

RADIOCARBON DATING OF SOILS: DATABASE CONTRIBUTION BY BONN AND HAMBURG

H. W. SCHARPENSEEL, FRANZ PIETIG, HEINRICH SCHIFFMAN and PETER BECKER-HEIDMANN

Institut für Bodenkunde, University of Hamburg, Allende-Platz 2, D-20146 Hamburg, Germany

ABSTRACT. We present a compilation of ^{14}C soil dates measured at the University of Hamburg through 1984 (HAM-1597).

INTRODUCTION

The inherent problems in determining the “age of a soil” were described by Scharpenseel and Becker-Heidmann (1992). The dating procedure applied in the production of ^{14}C dates of soil profiles and samples listed below was described by Scharpenseel, Pietig and Tamers (1968) and Scharpenseel and Pietig (1970). For reasons of brevity, we report only the oldest ^{14}C age of the data set indicated for the layers, thin layers or horizons of the ^{14}C -dated soil profiles. We present an annotated bibliography as well as date lists of our work. We also include unpublished soil dates measured in our laboratory, and, following this contribution, Peter Becker-Heidmann reports continuing dates from HAM-1600 onward.

DATE LISTS IN RADIOCARBON: BONN I–VII AND HAMBURG I–IV*

Material dated	Lab code(s)	Age (yr BP)
University of Bonn, Natural Radiocarbon Measurements I (Scharpenseel, Pietig and Tamers 1968)		
<i>Soil and Soil Profile Dates</i>		
<i>Germany</i>		
Hapludoll, Söllingen A	B 26–31	$\leq 4800 \pm 100$
Hapludoll, Söllingen B	B 33–40	$\leq 4060 \pm 80$
Hapludoll, Söllingen C	B 98–104	$\leq 5300 \pm 80$
Hapludoll, Söllingen D	B 106–113	$\leq 5550 \pm 80$
Haplaquoll, Hildesheim A	B 114–120	$\leq 3130 \pm 70$
Haplaquoll, Hildesheim A	B 121–128	$\leq 4000 \pm 80$
Fossil Chernozem below Hapludalf, Soest II	B 3	4000 ± 80
Fossil Chernozem below Hapludalf, Soest I	B 4	4170 ± 80
Fossil Chernozem in dark-brown steppe soil, Wallertheim	B 22	2560 ± 60
Buried Eutrochrept below Allerød trachyt blanket	B 96	9130 ± 100
Udoll, Ostholsteen A, Grossenbrode	B 156	$\leq 1850 \pm 70$
Udoll, Ostholsteen B, Grossenbrode	B 161–165	$\leq 1390 \pm 70$
Plaggept, Greven (Albachtensesch, Marktesch, etc.)	B 9–13	$\leq 1300 \pm 80$
Plaggept, Greven, Albachtensesch, whole profile	B 43–48	$\leq 1220 \pm 80$
Plaggept, Rheine	B 49–54	$\leq 1260 \pm 60$
Plaggept, Lengerich	B 129–135	$\leq 1190 \pm 70$
(B 135, 80 cm deep 3960 ± 80)		
Spodosol, Sennesand	B 14	930 ± 80
Spodosol, Irrel	B 19	810 ± 50
Spodosols, Darlaten A and B	B 20, 21	$\leq 1220 \pm 60$

*From 1968–1974 our laboratory was located in Bonn, and our laboratory code designation, as reported in *Radiocarbon*, was BONN. In 1976, our laboratory numbers changed to HAM- to reflect our relocation to Hamburg. (Lab codes in this table are abbreviated to “B” and “H”.) This compilation of our work represents 27 years of soil dating from all over the world.

Material dated	Lab code(s)	Age (yr BP)
Spodosols, Scherpenseel A and B	B 90, 91	$\leq 2960 \pm 70$
Spodosol, Wilsede	B 41	1140 ± 60
Spodosol, Obrehaverbeck	B 42	940 ± 50
Spodosols, Flaesheim	B 15–17	$\leq 2420 \pm 80$
Hapludalf, Frimmersdorf	B 92–95	$\leq 1880 \pm 80$
Half bog soils, Fibrst, Kalkarer Moor I	B 82–85	$\leq 7790 \pm 110$
Half bog soils, Fibrst, Kalkarer Moor II	B 86–89	$\leq 3160 \pm 50$

University of Bonn, Natural Radiocarbon Measurements II (Scharpenseel, Pietig and Tamers 1969)

Germany

Rendolls

Tangelrendsina, Kramer (German Alps)	B 318–322	$\leq 4180 \pm 70$
Moderrendsina Krottenkopf (German Alps)	B 324	600 ± 50

Udalfs, argillic horizon probably former A horizon of Mollisol:

Parabrown earth, Eltville	B 326–331	$\leq 4940 \pm 80$
Parabrown earth, Inden	B 334–342	$\leq 4170 \pm 70$
Brown earth, Haaren-Sintfeld	B 355–358	$\leq 1580 \pm 50$
Parachernozem, Fellbach	B 372–379	$\leq 2730 \pm 70$
Parachernozem, Fellbach, brickpit	B 380–384	$\leq 4150 \pm 50$

Plaggepts:

Southeast of Rietberg	B 343–345	$\leq 1200 \pm 70$
Brede near Rietberg	B 348	720 ± 70
Hoffeld	B 349–350	$\leq 1130 \pm 70$
Sinnesche Brede	B 351	1540 ± 60
Am Hohen Lande	B 352	810 ± 70
Krax bei Neuenkirchen	B 353	900 ± 60

Modern bomb-carbon samples BONN 172–200 and BONN 303–317
(bomb C curve on cereals, beets, winter rape, wine, 1956–1967)

University of Bonn, Natural Radiocarbon Measurements III (Scharpenseel and Pietig 1970)

Udolls, Vertisols, Fossil A-horizon of Paleosol-Mollisol in Argillic Horizon of Hapludalf

Germany

Parabrown earth Lantershofen	B 403–409	$\leq 5530 \pm 90$
Ochtendung (below trachytic pumice)	B 411–416	$\leq 10,580 \pm 100$
Muddersheim, Thineland	B 417–421	$\leq 3700 \pm 60$
Quarry “Schäferkalkwerke”	B 422–431	$\leq 25,000 \pm 700$
Buried soil organic matter (SOM), Eddersheim	B 448	8300 ± 120
Humus containing sand with charcoal (fireplace), Amalienhof	B 608a	2530 ± 70
Buried humus, Heiligensee Forest, Berlin	B 609	760 ± 60
Bone collagen in paleosol below trachytic tuff, Michelsberg	B 763	$10,800 \pm 100$

Bohemia, Czech Republic

Argiudoll, Kozojedy, Jicin District	B 437–440	$\leq 4150 \pm 90$
Agiudoll, Smince, Uradec, Kralové District	B 441	4020 ± 60
Hapludoll, Brazdim, Prahoviphod, Tilery District	B 442–444	$\leq 3430 \pm 65$
Vertisol (Smonitza), Prunevor, Choumtov District	B 445–447	$\leq 6370 \pm 65$
Hapludoll, Chernozem, Zozelice, Königgrätz District	B 485–487	$\leq 1460 \pm 110$
Aquoll, Zozelice II, Königgrätz District	B 488–490	$\leq 1950 \pm 70$

