[RADIOCARBON, VOL. 18, NO. 2, 1976, P. 161-171]

GLASGOW UNIVERSITY RADIOCARBON MEASUREMENTS VIII

M J STENHOUSE* and M S BAXTER

Department of Chemistry, University of Glasgow, Glasgow G12 8QQ

INTRODUCTION

The analytical facilities at Glasgow have been extended to include gas proportional (CO_2 and CH_4) and liquid scintillation (C_6H_6) counting laboratories. The results presented here were obtained during 1972-1974 using the CO_2 gas counting system only. In brief, organic samples, after pretreatment as described in the text, are burned in a tube combustion unit and the evolved CO_2 absorbed in KOH solution. $BaCO_3$ is precipitated and acid-hydrolyzed in vacuo using H_3PO_4. Evolved CO_2 is purified via adsorption/desorption on CaO and is stored prior to counting. The 2.6L proportional counter is surrounded by a gas-flow Geiger anticoincidence guard and 10cm thick Pb shielding to reduce background count rates to ca 4.9 cpm at 1 atm filling and barometric pressures. A barometric sensitivity in background of −0.01cpm/mbar is observed. Constant gas gain is ensured by monitoring the coincidence meson spectrum and normalizing the detector operating voltage. All sample activities are related to the NBS oxalic acid standard count rate which averages 14.71cpm at 1 atm filling pressure and 15°C. Mass spectrometric assay of CO_2 after counting is performed on a VG Micromass 602B instrument to a precision of 0.05‰ ($\pm 1\sigma$). Since uncertainties quoted on all results represent 1σ counting errors alone, they are related to precision of measurement rather than accuracy. The bulk of data quoted here are connected with a long-term study of the medical aspects of artificial ^{14}C from nuclear weapon tests. These results should therefore be assessed in conjunction with those pub previously (Harkness and Walton, 1972; Farmer *et al,* 1972).

ACKNOWLEDGMENTS

This research was generously supported by a grant from the Medical Research Council. One of us (MJS) thanks the Natural Environment Research Council for financial aid. Our gratitude is extended to the many suppliers of samples. W A Harland, besides collecting tissue samples, added useful comment. Mass-spectrometric analyses owe much to A E Fallick while the technical assistance of A Miller is gratefully acknowledged.

SAMPLE DESCRIPTIONS

I. ARCHAEOLOGIC SAMPLES

While the principal objectives of the Glasgow labs lie in geochemical research, a small number of dating samples are assayed. Usually, measurements are made for intercalibration with other labs. All samples described here were pretreated by successive boiling in 5% NaOH/distilled water/ 5% HCl prior to combustion.

* Present address: Mount Soledad Radiocarbon Laboratory, University of California at San Diego, California 92093

GU-514. Kilphedir hut circles, Sutherland, Scotland **2215 ± 60 / 265 BC**

Charcoal (*Birch-Betula*). *Comment*: sample previously described and reported under GU-10, 1908 ± 60; GU-11, 2064 ± 55; GU-67, 1922 ± 60; SRR-3, 2100 ± 50; L-1061, 2100 ± 80.

GU-515. Kilphedir hut circles, Sutherland, Scotland **2045 ± 65 / 95 BC**

As GU-514.

GU-516. Wakefield, Yorkshire **2580 ± 60 / 630 BC**

Wood (*Quercus*). *Comment*: sample previously described and reported under IGS-C14/65 (St-3399), 2585 ± 100 and SRR-7, 2569 ± 80.

GU-517. Leeds, Yorkshire **4120 ± 105 / 2170 BC**

Wood. *Comment*: sample previously described and reported under IGS-C14/4 (St-3057), 4280 ± 100.

GU-518. Leeds, Yorkshire **4155 ± 70 / 2205 BC**

As GU-517, analyzed 1 yr later (1972).

GU-519. Leeds, Yorkshire **4150 ± 105 / 2200 BC**

As GU-517, -518, analyzed 1973.

