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BRATISLAVA RADIOCARBON MEASUREMENTS I

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INTRODUCTION

The Radiocarbon Dating Laboratory was established in 1967 at the Department of Nuclear Physics, Comenius University, as part of a program of low level counting research of the department and as a contribution to geophysical, geologic, archaeologic and hydrologic research.

The first series of C^{14} measurements were obtained using CO_2 as a gas filling of a proportional counter (Povinec *et al.*, 1968). Chemical and counting procedure adopted for radiocarbon dating of archaeologic and geologic samples has been described by Povinec *et al.* (1971). The counting unit is a 2.8L copper proportional counter. For a two day count with 4 atm CO_2 filling, the maximum measurable age is 37,000 years (4σ criterion).

Recently we have adopted Lal's method of methane preparation, using CO_2 and H_2O in the presence of zinc dust and a ruthenium catalyst (Lal, 1965; Povinec, 1972).

For more precise measurements we have built an Oeschger-type proportional counter volume of 3.30L. At 5 atm of methane filling the maximum measurable age (48 hrs counting, 4σ criterion) is 50,000 years (Povinec *et al.*, 1971). For samples of limited weight, a proportional counter volume of 0.4L with plastic scintillator as an anticoincidence counter has been constructed (Provinec *et al.*, 1971). CO_2 is mostly used as the gas filling of this counter.

The numbers of pulses registered by scalers are printed out on a strip printer every 20 minutes. The data are processed on a computer, where age of samples and standard deviations are calculated. Calculations are based on the Lamont formulae (Broecker and Olson, 1961) and the standard deviations quoted (1σ) describe only the uncertainties associated with the sample, standard and background determinations. The contemporary reference used is 95% of the specific activity of NBS oxalic acid. Dates are calculated using the Libby half-life of 5568 ± 30 years with 1950 as the standard year of reference.

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SAMPLE DESCRIPTIONS

I. INTERLABORATORY CHECK SAMPLES

To cross-check with other laboratories, we measured C^{14} concentration in a wood sample from the tomb of King Zoser and in charcoal samples, subm. by D. P. Agrawal.

TABLE 1
Interlaboratory cross-check samples

Lab. no.	Date	Check sample	Date	Reference
Ba-79	2580 ± 110	TF-783	2495 ± 100	Agrawal *et al.*, 1969
Ba-80	4050 ± 120	TF-942	4055 ± 110	Agrawal *et al.*, 1971
Ba-85	4030 ± 100	TF-56	3990 ± 110	Kusumgar *et al.*, 1963
		SL-8	4020 ± 100	Ellis and Sharp, 1964
		LJ-175	4080	Kusumgar *et al.*, 1963
		A-219	4240 ± 150	
		C-1	3979 ± 350	

Comment (P.P.): the table shows satisfactory agreement with other laboratories.

II. ATMOSPHERIC CO_2 SAMPLES

Data reported here are derived from atmospheric CO_2 samples coll. at Jaslovské Bohunice and Bratislava. Measurements were made as part of continuing study of the C^{14} transport within the carbon reservoirs and as a part of our radioecological program.

Jaslovské Bohunice series, 1968-1970

Samples coll. at Jaslovské Bohunice (48° 29′ N Lat, 17° 37′ E Long), dist. Trnava, SW Slovakia, at ground level. The sampling sta. is far from any source of fossil fuel CO_2. Sample of CO_2 is coll. by bubbling air through $Ba(OH)_2$ sampler.

TABLE 2
Jaslovské Bohunice 1968-1970

Sample no.	Date	δC^{14}‰
Ba-1	Jan. 19, 31, 1968	63.6 ± 3.0
Ba-2	Feb. 14, 28, 1968	64.4 ± 2.3
Ba-3	April 30, 1968	72.5 ± 1.0
Ba-4	May 7, 1968	64.4 ± 0.9

Table 2 (continued)