Moravia, Czech Republic

Argiudoll, Brnicko, Olmütz District	B 491, 495	$\leq 4055 \pm 80$
Udoll, sandy loess, Moravia	B 496–499	$\leq 3610 \pm 75$
Udoll, Chernozem, Bilorice	B 500, 600–603	$\leq 2450 \pm 70$
Vertic Udoll (Vertisol-like Chernozem), Tegel, Pole, Brünn	B 604–607	$\leq 4070 \pm 70$

Material dated	Lab code(s)	Age (yr BP)
<i>Russia</i>		
Hapludoll, Vermudoll, Chernozem, Orel	B 455–457	$\leq 4720 \pm 60$
Udoll, Chernozem, Charkov	B 460–462	$\leq 5920 \pm 140$
Udoll, Chernozem, Zaparorskje	B 464–466	$\leq 3270 \pm 80$
Udoll, Chestnut soil, Askania Nova	B 468–470	$\leq 2710 \pm 80$
<i>Tunisia</i>		
Vertisol, Beja (deepest humus layer)	B 433	2920 ± 40
Vertisol, Zouarine, Ebba Ksour	B 434	3680 ± 65
<i>Finland</i>		
Sandy humus 75 cm deep, Kevo, North Finlandia	B 449	2350 ± 70
<i>Spitzbergen</i>		
Fossil A horizon, 55 cm deep, Hohenstaufen Plateau, Barents I	B 432	3040 ± 80
<i>Germany</i>		
SOM fractions		
Chernozem, Söllingen, total organic matter	B 6A	2100 ± 80
Chernozem, Söllingen, humic acid extract only	B 6B	2240 ± 80
Spodosol, Scherpenseel, brown humic acid fraction	B 138	2060 ± 60
Spodosol, Scherpenseel, gray humic acid fraction	B 139	1720 ± 60
Spodosol, Scherpenseel, rim of gravel pit	B 366	2930 ± 40
Spodosol, Scherpenseel, hymatomelanic acid fraction	B 367	1580 ± 80
Spodosol, Scherpenseel, brown humic acid fraction	B 368	2530 ± 60
Spodosol, Scherpenseel, gray humic acid fraction	B 369	2980 ± 70
Spodosol, Scherpenseel, humin fraction	B 370	2850 ± 70
Histosol, Kalkarer Moor, fulvic acid fraction	B 360	4270 ± 80
Histosol, Kalkarer Moor, hymatomelanic acid fraction	B 361	4510 ± 80
Histosol, Kalkarer Moor, brown humic acid fraction	B 362	5380 ± 80
Histosol, Kalkarer Moor, gray humic acid fraction	B 363	5970 ± 40
Histosol, Kalkarer Moor, humin fraction	B 364	3490 ± 70
Histosol, Kalkarer Moor, humus coal fraction	B 365	4460 ± 80
Aquoll, pseudogley-Chernozem, Adlum, fulvic acid fraction	B 397	1800 ± 60
Aquoll, pseudogley-Chernozem, hymatomelanic acid fraction	B 398	1390 ± 70
Aquoll, pseudogley-Chernozem, brown and gray humic acid fraction	B 399	4890 ± 50
Aquoll, pseudogley-Chernozem, humin fraction	B 401	2980 ± 70
Aquoll, pseudogley-Chernozem, humus coal fraction	B 402	2810 ± 60

University of Bonn, Natural Radiocarbon Measurements IV (Scharpenseel and Pietig 1971)

Soil Profiles

Hungary

Udalf, Chernozem, Erd, southeast Budapest	B 611–615	$\leq 9680 \pm 100$
Udalf, Chernozem in sand-loess, Balatonföldvár, south bank of Lake Balaton	B 625–627	$\leq 4690 \pm 60$
Udalf, Chernozem in fine sandy loess, Koszarhegy	B 633–636	$\leq 4575 \pm 60$
Udalf, meadow soil, Boconad, east-northeast Budapest	B 616–620	$\leq 5260 \pm 50$
Eutrochrept, Brown earth in loess, Kapoly	B 628–632	$\leq 3990 \pm 70$
Hapludalf, Nagyrécsce, southeast Budapest (below 112 cm, ^{14}C age jumps to $16,750 \pm 290$)	B 621–624	$\leq 2870 \pm 115$
Natrustalf, Hortobagy, southwest Debrecen, Rusta Plain	B 648–651	$\leq 10,080 \pm 160$
Histosol, bog soil, Nadasdlaany, northeast of Lake Balaton	B 637–647	$\leq 9300 \pm 340$

Russia

Udoll, deep Chernozem, Orel (240 cm)	B 458	$12,470 \pm 360$
--------------------------------------	-------	------------------

Material dated	Lab code(s)	Age (yr BP)
<i>Ireland</i>		
Plaggept, Donoure, Ardfield	B 660	480 ± 50
Plaggept, Cahesetrant, Dingle	B 661–663	≤ 2135 ± 50
<i>Australia</i>		
Ustoll, Krasnozern, Wollongbar	B 664	1400 ± 60
Ustoll, Krasnozern, Babbinsbar	B 679–680, 766	≤ 6010 ± 100
Ustoll, Krasnozern, Beechmont	B 681, 767	≤ 3850 ± 360
Krasnozern, Binjour on lateritic plateau	B 682 and 768	≤ 1780 ± 70
Krasnozern, Gurgena on lateritic plateau	B 683 and 769	≤ 570 ± 70
Krasnozern, Coulston Lakes I, valley plain	B 684 and 770	≤ 950 ± 50
Krasnozern, Coulston Lakes II, valley plain	B 685 and 771	≤ 980 ± 50
Krasnozern, Maleny, dissected plateau, 15 cm	B 685	150 ± 50
Krasnozern, Memerambi, dissected plateau	B 687 and 772	4000 ± 150
<i>Argentina</i>		
Vertisol, Entre Rios, Concepción del Uruguay	B 804–813	≤ 11,160 ± 150
<i>Germany</i>		
Humod, Hauset/Hergenrath	B 652–656	≤ 2240 ± 50
Placorthod, Schliffkopfhaus	B 859–861	≤ 2280 ± 60
Andosol, Brown earth in trachytic ash, 200 m south of Andernach-Kruft road	B 818–822	≤ 4470 ± 70
Andosol, Brown earth in trachytic ash, Neuwied basin	B 823–828	≤ 4210 ± 80
Inceptisol, Brown earth in trachytic ash, Niedermendig	B 829	3990 ± 100
Mardelle with peat-carbon, Pirmasens	B 1132	900 ± 60
<i>Czech Republic</i>		
Udalf, Chernozem (buried), Sedlec	B 843–845	≤ 12,480 ± 120
Udalf, Chernozem (not buried), Sedlec	B 843–845	≤ 5910 ± 60
Udalf, Chernozem (buried) underlying Holocene Chernozem	B 847	25,730 ± 550
Udalf, Chernozem, Chabry (Holocene)	B 848–849	≤ 5810 ± 60
Udalf, Chernozem, Chabry (Pleistocene)	B 850–853	≤ 17,520 ± 540
Udalf, Chernozem, Chabry (some locations, deepest point)	B 854	25,630 ± 710
<i>Italy</i>		
Fossil steppe soil, buried, Vintschgau, Bolzano	B 864	5270 ± 60
<i>SOM Fractions</i>		
<i>Germany</i>		
Udalf, Chernozem, Söllingen, fulvic acids	B 670	104.3 ± 0.5 pMC
Same soil, brown- and gray humic acids	B 671	1560 ± 70
Same soil, humin and humus coal	B 672	2275 ± 60
Michelsberg, fulvic acids	B 673	4310 ± 210
Same soil, brown and gray humic acids	B 674	7600 ± 220
Same soil, humins	B 675	6930 ± 80
Same soil, humus coal	B 676	6830 ± 100
SOM of Udalf, Chernozem, Söllingen, different centrifugal gravity		
500 rpm	B 831	2000 ± 50
2000 rpm	B 832	1870 ± 70
3000 rpm	B 833	1680 ± 50
4000 rpm	B 834	1820 ± 100
5000 rpm	B 835	1770 ± 60
5400 rpm	B 836	1780 ± 50