GU-520. Chesil Beach, Abbotsbury **3875 ± 90 / 1925 BC**

Peat (*Phragmites*). *Comment*: sample previously described and reported under Q-1028, 4234 ± 60; Q-1029, 4251 ± 60; Q-1030, 5058 ± 60; I-5760, 5770 ± 100; SRR-24, 4023 ± 50; SRR-25, 4095 ± 60. Wide range of reported dates due to intrusion of non-contemporaneous fractions of plant materials and to varying degrees of success in their removal.

Ayios Epiktitos Vrysi, Cyprus series

Samples from middle phase of Neolithic coastal settlement 9.7km E of Kyrenia, Cyprus (35° 20′ N, 33° 26′ E). Samples coll by E J Peltenburg, Dept Extra-Mural Educ, Univ Glasgow.

GU-521. Kyrenia 1 **3105 ± 130 / 1155 BC**

Wood charcoal from beside hearth in Passage A, Floor 5, 1.20m below surface.

GU-522. Kyrenia 2 **5420 ± 80 / 3470 BC**

Wood charcoal around major hearth of House 2A, Floor 3, 2.32m below surface.

GU-523. Kyrenia 3 **5340 ± 95 / 3390 BC**

Wood charcoal from same place as GU-522.

5255 ± 120
3305 BC

GU-524. Kyrenia 4

Wood charcoal flecks scattered in SW corner of Floor 2, House 1, 1.50m below surface.

General Comment (EJP, MSB & MJS): in all cases, the Kyrenia samples were of poor quality, finely dispersed charcoal grains heavily intermixed with soil. Laborious microscopic examinations and extractions were required to separate charcoal particles. Thus, even after pretreatment, the possibility of contamination remained significant. In addition, small size of samples necessitated CO_2 dilution procedures for counting. GU-521, the least satisfactory sample, yielded an archaeologically unacceptable date as there is no 1st to 2nd millennium BC occupation on site. Remaining Kyrenia dates are slightly later than expected relative to results on similar sites (Birm-182, 5825 ± 145; Birm-337, 5740 ± 140).

Considered along with nuclear era intercalibration samples, GU-560-562 and with weekly data on NBS oxalic acid standard samples, samples GU-514-524 imply satisfactorily accurate measurement.

II. ATMOSPHERIC SAMPLES

Troposheric ^{14}C activities over U K have been monitored at Glasgow since 1968. Results presented here extend previously pub data and provide essential input information for dietary and human tissue studies in later sections. Also, they record ^{14}C fluctuations induced by continued nuclear weapon testing. Monthly tropospheric CO_2 samples from colln stas at Lerwick (60° 08′ N, 01° 11′ W), Snowdon (53° 03′ N, 04° 00′ W), and Harwell (51° 31′ N, 01° 20′ W) were obtained by exposure of carbonate-free 4M KOH solution to the atmosphere for each calendar month. After precipitation as $BaCO_3$, samples were hydrolyzed with H_3PO_4. While analysis of every sample was not possible, representative samples were measured.

Lerwick series, 1971-1973

Samples coll by Meteorol Office in ventilated E hut, Lerwick.

Sample no.	Date coll	$\delta^{14}C$‰	$\delta^{13}C$‰*	Δ ‰
GU-525	July 1971	53.3 ± 1.2	−18.3	51.2 ± 1.2
GU-526	Sept 1971	54.4 ± 1.1	−19.4	52.7 ± 1.2
GU-527	April/May 1972	49.3 ± 0.8	(−16.2)	46.7 ± 0.8
GU-528	July 1972	51.8 ± 0.8	−14.8	48.7 ± 0.8
GU-529	Oct/Nov 1972	46.7 ± 0.8	−16.0	44.1 ± 0.8
GU-530	Feb 1973	44.8 ± 0.8	−16.1	42.2 ± 0.8
GU-531	May 1973	45.7 ± 1.0	(−16.2)	43.1 ± 1.0

* Where $\delta^{13}C$ measurement was not possible, normally as a result of dilution of sample CO_2, a mean $\delta^{13}C$ for the sample type is assumed and recorded in parenthesis. For these samples a ± 1σ error of 1‰ is estimated, *cf* 0.05‰ for directly measured samples.

https://doi.org/10.1017/S0033822200003015 Published online by Cambridge University Press

