated in 5-L counter at 4 atm. Date based on one 1-day count.

GSC-978. Patience Lake, Saskatchewan **>38,000**

Wood from intertill sand bed at 114 to 156 ft depth in mine shaft near Patience Lake, Saskatchewan, LSD11, sec. 9, tp. 36 rge. 3, W3 (52° 05′ N Lat, 106° 20′ W Long). Sand bed is overlain by 2 tills. Coll. 1967 by L. L. Price; subm. by R. W. Klassen.

Medicine Hat series, Alberta (III)

GSC-847. 'Golden Valley Bluff' **>36,000**

Poorly-preserved plant fragments from S end of 'Golden Valley Bluff', on E bank South Saskatchewan R., directly beyond N limit of Medicine Hat in SW¼, sec. 33, tp. 12, rge. 5, W 4th mer. (50° 02′ 20″ N Lat, 110° 38′ 15″ W Long). Ca. 12 ft above river (alt ca. 2175 ft.), near base of 125 ft-thick alluvium deposit and overlain by much drift including 2 or more till sheets. Coll. 1966 by A. M. Stalker.

GSC-876. 'Surprise Bluff' **>36,000**

Aquatic and terrestrial mollusc shells (mostly *Sphaerium* sp.), from S bank South Saskatchewan R. near W edge of Medicine Hat, in SE¼, sec. 34, tp. 12, rge. 6, W 4th mer. (50° 02′ 10″ N Lat, 110° 44′ W Long), and 80 ft above river at alt ca. 2250 ft. In alluvium overlying fine gravel containing abundant vertebrate fossils and overlain by thick drift that includes 3 till sheets. Coll. 1967 by A. M. Stalker.

General Comment (A.M.S.): GSC-847 is from same deposit as GSC-543, >46,700 (Radiocarbon, 1967, v. 9, p. 168-169), but from slightly higher stratigraphically and 3 mi S. Deposit now thought to be of Yarmouthian or greater age (Stalker, 1969a). GSC-876 is from same deposit as GSC-780, >30,000 (Radiocarbon, 1968, v. 10, p. 219) 8 mi SW. Deposit now thought to be of Sangamon age. GSC-847 based on one 3-day count. For GSC-876 only outermost 10% removed due to small sample size (15 g); sample mixed with dead gas for counting.

GSC-888. 'Rattlesnake Bluff', Taber, Alberta >37,000

Pieces of wood from 'Rattlesnake Bluff' on E bank Oldman R., 8 mi NNE of Taber, Alberta, in SE¼, sec. 24, tp 11, rge. 16, W 4th mer. (49° 55′ 30″ N Lat, 112° 04′ W Long). Wood is from 10 ft above base of 30 ft-thick sec. of alluvial sand and 60 ft above river, alt ca. 2430 ft. Sand underlies 60 ft drift, including 2 till sheets, and overlies till and preglacial gravel. Coll. 1967 by A. M. Stalker. *Comment* (A.M.S.): GSC-728 (35,980 ± 1060; Radiocarbon, 1968, v. 10, p. 220), came from same site. This date probably was affected by abundant, modern rootlets; GSC-888 is judged more reliable. Alluvium appears to be continuation of bed that yielded human bones near Taber, and is of either mid-Wisconsin or Sangamon age. Sample mixed with dead gas for counting.

Castle River series, Alberta (III)

Samples from 'Mountain Mill Bluff' on S bank Castle R., ca. 6 mi W of town of Pincher Creek, Alberta, in SE¼ sec. 21, tp. 6, rge. 1, W 5th mer. (49° 29′ N Lat, 114° 03′ 30″ W Long). Sec. shows 55 ft eolian sand overlying, successively, up to 90 ft alluvium and as much as 110 ft outwash. Coll. 1967 by A. M. Stalker.

1790 ± 140
GSC-898. Castle River, shells (II) A.D. 160

Terrestrial-gastropod shells (*Oreohelix strigosa* Gould, id. by A. M. Clarke, Jr., Natl. Mus. of Canada) from topmost buried soil, directly underlying eolian sand. Sample from near center of 'Mountain Mill Bluff' and ca. 220 ft above Castle R., alt ca. 4000 ft.

2490 ± 180
GSC-901. Castle River, charcoal (II) 540 B.C.

Charcoal from firebands, contained in alluvium near E end 'Mountain Mill Bluff'. Ca. 12 ft above lowest and best-developed (of 3) major buried soil in sec., 15 ft above basal outwash, and 60 ft above Castle R., alt ca. 3830 ft.

General Comment (A.M.S.): GSC-901 gives approx. age for deposition of alluvium, which probably resulted from glacier advances upvalley

(Stalker, 1969b). It indicates underlying soil developed during Climatic Optimum, for basal outwash has yielded dates of 6150 ± 140 (GSC-447, bison jaw), 6100 ± 180 (GSC-490, bison teeth; both in Radiocarbon, 1967, v. 9, p. 169), and 6340 ± 140 (GSC-705, bison bone; Radiocarbon, 1968, v. 10, p. 221). GSC-901 came from same beds as GSC-741 (3380 ± 170, *Oreohelix strigosa* shells) and GSC-743 (2680 ± 140, charcoal; both in Radiocarbon, 1968, v. 10, p. 221); its closer agreement with GSC-743 than with GSC-741 suggests that terrestrial gastropods of area can date several hundred yr too old. GSC-898 date is maximum for start of last episode of dune development. Because terrestrial-gastropod shells were used, date also may be several hundred yr too old. Only outermost 10% of GSC-898 removed due to small sample size (11.9 g). Both samples mixed with dead gas for counting. GSC-898 based on one 3-day count.

Cochrane Terrace series, Alberta (II)

Bones from middle terrace of 3 postglacial terraces of Bow River near Cochrane, Alberta. Surface of terrace lies ca. 75 ft above river and ca. 25 ft below highest terrace. Samples coll. from cross-bedded, sandy alluvium ca. 7 ft below terrace surface. Fauna includes *Bison bison occidentalis, Equus conversidens, Ovis canadensis,* and *Cervus canadensis* (id. by C. S. Churcher, Univ. of Toronto; cf. Churcher, 1968).

5670 ± 150
GSC-988. Griffin Gravel Pit, Cochrane (II) 3720 B.C.

Bone from E. Griffin Gravel Pit, ca. 0.5 mi ESE of Cochrane, Alberta, in NE¼ sec. 35, tp. 25, rge 4, W 5th mer. (51° 10′ 40″ N Lat, 114° 27′ 10″ W Long). Coll. 1965, 1966, 1967 by C. S. Churcher and A. M. Stalker.

11,100 ± 160
GSC-989. Clarke Gravel Pit, Cochrane (II) 9150 B.C.

Bone from A. Clarke and Sons' Gravel Pit, ca. 0.3 mi SE of Cochrane, Alberta, in NW¼ sec. 35, tp. 25, rge. 4, W 5th mer. (51° 10′ 40″ N Lat, 114° 27′ 30″ W Long). Coll. 1965, 1966, 1967 by G. Clarke and C. Clarke, both of Cochrane, C. S. Churcher, and A. M. Stalker.

General Comment (A.M.S.): GSC-989 agrees closely with GSC-613 (11,370 ± 170, Radiocarbon, 1967, v. 9, p. 170) from same pit (Stalker, 1968). GSC-988 is much younger than previous date from same pit (GSC-612, 10,760 ± 160 (Radiocarbon, 1967, v. 9, p. 169-170); sample may have been contaminated by inclusion of modern bones or during preparation of bones for identification. NaOH-leach omitted from pretreatment of GSC-988; sample mixed with dead gas for counting; date based on one 4-day count.

Warden Rock series, Alberta

Charcoal and gastropod shells from bedded sands overlying till 70 to 80 ft above Red Deer R. Layer of volcanic ash overlies till and underlies dated samples. Sand appears to be related to main stream, although occurring over a wide range of alt. Warden Rock site is 46 mi WSW of

Sundre, on N bank of Red Deer R. 1 mi E of Banff Natl. Park Boundary, Alberta (51° 42′ 50″ N Lat, 115° 41′ 30″ W Long). Coll. 1967 by M. J. Chambers, Univ. of Calgary, Calgary.

2870 ± 140
GSC-894. Warden Rock site, lower charcoal **920 B.C.**

Charcoal from base of sand, 12 ft depth.

2510 ± 180
GSC-906. Warden Rock site, shells **560 B.C.**
$\delta C^{13} = -6.7‰$

Gastropod shells (*Angispira alternata*) from sand at 8 to 12 ft depth. No correction applied to date as initial C^{14} content unknown.

1580 ± 140
GSC-974. Warden Rock site, upper charcoal **A.D. 370**
$\delta C^{13} = -23.5‰$

Charcoal from sand at 8 ft depth.

General Comment (W. Blake, Jr.): dates show good internal agreement between shells and charcoal. GSC-974, 1580 ± 140 yr old, indicates this sec. of Red Deer R. has cut down 75+ ft in less than 1500 yr, a minimum mean rate of 5 ft/100 yr. GSC-894 mixed with dead gas for counting. Pretreatment of GSC-906 included leaching of only outer 5% of shells, because of small sample size (5.5 g). Sample mixed with dead gas for counting. NaOH-leach omitted from pretreatment of GSC-974. Dates for GSC-906 and GSC-974 each based on one 3-day count.

43,500 ± 620
GSC-1020. Watino, Alberta **41,550 B.C.**

Wood from 2 ft above base of coarsely bedded to massive silt ca. 10 ft thick, 53 ft above Smoky R. and 98 ft below surface, W bank, ca. 0.5 to 0.75 mi upstream from Watino, Alberta (55° 43′ N Lat, 117° 38′ W Long). Bedrock at river level is overlain, successively, by colluvium and scree, quartzite gravels, sand, and bedded silt and clay. Above wood, peat, and mollusc-bearing unit are interbedded sand, silt and clay (first Shield stones at top of this unit), then glacial gravel and sand overlain by fine sand and silt. Coll. 1968 by J. Westgate, Univ. of Alberta, Edmonton. *Comment* (J.W.): dated horizon is ca. 65 ft below oldest sediments containing Shield stones, suggesting that Watino area was not glaciated until Late Wisconsin time. Date agrees with GX-1207, >38,000 on wood from same layer, and with I-2516 ($35{,}500\,{}^{+2300}_{-1800}$) and I-2615 ($35{,}500\,{}^{+3300}_{-2300}$), on wood from beds 3 and 9 ft higher, respectively, and shows that I-2616 ($34{,}900\,{}^{+3000}_{-2000}$), on wood in gravel 13 ft lower, must be too young. Date based on one 3-day count and one 1-day count in 5-L counter at 4 atm.

1220 ± 130
GSC-832. Leviathan Lake, British Columbia, wood A.D. 730

Wood at 5 cm depth beneath "surface" volcanic ash layer at W edge of Leviathan Lake, 1 mi E of mouth of Campbell Creek, E side of Kootenay Lake, 3.5 mi NE of Kaslo, British Columbia (49° 57′ 00″ N Lat, 116° 51′ 15″ W Long). Volcanic ash bed (1 cm thick) is beneath 4 cm peaty turf. Basal peat (190 cm depth) is 10,270 ± 190 yr old (GSC-719; Radiocarbon, 1968, v. 10, p. 223-224; Fulton, 1968). Coll. 1966 by R. J. Fulton. *Comment* (R.J.F.): date is maximum for overlying volcanic ash bed. Preliminary petrographic study suggests correlation with St. Helens W ash fall (Wilcox, 1965; Crandell *et al.*, 1962). Sample mixed with dead gas for counting. Date based on one 3-day count.

Meadow Creek series, British Columbia (II)

Peat from road cuts near borrow pit on E side of Meadow Creek, 1.5 mi W of Duncan Lake Dam and 6 mi N of Kootenay Lake, British Columbia (50° 15′ N Lat, 116° 59′ W Long). Road cut exposes till overlying interstratified silt and gravel containing peat beds and wood (Fulton, 1968). Coll. 1967 by R. J. Fulton. For other dates in same series see Radiocarbon, 1968, v. 10, p. 224-225.

42,300 ± 650
GSC-1015. Meadow Creek (VIII) 40,350 B.C.

Woody stems and sphagnum moss, scattered through 40 cm of silt and fine-grained sand, 1.9 m below contact with till. Date based on four 1-day counts in 5-L counter at 4 atm.

41,500 ± 520
GSC-1017. Meadow Creek (IX) 39,550 B.C.

Peat from 2-cm-thick bed in silt, 3 m below contact with till.

General Comment (R.J.F.): GSC-1015 was ca. 5.5 m lower in sequence than GSC-740 (43,800 ± 800; Fulton, 1968; Radiocarbon, 1968, v. 10, p. 224), a wood sample. It was hoped that age of subtill sediments would be extended. Anomalously young date may be due to rootlet penetration of sampled zone after sediment deposition. GSC-1017 was coll. ca. 1.5 m below GSC-720, peat dated at 42,300 ± 700 yr (*loc. cit.*). Even though statistical errors of dates overlap by ca. 400 radiocarbon yr, GSC-1017 appears younger than stratigraphy and other dates from this sec. indicate; cf. GSC-716 (41,800 ± 600) and GSC-733 (41,900 ± 600; *loc. cit.*). Date based on one 1-day and one 3-day count in 5-L counter at 4 atm.

33,000 ± 280
GSC-1008. Balfour Creek, British Columbia 31,050 B.C.

Charcoal from road cut near Balfour Creek, N side of Columbia R. 5 mi W of Castlegar, British Columbia (49° 21′ 00″ N Lat, 117° 44′ 50″ W Long). Charcoal from 50 cm of oxidized fine-grained sand interpreted as "A" horizon of paleosol, overlain, successively, by 2 m gravel and sand, 2 m till, and 2 m gravel. Coll. 1967 by R. J. Fulton. *Comment* (R.J.F.):

date confirms field interpretation that sand unit was deposited during Olympia Interglaciation (cf. Armstrong *et al.*, 1965; Fulton, 1968). Date is based on one 1-day and one 3-day count in 5-L counter at 4 atm.

10,000 ± 150
GSC-855. Sheep Lake, British Columbia **8050 B.C.**

Peat from base of bog deposit on Blueberry Creek-Big Sheep Creek divide, 16 mi WSW of Castlegar, British Columbia (49° 14′ 40″ N Lat, 117° 48′ 50″ W Long) at alt ca. 4350 ft. Bog deposit consists of 330 cm peat with 1-cm-thick volcanic ash bed at 35 cm depth and 18-cm-thick volcanic ash bed at 235 cm depth. Sample from 320 to 330 cm depth. Coll. 1967 by R. J. Fulton with Davis sampler. *Comment* (R.J.F.): date is minimum for deglaciation of Rossland Range of Monashee Mts. NaOH-leach omitted from sample pretreatment.

Twobit Creek series, British Columbia

Bog deposit 1 mi E of Lower Arrow Lake, 1.5 mi SE of mouth of Twobit Creek, 7 mi NNW of mouth of Deer Creek (49° 30′ 30″ N Lat, 118° 05′ 20″ W Long) at alt. ca. 2400 ft. Bog deposit consists of 109 cm peat and fibrous muck overlying 114 cm marl (in part peaty). A 3-cm-thick volcanic ash bed is present at 25 to 28 cm depth; an 8-cm-thick volcanic ash bed at 96 to 104 cm depth. Coll. 1967 by R. J. Fulton with Davis sampler.

8310 ± 150
GSC-875. Twobit Creek, peaty marl **6360 B.C.**

Peaty marl (124 to 134 cm depth) from below fibrous muck-marl contact. Two determinations were made; cf. Table 5, this list:

inorganic portion (marl) (one 3-day count)	8540 ± 140
organic portion, left after sample dissolved in H_3PO_4 (one 3-day count)	8310 ± 150

11,000 ± 180
GSC-909. Twobit Creek, basal marl **9050 B.C.**

Marl from base of bog deposit (230 to 238 cm depth). Blue clay, sand, and silt occur at 238 to 250 cm depth.

General Comment (R.J.F.): ages of both portions of GSC-875 were determined to establish degree of correspondence between peat and marl dates for this area. Organic part might be expected to give slightly younger date than inorganic, as dated material might contain rootlets from overlying fibrous muck, but two dates agree closely, unlike others reported in this list for New Brunswick (GSC-657, GSC-662, and GSC-675). GSC-909 is minimum date for deglaciation of Valkyr Range of Selkirk Mts. Date is somewhat older than other bog bottom determinations from this general area; cf. GSC-719 (10,270 ± 190; Radiocarbon, 1968, v. 10, p. 223-224; Fulton, 1968); GSC-855 (10,000 ± 150) and GSC-905 (10,200 ± 190), both in this list.

GSC-961. Fauquier, British Columbia **7370 ± 140**
5420 B.C.

Wood from test hole drilled in bottom of Lower Arrow Lake at Fauquier, 42 mi NNW of Castlegar, British Columbia (49° 52′ 20″ N Lat, 118° 05′ 40″ W Long). Drill hole penetrated 50 ft gravelly sand overlying 150 ft sand containing silt and clay beds and traces of organic materials. Wood obtained with split tube sampler from depth 150 ft in cased hole. Coll. 1966 by H. G. Gilchrist; subm. by W. H. Mathews, Univ. of British Columbia, Vancouver. *Comment* (R.J.F.): date indicates sediments to depth of at least 150 ft are postglacial.

GSC-923. Lusk Lake, British Columbia **9280 ± 160**
7330 B.C.

Basal peat at 560 cm depth from bog, 0.5 mi N of Lusk Lake, 18 mi E of Enderby and 34 mi N of Lumby, British Columbia (50° 36′ 30″ N Lat, 118° 43′ 30″ W Long). Basal peat overlain by intercalated marl and peat containing volcanic ash at 190 cm depth, and underlain by lacustrine silty clay. Coll. 1968 by G. W. Smith (Ohio State Univ., Columbus; now at Ohio Univ., Athens, Ohio) with Hiller peat sampler. *Comment* (G.W.S.): date is minimum for deglaciation. NaOH-leach omitted from sample pretreatment. Date based on one 4-day count.

GSC-905. Bear Valley, British Columbia **10,200 ± 190**
8250 B.C.

Fibrous plant material within lacustrine silty clay near base of bog, surface alt ca. 2650 ft, 8.5 mi W of Lumby, British Columbia (50° 15′ N Lat, 118° 47′ W Long). Silty clay, which extends to 400+ cm depth, is overlain by intercalated marl and peat containing volcanic ash at 42 cm depth. Coll. 1968 by G. W. Smith with Davis sampler at 260 cm depth. *Comment* (G.W.S.): date is minimum for deglaciation. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count.

GSC-913. Bessette Creek, British Columbia **19,100 ± 240**
17,150 B.C.

Plant detritus and peat within lacustrine sediments from stream cut on S bank of Bessette Creek, ca. 5 mi NW of Lumby, British Columbia (50° 18′ N Lat, 118° 51′ W Long). Sampled horizon occurs ca. 65 ft above stream at top of undetermined thickness of organic silt and sand overlain, successively by 60 ft laminated silt and 70 ft sand and gravel capped by till and veneer of lacustrine silt. Coll. 1968 by G. W. Smith. *Comments* (G.W.S.): date is maximum for last (Fraser) glacial advance; cf. GSC-194 (20,230 ± 270; Radiocarbon, 1965, v. 7, p. 33); (R.J.F.): fibrous nature of dated material makes it impossible to tell if sample was contaminated by rootlets of modern plants rooted in sampled unit. NaOH-leach omitted from sample pretreatment.

GSC-1004. Lavington, British Columbia **8320 ± 140**
6370 B.C.

Fibrous organic material mixed with sand and silt, from base of bog, 540 to 550 cm depth, N side of Coldstream Creek valley 11 mi E of Vernon, near Lavington, British Columbia (50° 14′ 10″ N Lat, 119° 01′ 30″ W Long) at alt ca. 1700 ft. Deposit consists of 550 cm mucky peat, with 10 cm-thick volcanic ash (Mazama?) layer at 360 to 370 cm, overlying 100 cm sandy silt and clay containing thin beds of fibrous organic material. Coll. 1966 with Hiller peat sampler by R. J. Fulton.

Comment (R.J.F.): Coldstream Creek valley was spillway for glacial lakes occupying Shuswap R. valley E of Lumby. Date is minimum for deglaciation and for last use of spillway. Sandy silt and other poorly sorted and poorly stratified sediments in lower part of sequence are fan deposits; date approximates end of significant fan deposition more closely than beginning of post-spillway sedimentation; cf. GSC-923 (9280 ± 160) and GSC-905 (10,200 ± 190), both basal bog dates near Lumby (this list). NaOH-leach omitted from sample pretreatment. Date based on one 4-day count.

Rutland series, British Columbia

Wood from holes drilled near Rutland on E side of Okanagan Lake. Coll. 1964 by E. Livingston, Water Investigations Branch, Dept. of Lands, Forests, and Water Resources, Victoria.

GSC-563. Black Mountain No. 1 **30,180 ± 530**
28,230 B.C.

Wood from 190 ft depth in cable-tool hole 6 mi ENE of bridge at Kelowna (49° 54′ 45″ N Lat, 119° 20′ 30″ W Long). Wood from 100-ft-thick sand-silt unit overlain by 50 ft till and 95 ft glacio-lacustrine silt.

GSC-1005. Rutland No. 1 **30,700 ± 1090**
28,750 B.C.

Wood from 299 ft depth in cable-tool hole 4 mi ENE of bridge at Kelowna (49° 53′ 30″ N Lat, 119° 24′ 30″ W Long). Wood from sand and silt at least 150 ft thick. This plant bearing unit is overlain by thick glacio-lacustrine silt.

General Comment (E.L.): samples of wood are from silty sand containing plant remains, widespread in Okanagan Valley. Several deep test holes indicate that these beds may be as thick as 900 ft. Drilling shows that unit is only locally overlain by till (as in Black Mountain No. 1 hole). Dates indicate that silt sand unit was deposited during Olympia Interglaciation (cf. Armstrong *et al.*, 1965; Fulton, 1968). GSC-1005 mixed with dead gas for counting. Each date based on one 3-day count.

GSC-763. MacKenzie Ave., Victoria, British Columbia **12,720 ± 160**
10,770 B.C.

Whole shells (*Hiatella arctica*) from shell bed overlying gray silty clay and overlain by peat, exposed in ditch leading to culvert under

MacKenzie Ave. a few hundred ft E of Quadra St., Victoria, British Columbia (48° 27′ 39″ N Lat, 123° 26′ 36″ W Long). Coll. 1962 and subm. by H. W. Nasmith, R. C. Thurber & Assoc., Ltd., Victoria, during drilling. *Comment* (H.W.N.): shell bed at alt 85 ft (geodetic) dates from latest marine submergence; age agrees with other dates from region (cf. *Comment* for GSC-945, this list).

Rithets Bog series, British Columbia

Gyttja samples from Rithets Bog, junction of Royal Oak Ave. and Patricia Hwy., Saanich Peninsula, Vancouver I., British Columbia (48° 27′ N Lat, 123° 29′ W Long). Coll. 1967 with Hiller peat borer by J. T. Fyles, B. C. Dept. of Mines and Petroleum Resources and H. W. Nasmith in connection with preparation of display for Provincial Mus., Victoria.

11,400 ± 190
GSC-945. Rithets Bog, basal gyttja 9450 B.C.

Gyttja from 9.9 m depth, ca. 5 to 8 cm above contact with underlying marine clay.

6390 ± 160
GSC-963. Rithets Bog, gyttja below ash 4440 B.C.

Gyttja from 6.6 m depth below distinctive layer of ash believed to be from Mt. Mazama (Crater Lake), Oregon.

General Comment (H.W.N.): date GSC-945 marks early stage of freshwater deposition following late glacial marine submergence. Pond was isolated from sea when relative sea level fell below alt 50 ft. Date agrees with those on marine shells from elsewhere on Saanich Peninsula: GSC-246 (12,660 ± 160; Radiocarbon, 1965, v. 7, p. 36) at alt 90 ft; GSC-398 (12,440 ± 230) and GSC-418 (12,750 ± 170; both in Radiocarbon, 1966, v. 8, p. 113), for sea levels at alt 60+ ft and ca. 80 ft, respectively; and GSC-763 (12,720 ± 160; this list) at alt 85 ft. GSC-963 is possibly slightly younger than generally accepted age for Mt. Mazama eruption (6600 B.P., Powers and Wilcox, 1964); cf. GSC-214, (6270 ± 140; Radiocarbon, 1965, v. 7, p. 33; date on organic muck above ash near Okanagan Lake, B.C.), but date is believed to confirm source of ash in Rithets Bog; NaOH-leach omitted from pretreatment of both samples. GSC-963 mixed with dead gas for counting.

C. Northern Canada, Mainland

4930 ± 150
GSC-781. West Aishihik River, Yukon 2980 B.C.

Organic silt from stringer 7 ft below surface in natural exposure in gully, N side West Aishihik R., Yukon (61° 0.25′ N Lat, 137° 07.6′ W Long). Stringer is at irregular contact of gray-brown silt (above) and permanently frozen gray silt (below). Gray silt was deposited in glacial lake during retreat of ice tongue from West Aishihik Valley; gray-brown silt is probably reworked by colluviation and cryoturbation, contact forming base of active layer. Coll. 1966 by O. L. Hughes. *Comment* (O.L.H.): date is minimum for drainage of glacial lake in West Aishihik

Valley. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

Aishihik Lake series, Yukon

Wood and peat from near Aishihik Lake, Yukon. Coll. 1966 by O. L. Hughes.

9660 ± 150
GSC-749. Aishihik Lake, peat **7710 B.C.**

Peat from frozen pond sediments in depression on S margin of hummocky moraine belt, at NW corner of unnamed pond E of road to radio towers, 3.6 mi N of Aishihik Lake (61° 40.7′ N Lat, 137° 27.2′ W Long). Discontinuous organic layer (this sample) 0.5 ft thick (in sand) is underlain by blue-gray lacustrine silt and overlain, successively, by 1.3 ft silty clay with abundant molluscs, 3 ft fine sand with molluscs at base and organic stringers at top, 0.5 ft White River Ash, and 0.1 ft surface organic layer.

7170 ± 140
GSC-755. Aishihik Lake, wood **5220 B.C.**

Wood from 5.1 ft below surface in bluff, N shore of Aishihik Lake (61° 37′ N Lat, 137° 29′ W Long). Woody layer 0.2 ft thick is underlain by silty clay that grades downward into distinctly varved glacio-lacustrine sediments and is overlain by 2.1 ft silty clay with molluscs, 1.1 ft silt with peat stringers, 0.8 ft silty peat with molluscs, 0.2 ft organic soil with charcoal, 0.6 ft White River Ash, 0.2 ft eolian silt with organic stringers. *General Comment* (O.L.H.): GSC-749 is minimum for retreat of ice from position marked by moraine belt. GSC-755 is minimum for drainage of glacial lake that occupied basins of Sekulmun and Aishihik Lakes and drained N to Nisling R.; it is compatible with GSC-749. Each date based on one 3-day count.

340 ± 130
GSC-867. Kluane Lake, Yukon **A.D. 1610**

Wood from *in situ* white spruce stump partly imbedded in beach gravel, 6 ft below normal high water level, S side of Christmas Bay, Kluane Lake, Yukon (61° 03.5′ N Lat, 138° 21′ W Long). Stump excavated to 18 in. below gravel surface, then cut off with saw; depth to base of stump (*i.e.*, original surface level) unknown but probably $<$5 ft. Outermost 0.5 cm (ca. 20 annual rings) used for dating. Coll. 1967 by J. Look and R. Klaubert for O. L. Hughes. *Comment* (O.L.H.): stumps of drowned spruce forest are common in Christmas Bay and elsewhere in Kluane Lake; according to Bostock (1952, 1969) trees were drowned when Neoglacial advance of Kaskawulsh Glacier dammed a S outlet of Kluane Lake via Slims-Kaskawulsh Valley, and forced discharge through present NW outlet (cf. Borns and Goldthwait, 1966; Denton and Stuiver, 1966, 1967; Porter and Denton, 1967). Date based on one 3-day count.

Silver Creek series, Yukon

Organic debris including wood, from silt beds in Icefield Outwash II, W side of Silver Creek, Yukon (61° 00′ N Lat, 138° 19′ W Long). Exposures at this locality have been studied in detail by Denton and interpreted by Denton and Stuiver (1967). Coll. 1966 by O. L. Hughes and V. Rampton. Detailed cross sections provided by Denton in advance of publication were used to duplicate as closely as possible samples coll. by Denton that yielded finite "older" dates. Samples were intended to be cross-check with Yale Radiocarbon Lab.

GSC-734. Silver Creek series (I) **>35,000**

Organic debris including wood in silt layer within gravel of Icefield Outwash II; same as Y-1356 (37,700 $^{+1500}_{-1300}$; Denton and Stuiver, 1967). *Comment* (J.A.L. and W.B., Jr.): small sample size used (100 g) necessitated dating in 2-L counter, in which finite ages over 35,000 yr are rarely obtained. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

29,600 ± 460
GSC-769. Silver Creek series (II) **27,650 B.C.**

Organic debris including wood in silt layer within gravel of Icefield Outwash II; same as Y-1385 (30,100 ± 600; Denton and Stuiver, 1967). *Comment* (O.L.H.): agreement with Y-1385 is within stated limits of error. Pretreatment included *cold* NaOH-leach. Date based on one 3-day count.

170 ± 140
GSC-895. Bighorn Glacier, Yukon **A.D. 1780**

Wood chunks and rootlets from within ice-contact stratified material deposited after stagnation and melting of "surged" Bighorn Glacier, Yukon (61° 05 N Lat, 139° 05′ W Long). Organic matter from sand bed at ca. 20 ft depth in 40 ft sec. of freshly exposed coarse material. Coll. 1967 by N. W. Rutter. *Comment* (N.W.R.): since wood is interpreted as material that lived before "surge", age is maximum for time of "surge" (Rutter, 1969). Sample mixed with dead gas for counting.

4630 ± 130
GSC-996. Dempster Highway, Yukon, wood **2680 B.C.**
$\delta C^{13} = -24.9‰$

Wood from base of 10-ft-thick frozen peat layer in roadside exposure, at Mile 102, Dempster Hwy., Yukon (65° 05′ N Lat, 139° 30′ W Long). Peat overlies outwash from oldest recognized glaciation in Ogilvie Mts. (Vernon and Hughes, 1966). Coll. 1966 by J. T. Gray, McGill Univ., Montreal. *Comment* (J.T.G.): date obtained is too young to establish glacial chronology of area. Peat development at site appears to have been recent phenomenon, dependent upon other factors than time of deglaciation. Date based on one 4-day count.

Wolverine Creek series, Yukon

Organic clay and wood from N bank of Wolverine Creek, 0.3 mi downstream from mouth of Lynx Creek, Yukon (61° 32′ N Lat, 139° 53.5′ W Long). Coll. 1967 by V. N. Rampton.

GSC-919. Wolverine Creek, Yukon (I) **>35,000**

Organic clay overlies 2.5 ft gravel and 10+ ft till, and underlies 5 ft clay, 45 ft sand, 80 ft gravel, and 30+ ft till.

GSC-962. Wolverine Creek, Yukon (II) **>40,000**

Wood (compressed twigs) from 20 ft deltaic sand overlying, successively, 25 ft sand, 5 ft clay, 2 ft organic clay, 7.5 ft gravel, and 10+ ft till, and underlying 80 ft gravel and 30+ ft till.

General Comment (V.N.R.): dates indicate that sediments (enclosing organic materials) resulting from damming of valley by glacier advance from E (which deposited upper till) were laid down more than 40,000 yr ago, (Rampton, 1969), GSC-962 being considered more reliable than GSC-919. NaOH-leach omitted from pretreatment of GSC-919. Date for GSC-962 based on one 5-day count.

GSC-960. O'Brian Creek, Yukon **>38,000**

Peat from near base of 54+ ft of organic silt, E bank of White R. opposite mouth of O'Brian Creek, Yukon (62° 38′ N Lat, 140° 0.5′ W Long). Silts overlie 29 ft gravel. Coll. 1967 by V. N. Rampton. *Comment* (V.N.R.): date is minimum for deposition of underlying gravels which grade to maximum limit of glaciation on White R. (Rampton 1969). NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting.

GSC-1002-2. Bull Creek, Yukon **>48,000**

Peat from 6 ft organic silts and colluvium on W bank of Bull Creek, 5 mi upstream from its mouth, Yukon (61° 30′ N Lat, 140° 15′ W Long). Organic silts and colluvium lie along dipping contact between 150 ft gravel above and 10+ ft till below. Coll. 1967 by V. N. Rampton. Two determinations were made:

GSC-1002 (one 1-day count in 2-L counter)	>40,000
GSC-1002-2 (one 3-day count and two 1-day counts in 5-L counter at 4 atm	>48,000

Comment (V.N.R.): underlying till was deposited over 48,000 yr ago.

St. Clare Creek series, Yukon

Compressed twigs and silty peat from under tills along St. Clare Creek, near Klutlan Glacier, Yukon. Coll. 1966, 1967 by V. N. Rampton.

GSC-799. St. Clare Creek, Yukon (I) **>39,000**

Compressed twigs and peat overlain, successively, by 45 ft silty till and 10 ft sandy till and overlie 25 ft sandy till on W bank of St. Clare Creek (61° 37′ N Lat, 140° 31′ W Long). Upper portion of underlying till is oxidized. Exposure is within limits of oldest Neoglacial advance of Klutlan Glacier (cf. GSC-751, 1520 ± 130, this list).

GSC-924. St. Clare Creek, Yukon (II) **>41,000**

Silty peat from upper part of 3 ft of silty peat on NE bank of St. Clare Creek, 0.2 mi downstream from mouth of Bull Creek (61° 32′ N Lat, 140° 23.5′ W Long). Silty peat is overlain, successively, by 10 ft sand, 6 ft till, and 80 ft alluvium, and overlies 2+ ft of till. Coll. 1966, 1967 by V. N. Rampton.

General Comment (V.N.R.): infinite dates do not permit exact ages of overlying tills to be defined, but underlying till was deposited over 39,000 yr ago. NaOH-leach omitted from pretreatment of GSC-924. Dates for GSC-924 and GSC-799 each based on one 3-day count.

Klutlan Glacier series, Yukon

Forest duff, spruce needles, and wood assoc. with Neoglacial drift near Klutlan Glacier, Yukon. Coll. 1966, 1967 by V. N. Rampton.

1520 ± 130
GSC-751. Klutlan Glacier, Yukon (I) **A.D. 430**

Wood from midpoint of 50 ft exposure of till, W bank of Count Creek, 1.5 mi upstream from junction with St. Clare Creek (61° 33′ N Lat, 140° 31′ W Long).

340 ± 130
GSC-929. Klutlan Glacier, Yukon (II) **A.D. 1610**
$\delta C^{13} = -23.1‰$

Outer portion of spruce log (30 rings from 130-yr-old tree) from below 1 ft of slightly decomposed moss and from above alluvium and till(?), W bank of St. Clare Creek, 5.5 mi upstream from its mouth (61° 37′ N Lat, 140° 32.5′ W Long). Wood wet and partly frozen when coll.

350 ± 130
GSC-966. Klutlan Glacier, Yukon (III) **A.D. 1600**
$\delta C^{13} = -25.6‰$

Spruce needles and forest duff from same stratigraphic position and locality as GSC-929.

310 ± 130
GSC-912. Klutlan Glacier, Yukon (IV) **A.D. 1640**
$\delta C^{13} = -23.6‰$

Branches of tilted trees exposed in creek cut; from between 2 tills at exposure within Klutlan Neoglacial moraines (61° 38′ N Lat, 140° 33′ W Long).

General Comment (V.N.R.): GSC-751 may give age of initial Neoglacial advance (Rampton, 1969). No distinction can be made between ages, in radiocarbon yr, obtained for GSC-929, GSC-966, and GSC-912; GSC-929 and GSC-966 are minima for retreat of ice from maximum Neoglacial position, and GSC-912, farther NW, predates a major Neoglacial re-advance. GSC-966 mixed with dead gas for counting.

White River series, Yukon

Wood and organic silts from exposures downstream from Alaska Hwy. bridge across White R., Yukon. Coll. 1965, 1966 by V. N. Rampton.

GSC-714. White River, Yukon (I) **11,000 ± 160** **9050 B.C.**

Organic silt from base of bog, W bank of White R., 2.2 mi downstream from Alaska Hwy. bridge (62° 01′ N Lat, 140° 34′ W Long); 1.5 ft organic silt is overlain by 10 ft peat and underlain, successively, by 12 ft gravel and 45 ft till.

GSC-777. White River, Yukon (II) **7760 ± 170** **5810 B.C.**

Wood from base of bog, W bank of White R., 2.3 mi downstream from Alaska Hwy. bridge (62° 01′ N Lat, 140° 34′ W Long). Peat is underlain, successively, by 2 ft till-like material, 47 ft gravel, and 30 ft till.

GSC-552. White River, Yukon (III) **>42,000**

Organic silt and silty peat from W bank of White R., 1.3 mi downstream from Alaska Hwy. bridge (62° 00′ N Lat, 140° 34′ W Long). Organic silts are from angular unconformity between till and underlying gravels and sands. Till is capped by gravel and peat.

GSC-732. White River, Yukon (IV) **48,000 ± 1300** **46,050 B.C.**

Wood from mud-flow debris, W bank of White R., 1.2 mi downstream from Alaska Hwy. bridge (62° 00′ N Lat, 140° 34′ W Long). Mud-flow debris is underlain by 10 ft till whose top 5.5 ft is oxidized and overlain by slump composed of gray drift.

GSC-995. White River, Yukon (V) **>41,000**

Wood and silty peat from alluvium, W bank of White R., 1.3 mi downstream from Alaska Hwy. bridge (62° 00′ N Lat, 140° 34′ W Long). Alluvium is at river level and is overlain by 100 ft olive gray till containing pods of peat and mud-flow debris in its basal part. Till is capped by gravel and peat.

General Comment (V.N.R.): GSC-714 is minimum for deglaciation. GSC-732 is maximum for time of mud-flow, and minimum for underlying till, although possibility of sample contamination cannot be ruled out (Rampton, 1969). NaOH-leach omitted from pretreatment of GSC-552 and GSC-714. Dates for GSC-552 and GSC-732 each based on one 3-day count, the latter in 5-L counter at 4 atm.

GSC-776. Generc River, Yukon **9360 ± 150** **7410 B.C.**

Organic silt from base of peat bog overlying 8 ft till and 25 ft gravel, W bank of Generc R., 1.5 mi upstream from mouth of unnamed small creek, Yukon (61° 42.5′ N Lat, 140° 38′ W Long). Coll. 1966 by V. N. Rampton. *Comment* (V.N.R.): date is minimum for deglaciation of locality. NaOH-leach omitted from sample pretreatment.

White River ash series, Yukon (II)

Wood and forest duff from below E lobe of White R. volcanic ash which blankets much of SW Yukon (cf. Bostock, 1952; Berger, 1960; Lerbekmo *et al.*, 1968; 1969). Coll. 1966, 1967 by V. N. Rampton.

GSC-748. Little Boundary Creek, Yukon **1210 ± 130**
A.D. 740
$\delta C^{13} = -21.9‰$

Outer portion of partially exhumed stump at upstream edge of island in channel of Little Boundary Creek, 11 mi from its mouth (61° 38′ N Lat, 140° 55′ W Long); 2 ft lapilli overlie tree roots and soil.

GSC-934. Big Boundary Creek, Yukon (I) **1280 ± 130**
A.D. 670
$\delta C^{13} = -24.0‰$

Wood and forest duff from below 5 ft lapilli, W bank of Big Boundary Creek, 4.5 mi downstream from Natazhat Glacier (61° 37′ N Lat, 140° 49′ W Long).

GSC-1000. Big Boundary Creek, Yukon (II) **1300 ± 130**
A.D. 650
$\delta C^{13} = -20.8‰$

Outer 40 rings of stump protruding through thick blanket of lapilli on upland between Big Boundary Creek and Brooke Creek (61° 38′ N Lat, 140° 46′ W Long).

General Comment (V.N.R.): dates are similar to dates of 1200 ± 140 (GSC-408) and 1240 ± 130 (GSC-343, both in Radiocarbon, 1968, v. 10, p. 229-230), obtained on material below E lobe of White R. ash both N and S of present series; cf. also Fernald, 1962; Stuiver *et al.*, 1964. Date for GSC-1000 based on one 3-day count.

GSC-959. Niggerhead Mountain, Yukon **>38,000**

Peat and organic silt from bank at edge of small lake N of Niggerhead Mt. and 1.3 mi W of Alaska Hwy. Mile 1196.3, Yukon (62° 18.5′ N Lat, 140° 50′ W Long). Dated material from near top of 2 ft unit containing ice wedge cast. Unit overlies silt containing peaty layers and is overlain, successively, by peat, gray silt, and turf. Coll. 1967 by V. N. Rampton. *Comment* (V.N.R.): it was hoped to obtain maximum age for formation of ice wedge and deposition of gray silt (loess); date indicates that enclosing and underlying silts were deposited over 38,000 yr ago. NaOH-leach omitted from sample pretreatment. Sample mixed with dead gas for counting. Date based on one 3-day count.

Natazhat Glacier series, Yukon

Wood and peat from below Neoglacial drift, near Natazhat Glacier, Yukon. Coll. 1966, 1967 by V. N. Rampton.

GSC-766. Natazhat Glacier, Yukon (I) **480 ± 130**
A.D. 1470

Peat beneath till of Natazhat Glacier near its Neoglacial terminal position (61° 36′ N Lat, 140° 54′ W Long). Sample (frozen) coll. at 3.5 ft depth at headwaters of Little Boundary Creek.

3280 ± 130
GSC-933. Natazhat Glacier, Yukon (II) **1330 B.C.**
$\delta C^{13} = -23.0‰$

Outer 28 rings of log, 30 ft below top of 40 ft till exposure on W bank of Little Boundary Creek, 0.3 mi downstream from its source (61° 36′ N Lat, 140° 55′ W Long).

3300 ± 130
GSC-1003. Natazhat Glacier, Yukon (III) **1350 B.C.**
$\delta C^{13} = -23.4‰$

Log, 28 ft below top of 40 ft till exposure; location as for GSC-933, above.

General Comment (V.N.R.): GSC-766 is maximum for greatest Neoglacial extent of Natazhat Glacier; GSC-933 and GSC-1003 date an earlier Neoglacial advance (Rampton, 1969; cf. Porter and Denton, 1967). Date for GSC-933 based on one 3-day count.

6500 ± 140
GSC-932. Cache Creek, Yukon **4550 B.C.**

Peat from lower part of 2.5 ft of silty sand, W bank of White R. 0.5 mi downstream from mouth of Cache Creek, Yukon (61° 45′ N Lat, 140° 56′ W Long). Silty sand overlies, successively, 25 ft gravel, 2.5 ft silt, 15 ft gravel, and 5 ft till, and underlies 5 ft gravel and 32 ft poorly exposed sands, silts, and peat. Coll. 1967 by V. N. Rampton. *Comment* (V.N.R.): date is minimum for deglaciation of region; cf. GSC-714 (11,000 ± 160) and GSC-777 (7760 ± 170; both in this list). NaOH-leach omitted from sample pretreatment.

2340 ± 130
GSC-926. Fort Resolution, Northwest Territories **390 B.C.**
$\delta C^{13} = -23.4‰$

Wood (*Picea*, sp., id. by R. J. Mott) from sand exposed in excavation behind school, Fort Resolution, Northwest Territories (61° 10′ N Lat, 113° 40′ W Long), depth ca. 7 ft; ca. 1 ft above Great Slave Lake (alt 513 ft, 1967). Coll. 1967 by W. B. Kudelik, Fort Resolution. *Comment* (B. G. Craig): sample, from alluvial plain along Slave R. (Craig, 1965a); together with S-268 (2725 ± 115) and S-269 (2215 ± 95; both in Radiocarbon, 1968, v. 10, p. 371) indicates that relative level of Great Slave Lake had fallen from maximum (ca. 900 ft) at Glacial Lake McConnell level to its present level by 2300 to 2700 B.P. Date based on one 4-day count.

6570 ± 140
GSC-1016. Duffy Lake, Northwest Territories **4620 B.C.**

Whole shells and fragments (*Hiatella arctica*) from frost boil in marine silt, alt ca. 400 ft, ca. 150 ft below marine limit, 1 mi NE of Duffy Lake, Northwest Territories (62° 49′ N Lat, 94° 48′ W Long). Coll. 1967 by A. Davidson for B. G. Craig. *Comment* (B.G.C.): shells are highest coll. in SE Dist. of Keewatin. Date was expected to approximate more closely time of deglaciation and inundation by Tyrrell Sea of NW coast of Hudson Bay than only previous date (6975 ± 250, I(GSC)-8; shells at alt 210 ft; Lee, 1959; Radiocarbon, 1961, v. 3, p. 50-51). Slightly younger age of present sample indicates that it relates to slightly later stand of Tyrrell Sea than I(GSC)-8. Date based on three 1-day counts.

D. Northern Canada, Arctic Archipelago

GSC-911. Henry Kater Peninsula, Baffin Island **>35,000**

Pelecypod shell fragments (*Mya truncata, Astarte striata,* and *A. borealis*) from stratified silt and sand, NE coast of Henry Kater Peninsula, Baffin I., Northwest Territories (69° 26′ N Lat, 67° 02′ W Long), at alt 48 ft, 12 ft below surface. Shells, fragmentary and worn, were assoc. with well-rounded stones, suggesting deposition in beach environment. Coll. site slightly above highest obvious postglacial marine beach features. Coll. 1967 by C. A. M. King, Univ. of Nottingham, Nottingham, England. *Comments* (C.A.M.K.): age of shells indicates that sea level must have been at least 60 ft higher, relative to land, during an interglacial or interstadial; (W.B.,Jr.): possibility that "old" shells have been redeposited in postglacial feature is not excluded. Sample mixed with dead gas for counting. Date based on one 3-day count.

8270 ± 150
GSC-991. 'Truelove Inlet', Devon Island **6320 B.C.**

Whalebone from skull imbedded in yellow silty sand, at foot of escarpment 2.5 mi N of head of 'Truelove Inlet' and 3 mi E of Arctic Inst. of North America's Base Camp, Devon I., Northwest Territories (75° 40′ N Lat, 84° 23′ W Long). Skull, lower portion in permafrost, at alt 123 ft; marine limit in area at ca. 240 ft. Coll. 1967 by W. Barr, McGill Univ., Montreal, now at Univ. of Saskatchewan, Saskatoon. *Comment* (W.B.): date is reasonable in view of date on marine shells nearer marine limit (Y-1299, 9360 ± 160, alt 196 ft; cf. Müller and Barr, 1966). Whalebone date is probably more reliable as indicator of contemporary sea level. Both dates uncorrected for any C^{14} deficiency in Arctic sea water. Date based on one 3-day count.

120 ± 130
GSC-891. Ice-cap margin, Ellesmere Island **A.D. 1830**

Moss (*Rhacomitrium lanuginosum* [Hedw.] Brid., id. by G. R. Brassard, Univ. of Ottawa, Ottawa), adjacent to NW margin of main ice-cap in SW Ellesmere I., Northwest Territories (76° 58.5′ N Lat, 86° 14′ W Long), at alt ca. 2400 ft. Frozen sample coll. at 3 to 5 in. depth beneath mixed till and outwash, and exposed in rivulet flowing parallel to edge of ice lobe, 15 ft away. Coll. 1967 by W. Blake, Jr. *Comment* (W.B., Jr.): geomorphic and botanical evidence indicate that moss, a species generally found covering large areas of dry acid ground, and common in vicinity, grew when ice lobe was diminished in size. Moss was killed when ice advanced to or beyond present position; in latter case slight retreat of margin has occurred recently, re-exposing moss. Sample mixed with dead gas for counting. Date based on one 4-day count.

GSC-1025. Ward Hunt Island, Ellesmere Island **4510 ± 150**
2560 B.C.
$\delta C^{13} = +1.5‰$

Pelecypod shells from surface of ice grounded below sea level between E end of Ward Hunt I. and ice shelf, Ellesmere I., Northwest Territories (83° 05′ N Lat, 73° 52′ W Long), at alt 1 to 2 ft. Coll. 1968 by G. Hattersley-Smith, Defence Research Bd., Ottawa. *Comment* (G.H-S.): shells probably picked up from sea bottom by freezing in shallow water, then gradually elev. to ice surface through ablation and further bottom freezing. Date is compatible with other evidence that Ward Hunt Ice Shelf has existed for not more than ca. 3000 yr (cf. Crary *et al.*, 1955; Crary, 1960; Christie, 1967). Dated in 2-L counter at 1 atm.

GSC-637. White Glacier moraine, Axel Heiberg Island **370 ± 130**
A.D. 1580

Roots and twigs in silt and fine sand beneath till of end moraine, in front of White Glacier, Axel Heiberg I., Northwest Territories (79° 25.5′ N Lat, 90° 36.7′ W Long). Moraine above sample is itself overlain by present end moraine of White Glacier. Sample is from interface between horizontally-bedded gravel and till, and is ca. 80 m S of White Glacier. Coll. 1966 by F. Müller and D. Terroux, McGill Univ., Montreal. *Comment* (F.M.): date agrees with B-464 (240 ± 100; Müller, 1963), on proximal side of older moraine overlying GSC-637 and at interface between gravel and till of present moraine. For dates on organic material in outwash in front of White Glacier moraines see Hegg (1961), Gfeller and Oeschger (1963), and Müller (1963). Date based on one 3-day count.

GSC-432. 'Rens Lake', Axel Heiberg Island, 230 ft **14,180 ± 180**
12,230 B.C.

Pelecypod shells (*Hiatella arctica*) from surface of patterned ground ca. 1.9 mi NE of 'Rens Lake', Axel Heiberg I., Northwest Territories (81° 05.5′ N Lat, 91° 55.5′ W Long), at alt ca. 213 to 230 ft. Site is ca. 131 ft above 'Rens Lake' at N end of hill with alt ca. 295 ft. Coll. 1961 by F. Müller. *Comment* (F.M.): although sample not coll. at marine limit, date is older than expected; cf. GSC-167 (8250 ± 140; Müller, 1963; Radiocarbon, 1965, v. 7, p. 42), date on shells at ca. 100 ft nearby. Possibly postglacial shells have been mixed with older ones by glacier movement. Outermost 30% of shell removed prior to dating.

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GSC II	Dyck and Fyles, 1963
GSC IV	Dyck, Fyles, and Blake, 1965
GSC V	Dyck, Lowdon, Fyles, and Blake, 1966

GSC VI	Lowdon, Fyles, and Blake, 1967
GSC VII	Lowdon and Blake, 1968
GSC VIII	Lowdon, Wilmeth, and Blake, 1969
Isotopes I	Walton, Trautman, and Friend, 1961
Lamont VII	Olson and Broecker, 1961
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UCLA V	Berger and Libby, 1966

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ISOTOPES' RADIOCARBON MEASUREMENTS VIII

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ISOTOPES—A Teledyne Company, Westwood, New Jersey

INTRODUCTION

This date list presents results of samples measured at ISOTOPES during 1968 and 1969 and several measurements made previously for which complete sample data has recently been received.

Samples were analyzed by the same methods as described in Radiocarbon 1968, v. 10, p. 246, with each sample being assayed twice in different counters and on different days. It is interesting to note the increasing application of the method to dating soil profiles. For these samples inorganic carbonate is first removed by hydrochloric acid digestion at 90°C for eight hours and, when required, possibility of contamination by migratory humic acids is eliminated by sodium hydroxide extraction as described by Perrin, Willis, and Hodge (1964). Bone samples were pretreated in a manner similar to that described by Berger, Horney, and Libby (1964) with modifications by Haynes (1967). Shell samples were abraded to remove physical signs of weathering and the residue treated with hydrochloric acid prior to evolution of the sample gas.

Errors associated with age determinations in this list are calculated by combining standard deviations calculated for total counts of standard, background, and actual sample. Counting time used for calculation of errors of background and standard is the same as that used for the sample. The error associated with the De Vries effect and the uncertainty in the half-life are not included.

ACKNOWLEDGMENTS

It is recognized that data obtained at this laboratory remain the sole property of our clients. Nevertheless we encourage our clients to submit these dates for publication and we are indebted to those who have consented to have their data published here and particularly to those supplying informative comments.

The laboratory operations benefited from the technical support of Mr. J. Bonicos and Miss P. Kondratick. We would like to thank Mrs. J. Buckley for her assistance in compiling the data associated with this listing, and Mrs. M. Mandel for her careful attention to the manuscript preparation.

I. GEOLOGIC SAMPLES

Western United States

Kukak Bay, pollen profile series, Alaska

Samples from Kukak Bay (58° 19′ N Lat, 154° 10′ W Long), Alaska. Dated to provide evidence of climatic sequence in vicinity of archaeol. excavations. Coll. and subm. by D. E. Dumond, Univ. of Oregon, Eugene, Oregon. Pollen analysis by C. J. Heusser, Am. Geog. Soc., New York, N.Y.

7670 ± 350
I-1627. Kukak Bay, 1.9 m (A) **5720 B.C.**

Peat from bog, 1.9 m deep. Coll. 1964; subm. 1965. *Comment* (D.E.D.): adjacent to distinctive volcanic ash horizon, appears too old for depth of bog, interpreted as Hypsithermal.

9100 ± 220
I-1628. Kukak Bay, 3.1 m **7150 B.C.**

Peat from bog, 3.1 m deep, 35 cm above base of column, from peat containing substantial proportion of birch pollen. Coll. 1964; subm. 1965.

4360 ± 115
I-3113. Kukak Bay, 1.9 m (B) **2410 B.C.**

Peat from same vicinity and depth as I-1627. Coll. and subm. 1967. *Comment* (D.E.D.): in accord with geol. and palynologic evidence, and consistent with I-1628.

Blue Creek series, California

Wood (*Abies concolor*) from 9.2 mi SE of Klamath (41° 27′ 00″ N Lat, 123° 53′ 40″ W Long), NE ¼ of NW ¼, Sec. 12, T. 12N, R. 2E, California. From 12 ft below terrace (Helley and La Morchi, 1968). Coll. 1966 and subm. 1969 by E. J. Helley, U. S. Geol. Survey, Menlo Park, California.

260 ± 90
I-4151. Blue Creek IA **A.D. 1690**

Sample is 113 annual rings from tree bark. *Comment*: terrace deposit is probably result of floods of 1862.

280 ± 90
I-4152. Blue Creek IB **A.D. 1670**

Sample from same position as I-4151.

Niwot Ridge series, Colorado

Soil samples from Niwot Ridge, Boulder Co., Colorado. Coll. 1968 and subm. 1969 by J. B. Benedict, Inst. of Arctic and Alpine Research, Boulder, Colorado.

1140 ± 90
I-4044. Niwot Ridge, No. 1 **A.D. 810**

Buried soil A horizon (40° 03′ 23″ N Lat, 105° 35′ 28″ W Long). From 3.4 ft behind stone banked terrace (Benedict, 1966).

2340 ± 130
I-4045. Niwot Ridge, No. 2 **390 B.C.**

Buried soil A horizon (humates extracted) (40° 03′ 35″ N Lat, 105° 36′ 35″ W Long). From 14.6 ft behind small turf banked lobe.

General Comment: dates indicate beginning of A-horizon development on slope after disappearance of perennial Temple Lake snowbank, gives minimum age for turf banked lobe. Rate of movement since late Temple

Lake time is 1.9 mm/yr, which is slower than present measured rates. Additional data in series reported in Radiocarbon, 1968, v. 10, p. 249.

I-4191. Mechanicsville Bog, Iowa **>39,900**

Peaty silt from Mechanicsville Bog, 2.5 mi NE of Mechanicsville (41° 56′ 23″ N Lat, 91° 13′ 13″ W Long), Iowa. From bottom of 4 ft thick peat zone, below 10 ft of alluvium and colluvium. Coll. and subm. 1968 by L. D. Drake, Univ. Iowa, Iowa City, Iowa. *Comment*: augering indicates a buried bog of several sq. mi overlying Iowan outwash and till. Spruce pollen dominates spore content of dated peat.

9940 ± 160
I-3880. Agassiz Mosbeck site, Minnesota **7990 B.C.**

Driftwood from Agassiz Mosbeck site 1/4 mi E of St. Hilaire (48° 01′ N Lat, 96° 19′ W Long), Pennington Co., Minnesota. Sample horizon overlies 2 ft peat and silt, overlain by 4 ft Lake Agassiz silt and sand. Coll. and subm. 1968 by L. Clayton, Univ. of North Dakota, Grand Forks, North Dakota. *Comment* (L.C.): site between Campbell and McCauleyville beaches of glacial Lake Agassiz. Driftwood deposited during rising stage of Phase III, overlying silt deposited during Phase III when Lake Agassiz rose to Campbell beach for last time.

Rice Lake series, Minnesota

Samples from sediment cores in Rice Lake (46° 55′ 16″ N Lat, 95° 34′ 30″ W Long), Becker Co., Minnesota. Coll. and subm. 1968 by J. H. McAndrews, Royal Ontario Mus., Toronto, Canada.

2450 ± 100
I-3928. Rice Lake—1 **500 B.C.**

Marly gyttja at base of *Gramineae* pollen rise.

590 ± 95
I-3927. Rice Lake—2 **A.D. 1360**

Detritus gyttja at base of *Ambrosia* pollen rise. *Comment*: *Ambrosia* pollen rise resulted from land settlement ca. 75 yr ago. Date indicates presence of older contaminant in sediment.

Trolinger Bog series, Missouri

Samples from Trolinger Bog, Avery, Benton Co. (38° 04′ N Lat, 93° 20′ W Long), Missouri. Coll. 1968 by P. J. Mehringer and C. V. Haynes; subm. by W. R. Wood, Univ. of Missouri, Columbia, Missouri. Chemical pretreatment by Dept. Geochron., Univ. of Arizona. Comments by C.V.H.

20,500 ± 450
I-3535. 4A **18,550 B.C.**

Peat residue of Unit e. *Comment*: date indicates that strata in this sec. of spring bog has been disturbed.

17,250 ± 600
I-3536. 4B **15,300 B.C.**

Humates extracted from peat of Unit e.

I-3537. 4A-1 **25,650 ± 700**
23,700 B.C.

Vegetable debris from Unit b. *Comment*: date consistent with I-3599 and applies to extinct fauna.

I-3599. 1A **32,200 +1900 −1600**
30,250 B.C.

Peat residue from lowermost Unit d_2.

I-3922. Boney Spring, Missouri **16,580 ± 220**
14,630 B.C.

Wood (*Picea sp.*) from Boney Spring (38° 06′ N Lat, 93° 22′ W Long), Benton Co., Missouri. Assoc. with *Mammut americanum* in excavated bone bed ca. 4 m deep (Mehringer *et al.*, 1968). Coll. and subm. 1968 by P. J. Mehringer, Univ. of Arizona, Tucson, Arizona. *Comment*: sample contained 10 annual rings of log with ca. 70 rings.

Dixie Valley, Nevada

Two samples of algal tufa (microcrystalline calcite) from E front of Stillwater Range, Dixie Valley (39° 54′ 20″ N Lat, 117° 59′ 45″ W Long), Nevada. Occur as botryoidal rind on Pleistocene lake shore gravel, ca. 25 ft below highest features of this type and ca. 5 ft below highest lake stand. Elev. 3520 ft. Coll. and subm. 1967 by G. A. Thompson and D. B. Burke, Stanford Univ., Stanford, California. *Comment*: dates last high rise of Dixie Lake which has well-developed shoreline features, not discernible for earlier lake stands.

I-3269. 67-5A **11,560 ± 180**
9610 B.C.

I-3270. 67-5B **11,700 ± 180**
9750 B.C.

Tularosa River series, New Mexico

Samples of Tularosa R. alluvium from Otero Co., New Mexico. Coll. and subm. 1968 by A. L. Metcalf, Univ. of Texas, El Paso, Texas.

I-3782. No. 1 **2930 ± 105**
980 B.C.

Peat-like material exposed along U. S. Hwy. 70 (33° 07′ 00″ N Lat, 106° 55′ 50″ W Long), SW 1/4, NE 1/4, Sec. 12, T. 14 S, R. 10 E. Similar material consistently occurs 3 to 5 ft below top of exposures.

I-3783. No. 2 **6650 ± 130**
4700 B.C.

Charcoal found 200 ft downstream from U. S. Hwy. 70 bridge (33° 08′ 42″ N Lat, 106° 53′ 50″ W Long), SE 1/4, NW 1/4, Sec. 32, T. 13 S, R. 11 E. From 20 ft below top of exposure.

I-3784. Rincón Valley, New Mexico **9360 ± 150**
7410 B.C.

Charcoal from 1.5 mi WSW of general store, Garfield (32° 45′ 10″ N Lat, 107° 17′ 15″ W Long), Doña Ana Co., New Mexico. From bluff, W edge Rio Grande floodplain, elev. ca. 4100 ft. Geol. sec.: max 11 ft Fillmore fan alluvium with basal disconformity; 11 to 19 ft Leasburg alluvium of clay and sandy clay with scattered carbonate nodules. Sample from layer of scattered charcoal fragments at 16 ft; 20 ft modern Rio Grande floodplain (Hawley and Kottlowski, 1965; Hawley, 1965). Coll. and subm. 1968 by J. W. Hawley and A. L. Metcalf.

Southern Oregon Continental Slope series

Marine sediment from S Oregon continental slope taken with piston core. Coll. 1967 and subm. 1969 by J. J. Spigai, Oregon State Univ., Corvallis, Oregon.

I-4048. Piston Core 6706-2 **23,900 ± 650**
21,950 B.C.

Olive gray silt from 300 to 350 cm depth in 400 cm core, in small topographic bench (42° 09′ 36″ N Lat, 124° 56′ 12″ W Long). Water depth 1060 m. Sedimentation rate approx. 13.6 cm/1000 yr.

I-4049. Piston Core 6706-3 **34,300 ± 3500**
32,350 B.C.

Olive gray clay from 325 to 375 cm depth in 375 cm core, in topographic bench (42° 14′ 30″ N Lat, 124° 47′ 56″ W Long). Water depth 544 m. Sedimentation rate approx. 10.2 cm/1000 yr.

I-4146. Piston Core 6711-2 **6340 ± 140**
4390 B.C.

Foraminifera (rich silt) from 110 to 125 cm depth in 425 cm core, in axis of small submarine valley (42° 07′ 18″ N Lat, 124° 58′ 42″ W Long). Water depth 1363 m. Sedimentation rate approx. 18.4 cm/1000 yr. *Laboratory Comment*: all samples pretreated with HCl before combustion.

I-4068. Benton County, Oregon **>39,900**

Wood (*Quercus garryana*) Benton Co. (44° 40′ N Lat, 123° 11′ W Long), Sec. 28, T. 10S, R. 4W, Oregon. From 13.5 ft below surface in local alluvium, assoc. with Luckiamute geomorphic surface and cut into Dolph geomorphic surface. Proboscidian tusk at 11.5 ft (Balster and Parsons, 1968). Coll. and subm. 1968 by R. B. Parsons, Oregon State Univ., Corvallis, Oregon.

I-4069. Winkle, Lane County, Oregon **5960 ± 110**
4010 B.C.

Wood (*Acer macrophyllum*) from Lane Co. (44° 10′ N Lat, 123° 04′ W Long), Oregon. From 72 in. under Coburg soil profile in gleyed clay, assoc. with Winkle geomorphic surface (Balster and Parsons, 1968). Coll. 1967 by R. Herriman, K. Horn, and R. Parsons; subm. 1969 by R. Parsons. *Comment* (R.P.): date substantiated by other evidence from Indian hearth beneath sediments of Winkle age; correlates with eruption of Mt. Mazama, whose pumice is commonly found in sediments assoc. with Winkle surface.

I-4148. Southern Oregon Continental Shelf 6708—42 **22,100 ± 500**
20,150 B.C.

Mollusk shell from S Oregon continental shelf (42° 41′ 54″ N Lat, 124° 37′ 18″ W Long). From 434 to 454 cm depth in piston core, water depth 148 m. Coll. 1967 by D. Chambers and J. J. Spigai; subm. 1969 by R. C. Roush, Oregon State Univ., Corvallis, Oregon. *Comment* (R.C.R.): date indicates shell layer formed at shallower depth during last part of Wisconsin sea-level regression.

I-4145. Rogue Submarine Canyon 6708—37, Oregon Coast **29,950 ± 2250**
28,000 B.C.

Silty clay from axis of Rogue Submarine Canyon (42° 30′ 24″ N Lat, 124° 50′ 18″ W Long), S Oregon continental slope. Depth 769 m, from 250 to 280 cm interval in 580 cm piston core. Coll. 1967 and subm. 1969 by J. J. Spigai. *Comment*: date indicates small sediment accumulation.

I-4147. Central Oregon Continental Shelf 6809—6 **660 ± 95**
A.D. 1290

Shell (*Pecten,* epifauna) from outer continental shelf (45° 00′ 06″ N Lat, 124° 14′ 36″ W Long), off Central Oregon. From 12 cm depth in box core, 146 m water depth. Coll. 1968 by R. C. Roush; subm. 1969 by J. J. Spigai.

Little St. Germain Lake series, Wisconsin

Gyttja from S Bay and E Bay, Little St. Germain Lake, Vilas Co., Wisconsin. Coll. 1967 by D. S. Charlton; subm. 1968 by R. F. Black, Univ. of Wisconsin, Madison, Wisconsin.

10,880 ± 160
I-3651. L 73-10, South Bay **8930 B.C.**

From 33 ft 2 in. to 33 ft 7 in. depth in core (45° 54′ 12″ N Lat, 89° 27′ 6″ W Long).

4530 ± 120
I-3652. L 73-29, South Bay **2580 B.C.**

From 25 ft 6 in. to 25 ft 11 in. depth in core (45° 54′ 12″ N Lat, 89° 27′ 6″ W Long).

12,900 ± 300
I-3780. L 72-6, East Bay **10,950 B.C.**

From 38 ft 11 in. to 39 ft 4 in. depth in core (45° 55′ 26″ N Lat, 89° 27′ 31″ W Long).

Willow Spring series, Wyoming

Samples from walls of deflation hollows near Willow Spring archeol. site, S Albany Co. (41° 06′ N Lat, 103° 37′ W Long), SE Wyoming. Coll.

1968 by B. V. Hanson; subm. 1968 by B. Mears, Univ. of Wyoming, Laramie, Wyoming.

640 ± 95
I-4004. Willow Spring, T-2, T-3 **A.D. 1310**

Root (*Pinus Ponderosa*) from paleosol separated by 30 to 52 in. fine sand from Permo-Pennsylvanian bedrock. *Comment* (B.V.H.): present vegetation prairie with small scattered Ponderosa pines. Ancient climate cooler and more moist.

8790 ± 140
I-4005. Willow Spring, T-1 **6840 B.C.**

Fresh-water pelecypods and gastropods (*Pisidium, Fossaria, Gryaulus, Helisoma, Promenetus, Stagnicola, Charychium, Discus,* and *Econulus*) in marl, separated by 7 ft sand from Permo-Pennsylvanian bedrock. Strata yielded no artifacts.

Eastern United States

2820 ± 100
I-4072. Deer Island, Florida (114) **870 B.C.**

Disarticulated valves of oyster (*Crassostrea virginica*) from partially buried, raised oyster bank on Deer I., Levy Co. (29° 14′ 18″ N Lat, 83° 04′ 48″ W Long), Florida. From 31 to 34 in. depth in raised bank, parallel with and behind beach on W side of island (Vernon, 1951). Coll. 1968; subm. 1969 by R. S. Grinnell, State Univ. of New York, Binghamton, N. Y.

Glovers Pond series, NW New Jersey

Core samples from Glovers Pond, ¼ mi SW of Johnsonburg (40° 56′ 30″ N Lat, 74° 53′ 30″ W Long), Warren Co., NW New Jersey. Coll. 1966 and 1968 by J. M. Erickson, F. D. Holland, Jr., and J. A. Anderson; subm. 1968 and 1969 by J. M. Erickson and F. D. Holland, Jr., Univ. of North Dakota, Grand Forks, North Dakota.

4170 ± 110
I-3893. C—LK—le, d **2220 B.C.**

Gyttja from center N end Glovers Pond, base of upper gyttja (Unit VIII), water depth 8.5 m.

8690 ± 140
I-3980. C—IV—3b **6740 B.C.**

Reed and sedge peat from SW bog 450 ft from edge of Glovers Pond, base of peat (Unit F), 3.0 m from surface.

10,310 ± 160
I-3979. C—I—2e, g **8360 B.C.**

Reed and sedge peat from NE bog 100 ft from edge of Glovers Pond, base of peat (Unit F), 4.2 m from surface.

10,430 ± 160
I-3978. C—LK—il **8480 B.C.**

Gyttja from center N end Glovers Pond, top of lowest gyttja (Unit V) above organic-rich silt.

14,720 ± 260
I-4162. C—LK—ln 12,770 B.C.

Organic-rich silt from center N end Glovers Pond, base of lowest organic-rich silt (Unit IV) above oliogotrophic lake clay. *Comment* (J.M.E.): date indicates that deglaciation of this region began > 15,000 yr ago. Continuation of series reported in Radiocarbon, 1969, v. 11, p. 61-62.

10,950 ± 150
I-4016. Middletown, New York 9000 B.C.

Rib bone of *Cervalces scotti* (moose-elk) from 7.8 mi SSW of Middletown (41° 20′ N Lat, 74° 27′ 30″ W Long), Orange Co., New York. At lower peat-marl interface, 4.5 to 5 ft deep. Coll. 1968 by D. W. Fisher and E. M. Reilly; subm. 1969 by D. W. F., New York State Mus. and Sci. Service, Albany, New York. *Comment*: 1st *Cervalces* found in New York and 2nd most complete skeleton.

Leap Peat Bog site series, Pennsylvania

Wood samples from Leap Peat Bog (41° 02′ 50″ N Lat, 75° 06′ 37″ W Long), Monroe Co., Pennsylvania. Site located 2.9 mi N of junction of Marshalls Creek with Delaware R., and 4.5 mi NE of E Stroudsburg. Assoc. with Marshalls Creek Mastodon, 5 ft 7½ in. deep. Coll. and subm. 1968 by D. Hoff, Wm. Penn Memorial Mus., Harrisburg, Pennsylvania. *Comment*: skeleton disarticulated; remains apparently rafted into position.

12,160 ± 180
I-3929. Leap Peat Bog—1 10,210 B.C.

12,020 ± 180
I-3930. Leap Peat Bog—2 10,070 B.C.

11,230 ± 170
I-3647. Charlotte 1, Vermont 9280 B.C.

Pelecypod shells from sand/gravel beach 1.7 mi S of Charlotte (44° 17′ N Lat, 73° 15′ W Long), Vermont. From pit, 10 ft depth. Coll. and subm. 1968 by W. P. Wagner, Univ. of Vermont, Burlington, Vermont. *Comment* (W.P.W.): dates phase of Champlain Sea (Karrow, 1961).

8570 ± 160
I-4074. Williston Bog, Vermont 6620 B.C.

Peat from 1.5 mi S of Williston, along Allen Brook (44° 25′ N Lat, 73° 30′ W Long), Vermont. From bottom 2 in. of 50 ft sec. Bog occurs in depression of hummocky dead ice terrain. Coll. 1969 by W. P. Wagner and R. Switzer; subm. 1969 by W. P. Wagner. *Comment* (W.P.W.): date gives minimum estimate of dead ice terrain.

9280 ± 150
I-4075. Gillett Pond, Vermont 7330 B.C.

Peat from Gillett Pond, 3.8 mi SE of Richmond (44° 21′ N Lat, 72° 58′ W Long), Vermont. From bottom 2 in. of 20 ft core measured from water surface. Coll. 1969 by W. P. Wagner and R. Fillon; subm. 1969 by W. P. Wagner. *Comment* (W.P.W.): date is minimum for outlet channel.

Canada

Aspy Basin series, Canada

Samples from Aspy Basin coll. and subm. 1966 by W. A. Newman, Syracuse Univ., Syracuse, New York.

3090 ± 95
I-2437. Aspy Basin 1 **1140 B.C.**

Twigs and branches from peat, N Aspy R. bank (46° 52′ 04″ N Lat, 60° 34′ 48″ W Long), Cape Breton I., Canada. From lower 2 in. of 4 in. peat layer at base of terrace at 12 ft.

20,300 ± 400
I-2438. Aspy Basin 2 **18,350 B.C.**

Organic debris embedded in clay 1320 ft downstream from Upper S Aspy Bridge (46° 52′ 27″ N Lat, 60° 30′ 00″ W Long), Cape Breton I., Canada. From fluvioglacial deposit.

Home Bay series

Samples relating to glacial chronology and postglacial uplift in fiords entering Home Bay, E Baffin I., NW Territories. Coll. 1966 and 1967 by members or associates of Geog. Branch, Dept. of Energy, Mines and Resources, Ottawa, Ontario, Canada.

8300 ± 135
I-2611. Tingin Fiord **6350 B.C.**

Marine shells from + 62m (68° 57′ N Lat, 69° 07′ W Long), deposit extended from 43 to 72 m. Coll. and subm. 1966 by J. T. Andrews, Univ. of Colorado, Inst. of Arctic and Alpine Research, Boulder, Colorado. *Comment* (J.T.A.): dated to estimate rate of silt deposition and thus date onset of deposition at 43 m.

7560 ± 140
I-3063. Fox Charlie Bay **5610 B.C.**

Fragmented shells (*Mya truncata, Hiatella arctica*) from remnant of silt terrace (68° 44′ N Lat, 68° 39′ W Long), at + 48 m, proximal side of Ekalugad readvance moraine. Coll. 1967 by J. H. England; subm. 1967 by J. T. Andrews.

7460 ± 130
I-3065. Home Bay **5510 B.C.**

Shells (*Mya truncata, Hiatella arctica*) *in situ,* from clay immediately below surface of shallow delta terrace (68° 43′ N Lat, 67° 50′ W Long), at + 18 m. Coll. 1967 by J. H. England; subm. 1967 by J. T. Andrews. *Comment* (J.T.A.): minimum date for deglaciation.

6190 ± 120
I-3064. Bonny Bay **4240 B.C.**

Shells (*Mya truncata*) from distal slope of youngest readvance moraine at head of Bonny Bay (68° 53′ N Lat, 69° 02′ W Long), at

+ 30 m. Shells overridden, and clay matrix contained considerable morainic debris. Coll. 1967 by J. H. England; subm. 1967 by J. T. Andrews.

I-2583. Tingin Fiord, E Baffin Island **6130 ± 120**
4180 B.C.

Marine shells from + 16 m (68° 57′ N Lat, 69° 03′ W Long), sparsely distributed in well-defined foreset beds traced to delta surface at 24 m (Andrews, 1967; 1968). Coll. and subm. 1966 by J. T. Andrews. *Comment* (J.T.A.): date provides reliable estimate for sea level at 24 m.

I-2412. "Venturi Bay" **5900 ± 130**
3950 B.C.

Shells (*Macoma calcarea,* Gmelin) (*Mya truncata,* Linné) from + 32.8 m (68° 42′ N Lat, 69° 21′ W Long), in oxidized sand 5 cm width (Andrews, 1967). Coll. and subm. 1966 by J. T. Buckley. *Comment* (J.T.B.): date is minimum for ice retreat to head of Ekalugad Fiord.

I-3062. "Ekalugad Fiord" **5840 ± 150**
3890 B.C.

Shells (*Mya truncata, Hiatella arctica*) *in situ,* with periostracum still attached, from foreset beds at + 33 m (68° 52′ N Lat, 69° 25′ W Long), surface of deposit at + 40 m. Coll. 1967 by M. Church; subm. 1967 by J. T. Andrews. *Comment* (J.T.A.): dates 3 moraine loops closely assoc. with initiation of terrace at 43 m.

I-2548. "Pitchforth Fiord" **5580 ± 130**
3630 B.C.

Marine shells from + 6.4 to + 18 m (68° 58′ N Lat, 68° 34′ W Long), at base of stream-cut sec. in delta with top at ca. 18 m (Andrews, 1967). Coll. and subm. 1966 by J. T. Andrews. *Comment* (J.T.A.): date compares in alt. and time with I-2549 (5100 ± 120) from Kangok Fiord (this series).

I-2411. Inner Kangok Fiord **5380 ± 185**
3430 B.C.

Shells (*Mya truncata,* Linné) from delta in bay on S side of head of N arm of Kangok Fiord (68° 36′ N Lat, 68° 50′ W Long), at + 30.6 m. In black clay 3 m below main delta surface (Andrews, 1967). Coll. and subm. 1966 by J. T. Buckley. *Comment* (J.T.B.): indicates age of ice retreat from head of Kangok Fiord; delta surface is crossed by large moraine.

I-2422. Ekalugad Fiord, E.B.I. **4990 ± 175**
3040 B.C.

Shells (*Nucula tenis,* Montagu), (*Mya truncata,* Linné), (*Mya pseudoarenaria,* Schlesch), (*Hiatella arctica,* Linné), (*Macoma calcarea,* Gmelin), (*Clinocardium ciliatum,* Fabricius) *in situ* from anaerobic silt at river surface (68° 52′ N Lat, 69° 25′ W Long), 9.17 m elev., 8 m depth, overlain by foreset terrace sediments (Andrews, 1967). Coll. and subm.

1966 by M. Church. *Comment* (J.T.A.): date probably a reliable estimate of marine limit and contrasts with I-2412 (5900 ± 130) (this series) for a moraine farther down the fiord.

4850 ± 120
I-3066. South Arm, Ekalugad Fiord **2900 B.C.**

Shells (*Hiatella arctica, Mya truncata*), *in situ* from silt matrix (68° 48′ N Lat, 69° 24′ W Long), at + 11.5 m. Coll. 1967 by J. H. England; subm. 1967 by J. T. Andrews.

5100 ± 120
I-2549. "Corrie Bay", Kangok **3150 B.C.**

Shells (*Clinocardium ciliatum,* Fabricius), (*Mya truncata,* Linné), at + 11.5 to 15 m (68° 32′ N Lat, 68° 08′ W Long), from foreset beds of delta (Andrews, 1967; 1968). Coll. and subm. 1966 by J. T. Andrews.

4590 ± 115
I-2582. North Kangok Fiord **2640 B.C.**

Marine shells from sand in gullied river cliff (68° 36′ N Lat, 68° 55′ W Long), at + 9.85 m (Andrews, 1967). Coll. and subm. 1966 by J. T. Buckley.

4430 ± 110
I-2584. Ekalugad Fiord, Home Bay **2480 B.C.**

Marine shells paired *in situ* from sandy foreset beds (68° 52′ N Lat, 69° 27′ W Long), at + 19 m (Andrews, 1967). Coll. and subm. 1966 by M. Church.

4420 ± 110
I-2413. "Bonny Bay" **2470 B.C.**

Shells (*Mytilus edulis,* Linné) *in situ* from clay resembling deltaic material but in form resembling beaches (68° 53′ N Lat, 69° 01′ W Long), 2 m below gravel/sand surface (Andrews, 1967). Coll. and subm. 1966 by J. T. Buckley. *Comment* (J.T.B.): moraine marks stage in glacial retreat down "Bonny Bay" of main Ekalugad ice. Date is minimum for time by which "Bonny Bay" was ice-free and invaded by sea.

4050 ± 130
I-2546. "South Ekalugad River" **2100 B.C.**

Shells (*Macoma calcarea,* Gmelin), (*Mya truncata,* Linné), (*Clinocardium ciliatum,* Fabricius) from surface of terrace of black clay at base of mt. (68° 43′ N Lat, 69° 10′ W Long), 14.6 m elev. (Andrews, 1967). Coll. and subm. 1966 by J. T. Buckley. *Comment* (J.T.B.): date compares with that of shells at 40 m at mouth of river, and should indicate time of ice retreat from valley.

3890 ± 105
I-2586. "Loozie Bay" **1940 B.C.**

Marine shells (*Astarte borealis,* Schumacher), (*Astarte montagui,* Hancock), (*Mytilus edulis,* Linné) from beds of silty sand dipping seaward (68° 47′ N Lat, 68° 37′ W Long), alt 3 m (Andrews, 1967). Coll. and subm. 1966 by J. T. Andrews.

I-2585. Kangok Fiord, Bay 2 **3850 ± 105**
1900 B.C.

Marine shells from distinct sandy stratum and bed traced to surface at 5 m (68° 32′ N Lat, 68° 01′ W Long), alt 2 m (Andrews, 1967; 1968). Coll. and subm. 1966 by J. T. Andrews. *Comment* (J.T.A.): date will be used to construct uplift curve for outer Kangok Fiord.

Baffin Island Miscellaneous series

I-3200. Broughton Island **32,200 + 1700 − 1400**
30,250 B.C.

Marine shells (*Mya truncata, Hiatella arctica*) from excavated exposure at + 17 m (67° 34′ N Lat, 64° 00′ W Long), Baffin I. In coarse sand considered to represent littoral facies. Coll. and subm. 1967 by J. T. Andrews. *Comment* (J.T.A.): date unexpectedly old. Interpretations: (1) Shells were *in situ* and represent interstadial/interglacial deposits. (2) Sample had been dredged from former marine deposits during a readvance. Former hypothesis considered more likely.

I-2414. Dewar Lakes **1360 ± 105**
A.D. 590

Peat from 305 m elev., 1.5 m depth (68° 45′ N Lat, 71° 20′ W Long), 3.8 km N of Dewar Lakes, (Fox-3) central Baffin I. From base of peat, sand, and silt sec. in enclosed depression within morainic loop (Andrews, 1967). Coll. and subm. 1966 by D. M. Barnett. *Comment* (D.M.B.): only date from central part of island at this lat, gives minimum date for deglaciation of this locality.

I-2410. Butterfly Lake **6270 ± 210**
4320 B.C.

Marine shells (*Portlandia arctica, Hiatella arctica, Mya truncata, Clinocardium ciliatum*) from + 75.4 m (69° 21′ N Lat, 75° 49′ W Long), W coast Baffin I. In sand delta at 84.3 m. Coll. and subm. 1965 by C. A. M. King and J. T. Buckley.*Comment* (C.A.M.K.): local marine limit to N at 94 m. Highest shell sample from this area. Date related presumably to ice front close by, which supplied sediments of delta.

I-1932. Inner Clyde Inlet **7940 ± 130**
5990 B.C.

Marine shells (*Clinocardium ciliatum,* Fabricius, *Mya truncata,* Linné) id. by Dr. F. J. E. Wagner, from clay (69° 52′ N Lat, 70° 28′ W Long), 50.5 m elev., E Baffin I. Coll. and subm. 1965 by D. M. Barnett. *Comment* (D.M.B.): sample dates moraine phase and transgression to marine limit of 61 m. Date compares with I-1673 and I-1602 (Radiocarbon, 1966, v. 8, p. 184) from head of Inugsuin Fiord (Andrews, 1967).

I-2581. Sam Ford Fiord **36,250 +3600 −2500**
34,300 B.C.

Marine shells (*Hiatella arctica,* Linné) from 72.7 m elev., 1 mi from coast near mouth of Sam Ford Fiord (70° 59′ N Lat, 70° 37′ W Long), above left bank of river draining "Remote Lake", E Baffin I. From sandy delta probably ice cored, lying between 2 large moraines. Coll. and subm. 1966 by J. T. Buckley. *Comment* (J.T.B.): date significant in dating retreat of ice in Sam Ford Fiord after Wisconsin maximum. Date is maximum for oldest moraines visible on outer coast.

Isabella Bay, Itirbilung series

8760 ± 140
I-3211. Isabella Bay, a **6810 B.C.**

Marine mollusks (*Mya truncata, Astarte striata, Macoma calcarea*) from silty sand in front face of delta (69° 28′ N Lat, 68° 52′ W Long), at + 11.58 m. Surface of delta at 25 m elev. Coll. and subm. 1967 by C. A. M. King. *Comment* (C.A.M.K.): shells found as whole bivalves, probably *in situ.*

8530 ± 140
I-3133. Isabella Bay, b **6580 B.C.**

Fragments of marine mollusks from deltaic sand (69° 28′ N Lat, 68° 52′ W Long), Henry Kater Peninsula, alt. 21.37 m. Coll. and subm. 1967 by C. A. M. King.