Material dated	Lab code(s)	Age (yr BP)
Hapludalf, Inden, fossil A horizon in B _t (argillic horizon), varying texture fractions		
>60 μ ϕ	B 1133	3170 $\pm$ 80
60–2 μ	B 1134	3450 $\pm$ 80
2–1 μ	B 1135	3280 $\pm$ 80
1–0.5 μ	B 1136	2790 $\pm$ 770
0.5–0.25 μ	B 1137	2500 $\pm$ 70
<i>Subhydrous Soils, Gytija</i>		
<i>Germany</i>		
Schalkenmeerer Maar, 0–230 cm	B 781–802	$\leq$ 4600 $\pm$ 70
Lake of Selent, gytija, 0–560 cm	B 882–908	$\leq$ 6800 $\pm$ 150

University of Bonn, Natural Radiocarbon Measurements V (Scharpenseel and Pietig 1973a)

Soil Profiles

Israel

Xeralf, Hamra, below dune cover, Tel Aviv–Haifa highway, corner of Richlon Street	B 688–691	$\leq$ 14,740 $\pm$ 200
Xeralf, same location, foot of slope, no continuous dune cover	B 692–695	$\leq$ 10,470 $\pm$ 130
Xeralf, same location, emerging into recent soil, no dune cover	B 696–699	$\leq$ 11,860 $\pm$ 150
Xeralf, Hamra, in dune material with lime concretions (Curcar), Wingate Institute of Athletics, near Tel Aviv–Haifa highway	B 701–706	$\leq$ 17,920 $\pm$ 180
Xeralf, calcinated root in Hamra, street to Ecron	B 709	16,930 $\pm$ 240
Curcar–Hamra sequence, Rehovot, corner of Main Street and Batia Markov	B 711	14,920 $\pm$ 230
Aqualf, Nazas, Jashresh	B 712, 713	$\leq$ 2960 $\pm$ 220
<i>Soil Associations on Limestone</i>		
Xeroll on soft limestone, Mitzpe Mesua	B 742, 743	$\leq$ 1500 $\pm$ 50
Xerochrept, calcareous brown earth on harder limestone, near Mitzpe Mesua	B 744	2040 $\pm$ 60
Rhodustalf–Terra Rossa on hard limestone, Mattah	B 745	2420 $\pm$ 70
Xeralf with recalcification (Husmas soil), Agricultural School, Kanot	B 748, 749	$\leq$ 5050 $\pm$ 160
Xeroll, Burozem, overlying Xeralf with recalcification (Husmas), Kibbutz Ruchama		
Xeroll	B 751, 752	$\leq$ 9000 $\pm$ 200
Underlying recalcified Xeralf	B 753–755	$\leq$ 13,400 $\pm$ 190
Fossil clay below recalcified Xeralf	B 757	19,920 $\pm$ 340
Dark brown soil in calcareous dune sand, chesnut-like soil, Mafkiim, south of Ashkalon	B 750	4760 $\pm$ 80
Palexeroll near Shuval, road from Beer Shewa to Tel Aviv	B 760–762	$\leq$ 15,470 $\pm$ 230
Paleorthid in loess, Eshel Hanassi, near Beer Sheva	B 758–759	$\leq$ 4020 $\pm$ 220
Xerert, west Plain of Barkai, road from Afula to Hedra	B 715–718	$\leq$ 1850 $\pm$ 70
Xerert, Valley of Jesrael	B 719–723	$\leq$ 2760 $\pm$ 80
Xerert, Valley of Jesrael, drainage ditch	B 724–728	$\leq$ 7440 $\pm$ 80
Xerert, El Hamma	B 729–734	$\leq$ 19,430 $\pm$ 350
Xerert, near Kefar Manachem Kibbutz	B 735–741	$\leq$ 16,100 $\pm$ 270
Xerert along Syrian Quarantine Station and Jordan flow into Lake Genezareth	B 773–776	$\leq$ 2670 $\pm$ 100

Bulgaria

Vertic Albaqualf, Glavatsi	B 1071–1074	$\leq$ 8050 $\pm$ 80
Udic Haplustoll, leached Chernozem, near Gorni Dubnik	B 1075–1079	$\leq$ 11,100 $\pm$ 90

Material dated	Lab code(s)	Age (yr BP)
Typic Caciustoll, calcareous Chernozem, northwest Pleven	B 1080–1085	$\leq 5760 \pm 90$
Paleustalf, Gray Forest soil, 12 km south of Pleven	B 1086–1092	$\leq 18,920 \pm 340$
Udic Haplustalf, Gray Forest soil, Kozlevo–Shoumen	B 1093–1097	$\leq 3370 \pm 100$
Udertic Paleustalf, degraded Cinnamon Forest soil, near Bourgas	B 1098–1104	$\leq 14,150 \pm 240$
Vertic Albaqualf, Cinnamonic, podzolized Planosol, Badeshte, Thracian plain	B 1105–1108	$\leq 9850 \pm 240$
Pellustert, Smonitsa-Vertisol, Sredets, Thracian Plain	B 1108–1114	$\leq 16,140 \pm 460$
Chromic Luvisol, Cinnamonic Forest soil, Koren	B 1115–1119	$\leq 8480 \pm 140$
<i>Sardinia</i>		
Xerert (aquic), Plane de Cuga, Ittiri, southwest Sassari	B 1154–1157	$\leq 570 \pm 50$
Chromoxerert, river terrace, Rio Mannu di S. Vero	B 1141–1164	$\leq 3870 \pm 130$
Pelloxerert, Arziadas, Tuvoi	B 1167–1174	5430 ± 100
Chromoxerert, Monastir, 20 km north of Cagliari	B 1175–1178	$\leq 2270 \pm 70$
Pellustert, Nurallo	B 1180–1187	$\leq 3220 \pm 80$
<i>Sicily</i>		
Chromoxerert, Scalilli near Corleone	B 1326–1331	$\leq 3030 \pm 90$
Pelloxerert, Plana di Scala, Corleone	B 1332–1338	$\leq 3670 \pm 100$
Pelloxerert, Aziena Sporacia, Farm, Università di Palermo	B 1339–1351	$\leq 5470 \pm 120$
Pelloxerert, Aziena Sporacia, Farm, Università di Palermo	B 1352–1363	$\leq 15,160 \pm 370$
<i>Romania</i>		
Humic horizon underlying Danube alluvium, near Bucharest	B 1379–1385	$\leq 8070 \pm 130$
<i>Germany</i>		
Aqualfic Fragiorthod, Amelsbüren (below 160 cm, $15,170 \pm 230$)	B 1363–1369	$\leq 1980 \pm 80$
Placorthod, Grindenschwarzwald, Gernsbach	B 1371–1377	$\leq 2550 \pm 70$