Snowdon series, 1971-1973

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

Sample no.	Date coll	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta ‰$
GU-532	April 1971	52.0 ± 0.9	−17.4	49.7 ± 0.9
GU-533	July 1971	55.8 ± 1.2	−14.2	52.4 ± 1.2
GU-534	Sept 1971	51.6 ± 0.9	(−16.0)	48.9 ± 0.9
GU-535	Dec 1972	44.9 ± 0.8	−15.8	42.3 ± 0.8
GU-536	March 1973	45.5 ± 0.9	(−16.0)	42.8 ± 0.9
GU-537	June 1973	47.1 ± 0.9	(−16.0)	44.5 ± 0.9

Harwell series, 1971-1973

Samples coll by U K Atomic Energy Comm at site adjacent to A E R E, Harwell.

Sample no.	Date coll	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta ‰$
GU-538	March 1971	47.2 ± 1.0	−20.8	45.9 ± 1.0
GU-539	June 1971	63.3 ± 1.0	−18.7	61.3 ± 1.0
GU-540	Sept 1971	58.4 ± 0.8	−19.8	56.8 ± 0.8
GU-541	Aug/Sept 1972	57.8 ± 0.9	−20.4	56.3 ± 0.9
GU-542	Jan 1973	46.9 ± 0.8	−21.8	45.9 ± 0.8
GU-543	May 1973	46.1 ± 0.8	(−20.7)	44.8 ± 0.9

General Comment: ^{14}C variations, both temporal and spatial, continue in U K tropospheric air as the major artificial input of the early 1960's equilibrates with the oceanic and biospheric reservoirs and as nuclear testing, on a smaller scale, persists. Fluctuations are superimposed on a decreasing trend averaged at ca 2.5‰/yr by 1972. Aided by the Suess effect, atmospheric ^{14}C activities should decrease below the natural level by AD 2000. Results of the Harwell series indicate no major ^{14}C release from the adjacent nuclear reactor. Taken together, the atmospheric data provide a basis for evaluation of dietary and tissue results of the following sections.

III. DIETARY SAMPLES

A realistic assessment of ^{14}C levels and variations in human tissues requires accurate information on the ^{14}C input via diet. Systematic investigation of ^{14}C activities of all constituents of diet is, however, impracticable. In this study, samples of uncertain relationship to atmospheric ^{14}C concentrations, *ie,* fish and meat tissues, were analyzed. Meat samples were pretreated identically to human tissues while fish were freeze-dried after removal of bones. All samples quoted here were purchased in Glasgow stores. Included in this section are results of intercalibration samples of bovine tissues supplied by R M Chatters, Washington State Univ.

https://doi.org/10.1017/S0033822200003015 Published online by Cambridge University Press

Fish samples, series

Samples obtained fresh, March 1973, except GU-550, which was canned.

Sample no.	Species	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta‰$
GU-544	Herring	14.1 ± 0.8	−19.7	12.9 ± 0.8
GU-545	Whiting	17.6 ± 0.8	−17.3	15.8 ± 0.8
GU-546	Herring (smoked)	14.3 ± 0.9	−19.4	13.0 ± 0.9
GU-547	Cod	14.6 ± 1.0	−17.8	12.9 ± 1.0
GU-548	Plaice	29.0 ± 0.8	−15.3	26.5 ± 0.8
GU-549	Haddock	18.2 ± 0.8	−18.3	16.6 ± 0.8
GU-550	Salmon	14.9 ± 0.7	−22.1	14.2 ± 0.7

Meat samples, series

Samples obtained fresh, Jan 1972. For each sample, whole tissue (W), protein (P) and lipid (L) fractions were analyzed.

