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GLASGOW UNIVERSITY RADIOCARBON MEASUREMENTS VI

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INTRODUCTION

The following list presents results obtained during 1970-1971 and is a continuation of research of which data have been pub. previously (Baxter *et al.*, 1969; Ergin *et al.*, 1970; Baxter and Walton, 1970; Harkness and Walton, 1972; Ergin *et al.*, 1972). The major research efforts at Glasgow are aimed at evaluation of (a) natural annual C^{14} levels and (b) burdens and residence times of artificial C^{14} in the environment and human tissues. The results of these studies are presented as δC^{14} and Δ values based on age-corrected activities, although this correction is very small. The errors quoted are counting uncertainties only, expressed at the 1σ level. Pretreatment procedures are outlined in the text and analytical methods are essentially unchanged. Gas proportional counting of both CO_2 and CH_4 is employed in 2.6L and 0.5L detectors, respectively. Mass spectrometric analyses are performed to a precision of 0.1‰ ($\pm 2\sigma$) on a V.G. Micromass 602B stable isotope mass spectrometer.

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SAMPLE DESCRIPTIONS

I. TREE-RING SAMPLES

A study of 19th century atmospheric C^{14} concentrations has begun through analyses of annual rings of Oak (*Quercus robur*) planted in 1810 (felled 1970) in Russell's Enclosure, Forest of Dean (51° 48′ N Lat, 2° 37′ W Long), Gloucestershire, England. Rings id. by calendar yr by F. S. Walker with J. M. Fletcher, Research Lab. for Archaeol. and History of Art, Oxford. Wood of each ring was split into thin shavings, extracted with 40/60 petroleum ether, and bleached to yield the pure cellulose fraction. The cellulose was charred at 500°C prior to combustion in the gas preparation system.

Tree rings, Forest of Dean series

Sample no.	Yr	$\delta C^{14}‰$	$\delta C^{13}‰$	$\Delta‰$
GU-381	1829	+2.0 ± 0.6	−23.4	+1.7 ± 0.6
GU-382	1830	+0.9 ± 0.5	−23.6	+0.6 ± 0.5
GU-383	1831	+1.4 ± 0.6	−24.1	+1.3 ± 0.6
GU-384	1832	+0.1 ± 0.6	−24.2	−0.1 ± 0.6
GU-385	1833	+0.8 ± 0.5	−24.3	+0.6 ± 0.5
GU-386	1834	−0.3 ± 0.8	−25.0	−0.3 ± 0.8
GU-387	1836	+2.0 ± 0.6	−23.6	+1.7 ± 0.6
GU-388	1838	+1.2 ± 0.5	−24.8	+1.2 ± 0.5
GU-389	1839	+0.2 ± 0.6	−24.7	+0.1 ± 0.6
GU-390	1840	+0.7 ± 0.5	−23.9	+0.5 ± 0.5
GU-391	1841	+0.6 ± 0.6	−24.0	+0.4 ± 0.6
GU-392	1842	−0.3 ± 0.6	−24.3	−0.5 ± 0.6
GU-393	1843	−0.7 ± 0.6	−24.6	−0.8 ± 0.6
GU-394	1844	−0.3 ± 0.5	−24.2	−0.5 ± 0.5
GU-395	1849	+0.2 ± 0.5	−23.4	−0.2 ± 0.5
GU-396	1850	+0.2 ± 0.6	−24.6	+0.1 ± 0.6
GU-397	1851	−0.3 ± 0.6	−25.0	−0.3 ± 0.6
GU-398	1852	−2.0 ± 0.6	−23.9	−2.2 ± 0.6
GU-399	1853	−2.8 ± 0.6	−25.3	−2.7 ± 0.6
GU-400	1854	−0.7 ± 0.6	−23.3	−1.0 ± 0.6
GU-401	1855	−0.5 ± 0.6	−23.3	−0.8 ± 0.6
GU-402	1856	−1.4 ± 0.5	−23.9	−1.6 ± 0.5
GU-403	1857	−0.5 ± 0.6	−24.5	−0.6 ± 0.6
GU-404	1858	+1.5 ± 0.6	−24.2	+1.3 ± 0.6
GU-405	1859	−0.3 ± 0.5	−24.2	−0.4 ± 0.5
GU-406	1860	−0.2 ± 0.5	−24.5	−0.3 ± 0.5
GU-407	1861	−0.1 ± 0.6	−24.4	−0.2 ± 0.6
GU-408	1862	+0.3 ± 0.6	−24.4	+0.2 ± 0.6
GU-409	1863	−1.3 ± 0.5	−23.4	−1.6 ± 0.5
GU-410	1864	−2.0 ± 0.6	−22.9	−2.4 ± 0.6
GU-411	1865	−0.6 ± 0.6	−23.8	−0.8 ± 0.6