University of Bonn, Natural Radiocarbon Measurements VI (Scharpenseel and Pietig 1973b)

Soil Profiles

Spain

Xerert, La Rinconada (Seville), Casas vacas	B 1388–1392	$\leq 6470 \pm 130$
Xerert, Carmona, km 10.5 Carmona-Arahal Street	B 1393–1397	$\leq 6650 \pm 120$
Xerert, Los Palacios, Torbiscal Farm	B 1398–1406	$\leq 8850 \pm 130$
Xerert, El Arahal, Estrella Farm, 40 km east of Seville	B 1407–1413	$\leq 3480 \pm 100$
Xerert, Carmona, La Motilla Chica Farm	B 1417–1423	$\leq 3440 \pm 290$

Portugal

Xerert, Black Barros, Beja	B 1425–1432	$\leq 3070 \pm 140$
Vertic Xerochrept, Safara-Camauros Farm	B 1433–1437	$\leq 2430 \pm 70$
Xerert, Safara field	B 1438–1442	$\leq 2230 \pm 190$
Red Xerert, Salvada-Beja	B 1443–1446	$\leq 1380 \pm 70$
Roman grain silo in Xerert, Beja-Serpa	B 1447	5150 ± 100
Dark red Xerert, Montes Velhos Aljustrel	B 1452–1457	$\leq 2240 \pm 80$
Red-brown Xerert, Terra Grande de Lisboa, Tapaiao da Ajuda, university campus near Lisbon	B 1458–1463	$\leq 3170 \pm 80$

Australia

Ustert, Lillimur, Kaniva District, Victoria, Gilgai mound	B 1466–1485	$\leq 5880 \pm 180$
Ustert, Lillimur, Kaniva District, Victoria, Gilgai depression	B 1486–1507	$\leq 2280 \pm 150$
Ustert, Miram, Kaniva District, Victoria, Gilgai mound	B 1508–1527	$\leq 8530 \pm 250$
Ustert, Miram, Kaniva District, Victoria, Gilgai depression	B 1528–1548	$\leq 8450 \pm 260$

Material dated	Lab code(s)	Age (yr BP)
<i>Germany</i>		
Fossil A horizon, Eberspoint, 10 km west of Freising	B 1464	6160 $\pm$ 90
Fossil A horizon, terrace brown earth, 5 km south of Siegenburg, Abens Valley, north Bavaria	B 1648	2270 $\pm$ 70
Charcoal from different fireplaces	B 1648, 1649	$\leq$ 1460 $\pm$ 70
Hapludalf in flood loam, lower terrace of the Rhine River	B 1652	5080 $\pm$ 110
Fossil A horizon below Hapludalf, same location	B 1653	8230 $\pm$ 470
Bituminous coating on gravel in younger Isar terrace, Ascholding, Wolfratshausen Basin	B 1657	28,320 $\pm$ 470
Umbrept (Plaggept?), Würmian basal moraine of Isar foreland glacier, Unterbuchen, Bavaria	B 1669–1672	$\leq$ 3800 $\pm$ 80
Root in Maintag gravel pit, Upper Franconia	B 1700	1810 $\pm$ 70
Fossil A horizon in Maintag gravel pit, Upper Franconia	B 1801	7980 $\pm$ 110
Root, vertical in sediment, Maintag gravel pit	B 1802	4360 $\pm$ 90
Fossil A horizon, covered by Pleistocene terrace material, Kärlich, Rhineland	B 1659	30,450 $\pm$ 1270
Humus in silty A horizon, below tuffaceous material, north slope of Bausenberg, Lengsdorf, Rhineland	B 1699	22,360 $\pm$ 510
Fossil A horizon, gravelly gley, Gammelsbach valley, North Eberbach, Odenwald	B 1815	1350 $\pm$ 110
<i>Soil Fractions</i>		
Fossil A horizon, underlying Allerød trachytic tuff, charcoal only	B 1681	11,550 $\pm$ 160
Same location, particle size fraction > 0.2 mm	B 1681	7570 $\pm$ 190
Same location, particle size fraction 63–2 μ	B 1684	10,950 $\pm$ 150
SOM from continuous extraction, successive fractions (1st extraction: 0.1N H_2SO_4 ; 2nd extraction: 0.15 M $\text{Na}_4\text{P}_2\text{O}_7$)		
Udalf Aseler Holz:	B 1809	1030 $\pm$ 100
	B 1810	4130 $\pm$ 270
	B 1811	4970 $\pm$ 80
Spodosol (Humod) gravel pit Weber, Scherpenseel (Dutch border):	B 1688	1400 $\pm$ 140
	B 1689	1160 $\pm$ 70
	B 1691	1460 $\pm$ 80
	B 1692	1350 $\pm$ 110
	B 1693	1510 $\pm$ 130
	B 1697	1290 $\pm$ 70
<i>Subhydrous Soils</i>		
Gyttja, bottom of Schalkenmehrer Maar, Eifel I	B 994–1005	$\leq$ 12,130 $\pm$ 140
Gyttja, bottom of Schalkenmehrer Maar, Eifel II	B 1007–1025	$\leq$ 12,160 $\pm$ 130
Gyttja, bottom of Schalkenmehrer Maar, Eifel IV	B 1026–1045	$\leq$ 12,130 $\pm$ 140
Gyttja, bottom of Schalkenmehrer Maar, Eifel V	B 1046–1064	$\leq$ 3840 $\pm$ 80
Gyttja, bottom of Lake of Selent, Holsteen I	B 869–880, 1122–1125	$\leq$ 1670 $\pm$ 100
2 m below end of case lot (sampling instrument)		10,170 $\pm$ 140
Gyttja, bottom of Lake of Selent, Holsteen III	B 911–932, 963–964	$\leq$ 24,830 $\pm$ 970
Gyttja, bottom of Lake of Selent, Holsteen IV	B 933–959	$\leq$ 17,390 $\pm$ 460
On-shore profile, Lake of Selent, Holsteen IV (opposite Profile IV)	B 1127–1131	$\leq$ 2670 $\pm$ 70
Gyttja, bottom of Lake of Selent, Holsteen V	B 967–976	$\leq$ 14,180 $\pm$ 670
Gyttja, bottom of Lake of Selent, Holsteen VI	B 977–993	$\leq$ 10,080 $\pm$ 520
at 340 cm depth		30,930 $\pm$ 1150