Sample no.	Description	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta‰$
GU-551	Lamb's heart (W)	44.4 ± 1.0	−28.3	45.3 ± 1.0
GU-552	Lamb's heart (L)	49.4 ± 1.1	−31.1	51.2 ± 1.1
GU-553	Lamb's heart (P)	46.4 ± 1.1	−25.5	46.6 ± 1.1
GU-554	Lamb's kidney (W)	54.5 ± 2.4	−29.9	56.0 ± 2.5
GU-555	Lamb's kidney (L)	50.7 ± 1.2	−25.9	51.0 ± 1.2
GU-556	Lamb's kidney (P)	59.5 ± 1.3	−25.0	59.5 ± 1.3
GU-557	Cow's liver (W)	43.8 ± 1.0	−26.5	44.2 ± 1.0
GU-558	Cow's liver (L)	60.0 ± 1.0	−28.7	61.2 ± 1.0
GU-559	Cow's liver (P)	47.9 ± 1.1	−24.8	47.6 ± 1.1

Animal tissues, series

Samples subm by R M Chatters, Washington State Univ. All samples from animals slaughtered 1971. Data are presented as Δ (‰) with corresponding WSU sample nos. and results that are based on an assumed $\delta^{13}C$ of −25‰.

Sample no.	Description	Δ‰ (GU)	Δ‰ (WSU)
GU-560/WSU-1189	Cow heart	51.5 ± 1.1	48.2 ± 1.7
GU-561/WSU-1187	Cow cartilage	31.5 ± 0.9	31.8 ± 1.9
GU-562/WSU-1168	Cow muscle	58.3 ± 1.0	60.7 ± 2.8

General Comment: the data indicate that ^{14}C contents of dietary samples analyzed reflect, fairly closely, environments of their origin, *ie,* surface ocean and troposphere/plant biosphere, respectively. The low value of bovine cartilage, GU-561, reflects the slow turnover of that material.

Intercalibration samples show excellent agreement. Since the object of the program was to evaluate ^{14}C content of diet for any given time during the nuclear era, the above experimental data were accompanied by a theoretical survey of dietary habits and statistics (Stenhouse, 1974). Account was taken of ^{14}C lag-time effects in food production, of importation particularly from S hemisphere, and of protein, fat, and carbohydrate contents of foodstuffs. From this study, the ^{14}C content of U K diet over any desired time period 'i' can be calculated via the following equation,

$$\Delta_D{}^{ni} = 0.24\Delta_{TN}{}^{ni} + 0.19\Delta_{TN}{}^{(n-1)i} + 0.16\Delta_{TN}{}^{(n-2)i} + 0.28\Delta_{TN}{}^{J} + 0.02\Delta_{TS}{}^{ni} + 0.035\Delta_{TS}{}^{(n-2)i} + 0.035\Delta_{TS}{}^{J} + 0.03\Delta_{M}{}^{ni} + 0.01\Delta_{M}{}^{(n-1)i}$$

where subscripts TN, TS, and M represent N troposphere, S troposphere and surface ocean, respectively, and superscript J refers to the preceding period of maximum photosynthesis. In practice, 'i' was taken as 6 mos. The equation enables definition of U K dietary ^{14}C intake at any time after nuclear testing commenced. Full details of the derivation of this and related dietary models will be pub elsewhere (Stenhouse and Baxter, mss in preparation). Its significance here is that it enables quantitative treatment of human tissue ^{14}C variations.

IV. HUMAN TISSUE SAMPLES

Observation of the rate at which human tissues responded to the pulse of artificial ^{14}C from nuclear weapon testing should enable assessment of the kinetics of tissue carbon turnover. Also, estimated present and future radiation dose levels to body tissues are possible. The following data add to those already obtained at this lab (Harkness and Walton, 1972; Farmer *et al*, 1972). Samples were coll at post-mortem examinations no later than 5 days after death. For each specimen, age at death, sex, and cause of death were recorded. All tissues, except where stated, were of Glasgow origin. Samples were first washed with distilled water to remove external traces of blood and were dissected free from extraneous fat, homogenized with 10 to 15ml distilled water to purée texture, and freeze-dried overnight; 2 to 5g dried material was obtained for combustion. In several cases, analyses were performed on whole tissue (W), protein (P) and lipid (L) fractions of each sample. Protein- and lipid-rich components were separated, using Bloor's solvent (ethanol/diethyl ether, 3:1 v/v). Solvent contamination was shown to be negligible by using ^{14}C-labeled solvents for several extractions at activities sufficient to produce 10cpm/counter fill at 1% contamination level. Aortic samples from victims of atherosclerosis were pretreated for lipid extraction using a chloroform/methanol mixture (2:1 v/v) followed by dissolution in diethyl ether/hexane (1:1 v/v) and washing with saline solution to remove non-lipid contaminants. The samples analyzed therefore represent the combined cholesterol, cholesterol esters, free fatty acids and phospholipids of arterial deposits.