Sample no.	Date	$\delta C^{14}\%$
Ba-5	May 22, 1968	81.0 ± 3.3
Ba-6	June 4, 1968	65.0 ± 2.4
Ba-7	June 19, 1968	65.7 ± 1.9
Ba-8	July 16, 1968	56.0 ± 0.8
Ba-9	Sept. 3, 1968	67.2 ± 1.2
Ba-10	Sept. 17, 1968	69.0 ± 1.2
Ba-11	Oct. 2, 1968	63.6 ± 1.3
Ba-12	Oct. 22, 1968	58.6 ± 1.1
Ba-13	Nov. 5, 1968	68.0 ± 1.1
Ba-14	Jan. 7, 1969	50.2 ± 2.4
Ba-15	Feb. 18, 1969	43.2 ± 2.0
Ba-16	March 4, 1969	50.0 ± 2.1
Ba-17	March 18, 1969	62.6 ± 2.2
Ba-18	April 2, 1969	66.7 ± 2.4
Ba-19	April 15, 1969	64.2 ± 2.4
Ba-20	May 13, 1969	74.2 ± 2.2
Ba-21	May 27, 1969	63.0 ± 2.0
Ba-22	July 22, 1969	59.5 ± 2.0
Ba-23	Sept. 10, 1969	56.3 ± 2.4
Ba-24	Sept. 23, 1969	60.3 ± 2.2
Ba-49	Jan. 21, 1970	45.2 ± 1.6
Ba-50	Feb. 24, 1970	38.4 ± 1.5
Ba-46	March 17, 1970	43.5 ± 1.5
Ba-96	April 7, 1970	51.3 ± 1.4
Ba-97	April 30, 1970	50.4 ± 1.3
Ba-48	May 5, 1970	46.6 ± 1.6
Ba-45	June 12, 1970	52.8 ± 2.0
Ba-98	July 21, 1970	53.1 ±1.4
Ba-47	Aug. 4, 1970	50.6 ± 2.1
Ba-57	Oct. 13, 1970	51.4 ± 2.0

Comment (P.P.): decrease in C^{14} concentrations during 1970 is noticeable.

Bratislava series, 1969-1970

Atmospheric CO_2 is coll. weekly on the roof of the department building by static absorption of concentrated NaOH solution. The department is situated in the center of town.

TABLE 3
Bratislava 1969-1970

Sample no.	Date	$\delta C^{14}\%$
Ba-25	Feb. 11-17, 1969	42.5 ± 2.4
Ba-26	March 3-10, 1969	55.7 ± 2.4

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Table 3 (continued)

Sample no.	Date	$\delta C^{14}‰$
Ba-27	April 28-May 5, 1969	63.2 ± 2.4
Ba-95	May 26-June 2, 1969	63.4 ± 2.3
Ba-28	July 7-14, 1969	58.4 ± 2.3
Ba-29	July 28-Aug. 11, 1969	52.3 ± 2.1
Ba-92	Oct. 26-Nov. 2, 1969	51.0 ± 2.8
Ba-128	Dec. 3-11, 1969	47.2 ± 2.1
Ba-94	Jan. 5-12, 1970	40.6 ± 2.2
Ba-99	Feb. 11-18, 1970	43.0 ± 1.9
Ba-100	March 4-11, 1970	41.7 ± 2.1
Ba-108	April 2-9, 1970	50.1 ± 2.1
Ba-119	May 12-19, 1970	47.9 ± 1.9
Ba-109	June 15-23, 1970	50.1 ± 2.0
Ba-110	July 16-24, 1970	55.3 ± 2.0
Ba-133	Aug. 12-21, 1970	51.2 ± 1.2
Ba-120	Sept. 8-17, 1970	48.5 ± 1.9
Ba-134	Oct. 7-16, 1970	49.2 ± 1.2
Ba-126	Nov. 12-20, 1970	51.3 ± 2.0
Ba-127	Dec. 8-16, 1970	42.5 ± 1.8

Comment (P.P.): a clear industrial effect was observed in winter. C^{14} concentrations still show seasonal fluctuations with maximum in summer months. Results agree with present theories of C^{14} transport through carbon reservoirs (Povinec *et al.*, 1971). Tables 2 and 3 show that daily and weekly concentrations of C^{14} in atmospheric CO_2 are comparable.

III. BIOSPHERIC SAMPLES

Various biospheric materials were dated for radioecological purposes.

