

**NATIONAL PHYSICAL LABORATORY RADIOCARBON  
MEASUREMENTS IV**

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The following list comprises measurements made since those reported in NPL III and is complete to the end of November 1965.

Ages are relative to A.D. 1950 and are calculated using a half-life of 5568 yr. The measurements, corrected for fractionation (quoted  $\delta C^{13}$  values are 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 derived from a proper combination of the parameter variances as described in detail in NPL III. These variances are those of the standard and background measurements over a rolling twenty week period, of the sample  $\delta C^{14}$  and  $\delta C^{13}$  measurements and of the de Vries effect (assumed to add an additional uncertainty equivalent to a standard deviation of 80 yr). Any uncertainty in the half-life has been excluded so that relative  $C^{14}$  ages may be correctly compared. Absolute age assessments, however, should be made using the accepted best value for the half-life and the appropriate uncertainty then included. If the net sample count rate is less than 4 times the standard error of the difference between the sample and background count rates, a lower limit to the age is reported corresponding to a net sample count rate of 4 times the standard error of this difference.

The description of each sample is based on information provided by the person submitting the sample to the laboratory.

The work reported forms part of the research program of the National Physical Laboratory and is published by permission of the Director of the Laboratory.

I. ARCHAEOLOGIC AND GEOLOGIC SAMPLES

*A. England*

	<b>2480 ± 90</b>
<b>NPL-104. Cow Down I. Wiltshire</b>	<b>530 B.C.</b>

Wood charcoal (*Q. robur*) from post hole, probably from post itself, of house of Late Bronze Age or very Early Iron Age at Cow Down (51° 10' N Lat, 2° 10' W Long), Longbridge Deverhill, nr. Warminster, Wiltshire. Coll. 1958-60 by S. Hawkes; subm. by L. Biek, Ministry of Public Bldg. and Works. *Comment* (L.B.): although the associated pottery has remarkable affinities to French Bronze Age types of 8th-7th century B.C., result in fact confirms excavators' estimate of time occupation of this house.  $\delta C^{13} = -25.0\%$ .

	<b>+1850</b>
	<b>8570 -1500</b>
<b>NPL-72. Mockerkin Tarn, West Cumberland</b>	<b>6620 B.C.</b>

Wood fragment (probably *Betula pubescens*) from pollen zone

boundary VIIa/b of lake deposit, 270 cm below mud surface, Mockerkin Tarn (54° 35' N Lat, 3° 25' W Long), West Cumberland. Coll. 1963 and subm. by W. Tutin, Univ. of Leicester. *Comment* (W.T.): result is more than 3000 yr greater than expected from sample position in profile. This discourages use of fragments of allochthonous organic matter as dating material (Clark and Godwin, 1962).

8580 +830  
-755

**NPL-86. Teignmouth, Devonshire**

6630 B.C.

Peat from layer 5 cm thick underlying 74 cm of estuarine clay and 100 cm of sand off English Channel seaboard near Teignmouth (50° 31' 30" N Lat, 3° 25' 00" W Long), Devonshire, England. Coll 1964 and subm. by R. H. Clarke, Univ. of Bristol. *Comment* (R.H.C.): pollen analyses place sample at beginning of Zone VIa which with this C<sup>14</sup> measurement substantiates assignment of Late Glacial-Postglacial (Flandrian) age to these submerged estuarine deposits. Sample lies approx. -78 ft O.D. and apparently underlain by a (terrestrial) soil, thus appearing to represent onset of brackish water at that point. Present tidal range at Teignmouth is 12.7 ft (Springs), so mean sealevel at that time was therefore approx. 85 ft. This agrees well with published information on Postglacial eustatic rise in sealevel (Godwin *et al*, 1958).

**NPL-87. Brandon Terrace, Warwickshire**

28,200 ± 500  
26,250 B.C.

Twigs and leaves (*B. nana*) washed from vegetable debris in thin peat layer underlying 13-ft thick gravel deposit of Avon No. 2 terrace at Brandon (52° 22' 30" N Lat, 1° 26' 00" W Long), Warwickshire. Coll. 1964 and subm. by F. W. Shotton, Univ. of Birmingham. *Comment* (F.W.S.): sample was rolled mass from channel of peaty silts under 12 ft gravel belonging to Avon No. 2 river terrace. Insect fauna indicates cold conditions, and a peat with similar fauna and in same basal position from same terrace at Fladbury (Worcs.) gave age of 38,000 ± 700 (GRO-1269). Brandon sample is therefore younger than expected but this might be result of a long period of alluviation progressively upstream.  $\delta C^{13} = -25.0\text{‰}$ .