Material dated	Lab code(s)	Age (yr BP)
University of Bonn, Natural Radiocarbon Measurements VII (Scharpenseel and Pietig 1974)		
<i>Germany</i>		
<i>Subhydrous Soils</i>		
Gyttja, bottom of Lake Laach, Eifel I	B 1572–1590	$\leq 23,010 \pm 460$
Gyttja, bottom of Lake Laach, Eifel II	B 1591–1607	$\leq 20,500 \pm 380$
Gyttja, bottom of Lake Laach, Eifel III	B 1609–1622	$\leq 22,070 \pm 440$
Gyttja, bottom of Lake Laach, Eifel IV	B 1623–1636	$\leq 10,700 \pm 140$
Gyttja, bottom of Lake Laach, Eifel V	B 1637–1643	$\leq 20,130 \pm 300$
Gyttja, bottom of Meerfelder Maar, Eifel I	B 1818–1832	$\leq 6800 \pm 100$
Gyttja, bottom of Meerfelder Maar, Eifel II	B 1838–1838	$\leq 9140 \pm 120$
Gyttja, bottom of Meerfelder Maar, Eifel III	B 1839–1849	$\leq 7380 \pm 90$
Gyttja, bottom of Meerfelder Maar, Eifel IV	B 1850–1859	$\leq 5550 \pm 90$
Gyttja, bottom of Meerfelder Maar, Eifel V	B 1860–1867	$\leq 3520 \pm 80$
Gyttja, bottom of Meerfelder Maar, Eifel VI	B 1868–1876	$\leq 4050 \pm 80$
Gyttja, bottom of Pulvermaar, Eifel I	B 1877–1891	$\leq 8040 \pm 120$
Gyttja, bottom of Pulvermaar, Eifel II	B 1892–1903	$\leq 6720 \pm 110$
Gyttja, bottom of Pulvermaar, Eifel III	B 1904–1916	$\leq 6420 \pm 180$
Gyttja, bottom of Pulvermaar, Eifel IV	B 1917–1930	$\leq 4980 \pm 80$
Gyttja, bottom of Pulvermaar, Eifel VI	B 1931–1946	$\leq 5170 \pm 180$
Hamburg University, Radiocarbon Dates I (Scharpenseel, Pietig and Schiffmann 1976)		
<i>Germany</i>		
<i>Soil samples and soil profile samples</i>		
Argillic horizon of Hapludalf, Friesdorf near Bonn	H 1	5010 ± 280
South side of same pit, Friesdorf	H 2	3620 ± 70
Aquept, alluvial loess, Isar terrace, Landshut/Ergolding	H 4–7	$\leq 10,880 \pm 140$
Udoll high terrace of Isar, Landshut/Ergolding	H 8–10	$\leq 3190 \pm 80$
Hapludalf, high terrace of Isar, Landshut/Ergolding	H 11–13	$\leq 3320 \pm 70$
Koislhof, lower to upper nether terrace, Isar River	H 14–25	$\leq 10,680 \pm 140$
North Bavaria, north of Danube, humic colluvium on old Riss moraine north of Landsberg	H 26–31	$\leq 4340 \pm 70$
Mollisol in steep bank of Lech River, Kaufering	H 32–36	$\leq 4410 \pm 80$
Fossil organic matter in tuffaceous limestone, Neuenried, near sources of Mindel River	H 37–43	$\leq 4580 \pm 90$
Fossil argillic horizon between terrace gravel and loess loam, Fellheim brick factory, Iller River	H 44–46	$\leq 4340 \pm 130$
Eutochrept, Hohentrüdigen on Dogger (Jurassic)	H 47–49	$\leq 15,730 \pm 410$
Vertisol on Tertiary deposits in the Ries, Maihingen	H 50–55	$\leq 11,820 \pm 170$
Aquic Vertisol on younger Ries lake deposits, Pfäfflingen	H 56–60	$\leq 10,470 \pm 130$
Aquic Vertisol, Ries lake deposits Wechingen	H 61, 62	$\leq 3860 \pm 80$
Vertic Brown earth (Inceptisol), Ries lake deposits, Munningen	H 63, 64	$\leq 4840 \pm 60$
Folist, Nether Moor, Koislhof, near Landshut	H 64	$10,960 \pm 180$
Udalf Smonica/Chernozem, Lötzeweiler, Rheinhessen	H 66, 67	$\leq 5430 \pm 90$
	H 68, 69	$\leq 2580 \pm 70$
Mollisol/Hapludalf, Dorla I/2, Fritzlar-Gudensberg	H 70	3300 ± 70
Mollisol/Hapludalf, Lohne I, north of village of Lohne	H 71	2040 ± 60
Mollisol/Hapludalf, Wehren I/2, Wehren-Kirchberg	H 72	2890 ± 70
Mollisol/Hapludalf, Wehren I/3, Wehren-Kirchberg	H 73	4740 ± 80
Mollisol Heuchelheim, overlying degraded Chernozem	H 74	3660 ± 90
Colluvium overlying degraded Chernozem, Bleichen II	H 75	6480 ± 80
Loess on solifluction debris, south of Höingen, Vogelsberg	H 76	$10,550 \pm 130$
Humus in solifluction debris, 300 m east of Taufstein, Vogelsberg	H 77, 78	$\leq 5360 \pm 80$

Material dated	Lab code(s)	Age (yr BP)
High flood loam, Main River, Kelsterbach-Lerchenberg, Kiesgrube Schmidt	H 79, 80	$\leq 7900 \pm 100$
Fossil epipedon, on Allerød trachyte, Buchslag, plain south of Main River	H 81	$10,000 \pm 210$
Colluvial loam, Hochheim, Hattersheim, valley sediments	H 82–93	$\leq 6970 \pm 100$
Colluvium, Waldeck (Freienhagen, Ippinghausen)	H 94, 95	$\leq 820 \pm 110$
Spodosol, "Raseneisengley", Black Forest, Altglashütten	H 96–101	$\leq 3120 \pm 90$
Spodosol, Black Forest, between Breitnau and Hollertal	H 109–112	$\leq 1120 \pm 60$
Charcoal and fossil Brown earth, Trescher, Black Forest	H 113–117	$\leq 1040 \pm 50$
Low moor peat, charcoal, paleosol on Riss boulder marl, Altenerding, Bavaria	H 118–122	$\leq 30,340 \pm 1130$
Cliff wall at Baltic Sea coastline, Heiligenhafen	H 123–127	$\leq 4020 \pm 90$
Fossil Chernozem (Udalf), outskirts of Homberg, Kassel County	H 128	5650 ± 80
Fossil Chernozem (Udalf), Worms I, near town of Worms	H 129	3530 ± 70
Bones, wood, sediments believed from Roman times, Xanten	H 130–133	$\leq 3150 \pm 70$
Humic soils near Dutch border, organic matter from plaggen or deep ploughing, total samples and 6 N HCl hydrolysis residue		
Walbecker Heide	H 134, 135	$\leq 9580 \pm 100$
Maasaue near Velden	H 136, 137	$\leq 2070 \pm 90$
Haus Beerenbruck	H 138, 139	$\leq 1860 \pm 90$
Schandelah	H 140, 141	$\leq 1440 \pm 60$
Walbeck	H 142, 143	$\leq 1880 \pm 130$
Subhydrous soil samples, Baldeney lake, Essen-Werden, south shore	H 183–188	$\leq 12,160 \pm 270$
Clay pit Kaerlich, wood sample underlying Allerød and Holocene soil	H 189	$29,600 \pm 1150$
<i>Wales</i>		
Placorthods, Hiraethog, Denbighmors, Denbigshire	H 103–108	$\leq 5810 \pm 150$
Peny Gwrydd Pass, Snowdonia National Park, Caernarvonshire	H 105–106	$\leq 1770 \pm 80$
<i>Austria</i>		
Low moor (Histosol), Neumarkt, Am Wallersee, Salzburg	H 144–145	$\leq 3770 \pm 70$
<i>Former USSR</i>		
Predkaokadzye Chernozem (Ustoll), south Rostov	H 146	$11,330 \pm 980$
Chernozem, lower terrace of Don River, from krotovinas	H 147	5250 ± 150
Meadow Chernozem in Azow system	H 148	6510 ± 260
Dark Gray Forest soil, Zhiguli	H 149	5490 ± 280
Pelehymorphic Chernozem, Zhiguli, krotovina	H 150–151	$\leq 4750 \pm 80$
Chernozem Privolzhye Upland, Karlinsky Far, Ulyanovsk	H 152	5390 ± 120
Chernozem near Solod Meadow, Ulyanovsk Agricultural Institute campus	H 153	5550 ± 140
Gray Forest soil, Vysokogorsky, Tatar SSR	H 154	7890 ± 680
Chernozem, Tour I, 10th International Congress on Soil Science, Moscow	H 155–156	$\leq 4540 \pm 80$
<i>Tunisia</i>		
Paleosol in pasture, Ain Oktor, Korbous	H 157	2250 ± 60
Fossil horizons, Ferme Korba, pasture experiment	H 158–160	$\leq 2300 \pm 100$
Fossil horizons near Ferme Korba, pasture experiment	H 161–162	$\leq 2470 \pm 70$
Fossil horizons, Ferme Ennasser near Bir Bou Rekba	H 163–164	$\leq 4230 \pm 60$
Fossil horizon near Enfida, km 52, road to Kairouan	H 165	4510 ± 80
Fossil horizon, Medjerdah alluvium near Ghardimaou bridge	H 166–167	$\leq 8000 \pm 180$
Fossil horizons in Medjerdah alluvium, near Bou Salem	H 168–171	$\leq 7800 \pm 160$
Fossil horizons, Medjerdah River, Bou Huertma River	H 172–174	$\leq 2400 \pm 120$
Pale-Xerochrept, Sol Brun à Croûte (crust faintly developed), Medjerdah Valley, hill site	H 175–182	$\leq 27,160 \pm 1090$