8160 ± 135
I-3134. Isabella Bay, c **6210 B.C.**

Marine mollusks (whole bivalves and *Mytilus edulis*) *in situ,* from delta surface in silty sand (69° 28′ N Lat, 68° 52′ W Long), Henry Kater Peninsula, 18.62 m elev. Coll. and subm. 1967 by C. A. M. King.

8670 ± 140
I-3136. Itirbilung Fjord, b **6720 B.C.**

Marine mollusks (large *Mya truncata* in whole pairs) from sand underlying crest of outermost moraine (69° 18′ N Lat, 68° 10′ W Long), Henry Kater Peninsula. Coll. and subm. 1967 by C. A. M. King.

7970 ± 140
I-3213. Itirbilung Fjord, c **6020 B.C.**

Marine mollusks (*Mya truncata, Macoma calcarea, Astarte striata, Hiatella arctica,* and *Serrapes groenlandicum*) from delta surface to 10 cm depth in sand (69° 18′ N Lat, 68° 10′ W Long), N side Itirbilung Fjord. From + 21.02 m, whole paired bivalves, probably *in situ.* Coll. and subm. 1967 by C. A. M. King.

7160 ± 140
I-3135. Itirbilung Fjord, d **5210 B.C.**

Marine mollusks (*Astarte striata, Clinocardium cliatum, Mytilus edulis*) paired valves *in situ,* from sand, covering range of 10 cm (69° 18′

N Lat, 68° 10′ W Long), Henry Kater Peninsula. In delta. Coll. and subm. 1967 by C. A. M. King.

Hudson Bay, Hudson Strait series

I-2415. Fox Valley, Hudson Bay 1 **6590 ± 125**
4640 B.C.

Shells (*Mya truncata* Linné, *Hiatella arctica* Linné, *Macoma calcarea* Gmelin, *Mytilus edulis* Linné) from + 94 m, depth, 4 m, Gilmour I. (59° 50′ N Lat, 80° 00′ W Long) Ottawa I. From foreset beds 4 m below terrace surface. Coll. and subm. 1966 by J. T. Andrews and G. Falconer.

I-2416. Wide Strand Bay **6580 ± 125**
4630 B.C.

Shells (*Mya truncata* Linné), *in situ*, from + 39 m, Gilmour I. (59° 50′ N Lat, 80° 00′ W Long), Ottawa Is. From foreset beds which were traced to intersection with 50 m terrace. Coll. and subm. 1966 by J. T. Andrews and G. Falconer. *Comment* (J.T.A.): date suggests that (1) shells were redeposited from higher level and (2) beds were truncated by progressively falling sea level (Andrews, 1967; 1968).

I-2547. Gilmour Island **4960 ± 130**
3010 B.C.

Marine shells (and vegetation) (*Mya truncata* Linné, *Hiatella arctica* Linné, *Macoma calcarea* Gmelin, *Balanus balanus* Linné, *Macoma* sp. cf. *Macoma balthica* Linné) from + 48 to + 55 m (59° 50′ N Lat, 80° 00′ W Long), Ottawa Is. From foreset sand beds, relative sea level at 55 m. Coll. and subm. 1966 by J. T. Andrews and G. Falconer.

I-2417. Gilmour Island, Ottawa Islands **3530 ± 110**
1580 B.C.

Shells (*Mya truncata* Linné) *in situ*, paired, some with siphons attached, from 10 m elev. (59° 50′ N Lat, 80° 00′ W Long), Site 9. From foreset beds traced to surface at ca. 21 m. Coll. and subm. 1966 by J. T. Andrews and G. Falconer. *Comment* (J.T.A.): dates prominent and semicontinuous delta. Suggests average fall of relative sea level approx. 0.6 m per century. Estimate is minimum for rate of uplift (Andrews, 1967; 1968).

I-2418. Fox Valley, Hudson Bay 2 **1150 ± 100**
A.D. 800

Shells, *in situ*, from steeply dipping foreset beds of beach near present sea level (59° 50′ N Lat, 80° 00′ W Long), + 2 m, Gilmour I., Ottawa Is. Coll. and subm. 1966 by J. T. Andrews and G. Falconer. *Comment* (J.T.A.): date refers to relative sea level ca. 4 to 5 m and implies rebound of ca. 0.45 m per century (Andrews, 1967; 1968).

I-2443. The Points **6950 ± 130**
5000 B.C.

Shells (*Hiatella arctica* Linné, *Mya truncata* Linné) from + 127 m, depth 5 cm (63° 33′ N Lat, 85° 00′ W Long), Southampton I. From marine sands. Coll. and subm. 1966 by J. B. Bird. *Comment* (J.B.B.): minimum age for formation of The Points (a fluvioglacial ridge) and for deglaciation (Andrews, 1967).

6610 ± 125
I-2432. Duke of York Bay **4660 B.C.**

Shells (*Mya truncata* Linné, *Hiatella arctica* Linné, *Balanus balanus* Linné) from mud circles of marine silt, + 112 m (65° 13′ N Lat, 85° 32′ W Long), Southampton I. Coll. and subm. 1966 by J. B. Bird. *Comment* (J.B.B.): minimum date for disappearance of ice from Southampton I. lowlands (Andrews, 1967).

6580 ± 125
I-2444. Cape Weggs **4630 B.C.**

Shells (*Hiatella arctica* Linné, *Mya truncata* Linné) from beach ridge, sandy matrix, + 44 m (62° 50′ N Lat, 72° 54′ W Long), Labrador/Ungava. Coll. and subm. 1966 by R. J. Rogerson. *Comment* (R.J.R.): date fits uplift curve for N Ungava.

Portage Inlet series, Canada

Peat and organic matter from N shore Portage Inlet (inlet directly connected to Strait of Juan de Fuca), S of Trans-Canada Hwy. (48° 27′ 50″ N Lat, 123° 25′ 20″ W Long), SE Vancouver I., Canada. Coll. 1968 by H. D. Foster and P. W. Marshall; subm. 1968 by H. D. Foster, Univ. of Victoria, Victoria, British Columbia.

5470 ± 115
I-3673. 5.60 ft **3520 B.C.**

Peat from top of peat horizon 5.60 ft deep, 3.01 ft below mean sea level. Underlying 4 ft shelly, gray marine clay. *Comment* (H.D.F.): date is maximum for beginning of marine transgression (Porter and Denton, 1967; Godwin, Suggate, and Willis, 1958).

6670 ± 120
I-3674. 6.40 ft **4720 B.C.**

Peat from immediately above ½ to ¾ in. thick volcanic ash band preserved within peat horizon, 6.40 ft deep, 4.01 ft below mean sea level. Peat horizon overlain and underlain by marine clay. *Comment* (H.D.F.): indicates time of an eruption of Mt. Mazama (Fryxell, 1965).

9250 ± 140
I-3676. 8.75 ft **7300 B.C.**

Peat from base of peat horizon overlying weathered Victoria Clay, 8.75 ft deep, 6.36 ft below mean sea level. Horizon overlain by 4 ft shelly marine clay. *Comment* (H.D.F.): date indicates time when relative sea level fell (Hansen, 1950).

11,700 ± 170
I-3675. 12.40 ft **9750 B.C.**

Organic matter from weathered Victoria Clay, 12.4 ft deep, 10 ft below mean sea level. Victoria Clays underlying 3 ft of peat, peat overlain by 4 ft shelly marine clay. *Comment* (H.D.F.): indicates that Victoria Clays, elsewhere exposed above sea level, predate this period (Armstrong *et al.*, 1965).

I-3671. Duck Pond Bog, New Brunswick **6890 ± 110** **4940 B.C.**

Peat from Duck Pond Bog, Campobello I., Charlotte Co. (44° 51′ N Lat, 66° 57′ W Long), New Brunswick, Canada. From bottom of bog, overlying blue-gray clay, ca. 14 ft depth. Coll. and subm. 1968 by J. A. Teeri, Univ. of New Hampshire, Durham, New Hampshire. *Comment* (J.A.T.): date agrees with inferred fluctuations of postglacial sea level and crustal rebound.

I-3672. Hinton, Alberta **2730 ± 100** **780 B.C.**

Charcoal from Bm horizon, 7 ft depth in Jasper National Park (53° 11′ N Lat, 117° 57′ W Long), Hinton, Alberta, Canada. Soil profile developed in loess from Athabasca R. floodplain. Coll. 1967 by J. Dumanski; subm. 1968 by S. Pawluk, Univ. of Alberta, Edmonton, Alberta, Canada. *Comment* (S.P.): dated to determine whether profile was a paleosol.

Europe

Blelham Bog series, England

Organic lake mud from Blelham Bog, Windermere (54° 24′ N Lat, 02° 58′ W Long) N Lancashire, England. From near base of sediments of small filled kettle hole lake. Coll. and subm. 1968 by W. Tutin, Univ. of Leicester, England.

I-3589. No. 1 **12,500 ± 190** **10,550 B.C.**

From 434 to 438 cm depth. *Comment* (W.T.): dates 1st evidence of rise in temperature by expansion of juniper into late-glacial vegetation.

I-3590. No. 2 **12,650 ± 170** **10,700 B.C.**

From 430 to 434 cm depth.

I-3591. No. 3 **12,460 ± 190** **10,510 B.C.**

From 426 to 430 cm depth.

I-3592. No. 4 **12,000 ± 200** **10,050 B.C.**

From 422 to 426 cm depth.

I-3593. No. 5 **12,050 ± 180** **10,100 B.C.**

From 415 to 420 cm depth.

I-3594. No. 6 **11,430 ± 170** **9480 B.C.**

From 408 to 413 cm depth.

11,450 ± 180
I-3595. No. 7 **9500 B.C.**

From 400 to 401 cm depth.

13,450 ± 220
I-3596. No. 8 **11,500 B.C.**

From 438 to 443 cm depth. *Comment* (W.T.): immediately overlies Cambridge Q-758 dated 12,380 B.C. ± 230, date correlates well.

10,650 ± 170
I-3597. No. 9 **8700 B.C.**

From 384 to 389 cm depth.

10,490 ± 160
I-3598. No. 10 **8540 B.C.**

From 379 to 384 cm depth.

General Comment (W.T.): series covers Late-Weichselian profile at site. Plot of dates indicates profile can be divided into 3 periods of accumulation rate and is suitable for preparation of an absolute pollen diagram. Comparison with other dates in NW Europe suggest dates from Blelham Bog are consistently 300 to 500 yr too old (Godwin 1960, Van der Hammen *et al.*, 1967). Possible C^{14} deficiency in district lake sediments is being investigated.

6120 ± 250
I-3538. Pegwell Bay, Kent, England **4170 B.C.**

Organic silt from cliff exposure Pegwell Bay, near Ramsgate (51° 19′ 44″ N Lat, 01° 22′ 44″ E Long), Kent, England. Sample horizon overlies thick loess, overlain by colluvial deposit containing Neolithic or Bronze Age flint flakes. From 8 to 15 cm below top of organic horizon, 1.3 m deep (Kerney, 1965). Coll. and subm. 1968 by J. A. Catt, Rothamsted Experimental Sta., Harpenden Herts, England.

1125 ± 100
I-3744. Broadbalk, Plot 3, England **A.D. 825**

Soil from Broadbalk field, Rothamsted Experimental Farm (51° 48′ N Lat, 0° 23′ W Long), Harpenden Herts, England. From Plot 3, 0 to 9 in. depth. Coll. 1944 by R. G. Warren and subm. 1968 by D. S. Jenkinson, Rothamsted Experimental Sta. *Comment* (D.S.J.): sample from continuous wheat growing experiment to study entry of bomb-derived C^{14}.

7320 ± 120
I-3713. 8B Bridgewater Bay, Somerset **5370 B.C.**

Peat from top of gravel bed at Highbridge (51° 15′ N Lat, 2° 59′ W Long), Somerset, England. From boring 45 ft 2 in. to 45 ft 6 in. depth, ca. 37 ft below British Ordnance Datum. Sample represents early part of Pollen Zone 7a. Coll. 1968 by C. Kidson; subm. 1968 by A. Heyworth, Univ. College of Wales, Aberystwyth, Cards., U.K.

10,200 ± 300
I-3966. 1—Koivusilta Bog, Finland **8250 B.C.**

Gyttja from Koivusilta Bog (61° 38′ N Lat, 29° 42′ E Long), Saari Co., SE Finland. From 4 cm thick layer, 4.39 m below bog surface. Coll. and subm. 1968 by Reino Repo and Risto Tynni, Geol. Survey, Univ. of Finland, Otaniemi, Finland. *Comment* (R.R.): gyttja layer represents pollen of Younger Dryas period. Silt directly above represents pollen transition to Preboreal period.

10,100 ± 400
I-3967. 2—Bog Pond, Finland **8150 B.C.**

Silt containing *Bryales* peat from Bog Pond (61° 29′ N Lat, 29° 46′ E Long), Puumala Co., SE Finland. From depth 3.96 to 4.00 m. Coll. and subm. 1968 by R. Repo and R. Tynni. *Comment* (R.R.): pollen analysis shows sample to represent transition between Younger Dryas and Preboreal periods.

Apulian-Ionian Ridge series, Mediterranean

Organic carbon from box core on top of Apulian-Ionian Ridge (39° 32′ N Lat, 18° 56′ E Long), NE Ionian Sea, Mediterranean. Water depth 860 m. Coll. 1968 and subm. 1969 by R. Hesse and U. von Rad, Inst. f. Geol., Techn. Hochschule, Munchen, W. Germany.

4530 ± 140
I-4168. Kastenlot OT 25 A **2580 B.C.**

Sample from 0 to 10 cm.

9640 ± 150
I-4169. Kastenlot OT 25 L **7690 B.C.**

Sample from base of core, 170 to 185 cm. *Comment* (U.v.R.): fine varve-like laminae, 0.2 mm thick, between 160 and 170 cm, could be annual layers deposited during warm Atlanticum period (Van Straaten, 1966; Ninkovich and Heezen, 1965; Hesse, von Rad, and Fabricius, Sediments from the Strait of Otranto between the Adriatic and Ionian Seas: Marine Geol., (ms. in preparation).

14,820 ± 210
I-3649. Western Mediterranean Sea **12,870 B.C.**

Wood, 3.59 cm below sea bottom in 12 cm diam. core (35° 43′ N Lat, 4° 20′ W Long), aboard *Maria Paolina G.* (oceanographic vessel), W Mediterranean Sea. Coll. 1968 by Saclant ASW Research Center; subm. 1968 by Carlo Bartolini, Inst. Di Geol., Firenze, Italy. *Comment* (C.B.): date being correlated with oxygen isotopes and current nannoplankton studies.

Africa and Near East

Chad Republic series, Africa

Carbonate nodules from Republic of Chad, Africa. Coll. and subm. 1968 by G. Bocquier, Services Scientifiques Centraux, Bondy, France. *Comment*: carbonate accumulation probably occurred during 3rd lacustrine transgression in Chad basin.

I-4056. KK 4 **8570 ± 210**
6620 B.C.

Feldspar cemented with calcite from peidmont of Guera bordering Chad basin (12° 07′ N Lat, 18° 37′ E Long). Alt. 415 m. From depth 120 cm in lithomorphic vertisol containing montmorillonite (Bocquier, 1968).

I-4057. MK 62 **8665 ± 240**
6715 B.C.

Quartz cemented with calcite from edge of Logone flooded area (10° 24′ N Lat, 16° 21′ E Long). Alt: 330 m. From depth 110 cm in solodized solonetz. At depth 6.1 m, soil becomes hydromorphic vertisol.

I-4110. KF 8 **2710 ± 160**
760 B.C.

Quartz cemented with calcite from piedmont of Guera, bordering Chad basin (11° 54′ N Lat, 18° 29′ E Long). Alt: 480 m. From depth 90 cm in solonetzic soil.

I-2061. Wadi Or, Egyptian Nubia **27,200 ± 1000**
25,250 B.C.

Marl from lower part of upper member Korosko Formation, Wadi Or (22° 17′ N Lat, 31° 37′ E Long), Egypt. Coll. 1963 by C. L. Hansen and K. W. Butzer; subm. 1965 by K. W. Butzer, Univ. of Wisconsin, Madison, Wisconsin.

I-2060. New Korosko, Upper Egypt 1 **18,300 ± 300**
16,350 B.C.

Clayey marl from upper part Masmas Formation at New Korosko, Kom Ombo Plain (24° 32′ N Lat, 33° 04′ E Long), Egypt. Coll. 1962 by K. W. Butzer and C. L. Hansen; subm. 1965 by K. W. Butzer. *Comment* (K.W.B.): limestone absent in Wadi Shait and Nile Basin upstream. Dated carbonate derived from sub-Saharan Nile drainage, providing ample time for equilibrium with atmospheric CO_2 (Butzer and Hansen, 1968).

I-2063. Northwest Wadi, Egypt **>39,900**

Marl of fluvial origin from NW Wadi, Kurkur Oasis (23° 54′ N Lat, 32° 19′ E Long), Egypt. Coll. 1963 and subm. 1965 by K. W. Butzer.

I-2064. North Well, Egypt **>39,900**

Marl of subaqueous origin from North Well, Kurkur Oasis (23° 54′ N Lat, 32° 19′ E Long), Egypt. Coll. 1963 and subm. 1965 by K. W. Butzer.

I-2178. New Shaturma, Upper Egypt **17,100 ± 400**
15,150 B.C.

Marly sandy silt, subfacies of Masmas Formation, from Pit BH, New Shaturma, Kom Ombo Plain (24° 32′ N Lat, 33° 04′ E Long), Egypt. Coll. 1962 by C. L. Hansen and K. W. Butzer; subm. 1965 by K. W.

Butzer. *Comment* (K.W.B.): marl contains *Planorbis, Bulinus,* and *Valvata* shells, contamination by younger carbonate from overlying Ineiba Formation possible.

17,400 ± 300
I-2179. New Korosko, Upper Egypt 2 **15,450 B.C.**

Silty marl from Malki Member of Ombo Plain (24° 32′ N Lat, 33° 04′ E Long), Egypt. From Pit 36, Bed E. Coll. 1962 by C. L. Hansen and K. W. Butzer; subm. 1965 by K. W. Butzer.

860 ± 115
I-2561. Wadi Qena, Upper Egypt **A.D. 1090**

Charcoal from hearth zone 4 km NE of Qena Town, Wadi Qena (26° 09′ N Lat, 32° 46′ E Long), Egypt. Coll. 1963 by V. Burton and K. W. Butzer; subm. 1966 by K. W. Butzer. *Comment* (K.W.B.): sample contemporary with post-Byzantine alluviation.

4660 ± 100
I-2567. Wadi Kharit, Egypt **2710 B.C.**

Bark *Acacia* from 11 km E New Arminna, Kom Ombo Plain (24° 28′ N Lat, 33° 10′ E Long), Egypt. Coll. 1962 by C. L. Hansen and K. W. Butzer; subm. 1966 by K. W. Butzer. *Comment* (K.W.B.): believed contemporary with sunken hearth of late prehistoric settlement in Wadi Kharit, may provide date for Member I of Shaturma Formation.

11,560 ± 180
I-3706. El Kilk el Gebel, Loc. A, Egypt **9610 B.C.**

Shell (*Unio*) from 2 km W of village of El Kilk el Gebel, near Idfu (24° 59′ N Lat, 32° 50′ E Long), W bank Nile R., Egypt. From 5 cm deep silt cap on 3 m rise fluvial sand. Coll. 1967 by J. Phillips; subm. 1968 by F. Wendorf, Southern Methodist Univ., Dallas, Texas. *Comment* (F.W.): site occurred during Birbet interval, between Sahaba and Arkin depositions. Date fits well with dates from Nubia: Site 330, top of Sahaba, 10,300 B.C. ± 200 (WSU-109) and Site DIW-1, bottom of Arkin, 7440 B.C. ± 180 (WSU-175) (de Heinzelin, 1968; Wendorf, 1965).

I-3864. Algal Stromatolite, West Africa Coast **>39,900**

Algal stromatolite, W of Guinea (09° 14′ 30″ N Lat, 15° 37′ 00″ W Long), W Africa. Well-rounded ball from dredge haul, depth 98 to 104 m. Coll. and subm. 1966 by R. L. McMaster, Narragansett Marine Lab., Univ. of Rhode Island, Kingston, Rhode Island.

Asia

2740 ± 100
I-3781. Khorramabad, Iran **790 B.C.**

Soil and charcoal from 4½ km N of Khorramabad, S bank of ravine crossed by Harsin Rd. (33° 31′ 30″ N Lat, 48° 20′ E Long), Iran. From contact between Tehran and Khorramabad formations, former yielded Baradostian implement at this exposure. Coll. 1967 and subm. 1968 by Claudio Vita-Finzi, Univ. College, London. *Comment* (C.V.F.): date supports proposed correlation between Tehran alluvium and older alluvial fill of Mediterranean valleys.

I-4193. Lake Biwa-ko Boring, Japan **14,980 ± 460**
13,030 B.C.

Sediment from center of Lake Biwa-ko (35° 15′ N Lat, 136° 05′ E Long), Japan. From 12 m depth in 70 m water depth (I-2742, I-2844, Radiocarbon, 1969, v. 11, p. 71). Coll. 1967 and subm. 1969 by S. Horie, Kyoto Univ., Otsu Shiga-Ken, Japan.

I-3667. Sui Sim Tin Mine No. 3, W Malaysia **>39,000**

Wood from log in tin-bearing alluvium, Sui Sim Tin Mine No. 3 Grid. Ref. 942 785, Ser. L707, Sheet 2 N/5 (4° 38′ N Lat, 5° 7′ E Long). Kampong Bercham, Perak, W Malaysia. From 20 ft depth, ca. 2 ft above limestone bedrock. Coll. 1968 by S. P. Sivam; subm. 1968 by N. S. Haile, Univ. of Malaya, Kuala Lumpur, Malaysia. *Comment* (S.P.S.): date indicates alluvium is probably Pleistocene age and fluvial conditions were predominant during this time.

Kampong Pinosuk series, Malaysia

Wood from Kampong Pinosuk near Ranaw (5° 58′ 36″ N Lat, 116° 36′ 48″ E Long), Sabah, Malaysia. Coll. 1968 and 1969 by G. Jacobson, Geol. Survey of Malaysia; subm. 1968 and 1969 by Esso Exploration Malaysia, Inc.

I-4046. 100 ft **>39,900**

From 100 ft above base of 300 ft thick tilloid deposit.

I-4047. 90 ft **>39,900**

From 90 ft above base.

I-4207. 200 ft **>39,900**

From 200 ft above base.

General Comment (Esso): dates indicate that main part of tilloids formerly thought to be of solifluction origin, probably related to Pleistocene glaciation (Jacobson, G., Geol. of the Mount Kinabalu area: Geol. Survey Malaysia, Rept. 8, ms. in preparation).

Mangalum Island series, Sabah Malaysia

Wood and peat from NE tip Mangalum Is., 31 mi WNW of Kota Kinabalu (6° 12′ 30″ N Lat, 115° 36′ 13″ E Long), Sabah Malaysia. Coll. 1968 by N. S. Haile and N. Wong; subm. 1968 by P. H. Monaghan, Esso Prod. Research Co., Houston, Texas.

I-3611. No. 1 **260 ± 95**
A.D. 1690

Wood from 1 ft layer peaty gray clay, 3 to 6 ft depth.

I-3612. No. 2 **<185**

Peat from 1 ft layer peaty gray clay, 3 to 6 ft depth.

General Comment (P.H.M.): dates confirm palaeontologic determination given by British Mus., United Kingdom.

I-3668. South China Sea **920 ± 95**
A.D. 1030
$C^{13}/C^{12} = -31.8$

Peat from E of Singapore (104° 38′ 12″ E Lat, 01° 25′ 18″ N Long), on board *USC* and *GS Oceanographer*, S China Sea. From core of Holocene gray mud, distinct layer 3 cm thick, 42 cm from top. Coll. and subm. 1968 by N. S. Haile, Univ. of Malaya, Kuala Lumpur, Malaysia.

Bahamas and South America

Cat Island series, Bahama Islands

A study of glacial-eustatic and storm sea-level changes of Holocene topography in stable Bahama Banks region where tidal range is 0.9 m. Coll. 1966 and subm. 1967 by A. O. Lind, U. S. Army Terrestrial Sci. Center, Hanover, New Hampshire.

I-2724. Greenwood Barrier-Dune Tract A-180.2 **3250 ± 90**
1300 B.C.

Carbonate sand (coral-algal fragments with foraminifera tests and other unident. fragments) from Atlantic coast of Cat I. (24° 11′ N Lat, 75° 18′ W Long), Bahamas. Dune Tract A is massive fossil coastal dune behind oldest Holocene beach-ridge terrace. From exposure of semi-lithified eolianite, 2 m below dune crest, 11 m above mean-low-tide level. *Comment* (A.O.L.): dunes are related to major fall in relative sea level at middle of 2nd millennium B.C. Combined with I-2922 (this series) rate of vertical accretion is ca. 2 m per 150 yr (Lind, 1968).

I-2725. South Bird Point—Terrace B-28 **1600 ± 80**
A.D. 350

Sample material same as I-2724 from Atlantic coast of Cat I. (24° 32′ N Lat, 75° 34′ W Long), Bahamas. Intermediate beach-ridge terrace. From 30 to 40 cm below ridge crest, ca. 4 m above mean low water. A 10 cm A-1 horizon overlies sample horizon. *Comment* (A.O.L.): Terrace B ridges were deposited after erosion truncated Terrace A topography, and during stand of relative sea level 1 m higher than present. Similar, more recent series of events is associated with Terrace C.

I-2726. South Bird Point—Terrace A-76 **2450 ± 110**
500 B.C.

Sample and location same as I-2725. From youngest beach-ridge of Terrace A at 30 to 40 cm below ridge crest, 6 m above mean low water. *Comment* (A.O.L.): Terrace A deposits formed when relative sea level was ca. 2 m higher than present.

I-2839. Alligator Point. Terrace B Fossil Beach-5 **910 ± 145**
A.D. 1040

Pelecypod valves (*Trigonocardia medium* Linné) from Exuma Sound coast of Cat I. (24° 32′ N Lat, 75° 39′ W Long), Bahamas. From lithified surface representing foreshore deposit, presently 2.5 m above mean low water. *Comment* (A.O.L.): shelly foreshore deposit good marker for estimating former high relative sea level.

I-2922. Greenwood Barrier Dune Tract A-180.4 **3400 ± 110**
1450 B.C.

Material and location same as I-2724, 4 m below crest of Terrace A, ca. 9 m above mean low water.

I-2923. South Bird Point—Terrace A-278 **3030 ± 110**
1080 B.C.

Material and location same as I-2725. From upper level of oldest beach ridge of Terrace A, 30 to 40 cm below ridge crest, 5 m above mean low water.

I-2924. Anguilla Barrier—Terrace B-38 **1550 ± 95**
A.D. 400

Material same as I-2724 from Atlantic coast of Cat I. (24° 39′ N Lat, 75° 38′ W Long), Bahamas. From 60 to 70 cm below surface of Terrace B, 3 m above mean low water. *Comment* (A.O.L.): date agrees with Terrace B at South Bird Point (I-2725, this series).

I-2925. Anguilla Barrier—Terrace A-125 **2530 ± 105**
580 B.C.

Material and location same as I-2924. From upper level of Terrace A, 90 to 100 cm below surface, 5.5 m above mean low water. *Comment* A.O.L.): date correlates with upper level of Terrace A at South Bird Point (I-2726, this series).

I-2926. Greenwood Barrier—Terrace B-61 **625 ± 100**
A.D. 1325

Material and location same as I-2724. Intermediate-level beach-ridge terrace. From surface of shallow dune cap 0 to 10 cm depth, 4.5 m above mean low water. A-1 horizon present at sampling point. *Comment* (A.O.L.): date indicates eolian accretion ended in early part of 2nd millennium A.D.

I-2927. Greenwood Barrier—Terrace C-46 **490 ± 95**
A.D. 1460

Material and location same as I-2724, 0 to 10 cm depth from surface of dune cap, 3 m above mean low water. A-1 horizon at sampling point. *Comment* (A.O.L.): Terrace C was deposited when sea level was at ca. + 0.5 m; no significant beach-ridge accretion since.

I-2979. Alligator Point—Terrace C Fossil Beach-4 **395 ± 100**
A.D. 1555

Pelecypod valves (*Lucina jamaicensis*) location same as I-2837, from surface of fossil beach, 1.2 m above mean low water. *Comment* (A.O.L.): this fossil shingle beach is identical with modern low tide beaches in same area. Shingle is derived from adjacent beach.

I-3408. Bariloche Bog, Argentina No. 1 **1170 ± 95**
A.D. 780

Heart wood from log *Austrocedrus* (*Libocedrus*) *chilensis* (wood ca. 120 yr old before death of tree) from Bariloche Bog km Post 1738, 12 km

W of San Carlos de Bariloche (41° 06′ 50″ S Lat, 71° 26′ 20″ W Long), Argentina. Layer of pumice lapilli ½ in. thick overlies log (Auer, 1949; 1965). Coll. 1967 and subm. 1968 by D. B. Lawrence, Univ. of Minnesota.

1020 ± 100
I-3409. Bariloche Bog No. 2 **A.D. 930**

Sample and location same as I-3408, but may have been contaminated with modern dust.

General Comment (D.B.L.): purpose of dating is to learn timing of volcanic eruptions along axis of S Andes and to test hypothesis of Auer (1949; 1965).

3110 ± 110
I-3843. Otuma Embayment, Peru **1160 B.C.**

Pecten valve (*Pecten purpuratus*) from basal layer of Midden 12, ca. 16 ft above MSL, on margin of raised Otuma embayment (14° S Lat, 76° 15′ W Long), Otuma lagoon, Ica Prov., Peru. Site presently on crest of 7 to 8 ft sea cliff bordering lagoon; entire lagoon has been raised to subaerial position ca. 2 mi from modern coast. Coll. 1968 by N. P. Psuty and A. K. Craig; subm. 1968 by N. P. Psuty, Dept. of Geog., Univ. of Wisconsin, Madison, Wisconsin. *Comment* (N.P.P.): date indicates lagoon was viable ecologic unit and uplift that stranded lagoon is more recent.

510 ± 100
I-3844. Lagunillas Embayment, Peru **A.D. 1440**

Seaweed from elevated Strandline 4, 28 ft above MSL, W margin Lagunillas embayment (13° 53′ S Lat, 76° 19′ W Long), 5 mi S of Paracas, Ica Prov., Peru. Coll. 1968 by N. P. Psuty and A. K. Craig; subm. 1968 by N. P. Psuty. *Comment* (N.P.P.): indicates time of rapid crustal shifts that elevated high-tide swash line.

II. ARCHAEOLOGIC SAMPLES

Western United States

Katmai National Monument series, Alaska

Samples coll. during excavations by Univ. of Oregon in 2 separate areas of Katmai Natl. Monument, Brooks R. in Naknek drainage system NW side Alaska Peninsula and Pacific coast SE side of Peninsula. All comments by D. E. Dumond.

Materials from Naknek drainage have been divided into 8 sequential cultural phases with modifications (Dumond and Cressman, 1962; 1963; Radiocarbon, 1964, v. 6, p. 273-278; Pacific Coast materials have been divided into 5 sequential phases. Typologic distinctions supported especially by series of volcanic ash deposits found on both sides of Peninsula (Nowak, 1968).

All samples except where noted coll. and subm. by D. E. Dumond, Univ. of Oregon, Eugene, Oregon.

Brooks River Bluffs phase

From S bank Brooks R., Alaska (58° 35′ N Lat, 155° 44′ W Long), assoc. with rubbed slate implements and gravel-tempered pottery. Previously reported determinations were Y-932, 450 ± 60 (Radiocarbon, 1962, v. 4, p. 256), and I-209, 230 ± 80 (Radiocarbon, 1964, v. 6, p. 274). Geologic, typologic, and radiocarbon evidence assigned phase to A.D. 1500 to 1800.

480 ± 90
I-523. B.R. Bluffs phase, BR 5-1 A.D. 1470

Charred wood from slab-lined hearth outside habitations, early stage of latest occupation of Locality BR5. Coll. 1961 by D. E. Dumond; subm. 1961 by L. S. Cressman.

B.R. Camp phase

From N bank Brooks R., Alaska (58° 35′ N Lat, 155° 44′ W Long), assoc. with polished slate implements and gravel-tempered pottery comparable to artifacts of Nukleet culture of Norton Bay (Giddings, 1964). Previous determinations I-524, 300 ± 75 and I-525, 680 ± 90 (Radiocarbon, 1964, v. 6, p. 274-275). Geologic, typologic, and radiocarbon evidence assigned phase to A.D. 1000 to 1500.

670 ± 105
I-1632. B.R. Camp phase, BR 20-1, House A.D. 1280

Charred wood, scattered on floor of house with sunken entrance, Locality BR 20. Coll. 1964; subm. 1965.

845 ± 100
I-1635. B.R. Camp phase, BR 20-1, Fireplace A.D. 1105

Charred wood from hearth outside house (I-1632), assoc. with pottery. Coll. 1964; subm. 1965.

B.R. Weir phase

From one site on N bank and another on S bank of Brooks R., Alaska (58° 35′ N Lat, 155° 44′ W Long). Assoc. with implements predominantly of flaked dense igneous rock, and fiber-tempered pottery bearing exterior impressions of small checks or diamond shapes applied with paddle. Previous determinations I-210, 1850 ± 100 and I-526, 1230 ± 150 (*op. cit.*, above, p. 275-276). Geologic, typologic, and radiocarbon evidence assigned phase to A.D. 100 to 500.

2110 ± 350
I-1158. B.R. Weir phase, BR 14-1 160 B.C.

Charred wood from campfire of briefly occupied site, Locality BR 14, S bank of river. Assoc. with check-stamped pottery. Coll. and subm. 1963.

1895 ± 140
I-1631. B.R. Weir phase, BR 20-1, Hearth A.D. 55

Charred wood from campfire remnant within zone of B.R. Weir phase occupation debris, Locality BR 20, N bank of river. Coll. 1964 and subm. 1965.

I-1633. B.R. Weir phase, BR 20-1, Floor **1790 ± 130**
A.D. 160

Charred wood, scattered on occupation floor, Locality BR 20, N bank of river. Coll. 1964 and subm. 1965.

I-3116. B.R. Weir phase, BR 20-2 **1690 ± 110**
A.D. 260

Charred wood, scattered in occupation floor with diagnostic artifacts, Locality BR 20, N bank of river. Coll. and subm. 1967.

B.R. Gravels phase

From N and S banks of 1½ mi long Brooks R. (58° 35′ N Lat, 155° 44′ W Long), Alaska. Assoc. with small bipointed endblades of chipped chalcedony, burins, microblades, and small polished adze heads; phase clearly related to Arctic Small Tool tradition, of which Denbigh Flint complex of Norton Bay (Giddings, 1964) is best known example. Previous determinations Y-930, 3972 ± 440 (Radiocarbon, 1962, v. 4, p. 255); I-517, 3125 ± 200; I-518, 3250 ± 200 (Radiocarbon, 1964, v. 6, p. 277). Geologic, typologic and radiocarbon evidence assigned phase to 1900 to 1000 B.C.

I-1157. B.R. Gravels phase, BR 15-1 **3090 ± 200**
1140 B.C.

Charred wood, scattered on floor of semi-subterranean habitation, Locality 15, Unit 1, S side of river. Coll. and subm. 1963.

I-1159. B.R. Gravels phase, BR 4-1 **3050 ± 250**
1100 B.C.

Charred wood from stone fireplace, Locality BR 4, N side of river. Coll. and subm. 1963.

I-1629. B.R. Gravels phase, BR 10-3 **3900 ± 130**
1950 B.C.

Charred wood from stone fireplace, Locality BR 10, S side of river. Coll. 1964 and subm. 1965.

I-1947. B.R. Gravels phase, BR 16-2 **3450 ± 110**
1490 B.C.

Charred wood from fire area, central floor of semi-subterranean habitation, Locality BR 16, S side of river. Coll. and subm. 1965.

I-3115. B.R. Gravels phase, BR 15-2 **3390 ± 110**
1440 B.C.

Charred wood from E ¼ of floor, semi-subterranean habitation, Locality BR 15, Unit 2, S side of river. Coll. and subm. 1967. *Comment*: unusual number of polished implements (adze blades, burin-like implements) and presence of some stemmed points similar to those of Smelt Creek form, suggest this occupation may post-date others of B.R. Gravels phase; not supported by geologic or radiocarbon evidence.

Smelt Creek phase

From N bank Brooks R., Alaska (58° 35′ N Lat, 155° 44′ W Long), assoc. with implements chipped of chalcedony and igneous rock, and urn-shaped fiber-tempered, check-stamped pottery comparable to artifacts of Norton culture of Norton Bay (Giddings, 1964). Previous determination I-508, 1900 ± 150 (Radiocarbon, 1964, v. 6, p. 276). Geologic, typologic, and radiocarbon evidence assigned phase to 200 B.C. to A.D. 100.

I-1948. Smelt Creek phase, BR 11 **2140 ± 105** **190 B.C.**

Charred wood from campfire in substantial Smelt Creek occupation zone, Locality BR 11, Test 6. Coll. and subm. 1965.

B.R. Strand phase

From 2 sites, one N and one S of Brooks R. (58° 35′ N Lat, 155° 44′ W Long), each on ridge thought to have flanked mouth of Brooks R. and been under construction by waves of Naknek Lake 2000 B.C. and earlier. All occupation debris was covered by lake-deposited sand and gravel and by volcanic ash, Y-931, 3860 ± 90 (Radiocarbon, 1962, v. 4, p. 256). Assoc. with leaf-shaped and side-notched knives of chipped stone comparable to those of Palisades II complex of Onion Portage and large thrusting implements of polished slate similar to those of T. Birch phase of Pacific coast (Clark, 1968). Geologic, typologic, and radiocarbon evidence assigned phase to 2500 to 1900 B.C.

I-1630. B.R. Strand phase, BR 10-3 **3840 ± 130** **1890 B.C.**

Charred wood, scattered over thin occupation layer in beach sand, Locality BR 10, S side of river, strat. below strata yielding B.R. Gravels phase implements and I-1629 (this list). Coll. 1964 and subm. 1965.

I-1946. B.R. Strand phase, BR 20-3 **4430 ± 110** **2480 B.C.**

Charred wood from thick fire area of tear-drop shaped occupation floor yielding B.R. Strand phase implements. Locality BR 20, N side of river. Coll. and subm. 1965.

I-1634. B.R. Strand phase, BR 20-1 **4240 ± 250** **2290 B.C.**

Charred wood, scattered over thin occupation layer with B.R. Strand phase implements, Location BR 20, N side river. Coll. 1964 and subm. 1965.

I-3114. B.R. Strand phase, BR 20-2 **3900 ± 120** **1950 B.C.**

Charred wood from various places on extensive occupation floor yielding B.R. Strand phase implements, overlain by 20 to 40 cm partially cemented lake gravels deposited on ancient beach by ancestral Naknek Lake. Coll. and subm. 1967.

I-1160. Pre-occupation, BR 5-2 **7360 ± 250**
5410 B.C.

Charred wood apparently deposited by wave action in beach sand, S bank of Brooks river (58° 35′ N Lat, 155° 44′ W Long), Alaska. Beneath lowest (at least 10) volcanic ash deposits, Locality BR 5, 10 m above present level of Naknek Lake (Muller, 1952). Coll. and subm. 1963.

Pacific Coast sub-series

Two major site areas 25 mi apart. Coll. 1964 and 1965; subm. by D. E. Dumond.

Katmai Mound phase

From 2-component site consisting of remains of 89 semi-subterranean habitations, at Kukak Bay, Shelikof Strait coast of Katmai Natl. Monument (58° 19′ N Lat, 154° 10′ W Long), Alaska. Assoc. with polished slate implements and gravel-tempered pottery identical to those of B.R. Camp phase of Naknek drainage, 60 mi away. Previous determination I-505, 775 ± 95 (Radiocarbon, 1964, v. 6, p. 277). Geologic, typologic, and radiocarbon evidence assigned phase to A.D. 1000 to 1500.

I-1636. K. Mound phase, KK 1-13 **775 ± 110**
A.D. 1175

Charred wood from hearth of K. Mound phase floor, House 13, Site KK 1. Hearth contained gravel-tempered pottery. Coll. 1964 by H. S. Rice; subm. 1965.

K. Beach phase

From Kukak Bay, Shelikof Strait coast of Katmai Natl. Monument (58° 19′ N Lat, 154° 10′ W Long), Alaska. Assoc. with chipped projectile blades of chalcedony and igneous rock, polished slate implements, and fiber-tempered pottery; collection similar to B.R. Falls phase of Naknek drainage. Geologic, typologic, and radiocarbon evidence assigned phase to A.D. 500 to 1000.

I-1637. K. Beach phase KK 1-73 **1450 ± 130**
A.D. 500

Charred wood from midden debris within House 73, Site KK 1, yielded diagnostic K implements. Coll. 1964 by H. S. Rice; subm. 1965.

I-1638. K. Beach phase, KK 1-66 **1075 ± 100**
A.D. 875

Charred wood from fireplace in major occupation floor of House 66, Site KK 1. Coll. 1964 by H. S. Rice; subm. 1965.

I-1944. K. Beach phase, KK 1-19 **1460 ± 95**
A.D. 490

Charred wood from lowest and major occupation floor of House 19, Site KK 1. Coll. 1965 by H. S. Rice; subm. 1965.

T. Cottonwood phase

From Takli I., off Shelikof Strait coast of Katmai Natl. Monument (58° 4′ N Lat, 154° 30′ W Long), Alaska. Assoc. with chipped projectile blades primarily of igneous rock, polished slate implements, and small amount of fiber-tempered pottery. Typologic evidence assigned phase to 1st centuries A.D.

1680 ± 100
I-1942. T. Cottonwood phase, AK 3 **A.D. 270**

Charred wood from occupation floor at base of Stratum I, Site AK 3. Coll. 1963 by M. Nowak; subm. 1965.

T. Birch phase

From Takli I., off Shelikof Strait coast of Katmai Natl. Monument (58° 4′ N Lat, 154° 30′ W Long), Alaska. Assoc. with large chipped projectile blades of igneous rock, and numerous polished slate implements comparable to Ocean Bay II phase of Kodiak I. (Clark, 1966). Geologic typologic, and radiocarbon evidence assigned phase to between 2200 and 800 B.C. (Clark, 1968).

4110 ± 160
I-1639. T. Birch phase, AK 1, Base **2160 B.C.**

Charred wood, scattered, from base of Stratum II, Site AK 1. Coll. 1964 by M. Nowak; subm. 1965.

2910 ± 105
I-1941. T. Birch phase, AK 1, Top **960 B.C.**

Charred wood, apparently remains of campfire in heaviest T. Birch phase occupation zone, top of Stratum II, Site AK 1. Coll. 1965 by M. Nowak; subm. 1965.

3470 ± 110
I-1943. T. Birch phase, AK 3 **1520 B.C.**

Charred wood, hearth in Stratum II, Site AK 3. Coll. 1965 by M. Nowak; subm. 1965.

2810 ± 100
I-3733. T. Birch phase, AK 1, Stratum I **860 B.C.**

Charred wood, scattered, substantially at top of occupation, Site AK 1. Coll. 1965 by M. Nowak; subm. 1968.

Takli Alder phase

From Shelikof Strait coast of Katmai Natl. Monument, Alaska. Major part of collection is from lowest 2 of 4 distinguishable strata of Site AK 1. Assoc. with chipped projectile blades and knives, comparable to Near group of Aleutian I. Geologic, typologic, and radiocarbon evidence assigned this phase to 4000 to 3000 B.C.

5650 ± 115
I-1940. T. Alder phase, AK 1 **3700 B.C.**

Charred wood, scattered, from base of Stratum II, Site AK 1, Takli I. (58° 4′ N Lat, 154° 30′ W Long), Alaska. Coll. 1965 by M. Nowak; subm. 1965.

5830 ± 120
I-1945. T. Alder phase, KK la **3880 B.C.**

Charred wood, scattered, in red, oxidized stratum of apparent midden deposit in outlying area of Site KK 1, Kukak Bay (58° 19′ N Lat, 154° 10′ W Long), Alaska. Coll. 1965 by H. S. Rice; subm. 1965.

4530 ± 110
I-4161. Pedro Bay site, 2, Early Component, Alaska **2580 B.C.**

Charcoal from Pedro Bay site, NE shore of Lake Iliamna (59° 45′ N Lat, 154° 10′ W Long), SW Alaska. From base of cultural layer in charcoal band 24 to 28 in. below soil surface, Pits 18 and 21 (Clark, 1966; Townsend and Townsend, 1961). Coll. 1967 and subm. 1969 by J. B. Townsend, Univ. Manitoba, Winnipeg, Canada. *Comment*: date indicates early occurrence of ground slate tools in Alaska.

370 ± 95
I-3658. Polacca Wash, Arizona **A.D. 1580**

Human bone from Hopi Indian Reservation, Polacca Wash (35° 38′ N Lat, 110° 35′ W Long), Arizona. From mass burial 2 ft deep (Turner, 1968; Olson, 1966). Coll. 1964 by A. P. Olson; subm. 1968 by C. G. Turner, II, Arizona State Univ., Tempe. *Comment* (C.G.T.): features of this burial, except apparent cannibalism, are high correlated with 2.7 century old Hopi legend about destruction of Awatobi (extinct Hopi village).

2260 ± 210
I-4006. Point St. George I, California **310 B.C.**

Charcoal with fine sand from Point St. George (41° 45′ N Lat, 124° 15′ W Long), Del Norte Co., California. From cluster of small hearths between 42 and 45 in. depth, Sq. 52, Trench 3, near bottom of Feature 36 (Gould, 1966). Coll. 1964 and subm. 1969 by R. A. Gould, Am. Mus. Nat. Hist., New York, N.Y. *Comment*: cultural assocs. indicate sample dates early part of Point St. George I occupation. Earliest reported date for N California or S Oregon coast.

1010 ± 100
I-4107. Ismay Pueblo, Colorado **A.D. 940**

Charcoal (*Pinus edulis, Juniperus utahensis*) from floor stratum, Rm. 3, Ismay Pueblo (37° 14′ N Lat, 108° 41′ W Long), NW 1/4 Sec. 2, R 17E, Township 34 N, New Mexico PM, Cortez, Colorado. Site 1 mi SSW of Yucca House. Coll. 1967 and subm. 1969 by R. A. Luebben, Grinnell College, Grinnell, Iowa. *Comment*: small pueblo with tower and ground features. Architecture and artifacts are typically Mesa Verde Pueblo III (Martin, 1929). Date suggests reuse of old timbers.

I-3818. 5JF10 Van Bibber Creek, Colorado **2140 ± 145**
190 B.C.

Charcoal from Van Bibber Creek (39° 47′ 54″ N Lat, 105° 14′ 30″ W Long) SE 1/4, Sec. 8, T. 3S, R. 70W, Golden Quad., Colorado. From depth 23 in. assoc. with 3 projectile points. Site contained 3 cultures: Woodland, Southwestern, and Archaic. Comparable Archaic materials were found at nearby sites (Leech, 1966). Coll. 1968 by C. E. Nelson, subm. 1968 by J. Benedict.

I-3365. Harris Chamber, Dry Cave, New Mexico **14,470 ± 250**
12,520 B.C.

Feces primarily *Neotoma* from Dry Cave, SE 1/4, Sec. 22, T. 22 S, R. 24 E (32° 22′ 25″ N Lat, 104° 28′ 55″ W Long), Eddy Co., New Mexico. From upper 2 excavation units overlying sterile limestone. Coll. and subm. 1968 by A. H. Harris, Univ. of Texas. *Comment* (A.H.H.): over 40 species of vertebrates, most from dated horizon, including species of *Sorex, Notiosorex, Myotis, Eptesicus, Plecotis, Lepus, Marmota, Ondatra, Mustela et al.* are under study.

I-4108. Site BJ74, New Mexico **635 ± 95**
A.D. 1310

Weaving batten (*Quercus gambelii* Nutt) from earliest occupational stratum, below Rm. 1, Site BJ74 (35° 49′ 15″ N Lat, 106° 37′ 30″ W Long), Jemez Mts., New Mexico. Site 1.1 mi E of junction of Jemez R. and its E fork. Coll. 1939 by Paul Reiter; subm. 1969 by R. A. Luebben. *Comment* (R.A.L.): assoc. with Post-Spanish intrusive red wares and glazepolychromes. Date indicates batten is heirloom. BJ74 probably satellite of nearby larger pueblo of Unshagi.

South Cannonball Village series, North Dakota

Samples from S Cannonball Village, confluence of Cannonball and Missouri R. (46° 24′ 30″ N Lat, 100° 35′ 15″ W Long), Sioux Co., North Dakota. Coll. 1966 by J. J. Hoffman; subm. 1969 by R. B. Johnston, Div. of River Basins Surveys, Lincoln, Nebraska.

I-4202. 32 S 119—(A) **840 ± 90**
A.D. 1110

Charcoal and charred wood from collapsed structural member on SW 1/4 of floor of House 1, semi-subterranean habitation.

I-4203. 32 S 119—(B) **610 ± 95**
A.D. 1340

Decayed wood from post butt, NW wall of House 5, semi-subterranean habitation.

I-4204. 32 S 119—(C) **630 ± 95**
A.D. 1320

Decayed wood from post butt, NW corner of House 4, semi-subterranean habitation.

820 ± 100
I-4205. 32 S 119—(D) **A.D. 1130**

Decayed wood from post butt, NW corner of House 2, semi-subterranean habitation.

Eastern United States

Fort Center series, Florida

Charcoal from Fort Center (26° 45′ N Lat, 81° 20′ W Long), W shore Lake Okeechobee, Florida. Coll. 1967 and subm. 1968 by W. H. Sears, Florida Atlantic Univ., Boca Raton, Florida.

1645 ± 115
I-3552. Mound A **A.D. 305**

Midden lens, probably house floor, in living platform. *Comment* (W.H.S.): artifact complex includes clay platform pipes. Date applies to living area in Hopewellian ceremonial complex.

1610 ± 110
I-3553. Mound B-1 **A.D. 340**

Midden material on 1st stage structure in large mound. *Comment* (W.H.S.): Hopewellian material strat. assoc. The 1st stage structure was built with fill from charnel house pond, which contains clay platform pipes in 1st layer deposited.

1690 ± 100
I-3554. Mound B-2 **A.D. 260**

Isolated charcoal fragment in mound construction layer. *Comment* (W.H.S.): construction layer, with secondary burials, slightly later than unit with date I-3553. Earlier date suggests charcoal picked up with fill dirt.

1770 ± 110
I-3555. Midden A **A.D. 180**

Midden deposit, lower stratum 1 ft above midden base. *Comment* (W.H.S.): horizon at end of, or immediately post-dating, period with semi-fiber tempered ware. Equivalent to early St. Johns Ia.

2400 ± 105
I-3556. Great Circle fill **450 B.C.**

Midden deposited in base of 1200 ft diam. circular ditch. Strat. 1st fill in 2nd period of construction. *Comment* (W.H.S.): circle with causeways, definitely Adena type. Rebuilt, probably enlarged, number of times. Earliest structure on site, initial construction with semi-fiber tempered pottery earlier than this date.

1055 ± 100
I-3441. Kipp Island, New York **A.D. 895**

Charcoal from Burial 7, Kipp I. #4 site (Aub. 13-1) Seneca Co. (42° 59′ 32″ N Lat, 76° 43′ 39″ W Long), New York. From cremation burial containing burned human remains and charcoal of crematory fire, interred without burial offerings in shallow grave at subsoil level, 11 in. depth (Sec. E 20 S 50). Coll. 1963 and subm. 1968 by W. A. Ritchie, New

York State Mus. and Sci. Service. *Comment* (W.A.R.): burial pertained to cemetery of Hunter's Home phase, late Middle Woodland stage. Date agrees with existing radiocarbon determinations for sites of this phase in New York State (Ritchie, 1965).

I-3442. Fredenburg site, New York **1590 ± 100** **A.D. 360**

Charcoal from Feature 1, Sec. 22, Fredenburg site (42° 28′ 05″ N Lat, 75° 08′ 47″ W Long), Otsego Co., New York. From shallow basin-shaped hearth found in thin artifact-bearing layer of single-component site. Coll. 1967 by H. D. Tuggle; subm. 1968 by R. E. Funk, New York State Mus. and Sci. Service. *Comment* (R.E.F.): date consistent with estimates for age of newly defined, late Middle Woodland, Fox Creek complex.

I-3444. Black Rock site, New York **1100 ± 95** **A.D. 850**

Charcoal from Feature 2, Sec. W 50 S 10, Black Rock site, Athens (42° 15′ 28″ N Lat, 73° 48′ 50″ W Long), Greene Co., New York. From shallow basin-shaped pit, pit contents clearly indicated its assoc. with primary late Middle Woodland component on site. Coll. 1963 and subm. 1968 by R. E. Funk. *Comment* (R.E.F.): date as anticipated on typologic grounds and comparisons with the Point Peninsula sequence of central New York.

I-3731. A (dequentaga I)—W90N15, New York **1565 ± 100** **A.D. 385**

Charcoal from fire hearth at 21 in. depth, stratified site along Susquehanna R., 2 mi E of Oneonta (42° 26′ 45″ N Lat, 75° 01′ 15″ W Long), New York. Assoc. with Steubenville type projectile points and Vinette 1 pottery sherds. Coll. and subm. 1968 by B. E. Raemsch, Hartwick College, Oneonta, N. Y. *Comment* (B.E.R.): dates from this component are among 1st for this culture, site presently being excavated.

Susquehanna series, New York

Charcoal and soil from S shore Susquehanna R. (42° 26′ 45″ N Lat, 75° 01′ 15″ W Long), ca. 2 mi E of Oneonta, New York. Coll. and subm. 1968 by B. E. Raemsch.

I-3730. A W85-S20 **4040 ± 115** **2090 B.C.**

From hearth area in 16 in. soil, overlying late Pleistocene gravel. *Comment*: date indicates Lamoka component overlying thinly distributed late Lithic stage component. Assoc. with Hell Gap type point snub-nosed scraper and side-scrapers somewhat similar to Bull Brook type (Ritchie, 1965).

I-3732. A W85-N15 **1190 ± 110** **A.D. 760**

From stratified site where red-soil fire hearths were common, 14 to 20 in. depth. *Comment*: date indicates Steubenville component. Assoc. with type points, sherds of Vinette styles of pottery, and shell.

1300 ± 100
I-3931. A W90-N20 **A.D. 650**

From same location as I-3732, same comment.

3830 ± 100
I-3917. A W110-N20—1 **1880 B.C.**

From hearth area covered by tan river sand, above glacio-fluvial gravels, 71 in. depth. *Comment*: projectile points recovered of gray chert and brown jasper indicative of Boreal Archaic component (Byers, 1959).

4080 ± 105
I-3918. A W110-N20—2 **2130 B.C.**

From ca. 18 in. from I-3917. *Comment*: same as I-3917. Assoc. with stemmed side-notched and eared points showing evidence of stone grinding (Byers, 1959).

3380 ± 100
I-3974. Adequentaga site **1430 B.C.**

From 5 ft diam. hearth at 24 in. depth (measured from grass roots). Assoc. with shell fragments, bone, and an Orient Fishtail knife type. At 27 in. horizon Susquehanna Broad points were found. These cultures are considered by Ritchie (1965) to be transitional from late Archaic to Early Woodland. *Comment*: date believed assoc. with Susquehanna Broad points and agrees with Ritchie's Snook Kill date.

Mexico

6500 ± 125
I-4098. Tlapacoya II-140, Mexico **4550 B.C.**

Soil from Site II, Sq. 140, SE ¼, Tlapacoya (19° 18′ N Lat, 98° 55′ W Long), Basin of Mexico. Lacustrine plain in former Chalco lake, depth 2.30 m. Coll. 1969 by Raul Araña; subm. 1969 by J. L. Lorenzo, Dept. de Prehist., Moneda, Mexico. *Comment* (J.L.L.): assoc. with Coxcatlan (Gary) point, date coherent with cultural material (Mirambell, 1967; Mooser, 1967).

760 ± 90
I-4106. Whetton Pueblo, Chihuahua, Mexico **A.D. 1190**

Charred roof material from floor stratum, Rm. 4, Whetton Pueblo (30° 2′ N Lat, 108° 30′ W Long), Rancho Gavilán, Chihuahua, Mexico. Site 650 m WSW of confluence of Rio Gavilán and Rio Gavilán del Norte. Coll. 1968 and subm. 1969 by R. A. Luebben. *Comment*: small stone pueblo of Medio period, Village Farming Community horizon. No comparable site excavated in N Sierra Madre occidental.

6200 ± 125
I-4192. Tlapacoya IV-A24, Mexico **4250 B.C.**

Soil from Site IV, Sq. A-24, SE ¼, Tlapacoya (19° 18′ N Lat, 98° 55′ W Long), Basin of Mexico. Riparian zone in Tlapacoya, then an island on Chalco Lake, 3.7 m depth. Coll. 1969 by Christine Niederberger; subm.

1969 by J. L. Lorenzo. *Comment* (J.L.L.): middle preceramic horizon, probably incipient agriculture (Mirambell, 1967; Mooser, 1967).

Canada

Battle Creek series, Canada

Charcoal, charred bones and soil from Battle Creek (49° 39′ 40″ N Lat, 110° 04′ 18″ W Long), Cypress Hills, Alberta, Canada. Coll. and subm. 1966 by P. D. Jungerius, Dept. of Mines and Tech. Surveys, Ottawa, Canada (Andrews, 1967).

I-2428. No. 1 **3880 ± 165**
1930 B.C.

Charcoal and charred bones from Indian composite beneath 70 cm alluvium.

I-2608. No. 2 **880 ± 100**
A.D. 1070

Soil from 0 to 15 cm depth, stream bank exposure. Soil developed in alluvial material overlying buried soil containing Indian remains.

I-2609. No. 3 **3610 ± 100**
1660 B.C.

Buried soil in alluvial fan, 2 A horizon, elev. 1174 m.

Pediment series, Canada

Charcoal and soil from South Pediment and Pediment, Cypress Hills, Alberta, Canada. Coll. and subm. 1966 by P. D. Jungerius (Andrews, 1967).

I-2429. South Pediment 1 **4320 ± 110**
2370 B.C.

Charcoal from 19 cm depth (49° 33′ N Lat, 110° 14′ W Long), South Pediment. From Indian fireplace under 19 cm colluvium.

I-2430. South Pediment 2 **580 ± 95**
A.D. 1370

Soil from stream bank exposure (49° 31′ 30″ N Lat, 110° 13′ 48″ W Long), 9 cm depth, South Pediment. Soil *in situ* in alluvial plain of recent pediment. From upper two well-developed A-horizons.

I-2610. Pediment **520 ± 95**
A.D. 1430

Soil from 1250 m elev. (49° 33′ 12″ N Lat, 110° 13′ 04″ W Long), Pediment. A-1 horizon of buried soil.

I-3956. Kamut Lake (MePn-1), Canada **210 ± 90**
A.D. 1740

Charred caribou bone from NE end of Kamut Lake (66° 43′ 10″ N Lat, 116° 17′ 20″ W Long), Northwest Territory, Canada. From 4 ft diam. hearth 6 in. below sandy surface. Coll. and subm. 1968 by W. C.

Noble, McMaster Univ., Hamilton, Canada. *Comment*: site is multicomponent with date relating to late Eskimo occupation. Site contains materials of Acasta Lake complex, small tool complex and late Eskimo copper.

6970 ± 360
I-3957. Acasta Lake (LiPk-1), Canada **5020 B.C.**

Charcoal from NE corner of Acasta Lake (65° 24′ N Lat, 115° 30′ W Long), Northwest Territory, Canada. From Hearth 95, Unit D, 13 in. below soil surface of sandy esker. Assoc. with artifacts (Forbis, 1961). Coll. and subm. 1968 by W. C. Noble. *Comment*: date marks earliest Indian complex E of Great Bear Lake substantiating early Indian penetration to within few mi of central Arctic coast. Closest similar artifacts lie far to S in Alberta, Montana, and Wyoming.

Europe

1925 ± 85
I-3968. PC 68-10a, Cosa, Italy **A.D. 25**

Wood (*Quercus*) from cofferdam of Roman dock, Cosa (42° 24′ N Lat, 11° 17′ E Long), Ansedonia, Italy. Buried in mud and water 1.2 to 1.9 m below present ground level. Coll. and subm. 1968 by J. D. Lewis and A. M. McCann, Am. Acad. in Rome, Italy. *Comment* (A. McC.): sample documents existence of inner harbor at ancient port of Cosa. Cultural period late Republican or early Imperial. Date consistent with other finds from dock level.

4290 ± 110
I-3788. Port au Choix—3, Newfoundland **2340 B.C.**

Charcoal from Port au Choix (50° 42′ 27″ N Lat, 57° 20′ 30″ W Long), Newfoundland, Canada. From Burial 22 beneath human bones and grave goods. Coll. 1968 by W. A. Ritchie; subm. 1968 by J. A. Tuck, Memorial Univ. of Newfoundland, St. John's, Newfoundland. *Comment* (J.A.T.): dates large cemetery of Port au Choix phase of Maritime Archaic tradition.

Pontevedra series, Spain

Charcoal and carbonized vegetable matter from Pontevedra Province, Spain. Coll. 1964 by E. de Aguirre and subm. 1966 by K. W. Butzer, Univ. of Wisconsin, Madison, Wisconsin.

26,700 ± 3600
I-2174. Budiño site, No. 1 **24,750 B.C.**

Powdered carbonized wood and vegetable matter from Budiño site (42° 06′ 30″ N Lat, 8° 35′ 00″ W Long). Pontevedra Prov., Spain. From Paleolithic occupation floor in late Pleistocene colluvium (de Aguirre and Butzer, 1967; Butzer, 1967). *Laboratory Comment*: dated material separated from bulk soil by flotation. Sample soluble in dilute NaOH, but was pretreated with HCl.

I-2175. Budiño site, No. 2 **18,000 ± 300**
16,050 B.C.

Powdered charcoal, carbonized vegetation and soil from same location as I-2174. From hearth 10 cm above I-2174. *Comment* (K.W.B.): Paleolithic industry at Budiño includes choppers, trihedral picks, Clactonian flakes and notches, proto-bifaces, and denticulates worked in quartz. Artifacts found in undisturbed assocs. It's unlikely that 8000 yr separate the 2 samples. I-2174 though much smaller would be less liable to contamination by humic acids. *Laboratory Comment*: finely divided nature of sample prevented separation from bulk soil. Sample pretreated with HCl.

I-2176. LaGuardia **18,700 ± 320**
16,750 B.C.

Carbonized organic debris and soil from Playa de Fedorento, La Guardia (41° 54′ 30″ N Lat, 8° 51′ 00″ W Long), Pontevedra Prov., Spain. From 4 m depth, part of Sanjían beds.

I-2177. Mougás **>39,900**

Carbonized wood and soil from Mougás (42° 03′ 12″ N Lat, 8° 51′ 00″ W Long), Pontevedra Prov., Spain. From 0.8 m above base of 3 m peaty sediment on interglacial beach.

I-2261. Sanjián **28,400 ± 1200**
26,450 B.C.

Powdered carbonized wood and organic debris in sediment from Sanjián (41° 58′ 5″ N Lat, 8° 51′ W Long), Pontevedra, Spain. From middle of 5 m organic silt underlying 15 m coarse alluvial fan sediment. *Comment* (K.W.B.): sequence represents type site of Sanjián formation, dates cold interval following mid-Würm interstadial.

I-3984. Gobaederra Cave, Spain **3660 ± 100**
1710 B.C.

Human bones from Sierra de Badaya, N of Subijana de Morillas (42° 50′ 17″ N Lat, 00° 48′ 03″ W Long), Spain. Alt: 870 m. Sample from burial level corresponding to Spanish Bronze Age I (Apellaniz, Llanos, and Fariña, 1967). Coll. 1968 and subm. 1969 by A. Llanos, J. M. Apellaniz and J. Fariña, Mus. Prov. de Arqueología, Vitoria (Alava) Spain.

I-3985. Cueva de los Husos I, Spain **3920 ± 100**
1970 B.C.

Charcoal from N of Elvillar (42° 35′ 48″ N Lat, 01° 08′ 05″ W Long), Spain. From Bronze Age I level. Coll. 1968 and subm. 1969 by J. M. Apellaniz.

Africa

Mauritania series, Africa

Charcoal from various sites in S central Mauritania, Africa. Coll. and subm. 1968 by P. J. Munson, Univ. of Illinois, Urbana, Illinois.

I-3561. Goungou A **3350 ± 110**
1400 B.C.

From Features 2 and 5 (18° 21′ N Lat, 9° 12′ W Long), 2 refuse-filled pits, 10 to 30 cm depth. *Comment* (P.J.M.): dates Khimiya phase of Neolithic occupation of region. Date in agreement with 3205 ± 95 B.P. (GX-1323) from same site, Mauny, 1950).

I-3562. Goungou B **3190 ± 110**
1240 B.C.

From Test Sq. #1 (18° 20′ 50″ N Lat, 9° 11′ 55″ W Long), 60 to 80 cm depth. *Comment* (P.J.M.): dates early portion of Goungou phase of Neolithic occupation.

I-3563. Goungou B **2950 ± 100**
1000 B.C.

From same location as I-3562, 20 to 40 cm depth. *Comment* (P.J.M.): dates later portion of Goungou phase of Neolithic occupation.

I-3564. Naghez **3205 ± 105**
1255 B.C.

From Test Sq. #1 (18° 21′ N Lat, 9° 11′ 30″ W Long), 30 to 50 cm depth. *Comment* (P.J.M.): dates Naghez phase of Neolithic occupation. Earliest architectural sites.

I-3565. Seyyid Ouinquil **3100 ± 105**
1150 B.C.

From Test Sq. #1 (18° 22′ 10″ N Lat, 9° 9′ 20″ W Long), 5 to 18 cm depth. *Comment* (P.J.M.): dates Chebka phase of Neolithic occupation. Large fortified architectural sites. Date in essential agreement with 2780 ± 140 (GX-1325) from late Chebka phase site Le Baidla I.

I-3566. Taidart II **2330 ± 105**
380 B.C.

From deposits within small walled-in rockshelter (18° 26′ 30″ N Lat, 9° 24′ 20″ W Long), 13 to 35 cm depth. *Comment* (P.J.M.): dates Akjinjeir phase, terminal Neolithic. Date is in fair agreement with 2600 ± 110 (GX-1326) from Bledd Initi site, and in good agreement with historical records which place initial "Libyco-Berber" invasion at ca. 500 B.C.

South America

Central Coast, Peru series

Various samples of archaeologic interest from central coast of Peru. Coll. and subm. 1966 to 1968 by F. Engel, Univ. Agraria, Lima, Peru.

I-2440. V. 2448 **8030 ± 150**
6080 B.C.

Powdered charcoal and soil from just below entrance to cave in Puna (12° 14′ S Lat, 76° 21′ W Long). From 4th level of refuse.

I-3091. V. 2526 **10,030 ± 170**
8080 B.C.

Charred wood from Chilca Canyon (12° 13′ S Lat, 76° 22′ W Long). From Cave 1, Site 12 B-VI-450, Level 800.

I-3092. V. 2518 **6290 ± 120**
4340 B.C.

Vegetal remains from same location as I-3091, younger stratigraphic layer.

Pampa of Haldas series, Peru

Various cultural samples from villages in Pampa of Haldas, N coast Peru. Coll. 1968 by B. Ojeda and F. Engel; subm. 1968 by F. Engel.

I-3275. N. 82 **3135 ± 105**
1185 B.C.

Charcoal from Level 500, Site 9A-II-10, Haldas (9° 42′ 44″ S Lat, 78° 18′ 05″ W Long), Peru. *Comment* (F.E.): dates pottery expected to be pre-Chavin.

I-3276. N. 223 **4770 ± 120**
2820 B.C.

Wood from funeral bundle in Grave 2, Site 488, Haldas (9° 40′ S Long, 78° 16′ 40″ W Long), Peru. *Comment* (F.E.): graves belong to early pre-agricultural settlers on N coast.

I-3277. N. 263 **870 ± 100**
A.D. 1080

Plant remains from Level 300, Site 9A-II-125, Haldas (9° 41′ 50″ S Lat, 78° 18′ 58″ W Long), Peru. *Comment* (F.E.): sample helps date post-Chavin re-occupation of Pampa of Haldas.

I-3466. N. 403 **2920 ± 105**
970 B.C.

Charcoal from Level 1, Site 9A-II-2088, Haldas (9° 42′ 43″ S Lat, 78° 17′ W Long), Peru. *Comment* (F.E.): sample helps date Puerto Morin period.

I-3467. N. 396 **6650 ± 120**
4700 B.C.

Vegetal remains from Level 200, Site 9A-II-2075, Haldas (9° 42′ 53″ S Lat, 78° 17′ 33″ W Long), Peru. *Comment* (F.E.): sample helps date early agricultural period in Haldas.

I-3468. N. 404 **3870 ± 110**
1920 B.C.

Vegetal remains from Level 100, inside large quadrangular preceramic platform, Site 9A-II-3002, Haldas (9° 42′ 43″ S Lat, 78° 18′ 19″ W Long), Peru. *Comment* (F.E.): sample helps date early community architecture on N coast.

I-2841. Village 922, V. 2478, Peru **205 ± 85**
A.D. 1745

Charcoal from Village 922 in Chilca canyon (12° 33′ 34″ S Lat, 76° 38′ 39″ W Long), Peru. Coll. and subm. 1967 by F. Engel.

I-2843. Village 2081, V. 2485, Peru **580 ± 100**
A.D. 1370

Charcoal from Village 2081 in Chilca canyon (12° 23′ 30″ S Lat, 76° 39′ 40″ W Long), Peru. From Level 1, Site 12B-VII-2081. Coll. 1967 by B. Ojeda; subm. 1967 by F. Engel. *Comment* (F.E.): sample helps date large villages found in dry canyons of lower Andes and provides information about possible climatic changes.

I-3274. Pampa Ancon, N. 211, Peru **3560 ± 115**
1610 B.C.

Charcoal from Pampa Ancon, I (11° 43′ S Lat, 77° 08′ W Long), central coast Peru. From Level 100, Site 11B-VIII-100. Coll. and subm. 1968 by F. Engel. *Comment* (F.E.): dates large village of stone houses belonging to early pre-maize period.

I-3560. Village 25, N. 458, Peru **6150 ± 120**
4200 B.C.

Charcoal from Village 25 at mouth of Ica R. (14° 52′ 23″ S Lat, 75° 34′ 06″ W Long), S coast Peru. From strat. Cut 1, Level 9, Site 15B-VII-25, at + 10 m. Coll. and subm. 1968 by F. Engel.

Viru Valley series, Peru

Samples from Viru Valley, N coast Peru. Coll. 1969 by F. Engel and B. Ojeda; subm. 1969 F. Engel.

I-4111. Guañape, V. 2703 **3240 ± 100**
1290 B.C.

Charcoal from Site 7A-VIII-71B #500 (8° 25′ 25″ S Lat, 78° 54′ 10″ W Long), Guañape, Level 500.

I-4112. Guañape, V. 2704 **3030 ± 100**
1080 B.C.

Textiles and vegetal remains from Site 7A-VIII-71B #200 (8° 25′ 25″ S Lat, 78° 54′ 10″ W Long), Guañape, Level 2.

I-4113. Gallinazo, V. 2701 **1700 ± 130**
A.D. 250

Ashes from Site 7A-VIII-59 #100 (8° 26′ 25″ S Lat, 78° 53′ 22″ W Long), Gallinazo, Level 100.

I-4114. Gallinazo, V. 2702 **1850 ± 100**
A.D. 100

Charcoal from Site 7A-VIII-59 SC II #1.100 (8° 26′ 25″ S Lat, 78° 53′ 22″ W Long), Gallinazo, Level 1.100.

I-4174. V. 2730 **2150 ± 95**
200 B.C.

Charcoal from Site 7A-VIII-66 #1 (8° 24′ 39″ S Lat, 78° 53′ 39″ W Long), Level 1. *Comment* (F.E.): aid in dating Puerto Morin occupation on N coast of Peru.

I-4175. Chilca Canyon, Peru **1100 ± 100**
A.D. 850

Charcoal from hearth inside house, Village 12B-VII-947 #200 (12° 25′ 26″ S Lat, 76° 44′ 45″ W Long), Level 200, Chilca canyon, central coast Peru. Coll. and subm. 1969 by F. Engel and B. Ojeda, Natl. Agrarian Univ. of Peru, Lima, Peru. *Comment* (F.E.): aid in dating above ground architecture and orange polished pottery of unknown type found in village.

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Isotopes V	Trautman and Willis, 1966
Isotopes VI	Buckley, Trautman, and Willis, 1968
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CORRECTION

In Volume 11, No. 1, p. 66, Sample I-3430 should refer to Orford, Suffolk, and not Oxford, as stated.

[RADIOCARBON, VOL. 12, NO. 1, 1970, P. 130-155]

RADIOCARBON DATES OF THE INSTITUTE OF ARCHAEOLOGY II*

1 January—31 July 1967

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and A. A. SEMYONTSOV

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The present list covers samples measured between 1963 and July, 1967. Three previous lists have been published in Leningrad I (Sovetskaya arkheologiya, 1961, p. 3); Leningrad II (The Absolute Geochronology of the Quaternary Period, 1963); and Leningrad III (New Methods in Archaeological Investigations, 1963, p. 9-56). The samples measured include charcoal from cultural layers and hearths, wood from barrows [kurgans]** and cemeteries, wooden tools from peat deposits, and mounds, as well as peat and animal tissue.

For the series numbered up to LE-599†, ethylbenzene conversion was used (Starik, Arslanov, and Klener, 1963). Samples LE-600 to LE-661 were measured by the method of benzene conversion in which benzene is synthesized from sample-derived acetylene with Zigler's alumino-organic catalyst according to the following scheme:

$$C \longrightarrow CaC_2 \xrightarrow{H_2O} C_2H_2 \xrightarrow{(\text{iso } C_4H_9)_3\ \text{Al-TiCl}_4} C_6H_6$$

The yield was 50 to 60%. Use of an alumina–nickel–molybdenum catalyst permitted increasing yields up to 80% for Samples LE-654 through LE-661. At present, benzene synthesis is being attained by means of acetylene trimerization with a vanadium–alumina–silica catalyst (Arslanov and Gromova, 1967; Noaks *et al.*, 1967). The yield is 90 to 96%. Samples numbered LE-662 to LE-717 were measured by this method.

Measurements of radioactivity were carried out on liquid scintillation counters with single photo-multipliers. High-gain amplifiers permitted use of photo-multipliers arranged in coincidence. With the lower gate set at a level of 30 kev, about 0.5 to 1.2 counts/min were lost in every series of measurements. Monitoring of the scintillator's efficiency was carried out on a Co^{60} spectrum boundary.

For 8.5 g of benzene, the standard counting rate is 41.3 ± 0.19 counts/min, the background rate being 4.5 ± 0.6 counts/min.

* Translated by P. M. Dolukhanov. Edited from Mr. Dolukhanov's translation and the original Russian text by Edith M. Shimkin, Univ. of Illinois, with comments by Demitri B. Shimkin, Univ. of Illinois. Original Russian text transmitted to Dr. Henry Field by D. B. Shelov, Project Dir., Inst. of Archaeology, Acad. of Sci., USSR, 19 Dm. Ul'yanova, Moscow (Document No. 307/654/1). Dr. and Mrs. Shimkin wish to express their appreciation to Dr. Field for his aid in initiating this work, and to Professor Ralph T. Fisher, Jr., Dir., Russian and East European Center, Univ. of Illinois for the assistance rendered by the Center in the preparation of the manuscript.

** Information in brackets added by editor (E.M.S.) and commentator (D.B.S.).

† The original official designation of this lab was RUL; dates publ. as Inst. of Archaeology I (Radiocarbon, 1965, v. 7, p. 223-228) carry this designation. References to dates in Inst. of Archael. I, 1965 are designated LE[RUL]—in this list (E.M.S.).

Benzene synthesized from a 30-yr-old birch felled in Kamchatka in 1908 is used as a modern reference standard, which is the same standard used by the Vernadsky Inst.

Moldavian SSR

7090 ± 195
LE-391. Varvarovka, Floreshty Raion 5140 B.C.

Charcoal from Dwelling 1, Varvarovka village, Floreshty Raion (47° 55′ N Lat, 28° 18′ E Long). Depth not given (E.M.S.). Archaeologic age: late Tripolye, 4th millennium B.C. Subm. by T. S. Passek, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (T.S.P.): date much older than expected.

5300 ± 60
LE-640. Vulkaneshty II, Vulkaneshty Raion 3350 B.C.

Fragment of charred wooden block from dwelling foundation, Excavation 1, Vulkaneshty II settlement, Vulkaneshty Raion (45° 42′ N Lat, 28° 25′ E Long). Depth not given (E.M.S.). Subm. by T. S. Passek. *Comment* (T.S.P.): settlement belongs to Gumel'nitsa culture. Another date: 5810 ± 150, Mo-417 (Radiocarbon, 1968, v. 10, p. 454). Ref: Passek, 1966; Gimbutas, 1956.

Ukrainian SSR

4340 ± 65
LE-645. Mayaki, Odessa Oblast 2390 B.C.

Charcoal from site at Mayaki village, Velyayevsk Raion, Odessa Oblast (46° 25′ N Lat, 30° 19′ E Long). Sample from dwelling pit, depth 2.0 to 2.4 m. Inferred age: late stage of Tripolye culture, Usatovo. Subm. by V. G. Zbenovich. *Comment* (V.G.Z.): date corresponds to estimated archaeologic age.

3340 ± 80
LE-659. Poles'ye, Chernigov Oblast 1390 B.C.

Peat from bog at Poles'ye village, Chernigov Oblast (51° 30′ N Lat, 31° 30′ E Long). Depth, 1.80 to 2.0 m. Primitive wooden plow [*ralo*], typically belonging to end of Bronze to Early Iron age, found in peat. Subm. by B. A. Shramko.

1410 ± 90
LE-573. Magala, Chernovtsy Oblast A.D. 540

Charcoal from upper cultural layer of ancient Thracian site at Magala village, Sadgor Raion, Chernovtsy Oblast [48° 18′ N Lat, 26° 03′ E Long]. Depth not given (E.M.S.). Archaeologic age: early Iron. Subm. by G. I. Smirnova, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (D.B.S.); chronologic discrepancy. Thracian settlement on Dnestr R. ca. 400 B.C., cf. Tret'yakov and Mongayt (1956, p. 294) interpreting Herodotus.

1120 ± 100
LE-654. Peschanoye, Cherkassy Oblast A.D. 830

Fragment of dug-out boat [*cheln*] discovered at Peschanoye village, Gel'myazev Raion, Cherkassy Oblast. [Gel'myazov: 49° 55′ N Lat, 31° 50′ E Long]. Depth not given (E.M.S.). Subm. by O. D. Ganina.

Belorussian SSR

Krasnoye Selo flint mines series, Grodno Oblast

Neolithic flint mines near Krasnoye Selo, Volkovysk Raion, Grodno Oblast (53° 08′ N Lat, 24° 25′ E Long). Archaeologic age: Late Neolithic. Subm. by N. N. Gurina, Inst. of Archaeol., Acad. of Sci., USSR.

LE-636. Shafts 2, 3, and 12 — **3190 ± 60** — **1240 B.C.**

Charcoal from 3 shafts; depth, 2.6 to 3.0 m.

LE-680. Shaft 12 — **3370 ± 50** — **1420 B.C.**

Charcoal from Shaft 12; depth, 0.9 m.

LE-637. Shafts 15, 21, and 56 — **5300 ± 300** — **3350 B.C.**

Charcoal from Shafts 15, 21, and 56. Depths not given (E.M.S.). *Comment* (N.N.G.): culturally, mines belong to Late Neolithic (Gurina, 1965b, 1966). Charcoal from Shaft 13 dated at 4310 ± 45 yr, GIN-148 (Radiocarbon, 1968, v. 10, p. 437), and from Shafts 3, 11, and 18 at 5050 ± 25 yr, GIN-164 (*op. cit.*).

Zarubinets sites series, Mogilyov Oblast

Samples from sites in Bykhov Raion, Mogilyov Oblast. Inferred age: late Zarubinets [early E Slavic (D.B.S.)]. Subm. by L. D. Pobol, Inst. of Hist., Acad. of Sci., Belorussian SSR. Ref: Bud'ko, 1967; Tret'yakov, 1959.

LE-691. Obidnya — **1760 ± 60** — **A.D. 190**

Wood from Excavation 17, Obidnya village [*urochishche*], Bykhov Raion (53° 32′ N Lat, 30° 15′ E Long). Depth, 1 m. Bud'ko (1967, p. 261) estimates age at 2nd to 5th century A.D. Alternate spelling: Abidnya (E.M.S.).

LE-340. Adamenka — **1670 ± 240** — **A.D. 280**

Charcoal from Dwelling 1, Adamenka settlement, Bykhov Raion (53° 32′ N Lat, 30° 15′ E Long).

LE-688. Radysheva Gora — **1620 ± 60** — **A.D. 330**

Charcoal from cemetery without kurgans, Radysheva Gora village [*urochishche*], Novyy Bykhov, Bykhov Raion (53° 18′ N Lat, 30° 24′ E Long). Burial 35; depth, 0.30 m. *Comment* (D.B.S.): Zarubinets culture in middle Dnestr region estimated to span period from 2nd century B.C. to 1st to 2nd century A.D. by dating of fibulae found at sites (Tret'yakov, 1959, p. 151). Dates in series agree well with Tret'yakov's analysis, but note lead seal from later period (*op. cit.*, p. 29), 8th century A.D.

Kolochin I series, Gomel' Oblast

Kolochin I fortified settlement [*Kolchinskoye gorodishche*], Gomel' Oblast (52° 10′ N Lat, 30° 25′ E Long). Subm. by E. A. Symonovich, Inst. of Archaeol., Acad. of Sci., USSR.

2180 ± 160
LE-400. Kolochin I **230 B.C.**

Charcoal from semi-subterranean Dwelling 2. Depth not given (E.M.S.).

1770 ± 110
LE-442. Kolochin I **A.D. 180**

Wood from stockade [*tyn*], Quadrant 349. Archaeologic age: middle of 1st millennium A.D. *Comment* (D.B.S.): internally isolated fortress settlement founded in Zarubinets period (Symonovich, 1963, p. 97); burned and rebuilt with final destruction ca. 7th to 8th century A.D. Later phase correlated with Tushemlya, LE-344 (this list; Symonovich, 1963, p. 133-137). (Cf. also LE [RUL]-246 = 920 ± 100 yr, Radiocarbon, 1965, v. 7, p. 228).

Latvian SSR

Madona Raion sites series

Peat samples from campsites in Madona Raion, E part of Latvian SSR (56° 53′ N Lat, 26° 15′ E Long). Subm. by I. A. Loze, Acad. of Sci., Latvian SSR. Ref: Loze, 1965.

4170 ± 130
LE-648. Nainiekste campsite **2220 B.C.**

Peat from depth 0.4 to 0.5 m. Inferred age: Neolithic, end of 3rd millennium B.C. *Comment* (I.A.L.): site contains porous pottery with cord-marking, and comb and linear punctate decoration; typical pit-and-comb ware occurring in small numbers. (Cf. also another date for early cord-marked pottery at Kut site, W Ukraine: GIN-152 = 4090 ± 80 yr, Radiocarbon, 1968, v. 10, p. 437 [D.B.S.]).

