[RADIOCARBON, VOL. 12, No. 1, 1970, P. 19-39]

UNIVERSITY OF BONN
NATURAL RADIOCARBON MEASUREMENTS III

H. W. SCHARPENSEEL and F. PIETIG

Institut für Bodenkunde, Universität Bonn
Bonn, Bundesrepublik Deutschland

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

ACKNOWLEDGMENTS

Much of the technical work for sample preparation was carried out by E. Kruse and H. Topüth. We are indepted to G. Strunk-Lichtenberg for help in the preparation of a computer program to facilitate calculation of results. This work was supported by grants from the German Federal Department of Scientific Research. Preparation of carbonate samples from aquifers in Tunisia was financed by the German Federal Department of Economic Cooperation.

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 (50° 59′ N Lat, 6° 33′ E Long) — 10,100 ± 95 / 8150 B.C.

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

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

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

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

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

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

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

BONN-520. Pegel 4.141, 4 Blatzheim (50° 51′ N Lat, 6° 36′ E Long) — 2640 ± 80 / 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 (50° 47′ N Lat, 6° 4′ E Long) — 14,200 ± 205; 12,250 B.C.

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

BONN-511. Landesbad Aachen-Burscheidt, Tiefenquelle (50° 47′ N Lat, 6° 4′ E Long) — 17,140 ± 225; 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) (51° 33′ N Lat, 6° 53′ E Long) — 11,290 ± 155; 9340 B.C.; 9650 ± 570 B.P.

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

BONN-515. Ruhrchemie (51° 31′ N Lat, 6° 48′ E Long) — 9370 ± 100; 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.

10,480 ± 140
8530 B.C.

BONN-512. Meachiche, Venezuela
(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.

https://doi.org/10.1017/S0033822200036195 Published online by Cambridge University Press

	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.

730 ± 50

BONN-436. Parabraunerde Bergheim **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.

8300 ± 120

BONN-448. W. Eddersheim, humus loam **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

https://doi.org/10.1017/S0033822200036195 Published online by Cambridge University Press

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.

References

Date lists:

Bonn I	Scharpenseel, Pietig, and Tamers, 1968
Bonn II	Scharpenseel, Pietig, and Tamers, 1969
Stockholm V	Östlund and Engstrand, 1963

Balke, K. D., 1969, Geothermische und hydrogeologische Untersuchungen in der südlichen Niederrheinischen Bucht. Dissert., Bonn Univ.

Flaig, W., Scheffer, F., and Klamroth, B., 1955, Zur Charakterisierung der Huminsäuren des Bodens: Z. Pflanzenernähr., Düng., Bodenkunde 71, p. 33.

Münnich, K. O., 1957, Erfahrungen mit der ^{14}C-Datierung verschiedener Arten von Sedimenten: Verhandlungen der vierten Int. Tagung der Quartärbotaniker, Veröff, Geobotanisches Inst. Rübel b. Zürich, no. 34.

Nakhla, S. M. and Delibrias, G., 1967, Utilisation de carbon-14 d'origine thermonucléaire pour l'étude de la dynamique de carbon dans le sol: I.A.E.A. Conf. radioactive dating and methods of low level counting, proc. Monaco, p. 169.

Östlund, H. G. and Engstrand, L. G., 1963, Stockholm radiocarbon measurements V: Radiocarbon, v. 5, p. 203-227.

Paul, E. A., Campbell, C. A., Rennie, D. A., and McCallum, K. J., 1964, Investigations of the dynamics of soil humus utilizing carbon dating techniques: 8th internatl. cong. soil science III, proc. Bucharest, p. 201.

Rauterberg, E. and Kremkus, F., 1951, Bestimmung von Gesamt- und alkalilöslichen Huminstoffen im Boden: Z. Pflanzenernähr., Düng., Bodenkunde, v. 54, p. 240.

Scharpenseel, H. W. and Pietig, F., 1969a, Radiokohlenstoff- und Tritium-Datierung von Boden und Wasser durch die Benzolmethode: Geoderma, v. 2, p. 273-289.

———— 1969b, Altersbestimmung von Böden durch die Radio-kohlenstoffdatierungsmethode, III, Böden mit B_t-Horizont und fossile Schwarzerden: Z. Pflanzenernähr., Düng., Bodenkunde, v. 122, p. 145.

Scharpenseel, H. W., Pietig, F., and Tamers, M. A., 1969, University of Bonn natural radiocarbon measurements II, v. 11, p. 3-14.

———— 1968, University of Bonn natural radiocarbon measurements I, v. 10, p. 8-28.

Scharpenseel, H. W., Ronzani, C., and Pietig, F., 1968, Comparative age determination on different humic matter fractions: I.A.E.A. Symposium isotopes and radiation in soil organic matter studies, proc. Vienna, p. 67-73.

Semmel, A., 1968, Studien über den Verlauf jungpleistozäner Formung in Hessen: Frankfurter Geog. Hefte, 45, W. Kramer Pub., Frankfurt.

Strunk-Lichtenberg, G., 1968, Humusuntersuchungen mittels Farbquotienten an archäologischen Objekten aus dem Neolithikum, rep., "Deutsche Forschungsgemeinschaft", 1968.

Tamers, M. A., 1966, Ground water recharge of aquifers as revealed by naturally occurring radiocarbon in Venezuela: Nature, v. 212, p. 489-493.

———— 1967, Radiocarbon ages of ground water in an arid zone unconfined aquifer: Am. Geophys. Union Mon., v. 11, p. 143.

Tamers, M. A., Balke, K. D., and Scharpenseel, H. W., 1968, Untersuchungen zur Fliessgeschwindigkeit des Grundwassers durch Bestimmung der Radiokohlenstoff- und Tritium- aktivität: I. Teil. Zeitschr. f. Kulturtechnik u. Flurbereinigung, v. 9, no. 6, p. 364-380.