39-year-old human tissues, series

Samples from a 39-yr-old male who died Aug 1971 of coronary artery disease.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	Δ ‰
GU-563	Liver	43.0 ± 1.2	(−22.5)	42.3 ± 1.2
GU-564	Brain	49.3 ± 0.9	−21.1	48.1 ± 0.9
GU-565	Spleen	39.5 ± 1.0	(−21.7)	38.6 ± 1.0
GU-566	Thyroid	38.6 ± 1.5	(−22.5)	37.9 ± 1.5
GU-567	Pancreas	46.1 ± 1.2	(−24.7)	46.0 ± 1.2
GU-568	Heart	40.8 ± 1.2	−21.2	39.8 ± 1.2

42-yr-old human tissues, series

Samples from a 42-yr-old male who died Sept 1971 of rheumatic heart disease.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	Δ ‰
GU-569	Heart	52.3 ± 1.5	(−21.6)	51.3 ± 1.5
GU-570	Kidney	34.5 ± 0.9	(−22.6)	33.9 ± 0.9
GU-571	Liver	48.5 ± 0.9	(−22.5)	47.7 ± 1.0
GU-572	Brain	52.7 ± 1.0	(−22.4)	51.9 ± 1.0
GU-573	Lung	38.5 ± 1.0	(−22.5)	37.8 ± 1.0
GU-574	Thyroid	44.5 ± 0.9	−21.1	43.3 ± 0.9
GU-575	Spleen	44.4 ± 2.5	(−21.7)	43.5 ± 2.5

21-yr-old human tissues, series

Samples from a 21-yr-old male who died Sept 1971 in road traffic accident.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	Δ ‰
GU-576	Heart	43.3 ± 1.4	(−21.6)	42.4 ± 1.4
GU-577	Spleen	46.9 ± 0.8	−22.1	46.0 ± 0.8
GU-578	Liver	55.1 ± 0.9	−23.3	54.6 ± 0.9
GU-579	Thyroid	44.2 ± 1.5	(−22.1)	43.3 ± 1.6
GU-580	Kidney	52.0 ± 1.6	(−22.6)	51.2 ± 1.6
GU-581	Testes	56.4 ± 1.3	(−23.7)	56.0 ± 1.3
GU-582	Lung	54.7 ± 1.6	(−22.5)	53.9 ± 1.6
GU-583	Muscle	56.8 ± 1.3	−22.0	55.9 ± 1.3
GU-584	Pancreas	52.3 ± 1.1	−24.7	52.2 ± 1.1

21-yr-old human tissues, series

Samples from a 21-yr-old female who died Sept 1971 of acute diabetes.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta ‰$
GU-585	Kidney	53.0 ± 1.2	−25.3	53.1 ± 1.2
GU-586	Muscle	52.4 ± 1.3	(−22.5)	51.7 ± 1.3
GU-587	Spleen	55.2 ± 1.6	−23.5	54.8 ± 1.6
GU-588	Heart	55.6 ± 1.3	−21.4	54.5 ± 1.3
GU-589	Liver	55.5 ± 1.0	−24.0	55.2 ± 1.0
GU-590	Lung	51.9 ± 1.1	−22.5	51.1 ± 1.1
GU-591	Pancreas	55.2 ± 1.1	−23.3	54.6 ± 1.1
GU-592	Thyroid	51.6 ± 1.1	−22.1	50.7 ± 1.1
GU-593	Brain	53.1 ± 1.1	−22.4	52.3 ± 1.1
GU-594	Ovaries	51.3 ± 2.0	(−22.5)	50.6 ± 2.0