3870 ± 70
LE-671. Abora campsite **1920 B.C.**

Peat from depth 0.74 to 0.90 m. Inferred age: beginning of 2nd millennium B.C. *Comment* (I.A.L.): site contains corded, and early textile-impressed pottery. Date close to Tamula, corded ware site, in Estonian SSR: TA-10 = 3600 ± 180 yr; TA-28 = 4050 ± 180 yr (Radiocarbon, 1966, v. 8, p. 433); cf. also Liiva *et al.* (1965).

Karelia and North Russia

Ust'-Rybezhnoye I series, Leningrad Oblast

Ust'-Rybezhnoye I settlement site, at village of Ust'-Rybezhno, Volkhovsk Raion, Leningrad Oblast (60° 22′ N Lat, 32° 35′ E Long) is located S of L. Ladoga. Archaeologic age: Neolithic.

LE-405. Ust'Rybezhnoye I **6380 ± 220**
4430 B.C.

Charcoal from hearth, Excavation 1. Subm. by N. N. Gurina (1965a). Depth not given (E.M.S.).

LE-599. Ust'-Rybezhnoye I **4000 ± 70**
2050 B.C.

Wood from Excavation 2, upper limno-telmatic contact of peat layer, covered by sands of Ladoga transgression. Right bank of Pasha R., 1 km upstream from Excavation 1 (LE-405). Subm. by P. M. Dolukhanov, Inst. of Archaeol., Acad. of Sci., USSR.

LE-634. Ust'-Rybezhnoye I **4510 ± 85**
2560 B.C.

Peat from Excavation 3, upper limno-telmatic contact of peat layer, left bank of Pasha R. Subm. by P. M. Dolukhanov. *Comment* (P.M.D.): Sample LE-405 obtained directly from cultural layer; LE-599 and LE-634 from peat horizon believed synchronous with cultural layer and predating beginning of Ladoga transgression which submerged site area. (Cf. also Foss, 1952, p. 268, no. 539, and map opp. p. 23 [D.B.S.]).

Bol'shoy Mokh peat bog series, Leningrad Oblast

Peat from Bol'shoy Mokh bog, Podporozh'ye Raion [Podporozh'ye city: 60° 55′ N Lat, 34° 12′ E Long]. Subm. by P. M. Dolukhanov.

LE-610. Bol'shoy Mokh bog **6060 ± 75**
4110 B.C.

Peat. Depth, 3.5 m. Inferred age: Atlantic period. (Cf. also Shuvalovo bog, Leningrad Oblast: Mo-324 [depth, 3.13 to 3.18 m] = 8720 ± 270 yr, Radiocarbon, 1966, v. 8, p. 294).

LE-608. Bol'shoy Mokh bog **4470 ± 80**
2520 B.C.

Peat. Depth, 1.5 m. Inferred age: pollen-zone boundary of Atlantic and Sub-boreal periods. (Cf. also Shuvalovo bog: Mo-325 [depth, 1.35 to 1.85 m] = 4120 ± 190 yr, Radiocarbon, 1966, v. 8, p. 294: Neustadt [1965, p. 78] dates Atlantic-Sub-boreal boundary at 4950 to 5250 yr B.P. [D.B.S.]).

V'yun I campsite series, Leningrad Oblast

Samples from vicinity of V'yun I Neolithic campsite, Sosnovo Raion [V'yun: 60° 35′ N Lat, 30° 29′ E Long]. Geologic age: Holocene. Subm. by O. M. Znamenskaya, Leningrad State Univ.

LE-561. V'yun I **5980 ± 100**
4030 B.C.

Wood from deposits of Lake Ladoga, near V'yun I campsite. Depth, 4.3 m.

LE-500. V'yun I **2040 ± 130**
90 B.C.

Wood from buried peat layer near V'yun I campsite. Depth, 4.3 m.

LE-498. Leningrad, Leningrad Oblast **6060 ± 170**
4110 B.C.

Peat from Boring 4, Leningrad (59° 55′ N Lat, 30° 15′ E Long). Depth, 13.6 to 13.7 m. Samples 39 and 40. Subm. by O. M. Znamenskaya.

Marmuginskiy peat bog series, Vologda Oblast

Marmuginskiy peat bogs are located in Velikiy Ust'-yug Raion, in flood plain of Yug R. [Velikiy Ust'-yug: 60° 48′ N Lat, 46° 18′ E Long]. Subm. by G. M. Burov, Komi Affiliate, Acad. of Sci., USSR.

LE-711. Marmuginskiy I **4700 ± 60**
2750 B.C.

Wood remains of fish traps made of lathes [*dranka*]. Structure 1, Sample 1. Depth not given (E.M.S.). Inferred age: Neolithic.

LE-703. Marmuginskiy I **4510 ± 50**
2560 B.C.

Wood remains of fish weir made of lathes. Structure 2, Sample 2. Depth not given (E.M.S.). Inferred age: Neolithic.

LE-705. Marmuginskiy II **2650 ± 50**
700 B.C.

Wooden sticks. Sample 3, Artifact 1. Depth, 1.4 m.

LE-704. Marmuginskiy II **2000 ± 50**
50 B.C.

Wooden sticks. Sample 3, Artifact 2. Depth, 1.2 m. *Comment* (G.M.B.): these determinations confirm Neolithic age of Marmuginskiy I; Marmuginskiy II is younger.

Usvyata IV site series, Pskov Oblast

Pile structures bordering Usvyata Lake, Usvyata Raion (55° 43′ N Lat, 30° 47′ E Long). Samples from oldest ("B") settlement of Usvyata IV site (Dolukhanov and Miklyayev, 1968). Subm. by A. M. Miklyayev, Hermitage Mus., Leningrad.

LE-651. Usvyata IV **5530 ± 90**
3580 B.C.

Wood from pile dwelling, lowermost level of cultural Layer B, depth, 1.4 m. Inferred age: Neolithic.

LE-649. Usvyata IV **3920 ± 90**
1970 B.C.

Wood from pile dwelling, upper part of cultural Layer B, depth, 0.96 m. Inferred age: Neolithic. *Comment* (A.M.M.): determinations establish Neolithic age of lower and upper cultural layers. Middle portion of cultural layer dated at 4520 ± 70 yr (TA-105, Radiocarbon, 1968, v. 10, p. 125).

LE-501. Dal'niye Zelentsy, Murmansk Oblast **1720 ± 170**
A.D. 230

Peat from 12-m marine terrace above cultural layer at Dal'niye Zelentsy site, Murman Coast [69° 07′ N Lat, 36° 05′ E Long]. Subm. by

V. D. Dibner, Inst. of Arctic Geol. *Comment* (P. M. Dolukhanov): Dal'niye Zelentsy is early Iron Age site.

600 ± 90
LE-480. Yumochorr Mountain, Murmansk Oblast A.D. 1350

Wood from W slope, Yumochorr Mt., Khibiny range [Khibiny Mts.: 67° 45′ N Lat, 33° 45′ E Long]. Subm. by G. M. Kozubov, Inst. of Forestry, Karelian Affiliate, Acad. of Sci., USSR.

Central and Northeast Russia

1700 ± 70
LE-516[506]. Dikarikha, Yaroslavl' Oblast A.D. 250

Charcoal from hearth, Dikarikha campsite, Pereyaslavl' Raion (56° 48′ N Lat, 38° 45′ E Long). Depth, 0.5 m. Inferred age: Late Bronze. Subm. by A. L. Nikitin, Inst. of Archaeol., Acad. of Sci., USSR. Same site dated at 2200 ± 30 yr (GIN-128, Radiocarbon, 1968, v. 10, p. 429). (Cf. also other dates for Pleshcheyevo campsite series, GIN-113 through 116, *op. cit.*, p. 428; note correction of location for GIN-128 [E.M.S.].)

Proto-Kievan Rus series, Smolensk Oblast

Samples from Proto-Kievan Rus sites, Smolensk Oblast, S of city of Smolensk. Archaeologic age: end of 8th century A.D. Subm. by P. N. Tret'yakov, Inst. of History of Material Culture, Acad. of Sci., USSR.

960 ± 150
LE-344. Tushemlya A.D. 990

Charcoal from soil layer, Tushemlya site (54° 17′ N Lat, 32° 18′ E Long). Depth not given (E.M.S.). Ref: Shmidt, 1957.

980 ± 90
LE-386. Voshkino A.D. 970

Charcoal from soil layer, Voshkino fortified settlement [*gorodishche*] (54° 24′ N Lat, 32° 28′ E Long). Depth not given (E.M.S.).

950 ± 120
LE-411. Glushitsa A.D. 1000

Carbonized crust from soil layer, Glushitsa freehold [*sloboda*] (54° 22′ N Lat, 32° 23′ E Long). Depth not given (E.M.S.).

Viss I and II peat bogs series, Komi ASSR

Viss Peat Bogs I and II are located near Sindor village, Zheleznodorozh Raion (62° 35′ N Lat, 50° 55′ E Long). Sites of pile dwellings supposedly Mesolithic (Viss I) and Early Iron (Viss II). Coll. and subm. by G. M. Burov, Komi Affiliate, Acad. of Sci., USSR. Ref.: Burov, 1966.

7820 ± 80
LE-616. Viss I 5870 B.C.

Wood from depth 1.6 m. Inferred age: 7th to 6th millennium B.C.

LE-684. Viss I **7150 ± 60**
5200 B.C.

Wood from pole with hand grip. Sample 1. Depth not given (E.M.S.). Inferred age: Mesolithic.

LE-685. Viss I **7090 ± 80**
5140 B.C.

Wood from pole with tread. Depth, 1.2 m. Sample 1, artifact B. Inferred age: Mesolithic. *Comment* (D.B.S.): comparable artifacts from Shigir culture, C Urals, have been interpreted as digging sticks (Bryusov, 1952, p. 158).

LE-713. Viss I **7090 ± 70**
5140 B.C.

Wood from plank with [evidence of] sawing. Sample 3, artifact B. Depth, 1.9 m. Inferred age: Mesolithic.

LE-568. Viss II **3610 ± 80**
1660 B.C.

Wood from Viss II bog. Depth, 0.9 to 1.3 m. Inferred archaeologic age: 2nd millennium B.C. to 5th century B.C.

LE-669. Viss II **1990 ± 50**
40 B.C.

Wood from paddle. Sample 1. Depth, 2.1 m. Inferred age: 1st millennium B.C.

LE-686. Viss II **1520 ± 50**
A.D. 430

Wood from piling. Sample 2. Inferred age: 1st millennium A.D. *Comment* (G.M.B.): dates corroborate inferred archaeologic dates.

LE-538. Sizhina River, Kalinin Oblast **23,800 ± 570**
21,850 B.C.

Peat from sec. on Sizhina R. [Sizhinskoye: 56° 46′ N Lat, 33° 33′ E Long]. Depth, 5 m. Inferred age: Mikulino Interglacial. Subm. by Z. V. Yatskevich, Fifth Geol. Adminis.

LE-453[456]. Bol'shaya Kosha River, Kalinin Oblast **33,400 ± 1200**
31,450 B.C.

Peat from Sec. 2, Bol'shaya Kosha R. [56° 44′ N Lat, 33° 42′ E Long]. Inferred age: Mikulino Interglacial (Riss-Würm). Subm. by Z. V. Yatskevich.

South Russia and Lower Volga Region

LE-545. Smolyan', Bryansk Oblast **1380 ± 75**
A.D. 570

Charcoal from bottom of pit, Excavation 2, Smolyan' dwelling site (53° 20′ N Lat, 34° 30′ E Long). Archaeologic age: 1st millennium A.D. No depth given (E.M.S.). Subm. by P. N. Tret'yakov.

LE-708. Il'men', Voronezh Oblast **3410 ± 50**
1460 B.C.

Wood from burial pit, Kurgan 8, at Il'men' village, Borisoglebsk Raion (51° 23′ N Lat, 42° 05′ E Long). Depth, 2.5 to 3.0 m. Subm. by P. D. Liberov, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (D.B.S.): Puzikova and Kachalova (1967) report Bronze Age (Catacomb and Timber Grave) burial sites in this vicinity.

LE-701. Russkaya Trostyanka, Voronezh Oblast **2010 ± 50**
60 B.C.

Charcoal from burial pit, Kurgan 9, at Russkaya Trostyanka village (51° 00′ N Lat, 38° 45′ E Long). Depth, 1.0 m from summit of kurgan. Inferred age: Early Iron. Subm. by P. D. Liberov.

LE-707. Storozhevoye, Voronezh Oblast **2350 ± 60**
400 B.C.

Remnants of wooden construction from rampart of fortified village [*gorodishche*] at Storozhevoye village (ca. 51° N Lat, 38° E Long). Depth, 1.0 to 1.5 m from top of rampart. Inferred age: Early Iron. Subm. by P. D. Liberov.

Durovka kurgan series, Belgorod Oblast

Samples from Kurgans 1, 4, and 5, at Durovka village, Alekseyevka Raion. [Alekseyevka: 50° 37′ N Lat, 38° 42′ E Long]. Inferred age: Early Iron. Subm. by P. D. Liberov.

LE-699. Durovka 1 **1930 ± 60**
A.D. 20

Wood from burial pit cover, Kurgan 1, Depth, 3.0 m from summit of kurgan.

LE-702. Durovka 4 **2120 ± 60**
170 B.C.

Wood from burial pit cover, Kurgan 4. Depth, 2.0 m from summit of kurgan.

LE-709. Durovka 5 **2150 ± 50**
200 B.C.

Charcoal from bottom of burial pit, Kurgan 5. Depth, 2.5 m from summit of kurgan. *Comment* (D.B.S.): presumably marginal Scytho-Sarmatian burial site (cf. Grakov and Melyukova, 1954, map, p. 83, and Smirnov, 1954, map opp. p. 216).

LE-511. Kudinov, Rostov Oblast **3180 ± 80**
1230 B.C.

Wood from Kurgan 1, Grave 7, from cultural layer of site at Kudinov farmstead (47° 23′ N Lat, 40° 35′ E Long). Inferred archaeologic age: Bronze, Timber Grave [*srubnaya*] culture. Subm. by A. N. Melent'yev. *Comments* (P. M. Dolukhanov): [wood from] same grave dated at 3520 ± 80 yr (UCLA-1274, Radiocarbon, 1968, v. 10, p. 411). (D.B.S.): attribution to earlier Pit Grave [*yamnaya*] culture in Russian original corrected by Dolukhanov (Tret'yakov and Mongayt, 1956, p. 141-152).

LE-624. Rostov city, Rostov Oblast **3880 ± 90**
1930 B.C.

Wood from Kurgan 7, Grave 3, E of Rostov (47° 10′ N Lat, 39° 45′ E Long). Inferred archaeologic age: Bronze, N Caucasian Catacomb culture. Subm. by I. B. Brashinskiy. (Cf. also Tret'yakov and Mongayt, 1956, p. 141-152 [D.B.S.].)

LE-415. Kobyakovo, Rostov Oblast **2070 ± 140**
120 B.C.

Carbonized reed [*kamysh*] and charcoal from Dwelling 1, Kobayakovo settlement site (47° 14′ N Lat, 39° 48′ E Long). Depth not given (E.M.S.). Archaeologic age: Sarmatian. Subm. by S. I. Kaposhina. *Comment* (D.B.S.): according to archaeologic and historic evidence, Sarmatians crossed to W of Don R. in 2nd century B.C. (Tret'yakov and Mongayt, 1956, p. 507).

North Caucasus and Transcaucasus

LE-613. Il' River, Krasnodar Krai **9000 ± 100**
7050 B.C.

Wood from alluvial layer, 1st flood-plain terrace of Il' R., near Il' Paleolithic campsite, Kuban' region [ca. 44° 50′ N Lat, 38° 40′ E Long]. Geologic age: Lower Holocene. Subm. by N. D. Praslov. (Cf. Beregovaia, 1966, p. 32 and Map 1, p. 50 [D.B.S.].)

Ust'-Dzhegutinskaya cemetery series, Stavropol' Krai

Kurgans 24, 32, and 33 near Ust'-Dzhegutinskaya *stanitsa* [village], Prikubansk Raion (44° 06′ N Lat, 41° 58′ E Long). Subm. by R. M. Munchayev.

LE-693. Ust'-Dzhegutinskaya 1 **4110 ± 60**
2160 B.C.

Wood from Kurgan 32, Grave 10. Depth, 6.5 m from summit of kurgan. Inferred archaeologic age: 1st half of 2nd millennium B.C.

LE-687. Ust'-Dzhegutinskaya 2 **4040 ± 60**
2090 B.C.

Wood from Kurgan 24, Grave 1. Depth, 2.7 m from summit of kurgan. Inferred archaeologic age: 1st half of 2nd millennium B.C.

LE-692. Ust'-Dzhegutinskaya 3 **3900 ± 60**
1950 B.C.

Wood from Kurgan 33, Grave 2. Depth, 2.2 m from summit of kurgan. Inferred archaeologic age: 1st half of 2nd millennium B.C.

Serzhen'-Yurt series, Checheno-Ingush ASSR

Samples from Serzhen'-Yurt 1 site, Checheno-Ingush ASSR [Serzhen'-Yurt village: 43° 07′ N Lat, 45° 59′ E Long]. Subm. by Ye. I. Krupnov, Inst. of Archaeol., Acad. of Sci., USSR. Ref.: Krupnov *et al.*, 1967. (Cf. also LE[RUL]-258 and 265, Radiocarbon, 1965, v. 7, p. 227 [D.B.S.].)

LE-661. Serzhen'-Yurt 1 **2860 ± 60**
910 B.C.

Charcoal from dwelling, upper layer, Quad. D-7. Depth not given (E.M.S.).

LE-491. Serzhen'-Yurt 1 **2890 ± 75**
940 B.C.

Charcoal from artifact assembly [*Shtyk*] 3, Quad. D-7. Depth not given (E.M.S.).

LE-575. Serzhen'-Yurt 1 **2620 ± 75**
670 B.C.

Charcoal from upper layer. *Comment* (Ye. I. K.): samples taken from upper layer; Late Bronze, Early Iron, 9th to 7th century B.C. (Krupnov *et al.,* 1967, p. 60).

LE-330. Uch-Tepe, Azerbaydzhan SSR **4830 ± 230**
2880 B.C.

Charcoal from Kurgan 3, Uch-Tepe, 4 to 6 km S of Karkay-Chay (39° 55′ N Lat, 47° 20′ E Long). Burned covering of principal tomb. Inferred archaeologic age: end of 3rd to 2nd millennium B.C. Subm. by A. A. Yessen, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (A.A.Y.): another date for charcoal from cover of grave pit: 4500 ± 120 yr (LE[RUL]-305, Radiocarbon, 1965, v. 7, p. 227); cf. also Ivanova, Kind, and Cherdyntsev, 1963, p. 146, and Yessen, 1965b, p. 185.

LE-631. Shomu-Tepe, Azerbaydzhan SSR **7510 ± 70**
5560 B.C.

Charcoal from Shomu-Tepe settlement, Akstafa Oblast [Akstafa: 41° 07′ N Lat, 45° 27′ E Long]. Depth, 1 m. Inferred archaeologic age: Eneolithic, 5th to 4th millennium B.C. Subm. by I. G. Narimanov.

Kyul'-Tepe series, Nakhichevan ASSR, Azerbaydzhan SSR

Charcoal from mound and campsites at Kyul'-Tepe, Nakhichevan ASSR (39° 11′ N Lat, 45° 56′ E Long).

LE-434. Kyul'-Tepe mound **4870 ± 150**
2920 B.C.

Charcoal from lower layer of mound. Exact depth not given (E.M.S.). Inferred archaeologic age: Eneolithic, 4th millennium B.C. Subm. by A. A. Yessen.

LE-477. Kyul'-Tepe campsite **5770 ± 90**
3820 B.C.

Charcoal from Layer 1-B, depth, 18.2 m. Inferred archaeologic age: Eneolithic, end of 5th to 4th millennium B.C. Subm. by O. A. Abibullayev. *Comment* (O.A.A.): Sample LE[RUL]-163, depth, 8.5 m, dated at 4880 ± 90 yr (Radiocarbon, 1965, v. 7, p. 226); cf. also Ivanova, Kind, and Cherdyntsev, 1963, p. 146, and Yessen, 1965a, p. 12. Depth of 18.2 m correct (Yessen, 1965a, p. 12) (E.M.S.).

LE-508. Kvelo Cheladidi, Georgian SSR **2400 ± 70**
450 B.C.

Carbonized wood from remains of burned dwelling, Kvelo Cheladidi settlement, near Poti (42° 07′ N Lat, 41° 40′ E Long). Depth, 2.0 to 2.2 m. Archaeologic age: Colchis. Subm. by T. K. Mikeladze Inst. of History, Georgian SSR. *Comments* (D.B.S.): Colchis was Late Bronze age culture of Georgia believed by B. A. Kuftin (1941) to be synchronous with Urartu kingdom (cf. GIN-1, Radiocarbon, 1968, v. 10, p. 423; GIN-32, *ibid.*, p. 433; Mo-241, *ibid.*, p. 460), and dated to 12th and 9th century B.C. by Dzhaparidze (1953). Date for LE-508 appears unexpectedly late; (E.M.S.): note that correction of name and exact location are given in LE-508 for TB-5 (Radiocarbon, 1968, v. 10, p. 466).

LE-337. Racha, Georgian SSR **3530 ± 165**
1580 B.C.

Fragment of wooden prop from Racha copper mines, Gebi village [42° 46′ N Lat, 43° 30′ E Long]. Inferred archaeologic age: Late Bronze. Subm. by G. F. Kobedzhishvili.

LE-667. Atsavan fortress, Armenian SSR **1460 ± 50**
A.D. 490

Wood, part of beam of doorway, Atsavan fortress [*krepost'*], 15 km SE of Yerevan (40° 06′ N Lat, 44° 37′ E Long). Depth, 2.2 to 2.3 m. Inferred age: 1st century A.D., Roman period of Armenia. Subm. by G. A. Tiratsyan.

LE-681. Dziguti River, Abkhazian ASSR **26,600 ± 500**
24,650 B.C.

Peat from buried peat layer, right bank of Dziguti R., Ochamchire Raion [Ochamchire city: 42° 43′ N Lat, 41° 28′ E Long]. Depth, 1.9 m. Inferred age: Upper Pleistocene. Subm. by B. L. Solov'yev.

Central Asia and Kazakhstan

LE-592. Chagylly-Tepe, Turkmen SSR **7000 ± 110**
5050 B.C.

Charcoal from 2nd cultural layer, Chagylly-Tepe site, near Meana settlement (36° 52′ N Lat, 60° 28′ E Long). Coll. name not given (E.M.S.). *Comments* (V.M.M.): layer belongs to late Dzheytun culture; archaeologic date: 6th to 5th millennium B.C. (Masson, 1966, p. 76-92, and map, p. 24); (D.B.S.): Late Dzheytun characterized by microlithic inventory, painted pottery, livestock, agriculture, and compact villages. Masson correlates late Dzheytun with Dzhebel 5, and 10 to 11 m strata of Gari-Kamarband. Cf. also LE[RUL]-1 (Radiocarbon, 1965, v. 7, p. 226).

LE-647. Geoksyur I site, Turkmen SSR **4440 ± 180**
2490 B.C.

Charcoal from upper layer of Geoksyur I settlement site (37° 21′ N Lat, 60° 46′ E Long). Depth, 1.4 m. Location 54, Excavation 1. Inferred archaeologic age: Late Eneolithic, 1st half of 3rd millennium B.C. Subm.

by V. I. Sarianidi. (Cf. also LE[RUL]-257, Radiocarbon, 1965, v. 7, p. 226 [E.M.S.].)

LE-664. Altyn-Tepe, Turkmen SSR **4070 ± 50**
2120 B.C.

Charcoal from Altyn-Tepe settlement site, Tedzhen Raion (37° 23′ N Lat, 60° 30′ E Long). Inferred archaeologic age: beginning of 2nd millennium B.C. Subm. by V. M. Masson, Inst. of Archaeol., Acad. of Sci., USSR. *Comments* (V.M.M.): sample from layer underlying Namazga V complex, dated to beginning of 2nd millennium B.C. (Masson, 1967). (D.B.S.): cf. also Masson, 1966, p. 152, 157; Altyn-Tepe is fortified Bronze Age settlement correlated with Namazga V.

LE-665. Namazga-Tepe, Turkmen SSR **2980 ± 60**
1030 B.C.

Charcoal from Namazga-Tepe settlement site, Kaakhka Raion (37° 20′ N Lat, 59° 39′ E Long). Hearth 3. Depth not given (E.M.S.). Inferred archaeologic age: 3rd to 2nd millennium B.C. Subm. by V. M. Masson. *Comment* (D.B.S.): stratigraphic position unclear in series from Neolithic through Bronze (cf. Masson, 1966, p. 151-152, and map, p. 153).

LE-639. Altyn-Akar, Turkmen SSR **2250 ± 70**
300 B.C.

Wood from Kurgan 1, Altyn-Akar cemetery, NE extremity of Bol'shoy Balkan range, Krasnovodsk Raion (39° 40′ N Lat, 55° 20′ E Long). Depth not given (E.M.S.). Inferred age: 4th century B.C. to 5th century A.D. Subm. by A. M. Mandel'shtam, Acad. of Sci., Tadzhik SSR.

LE-716. Meshrepi-Takhra, Turkmen SSR **1660 ± 50**
A.D. 290

Wood from Kurgan D, Meshrepi-Takhra cemetery, Kyzyl Arvat Raion, Ashkhabad Oblast (39° 00′ N Lat, 56° 18′ E Long). Depth not given (E.M.S.). Inferred age: 4th century B.C. to 5th century A.D. Subm. by A. M. Mandel'shtam.

Ak-Tan'ga shelter series, Tadzhik SSR

Ak-Tan'ga shelter is in Turkestan range (39° 33′ N Lat, 68° 48′ E Long). Subm. by V. A. Ranov, Acad. of Sci., Tadzhik SSR. Ref: Litvinskiy and Ranov, 1964. Site belongs to Hissar [Russian: *Gissar*] culture. (Cf. also Masson, 1966, p. 145-148 [E.M.S.].)

LE-534. Hissar 6 **8785 ± 130**
6835 B.C.

Charcoal from Hissar 6 layer, Quad. B-17, depth, 9 m. Inferred archaeologic age: Mesolithic or Early Neolithic.

LE-474. Hissar 4 **5950 ± 380**
4000 B.C.

Charcoal from Hissar 4 layer. Depth not given (E.M.S.). Inferred archaeologic age: Neolithic.

LE-429. Hissar 3 **4170 ± 110**
2220 B.C.

Charcoal from Hissar 3 layer, Excavation 2. Depth not given (E.M.S.). Inferred archaeologic age: Eneolithic or Bronze.

LE-432. Hissar 2 **3220 ± 140**
1270 B.C.

Charcoal from Hissar 2 layer, Quad. B-18. Depth not given (E.M.S.). Inferred archaeologic age: Bronze (cf. also LE-614, this list [E.M.S]). *Comment* (D.B.S.): Hissar culture combines river-pebble chopper, retouched flake, and polished stone technologies; pottery; and perhaps domesticated animals.

LE-690. Tutkaul, Tadzhik SSR **7100 ± 140**
5150 B.C.

Charcoal from hearth, Tutkaul settlement site, Nurek Raion (38° 20′ N Lat, 69° 13′ E Long). [Excavation is in inundation area of Nurek Hydroelectric Sta.; cf. Litvinskiy, 1967, p. 313 (E.M.S.).] 1st cultural horizon, depth, 4.46 m. Inferred archaeologic age: 6th to 5th millennium B.C.; Hissar culture with pebble industry, belonging to C. Asiatic mountain Neolithic. Subm. by V. A. Ranov. *Comment* (D.B.S.): Litvinskiy (1967) ascribes 2 upper layers to Hissar culture; cf. also Masson, 1966, p. 145-148, and Ak-Tan'ga series, LE-534, 474, 429, and 432, this list.

LE-715. Tigrovaya Balka, Tadzhik SSR **3350 ± 60**
1400 B.C.

Charcoal from Tigrovaya Balka cemetery, lower reaches of Vakhsh R., Shaartuz Raion [Shaartuz: 37° 16′ N Lat, 68° 08′ E Long]. Terrace 5, Kurgan 7, depth, 0.7 m. Inferred age: Late Bronze; "Vakhsh culture." Subm. by B. A. Litvinskiy, Acad. of Sci., Tadzhik SSR. (Cf. also Masson, 1966, p. 253 [E.M.S.].)

LE-445. Chust site, Uzbek SSR **2240 ± 75**
290 B.C.

Charcoal from Chust settlement site, Fergana valley, Chust Raion (41° 00′ N Lat, 71° 13′ E Long). Depth, 1.0 to 1.25 m. Inferred age: Late Bronze. Subm. by V. I. Shrishevskiy.

LE-712. Chun-Tepe, Uzbek SSR **970 ± 50**
A.D. 980

Charcoal from Chun-Tepe settlement site, SE Fergana valley, Kuva Raion (40° 20′ N Lat, 71° 44′ E Long). From cultural layer; depth, 4.5 m. Inferred age: 7th to 8th centuries A.D.; Early Medieval. Subm. by N. G. Gorbunova, Hermitage Mus., Leningrad.

LE-543. Torken, Kirgiz SSR **1440 ± 60**
A.D. 510

Wood (part of coffin) from Torken cemetery, Mound 43, Dzhalalabad Oblast (41° 50′ N Lat, 73° 10′ E Long). Archaeologic age: 2nd to 5th century A.D. Subm. by I. Kozhomberdiyev, Inst. of History, Kirgiz SSR.

2430 ± 200
LE-309. Tagisken, Kazakh SSR **480 B.C.**

Charcoal from base of hearth, Kurgan 6, Kyzyl Orda Oblast [delta of Syr Darya, ca. 45° 30′ N Lat, 62° 30′ E Long]. Archaeologic age: Scythian. Subm. by S. P. Tolstov, Inst. of Archaeol., Acad. of Sci., USSR. [Excavation of Khorezm (Khwarazym) Expedition; depth not given (E.M.S.).] *Comment* (D.B.S.): Gryaznov believes Kurgan (Mausoleum) 6 at Tagisken earlier than Scythic, *i.e.*, Karasuk; cf. Gryaznov, 1966, p. 233-238.

3360 ± 130
LE-535. Chilikta, Kazakh SSR **1410 B.C.**

Wooden support from Kurgan 35, central cemetery, Chilikta valley [Chilik: 43° 33′ N Lat, 78° 17′ E Long]. Archaeologic age: Saka. Subm. by S. S. Chernikov, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (D.B.S.): an extreme discrepancy between reported and estimated dates. The Saka (Sacae), or E Scyths, are known historically for Achaemenid period to invasion of Ephthalites, roughly 400 B.C. to A.D. 400, and attributed by Soviet archaeologists conventionally to 5th century B.C. Cf. also LE[RUL]-247, Radiocarbon, 1965, v. 7, p. 228.

Bes-Shatyr cemetery series, Kazakh SSR

Wood from kurgans in Bes-Shatyr cemetery, right bank of Ili R., Ili Raion [Ili: 43° 53′ N Lat, 77° 10′ E Long]. Archaeologic date: 5th century B.C. Depths not given (E.M.S.). Subm. by K. A. Akishev.

2550 ± 65
LE-603. Bes-Shatyr **600 B.C.**

Wood from Kurgan 1.

1850 ± 70
LE-590. Bes-Shatyr **A.D. 100**

Wood from Kurgan 3.

2760 ± 60
LE-632. Predgornoye cemetery, Kazakh SSR **810 B.C.**

Wood from burial, Kurgan 2, at Predgornoye village, Ust'-Kamenogorsk Raion (50° 16′ N Lat, 82° 17′ E Long). Archaeologic age: Andronovo. Subm. by S. S. Chernikov.

3500 ± 65
LE-614. Tasty-Butak, Kazakh SSR **1550 B.C.**

Wood (wattle) from Pit 14, Tasty-Butak site, Aktyubinsk Oblast (50° 16′ N Lat, 58° 00′ E Long). Inferred age: Andronovo. Depth not given (E.M.S.). Subm. by V. S. Sorokin, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (V.S.S.): wattle from Pit 2 dated at 3190 ± 80 yr (LE[RUL]-213, Radiocarbon, 1965, v. 7, p. 227); (D.B.S.): Tasty-Butak is referred by Masson (1966, p. 216) to later, or Ala-Kul', stage of Andronovo culture with which Hissar 2 horizon of Ak-Tan'ga (LE-432, this list) has also been correlated (*op. cit.*, p. 145-148).

Urals and Western Siberia

3080 ± 50
LE-662. Tursumbay cemetery, Orenburg Oblast 1130 B.C.

Wood from Tursumbay cemetery [Stone] Circle 7, Burial 1, Dombarovskiy Raion (50° 32′ N Lat, 59° 32′ E Long). Depth, 0.9 m. Inferred age: Andronovo. Subm. by Ye. Ye. Kuz'mina. *Comment* (D.B.S.): cemetery and assoc. settlement are characteristic Late Andronovo; cf. Kuz'mina, 1967.

3590 ± 90
LE-633. Lipovaya Kur'ya, Chelyabinsk Oblast 1640 B.C.

Charcoal from semi-subterranean dwelling, Lipovaya Kur'ya campsite, Miass Raion (55° 00′ N Lat, 60° 06′ E Long). Depth not given (E.M.S.). Archaeologic age: Andronovo. Subm. by L. P. Khlobystin.

3010 ± 70
LE-548. Churakayevo, Bashkir ASSR 1060 B.C.

Wood from cemetery at Churakayevo village [Churayevo: 55° 25′ N Lat, 55° 30′ E Long]. Inferred archaeologic age: Abashevo. Subm. by K. V. Sal'nikov, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (D.B.S.): Abashevo synchronous with Andronovo and Timber Grave cultures in S Urals (Sal'nikov, 1954, p. 94).

2430 ± 110
LE-467. Bashadar, Gorno-Altay Autonomous Oblast 480 B.C.

Trunk of larch (*Larix sibirica*) from cover of kurgan, Bashadar, Gorno-Altay Autonomous Oblast (50° 43′ N Lat, 85° 46′ E Long). Archaeologic age: Scythian. Subm. by S. I. Rudenko, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (D.B.S.): princely burial synchronous with Pazyryk (Tret'yakov and Mongayt, 1956, p. 391); cf. also dates for Pazyryk: LE[RUL]-120 = 2350 ± 140 yr (Radiocarbon, 1965, v. 7, p. 223), and LE[RUL]-151 = 2440 ± 50 yr (*ibid.*).

3180 ± 70
LE-660. Odinovo, Tyumen' Oblast 1230 B.C.

Charcoal from Odinovo campsite, left bank of Ishim R., Vikulovo Raion (56° 43′ N Lat, 70° 30′ E Long). Inferred age: Early Bronze. Depth not given (E.M.S.). Subm. by L. Ya. Krizhevskaya, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (D.B.S.): may be one of earliest Bronze age sites in SW Siberia (Shimkin, 1960, p. 648-661).

Yagunya cemetery series, Kemerovo Oblast

Samples from Yagunya cemetery, on Yagunya R. (55° 17′ N Lat, 86° 00′ E Long). Depths not given (E.M.S.). Subm. by I. A. Martynov.

2280 ± 120
LE-399. Yagunya 6 330 B.C.

Decomposed wood from Kurgan 6, Burial 3. Archaeologic age: 6th to 4th century B.C.

LE-505. Yagunya 7 **1970 ± 60**
A.D. 20

Charcoal from Kurgan 7, Burial 2. Archaeologic age: 2nd stage, Tagar epoch.

LE-553. Yagunya 5 **1520 ± 100**
A.D. 430

Charcoal from Kurgan 5, Burial 1. Archaeologic age: Tagar epoch. *Comment* (D.B.S.): Tagar epoch of Altay is typologically synchronous with Scythic, 6th to 4th century B.C.; cf. Kiselev, 1951, p. 185-303.

Central Siberia: Minusinsk Basin

Kokorevo series, Krasnoyarsk Krai

This group of Paleolithic sites is located near Kokorevo village, on left bank of Yenisey R., ca. 230 km S of Krasnoyarsk, Novosyolovo Raion (55° 05′ N Lat, 91° 10′ E Long).

LE-526. Kokorevo I **12,940 ± 270**
10,990 B.C.

Charcoal from 2nd cultural layer, depth, 2.6 m. Archaeologic age: Upper Paleolithic; geologic age: 2nd half Sartanskoye [Würm III] glaciation. Subm. by Z. A. Abramova, Inst. of Archaeol., Acad. of Sci., USSR.

LE-628. Kokorevo I **14,450 ± 150**
12,500 B.C.

Charcoal from 3rd cultural layer, Location 2, depth, 2.8 to 2.9 m. Upper Paleolithic; 2nd half Sartanskoye glaciation. Subm. by Z. A. Abramova. Charcoal from same layer, depth, 3.8 m, dated at 13,300 ± 50 yr (GIN-91, Radiocarbon, 1968, v. 10, p. 435); cf. also Grichuk *et al.*, 1966, p. 273.

LE-629. Kokorevo III (Kamennyy Log) **12,690 ± 140**
10,740 B.C.

Charcoal from Kokorevo III (Kamennyy Log [Stony ravine]). Late Paleolithic; 2nd half Sartanskoye glaciation. Subm. by Z. A. Abramova.

LE-540. Kokorevo IV (Kipernyy Log) **15,460 ± 320**
13,510 B.C.

Charcoal from Excavation 4, depth, 5.2 m. Late Paleolithic; middle of Sartanskoye glaciation. Subm. by S. N. Astakhov, Inst. of Archaeol., Acad. of Sci., USSR.

LE-469. Kokorevo IV **14,320 ± 330**
12,370 B.C.

Charcoal from Excavation 1, Cultural Layers 3 through 5 in loess deposit at depth 4.0 to 4.5 m. Subm. by S. N. Astakhov. *Comment* (Z.A.A. and S.N.A.): Kokorevo I, II [GIN-90, Radiocarbon, 1968, v. 10, p. 435], and III belong to same group. Kokorevo I and Kokorevo IV, Excavation 1, have a more evolved aspect. Kokorevo III is youngest, dated geologically to terminal phases of Sartanskoye (Abramova, 1966; Astakhov, 1966). Note correction for location of GIN-90 and 91 (E.M.S.).

LE-455. Malyy Kopyony II, Krasnoyarsk Krai **4440 ± 150**
2490 B.C.

Charcoal from burial, Kurgan 2, Malyy Kopyony II (54° 20′ N Lat, 91° 30′ E Long). Inferred age: Afanas'yevo [Eneolithic]. Depth not given (E.M.S.). Subm. by L. P. Zyablin. (Cf. also Kiselev, 1951, p. 42, for description of burials and evidence of pillage [E.M.S.]).

LE-694. Sargov Ulus, Khakass ASSR **4270 ± 60**
2320 B.C.

Wood from Grave 3, Sargov Ulus cemetery, left bank Yenisey R., near Sovetskaya Khakassiya settlement (ca. 54° 00′ N Lat, 91° 30′ E Long). Inferred age: Afanas'yevo [Eneolithic]. Subm. by M. P. Gryaznov, Inst. of Archaeol., Acad. of Sci., USSR.

LE-532. Chernovaya III cemetery, Krasnoyarsk Krai **3700 ± 80**
1750 B.C.

Wood from Chernovaya III cemetery, Grave 3, Kurgan 4, on Chernovaya R., Bograd Raion [unlocated; Bograd: 54° 13′ N Lat, 90° 51′ E Long]. Subm. by G. A. Maksimenkov. Inferred age: Afanas'yevo.

Karasuk III cemetery series, Krasnoyarsk Krai

Samples of wood from Karasuk III cemetery, Bograd Raion (ca. 55° 00′ N Lat, 91° 00′ E Long). Depths not given (E.M.S.). Subm. by M. P. Gryaznov. Inferred age: Afanas'yevo.

LE-519. Karasuk III cemetery **3470 ± 200**
1520 B.C.

Wood from Enclosure 7.

LE-563. Karasuk III cemetery **2235 ± 100**
285 B.C.

Wood from Enclosure 3, Grave 1. *Comment* (D.B.S.): for a general discussion of Afanas'yevo culture (antecedent to Andronovo) see Tret'yakov and Mongayt, 1956, p. 117-119.

LE-587. Uzhur, Krasnoyarsk Krai **4600 ± 250**
2650 B.C.

Decomposed wood from grave cover, Kurgan 14, Uzhur (55° 17′ N Lat, 89° 53′ E Long). Archaeologic age: Andronovo. Subm. by N. L. Chlenova.

LE-602. Pristan' I cemetery, Krasnoyarsk Krai **3750 ± 60**
1800 B.C.

Wood from Pristan' I cemetery, Enclosure 6, Grave 2 (ca. 55° 00′ N Lat, 91° 15′ E Long). Archaeologic age: Andronovo. Subm. by M. P. Gryaznov.

Lanin Log series, Krasnoyarsk Krai

Wood from Lanin Log [ravine] cemetery, left bank Syda R. (54° 22′ N Lat, 91° 47′ E Long). Depths not given (E.M.S.). Archaeologic age: Andronovo. Subm. by M. P. Gryaznov.

LE-630. Lanin Log, Kurgan 1 **3390 ± 70** **1440 B.C.**

Wood from Kurgan 1, Grave 1.

LE-617. Lanin Log, Kurgan 1 **3660 ± 65** **1710 B.C.**

Wood from Kurgan 1, Grave 3.

LE-619. Lanin Log, Kurgan 2 **3970 ± 70** **2020 B.C.**

Wood from Kurgan 2, Grave 1.

Yarki II cemetery series, Krasnoyarsk Krai

Wood from Yarki II cemetery, Bograd Raion [Bograd: 54° 13′ N Lat, 90° 51′ E Long]. Depths not given (E.M.S.). Archaeologic age: Andronovo. Subm. by M. P. Gryaznov.

LE-518. Yarki II cemetery, Grave 1 **2370 ± 95** **420 B.C.**

Wood from Grave 1.

LE-529. Yarki II cemetery, Grave 2 **2970 ± 70** **1020 B.C.**

Wood from Grave 2.

Kamenka II cemetery series, Krasnoyarsk Krai

Wood from Kamenka II cemetery [unlocated: probably near Yarki II, LE-518, 529]. Depths not given (E.M.S.). Archaeologic age: Andronovo. Subm. by M. P. Gryaznov.

LE-604. Kamenka II cemetery, Grave 1 **3910 ± 75** **1960 B.C.**

Wood from Enclosure 24, Grave 1.

LE-595. Kamenka II cemetery, Grave 2 **2540 ± 65** **590 B.C.**

Wood from Enclosure 24, Grave 2. *Comments* (M.G.P.): sharp differences in ages of samples from neighboring graves within same cemeteries (LE-518 and 529; LE-604, and 595) could not be explained on basis of laboratory error. Hence, this laboratory intends to repeat analysis with newly-collected samples. (D.B.S.): note that many graves in Minusinsk Basin have been pillaged; there is also evidence that the same cemeteries were used for burials over long periods of time. For general discussions of Andronovo culture, see Tret'yakov and Mongayt, 1956, p. 169-173 and Kiselev, 1951, p. 67-105.

Karasuk IV cemetery series, Krasnoyarsk Krai

Samples from Karasuk IV cemetery, Bograd Raion (ca. 55° 00′ N Lat, 91° 00′ E Long). Depths not given (E.M.S.). Inferred age: Kamennyy Log [late] stage, Karasuk culture, 10th to 8th century B.C. Subm. by M. P. Gryaznov.

LE-695. Karasuk IV cemetery **2930 ± 60**
980 B.C.

Charcoal from Enclosure 10, Grave 2.

LE-577. Karasuk IV cemetery **2710 ± 75**
760 B.C.

Wood from Enclosure 19, Grave 2. *Comment* (D.B.S.): close resemblances, especially in *tao* knives, link Karasuk culture to Middle and Late Shang (1300 to 1100 B.C.), according to Chinese historical chronology. Dates given are not inconsistent. Cf. Kiselev, 1951, p. 106-183 and Chêng, 1960, v. 2, p. 19, 32-34, 275, 293-295, 297.

LE-696. Ulug-Kyuzyur I, Krasnoyarsk Krai **2450 ± 50**
500 B.C.

Wood from Ulug-Kyuzyur I cemetery, Kurgan 3, Grave 1, left bank of Yenisey R., near Sovetskaya Khakassiya settlement (54° 20′ N Lat, 91° 27′ E Long). Depth not given (E.M.S.). Inferred age: Saragash stage, Tagar culture. Subm. by M. I. Pshenitsyna, Inst. of Archaeol., Acad. of Sci., USSR. *Comment* (D.B.S): sample presumably from larch grave cover of Grave 1, containing remains of 2 men and 3 women; cf. Pshenitsyna, 1967, p. 143.

Central Siberia: Lower Yenisey region

LE-600. Dudinskaya sopka, Krasnoyarsk Krai **26,900 ± 1300**
24,950 B.C.

Wood from stratified deposits, right bank of Yenisey R., at Dudinskaya sopka [*peak*] [Dudinka: 69° 25′ N Lat, 86° 15′ E Long]. Depth not given (E.M.S.). Inferred age: 25 to 50 thousand yr. Subm. by G. F. Odinets, Permafrost Inst.

LE-424. Zyryanka River, Krasnoyarsk Krai **5150 ± 100**
3200 B.C.

Wood from lower part of buried peat layer, mouth of Zyryanka R., right bank of Yenisey R. [not located; probably near Zyryanka: 72° 20′ N Lat, 81° 30′ E Long]. Peat layer 8 to 10 m thick Inferred age: 40 thousand yr. Subm. by G. F. Odinets.

LE-612. Pyasina River, Krasnoyarsk Krai **25,100 ± 550**
23,150 B.C.

Mammoth tissue from Pyasina R., Taymyr Peninsula, Taymyr Nat. Okrug [Pyasina: 73° 50′ N Lat, 87° 10′ E Long]. Discovered, 1964. Inferred age: ca. 30 thousand yr. Subm. by Inst. Zoology, Acad. Sci., USSR.

Central Siberia: Baikal region

LE-513. Serovo, Irkutsk Oblast **3990 ± 80**
2040 B.C.

Charcoal from Grave 2, Serovo (54° 20′ N Lat, 103° 10′ E Long). Inferred age: 3rd millennium B.C., Serovo stage, Transbaikal Neolithic (Okladnikov, 1950). Subm. by A. P. Okladnikov, Inst. of Archaeol., Acad. of Sci., USSR. (Cf. also description of Serovo culture in Michael [1958,

p. 45-61]; Kitoi, succeeding phase, cross-relates with Afanas'yevo in Minusinsk Basin, LE-455, 694, 532, 519, 563, this list [D.B.S.].)

5250 ± 170
3300 B.C.

LE-550. Irkut River, Buryat ASSR

Charcoal from 4th flood-plain terrace, Irkut R. [flood plain between ca. 50° 30′ and 51° 00′ N Lat, 102° 00′ and 103° 30′ E Long]. Inferred age: 5 to 6 thousand yr. Depth not given (E.M.S.). Subm. by Ye. V. Maksimov, Hertsen Pedagogical Inst., Leningrad.

Yakut ASSR

Bel'kachi series, Yakut ASSR

Bel'kachi I is multi-stratum campsite, left bank of Aldan R., 1.3 km S of mouth of Ulakhan-El'ge R. (59° 00′ N Lat, 131° 57′ E Long). Subm. by Yu. A. Mochanov, Yakut Affiliate, Siberian Br., Acad. of Sci., USSR. Ref: Okladnikov, 1964, p. 32-79, especially p. 69-72 (D.B.S.).

6720 ± 50
4770 B.C.

LE-650. Bel'kachi I, Stratum 10

Charcoal from Cultural Stratum 10; depth, 3.0 m. Inferred age: "Holocene Upper Paleolithic."

6750 ± 70
4800 B.C.

LE-698. Bel'kachi I, Stratum 10a

Charcoal from Cultural stratum 10a; depth, 3.1 m; Quad. AB-19 and -20. Inferred age: "Holocene Upper Paleolithic."

6250 ± 60
4300 B.C.

LE-697. Bel'kachi I, Stratum 9

Charcoal from Cultural Stratum 9; depth, 2.4 m; Quad. D-5. Inferred age: "Holocene Upper Paleolithic."

5900 ± 70
3950 B.C.

LE-678. Bel'kachi I, Stratum 8

Charcoal from Cultural Stratum 8; depth, 1.8 m; Quad. G-6. Inferred age: "Holocene Upper Paleolithic."

5970 ± 70
4020 B.C.

LE-676. Bel'kachi I, Stratum 7

Charcoal from Cultural Stratum 7; depth, 1.2 m; Quad. V-2. Inferred age: Early Neolithic.

5270 ± 70
3320 B.C.

LE-656. Bel'kachi I, Stratum 6

Charcoal from Cultural Stratum 6; depth, 1.1 m; Quad. B-32. Inferred age: Early Neolithic.

2930 ± 50
980 B.C.

LE-666. Bel'kachi I, Stratum 2

Charcoal from Cultural Stratum 2; depth, 0.4 m; Quad. B-33. Inferred age: Late Neolithic.

Magadan Oblast and Kamchatka

LE-674. Vakarevskaya campsite, Magadan Oblast **500 ± 50** **A.D. 1450**

Charcoal from cultural layer, Vakarevskaya campsite, Mayn R., Anadyr R. basin (64° 47′ N Lat, 171° 40′ E Long). Depth, 1.0 m. Inferred age: Neolithic survival. Subm. by N. N. Dikov, Siberian Div., Acad. of Sci., USSR.

LE-677. Ekiatan, Magadan Oblast **Modern**

Charcoal from pastoral nomadic burial, Ekiatan R., right tributary of Amguyema R. (66° 40′ N Lat, 180° Long). Depth, 10 cm. Subm. by N. N. Dikov.

LE-623. Shiveluch Volcano, Kamchatka **5620 ± 100** **3670 B.C.**

Charcoal from Shiveluch volcano [56° 39′ N Lat, 161° 18′ E Long]. Subm. by G. S. Shteynberg, Inst. of Vulcanology, Siberian Div., Acad. of Sci., USSR.

LE-625. Avacha Volcano, Kamchatka **6000 ± 100** **4050 B.C.**

Charcoal from Avacha volcano (53° 15′ N Lat, 158° 49′ E Long). Wood charred during eruption. Inferred age: Holocene. Subm. by V. S. Aver'yanov, Inst. of Vulcanology, Siberian Div., Acad. of Sci., USSR. (Cf. also GIN-122 = 5480 ± 70 yr, Radiocarbon, 1968, v. 10, p. 436; GIN-119 = 5555 ± 45 yr, *ibid.*, p. 442; and GIN-120 = 3300 ± 35 yr, *ibid.*, p. 442 [E.M.S.]).

LE-670. Klyuchi campsite, Kamchatka **490 ± 50** **A.D. 1460**

Charcoal from Klyuchi campsite, left bank Klyuchi R., tributary of Kamchatka R. [Klyuchi: 56° 18′ N Lat, 160° 51′ E Long]. Depth, 1.0 m. Inferred age: Neolithic. Subm. by N. N. Dikov. Note corrected location for Ushki I site, GIN-184, 186 (Radiocarbon, 1968, v. 10, p. 442) is 56° 20′ N Lat, 161° 00′ E Long (E.M.S.).

LE-473. Nikolka, Kamchatka **730 ± 110** **A.D. 1220**

Charcoal from hearth of semi-subterranean Dwelling 5, Nikolka fortified settlement [*gorodishche*], [unlocated; probably near Mt. Nikolka: ca. 55° 30′ N Lat, 160° 00′ E Long]. Depth not given (E.M.S.). Inferred age: 2nd millennium A.D. Subm. by N. N. Dikov.

Khabarovsk Krai and Maritime Region

LE-675. Polyakovo, Amur Oblast **1290 ± 50** **A.D. 660**

Charcoal from site at Polyakovo village, Zeya R. valley, Svobodny Raion [Svobodny: 51° 25′ N Lat, 128° 10′ E Long]. Depth, 1.5 m. Inferred age: Neolithic. Subm. by A. P. Okladnikov. *Comment* (D.B.S.): discordance with inferred age.

LE-652. Pol'tso, Khabarovsk Krai **2930 ± 80** **980 B.C.**

Charcoal from Pol'tso settlement site, near Kukelevo village, Leninsk Raion, Jewish Autonomous Oblast (47° 35′ N Lat, 132° 30′ E Long). Depth, 1.0 to 1.5 m. Inferred age: 6th to 5th century B.C. Subm. by A. P. Okladnikov. *Comment* (D.B.S.): Derevyanko and Derevyanko (1967, p. 175) describe assoc. well-developed iron-working complex: awls, needles, knives, daggers, and armor. Date is unexpectedly early and precedes major development of iron forging in China in Chan-Kuo phase of Chou period, 480 to 222 B.C. (Chêng, v. 3, p. xxiv-xxxii, 43-45).

LE-663. Malyshevo, Khabarovsk Krai **3590 ± 60** **1640 B.C.**

Charcoal from Malyshevo-on-Amur site (48° 15′ N Lat, 134° 40′ E Long). Depth, 2.1 m. Inferred age: 3rd to 2nd millennium B.C., lower Amur R. early Neolithic (Okladnikov, 1967). Subm. by A. P. Okladnikov.

LE-657. Siniye Skaly, Maritime Region **1460 ± 50** **A.D. 490**

Charcoal from cultural layer of dwelling, Siniye Skaly settlement site, Ol'ginsk Raion [Ol'ga: 43° 45′ N Lat, 135° 20′ E Long]. Depth not given (E.M.S.). Inferred age: 1st millennium A.D. Subm. by Zh. V. Andreyeva, Div. of History, Far Eastern Affiliate, Siberian Br., Acad. of Sci., USSR.

Kurile Islands, Sakhalin Oblast

LE-609. Zavaritskiy Volcano, Simushir Island **Modern**

Charcoal from Zavaritskiy volcano, Simushir I. [46° 58′ N Lat, 152° 02′ E Long]. Subm. by K. I. Shmulevich, Inst. Vulcanology, Siberian Div., Acad. of Sci., USSR.

LE-566. Tao-Rusyr Volcano, Onnekotan Island **7040 ± 100** **5090 B.C.**

Charcoal from slopes of caldera, Tao-Rusyr volcano, Onnekotan I., N Kurile I. [49° 25′ N Lat, 154° 45′ E Long]. Inferred age: 4 to 10 thousand yr. Subm. by K. I. Shmulevich.

Soviet Arctic

LE-706. Matusevich Fjord, Novaya Zemlya **7210 ± 70** **5260 B.C.**

Driftwood from moraine of glacier discharging into Matusevich Fjord, Oktyabr'skaya Revolyutsiya I. [80° 00′ N Lat, 98° 15′ E Long]. Elev: +50 m. Probably redeposited from marine terrace. Inferred age: Upper Pleistocene. Subm. by L. S. Govorukha, Inst. of Arctic and Antarctic.

Antarctica

LE-658. Westfall oasis, Antarctica **1480 ± 75** **A.D. 470**

Mummified remains of seals from Westfall oasis [Vestfold: near 80° 00′ E Long, 68° 00′ S Lat]. Seals found on surface, partly covered with sand. Subm. by Inst. of Arctic and Antarctic. (Cf. also Mo-255, Radiocarbon, 1966, v. 8, p. 32 [E.M.S.].)

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Geological Institute II	Cherdyntsev *et al.*, 1968
Geological Institute III	Cherdyntsev *et al.*, 1968
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Leningrad I	Artyom'yev *et al.*, 1961
Leningrad II	Ivanova, Kind, and Cherdyntsev, 1963
Leningrad III	Butomo, 1963
Tartu I	Liiva, Ilves, and Punning, 1966
Tartu II	Punning, Ilves, and Liiva, 1968
Tbilisi I	Burchuladze, 1968
UCLA VIII	Berger and Libby, 1968
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LOUVAIN NATURAL RADIOCARBON MEASUREMENTS VIII

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The measurements reported in this list were made in the Louvain C^{14} Dating Laboratory in 1968 with the 0.6L CH_4 proportional counter. The counter generally operates at 3 atm pressure. Samples too poor to provide 2 L methane are measured at 1000 mm Hg pressure. Ages are calculated on the basis of a C^{14} half life of 5570 yr and are quoted with 1σ counting error. The description of each sample is based on information provided by the submitters.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

Anlier III series

Peat with alder rootlets (*Alnus*), id. by J. Heim from Bois le Prêtre (49° 45′ 25″ N Lat, 5° 36′ 55″ E Long) in forest of Anlier at Habay la Neuve, Prov. of Luxembourg, Belgium, alt 430 m. Bottom of Sub-Atlantic peat bog. Coll. 1963, subm. and pollen anal. by J. Heim, Univ. of Louvain, Lab. of Palynology.

2060 ± 75
Lv-169. Anlier III/1 **110 B.C.**

Peat from 70 to 80 cm. Pollen analysis shows beginning of Sub-Atlantic period, with beginning of continuous curve of *Fagus*, end of continuous curve of *Tilia* and sporadic presence of corn pollen. Level assumed first *Fagus* maximum F I masked by predominance of *Alnus*. In this region, date of this maximum is presumed A.D. 100 (Mullenders *et al.*, 1967).

1600 ± 90
Lv-170. Anlier III/2 **A.D. 350**

Peat from 80 to 90 cm. Age too young according to Lv-169. Sample probably contaminated by alder rootlets.

Anlier IV series

Peat with alder rootlets (*Alnus*), id. by J. Heim from Gros Chêne (49° 45′ 55″ N Lat, 5° 39′ 20″ E Long) at Habay la Neuve, Prov. of Luxemburg, Belgium, alt 460 m. Bottom of Sub-Atlantic peat bog in moist depression of forest of Anlier. Coll. 1963, subm. and pollen anal. by J. Heim.

930 ± 60
Lv-171. Anlier IV/1 **A.D. 1020**

Peat from 50 to 60 cm. Sample probably contemporaneous of 3rd *Fagus* maximum F III age estimated A.D. 1200 (Mullenders *et al.*, 1967), although maximum does not appear in pollen diagram because of predominance of *Salix* and *Alnus.*

1490 ± 105
Lv-172. Anlier IV/2 **A.D. 460**

Peat from 60 to 70 cm. According to pollen curves of *Tilia, Carpinus,* and corn, level younger than Lv-169 and perhaps corresponding to 2nd *Fagus* maximum F II age estimated A.D. 600 (Mullenders *et al.,* 1967).

II. ARCHAEOLOGIC SAMPLES

2410 ± 120
Lv-374. Cornaux, Switzerland **460 B.C.**

Wood (*Quercus*), id. by A. Munaut from Cornaux (47° 02′ N Lat, 7° 04′ E Long), Canton of Neuchâtel, Switzerland. Remains of wooden bridge found in former bed of Thiele R. at 2 m below Roman horizon. Coll. 1965 and subm. by J. P. Jecquier, Cantonal Archaeol. Mus. of Neuchâtel. Among remains of bridge, 4 skeletons of warrior and horse bones, a Late La Tene sword, and 3 heads of pike. Bridge assumed Celtic (Schwab, 1966).

8350 ± 160
Lv-393. Elkab, Egypt **6400 B.C.**

Charcoal from Elkab (25° 08′ N Lat, 32° 47′ E Long), Prov. of Edfu, Egypt. Sample imbedded at 1 m depth in clayey silt filling former bed probably of Nile R. and assoc. with lamellar microlithic epipaleolithic industry. Coll. 1968 and subm. by P. Vermeersch, Comité des Fouilles Belges en Egypte. *Comment* (P.V.): this industry is still unknown in Egypt. It completes hiatus between Upper Sebilian (9000 B.C.) and Fayum (4600 B.C.) in chronology of prehistoric industries N of Assawan (Vermeersch, 1969). Sample too small to suffer NaOH leach.

11,280 ± 220
Lv-383. Grotte Blanchard, France **9330 B.C.**

Burned bones from cave hearth in Grotte Blanchard in Magdalenian site of La Garenne at Saint Marcel (46° 34′ N Lat, 1° 30′ E Long), Dept. of Indre, France. Sample from upper part of Level 2 (Allain, 1953; 1961) near bottom of cave. Coll. 1958 by M. R. Sauter; subm. by A. Leroi-Gourhan, Mus. de l'Homme, Paris. Cave is separated from upper cave "Grand Abri" and closed by rock fall and clay layer containing Upper Magdalenian industry from Level 4 and 7 bis. Hearth from this Level 4, in "Grand Abri," is dated by Libby as follows: C-577, burned bone, 9159 B.C. ± 480; C-578, ashy material, 13,897 B.C. ± 1200; C-579, burned bone from same horizon but outside hearth, 11,036 B.C. ± 560 (Libby, 1955). Level 6 is dated as L-399 D, burned bone from hearth, 7550 B.C. ± 500 (Radiocarbon, 1959, v. 1, p. 23), and as Gsy-34, charcoal cinders and charred bones, 9280 B.C. ± 500 (Radiocarbon, 1966, v. 8, p. 134). Present C^{14} date is a little more recent than assumed by Allain. *Comment*: sample was dissolved in HCl and solid residue used for dating.

Lv-358. El Khiam, Jordan **2990 ± 250**
1040 B.C.

Bones from El Khiam (31° 37′ 50″ N Lat, 35° 16′ 00″ E Long), Jordan. Sample from Area II B, Level 1 b at 0.40 m depth, Prepottery Neolithic horizon, Tahounian facies (Echegaray, 1963; 1964). Coll. 1962 and subm. by J. G. Echegaray, Prehist. Mus. of Santander, Spain. *Comment* (J.G.E.): sample dissolved in HCl and solid residue used for dating; measured at 1000 mm Hg pressure. In other sites, this horizon is dated ca. 6000 B.C.

Ordona series, Italy

Samples from Ordona (41° 18′ N Lat, 15° 37′ E Long), Prov. of Foggia, Italy. Series dates occupation of ancient Roman colony at Herdoniae (Mertens, 1967). Other dates pub. in Radiocarbon, 1965, v. 7 and 1967, v. 9. Subm. by J. Mertens, Univ. of Louvain, Archaeol. Inst.

Lv-282. Ordona 65.OR.76 **2160 ± 260**
210 B.C.

Charcoal from pit dug in rock and filled up before building of Temple B. Coll. 1965 by J. Mertens. Temple is archaeologically dated 2nd century B.C. C^{14} date agrees with archaeology. *Comment*: sample measured at 1000 mm Hg pressure.

Lv-294. Ordona 65.OR.92 **1820 ± 80**
A.D. 130

Charcoal found at 1.20 m depth with potsherds in filling cryptoporticus of Forum. Coll. 1965 by G. De Boe. Archaeologic estimation is 2nd half of 1st century A.D.

Lv-295. Ordona 66.OR.01 **1900 ± 85**
A.D. 50

Charcoal from incineration grave at 1.10 m depth in zone of Amphitheatre. Coll. 1966 by R. Iker. In grave, coin of emperor Domitian (85 to 96 A.D.)

Alba Fucens series, Italy

Charcoal from Alba Fucens (42° 05′ N Lat, 13° 25′ E Long), Prov. of Aquila, Italy. Coll. 1966 by G. De Boe; subm. by J. Mertens.

Lv-334. Alba Fucens 66.AF.18 **2350 ± 75**
400 B.C.

Burned horizon in shop along principal street of town.

Lv-336. Alba Fucens 66.AF.30 **1700 ± 75**
A.D. 250

Burned horizon from urban villa. Trench 66.IV. Coins found in same horizon are dated from 3rd and 4th centuries A.D.

Lv-337. Alba Fucens 66.AF.36 **2180 ± 100**
230 B.C.

Burned horizon, mixed, in back of room of urban villa. Trench 66.IV, S of Wall B.

Lv-338. Alba Fucens 66.AF.46 **1440 ± 70**
A.D. 510

Burned horizon from room of important house of town. Trench 66.III.

General Comment: archaeologic context for these samples indicates Late Roman epoch and layers seem homogenous. Two late C^{14} dates agree with interpretation but 2 ancient are still unexplained. New investigations are necessary.

Lv-333. Bruges **860 ± 95**
A.D. 1090

Wood from pile used to lay out plan of Roman St. Donatius church at Bruges (51° 13′ N Lat, 3° 13′ E Long), Prov. of West Flanders, Belgium. Sample found at 4 m depth. Coll. 1955 and subm. by J. Mertens. Church is generally dated as beginning of 10th century. Dates agrees with C^{14} date for basement of pre-Roman construction: Lv-43, A.D. 1110 ± 130 (Radiocarbon, 1962, v. 4, p. 97 and 1964, v. 6, p. 160).

Lv-349. Liege **880 ± 240**
A.D. 1070

Wood (*Quercus*) from statue from private collection of M. Van Zuylen, Quai Van Beneden, Liege (50° 40′ N Lat, 5° 42′ E Long), Belgium. Coll. 1967 and subm. by R. Antoine, Univ. of Louvain. Statue is archaeologically estimated from 14th century. C^{14} date confirms expectation. *Comment*: sample measured at 1000 mm Hg pressure.

Lv-317. Hal **2000 ± 85**
50 B.C.

Charcoal from prehistoric hearth at Maasdaal (50° 42′ 16″ N Lat, 4° 15′ 16″ E Long) near Hal, Prov. of Brabant, Belgium. Hearth is overlain by 1.30 m dark sandy clay and yellowish sand. Coll. 1966 and subm. by R. Borremans, Zuidwest-Brabants Heemskundig Mus. Site is situated within short distance of spring on E bank of Senne R. Only artifact found in hearth is potsherd dated as La Tene (without precision). Other potsherds of same epoch were found in neighborhood. C^{14} date confirms estimation.

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[RADIOCARBON, VOL. 12, No. 1, 1970, P. 161-180]

UNIVERSITY OF MICHIGAN RADIOCARBON DATES XIII

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The following is a list of dates obtained since the compilation of List XII. The method is essentially the same as described in that list. Two CO_2-CS_2 Geiger counter systems were used. Equipment and counting techniques have been described elsewhere (Crane, 1961). Dates and estimates of error in this list follow the practice recommended by the International Radiocarbon Dating Conferences of 1962 and 1965, in that (a) dates are computed on the basis of the Libby half-life, 5570 yr, (b) A.D. 1950 is used as the zero of the age scale, and (c) the errors quoted are the standard deviations obtained from the numbers of counts only. In Michigan date lists up to and including VII, we quoted errors at least twice as great as the statistical errors of counting, to take account of other errors in the over-all process.

We wish to acknowledge the help of Patricia Dahlstrom in preparing chemical samples and John D. Speth and Roberta L. Pennypacker in preparing the descriptions.

I. GEOLOGIC SAMPLES

Green Point site series, Michigan

Unburned twigs and wood fragments from Green Point site (23° N Lat, 83° 59′ W Long), S ½ NE ¼ Sec. 3, T11N, R4E, Saginaw Co., Michigan. Transgression of lake which sample represents presumed to be rise to Lake Nipissing. Samples date series of pollen samples and macro-vegetation samples now being analyzed by W. S. Benninghoff. Study should shed light on paleoecology of area during late Archaic. Coll. 1964 by H. T. Wright; subm. by W. S. Benninghoff, Dept. of Bot., Univ. of Michigan, and H. T. Wright, Mus. of Anthropol., Univ. of Michigan.

5050 ± 170
M-1633. Green Point site **3100 B.C.**

Sample point Locus 563 E 596, + 581.2 ft. Top of swamp sediment column and top of pollen column. Dates rise of water over +582 ft on some unknown transgression of lake.

4250 ± 150
M-1634. Green Point site **2300 B.C.**

Sample point Locus 563 E 596, + 579.9 ft near bottom of pollen column. Dates rise of water above 580 ft.

General Comment (J.B.G.): pollen analysis not complete and transposition of dates is not understood.

920 ± 100
M-1885. Welwitschia bainesii, South Africa **A.D. 1030**

Wood, part of stem of *Welwitschia bainesii* plant found near Swakop R. (22½° S Lat, 12° E Long), SW Africa (Tijmens, 1965, 1966). Coll.

1966 by H. Maelder; subm. by W. J. Tijmens, Univ. of Stellenbosch, S. Africa. *Comment* (W.J.T.): knowledge of age of plant aids study of Welwitschias of Namib Desert.

Pellston Plain series, Michigan

Wood and peat samples from bog 2 mi S of Pellston (45° 32′ N Lat, 84° 47′ W Long), Emmet Co., Michigan. Bog is on kame surface of Valders outwash sands at E margin of Pellston Hills. Alt. of bog ca. 695 ft, and Maple R. 1 mi E is at ca. 640 ft. Organic sediments are ca. 1 m thick, comprising fibrous peat, amorphous peat with wood fragments, lacustrine ooze, and sandy peat grading into coarse sand. Charcoal layers, indicating fires, occur at 4 cm, 25 cm, and 30 cm. Charcoal is dispersed in peat at depths of 45 cm and 63 cm. Coll. 1966 and subm. by T. W. Hushen and W. S. Benninghoff, Univ. of Michigan.

2160 ± 140
M-1946. Pellston Plain, 32 cm deep 210 B.C.

Conifer wood, 32 cm deep, immediately below charcoal layer at 30 cm.

2810 ± 150
M-1947. Pellston Plain, 43 cm deep 860 B.C.

Conifer wood from 43 cm deep, taken from fine-grained decayed peat that contained abundant small pieces of wood and lay immediately above 45 cm charcoal level.

4050 ± 180
M-1948. Pellston Plain, 87 cm deep 2100 B.C.

Sedge-moss peat from 87 cm deep, immediately above basal organic sand.

General Comment (W.S.B.): dates demonstrate that this peat originated a little more than 4000 yr B.P., and that most recent natural change in forest composition began ca. 3000 yr B.P. with invasion of hemlock and birch (one or several species) which was completed ca. 2000 yr B.P. Peat stratigraphy indicates charcoal layers from severe forest fires at 2 intervals soon after 2000 B.P. and again very near surface and representing widespread timber cutting within last 100 yr. Pollen diagram prepared by T. W. Hushen shows invasion of Ericaceae ca. 3000 B.P. in small amounts but becoming very significant at same time as strong rise in Chenopod-Amaranth and composite pollen during post-lumbering phase of past century. A manuscript is being prepared for publication by T. W. Hushen and W. S. Benninghoff.

7570 ± 250
M-1972. Lake Michigan, Chippewa Stage, Michigan 5620 B.C.

Shells from lake bottom at elev. of Chippewa low stage (44° 00′ N Lat, 87° 14′ W Long). Sample from shell and sand zone ca. 3 cm thick overlain by ca. 10 cm fine lake clay at present depth 350 ft. Should date Chippewa low stage or its maximum low level ca. 7500 to 9500 B.P.

(Hough, 1955). Coll. 1966 and subm. by J. L. Hough, Univ. of Michigan. *Comment* (J.L.H.): 3000 yr too young in view of M-1996 (see below).

9780 ± 330
M-1996. Straits of Mackinac, Michigan **7830 B.C.**

Conifer wood, possibly spruce, from Straits of Mackinac (45° 49′ 50″ N Lat, 84° 43′ 50″ W Long), Michigan. Sample rooted in 120 ft water under Strait 150 yds WSW of S bridge tower. Whole forest drowned in place by rising waters of Lakes Michigan and Huron to Nipissing level. Coll. 1967 by L. H. Somers; subm. by J. L. Hough. *Comment* (J.L.H.): date provides point in age and elev. that fills important gap in lake level curves.

II. ARCHAEOLOGIC SAMPLES

Upper Mississippi Valley and Great Lakes

New Castle site series, Indiana

Charcoal from New Castle site (39° 57′ N Lat, 85° 21′ W Long), Indiana. Possibly Adena plain pottery assoc. in ash pit. Samples located in Mound 4 (Swartz, 1966). Coll. 1965 and 1966 by D. R. Middleton and W. B. Koch; subm. by B. K. Swartz Jr., Dept. of Sociol. and Anthropol., Ball State Univ.

1910 ± 140
M-1851. New Castle site, Mound 4 **A.D. 40**

Charcoal from E side of mound.

1940 ± 160
M-1852. New Castle site, Mound 4 **A.D. 10**

Charcoal from Mound 4 (BSU-8F-9-12), Unit 9W-1N, ash pit 0 to 10 in. W of E wall at 74 in. depth.

General Comment (B.K.S.): both lobes of Mound 4 were constructed at same time. Ceremonial complex is Hopewellian. Sample M-1852 dates New Castle Incised Adena pottery. Thirty yr span suggests solid dates.

610 ± 110
M-1891. Backland Mound Group, Michigan **A.D. 1340**

Left femur, distal and proximal portions destroyed from Burial 2, mature male from Backland Mound Group (20 MN 2) (45° 39′ N Lat, 87° 50′ W Long), SW 1/4 of NW 1/4, Sec. 6, T35N, R28W, Menominee Co., Michigan. Submound floor burial of 7 individuals in pit. Bottom est. 2.1 ft below top of mound (N60 E10). Assoc. with Oneota-like shell-tempered ceramics and grit-tempered ceramics with Oneota-like vessel shape and late Manitoba focus (Sturgeon Falls Punctate:Alexander Punctate) decorative motif. Should date ca. A.D. 1400. Coll. 1956 by A. C. Spaulding; subm. by D. S. Brose, Mus. of Anthropol., Univ. of Michigan. *Comment* (D.S.B.): date is reasonable.

Moccasin Bluff series, Michigan

Wood from Moccasin Bluff site (41° 51′ N Lat, 86° 22′ W Long), Berrien Co., Michigan. Coll. 1948 by Hale Smith; subm. by Robert Bettarel, Univ. of Michigan.

310 ± 100
M-1935. Moccasin Bluff site A.D. 1640

Carya ovata, exterior of log 6 to 8 in. diam., Pit 21, Level 6. Should date pottery with notched applique strip around rim 1 cm below lip. *Comment* (R.B.): dates final occupation of site.

360 ± 100
M-1936. Moccasin Bluff site A.D. 1590

Quercus bicolor, interior of log in 4 in. diam., Pit 91, Level 4, Trench C. *Comment* (R.B.): should date Oneota occupation or influence.

890 ± 110
M-1937. Moccasin Bluff site A.D. 1060

Quercus bicolor from earth oven, exterior of log not over 6 in. diam., worm eaten, dead before use. Pit 54, Level 3. Should date late Spring Creek type assoc. with collared and castellated shell-tempered Woodland body sherd. *Comment* (R.B.): date identifies occupation of Late Woodland group.

860 ± 110
M-1938. Moccasin Bluff site A.D. 1090

Celtis occidentalis, log 10 in. diam.; *Quercus bicolor; Castenea dentato*, outside of log 8 in. diam.; *Acer*, 3 in. from center of log. Pit 86, Trench C, Levels 5, 6, and 7. *Comment* (R.B.): records period of manufacture of exterior lip-notched pottery and Fisher influence.

740 ± 110
M-1939. Moccasin Bluff site A.D. 1210

Quercus bicolor, interior of log or twig, Pit 49. *Comment* (R.B.): mixed sample dates feature, not artifact types.

800 ± 110
M-1940. Moccasin Bluff site A.D. 1150

Celtis occidentalis, Quercus alba, Acer, Carya, Castenea dentato, Quercus bicolor, and *Platanus occidentalis* from Pit 62, Level 3, Trench C. Exterior mainly 1/8 in. bark, some interior. *Comment* (R.B.): dates Late Woodland occupation.

890 ± 110
M-1941. Moccasin Bluff site A.D. 1060

Platanus occidentalis from Pit 15, Level 5. Interior of 6 in. limb or trunk. *Comment* (R.B.): mixed sample dates major occupation with exterior lip-notched pottery.

General Comment (R.B.): 3 occupations indicated: (a) ca. A.D. 1050 with cord-marked, exterior lip-folded pottery like Spring Creek and Fisher, (b) continuation of previous with collared vessels, (c) ca. A.D. 1600 Oneota-influenced occupation.

M-1951. Loftin site, Missouri **950 ± 110**
A.D. 1000

Charcoal from Loftin site (23 SN 42) (36° 38′ N Lat, 93° 28′ W Long), Stone Co., Missouri. Sample from lined pit at Point 4, House 4. Unclassified Mississippian site with strong Caddoan overtones. Coll. 1968 by D. R. Henning; subm. by W. R. Wood. *Comment* (W.R.W.): this date in Mississippian or Caddoan variant in SW Missouri appears valid. Previous dates (unpubl.) from same site are GXO-676: A.D. 1220 ± 150, and GXO-748: A.D. 360 ± 70.

Turner-Snodgrass site series, Missouri

Charred and burned bark, corn, and cane from Turner-Snodgrass site (36° 33′ N Lat, 90° 33′ W Long), Butler Co., Missouri. Middle Mississippian site, should date occupation. Coll. 1966 and subm. by J. E. Price, Univ. of Michigan.

M-1957. Sample RC-1 **500 ± 100**
A.D. 1450

Burned bark, Structure 2, bin floor, 23N 2.5E, D.D. 6.0 ft. Should date structure and corn that it contained.

M-1958. Sample RC-2 **570 ± 100**
A.D. 1380

Charred corn, Structure 2, bin floor. Sample from corn bin D.D. 5.8 ft. Should date structure and corn.

M-1959. Sample RC-3 **720 ± 100**
A.D. 1230

Burned wood from Structure 4, 60N 35E, D.D. 6.1 ft. Fallen wall posts. Should date structure and occupation.

M-1960. Sample RC-4 **590 ± 100**
A.D. 1390

Burned bark, Structure 4, 67N 41E, D.D. 9.2 ft. Should date structure and occupation.

M-1961. Sample RC-5 **810 ± 110**
A.D. 1140

Charred post, Structure 6, 19.6N 72.4E, D.D. 6.5 ft. Should date structure and occupation.

M-1962. Sample RC-6 **560 ± 100**
A.D. 1390

Burned wood, Structure 6, 22.4 N 72.6E, no D.D., F.S. 93. Should date structure and occupation.

M-1963. Sample RC-7 **560 ± 100**
A.D. 1390

Burned cane, Structure 8, 43N 19E, D.D. 6.2 ft. Should date structure and occupation.

730
M-1964. Sample RC-8 **A.D. 1220**
1220 N

Burned rafter, Structure 8, 53N 12E, D.D. 6.9. Should date structure and occupation.

General Comment (J.E.P.): 6 dates appear valid in dating this phase. They range considerably, but are close enough to confirm suspicions about age of site.

640 ± 100
M-1965. Incinerator Village site, Ohio **A.D. 1310**

Charcoal from Incinerator Village site (39° 43′ N Lat, 84° 14′ W Long), Vance Farm, Montgomery Co., Ohio. Sample made up of small pieces of charcoal from 6 or 8 of 20 refuse pits excavated. Site designated as Incinerator component of Anderson focus of Fort Ancient aspect. Coll. 1964 to 1966 and subm. by J. C. Allman, Dayton, Ohio. *Comment* (J.C.A.): only other Anderson focus site that has been dated is Erp site N of here near Pleasant Hill: M-1086, A.D. 1435 to 1475 (Radiocarbon, 1963, v. 5, p. 230). Considering plus and minus factors, dates match very closely otherwise. This date seems to agree with Fort Ancient dates in general.

1560 ± 140
M-1967. Bowling Stone Mound, Missouri **A.D. 390**

Charred nutshells, principally walnut, from Bowling Stone Mound (37° 37′ 01″ N Lat, 93° 39′ 26″ W Long), Cedar Co., Missouri. Sample from Sqs. 50 NW 50 and 60 NW 50, Woodland burial mound (rock and earth fill), containing limestone-tempered pottery of as yet uncertain affiliation. Coll. 1965 and subm. by W. R. Wood. *Comment* (W.R.W.): date determination appears to be somewhat early, although mound yielded only limestone-tempered pottery. Rarity of dated sites in SW Missouri, and poorly known cultural sequence make an appraisal difficult.

960 ± 110
M-1969. Kram Farm site, Missouri **A.D. 990**

Wood post from Kram Farm site (23 SL 78) (38° 48′ N Lat, 90° 10′ W Long), Missouri. Sample from House I (crematory or charnel house), Feature A (post pit), Post 2, assoc. with few scraps of shell-tempered pottery, some clay- or grog-tempered pottery (Korando Ware?) in wall trench. Coll. 1959 by D. R. Henning and R. E. Pangborn; subm. by W. R. Wood. *Comment* (W.R.W.): assoc. clay and grit-tempered pottery apparently of Bluff-Mississippian assoc. Date appears satisfactory.

2260 ± 140
M-1982. Jancarich site, Michigan **310 B.C.**

Charcoal from Jancarich site (20 NE 113) (43° 24′ N Lat, 85° 44′ W Long), T12N, R12W, Newaygo Co., Michigan. Sample is from Feature

2, TP S6 W2, excavation trench at depth 2.2 ft to 3.0 ft. Coll. 1966 and subm. by E. J. Prahl, Univ. of Toledo, Toledo, Ohio. *Comment* (E.J.P.): too early.

2030 ± 140
M-1983. Shumaker Mound, Michigan **80 B.C.**

Charcoal from Shumaker Mound (20 NE 107) (43° 25′ N Lat, 85° 44′ W Long), NE 1/4, NE 1/4 Brooks Twp., Newaygo Co., Michigan. Coll. and subm. by E. J. Prahl. *Comment* (E.J.P.): too early.

1960 ± 140
M-1985. Palmeteer site, Michigan **10 B.C.**

Charcoal from Palmeteer site (20 NE 101) (43° 24′ N Lat, 85° 44′ W Long), SE 1/4, SW 1/4, Sec. 22, T12N, R12W, Newaygo Co., Michigan. Coll. 1955 by E. Gillis; subm. by E. J. Prahl. *Comment* (E.J.P.): dates from Jancarich village and nearby Palmeteer and Shumaker mounds, representing period of Hopewellian influence in Lower Muskegon valley, would all seem too early according to postulated time of this activity in area. Cultural material from these 3 sites has been thought to represent stylistic decline assoc. with Late Hopewellian period, as manifested in other areas S of Muskegon.

2490 ± 150
M-1984. Carrigan A Mound, Michigan **540 B.C.**

Charcoal from Carrigan Mound A (20 NE 106) (43° 28′ N Lat, 83° 38′ W Long), Newaygo Co., Michigan. Sample from depth 6.3 ft, 2 ft S, 2.5 ft E of Datum A. Coll. 1965 and subm. by E. J. Prahl. *Comment* (E.J.P.): Carrigan A date from hearth at base of mound agrees with 590 ± 150 B.C. date of Carrigan B (M-1894), another of group of 5 mounds at confluence of Big and Little Muskegon R. Previously publ. date, A.D. 600 ± 120 (M-1759, Radiocarbon, 1968, v. 10, p. 78), dates period of intrusive activity in lower Muskegon valley. Intrusive nature of Carrigan A burial has been corroborated by both cultural and pedologic evidence. Earlier dates for Carrigan A and B line up nicely with dates from Early Woodland level of Schultz site in Saginaw valley.

Yokem Mound site series, Illinois

Charcoal from Yokem Mounds (39° 29′ 38″ N Lat, 90° 56′ 16″ W Long), Pike Co., Illinois. Coll. 1967 and subm. by Gregory Perino, Tulsa, Oklahoma.

760 ± 110
M-1976. Yokem Mound 3 **A.D. 1190**

Charcoal from intrusive charnel structure found in undisturbed area of potted cemetery. Late Woodland mound with intrusive cremation or crematorium assoc. with 3 long-nosed god masks. Structure of 2 post construction, posts 10 in. diam. placed in ground 90 in. apart, 4 ft deep. Should date masks.

M-1994. Yokem Mound 2 **520 ± 100 A.D. 1430**

Charcoal from burned structure containing 8 Late Woodland burials of which one had 2 triangular side-notched points in rib cage. Should cross-date with charcoal from Mound 3. Structure beneath Mound 2 was 68 in. wide, 14 ft 4 in. long, constructed on bluff. Contained 6 skeletons and 2 burial bundles.

General Comment (G.P.): date for M-1976 is very good for maximum date and could be 100 yr later. M-1994 seems to be too late. It is unlikely that similar structure with same exact measurements would have been constructed over 200 yr. Compromise of 2 dates ca. A.D. 1300 might be more meaningful. Evidence found in Yokem Mounds 1, 2, and 3 is that 2nd wave of Mississippian-Late Woodland acculturation had been accomplished.