TABLE 4

Modern plant samples

Sample no.	Sample	Date	$\delta C^{14}‰$
Ba-33	Wheat straw	June 1966	75 ± 3
Ba-32	Nut twigs	Sept. 1968	63 ± 3
Ba-34	Sugar	Nov. 1968	73 ± 3
Ba-53	Grass	June 1970	56.8 ± 2.1
Ba-52	Wheat straw	July 1970	57.3 ± 1.9
Ba-54	Barley grain	July 1970	59.5 ± 2.0
Ba-55	Potatoes	Oct. 1970	52.7 ± 2.0
Ba-56	Apples	Oct. 1970	59.4 ± 2.1

IV. GEOLOGIC SAMPLES

Jurský šúr series

Peat from bog Jurský šúr near Jur (48° 15′ N Lat, 17° 14′ E Long), dist. Bratislava, SW Slovakia. Coll. and subm. 1968 by E. Povincová, Dept. Phys. Geog., Comenius Univ., Bratislava.

Ba-39. Jurský šúr 1/68 — **4200 ± 220** / **2250 B.C.**

Peat from depth 0.80 to 0.85m.

Ba-40. Jurský šúr 2/68 — **12,000 ± 260** / **11,050 B.C.**

Peat from depth 2.65 to 2.70m.

Domica Cave series

Stalagmite from Domica Cave (48° 30′ N Lat, 20° 20′ E Long) 10km SE of Plešivec, dist. Rožnava, S Slovakia. Coll. and subm. 1970 by M. Liška, Slov. ústav pam. starost., Bratislava. *Comment* (P.P.): outer layer of sample etched off with dilute acid, inner part measured.

Ba-106. Domica, No. 1 — **13,740 ± 300** / **12,790 B.C.**

Center part of stalagmite.

Ba-107. Domica, No. 2 — **8680 ± 220** / **6730 B.C.**

Outer part of same stalagmite.

Travertine series

In collaboration with Geol. Inst. Slov. Acad. Sci., Bratislava we are studying the origin of travertine from different localities of Slovakia. Coll. 1971 and subm. by R. Demovič. *Comment* (R.D.): δC^{13} values were measured in Central Isotope Lab., Gottingen Univ., and are quoted relative to the PDB standard.

Ba-114. Bešeňová — **10,400 ± 300** / **8450 B.C.**

$\delta C^{13} = +8.0‰$

Travertine from sinter cascade near village Bešenová (49° 6′ N Lat, 19° 25′ E Long), dist. Lipt. Mikuláš, N Slovakia. Yellow-brown, hard travertine. *Comment* (P.P.): no correction for isotopic fractionation.

Ba-116. Vrútky—Dubná Skala — **>45,000**

$\delta C^{13} = +5.5‰$

Travertine from quarry opposite railway sta. Vrútky (49° 7′ N Lat, 18° 54′ E Long), dist. Martin, N Slovakia. Brown, very hard travertine. *Comment* (R.D.): travertine supposedly originated in Miocene.

V. ARCHAEOLOGIC SAMPLES

Jazdiareň series

Wood from supporting beams from riding-ground building in Prague, Bohemia. Subm. 1968 by J. Lexa, Research Inst. Wood, Bratislava.

Ba-37. Jazdiareň D 2 **250 ± 45** **A.D. 1700**

Wood from Beam D-2.

Ba-78. Jazdiareň D 4 **280 ± 55** **A.D. 1670**

Wood from Beam D-4.

Mirbach's Palace series

Wooden beams from Mirbach's palace, Bratislava, Slovakia. Subm. 1968 by J. Lexa.

Ba-30. Mirbach's Palace M 3 **180 ± 50** **A.D. 1770**

Wood from Beam M-3.

Ba-74. Mirbach's Palace M 2 **140 ± 50** **A.D. 1810**

Wood from Beam M-2.

Lužany series

Samples from burial barrow discovered at Lužany (48° 31′ N Lat, 18° 1′ E Long), dist. Topolčany, W Slovakia. Coll. 1967 and subm. by J. Paulík, Slov. Natl. Mus., Bratislava.

Ba-38. Lužany 1 **3040 ± 160** **1090 B.C.**

Charcoal from Tomb I/67/, top layer.

Ba-90. Lužany 2 **3260 ± 110** **1310 B.C.**

Charcoal from Tomb I/67/, bottom layer.