**NPL-88. Austerfield, Yorkshire**

>41,200

Wood fragments from peaty layer at depth of 6 ft 6 in. at Austerfield gravel pit (53° 27' 22" N Lat, 0° 59' 47" W Long), Yorkshire. Coll. 1964 and subm. by G. D. Gaunt, Geol. Surv. & Mus. *Comment*: it was hoped that measurement would provide useful information on which to base mapping of Humber basin deposits, hitherto estimated as Fluvio-glacial.  $\delta C^{13} = -25.0\text{‰}$ .

**NPL-99. Isleworth 2 Middlesex**

>42,900

Stem fragments in silt at base of gravels comprising a low terrace of the Thames at Isleworth (51° 27' 30" N Lat, 0° 20' 00" W Long), Mid-

dlex. Coll. 1959 and subm. by F. W. Shotton, Univ. of Birmingham. *Comment:* sample derived from deposit of organic silt underlying sands and gravels which produced numerous bones of bison and reindeer. Structure of gravels and enclosed fauna indicated cold conditions. Stratigraphy of gravels indicated that they were deposited at some time during Last (Weichselian or Würm) Glaciation. Insects from plant beds indicate temperate conditions and may thus have lived either during Last (Eemian) Interglacial or an interstadial in Last Glaciation (NPL-34, NPL II).  $\delta C^{13} = -25.0\%$ .

### Romney Marsh series, Kent

Samples from clay and peat deposits at Scotney Court Farm (50° 57' N Lat, 00° 54' E Long), Lydd, Romney Marsh, Kent. Coll. 1964 and subm. by R. D. Green, Rothamsted Expt. Stn. *Comment:* NPL-91 establishes latest possible date for development of older parts of shingle beach complex of Dungeness. Roots of NPL-92 were clearly *in situ* and were certainly present before overlying clay sediments were deposited. Result suggests roots to be approx. contemporary with peat elsewhere in Romney Marsh (NPL-23, NPL II) and, with age of NPL-91, implies this thin peat not to be sedimentary but all *in situ*. Thus associated shingle ridges may not be "the shore formed when sealevel rose to near the present and drowned the 25 ft submerged forest", as previously suggested (Lewis and Balchin, 1940).

**2050 ± 90**

#### NPL-91. Scotney Court Farm 1

**100 B.C.**

Peat from layer 2 in. thick, at depth of 48 in. overlying clay deposit with roots (NPL-92).  $\delta C^{13} = -27.0\%$ .

**2740 ± 400**

#### NPL-92. Scotney Court Farm 2

**790 B.C.**

Roots from clay deposit, 30 in. thick, at depth of 50 in. underlying thin peat layer (NPL-91).

### Channel Borehole series

Drift deposits from Channel Tunnel Site Investigation borehole P.040 (P3) (51° 06' 04" N Lat, 01° 24' 08" E Long), beneath sea bed -34.7 m N.G.F. (-113 ft O.D.) occupying shallow sinuous valley on submerged dip slope of Middle Chalk (Turonian) inclined gently to NNE. Coll. 1964 by Wimpey; subm. by E. R. Shephard-Thorn, Geol. Survey and Mus. *Comment* (E.R.S.T.): date for NPL-103 falls in pollen Zone III, that for NPL-101 in Zone IV, implying deposits to span conventionally accepted Late Glacial-Holocene boundary. Palynological evidence confirms this conclusion. In both samples tree pollen is dominated by pine and birch, but NPL-103 has higher proportion of herbaceous pollen; neither sample contains evidence of marine or estuarine deposition. Age and depth of deposits confirm that they predate Lower

Peat of the Netherlands (Jelgersma, 1961), and that there has since been a minimum relative sealevel rise of 120 ft; they also indicate their comparability with deeper moorlogs of North Sea (Godwin 1943, 1945, 1960).

**NPL-101. Borehole P3 Sample A** **9920 ± 120**  
**7970 B.C.**

Peat from layer 1 ft thick, underlying 5 ft of medium gravel from sea bed surface.  $\delta C^{13} = 25.0\%$ .

**NPL-103. Borehole P3 Sample B** **10,530 ± 120**  
**8580 B.C.**

Peat clay from layer 3 ft thick immediately underlying NPL-101.  $\delta C^{13} = -25.0\%$ .

*B. Scotland*

**Scottish Highland series**

This series of samples from east-central Highlands represents sites of both hill (NPL-94, 95) and basin (NPL-96, 111, 112) peat formation. Results support current view, suggested from palynological data, that the latter were first to begin formation (Synge, 1956). All samples coll. 1964 and subm. by J. M. Stewart, Macaulay Inst. for Soil Res.