Bridgewater site series, Illinois

Charcoal of *Equisetum* stem (39° 23′ 33″ N Lat, 90° 33′ 21″ W Long), Greene Co., Illinois. Bridgewater is single-component site of the White Hall phase (early Late Woodland). White Hall series sherds were removed from features. Plant remains id. by Shirley S. Maina (n.d.). Samples should date White Hall phase. Coll. 1962 and subm. by S. Struever, Northwestern Univ.

M-1998. Bridgewater site **1470 ± 130 A.D. 480**

Feature 2a, charred plant remains from hearth debris in bottom of pit.

M-1999. Bridgewater site **1050 ± 200 A.D. 900**

Feature 1, portion of charcoal concentration recovered from base of pit.

General Comment (S.S.): M-1998 is within previously established White Hall time span; M-1999 is too late.

Apple Creek site series, Illinois

Wood charcoal from Apple Creek site (39° 22′ 15″ N Lat, 90° 32′ 22″ W Long), Greene Co., Illinois. White Hall series sherds in direct assoc. with charcoal. Sample should date White Hall component. Coll. 1963 and subm. by Stuart Struever.

M-1997. Apple Creek site **1030 ± 120 A.D. 920**

Feature 451d. Charcoal removed from mass near base of cylindrical pit (Feature 451).

M-2001. Apple Creek site **1200 ± 130 A.D. 700**

Charcoal from *in situ* remnant of hearth in base of cylindrical earth oven.

General Comment (S.S.): M-2001 falls within previously established White Hall time span (M-1262, M-1263, Radiocarbon, 1964, v. 6, p. 4; M-1406; and M-1407, Radiocarbon, 1966, v. 8, p. 266: A.D. 450 to A.D. 750. M-1997 is too late.

Newbridge site series, Illinois

Charred plant remains from Newbridge site (39° 24′ 08″ N Lat, 90° 33′ 31″ W Long), Greene Co., Illinois. Newbridge is single-component, White Hall phase (early Late Woodland) site. Coll. 1962 and subm. by Stuart Struever.

1290 ± 130
M-2000. Newbridge site **A.D. 660**

Feature 6, charred *Chenopodium* and *Polygonum* seeds (id. by Shirley L. Maina, Dept. of Bot., Univ. of Massachusetts). Sample portion of large seed mass recovered from base of pit.

1330 ± 400
M-2002. Newbridge site **A.D. 620**

Feature 2, wood charcoal and charred *Equisetum* stem fragments. Remains removed from base of storage-refuse pit.
General Comment (S.S.): both dates fall within previously established time range for White Hall phase.

Indian Point site series, Ohio

Charcoal from Indian Point (Lyman) site (41° 43′ 15″ N Lat, 81° 11′ 24″ W Long), LeRoy Twp., Lake Co., Ohio. Site disturbed, but date, if sample is contemporaneous with pottery, will reveal whether or not Late Prehistoric culture was contemporaneous with construction of earth works at site as well as date relatively late (possibly post-contact) Whittlesey site (Mayer-Oakes, 1955; Guthe, 1958). Coll. 1966 and subm. by J. L. Murphy, Nat. Sci. Mus., Cleveland, Ohio.

200 ± 100
M-2003. Sample 1 **A.D. 1750**

Sample from unexcavated portion of site along W side of bluff 4 in. below surface and assoc. with both grit and shell-tempered pottery. *Comment* (J.L.M.): sample contaminated or non-aboriginal. It barely falls within time range expected for Late Whittlesey material with maximum margin of error.

2090 ± 150
M-2004. Sample 2 **140 B.C.**

Sample from 4.10 in. below surface. *Comment* (J.L.M.): substantiates theory that all N Ohio hilltop fortifications are not Late Prehistoric.

Yankeetown site series, Indiana

Carbonized wood and burned nut shells from Yankeetown site (37° 54′ 20″ N Lat, 87° 18′ 54″ W Long), Anderson Twp., Warrick Co., Indiana (Curry, 1954). Coll. 1967 by J. T. Dorwin; subm. by J. H. Keller, Glenn A. Black Lab. of Archaeol., Indiana Univ.

1050 ± 130
M-2007. Yankeetown site, Indiana A.D. 900

Carbonized wood from Feature 11, bell-shaped pit 3.04 ft deep in Ohio R. alluvial deposit; 1.95 ft top diam.; 4.2 ft at bottom, 1.8 ft deep. Pit contained fish, bird, and mammal bone; worked and unworked stone, large quantities of Yankeetown pottery, and considerable amounts of carbonized wood. *Comment* (J.H.K.): date is consistent with conclusion that Yankeetown complex was at least coeval with early Mississippian.

2250 ± 140
M-2008. Yankeetown site, Indiana 300 B.C.

Carbonized wood from Feature 18, heavily fired silt area 8.1 ft deep in Ohio R. alluvial deposit. Assoc. with poorly preserved bone, water-worn sandstone pebbles, thick grit and clay-tempered, cord-marked sherds. *Comment* (J.H.K.): date suggests early Middle Woodland, and we substantially agree.

2740 ± 150
M-2009. Yankeetown site, Indiana 790 B.C.

Burned nut shells from Feature 19, basin-shaped area of fired silt 11.3 ft deep in Ohio R. alluvial deposit. Assoc. with fragments of poorly preserved bone, 3 flint flakes, 2 pieces water-worn sandstone. Auger tests immediately below feature produced carbon at 14 ft and fired silt at 19 ft. Burned areas at relatively great depth have been observed in caving Ohio R. bank for years. *Comment* (J.H.K.): date suggests Early to Middle Woodland transition.

475 ± 100
M-2024. Woodpecker site, Missouri A.D. 1475

Charcoal from Woodpecker site (37° 38′ 41″ N Lat, 93° 44′ 23″ W Long), Cedar Co., Missouri. Sample from Sq. 100N 90W, Feature 63 (pit fill) dug into occupational level. Probably single-component, non-ceramic site, perhaps Late Archaic. Coll. 1967 by R. E. Pangborn; subm. by W. R. Wood. *Comment* (W.R.W.): date is later than suggested by cultural remains.

M-2041. Oak Grove site, Missouri 0 ± 100

Charcoal from Oak Grove site (37° 33′ 32″ N Lat, 93° 36′ 40″ W Long), Polk Co., Missouri. Sample from occupational zone Sq. 477, 8N 407.5W, 15 in. below surface. Should date pottery-bearing component. Coll. 1967 by H. T. Ward; subm. by W. R. Wood. *Comment* (W.R.W.): result not in accord with field data.

2230 ± 140
M-2049. Daines Mound II site, Ohio 280 B.C.

Charcoal from Daines Mound II site (34° 18′ 52″ N Lat, 82° 06′ 25″ W Long), Athens, Ohio. Carbon from base of mound 7 ft high in initial N-S trench, 25 ft S of edge of mound. Date will be 1st for occurrence of Adena corn. Artifacts sparse, but mound is probably Late Adena. Coll.

and subm. by J. L. Murphy. *Comment* (J.L.M.): fits known range of Adena culture, and is of particular significance because of occurrence in mound of an ear of Tropical Dent corn (id. by H. C. Cutler, Misssouri Bot. Gardens), 1st definite evidence of Adena corn, and I believe oldest known occurrence of corn in E North America.

M-2055. Naomikong Point site, Michigan **1520 ± 400**
A.D. 430

Charred material scraped from interior of potsherds from Naomikong Point site (45° 30′ N Lat, 84° 52′ W Long), Chippewa Co., Michigan. Scrapings from pseudo-scallop shell vessel found in midden Level 1 of Excavation 525 E 525. Coll. 1967 and subm. by D. E. Janzen, Mus. of Anthropol., Univ. of Michigan. *Comment* (D.E.J.): since Naomikong Point is atypical Laurel (because of its size), Late Middle Woodland date of A.D. 430 is fine.

M-2069. Fairport Harbor Village site, Ohio **180 ± 100**
A.D. 1770

Charcoal from Fairport Harbor Village site (41° 44′ 47″ N Lat, 81° 16′ 10″ W Long), Lake Co., Ohio. Sample from Trench I. Date should substantiate or disprove Fitting's theory that Fairport site is relatively early in Whittlesey phase (Morgan and Ellis, 1943; Fitting, 1964). Coll. 1966 and subm. by J. L. Murphy. *Comment* (J.L.M.): site was used for dump, and bad sample is not surprising.

Summer Island site series, Michigan

Wood charcoal and charred bone from Summer Island site (45° 34′ 30″ N Lat, 86° 37′ W Long), Delta Co., Michigan. Coll. 1967 and subm. by D. S. Brose.

M-1995. Summer Island site **1700 ± 140**
A.D. 250

Charcoal from sand ridge 100 ft W of shore. Material from refuse pit filled with large, burned limestone and igneous rock fragments, faunal remains, and broken ceramics. Pit assoc. with large midden at this level. Ceramics found in fire-pit: grit-tempered, dentate sherds which seem to relate to Laurel occupation.

M-2070. Summer Island site **2320 ± 140**
370 B.C.

Wood charcoal and charred bone from pit in sand ridge W of Summer Harbor. Pit is in sub-Mississippian level sands outside midden containing charcoal, 1 poor bifacial blank, much burned rock, and several fragments of mussel shell assoc. with Oneota component.

M-2071. Summer Island site **660 ± 100**
A.D. 1290

Wood charcoal from post molds of double-walled (?) oval structure containing refuse pit with thin cord-marked and sandy incised ceramics. To N of main occupation of Middle Woodland site: Area B, as part of Oneota component.

660 ± 100
M-2072. Summer Island site **A.D. 1290**
(Error 2x)

Charcoal of small twigs and branches of cedar from sand ridge W of Summer Harbor. Pit originating in midden at depth of .65 ft. Charcoal assoc. with 5 kg fire-cracked rock, 1 unifacial scraper (preform), much burned fish and mammal bone, and Oneota pottery.

1880 ± 280
M-2073. Summer Island site **A.D. 70**

Wood charcoal of small twigs of E cedar in hearth in dense, sandy layer at elev. ca. 596 ft. Sample from midden floor from concentration of charcoal, ash and potsherds (plain surface, grit-tempered, dentate stamped). Assoc. fish bone. Ceramics quite Laurel-like. May date A.D. 100 to 400, assoc. with Laurel occupation.

1790 ± 130
M-2074. Summer Island site **A.D. 160**

Charcoal of small branches of aspen and cedar. Fire pit (in N structure, Area C, originates in midden layer and cuts into sterile sands underlying site. Sample assoc. with fish bone, 1 white chert bifacial blade, and grit-tempered, punctate sherds which look like Mason's (Mason, 1966) "Becker Punctate" (A.D. 170). Assoc. with Laurel occupation.

330 ± 100
M-2014. Summer Island site **A.D. 1620**

Charred bones of mature *Cervus canadensis canadensis* and *Ursus americanus* from isolated pit below humus along N wall of excavation unit 500 E 500 at point 505 E 553, 1.3 ft deep from surface or 595.7 ft above mean tide. Bones intimately assoc. with body and rim sherds of shell- and grit-tempered vessels tentatively id. as Grand River Plain and Lake Winnebago Trailed (Hall, 1962), as well as Late Woodland ceramics similar to Quimby's (1967) Dumaw Creek in protohistoric component.

General Comment (D.S.B.): M-2073, M-2074, and M-1995 date Middle Woodland occupation in complete agreement with similar materials from Wisconsin (Mason, 1966) and Ontario (Johnston, 1968; Wright, 1967). M-2070, M-2071, and M-2072 pertain to features assoc. with an Upper Mississippian ceramic complex. M-2071 and M-2072 agree with similar Oneota materials from Wisconsin (Hall, 1962; Mason, 1966). M-2070 is from a feature of this component containing large amounts of mussel shell, presumably coll. from gravel bar to NW of site. Waters of this area contain high $CaCO_2$ content (Ayers, 1961) dissolved from Middle Silurian Limestone series, and this may account for unreasonably old date. The pH of this feature was 8.5 higher than in surrounding soils. M-2014 is gratifying in light of est. date based upon French trade goods, A.D. 1625 to A.D. 1675 (Quimby, 1966).

Northeastern United States

Sheep Rock Shelter series, Pennsylvania

Charcoal from Sheep Rock Shelter (78° 00′ N Lat, 40° 15′ W Long), Huntingdon, Pennsylvania. Coll. and subm. by J. W. Michels, Pennsylvania State Univ.

M-2081. Sheep Rock Shelter **80 ± 100**
A.D. 1870

W 15, S 05, level 66 to 72 in. Middle Woodland. *Comment* (J.W.M.): date is apparently derived from large pit, presumably of Susquehannock origin, which penetrates through ash lens from above. To accommodate this interpretation 2 sigmas would be required. Another possibility is historic occupation which is known to have occurred. A.D. 1870 is not surprising.

M-2082. Sheep Rock Shelter **1630 ± 140**
A.D. 320

E 20, S 05, level 70 to 84 in. Early Woodland. *Comment* (J.W.M.): date is in line with corroborating evidence.

M-2083. Sheep Rock Shelter **1890 ± 140**
A.D. 60

E 20, S 00, level 72 in. Early Woodland. *Comment* (J.W.M.): date is entirely in line and is supported by Sample M-2082.

M-2084. Sheep Rock Shelter **460 ± 100**
A.D. 1490

E 00, S 15, level 78 to 14 in. Early Woodland. *Comment* (J.W.M.): Middle Woodland date satisfactorily fits Early-Middle Woodland expectations.

M-2085. Sheep Rock Shelter **3220 ± 160**
1270 B.C.

E 25, S 15, level 79 in. Early Woodland. *Comment* (J.W.M.): date concurs with ceramic inferences.

M-2086. Sheep Rock Shelter **500 ± 100**
A.D. 1450

E 45, S 15, level 95 to 96 in. Early Woodland. *Comment* (J.W.M.): provenience of this sample and assoc. deposit was in doubt though stratigraphy suggested Late Woodland. Date clarifies chronometric provenience of deposit.

General Comment (J.W.M.): over-all evaluation of samples indicates rather good agreement between expected and observed results. Only M-2081 is clearly out of line, a result which was anticipated and is explained by presence of a large intrusive deposit dating from more recent occupation.

Lower Mississippi Valley and Southeast U. S.

M-1358. Barton Ranch site, Arkansas **650 ± 110**
A.D. 1300

Charred red oak from Barton Ranch site (35° 22′ 30″ N Lat, 90° 23′ 40″ W Long), Crittenden Co., Arkansas. Carbon of charred house posts in subfloor of house pattern 4 ft deep from present ground surface. House floor 2 ft deep when originally excavated by Indians. Coll. 1961 and subm. by Gregory Perino. *Comment* (G.P.): date seems a little early, for artifacts from site are regarded as typologically later. As a rule, St. Francis sites like Barton Ranch are later than A.D. 1300. House floor sample was taken from also had large sherd of Manley Punctate ware, one of major types at Banks site.

Obion site series, Tennessee

Wood charcoal from Obion site (16 HY 14) (36° 24′ 15″ N Lat, 88° 23′ W Long), Henry Co., Tennessee. Coll. 1967 and subm. by E. E. Baldwin, Dept. of Anthropol., Western Michigan Univ.

910 ± 110
M-1953. Specimen 1 **A.D. 1040**

Wood charcoal from midden underlying 1st constructional phase of largest mound (6) on site. Should date early (pre-mound) occupation of this Mississippian site (Baldwin, 1967).

970 ± 250
M-1954 and M-1956. Specimens 2 and 4 **A.D. 980**
910 N
A.D. 1040

Wood charcoal from floor 5 ft 9 in. below present summit of Mound 6, and 1 ft 6 in. above Phase C of construction. Should date middle period of mound "Summit C Times."

960 ± 150
M-1955. Specimen 3 **A.D. 990**

Wood charcoal from midden underlying 1st constructional phase of Mound 6. Date should be same as Specimen 1.

General Comment (E.E.B.): M-1953, M-1955: dates are very acceptable for early occupation. M-1954, M-1956: somewhat too early, but in view of large lab. error, dates should not be viewed as disruptive of highly consistent sub-mound dates.

Mexico, Central, and South America

Cueva Blanca site series, Mexico

Charcoal from Cueva Blanca site (16° 57′ N Lat, 96° 20′ W Long), Oaxaca, Mexico (Flannery *et al.*, 1967). Coll. 1966 and subm. by K. V. Flannery, Univ. of Michigan.

1330 ± 130
M-2091. Sample OC-30, E9, Zone A **A.D. 620**

Zone A dates to Monte Alban V period, Post-Classic, and should have absolute date ca. A.D. 1300 to 1500. *Comment* (K.V.F): too early.

4750 ± 190
M-2092. Sample OC-30, E13, Zone D **2800 B.C.**

Should date to pre-ceramic Coxcatlan phase, ca. 3000 to 4000 B.C. *Comment* (K.V.F.): not bad.

M-2093. Sample OC-30, D8, Zone E **10,050 ± 350**
8100 B.C.

Pre-ceramic living floor. *Comment* (K.V.F.): somewhat earlier than expected.

M-2094. Sample OC-30, I13, Zone E **11,000 ± 400**
9050 B.C.

Sample from Feature 15, shallow hearth in stratigraphic Zone E, pre-ceramic living floor. *Comment* (K.V.F.): earlier than expected. Assoc. fauna is all "Recent," and does not include extinct Pleistocene forms.

Guila Naquitz Cave site series, Mexico

Charcoal from Guila Naquitz Cave site (16° 57′ N Lat, 96° 20′ W Long), Oaxaca, Mexico (Flannery *et al.*, 1967). Coll. 1966 and subm. by K. V. Flannery.

M-2095. Sample OC-43, I7, Feature 7 **240 ± 100**
A.D. 1710

Feature 7 was large maguey-roasting pit dating to Post-Classic period. Should date ca. A.D. 1300 to 1500. *Comment* (K.V.F.): not bad considering standard deviation.

M-2096. Sample OC-43, GH, Zone A **1330 ± 130**
A.D. 620

Monte Alban III-B–IV period, presumably A.D. 600 to 900. *Comment* (K.V.F.): good.

M-2097. Sample OC-43, D10, Zone C **9400 ± 300**
7450 B.C.

Pre-ceramic living floor, previously dated to 6000 to 7000 B.C. (Geochron, unpubl.). *Comment* (K.V.F.): perfect.

M-2098. Sample OC-43, D10, Zone D **4300 ± 180**
2350 B.C.

Pre-ceramic living floor, previously dated to 7000 to 8000 B.C. (Geochron, unpubl.). *Comment* (K.V.F.): too young.

M-2099. Sample OC-43, E5, Zone D **10,700 ± 350**
8750 B.C.

Pre-ceramic living floor, previously dated to 7000 to 8000 B.C. (Geochron, unpubl.). *Comment* (K.V.F.): earlier than expected, but not bad.

M-2100. Sample OC-43, F9, Zone C **5980 ± 220**
4030 B.C.

Pre-ceramic living floor, previously dated to 6000 to 7000 B.C. (Geochron, unpubl.). *Comment* (K.V.F.): too young.

M-2101. Sample OC-43, F8, Zone E **6300 ± 220**
4350 B.C.

Pre-ceramic living floor presumed to date before 7000 B.C. *Comment* (K.V.F.): too young.

Hierve el Agua site series, Mexico

Charcoal from Hierve el Agua site (16° 54′ N Lat, 96° 15′ W Long), Oaxaca, Mexico. Site consists of 1 pyramid, series of plazas contoured to mountain side, large travertine-rich spring, and series of prehistoric agricultural terraces and irrigation canals "fossilized" by travertine deposition. Coll. 1967 by J. A. Neely; subm. by K. V. Flannery.

1010 ± 100
M-2105. Test Pit I **A.D. 940**

75 cm deep, Monte Alban III-B(?) ceramics.

1600 ± 130
M-2106. Test Pit 40 **A.D. 350**

113 cm deep, Late Formative-Early Classic ceramics.

1810 ± 150
M-2107. Test Pit 40 **A.D. 140**

175 cm deep, Late Formative ceramics.

2260 ± 150
M-2108. Test Pit 40 **310 B.C.**

190 cm, Formative ceramics.

2370 ± 140
M-2109. Test Pit 41 **420 B.C.**

70 cm deep, Late Formative ceramics.

General Comment (K.V.F.): dates are most satisfactory and acceptable.

1530 ± 120
M-1638. Site 1, Costa de Reyes, Argentina **A.D. 420**

Charcoal from Site 1, Costa de Reyes, Catamarca Province, Argentina. Sample 3 ft 3 in. deep dates oldest pottery known in Abauncan Valley in central zone of NW Argentina. Also dates oldest maize yet known in area. Coll. 1964 and subm. by A. R. Gonzales, Mus. de La Plata, La Plata, Argentina. *Comment* (A.R.G.): date is satisfactory.

Ancon-Las Colinas site series, Peru

Charcoal and ashes (probably *Tillandsia*), from Zona del Tanque de Agua at Ancon (11° 55′ S Lat, 77° 10′ W Long), Peru. Coll. 1961 by Lorenzo Rossello-Truel and Ramiro Matos Merdietta; subm. by Lorenzo Rossello-Truel, Lima, Peru.

2910 ± 160
M-1949. Ancon-Las Colinas **960 B.C.**

Charcoal from deepest level (5.50 to 5.75 m) of subsidiary Pit A in Trench T3. Deposit rests atop sterile sand, and is stratigraphically below levels containing materials pertaining to Chira-Villa and Haldas styles. This may date oldest ceramics yet found at site (Willey and Corbett, 1954; Lanning, 1960; Matos, 1962; Rossello, 1962).

3100 ± 160
M-1950. Ancon-Las Colinas **1150 B.C.**

Ashes from depth of 4.50 m in Pit A, Trench T3. Level marks critical stratigraphical and typological break in cultural deposit. Ceramic assoc. are material related to zone-red type defined by Willey and Corbett, material beginning thinner and variegated rim forms of Chira-Villa and Haldas styles (Willey and Corbett, 1954; Lanning, 1960, 1961; Matos, 1960, 1962; Rossello, 1962).

General Comment (L.R.T.): date of M-1950 corresponds well to other recently dated pre-ceramic materials at Las Colinas and La Florida. M-1949 seems somewhat too young. Late date on this latter sample might possibly be explained by the fact that charcoal was stored for several years in small cloth bag. M-1950, on the other hand, was placed in an air-tight plastic container immediately after collection.

Africa, Europe, Near East, and Asia

Radziejow Kujawski series, Poland

Charcoal and charred wheat from Radziejow Kujawski site No. 1 (52° 37′ 33″ N Lat, 18° 32′ 30″ E Long), Poland. Samples taken from Pit A, 104 cm below surface. Pit contained only Funnel Beaker sherds; at level of sample an amphora of Funnel Beaker culture was found. Amphora dates site at border of Polish Neolithic Period II and III. Samples will date Funnel Beaker culture and agriculture in Kuyavia. Coll. 1961 by L. Gabalowna; subm. by Sarunas Milisauskas, Univ. of Michigan.

4590 ± 190
M-1845. Radziejow Kujawski, charcoal, Pit A 2640 B.C.

4860 ± 200
M-1845. Radziejow Kujawski, wheat, Pit A 2910 B.C.

General Comment (S.M.): dates agree with expected age of site.

4810 ± 200
M-1847. Zlotniki site, Poland 2860 B.C.

Charcoal from Zlotniki site (50° 06′ 00″ N Lat, 20° 16′ 25″ E Long), Poland. Sample from Pit 51, assoc. with Lengyel and Lustian sherds. Should date Late Lengyel. Coll. 1964 by A. Dzieduszycka-Machnikowa; subm. by Sarunas Milisauskas. *Comment* (S.M.): date probably would fall within late period of Lengyel culture in S Poland.

1330 ± 130
M-1848. Przywoz Mound 1, Poland A.D. 620

Charcoal from Przywoz Mound 1 (51° 08′ N Lat, 18° 43′ 05″ E Long), Poland. Sample from fireplace occurring in NW part of mound at depth 2.90 cm from top. Assoc. with 1 sherd from Roman period. Should date ca. A.D. 180. Coll. 1964 by K. Jazdzewski; subm. by Sarunas Milisauskas. *Comment* (S.M.): date does not fall within Roman period in Poland.

Olszanica site series, Poland

Charcoal from Olszanica site (50° 06′ N Lat, 18° 50′ E Long), Poland. Should be 1st Danubian I dates in S Poland. Coll. 1967 by Gregory Johnson; subm. by Sarunas Milisauskas.

M-1986. Olszanica site, Poland **6020 ± 220**
4070 B.C.

Charcoal from Feature I, 234.25, Danubian (Linear) Pit.

M-2011. Olszanica site, Poland **6300 ± 400**
4350 B.C.

Charcoal from Danubian I (Linear) pits. Features 1 (235.56a) and 6 (235.20).

General Comment (S.M.): most of pottery at Olszanica belongs to Middle and Late phases of Danubian I culture. Dates agree with expected age for site.

Espekaer site series, Denmark

Charcoal from Espekaer site (55° 43′ 21″ N Lat, 09° 29′ 33″ E Long), Daugård, Denmark. Samples from conventional "stone heap grave" feature though no direct evidence of burial was present. Unitary feature is man-sized trench filled with stones and boulders assoc. with potsherds, amber, and stone tools of Jutish "Middle Neolithic." Late (?) Pitted-Ware culture site. Est. date 2500 to 2000 B.C. Coll. 1967 by R. M. and E. S. J. Rowlett; subm. by R. M. Rowlett, Univ. of Missouri.

M-2089. Sample I **4200 ± 250**
2250 B.C.

Bits and pieces of charcoal from cracks around middle and bottom of layers of stone.

M-2090. Sample II **3460 ± 220**
1510 B.C.

Bits and pieces of charcoal from immediately in contact with upper stone layer and from cracks between stones and this layer.

General Comment (R.M.R.): dating determination for Sample I, most protected sample, is probably most applicable. Sample II seemingly includes later, intrusive material.

Munhata series, Israel

Soil samples from Munhata (32° 30′ 55″ N Lat, 35° 30′ 25″ E Long), Israel. Coll. 1965 and subm. by Jean Perrot, Archaeol. Mission, French Consulate Gen., P.O.B. 182, Jerusalem.

M-1792. Munhata, Fireplace 644 **7370 ± 400**
5420 B.C.

Soil (Sample 869) from Fireplace 644, Sq. M 14, Level IV A .5 m deep. Should date pre-pottery near 6000 B.C. *Comment* (J.P.): considerably younger than expected.

M-1793. Munhata, Trench 631 **9160 ± 500**
7210 B.C.

Soil (Sample 631) from Trench 631, Sq. L 16, Level IV B or V. Should date near 6500 to 6000 B.C. based on Jericho tests.

Bab edh-Dhra site series, Jordan

Burnt cloth and wood from Bab edh-Dhra site (31° 14′ 34″ N Lat, 35° 31′ 42″ E Long), Lisan, Jordan. Coll. and subm. by P. V. Lapp, Am. School of Oriental Research, Israel.

M-2036. Sample No. 9 **4160 ± 180**
2210 B.C.

Burnt cloth from floor of entryway to Charnel House A 8, from mass of cloth set afire immediately before final sealing. Ceramic comparative typology including dated Egyptian links suggest date in 25th century B.C. Charnel house contained heaps of disarticulated bones mixed with pots and few copper weapons. Cloth first appeared $<$ 5 cm deep. Sample ca. 50 cm deep.

M-2037. Sample No. 10 **4350 ± 180**
2400 B.C.

Burnt cloth and wood from cobbled floor of Charnel House A 51. Conditions as in A 8, except typology suggests date in 24th or 23rd century B.C.

General Comment (P.V.L.): in general dates provided are satisfactory, and I would tend to keep sequence so far as suggested by preliminary typological study, and say roughly 24th century B.C. for M-3036 and 23rd century B.C. for M-2037. It is possible that more detailed typological study might reverse sequence.

Ishigami-Bokuden Shell Mound series, Japan

Charcoal from Ishigami-Bokuden Shell Mound (35° 50′ N Lat, 139° 45′ E Long), Kawaguchi City, Saitama Pref., Japan. Should date from late to latest Jomon period. Coll. 1965 by Masaru Aso; subm. by J. E. Kidder, Internatl. Christian Univ., 1500 Osawa, Mitakashi, Tokyo, Japan.

M-1861. Ishigami-Bokuden Shell Mound, 105 cm deep **3110 ± 190**
2160 B.C.

Charcoal from Level 3, pure shell layer, 105 cm deep. Assoc. with Angyo IIIa pottery of early Latest Jomon period.

M-1862. Ishigami-Bokuden Shell Mound, 160 cm deep **3190 ± 160**
1240 B.C.

Charcoal from fireplace of Horinouchi type pit house 160 cm deep in Late Jomon period.

General Comment (J.E.K.): dates are satisfactory, but would have prefered M-1862 to be 200 yr earlier. Horinouchi may be younger than considered.

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NATIONAL PHYSICAL LABORATORY RADIOCARBON MEASUREMENTS VII

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The following list comprises measurements made since those reported in Radiocarbon, 1969, v. 11, p. 130-136. No changes have been made in measurement technique or in the method of calculating the results described in Radiocarbon, 1965, v. 7, p. 156-161. It was necessary during 1968 to replace all the geiger counters used in the anti-coincidence rings, but the long term stability of background and standard count rates implicit in the use of a 20-week rolling mean has been maintained.

Ages are given relative to A.D. 1950 and have been calculated using a half-life of 5568 yr. Measurements, corrected for fractionation relative to the P.D.B. standard, are referred to 0.950 times the activity of the NBS oxalic acid as contemporary reference standard. The quoted uncertainty is one standard deviation and includes an additional uncertainty, taken to be equivalent to a standard deviation of 80 yr, for the de Vries effect, but excludes the uncertainty of the half-life. Should a net sample count rate be less than 4 times the standard error of the difference between the sample and background count rates a lower limit to the age would be reported corresponding to a net sample count rate of 4 times the standard error of this difference.

I. SOIL SAMPLES

England

Rothamsted series, Hertfordshire

Soil samples at Rothamsted Experimental Station (51° 48′ N Lat, 00° 23′ W Long), Harpenden, Herts. Subm. by D. S. Jenkinson, Rothamsted Experimental Sta.

NPL-149. Broadbalk 1 — **1385 ± 140**
A.D. 565
$\delta C^{13} = -25.8‰$

Soil from Broadbalk Plot 3; continuous wheat; sample depth 0 to 9 in. Coll. 1881 by H. Gilbert.

NPL-154. Broadbalk 2 — **1950 ± 130**
A.D. 0
$\delta C^{13} = -26.0‰$

Soil from Broadbalk Plot 3; continuous wheat; sample depth 9 to 18 in. Coll. 1881 by H. Gilbert.

NPL-153. Broadbalk 3 — **3670 ± 130**
1720 B.C.
$\delta C^{13} = -22.2‰$

Soil from Broadbalk Plot 3; continuous wheat; sample depth 18 to 27 in. Coll. 1881 by H. Gilbert.

NPL-161. Broadbalk 4 **875 ± 120**
A.D. 1075
$\delta C^{13} = -26.4‰$

Soil from Broadbalk Plot 3; continuous wheat; sample depth 0 to 9 in. Coll. 1965 by D. S. Jenkinson.

NPL-150. Park Grass 1 **1040 ± 125**
A.D. 910
$\delta C^{13} = -26.7‰$

Soil from Park Grass Plot 3; continuous grass; sample depth 0 to 9 in. Coll. 1886 by H. Gilbert.

NPL-151. Park Grass 2 **280 ± 125**
A.D. 1670
$\delta C^{13} = -26.3‰$

Soil from Park Grass Plot 3; continuous grass, limed; sample depth 0 to 9 in. Coll. 1965 by D. S. Jenkinson.

NPL-155. Park Grass 3 **390 ± 120**
A.D. 1560
$\delta C^{13} = -27.5‰$

Soil from Park Grass Plot 3; continuous grass, unlimed; sample depth 0 to 9 in. Coll. 1965 by D. S. Jenkinson.

NPL-156. Park Grass 4 **290 ± 125**
A.D. 1660
$\delta C^{13} = -27.0‰$

Soil from Park Grass Plot 3; continuous grass, limed; sample depth 0 to 9 in. Coll. 1965 by D. S. Jenkinson.

NPL-214. Geescroft 27 **1870 ± 125**
A.D. 80
$\delta C^{13} = -27.2‰$

Sub-soil, Batcombe series, from 9 to 18 in. layer of soil on Plots 3 and 4 of Geescroft continuous beans experiment. Coll. 1883 by H. Gilbert.

NPL-215. Geescroft 28 **3180 ± 135**
1230 B.C.
$\delta C^{13} = -25.4‰$

Sub-soil, Batcombe series, from 18 to 27 in. layer of soil on Plots 3 and 4 of Geescroft continuous beans experiment. Coll. 1883 by H. Gilbert. *General Comment* (D.S.J.): samples dated as part of program of work on turnover of organic matter in soils from some of the experimental fields at Rothamsted. As agricultural soils contain organic matter of different age, ranging from fresh plant roots to relatively resistant humic materials, radiocarbon dates obtained on such soils are best regarded as "equivalent ages." Equivalent age is defined as "the age of the organic C in a chronologically homogeneous sample having the same normalized C^{14} abundance (Δ) as that of the (heterogeneous) soil sample analysed." The main findings so far from radiocarbon measurements are: (1) the equivalent age of organic carbon in arable top-soil is much greater than that suggested by earlier calculations (Jenkinson, D. S., 1963) based on measurements of rate of accumulation of organic matter in soil (NPL-149).

(2) ages of organic carbon in soils sampled in 1880's, from two arable fields ca. ½ mi. apart on same soil series, were similar all the way down profiles (NPL-154, 153, 214, 215). This suggests that age of organic matter in these soils is a characteristic of the soil.

(3) as amount of organic carbon decreases down profile, age increases (NPL-149, 154, 153).

(4) all samples from Park Grass contain coal, in contrast to Geescroft and Broadbalk samples, which contain little, if any, coal or charcoal. The 1886 sample from Plot 3 of Park Grass (NPL-150) contained 0.16% coal carbon and 1966 sample (NPL-155) 0.13% coal carbon. Calculated equivalent age of coal-free soil organic carbon in 1886 sample is 600 yr, that of 1966 sample, 50 yr, assuming that the coal contains no radiocarbon.

(5) samples taken in 1966 from both Park Grass and Broadbalk date much younger than corresponding samples taken from same plots in 1880's (NPL-149 and 161, 150 and 155). This difference is attributed to entry of radiocarbon from thermonuclear explosions into soil organic matter. From amount of thermonuclear radiocarbon in atmosphere over last decade (Nydal, 1968) it is possible to calculate amount of organic matter entering soil each yr from the difference between pre-bomb and post-bomb results. For Broadbalk Plot 3 this amounts to 0.41 tons organic carbon per acre per yr: for Park Grass Plot 3 from 1.01 to 0.78 tons, exact figure depending on assumptions about life span of grass roots. For comparison, amount of organic carbon harvested each yr from Broadbalk (Plot 3) is 0.54 tons per acre (grain + straw), from Park Grass (Plot 3) 0.27 tons per acre (2 hay crops).

II. ARCHAEOLOGIC SAMPLES

England

St. Eval series, Cornwall

NPL-134. St. Eval **3060 ± 95**
1110 B.C.
$\delta C^{13} = -24.5‰$

Oak wood charcoal, Sample 34 T/168 from NW side of Hut A floor at St. Eval (50° 28′ 41″ N Lat, 04° 58′ 43″ W Long), Cornwall. Coll. 1955/56 by E. Greenfield and subm. by L. Biek, Ministry of Public Bldg. and Works. *Comment* (A. M. ApSimon): should date late phase (Trevisker Style 4 pottery) of long occupation of house and site by regional Bronze age group characteristic of SW England. Date suggested on archaeologic grounds was ca. 1200 to 1000 B.C. Good agreement with NPL-21, 3070 ± 103 (1120 B.C.) for comparable but perhaps earlier material from Gwithian, Cornwall.

NPL-135. St. Eval **2135 ± 90**
185 B.C.
$\delta C^{13} = -23.8‰$

Wood charcoal (unidentified) Sample 5 from floor of Hut 2 at St. Eval (50° 28′ 41″ N Lat, 04° 58′ 43″ W Long), Cornwall. Coll. 1955/56 by E. Greenfield and subm. by L. Biek. *Comment* (A.M.ApS.): dates occupation of later pre-Roman Iron age house with Glastonbury style pottery. Expected age, based on assocs. in Somerset with material of Late La Tène (= La Tène *III*) character, not before 1st century B.C. Sample might correspond to beginning of settlement. Use of present best value for half-life *viz.* 5730 yr would give age difficult to accept within limits of current archaeologic chronology.

NPL-141. Snail Down, Nr. Everleigh, Wiltshire **3490 ± 90**
1540 B.C.
$\delta C^{13} = -25.2‰$

Oak charcoal, Sample A, Site III, site of funeral pyre at Snail Down (51° 16′ N Lat, 01° 41′ W Long), Wiltshire. Coll. 1955 by N.E.W. Thomas; subm. by L. Biek. *Comment* (N.E.W.T.): 1540 ± 90 B.C. is highly satisfactory archaeologically. Urn which contained primary cremation burial assoc. with funeral pyre from which sample was obtained, was removed in 1805 by Hoare, but from his descriptions it is likely to have been early Bronze age of our collared series. Since a faience bead, generally dated in Britain at 1550/1500 to ca. 1400 B.C., was found with a secondary burial in this barrow, the 1σ date range of 1630 to 1450 B.C. for funeral pyre, burnt just before construction of barrow, places latter with British Early Bronze Age I, for which period 1650/1600 to ca. 1550/1500 B.C. is at present widely accepted.

NPL-133. Brightwell Heath, Suffolk **3720 ± 130**
1770 B.C.
$\delta C^{13} = -25.2‰$

Oak charcoal from Urn C.28 in Primary Barrow C, at Devils Ring group of round barrows (52° 03′ 07″ N Lat, 01° 18′ 04″ E Long), Brightwell Heath, Nr. Ipswich, Suffolk. Coll. 1953 by R. Gilyard-Beer, subm. by L. Biek. *Comment* (R. Robertson-Mackay): sample assoc. with primary burial from Barrow C. Date 1770 ± 130 B.C. is inconsistent with its being typologically early in Secondary Series of collared urns, although it was stratigraphically earlier than Urn C.40, which must belong to end of Primary Series (ca. 1400 B.C.). Whole series of urns from Barrows C and D would appear to belong around this period. Local overlap makes end of Primary Series slightly later than beginning of Secondary Series. Nonetheless 1770 ± 130 B.C. seems too early for this urn.

Durrington Walls series, Wiltshire

NPL-191. Durrington Walls **4400 ± 150**
2450 B.C.
$\delta C^{13} = -25.6‰$

Charcoal, mainly oak, found under bank at Late Neolithic enclosure at depth 2 ft 6 in. (51° 12′ N Lat, 01° 47′ W Long), Durrington Walls, Wiltshire. Coll. 1966 by G. J. Wainwright; subm. by L. Biek. *Comment* (G.W.): date applied to pottery and stone tools of Middle Neolithic type found under bank of Late Neolithic enclosure (Antiquaries Journal XLVII 1967). Measurement consistent with assoc. archaeologic evidence.

NPL-192. Durrington Walls **4270 ± 125**
2320 B.C.
$\delta C^{13} = -25.0‰$

Wood charcoal from occupation debris on hut floor (Fe. 122) at Durrington Walls (51° 11′ N Lat, 01° 47′ W Long), Wiltshire. To date oval hut floor terraced into side of hill and surrounded by stake holes. Such huts in Late Neolithic period are very rare. Coll. 1967 by G. J. Wainwright; subm. by L. Biek. *Comment* (G.W.): date obtained from midden deposit within henge monument which produced Late Neolithic pottery and stone tools. (Antiquity, v. XLII, 1968, p. 20-26). Date earlier than expected on archaeologic grounds.

NPL-199. Arne, Dorset **3690 ± 90**
1740 B.C.
$\delta C^{13} = -28.0‰$

Charcoal, partly oak, from Pit II Burial II at Worgret Barrow (50° 40′ 57″ N Lat, 02° 08′ 29″ W Long), Arne, Dorset. Pit from which charcoal recovered is sealed by turf mound. Coll. 1964 by G. J. Wainwright; subm. by L. Biek. *Comment* (G.W.): date assoc. with bucket urn of Late Bronze age type found under round barrow. (Proc. Dorset Archaeol. and Nat. History Soc. 1966, v. 87, p. 119-125). Measurement considerably earlier (ca. 700 yr) than expected and is inconsistent with assoc. archaeologic evidence.

III. GEOLOGIC SAMPLES

A. Scotland

NPL-127. Carey, Abernethy, Perthshire **7605 ± 180**
5655 B.C.
$\delta C^{13} = -28.2‰$

Peat from buried peat bed exposed in S bank of R. Earn near Carey Farm (56° 20′ 19″ N Lat, 03° 20′ 22″ W Long), ca. 1 mi WNW of Abernethy, Perthshire. Peat bed 2 ft thick, overlain by ca. 19 ft gray silty clay ("carse clay") and rests on deposit of gray silty sand believed to be of estuarine origin and to be assoc. with extensive buried raised beach in vicinity. Sample taken from extreme top of peat bed at site dated by Isotopes, Inc. (I-2796, 9640 ± 140 B.C.). Pollen anal. by S. E. Durno, Macauly Inst., Aberdeen, dates base of peat as Zone IV; insufficient pollen obtained to date extreme top of peat, but analysis of sample 14 cm from top suggests Zone V or early Zone VI. Coll. 1965 by R. A. Cullingford, Exeter Univ., and subm. J. B. Sissons, Edinburgh Univ. *Comment* (R.A.C.): dates are in agreement with pollen evidence and provide an age for burial of peat by carse clay at this point during

Main Postglacial transgression (NPL-127), and minimum age for raised beach in vicinity (I-2796).

B. England

NPL-122. Red Tarn Moss, Great Langdale, Westmorland **3890 ± 90**
1940 B.C.
$\delta C^{13} = -26.4‰$

Wood (*Betula* Sp.) probably pubescens (Silver Birch) from contact between former overlying blanket peat at alt. 1700 ft at high level valley containing Red Tarn between Wrynose Pass and Oxendale (54° 25′ N Lat, 03° 07′ W Long), Great Langdale, Westmorland. Site described by Pennington (1965). Coll. 1965 and subm. by Winifred Pennington (Mrs. T. G. Tutin), Univ. of Leicester. *Comment* (W.P.): date 3890 ± 90 B.P., shows that growth of peat began at this site much earlier than supposed, *i.e.*, much earlier than shift to cooler and wetter climate at opening of Sub-Atlantic period. It suggests that replacement of high-level forests in Lake District by bog came about at different times during Postglacial period in response to soil degradation, rather than as synchronous process in response to change in climate.

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NATIONAL TAIWAN UNIVERSITY RADIOCARBON MEASUREMENTS I

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Natural C^{14} measurements have been performed at the Dept. of Physics, National Taiwan University since 1965, using a cylindrical proportional counter of 1000 ml (Hsu *et al.*, 1965). The proportional counter is operated with CO_2 as the filling gas at a pressure of 1216 mm Hg at room temperature of 20°C. Working voltage is 4.7 Kv, with a plateau length of more than 700 v and a plateau slope of ca. 1% per 100 v. Background is reduced to 5.1 counts/min and the counting rate of the NBS oxalic acid standard is 9.4 counts/min at the normal counting pressure of 1216 mm Hg.

The counter, which is shielded by iron plates of 25 cm thickness and by anti-coincidence with a multianode propane-flow proportional counter of Houtermans' type (Houtermans and Oeschger, 1955), is connected by copper tubing to a pumping system (rotary and diffusion pump with liquid air trap). The vacuum inside the counter is better than 10^{-5} mm Hg.

Samples are first examined under a binocular to pick up as many rootlets as possible and to remove foreign matters. They are then treated with 2% NaOH and 2% HCl. After being rinsed with distilled water and dried, they are burnt in a stream of oxygen. The released CO_2 is passed through hot CuO and absorbed in aqueous ammonia. Then it is precipitated as calcium carbonate after calcium chloride solution is added. After washing with hot distilled water and drying, the pure calcium carbonate is placed in a quartz tube which is kept at a temperature of 400°C and evacuated for more than five hours. The carbon dioxide is liberated by raising the temperature to 800°C and passed through dry-ice trap, frozen out by a serial of liquid air traps, purified by pumping off gaseous impurities between displacement from one trap to another in a solid state with a diffusion pump and finally evaporated into the counter.

Every sample is counted for at least 48 hours. Background determinations have been based on CO_2 obtained from marble. All ages are calculated using as "living" standard 0.95 of the activity measured on NBS oxalic acid and 5570 yr for the half-life of C^{14}, 1950 being the reference year. Errors quoted include the standard deviations of the count rates for the unknown sample, the contemporary standard, and the background.

In this article, results obtained for geologic, archaeologic, and geophysical samples are described. The description of each sample is based on information provided by the person submitting the sample to the laboratory.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. China

NTU-68. Chinmun Island **4690 ± 280**
2740 B.C.

Peat from +30 m, at 0.5 m depth, in farm of Houlong, Chinmun I., Fukien prov., China (24° 24′ N Lat, 116° 25′ E Long). Coll. 1958 by Fu-Yin Lin and subm. 1969 by Pei-Yuan Chen, Dept. of Geol., Natl. Taiwan Univ. *Comment* (P.Y.C.): sample is from peat deposit of Quaternary age from Chinmun I. (Lin, 1958). According to present data, deposit should be from middle Holocene time.

B. Malaysia

NTU-73. Malaysia **>27,000**

Driftwood found at ca. +100 m, 20 m deep, at Ipoh, Perak, Malaysia (04° 34′ N Lat, 101° 06′ E Long). Coll. 1968 and subm. 1969 by Y. Wang, Dept. of Geol., Natl. Taiwan Univ. *Comment* (Y.W.): date is appropriate provided that this part of Malay Peninsula has been subjected to long-term erosion (Ingham and Bradford, 1960) and recent rate of deposition has been very slow.

II. ARCHAEOLOGIC SAMPLES

China

Hsi-hsin-chuang-tze series

Shell (*corbicula* subsulcata) found from Early Iron age shell mound at Hsi-hsin-chuang-tze, Taipei, Taiwan, China (25° 04′ N Lat, 121° 31′ E Long), at +5 m. Coll. 1967 and subm. 1968 by W. H. Sung, Dept. of Archaeol. and Anthropol., Natl. Taiwan Univ.

NTU-52. Hsi-hsin-chuang-tze 1 **1940 ± 190**
A.D. 10

Ca. 1.1 m depth.

NTU-53. Hsi-hsin-chuang-tze 2 **2390 ± 200**
440 B.C.

Ca. 0.7 m depth.

NTU-54. Hsi-hsin-chuang-tze 3 **2010 ± 200**
60 B.C.

Ca. 0.3 m depth. *Comment* (W.H.S.): dates seem to agree with estimates based on cultural materials which may compare in part with the Shih-san-hang site (Sung, 1965), 1444 ± 204 and 1145 ± 206 (NTU-7 and NTU-8, Hsu and Huang, 1965) and the Fan-tze-yuan site 1500 ± 80; Y-1499 (Sung, 1965).

NTU-55. Chishivayan, Ch'i-lin **3060 ± 280**
1110 B.C.

Charcoal from Megalithic site at Chishivayan, Ch'i-lin, Taitung, Taiwan (23° 06′ N Lat, 121° 21′ E Long), at +80 m, 0.8 m depth. Coll. and subm. 1968 by W. H. Sung. *Comment* (W.H.S.): date seems to agree with estimates based on cultural material.

General Comment (W.H.S.): NTU-52, NTU-53, NTU-54, and NTU-55 were all closely connected with floor level of megalithic feature at T1P4 pit (Sung, 1969).

Tung-chiao series

Charcoal fragments in sandy soil, at +300 m, at Tung-chiao, Chi-chi, Nan-t'ou Hsien, Taiwan (23° 45′ N Lat, 120° 47′ E Long). Coll. and subm. 1968 by Judith M. Treistman, Dept. of Archaeol. and Anthropol., Natl. Taiwan Univ.

NTU-56. Tung-chiao 1 **1630 ± 160**
A.D. 320

From ca. 0.68 m depth. *Comment* (J.M.T.): appears younger than expected. Cultural materials may compare in part with Yin P'u site (Huang, 1968), which has C^{14} dates ranging between 2970 ± 80 (Y-1630, Sung, 1965) to 2250 ± 60; Y-1632 (Sung, 1965).

NTU-57. Tung-chiao 2 **3840 ± 380**
1890 B.C.

From ca. 0.5 m depth. *Comment* (J.M.T.): age seems to agree with estimates based on cultural material.

Fukuotun series, Chinmun Island

Shell mound consists of abundant shells, including some blackish and brownish pottery fragments, with or without sculptured patterns. Coll. 1968 by C. C. Lin, Dept. of Geol., Natl. Taiwan Univ., at Chinmun I., Fuchien prov., China (24° 40′ N Lat, 118° 30′ E Long), at ca. +40 m. *Comment* (C.C.L.): thickness of shell mound is ca. 70 cm and the only archaeol. site ever found on the Island.

NTU-63. Fukuotun 1 **5460 ± 320**
3510 B.C.

Shell samples from 10 to 20 cm depth.

NTU-64. Fukuotun 2 **5800 ± 340**
3850 B.C.

Shells from 40 to 50 cm depth.

NTU-65. Fukuotun 3 **6310 ± 370**
4360 B.C.

Shells from 70 to 80 cm depth.

Chang-pin series

Charcoal from LHII (Sung, 1969) Cave, Chang-pin, Taitung, Taiwan (23° 24′ N Lat, 121° 25′ E Long), at +40 m. Coll. and subm. 1969 by W. H. Sung.

5240 ± 260
NTU-69. Chang-pin 1 **3290 B.C.**

From ca. 1.22 m depth from preceramic cultural layer at T4P2NE pit.

5340 ± 260
NTU-70. Chang-pin 2 **3390 B.C.**

From ca. 1.03 m depth from preceramic cultural layer at T3P1S pit.

4970 ± 250
NTU-71. Chang-pin 3 **3020 B.C.**

From ca. 0.75 to 0.85 m depth from preceramic cultural layer of T3P2S pit. *Comment* (W.H.S.): NTU-69, NTU-70, and NTU-71 samples appear younger than expected. Cultural materials may compare in part with those from Tabon Cave, Palawan, Philippines, which have C^{14} dates ranging between 7,000 to 30,000 yr ago (Fox, n.d. and 1968).

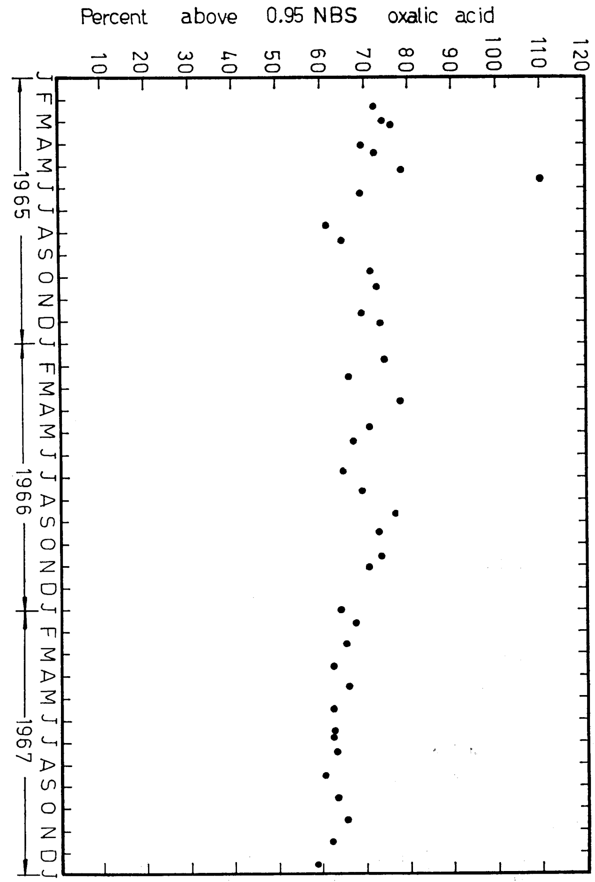

Fig. 1. C^{14} enrichment over NBS standard of atmospheric CO_2 during 1965 to 1967 at Taipei, Taiwan (25° 02′ N Lat, 121° 31′ E Long).

General Comment (W.H.S.): younger dates of samples might be caused by inherent contamination.

III. GEOPHYSICAL SAMPLES

C^{14} in Atmospheric Carbon Dioxide

Atmospheric Radiocarbon Activity series, Taipei

C^{14} content in ground level atmospheric CO_2 is monitored monthly at Taipei, Taiwan (25° 02′ N Lat, 121° 31′ E Long).

The following list contains exposure time of NaOH solutions to air and per cent increase of δC^{14} above 95% NBS oxalic acid. Data are graphed in Fig. 1. The statistical error is less than 1%. *Comment* (authors): the unusually high value of NTU-80 for collection period 19 May—25 May 1965 may be due to the nuclear test in the mainland of China on 13 May 1965.

Sample no.	Exposure time	δC^{14}, %
NTU-74	11 Feb. 1965	+72.2
NTU-75	1 Mar. 1965	+74.1
NTU-76	2 Mar. – 8 Mar. 1965	+76.4
NTU-77	2 Apr. 1965	+69.5
NTU-78	12 Apr. 1965	+72.4
NTU-79	3 May – 18 May 1965	+78.4
NTU-80	19 May – 25 May 1965	+110.1
NTU-81	8 June 1965	+69.0
NTU-82	21 July 1965	+61.3
NTU-83	13 Aug. 1965	+64.7
NTU-84	22 Sept. 1965	+71.2
NTU-85	14 Oct. 1965	+72.6
NTU-86	20 Nov. 1965	+69.2
NTU-87	3 Dec. – 20 Dec. 1965	+73.4
NTU-88	26 Jan. – 31 Jan. 1966	+74.5
NTU-89	16 Feb. – 28 Feb. 1966	+66.0
NTU-90	19 Mar. – 27 Mar. 1966	+77.6
NTU-91	25 Apr. – 30 Apr. 1966	+70.9
NTU-92	11 May – 18 May 1966	+67.2
NTU-93	22 June – 30 June 1966	+64.7
NTU-94	20 July – 29 July 1966	+69.0
NTU-95	20 Aug. – 25 Aug. 1966	+76.6
NTU-96	15 Sept. – 25 Sept. 1966	+72.8
NTU-97	18 Oct. – 27 Oct. 1966	+73.1
NTU-98	2 Nov. – 12 Nov. 1966	+70.4
NTU-99	30 Dec. – 5 Jan. 1967	+64.0
NTU-100	17 Jan. – 22 Jan. 1967	+67.5
NTU-101	16 Feb. – 22 Feb. 1967	+65.1
NTU-102	18 Mar. – 21 Mar. 1967	+62.2
NTU-103	15 Apr. – 20 Apr. 1967	+65.9

Sample no.	Exposure time	δC^{14}, %
NTU-104	15 May – 17 May 1967	+62.2
NTU-105	15 June – 20 June 1967	+62.3
NTU-106	22 June – 27 June 1967	+62.1
NTU-107	15 July – 22 July 1967	+62.8
NTU-108	15 Aug. – 20 Aug. 1967	+60.3
NTU-109	16 Sept. – 21 Sept. 1967	+63.2
NTU-110	15 Oct. – 20 Oct. 1967	+65.1
NTU-111	15 Nov. – 20 Nov. 1967	+61.8
NTU-112	16 Dec. – 21 Dec. 1967	+58.5

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[RADIOCARBON, VOL. 12, NO. 1, 1970, P. 193-204]

SMITHSONIAN INSTITUTION RADIOCARBON MEASUREMENTS VI*

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INTRODUCTION

This list includes those analyses completed December, 1968, with equipment and procedures previously employed here.

All samples were counted at least twice for periods of not less than 1000 minutes each; where necessary, samples were counted for additional periods to obtain the desired consistency of measurements. Errors quoted are derived from measurements of the sample, background, and NBS oxalic acid standard, and have been adjusted where appropriate for small sample dilution. NaOH pretreatments were given all suitable samples for the removal of possible humic contaminants.

Unless otherwise noted, all samples were submitted by members of the Smithsonian staff, each of whom supplied information pertinent to the samples and contributed generously to the discussion of results.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

A. Eastern United States

Shepard site series, Maryland

Charcoal samples from Shepard site 18M03 (39° 5′ N Lat, 77° 26′ W Long), Montgomery Co., Maryland, from refuse attributed to early part of Late Woodland period. Coll. 1967 by Slattery and Woodward, Archaeol. Soc. Maryland; subm. by G. E. Phebus (MacCord *et al.*, 1957).

730 ± 60
SI-553. Midden test pit **A.D. 1220**

Charcoal from 14 to 21 in. depth in midden Test Pit 1, assoc. with bones and sherds.

750 ± 50
SI-554. Refuse pit **A.D. 1200**

Charcoal from 14 to 21 in. depth in Refuse Pit 2, assoc. with animal bones, sherds, and stone artifacts.

Lewis Creek Cement Plant series, Virginia

This site (35° 12′ N Lat, 78° 59′ W Long), Augusta Co., Virginia, is believed to be annual hunting camp of people using fabric-marked Albemarle ceramics, large triangular projectile points, and circular houses. Coll. 1966 by C. G. Holland; subm. by Clifford Evans.

* Published with the approval of the Secretary of the Smithsonian Institution.

1100 ± 60
SI-480. Lewis Creek, Pit 1 **A.D. 850**

Charcoal and charred nuts from Pit 1, 12 in. deep, in clay subsoil.

1410 ± 60
SI-481. Lewis Creek, Pit 10 **A.D. 540**

Charcoal and charred nuts from Pit 10, 10 to 20 in. deep, in clay subsoil.

General Comment: by analogy with Lewis Creek mound, this site was expected to date ca. A.D. 1300 (SI-218, 860 ± 240; and SI-219, 580 ± 200; Radiocarbon, 1967, v. 9, p. 368-9).

900 ± 70
SI-535. Kerns site, Virginia **A.D. 1050**

Charcoal from early phase of Late Woodland period at Kerns site (39° 5′ N Lat, 78° W Long), Clarke Co., Virginia. Sample from 14 to 23 in. depth, assoc. with sherds, animal bones, shell, and stone artifacts. Coll. by Slattery and Woodward; subm. by W. R. Wedel (MacCord, *et al.*, 1957).

B. Western United States

Lansing Man series, Kansas

Right femur of adult *Homo sapiens* (id. by W. M. Bass) at Lansing Man site 14LV315 (39° 15′ N Lat, 94° 51′ W Long), Leavenworth Co., Kansas. Coll. 1902 by M. Concannon; subm. by W. R. Wedel.

6970 ± 200
SI-360. Lansing Man femur **5020 B.C.**

Comment: preservative and glue scraped from specimen before pulverizing and rinsing in HCl.

4610 ± 200
SI-360R. Re-run **2660 B.C.**

Comment: plaster and preservative removed before leaching in acetic acid and hydrolysis in HCl.

General Comment (W.R.W.): left femur dated as GX-0586, 5875 ± 105 (unpub.), and another portion dated as M-1890, 4750 ± 250 (unpub.). All these dates suggest that Lansing Man is assignable to Archaic period, for which there is increasing archaeologic evidence in E Kansas. There were no known direct cultural assocs. with Lansing Man at time of discovery.

Red Fox site series, North Dakota

Red Fox site 32B0213 (46° N Lat, 103° 15′ W Long), Bowman Co., North Dakota, is 4-component site. Top component is probably of Coalescent tradition, 2nd and 3rd components are unidentified, while 4th component is affiliated with McKean complex. Coll. 1966 and subm. by O. L. Mallory (Mulloy, 1954; Strong, 1935).

SI-478. Third component **3850 ± 60**
1900 B.C.

Charcoal from rock-filled basin-shaped firepit at bottom of eolian soil zone, 2.4 ft deep, in 3rd component. Assoc. with bone scraps, knives, scrapers, and large side-notched projectile points.

SI-479. Fourth component **3770 ± 90**
1820 B.C.

Charcoal from rock-filled basin-shaped firepit, 3.4 ft deep in 4th component, at top of soil zone below eolian zone of SI-478. Assoc. with projectile points of McKean complex, stone knives and scrapers, fire and storage pits, and possible dwelling foundation.

General Comment (O.L.M.): dates are essentially contemporaneous and within range of dates for late McKean complex sites elsewhere; no substantial stratigraphic gap existed between 2 components dated.

Cattle Oiler site series, South Dakota

Cattle Oiler site 39ST224 (44° 18′ N Lat, 100° 4′ W Long), Stanley Co., South Dakota, represents both Middle Missouri (Initial and Extended horizons) and Coalescent (Extended horizon) traditions. Coll. 1966 and subm. by D. T. Jones.

SI-474. House F-124 **1140 ± 60**
A.D. 810

Juniperus virginiana (id. by W. Weakly) shaved from exterior of W wallpost butt in burned long rectangular House F-124, 4.0 to 4.5 ft deep. Assoc. with materials of Middle Missouri tradition (Initial horizon). *Comment* (D.T.J.): date would seem somewhat early for Initial Middle Missouri horizon component, although there are similar dates for related Breeden site (39ST16) of A.D. 710 ± 150 (M-608, Radiocarbon, 1960, v. 2, p. 39) and A.D. 850 ± 250 (M-839, ibid., p. 40) for Swanson site (39BR16). Main clustering of Initial Middle Missouri horizon sites, however, extends over 200 or 300 yr period beginning ca. A.D. 1000.

SI-475. House F-130 **860 ± 60**
A.D. 1090

Burned grass matting, possibly from house wall, from fill of burned long rectangular House F-130, 4.5 ft deep, 0.5 ft above house floor. Assoc. with materials attributed elsewhere to Middle Missouri tradition (Initial horizon). *Comment* (D.T.J.): date places this sample in mid-range of dated Initial Middle Missouri horizon sites.

General Comment: for other dates from Cattle Oiler site, see SI-314, SI-315, SI-316, SI-317, and SI-318 (Radiocarbon, 1967, v. 9, p. 370-371); also, SI-379 (Radiocarbon, 1969, v. 11, p. 169).

SI-476. St. John site, South Dakota **1180 ± 60**
A.D. 770

Charcoal from loose lens of charcoal and sand at St. John site 39HU213 (44° 8′ N Lat, 99° 37′ W Long), Hughes Co., South Dakota.

Sample from 2.8 to 3.2 ft deep in Test 18; assoc. with Great Oasis Plain and Incised rimsherds, and with smooth and cord-roughened bodysherds. Coll. 1963 and subm. by R. E. Jensen. *Comment* (R.E.J.): this site is northernmost excavated component of Great Oasis materials; greatest similarities lie with Initial Middle Missouri tradition, with minor ties to Late Woodland sites. This first date for Great Oasis complex in Middle Missouri area falls within period suggested by cultural relationships.

810 ± 60

SI-477. John Ketchen site, South Dakota **A.D. 1140**

Charcoal from floor of burned long rectangular House F-17 at John Ketchen site 39ST223 (44° 18′ N Lat, 100° 4′ W Long), Stanley Co., South Dakota. Assoc ceramics are of Middle Missouri tradition (Extended horizon), although there is some evidence of Coalescent tradition (Extended horizon). Coll. 1966 and subm. by D. T. Jones. *Comment* (D.T.J.): date is compatible with SI-378 (A.D. 1260 ± 140) from this site (Radiocarbon, 1969, v. 11, p. 168), as it is more generally with other dated Extended Middle Missouri horizon sites in this district.

13th and Oak Street series, Oregon

This site (45° 42′ N Lat, 121° 30′ W Long), Hood River Co., Oregon, was excavated 1934 without benefit of records. Wide range of projectile point types suggests occupation from unknown time B.C. to as late as A.D. 1700. Unknown amount of upper portion of site has been removed, and original depth of features is now impossible to assess. Coll. 1966 and subm. by G. E. Phebus.

SI-482. HR3-1, Pit 1 **Modern**

Charcoal from Pit 1, profiled in bank cut, 8 to 13 in. below present surface.

450 ± 70

SI-483. HR3-2 **A.D. 1500**

Charcoal from 4 to 6 in. depth, 6 ft S of SI-482, above.

330 ± 90

SI-484. HR3-3 **A.D. 1620**

Charcoal, 4 to 12 in. below present surface, random sampling of stratum.

C. Mexico

Cueva Blanca series, Mexico

Cueva Blanca (16° 57′ N Lat, 96° 22′ W Long), near Mitla, Oaxaca, Mexico, presents both preceramic and Postclassic horizons. Coll. 1966 and subm. by K. V. Flannery, Univ. of Michigan.

520 ± 50

SI-510. Zone A, Monte Alban V **A.D. 1430**

Charcoal from Zone A, 20 cm deep. Assoc. with corn, squash, zapotes, and ceramics of Monte Alban V period. Sample dates construction of dry-laid stone-walled agricultural terraces outside cave as well as plants grown there.

9470 ± 190
SI-512. Zone D, Coxcatlán phase **7520 B.C.**

Charcoal from Zone D, 65 cm deep. Assoc. with deer and rabbit bones, projectile points typical of Coxcatlán phase, one-hand manos, scrapers, and crude blades. This is richest Coxcatlán occupation level in cave. *Comment* (K.V.F.): expected date was perhaps 5000 B.C. to 3000 B.C. Prior date for Zone D was 2800 ± 190 B.C. (M-2092, this issue), and date on hearth Feat. 18 was 3295 ± 105 B.C. (GX-0782, unpub.). Sample SI-512 possibly contaminated by charcoal redeposited from Zone E, below.

10,910 ± 80
SI-511. Zone E, preceramic **8960 B.C.**

Charcoal from hearth Feat. 15 in Zone E, 55 cm deep. Assoc. with preceramic artifacts.

10,730 ± 220
SI-511R. Re-run **8780 B.C.**

Re-run of additional material from same sample. *Comment*: average of SI-511 and SI-511R is 10,820 ± 120, 8870 B.C. (K.F.V.): Zone E has also yielded dates of 8100 ± 350 B.C. (M-2093, this issue) and 9050 ± 400 B.C. (M-2094, this issue).

Guila Naquitz Cave series, Mexico

Guila Naquitz Cave (16° 57′ N Lat, 96° 22′ W Long), near Mitla, Oaxaca, Mexico, provides materials of several periods of occupation from preceramic to Postclassic. Coll. 1966 and subm. by K. V. Flannery, Univ. of Michigan.

680 ± 80
SI-513. Monte Alban V **A.D. 1270**

Oak charcoal from Feat. 7, maguey roasting pit 50 cm deep. Assoc. with carbonized maguey, firecracked rock, and Monte Alban V pottery. Pit construction similar to that used by modern Zapotecs in area.

1210 ± 40
SI-514. Monte Alban IIIb or IV **A.D. 740**

Oak charcoal from depth 15 cm in Zone A, assoc. with pottery of Monte Alban IIIb or IV, preserved corn, beans, squash, avocado, zapotes, and cotton. *Comment* (K.V.F.): sample dates beginning of agricultural pattern described by Spanish on their arrival in Mitla area.

8620 ± 160
SI-515. Preceramic **6670 B.C.**

Charcoal from 40 to 45 cm depth in Zone B_2, from preceramic horizon containing preserved wild runner beans, cucurbits, and bottle gourds. These are among oldest preserved beans thus far found in Mesoamerica. *Comment*: other material from this level dated as GX-0784, 6910 ± 180 B.C. (unpub.).

D. South America

SI-534. San Geronimo, Venezuela **810 ± 170**
A.D. 1140

Charcoal from San Geronimo site (8° 30′ N Lat, 71° W Long), Liberatador, Mérida, Venezuela. Assoc. with sherds and foundation stones, storage pits, metates and manos; believed to be proto-historic site assoc. with later historic Timotes cultures. Coll. 1965 by Mario Sanoja, Univ. de los Andes, Mérida; subm. by Clifford Evans (Iraida Vargas, Investigaciones arquelogicas en el Alto Chima: la Fase San Geronimo: Inst. de Inv. Economicas y Sociales, Ser. Antropol. no. 1, Univ. Central, Caracas, in press). *Comment*: small sample, diluted. (M.S.): typologically dated between A.D. 900 and A.D. 1500.

El Onio series, Venezuela

El Onio (9° N Lat, 72° W Long), lies in Lake Maracaibo basin, Zulia, Venezuela. Coll. 1965 and 1966 by Mario Sanoja; subm. by Clifford Evans (Sanoja and Vargas, 1968).

SI-531. Cut 1, Level 1 **320 ± 70**
A.D. 1630

Charcoal assoc. with sherds and animal bones 0 to 40 cm deep at bottom of humus layer. *Comment*: many rootlets present. (M.S.): date too recent; site typologically dated between A.D. 800 and A.D. 1000.

SI-532. Cut 2, Level 2 **900 ± 390**
A.D. 1050

Charcoal assoc. with sherds and animal bones from humus layer 40 cm deep. *Comment*: very small sample, diluted. (M.S.): date acceptable.

SI-533. Cut 2, Level 3 **5740 ± 230**
3790 B.C.

Charcoal assoc. with sherds and human skeletal material in sand layer 60 cm deep. *Comment*: very small sample, diluted. (M.S.): date too early.

Rio Grande do Sul, Brazil

Samples of this series represent four sites in the NE Rio Grande do Sul, Brazil, representing Taquara phase (Taquara tradition) and Maquiné phase (Tupiguaraní tradition). Coll. 1965 and 1966 by E. Th. Miller, Brazilian Archaeol. Proj.; subm. by Clifford Evans.

Morro da Formiga

Charcoal from Morro da Formiga Site S-61 (29° 38′ S Lat, 50° 45′ W Long), Taquara Município, type-site for Taquara phase.

SI-409. Taquara phase **1190 ± 100**
A.D. 760

Comment: date acceptable.

Palmeira

Charcoal and sand from Palmeira Site RS-S-282 (29° 40′ S Lat, 50° 55′ W Long), Saparinga, assoc. with pottery of Taquara and Tupiguaraní traditions, immediately above sterile sand.

SI-414. Taquara/Tupiguaraní **1380 ± 110**
A.D. 570

Comment (C.E.): probably dates Taquara tradition.

Paso Fundo

Charcoal samples from Paso Fundo Site RS-M-16 (29° 56′ S Lat, 50° 13′ W Long), Osório Município, assoc. with early Maguiné phase pottery of Tupiguaraní tradition.

SI-410. Cut 1, 20 to 30 cm **520 ± 200**
A.D. 1430

Comment: date too recent.

SI-411. Cut 1, 30 to 40 cm **540 ± 100**
A.D. 1410

Comment: date too recent.

Bassani

Charcoal samples from Bassani Site RS-M-35 (29° 46′ S Lat, 50° 5′ W Long), Osório Município. Assoc. with pottery of middle Maquiné phase. Tupiguaraní tradition.

SI-412. Cut 2, 23 to 28 cm **870 ± 100**
A.D. 1080

Comment: date acceptable.

SI-413. Cut 1, 20 to 25 cm **1070 ± 110**
A.D. 880

Comment: date may be too early.

SI-423. Rio Tibagí, Brazil **Modern**

Charcoal from Site PR-IB-3 (23° 17′ S Lat, 51° W Long), on left bank Tibagí R., Ibiperã Prov., Paraná, Brazil. Sample from 15 to 30 cm depth, assoc. with pottery of Tibagí phase, Tupiguaraní tradition. Coll. 1966 by Igo Chmyz; subm. by Clifford Evans. *Comment*: date acceptable.

Rio Itararé series, Brazil

Charcoal samples from Site SP-BA-7 (23° 35′ S Lat, 49° 36′ W Long), on right bank Rio Itararé, Itaporanga Município, São Paulo, Brazil. Assoc. with pottery of Cambará phase, Tupiguaraní tradition. Coll. 1965 by Igor Chmyz; subm. by Clifford Evans.

SI-417. Cut A, 0 to 15 cm **850 ± 150**
A.D. 1100

SI-418. Cut A, 15 to 30 cm **1870 ± 100**
A.D. 80

Comment (C.E.): date too early.

1130 ± 150
SI-422. Rio Paranapanema, Brazil **A.D. 820**

Charcoal from Site SP-AS-14 on right bank Rio Paranapanema (22° 46′ S Lat, 51° 3′ W Long), Municipio of Iepê, São Paulo, Brazil. Assoc. with pottery of Cambará phase, Tupiguaraní tradition, 0 to 15 cm deep. Coll. 1966 by Igor Chmyz; subm. by Clifford Evans.

E. Africa

Samatite series, West Africa

Samatite (12° 32′ N Lat, 16° 38′ E Long), Pte. St. George in Casamanca region of Senegal, West Africa, is stratified site with pottery and bog-iron. Present occupation is by Diola in nearby villages. Samples are from Cut 2 in Mound C. Levels 0 to 140 cm belong to more recent cultural period with punctate, red-slipped, and shell-tempered pottery; levels 140 to 200 cm are older cultural period with wavy-line, basket-impressed, braid-impressed, and sherd-tempered pottery. These are 1st C^{14} dates for sub-tropical Senegal. Coll. 1966 by O. Linares de Sapir; subm. by Clifford Evans.

380 ± 70
SI-489. 30 to 40 cm **A.D. 1570**

Charcoal from hearth, assoc. with mollusks, mammal bones, and pottery of pre-European Diola occupation.

920 ± 50
SI-490. 50 to 60 cm **A.D. 1030**

Charcoal from hearth, assoc. with mollusks, bones, and pottery of recent ceramic phase of pre-European Diola occupation. *Comment* (O.L. de S.): date too early.

320 ± 100
SI-491. 100 to 110 cm **A.D. 1630**

Charcoal from cooking area, assoc. with pottery of recent ceramic phase of pre-Diola occupations. Very little shellfish assoc. with sample.

490 ± 80
SI-492. 120 to 130 cm **A.D. 1460**

Charcoal from cooking area, assoc. with bones and pottery of recent ceramic phase of pre-Diola occupation. *Comment*: small sample, diluted.

590 ± 140
SI-493. 140 to 150 cm **A.D. 1360**

Charcoal from cache of shell and pottery which represents end of older period characterized by wavy-line, braid- and basket-impressed ceramics. *Comment*: small sample, diluted.

390 ± 70
SI-495. 170 to 180 cm **A.D. 1560**

Charcoal from hearth, assoc. with older ceramic phase. *Comment*: small sample, diluted. (O.L.de S.): sample apparently contaminated with more modern material.

SI-496. 180 to 190 cm **2150 ± 80**
200 B.C.

Charcoal from hearth, assoc. with older ceramic phase. *Comment*: small sample, diluted.

Niomoune series, West Africa

Niomoune (12° 38′ N Lat, 16° 39′ E Long), Dioloulou in Casamanca region of Senegal, West Africa, is 2-period site extending from Late Neolithic/Early Iron age through Late Iron age. Samples from 0 to 60 cm are of more recent period with punctate ceramics, spouts, and red slip in upper levels, but lacking braid- or basket-impressed or wavy-line ware. Levels 60 to 120 cm are of older period with crushed-shell temper, braid- and basket-impressed wares, but lacking red slip. Coll. 1966 by O. Linares de Sapir; subm. by Clifford Evans.

SI-497. 20 to 40 cm **330 ± 50**
A.D. 1620

Charcoal assoc. with bone fragments, iron, and ceramics of more recent phase.

SI-499. 100 to 120 cm **1680 ± 80**
A.D. 270

Charcoal assoc. with older ceramic component and with rice agriculture.

F. Far East

Iwashita Cave series, Japan

Iwashita Cave (33° 14′ N Lat, 129° 45′ E Long), Sasebo City, Nagasaki Pref., Kyushu, Japan, is one of several cave sites yielding Jomon pottery of apparently older age than that provided by open sites. Coll. 1964 by Masuru Aso; subm. by Clifford Evans (Aso, 1968).

SI-501. Layer V, 92 cm **9010 ± 120**
7060 B.C.

Charcoal from 92 cm below cave floor, B-4, Layer V, assoc. with roulette pottery of Earliest Jomon period.

SI-502. Layer V, 1.20 m **8710 ± 100**
6760 B.C.

Charcoal from 1.20 m below cave floor, A-4, Layer V, assoc. with zigzag roulette pottery of Earliest Jomon period. *Comment*: small sample, diluted. (M.A.): depth of A trench est. since original surface was disturbed in construction of bomb shelter during World War II.

SI-503. Layer IX, 1.84 m **11,300 ± 130**
9250 B.C.

Charcoal from 1.84 m below cave floor, C-1, Layer IX, assoc. with plain and nail-marked pottery of Earliest Jomon period. *Comment*: small sample, diluted.

II. GEOLOGIC AND PALEONTOLOGIC SAMPLES

SI-545. Black Beach, Massachusetts **650 ± 70**
A.D. 1300

Peaty marsh material from Black Beach, fronting Sippewissett Marsh (41° 35′ N Lat, 70° 39′ W Long), near West Falmouth, Massachusetts. Sample from 0.6 m depth exposed along shore by migration of sand dunes shoreward from Black Beach toward Sippewissett Marsh. Coll. 1967 and subm. by D. J. Stanley (Stanley and Rhoads, 1967).

Atlantic Shell Bed series, North Carolina

Shells from several localities along coast of North Carolina, id. and coll. by O. H. Pilkey, Duke Univ.; subm. by J. W. Pierce.

SI-518. Shell bed, 19.3 m **9060 ± 100**
7110 B.C.

Ostrea virginia from oyster bank at 19.3 m water depth (34° 51′ N Lat, 70° 12′ W Long).

SI-519. Shell bed, 25.9 m **10,820 ± 200**
8870 B.C.

Ostrea virginia from oyster bank at 25.9 m water depth (33° 52′ N Lat, 77° 13′ W Long).

SI-521. Shell bed, 100 m **26,440 ± 1170**
24,490 B.C.

Spisula solidisima, Mulina lateralis, and *Polynices duplicatus* from 100 m water depth (34° 12′ N Lat, 76° 6′ W Long).

SI-520. Beach surface **7880 ± 80**
5930 B.C.

Ostrea virginia from surface of present beach (34° 36′ N Lat, 76° 32′ W Long). Discolored shells of same species are found at depths 26 m to 91 m. Age of this sample suggests shoreward transport of shells from deep water to beach by storm waves.

SI-539. Barnegat Light Walrus **25,780 ± 1340**
23,830 B.C.

Sample of bone from mexilla adjacent to right tusk alveolus of *Odobenus rosmarus* (id. by C. E. Ray) from Specimen U.S.N.M. 23784 dredged from water depth 18 to 24 m ca. 17 km off Barnegat Light (39° 46′ N Lat, 73° 56′ W Long), New Jersey. Coll. 1966 by scallop dredger (received through Bur. Comml. Fisheries); subm. by C. E. Ray (Ray *et al.*, 1968). *Comment*: small sample, diluted. Sample very hard, leached in warm acetic acid 12 to 14 days before hydrolysis. It has been assumed that walrus shifted its range southward in response to glacial cooling, but assumption has yet to be corroborated by dating of southerly specimens such as this.

SI-459. Saltpeter Cave bear **33,660 ± 3980**
31,710 B.C.

Rib fragments of *Tremarctos floridanus* (*Gidley*), id. by J. E. Guilday, from Saltpeter Cave, Grassy Cove (35° 50′ N Lat, 84° 57′ W Long), Cumberland Co., Tennessee. Northernmost recorded find of extinct Florida Spectacled bear, found as single individual on cave floor beneath flowstone, in narrow side passage 4000 ft from cave entrance. Coll. 1965 by D. C. Irving; subm. by J. E. Guilday and C. E. Ray (Guilday and Irving, 1967). *Comment*: very small sample, diluted. Sample leached in acetic acid before hydrolysis.

Ladds series, Georgia

Carbonate land snails from Ladds site (34° 9′ N Lat, 84° 50′ W Long), Bartow Co., Georgia. Shells assoc. with remains of Late Pleistocene vertebrates. Coll. 1966 by Lewis Lipps; subm. by C. E. Ray (Lipps and Ray, 1967).

SI-458. Shell with fauna **17,520 ± 630**
15,570 B.C.

SI-459. Modern control shell **148% Modern**

Comment: post-modern C^{14} activity of modern control lends confidence to date for shells assoc. with fauna.

SI-456. Ester Creek, Alaska **22,680 ± 300**
20,730 B.C.

Tendon and organic fraction of left tibia of *Felis atrox* (id. T. Galusha) from Ester Creek area frozen-muck (65° N Lat, 147° 30′ W Long). Coll. 1938 by Otto Geist; subm. by C. E. Ray.

Fairbanks Creek series, Alaska

Organic samples from mummified fauna found in frozen muck at Fairbanks Creek (65° N Lat, 147° W Long). Subm. by C. E. Ray.

SI-453. Mammuthus primigenius **15,380 ± 300**
13,430 B.C.

Flesh from lower leg found 85 ft deep, at floor of snow gulch. Coll. 1940 by R. H. Osborne. *Comment* (C.E.R.): sample believed assoc. with artifact now under study by Osborne.

SI-454. Musk-ox hair **17,210 ± 500**
15,260 B.C.

Hair from hind limb of single mummified musk-ox. Coll. 1940 by Otto Geist. *Comment*: see SI-455, below.

SI-455. Musk-ox muscle **24,140 ± 2200**
22,190 B.C.

Muscle from beneath scalp on skull roof of same musk-ox as SI-454, above. *Comment*: very small sample, diluted.

Rio de la Plata series, Argentina

Oyster shells from 2 extensive shell beds off mouth of Rio de la Plata, Argentina. Coll. 1966 and id. by C. M. Urien; subm. by J. W. Pierce.

580 ± 90
SI-516. 18 m water depth **A.D. 1370**

Oyster shell from bed (37° 5′ S Lat, 56° 28′ W Long), 18 m water depth.

420 ± 60
SI-517. 31 m water depth **A.D. 1530**

Ostrea puelchana from shell bed (35° 40′ S Lat, 54° 45′ W Long).

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TRONDHEIM NATURAL RADIOCARBON MEASUREMENTS V

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INTRODUCTION

The present date list covers mainly the datings done from 1964 to 1968. Each sample is measured in one of the two counting units described earlier (Nydal, 1965). The background of the counters has been somewhat reduced during the past few years. Counter 2 with an effective volume of 1.5 L (1.9 L total volume), has a background of 0.9 counts/min, and a recent standard net count of 19.2 counts/min. Counter 3, with an effective volume of 1.1 L (1.3 L total volume), has a background of 2.4 counts/min and a recent standard net count of 14.2 counts/min.

Samples of wood and charcoal are treated with 1 M HCl and 1 M NaOH. Peat and gyttja are only treated with 1 M HCl. Shells are treated with dilute H_3PO_4, and generally 10 to 20% of the weight is removed in cleaning the surface.

All dates are calculated both in years before 1950 and in the A.D./B.C. scale. The applied C^{14} halflife is 5570 yr; its standard deviation of $\pm$ 30 yr is not included in the standard deviation (1σ) of the dating results. Correction for isotopic fractionation is generally performed only for samples with age less than 2000 yr B.P. The NBS recent standard is 95% of the C^{14} activity in the oxalic acid.

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SAMPLE DESCRIPTIONS

I. GEOLOGIC SAMPLES

A. Norway

1. Glacial events, Troms

T-436. Tromsö shell **11,520 ± 150**
9570 B.C.

Shells (*Astarte elliptica, Arctica* [*Cyprina*] *islandica, Chlamys* [*Pecten*] *islandicus*, and *Mya truncata*) from gravel pit, Tromsö Airport, (69° 42′ N Lat, 18° 55′ E Long), Troms, Norway. In low Tromsö-Lyngen moraine ridge S end of runway. Broken and whole shells lie in bouldery glaciomarine clay, overlain by 5 m marine sand and 1 to 3 m till. Coll. and subm. 1964 by B. G. Andersen, Univ. of Oslo.