5-yr-old human tissues, series

Samples from a 5-yr-old male who died Oct 1971 in road traffic accident.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta ‰$
GU-595	Muscle	53.5 ± 1.0	−21.7	52.5 ± 1.0
GU-596	Kidney	51.2 ± 1.4	(−22.6)	50.4 ± 1.5
GU-597	Spleen	45.8 ± 0.8	(−21.7)	44.9 ± 0.8
GU-598	Brain	51.7 ± 0.9	−21.1	50.5 ± 0.9
GU-599	Pancreas	53.6 ± 1.1	−24.7	53.5 ± 1.2
GU-600	Liver	53.4 ± 0.9	−22.8	52.8 ± 0.9

37-yr-old human tissues, series

Samples from a 37-yr-old male who died April 1972 of cardiac failure.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta ‰$
GU-601	Heart	48.7 ± 1.0	−20.4	47.3 ± 1.0
GU-602	Liver	49.1 ± 0.9	−22.5	48.4 ± 0.9
GU-603	Testes	50.2 ± 1.8	−23.5	49.8 ± 1.8

https://doi.org/10.1017/S0033822200003015 Published online by Cambridge University Press

67-yr-old human tissues, series

Samples from a 67-yr-old male who died Jan 1973 of cardiac failure.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta ‰$
GU-604	Kidney (W)	47.5 ± 0.8	−21.8	46.6 ± 0.8
GU-605†	Kidney (P)	49.8 ± 0.9	−20.5	48.5 ± 0.9
GU-606	Heart (W)	47.7 ± 0.8	−21.9	46.8 ± 0.8
GU-607†	Heart (L)	51.2 ± 0.8	−24.6	51.1 ± 0.8
GU-608†	Heart (P)	46.4 ± 0.8	−21.8	45.4 ± 0.8
GU-609	Liver (W)	50.2 ± 0.8	−22.4	49.4 ± 0.8
GU-610	Liver (P)	50.2 ± 0.9	(−22.5)	49.4 ± 1.0
GU-611	Liver (L)	49.4 ± 1.2	(−22.5)	48.7 ± 1.2

† Sample extracted using ^{14}C-labeled solvents.

87-yr-old human tissues, series

Samples from an 87-yr-old female who died Jan 1973 of cardiac failure.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta ‰$
GU-612	Liver (W)	48.8 ± 0.9	−22.4	48.0 ± 0.9
GU-613	Liver (P)	50.4 ± 1.0	−20.7	49.1 ± 1.0
GU-614	Kidney (W)	47.3 ± 0.9	−21.3	46.2 ± 0.9
GU-615	Kidney (P)	49.2 ± 0.8	−20.6	47.9 ± 0.8
GU-616	Spleen (P)	52.4 ± 0.9	−20.8	51.1 ± 0.9

64-yr-old human tissues, series

Samples from a 64-yr-old male who died Nov 1972 of cardiac failure.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	$\Delta ‰$
GU-617	Kidney (W)	47.6 ± 0.9	−20.8	46.3 ± 0.9
GU-618	Kidney (P)	49.4 ± 1.0	−21.5	48.4 ± 1.0
GU-619	Liver (W)	48.6 ± 0.8	−21.3	47.5 ± 0.8
GU-620	Liver (P)	49.9 ± 0.9	−20.9	48.7 ± 0.9
GU-621	Liver (L)	47.2 ± 1.1	−25.0	47.2 ± 1.1
GU-622	Spleen (W)	44.1 ± 0.9	(−21.7)	43.2 ± 1.0
GU-623	Spleen (P)	44.0 ± 0.9	−20.5	42.8 ± 0.9
GU-624	Lung (W)	44.8 ± 1.2	−22.2	44.0 ± 1.2
GU-625	Lung (P)	47.3 ± 2.2	(−22.5)	46.5 ± 2.2
GU-626	Heart (P)	42.2 ± 0.9	−20.4	40.9 ± 0.9

61-yr-old human tissues, series

Samples from a 61-yr-old male who died Oct 1972 of carcenoma of the lung.