**NPL-94. Cruden 1 Aberdeenshire** **5020 ± 95**  
**3070 B.C.**

Amorphous peat from organic-mineral interphase at depth of 125 cm, 450 ft O.D. at Cruden ( $57^{\circ} 27' 12''$  N Lat,  $1^{\circ} 57' 6''$  W Long), Aberdeenshire Scotland.  $\delta C^{13} = -25.0\%$ .

**NPL-95. Cairn o Mount, Kincardineshire** **4040 ± 95**  
**2090 B.C.**

Amorphous peat from organic-mineral interphase at depth of 237 cm, 1470 ft O.D. at Cairn a Mount ( $56^{\circ} 55' N$  Lat,  $2^{\circ} 34' W$  Long), Kincardineshire, Scotland.  $\delta C^{13} = -21.0\%$ .

**NPL-96. Slack Burn, Kincardineshire** **7220 ± 235**  
**5270 B.C.**

Amorphous peat from organic-mineral interphase at depth of 810 cm, 1400 ft O.D. at Slack Burn ( $56^{\circ} 55' 30''$  N Lat,  $2^{\circ} 33' 0''$  W Long), Kincardineshire, Scotland.  $\delta C^{13} = -22.3\%$ .

**NPL-111. Candyglirach, Aberdeenshire** **9000 ± 135**  
**7050 B.C.**

Amorphous peat from organic-mineral interphase at depth of 505 cm, 250 to 275 ft O.D. at Candyglirach ( $57^{\circ} 06' 12''$  N Lat,  $02^{\circ} 25' 00''$  W Long). Aberdeenshire, Scotland.  $\delta C^{13} = -27.0\%$ .

**NPL-112. Cruden 2 Aberdeenshire** **5580 ± 100**  
**3630 B.C.**

Amorphous peat from organic-mineral interphase at depth of 206 cm, 350 to 400 ft O.D. at Cruden ( $57^{\circ} 27' 18''$  N Lat,  $01^{\circ} 57' 06''$  W Long), Aberdeenshire, Scotland.  $\delta C^{13} = -30.4\%$ .

## C. Wales

37,310 <sup>+1515</sup>  
 -1275

**NPL-97. Tre-Llys, North Pembrokeshire**

35,360 B.C.

Marine shell from gravel pit at Tre-Llys (51° 57' 45" N Lat, 5° 4' 25" W Long), nr. St. Nicholas, Fishguard, North Pembrokeshire, 200 ft O.D. Coll. 1964 and subm. by B. S. John, Univ. of Oxford. *Comment* (B.S.J.): this date and NPL-80 (37,960 <sup>+1700</sup> -1400, NPL III) relate to outwash gravels laid down during melting of last Irish Sea ice sheet and indicate that gravels of so-called "South Wales End-moraine" of N Pembrokeshire are no younger than glacial deposits found 18 mi further S. Evidence suggests that interstadial boreal conditions persisted in Irish Sea 38,000 yr B.P. and that Last Glaciation of W Wales followed this interstadial phase, possibly as equivalent of European Main Würm glaciation (John, 1965; West, 1963; Mitchell, 1960; Zeuner, 1959; Charlesworth, 1929).  $\delta C^{13} = -8.2\%$ .

**NPL-98. Aber-Mawr, North Pembrokeshire**

>40,300

Wood (probably *Pinus* sp) from calcareous boulder clay at Aber-Mawr (51° 57' 40" N Lat, 5° 5' 30" W Long), nr. St. Nicholas, Fishguard, N Pembrokeshire. Coll. 1964 and subm. by B. S. John, Univ. of Oxford. *Comment* (B.S.J.): stratigraphic evidence suggests that this Irish Sea till is no older than shelly outwash at Mullock Bridge (NPL-80 37,960 <sup>+1700</sup> -1400, NPL III) and Tre-llys (NPL-97) (Mitchell, 1960; Syngé, 1961; Syngé and Stevens, 1960; West, 1963; John, 1965).

## D. Canada

6760 ± 140

**NPL-82. R. aux-Roches Valley, Quebec**

4810 B.C.

Shell (*Mya truncata* and *Hiatella arctica*) from side of A2 terrace at 148 ft O.D. in N bank R. aux-Roches Valley (62° 02' N Lat, 74° 32' W Long), near Deception Bay, Quebec, Canada. Coll. 1962 and subm. by Barry Matthews, McGill Univ. *Comment* (B.M.): as sample was obtained from the only marine deposit found 8 mi inland from Deception Bay, date suggests a valley glacier prevented incursion of sea into R. aux-Roches valley until well into "postglacial" times.  $\delta C^{13} = -6.8\%$ .