T-436A. Tromsö shell, outer fraction (55%) **9960 ± 130**
8010 B.C.

11,520 ± 150
T-436B. Tromsö shell, inner fraction (45%) 9570 B.C.

Comment (B.G.A.): glaciomarine clay and shells date a phase prior to advance in which upper till was deposited. This phase is either early Tromsö-Lyngen phase or immediately prior to it. T-436A and T-436B represent, respectively, 55% and 45% of cleaned and surface-treated shell sample. The great difference in age between 436A and 436B suggests considerable contamination of shells by ionic exchange. T-436B is, most likely, minimum age for shells (Andersen, 1968, p. 47).

11,650 ± 220
T-437. Rensaa shell 9700 B.C.

Shell fragments (*Astarte elliptica, Arctica* [*Cyprina*] *islandica, Chlamys* [*Pecten*] *islandicus, Mya truncata,* and *Hiatella* [*Saxicava*] *arctica*) from gravel pit in submarine-deposited Tromsö-Lyngen end moraine at Rensaa (68° 41′ N Lat, 16° 55′ E Long), Troms, Norway. Distinct moraine ridge consists of upper gravelly deltaic sec. at +68 m to 45 m, and a middle marine sec. at +45 m to 15 m. Shell fragments lie in silty parts of gravelly deltaic foreset sec. Coll. and subm. 1964 by B. G. Andersen.

10,830 ± 180
T-437A. Rensaa shell, outer fraction (35%) 8880 B.C.

11,650 ± 220
T-437B. Rensaa shell, inner fraction (65%) 9700 B.C.

Comment (B.G.A.): shell fragments are most probably older than host sediments, corresponding in age to lower lying glaciomarine clay, where same species occur in abundance. Great age difference between T-437A and T-437B suggests considerable contamination by ionic exchange. T-437B probably represents minimum age of shells (Andersen, 1968, p. 64).

11,880 ± 170
T-438. Rensaa shell (average)

Shells (*Astarte elliptica, Arctica* [*Cyprina*] *islandica, Chlamys* [*Pecten*] *islandicus, Mya truncata,* and *Hiatella* [*Saxicava*] *arctica*) from bouldery glaciomarine clay at foot of Rensaa moraine (68° 41′ N Lat, 16° 55′ E Long) Troms, Norway. (See description for T-437). Coll. and subm. 1964 by B. G. Andersen.

11,990 ± 250
T-438A. Rensaa shell, outer fraction (40%) 9040 B.C.

11,770 ± 210
T-438B. Rensaa shell, inner fraction (60%) 9820 B.C.

Comment (B.G.A.): shells were unbroken, and must be of same age as host sediment. They date old phase of Tromsö-Lyngen event or phase prior to this event. Notice agreement between T-438A and B, and T-436B (Andersen, 1968, p. 64).

T-511. Bjorelvnes shell **11,290 ± 210**
9340 B.C.

Shells (*Mya truncata*) from foreset bed of raised outwash delta at +60 m at Bjorelvnes (69° 22′ N Lat, 18° 5′ E Long) Troms, Norway. Coll. and subm. 1965 by B. G. Andersen.

T-511A. Bjorelvnes shell, outer fraction (60%) **11,330 ± 280**
9380 B.C.

T-511B. Bjorelvnes shell, inner fraction (40%) **11,250 ± 310**
9300 B.C.

Comment (B.G.A.): as outwash delta lies in front of a Tromsö-Lyngen end moraine, main part of delta must correspond to this moraine. Shells from slightly higher and lower stratigraphic positions than T-511 have been dated at 10,500 ± 400 yr (T-50, Radiocarbon, 1959, v. 1, p. 46) and 11,150 ± 500 yr (T-174, Andersen, 1968, p. 57), respectively.

T-173. Bröstadbotn shell **10,100 ± 500**
8150 B.C.

Shells (*Portlandia arctica* and *Macoma calcarea*) from rd. cut 1 km E of Bröstad (69° 5′ N Lat, 17° 40′ E Long) Troms, Norway. From glaciomarine clay below 4 m gravel and sand in outwash delta, at +62 m to 68 m. Tromsö-Lyngen end moraine lies 1 km distant. Coll. and subm. by B. G. Andersen. *Comment* (B.G.A.): outwash and possibly clay correspond to Tromsö-Lyngen moraine. Early Younger Dryas age for shells was expected. Sample consisted of thin shells, which could have been slightly contaminated by ionic exchange (Andersen, 1968, p. 61).

T-174. Bjorelvnes shell **11,150 ± 500**
9200 B.C.

Shells (*Macoma calcarea*) from foreset beds of raised outwash delta at +60 m at Bjorelvnes (69° 22′ N Lat, 18° 5′ E Long) Troms, Norway. Coll. and subm. by B. G. Andersen. *Comment* (B.G.A.): as outwash delta lies in front of Tromsö-Lyngen end moraine, main part of delta must correspond with this moraine. Shells from higher-lying foreset beds within delta were dated at 10,500 ± 400 yr (T-50, Radiocarbon, 1959, v. 1, p. 77) and 11,290 ± 210 (T-511, Andersen, 1968, p. 57).

2. Various moraines, Troms

T-490. Sandstrand shell **12,310 ± 100**
(average)

Shells (*Mya truncata*) from gravel pit at +70 m to 78 m at Sandstrand (68° 40′ N Lat, 16° 45′ E Long) Troms, Norway. Broken and whole shells lie in bouldery gravel, 1.5 m thick overlying marine sand with boulders. Ca. 5 m well-sorted beach sand overlies gravel, which must be a near-shore deposit. Some large boulders within gravel are striated; probably ice rafted. Coll. and subm. 1964 by B. G. Andersen.

T-490A. Sandstrand shell, outer fraction (31%) **12,340 ± 160**
10,390 B.C.

T-490B. Sandstrand shell, middle fraction (34%) **12,470 ± 160** **10,520 B.C.**

T-490C. Sandstrand shell, inner fraction (35%) **12,110 ± 160** **10,160 B.C.**

Comment (B.G.A.): since pit is located only 200 m outside Langnes end moraine, boulders within gravel were probably rafted on icebergs from Langnes ice front. Shells and boulder-gravel probably date Langnes moraine, which corresponds to Skarpnes event (Andersen, 1968, p. 33).

T-509. Ulsfjord shell **11,200 ± 190** **9250 B.C.**

Shells (*Macoma calcarea, Mya truncata,* and *Hiatella* [*Saxicava*] *arctica*) from Svensby, Ulsfjord (69° 40′ N Lat, 19° 50′ E Long) Troms, Norway. Shells lie in glaciomarine bouldery clay exposed in gully at ca. +40 m. Coll. and subm. 1965 by B. G. Andersen. *Comment* (B.G.A.): lying immediately outside Skarpnes end moraine and ca. 5 km outside Tromsö-Lyngen end moraine, clay could correspond to either of the 2 events, or to melting between the 2 events (Andersen, 1968, p. 30).

T-510. Balsfjord shell **9140 ± 110** **7190 B.C.** **(average)**

Shells (*Mya truncata and Macoma calcarea*) from river bluff 5 km S of Storsteinnes, Balsfjord (69° 12′ N Lat, 19° 15′ E Long) Troms, Norway. Shells lie in marine clay at ca. +45 m at foot of marine end moraine. Coll. and subm. 1965 by B. G. Andersen.

T-510A. Balsfjord shell, outer fraction (61%) **9190 ± 160** **7240 B.C.**

T-510B. Balsfjord shell, inner fraction (39%) **9100 ± 150** **7150 B.C.**

Comment (B.G.A.): end moraine is correlated with Stordal event. Clay bed continues into moraine, and shells date phase of end moraine and Stordal events (Andersen, 1968, p. 82).

Gratangen shell series

Shells (*Mya truncata, Hiatella* [*Saxicava*] *arctica,* and *Macoma calcarea*) from river bluff at Gratangen (68° 40′ N Lat, 17° 45′ E Long) Troms, Norway, in sand and silt at +25 m to 30 m, overlain by 10-m sec. glaciomarine (till-like) gravelly sediments. Marine silt and sand occur up to +75 m. Coll. and subm. 1965 by B. G. Andersen.

T-512A. Gratangen shell (I), outer fraction (40%) **9560 ± 120** **7610 B.C.**

T-512B. Gratangen shell (I), inner fraction (60%) **9470 ± 160** **7520 B.C.**

T-630. Gratangen shell (II) **9520 ± 190**
7570 B.C.

Comment (B.G.A.); gravelly, till-like sediments must have been deposited partly in contact with glacier or immediately in front of glacier. Located a few m inside marine end moraine, these sediments are probably related to moraine. Sand-silt beds and shells probably date phase shortly prior to glacier advance at which end moraine was deposited; it has been correlated with a Stordal event (Andersen, 1968, p. 86).

T-631. Oldervikdal shell **11,550 ± 190**
9600 B.C.

Shells (*Mya truncata, Hiatella arctica,* and *Macoma calcarea*) from glaciomarine clay 2 km W of Oldervik village (69° 45′ N Lat, 19° 40′ E Long) Troms, Norway. Clay was exposed at foot of marine terrace at +52 m to 54 m. Coll. and subm. 1966 by B. G. Andersen. *Comment* (B.G.A.): date shows valley was ice-free in Alleröd time and 52- to 54-m terrace was formed at or after mid-Alleröd time (Andersen, 1968, p. 43).

T-622. Örlandsmorenen **7620 ± 130**
5670 B.C.

Shell and shell fragments from moraine ridge Uthaug-Brekstad, Uthaug, Örlandet (63° 43′ N Lat, 9° 37′ E Long) S. Tröndelag, Norway. Found in clay 0.30 to 1.40 m deep. Coll. and subm. 1967 by J. L. Sollid, Univ. of Oslo (Sollid, 1965; Holtedahl, 1928; Gjessing, 1966).

3. Driftwood, Northern Norway

T-504. Skjervik **3130 ± 110**
1180 B.C.

Driftwood log (*Larix*) from Skjervik, Nord-Kvalöy, Karlsöy (70° 10′ N Lat, 19° 14′ E Long) Troms, Norway. In peat at +5.42 m and 0.5 m deep. Coll. 1964 and subm. 1965 by H. P. Hansen, Inst. of Geog., Univ. of Oslo (P. T. Tromsö off. lærerskole, Tromsö). *Comment* (H.P.H.): according to shoreline diagrams (Hansen, 1966, Pl. 1; Marthinussen, 1960, Pl. 16) log lies between levels N_2 (ca. 2450 yr B.P.) and N_4 (ca. 4100 yr B.P.; Marthinussen, 1962, Pl. 1 and Pl. 2). Dating result thus agrees with expectation.

T-505. Bekkestrand **4130 ± 100**
2180 B.C.

Driftwood log (*Larix*) from Bekkestrand, Vannöy, Karlsöy (70° 08′ N Lat, 19° 40′ E Long) Troms, Norway. In peat at +6.75 to 7.15 m and 1.0 to 1.5 m deep. Coll. 1964 and subm. 1965 by H. P. Hansen. *Comment* (H.P.H.): log lies in peat bog at level near height of N_4-line (Hansen, 1966, Pl. 1, Marthinussen, 1960, Pl. 16). Dating results (T-504 and T-505) seem to prove position of neoglacial lines; also that relation between height of each of these lines and Main line (S_0) is same in N Troms as in W Finnmark.

4. Various moraines, Southern Norway

T-424. Ra-moraine at Rygge **10,760 ± 200**
8810 B.C.

Shells (*Portlandia arctica*) from a well ca. 4 km E of Rygge (59° 22′ N Lat, 10° 42′ W Long) Östfold, Norway. In glaciomarine clay ca. 4.5 m deep. Numerous boulders lie within clay, and beach-washed boulder layer covers surface. Located on distal slope of distinct marine Ra End moraine. Coll. and subm. 1963 by B. G. Andersen, Univ. of Oslo, and G. W. Holmes, U.S. Geol. Survey. *Comment* (B.G.A.): the clay corresponds to the moraine. Many shells were paired and must be same age as clay and moraine (Andersen, 1968, p. 75).

T-425. Ra-moraine near Sarpsborg **10,080 ± 160**
8130 B.C.

Shells (*Portlandia arctica, Macoma calcarea, Hiatella* [*Saxicava*] *arctica*) from gravel pit ca. 3 km W of Sarpsborg (59° 18′ N Lat, 11° 4′ E Long) Östfold, Norway. Pit lies next to asphalt plant on crest of marine Ra-moraine. Many unbroken shells coll. from glaciomarine bouldery clay. Coll. and subm. 1963 by B. G. Andersen and G. W. Holmes. *Comment* (B.G.A.): stratigraphy suggests clay and shells deposited during late phase, or melting phase of Ra glacier (Andersen, 1968, p. 75).

T-426. Ra-moraine near Sandefjord **10,650 ± 150**
8700 B.C.

Shells (*Portlandia arctica, Macoma calcarea,* and *Hiatella* [*Saxicava*] *arctica*) from gravel pit 5 km SW of Sandefjord (59° 6′ N Lat, 10° 5′ E Long) Vestfold, Norway. Pit is on proximal slope at foot of Ra-moraine. In bouldery glaciomarine clay, overlain by folded, stratified marine silt and till. Coll. and subm. 1963 by B. G. Anderson and G. W. Holmes. *Comment* (B.G.A.): all shells are unbroken; must be same age as clay. Shells and clay date Ra phase prior to advance at which upper till was deposited (Andersen, 1968, p. 75).

5. Various geologic samples

Blomvåg series, Hordaland

Lacustrine sediments from Dale at Blomvåg, Blomöy (60° 30′ N Lat, 4° 53′ E Long) Hordaland, Norway. Coll. with a piston borer (diam. 0.045 m) of type described by J. Olsson (1925). Coll. and subm. 1966 and 1967 by J. Mangerud, Univ. of Bergen. *Comment* (J.M.): from 1941 to 1942, organic sediments were found below till at Blomvåg (Undås, 1942; Holtedahl, 1960). Two earlier radiocarbon dates, T-138 and T-139 (Radiocarbon, 1960, v. 2, p. 88) indicate Bölling age of sediments. Present dates are from bog near locality mentioned, stratigraphically situated above till. Dates confirm till was deposited by ice advance during older Dryas time, and Blomvåg was not covered later by ice (Mangerud, 1968).

T-623. Fine-detritus gyttja, 2.04 to 2.17 m deep **9340 ± 160**
7390 B.C.

Coll. just above clay 0.15 m thick. *Comment* (J.M.): corresponds to Pre-Boreal in pollen diagram, and probably lower part of Boreal.

T-624. Clay gyttja, 2.22 to 2.29 m deep **10,940 ± 180**
8890 B.C.

Coll. just below clay layer (see T-623). *Comment* (J.M.): corresponds to end of Alleröd in pollen diagram.

T-625. Clay gyttja, 2.36 to 2.48 m deep **11,070 ± 190**
9120 B.C.

Comment (J.M.): upper part of Alleröd in pollen diagram.

T-672. Clay gyttja, 2.85 to 2.95 m deep **12,070 ± 180**
10,120 B.C.

Deepest part of organic sediments, 0 to 0.10 m above gray-green clay.

T-594. Vindenes **10,970 ± 180**
9020 B.C.

Shells (*Mya truncata*) from Late-glacial clay at Vindenes, Fusa (60° 9′ N Lat, 5° 38′ E Long) Hordaland, Norway. Clay extends up to +5 m. Coll. 1920 by C. K. Kolderup; subm. 1966 by J. Mangerud. *Comment* (J.M.): date indicates late Alleröd age of Vindenes clay. No evidence of post-clay ice advance is described (Kolderup, 1908). If assumption (*op. cit.*) is right, moraines of Younger Dryas age must be situated E of Vindenes.

T-580. Lepsöyvann, Hordaland **8380 ± 180**
6430 B.C.

Lacustrine (fine detritus) gyttja from Lake Lepsöyvann +0.20 m, Os (60° 9′ N Lat, 5° 24′ E Long) Hordaland, Norway. Coll. with Hiller borer at 9.56 to 9.61 m depth just above marine clay. Coll. and subm. by J. Mangerud. *Comment* (J.M.): dates C^{14} age of isolation of basin from sea. Corresponds to *Corylus* maximum pollen diagram.

T-645. Langeland, Sogn og Fjordane **10,470 ± 170**
8520 B.C.

Shells (*Saxicava pholadis, Mya truncata,* and *Macoma calcarea*) from glaciomarine clay, Langeland, Nordfjordeid, (61° 55′ N Lat, 6° 01′ E Long), Sogn og Fjordane, Norway. Coll. at 10 to 12 m depth (Kaldhol, 1912; Rekstad, 1905). Coll. 1904 by J. Rekstad; subm. 1967 by O.W. Fareth, Univ. of Bergen. *Comment* (O.W.F.): recent investigations in Nordfjord, W Norway (ms. in prep.), indicate several glacial substages, of which the most prominent is Main substage. During that substage long outlet glaciers from ice sheet, occupied basins of Lake Hornindalsvannet and Nordfjord E of Anda, and filled the valley system of Breim and Gloppen. This is indicated by prominent lateral and terminal moraines and a distinctive shoreline in fjord outside the moraines.

Dated shells were just outside outwash delta built in front of glacier occupying Lake Hornindalsvannet. Shell-bearing clay seems to have been deposited in early phase of this substage, probably late Younger Dryas (cf. also T-616, below). Expected age: 10,000 to 11,000 yr.

T-616. Oldevannet, Sogn og Fjordane **9420 ± 200**
7470 B.C.

Shells (*Cyprina islandica* and *Cardium echinatum*) from marine clay at +31 m at E shore of Lake Oldevannet, Haaheim, Olden, Stryn (61° 47′ N Lat, 6° 50′ E Long) Sogn og Fjordane, Norway. Coll. 1965 by I. Beinnes; subm. 1967 by O. W. Fareth. *Comment* (O.W.F.): shells, ca. 2 km from Eide moraine (N end of Lake Oldevannet), are younger than this moraine (Kahldhol, 1912, p. 32, 54). Yet Eide moraine must be younger than Main substage (cf. T-645), when ice front was nearly 50 km further to W, and lateral moraines indicated ice thickness at Eide > 1100 m. Eide substage, possibly including moraines in front of Lakes Strynsvann and Sanddalsvann (Kaldhol, 1912, p. 53), is probably Pre-Boreal.

T-608. Kosmoli, Nordland **2740 ± 90**
790 B.C.

Regenerative *Sphagnum* peat from ombrogenous bog E of Kykkelsvann, Skjerstad (67° 02′ N Lat, 15° 01′ E Long) Nordland, Norway. Coll. with Hiller borer from bottom of bog, at 1.60 to 1.66 m depth, just above basal sand. Coll. and subm. 1966 by D. Moe and U. Hafsten. *Comment*: T-608 dates 1st appearance (absolute pollen boundary) of spruce in pollen profile, ascribed to long-distance pollen transport from N Sweden (Moe, 1968).

T-634. Arstadmyrene, Nordland **1080 ± 60**
A.D. 870
(average)

Peat from bog in Arstad, Beiarn (67° 02′ N Lat, 14° 35′ E Long) Nordland, Norway. Coll. with Hiller borer from *Eriophorum vaginatum* peat at base of bog, at 0.80 to 0.90 m depth, on top of sand. Coll. 1966 and 1967 by D. Moe; subm. 1967 by D. Moe and U. Hafsten. *Comment*: T-634A and T-634B were taken from same peat layer at same depth, but T-634A may have been contaminated because sampling was done in bad weather.

T-634B would appear to be more reliable and dates pronounced increase in pollen of cultivated plants in this diagram (Moe, 1968).

T-634 A. **1010 ± 70**

T-634 B. **1140 ± 80**

Sjetnemyr series, Trondheim

Peat from Bog Sjetnemyr, Trondheim (63° 21′ N Lat, 10° 23′ E Long) Sör-Tröndelag, Norway. Coll. with Hiller borer from depth 4.30 to 4.40 m. Coll. 1967 by Kari Vik Knudsen; subm. 1967 by K. V. Knudsen and U. Hafsten.

T-680. Sjetnemyr I **6040 ± 90**
4090 B.C.

T-681. Sjetnemyr II **8370 ± 90**
6420 B.C.

Comment: T-680 dates very abrupt rise in most warmth-demanding tree species in this region, *viz.* elm and hazel, and sudden decline in preceding maximum of alder curve. At the same time there is an obvious increase in forest density, confirming that phytogeographical optimum in Tröndelag took place during Late Atlantic. T-681 dates dark layer, which marks transition from marine to fresh-water conditions, *i.e.*, date at which this site in Tröndelag (ca. +160 m) became isolated from sea. Date also indicates that high birch and low pine values of pollen spectra near base of diagram, seemingly Pre-Boreal, are actually Boreal (Knudsen, 1969, ms. in prep.).

Flöytmyr series, Akershus

Samples coll. with Hiller borer from same profile in former lake underlying Flöytmyr bog at +192 m in Bærum (59° 59′ N Lat, 10° 37′ E Long) Akershus, Norway. Coll. and subm. 1967 by U. Hafsten.

T-657. Flöytmyr I, nekron mud **9150 ± 150**
7200 B.C.

Coll. 5.50 to 6.50 m below lake surface, just above basal marine nekron clay mud.

T-658A. Flöytmyr II, charcoal **3780 ± 100**
1830 B.C.

Coll. 2.05 to 2.10 m below lake surface.

T-658B. Flöytmyr II, *Sphagnum* peat **3670 ± 90**
1720 B.C.

Coll. 2.05 to 2.10 m below lake surface. *Comment* (U.H.): T-657 confirms pollen-analytic dating made in 1956 of 1) change from birch to pine dominance and contemporaneous immigration of hazel at Pre-Boreal/Boreal zone boundary, and 2) time at which this site (192 m) became isolated from sea. T-658A and T-658B are from start of marked agricultural clearance phase in pollen diagram, which Hafsten (1956) referred to the Late Neolithic (Flint Dagger period) expansion of agriculture. Date fully confirms this hypothesis. Charcoal was sorted out from surrounding peat and the 2 samples dated separately. Results are in good agreement, being within standard deviation, showing that both types of material are equally good for dating purposes.

Röyrtjönn series, Lista

Nekron mud coll. with Hiller sampler from above and below marine transgression layer in small lake, Röyrtjönn, ca. +7 m, near Farm Vollmona, Lista (58° 05′ N Lat, 06° 48′ E Long) Vest-Agder, Norway. Coll. and subm. 1966 by U. Hafsten.

4850 ± 100
T-635. Röyrtjönn A **2900 B.C.**

Coll. 2.65 to 2.78 m below surface, above transgression layer.

6770 ± 150
T-636. Röyrtjönn B **4820 B.C.**

Coll. 2.80 to 3.00 m below surface, below transgression layer. *Comment* (U.H.): samples date Tapes transgression during its maximum phase, coinciding in pollen diagram with major expansion of mixed oak forest. They also confirm archaeologic evidence of early Stone age, temporary (hunting) settlements in this area which were occupied at a time when shoreline lay higher than at present (7 m) and there was abundant game to be found in shallow lakelets and lagoons nearby which would also agree with high percentage of grass pollen in pollen profile.

Vasstöl series, Suldal

Peat from bog at +733 m, below old settlement sites near Vasstölvatn lake, Suldal (59° 43′ N Lat, 06° 52′ E Long) Rogaland, Norway. Coll. and subm. 1965 by U. Hafsten.

5870 ± 100
T-520. Vasstöl A **3920 B.C.**

Coll. at 1.63 to 1.75 m below lake surface.

3700 ± 100
T-521. Vasstöl B **1750 B.C.**

Coll. at 0.91 to 0.94 m below lake surface. *Comment* (U.H.): 2 samples date lower and upper alder maxima of pollen diagram, intervening minimum representing climatic deterioration affecting subalpine region during Late Atlantic and early Sub-Boreal periods.

Ullshelleren series, Röldal

Eriophorum vaginatum peat from profile in bog at +700 m in Valldalen (now site of hydro-electric reservoir), Röldal (59° 54′ N Lat, 06° 55′ E Long) Hordaland, Norway. Coll. and subm. 1964 by U. Hafsten.

2330 ± 90
T-447. Ullshelleren A **380 B.C.**

Coll. at 0.82 to 0.85 m below surface, just above minerogeneous peat layer.

2950 ± 100
T-448. Ullshelleren B **1000 B.C.**

Coll. at 0.97 to 1.00 m below surface, just below minerogeneous peat layer.

8140 ± 140
T-449. Ullshelleren C **6190 B.C.**

Coll. at 3.10 to 3.13 m below surface, just above basal minerogeneous peat layer. *Comment* (U.H.): T-447 and T-448 confirm evidence for agriculture in subalpine region shown in pollen diagram during Late Sub-

Boreal (Bronze age) period with contemporary (2nd) maximum in alder curve.

T-449 dates change from birch to pine dominance in pollen diagram, change which at lower alts occurs >1000 yr earlier (Hafsten, 1965).

Övstebö series, Aurland

Pine wood (T-609) and overlying peat (T-610) in bog at +800 m, ca. 1 km E of Övstebö tourist hut, Aurland (60° 49′ N Lat, 07° 31′ E Long) Sogn og Fjordane, Norway. Coll. and subm. 1966 by U. Hafsten.

T-609. Övstebö A, pine wood **1560 ± 80** **A.D. 390**

Coll. at 0.40 m below surface.

T-610. Övstebö B, peat **1220 ± 80** **A.D. 730**

Coll. at 0.35 m below surface. *Comment* (U.H.): pine stump layer, dated by T-609, shows that despite its absence at this alt today, pine could grow here during Late Roman period. T-610 may indicate subsequent deterioration of climate during Migration period.

T-412. Jettegryte, Flåmsdalen **9300 ± 300** **7350 B.C.**

Nekron mud coll. with Hiller sampler 0.10 m above base of 5-m-deep organic deposit in pothole on Furuberget, a rocky promontory in lower Flåmsdalen valley, Aurland (60° 45′ N Lat, 07° 07′ E Long) Sogn og Fjordane, Norway. Coll. and subm. 1963 by U. Hafsten. *Comment* (U.H.): date shows that this part of valley was free of ice before 7000 B.C. and that high birch and low pine values of pollen spectra in lower part of diagram, seemingly Pre-Boreal, are, in fact, Boreal (Hafsten, 1965; Klovning and Hafsten, 1965).

T-662. Gjördöla, Trollheimen **5340 ± 120** **3390 B.C.**

Pine wood from stump layer, at 2.5 m depth, in gully eroded by Gjördöla stream through bog at ca. +750 m, Oppdal (62° 43′ N Lat, 09° 25′ E Long) Sör-Tröndelag, Norway. Coll. and subm. 1967 by U. Hafsten. *Comment* (U.H.): alder pollen maximum in dated sample agrees with original pollen-analytic conclusion that this maximum falls within Atlantic.

T-743. Hensmoen **$48{,}000 \begin{smallmatrix} +4000 \\ -2000 \end{smallmatrix}$**

Tree stump of spruce from North Hen sandpit at ice-marginal delta Hensmoen-Jytmoen, Ringerike (60° 14′ N Lat, 10° 37′ E Long) Buskerud, Norway. Sample was imbedded in sorted sand, 12 to 15 m below ground surface which is about upper marine limit, +203 m. Sec. was 25 m high, based on bedrock threshold. Lower 10 m consisted predominantly of bedded, stone-free sand; upper part had more pronounced bedding with small, rounded stones (Gjessing, 1966; Holmsen, 1955; Nygård, 1969; Sollid, 1969). Coll. 1966 by L. Kjemperud, Hen; subm. 1968 by T. Nygård, Univ. of Oslo.

Buevannet series, Finnmark

Peat from +195 m at Buevannet, Berlevåg (70° 33′ N Lat, 29° 4′ E Long) Finnmark, Norway. Coll. 1962; subm. 1965 by Rauno Ruuhijärvi, Dept. of Botany, Univ. of Helsinki.

T-495. Buevannet (XVI/1) — **1130 ± 100** / **A.D. 820**

0.50 to 0.60 m below surface.

T-496. Buevannet (XVI/2) — **2510 ± 90** / **560 B.C.**

0.95 to 1.00 m below surface.

T-497. Buevannet (XVI/3) — **8430 ± 170** / **6480 B.C.**

1.95 to 2.00 m below surface. *Comment* (R.R.): T-497 is beginning of paludification in this mire. T-496 is probably age of climatic deterioration in this dist. It can be seen in small absolute arboreal pollen frequency in pollen diagram.

T-498. Russeelvdalen, Finnmark — **3390 ± 100** / **1440 B.C.**

Carex peat from +75 m and 0.65 to 0.70 m below surface in Russeelvdalen, Måsöy (70° 33′ N Lat, 24° 50′ E Long) Finnmark, Norway. Coll. 1962; subm. 1965 by R. Ruuhijärvi. *Comment* (R.R.): *Pinus* (*silvestris*) pollen maximum in Sub-Boreal period. Sample probably gives age of *Pinus* in its northernmost localities at Porsanger fjord.

Natvatn series, Finnmark

Sphagnum peat from +300 m at Natvatn, Karasjok (69° 40′ N Lat, 25° 15′ E Long), Finnmark, Norway. Coll. 1962; subm. 1965 by R. Ruuhijärvi.

T-493. Natvatn (XII/1) — **1190 ± 80** / **A.D. 760**

0.40 to 0.50 m below surface.

T-494. Natvatn (XII/2) — **6690 ± 160** / **4740 B.C.**

1.35 to 1.45 m below surface. *Comment* (R.R.): according to pollen diagram, T-494 indicates coming of *Pinus silvestris* to its present forest limit after Ice age. Paludification in this mire is ca. 2000 yr older. T-493 indicates age of Sub-Atlantic maximum of *Picea abies* pollen in this dist.

6. Ice-cored moraine ridges in Jotunheimen

Various samples of organic fragments from ice in end-moraine system at Gråsubreen, Jotunheimen (61° 40′ N Lat, 8° 37′ E Long), Norway. Stratigraphic position of each sample has been described (Östrem, 1965, p. 5). Ca. 100 kg ice in each ice core was applied for each sample. Ice was melted and, except for rocks and pebbles, enclosed organic material was left for sedimentation. Coll. and subm. 1962 and 1963 by Gunnar Östrem, Norwegian Water Resources and Electricity Bd., Oslo. *Comment* (G.Ö.): this ice was also dated by Tritium (St-1259 to 1272, Östrem, 1964), and ages were <50 years. Probably the discrepancy results from wind-blown humus particles of similar material which is already quite old when deposited on the snowbank (Östrem, 1965).

T-405. Gråsubreen, humus **Modern**

Sample from upper part of ground-moraine sediment outside moraine system. *Comment*: T-405 had C^{14} excess of 4.0 ± 1.0% above recent standard, and is consequently influenced by atomic bomb.

8350 ± 120
T-406. Gråsubreen, humus **6400 B.C.**

Sample from below surface layers in ground moraine (at ca. 0.20 depth). Sieved through 0.5 mm mesh to remove possible plant fragments. *Comment* (G.Ö.): surprisingly great age shows that in high-mountain climate, humus decomposes slowly or not at all. (See also St. 1535 to 1537, Radiocarbon, 1965, v. 7, p. 289).

720 ± 170
T-373. Gråsubreen, moss and buried rock **A.D. 1230**

Moss from rock completely buried in ice core, from which T-356B was coll. *Comment* (G.Ö.): rock was covered with lichen and mosses. Discrepancy between ice dating result (1300 ± 100) and age of moss is believed to originate from wind-blown older particles, possibly humus. Contrary to N Sweden series (see below) no graphite or carboniferous material were present; no corrections for "dead" carbon should be necessary. However, as humus from the vicinity can yield great ages (St-1364 to 1367, Radiocarbon, 1965, v. 7, p. 288) it appears that contamination by such particles increases ages by ca. 1000 yr (see T-397 below).

2370 ± 190
T-356A. Gråsubreen, Pit 3 **420 B.C.**

Ice from outermost moraine ridge. Compare with T-285 (Radiocarbon, 1962, v. 4, p. 173).

1300 ± 100
T-356B. Gråsubreen, Pit 3 **A.D. 650**

Compare with T-273 below.

3780 ± 150
T-357. Gråsubreen, Pit 0 **1830 B.C.**

Sample obtained from one of many ridges in same moraine system. (For location, see Östrem, 1965, p. 5).

4060 ± 170
T-371. Gråsubreen, Pit K **2110 B.C.**

6770 ± 270
T-372. Gråsubreen, Pit M **4820 B.C.**

T-374A. Gråsubreen, Pit R **4190 ± 80**
2240 B.C.

T-397. Gråsubreen, snowbank **1120 ± 90**
A.D. 830

A 500-kg ice sample was taken from ice within permanent snowbank in front of moraine.

B. Sweden

Ice-cored moraine series in Northern Sweden

Organic detritus matter from ice core in end moraine system in front of 2 corrie glaciers in Swedish Lapland (67° 59′ N Lat, 18° 25′ E Long, and 67° 55′ N Lat, 18° 39′ E Long), Sweden. *Comment* (G.Ö.): based upon seismic soundings, geo-electric surveys, and air-photo interpretation, it is thought that several large end moraines in Kebnekaise area contain ice cores (Östrem, 1961, 1965). Crystallographic studies show that, in many cases, ice originates from old snowbanks exposed to free atmosphere before being buried by till of later glacier advances. Age of buried, previously air-borne organic particles will be *maximum* for this glacier advance and formation of end moraine.

T-345A. Vaktposten glacier, Pit A **3800 ± 110**
1850 B.C.

Ca. 150 kg ice near bottom of pit was melted and organic material extracted by sedimentation.

T-345B. Vaktposten glacier, Pit A **1250 ± 110**
A.D. 700

Similar to T-345A, but taken at higher elev. in pit. *Comment* (G.Ö.): some contamination of modern reindeer hair makes results doubtful. Age differences are due to variation in depth. Similar differences are found in modern snowbanks (Östrem, 1965, p. 7).

T-346. Tarfala glacier, Pit C **16,420 ± 450**
14,470 B.C.

Sample similar to T-345A. By sedimentation it was obtained ca. 480 g fine-grained mixture of organic particles and silt. This gave by combustion 2.0 L CO_2. *Comment* (G.Ö.): surprisingly great age led to more comprehensive study of sediment obtained after melting procedure. Microscopic grains of pure graphite were found and assumed to originate from carboniferous Cambro-Silurian rocks in vicinity. Tentative correction for opaque and "dead" graphite grains brings age forward to 13,330 B.P. However, obviously other carbon-bearing ("semimetamorphosed") rock particles were present in sample, for which a reliable correction will be very difficult.

T-347. Tarfala glacier, Pit D **5000 ± 600**
3050 B.C.

Sample coll. similar to T-345A. Contamination of old carbon as in T-346B. *Comment* (G.Ö.): correction for graphite gave age 3000 B.P., a maximum age for ridge, as no correction was made for other carbon-bearing material that may be present.

9660 ± 210
T-348. Tarfala glacier, Pit E **7710 B.C.**

Ice sample from outermost ridge in end moraine system (see also T-346). *Comment* (G.Ö.): correction for graphite grains gave age 7260 B.P., but no correction was possible for other carbonaceous material (St-1535 to 1537, Radiocarbon, 1965, v. 7, p. 289).

C. Finland

Mustajärvi series, Finnish Lappland

Samples coll. with piston drill from bottom of Lake Mustajärvi, Kittilä (25° 15′ E Long, 67° 40′ N Lat), Finnish Lappland. Lake is at +193 m, at depth 2 m, where samples were coll. Coll. and subm. 1963 by Martti Salmi, Inst. of Geol., Turku Univ. C^{14} dates were only based on organic fraction of samples. *Comment* (M.S.): profile of Lake Mustajärvi contains much *Pediastrum* and many fresh-water mollusc shells (Salmi, 1965).

12,690 ± 190
T-407. Mustajärvi 1 **10,740 B.C.**

Pediastrum-gyttja 4.35 to 4.42 m below bottom level, above silt. *Comment* (M.S.): according to pollen analysis, horizon represents beginning of *Betula*-maximum: 74% *Betula*, 25% *Pinus*, 1% *Picea*. Vigorous spread of *Pediastrum* began at this level. Sample contains many dark plant remains.

10,070 ± 150
T-408. Mustajärvi 2 **8120 B.C.**

Pediastrum-lime ooze with fresh-water mollusc shells 5.13 to 5.22 m below bottom surface. *Comment* (M.S.): according to pollen analysis, horizon represents latter part of *Betula*-maximum: 91% *Betula*, 9% *Pinus*. *Pediastrum* decreases at this level.

10,010 ± 140
T-409. Mustajärvi 3 **8060 B.C.**

Pediastrum-lime ooze 4.32 to 4.40 m below bottom surface. *Comment* (M.S.): according to pollen analysis, from upper part of *Betula*-maximum: 2% *Alnus*, 55% *Betula*, 42% *Pinus*. Sediment is striped.

Siikaneva series, W Finland

Samples coll. with piston drill from bog Siikaneva, Ruovesi (61° 50′ N Lat, 24° 10′ E Long), W Finland. Bog is at +170 m. Coll. 1962 and subm. 1964 by Martti Salmi. C^{14} dates were only based on organic fraction of samples.

9100 ± 100
T-432. Siikaneva 1 **7150 B.C.**

Fine and coarse detritus ooze 7.95 to 8.05 m below bog surface.

Comment (M.S.): according to pollen analysis, horizon represents latter part of Pre-Boreal *Betula*-maximum.

8400 ± 130
T-433. Siikaneva 2 **6450 B.C.**

Peat (*Sphagnum-Carex*) 7.45 to 7.55 m below bog surface. *Comment* (M.S.): according to pollen analysis, horizon represents beginning of *Alnus* curve and Boreal *Pinus* period.

4410 ± 90
T-434. Siikaneva 3 **2460 B.C.**

Peat (*Sphagnum-Carex*) 3.95 to 4.05 m below bog surface. *Comment* (M.S.): according to pollen analysis, vigorous spread of *Picea* began in area at that time and horizon represents Sub-Boreal period.

Sottujoki palsa series, N Finland

Samples from various profiles in bog at +391 to 394 m in Sottujoki palsa area, Enontekiö (68° 36′ N Lat, 21° 52′ E Long), N Finland. Coll. 1967 and subm. 1968 by Martti Salmi. *Comment* (M.S.): Profiles 3 and 4 are taken from the palsa, Profile 9 from peat bog adjacent to Sottujoki palsa (Salmi, 1968).

5170 ± 70
T-699. Profile 4, 11/MS **3220 B.C.**

Peat (*Bryales-Carex*) coll. with spade at depth 0.55 to 0.60 m, above permafrost. Pollen analysis (M.S.): *Pinus* maximum.

6010 ± 120
T-700. Profile 4, 12/MS **4060 B.C.**

Peat (*Bryales-wood*) coll. with borer at depth 1.0 to 1.05 m, above silt. Pollen analysis (M.S.): on limit between *Betula* and *Pinus* maximum.

7020 ± 100
T-701. Profile 3, 13/MS **5070 B.C.**

Peat (*Sphagnum-Carex*) coll. with spade at depth 0.55 to 0.6 m, above permafrost. Pollen analysis (M.S.): from middle of *Pinus* maximum with 55% *Pinus*, 44% *Betula*, 1% *Alnus*.

8480 ± 110
T-708. Profile 3, 22/MS **6530 B.C.**

Peat (*Carex-Sphagnum*) coll. with borer at depth 1.7 to 1.8 m. Pollen analysis (M.S.): from middle of *Betula* maximum.

8490 ± 110
T-702. Profile 3, 14/MS **6540 B.C.**

Peat (*Bryales-Carex*) coll. with borer at depth 2.7 to 2.8 m, above silt. Pollen analysis (M.S.): from lowest part of *Betula* maximum.

5030 ± 90
T-707. Profile 9, 18/MS **3080 B.C.**

Peat (*Carex-Sphagnum*) coll. with spade at depth 0.45 to 0.55 m. Pollen analysis (M.S.): from upper part of *Pinus* maximum.

5630 ± 100
T-706. Profile 9, 17/MS 3680 B.C.

Peat (*Carex-Sphagnum*) coll. with borer at depth 0.95 to 1.05 m. Pollen analysis (M.S.): from middle of *Pinus* maximum.

7950 ± 110
T-705. Profile 9, 16/MS 6000 B.C.

Peat (*wood-Sphagnum*) coll. with borer at depth 1.75 to 1.85 m. Pollen analysis (M.S.): at limit between *Betula* and *Pinus* maximum.

8000 ± 120
T-703. Profile 9, 15/MS 6050 B.C.

Sandy gyttja coll. with borer at depth 1.95 to 2.0 m. Pollen analysis (M.S.): from *Betula* maximum.

4930 ± 110
T-709. Pinus, 25/MS 2980 B.C.

Wood (*Pinus*) from Sottujoki palsa with spade at depth 0.95 to 1. 0 m, in contact between peat and frozen mineral soil. *Pinus* trunk was ca. 4 m long. *Comment* (M.S.): Sottujoki palsa situated 21 km N of present *Pinus* forest limit. According to pollen analysis, *Pinus* horizon represents *Pinus* maximum.

D. Canada

L'Anse aux Meadows series, Newfoundland

Peat and gyttja from bogs and tarns at and in surroundings of Norse settlement site, L'Anse aux Meadows, (51° 34′ N Lat, 55° 35 W Long), Newfoundland, Canada. All samples except T-530 and T-531 coll. with Hiller borer. T-530 and T-531 coll. by knife from peat wall of ruins. Coll. 1962 by Kari Henningsmoen, Univ. of Oslo, during one of L'Anse aux Meadows expeditions by Helge Ingstad (see archaeologic section, this date list). Subm. 1965 by K. Henningsmoen. *Comment* (K.H.): 1) vegetation seems to have been very similar ca. 1000 yr ago as it is today. Eventual changes in climatic conditions have been too small to be recognizable in pollen diagrams. Vegetational changes shown by diagrams seem to be a) different in age from Norse settlement, and/or b) due to local ecologic development of sampling sites. 2) European weeds are, so far, found only in a few very young samples, reflecting influence of more recent invasion of European man. 3) Sea level changes during last 7500 yr amount to relative rise of land of ca. 31 m. Sea level may have been 0.50 to 0.75 m higher 1000 yr ago than it is today. Additional sample series have been coll. during summer 1968, to control and supply results so far obtained.

3890 ± 110
T-500. Pond at L'Anse aux Meadows 1940 B.C.

Gyttja from depth 1.75 m below lake surface, at contact between inorganic and organic deposits. Sample from layers 0 to 0.10 m above level of contact.

T-501. Tarn W of Saddle Hill Pond **7500 ± 130**
5550 B.C.

(51° 35′ N Lat, 55° 32′ W Long), ca. +31 m. Gyttja from depth 3.77 m below lake surface, at contact between inorganic and organic deposits. Sample from layers 0 to 0.10 m above level of contact.

T-502. Pond between Ship Cove and Raleigh **6420 ± 130**
4470 B.C.

(51° 34′ N Lat, 55° 40′ W Long), ca. +52 m. Gyttja from depth 2.65 m below lake surface, at contact between inorganic and organic deposits. Sample from layers 0 to 0.10 m above level of contact.

T-503. Tarn at Straitsview **1960 ± 90**
10 B.C.

(51° 36′ N Lat, 55° 31′ W Long), at +1.4 m. Gyttja from depth 0.68 m below lake surface, at contact between inorganic and organic deposits. Sample from layers 0 to 0.10 m above level of contact.

Turf walls, L'Anse aux Meadows

Turf samples from 2 houses, A and F, in dig. Walls had collapsed and shrunk vertically together, and were completely overgrown by younger turf.

T-530. Turf wall, House A **950 ± 90**
A.D. 1000

T-531. Turf wall, House F **950 ± 50**
A.D. 1000

Comment (K.H.): younger turf may have contaminated older walls and consequently given samples somewhat low age, or, more likely, walls were built up of mats of living turf, so that age is close to time when houses were built.

T-532. Skin Pond **6610 ± 150**
4660 B.C.

(51° 33′ N Lat, 55° 35′ W Long), ca. +20 m. Gyttja from depth 1.80 m below lake surface, at contact between inorganic and organic deposits. Sample from layers 0 to 0.10 m above contact.

T-533. L'Anse aux Meadows, peat from dig area **1480 ± 100**
A.D. 470

(51° 34′ N Lat, 55° 35′ W Long), ca. 30 m from House F. Peat cover of varying thickness extends over whole area around dig. Sample from thickest part of peat, *viz.* 0.52 m, and consists of bottom peat layers, 0.42 to 0.52 m below peat surface.

II. ARCHAEOLOGIC SAMPLES

A. Canada

Norse settlement at L'Anse aux Meadows, Newfoundland series

A Norse settlement site was discovered in Newfoundland in 1960 by Helge Ingstad, who previously set forth theory that *Vinland* mentioned in Icelandic sagas and discovered by Norsemen ca. 1000 A.D., must be in Newfoundland (Ingstad, 1959, 1966). He made 7 archaeologic expeditions to the site (1961 to 1968), during which Anne Stine Ingstad was in charge of archaeologic work. *Comment* (H.I.): L'Anse aux Meadows (51° 34′ N Lat, 55° 35′ W Long) is at N tip of Newfoundland somewhat W of Cape Bauld. All sites mentioned below are located on old beach terrace ca. +4 m, and near Épaves Bay. Sandbed is overlain with humus mixed with sand and covered by turf. Eight house sites were excavated, all of which have walls of turf, except for two dug into terrace; also a kiln, 2 large outdoors cooking pits, and sites of 4 boat sheds in a row. According to archaeologic assessment, house sites are Norse and from 1000 to 1100 A.D.

Nearby Épaves Bay is typical bay where driftwood would accumulate along beach in great quantities. In the rather cool climate of N Newfoundland driftwood would be preserved for considerable time. In this way some radiocarbon measurements might indicate older dates than the time when the driftwood was coll.

Laboratory Comment (R.N.): the 16 radiocarbon dates (Turf walls, T-530 and T-531 included, see Fig. 1) have mean value of 910 ± 20 yr A.D., where only statistical errors are suggested in calculation. According to Ingstad, storage time of driftwood may have influenced some dates. Ages of samples coincide with period when C^{14} ages are somewhat greater than true ages (Willis *et al.*, 1960; Suess, 1965; Kigoshi, 1965; Dyck, 1965). Latter error alone could have made all dates 100 yr too old. Mean C^{14} age ca. 1000 yr A.D. is in reasonable agreement with the age expected by Ingstad.

1310 ± 130
T-310. House Site A **A.D. 640**

Scattered charcoal from test excavation 0.25 m below turf surface in sand and above floor of site. Area had been washed over by R. Black Duck Brook. Coll. 1961 by A. S. Ingstad, cooperating with Univ. Mus. of Natl. Antiquities, Oslo; subm. by S. Richter, Norsk Polarinst., Oslo. *Comment*: this is an early test measurement and deals with scattered charcoal from middle part of cultural layer. In 1967 and 1968 excavation was continued down to the floor and extended toward river. A house site of Norse type, 24 m long and 4 m wide (inside measurement) was uncovered. Walls outside are of turf and very distinct. Among finds: some very rusted nails, fragments of iron, lumps of slag, and a ring-headed bronze pin of a type commonly used during Viking period. Radiocarbon measurement from turf wall (T-530) gave age A.D. 1000 ± 90.

1210 ± 110
T-306. House Site B **A.D. 740**

Charcoal from cooking pit, from depth 0.55 m below turf surface in 4.75 × 3.40 m house site with turf walls. Coll. 1961 by A. S. Ingstad; subm. by S. Richter. *Comment*: a piece of slag was found in cooking pit. Of particular interest is stone made Norse type ember pit.

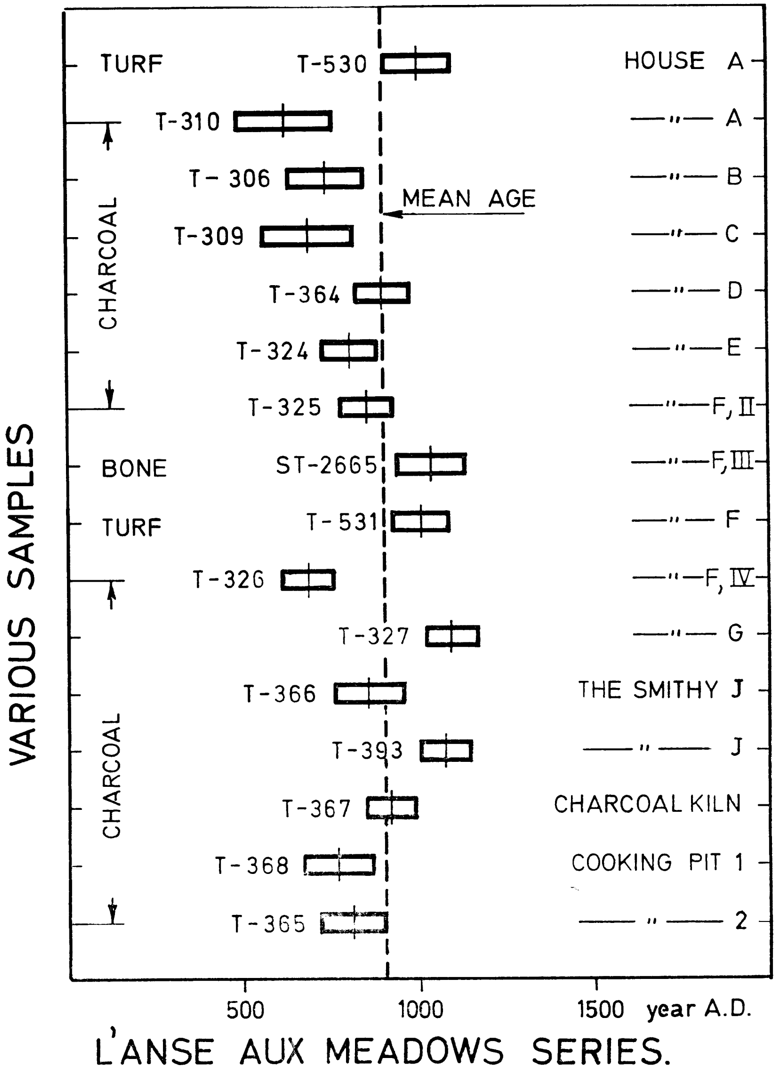

Fig. 1.

T-309. House Site C **1240 ± 130**
A.D. 710

Charcoal from scorched patch at floor level, from depth 0.20 m below turf surface in 2.75 × 2.75 m house site with turf walls. Coll. 1961 by A. S. Ingsted; subm. by S. Richter. *Comment*: 2 pieces of slag were found in house site, and a very rusted nail was found in a small midden outside door.

1050 ± 70
T-364. House Site D **A.D. 900**

Charcoal from fireplace 0.40 m below turf surface in 10 × 5 m NE room of house site. Coll. 1962 by Rolf Petré, Univ. of Lund; subm. by H. Ingstad. *Comment*: house-site, which is Norse type, consists of 2 lengthwise rooms with inside area of 18.3 × 5.0 m, and small projecting room to N. In fireplace where charcoal was coll., a fragment of copper with simple ornaments was found. Other finds: a bone needle and a stonemade ember pit of Norse type beside rusted nails and slag.

1130 ± 70
T-324. House Site E **A.D. 820**

Charcoal from fireplace from depth 0.40 m below turf surface in 3.75 × 3.30 m house site with turf walls. Coll. 1961 by A. S. Ingstad; subm. by H. Ingstad.

1080 ± 70
T-325. House Site F, Room II **A.D. 870**

Charcoal from 1.90 m long fireplace in Rm. II, 0.60 m deep in fireplace, which is Norse type and situated in central largest room. Coll. 1961 by A. S. Ingstad; subm. by H. Ingstad. *Comment*: House Site F has inside area of 14 × 21 m, containing 6 rooms with turf walls. Finds were very rusted nails, fragment of iron and slag, a stone lamp, and a spindle whorl of Norse-type soapstone. Radiocarbon measurement from turf wall (T-531) gave age of 1000 ± 50 yr A.D.

1250 ± 70
T-326. House Site F, Room IV **A.D. 700**

Charcoal from stone fireplace in Rm. IV, 0.30 m deep in NE room, 3.0 × 3.5 m. Coll. 1962 by A. S. Ingstad; subm. by H. Ingstad (see comment for T-325).

925 ± 100
St-2665. House Site F, Room III **A.D. 1025**

Fragment of whale bone from fireplace in House Site F, Rm. III. Coll. 1967 by A. S. Ingstad and M. Stenberger; subm. by M. Stenberger, Univ. of Uppsala. *Comment*: (See comment for T-325). C^{14} dated 1967 by L. Engstrand, Radioactive Dating Lab., Stockholm.

870 ± 70
T-327. House Site G **A.D. 1080**

Charcoal from fireplace 0.50 m deep in 3.0 × 2.75 m house site dug into flank of terrace. Coll. 1961 by A. S. Ingstad; subm. by H. Ingstad. *Comment*: a number of firecracked stones and other features might indicate that this house site was vapor bath as known from Norse area. Finds: 2 nails and fragment of iron.

The Smithy J

Charcoal from forge 0.30 m below peat surface in 3.75 × 2.75 m house site, dug into flank of terrace near Black Duck Brook. Coll. 1962 by K. Eldjarn and G. Gestsson, Natl. Mus. of Iceland; subm. by H. Ingstad.

1090 ± 90
T-366. The Smithy J **A.D. 860**

Inside 2 small stones.

890 ± 70
T-393. The Smithy J **A.D. 1060**

In front of the 2 small stones. *Comment*: flat, partly broken stone, which must have been anvil, was found in central part of floor. Many hundred pieces of slag, some bog iron and small fragments of iron were found on floor, which was partly black from soot and charcoal.

1130 ± 70
T-367. Charcoal kiln **A.D. 820**

Charcoal from bottom of charcoal layer in outdoor pit dug down into terrace ca. 7 m SW of smithy; 0.75 m deep, surface and bottom area 2.0 × 0.8 m and 1.5 × 0.8 m, respectively. Charcoal layer at bottom is ca. 0.20 m thick. Much charcoal also appears above this layer more or less mixed with sand. Coll. 1962 by K. Eldjarn and G. Gestsson; subm. by H. Ingstad. *Comment*: charcoal was probably produced for use in smithy in this pit. Judging from slag found in smithy and several house sites and from bog iron found in turf nearby, charcoal might also have been used for melting bog iron.

1170 ± 90
T-368. Cooking Pit 1, near bridge **A.D. 780**

Charcoal from bottom of pit ca. 10 m W of bridge across R. Black Duck Brook. Pit is 0.70 m deep, with surface and bottom areas 1.10 × 2.30 m and 1.10 × 1.60 m, respectively, dug into beach terrace, containing 0.04 to 0.15 m thick layer of charcoal in bottom, continuing up sides and covered by reddish sand. Layer of firecracked strandstones the size of a fist were on top of and partly in the sand. Coll. 1962 by G. Gestsson and K. Eldjarn; subm. by H. Ingstad.

1140 ± 90
T-365. Cooking Pit 2, near House Site F **A.D. 810**

Charcoal from bottom of pit ca. 10 m NW of House Site F, 0.70 m deep, dug in beach terrace, with turf surface ca. 3 m diam. and bottom diam. 2.30 m. Charcoal layer is 0.05 m thick, and wall layer has maximum thickness 0.20 m. Considerable number of firecracked strandstones the size of a fist were found in layer of sand mixed with soot. Coll. 1962 by R. Petré; subm. by H. Ingstad. *Comment*: fragment of iron found at bottom, and some stone artifacts from natives were found at other places in and outside pit.

B. Marquesas Isles

Tohua series, Marquesas Isles

Charcoal samples from ceremonial place (*Tohua*) in Puamau valley, Hiva Oa, Marquesas Isles (9° 45′ N Lat, 139° 00′ E Long), French Polynesia. Coll. 1963 and subm. 1968 by A. Skjölsvold, Univ. Oldsaksamling, Oslo. *Comment* (A.S.): central part of this *Tohua* consists of platform, showing 2 building steps. In 1st step, platform is built as low, earth bank, and in 2nd step it is built as rectangular stone wall, built on top of earth bank. Some erected slaks were found, which possibly mark extension of *placa* (dancing place) in connection with youngest period of the *Tohua*.

This *Tohua* was excavated as part of survey carried out by Norwegian archaeologic expedition in 1963 to 1964, organized by Thor Heyerdahl and conducted by A. Skjölsvold. Expedition was financed by Kon Tiki Mus., Oslo.

760 ± 70
T-717. Puamau (XX) A.D. 1190

Coll. from thin charcoal layer at bottom of earth bank. *Comment* (A.S.): date should indicate beginning of work on 1st building period.

560 ± 70
T-719. Puamau (H.H.H.) A.D. 1390

Coll. at depth 0.20 m in hole, which belongs to pole of supposed wood construction belonging to oldest part of platform.

400 ± 70
T-720. Puamau (r) A.D. 1550

Coll. in stone packing belonging to youngest part of platform.

400 ± 60
T-721. Puamau (L.L.L.) A.D. 1550

Charcoal coll. from thin charcoal layer on top of earth bank forming 1st building step. Sample should date beginning of construction of stone platform, which comprises last building step.

290 ± 70
T-718. Puamau (M.M.M.) A.D. 1660

Charcoal from fire pit (*umu*) under one of edging stones marking enclosure of ceremonial place (dancing place) connected with the *Tohua*. *Comment* (A.S.): sample should outdate construction of the "fence."

C. Norway

1. Stone age settlement

Radöy series, Hordaland

Charcoal from habitation layer rich in artifacts in settlement site in Straume, Radöy, (60° 43′ N Lat, 4° 43′ E Long), Hordaland, Norway. Site covered area of ca. 300 m^2, and habitation layer had maximum depth 1.5 m. Sample T-430 coll. above shore gravel at bottom of layer (Sq. M.9, Layer VIII). Sample T-431 coll. 0.10 m above rock bottom (Sq. M.9, Layer VIII). Coll. and subm. 1963 by E. Bakka, Historical Mus., Univ. of Bergen.

5100 ± 90
T-430. 0.92 to 0.95 m depth 3150 B.C.

T-431. 0.80 to 0.85 m depth **5010 ± 110**
3060 B.C.

Comment (E.B.): archaeologic date of all undisturbed cultural deposits of site is middle Neolithic period (ca. 1800 to 2500 B.C.); samples belong to earlier cultural phase of site, but not necessarily from beginning of middle Neolithic period. Estimated archaeologic date of samples is 2000 to 23,000 B.C., or ca. 1000 yr later than radiocarbon dates (Bakka, 1964).

Laerdal series, Sogn- og Fjordane

Charcoal from settlement sites in Lærdal. Sample T-671 coll. from alt 1420 m (61° 5′ N Lat, 8° 14′ E Long), and the other from alt 1120 m (61° 1′ N Lat, 8° 7′ E Long), Sogn- og Fjordane, Norway. Coll. and subm. 1967 by A. B. Johansen, Historical Mus., Univ. of Bergen.

T-664. Osen II (E9) **8290 ± 120**
6340 B.C.

Fireplace 0.30 m deep.

T-665. Osen II (F8) **7500 ± 110**
5500 B.C.

0.40 m deep.

T-666. Osen II (F11) **7120 ± 120**
5170 B.C.

Fireplace 0.30 m deep.

T-667. Jukleåni (N13) **7530 ± 100**
5580 B.C.

0.30 m deep.

T-668. Jukleåni (M12) **7410 ± 100**
5460 B.C.

Fireplace 0.40 to 0.50 m deep.

T-669. Jukleåni (T15) **7180 ± 110**
5130 B.C.

0.20 m deep.

T-670. Mörkedöla I (I17) **4830 ± 160**
2888 B.C.

Ca. 0.10 m deep.

T-671. Sulemarki VII (K16-17) **7910 ± 120**
5970 B.C.

0.45 m deep.

Comment (A.B.J.): findings in Stone age settlements in mts. are usually located in region between peat and gravel at maximum depth 0.10 m, (see Sample T-670). Other samples with appreciably higher age were found in sterile gravel at depth ca. 0.30 m. Most reasonable explanation is that settlement occurred in 2 periods with such a great time interval that gravel sedimentation from sand deposit took place. According to our knowledge, about retreat of ice sheet (Hafsten, 1965), earliest settlement in mt. took place at edge of retreating ice sheet. Dates above might give decisive contribution to discussion of character of oldest mt. settlements (Hagen, 1960-1961, p. 141; Odner, 1965, p. 237).

Karmöy series, Rogaland

Samples from several dwelling places at +10 m in Håvik, Avaldsnes, Karmöy, (59° 20′ N Lat, 5° 25′ E Long) Rogaland, Norway. Both material and artifacts vary from one place to the other. Archaeologic date (O.M.): younger Stone age. Coll. 1963; subm. 1964 by O. Möllerop, Stavanger Mus., Stavanger.

T-480. Håvik (K-C-1) — **4040 ± 80**, **2090 B.C.**

Coll. within area of 1 m^2.

T-481. Håvik (M-Grop I) — **3080 ± 100**, **1130 B.C.**

Coll. in charcoal pit.

T-482. Håvik (N-11 h) — **5490 ± 130**, **3530 B.C.**

Coll. in cultural layer within 1 m^2.

T-483. Håvik (T-10 B) — **4970 ± 130**, **3020 B.C.**

Coll. in cultural layer within 1 m^2.

T-484. Håvik (R-4a) — **3330 ± 80**, **1380 B.C.**

Coll. in cultural layer within 1 m^2.

Lysheiane series, Rogaland

Charcoal from several dwelling places in Lysheiane, Rogaland. Archaeologic date: younger Stone age. Samples were mainly coll. 1962; subm. 1964 by O. Möllerop. *Comment* (I.M.): material from these dwelling places is not fully worked out but seems to fit nicely with material from other mt. dwelling places in S Norway. Arrowhead types, scrapers as well as material (flint) seems to indicate that dwelling places were inhabited by people coming up from sea dwellings during seasons.

T-450. Nilsebu (IV B-2) — **4330 ± 120**, **2380 B.C.**

Charcoal at outlet of Nilsebuvann, (59° 10′ N Lat, 4° 6′ E Long), Rogaland, Norway. Found in charcoal layer 0.20 m below peat.

T-452. Storhidler — **7130 ± 140**, **5180 B.C.**

Charcoal at Storhidlervann, Årdal (59° 12′ N Lat, 4° 7′ E Long), Norway, from 0.20 to 0.35 m thick cultural layer with flint artifacts. Coll. 1962 by P. Rolfsen. *Comment* (O.M.): only small part of dwelling place is excavated, and younger artifacts than C^{14} age were also found.

T-445. Fistöylvatn I, Aust-Agder **6770 ± 130**
4820 B.C.

Charcoal from Stone age settlement at +600 m in Finndalen, Valle, (59° 10′ N Lat, 7° 40′ E Long), Aust-Agder, Norway. Finds located in sandy ground just under peat. Sample coll. in carbon concentration found directly on subsoil. Archaeologic date: 5000 to 2000 B.C. Coll. 1961 by A. E. Christensen; subm. 1964 by I. Martens. *Comment* (I.M.): finds belong to same main group (Fosna culture) as those from Finseöya I A, but differ from them in several respects. They are of Mesolithic character, but there is still disagreement between archaeologists on date of earliest phase (Odner, 1965).

T-446. Digernes I, Buskerud **7380 ± 120**
5430 B.C.

Charcoal from Stone age settlement, at +985 m at Ustevatn, Hol, (60° 30′ N Lat, 8° 0′ E Long), Buskerud, Norway. Site was covered with thin layer of peat. Sample from pit 0.50 to 0.60 m deep. Archaeologic date: 5000 to 2000 B.C. Coll. 1960 by Th.S. Eikholm; subm. 1964 by I. Martens. *Comment* (I.M.): finds cannot be connected with any well-known Norwegian Stone age cultures, but are of Mesolithic character. Another sample from same site dated in Copenhagen at 5460 ± 130 B.C. Agreement between 2 dates is extremely good.

T-223. Finseöya (IA), Buskerud **7650 ± 200**
5700 B.C.

Charcoal from Stone age settlement at +1215 m at Finsevatn, Hol, (60° 35′ N Lat, 7° 30′ E Long), Buskerud, Norway. Thin peat layer covered site, mainly containing quartzite artifacts. Sample from fire pit 0.30 to 0.40 m deep. Coll. 1961 by Th.S. Eikholm; subm. by I. Martens. *Comment* (I.M.): finds belong to Fosna group (see comments to T-445). Several dates of related finds from Lærdalsvassdraget come very close to this one (Hagen, 1960).

T-696. Vestredalshelleren, Buskerud **3840 ± 90**
1890 B.C.

Charcoal from rock shelter at +1140 m, 0.50 m deep, at Vestredalstjern, Hol, (60° 45′ N Lat, 7° 40′ E Long), Buskerud, Norway. Artifacts belong to late Stone age and early Metal age. Coll. 1967 by A. Stalsberg; subm. by I. Martens. (See comment to T-697, this date list).

Gråmyra series, Romsdal

Charcoal from 2 different fire pits in older Stone age site in Gråmyra, Otteröy, (62° 41′ N Lat, 6° 39′ E Long), Möre og Romsdal, Norway. Coll. and subm. 1963 by Kr. R. Möllenhus, Videnskapsselskapets Oldsaksamling, Trondheim.

T-422. Gråmyra I **2230 ± 90**
280 B.C.

T-423. Gråmyra II **2060 ± 70**
110 B.C.

Comment (Kr.R.M.): fire pits were on Tapes terrace (b-line). Poor inventory material from site had Mesolithic character. A slate arrow point was single artifact of late Stone age type, found on same level as fire pits. Archaeologic material appears to represent 2 chronologically different settlements. If so, fire pits must evidently belong to later settlement, that is, to same period as slate point.

Trollvika series, Romsdal

Charcoal from Stone age site in Trollvika, Otteroy, (62° 40′ N Lat, 6° 40′ E Long) Möre og Romsdal, Norway. Sample coll. just below cultural layer containing artifacts.

T-555. Trollvika I **2340 ± 90**
390 B.C.

T-556. Trollvika II **2590 ± 100**
640 B.C.

Comment (Kr.R.M.): site may be divided into 3 separate locations. Lowest location with slate objects is beneath Tapes terrace (b-line). Cultural layer on terrace contained stone axes of late Nöstvet type with partly ground surface. Location higher than terrace showed materials of mesolithic character. Dated charcoal from cultural layer indicate that late Nöstvet axe and use of stone artifacts, in general, continued into Metal ages.

Ålbusetra series, Sör-Tröndelag

Charcoal from settlement site at Ålbusetra, Oppdal, (62° 3′ N Lat, 10° 3′ E Long), Sör-Tröndelag, Norway. Charcoal was found among wastes and flint artifacts. Coll. 1963 by H. Aalbu, and subm. 1964 by Marstrander, Univ. Oldsaksamling.

T-442. Ålbusetra, A **6100 ± 120**
4150 B.C.

From fireplace.

T-443. Ålbusetra, B **8530 ± 360**
6580 B.C.

Surface sample.

Comment (S.M.): artifacts of flint and quartz found 1948 to 1949 in moraines in mt. regions between Oppdal and Kvikne at +960 to 990 m. Flint must originate from coastal deposits; types and technique of artifacts indicate connections with finds of Fosna type from dwelling places in coastal area. It is 1st time material of Fosna character has been dated in Tröndelag region.

2. Iron age settlement

Naerbö series, Rogaland

Samples from dwelling place Klauhauane on farm Ödemotland, (58° 39′ N Lat, 5° 7′ E Long) Rogaland, Norway. It contained ca. 20

houses arranged in circle around open place where roof of a square house was found. This house had palisade-like walls of timber. No fire pits were found in site, but several pits were located outside and at same level. Coll. 1960 and subm. 1961 by O. Möllerop. *Comment* (O.M.): square house is either contemporary with, or younger than fire pits. At higher level above house, potsherds older than C^{14} age were found. House must, therefore, either have been set up by digging through older cultural layers or charcoal from walls must have been mixed with younger material.

1590 ± 100
T-328. Klauhauane, central house **A.D. 360**
Charcoal from wall.

1920 ± 100
T-420. Klauhauane, Pit II **A.D. 30**
Charcoal from fire pit.

2080 ± 100
T-421. Klauhauane, Pit III **130 B.C.**
Charcoal from fire pit.

Risavika series, Rogaland

Charcoal from dwelling place Risavika on Tjoraneset, Sola, (58° 55′ N Lat, 5° 8′ E Long), Rogaland, Norway. Archaeologic date: probably younger Iron age. Coll. 1964 to 1965 by several archaeologists at Stavanger Mus.; subm. 1966 by O. Möllerop.

1260 ± 80
T-557. Risavika, Site 13 **A.D. 690**
Charcoal from fireplace in site of farm. Fireplace was situated at long-wall. Archaeologic date: Viking age. Farm dated by potsherds and silver coins. Coll. by O. Espedal.

2400 ± 90
T-581. Risavika Rock Shelter I (a 1) **450 B.C.**
Charcoal from upper cultural layer which contained Iron age pottery.

2040 ± 90
T-582. Risavika Rock Shelter I (a 3) **90 B.C.**
Charcoal from lower cultural layer which contained Stone age artifacts.

2000 ± 80
T-583. Risavika Rock Shelter II (D 10) **50 B.C.**
Charcoal from fire pit in cultural layer of maximum thickness 0.60 m in rock shelter. Found together with ceramics of Iron age type, arrow heads, and a shaft hole axe. Coll. by H. Hansen.

1710 ± 80
T-619. Risavika Site 1 (Sq. H, I 21-22) **A.D. 240**
Charcoal from fire pit in site of boat house. Archaeologic date: ca. 500 A.D. Coll. by P. Rolfsen. *Comment* (O.M.): more detailed analysis of

material shows different stages. Older house partly under wall between Houses 1 and 2 is clearly from 2nd or 3rd century A.D.

T-621. Risavika Site 1 (Sq. H 13) **1620 ± 80**
A.D. 330

Charcoal from middle of site.

T-620. Risavika Site 2 (Sq. T 12) **1780 ± 80**
A.D. 170

Charcoal from site of boat house. Archaeologic date: 0 to 200 A.D. Coll. by P. Rolfsen.

Boat house series, Rogaland

Charcoal from 2 boat house sites in Rogaland. Archaeologic date: late Viking age. Coll. 1960 to 1966 by several archaeologists at Stavanger Mus.; subm. 1967 by O. Möllerop. *Comment*: prior to excavation, boat houses of these types were considered of Viking age or Medieval period.

T-646. Boat house (Sq. H 12) **1080 ± 70**
A.D. 870

Charcoal from site 0.15 to 0.20 m deep in Köbenhavnerbukta, N Sunde, Stavanger, (58° 58′ N Lat, 5° 7′ E Long) Rogaland, Norway. Coll. 1966 by P. Rolfsen.

T-647. Western boat house (S. 8692a) **1300 ± 80**
A.D. 650

T-648. Western boathouse (S. 8692b) **1810 ± 80**
A.D. 140

Wood from site in Nes, Karmöy, (59° 14′ N Lat, 5° 53′ E Long), Rogaland, Norway. Coll. 1960 by B. Myhre. *Comment*: as in Risavika series, older house underlies younger, partly under wall of younger one. Dates of these houses have been used as basis for dating 1.80 m shoreline to Viking age.

Gauthelleren series, Hordaland

Charcoal from rock shelter, Gauthelleren, at +1000 m at Növlevannene, Odda, (59° 48′ N Lat, 6° 56′ E Long), Hordaland, Norway. Samples from very unhomogeneous cultural layer, mostly 0.60 m thick. Coll. and subm. 1964 by K. Odner, Historical Mus., Univ. of Bergen.

T-458. Gauthelleren **1980 ± 100**
30 B.C.

0.45 to 0.55 m depth.

T-485. Gauthelleren **1690 ± 100**
A.D. 260

0.35 to 0.45 m depth.

T-487. Gauthelleren **270 ± 90**
A.D. 1680

0.0 to 0.15 m depth.

Comment (K.O.): layer between 0.35 and 0.55 m contained artifacts of quartz, quartzite, and flint (flat arrowheads, dagger fragments, strike-a-light stone, etc.). Earlier, these would have been dated to late Neolithic time (1800 to 1500 B.C.). From experience of other investigators (Lomborg, 1959; Schönbäck, 1950-51; Strömberg, 1954) it is not unreasonable that in geographically insulated places like Röldal, mentioned artifacts were still in use at birth of Christ. Layer between 0 and 0.15 m contained artifacts such as clincher nails and hones. Archaeologic date of this layer is in agreement with C^{14} age (Odner, 1965 and 1968).

Ullshelleren series, Röldal

Charcoal from rock shelter, Ulshelleren, at +700 m in Valldal, Röldal, (59° 56′ N Lat, 6° 57′ E Long), Hordaland, Norway. Coll. 1963 by I. Altern; subm. 1964 by K. Odner. Archaeologic date: older Iron age, 500 B.C. to 500 A.D.

1610 ± 90
T-459. Ullshelleren **A.D. 440**

0.95 to 0.99 m deep in layer with ceramics, flake of quartzite, etc.

1700 ± 90
T-460. Ullshelleren **A.D. 250**

0.30 m deep in layer with quartzite, artifacts, and iron slag. *Comment* (K.O.): archaeologic date gives ages between 200 and 600 A.D., which agrees with C^{14} age. Pollen analytic investigation and C^{14} measurements were made on peat from site (Hafsten, 1965, and this date list, T-447 to T-449). There is ca. 1000 yr difference in age between peat and charcoal found in same layer.

1860 ± 80
T-697. Heller II, Geiteryggen, Buskerud **A.D. 110**

Charcoal from Rock Shelter E of Geiteryggen, Hol, (60° 40′ N Lat, 7° 40′ E Long), Buskerud, Norway, 0.30 to 0.40 m deep, within area of 1 m^2. Artifacts found belong to late Stone age and early Metal age. Coll. 1967 by A. Stalsberg; subm. by I. Martens. *Comment* (I.M.): finds are of same character as those from Vestredalshelleren (T-445, this date list), which is 3 to 4 km to NW. A sample from latter has been dated to 1890 ± 90 B.C., earliest possible date for archaeologic material. Lower time limit is uncertain, and more thorough treatment of this group of finds has not yet been done. Several radiocarbon samples (*i.e.*, Bordalshelleren, T-217, Radiocarbon, 1964, v. 6, p. 289) have been dated to centuries around A.D., and there is no archaeologic evidence against such a late date.

1080 ± 70
T-383. King Öystein seaport, Agdenes **A.D. 870**

Wood from log of timber found at Agdenes, Örlandet, (63° 38′ N Lat, 9° 46′ E Long), Sör-Tröndelag, Norway. Sample seems to derive from timber construction in a stone pier. Timber is visible at low water level. Coll. 1962 and subm. 1963 by S. Marstrander, Videnskapsselskabets Oldsaksamling, Trondheim. *Comment* (S.M.): according to relations of

Snorre Sturlasson in saga of sons of King Magnus, King Öystein (1103 to 1122 A.D.) made harbor at outermost part of promontory of Agdenes, lying on S side of mouth of Trondheimsfjord. Remnants of pier are on shore at inlet to little bay, which served as harbor.

3. Soapstone and bog iron industries

T-685. Kleberbrudd, Lesja I **1170 ± 80**
A.D. 780

Charcoal from fire pit in 3 compartment house site, ca. +1450 m, soapstone quarries in Sjongsnabben Mt., Lesja, Opland (62° 15′ N Lat, 9° E Long), Norway. Coll. at depth 0.20 m in cultural deposit, consisting of soapstone debris, and fragments of soapstone pots. Coll. and subm. 1967 by A. Skjölsvold, Univ. Oldsaksamling, Oslo. *Comment* (see T-686).

T-686. Kleberbrudd, Lesja IV **1150 ± 80**
A.D. 800

Charcoal from concentration (in fire pit) in house site ca. +1400 m and 400 m apart from T-685 near soapstone quarries below Store Horungen Mt., Lesja, (62° 15′ N Lat, 9° E Long) Opland, Norway. Coll. among soapstone debris at depth 0.15 m. Coll. and subm. 1965 by A. Skjölsvold. *Comment* (A.S.): T-685 and T-686 are 1st C^{14} dates obtained from Norwegian soapstone quarries of Viking age.

T-687. Kleberbrudd, Kvikne **2350 ± 90**
400 B.C.

Piece of wooden spade from soapstone quarry in mts. W of Bubakk, Kvikne (62° 25′ N Lat, 10° 15′ E Long) Hedmark, Norway. Found at depth 3 m, buried by soapstone debris from prehistoric quarry. Coll. and subm. 1967 by A. Skjölsvold. *Comment* (A.S.): if date is reliable, it proves that use of soapstone for mass-fabrication of pots and vessels was fully developed in Norway by Celtic Iron age.

Traces in quarry show that thousands of vessels were manufactured at this spot. A 2nd charcoal sample from this quarry has been subm. for analysis for cross dating result.

T-698. Bog iron, Neset **960 ± 60**
A.D. 990

Charcoal from store close to melting furnace at Martinvika, Neset, Mösstrand, Telemark (59° 50′ N Lat, 8° 10′ E Long), Norway. Coll. and subm. 1967 by I. Martens, Univ. Oldsaksamling, Oslo. *Comment* (I.M.): sample was close to outer wall of housesite in which there was a melting furnace. No datable artifacts were found. Site had been in use for a long time, and radiocarbon date lies within supposed time limits, max. 800 to 1350 yr A.D.

Bog iron, Hovden, Telemark

Samples from housesite at Hovden, Mösstrand, Rauland, Telemark (59° 50′ N Lat, 3° 0′ E Long), Norway. Samples T-506 and T-507 derive, respectively, from remains of roof and melting furnace for bog iron. Coll. 1963; subm. 1965 by I. Martens.

T-506. Hovden, log of timber **1060 ± 80**
A.D. 890

T-507. Hovden, charcoal **780 ± 80**
A.D. 1170

Comment (I.M.): house cannot be dated accurately, but has obviously been inhabited for a long time and bears signs of reconstruction. Archaeologic date: 12th and 13th centuries. Older logs may have been applied; melting furnace is presumably same age as house.

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TARTU RADIOCARBON DATES IV

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The following list includes C^{14} dates and deals with the results of the methodological investigations carried out at the Geobiochemical Laboratory of the Institute of Zoology and Botany of the Academy of Sciences of the Estonian SSR in 1967-1968.

Wood dating from A.D. 1850 ± 10 yr has been used as a contemporary reference standard of modern carbon. All radiocarbon dates were calculated with the half-life of C^{14} being equal to 5568 ± 30 yr. All dates have been calculated from the year 1950.

In recent years several dating laboratories working by the scintillation method have been using solid catalysts for the trimerization of acetylene in benzene (Clark *et al.*, 1959; Noakes, 1965; Pietig and Scharpenseel, 1966). In our laboratory we have applied the alumosilicate-vanadium catalyst suggested by Arslanov and Gromova (1967). Tempered at 500°C, the granulated alumosilicate carrier was treated in vacuum with a solution containing 90 g of V_2O_5 and 270 g of $(COOH)_2 \cdot 2\,H_2O$ in 0.5 l of distilled water for 1 kg of the carrier. After washing with distilled water, drying and tempering at 500°C the catalyst is ready for use. The absorption rate of C_2H_2 on the catalyst (50 g of the catalyst and 12 l of C_2H_2) is 6 l per hour. The benzene yield (calculated on the basis of C_2H_2) is 92 to 98%.

The synthesis of carbide from carbonaceous samples is performed by the Barker method (1953) according to the formula:

$$2\,CO_2 + 10\,Li \xrightarrow{660°C} C_2H_2 + 4\,Li_2O$$

When the molar ratio of CO_2:Li equals 1:10, the C_2H_2 yield (on the basis of CO_2) accounts for 92%.

An additional one-channel scintillation device has been assembled and adjusted (Ilves, 1969). With 25 ml of benzene, the pure count of modern carbon has been 147.96 ± 0.23 cpm, the rate of the background was 8.31 ± 0.054 cpm, the maximum determinable age being 49,800 yr (48 hrs counting, 4 σ criterion).

I. GEOLOGIC SAMPLES

Kalina series

Kalina peat bog is located in NE Estonia, 14 km SW of town Jõhvi. Samples from vertical wall of prospecting shaft dug 1 m from drainage channel crossing S part of bog (Ilves, E. and Sarv, A., 1969, Stratigraphy and chronology of lake and bog deposits of Kalina Peat Bog: ENSV TA Toimetised, Keemia, Geoloogia, v. 18, no. 4, in press, in Russian).

Coll. 1966 and subm. by E. Ilves and A. Sarv, Inst. Geol. Pollen analyses by A. Sarv. The Holocene is subdivided into pollen zones

TABLE 1

Kalina peat bog, stratigraphy of section

Depth (cm)	Sediment type	Degree of decomposition (humification %)
to 15	*Sphagnum fuscum* peat	30
15 to 110	*Eriophorum* and *Sphagnum* peat	35 to 45
110 to 195	*Sphagnum fuscum* peat	25
195 to 200	pine and *Sphagnum* peat	30
200 to 205	*Eriophorum* and wood peat	30
205 to 230	wood and reed peat	35
230 to 235	*Sphagnum* peat	35
235 to 240	reed and *Sphagnum* peat	30 to 35
240 to 250	wood and reed peat	30 to 35
250 to 265	reed peat	25 to 30
265 to 270	*Bryales* and reed peat	25
270 to 275	peat sapropel	
275 to 290	brown sapropel, compact	
290 to 302	olive-green sapropel containing aleurite	
302 +	moraine	

according to T. Nilsson system (1961). Botanical analyses by H. and J. Allikvee.

TA-143. Kalina **1415 ± 125**
A.D. 535

Eriophorum and *Sphagnum* peat at depth 55 to 60 cm. Contact between Pollen Zones SA_1 and SA_2.

TA-155. Kalina **2905 ± 65**
955 B.C.

Eriophorum and *Sphagnum* peat at depth 75 to 80 cm. Contact between Pollen Zones SB_2 and SA_1 (Sub-Boreal—Sub-Atlantic contact).

TA-144. Kalina **3520 ± 65**
1570 B.C.

Eriophorum and *Sphagnum* peat at depth 85 to 90 cm. Pollen Zone SB_2, maximum of spruce.

TA-145. Kalina **3595 ± 65**
1645 B.C.

Eriophorum and *Sphagnum* peat at depth 95 to 100 cm. Contact between Pollen Zones SB_1 and SB_2.

TA-146. Kalina **4660 ± 95**
2710 B.C.

Sphagnum fuscum peat at depth 135 to 140 cm. Pollen Zone SB_1.

TA-147. Kalina **4805 ± 65**
2855 B.C.

Sphagnum fuscum peat at depth 145 to 150 cm. Pollen Zone SB_1.

TA-148. Kalina **4745 ± 95**
2795 B.C.

Sphagnum fuscum peat at depth 155 to 160 cm. Contact between Pollen Zones AT_2 and SB_1 (Atlantic-Sub-Boreal contact).

TA-149. Kalina **5395 ± 70**
3445 B.C.

Sphagnum peat with arboreal remains at depth 195 to 200 cm. Pollen Zone AT_2, rational boundary of spruce pollen.

TA-150. Kalina **6410 ± 70**
4460 B.C.

Wood and reed peat at depth 245 to 250 cm. Pollen Zone AT_2, empirical boundary of spruce and oak pollen.

TA-151. Kalina **7480 ± 190**
5530 B.C.

Bryales and wood peat at depth 265 to 270 cm. Pollen Zone AT_1, maximum of walnut.

TA-152. Kalina **8040 ± 75**
6090 B.C.

Brown compact sapropel at depth 281 to 284 cm. Contact between Pollen Zones BO_2 and AT_1 (Boreal-Atlantic contact).

TA-153. Kalina **9130 ± 135**
7180 B.C.

Olive-green sapropel containing aleurite at depth 293 to 296 cm. Contact between Pollen Zones PB and BO_1 (Pre-Boreal and Boreal contact).