Sample no.	Tissue	$\delta^{14}C‰$	$\delta^{13}C‰$	Δ ‰
GU-627	Heart (W)	51.1 ± 0.8	−22.8	50.4 ± 0.8
GU-628	Heart (P)	46.0 ± 1.0	−21.1	44.9 ± 1.0
GU-629	Kidney (W)	46.5 ± 0.8	−20.8	45.3 ± 0.8
GU-630	Kidney (P)	44.4 ± 1.0	(−22.6)	43.7 ± 1.0
GU-631	Spleen (W)	44.3 ± 0.9	−22.0	43.4 ± 0.9
GU-632	Spleen (P)	47.5 ± 1.0	−20.8	46.2 ± 1.0
GU-633	Liver (W)	49.2 ± 0.9	(−22.5)	48.5 ± 1.0
GU-634	Liver (P)	45.8 ± 1.1	−22.3	45.0 ± 1.1

Tumor tissues, series

Samples from individuals who died of cancer of the particular diseased tissue analyzed. Data from undiseased material are included for comparison.

Sample no.	Description	$\delta^{14}C‰$	$\delta^{13}C‰$	Δ ‰
GU-635	Liver (normal)—male, 66 yr, died March 1973	51.3 ± 0.9	−20.8	50.0 ± 0.9
GU-636	Liver (diseased)—donor as GU-635	56.0 ± 1.3	(−22.5)	55.2 ± 1.4
GU-637	Spleen (normal)—male, 63 yr, died Feb 1973	52.0 ± 0.8	(−21.7)	51.0 ± 0.9
GU-638	Liver (diseased)—donor as GU-637	53.8 ± 1.2	(−22.5)	53.0 ± 1.2
GU-639	Kidney (diseased)—male 59 yr, died Feb 1973	49.4 ± 0.8	(−20.7)	48.1 ± 0.8

Aortae lipids, series

Samples from aortae of victims of atherosclerosis. Lipid samples GU-640-642 from New Orleans, Louisiana. Samples GU-643 and -644 from Glasgow, represent intimal lipid and adventitial layer of the same artery.

Sample no.	Description	$\delta^{14}C‰$	$\delta^{13}C‰$	Δ ‰
GU-640	Aorta (intimal lipid)—male, 68 yr, died 1963	5.8 ± 0.6	−20.2	4.8 ± 0.6
GU-641	Aorta (intimal lipid)—male, 67 yr, died 1964	10.7 ± 0.9	(−20.3)	9.7 ± 0.9

Sample no.	Description	$\delta^{14}C‰$	$\delta^{13}C‰$	Δ ‰
GU-642	Aorta (intimal lipid)—male, 69 yr, died 1964	18.9 ± 0.8	−20.6	17.9 ± 0.8
GU-643	Aorta (intimal lipid)—female, 86 yr, died 1973	47.5 ± 0.9	−24.0	47.1 ± 0.9
GU-644	Aorta (adventitia)—donor as GU-643	32.7 ± 0.8	−21.1	31.6 ± 0.8

General Comment: all human tissue samples reflect above natural ^{14}C levels due to nuclear testing. Human tissue ^{14}C activities scatter outside statistical errors of measurement as a result, we believe, of variations in rate of carbon turnover in different organs of the body. Box model calculations for both steady state and growing tissues coupled with dietary studies and observed ^{14}C levels, indicate variations of mean residence time for ^{14}C within the range 6 ± 4 yr for soft tissues (Stenhouse, 1974; Stenhouse and Baxter, mss in preparation). Application of bomb ^{14}C as a biochemical tracer is further demonstrated by ^{14}C activities of arterial lipid extracts that imply a lipid turnover in $>$ 10 yr. This finding is significant for a fuller understanding of the timescale of development and treatment of atherosclerosis. Based on extensive data recently compiled on somatic and genetic risks from ionizing radiation, corresponding risk estimates for artificial ^{14}C have been prepared. These suggest that, as a result both of the Suess effect and of bomb ^{14}C equilibration, this source of radioactivity does not present a severe threat to mankind. Overall, the net extent of severe damage, over that from natural ^{14}C and in the absence of major nuclear tests in the future, is assessed at 225 offspring with genetic disorders, of which ca 10 will occur in 1st generation offspring, while 350 to 1000 persons will suffer ^{14}C-induced leukemia. A similar range of persons affected by ^{14}C-induced bone tumors is predicted. In a world population of $\sim 2.5 \times 10^9$ and over a period of several generations, such an incidence of damage will occur undetected.

References

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