Comment: these results suggest N hemisphere C^{14} activities fluctuated significantly on an annual basis from 1829 to 1865. Baxter and Walton (1971) previously reported significant annual variations for period 1890 to 1950 in N hemisphere.

II. VINTAGE WINE SAMPLES

The study of atmospheric C^{14} concentrations in past years through analyses of vintage wine samples (Baxter and Walton, 1970) was extended to S hemisphere. Several wine samples from Australia were analyzed. The grapes were picked in March of the year of production of each wine sample, after ca. 4 to 5 mos. on the vine.

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Vintage wine, Australia series

Sample no.	Yr	$\delta C^{14}‰$	$\delta C^{13}‰$	$\Delta‰$
GU-412	1919	−2.6 ± 0.5	−25.6	−2.5 ± 0.5
GU-413	1928	−1.6 ± 0.6	−26.4	−1.3 ± 0.6
GU-414	1933	−1.2 ± 0.5	−29.6	−0.3 ± 0.5
GU-415	1934	−2.8 ± 0.5	−27.4	−2.3 ± 0.5
GU-416	1936	−2.7 ± 0.5	−27.4	−2.2 ± 0.5
GU-417	1940	−3.5 ± 0.6	−26.9	−3.2 ± 0.6
GU-418	1944	−1.8 ± 0.5	−25.5	−1.7 ± 0.5

Comment: further measurements are being made on wheat seeds, oats, wines, and annual tree rings. Correction for industrial Suess effect will enable assessment of natural C^{14} fluctuations.

III. HUMAN TISSUE SAMPLES

The C^{14} activity in individual human tissues is being measured in specimens of varying age at time of death. Human tissue C^{14} measurements have already been obtained at this lab. (Harkness and Walton, 1972); the present study is a continuation of previous work using similar pretreatment and analytical procedures. Tissues were first washed with distilled water to remove external traces of blood, separated from fat, and homogenized; 15 to 25 mls distilled water were added, if necessary, before homogenizing. The resulting solution was freeze-dried and the product material combusted; 20 g of tissue yielded ca. 2 g to 5 g of dried material, the amount depending on the particular tissue. Bone samples were first cut into < 1 cm^3 pieces; fragments were boiled in 2M NH_4OH, which released marrow fat into the aqueous phase. Marrow fat was isolated by benzene extraction followed by solvent distillation. The remaining bone sample was digested in 2M HCl, during which, hydrolysis of the protein (collagen) fraction occurred. Collagen was obtained by evaporating the solution to dryness so that collagen was absorbed on the calcium phosphate residue which was combusted.

50-yr-old human tissues, series

Samples GU-419 to -423 from a 50-yr-old male who died Jan. 10, 1971 of cerebral haemorrhage.

Sample no.	Tissue	$\delta C^{14}‰$	$\delta C^{13}‰$	$\Delta‰$
GU-419	Liver	44.3 ± 0.8	−21.9	43.4 ± 0.8
*GU-420	Muscle	51.0 ± 1.2	−18.2	48.9 ± 1.2
GU-421	Testes	38.3 ± 1.0	−23.4	37.8 ± 1.0
*GU-422	Heart	53.3 ± 1.8	− 4.1	46.9 ± 1.8
GU-423	Kidney	45.1 ± 0.8	−24.0	44.8 ± 0.8

* Samples diluted with inactive CO_2.

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72-yr-old human tissues, series

Samples GU-424 to -434 from a 72-yr-old male who died March 24, 1971 of bronchial pneumonia.