Ulila series

Ulila peat bog lies in depression of Lake Võrtsjärv. Samples from wall of prospecting shaft dug ca. 1 km N of settlement Ulila (Tartu Dist., Estonian SSR).

Samples coll. 1965 and subm. by E. Ilves. Pollen analyses by A. Sarv, botanical analyses by U. Valk, Silvicultural Research Lab., Ministry of Forest Management and Conservation of Estonian SSR.

TA-164. Ulila **515 ± 60**
A.D. 1435

Reed and *Sphagnum* peat at depth 25 to 30 cm. Pollen Zone SA_2.

TA-201. Ulila **1740 ± 70**
A.D. 210

Reed and *Sphagnum* peat at depth 55 to 60 cm. Pollen Zone SA_1.

TABLE 2

Ulila peat bog, stratigraphy of section

Depth (cm)	Sediment type	Degree of decomposition (humification %)
to 30	wood peat	40 to 50
30 to 70	reed and *Sphagnum* peat	25 to 35
70 to 100	wood and reed peat	35 to 40
100 to 270	reed peat	25 to 35
270 to 285	calcareous sapropel with admixture of reed peat	
285 to 315	lacustrine lime	
315 to 490	clay containing lacustrine lime in top part	
490 +	sand	

TA-110. Ulila **2540 ± 70**
590 B.C.

Wood and reed peat at depth 70 to 75 cm. Pollen Zone SA_1.

TA-111. Ulila **3420 ± 90**
1470 B.C.

Wood and *Sphagnum* peat at depth 90 to 95 cm. Pollen Zone SB_2, maximum of spruce.

TA-112. Ulila **4635 ± 90**
2685 B.C.

Reed peat at depth 125 to 130 cm. Pollen Zone SB_1.

TA-113. Ulila **4905 ± 70**
2955 B.C.

Reed peat at depth 155 to 160 cm. Contact between Pollen Zones AT_2 and SB_1 (Atlantic and Sub-Boreal contact).

TA-114. Ulila **5260 ± 70**
3310 B.C.

Reed peat at depth 170 to 175 cm. Pollen Zone AT_2.

TA-115. Ulila **5460 ± 70**
3510 B.C.

Reed peat at depth 180 to 185 cm. Pollen Zone AT_2.

TA-116. Ulila **5580 ± 70**
3630 B.C.

Reed peat at depth 195 to 200 cm. Pollen Zone AT_2, rational boundary of spruce pollen.

TA-117. Ulila **5890 ± 75**
3940 B.C.

Reed peat at depth 205 to 210 cm. Pollen Zone AT_2, maximum of lime pollen and accumulation curve of broad-leaved species.

TA-118. Ulila **6315 ± 70**
4365 B.C.

Reed peat at depth 215 to 220 cm. Pollen Zone AT_1.

TA-119. Ulila **6580 ± 90**
4630 B.C.

Reed peat coll. at depth 255 cm to 260 cm. Pollen Zone AT_1, maximum of elm and walnut.

TA-120. Ulila **6915 ± 70**
4965 B.C.

Calcareous sapropel with admixture of peat at depth 280 to 285 cm. Pollen Zone AT_1, empirical boundary of spruce pollen.

Orgita series

Orgita peat bog is in NW part of Estonian SSR, 4 km NE of settlement Märjamaa. Samples from vertical wall of prospecting shaft dug 1.5 m from drainage channel.

TABLE 3

Orgita peat bog, stratigraphy of section

Depth (cm)	Sediment type	Degree of decomposition
to 140	*Sphagnum* peat	little-decomposed
140 to 240	*Sphagnum* peat containing *Eriophorum* (particularly in lower part)	"
240 to 245	*Sphagnum* peat	"
245 to 252	*Eriophorum* and *Sphagnum* peat	"
252 to 260	wood and *Sphagnum* peat	"
260 to 270	sedge peat containing wood	"
270 to 280	*Bryales* and sedge peat	medium-decomposed
280 to 295	*Bryales* and sedge peat containing wood	"
295 to 310	wood peat	"
310 to 317	moraine containing organics	"
317 to 330 +	moraine	

Samples coll. 1967 and subm. by E. Ilves and A. Sarv. Pollen analyses by A. Sarv.

TA-226. Orgita **790 ± 60**
A.D. 1160

Sphagnum peat at depth 150 to 155 cm. Contact between Pollen Zones SA_1 and SA_2.

TA-227. Orgita **1470 ± 70**
A.D. 480

Sphagnum peat at depth 215 to 220 cm. Pollen Zone SA_1.

2240 ± 70
TA-228 A. Orgita **290 B.C.**

Sedge peat at depth 260 to 265 cm. Pollen Zone SA_1. *Comment*: sample contained fragments of carabid beetles *Pterosctichus* sp., *Agonum* cf. *ericeti* (Panz.), and *Agonum* cf. *mülleri* (Hbst.); and of dytiscid beetles, *Ilybius* sp. Determinations were carried out by Prof. H. Haberman.

2000 ± 70
TA-228 B. Orgita **50 B.C.**

Wood (pine) coll. at depth 260 to 265 cm. Pollen Zone SA_1.

2620 ± 75
TA-229. Orgita **670 B.C.**

Bryales and sedge peat at depth 270 to 275 cm. Contact between Zones SB_2 and SA_1. (Sub-Boreal–Sub-Atlantic contact).

3815 ± 70
TA-230. Orgita **1865 B.C.**

Wood peat at depth 300 to 205 cm. Pollen Zone SB_2.

6350 ± 80
TA-178. Vesiku **4400 B.C.**

Reed peat on right bank of R. Vesiku (I. Saaremaa). Peat layer, 30 cm thick, underlies coastal sands and gravel of Littorina Sea. Organogenous layer is underlain by lacustrine clayey marl. Sample coll. at depth 0 to 3 cm (from top of organogenous layer). Pollen analysis by H. Kessel, Inst. Geol. Sample is referred to Pollen Zone VII (after von Post and Nilsson). Coll. 1966 and subm. by J.-M. Punning.

7960 ± 80
TA-179. Vesiku **6010 B.C.**

Sample from same complex as TA-178 at depth 33 to 36 cm from top of organogenous layer. Sample is assigned to Pollen Zone VII (after von Post and Nilsson).

Gorelovo series

Profile Gorelovo is situated in SW suburb of Leningrad. Description of this dist. is given in monograph by K. Markov (1931). Recent geomorphologic and palynologic investigations carried out in this dist. and a number of C^{14} datings indicate that organogenous materials accumulated in early Holocene and were later probably submerged under river deposits (Serebryanny and Punning, 1969).

9470 ± 120
TA-184. Gorelovo **7520 B.C.**

Peat at depth 110 to 112 cm.

9740 ± 80
TA-185. Gorelovo **7790 B.C.**

Peat at depth 112 to 114 cm.

TA-186. Gorelovo **10,010 ± 120**
8060 B.C.

Peat at depth 114 to 116 cm.

TA-187. Gorelovo **10,070 ± 130**
8120 B.C.

Peat at depth 120 to 122 cm.

Märkys and Ula series

In many places along R. Märkys and its left tributary R. Ula in SE Lithuania, one can observe among sands dark-colored organogenous layers of interstadial character. These sediments contain aleurites, sapropels, peat, sometimes accumulations of considerable woody remains (*Pinus silvestris* L.). Shells of subfossil mollusks have been found in all profiles.

TA-188. Mančiagire **11,630 ± 120**
9680 B.C.

Fragment of tree trunk from left bank of R. Ula, ca. 7 km below Mančiagire. Tree trunk is embedded in layer of dark-gray aleurite peat overlain by sands 16 m thick. Limonitized sands underlie organogenous layer. Coll. 1967 and subm. by J.-M. Punning and P. Vaitiekunas, Vilnius State Univ. *Comment*: C^{14} dating by Inst. Geol., Acad. Sci., Lithuanian SSR put putative age of sample at 17,340 ± 840 yr (Shulia *et al.*, 1967).

TA-240. Mančiagire **11,930 ± 110**
9980 B.C.

Moss peat from same layer as TA-188.

TA-189. Pauosupe **8790 ± 90**
6840 B.C.

Tree trunk from right bank of R. Uosupe near village Pauosupe. Sample is interbedded in fine- and medium-grained sands at depth 650 to 660. Coll. 1967 and subm. by J.-M. Punning.

TA-190. Rudnja **11,530 ± 120**
9580 B.C.

Tree trunk on right bank of R. Ula near village Rudnja. Wood and peat lie interbedded in complexes of horizontal layers of sand. Overlying layer is 9 m thick, ca. 2 m back from edge of water. Check sample was taken from same trunk. Coll. 1967 and subm. by J.-M. Punning and P. Vaitiekunas. *Comment*: datings by Uppsala C^{14} Lab. are as follows:

U-2107: 12,080 $^{+460}_{-430}$

U-675: 11,970 ± 180 (Olsson, written commun.)

TA-191. Zervynos **12,650 ± 130**
10,700 B.C.

Peat on left bank of R. Ula near village Zervynos, from prospecting shaft 5 m from place of contact of floodland with lower slope of left bank of R. Ula. Coll. 1967 and subm. by J.-M. Punning and P. Vaitiekunas. *Comment*: absolute ages of samples TA-124 and TA-125 from same profile had been previously dated at 11,930 ± 110 and 12,160 ± 120, respectively (Radiocarbon, 1968, v. 10, p. 128-129).

11,730 ± 110
TA-192 A. Pamärkes **9780 B.C.**

Wood on right bank of R. Märkis near village Pamärkes. Lake and bog deposits are included in sand beds. Coll. 1967 and subm. by J.-M. Punning and P. Vaitiekunas. Age of sample was determined by lignin fraction.

11,820 ± 110
TA-192 B. Pamärkes **9870 B.C.**

Same piece of wood as TA-192 A, but its age was determined by cellulose fraction.

8560 ± 110
TA-195. Ohtla **6610 B.C.**

Brown wood peat N of town Keila (N Estonia), 17 cm thick, overlain by deposits of Littorina Sea and clayey-aleuritic interbed of transgression of Lake Ancylus. Coll. 1967 by S. Püvi, Geol. Board; subm. by H. Stumbur, Geol. Board.

8060 ± 70
TA-196. Sosnovy Bor **6110 B.C.**

Wood fragments on left bank of R. Kovash (central part of Leningrad Region) at depth 10.4 m. Sands overlying peat and arboreal remains are characterized by Atlantic pollen spectrum and salt-water diatomaceous flora. Accumulation of peat started after regression of Ancylus Lake. Coll. 1967 and subm. by L. Serebryanny, Inst. Geog., Acad. Sci., USSR.

7350 ± 70
TA-197. Molodyozhnoye **5400 B.C.**

Wood fragments on left bank of R. Chornaya W of town Zelenogorsk, NW part of Leningrad Region. Sample lies at depth 205 cm in lower part of organogenous complex buried under beach barrier of Littorina Sea. Coll. 1967 and subm. by L. Serebryanny. On basis of pollen-analytic data L. Serebryanny attributed accumulation of organogenous layers to Pollen Zone VII (after von Post and Nilsson).

6960 ± 70
TA-198. Järise **5010 B.C.**

Dark-brown well-decomposed peat near village Järise (W Estonia). Organogenous deposits, 20 cm thick, overlain by beach barrier of Littorina Sea. Coll. 1967 and subm. by G. Eltermann, Geol. Board.

TA-199. Deseles Leinieki **≥55,000**

Dark-brown hard sapropelite near village Deseles in basin of R. Letize (SW Latvia). Sapropelite layer is embedded in moraines. Coll. 1966 and subm. by J.-M. Punning. Pollen-analytic investigations by M. Danilans (1966) assigned accumulation of lake and bog deposits to Likhvin (Mindel-Riss) Interglacial. *Comment*: at Vernadski Inst. of Geochem., sample had been dated ≥34,000 yr (Vinogradov *et al.*, 1966).

TA-200. Gvildzai **⩾50,000**

Submorainic lake and bog deposits in valley of R. Dange N of town Klaipeda (NW Lithuania). Sample coll. 1967 and subm. by P. Vaitiekunas and J.-M. Punning. *Comment*: accumulation of these deposits has been referred to Riss-Würm Interglacial (Woldstedt, 1955; Vaitiekunas, 1961), to Neo-Pleistocene (Gudelis, 1961; Vonsavičius, 1967), and to Mindel-Riss Interglacial (Kondratene, 1967).

TA-194. Kunda **11,690 ± 150**
9740 B.C.

Bryales moss near town Kunda (N Estonia). Moss is contained in lacustrine marl and overlies varved clay and sand. Coll. 1967 and subm. by R. Pirrus, Inst. Geol., Acad. Sci., Estonian SSR.

TA-193. Oara **6100 ± 50**
4150 B.C.

Lagoon sapropel on beach of Bay of Pärnu, 6 km N of Audru (SW Estonia). Sample coll. in upper part (0 to 3 cm) of organogenous layer whose total thickness amounts to 33 cm. Lower and upper parts of this layer contain remains of salt-water diatomaceous algae. Coll. 1967 and subm. by J.-M. Punning. Pollen analysis performed by H. Kessel refers upper part of submerged deposits to Pollen Zone VI (after Post-Nilsson).

TA-222. Dröstorp starr **δC^{14} = 616 ± 10‰**

Plants (*Carex elata*) coll. 1966 in Sweden (56° 35′ N Lat, 16° 33′ E Long). Coll. by L. K. Königsson, subm. by I. U. Olsson (Univ. of Uppsala). Sample was measured at Uppsala C^{14} laboratory as follows: U-51, $\delta C^{13} = -28.1‰$, $\Delta = 699.5 \pm 12.6‰$, (Olsson, written commun.).

TA-225. Kakra **9150 ± 80**
7200 B.C.

Well-preserved piece of wood (pine, ca. 4 cm diam. with 33 year-rings) from NE part of I. Kihnu, Pärnu Dist., SW Estonia. Sample coll. from 4.2 m deep prospecting shaft lying horizontally at depth 4 m (ca. 1 m above sea level) in fine-grained sand. Sample overlain by fine-grained sand 2.5 m thick, pebble and gravel 1 m thick, and eolian sand 0.5 m thick. Coll. 1967 and subm. by H. Sepp, Collective Farm "Soviet Partisan".

TA-223. Naroch **10,330 ± 100**
8380 B.C.

Wood remains (pine) from outcrop on S bank of R. Naroch (Belorussian SSR). Coll. 1967 and subm. by L. N. Voznyachuk, Belorussian Lenin State Univ. See TA-134, TA-135, Radiocarbon, 1968, v. 10, p. 379.

TA-239. Pühajoe **2850 ± 130**
900 B.C.

Wood remains from boring on left bank of R. Pühajõe (N Estonia). Remains are embedded in coarse-grained, little-graded sand containing gravel, pebble, and boulders. Subjacent to them lie deposits of Lower

Cambrian system. Sample lay at depth 16 m. Coll. 1968 and subm. by H. Erisalu (Geol. Board).

TA-241. Nouni **10,900 ± 110**
8950 B.C.

Plant remains picked from prospecting shaft near Lake Nõuni, Valga Dist., SE Estonia. Stratigraphy of sec.: gravel, 50 cm; layered fine-grained sand, 50 cm; layered medium-grained sand with aleurite interbeds, 25 cm; aleurite fine-grained sand with plant and moss remains, 20 cm; below bluish-gray coarse sand and gravel. Coll. 1968 and subm. by J.-M. Punning and R. Pirrus, Inst. of Geol.

II. ARCHAEOLOGIC SAMPLES

TA-202. Usvyaty **4230 ± 70**
2280 B.C.

Wood from Neolithic settlement Usvyaty IV, Usvyaty Dist., Pskov Region, RSFSR on S outskirts of settlement Usvyaty in flood-land of N part of Lake Usvyaty. Sample coll. from lower horizon (IV) of cultural layer (B) at depth of 110 cm and represents log fragment lying horizontally with peg driven through it (Sample TA-203). Pollen-analytic data by E. Spiridonova attribute Layer B to 2nd half of Atlantic period. Presumed archaeologic age of Layer B: 2nd half of 3rd millennium or boundary of 3rd/2nd millennium B.C. Coll. 1966 and subm. by A. Miklayev, State Hermitage of USSR.

TA-203. Usvyaty **4110 ± 70**
2160 B.C.

Wood fragment of peg driven through log (Sample TA-202) coll. from Neolithic settlement Usvyaty IV. Top of peg 65 cm, its end driven through log 130 cm deep. Coll. 1966 and subm. by A. Miklayev. Probable age of sample: 2nd half of 3rd millennium or boundary of 2nd/3rd millennium B.C.

TA-204. Lohavere **705 ± 70**
A.D. 1245

Charcoal from NW part of wall of fortified stronghold Lõhavere, Viljandi Dist., Estonian SSR, 4 km E of settlement Suure-Jaani. Depth of sample 72 cm. Coll. 1960 by A. Liiva; subm. by Acad. H. Moora, Inst. of Hist., Acad. Sci., Estonian SSR. Putative age of sample: 1st half of 13th century.

TA-217. Padise **780 ± 100**
A.D. 1170

Charcoal from S part of E wall of fortified stronghold Padise, Harju Dist., N Estonia. See TA-73, Radiocarbon, 1966, v. 8, p. 436. Depth of sample 225 cm. Presumed archaeologic age: ca. 700 A.D. Coll. 1964 and subm. by O. Saadre, Inst. of Hist.

TA-218. Medvezhya peshchera (cave) **8480 ± 100**
6530 B.C.

Fragments of subfossil bones from Medvezhya peshchera (cave), Ust-Unyin village soviet, Troitsko-Pechorski Dist., Komi ASSR. Coll.

1966 and subm. by I. Kuzmin, Inst. of Zool., Acad. Sci., USSR. Putative age: Late Pleistocene.

4080 ± 100
2130 B.C.

TA-219. Tamula

Wood from Burial 22 of Late Neolithic settlement Tamula, 0.5 km S of town Võru, SE Estonia. Sample coll. from under cultural layer at depth 58 to 77 cm and is referred to early stage of settlement. Coll. 1961 and subm. by L. Jaanits, Inst. of Hist. Presumable age: boundary of 3rd/2nd millennium or early 2nd millennium B.C.

1900 ± 110
A.D. 50

TA-221. Kaninskaya

Fragment of subfossil bones from monastery Kaninskaya, Ust-Unyin village soviet. Troitsko-Pechorski Dist., Komi ASSR. Coll. 1966 and subm. by I. Kuzmin. Putative age of sample: 2nd millennium B.C.

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UNIVERSITY OF TEXAS AT AUSTIN RADIOCARBON DATES VII

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This list reports C^{14} measurements made in dating projects completed in the year ending December, 1968, and some measurements for projects still in progress. Age calculations are based on C^{14} half-life of 5568 yr and a modern standard of 95% of NBS oxalic acid. Deviations reported are based on counting statistics of sample, background, and modern, and are $\pm 1\sigma$ except that when sample count approaches either modern or background, 2σ limits are reported. The laboratory uses liquid scintillation counting of benzene, with Li_2C_2 and vanadium activated catalyst in preparation, as described in Texas IV (Radiocarbon, 1966, v. 8, p. 453-466) and earlier lists. Chemical yields average 85%.

Valastro is in charge of technical operations in the laboratory, and he and Davis share administrative responsibilities. Davis handles sample screening and archaeological appraisal, and has compiled this list.

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I. CHECK SAMPLES

120 ± 50
Tx-540. Greenwade House, B **A.D. 1830**

Wood from foundation post of Greenwade House, pioneer log cabin built in middle 1850's in Brazos R. valley near Whitney, Texas (31° 54′ N Lat, 97° 23′ W Long). Coll. 1950 by R. L. Stephenson; subm. by E. M. Davis. Not same specimen as one from same house dated Tx-43, 100 ± 80 (Radiocarbon, 1964, v. 6, p. 140). Date represents average of 4 separate syntheses and counts. Individual runs are as follows, in cpm/gm: 9.33 ± 0.07; 9.32 ± 0.07; 9.29 ± 0.06; 9.35 ± 0.07. *Comment*: agrees with Tx-43.

11,620 ± 80
Tx-541. Appleton, Wisconsin **10,670 B.C.**

Spruce wood (*Picea*) from Appleton, Wisconsin, 14 ft below plain of glacial Lake Oshkosh (44° 20′ N Lat, 88° 25′ W Long). Should be same age as Two Creeks Forest Bed. Date shown is average obtained from 3 pieces of sample, prepared and counted independently: 11,610 ± 170; 11,700 ± 170; 11,550 ± 170. Coll. by Wm. Read and subm. by R. J. Mason, Lawrence Coll., Appleton, Wisconsin. *Comment*: other dates pub. previously from same wood specimen are: Tx-44, 10,700 ± 210 (Radiocarbon, 1964, v. 6, p. 141); Tx-269, 10,750 ± 210 (Radiocarbon, 1966, v. 8, p. 460; PIC-1, 12,000 ± 300 (Radiocarbon, 1965, v. 7, p. 202);

FSU-3, 11,245 ± 450 (Radiocarbon, 1966, v. 8, p. 48); ANU-5, 11,700 ± 260 (Radiocarbon, 1967, v. 9, p. 18); ISGS-7; 11,500 ± 300 (Radiocarbon, 1969, v. 11, p. 395). Another Appleton Two Creeks date, presumably from same find spot, is L-698D, 11,830 ± 100 (Broecker and Farrand, 1963). Present date agrees with others except for Tx-44 and Tx-269 which appear too young.

II. GEOLOGIC AND OCEANOGRAPHIC SAMPLES

A. Coast of Tamaulipas, Mexico

Carvajal Bluff series

Marine shells (*Busycon contrarium* except where noted) from Carvajal Bluff, NE side Bahia Salada, 1 mi S of Carvajal, Tamaulipas, Mexico (24° 30′ N Lat, 97° 45′ W Long). Samples are from Brown Sand (Behrens, 1966), a beach representing higher relative sea level. Dated to determine (a) number of submergences and (b) lateral variation within a single shell bed. Coll. 1967 and subm. by E. W. Behrens, Univ. of Texas Marine Sci. Inst., Port Aransas, Texas.

1780 ± 70
Tx-542. Carvajal Bluff A **A.D. 170**

From +3.35 m, 241 m W of ice house on peninsula between Laguna Madre and Bahia Salada.

1850 ± 80
Tx-543. Carvajal Bluff B **A.D. 100**

From +2.53 m, 235 m W of ice house.

1950 ± 80
Tx-544. Carvajal Bluff C **A.D. 1**

Macrocallista nimbosa shells, +2.53 to +3.35 m, 235 to 241 m W of ice house.

3970 ± 90
Tx-545. Carvajal Bluff D **2020 B.C.**

From +2.59 m, 241 m W of ice house. Shells have very little original color preserved, surfaces are slightly chalky. Relative sea level +1.5 m.

3710 ± 90
Tx-546. Carvajal Bluff E **1760 B.C.**

From +2.44 m, 159 m W of ice house. Shells very fresh; original colors well preserved. Relative sea level + 1.5 m.

General Comment (E.W.B.): dates establish 2 high stands of Holocene sea level relative to Mexican E coast. Younger dates (Tx-542, 543, 544) correlate with previous dates from same sand (Tx-154, 2340 ± 100, Radiocarbon, 1965, v. 7, p. 298; Tx-249, 1940 ± 60, Radiocarbon, 1966, v. 8, p. 457) and with a sample from Brazilian coast (A-21, van Andel and Laborel, 1964, 1750 ± 170, sea level + 1.4 m); but they are younger than Abrolhos Terrace (2600 to 2100 B.P., sea level + 1.5 m); (Fairbridge, 1961). Lack of widespread correlation makes it uncertain whether this deposit represents eustatic high sea level. Dates do not vary significantly with species or condition of shell. Older dates (Tx-545, 546), from stratigraphically lower part of unit, establish 2nd time of high relative sea level; their greater age is conformable with their position. They correlate well with high stand recorded on Brazilian coast (A-22, van Andel and Laborel, 1964, 3660 ± 170, sea level + 2.6 m) and with postulated Younger Peron submergence of Fairbridge (1961, 3900 to 3500 B.P., sea level + 3 m). Neither set of data correlates with dates from subsiding coasts, e.g., Gulf and Atlantic coasts of U.S.A. or NW coast of Europe; thus it is still uncertain whether these deposits represent local diastrophism or eustatic movements of sea level.

B. Jamaica

Jamaica Sediment series

Samples of coral from submarine sites, N coast of Jamaica, dated in study of age of framework growth and lithification of recent reefs and chronology of recent sea-level rise. Coll. 1968 and subm. by L. S. Land, Dept. of Geol. Sci., Univ. of Texas, Austin. δC^{13} values determined by Land, relative to Chicago Belemnite Standard (PDB).

1940 ± 90

Tx-667. Stairway Point, 95 ft **A.D. 10**

$\delta C^{14} = -214 \pm 7‰$ $\delta C^{13} = +0.51‰$

From site 1 mi W of Runaway Bay Hotel (18° 27′ 12″ N Lat, 77° 20′ 40″ W Long). *Montastrea annularis*, −95 ft, from blast in vertical cleft in reef, assoc. with recent lithification.

Tx-669. Discovery Bay Buoy, 85 ft **130 ± 140**

$\delta C^{14} = -16 \pm 7‰$ **Modern**

From site at T. F. Goreau diving buoy, Discovery Bay (18° 28′ 06″ N Lat, 77° 24′ 48″ W Long). Depth 85 ft, 3 ft into tip of recent reef buttress, assoc. with massive shallow lithification. Error quoted is 2σ.

8410 ± 140

Tx-670. Rio Bueno, 135 ft **6460 B.C.**

$\delta C^{14} = -650 \pm 4‰$ $\delta C^{13} = +3.38‰$

From site just off Cricket Pitch, W side Rio Bueno Harbor (18° 28′ 25″ N Lat, 77° 27′ 45″ W Long). Brown $CaCO_3$ crust from 135 ft blast site. Vertical fractured cliff with minimal recent overgrowth.

5670 ± 90

Tx-671. Rio Bueno, 70 ft **3720 B.C.**

$\delta C^{14} = -510 \pm 4‰$ $\delta C^{13} = +0.64‰$

From same locality as Tx-670 (above). *Diploria* sp. from 70 ft blast site, beneath recent overhang in vertical cliff.

General Comment (L.S.L.): all samples are limited in age by presently accepted curves for rise of recent sea level (Shepard, 1960). Tx-667, 670, 671 indicate reef growth did not keep pace with sea-level rise, nor did most recent framework growth take place at a past sea level. Also all samples are assoc. with recent lithification of reef sediments by precipitation of intergranular crystalline $CaCO_3$ cements. Modern age of Tx-669 demonstrates extreme rapidity of lithification hitherto regarded (Fischer and Garrison, 1967) as rare and unimportant.

C. Lacustrine Carbonate Samples, West Texas

Lacustrine carbonate from 2 localities in playa of Mound Lake, Terry County, Texas (33° 14′ N Lat, 102° 05′ W Long). Coll. 1967 and subm. by C. C. Reeves, Jr., Dept. Geosci., Texas Tech. College, Lubbock, Texas.

Mound Lake Core series

Samples from 3 cores at N edge of playa. Core 1 is 50 ft E of Oscar Roberts' house; Core 2 just N of dunes and ca. 100 yds N of Core 1; Core 3 N of dunes and ca. 220 yds N of Core 2.

18,050 ± 540
Tx-549. Mound Lake Core 1/11 **16,100 B.C.**

Core 1, 11 ft depth.

Tx-550. Mound Lake Core 1/15 1/2 **>37,000**

Core 1, 15½ ft depth.

26,790 ± 2540
Tx-551. Mound Lake Core 2/26 **24,840 B.C.**

Core 2, 26 ft depth.

16,720 ± 320
Tx-552. Mound Lake Core 3/7 **14,770 B.C.**

Core 3, 7 ft depth.

General Comment (C.C.R.): dates indicate Mound Lake dolomite is of pre-Tahoka age, that Series II dunes are somewhat younger than 14,000 yr B.P., and that carbonate of Ruh Lake age exists in the area.

Mound Lake Carbonate-pair series

Dolomite and calcite assoc. with carbonate (indurated dolomite) lens, W edge of playa, N of oil-well access road in second drainage influent. This is the only co-existing pair of lacustrine carbonates so far found in lake basins in this area.

27,720 ± 1070
Tx-547. Mound Lake JL-4, dolomite **25,770 B.C.**

Lacustrine carbonate (dolomite) at top of indurated dolomite.

34,510 ± 2490
Tx-548. Mound Lake JL-1, calcite **32,560 B.C.**

Lacustrine carbonate (calcite) at base of indurated dolomite.

General Comment (C.C.R.): dates show correlation of exposed indurated dolomite lenses of Mound Lake to those in N, T-Bar Lake basin (0-2264, 26,000 ± 1250, Reeves, pers. commun.), and to carbonate in Mound Lake Core 2/26 (Tx-551, above).

III. PALEOBOTANICAL SAMPLES

Hershop Bog series, Texas

Samples of peat from 5 cores in Hershop Bog, on Fred Alex farm, 2 mi SW of Ottine, Gonzales County, Texas (29° 35′ N Lat, 97° 36′ 30″ W Long), ca. 55 mi ENE of San Antonio. Cores were from area 8 m sq. in deepest part of bog. Two other cores taken from same area for pollen analysis showed following sequence: 5.4 to 4.7 m depth, Birch Pollen Zone, pluvial; sharp change at ca. 4.7 m; 4.7 to 2.8 m, Maximum Grass Zone, possibly representing Altithermal times; 2.8 to 0.8 m, Umbelliferae Pollen Zone, may indicate change in physical nature of bog or its vegetation rather than change in regional moisture; 0.8 m to surface, Oak-Mixed Grass Pollen Zone, slight shift to more mesic. Insufficient regional work has been done to know how closely this section reflects regional climatic sequence.

Earlier study in nearby Soefje Bog produced date of 7825 ± 200 (0-501, Graham and Heimsch, 1960, p. 753-759) from zone possibly corresponding to some part of Maximum Grass Pollen Zone at Hershop. However, specific correlation between the 2 bogs cannot yet be made and significance of Soefje date is problematical.

Upper, middle, and lower samples were taken from each core, as shown, each sample being a 20 cm sec. Coll. 1967 by Patty and Valastro; subm. by T. S. Patty and D. A. Larson, Dept. of Botany, Univ. of Texas at Austin.

2340 ± 80
Tx-553. Hershop Core A, Upper **390 B.C.**

Core A, 0.3 to 0.5 m.

6150 ± 130
Tx-554. Hershop Core A, Middle **4200 B.C.**

Core A, 2.3 to 2.5 m.

10,920 ± 160
Tx-555. Hershop Core A, Lower **8970 B.C.**

Core A, 4.8 to 5.0 m.

1960 ± 100
Tx-556. Hershop Core B, Upper **10 B.C.**

Core B, 0.3 to 0.5 m.

5980 ± 100
Tx-557. Hershop Core B, Middle **4030 B.C.**

Core B, 2.3 to 2.5 m.

10,450 ± 160
Tx-558. Hershop Core B, Lower **8500 B.C.**

Core B, 4.4 to 4.6 m.

2120 ± 90
Tx-559. Hershop Core C, Upper **170 B.C.**

Core C, 0.3 to 0.5 m.

Tx-560. Hershop Core C, Middle **5850 ± 120**
3900 B.C.

Core C, 2.3 to 2.5 m.

Tx-561. Hershop Core C, Lower **10,490 ± 160**
8540 B.C.

Core C, 4.8 to 5.0 m.

Tx-562. Hershop Core D, Upper **1520 ± 80**
A.D. 430

Core D, 0.3 to 0.5 m.

Tx-563. Hershop Core D, Middle **6000 ± 130**
4050 B.C.

Core D, 2.3 to 2.5 m.

Tx-564. Hershop Core D, Lower **10,560 ± 160**
8610 B.C.

Core D, 4.9 to 5.1 m.

Tx-565. Hershop Core E, Upper **2170 ± 90**
220 B.C.

Core E, 0.3 to 0.5 m.

Tx-566. Hershop Core E, Middle **6050 ± 100**
4100 B.C.

Core E, 2.3 to 2.5 m.

Tx-567. Hershop Core E, Lower **10,450 ± 160**
8500 B.C.

Core E, 4.9 to 5.1 m.

General Comment (T.S.P.): dates are reasonably consistent from core to core, making upper level ca. 2000 B.P., middle level ca. 6000 B.P., lower level ca. 10,500 B.P. Sharp decline of forest tree types at ca. 4.7 m occurred ca. 10,000 yr ago, possibly relating to end of late-glacial pluvial period in S United States. More palynologic work is needed in this region before full significance of pollen profile and dates can be understood.

IV. ARCHAEOLOGIC SAMPLES: CADDOAN AREA

The following samples, mostly from Oklahoma, make up 2nd list (1st list was in Radiocarbon, 1968, v. 10, p. 390 ff.) from continuing dating project dealing with Caddoan archaeologic area in adjacent parts of Texas, Oklahoma, Arkansas, and Louisiana. Caddoan assemblages represent horticultural, village-dwelling peoples and are classed either as Gibson aspect, usually earlier, or Fulton aspect which extends into historic (post-A.D. 1600) peroid.

A. Harlan Site, Oklahoma

Charcoal samples from Harlan site (Ck-6), in Sequoia State Park, Cherokee County, Oklahoma (35° 55′ N Lat, 95° 14′ W Long). This is an early Gibson aspect Caddoan site. Some dates are averages of 2 separate preparations and counts, in which case the 2 dates are given in sample description. All samples subm. by R. E. Bell, Dept. Anthropol., Univ. of Oklahoma, Norman. Comments by Bell.

Harlan site, Mound 3 series

Mound 3 contained a large unidentified square rock feature with some interior flagstone areas.

1280 ± 50
Tx-601. Harlan 16; Mound 3 **A.D. 670**

From underneath flagstones; apparently from mound fill forming integral part of mound. Coll. 1950 by R. E. Bell. 1180 ± 60 and 1390 ± 70.

1250 ± 50
Tx-604. Harlan 19; Mound 3 **A.D. 700**

From underneath rock layer forming N wall of large square at NW corner. Should be same age as Tx-601 (above). Coll. 1958 by T. Koehler. 1170 ± 70 and 1330 ± 70.

General Comment: dates agree with each other but are early in terms of other Harlan site dates. Mound Unit 3 is different from other mounds at Harlan and might represent earlier, unrecognized facet of occupation.

Harlan site, Mound 4 series

Mound 4 has 3 construction phases: House 3 (oldest) covered by Layer C, House 2 covered by Layer B, and House 1 covered by Layer A. Total height 4 ft. Coll. 1949 by L. Johnson.

770 ± 70
Tx-471. Harlan, Mound 4, Layer A **A.D. 1180**

Should be same age as M-858, 610 ± 75 (Radiocarbon, 1963, v. 5, p. 239).

860 ± 70
Tx-593. Harlan 8; Mound 4, A **A.D. 1090**

Layer A: charcoal from burning of House 1, or in fill overlying House 1 floor. Should be same as Tx-471 (above).

810 ± 70
Tx-470. Harlan, Mound 4, Layer B **A.D. 1140**

Should be same age as M-859, 820 ± 75 (Radiocarbon, 1963, v. 5, p. 239).

990 ± 50
Tx-588. Harlan 3; Mound 4, B **A.D. 960**

Layer B: from burned House 2 or within fill overlying House 2. 990 ± 70 and 990 ± 70.

1050 ± 50
Tx-589. Harlan 4; Mound 4, B **A.D. 900**

Layer B: as in Tx-588 (above), but from another excavation square. 1030 ± 70 and 1060 ± 70.

1220 ± 50
Tx-590. Harlan 5; Mound 4, B **A.D. 730**

Layer B: as in Tx-588 and Tx-589 (above), but from another excavation square. 1390 ± 70 and 1050 ± 70. *Comment*: date early in terms of other dates from Layer B; 1050 ± 70 count more in agreement.

860 ± 50
Tx-594. Harlan 9; Mound 4, B **A.D. 1090**

Layer B: charcoal from burning of House 2, or in fill covering House 2.

1100 ± 50
Tx-597. Harlan 12; Mound 4, B **A.D. 850**

Layer B: 1030 ± 60 and 1170 ± 70.

880 ± 70
Tx-586. Harlan 1; Mound 4, B or C **A.D. 1070**

Layer B or C: from center post of either House 2 or House 3; probably House 2, at bottom of Layer B.

900 ± 70
Tx-596. Harlan 11; Mound 4, B or C **A.D. 1050**

Layer B or C: as in Tx-586 (above), but another center post from another excavation square. Probably House 2.

960 ± 50
Tx-587. Harlan 2; Mound 4, B or C **A.D. 990**

Layer B or C: large post, probably House 2 but possibly House 3. 970 ± 70 and 940 ± 70.

840 ± 60
Tx-598. Harlan 13; Mound 4, B or C **A.D. 1110**

Layer B or C: log, House 3 or House 2.

860 ± 70
Tx-469. Harlan, Mound 4, Layer C **A.D. 1090**

Layer C: might be part of same piece of wood as M-860, 775 ± 75 (Radiocarbon, 1963, v. 5, p. 239), but is more likely another piece from same structure.

980 ± 50
Tx-591. Harlan 6; Mound 4, C **A.D. 970**

Layer C: charcoal from burning of House 3. 970 ± 70 and 990 ± 70.

920 ± 70
Tx-592. Harlan 7; Mound 4, C **A.D. 1030**

Layer C: charcoal from burning of House 3.

960 ± 40
Tx-595. Harlan 10; Mound 4, C **A.D. 990**

Layer C: charcoal from burning of House 3. 990 ± 60 and 920 ± 50.

Tx-599. Harlan 14; Mound 4, C **1090 ± 50**
A.D. 860

Fill of Layer C: above House 3, below House 2. 1180 ± 80 and 1010 ± 50.

General Comment: considering all samples and their proveniences, construction dates may be suggested. House 1 and Layer A, A.D. 1100 to 1200; M-858 appears late. House 2 and Layer B, A.D. 1000 to 1120; Tx-590 appears early. House 3 and Layer C, A.D. 950 to 1050; M-64 appears early. Mound construction covers no more than 200 yr; this is also suggested by dates for Mound Unit 7 (see below).

Harlan site, Mound 6 series

Mound 6 covered a single house structure which had burned. Samples are from charred remains of structure. Coll. 1958 by R. E. Bell.

Tx-603. Harlan 18; Mound 6 **960 ± 60**
A.D. 990

Log no. 2, from collapsed roof or wall.

Tx-605. Harlan 20; Mound 6 **860 ± 60**
A.D. 1090

Mixed sample, from several logs, all different from Tx-603 (above).

Tx-607. Harlan 22; Mound 6 **930 ± 60**
A.D. 1020

Log no. 1.

General Comment: dates agree with structural evidence that mound represents a single episode—burning of house and covering with mound. Overlap of 1σ ranges suggests date of A.D. 1030 to 1050. These dates demonstrate value of samples derived from simple, tight associations.

Harlan site, Mound 7 series

Mound Unit 7 was built in 4 stages, called Mounds A (most recent) through D (oldest). Under Mound D was a structure on original ground surface; it had burned and some remains were included in lower Mound D fill. Coll. 1958 by R. E. Bell.

Tx-606. Harlan 21; Mound 7, A **830 ± 60**
A.D. 1120

Scattered charcoal from fill of Mound A. Should be same age as M-1092, 860 ± 100 (Radiocarbon, 1965, v. 7, p. 132). *Comment*: good agreement with M-1092.

Tx-610. Harlan 25; Mound 7, B **970 ± 70**
A.D. 980

From fill of Mound B. Should be same age as M-1094, 1130 ± 100 (Radiocarbon, 1965, v. 7, p. 133). *Comment*: agrees with M-1094 within 1σ.

Tx-466. Harlan, Mound 7, B **720 ± 70**
A.D. 1230

From fill of Mound B.

1020 ± 50
Tx-467. Harlan, Mound 7, Sub-D **A.D. 930**

From fill below primary mound, Mound D. From same level came M-1093, 1360 ± 100 (Radiocarbon, 1965, v. 7, p. 132), which seems ca. 200 yr too early.

1000 ± 50
Tx-608. Harlan 23; Mound 7, Sub-D **A.D. 950**

Burned debris under earliest stage, Mound D.

970 ± 70
Tx-609. Harlan 24; Mound 7, Sub-D **A.D. 980**

Log beneath earliest stage, Mound D.

General Comment: Mound A, in view of dates from lower mounds, should date ca. A.D. 1200 rather than A.D. 1100 date indicated here; reason for this discrepancy is not apparent. Mound B appears to date A.D. 1100-1200, and Mound D ca. A.D. 950—same time as 1st construction of Mound Unit 4 at this site.

Harlan site, Test Area 4 series

Charcoal from burned remains of House 3 in Test Area 4, a spot in village where 2 superimposed house patterns were uncovered. Dates should be same as M-65, 720 ± 200 (Science, 1958, v. 128, p. 1120). Coll. 1950 by R. E. Bell.

720 ± 50
Tx-468. Harlan, Test 4, House 3, A **A.D. 1230**

960 ± 50
Tx-600. Harlan, Test 4, House 3, B **A.D. 990**

Date is average: 910 ± 60 and 1010 ± 70.

General Comment: charcoal was thought to be from later of 2 houses but earlier age of Tx-600 may indicate that both houses are involved, with construction taking place between A.D. 1000 and 1200; these dates agree with Unit 2 (Tx-602, below) and house under Mound Unit (Tx-603, 605, 607, above) which are similar in form.

930 ± 70
Tx-602. Harlan 17; Unit 2 **A.D. 1020**

From center post of house structure in Unit 2, an isolated house of village. House is similar in form to House 3 in Test Area 4 (Tx-458, Tx-600, above). Coll. 1949 by D. Wenner. *Comment*: date agrees with earlier date at Test Area 4 (Tx-600, above).

General Comment on Harlan site dates: main occupation of site begins ca. A.D. 950 and lasts to ca. A.D. 1200. Most construction begins ca. A.D. 950 to 1000 except that Mound Unit 3 is some 200 yr earlier; this may turn out to represent a separate, earlier occupation. Dates of latest construction, in Mound Units 4 and 7, are not as well established as beginning dates.

B. Other Oklahoma Caddoan Sites

Samples subm. by R. E. Bell and D. G. Wyckoff, Univ. of Oklahoma. Comments by Wyckoff.

550 ± 60
Tx-611. Harvey site, Feature 5, B **A.D. 1400**

Charcoal from Feature 5 at Harvey site (Sq-18), 4 mi W and 5 mi S of Sallisaw, Oklahoma (35° 22′ 45″ N Lat, 94° 52′ 10″ W Long). Feature 5 is bell-shaped pit with artifacts of Ft. Coffee focus, late Fulton aspect. Previous sample from same feature was Tx-486, 390 ± 60 (Radiocarbon, 1968, v. 10, p. 391). Coll. 1965 by Wyckoff. *Comment*: Harvey component seems earlier than Tyler (below, Tx-624, 625) in terms of artifact content; C^{14} dates support this inference.

680 ± 70
Tx-612. Baldwin site, Feature 1, B **A.D. 1270**

Charcoal from Feature 1, Baldwin site (Mc-84; Barr, 1965, p. 34-44), S side Long Creek ¾ mi SE of Ringgold, McCurtain Co., Oklahoma, in Pine Creek Reservoir area (34° 12′ 45″ N Lat, 95° 06′ 00″ W Long). Feature 1 is trash pit with some shell-tempered pottery, believed part of Fulton aspect component. Another sample from same feature is Tx-490, 610 ± 70 (Radiocarbon, 1968, v. 10, p. 391). Coll. 1965 by Israel and Wyckoff. *Comment*: good agreement with Tx-490, but seems a little early for Fulton component.

570 ± 60
Tx-613. Bill Hughes site, Feature 2, B **A.D. 1380**

Charcoal from Feature 2 at Bill Hughes site (Mc-21), on ridge N of where Bee Creek enters flood plain of Mountain Fork R., McCurtain Co., Oklahoma (34° 13′ 50″ N Lat, 94° 40′ 50″ W Long). Feature 2 was burned area with shale-tempered pottery typical of local early Fulton manifestations. Other samples from this feature are Tx-488, 540 ± 60 (Radiocarbon, 1968, v. 10, p. 390) and SM-887, 294 ± 170 (Wyckoff, 1967a, p. 7). Coll. 1964 by Wyckoff. *Comment*: Tx-613 and Tx-488 in close agreement; SM-887 seemingly more recent, but almost agrees within 1σ. Bill Hughes component closely resembles those at Beaver (Tx-626, below) and Woods Mounds (Tx-475, 491, 492, below), and similar C^{14} dates support this identification.

440 ± 70
Tx-619. Sheffield site, Feature 2 **A.D. 1510**

Charcoal from Feature 2 at Sheffield site (Sq-22), 3 mi S and 2 mi W of Vian, Sequoyah Co., Oklahoma (35° 27′ N Lat, 95° 00′ W Long). Feature 2 was trash pit with shell-tempered pottery and other items characteristic of Fulton aspect occupation. Other samples from site are Tx-489, 790 ± 200 (Radiocarbon, 1968, v. 10, p. 391), felt to be too early for Fulton aspect, and WIS-256, 500 ± 60 (Radiocarbon, 1968, v. 10, p. 474), considered more appropriate in terms of archaeologic evidence. Coll. 1966 by Wyckoff. *Comment*: Tx-619 agrees with WIS-256 and with

Tx-611, 550 ± 60 (this date list) from closely similar Harvey site. Tx-489 is clearly too early.

600 ± 80
Tx-626. Beaver site, Feature 3 **A.D. 1530**

Charcoal from Feature 3 at Beaver site (Mc-1), directly N of old Hochatown bridge over Mountain Fork R., McCurtain Co., Oklahoma (34° 12′ N Lat, 94° 41′ W Long). Feature 3 was trash pit with shale-tempered sherds common to local early Fulton aspect components. From House 3, just S of Feature 3, came Tx-479, 560 ± 90 (Radiocarbon, 1968, v. 10, p. 390). Coll. 1965 by Israel and Wyckoff. *Comment*: agrees with Tx-479. Beaver component closely resembles those at Bill Hughes (Tx-613, above) and Woods Mounds (Tx-475, 491, 492, below). Beaver dates agree with dates from those sites.

Woods Mound series

Charcoal samples from Woods Mound group (Mc-104; Wyckoff, 1967b), 16 mi N and 9 mi E of Broken Bow, McCurtain Co., Oklahoma (34° 18′ N Lat, 94° 41′ W Long). Site believed to be early McCurtain focus, hence early Fulton aspect. Coll. 1964-5 by Wyckoff.

250 ± 50
Tx-491. Woods Mound BB **A.D. 1700**

Post from oval pattern underneath Mound BB. Date is average of 2 separate preparations and counts: 150 ± 70 (modern) and 360 ± 70.

640 ± 50
Tx-492. Woods Mound A **A.D. 1310**

Mound A, Feature 1, trash pit with shell-tempered pottery. Also from Mound A is SM-888, 159 ± 147 (Wyckoff, 1967a, p. 7), which is felt to be too recent. Date is average of 2 separate preparations and counts: 670 ± 60 and 610 ± 70.

500 ± 50
Tx-475. Woods Mound F **A.D. 1450**

Post 13 from irregular post pattern under fill of Mound F. Also from this mound is GaK-901, 710 ± 80 (Wyckoff, 1967a, p. 7). Date is average of 2 separate preparations and counts: 460 ± 70 and 530 ± 60. *General Comment*: Tx-491 is inconsistently young. Tx-492 and Tx-475 agree well enough with GaK-901 and with dates from closely similar components at Bill Hughes site (Tx-613, 570 ± 60) and Beaver site (Tx-626, 600 ± 80), both this date list.

Cat Smith series

Charcoal samples from Cat Smith site (Ms-52), E side of Arkansas R., directly N of Webbers Falls Dam, 3 mi NW of Gore, Oklahoma (35° 34′ N Lat, 95° 10′ W Long). Single-component site, early Fulton aspect. Coll. 1965-6 by T. P. Barr.

Tx-614. Cat Smith, House 2, B **800 ± 60**
A.D. 1150

Charred post in NW corner of House 2. Another post from same house dated 770 ± 70 (Tx-493, Radiocarbon, 1968, v. 10, p. 391), which was felt to be early.

Tx-615. Cat Smith, House 1, A **650 ± 60**
A.D. 1300

Charred log from House 1, Sq. 0-0 and 0-N1. House 1 is rectangular with 2 centerposts. Also from House 1 is WIS-254, 560 ± 60 (Radiocarbon, 1968, v. 10, p. 474).

Tx-616. Cat Smith, House 1, B **630 ± 60**
A.D. 1320

Another log from House 1 (see Tx-615, above), Sq. N1-L1 and N2-L1. *General Comment*: dates show good consistency but seem at variance with archaeologic data: (1) they all (especially those from House 2), seem too early for Fulton aspect material; (2) dates make House 2 significantly earlier than House 1, but archaeologic materials are same in both houses.

Fine site, series 2

Charcoal samples from Fine site (Sq-13), 4 mi S and 1.5 mi E of Vian, Sequoyah Co., Oklahoma (35° 26′ N Lat, 94° 57′ W Long). Site has both late Gibson aspect and early Fulton aspect components. Previous series from this site was in Radiocarbon, 1968, v. 10, p. 390. Coll. 1967 by Wyckoff.

Tx-617. Fine site, Trench C, 2 **920 ± 60**
A.D. 1030

Charred post from incomplete house pattern in Trench C, Sq. N2-W3, with late Gibson aspect ceramics. From same pattern was Tx-485, 840 ± 60 (Radiocarbon, 1968, v. 10, p. 390), which was felt to be too early for late Gibson. *Comment*: agrees with Tx-485, but still seems quite early.

Tx-621. Fine site, House 1, B **780 ± 60**
A.D. 1170

Charred log from House Pattern 1, small rectangular house in Trench I, early Fulton aspect. *Comment*: early Fulton should be later than this; disagrees with other dates from house (see Tx-623, below).

Tx-623. Fine site, House 1, C **620 ± 80**
A.D. 1330

Charred log from House 1 in Trench I. Also from this house is Tx-519, 500 ± 70 (Radiocarbon, 1968, v. 10, p. 390); also see Tx-621 above. *Comment*: agrees with Tx-519.

General Comment: dates agree with archaeologic data in clearly indicating 2 components.

Tyler site series

Charcoal obtained by flotation from trash pits in Tyler site (Hs-11), 7 mi N and 1½ mi W of Keota, Haskell Co., Oklahoma (35° 21′ 40″ N Lat, 94° 56′ 35″ W Long). Materials in site indicate late Fulton aspect assignment. Coll. 1966 by Wyckoff.

450 ± 110
Tx-624. Tyler, Feature 5 **A.D. 1500**

Feature 5 is trash pit in Graded Strip H.

420 ± 70
Tx-625. Tyler, Feature 12 **A.D. 1530**

Feature 12 is trash pit in Graded Strip O.

General Comment: dates agree with each other and with archaeologic evidence for late prehistoric occupation.

Horton site series

Samples from trash pits at Horton site (Sq-11), 3¾ mi S of Vian, Sequoyah Co., Oklahoma (35° 27′ 15″ N Lat, 94° 58′ 30″ W Long). Pits contained Fulton aspect material including shell-tempered pottery. Coll. 1967 by Wyckoff.

440 ± 90
Tx-627. Horton, Feature 1 **A.D. 1510**

Charcoal and flotated material from Feature 1, trash pit in Trench D.

780 ± 70
Tx-618. Horton, Feature 2 **A.D. 1170**

Charred wood and hickory nuts from Feature 2, trash pit in Trench L.

General Comment: samples do not agree with each other. Tx-627 may be a little late, whereas Tx-618 is too early for context and associations. No archaeologic explanation is apparent for inconsistency.

C. Louisiana

Werner Mound series, Louisiana

Charcoal samples from charred remains of large oval structure underneath mound at Werner Mound site (16B08) on Willow Chute Bayou, 5 mi NE of Bossier City, Bossier Parish, NW Louisiana (32° 34′ 30″ N Lat, 93° 40′ 00″ W Long). Component assigned to Bossier focus, probably later part, but not latest as only 1.2% of sherds were shell-tempered. Coll. 1958 and subm. by C. H. Webb, Shreveport, Louisiana.

510 ± 70
Tx-478. Werner Mound, 3 **A.D. 1440**

880 ± 80
Tx-628. Werner Mound, 2 **A.D. 1070**

Tx-628 sample was split and parts were prepared and dated separately: 970 ± 60, 790 ± 70. Another part of this same sample was dated by Humble, 0-1132, 2050 ± 110 (Webb, pers. commun.).

General Comment (E.M.D., S.V., Jr.): Tx-478 date is in accord with archaeologic evidence, but Texas and Humble dates on Tx-628 are so inconsistent that, as of now, site cannot be ascribed a radiocarbon age.

V. ARCHAEOLOGIC SAMPLES, GENERAL

A. Wallisville Reservoir, Texas Coast

Samples from sites in and near Wallisville Reservoir, Chambers Co., SE Texas, at mouth of Trinity R., E of Houston. Coll. 1966 and subm. by J. R. Ambler, Texas Archaeol. Salvage Project, Univ. of Texas, Austin.

Wallisville 41CH13 series

Paired charcoal and shell (*Rangia*) samples from Site 41CH13, stratified shell midden 1 mi S of Interstate Hwy 10 at Wallisville, ½ mi W of Trinity R., in Mayes Marsh (29° 49′ N Lat, 94° 45′ W Long). Site was first occupied in pre-pottery times; upper strata contain plain, sand-tempered pottery of tentatively defined Lost River phase. Present samples should provide information on span of site occupation and aid in correlation of prehistoric river channels, shorelines, and aboriginal sites in Trinity R. delta.

2070 ± 110
Tx-356. 41CH13/8, charcoal **120 B.C.**

2280 ± 90
Tx-345. 41CH13/8, shell **330 B.C.**

From Sq. M34 at junction of Strata 1 and 2, mostly at top of Stratum 1 which is sterile clay on which cultural debris rests. Samples should date earliest occupation of this part of site.

1890 ± 100
Tx-343. 41CH13/6, charcoal **A.D. 60**

1990 ± 100
Tx-341. 41CH13/6, shell **40 B.C.**

From hearth area, NE corner Sq. L34, Levels 13 and 14, elev. 97.80 to 98.00 m above site datum. This is a pre-pottery occupation. A bone projectile point was in same general stratum. Sample should provide date after which pottery appeared.

1560 ± 100
Tx-344. 41CH13/10, charcoal **A.D. 390**

1840 ± 90
Tx-342. 41CH13/10, shell **A.D. 90**

From Sq. 027, Level 4, elev. 98.30 to 98.40 m above site datum. Directly assoc. with earliest pottery in this part of site. Should help date beginning of pottery manufacture in this area. See general comment at end of Wallisville 41CH16 series, below.

Wallisville 41CH16 series

Paired samples (except Tx-395, Tx-398) of charcoal and shell (*Rangia*) from Site 41CH16, shell midden 1 mi S of Interstate Hwy 10 at Wallisville, ¼ mi W of Trinity R. (29° 49′ 30″ N Lat, 94° 44′ 30″ W Long). Contemporaneous with 41CH13 (above). Samples listed in stratigraphic order, oldest to most recent.

2540 ± 110
Tx-397. 41CH16/8, charcoal **590 B.C.**

2150 ± 60
Tx-388. 41CH16/8, shell **200 B.C.**

From Sq. V33, Level 26, elev. 96.40 to 96.50 m. Basal cultural layer in this part of mound. Tx-388 is average of separate syntheses and counts on 2 batches from same group of shells: 2010 ± 90 and 2280 ± 80.

2260 ± 110
Tx-395. 41CH16/19, charcoal **310 B.C.**

From Sqs. P15, Q15, in basal portion of midden in "Shell Stringer No. 1," thin shell layer separated from main body of deposit by sterile layer. Sample cannot be directly related stratigraphically to others from site but should be approximately contemporaneous with Tx-397.

1900 ± 90
Tx-396. 41CH16/25, charcoal **A.D. 50**

2240 ± 90
Tx-389. 41CH16/25, shell **290 B.C.**

From Sq. X33, Level 24, elev. 96.60 to 96.70 m. From near base of midden. Pre-pottery.

2020 ± 80
Tx-450. 41CH16/26, charcoal **70 B.C.**

2220 ± 80
Tx-460. 41CH16/26, shell **270 B.C.**

From Sq. X33, Level 24, elev. 96.60 to 96.70 m. Pre-pottery. Should agree with Tx-396.

1890 ± 150
Tx-398. 41CH16/5, charcoal **A.D. 60**

From Sq. W 33, Level 24, elev. 96.60 to 96.70 m. From near base of midden. Pre-pottery.

2010 ± 90
Tx-456. 41CH16/6, charcoal **60 B.C.**

1950 ± 70
Tx-455. 41CH16/6, shell **A.D. 1**

From Sq. U33, W quad., Level 26, elev. 96.40 to 96.50 m above site datum. Pre-pottery. Should agree with Tx-398.

1740 ± 100
Tx-399. 41CH16/1, charcoal **A.D. 210**

2010 ± 90
Tx-390. 41CH16/1, shell **60 B.C.**

From Sq. V33, Level 22, elev. 96.80 to 96.90 m. From near base of midden. Pre-pottery; stratigraphically above Tx-396, 397, 398.

Tx-449. 41CH16/3, charcoal **1950 ± 80**
A.D. 1

Tx-457. 41CH13/3, shell **2180 ± 90**
230 B.C.

From Sq. V33, Level 23a, elev. 96.70 to 96.80 m. Pre-pottery. Should agree with Tx-399.

Tx-400. 41CH16/12, charcoal **1880 ± 90**
A.D. 70

Tx-392. 41CH16/12, shell **2040 ± 90**
90 B.C.

From Sq. X33, Level 10. Lowest part of main pottery-bearing deposits.

Tx-401. 41CH16/10, charcoal **1780 ± 100**
A.D. 170

Tx-393. 41CH16/10, shell **1890 ± 90**
A.D. 60

From Sq. X33, Level 7, elev. 98.30 to 98.33 m. Lowest part of main pottery-bearing deposits, but stratigraphically later than Tx-400.

Tx-402. 41CH16/23, charcoal **1400 ± 110**
A.D. 550

Tx-394. 41CH16/23, shell **1810 ± 90**
A.D. 140

From Sq. Q32, Feature 1, trash-filled pit at edge of midden; stratigraphically late, containing a good deal of pottery. Probably slightly later than Tx-401.

General Comment on 41CH13 and 41CH16 dates (J.R.A.): samples show good internal consistency. Looking at charcoal samples alone, consistency within 41CH16 is further improved if one uses Tx-450, 456, 449, rather than Tx-396, 398, 399; former 3 were subm. later to check latter 3 which do not fit as well with remainder of series. Although both sites are contemporaneous archaeologically, dates indicate 41CH16 was occupied earlier. Dates shed light on crucial question of pottery introduction; first appearance at 41CH16 is ca. A.D. 100 (Tx-400, 401). At 41CH13 it is later (Tx-344) but only 1 date is available there; it might reflect later use of site by pottery-using peoples. Previous C^{14} dates assoc. with pottery in this area, on *Rangia*, are 0-911, 1900 ± 105, and 0-912, 3350 ± 115 (Ring, 1961); in light of present dates they now seem much too early. Pottery from present sites bears similarities to Tchefuncte pottery in Louisiana, and time span indicated for Lost River phase, A.D. 100 to A.D. 400-700, agrees with generally accepted time of late Tchefuncte in Louisiana (Gagliano, 1967). (S.V., Jr.): shells are older than charcoal by average of 1.36σ, except for Tx-397 and 388 pair, and Tx-456 and 455, in which relationship is inexplicably reversed. On average, shells were diluted with 1% to 3% dead carbon. Possibility is good that *Rangia* shell in this particular locality can be used for dating, taking into account a correction for this amount of dead carbon. However, more work is necessary.

Wallisville 41CH20 shell series

Samples of clam shells (*Rangia*) from S wall of Sq. A, Site 41CH20, in E bank of Old River Lake, 0.4 mi S of Interstate Hwy 10 (29° 49′ 37″ N Lat, 94° 47′ 30″ W Long). Tx-527 and Tx-528 assoc. with sherd-tempered incised pottery of what has been called "Galveston Bay focus." Each sample divided into 2 parts which were prepared and counted separately; date is average; dates from separate counts are given in descriptions.

840 ± 60
Tx-527. 41CH20/4 **A.D. 1110**

From 25 cm depth. Topmost heavy shell stratum. Both counts 840 ± 80.

820 ± 60
Tx-528. 41CH20/5 **A.D. 1130**

From 40 cm depth. Middle shell stratum. 790 ± 80 and 850 ± 80.

1550 ± 60
Tx-529. 41CH20/6 **A.D. 400**

From 60 cm depth. Lowest shell stratum, assoc. with sand-tempered pottery, including 1 incised sherd from vessel found mostly in level above. 1490 ± 80 and 1600 ± 80.
General Comment (J.R.A.): taking into account that *Rangia* shells in this area may date several centuries older than charcoal (Wallisville 41CH13 and 41CH16 series, above), Tx-527 and Tx-528 help date Galveston Bay focus in late prehistoric times, but do not define its temporal limits. Tx-529 may be too early, as no Lost River phase pottery was found in site (see comments on 41CH13 and 41CH16 series).

290 ± 80
Tx-458. San Agustín de Ahumada **A.D. 1660**

Rangia shells from site of Presidio San Agustín de Ahumada (41CH53), 1.3 mi NE of Trinity R. at Wallisville, Texas (29° 50′ 40″ N Lat, 94° 43′ 30″ W Long). Spanish occupation, A.D. 1766-1771 (Tunnell and Ambler, 1967). Dated to check validity of dates on shell in this area for this time span. Coll. 1967 by J. R. Ambler and subm. by Ambler and Valastro. *Comment* (S.V., Jr.): experience with older shell-charcoal pairs in same area (Wallisville 41CH13 and 41CH16 series, above) indicates that *Rangia* shells date older than charcoal by 100 to 400 yr. Present sample is at minimum end of this range.

B. Cedar Bayou, Texas Coast

Samples from 2 sites on Cedar Bayou, SE Harris Co., just E of Houston, Texas. Sites are reported by Ambler (1967). Coll. 1967 and subm. by J. R. Ambler.

Wright site shell series

Clam shells (*Rangia*) from E wall, Sq. 1, Trench A, Wright site (41HR50), 100 yds NW of Negrohead Lake, 400 yds W and 250 yds S of Cedar Bayou (29° 41′ 52″ N Lat, 94° 55′ 15″ W Long). Each sample separated into 2 parts which were prepared and counted separately; date is average; dates from separate counts given in descriptions.

Tx-530. Wright, 1 — **850 ± 60** — **A.D. 1100**

From 40 cm depth. Topmost shell layer, with sherd-tempered incised "Galveston Bay focus" pottery. 860 ± 80 and 830 ± 80.

Tx-532. Wright, 3b — **1510 ± 60** — **A.D. 440**

From 70 cm depth. Lower shell layer, assoc. with pre-ceramic horizon, probably Late Archaic. Date should provide *terminus post quem* for appearance of pottery. 1550 ± 80 and 1470 ± 80.

General Comment (J.R.A.): Tx-530 agrees well with shell dates from nearby Wallisville 41CH20 (Tx-527, 840 ± 60, and Tx-528, 820 ± 60, this date list) and Tx-533, 950 ± 50, from 41HR56 (below), indicating late prehistoric time for "Galveston Bay focus." Tx-532 seems much too recent, as pottery seems to appear in nearby Wallisville Reservoir area ca. A.D. 100 and *Rangia* dates in this area are usually falsely old (see comments on Wallisville 41CH13 and 41CH16 series, this date list).

Cedar Bayou 41HR56 series

Clam shells (*Rangia*) from E wall, Sq. 2, Site 41HR56, W bank of Cedar Bayou, ca. 100 yds S of Negrohead Lake (29° 41′ 30″ N Lat, 94° 55′ 15″ W Long). Each sample separated into 2 parts which were prepared and counted separately; date is average; dates from separate counts given in descriptions.

Tx-533. 41HR56/1 — **950 ± 50** — **A.D. 1000**

From 20 cm depth; top portion of shell deposit. Assoc. with "Galveston Bay focus" pottery. 980 ± 70 and 910 ± 70.

Tx-534. 41HR56/2 — **1190 ± 50** — **A.D. 760**

From 35 cm depth. Central portion of shell deposit. Assoc. with earliest sand-tempered pottery, apparently just before introduction of sherd temper. 1120 ± 60 and 1260 ± 70.

Tx-535. 41HR56/3 — **1840 ± 50** — **A.D. 110**

From 55 cm depth. Bottom portion of shell deposit. Preceramic, presumably Late Archaic. 1840 ± 70 and 1830 ± 70.

General Comment (J.R.A.): Tx-533 agrees well with shell dates Tx-530 from Wright site (above) and Tx-527 and Tx-528 from nearby Wallisville area 41CH20 (this date list). Tx-534 is only date now applicable to time of introduction of sherd temper, and therefore of beginning of "Galveston Bay focus;" in view of tendency of *Rangia* in this area to give dates 100 to 400 yr earlier than charcoal (Wallisville 41CH13 and 41CH16 series, this date list), actual date is presumably very late in 1st millennium A.D. Same consideration regarding shell dates makes Tx-535 seem late, judging from Wallisville 41CH13 and 41CH16 dates. However, only a few Lost River-phase sherds were found at Cedar Bayou sites, possibly indicating later survival of preceramic horizons in this locality.

C. Amistad Reservoir, Southwest Texas

Samples from sites in Amistad Reservoir area, on Rio Grande and tributaries in vicinity of mouth of Pecos R., Val Verde Co., Texas. All samples subm. by personnel of Texas Archaeol. Salvage Project, Balcones Research Center, Univ. of Texas, Austin.

Arenosa Shelter, Series 2

Charcoal from Arenosa shelter (41VV99), on right bank of Pecos R., 1 mi upstream from confluence with Rio Grande (29° 42′ N Lat, 101° 22′ W Long). For previous series from this site see Radiocarbon, 1967, v. 9, p. 444-5. Coll. 1967 and subm. by D. S. Dibble; comments by D.S.D.

1380 ± 60
Tx-661. Arenosa 55, Stratum 2 **A.D. 570**

Upper ½ of Stratum 2; Ensor and other late Archaic dart points as well as arrow points. *Comment*: somewhat older than anticipated on basis of such dates as those from Cammack Sotol Pit (Tx-227, 625 ± 185, Radiocarbon, 1966, v. 8, p. 460; Tx-361, 610 ± 80, Radiocarbon, 1968, v. 10, p. 398) and 5 dates from Dunlap Midden 1 varying from ca. 550 to 950 (Tx-310, 351, 357, 358, 359, *ibid.*, p. 396-397); but consistent with estimates of age of terminal Archaic within Amistad Reservoir area.

1910 ± 70
Tx-537. Arenosa 24, Stratum 5 **A.D. 40**

From top to bottom of Stratum 5, within 1 ft sq. column. Late Archaic, Ensor and Frio points, mostly Ensor. *Comment*: consistent with stratigraphic situation relative to other samples from site.

2150 ± 80
Tx-536. Arenosa 30, Stratum 7 **200 B.C.**

From base of Stratum 7; Late Archaic, Ensor and Frio points. *Comment*: consistent with stratigraphic position relative to Tx-284, 1970 ± 110 (Radiocarbon, 1967, v. 9, p. 444) from top of Stratum 7; but same age as Tx-285, 2070 ± 140 (*ibid.*) from base of deeper Stratum 9, possibly reflecting relatively rapid accumulation of cultural debris.

3640 ± 80
Tx-662. Arenosa 61, Stratum 22x **1690 B.C.**

From fill of hearth, Feature 15, within Stratum 22x. Middle Archaic, Langtry and other dart point types. *Comment*: consistent with cultural assocs. and with stratigraphic position relative to other samples from site.

4430 ± 80
Tx-538. Arenosa 31, Stratum 25A **2480 B.C.**

From hearth, Feature 10, on surface of Stratum 25A. Early Archaic, Pandale points. *Comment*: consistent with stratigraphic position and assocs.

4440 ± 110
Tx-660. Arenosa 612, Stratum 30 **2490 B.C.**

Upper component of Stratum 30. Early Archaic, Pandale points. *Comments*: younger than expected in view of dates from higher Strata 25 and 25A: Tx-538 (above) and Tx-312, 4790 ± 140 (Radiocarbon, 1967, v. 9, p. 445). (S.V., Jr.): possibly contaminated by growth of mold due to having been collected and sealed when wet; but no mold was observed in lab.

9550 ± 190
Tx-668. Arenosa 62, Stratum 38 **7600 B.C.**

All levels of Stratum 38, oldest definite culture-bearing deposit recognized at site; unifacial flake tools, nothing diagnostic; deeper than strata with "Early Barbed" points. *Comment*: might be earlier than Early Archaic.

Bonfire shelter, Series 3

Charcoal samples from Hearth 1 (Feature 27) in Bone Bed 2 of Bonfire Shelter (41VV218), stratified kill site in Mile Canyon just E of Langtry (29° 49′ N Lat, 101° 33′ W Long). Bone Bed 2 contained large extinct bison, Plainview and Plainview-like points, one Folsom point (Dibble and Lorraine, 1968, p. 29-40). Previous date series from this site are in Radiocarbon, 1964, v. 6 and 1965, v. 7. Coll. 1964 and subm. by D. S. Dibble.

9920 ± 150
Tx-657. Bonfire 561 **7970 B.C.**

10,100 ± 300
Tx-658. Bonfire 511 **8150 B.C.**

General Comment (D.S.D.): together with previous date from same hearth (Tx-153, 10,230 ± 160, Radiocarbon, 1965, v. 7, p. 304), these dates all agree within 1σ and provide reliable determination of age of hearth, ca. 8000 to 8300 B.C.

Perry Calk series

Charcoal samples from Perry Calk site (41VV87), on left bank of Rio Grande 5 mi downstream from mouth of Pecos R. (29° 39′ 20″ N Lat, 101° 21′ 0″ W Long). Site included late Archaic (Ensor points) and Neo-American (arrowpoint) occupations. Coll. 1967 and subm. by M. B. Collins.

Tx-620. Perry Calk 60 **590 ± 60**
A.D. 1360

Hearth 4, in Level 2, Sq. N107/W90. Ensor period, at time of introduction of arrowpoints.

Tx-622. Perry Calk 72 **1290 ± 50**
A.D. 340

From S ⅓ of fill in Feature 6, large pit dug at approximate time of introduction of arrowpoints to site. Should be same age as Tx-620 (above). Date is average of 2 separate syntheses and counts: 1390 ± 70, 1190 ± 70.

Tx-629. Perry Calk 74 **690 ± 50**
A.D. 1260

From basin of Hearth, Feature 1; beginning of site occupation, assoc. with Ensor dart points. Should be earlier than Tx-620 and Tx-622 (above). Date is average of 2 separate syntheses and counts: 680 ± 70, 690 ± 60. *General Comment* (M.B.C.): Tx-622 is out of sequence and earlier than current estimates of arrowpoint introduction (ca. A.D. 1000); probably represents intrusion of earlier charcoal in pit. Tx-620 and Tx-629 are slightly later than estimates of arrowpoint introduction but are well within expected time range (Johnson, 1964, p. 98).

Techo Bajo series

Samples from Techo Bajo shelter, on Rio Grande ca. 9 mi upstream from mouth of Pecos R. (29° 45′ 30″ N Lat, 101° 25′ 30″ W Long). From thin fiber layer with Ensor point in probable assoc. and overlying Langtry point. Sq. N105/W100, elev. 98.6 ft above site datum. Coll. 1967 and subm. by M. B. Collins.

Tx-630. Techo Bajo 6, charcoal **740 ± 60**
A.D. 1210

Tx-633. Techo Bajo 6, wood **830 ± 40**
A.D. 1190

Tx-633 date is average of 2 separate syntheses and counts: 760 ± 60 and 900 ± 60. *Comment* (M.B.C.): dates are in agreement with scant archaeologic data from site; probably give good indication of age of fiber layer.

Tx-570. Nopal Terrace 107 **2850 ± 80**
900 B.C.

Charcoal from Nopal Terrace site (41VV301) N bank of Rio Grande 2.6 mi upstream from mouth of Devil's R. (29° 28′ N Lat, 101° 06′ W Long). From Zone 7a; mostly Montell projectile points; a few Shumla. Coll. 1967 and subm. by W. M. Sorrow, Texas Archaeol. Salvage Project, Univ. of Texas at Austin. *Comment* (W.M.S.): 7 other dates are assoc. with Montell points in Amistad Reservoir area, all on charcoal except as noted: Bonfire Shelter, Bone Bed 3—Tx-46, 2310 ± 210 (bone, Radiocarbon, 1964, v. 6, p. 153); Tx-47, 2810 ± 110 (bone, *ibid.*, p. 154); Tx-106, 2780 ± 110 (*ibid.*); Tx-131, 2510 ± 100 (Radiocarbon, 1965,

v. 7, p. 304); Arenosa shelter, Stratum 11—Tx-211, 2440 ± 140 (Radiocarbon, 1967, v. 9, p. 444); Tx-286, 2410 ± 140 (*ibid.*); Devil's Mouth Zone 9—Tx-571, 2790 ± 80 (below). Tx-570 is in earlier part of this series, agreeing with fact that Shumla points suggest early rather than late Montell time.

Tx-571. Devil's Mouth 703, Zone 9 **2790 ± 80** **840 B.C.**

Charcoal from Zone 9 of Devil's Mouth site (41VV188) at confluence of Devil's R. and Rio Grande ca. 1 mi above Amistad Dam (29° 27′ N Lat, 100° 03′ W Long). Zone 9 is lowest zone with Montell points (Johnson, 1964, Table 2, p. 84-5). Coll. 1967 and subm. by W. M. Morrow. *Comment* (W.M.S.): present date is early in Montell date series (see comment for Tx-570, above), agreeing with early Montell stratigraphic position.

Tx-663. Piedra Diablo 22 **3080 ± 90** **1130 B.C.**

From Test Pit 1, lower portion of Zone 2, Piedra Diablo site (41VV263), left side Devil's R. canyon ½ mi upstream from mouth of Devil's R. (29° 27′ N Lat, 101° 03′ W Long). Marshall points assoc. Middle Archaic. Coll. 1965 by E. R. Prewitt and subm. by D. S. Dibble. *Comment* (D.S.D.): consistent with current estimates of age of Marshall point type.

D. Smith Shelter, Central Texas

Smith Shelter, series 2

Charcoal and snail shell samples from Smith Rock Shelter (41 TV 42) on Onion Creek S of Austin, Texas (30° 12′ N Lat, 97° 43′ W Long). Site, reported by Suhm (1957), has 11 layers, 3 components: Layer I (deepest), Transitional Archaic; upper Layer II through Layer IX, Austin focus; Layer X-XI, Toyah focus. Dated to check earlier series (Tx-21 through Tx-28; Radiocarbon 1964, v. 6, p. 145-146) which seemed too recent, and to compare charcoal and snail shell dates. Coll. 1954-55 and subm. by Dee Ann Suhm Story, Dept. of Anthropol., Univ. of Texas, Austin. Samples listed in order of increasing depth.

Tx-509. Smith 53, Layers X-XI, charcoal **240 ± 70** **A.D. 1710**

Sq. N4-N5, B-C, 0 to 6 in. depth. Mixed Layers X-XI, Toyah focus or modern.

Tx-510. Smith 26, Layers X-XI, charcoal **220 ± 70** **A.D. 1730**

Sq. 0-N1, C-D; 0 to 6 in. depth. Toyah focus or modern.

Tx-504. Smith 37, Layers X-XI, charcoal **200 ± 70** **A.D. 1750**

Sq. S1-S2, C-D; 0 to 6 in. depth. Toyah focus or modern.

Tx-505. Smith 42, Layer X, charcoal **370 ± 70** **A.D. 1580**

Tx-499. Smith 46, Layer X, shell **710 ± 80**
A.D. 1240
Sq. S1-S2, C-D, 6 to 12 in. depth. Toyah focus or modern.

Tx-508. Smith 34, Layers IX-X, charcoal **490 ± 80**
A.D. 1460

Tx-497. Smith 41, Layers IX-X, shell **920 ± 80**
A.D. 1030
Sq. S1-S2, C-D; 12 to 18 in. depth. Mixed Toyah and Austin foci.

Tx-514. Smith 25, Layer IX, charcoal **450 ± 70**
A.D. 1500

Tx-500. Smith 29, Layer IX, shell **990 ± 80**
A.D. 960
Sq. 0-N1, C-D, 18 to 24 in. depth. Mainly Layer IX. Late Austin focus.

Tx-513. Smith 32, Layer VIII, charcoal **680 ± 80**
A.D. 1270

Tx-501. Smith 28, Layer VIII, shell **1030 ± 80**
A.D. 920
Sq. 0-N1, C-D, 24 to 30 in. depth. Late Austin focus.

Tx-518. Smith 63, Layer VII, charcoal **830 ± 70**
A.D. 1120

Tx-503. Smith 65, Layer VII, shell **1370 ± 80**
A.D. 580
Sq. 0-N1, A-B, 34 to 39 in. depth. Austin focus.

Tx-512. Smith 52, Layers VI-VII, charcoal **930 ± 60**
A.D. 1020

Tx-502. Smith 48, Layers VI-VII, shell **1180 ± 80**
A.D. 770
Sq. 0-N1, B-C, 35 to 41 in. depth. Austin focus.

Tx-506. Smith 43, Zone VI, charcoal **940 ± 80**
A.D. 1010

Tx-496. Smith 39, Layer VI, shell **1250 ± 80**
A.D. 300
Sq. 0-N1, C-D; 36 to 42 in. depth. Austin focus.

Tx-516. Smith 27, Layers V-VI, charcoal **740 ± 80**
A.D. 1210

Tx-495. Smith 38, Layers V-VI, shell **1570 ± 80**
A.D. 380
Sq. 0-N1, C-D; 42 to 48 in. depth. Austin focus.

Tx-507. Smith 44, Layers IV-III, charcoal **800 ± 50**
A.D. 1150

Tx-498. Smith 45, Layers IV-III, shell **1180 ± 80**
A.D. 770

Sq. 0-N1, C-D; 48 to 54 in. depth. Austin focus.

Tx-511. Smith 60, Layer I, charcoal **930 ± 80**
A.D. 1020

Sq. 0-N1, C-D, 72 to 80 in. depth. Mainly Archaic, but possibly some Austin focus.

Tx-515. Smith 4, Layer I, charcoal **1120 ± 80**
A.D. 830

Sq. 0-S1, D-E; 78 to 84 in. depth. Transitional Archaic.

Tx-494. Smith 11, Layer I, shell **2170 ± 80**
220 B.C.

Sq. 0-S1, D-E, 78 to 84 in. depth. Transitional Archaic.

Tx-517. Smith 35, Layer I, shell **1440 ± 80**
A.D. 510

Sq. 0-S1, D-E; 84 to 90 in. depth. Transitional Archaic.

General Comment (D.A.S.): considering charcoal dates only, Toyah-focus dates in this series agree with those from Kyle site (Jelks, 1962, p. 97-98). Austin-focus dates are a little later than those from other sites (e.g., Kyle site; *ibid.*) but are more in agreement with other dates than were dates in Texas II series from Smith shelter; possibly late Austin focus is represented here. Tx-514, from highest layer assigned to Austin focus, either is anomalous or layer is mixed; or else focus assignment is wrong due to incorrect interpretation of affiliations of Eddy point type found in this layer. Both this series and Texas II series indicate rapid accumulation of middle part of deposits in shelter. Tx-515 from Archaic layer is more recent than the few other late Archaic dates from central Texas (Tx-233, 1865 ± 95; Tx-234, 1940 ± 110; Radiocarbon, 1966, v. 8, p. 461) and overlaps with Austin-focus dates, but in present state of knowledge it still might be appropriate for late Archaic. (S.V., Jr.): several shell samples are twice as old as charcoal; others are not consistent. Dilution by dead carbon in shells varies from 4% to 10%. More investigation of snail shell-charcoal pairs is in order in this environment, in which soil contains much $CaCO_3$.

E. Other Texas and Oklahoma Sites

Sotol site series, west Texas

Charcoal from Sotol site (X41CX8; Lorrain, 1968, p. 14-29), at base of northernmost of 3 Red Bluffs, E side of Pecos R. between Sheffield and Iraan, Crockett Co., Texas (101° 49′ N Lat, 30° 46′ W Long). Coll. 1967 and subm. by Dessamae Lorrain, Anthropol. Research Center, Southern Methodist Univ., Dallas, Texas.

Tx-649. Sotol, lot 31 **400 ± 60**
A.D. 1550

From basin-shaped, rock-lined Hearth 1 at base of uppermost zone (Zone D). No artifacts in direct assoc., but in same level were Perdiz point and potsherd. Should date transition from Perdiz to later arrow-point types such as Fresno and Garza.

370 ± 60
Tx-650. Sotol, lot 39 **A.D. 1580**

From under burned rocks in large hearth within Zone D. No artifacts in direct assoc., but in same level in same square were a Fresno and 2 Garza points, a burin, and several scrapers. Should date these recent point types. Should be later than Tx-649.

General Comment (D.L.): other dates relating to Perdiz points are from Toyah focus of central Texas 300 mi E of Sotol site (Smith site, Tx-305, 370 ± 70, this date list; Kyle site, SM-498, 400 ± 130, and SM-501, 685 ± 165, Jelks, 1962, p. 97, where samples are called C-5 and C-8). Fresno and Garza points are cross-dated at ca. A.D. 1700 by Pueblo trade sherds at Pete Creek site 180 mi N of Sotol (Parsons, 1967, p. 76). Fresno points are also dated in late 18th century by French trade goods at Gilbert site 400 mi ENE of Sotol site (Jelks, 1967). These dates, although from distant sites, indicate present dates give proper age for time of transition from Perdiz to stemless triangular points in this area.

Chicken House series, north Texas

Charred corn cobs from possible smoking pits within oval post mold pattern of house, Feature 20, at Chicken House site (X41C06) on low terrace N of Fish Creek, 2 mi W of Red R. and ca. 10 mi NNW of Gainesville, Cook Co., Texas (97° 13′ 10″ N Lat, 33° 46′ 30″ W Long). Site seems to represent an early Plains Village culture pattern. Coll. 1966 and subm. by Dessamae Lorrain, Anthropol. Research Center, Southern Methodist Univ., Dallas, Texas.

590 ± 60
Tx-651. Chicken House 188 **A.D. 1360**

From Hole 4.

480 ± 70
Tx-652. Chicken House 187 **A.D. 1470**

From Hole 5.

320 ± 80
Tx-653. Chicken House 186 **A.D. 1630**

From Hole 23.

670 ± 80
Tx-656. Chicken House 89 **A.D. 1280**

From Hole 24.

General Comments (D.L.): material complex at this site is intermediate in form, and hence is presumed to be intermediate in time, between late Woodland as represented at Pruitt site in Oklahoma and Henrietta-focus sites in Texas (Krieger, 1946). Pruitt site C^{14} dates are GaK-899, 1220 ± 90, and GaK-900, 1140 ± 90 (Barr, 1966, p. 125). There are no Henrietta-focus C^{14} dates but closely related Washita-focus sites in Oklahoma have dates ranging from ca. 550 to 950 B.P. (Pillaert, 1963, p. 43) and Henrietta focus is presumed to be of same age. Therefore present dates, expected to be between these 2 date groups (*i.e.*, 1000 to 1100 yr old), are more than 300 yr younger than expected. No archaeologic explanation for discrepancy is apparent. (E.M.D., S.V., Jr.): fractionation in corn might be responsible for discrepancy (Hall, 1967; Bender, 1968).

Anaqua-site shell series, central Texas coast

Shell samples (*Rangia cuneata*) from Anaqua site (41JK7), 8 mi airline SE of S edge of Edna city limits, on E bank of Lavaca R., Jackson Co., Texas (28° 51′ 00″ N Lat, 96° 35′ 00″ W Long). Site, reported by Story (1968, p. 43-67), contained discrete archaeologic complex including Scallorn and Granbury arrow points, sandy-paste pottery, compound fishhooks. Coll. 1967 and subm. by Dee Ann Story, Dept. Anthropol., Univ. of Texas, Austin. Depths given are below ground surface.