Material dated	Lab code(s)	Age (yr BP)
Hamburg University, Radiocarbon Dates II (Scharpenseel and Schiffmann 1977)		
<i>Argentina</i>		
Argiudoll, Brunizem, Rafaela	H 231–237	$\leq 480 \pm 80$
Argiudoll, Brunizem, Esperanza	H 238–244	$\leq 2030 \pm 80$
Argiudoll, slightly planosolic Brunizem, Angel Gallardo	H 246–252	$\leq 2780 \pm 80$
Argiudoll, Profile B9, Villa Concepción del Tío	H 253–257	$\leq 1870 \pm 90$
<i>Tunisia</i>		
Paleosol in Bou Huertma alluvium	H 258–259	$\leq 4930 \pm 80$
<i>Germany</i>		
Mud in old river bed of Ems River, on top of low moor, Rietberg	H 280–281	$\leq 6680 \pm 90$
Ochrept, Holzkirchen, near Munich-Salzburg highway	H 631–634	$\leq 2510 \pm 50$
Humic acid samples of Lower Saxonian soils	H 260–279	$\leq 19,800 \pm 710$
SOM fractions, Spodosol, Scherpenseel, near Dutch border	H 282–285	$\leq 5410 \pm 90$
SOM fractions, Udoll, Aseler Wald, near Hildesheim	H 286–297	$\leq 3160 \pm 70$
SOM fraction, paleosol of loess, below trachytic tuff of Allerød volcanism	H 298–310	$\leq 11,360 \pm 150$
SOM fractions, vertic, clayey Histosol, Koislhof, lower terrace of Isar River	H 311–328	$\leq 13,140 \pm 200$
SOM fractions after repeated 6 HCl hydrolysis, Udoll from Asel clay pit near Hildesheim	H 623–630, 801	$\leq 3260 \pm 100$
SOM fractions after repeated 6 HCl hydrolysis, histic Udoll, Ergold-ing near Landshut	H 762–788, 800	$\leq 6110 \pm 90$
Sea level–coast line study based on peat dating, North Sea shore	H 765–776	$\leq 6130 \pm 240$
Humus in Elbe River alluvium, Billwerder-Allermöhe, south Hamburg, measurement of deposition date	H 791–799	$\leq 3370 \pm 100$

Hamburg University, Radiocarbon Dates III (Scharpenseel, Schiffmann and Hintze 1984)
Germany

Histic Hapludoll, 5 km south of Söllingen, 0–90 cm, at 5-cm intervals		
Carbonate-free soil	B 2255–2272	$\leq 6210 \pm 90$
6 N HCl hydrolysis residue	B 2401–433	$\leq 6370 \pm 80$
6N HCl hydrolyzate	B 2400–2428	$\leq 3240 \pm 70$
Acid from carbonate destruction	B 2438–2450	$\leq 3570 \pm 70$
Typic Hapludoll, Söllingen, near old windmill, 0–75 cm, at 5-cm intervals, carbonate-free soil	B 2275–2289	$\leq 2450 \pm 60$
6 N HCl hydrolysis residue	B 2476, 2478, 2484–2492, 2500, 2502, 2504	$\leq 3260 \pm 60$
6 N HCl hydrolyzate	B 75, 2477, 2483–2491, 2499, 2501, 2503	$\leq 40 \pm 60$
Acid from carbonate destruction	B 2459–2469	$\leq 240 \pm 90$
Eutochrept, near Hohentrüdingen, Jurassic Dogger, near Nördlinger Ries crater, taken in 5-cm intervals, 5 to 105 cm depth	H 635–654	$\leq 16,776 \pm 280$
Haplaquept on Isar River terrace, near Landshut, Ergolding, Bavaria, taken in 5-cm intervals, 0 to 90 cm depth	H 655–672	$\leq 5560 \pm 80$
Humic matter, coastline levee along Baltic coast, near Heiligenhafen	B 2367–2385	$\leq 6240 \pm 110$
Elbe River marsh series, Allermöhe, Vier and Marschlande, south of Hamburg	H 826–841	$\leq 3970 \pm 80$
(H 835, paleosol, 7420 $\pm$ 110)		

Material dated	Lab code(s)	Age (yr BP)
Peaty material, underlying valley of Elbe River, sampled in three cross-sections, east and west of Hamburg	H 1393–1406	$\leq 8140 \pm 100$
<i>Australia</i> (see also B 664 to 772, Scharpenseel and Pietig (1973b: 258–263))		
Vertisol (Chromustert), Chinchilla	H 674–702	$\leq 9850 \pm 170$
Vertisol (Chromustert), Paget	H 734–758	$\leq 11,570 \pm 210$
Eutrustox (Krasnozem) Gabbinbar (H 731, 200–220 cm, 7420 ± 110)	H 719–726	$\leq 1810 \pm 80$
Eutrustox (Krasnozem), Beechmont (subtropical rainforest)	H 703–711	$\leq 2020 \pm 70$

Hamburg University, Radiocarbon Dates IV (Scharpenseel, Schiffmann and Becker 1984)