6660 ± 125

**NPL-83. R. Renard-Noir Valley, Quebec**

4710 B.C.

Marine shell (*Hiatella arctica*, *Mya truncata*, *Balanus balanus*, *Clinocardium ciliatum*) from silt polygons immediately below scarp of 237/248 ft raised beach remnant, N side of R. Renard-Noir Valley (62° 07' N Lat, 74° 38' W Long), Deception Bay, Quebec, Canada. Coll. 1962 and subm. by Barry Matthews.  $\delta C^{13} = -5.2\%$ .

**NPL-84. R. Renard-Noir Valley, Quebec****6660 ± 130  
4710 B.C.**

Marine shell (*Hiatella arctica*, *Mya truncata*, *Macoma balthica*, *Macoma calcarea*), from 242 ft raised beach, S side of R. Renard-Noir Valley (62° 07' N Lat, 74° 38' W Long), Deception Bay, Quebec, Canada. Coll. 1962 and subm. by Barry Matthews. *Comment* (B.M.): despite difference of 47 ft in altitude and differing percentages of various mollusc species, deposits represented by NPL-83 and this sample appear to have formed at about same time but probably in different depths of water. Comparative richness of marine fauna in 242 ft deposit might indicate a warming of sea at ca. 6700 yr ago during early part of Hypsithermal Interval.  $\delta C^{13} = -5.1\%$ .

**NPL-85. R. Renard-Noir Valley, Quebec****6970 ± 125  
5020 B.C.**

Marine shell (*Hiatella arctica*, *Balanus* sp.) from sandy clay near surface of 297 ft raised beach, N side R. Renard-Noir Valley (62° 07' N Lat, 74° 38' W Long), Deception Bay, Quebec, Canada. Coll. 1962 and subm. by Barry Matthews. *Comment* (B.M.): although age is much younger than expected in view of previous determination of 10,450 ± 250 B.P. (I-488, Isotopes, Inc., unpub.) obtained from same raised beach, it is similar to other  $C^{14}$  dates (I-729, I-726, Isotopes, Inc., unpub.) of material from near post-glacial marine limit in northern Ungava. Considerable doubt is now cast on theory that Hudson Strait was free from ice during classical Wisconsin Maximum (Ives, 1963) or even 10,500 yr ago. It is also doubtful if E-W warping of raised marine beaches below 300 ft O.D. occurred during postglacial isostatic uplift since shells from a raised marine beach at a similar elevation but 100 mi to W at Wolstenholme are of comparable age, i.e. 6900 ± 130 yr B.P. (NPL-58, NPL III) (Matthews, 1964, 1963, 1962; Farrand and Gadjia, 1962).  $\delta C^{13} = -1.9\%$ .

*E. Egypt***NPL-5. Tarkhan, interlaboratory check****4310 ± 90  
2360 B.C.**

Linen from 1st Dynasty mastaba (2050) at Tarkhan (29° 40' N Lat, 31° 13' E Long), near Cairo, Egypt. Material from W. M. Flinders Petrie Colln., Univ. College of London, is securely dated to Wadji, fourth king of this dynasty. Sample was measured at UCLA-739, 4265 ± 80, UCLA IV; descr. by Flinders Petrie (1914).  $\delta C^{13} = -25.0\%$ .

II. ATMOSPHERIC CO<sub>2</sub> MEASUREMENTS**NPL-90. Sizewell, Suffolk**

$\delta C^{14}\%$	$\delta C^{13}\%$	$\Delta\%$
<b>907 ± 13</b>	<b>-12.0 ± 1</b>	<b>857 ± 13</b>

Atmospheric CO<sub>2</sub> from Sizewell (52° 12' 30" N Lat, 1° 34' 00" W Long), Suffolk. Coll. July to October 1964 by F. E. Bentley; subm. by B. C. Godbold, Esq.

**NPL-100. Berkeley, Gloucestershire**       $\delta C^{14}\text{‰}$        $\delta C^{13}\text{‰}$        $\Delta\text{‰}$   
**882 ± 17**      **-11.8 ± 1**      **832 ± 17**

Atmospheric CO<sub>2</sub> from Berkeley (51° 41' N Lat, 2° 28' W Long), Gloucestershire. Coll. Autumn 1964 by K. E. White; subm. by B. C. Godbold, Esq.

### III. REFERENCE MEASUREMENT

**NPL-3. Heidelberg Sodium Carbonate Standard 10.224 = 0.033**

Labeled sample H-522 distributed by K. O. Munnich. Result given is ratio of activity of this sample to 95% of oxalic acid standard.  $\delta C^{13} = -9.8\text{‰}$ .

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