Tx-641. Anaqua 23 **2690 ± 80**
740 B.C.

Sq N100/W145, 0.5 to 0.6 ft deep.

Tx-642. Anaqua 25 **5160 ± 90**
3210 B.C.

Sq. N100/W145, 0.8 to 0.95 ft deep.

Tx-643. Anaqua 39 **5200 ± 90**
3250 B.C.

Sq. N100/W140, 0.5 ft deep.

Tx-644. Anaqua 40 **5130 ± 70**
3180 B.C.

Sq. N105/W130, surface to 0.7 ft deep.

Tx-654. Anaqua 24 **3240 ± 80**
1290 B.C.

Rangia sp., Sq. N125/W130, 0.5 to 1.0 ft deep.

Tx-655. Anaqua 38 **2100 ± 80**
150 B.C.

Rangia sp., Sq. N100/W140, 0.2 to 0.4 ft deep.

General Comment (D.A.S., S.V., Jr., E.M.D.): lacking independent controls (e.g., charcoal samples) or other dates from this area, significance of these shell dates cannot yet be assessed. Arrow points indicate site is probably no more than 2000 yr old. 3100-yr spread of dates is at variance with archaeologic evidence of relatively brief occupation. Dates are recorded here so that they can be evaluated when archaeologic chronology of central Texas coast is better known.

Tx-539. Burris #1, southeast Texas **1070 ± 70**
A.D. 880

Charcoal-stained soil from hearth in Area A-2, Burris #1 site (McClurkan, 1968, p. 60), ca. 3 mi ESE of Onalaska, Polk Co., Texas, in Livingston Reservoir basin (30° 47′ 30″ N Lat, 94° 04′ 20″ W Long). Should date first major appearance of arrow points and decorated pottery at site. Coll. 1966 by B. B. McClurkan and subm. by J. R. Ambler, Texas

Archeol. Salvage Project, Univ. of Texas, Austin. *Comment* (E.M.D.): date, with several from Jones Hill site in same reservoir basin (Tx-325, 970 ± 120; Tx-336, 1410 ± 190; Radiocarbon, 1967, v. 9, p. 448), suggests that arrow points appeared in area late in 1st millennium A.D.

520 ± 50
Tx-524. Lee I site, Oklahoma **A.D. 1430**

Burned corn cobs and other charcoal from Lee site (Gv-3), 3½ mi E of Lindsay, Garvin Co., Oklahoma, on N bank of Washita R. (34° 47′ N Lat, 97° 32′ W Long). From Grid A, Feature II, a pit from floor of Level 7 into sterile soil. Washita River focus, possibly early component. Coll. 1966 by Joe Winters and subm. by R. E. Bell, Dept. of Anthropol., Univ. of Oklahoma, Norman. Date is average of 2 separate preparations and counts: 520 ± 50 and 530 ± 70. *Comments* (R.E.B.): appears a little late in terms of other dates from Washita River focus, ranging from ca. 550 to 950 B.P. (Pillaert, 1963, p. 43), but is not outside range of probability in terms of archaeologic evidence. (E.M.D.): might be affected by fractionation in corn cobs (Hall, 1967; Benden, 1968), making it falsely young.

F. Utah

1820 ± 80
Tx-452. Dust Devil Cave, Hearth 3 **A.D. 130**

Charcoal from Hearth 3 outside overhang of Dust Devil Cave (NA7613), 7½ mi NE of summit of Navajo Mt., San Juan Co., Utah (37° 07′ N Lat, 110° 47′ W Long). Site had early pre-Basketmaker (Desha complex), Basketmaker II, and Pueblo III occupations. Hearth had no direct archaeologic assoc., but was morphologically like Basketmaker rather than Pueblo hearths. Coll. 1961 and subm. by J. R. Ambler, Univ. of Texas, Austin. *Comment* (J.R.A.): date indicates hearth dates from Basketmaker II period.

Sand Dune Cave series

Fragments of open-twined sandals of Desha complex, from lower portion of Stratum V, Sand Dune Cave (NA7523), 4¼ mi NE of summit of Navajo Mt, NE side of unnamed tributary of Cottonwood Creek, San Juan Co., Utah (37° 03′ N Lat, 110° 48′ W Long). Specimens are stratigraphically earlier than, and morphologically distinct from, typical Basketmaker II artifacts which are found in upper and middle portions of same stratum. Coll. 1961 and subm. by J. R. Ambler, Dept. of Anthropol., N. Ariz. Univ., Flagstaff, Arizona.

7540 ± 120
Tx-448. Sand Dune Cave, A **5590 B.C.**

From Sq. P23-24, Level 4, bottom portion of Stratum V.

7700 ± 120
Tx-447. Sand Dune Cave, B **5750 B.C.**

From Sqs. N23-24 and N20, Level 4. Bottom of Stratum V.

Tx-454. Sand Dune Cave, C **7150 ± 130**
5200 B.C.

From Sq. N19, Level 6. Stratum V.

Comment (J.R.A.): although in same stratum as Basketmaker II materials, dates are more than 5000 yr older than BM II. Lacking any comparable dated material, however, there is no reason now to question these ages for Desha complex.

G. Latin America

Cueva Ahumada series, Nuevo Leon, Mexico

Charcoal samples from Cueva Ahumada (NL-1), burned rock midden site, 1 mi N of Rinconada, Neuvo Leon, Mexico (25° 43′ N Lat, 100° 44′ W Long). Samples should date 1st occupation of site, below levels containing Clear Fork gouges, and give minimal age of pictographs buried by deposit. Depths given are below surface. Coll. 1966 by H. P. Jensen, Jr.; subm. by Jensen and J. F. Epstein, Dept. of Anthropol., Univ. of Texas at Austin.

Tx-572. Cueva Ahumada, Level 20(a) **4440 ± 90**
2490 B.C.

Sq. N10-E10, 200 to 210 cm.

Tx-573. Cueva Ahumada, Level 20(b) **3820 ± 90**
1870 B.C.

Sq. N8-E8, 200 to 210 cm.

Tx-574. Cueva Ahumada, Level 21(a) **4480 ± 90**
2530 B.C.

Sq. N8-E10, 210 to 220 cm.

Tx-575. Cueva Ahumada, Level 21(b) **4650 ± 100**
2700 B.C.

Sq. N10-E10, 210 to 220 cm.

Tx-576. Cueva Ahumada, Level 22 **4520 ± 90**
2570 B.C.

Sq. N10-E10, 220 to 230 cm.

General Comment (H.P.J., Jr., J.F.E.): except for Tx-573, all dates are in significant agreement, surprisingly so in view of amount of rodent burrowing in deposit. Anomalous Tx-573 date may be due to burrowing; it should probably not be used. Agreement of others indicates mixing of this part of deposit was minimal. These are 1st dates pertaining to rock art in this region; may help date similar styles found to W and NW in Mexico and Texas.

Las Haldas series, Peru

Charcoal from Las Haldas site, on Pacific coast 30 km S of Casma, Ancash Dept., Peru (9° 45′ S Lat, 78° 18′ W Long). Site shows non-ceramic occupation overlaid by strata containing pre-Chavín (Kotosh Waira-jirca/Kotosh Kotosh) and Chavín style pottery. Latest occupation was at time of breakdown of Chavín style. Coll. 1967; subm. by Terence Grieder, Dept. of Art, Univ. of Texas, Austin.

Tx-631. Las Haldas B **3430 ± 80**
1480 B.C.

Burned *Tillandsia* plants from several small fires 1 m above juncture of ceramic and non-ceramic deposits. Cut 1, Level 5, E flank Structure 4. Assoc. with pottery of pre-Chavín style, early construction of stone walls and mud floors.

Tx-648. Las Haldas A **3140 ± 80**
1190 B.C.

From Structure 6, Main Circle floor cut. From large ash lens on floor sealing non-ceramic levels. Dates beginning of construction of major buildings in center of site. Correlates with middle of Chavín style ceramic sequence.

Tx-632. Las Haldas C **2830 ± 70**
880 B.C.

From Structure 5 stairs; base of midden on top of floor. Dates beginning of brief reoccupation after hasty abandonment and brief hiatus. Correlates with final phase of Chavín style pottery.
General Comment (T.G.): these 3 dates span occupation of site by pottery makers, and agree with sequence of other dates from site: NZ-370-2, 3800 ± 80 (Engel, 1957) for late preceramic; GaK-607, 3590 ± 130 (Tokyo Daigaku, 1960, p. 518) for very early pottery level (before Tx-631, above); GaK-606, 2690 ± 150 (*ibid.*) and NZ-370-1, 2500 ± 100 (Engel, 1966, p. 88) for final period of occupation, represented above by Tx-632.

H. Korea

Tx-440. Kum River, Korea **6590 ± 220**
4640 B.C.

Charcoal from site on bank of Kum R., Korea, ca. 60 mi from its mouth (36° 21′ N Lat, 127° 11′ E Long). From preceramic level at which hammerstones, anvil stones, points, etc., are found; believed to be more than 30,000 yr old. Sample is from 4.6 m below current vegetation level which is at +17 m. Coll. 1965 by P. K. Sohn, Mus. Yonsei Univ., Seoul; subm. by S. M. Kim, Oak Ridge Inst. Nuclear Studies, Tennessee. *Comment* (S.M.K.): date unaccountably recent; sample may have been contaminated by younger material; site is inundated by river in rainy season.

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UPPSALA RADIOCARBON MEASUREMENTS X

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The following list covers samples measured since the last list of atmospheric samples (Radiocarbon, 1967, v. 9, p. 471-476) was written, to determine the increase of the C^{14}/C^{12} ratio due to explosion of nuclear devices.

Technique is the same as described previously (Olsson, 1958). Collection of CO_2 is still made by static absorption in 0.5 N NaOH as described earlier (Radiocarbon, 1965, v. 7, p. 331-335). The reference sample is 95% of the activity of the NBS oxalic-acid standard in 1950. Corrections for deviations from the normal C^{13}/C^{12} ratio are applied. No correction for industrial effect is applied. The results in this list are given as an excess, Δ, over the reference sample:

$$\Delta = \delta C^{14} - (2\delta C^{13} + 50)\left(1 + \frac{\delta C^{14}}{1000}\right)$$

where δC^{14} is the age corrected C^{14} deviation from the reference sample per mil in 1950, and δC^{13} is the deviation from the PDB standard per mil.

ACKNOWLEDGMENTS

Sincere thanks are due Prof. Gustav Sandberg, Uppsala: and to Telegrafstyret, Oslo for giving us help and allowing us to collect samples at Abisko and on Kapp Linné, Spitsbergen. Special thanks are due K. Andersson, R. Backe, and N. Å. Andersson (Abisko); Radiobestyrer H. Öien, N. J. Opsvik, I. Steinnes, and O. Ulvang (Spitsbergen), who helped us collect CO_2. Special thanks are also due Dr. R. Ryhage and his co-workers for making the C^{13}/C^{12} determinations; to Prof. K. Siegbahn, who made it possible to do this work at the institute; and to Statens Naturvetenskapliga Forskningsråd, which gave the necessary financial support. The authors are indebted to Ditte Ekwall, Birgitta Wallin, Maud Söderman, and Carina Ericsson for assisting during processing and measuring. The authors also want to express their thanks to the following students: Thyra Erikson, Rolf Jonsson, Torsten Jonsson, Maj-Liz Larsson, Ulla Lindahl, and Maj-Lis Persson for their help.

A. Abisko, Sweden

Abisko Naturvetenskapliga Station, a scientific station, belongs to Kungliga Vetenskapsakademien. Sampling apparatus (68° 20.5′ N Lat, 18° 49.3′ E Long) is at +390 m near Lake Torne Träsk in mt. dist. of Sweden. Nearby r.r. is electrically operated; the few houses and tourist sta. 0.2 to 1.5 km away are heated with oil or wood. Due to absence of a road connection only a few motor vehicles are used. Thus contamination of the locality by fossil fuels is minimal. Apparatus is placed above treetops.

Dating no.	Sample no.	Month Day Year	δC^{14}‰	δC^{13}‰	Δ ‰
U-397	UA-164s	Sept. 5- 8, 1965	854	−25.1	855 ± 14
U-398	UA-197	Aug. 16-19, 1966	747	−25.8	750 ± 14
U-399	UA-204	Nov. 15-18, 1966	652	−25.5	654 ± 10
U-907	UA-216	Mar. 15-18, 1967	626	−26.0	629 ± 10
U-908	UA-219	Apr. 15-18, 1967	679	−26.5	685 ± 9
U-909	UA-222	July 15-18, 1967	652	−23.0	645 ± 10
U-910	UA-224	Aug. 15-18, 1967	649	−24.7	648 ± 10
U-912	UA-211	Jan. 15-18, 1967	671	−29.0	684 ± 10
U-913	UA-226	Sept. 16-19, 1967	611	−25.2	612 ± 10
U-914	UA-196	Aug. 4- 7, 1966	725	−26.2	729 ± 11
U-915	UA-220	June 17-20, 1967	641	−28.0	651 ± 10
U-916	UA-228	Oct. 15-18, 1967	611	−26.0	615 ± 10
U-917	UA-233	Dec. 30, 1967 to Jan. 2, 1968	595	−26.5	599 ± 10
U-918	UA-235	Mar. 16-19, 1968	568	−25.1	569 ± 13
U-919	UA-237	May 15-18, 1968	585	−25.8*	(588 ± 14)
U-920	UA-195	July 25-28, 1966	735	−24.5	734 ± 12
U-2317	UA-194	July 15-18, 1965	750	−20.4	734 ± 14
U-2319	UA-162	Aug. 5- 8, 1965	1115	−23.1	1107 ± 18
U-2320	UA-202	Oct. 15-18, 1966	700	−25.8	702 ± 11
U-2321	UA-214	Feb. 15-18, 1967	652	−27.0	659 ± 11
U-2322	UA-208	Dec. 15-18, 1966	663	−27.2	670 ± 14
U-2326	UA-230	Nov. 17-20, 1967	592	−25.2	593 ± 12
U-2327	UA-232	Dec. 15-18, 1967	582	−28.0	592 ± 15
U-2328	UA-234	Feb. 16-19, 1968	571	−27.7	579 ± 11
U-2331	UA-236	Apr. 15-18, 1968	601	−25.8*	(603 ± 15)

* δC^{13} assumed

B. Kapp Linné, Spitsbergen

Kapp Linné is a radio and meteorologic station belonging to Telegrafstyret, Oslo, Norway. Sampling apparatus (78° 04′ N Lat, 13° 38′ E Long) is only a few m above sea level near shore at mouth of Isfjorden. Apparatus is placed on top of a small house far form generators and their smoke.

Dating no.	Sample no.	Month Day Year	δC^{14}‰	δC^{13}‰	Δ ‰
U-395	US-49	Mar. 21-25, 1966	699	−26.7	705 ± 10
U-396	US-42	Sept. 14-18, 1965	789	−26.1	793 ± 10
U-900	US-50	June 22-26, 1966	726	−24.6	725 ± 11
U-901	US-51	July 31, 1966 to Aug. 4, 1966	732	−22.2	722 ± 11
U-902	US-52	Aug. 31, 1966 to Sept. 4, 1966	709	−23.2	703 ± 10
U-903	US-53	Sept. 21-25, 1966	687	−25.4	689 ± 10
U-904	US-54	Oct. 18-21, 1966	705	−25.5	707 ± 8
U-905	US-56	Dec. 15-18, 1966	668	−26.7	674 ± 10
U-906	US-59	Mar. 15-18, 1967	644	−26.1	647 ± 10
U-911	US-61	May 15-18, 1967	644	−26.7	649 ± 11
U-921	US-560	Aug. 16-19, 1967	647	−24.9	647 ± 10
U-922	US-570	Sept. 15-18, 1967	642	−25.9	645 ± 12
U-923	US-580	Oct. 17-20, 1967	615	−25.1	615 ± 9
U-924	US-590	Nov. 15-18, 1967	622	−25.3	623 ± 11
U-925	US-62	Jan. 15-18, 1968	583	−24.2	580 ± 11
U-926	US-63	Feb. 17-20, 1968	573	−28.9	585 ± 9
U-927	US-64	Mar. 17-20, 1968	592	−26.7	597 ± 10
U-2315	US-48	Feb. 23-27, 1966	825	−25.8*	(828 ± 80)
U-2318	US-43	Sept. 27, 1965 to Oct. 1, 1965	706	−26.4	711 ± 15
U-2323	US-60	Apr. 15-18, 1967	623	−29.1	637 ± 14
U-2324	US-55	Nov. 16-19, 1966	674	−29.2	687 ± 13
U-2325	US-58	Feb. 21-24, 1967	668	−24.9	668 ± 14
U-2329	US-550	July 12-15, 1967	645	−25.8	648 ± 13
U-2330	US-600	Dec. 16-19, 1967	598	−28.4	609 ± 15

* δC^{13} assumed

General Comment: activity in 1967 showed only small summer increase, and seems to level out at value slightly less than 600‰ excess, which also reached in atmosphere of S hemisphere; it seems as if activity reached maximum there 1964 to 1965. Pretoria samples (pers. commun.) in 1964 showed almost 700‰ excess and Brazil samples in 1966 showed excess of ca. 600‰ (Radiocarbon, 1968, v. 10, p. 414). Since 1966, Uppsala values show no significant difference from Los Angeles values from China Lake (Radiocarbon, 1968, v. 10, p. 413). Since 1966 there is no significant difference between activity at Abisko and that on Spitsbergen.

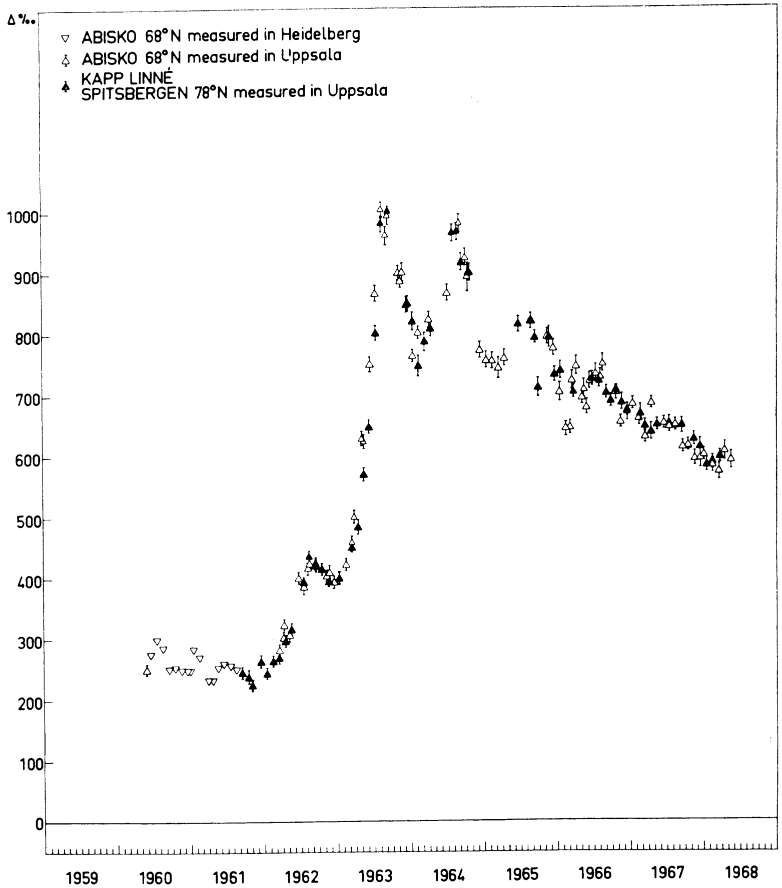

Fig. 1. Per mil C^{14} excess over natural concentration (Δ) at Abisko and on Kapp Linné. Points given with statistical errors are determined at the Uppsala C^{14} lab. Points given without statistical errors are determined at Heidelberg C^{14} Lab. (Münnich and Vogel, 1963) but collected through Uppsala Lab. Values from 1965 corresponding to contamination at Abisko (Olsson and Stenberg, 1967) are not included.

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[RADIOCARBON, VOL. 12, No. 1, 1970, P. 285-290]

BELFAST RADIOCARBON DATES I

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INTRODUCTION

The dating equipment in the Queen's University Palaeoecology Laboratory was installed to provide data for research projects, initially dealing with the development of agriculture, in the departments of Botany and Archaeology.

The dates reported have been obtained using a 2.2-L copper proportional counter filled with a constant mass of methane equivalent to an absolute pressure of 380 cm Hg at 20°C. Background varies inversely with barometric pressure (0.060 counts/min/mb: correlation coefficient-0.95). The background count corrected to 1000 mb is 10.25 counts/min. The net count rate for 95% of the NBS oxalic acid standard is 51.85 counts/min.

The CO_2 from combustion of the sample is converted to CH_4, on a ruthenium catalyst, using a Radiochemistry Inc. sample converter. The catalytic reactor, which is of a flow type, has been redesigned for cartridge loading of the catalyst pellets and to provide a reliably leak-tight system. Gas purity is monitored by determining the pulse amplitude arising from the absorption of the γ emission from an external Cs^{137} source in a standard geometry. This was previously compared to the C^{14} spectrum obtained from the detector using a known-high-purity methane that gave a gross plateau length of more than 1000 v. Our experience is that the Radiochemistry converter, as supplied, does not routinely produce gas of sufficiently high purity. The methane is, therefore, finally passed over a palladium catalyst in the presence of a small amount of hydrogen to remove electronegative impurities, particularly oxygen. Other modifications include additional pumping facilities and the transfer of the Radiochemistry detector assembly to a concrete-lined pit covered by 20 cm of old iron. The detector is surrounded by a 2.5-cm cylindrical mercury shield and a copper multiple-anode proportional guard counter which is filled to 152 cm with methane. Surrounding this is a 10-cm lead-shot shield.

The counting system consists of pre-amplifiers, main amplifiers, and anticoincidence circuitry supplied by Baird-Atomic Europe N.V. (Model LB 231) incorporating triple blanking from the guard/antenna channel and the α-channel. This unit feeds the scaler section of a spectrometer supplied by Baird-Atomic Inc. (Model 560), which also supplies the high voltage. The scaler pulses are fed into a Beckman (Model 1453 H) printer which is set to print at 10 min intervals to enable a statistical check to be made. The electronics are checked routinely using the internal test program together with simulated proportional pulses from a pulse generator. These pulses are fed into the guard and detector amplifier inputs to check on amplifier gain and discriminator levels. The operating voltage is 5.2 kv. The channel width is selected, on the basis of the oxalic acid standard, to include the optimum number of C^{14} β pulses with minimum background. A check on the channel width is obtained by measuring the number of counts from the external Cs^{137} source at different high-voltage settings above the gross and α discriminators. The samples have been counted for 1000 min at least twice, at roughly 14-day intervals (except UB-67 and UB-206).

The charcoal samples have been pretreated in the following way:

1) boiled in 10% NaOH for 1 hour and washed;
2) bleached in calcium hypochlorite, acidified with HCl, and washed;
3) nitrated in a 1:1 mixture of conc H_2SO_4 and conc HNO_3 and washed;
4) extracted in redistilled acetone in Soxhlet extractor until issuing solvent is clear;
5) extracted in water in Soxhlet;
6) dried for 3 days at 100°C.

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We gratefully acknowledge financial support from The Queen's University of Belfast and the Natural Environment Research Council. We are much indebted for advice on technical matters to E. H. Willis, V. R. Switsur, H. Barker, and A. Walton, and would like to thank H. Tauber and R. Burleigh for providing check samples. A special debt is owed to G. Moffatt and A. Richardson for their early work in attempting to bring the apparatus into operation. We acknowledge the cooperation in the field of D. M. Waterman and A. M. ApSimon in obtaining samples from Navan Fort and Ballynagilly. The sample descriptions and comments for Navan Fort have been written in collaboration with Waterman, and ApSimon has contributed to the comments on the Ballynagilly dates. We are indebted to P. Q. Dresser for his work on the barometric pressure correction and to I. Goddard for general assistance. E. M. Jope has given us the benefit of his advice and guidance throughout.

SAMPLE DESCRIPTIONS

I. CHECK SAMPLES

4110 ± 55
UB-63. Fallahogy, No. 6 **2160 B.C.**

Sphagnum peat from raised bog in Townland of Fallahogy, Co. Londonderry, Northern Ireland (54° 54′ 30″ N Lat, 6° 33′ 5″ W Long; Irish Grid Ref. C 925075). Sample from 227 cm depth immediately above main retardation layer and at beginning of 2nd phase of forest clearance as indicated by pollen analysis (Smith and Willis, 1962). Coll. 1957 by A.G.S. *Comment*: part of this sample was dated by the Cambridge Laboratory (Radiocarbon, 1962, v. 4, p. 68) Q-558; 4582 ± 120, 4492 ± 120, 4398 ± 120 B.P. No pretreatment.

UB-65. Mentuhotep, Thebes **3720 ± 60**
1770 B.C.

Sec. of tree trunk from mortuary temple of Neb-hepet-Re Mentuhotep (XIth Dynasty) at Deir el Bahri, Thebes (25° 44′ N Lat, 32° 38′ E Long), Egypt. Found by Egypt Exploration Fund 1907 and now in Dept. of Egyptian Antiquities, British Mus., No. 4779. Expected age, 2010 B.C. (3960 B.P.), is based on astronomical evidence and should not be more than 20 yr in error. *Comment*: part of this sample was dated by the British Mus. Lab. (Radiocarbon, 1959, v. 1, p. 85) BM-21, 3580 ± 150 B.P. Acid pretreatment.

UB-64. Ruds Vedby, Denmark **10,875 ± 70**
8925 B.C.

Wood from thin dark layer representing Pollen Zone Boundary II/III, Allerød/Younger Dryas. Isolated from peaty lake mud in profile at Ruds Vedby, Zealand, Denmark (55° 33′ N Lat, 11° 22′ E Long). *Comment*: this material, extensively used as interlaboratory check sample, has been dated 13 times by 9 labs. Dates are summarized by Håkansson (Radiocarbon, 1968, v. 10, p. 38) who gives weighted mean of those measurements made before his own (Lu-3, 10,840 ± 120) as 10,995 ± 55. No pretreatment.

UB-67. 1835-1845 larch wood **160 ± 100**
A.D. 1790

Wood from A.D. 1835-1845 rings of larch tree felled in 1964 at Pomeroy Forestry School, Co. Tyrone, Northern Ireland (54° 35′ N Lat, 6° 54′ W Long; Irish Grid Ref. H 705724). Coll. 1964 by A.G.S. *Comment*: carbonized before combustion.

II. ARCHAEOLOGIC SAMPLES

Navan Fort series, Co. Armagh, Northern Ireland

Samples are from Navan Fort (54° 21′ N Lat, 6° 41′ W Long; Irish Grid Ref. H 847452) under excavation by D. M. Waterman, Archaeol. Survey of Northern Ireland. After Neolithic utilization, there was a circular habitation enclosure with ditch (UB-188) and palisade, of Late Bronze age to Early Iron age date. Remains of settlement consist of series of wall-slots of 3 circular houses (UB-203). A soil which developed towards end of occupation (UB-187) underlies clean stratum suggesting period of disuse. A massive concentric-ring timber structure, 40 m in diam., was then erected, reconstructed, and burnt, apparently deliberately (UB-186 and UB-202). Finally, a composite mound 46 m in diam. and 4.5 to 5 m high was constructed. Coll. by D. M. Waterman following field discussion with A.G.S. and J.R.P.

UB-188. Navan Fort, primary ditch fill **2630 ± 50**
680 B.C.

Charcoal from base of primary ditch filling. *Comment*: should date earliest occupation within ditch. Date suggests circular enclosure was in use by end of Bronze age. Blade of a bronze socketed-sickle was discovered in cobbling assoc. with round houses.

UB-203. Navan Fort, wall slot of Phase 2 house **2360 ± 45**
410 B.C.

Charcoal (partly *Fraxinus,* id. by J.R.P.) from wall of Phase 2 timber round house. From rebuilding near end of series. *Comment*: material may be debris from earlier building in Phase 2, but date should be applicable to Phase 2 in general.

UB-187. Navan Fort, surface of ditch filling **2345 ± 50**
395 B.C.

Charcoal from above natural silting of ditch at base of soil which developed towards end of occupation of circular enclosure. *Comment*: sample does not relate to final occupation of circular enclosure, but can be taken with UB-188 and UB-203 as applicable to occupation of circular habitation enclosure in general.

UB-186. Navan Fort, concentric-ring post structure, 1 **2415 ± 50**
465 B.C.

Charcoal (*Quercus,* id. by J.R.P.) from destruction layer of periphery of 40-m concentric-ring post structure. *Comment*: sample was probably from large structural timbers, either original or replacements (for which there is stratigraphic evidence), or a mixture of both. Date refers, therefore, only indirectly to building and destruction of structure, which must be younger than occupation of circular habitation enclosure (UB-187, etc.). This occupation is separated from concentric-ring post structure by layer of apparently sterile soil indicating period of disuse: duration of this period cannot be specified exactly from C^{14} dates but is unlikely to have been more than a few centuries.

UB-202. Navan Fort, concentric-ring post structure, 2 **2215 ± 50**
265 B.C.

Charcoal, small branches (partly *Corylus,* id. by J.R.P.) from same stratigraphic horizon as UB-186. *Comment*: material was small hazel branches (though other woods may have been present); it seems that this was kindling material with which outer wall of concentric-ring post structure was fired. Date should refer to deliberate burning of structure. *General Comment*: this series is internally consistent and post-Neolithic occupations, to which dates relate, appear to have continued over several centuries. Time between means of oldest and youngest dates is some 400 yr. Occupations clearly belong to pre-Roman Iron age with possible initial utilization in Dowris phase of late Bronze age (Eogan, 1964). Early Iron age site at Lough Gara, Co. Sligo, yielded C^{14} dates covering roughly same range (Radiocarbon, 1961, v. 3, p. 26-38).

Ballynagilly Series 1, Co. Tyrone, Northern Ireland

The site, known as 'The Corby,' is in Ballynagilly Townland, Co. Tyrone, Northern Ireland (54° 42′ N Lat, 6° 51′ W Long; Irish Grid

Ref. H 743837) 5 mi NW of Cookstown. Series is from excavations carried out by A. M. ApSimon (Archaeol. Dept., Univ. of Southampton) on behalf of Ministry of Finance, Northern Ireland, during 1966-68 (Neolithic House in Ulster, 1968). Excavations revealed Neolithic settlement with rectangular house foundation and numerous hearths, pits, and postholes. Ca. 50 m from Neolithic site, Bell Beaker habitation site was discovered which yielded large quantities of flint implements and pottery. There are also signs of Early Bronze age utilization of site.

UB-197. Ballynagilly, Neolithic borrow pit (L, F135) **5625 ± 50** **3675 B.C.**

Charcoal (*Pinus*, id. by J.R.P.) from large pit containing hearth debris including burnt stone, burnt clay, and sherds of Neolithic pottery, ca. 7 m S of wall slot of Neolithic house (UB-201). Coll. 1967 by A.M.A. *Comment* (A.M.A.): assoc. pottery is of Dunmurry style (Case, 1961) tentatively placed at beginning of Irish Neolithic sequence.

UB-201. Ballynagilly, Neolithic house wall-slot (L, F158) **5165 ± 50** **3215 B.C.**

Charcoal (*Quercus,* id. by J.R.P.) from remains of split-oak planking compressed in wall-slot of Neolithic house. Coll. 1968 by J.R.P. *Comment*: date confirms Neolithic age of house, but is significantly younger than borrow-pit date (UB-197).

UB-198. Ballynagilly, Early Bronze age hearth (M, F33) **3590 ± 60** **1640 B.C.**

Charcoal from saucer-shaped mass of charcoal 40 cm diam. containing one Early Bronze age sherd and resting on burnt sandy clay with burnt Beaker artifacts. Coll. 1967 by A.M.A. *Comment*: sample should post-date Beaker pottery sherds below, and be applicable to Early Bronze age re-occupation.

Ballynagilly Series II, Co. Tyrone, Northern Ireland

Ballynagilly Series II samples relate to palaeoecologic work assoc. with excavations by A. M. ApSimon, as described under Ballynagilly Series I (this date list). Samples come from several cores and monoliths taken by J.R.P. and A.G.S. from peat overlying occupation horizons and from nearby deep organic deposits. Detailed pollen analyses have been made of sub-samples from monoliths.

UB-15. Ballynagilly, Monolith A, 22 to 24 cm **5195 ± 60** **3245 B.C.**

Charcoal (*Quercus,* id. by J.R.P.) isolated from charcoal-rich layer in sandy peat. Pollen diagram shows temporary decline of *Quercus* curve; *Pinus* curve falls to low values and *Betula* curve rises. These and other features, together with presence of charcoal, suggest phase of forest clearance. Coll. 1966 by J.R.P. *Comment*: date is comparable with that of Neolithic house (UB-201).

General Comment (Ballynagilly Series I and II): only small fraction of samples from Ballynagilly has been dated; it seems likely, however, that Neolithic occupation (or occupations) took place before 5000 radiocarbon yr ago. This is in line with other C^{14} dates for Neolithic material from Ireland (Radiocarbon, 1961, v. 3, p. 26-38; Watts, 1961) and with those for early Sub-boreal forest clearance at Fallahogy, Co. Londonderry (Radiocarbon, 1962, v. 4, p. 57-70; Smith and Willis, 1962).

III. GEOLOGIC SAMPLE

UB-206. Drumskellan, Co. Donegal, Republic of Ireland **6955 ± 100**
5005 B.C.

Wood (*Quercus*, id. by J.R.P.) from raised beach at Drumskellan, Co. Donegal, Irish Republic (55° 5′ N Lat, 7° 15′ W Long; Irish Grid Ref. C 5128). Sample from log 3 to 4 m long embedded in low raised beach (4.9 to 6.1 m O.D.) shoreline of which notches gravels of slightly higher Late-glacial raised beach (Synge and Stephens, 1965, 1966). Coll. 1966 by E. A. Colhoun; subm. 1968 by N. Stephens, Geog. Dept., Queen's Univ. Belfast. *Comment*: beach cannot be older than date of sample. But, if wood was redeposited as driftwood beach could be younger. Trunk showed no signs of abrasion, and date agrees with conclusions of Synge and Stephens (1966). Pretreatment: sample ground and leached with NaOH, washed, bleached in calcium hypochlorite, acidified with HCl, and washed until neutral.

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BELFAST RADIOCARBON DATES II

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INTRODUCTION

The dating equipment in the Palaeoecology Laboratory has remained essentially as described in Belfast I (this volume). Rewiring of the counter has increased the detection efficiency slightly. Background count corrected to 1000 mb is now 11.0 counts/min and the net count rate for 95% of the NBS oxalic acid standard is 56.0 counts/min. All charcoal samples have been pretreated in accordance with the schedule given in Belfast I.

All the dates in this list are from sites in Northern Ireland. Unless specifically stated the samples have been collected by the authors and other members of the laboratory: M. G. L. Baillie, P. Q. Dresser, Adelaide Goddard, and I. Goddard. Where a sample has been collected for a specific research project the collector's (s') initials are given. We are much indebted to Mrs. Marilyn Carse for technical assistance. Continued financial support from the Natural Environment Research Council is gratefully acknowledged.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

Annaghmare series, Co. Armagh

Samples from court cairn at Annaghmare, 2¼ mi SW of Cullyhanna, Nr. Newry, Co. Armagh (54° 6′ N Lat, 6° 37′ W Long; Irish Grid Ref. H 905178). Site excavated by D. M. Waterman in 1963/64. Coll. and subm. by D. M. Waterman, Archaeol. Survey of Northern Ireland (Waterman, 1965).

1425 ± 50
UB-209. Annaghmare Cairn, Chamber 3 **A.D. 525**

Charcoal from lower half of large stone filling of Chamber 3 of Cairn. Deposit contained pottery of Western Neolithic style.

1525 ± 60
UB-240. Annaghmare Cairn, Chamber 2 **A.D. 425**

Charcoal from Chamber 2 of cairn.

4310 ± 70
UB-241. Annaghmare Cairn, forecourt **2360 B.C.**

Charcoal sealed behind primary blocking of forecourt of cairn.

General Comment: only UB-241 provides archaeologically acceptable date. Reasons for comparative young age of other 2 dates are obscure. There was no stratigraphic evidence of disturbance which would have allowed charcoal of date younger than cairn to have been incorporated.

3660 ± 60
UB-207. Ballymacdermot Cairn **1710 B.C.**

Charcoal from black deposit below stone blocking of inner forecourt of cairn on S slope of Ballymacdermot Mt., Nr. Newry, Co. Armagh (54° 9′ N Lat, 6° 23′ W Long; Irish Grid Ref. H 063238). Site excavated 1962 by A. E. P. Collins and B. C. S. Wilson. Coll. and subm. by A. E. P. Collins, Archaeol. Survey of Northern Ireland (Collins and Wilson, 1964). *Comment* (A.E.P.C.): date is several centuries later than expected, though it may mark only latest period at which forecourt was clear for ceremonies, before closure by blocking stones (see Collins and Wilson, 1964, Figs. 3 and 4, facing p. 6 and 7).

3350 ± 45
UB-239. Ballykeel Dolmen **1400 B.C.**

Charcoal from Ballykeel Dolmen at foot of W flank of Slieve Gullion Mt., Nr. Newry, Co. Armagh (54° 8′ N Lat, 6° 28′ W Long; Irish Grid Ref. H 995213). Sample comes from Stratum 4, Sec. C-D (see Collins, 1965, Fig. 3). Site excavated 1963 by A. E. P. Collins. Coll. and subm. by A.E.P.C. *Comment* (A.E.P.C.): sample was from stratum incorporated in body of cairn. Date ca. 600 yr earlier would have seemed more likely.

3400 ± 70
UB-11. Beaghmore Stone Circles, Cairn 10 **1450 B.C.**

Charcoal from Cairn 10, Beaghmore stone circles, 9 mi NW of Cookstown, Co. Tyrone (54° 42′ N Lat, 6° 56′ W Long; Irish Grid Ref. H 685843). Material from old land surface under mound of cairn. Coll. by J.R.P. (May, 1943; Pilcher, 1969). *Comment*: dates earliest possible age of construction of cairn.

3555 ± 45
UB-23. Beaghmore Stone Circles, flint hoard **1605 B.C.**

Charcoal assoc. with flint hoard at Beaghmore stone circles. Co. Tyrone (54° 42′ N Lat, 6° 56′ W Long; Irish Grid Ref. H 685843). In stony soil under peat with group of small flint cores. Coll. by J.R.P. (Pilcher, 1969). *Comment*: date suggests that flints were left by builders of stone circles rather than earlier Neolithic inhabitants.

1795 ± 65
UB-266. Teeshan, No. 9 **A.D. 155**

Oak wood, from heavy split beam, from crannog in Teeshan Td., 150 m E of Teeshan Primary School, Co. Antrim (54° 54′ 30″ N Lat, 6° 19′ W Long; Irish Grid Ref. D 083078). Rescue excavations undertaken in 1967 by R. Warner, Ulster Mus., Belfast, and A. E. P. Collins (ms. in preparation). Coll. 1968. *Comment* (M.G.L.B.): sample ties into 500 yr floating tree-ring chronology from site, 250 yr from younger end. Finds, mostly unstratified, suggest occupation during Later Iron age (Early Christian times) (Warner, pers. commun.).

II. PALAEOECOLOGIC SAMPLES

Beaghmore series, Co. Tyrone

Samples from core, from which pollen diagram has been prepared, through post-glacial deposits in lake basin at Beaghmore, Co. Tyrone (54° 42′ N Lat, 6° 56′ W Long; Irish Grid Ref. H 685843). Work assoc. with excavation of stone circles, cairns, and alignments 100 m to E. (Pilcher, 1969). Coll. by J.R.P. All samples received acid pretreatment.

670 ± 60
UB-84. Beaghmore Series I, 38 to 42 cm **A.D. 1280**

Blanket peat.

1590 ± 75
UB-86. Beaghmore Series I, 94 to 98 cm **A.D. 360**

Blanket peat.

2090 ± 70
UB-87. Beaghmore Series I, 126 to 130 cm **140 B.C.**

Blanket peat. Beginning of extensive agriculture and forest clearance indicated in pollen diagram.

2800 ± 60
UB-89. Beaghmore Series I, 190 to 194 cm **850 B.C.**

Reedswamp peat.

3350 ± 65
UB-90. Beaghmore Series I, 214 to 218 cm **1400 B.C.**

Reedswamp peat. Sample from just below point at which plantain pollen forms continuous curve.

3880 ± 65
UB-91. Beaghmore Series I, 242 to 246 cm **1930 B.C.**

Reedswamp peat. First increase in heath pollen.

4525 ± 55
UB-92. Beaghmore Series I, 270 to 274 cm **2575 B.C.**

Muddy reedswamp peat with wood. End of forest regeneration following earliest clearance.

4565 ± 70
UB-97. Beaghmore Series I, 278 to 280 cm **2615 B.C.**

Muddy reedswamp peat with wood. Middle of probable grazing stage of early agricultural phase.

4995 ± 60
UB-98. Beaghmore Series I, 282 to 284 cm **3045 B.C.**

Muddy reedswamp peat with wood. End of cereal-growing stage of early agricultural phase.

5110 ± 75
UB-99. Beaghmore Series I, 286 to 288 cm **3160 B.C.**

Muddy reedswamp peat with wood. Beginning of cereal growing following early forest clearance.

UB-93. Beaghmore Series I, 294 to 298 cm **5295 ± 75** **3345 B.C.**

Muddy reedswamp peat with wood. Beginning of alder increase.

UB-94. Beaghmore Series I, 308 to 312 cm **5965 ± 80** **4015 B.C.**

Coarse-detritus mud with wood.

UB-95. Beaghmore Series I, 334 to 338 cm **6225 ± 50** **4275 B.C.**

Coarse-detritus mud.

UB-96. Beaghmore Series I, 358 to 362 cm **7000 ± 90** **5050 B.C.**

Coarse-detritus mud with wood. Pollen Zone VI-VII boundary *sensu* Jessen (1949).

General Comment (J.R.P.): series was taken at more or less constant vertical intervals rather than at particular horizons of interest so that continuous time scale could be constructed for profile. Series is internally consistent. See also general comment on Ballynagilly Series II (this list).

Ballynagilly Series II, Co. Tyrone

This is a continuation of series reported in Belfast I from palaeoecologic work assoc. with excavations of A. M. ApSimon at "The Corby," Ballynagilly Td., Co. Tyrone (54° 42′ N Lat, 6° 51′ W Long; Irish Grid Ref. H. 743837) (see under Ballynagilly Series I, Belfast I). Samples in this list are from core, from which pollen diagram has been prepared, taken through valley bog deposits near settlement sites. All samples received acid pretreatment.

UB-245. Ballynagilly core, 164 to 167 cm **3135 ± 60** **1185 B.C.**

Highly decayed peat with charcoal. Peak of plantain pollen.

UB-246. Ballynagilly core, 178 to 181 cm **3340 ± 65** **1390 B.C.**

Reedy transition peat with charcoal.

UB-247. Ballynagilly core, 194 to 197 cm **3620 ± 60** **1670 B.C.**

Woody reedswamp peat with charcoal. Towards end of large peak of birch pollen.

UB-248. Ballynagilly core, 204 to 207 cm **3870 ± 70** **1920 B.C.**

Woody reedswamp peat. Just above increase in pollen of plantain, cereals, and heaths.

UB-249. Ballynagilly core, 214 to 217 cm **4025 ± 65** **2075 B.C.**

Woody reedswamp peat.

4340 ± 65
UB-250. Ballynagilly core, 226 to 229 cm **2390 B.C.**

Reedswamp peat with pine cone. Rapid decline of pine pollen; peak of *Sorbus* pollen.

4540 ± 65
UB-251. Ballynagilly core, 236 to 239 cm **2590 B.C.**

Muddy reedswamp peat. Beginning of recovery of elm and pine following forest clearance.

4850 ± 70
UB-252. Ballynagilly core, 244 to 247 cm **2900 B.C.**

Muddy reedswamp peat. Beginning of plantain stage of early agricultural phase.

5145 ± 70
UB-253. Ballynagilly core, 253 to 256 cm **3195 B.C.**

Coarse-detritus mud with charcoal. Elm and pine pollen drop suddenly. Pine charcoal layer at same level.

5575 ± 70
UB-254. Ballynagilly core, 261 to 264 cm **3625 B.C.**

Coarse-detritus mud. Peak in willow-pollen curve shortly before elm decline and only just below beginning of major rise of alder curve.

5835 ± 80
UB-255. Ballynagilly core, 270 to 273 cm **3885 B.C.**

Coarse-detritus mud.

General Comment: samples were taken at regular intervals to provide continuous time scale for vegetational changes recorded by pollen analyses and to measure growth rate of deposit. Results fall on curve which has a roughly exponential form as might be expected from a compressible deposit with a relatively uniform growth rate. Time scale will be used to correlate archaeologic occupation (samples from Ballynagilly Series I, Belfast I) with vegetational changes.

Major rise of alder curve at Beaghmore does not begin until 312 cm, just below UB-93 (5295 ± 75), though small amounts of alder pollen are present back to level of UB-96 (7000 ± 90). The major rise of alder pollen at Ballynagilly is bracketed by UB-253 (5145 ± 70) and UB-254 (5575 ± 70) but small amounts of alder pollen run down to 296 cm. UB-96 dates Boreal-Atlantic transition (Pollen Zone Boundary VI-VII) *sensu* Jessen (1949). Major rise of alder dated by UB-93, UB-253, and UB-254 comes at both sites where pine curve begins to fall. These features seem to conform with Boreal-Atlantic transition *sensu* Mitchell (1951).

Decline of elm marking Pollen Zone VIIa-VIIb boundary of Jessen (1949) and Pollen Zone VII-VIII boundary of Mitchell (1956) is dated at Beaghmore most closely by UB-99 (5110 ± 75) and at Ballynagilly by UB-253 (5145 ± 70). At Beaghmore indications of prehistoric agriculture occur at elm decline and dates from both sites are similar to those obtained for beginning of Landnam phase at Fallahogy, Co. Londonderry

(Radiocarbon, 1962, v. 4, p. 67-68; Smith and Willis, 1962). The Neolithic house at Ballynagilly (UB-201, Belfast I) gave date 5165 ± 50.

Pollen diagrams from both Beaghmore and Ballynagilly show reduction in pine curve to insignificant values. At Ballynagilly UB-250 (4340 ± 65) comes at this decline. At Beaghmore this decline is bracketed by UB-91 (3880 ± 65) and UB-92 (4525 ± 55).

2610 ± 65
UB-264. Loughaveema, 172 to 173 cm 660 B.C.

Soil from under blanket peat near Loughaveema lake 6 mi ESE of Ballycastle, Co. Antrim (55° 9′ N Lat, 6° 6′ 35″ W Long; Irish Grid Ref. D 205363). Sample taken 50 ft from Bronze age cairn with cist containing food vessel and at 172 to 173 cm from surface of blanket peat. Cairn was excavated by V. B. Proudfoot (Department of Geog., Univ. of Alberta, Edmonton). Blanket peat starts at 170 cm and there is an iron pan at 201 cm. Coll. 1968 by A. Goddard. *Comment* (A.G.): pollen analysis shows sample lies just below rise in Cyperaceae, drop in Gramineae, and beginning of continuous curve for *Sphagnum* spores. Acid pretreatment.

3515 ± 70
UB-265. Ballypatrick Forest, 203 to 206 cm 1565 B.C.

Base-soluble humus from soil with remains of *Phragmites*, below blanket peat on slopes of Carneighaneigh Mt., 5½ mi SE of Ballycastle, Co. Antrim (55° 9′ 30″ N Lat, 6° 7′ 35″ W Long; Irish Grid Ref. D 193364). Sample from 203 to 206 cm depth. Blanket peat formation starts at 199 cm. Coll. 1968 by A. Goddard. *Comment* (A.G.): pollen analysis shows sample lies just below drop in tree pollen where there is marked increase in Gramineae, and beginning of rise in Ericaceae. Acid pretreatment.

III. GEOCHEMICAL SAMPLES

Samples in this section were obtained as part of program for investigation of reliability of various peat types for dating. Preparations have been carried out by P. Q. Dresser. All whole peat samples have been given HCl pretreatment. In addition some samples have been fractionated. Suffix A samples are whole peat; Suffix B samples are hot-water-soluble component; Suffix C samples are NaOH-soluble component (after removal of Fraction B); Suffix D samples are residue after removal of Fractions B and C; Suffix E samples are other stated peat components.

Sluggan series, Co. Antrim

Peat samples from Sluggan bog, Magheralane Td., 1½ mi NE of Randalstown, Co. Antrim (54° 46′ N Lat, 6° 18′ W Long; Irish Grid Ref. J 099921). Samples were obtained by excavation from part of raised bog 5.2 m deep.

4650 ± 75
UB-219 A. Sluggan series, No. 10, 230 to 235 cm 2700 B.C.

Sphagnum imbricatum peat with *Eriophorum* and *Calluna*.

UB-219 B. 4520 ± 80

UB-219 D. 4500 ± 80

Comment (P.Q.D.): no significant difference between fractions.

5290 ± 65

UB-220 A. Sluggan series, No. 11, 270 to 275 cm 3340 B.C.

Sphagnum/Eriophorum peat with carbonized branch of hazel (id. by J.R.P.)

UB-220 D. 5230 ± 70
UB-220 E. (charcoal) 5440 ± 60

Comment: precise origin of charcoal unknown, but appears older than peat.

2035 ± 70

UB-261 A. Beaghmore, basal blanket peat 85 B.C.

Blanket peat from Beaghmore stone circle site (see UB-11, this list) 9 mi NW of Cookstown, Co. Tyrone (54° 42′ N Lat, 6° 56′ W Long; Irish Grid Ref. H 685843). Basal 2 cm layer of blanket peat from 15 m W of Cairn 10, adjacent to monolith cut out for pollen analysis. Coll. 1969 by P.Q.D. and J.R.P.

UB-261 B. (6.6% C) 1570 ± 70
UB-261 C. (45.5% C) 1735 ± 80
UB-261 D. (47.9% C) 2085 ± 70

Comment (P.Q.D.): figures for % carbon represent carbon content of fraction as percentage of whole peat (Sample A) carbon. Fractions A, C, and D are not significantly different; exclusion of Fraction B from whole peat would make the age, weighted by proportion of C^{14}, only ca. 30 yr older. Peat from similar stratigraphic position at this site has been dated by Dublin Lab. (D-30, 1400 ± 120; Radiocarbon, 1961, v. 3, p. 31).

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VIENNA RADIUM INSTITUTE RADIOCARBON DATES I

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INTRODUCTION

A dating system consisting of gas sample counter with internal anticoincidence counter ring, transistorized electronic equipment, and chemical apparatus was developed in the Institute (Felber and Vychytil, 1962; Felber, 1965). A high voltage supply Fluke Model 408B is used. For routine dating, begun in 1965, an improved 2.4 L counter with Teflon insulators is used, shielded on all sides by 20 cm of iron. The counter is run with methane at 760 torr/15°C. Spurious counts are carefully eliminated by a systematic procedure (Felber, 1966). Stability of electronics and counter is checked once a day by taking the topmost part of the peak of Mn_{α}-X-rays following electron capture in Fe-55, radiated through a beryllium window. Checking is done with the same single channel analyzer (switched over to operation with small window) used for energy discrimination (switched over to two discriminator operation) during measurement. If any change should be observed, discriminator settings are corrected. Energy discrimination is not optimized (Felber, 1962) because a neutron generator using (d,t) reaction is run in the same building in which the samples are prepared: the lower discriminator is set above tritium maximum energy at 22 keV, the upper one at 120 keV, the highest possible energy absorption of C^{14} β particles in the special counter. The background is 1.58 cpm, the net contemporary value (95% of NBS oxalic acid standard activity) is ca. 8.8 cpm.

After careful mechanical cleaning, excavated organic material is pretreated with hot 1% HCl and hot 1% NaOH. Pretreated organic sample is burnt in oxygen flux; heated copper oxide completes combustion. Any excess O_2 is bound on heated copper. CO_2, cleaned by acidified potassium permanganate solution, is frozen out by liquid nitrogen. Shells, after mechanical cleaning, are pretreated with HCl to remove the surface; CO_2 is liberated by H_3PO_4.

The CO_2 released into an apparatus for methane synthesis is mixed with a small excess of commercial H_2 (because of our discriminator setting mentioned earlier, we see no reason for selection of special tritium-free hydrogen), and circulated over heated (420°C) ruthenium finely divided on aluminium oxide pellets (F. A. Baker, Newark, New Jersey). The synthesized methane is dried in a dry-ice-ethanol-cooled trap, frozen into a small steel bomb, freed from excess hydrogen by pumping, and stored for 4 weeks for the purpose of radon decay. Purity of methane is gas-chromatographically checked.

Age calculations are based on a contemporary counting rate equal to 0.95 of the activity of the NBS oxalic acid standard and on a half-life for radiocarbon of 5568 ± 30 years. Results are given in years before

1950 (B.P.) and in the A.D./B.C. scale. Uncertainties quoted are single standard deviations originating from the statistical nature of radioactive decay including standard, sample, background, and half-life.

In the case of old samples, if in the measuring time θ a sample net counting rate comes out smaller than three times its standard deviation, an age limit is given that corresponds to a sample net counting rate, coming out three times its standard deviation in the same measuring time. The calculation is

$$t = \frac{\tau}{\ln 2} \ln \frac{C_R \sqrt{\theta}}{k \sqrt{2C_L}},$$

where $\tau = C^{14}$ half life, C_R = contemporary counting rate, C_L = background counting rate, θ = measuring time, equal for contemporany standard and background, and $k = 3$. In the case of young samples, if in the measuring time θ the difference between contemporary counting rate and sample counting rate comes out smaller than three times the standard deviation of this difference, an age limit is given

$$t = \frac{\tau}{\ln 2} \frac{k \sqrt{2}}{C_R \sqrt{\theta}} \sqrt{C_R + 2\, C_L}$$

corresponding to a sample net counting rate giving a difference equal to three times its standard deviation in the same measuring time (Felber, 1962).

No C^{13}/C^{12} ratios were measured. Sample descriptions have been prepared in collaboration with the submitter.

The dates listed in this paper were published in Sitzungsberichte der Österr, Akad. der Wissenschaften (Felber, 1965, 1966, 1967, 1968). As noticed in Felber, 1968, dates presented in Felber, 1965, 1966, 1967 have to be corrected because age of standard wood, used at that time, was wrong. In this date list dates are corrected and based on the NBS oxalic acid standard as mentioned above.

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staff of the electronic laboratory for planning, building, and service of electronic units.

SAMPLE DESCRIPTIONS

I. CROSS-CHECK SAMPLE

VRI-6. Ruds Vedby, Denmark **11,100 ± 200**
9150 B.C.

Wood from thin layer representing exact Pollen-Zone Boundary II/III, Alleröd/Younger Dryas, in profile at Ruds Vedby (55° 32′ N Lat, 11° 22′ E Long), Zealand, Denmark. *Comment*: distributed by H. Tauber, Copenhagen, Radiocarbon Lab., as cross-check sample and dated by many laboratories: Suess (1954), W-82, 10,260 ± 200; W-84, 10,510 ± 180; Östlund (1957a), St-18, 10,145 ± 370; Münnich (1957), H-105-87, 11,500 ± 300; de Vries, Barendsen and Waterbolk (1958), GrN-454, 10,995 ± 250; Olsson (1959), U-20, 10,950 ± 130, U-75, 10,810 ± 140; Barker and Mackey (1959), BM-19, 11,333 ± 200; Tauber (1953), K-101, 10,890 ± 240; Tauber (1960), K-101 bis, 11,090 ± 240; Tauber (1964), K-101 remeasured, 10,970 ± 120; Alessio, Bella and Cortesi (1964), R-64, 11,900 ± 170; Håkansson (1968), Lu-3, 10,840 ± 120.

II. GEOLOGY, GEOGRAPHY, SOIL SCIENCE, AND FORESTRY

A. Austria

VRI-127. Turracherhöhe, Kärnten **620 ± 70**
A.D. 1330

Decomposed blackish-brown *Carex*-woodland peat from Schwarzseemoor near Turracherhöhe (46° 55′ N Lat, 13° 53′ E Long), Carinthia, from 26 to 34 cm depth. Coll. 1966 by H. Mayer *et al.*; subm. by F. Kral, Inst. für Waldbau Hochschule für Bodenkultur, Vienna. *Comment* (F.K.): date fixes chronologically human influence on woodland (1st fellings in surroundings), clearly established pollen-analytically. Historically, 2 periods of fellings are suggested: one in connection with increasing iron industry (1st iron blast furnace in Turrach, 1664), another one in 13th to 14th century (pasture clearing). Date points to latter expectation.

Lunz series, N.Ö.

Sphagnum peat from upland moor "Rotmösel" in Revier Neuhaus, Rothschild'sche Forstverwaltung Langau, 12 km SE of Lunz (47° 52′ N Lat, 15° 02′ E Long), Lower Austria. Coll. 1966 by H. Mayer *et al.*; subm. by F. Kral.

VRI-100. Rotmösel 8-16 **<200**

Peat from 8 to 16 cm depth. *Comment* (F.K.): dating should chronologically fix first human influence on surrounding woodland, pollen-analytically established (Kral and Mayer, 1968). If date is corrected for de Vries–effect according to Suess's table (Suess, 1965), it is not in contradiction with pollen-analytical dating.

VRI-101. Rotmösel 32-40 **<200**

Peat from 32 to 40 cm depth. *Comment* (F.K.): date unexpectedly young. Contamination possible.

VRI-102. Lahnsattel, N.Ö. **<200**

Carr peat from small woodland moor at edge of primeval forest reservation "Neuwald" ca. 2 km E of Lahnsattel (47° 46′ 30″ N Lat, 15° 29′ 10″ E Long), Lower Austria. Sample from 15 to 23 cm depth. Coll. 1966 by H. Mayer *et al.*; subm. by F. Kral. *Comment* (F.K.): dating should chronologically fix 1st human influence on surrounding woodland, pollen-analytically established (Kral and Mayer, 1968). If date is corrected for de Vries–effect according to Suess's table (Suess, 1965), it is not in contradiction with pollen-analytical dating.

Litschau series, N.Ö.

Dark-brown carr peat from Rottalmoos near Litschau (48° 57′ N Lat, 15° 03′ E Long), Waldviertel, Lower Austria. Coll. 1966 by H. Mayer *et al.*; subm. by F. Kral.

730 ± 70
VRI-125. Litschau 4-12 **A.D. 1220**

Peat from 4 to 12 cm depth. *Comment* (F.K.): date fixes pollen-analytically established beginning of human influence on surrounding woodland. Date in agreement with submitter's estimate.

4110 ± 90
VRI-126. Litschau 25-33 **2160 B.C.**

Peat from 25 to 33 cm depth. *Comment* (F.K.): date fixes pollen-analytically established beginning of increased spread of *Abies*. Date in agreement with submitter's estimate.

4620 ± 120
VRI-18. Linz a. Donau, O.Ö. **2670 B.C.**

Stem, dredged from fluvial deposits of Danube during construction of tankage port West, Linz (48° 18′ N Lat, 14° 18′ E Long), Upper Austria. Coll. 1962; subm. by Stadtmuseum, Linz. *Comment*: date disproves estimate of 10,000 to 15,000 yr.

Mondsee series 1, O.Ö.

Subm. by W. Klaus, Geol. Bundesanstalt, Vienna.

VRI-31. Mondsee 1 **>35,000**

Subfossil wood (*Picea*) excavated at Autobahn Salzburg-Vienna, km 162.3, Gasterbauer cut, near Mondsee (47° 52′ N Lat, 13° 21′ E Long), Upper Austria, embedded in lacustrine clay and sand in region of Würm moraine of Ice Age Traun glacier. Coll. 1960 by J. Schadler. *Comment* (W.K.): problem was to distinguish between Alleröd, a Würm interstadial, and Riss-Würm Interglacial. Pollen-analytical result points to Riss-Würm Interglacial. Date not in contradiction.

VRI-39. Mondsee 2 **>35,000**

Fossil wood from *Taxus baccata, Picea,* and supposed Angiosperms, fossil *Picea* cones, excavated from plant-bearing layer in lacustrine clay in cut of rivulet Steinerbach ca. 50 m above pier of Mondsee-Autobahn-bridge near Mondsee. Lacustrine clay lies on ground moraine. Coll. 1965 by W. Klaus. *Comment* (W.K.): pollen-analytically Riss-Würm Interglacial is supposed. Date not in contradiction.

Unterach series, O.Ö.

Samples from big stems in bluish-gray lacustrine clay excavated 40 m above level of lake Attersee, near crossing Sonnwendbühelstrasse-Umfahrungsstrasse, Unterach (47° 49′ N Lat, 13° 29′ E Long), Upper Austria. Coll. 1966 by E. Koller; subm. by W. Freh, O. Ö Landesmus., Linz.

General Comment (W.F.): frequent excavations of big stems in this area together with geologic state suggest large landslip in Flysch of Hochplettenspitze by which forest was pushed into interglacial lake. Dates disprove estimate.

1350 ± 80
VRI-90. Unterach 1 **A.D. 600**

Sample from Stem 1.

1290 ± 80
VRI-91. Unterach 2 **A.D. 660**

Sample from Stem 2.

VRI-128. Schneegattern, O.Ö. **<200**

Moderately decomposed *Sphagnum* peat from Sieglmoos near Schneegattern (48° 01′ N Lat, 13° 17′ E Long), Upper Austria, Kobernauserwald, from 28 to 36 cm depth. Coll. 1966 by H. Mayer *et al.*; subm. by F. Kral. *Comment* (F.K.): relative young upland moor. Date should fix anthropogeneous influence on woodland clearly established by pollen-analyses. Date too young. Contamination by Cyperaceae roots.

6390 ± 110
VRI-129. Wenigzell-Sommersgut, Stmk. **4440 B.C.**

Decomposed black wood peat from ca. 2 m thick upland moor near Wenigzell-Sommersgut (47° 27′ N Lat, 15° 47′ E Long), Styria. Depth 46 to 54 cm. Coll. 1967 by K. Zukrigl; subm. by F. Kral. *Comment* (F.K.): date fixes pollen-analytically established spread of *Abies*. Date in agreement with submitter's expectation.

2810 ± 80
VRI-130. Wenigzell-Sichart, Stmk. **860 B.C.**

Decomposed brownish-black wood peat from 1.2-m-thick transitional moor near Wenigzell-Sichart (47° 27′ N Lat, 15° 47′ E Long), Styria. Depth 61 to 69 cm. Coll. 1967 by K. Zukrigl; subm. by F. Kral. *Comment* (F.K.): dates fixes pollen-analytically established beginning of anthropogeneous influence on woodland (earlier *Picea-Abies-Fagus*, today *Picea-Pinus*). Date in agreement with expectation.

Fernauferner series, Tirol

Samples from Buntes Moor (46° 59′ 27″ N Lat, 11° 08′ 45″ E Long), at +2290 m, Fernauferner, Stubai Valley, Tyrol, coll. in shaft surrounding Aario's profile (Aario, 1945). Depths given are below surface of bog. Coll. 1962 and subm. by F. Mayr, Geog. Inst., Univ. of Innsbruck.

6220 ± 110
VRI-8. Fernauferner 1 **4270 B.C.**

Pieces of wood, (*Pinus cembra, Alnus* cf. *viridis*, det. W. Larcher, Innsbruck) from bottom, depth 4.20 m (Aario's profile Fig. 2, depth 3.4 m). *Comment* (F.M.): sample dates ice-avalanches and postglacial maximum of a little unnamed glacier SE of Buntes Moor. At the same time, Fernauferner remained behind its post-Altithermal maximum.

6220 ± 150
VRI-9. Fernauferner 2 **4270 B.C.**

Pieces of wood near bottom, depth 4.20 m (Aario's profile, Fig. 2, depth 3.20 m). *Comment* (F.M.): sample coll. in ground-moraine-like altered layer of gyttja with sharp boundaries. It dates last ice-avalanches which came from glacieret SE of Buntes Moor.

3150 ± 120
VRI-10. Fernauferner 3 **1200 B.C.**

Pieces of wood from silt layer, depth 2.90 m (Aario's profile, Fig. 2, depth 2.10 m). *Comment* (F.M.): silt layer was deposited immediately after 1st post-Altithermal maximum of Fernauferner, on remains of Moorstauchmoräne.

1890 ± 120
VRI-11. Fernauferner 4 **A.D. 60**

Peat (sedges and Hypnaceae?) from thin peat layer between sand layers, depth 0.95 m (Aario's profile, Fig. 2, depth 0.65 m). *Comment* (F.M.): peat layer is maximum for 2nd Moorstauchmoräne of Fernauferner, 50 m W of shaft. This moraine is latest link in series of glacier advances during Zone Xb time.

2820 ± 120
VRI-13. Fernauferner 6 **870 B.C.**

Peat (sedges and Hypnaceae?) from 2 cm peat layer, depth 2.45 m (Aario's profile, Fig. 2, depth 1.92 m). *Comment* (F.M.): peat layer beneath long-term accumulation of Zone IX time.

2640 ± 110
VRI-14. Fernauferner 7 **690 B.C.**

Peat (sedges and Hypnaceae?) from 2 cm peat layer between sandy series, depth 1.85 m (Aario's profile, Fig. 2, depth 1.50 m). *Comment* (F.M.): in this peat layer herbaceous and *Salix* pollen grains reached extreme maxima. It is supposed to correspond with short but intensive retreat of Fernauferner.

VRI-15. Fernauferner 8 **2280 ± 110**
330 B.C.

Peat (sedges and Hypnaceae?) from lowest 2 cm of 12 to 15 cm peat layer, depth 1.20 (Aario's profile, Fig. 2, depth 0.78 m). *Comment* (F.M.): sample is maximum of Zone IXb/Xa boundary. Peat of Xa as well as sediments of IXa and IXb are incorporated into Moorstauchmoräne of Zone Xb time.

Kaunertal series, Tirol

Pieces of wood washed into sand deposits of rivulet Fagge. Samples taken in surroundings of dam project Griesboden (46° 56′ N Lat, 10° 45′ E Long), Tirol, from different depths by boring. Subm. by Tiroler Wasserkraftwerke A.G.

VRI-32. Borehole C 11 **9390 ± 160**
7440 B.C.

Depth 35.80 m. Coll. 1965 by Rudan and Schmidegg.

VRI-33. Borehole A 3 **5990 ± 140**
4040 B.C.

Depth 6.50 m. Coll. 1964 by Schmidegg.

VRI-34. Borehole South A 3 **8520 ± 160**
6570 B.C.

Wood-bearing layer with black soil. Coll. 1964 by Schmidegg.

VRI-35. Jägerhaus **9370 ± 160**
7420 B.C.

Wood embedded in sands from wall near research Drift W. Depth 1 m. Coll. 1964 by Zischinsky.

Venediger Group Series 1, Osttirol

Different samples from mountain group Venediger in East Tyrol. Coll. 1965 and subm. by G. Patzelt, Geog. Inst., Univ. of Innsbruck.

VRI-54. Venediger Group 1965/1 **7220 ± 140**
5270 B.C.

Thin roots between detritus of ground moraine below 1.20 m peat, 10 m before old end moraine of Simonykees near Rostockerhütte (47° 03′ 19″ N Lat, 12° 18′ 07″ E Long). *Comment* (G.P.): date is minimum for end moraine of Simonykees, 50 to 150 m before younger lateral moraines of joined Simony- and Maurerkees.

VRI-55. Venediger Group 1965/2 **8720 ± 150**
6770 B.C.

Branches from base of 2.3 m thick peat layer, ca. 400 m above timber line. Avalanche-preserved position, 100 m above Rostockerhütte (47° 03′ 15″ N Lat, 12° 17′ 56″ E Long). *Comment* (G.P.): date is minimum of postglacial Altithermal period in Alps.

VRI-56. Venediger Group 1965/3 **6130 ± 130**
4180 B.C.

Sample from wood horizon at base of 80-cm-thick, undisturbed peat layer between 2 oldest end moraines of Frossnitzkees, at +2225 m (47° 04′ 33″ N Lat, 12° 26′ 59″ E Long), near puddle "Auf der Achsel". *Comment* (G.P.): date is minimum of inner of the 2 moraines.

VRI-57. Venediger Group 1965/4 **7570 ± 140**
5620 B.C.

Split branches in and above folded silt below 1.6 m peat immediately before outer postglacial end moraine. Avalanche-preserved position, Dorferkees at +2170 m (47° 03′ 55″ N Lat, 12° 20′ 19″ E Long). *Comment* (G.P.): date gives age of greatest postglacial maximum of Dorferkees.

VRI-58. Venediger Group 1965/5 **5500 ± 140**
3550 B.C.

Fragments of tree (felled by avalanches) at base of 2-m-thick organic deposits. Avalanche tracks at opposite slope. Obersulzbachkees, at +1750 m (47° 08′ 30″ N Lat, 12° 16′ 49″ E Long). *Comment* (G.P.): sample dates oldest of 4 periods of increased avalanche activity established in profile.

Venediger Group Series 2, Osttirol

Cyperaceae peat from moor near Rostockerhütte (47° 03′ 19″ N Lat, 12° 18′ 07″ E Long), at +2270 m, Maurer Valley, S Venediger Group, Hohe Tauern, East-Tyrol. Peat layer 2.3 m thick without detectable growth disturbance. Coll. 1967 and subm. by G. Patzelt.

VRI-111. Venediger 1968/1 **8340 ± 130**
6390 B.C.

Depth 206 to 209 cm. *Comment* (G.P.): sample dates NAP peak of pollen diagram indicating climate deterioration. Advance of Simony glacier.

VRI-112. Venediger 1968/2 **8040 ± 120**
6090 B.C.

Depth 175 to 178 cm. *Comment* (G.P.): same as VRI-111.

VRI-131. Venediger 1968/3 **6400 ± 100**
4450 B.C.

Depth 107 to 110 cm. *Comment* (G.P.): sample dates NAP peak of pollen diagram indicating climate deterioration. Advance of Frossnitz glacier.

VRI-132. Venediger 1968/4 **4580 ± 90**
2630 B.C.

Depth 53 to 57 cm. *Comment* (G.P.): pollen spectrum indicates slight climate deterioration. No glacier advance in Venediger Group could be observed in this period.

VRI-133. Venediger 1968/5 **3530 ± 80**
1580 B.C.

Depth 33 to 37 cm. *Comment* (G.P.): pollen profile clearly indicates climate deterioration. Advance for Frossnitzkees and other Alpine glaciers was dated for same period.

Kälbertal series, Tirol

Wood samples from sediment fill of former puddle at exit of Kälbertal (47° 22′ 00″ N Lat, 10° 49′ 10″ E Long), Tyrol, belonging to Fernpass landslide (Abele, 1964; Mayr, 1968). Coll. 1965 and subm. by F. Mayr.

VRI-47. Kälbertal 1 **2580 ± 90**
630 B.C.

Wood from base of sediment fill. *Comment* (F.M.): sample dates cut-off of Kälbertal by landslide.

VRI-48. Kälbertal 2 **2370 ± 90**
420 B.C.

Picea wood from upper edge of sediment fill. *Comment* (F.M.): sample permits estimation of material transport by rivulet for longer period.

Grünauferner series, Tirol

Wood samples from Grünauferner forefield (46° 59′ 50″ N Lat, 11° 11′ 37″ E Long), Tyrol, at +2190 m (Mayr, 1964, 1968b). Coll. 1965 and subm. by F. Mayr.

VRI-50. Grünauferner 1 **7350 ± 130**
5400 B.C.

Branch of tree (*Pinus pumilio*?) in sand at base of peat, 2.5 m thick, 30 m in front of end moraines of Grünauferner. Position safe from avalanches. *Comment* (F.M.): oldest evidence of dwarf mountain fir in forefield of Grünauferner. Dates recolonization after oldest Larstig-maximum (Patzelt, VRI-54, VRI-57, this date list), consequently, greatest Postglacial maximum of Grünauferner.

VRI-51. Grünauferner 2 **6710 ± 130**
4760 B.C.

Stem wood at outer edge of nearly wood-free Moorstauchmoräne, 25 m in front of younger end moraine of Grünauferner. Position safe from avalanches. *Comment* (F.M.): like VRI-8 and VRI-9 date demonstrates that between oldest and youngest Larstig-maximum (Patzelt, VRI-56, VRI-57) Alpine treeline was higher than today. Moorstauchmoräne (Mayr, 1968b) is not dated.

VRI-52. Innsbruck-Amras, Tirol **570 ± 80**
A.D. 1380

Alnus fragments, depth 1.5 m, near Autobahn junction Innsbruck-Amras (47° 15′ 33″ N Lat, 11° 26′ 21″ E Long), Tyrol. Coll. 1965 and subm. by F. Mayr. *Comment* (F.M.): *Alnus* fragments are slightly older than youngest undercut of alluvial cone of R. Sill and terraces of ice cake near Amras.

Stillup Valley series, Tirol

Roots or stemwood fragments in fine-sand fill in Stillup Valley (47° 07′ N Lat, 11° 52′ E Long), Zillertaler Alpen, Tyrol, taken from different depths in boring A2. Coll. 1966 and subm. by Mignon, Tauernkraftwerke A. G., Mayrhofen.

1460 ± 80
VRI-95. Stillup 1 **A.D. 490**

Depth 7 to 11 m.

2210 ± 80
VRI-96. Stillup 2 **260 B.C.**

Depth 13 to 14 m.

4960 ± 100
VRI-98. Roppen, Tirol **3010 B.C.**

Charcoal (*Larix decidua*), taken near easternmost turn of newly built forest road to spring of rivulet Leonhardsbach, at +880 m, SSE above Roppen (47° 13′ N Lat, 10° 49′ E Long), gorge of Ötz Valley, Tyrol. Inner slope of Gschnitz lateral moraine of Ötztal glacier (Heuberger, 1966). Stratification disturbed by movements along steep slope (30° to 40°) supposedly consequence of forest fire. Burned horizon and former soil was kneaded into Tschirgant landslide moraine material. Landslide moraine is Younger Dryas. Coll. 1967 and subm. by H. Heuberger, Geog. Inst., Univ. of Innsbruck. *Comment* (H.H.): originally, submitter supposed disturbance of profile resulted from glacier activity, suggested by comparison with neighboring profiles, and hoped to date the pre-advance forest. Date proves that burned horizon was created *on* landslide moraine and hence is not pre-moraine. Date given by M. Rubin, W-2082: 4780 ± 300 (Radiocarbon, v. 12, p. 333) in excellent agreement.

Roppen series, Tirol

Charcoal from horizons of disturbed, buried fossil soil between 2 Late-glacial moraines of Ötz Valley glacier, mouth of Ötz Valley, Tyrol, new forest road (1967) SE above Roppen (47° 13′ N Lat, 10° 49′ E Long), easternmost curve, at ca. + 880 m. Older moraine contains only crystalline material of Central Alps. Younger (upper) moraine is rich in limestone of Tschirgant landslide, covering end of glacier tongue. Coll. 1968 by H. Heuberger, I. Neuwinger, and G. Heiss; subm. by Heuberger.

General Comment (H.H.): supposedly soil containing charcoal was formed in interstadial between 2 advances of Ötz Valley glacier. Length of former Ötz Valley glacier excludes younger date than Alleröd. The very young charcoal dates show that buried soil was not only disturbed by overriding glacier but also by later colluvial movements along 30° to 40° steep slope.

VRI-122. Roppen A **2300 ± 100**
350 B.C.

Charcoal from top horizon (burned; A horizon?)

VRI-123. Roppen B **3000 ± 350**
1050 B.C.

Charcoal from B horizon.

VRI-17. Galtür, Paznauntal, Tirol **990 ± 100**
A.D. 960

Charcoal from burned soil horizon ca. 35 cm below A horizon of podsolic brown earth. Galtür (46° 59′ N Lat, 10° 12′ E Long), Tyrol, N slope of Predigtberg, Silvretta Group, ca. + 1800 m. Coll. 1959 by G. Heiss; subm. by I. Neuwinger, Forstliche Bundesversuchsanstalt, Bodenkundliches Labor, Imst. *Comment* (I.N.): had been thought to belong to a forest-fire period in Bronze age, early Hallstatt, or early Middle ages. Date points to latter.

Ötz Valley series, Tirol

Charcoal from burned-soil horizons from Ötz Valley, Tyrol. Subm. by I. Neuwinger.

General Comment: dates fix burning horizon chronologically and give clue to soil genesis.

VRI-76. Obergurgl 1 **1900 ± 80**
A.D. 50

Charcoal from burning horizon above colluvial erosion horizon in podsolic brown earth, ca. 15 cm below contemporary humus horizon. Surroundings of Obergurgl (46° 52′ N Lat, 11° 02′ E Long), from Verwallbach in direction of Königstal, to Forstliche Bundesversuchsanstalt Sta., at +1980 m. Coll. 1965 by M. Doenecke.

VRI-78. Obergurgl 2 **2060 ± 200**
110 B.C.

Charcoal from burning horizon in iron podsol, ca. 25 cm below contemporary humus horizon, Obergurgl, "Zirbenwald", at +2060 m. Coll. 1965 by M. Doenecke.

VRI-75. Obergurgl 3 **650 ± 70**
A.D. 1300

Charcoal from burning horizon in contemporary iron-humus podsol ca. 25 cm below contemporary humus horizon, 50 m S of Sta. Obergurgl of Forstliche Bundesversuchsanstalt, Gurgler Heide, at +2080 m. Coll. 1965 by M. Doenecke. *Comment* (I.N.): charcoal from neighboring locality was dated by K. O. Münnich: 2460 ± 90 (H-365-507).

VRI-77. Gurgl **1540 ± 80**
A.D. 410

Charcoal in burning horizon in iron podsol, ca. 20 to 25 cm below contemporary humus horizon, above eluvial A_e horizon from older podsol. NE slope of Beerrinne in area of Sta. Gurgl (46° 53′ N Lat, 11° 02′ E Long) of Forstliche Bundesversuchsanstalt, at +1980 m. Coll. 1965 by I. Neuwinger.

VRI-16. Eggenstall ob St. Leonhard, Pitz Valley, Tirol **710 ± 100 A.D. 1240**

Charcoal from burned-soil horizon below 20 cm of contemporary raw humus, Eggenstall ob St. Leonhard (47° 04′ N Lat, 10° 51′ E Long), Pitz Valley, Ötztaler Alpen, Tyrol, ca. +2000 m. Coll. 1959 and subm. by I. Neuwinger. *Comment* (I.N.): had been thought to belong to a forest-fire period in Bronze age, early Hallstatt, or early Middle ages. Date points to latter.

Pitz Valley series, Tirol

Charcoal samples from burning horizons in soil, Pitz Valley, Ötztaler Alpen, Tyrol (Fromme, 1957). Coll. 1965 and subm. by I. Neuwinger. *General Comment*: dates fix burning horizons chronologically and give clue to soil genesis.

VRI-79. Pitz Valley end **890 ± 80 A.D. 1060**

Charcoal from burning horizon in podsolic brown earth (Kubiena), 15 to 25 cm below contemporary humus horizon above colluvial erosion horizon and eroded B horizon from former podsol. End of Pitz Valley, footpath from Taschachalm (46° 57′ N Lat, 10° 51′ E Long) to lake Riffelsee, +1950 m. *Comment* (I.N.): burning horizons are found in area of Taschachalm, a very old pasture land.

VRI-80. Pitz Valley, St. Leonhard **1180 ± 80 A.D. 770**

Charcoal in burning horizon, in eroded iron podsol, partially lying open after road works, at other localities ca. 15 cm below contemporary humus. Pitz Valley, forest road from St. Leonhard (47° 04′ N Lat, 10° 51′ E Long) to Neubergalm, at + 1750 m.

VRI-94/1. Fritzens, Tirol **11,370 ± 150 9420 B.C.**

Wood from tree trunk, 20 to 30 cm thick, and much more pressed and carbonized than in comparable Postglacial landslides, embedded in stratified flow-silt, together with striated pebbles and weathered pieces of Triassic limestone. Clay pit Fritzens (47° 18′ 25″ N Lat, 11° 34′ 19″ E Long), Tyrol, 0.5 m below present surface. Coll. 1966 and subm. by F. Mayr. *Comment* (F.M.): submitter assumed greater age, the interstadial between Mils and Würm (Mayr, 1968a). When date did not agree, a 2nd date: VRI-94/2 gave 11,200 ± 150.

VRI-92. Dölsach, Osttirol **2130 ± 80 180 B.C.**

See III A.

VRI-103. Feldkirch, Vorarlberg **10,110 ± 140 8160 B.C.**

Stem wood (*Pinus*) with tooth marks of beaver, embedded in Rhine Valley alluvium, at depth 18 m in ballast pit, Feldkirch (47° 14′ N Lat, 09° 38′ E Long), Vorarlberg. Coll. 1967 by E. Vonbank; subm. by R. Pittioni, Inst. für Ur- und Frühgeschichte, Univ. of Vienna. *Comment* (R.P.): age should be younger than last glacial epoch because Rhine Valley glacier there extended as far as Lake Constanz. Established age points to Alleröd.

B. Europe

11,300 ± 130
VRI-27. Lieth near Elmshorn, West Germany 9350 B.C.

Tree branches from peat near Lieth bei Elmshorn (53° 46′ N Lat, 09° 40′ E Long), West Germany. In Alleröd deposits. Subm. by R. Pittioni. *Comment* (R.P.): date consistent with expectation.

VRI-53. Hörmating, West Germany >35,000

Driftwood from water-laid sediments lacking fossils, intersected by networks of loam-filled frost cracks, several m deep, and covered by Würm ground moraine (Ebers, 1963). Hörmating, Oberbayern, Grüner Turm I (47° 56′ 57″ N Lat, 12° 01′ 03″ E Long), West Germany. Coll. 1965 and subm. by F. Mayr. *Comment* (F.M.): wood is older than frost cracks, formed when Inn glacier of Würm age arrived at locality. See also W-1002 (Radiocarbon, 1964, v. 6, p. 70).

5250 ± 110
VRI-106. Mont Blanc, Italy 3300 B.C.

Wood at base of pool sediments 1.4 m below bank of debris. Mt. Blanc S side, Alpe Lex Blanche inferieur, 2150 m, Val Veni, Aosta (45° 43′ N Lat, 07° 19′ E Long), Italy. Coll. 1967 and subm. by F. Mayr. *Comment* (F.M.): formation of bank and pool were forced by Postglacial maximum of Glacier de la Lex Blanche and Glacier d'Estellette. Sample dates beginning of bank formation.

6400 ± 100
VRI-107. Mont Blanc, France 4450 B.C.

Wood from ca. 12 m below surface of former Sandur. Sample from bog covered at greatest Postglacial glacier maximum. Mont Blanc N side, Montroc near Argentière, Valley of Chamonix, 300 m NE of bridge, Pt. 1363 m, (45° 59′ 51.1″ N Lat, 06° 56′ 15.6″ E Long), France. Coll. 1967 and subm. by F. Mayr. *Comment* (F.M.): sample is unique in that it dates the greatest Postglacial maximum of the great glaciers on N slope of Mt. Blanc. Interpretation and date in excellent agreement (Mayr, 1969).

III. ARCHAEOLOGIC SAMPLES

A. Austria

510 ± 120
VRI-4. Vienna 1 A.D. 1440

Wood from propping post of Wall 41 in 2nd basement of former House Berghof 3, later annexed to Hoher Markt 8, Vienna I. Basement was situated below Roman Pavement f. Coll. 1962 and subm. by Hertha

Ladenbauer-Orel, Bundesdenkmalamt, Vienna. *Comment* (H.L.): 2nd basement was built after Roman pavement between 1st (1529) and 2nd (1683) siege of Vienna by the Turks, as was concluded from excavation.