Soil Samples and Profiles

Tunisia

Fossil gyttja, northwest Degache, Chott el Rharsa	H 1029	2420 ± 70
Paleoargid, near Algerian border, underlying fringe of dunes	H 1030	$22,730 \pm 400$
Paleosol in terrace, Oued Lakarit	H 1031	8050 ± 100
Buried Argixeroll, 12 km from Ksour Essaf	H 1032	3470 ± 70
Tirsoid Xerert, Enfida, Station, Amélioration des Parours	H 1033	4550 ± 80
Paleroll, 18 km from Tadjerouine toward Le Kef	H 1034	7960 ± 110
Saem profile fossil horizon 180 cm deep	H 1035	8520 ± 180
Dates of paleosols from perhumid to Saharian climate, 20 km west of Nefta	H 1222–1223	$\leq 10,260 \pm 120$
North rim of Chott Djerid, 13 km from Nefta	H 1224–1226	$\leq 4330 \pm 90$
Humic layer, gravel terrace, rim of Chott	H 1227	1950 ± 60
Paleosol, street bridge G P 16, Kebili to Gabes, 62 km west of Gabes	H 1229	920 ± 80
Polyphasic steppe soil, bank of Oued Ersifa, 25 km from Matmata	H 1233–1236	$\leq 6420 \pm 130$
Paleosol in bank of Oued, 5 km north of Remada, near GP 19	H 1237, 1239	$\leq 5200 \pm 160$
Paleosols in Oued Tatahouine, profile north of Fom Tatahouine	H 1240, 1247	$\leq 13,490 \pm 220$
Cut in sediments 300 m southwest of Matmata-Toujane Street	H 1248–1251	$\leq 13,530 \pm 370$
Sequence of paleosols, south of St. M 201 Gafsa-Moulares, cut in bank of Oued Melah	H 1264–1274	$\leq 5520 \pm 80$
Polyphasic paleosol, west El Frouch, Djebel Chambi, east of road to Serept	H 1275–1279	$\leq 7270 \pm 90$
Red relict soil in rock crevices, Sta. Bordj Chambi, Djebel Chambi	H 1283	4080 ± 80
Polyphasic paleosol, ca. 800 m from H 1275–1279	H 1285–1292	$\leq 4880 \pm 80$
Cut in bank of Oued Bou Hamid, foot of Djebel Semmama	H 1295, 1304	$\leq 3070 \pm 90$
Bank of Oued Bou Hamid, profile 200 m downstream from H 1295–1304	H 1305–1311	$\leq 6860 \pm 100$
	(H 1311 300 cm)	$14,530 \pm 250$
Transition to terrace at base of previous profile	H 1312	9920 ± 120
Organic matter in Oued Bou Hamid terrace, opposite bank to profile H 1305–1312	H 1313–1318	$\leq 4670 \pm 90$
Duplex Vertisol, northwest Jendouba, north of street to Chamtau, before Satfoura	H 1319–1324	$\leq 6760 \pm 90$
Polyphasic paleosol, bank of Oued Ogla, 2 km west of GP 17, Le Kef-Tadjerouine, north bank	H 1326–1330	$\leq 5550 \pm 80$
Mejerdah alluvium, east Tebourba	H 1334–1340	$\leq 5850 \pm 90$
Alluvium of Oued Miliane, north of street Pont du Fahs-Smindja, 10 km from Pont du Fahs	H 1341–1346	$\leq 3350 \pm 90$
Paleosol in Wadi north of GP 3, Kairouan to Sbeitla	H 1347–1352	$\leq 4030 \pm 90$
Cut in alluvium of Oued Melize, south of GP 6, Jendouba to Ghardimaou, near bridge	H 1358–1364	$\leq 11,020 \pm 130$
West of GP 1, Tunis-Sfax, 84 km from Sousse, near crossing to Hammamet Road cut	H 1365–1367	$\leq 780 \pm 80$

Material dated	Lab code(s)	Age (yr BP)
Paleosol in bank of Oued Guilene, east of GP 12, Haffouz to Maktar, near bridge	H 1369	1040 ± 80
Paleosol in bank of Oued Hatab, south of GP 4, Maktar to Tebessa, 300 m before crossing with MC 71	H 1371–1377	≤ 8080 ± 130
Paleosol in Bank of Medjerdah River, 500 m east of Ghardimaou Bridge (H 1381, 100 m west 15,000 ± 210)	H 1378–1381	≤ 3820 ± 80
<i>Sudan</i>		
<i>Vertisol profiles from Gezira</i>		
Profile southwest of Wad Shawer	H 1407–1420	≤ 5570 ± 100
Profile Selemme Hum Dalik Minor, Wad Mahmoud Major	H 1424–1434	≤ 6300 ± 90
Vertisol 400 m west of Sara Omeir Minor	H 1440–1454	≤ 10,370 ± 150
Vertisol, Madina Block 15	H 1455–1464	≤ 4390 ± 120
Vertisol, 1 km west of Meheiriba	H 1473–1487	≤ 5980 ± 170
Vertisol, Qoz er Ruheid	H 1488–1497	≤ 4940 ± 250
Vertisol, in terrace of White Nile, southeast rim of Tureina	H 1500–1506	≤ 5340 ± 100
Vertisol, 1 km west of Buweika	H 1511–1515	≤ 4310 ± 100
Vertisol, 8 km west of Mesou, direction of Secondary School, Laota Block	H 1521–1524	≤ 5560 ± 100
Vertisol, 3 km northeast of Esh Shaval	H 1530–1538	≤ 5930 ± 120
Vertisol, 3 km north of Tamsul	H 1539–1547	≤ 5320 ± 110
Vertisol, entic Pellustert, Hosh series, Ghabsaneblock	H 1012–1016	≤ 3360 ± 90
Vertisol, entic Chromustert, Wad Medani, fallow plot in Gezira Research Station	H 1017–1021	≤ 1740 ± 80
<i>Argentina</i>		
Argiudoll, soil from rolling pampa near Pergamino	H 1178	2810 ± 70
Typic Argiudoll, loess, Rojas series	H 1179	2220 ± 70
Typic Hapludoll, sandy loess, Segui series	H 1180	1650 ± 60
Pelludert, intersection of La Paz Highway and Feliciano Street, San Gustavo	H 1204–1208	≤ 4440 ± 110
Pelludert, Facultad de Agricultura, Universidad Nacional del Litoral (UNL) near Parana	H 1209–1212	≤ 2180 ± 90
Argiudoll, Facultad de Agricultura, UNL near Parana	H 1213	108 ± 1% pMC
Pelludert, 10 km southwest of General Campos, near main street	H 1214, 1550–1554, 1666	≤ 4140 ± 90
Argiudoll, Oro Verde 2, 1.25 km northwest of INTA Experimental Station, Parana, Campo anexo	H 1556	1910 ± 60
Argiudoll, Facultad de Agricultura, UNL near Parana, Febré 2	H 1549	1110 ± 70

REFERENCES

- Scharpenseel, H. W. and Becker-Heidman, P. 1992 Twenty-five years of radiocarbon dating soils: Paradigm of erring and learning. In Long, A. and Kra, R. S., eds., Proceedings of the 14th International ^{14}C Conference. *Radiocarbon* 34(3): 541–549.
- Scharpenseel, H. W. and Pietig, F. 1969 Radiokohlenstoff- und Tritium-Datierung von Boden und Wasser durch die Benzolmethode. *Geoderma* 2: 273–289.
- _____. 1970 Altersbestimmung mit dem Flüssigkeits Szintillations Spektrometer, Vereinfachte Benzolsynthese, auch aus kleinen CO_2 -Mengen. *Atompraxis* 16(3): 1.
- _____. 1968 University of Bonn natural radiocarbon measurements I. *Radiocarbon* 10(1): 8–28.
- Scharpenseel, H. W. and Pietig, F. 1969 University of Bonn natural radiocarbon measurements II. *Radiocarbon* 11(1): 3–14.
- _____. 1970 University of Bonn natural radiocarbon measurements III. *Radiocarbon* 12(1): 19–39.
- _____. 1971 University of Bonn natural radiocarbon measurements IV. *Radiocarbon* 13(2): 189–212.
- _____. 1973a University of Bonn natural radiocarbon measurements V. *Radiocarbon* 15(1): 13–41.
- _____. 1973b University of Bonn natural radiocarbon measurements VI. *Radiocarbon* 15(2): 252–279.
- _____. 1974 University of Bonn natural radiocarbon measurements VII. *Radiocarbon* 16(2): 143–165.