Ba-73. Rudno **530 ± 80** **A.D. 1420**

Fragment of wooden beam from church at Rudno (48° 54′ N Lat, 18° 45′ E Long), dist. Martin, N Slovakia. Coll. 1968 by P. Povinec.

Ochodnica series

During excavations for a new building, a destroyed wooden cellar was found 1.80m below surface at Ochodnica (49° 23′ N Lat, 18° 46′ E Long), dist. Čadca, NW Slovakia. Coll. 1969 by P. Povinec.

Ba-82. Ochodnica, No. 1 **80 ± 60** **A.D. 1870**

Wood from a pale pit, Sec. A-1.

90 ± 70

Ba-83. Ochodnica, No. 2 **A.D. 1960**

Wood from a supporting beam, Sec. B-4.

75 ± 70

Ba-84. Ochodnica, No. 3 **A.D. 1875**

Wood from a supporting beam, Sec. D-4.

Plavecké Podhradie series

Excavations made by Slov. Natl. Mus., Bratislava, uncovered a Celtic settlement with pale buildings on hill "Pohanská" (48° 29′ 20″ N Lat, 17° 16′ 20″ E Long) near Plavecké Podhradie, dist. Senica, W Slovakia. Samples were charcoal fragments from construction parts of buildings. Coll. and subm. 1969 by J. Paulík.

1980 ± 90

Ba-88. Plavecké Podhradie, No. 1 **30 B.C.**

Charcoal from a pale pit, Sec. MO1-1 AB1/2.

2050 ± 90

Ba-89. Plavecké Podhradie, No. 2 **100 B.C.**

Charcoal from Beam 2, Sec. m-4-5 ABC.

2510 ± 190

Ba-101. Smolenice **560 B.C.**

Carbonized grain from early Hallstatt age site on "Molpír" hill near Smolenice (48° 30′ N Lat, 17° 25′ E Long), dist. Trnava, SW Slovakia. Sample from nearly destroyed store vessel from burnt hut. Coll. 1967 by M. Dušek, subm. by E. Hajnalová, Archaeol. Inst. Slovak Acad. Sci., Nitra.

2000 ± 150

Ba-102. Nová Lesná **50 B.C.**

Carbonized tree trunk from part of wooden fortification in sand mine "Piesková bana" near Nová Lesná (48° 8′ N Lat, 20° 20′ E Long), dist. Poprad, N Slovakia. Sample from Object 1, Sec. 3-K, depth 45cm. Coll. Aug. 1971 by L. Veliačik; subm. by E. Hajnalová.

3310 ± 190

Ba-103. Vráble **1360 B.C.**

Carbonized grain from late Bronze age village on loess eminence "Fidvár" on left bank of Zitava R. near Vráble (48° 15′ N Lat, 18° 19′ E Long), dist. Nitra, S Slovakia. Sample was from destroyed hut. Coll. Aug. 1967 by K. Sedlák; subm. by E. Hajnalová.

Ducové series

Charcoal from log which was a part of fortification on calcite tongue "Kostelec," 80m above Váh R. inundation area near Ducové (48° 58′ N Lat, 17° 51′ E Long), dist. Trnava, SW Slovakia. Bottom layer is dolomite calcite, above 40 to 80cm humus soil mixed with organic remains. Samples from 40 to 45cm depth of humus clay mixed with calcite gravel. Coll. 1970 by A. Ruttkay; subm. by E. Hajnalová.

910 ± 120

Ba-104. Ducové, No. 1 A.D. 1040

Charcoal from beam between W middle rooms.

850 ± 110

Ba-121. Ducové, No 2 A.D. 1100

Charcoal from beam of W wall of W room.

1020 ± 120

Ba-129. Ducové, No. 3 A.D. 930

Charcoal from beam of E wall.

980 ± 120

Ba-130. Ducové, No. 4 A.D. 970

Charcoal from beam between middle and E walls.

1810 ± 140

Ba-105. Liptovská Mara A.D. 140

Charcoal (*Fogus*) from cultural layer in valley of Váh R. near Liptovská Mara (49° 7′ N Lat, 19° 29′ E Long), dist. Lipt. Mikuláš, N Slovakia. Sample from Sec. I/68, depth 75 to 80cm. Coll. July, 1968 by K. Pieta; subm. by E. Hajnalová.

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