VRI-5. Vienna 2 **900 ± 150**
A.D. 1050

Wood from walled post propping stone Wall 16 of 1st basement of House Sterngasse 7, Vienna I. Coll. 1962 and subm. by H. Ladenbauer-Orel. *Comment* (H.L.): Gothic house was built ca. A.D. 1200.

VRI-19. Vienna 3 **450 ± 90**
A.D. 1500

Wood fragments from coffin or chest in vault below Gothic pavement, excavated in church "Am Hof," Vienna I. Skeleton covered with calcareous layer and humus. No artifacts. Coll. 1964 and subm. by G. Mossler, Bundesdenkmalamt, Vienna.

VRI-41. Loretto, Burgenland **2990 ± 120**
1040 B.C.

Charcoal from pyre of Hallstattian burial at reed "Ochsenstand," N slope of Leitha-Gebirge, Site 83, Loretto 47° 55′ N Lat, 16° 31′ E Long), Burgenland. Excavation with obtuse, cone-shaped pyre, placed near middle at bottom of grave, 1.10 m deep, together with vessels filled with fragments of vessels and sand-humus mixture. Filling disturbed by younger burial of La Tène (skeleton) to depth of 50 cm. Surface: sand with humic layer. Coll. 1955 and subm. by A. J. Ohrenberger, Burgenländisches Landesmus., Eisenstadt.

VRI-42. Unterpullendorf, Burgenland **6130 ± 140**
4180 B.C.

Charcoal in filling material of Neolithic Refuse Pit 1 in loam-sand soil, irregular in form, ca. 5×5 m^2, at depth 1 m. Humus filling mixed with painted ceramic fragments, small flints, Grünstein-tool fragments, animal bones, and charcoal. Relatively clean charcoal in some parts of pit. Filling covered with 10 to 15 cm humus. Unterpullendorf, Dist. Oberpullendorf (47° 30′ N Lat, 16° 30′ E Long), Burgenland. Coll. 1964 and subm. by A. J. Ohrenberger. *Comment* (A.O.): typologically early phase in Neolithic "Bemaltkeramische Kultur" (Pittioni, 1954; Novotny, 1962) is estimated. Date agrees with expectation.

VRI-104a. Unterpullendorf, Burgenland **5940 ± 100**
3990 B.C.

Charcoal in filling material of Neolithic Refuse Pit 2, 10×12 m^2, depth 1.6 m, Neolithic dwelling place E of Unterpullendorf Dist. Oberpullendorf (47° 30′ N Lat 16° 30′ E Long), Burgenland, at N slope in floated loess. Sample taken from 100 to 140 cm depth; subsoil water. Coll. 1967 and subm. by A. J. Ohrenberger. *Comment* (A.O.): chronologically homogeneous filling consists of ceramic fragments, stone tools. few bones, much charcoal. Pit 2, 80 m E of Pit 1 (VRI-42) belongs to same culture as Pit 1 (Quitta, 1967). Date agrees with expectation.

3340 ± 80
VRI-105. Müllendorf, Burgenland **1390 B.C.**

Charcoal from Bronze Age Refuse Pit, 2.4 × 3.0 m^2, depth 1.3 m, Müllendorf (47° 50′ N Lat, 16° 27′ E Long), Burgenland, near r.r. sta. at S slope of Leithagebirge. Coll. 1967 and subm. by A. J. Ohrenberger. *Comment* (A.O.): many ceramic fragments, animal bones, and charcoal. Stony soil. Date agrees with typologically expected age.

2030 ± 80
VRI-97. St. Veit a.d. Glan, Kärnten **80 B.C.**

Charred wood from Roman building excavated at Magdalensberg, at +950 m, E mt. border of Zollfeld, surroundings of St. Veit a.d. Glan (46° 46′ N Lat, 14° 21′ E Long), Carinthia. Supposedly construction of bake-oven. Coll. 1967 and subm. by Gertrud Mossler. *Comment* (G.M.): date agrees with etxpectation.

2670 ± 120
VRI-25. Horn, N.Ö. **720 B.C.**

Charcoal from Hallstatt cultural layer in brickyard Thalhammer near Horn (48° 40′ N Lat, 15° 40′ E Long), Lower Austria. Coll. 1960; subm. by R. Pittioni. *Comment* (R.P.): date agrees with expectation.

2180 ± 90
VRI-59. Inzersdorf ob der Traisen, N.Ö. **230 B.C.**

Charcoal from fireplace (Herdgrube 108) *in situ*, 80 cm deep, Inzersdorf ob der Traisen (48° 19′ N Lat, 15° 41′ E Long), K. G. Walpersdorf, Lower Austria, Parzelle No. 170, Ballast Pit K. Handl. Coll. 1965 by C. Eibner; subm. by R. Pittioni. *Comment* (R.P.): La Tène B-C post-building; graphite ceramics. Date agrees with expectation.

2240 ± 90
VRI-60. Trasdorf, Ger. Bez. Tulln, N.Ö. **290 B.C.**

Charcoal from ground plan of late Hallstattian house, Trasdorf (48° 19′ N Lat, 15° 53′ E Long), Lower Austria. Coll. 1964 by E. Lucius; subm. by R. Pittioni. *Comment* (R.P.): date not in agreement with expectation.

840 ± 70
VRI-61. Gars-Thunau, N.Ö. **A.D. 1110**

Charcoal from post of N rampart of bulwark (Friesinger and Mitscha-Märheim, 1968) built above older grave field. Gars-Thunau, Bez. Horn (48° 40′ N Lat, 15° 40′ E Long), Lower Austria. Coll. 1965 by H. Friesinger; subm. by R. Pittioni. *Comment* (R.P.): grave field belongs to middle of 9th century. Bulwark erection ca. A.D. 900 is expected.

1380 ± 80
VRI-62. Sommerein, N.Ö. **A.D. 570**

Charcoal excavated from ground plan of hut, 60 cm deep, in Brucker Pforte between villages Sommerein and Götzendorf (48° 01′ N Lat, 16° 35′ E Long), Lower Austria, Parzelle 4517/1. Coll. 1962 by H. Friesinger;

subm. by R. Pittioni. *Comment* (R.P.): last 3rd of 9th century was expected.

Gaiselberg series, N.Ö.

Samples excavated at Gaiselberg (48° 32′ N Lat, 16° 43′ E Long), near Zistersdorf, Lower Austria. Coll. 1960 and subm. by F. Felgenhauer, Inst. für Ur- und Frühgeschichte, Univ. of Vienna.
General Comment: dates agree with expectation.

860 ± 90
VRI-73. Gaiselberg 1 **A.D. 1090**

Charcoal from 1.20 m deep pit filled with earth.

690 ± 80
VRI-74. Gaiselberg 3 **A.D. 1260**

Wood (oak?) fragments from palisade of medieval defense building (rampart), loess, depth 1.6 m below grass-grown surface.

740 ± 80
VRI-82. Gaiselberg 4 **A.D. 1210**

Charcoal from 1.20 m deep pit filled with burned remnants.

VRI-83. Traismauer, N.Ö. **<200**

Wood from oldest part of "Gutscher-Mill" taken at rebuilding. Traismauer (48° 21′ N Lat, 15° 44′ E Long), Lower Austria. Coll. 1966 by F. R. Prokop; subm. by H. Stiglitz, Österreichisches Archäol. Inst., Univ. of Vienna.

3050 ± 90
VRI-93. Pitten, N.Ö. **1100 B.C.**

Charcoal sample from pyre of Bronze-age burial (Grave 5) from W slope at S edge of Pitten (47° 43′ N Lat, 16° 13′ E Long), Lower Austria, Parzelle 372. Beam of pyre *in situ*, depth 1 m, lying on loamy brownish earth, covered with same material. Wood structure clearly visible. Cross section of beam shows thin charcoal surface around calcareous earth kernel. Coll. 1967 by S Schmiedt; subm. by F. Hampl, N. Ö. Landesmus., Vienna. *Comment* (F.H.): date agrees with expectation.

1860 ± 110
VRI-22. Hallstatt-Lahn, O.Ö. **A.D. 90**

Wood lifted from layer of Roman culture, 1.8 m deep, in area of Roman settlement Friedelfeld (Morton, 1965), Hallstatt-Lahn (47° 34′ N Lat, 13° 59′ E Long), Upper Austria. Coll. 1962; subm. by F. Morton, Mus. Hallstatt. *Comment*: date consistent with expectation.

2270 ± 90
VRI-99. Hallstatt, Grüner-Werk, O.Ö. **320 B.C.**

Wood (*Picea* and *Abies*) remnants of Prehistoric fire stick in so-called "Heidengebirge," former salt mine pits filled with loam, clay, and different salts; Grüner-Werk, Salzberg, Hallstatt (47° 34′ N Lat, 13° 39′ E Long), Upper Austria. Coll. 1966 by Schauberger; subm. by F. Morton. Comment (F.M.): date points to La Tène.

Gosaumühle series, O. Ö.

Wood samples (*Larix*) from adits of thermal spring "Warmes Wasser," presently buried below slope of debris (Morton, 1932, 1944; Hehenwarter and Morton, 1956), between Gosaumühle and Steeg (47° 37′ N Lat, 13° 38′ E Long), Upper Austria, at W shore of lake Hallstättersee. Subm. by F. Morton.

General Comment: age of adits unknown. Existence of thermal water, known by tradition, rediscovered by "vapor holes" at snow-capped slope in winter and by ice-free water region at shore due to thermal water influx below water surface. Adit 1, reached by sinking a shaft in frozen debris, could be followed ca. 70 m. No spring was found. Later, Adit 2 was discovered ca. 2 m below the 1st. Immediately after sampling, Adit 2 collapsed. Spring could not be found.

730 ± 100
VRI-44. Gosaumühle 1 **A.D. 1220**

Sample from plank of Adit 1. Coll. 1965 by H. Pramesberger.

440 ± 110
VRI-65. Gosaumühle 2 **A.D. 1510**

Sample from propping post of Adit 2. Coll. 1965 by R. Zahler. *Comment*: younger than VRI-44. Supposedly, spring sank in course of time. Adit 2 was necessary to get spring again.

Mondsee series 2, O.Ö.

Samples of wooden piling from lake-dwelling remnants lifted from bottom of lake Mondsee at See am Mondsee (47° 49′ N Lat, 13° 27′ E Long), Upper Austria, depth 2 m. Subm. by J. Reitinger, O. Ö. Landesmus., Linz. *Comment*: dates consistent with Mondsee culture (Franz and Weninger, 1927; Reitinger, 1966).

4910 ± 130
VRI-37. See am Mondsee 1 **2960 B.C.**

Coll. 1965 by diver Papacek.

4750 ± 90
VRI-68. See am Mondsee 2 **2800 B.C.**

Coll. 1966 by Unterwasserarbeitsgemeinschaft Salzburg.

4800 ± 90
VRI-119. See am Mondsee 3 **2850 B.C.**

Coll. 1967 by Unterwasserarbeitsgemeinschaft Salzburg.

Mondsee series 3, O.Ö.

Samples of wooden pilings from lake-dwelling remnants near St. Lorenz (47° 50′ N Lat, 13° 22′ E Long), Upper Austria, at lake Mondsee, at present, completely buried in fluvial deposits and over grown with grass. Subm. by J. Reitinger.

General Comment: no artifacts; supposedly belongs to Mondsee culture (Franz and Weninger, 1927). Dates are contradictory.

1280 ± 100
VRI-23. St. Lorenz am Mondsee **A.D. 670**

Sample excavated from deposits of rivulet Griesler Ache from ca. 1 m depth, below subsoil water of this rivulet. Coll. 1961 by J. Reitinger.

830 ± 80
VRI-71. St. Lorenz-Achort **A.D. 1120**

Sample excavated from slope of rivulet Mühlbach from ca. 80 cm depth, 20 cm below water level of this rivulet. Coll. 1966 by Unterwasserarbeitsgemeinschaft Salzburg.

1700 ± 80
VRI-64. Imurium-Moosham, Salzburg **A.D. 250**

Charcoal (*Abies*) embedded in loam below terrazzo in Roman settlement Imurium-Moosham (47° 06′ N Lat, 13° 42′ E Long), Salzburg. Coll. 1965 and subm. by R. Fleischer, Österr. Archäol. Inst., Univ. of Vienna. *Comment* (R.F.): sample dates floor laying (Fleischer, 1964-65).

7250 ± 470
VRI-7. Krungl, Steiermark **5300 B.C.**

Wood of larch trunk lifted from 2 m under surface in Celtic grave field, Krungl near Mitterndorf (47° 34′ N Lat, 13° 56′ E Long), Salzkammergut, Styria. Coll. 1949 by Deopito; subm. by F. Morton. *Comment* (F.M.): unexpectedly high age; trunk does not belong to grave field.

VRI-84. Weiz, Steiermark **<220**

Wooden nail from hewn post excavated in mixing zone of Pleistocene ballast and recent soil ca. 2 m deep at Hauptplatz of Weiz (47° 13′ N Lat, 15° 38′ E Long), Styria. Coll. 1966 and subm. by L. Farnleitner, Archivalienpfleger, Weiz. *Comment* (L.F.): date does not contradict supposed connection between sample and rebuilding of tabor of Weiz (1644 and 1685) if age limit corrected for de Vries effect (Suess, 1965).

2130 ± 80
VRI-92. Dölsach, Osttirol **180 B.C.**

Charred wood in deposits of loamy sand with stones up to 30 cm diam. of rivulet Gödnacher Bach excavated from 3 m depth. Fluvial deposits of Gödnacher Bach ca. 50 m thick laying over alluvium of R. Drau, Dölsach (46° 50′ N Lat, 12° 50′ E Long), East Tyrol. Sample stems from artificial fireplace. Coll. 1967 and subm. by G. Platzer, Amt der Tiroler Landesregierung, Kulturbauamt Lienz. *Comment* (G.P.): date indicates age of fluvial deposits in valley of Lienz and age of settlement at Dölsach.

B. Europe, Asia, South America

2060 ± 110
VRI-30. Neuss, West Germany **110 B.C.**

Charcoal from Roman pottery furnace excavated at Neuss (51° 12′ N Lat, 06° 42′ E Long), Rheinland, West Germany. Coll. by H. Petrikovits; subm. by R. Pittioni. *Comment* (R.P.): date agrees with expectation.

Egolzwil series, Switzerland

Charcoal samples from Neolithic dwelling places Egolzwil-3 and Egolzwil-4 (47° 11′ N Lat, 05° 41′ E Long), Wauwilermoos, Lucerne, Switzerland. Dwelling places belong to Older Cortaillod culture (Vogt, 1951; Troels-Smith, 1956). Subm. by R. Pittioni.

5620 ± 130
VRI-28. Egolzwil-3 **3670 B.C.**

Coll. 1952 by E. Vogt. *Comment* (R.P.): date too young.

5360 ± 150
VRI-29. Egolzwil-4 **3410 B.C.**

Coll. 1954 by E. Vogt. *Comment* (R.P.): date too young. Sample probably contaminated by reed roots.

3450 ± 120
VRI-66. Mt. Gabriel, Ireland **1500 B.C.**

Charcoal from Prehistoric copper mines on Mt. Gabriel (51° 32′ 45″ N Lat, 09° 31′ 50″ E Long), W County Cork, Ireland. Coll. 1966 by J. Jackson and Raftery; subm. by R. Pittioni. *Comment* (J.J.): sample is composite of 2 stratigraphic horizons (Jackson, 1968), separated by zone of fines, which can reach thickness of 30 cm and may conceivably represent appreciable period of time. Date must therefore be minimum; mines possibly belong to Early Bronze age, as suggested by field evidence from area, rather than to middle of Bronze age.

1250 ± 110
VRI-40. Ephesos, Turkey **A.D. 700**

Wood from tree, embedded in alluvial clay and mud above base of Artemision altar, 7 m deep, in subsoil water. Ephesos (37° 55′ N Lat, 27° 19′ E Long), Turkey. Coll. 1965 and subm. by A. Bammer, Österr. Archäol. Inst., Univ. of Vienna. *Comment* (A.B.): date limits destruction of Artemision altar.

Pisco-Paracas series, Perú

Charcoal in burned layer ca. 50 cm deep under accumulation of pecten shells (Kjökken Möddinger) near Salinas de Otuma in desert S of Pisco-Paracas (13° 49′ S Lat, 76° 14′ W Long), Perú. Coll. 1964 and subm. by H. Kinzl, Geog. Inst., Univ. of Innsbruck.

General Comment (H.K.): dates in agreement with knowledge on Kjökken Möddinger from Peruvian coast.

3650 ± 130
VRI-36. Otuma 1 **1700 B.C.**

Charcoal.

3460 ± 90
VRI-121. Otuma 2 **1510 B.C.**

Pecten shells. Pretreatment: surface removed with hydrochloric acid.

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U. S. GEOLOGICAL SURVEY RADIOCARBON DATES XI*

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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, always larger than the one-sigma statistical counting error commonly used, takes into account variable 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 Jeanne Lambert, who assisted in the preparation of the samples.

SAMPLE DESCRIPTIONS

A. Eastern U.S.

20,400 ± 800
W-2170. Wilmington Canyon, Atlantic Ocean 18,450 B.C.

Aragonite from clear layers in aragonite-cemented sandstone from continental slope near Wilmington Canyon (38° 47.5′ N Lat, 73° 02.6′ W Long), Atlantic Ocean; depth 320 m. Coll. 1968 by H. W. Climm, Jr.; subm. by J. C. Hathaway. *Comment* (J.C.H.): age is maximum for organic matter from which aragonite carbon was derived. δC^{13} values for this carbon ca. −60‰. Quaternary methane, oxidized chemically or microbiologically to CO_2, is the proposed carbon source for the aragonite.

Norfolk series, Connecticut

Charcoal interbedded with stratified drift, thought to be ice-contact delta, of last glaciation. Exposed in Mulville Bros. Pit (41° 59′ 15″ N Lat, 73° 12′ 41″ W Long), Norfolk, Litchfield Co., Connecticut. Coll. 1967 and subm. by R. L. Melvin.

General Comment (R.L.M.): charcoal occurs in deposits from last deglaciation of S New England. However, dates indicate material antedates last glaciation of this area. Possibly material was picked up from older organic sediment by advancing ice and redeposited during deglaciation.

28,000 ± 1000
W-2043. 26,050 B.C.

Depth 12 ft 2 in. to 12 ft 6 in. Charcoal from large lenticular mass of black organic material.

W-2174. >33,000

Depth 10 ft 3½ in. to 11 ft 1½ in. Charcoal from thick organic layer in sand.

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

W-2083. Panama City, Florida **>27,000**

Wood (*Pinus*) protruding above humate sand layer at −30 ft in entrance channel between Gulf of Mexico and St. Andrew Bay (ca. 30° 09′ N Lat, 85° 41′ W Long), near Panama City, Florida. Coll. 1967 by G. G. Salsman; subm. by V. E. Swanson. *Comment*: humate sand layers are believed by the collector and submitter to represent a still-stand of the sea at that level.

12,380 ± 350
W-2117. East Boothbay, Maine **10,430 B.C.**

Shells (*Mytilus edulis*) from cut on Rte. 96 (43° 51′ 50″ N Lat, 69° 38′ 40″ W Long), East Boothbay, Maine; elev. 110 ft MSL. Coll. 1967 and subm. by R. L. Dow, Dept. Sea and Shore Fisheries, Augusta, Maine. *Comment*: morphology of shells and presence of fragments of warmer-water ribbed mussel suggest animals lived during early climatic optimum, but date indicates they are immediate-Postglacial.

W-2081. Piscataqua River, New Hampshire-Maine **Modern**

Spartina peat from subtidal bottom of Piscataqua R. (ca. 43° 10′ N Lat, 70° 50′ W Long), New Hampshire-Maine. Coll. 1966 and subm. by R. L. Dow. *Comment* (R.L.D.): sample originally thought to have grown when sea level was 8 to 9 ft lower than at present.

6260 ± 300
W-2200. Kittatinny Mountain, New Jersey **4310 B.C.**

Brown, fibrous peat at 9 to 10 ft depth and ca. 2 ft above underlying light gray underclay on main ridge of Kittatinny Mt. (41° 14′ 08″ N Lat, 74° 42′ 10″ W Long), N of Beemerville, Sussex Co., N New Jersey. Below underclay is Silurian Shawangunk Conglomerate. Coll. 1968 and subm. by J. P. Minard. *Comment* (J.P.M.): peat bog formed by damming behind one of the end moraines on Kittatinny Mt. Minimum date for this moraine; enables correlation with other end moraines here and terminal moraine to the S.

Sandy Hook series, New Jersey

Two peat samples, separated by stratigraphic break, from 3½ ft sec. of swamp deposit on Cretaceous Mount Laurel Sand, S Sandy Hook 7½′ quad. (40° 23.6′ N Lat, 74° 04.7′ W Long), New Jersey; alt. 60 ft. Coll. 1967 and subm. by J. P. Minard. *Comment* (J.P.M.): dates indicate ages of pollen samples.

12,330 ± 300
W-2118. Peat **10,380 B.C.**

From near top of upper 2½ ft sec.

13,680 ± 300
W-2119. Peat **11,730 B.C.**

From basal 1 ft sec.

B. Central U.S.

Arrington series, Kansas

Peat with spruce detritus in core from 2 mi NE of Arrington (39° 29.7′ N Lat, 95° 31.6′ W Long), Atchison Co., NE Kansas, at E edge of Delaware R. flood plain. Coll. 1967 and subm. by H. E. Wright, Dept. Geol., Univ. Minnesota, Minneapolis.

General Comment (H.E.W.): dates indicate that boreal spruce forest prevailed in NE Kansas throughout maximum Wisconsin Glaciation.

24,500 ± 800
W-2205. **22,550 B.C.**

Depth 753 to 763 cm, at base of spruce pollen zone.

15,880 ± 600
W-2206. **13,930 B.C.**

Depth 303 to 313 cm, at top of spruce pollen zone.

Muscotah series, Kansas

Peat from cores in spring marsh 1.5 mi S of Muscotah, SW 1/4 NW 1/4 sec. 15, T 6 S, R 17 E (39° 31.8′ N Lat, 95° 30.8′ W Long), Atchison Co., Kansas, on E edge of Delaware R. flood plain. Coll. 1967 and subm. by H. E. Wright.

23,040 ± 600
W-2150. Depth 978 to 988 cm **21,090 B.C.**

Organic detritus, largely spruce needles, from base of Wisconsinan spruce pollen zone. *Comment* (H.E.W.): time of main Wisconsin Glaciation was marked in NE Kansas by Boreal spruce forest.

11,340 ± 300
W-2149. Depth 935 to 940 cm **9390 B.C.**

Organic detritus from base of early Holocene oak pollen zone. *Comment* (H.E.W.): marks spread of deciduous forest following end of Boreal spruce forest.

9930 ± 300
W-2202. Depth 773 to 778 cm **7980 B.C.**

Plant detritus from base of *Ambrosia* pollen zone. *Comment* (H.E.W.): indicates time of climatic change to relatively warm-dry interval of mid-Postglacial time. Date earlier than correlative pollen zone boundary farther N in Minnesota; may indicate slow northward migration of major vegetation belt.

5100 ± 250
W-2203. Depth 373 to 383 cm **3150 B.C.**

Plant detritus from top of *Ambrosia* pollen zone. *Comment* (H.E.W.): records onset of cooler, moister climate at end of mid-Postglacial interval of maximum warmth.

W-2127. Hickman, Kentucky **>34,000**

Aragonitic gastropod shells (*Anquispira alternata* [Say]) ca. 4 ft above base of early Wisconsinan age loess, 1½ mi S of Hickman (36° 32′ 55″ N Lat, 89° 13′ 12″ W Long), Fulton Co., Kentucky. Shells are about same stratigraphic position as 4 fossil peccaries (*Platygonus compressus*). Coll. 1968 and subm. by W. I. Finch. *Comment*: infinite age neither proves nor refutes the presumed early Wisconsinan age of the loess.

W-2182. Sanborn Farm site, Michigan **>32,000**

Wood chips and strongly humified organic sediment (paleosol) underlying thick inorganic sediments that represent at least 2 separate glaciations, at Sanborn Farm site, near S edge of NE ¼ Sec. 6, T 8 N, R 4 W (43° 06′ 48″ N Lat, 84° 49′ 24″ W Long), Lebanon Twp., Clinton Co., Michigan. Coll. 1967 by H. Sanborn and C. Oberlitner; subm. by N. G. Miller, Dept. Botany and Plant Pathol., Michigan State Univ., East Lansing, Michigan, and K. E. Vanlier. *Comment* (N.G.M.): date suggests correlation with Port Talbot Interstade. Pre-Late Wisconsin peat uncovered near Grand Rapids in W Michigan is approx. same age.

5700 ± 300
W-2184. Hazen, North Dakota **3750 B.C.**

Wood fragments from depth ca. 25 ft in North Dakota State Water Comm. Test Hole 2677, ca. 100 ft S of Northern Pacific Ry. tracks and 20 ft E of county rd. 18 at Hazen, SW ¼ SE ¼ NE ¼ Sec. 18, T 144 N. R 86 W (ca. 47° 17′ 30″ N Lat, 101° 37′ 30″ W Long), North Dakota. Three major terraces occur within Knife R. Valley; sample from alluvium underlying intermediate terrace, on which thin carbonaceous soil is developed. Lowest terrace, formed of alluvium, is periodically flooded; highest terrace, cut into bedrock, is veneered with till. Coll. 1967 and subm. by M. G. Croft. *Comment* (M.G.C.): indicates alluvium that underlies lowest and intermediate terraces is Postglacial and carbonaceous soil on intermediate terrace <5700 yr old.

10,880 ± 320
W-2201. Day County, South Dakota **8930 B.C.**

Pelecypods from clay-rich, water-laid drift channel filling within till in NW Day Co. (45° 32′ N Lat, 97° 48′ W Long), South Dakota. Coll. 1967 and subm. by D. I. Leap, South Dakota Geol. Survey, Vermillion. *Comment* (D.I.L.): indicates enclosing till is of latest Wisconsinan Age.

W-2044. Java, South Dakota **>28,000**

Pelecypods in channel deposit of alluvium derived from west overlying Cretaceous strata and underlying till, at Java fauna site, SE ¼ NE ¼ Sec. 26, T 123 N, R 75 W (43° 26′ 40″ N Lat, 99° 51′ 00″ W Long), Walworth Co., South Dakota. Coll. 1966 by L. S. Hedges, J. C. Harksen, and R. Stach; subm. by L. S. Hedges, South Dakota Geol. Survey, Sci. Center, Vermillion. *Comment* (L.S.H.): date does not conflict with Yarmouth age suggested for this deposit on basis of vertebrate fossil content J. C. Harksen (oral commun.).

11,560 ± 350
W-2015. Middleton, Wisconsin **9610 B.C.**

Larix at 10 ft depth on marl deposited by Glacial Lake Mendota, NW 1/4 SE 1/4 Sec. 12, T 7 N, R 8 E (43° 06′ N Lat, 89° 29′ W Long), Middleton, Dane Co., Wisconsin. Coll. 1965 by T. E. Berg and R. F. Black; subm. by R. F. Black, Sci. Hall, Univ. Wisconsin, Madison. *Comment* (R.F.B.): marks close of high level Glacial Lake Mendota.

26,060 ± 800
W-2022. Menominee, Wisconsin **24,110 B.C.**

Spruce from 200 to 210 ft in drilled well in sand and gravel outwash, SW 1/4 NE 1/4 Sec. 20, T 28 N, R 12 W (44° 54′ N Lat, 91° 52′ W Long), Menominee, Dunn Co., Wisconsin. Coll. 1966 by Karl Young; subm. by R. F. Black. *Comment* (R.F.B.): 1st wood in Wisconsin dated as Farmdalian. Underlies sediments with fossil lake trout formerly correlated with Yarmouthian (Hussakof, 1916), but now recognized as Wisconsinan (Frye *et al.*, 1965, p. 50).

W-2052. Juneau County, Wisconsin **>34,000**

Organic-rich clay from 153 to 155 ft depth in drill hole in NE 1/4 NE 1/4 Sec. 4, T 19 N, R 4 E (44° 09′ N Lat, 90° 01′ W Long), Juneau Co., Wisconsin. Coll. 1967 by A. F. Allong; subm. by R. F. Black. *Comment* (R.F.B.): dates beginning of last major phase of Glacial Lake Wisconsin; postdates an earlier till.

11,880 ± 600
W-2048. Laird Farm Pond, Wisconsin **9930 B.C.**

Log from peat bed underlying 6 ft red varved clay and overlying red till in excavation for Steve Laird farm pond, Sec. 12, T 22 N, R 16 E (44° 24′ 04″ N Lat, 88° 30′ 37″ W Long), 9 mi NNW of Appleton, Outagamie Co., Wisconsin. Coll. 1966 and subm. by W. F. Read, Dept. Geol., Lawrence Univ., Appleton, Wisconsin. *Comment* (W.F.R.): date indicates Twocreekan age.

C. Western U.S.

7350 ± 350
W-2024. Ray, Arizona **5400 B.C.**

Partly mineralized wood from copper-oxide ore in stream channel in Gila Conglomerate on margin of Pearl Handle Pit, Ray porphyry-copper deposit, NW 1/4 Sec. 14, T 3 S, R 13 E (33° 11′ N Lat, 110° 59′ 30″ W Long), Sonora Quad; Arizona. Coll. 1967 by R. A. Metz, Kennecott Corp., Ray, Arizona; subm. by H. R. Cornwall. *Comment* (H.R.C.): age is maximum for secondary copper ore (Metz and Rose, 1966, p. 177) which has now been mined.

510 ± 250
W-2085. Glass Mountain, California **A.D. 1440**

Charcoal from cedar tree engulfed by snout of dacite portion of Glass Mt. composite lava flow 0.4 mi W of Sec. 7, T 43 N, R 5 E (41°

35′ 15″ N Lat, 121° 27′ 30″ W Long), Timber Mt. Quad, California. Coll. 1964 by I. Friedman and J. Ratté. *Comment* (I.F.): dates Glass Mt. flow.

Manzanita Creek series, California

Charcoal from lowest and middle of 3 pumice flows exposed in W bank of Manzanita Creek ca. 200 ft upstream from water storage tank in SW 1/4 Sec. 17, T 31 N, R 4 E (40° 32′ N Lat, 121° 32′ W Long), Lassen Volcanic Natl. Park, California. Deposit overlies sand and gravel at top of which is a soil profile. Coll. 1967 and subm. by D. R. Crandell. *General Comment* (D.R.C.): charcoal in uppermost deposit dated as <200 yr (W-812; Radiocarbon, 1960, v. 2, p. 156), but some trees growing on top of deposit are >300 yr old. Apparent age differences between this series and W-812 suggest widely spaced eruptions in recent volcanic history of Lassen Peak.

1230 ± 300
W-2135. **A.D. 720**

Charcoal log in lowest of 3 pumice flows.

1120 ± 300
W-2137. **A.D. 830**

Charcoal log in middle unit of 3 pumice flows.

5180 ± 600
W-2086. San Luis Canal, California **3230 B.C.**

Carbonized wood filling near-surface subsidence cracks in right bank of San Luis Canal, Sta. 3485 + 50, NW 1/4 SE 1/4 Sec. 25, T 17 S, R 15 E (ca. 36° 24′ N Lat, 120° 15′ W Long), W Fresno Co., California. Coll. 1966 by J. O. Berkland; subm. by W. B. Bull. *Comment* (W.B.B.): dates thousands of sediment-filled tension fractures in alluvial fans of western Fresno County; dates time when stream flow became sufficient to wet moisture-deficient deposits that had been accumulating on fans for thousands of years.

6050 ± 600
W-2038. Comanche Reservoir, Colorado **4100 B.C.**

Black earthy peat from ca. 20 ft below Comanche Reservoir, SW 1/4 Sec. 12, T 7 N, R 74 W (ca. 40° 35′ 05″ N Lat, 105° 38′ 40″ W Long), Comanche Peak Quad., Larimer Co., Colorado. Coll. 1966 by P. Voegeli and L. A. Cerrillo; subm. by L. A. Cerrillo, Dept. Geol., Colorado State Univ., Ft. Collins. *Comment*: sample was believed to indicate event between middle and late Pinedale Glaciation, but date is too young.

19,730 ± 500
W-2143. Grand Valley area, Colorado **17,780 B.C.**

Organic silt layer 17 ft below surface of alluvial terrace adjacent to and 50 ft above Colorado R., NW 1/4 SW 1/4 Sec. 34, T 7 S, R 96 W (39° 23′ 30″ N Lat, 108° 06′ W Long), Grand Valley 7 1/2′ Quad., Colorado. Coll. 1965 and subm. by W. E. Yeend. *Comment* (W.E.Y.): early Pinedale

Glaciation age fits in well with field interpretation. Few late Pleistocene dates in S Rocky Mts. Alluvial terrace is thought to be older gravel of Grand Mesa Formation (Pinedale?).

Abert Lake series, Oregon

Carbonate mud from pits in recent playa sediments at NNE end of Abert Lake, Sec. 7, T 33 S, R 22 E (42° 44′ N Lat, 120° 09′ W Long), S-central Oregon. Samples are same as W-1593 and W-1594 (Radiocarbon, 1967, v. 9, p. 517-518) except for leaching with distilled water to remove water-soluble carbonate. Coll. 1964 by B. F. Jones, A. H. Truesdell, A. S. Van Denburgh, and G. I. Smith; subm. by B. F. Jones.

General Comment (B.F.J.): although leached samples appear 700+ yr older than W-1593 (1150 ± 250) and W-1593 (3830 ± 250), indicating loss of significant C^{14} activity on removal of interstitial salts, age difference remains same, consistent with maximum sedimentation rate of 500 yr/ft for Abert Lake deposits.

1890 ± 250
W-2192. Silt **A.D. 60**

Dark silt from 2.0 to 2.2 ft depth.

4530 ± 250
W-2196. Clay **2580 B.C.**

Dark clay from 4.0 to 5.0 ft depth.

W-2172. Cape Fisheries, Oregon **>45,000**

Wood and *Picea sitchensis* cones in peaty sand zone at base of highly weathered marine sediments capping low marine terrace that displays southward tilt of 26.6 ft/mi along access road to Cape Fisheries dock, SE 1/4 SW 1/4 Sec. 5, T 33 S, R 15 W (42° 45.5′ N Lat, 124° 30′ W Long), Port Orford Quad., Oregon. Coll. 1967 and subm. by R. J. Janda. *Comment* (R.J.J.): shells from same stratigraphic horizon 7.5 mi to N of Port Orford have yielded concordant radiocarbon and uranium-thorium ages of 35,000 yr. The >45,000 yr age is more compatible with amount of weathering and tectonic deformation that have taken place since deposition of these marine sediments which probably occurred during Sangamon Interglaciation.

5130 ± 1000
W-2084. Bench Lake, Washington **3180 B.C.**

Wood, overlying pumice Layer Y from Mt. St. Helens and underlying series of thin younger ash beds, in stream bank ca. 1000 ft S of NW-point of Bench Lake (ca. 46° 45.5′ N Lat, 121° 42′ W Long), Mt. Rainier Natl. Park, Washington. Coll. 1967 and subm. by D. R. Mullineaux. *Comment* (D.R.M.): date is anomalously old for wood above well-dated, easily recognized Layer Y which is between 3000 and 3500 yr old (Crandell *et al.*, 1962, p. 64-68); sample may have been mislabeled or contaminated.

5020 ± 300
W-2053. Cowlitz Park, Washington **3070 B.C.**

Peat, overlying pumice Layers D and N and underlying Layer F in sequence of Mt. Rainier pyroclastic layers (Mullineaux, 1965, p. 24), from stream bank in Cowlitz Park (ca. 46° 49′ N Lat, 121° 38.5′ W Long), Mt. Rainier Natl. Park, Washington; ca. 6200 ft alt. Coll. 1966 and subm. by D. R. Mullineaux. *Comment* (D.R.M.): indicates pyroclastic Layer F is at least approx. same age as Osceola Mudflow which it does not overlie and which is also dated ca. 5000 yr old (Crandell and Waldron, 1956, p. 349).

16,070 ± 600
W-2125. Factoria, Washington **14,120 B.C.**

Peaty silt, overlying glacial drift and underlying Vashon recessional outwash gravel, from borrow pit along S side of Hwy 10, E of Seattle (47° 34.8′ N Lat, 122° 09.8′ W Long), near Factoria, Washington. Coll. 1968 by D. S. Tillson; subm. by D. R. Mullineaux. *Comment* (D.R.M.): indicates peaty material was deposited during late part of Olympia Interglaciation rather than during Vashon Stade.

W-2028. Maplewood, Washington **>42,000**

Peaty silt underlain by pre-Vashon oxidized till in bluff on W side of Colvos Passage, NE 1/4 NE 1/4 Sec. 21, T 22 N, R 2 E (47° 23′ 15″ N Lat, 122° 33′ W Long), ca. 0.8 mi S of Maplewood, Kitsap Co., Washington. Coll. 1963 by D. R. Crandell, H. H. Waldron, and D. R. Mullineaux; subm. by H. H. Waldron. *Comment* (H.H.W.): this unit is believed to be equivalent in age to Olympia Interglaciation.

W-2034. Paradise Valley, Washington **<200**

Wood and charcoal from above Paradise debris flow and below Mt. Rainier pumice Layers L and D in road cut along hwy. on E side of Paradise Valley (ca. 46° 47′ N Lat, 121° 44′ W Long), Mt. Rainier Natl. Park, Washington. Coll. 1966 and subm. by D. R. Mullineaux. *Comment* (D.R.M.): sample apparently from roots that grew into pyroclastic sequence rather than from material laid down between older eruptions.

450 ± 200
W-2027. Renton, Washington **A.D. 1500**

Wood from sand layer at 26 ft depth in alluvial fill of Duwamish Valley (47° 27.5′ N Lat, 122° 14′ W Long), ca. 2 mi SW of Renton, Washington. Sand layer is overlain by flood-basin silt and fine sand. Coll. 1967 by D. S. Tillson; subm. by D. R. Mullineaux. *Comment* (D.R.M.): these fine-grained White R. deposits were laid down rapidly, here at least 1 ft each 20 yr, compared to rate of deposition of alluvium of nearby rivers. Fine-grained alluvium above wood contains sand-size pumice of Layer W from Mount St. Helens, radiocarbon dated as ca. 300 yr old (Crandell, *et al.*, 1962, p. 64-68) and by tree-ring studies as at least 400 yr old.

W-2041. Grouse Creek Delta, Wyoming **9060 ± 300**
7110 B.C.

Organic-rich, gently crossbedded sand representing foreset or bottomset delta beds in S-central Frank I. Quad., ¾ mi up Grouse Creek from entrance to S arm of Yellowstone Lake (44° 16.6′ N Lat, 110° 20.6′ W Long), Yellowstone Natl. Park, Wyoming. Coll. 1966 and subm. by K. L. Pierce. *Comment* (K.L.P.): dates delta built during high stand, apparently 60 to 110 ft above present level, of Yellowstone Lake.

W-2037. Rocky Creek, Wyoming **13,140 ± 700**
11,190 B.C.

Humic silt from undercut bank on E side of Rocky Creek (44° 21.6′ N Lat, 110° 09.6′ W Long), 1.5 mi up valley of Rocky Creek from junction with Beaverdam Creek, Yellowstone Natl. Park, Wyoming. Overlies ice-contact stratified drift of middle Pinedale age, overlain by fluvial material of late Pinedale age. Coll. 1966 and subm. by K. L. Pierce. *Comment* (K.L.P.): sample closely post-dates stagnation of middle Pinedale icecap ca. 5 mi E of ice cap axis.

W-2142. Spread Creek Canyon, Wyoming **2200 ± 250**
250 B.C.

Wood from tree stumps in carbonaceous silt, overlain by loess and underlain by 2 tills, in Spread Creek Canyon, Sec. 13, T 44 N, R 114 W (43° 45′ N Lat, 110° 27′ 30″ W Long), Teton Co., Wyoming. Coll. 1967 and subm. by J. D. Love. *Comment* (J.D.L.): sample from what looks like an old soil zone—much older than date indicates. Appears older than loess material in Jackson Elk Refuge, 15 mi SW, where all dates are 10,000 to 15,000 yr.

D. Alaska

Amchitka Island series, Alaska

Plant remains interbedded with 3 ash falls from 2.8 m thick peat deposit on Amchitka I. (51° 26′ N Lat, 179° 15′ E Long), Rat Is. group, Aleutian Is., Alaska. Coll. 1968 and subm. by H. T. Shacklette.

General Comment (H.T.S.): plant material was at surface when 3 ash falls occurred; dates 3 ash layers within peat. Humified peat deposits are formed ca. 2 in. per century on this island. Considering amount of peat below ash layers, peat has been forming here for ca. 3000 yr, which may indicate length of time that this part of island has been elevated above sea level.

W-2129. **1740 ± 250**
A.D. 210

Sample coll. 0.80 m from bottom of 2.8 m thick peat deposit; from 1 cm thick ash deposit in peat.

W-2130. **1950 ± 250**
A.D. 0

Sample coll. 0.87 m from bottom of 2.8 m thick peat deposit; from 1 cm thick ash deposit in peat.

W-2131. **725 ± 250**
A.D. 1225

Sample coll. 1.4 m from bottom of 2.8 m thick peat deposit; from 1½ cm thick ash deposit in peat.

W-2154. Birchwood Elementary School, Alaska **>45,000**

Peat, overlying 2 ft gray silty clay and overlain by 9 ft horizontally bedded gravel, from E side of Birchwood Loop Rd. in utilidor excavation along N side of Birchwood Elementary School, NW ¼ SW ¼ Sec. 19, T 15 N, R 1 W (61° 22′ 26″ N Lat, 149° 31′ 42″ W Long), Anchorage (B-7) Quad., Alaska. Coll. 1967 and subm. by E. Dobrovolny and H. R. Schmoll. *Comment* (E.D. and H.R.S.): compatible with other dates [(W-77 (Science, 1954, v. 120, p. 467-473), W-174 (Science, 1955, v. 121, p. 481-488), W-535 (Radiocarbon, 1960, v. 2, p. 164), W-644 (*ibid.*, p. 169), and W-1806 (Radiocarbon, 1969, v. 11, p. 221)] in area underlying deposits of Naptowne Glaciation. Silty clay underlying sample is older than Bootlegger Cove Clay at type locality as dated by W-2151 (this date list).

W-2159. Brakes Bottom, Alaska **>45,000**

Wood in carbonaceous lens of sand in Kougarok Gravels in gravel pit at intersection of Kougarok Rd. and Dahl Creek (65° 21′ 30″ N Lat, 164° 40′ 50″ W Long), Bendeleben (B-6) Quad., Seward Peninsula, Alaska. Gravels display abundant fossil ice wedge casts. Coll. 1967 and subm. by C. L. Sainsbury. *Comment* (C.L.S.): Kougarok Gravels in this locality are cold weather fluvial gravels; they must be at least as old as Wisconsin Glaciation.

W-2147. Chekok Creek, Alaska **5520 ± 250**
3570 B.C.

Organic-rich sand 10 in. below surface of old beach ridge (52 to 55 ft above present lake level) of Iliamna Lake, 2.2 mi N 45° W of mouth of Chekok Lake, Alaska. Coll. 1966 and subm. by R. L. Detterman. *Comment* (R.L.D.): date falls between several other dates from beach ridges at W end of lake (Detterman, Reed, and Rubin, 1965); probably minimum date for melting of last major glaciation in area.

Douglas Island series, Alaska

Peat and sedge deposits from Douglas, Alaska. Coll. 1966 and subm. by R. D. Miller. *Comment* (R.D.M.): dates aid in determining rate of uplift of shoreline relative to sea level on Douglas I.

W-1949. **5730 ± 350**
3780 B.C.

Peat, sedge, and woody fragments from base of muskeg in contact with beach gravel below hwy. in excavation for rd. for new subdivision, NE ¼ SE ¼ Sec. 26, T 41 S, R 67 E (58° 16′ 51″ N Lat, 134° 13′ 56″ W Long), Douglas, Douglas I., Alaska.

3650 ± 250
W-2029. **1700 B.C.**

Peat, at 211 ft alt., from silty zone separating 2 thicker peat deposits in muskeg behind Douglas Elementary School, NE 1/4 NE 1/4 NE 1/4 Sec. 35, T 41 S, R 67 E (58° 16′ 41″ N Lat, 134° 24′ 13″ W Long), Douglas, Douglas I., Alaska.

5640 ± 280
W-2030. **3690 B.C.**

Peat, sedge, and woody particles from muskeg at alt. 209 ft behind Douglas Elementary School, NE 1/4 NE 1/4 NE 1/4 Sec. 35, T 41 S, R 67 E (58° 16′ 41″ N Lat, 134° 24′ 13″ W Long), Douglas, Douglas I., Alaska.

6580 ± 300
W-2031. **4630 B.C.**

Peat from base of muskeg where intermixed with upper part of 2 ft sec. of beach gravel and sand, over blue-gray diamicton, behind Douglas Elementary School, SE 1/4 SE 1/4 Sec. 26, T 41 S, R 67 E (58° 16′ 42″ N Lat, 134° 24′ 00″ W Long), in excavation for retaining wall, Douglas, Douglas I., Alaska.

2630 ± 600
W-2032. **680 B.C.**

Peat and sedge from 1 in. layer in beach gravel and tidal silts, underlain by hard diamicton, below hwy. in excavation for rd. for new subdivision, NE 1/4 SE 1/4 Sec. 26, T 41 S, R 67 E (58° 16′ 51″ N Lat, 134° 13′ 56″ W Long), Douglas, Douglas I., Alaska.

3900 ± 250
W-2153. Eagle River, Alaska **1950 B.C.**

Wood, slightly compressed, ca. 16 ft above base of 28.5 ft exposure of lacustrine blue-gray silt and clay, upper part of which includes interbedded sand, in exposure on N side of Eagle River, SE 1/4 SW 1/4 Sec. 18, T 14 N, R 1 W (61° 17′ 53″ N Lat, 149° 31′ 26″ W Long), Anchorage (B-7) Quad., Alaska. Ash bed 1.0 ft above sampled wood; sediments are in part disturbed and ash bed repeated. Coll. 1967 and subm. by Ernest Dobrovolny and H. R. Schmoll. *Comment* (E.D. and H.R.S.): seems too young to date late sediments as Eagle R. should not have been impounded by ice at that time. Wood was probably incorporated into sediments at time of disturbance which may have produced deep fractures.

Glacier Bay series, Alaska

Samples collected to determine Hypsithermal and Neoglacial history in NW arm of Glacier Bay and damming of Muir Inlet, causing deposition of middle Van Horn lake clay. Coll. 1966 and subm. by A. T. Ovenshine.

3090 ± 250
W-2017. Cushing Glacier terminus **1140 B.C.**

Tree rooted in peat layer on bedrock in recently deglaciated area

2.46 mi bearing 350° from hill elev. 1960 at N end of Bruce Hills, Skagway (A-4) Quad., Alaska. *Comment* (A.T.O.): burial of stump by upper Van Horn gravel probably resulted from outwash accumulation in front of advancing glaciers. Date closely reflects onset of glacial advance, as locality is close to headwater area of Muir Glacier drainage.

W-2018. Johns Hopkins Inlet **8210 ± 300**
6260 B.C.

Twigs from brown, fetid organic-rich lacustrine silts, interbedded with coarse gravel 500 ft thick, containing abundant angular clasts of local provenance, at 800 ft in gully on N side Johns Hopkins Inlet, 3.42 mi at 305° from prominent point N of E side of terminus of Lamplugh Glacier, Mt. Fairweather (D-3) Quad., Alaska. *Comment* (A.T.O.): establishes presence of gravels beneath Neoglacial deposits; NW Glacier Bay not continuously glaciated during Hypsithermal Interval as believed previously.

W-2019. Tarr Inlet **7620 ± 300**
5670 B.C.

Bark in sand and gravel in valley on E side of Tarr Inlet, 6.35 mi bearing 170° from Mt. Barnard, Glacier Bay, Skagway (A-6) Quad., Alaska. *Comment* (A.T.O.): sand and gravel may be equivalent to gravel in Johns Hopkins Inlet (see W-2018 above).

W-2021. Reid Glacier **9010 ± 300**
7060 B.C.

Brown peat layer, 4 in. thick, resting on compact clay till and overlain by gravels in streambank on E side of terminus of Reid Glacier, 3.14 mi bearing 222° from Ibach Point, Mt. Fairweather (D-3) Quad., Alaska. *Comment* (A.T.O.): date places upper limit age on lower till and gives approx. age for previously unrecognized advance in Glacier Bay.

W-2134. Hogatza, Alaska **>40,000**

Compressed peat with woody material from 8 in. thick horizon overlain by 35 ft of organic muck and underlain by 7 ft coarse, well-oxidized, auriferous gravel at base of bluff along N side of Hogatza gold placer mine workings ca. 1 mi E of Hogatza (66° 11′ 53″ N Lat, 155° 41′ 31″ W Long), Alaska. Coll. 1967 and subm. by O. J. Ferrians, Jr. *Comment* (O.J.F., Jr.): auriferous gravel is at least 40,000 yr old.

W-2123. Kamishak Bay, Alaska **2620 ± 250**
670 B.C.

Peat 30 in. deep and 18 ft 4 in. above top of wave-cut bedrock platform 50 ft above present sea level in sea cliff on S side of Kamishak Bay (59° 04′ 30″ N Lat, 154° 00′ 40″ W Long), Cook Inlet, Alaska. Coll. 1967 and subm. by R. L. Detterman. *Comment* (R.L.D.): this date in conjunction with other samples still to be run will hopefully determine uplift rate along W side of Cook Inlet.

W-2161. Kougarok Landing Strip, Alaska **>45,000**

Peat at top of silty, carbonaceous layer intercalated in Kougarok Gravels in pit E of Kougarok Rd. at Kougarok Landing Strip (65° 24′ 10″ N Lat, 164° 38′ 40″ W Long), Bendeleben (B-6) Quad., Seward Peninsula, Alaska. Coll. 1967 by R. Kachadoorian; subm. by C. L. Sainsbury. *Comm.* (C.L.S.): confirms that upper part of exposed Kougarok Gravels are at least as old as earliest Wisconsin.

260 ± 250
W-2169. Lake George, Alaska **A.D. 1690**

Wood from Troublesome Creek fan-delta, upper Lake George, Sec. 30, T 14 N, R 5 E (61° 16′ 31″ N Lat, 148° 36′ 46″ W Long), Anchorage (B-5) Quad., Alaska. Coll. 1967 by W. W. Barnwell, H. R. Schmoll, and E. Dobrovolny; subm. by Barnwell. *Comment* (W.W.B.): confirms that lake and lake-associated deposits, as well as moraines, in Lake George area are late Holocene, assignable to Tunnel (II) Glaciation.

10,730 ± 300
W-2171. Mentasta Basin, Alaska **8780 B.C.**

Organic silt at base of flood-plain alluvium overlying 5 ft lacustrine deposits extending down to river level in exposure on S side of Slana R., 0.5 mi NW of Slana R. bridge (62° 51′ 32″ N Lat, 143° 42′ 33″ W Long), Nabesna (D-6) Quad., Alaska. Coll. 1963 by H. R. Schmoll and John Trach; subm. by H. R. Schmoll. *Comment* (H.R.S.): dates a level of Slana R. deposits slightly higher than today's, and correlated with terraces upstream that postdate moraines in Slana Valley. Age is minimum for lake here, and in Copper R. basin at 2200 ft level, older than believed previously (W-1161, Radiocarbon, 1964, v. 6, p. 63).

4610 ± 250
W-2173. Mentasta Basin, Alaska **2660 B.C.**

Organic silt overlying 27 ft of sand of probable lacustrine origin and overlain by 2.5 ft of oxidized sand in exposure on W side of Slana R., 0.1 mi downstream from Slana R. bridge (62° 51′ 18″ N Lat, 143° 41′ 34″ W Long), Nabesna (D-6) Quad., Alaska. Coll. 1963 and subm. by H. R. Schmoll. *Comment* (H.R.S.): since W-2173 is higher but younger than W-2171 (this date list), probably it represents reworking of lacustrine sand in surface depression, prior to development of river bluff exposure. Samples demonstrate that whereas in some places river was close to present vertical and lateral position >10,000 yr ago, elsewhere valley has been widened since 5000 yr ago.

1930 ± 250
W-2157. Muir Inlet, Alaska **A.D. 20**

Wood embedded in reddish-brown, partly indurated, partly weathered, poorly stratified gravel from W side of Muir Inlet near mouth of Morse Creek (ca. 58° 48′ N Lat, 136° 30′ W Long), SE Alaska. Coll. 1966 and subm. by A. T. Ovenshine. *Comment* (A.T.O.): date suggests gravel is lateral equivalent of middle Van Horn lake clay. Its deposition near mouth of Muir Inlet may have been responsible for ponding of through drainage and development of middle Van Horn lake(s).

W-2148. Pedro Bay, Alaska **1340 ± 250**
A.D. 610

Organic material, undisturbed by human occupation, 10 in. deep at archaeologic site on beach ridge at Pedro Bay (59° 47′ 05″ N Lat, 154° 07′ 30″ W Long), Iliamna Lake, Alaska. Coll. 1966 by B. L. Reed; subm. by R. L. Detterman. *Comment* (R.L.D.): age is maximum for occupation of site at Pedro Bay Village. Compares with other sites on Alaska Peninsula.

W-2152. Potter Hill railroad cut, Alaska **7890 ± 250**
5940 B.C.

Peat, underlain by 4 ft gravel and 42 ft interbedded sand and diamicton of glacioaqueous origin, within lower part of 4-ft sand unit in top of Potter Hill cut along Alaska R.R., 1/4 mi S of intersection of Seward Hwy. and de Armoun Rd., SW 1/4 NE 1/4 Sec. 32, T 12 N, R 3 W (61° 05′ 20″ N Lat, 149° 50′ 19″ W Long), Anchorage area, Alaska. Coll. 1965 and subm. by E. Dobrovolny and H. R. Schmoll. *Comment* (E.D. and H.R.S.): dates deposition of sand of uncertain origin, probably alluvium or colluvium, date is minimum for underlying gravel. Both units probably correlative with the Tanya advance of Karlstrom (1964).

W-2158. Reid Glacier terminus, Alaska **4730 ± 250**
2780 B.C.

Wood embedded in stratified gravel in stream bank at E side of Reid Glacier terminus (ca. 59° N Lat, 136 ° 50′ W Long), Mt. Fairweather (D-3) Quad,. Alaska. Coll. 1966 and subm. by A. T. Ovenshine. *Comment* (A.T.O.): age is minimum for underlying compact clay till. Dates advance, previously unrecognized in Glacier Bay, which is younger than Wisconsinan and older than the Neoglacial (Little Ice Age of Bengtson [1962]).

Stikine River delta series, Alaska

Wood fragments from boring in prodelta deposits of Stikine R. in Dry Straits (56° 36′ 56″ N Lat, 132° 32′ 36″ W Long), Petersburg (C-2) Quad., SE Alaska. Coll. 1967 by W. H. Slater; subm. by R. W. Lemke. *General Comment* (R.W.L.): dates indicate very rapid sedimentation. W-2164 is anomalous, probably because of contamination of sample.

W-2163. **1690 ± 250**
A.D. 260

Depth, 90 ft.

W-2164. **960 ± 250**
A.D. 990

Depth, 80 ft.

1580 ± 250
W-2165. **A.D. 370**

Depth, 60 ft.

9330 ± 300
W-2160. Washington Creek, Alaska **7380 B.C.**

Wood from old beaver dam at base of silt, ca. 8 ft thick, that overlies auriferous gravel along Washington Creek (65° 44′ N Lat, 164° 52′ W Long), W fork of Kougarok R., Bendeleben (C-6) Quad., Seward Peninsula, Alaska. Coll. 1967 and subm. by C. L. Sainsbury. *Comment* (C.L.S.): dates warm cycle, despite its correspondence to postulated glacial advance recognized elsewhere on Seward Peninsula.

13,690 ± 400
W-2151. Woronzof Bluffs, Alaska **11,740 B.C.**

Mollusk shells from bluffs in Bootlegger Cove Clay on S side of Knik Arm, ca. 1 mi E of Point Woronzof, adjacent to Clay Products Rd., SW ¼ SW ¼ Sec. 22 and NE ¼ SE ¼ Sec. 21, T 13 N, R 4 W (61° 11′ 58″ N Lat, 149° 59′ 00″ to 21″ W Long), Anchorage (A-8) Quad., Alaska; 23 to 27 ft above mean high water. Coll. 1966 by L. A. Yehle, H. R. Schmoll, E. Dobrovolny, and R. A. M. Schmidt; subm. by Dobrovolny and Schmoll. *Comment* (E.D. and H.R.S.): significantly younger than previous ionium-uranium date of 33,000 to 48,000 yr on shells from same zone. If C^{14} date is correct, the clay in its type area, and hence the Woronzofian transgression, is younger than maximum of Naptowne Glaciation as currently dated, and the clay represents an intra-Naptowne marine transgression rather than one during Knik-Naptowne interglacial interval.

E. Hawaii

3620 ± 250
W-2016. Waiohino, Kau, Hawaii **1670 B.C.**

Charcoal underlying surface pahoehoe lava flow at Bishop Mus. Site 31, a cesspool excavation (15° 04′ 15″ N Lat, 155° 36′ 52″ W Long), Waiohino, Hawaii. Coll. 1966 by V. Hansen; subm. by R. R. Doell. *Comment* (R.R.D.): date is maximum for lava flow and substantiates 3740 ± 250 for W-856 (Radiocarbon, 1960, v. 2, p. 157) from beneath same flow.

F. Miscellaneous

W-2138. La Viborita mine, Colombia **>42,000**

Carbonized wood from clay in younger of 2 high-level bodies of alluvium exposed in La Viborita alluvial-gold mine (6° 56′ N Lat, 75° 05′ W Long) and vicinity, Amalfi, Antioquia, Colombia. Coll. 1967 and subm. by T. Feininger. *Comment* (T.F.): only indication of age of surficial materials in this area.

4780 ± 300
W-2082. Oetz Valley, Austria **2830 B.C.**

Larix decidua charcoal from within what appeared to be lateral moraine of Gschnitz Stade at Roppen (47° 14′ N Lat, 10° 50′ E Long), Oetz Valley, Tyrol, Austria. Coll. 1967 and subm. by H. Heuberger, Univ. Innsbruck, Austria. *Comment* (H.H.): date is not relevant to advance of Oetz Valley glacier that built moraine.

1440 ± 250
W-2141. Gardnersville, Liberia **A.D. 510**

Truncated root *in situ* in weathered sandstone overlain by black soil covered by unconsolidated sand at oil refinery at Gardnersville near Monrovia (ca. 6° 30′ N Lat, 6° 00′ W Long), Liberia. Coll. 1967 and subm. by R. White. *Comment* (R.W.): should represent maximum age of sand deposition.

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[RADIOCARBON, VOL. 12, No. 1, 1970, P. 335-345]

UNIVERSITY OF WISCONSIN RADIOCARBON DATES VII

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The radiocarbon dates obtained since August, 1968, are reported here. Wood, charcoal, and peat samples are pretreated with dilute NaOH and dilute H_3PO_4 before conversion to the methane used as counting gas; marls and lake cores are treated with acid only. The reported dates have been calculated using 5568 years as the half-life of C^{14}, 1950 as the reference year. Samples are run at least once in each of two 0.5 liter counters at 3 atm pressure for a minimum total of 15,000 counts. The standard deviation quoted includes only the 1σ of the counting statistics of background, sample, and standard counts.

In November, 1968, the laboratory was moved to a new location, the basement of a high rise building. As a result the background count at 3 atm pressures in our two counters has been reduced to 1.2 ± 0.1 cpm. The counter efficiencies remained unchanged.

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I. ARCHAEOLOGIC SAMPLES

A. Iowa

Rock Run Shelter series, Iowa (13CD10)

Charcoal samples from excavations at Rock Run Shelter on a small tributary of Cedar R. in Cedar Co., Iowa (41° 42′ N Lat, 91° 11′ W Long). Coll. 1968 by R. Alex, State Univ. of Iowa; subm. by D. A. Baerreis. These dates supplement those reported earlier (Radiocarbon, 1969, v. 11, p. 229).

1330 ± 55
WIS-331. Rock Run Shelter site (13CD10) A.D. 620

Charcoal from 22 to 24 in. depth.

1640 ± 60
WIS-328. Rock Run Shelter site (13CD10) A.D. 310

Charcoal, wood fragments, and nuts, from 32 to 34 in. depth.

2560 ± 60
WIS-333. Rock Run Shelter site (13CD10) 610 B.C.

Charcoal with mud 44 to 46 in. deep.

3660 ± 60
WIS-384. Rock Run Shelter site (13CD10) 1710 B.C.

Charcoal from 50 to 52 in. depth.

WIS-383. Rock Run Shelter site (13CD10) **4300 ± 65** **2350 B.C.**

Charcoal from 52 to 54 in. depth.

Jackson County, Iowa (13JK20)

Charcoal from rock shelter containing primarily Woodland occupation on Maquoketa R., Jackson Co., Iowa (42° 10 N Lat, 90° 50′ W Long). Coll. 1968 by M. Jaehnig; subm. by D. A. Baerreis.

WIS-344. Jackson County, Iowa (13JK20) **1780 ± 60** **A.D. 170**

Charcoal from Level 15 of Test Pit 2, 28 to 30 in. deep.

WIS-345. Jackson County, Iowa (13JK20) **980 ± 60** **A.D. 970**

Sample from Level 3 of Test Pit 3, 8 to 12 in. deep.

B. Wisconsin

Iowa County series, Wisconsin (47IA1 and 47IA38)

Charcoal samples from 2 stratified rock shelters, Governor Dodge State Park Rock Shelter (43° 01′ N Lat, 90° 06′ W Long) and Mayland Cave (43° 04′ N Lat, 90° 08′ W Long), excavated by Univ. of Wisconsin field school under the direction of J. B. Stoltman, Univ. of Wisconsin-Madison, during summer 1968. Subm. by J. B. Stoltman. Governor Dodge Rock Shelter had been tested previously by W. Wittry (1959).

WIS-335. Governor Dodge State Park Rock Shelter (47IA1) **1600 ± 55** **A.D. 350**

Charcoal from probable hearth in Feature 3, a dark, bone-rich layer localized within 3 five ft squares in NW corner of excavated area. Sample from Sq. 6, Level 4, 0.9 to 1.2 ft deep. Since nearly all dentate rocker-stamped pottery found at site was either in direct assoc. with or close to Feature 3, hearth probably is assoc. with Middle Woodland occupation of site. Date is in excellent agreement.

WIS-368. Governor Dodge State Park Rock Shelter (47IA1) **4170 ± 65** **2220 B.C.**

Bone and charcoal from Sq. A6, Level 13, Feature 15, 3.6 to 3.9 ft and Sq. Z6, Level 11, 3.0 to 3.3 ft deep.

WIS-367. Governor Dodge State Park Rock Shelter (47IA1) **3820 ± 65** **1670 B.C.**

Charcoal from Sq. Z6-9, Feature 15, 2.4 to 2.7 ft deep.

WIS-336. Mayland Cave (47IA38) **Modern**

Charcoal from Feature 1, shallow, basin-shaped depression, at depth 0.9 to 1.2 ft. Feature 1 is attributed to Late Woodland occupation which appears to have been in contact with Upper Mississippian (Oneota) peoples. Date is inconsistent with archaeologic evidence. In dry sediments of this cave, it is likely that charcoal from historic campfires has contaminated sample as a result of burrowing rodent activity.

WIS-337. Mayland Cave (47IA38) **680 ± 55**
A.D. 1270

Charcoal from Feature 6e, shallow basin-shaped depression at depth 1.8 to 2.1 ft; 25 body sherds from single vessel of type Grand River Trailed were also recovered from feature. Date, acceptable for Oneota, should also apply to Late Woodland (characterized by Madison ware) occupation at site.

WIS-357. Mayland Cave (47IA38) **1010 ± 55**
A.D. 940

Sample from Sq. B1, Level 5, 1.8 to 2.1 ft deep, in Feature 17, beneath large sandstone block from roof fall. Feature consisted of concentration of charcoal, pottery, and some animal bone.

WIS-369. Mayland Cave (47IA38) **1590 ± 55**
A.D. 360

Sample from Sq. B4, Level 14, 3.9 to 4.2 ft deep. Sample immediately below distinct change in relative frequencies of various animal species that might reflect local change in vegetation cover.

WIS-370. Mayland Cave (47IA38) **1630 ± 70**
A.D. 320

Charcoal from Sq. B1, Level 15, 4.8 to 5.4 ft deep. Date should indicate time of earliest occupation of site by Late Woodland peoples.

WIS-354. Hilgen Spring Park site **2410 ± 55**
460 B.C.

Charcoal from hearth on floor of Mound 2 at Hilgen Spring Park site Oz 7, Cedarburg, Wisconsin (43° 17′ 30″ N Lat, 87° 58′ 30″ W Long). Mound was one of 3 conical mounds of Effigy Mound culture (Brown, 1906). Coll. 1968 by H. Van Langen; subm. by T. F. Kehoe, Milwaukee Public Mus., Milwaukee, Wisconsin.

Jefferson County series (47JE244)

Samples from the Crescent Bay Hunt Club site, an Oneota component on Lake Koshkonong, Jefferson Co., Wisconsin (42° 53′ N Lat, 89° 00′ W Long) coll. 1968 by D. A. Baerreis.

WIS-346. Crescent Bay Hunt Club site (47JE244) **760 ± 50**
A.D. 1190

Charcoal from Feature 1.

WIS-348. Crescent Bay Hunt Club site (47JE244) **800 ± 50**
A.D. 1150

Charcoal from Feature 10.

WIS-358. Crescent Bay Hunt Club site (47JE244) **780 ± 50**
A.D. 1170

Charcoal from Feature 6.

WIS-382. Crescent Bay Hunt Club site (47JE244) **810 ± 50**
A.D. 1140

Charcoal from Feature 9.

C. Nebraska

Mowry Bluff site, Nebraska (25FT35)

Charcoal excavated 1967 by W. R. Wood, Univ. of Missouri, from Mowry Bluff site at Frontier Co., Nebraska (40° 22′ 30″ N Lat, 100° 13′ 12″ W Long); subm. by D. A. Baerreis. Site is of Upper Republican affiliation.

790 ± 55
WIS-318. Mowry Bluff site (25FT35) **A.D. 1160**

Sample from Feature 19, wall post from W house wall.

770 ± 55
WIS-319. Mowry Bluff site (25FT35) **A.D. 1180**

Charcoal from Feature 32.

930 ± 60
WIS-324. Mowry Bluff site (25FT35) **A.D. 1020**

Charcoal from Feature 45, center post of House 1.

D. Kansas

860 ± 55
WIS-326. Nuzum site, Kansas (14DP10) **A.D. 1090**

Charred wood from Nuzum site, Nebraska culture site, Doniphan Co., Kansas (39° 56′ 20″ N Lat, 95° 15′ 02″ W Long). Coll. 1967 by W. R. Wood; subm. by D. A. Baerreis. Sample from House 1, from fill of Feature 3, large charred post.

E. Oklahoma

McCurtain focus, McCurtain County (Mc-8 and Mc-104)

McCurtain focus in SE Oklahoma is quite similar to remains designated in Texas as Texarkana focus but is thought to represent a slightly earlier period (Bell and Baerreis, 1951). The Clement site (Mc-8) (*ibid.*, p. 53-55) is one of type sites of culture.

490 ± 55
WIS-327. Clement site, Oklahoma (Mc-8) **A.D. 1460**

Charred corn cob from Clement site, McCurtain Co., Oklahoma (34° 03′ N Lat, 95° 55′ W Long). Sample from Mound area, Grid I, Sq. 25:9, Layer 2, 64 in. deep. Coll. 1941 and subm. by D. A. Baerreis. Date includes correction of 200 yr for C^{13}/C^{12} isotopic fractionation (Bender, 1968).

WIS-248. Woods Mound Group, Oklahoma (Mc-104) **430 ± 55**
A.D. 1520

Sample from Woods Mound Group, McCurtain Co., Oklahoma (34° 18′ N Lat, 94° 41′ W Long). Charcoal from post which is part of rectangular, with rounded corners and extended entranceway, house pattern found under Mound B. Two dates were previously reported for this site, A.D. 1240 ± 80 (GaK-901) and A.D. 1791 ± 147 (SM-888), latter thought to be in error (Bell, 1968).

Cooper sites (DL-48 and DL-49)

Charcoal from Cooper site, Delaware Co., Oklahoma (36° 35′ N Lat, 94° 50′ W Long). Coll. 1939 and subm. by D. A. Baerreis. DL-33 and DL-49, for which dates were previously obtained are Middle Woodland components of Hopewellian affiliation. Earlier dates from this site reported (Radiocarbon, 1969, v. 11, p. 228-235) were WIS-307, -309, and -313, A.D. 970, 1270, and 110, respectively. DL-48 (D1CoVI) is nearby rock shelter containing both earlier and later occupations in addition to Middle Woodland zone. Dates for the Hopewellian occupation seem to be both too early and too recent for culture. Perhaps discrepant dates are due to storage of charcoal for 30 yr without protection from contamination.

3410 ± 70
WIS-372. Cooper site (DL-49) 1460 B.C.

Sample 1532 fom NE 11:6, Level 5, 20 to 24 in. deep.

700 ± 50
WIS-379. Cooper site (DL-48) A.D. 1250

Sample 379 from Sq 3:6, Level 10, 36 to 40 in. deep.

3000 ± 65
WIS-380. Cooper site (DL-48) 1050 B.C.

Sample 530 from Sq 2:3, Level 23, 88 to 92 in. deep.

2970 ± 60
WIS-385. Cooper site (DL-48) 1020 B.C.

Sample 1186 from Sq. 2:4, Level 28, 108 to 112 in. deep.

F. Illinois

Cahokia site, Monk's Mound

Wood charcoal from Monk's Mound Cahokia site, Madison Co., Illinois (38° 40′ N Lat, 90° 04′ W Long). Coll. 1967 and 1968 and subm. by M. Fowler, Univ. of Wisconsin-Milwaukee.

690 ± 55
WIS-359. Cahokia, Monk's Mound A.D. 1260

Sample 67-386 from stockade, log assoc. with trench 40 to 70 cm deep at E461.64-461.70, N336.80.

690 ± 50
WIS-362. Cahokia, Monk's Mound A.D. 1260

Charcoal from Feature 104, burned clay floor underneath small mound on SW corner of 1st terrace of Monk's Mound. Sample 68-459 from E112-114, N70-72, elev. 138.58 m.

840 ± 55
WIS-365. Cahokia, Monk's Mound **A.D. 1110**

Wood charcoal, probably oak, from Post 2 in Feature 114, burned structure which underlies small mound on SW corner of 1st terrace of Monk's Mound. Post was standing upright in wall trench and had broken off when structure collapsed. Burned structure predates "primary" mound and post dates series of unburned living surfaces and possible post pit. Sample 68-1015 from N63.45-63.62, E100.54-100.66, 160 cm deep at N62E102.

890 ± 55
WIS-366. Cahokia, Monk's Mound **A.D. 1060**

Charcoal from post assoc. with trench, 100 cm deep. Sample 68-770 from E159.60-159.74, S604.38-604.50.

845 ± 45
WIS-334. Divers site (MO-28) **A.D. 1105**

Specimen DC 14, outer 10 rings of charred post from NE wall of Feature 1, rectangular wall-trench house at Divers site, Monroe Co., Illinois (38° 27′ 42″ N Lat, 90° 15′ 25″ W Long). Site is Mississippian variant in Lundsford-Pulcher areas of American Bottoms. Date should provide lower limit for Old Village phase in Cahokia area. Coll. 1968 by Glen A. Freimuth; subm. by James Porter, both Univ. of Winnipeg, Winnipeg, Canada.

II. GEOLOGIC SAMPLES

A. Wisconsin

Schimelpfenig Bog series, Dane County, Wisconsin

Samples excavated 1967 from marl layer underlying peat deposit on Elmer Schimelpfenig farm, Dane Co., Wisconsin (43° 04′ 45″ N Lat, 89° 04′ 45″ W Long). Coll. by J. E. Dallman, Univ. of Wisconsin-Madison; subm. by D. A. Baerreis. Dates on mastodon bones and wood obtained in this excavation have been reported previously (Radiocarbon, 1968, v. 10, p. 475).

11,720 ± 140
WIS-305. Schimelpfenig Bog, Wisconsin **9770 B.C.**

Snail shells (*Gyraulus parvus* [Say]) from Sec. III, 38 to 40 in. deep. Outer 15% of shell removed by acid leaching.

12,870 ± 125
WIS-338. Schimelpfenig Bog, Wisconsin **10,920 B.C.**

Organic clay from Col. IV, 66 to 68 in. deep. Date is minimum for deglaciation and is comparable to WIS-48 (Radiocarbon 1965, v. 7, p. 407).

4270 ± 70
WIS-339. Jefferson County, Wisconsin **2320 B.C.**

Black homogeneous peat from ca. 300 cm deep in spring mound, very near base of organic deposit. Mound rises above glacio-lacustrine plain and is built around artesian spring in Jefferson Co., Wisconsin

(42° 52′ N Lat, 88° 46′ W Long). Possibly dates drainage of lake. Coll. 1968 by F. Byrne, Univ. of Wisconsin-Green Bay; subm. by R. A. Bryson.

WIS-381. Jefferson County, Wisconsin **8540 ± 85** **6590 B.C.**

Plant detritus and black muck at depth 8 ft below peat of spring mound that has been built to height 8 or 9 ft above glacio-lacustrine plain on which it lies in Jefferson Co., Wisconsin (42° 52′ N Lat, 88° 46′ W Long). One of a number of like mounds id. in this general area, all developed on glacio-lacustrine floors. Coll. 1969 by F. Byrne; subm. by R. A. Bryson.

Lake Mary and Stewart's Dark Lake, Wisconsin

Sediment cores from centers of 2 meromictic lakes in Wisconsin, Stewart's Dark Lake (45° 18′ N Lat, 91° 27′ W Long) and Lake Mary (46° 15′ N Lat, 89° 54′ W Long) obtained in 1962 by G. Likens, Dartmouth College, Hanover, New Hampshire; subm. by R. A. Bryson. Samples were dated to determine time of initiation of sedimentation in these meromictic lakes for which chemical analyses and diatom profiles have been reported (Likens, 1967). Complete pollen analyses are being undertaken for both these cores.

WIS-371. Lake Mary, Wisconsin **9460 ± 100** **7510 B.C.**

Sample from 186 to 201 cm interval in 248 cm core, just above till-lake sediment interface.

WIS-373. Stewart's Dark Lake, Wisconsin **10,280 ± 105** **8330 B.C.**

Sample from 603 to 612 cm level of 630 cm core; 613 to 630 cm level of core was glacial till.

WIS-342. Wingra Fen, Wisconsin **8590 ± 110** **6640 B.C.**

Brown marl, sand, and organic matter with snail shells from Wisconsin Arboretum, 0.2 mi S of SW shore of Lake Wingra, Dane Co., Wisconsin (43° 03′ N Lat, 89° 26′ W Long). Coll. 1968 by R. A. Bryson, R. L. Steventon, and T. Webb, Univ. of Wisconsin-Madison; subm. by R. A. Bryson. Sample 1.7 to 1.8 m deep, 5 cm above pure white sand. Dates beginning of peat growth after lowering of level of Lake Wingra.

WIS-353. Lake Mendota, Wisconsin **Modern**

85 to 95 cm portion of 95 cm core from Lake Mendota, Madison, Wisconsin (43° 07′ N Lat, 89° 36′ W Long). Material was dated to obtain a sedimentation rate (Murray, 1956) and hopefully date for beginning of cultural influence on drainage of Lake Mendota. Coll. 1966 by G. F. Lee and G. Bortelson, Univ. of Wisconsin-Madison; subm. by R. A. Bryson.

12,410 ± 100
WIS-347. Mequon, Wisconsin **10,460 B.C.**

Larix root wood (id. by Forest Products Lab., Madison, Wisconsin) from 15 cm thick wood and peat layer contained within 3 m thick clay sequence that rested on glacial outwash (sand and gravel). Wood thought to represent deposit of Two Creeks age near terminal moraine of Valders ice. Sample from SW wall of sand pit, Mequon, Wisconsin (43° 15′ N Lat, 88° 02′ W Long). Coll. 1965 by R. F. Black; subm. by L. J. Maher, Jr., Univ. of Wisconsin-Madison.

B. Louisiana

Investigations of Late Quaternary vegetational and climatic history of sites through North America were continued. Louisiana was searched for deep fossil organic accumulations which might allow comparisons with studies in Canada (Nichols, 1967), but deposits were shallow, largely minerogenic, and represented only short periods of Holocene. These materials were sampled with a modified Hiller-type borer which allowed removal of intact 4 cm diam. cores, 50 cm long, for examination in lab. Boring ceased when organic clays and silts became too stiff to penetrate. The deposits were waterlain; the reason for decreased organic content at their bases is unknown.

3750 ± 65
WIS-340. Lake Peigneur, Louisiana **1800 B.C.**

Organic silt from boring 220 to 230 cm deep of marshy edge of Lake Peigneur, Louisiana (29° 59′ N Lat, 92° 59′ W Long). Coll. 1966 by H. Nichols and R. L. Steventon, Univ. of Wisconsin-Madison; subm. by H. Nichols. Pretreatment by acid only.

1710 ± 55
WIS-341. Big Woods Island, Louisiana **A.D. 240**

Wood peat with clay 180 to 190 cm below modern surface of swamp at Big Woods I., near Esther, Louisiana (29° 51′ N Lat, 92° 11′ W Long). Coll. 1966 by H. Nichols and R. L. Steventon; subm. by H. Nichols. Acid pre-treatment only.

C. Iowa

Amos Ross site, Iowa (13PM16)

Samples coll. at Amos Ross site, Plymouth Co., Iowa (42° 37′ 30″ N Lat, 96° 06′ 30″ W Long) and subm. 1968 by R. A. Bryson.

2140 ± 60
WIS-322. Amos Ross site (13PM16) **190 B.C.**

Black walnut (id. by B. F. Kukachka, Forest Products Lab.) from one of many stumps *in situ* rooted in paleosol ca. 10 ft up side of deep gully. Stump buried under ca. 20 ft of silt with well-developed soil horizons. Stratigraphy very similar to that reported by Daniels *et al.* (1963) for Harrison Co., Iowa. Stratigraphic position and date agree with W-702, 2020 B.P. (Radiocarbon, 1960, v. 2, p. 145), at base of Hatcher formation.

2240 ± 65
WIS-332. Amos Ross site (13PM16) **290 B.C.**

Charcoal from 12 ft below modern surface. Date indicates wood probably from branches of black walnut, stumps of which were found 8 ft below.

D. Colorado

8890 ± 90
WIS-349. Molas Lake Bog **6940 B.C.**

Detritus gyttja with wood fragments from bog 0.6 km S of S entrance to Molas Lake, San Juan Co., near Silverton, Colorado (37° 45′ N Lat, 107° 41′ W Long). Site in subalpine vegetation zone of San Juan Mts. at elev. + 3230 m. Sample from lowest organic sediments, 122 to 132 cm below modern surface, lay on cobbles and boulders of glacial origin. Plant remains in sample indicated aquatic environment when sediments accumulated. Should date retreat of local glacial ice. Wood at 60 to 70 cm depth, LJ-539, dated as 2990 ± 300 B.C. (Radiocarbon, 1963, v. 5, p. 271). Coll. 1960 and subm. by L. J. Maher, Jr., Univ. of Wisconsin-Madison.

E. Canada

Additional samples obtained from the base of peat bogs to provide minimum dates for deglaciation or start of ombrogenous peat growth (see Radiocarbon, 1968, v. 10, p. 477; Bryson and Wendland, 1967; and Nichols, 1969).

4030 ± 75
WIS-323. Telford, Ontario **2080 B.C.**

Exposed peat bank sampled by digging pit down to base. Total of ca. 350 cm peat over black and then blue clay with what appeared to be lake sands intercalated in upper horizons of peat. Sample 346 to 348 cm below modern peat surface. May represent withdrawal of Lake Agassiz from site. From Telford, near Kenora, Ontario (49° 51′ N Lat, 95° 24′ W Long). Coll. 1967 and subm. by H. Nichols.

610 ± 60
WIS-329. The Bog at The Pas, Manitoba **A.D. 1340**

Very coarse oxidized woody fen peat, 142 to 147 cm below modern surface, immediately overlying marl. Coll. 1967 by R. A. Bryson and H. Nichols at The Bog, near The Pas, Manitoba (53° 15′ N Lat, 101° 06′ W Long); subm. by H. Nichols.

3550 ± 65
WIS-343. Entwhistle, Alberta **1600 B.C.**

Black, crumbly, oxidized necron mud containing charcoal and 5 mm band of volcanic ash 154 to 156 cm below modern surface of peat bog at Entwhistle, Alberta, Canada (53° 35′ 30″ N Lat, 114° 54′ 20″ W Long). Lowest organic sample (silty clay begins at 158 cm) dates start of organic deposition in lake and dates volcanic ash horizon. Coll. 1968 by H.

Nichols, Univ. of Wisconsin-Madison, and J. A. Westgate, Univ. of Alberta, Edmonton; subm. by H. Nichols.

F. Northwest Territories, Canada

Twin Lakes, Inuvik, N.W.T.

Col. of peat, 410 cm deep, overlying gray clay, obtained in 1967 from Twin Lakes, Inuvik, Dist. of Mackenzie, N.W.T., Canada (68° 22′ N Lat, 132° 42′ W Long). Sec. exhibited apparently horizontally continuous alternating layers of fibrous peat and *Sphagnum* mosses. Previous sample of peat from bottom of this bog (Mackay, 1963) was dated at 8200 ± 300 B.P., GSC-25 (Radiocarbon, 1962, v. 4, p. 20). Coll. 1967 and subm. by J. C. Ritchie, Dalhousie Univ., Halifax, Nova Scotia.

5420 ± 70
WIS-279. Twin Lakes, Inuvik, N.W.T. **3470 B.C.**

Sphagnum peat from 50 to 60 cm depth.

5840 ± 65
WIS-291. Twin Lakes, Inuvik, N.W.T. **3890 B.C.**

Fibrous woody peat from 120 to 130 cm depth.

7220 ± 80
WIS-310. Twin Lakes, Inuvik, N.W.T. **5270 B.C.**

Woody, fibrous sedge peat from 270 to 290 cm below modern surface.

G. Peru

Salinillas Lagoon

Excavations in midden on coastal cliff 6 m above modern sea level at Salinillas Lagoon, Salinas de Otuma, State of Ica, Peru (14° 00′ S Lat, 76° 15′ W Long) carried out 1968 and subm. by N. Psuty, Univ. of Wisconsin-Madison.

3550 ± 65
WIS-321. Salinillas Lagoon **1600 B.C.**

Charcoal from hearth at surface of midden. Date should indicate near-terminal date for occupation of site and for change in ecologic environment of lagoon as result of uplift of coast.

3650 ± 65
WIS-325. Salinillas Lagoon **1700 B.C.**

Shell (*Pecten purpuratus*) from lowest layer of midden, ca. 2 ft from surface. Outer 20% of shell removed by acid leaching. C^{14} content of shells from Peru coast is depleted by 3.5 to 8.5% compared to NBS standard (Taylor and Berger, 1967). δC^{13} compared to PDB standard +0.2‰.

580 ± 60
WIS-330. Salinillas Lagoon **A.D. 1370**

Shell (Pecten purpuratus) stranded on marine abrasion platform which rings Salinillas Lagoon. Because of C^{14} depletion in shells from this area (Taylor and Berger, 1967), we interpret the date as representing recent, rapid uplift of Otuma embayment. Undisturbed condition of valves suggests shell zone was not subjected to intense wave abrasion. Outer 20% of shell removed by acid leaching. δC^{13} compared to PDB standard −0.4‰.

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