Sample no.	Tissue	δC^{14}‰	δC^{13}‰	Δ‰
GU-424	Brain	47.0 ± 0.8	−21.5	46.0 ± 0.8
GU-425	Muscle	47.3 ± 0.9	−24.2	47.1 ± 1.0
GU-426	Pancreas	49.8 ± 0.8	−26.0	50.1 ± 0.8
GU-427	Lung	47.4 ± 0.9	−22.7	46.7 ± 0.9
GU-428	Spleen	47.8 ± 0.9	−22.1	46.9 ± 1.0
GU-429	Liver	49.4 ± 0.9	−22.5	48.7 ± 0.9
GU-430	Heart	47.1 ± 0.9	−21.8	46.2 ± 0.9
GU-431	Kidney	50.9 ± 0.8	−24.1	50.6 ± 0.8
GU-432	Testes	45.1 ± 0.9	−24.6	45.0 ± 0.9
GU-433	Marrow fat	47.7 ± 0.9	−27.1	48.3 ± 1.0
*GU-434	Collagen	8.2 ± 2.7	− 7.9	4.5 ± 2.9

* Sample diluted with inactive CO_2.

64-yr-old human tissues, series

Samples GU-435 to -440 from a 64-yr-old female who died June 2, 1971 of pulmonary embolism.

Sample no.	Tissue	δC^{14}‰	δC^{13}‰	Δ‰
GU-435	Muscle	47.9 ± 0.9	−24.0	47.6 ± 1.0
GU-436	Brain	47.3 ± 0.9	−24.9	47.3 ± 0.9
GU-437	Fat	45.7 ± 1.2	−25.0	45.7 ± 1.3
GU-438	Heart	41.7 ± 0.9	−22.2	40.9 ± 0.9
GU-439	Kidney	48.9 ± 0.9	−22.5	48.2 ± 1.0
*GU-440	Ovaries	46.0 ± 1.4	− 9.6	41.5 ± 1.4

* Sample diluted with inactive CO_2.

Comment: low Δ value for collagen agrees with previous results (Harkness and Walton, 1972; Libby *et al.,* 1964; Berger *et al.,* 1966) and indicates slow turnover rate. The Δ value for heart, GU-438, is abnormally low relative to other heart values. Although variations exist within and between series, brain and muscle data are generally consistent and may reflect turnover rates faster than in other tissues.

IV. ATMOSPHERIC SAMPLES

Monthly atmospheric samples from sampling stas. at Lerwick (60° 08′ N Lat, 01° 11′ W Long), Snowdon (53° 03′ N Lat, 04° 00′ W Long) and at Chilton (51° 31′ N Lat, 01° 20′ W Long) are being received at this lab. Although analysis of every sample is not possible at present, representative samples are being measured to supplement tissue data. CO_2 is coll. by exposure of carbonate-free 8N KOH solution to the atmosphere for each calendar month.

Lerwick series, 1970-1971

Samples coll. by Meteorologic Office in their ventilated East hut, Lerwick.

Sample no.	Coll. date		$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-441	April	1970	53.0 ± 1.3	−15.2	50.0 ± 1.3
GU-442	May	1970	51.0 ± 0.9	−15.4	48.1 ± 0.9
GU-443	June	1970	45.9 ± 1.3	−15.1	43.0 ± 1.3
GU-444	July	1970	57.9 ± 0.9	−15.1	54.8 ± 0.9
GU-445	Nov.	1970	54.3 ± 0.7	−17.6	52.0 ± 0.8
GU-446	March	1971	53.0 ± 0.9	−16.8	50.5 ± 1.0
GU-447	June	1971	56.8 ± 0.9	−18.9	54.9 ± 0.9

Snowdon series, 1970-1971

CO_2 coll. by Central Electricity Generating Board in a ventilated cabinet at Cwm Dyli Power Sta. on E slope of Mt. Snowdon.

Sample no.	Coll. date		$\delta C^{14}\%$	$\delta C^{13}‰$	$\Delta\%$
GU-448	May	1970	48.0 ± 0.9	−16.3	45.4 ± 0.9
GU-449	Nov.	1970	57.5 ± 0.9	−16.7	54.9 ± 0.9
GU-450	March	1971	50.0 ± 0.9	−17.4	47.7 ± 0.9
GU-451	June	1971	51.8 ± 0.9	−15.7	49.0 ± 0.9

Comment: Δ values still show seasonal fluctuations with maximum activity from June to July. Average Δ value from April 1970 to March 1971 is ca. 50%, thus during period most recent to coll. and measurements of tissue samples the average air Δ values are ca. 50%.

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