- Scharpenseel, H. W., Pietig, F. and Schiffman, H. 1976 Hamburg University radiocarbon dates I. *Radiocarbon* 18(3): 268–289.
- Scharpenseel, H. W., Pietig, F. and Tamers, M. A. 1968 University of Bonn natural radiocarbon measurements I. *Radiocarbon* 10(1): 8–28.
- Scharpenseel, H. W. and Schiffman, H. 1977 Hamburg University radiocarbon dates II. *Radiocarbon* 19(2): 170–182.
- Scharpenseel, H. W., Schiffman, H. and Becker, P. 1984 Hamburg University radiocarbon dates IV. *Radiocarbon* 26(3): 367–383.
- Scharpenseel, H. W., Schiffman, H. and Hintze, B. 1984 Hamburg University radiocarbon dates III. *Radiocarbon* 26(2): 196–205.

APPENDIX 1: ANNOTATED BIBLIOGRAPHY

(Publications based partly to completely on ^{14}C dates on soil and secondary carbonates in soils; arranged in chronological order)

Mückenhausen, E., Scharpenseel, H. W. and Pietig, F. 1968 Zum Alter des Plaggeneschs. *Eiszeitalter und Gegenwart* 19: 190–196.

- Description of Plaggepts
- Table of three ^{14}C -dated Plaggepts, in 10-cm intervals
- Table of 14 additional Plaggept ^{14}C -dating results

Scharpenseel, H. W., Ronzani, C. and Pietig, F. 1968 Comparative age determination on different humic-matter fractions. In *Isotopes and Radiation in Soil Organic Matter Studies*. Vienna, IAEA: 67–73.

- Fractionation method; table of ^{14}C dating, by 10-cm intervals, of Udoll, Aquoll, Rendoll, Hapludalf, Spodosol soils; table of comparative humus SOM fraction dates of Udalf, two Spodosols, Histosol and Aquoll, indicating highest C residence time in the Gray humic acid fractions

Scharpenseel, H. W., Tamers, M. A. and Pietig, F. 1968 Altersbestimmung von Böden durch die Radiokohlenstoffdatierungsmethode. *Zeitschrift für Pflanzenernährung und Bodenkunde* 119(1): 44–52.

- Tables with separate sets of ^{14}C dates: Mollisols of Germany, Hapludalfs, Rendolls and Histosols, Plaggepts, Histosols and Spodosols

Scharpenseel, H. W., Tamers, M. A. and Pietig, F. 1968 Altersbestimmung von Böden durch die Radiokohlenstoffdatierungsmethode. *Zeitschrift für Pflanzenernährung und Bodenkunde* 119(1): 34–44.

- Bomb-carbon curve of year-specific field-experimental crop samples and alcohol, distilled from wine of specific origin
- Description of sample preparation and method of benzene synthesis
- Reflection on rejuvenation of soil carbon
- Histogram of all ^{14}C dates known through 1967, identified by soil types and Quaternary geological origin

Scharpenseel, H. W. and Pietig, F. 1969 Altersbestimmung von Böden durch die Radiokohlenstoffdatierungsmethode. *Zeitschrift für Pflanzenernährung und Bodenkunde* 122(2): 145–152.

- Table of ^{14}C dates from Hapludalfs, probably formerly Udolls; dating of individual genetic horizons and subhorizons; the highest ^{14}C ages always occur in argillic horizons
- Table with ^{14}C dates of paleosols (Mollisols), some > 10,000 BP

Scharpenseel, H. W. 1972 Natural radiocarbon measurement of soil and organic matter fractions and on soil profiles of different pedogenesis. *Proceedings of the 8th International Conference on Radiocarbon Dating*. Wellington, New Zealand, Royal Society: 384–393.

- Table of ^{14}C dates on SOM fractions from Histosol, Spodosols, Aquoll, Udoll and a Paleudoll
- Table of ^{14}C dates of different particle fractions of silt and clay, compared with charcoal samples; highest age among particle fractions in fine silt and coarse clay
- Diagrams with date-points: regression line and correlation equation for available dates of Spodosols, Alfisols, Udolls, Plaggepts and Vertisols
- Age vs. depth curves of 39 Vertisols in diagram, split into six fields of different countries of origin

- Scharpenseel, H. W. 1972 Messung der natürlichen C-14 Konzentration in der organischer Substanz von rezenten Böden. Eien Zwischenbilanz. *Zeitschrift für Pflanzenernährung und Bodenkunde* 133(3): 241–263.
- Balance of work: Reference collection, 12 figures and 3 tables, summarizing all our ^{14}C -dating of soil samples, profile scans, SOM-fractions and integral regression/correlation curves
- Scharpenseel, H. W. 1974 Zur Berechtigung der Interpretation natürlicher Radiokohlenstoffmessungen an organischem Kohlenstoff CaCO_3 -reicher Böden. *Mitteilungen der Deutschen Bodenkundlichen Gesellschaft* 18: 198–201.
- Seven Udoll, Vertisol and Hapludf profiles from Czechoslovakia, Bulgaria, Italy and Germany; ^{14}C dating and $\delta^{13}\text{C}$ measurement in all genetic horizons
- Scharpenseel, H. W. 1975 Relative age sequence of fractions of soil organic matter. *Application of Nuclear Methods in Biology and Agriculture*. ENSA (European Society of Nuclear Methods in Agriculture) 5: 10–17.
- Table of SOM fraction dating, including Sephadex gel fractionation
 - Setup for preparative gel fractionation as a graph
- Scharpenseel, H. W. 1975 Relativalter und Sukzession von Fraktionen der organischen Bodensubstanz. *Mitteilungen der Deutschen Bodenkundlichen Gesellschaft* 22: 453–466.
- Soil fraction ^{14}C dating; all available fractionation methods are compared. Dimethylsulfoxide extract as well as 6N HCl hydrolysis residue seem to produce the highest ^{14}C ages
- Scharpenseel, H. W. and Schiffmann, H. 1977 Radiocarbon dating of soils, a review. *Zeitschrift für Pflanzenernährung und Bodenkunde* 140: 159–174.
- Review of the state of the art
- Scharpenseel, H. W. 1977 The search for biologically inert and lithogenic carbon in recent soil organic matter. *Soil Organic Matter Studies*. Volume 2. Vienna, IAEA: 193–200.
- All fractionation methods including gel fractions and repetitive 6N HCl-hydrolysis dating results and comparison. Repetitive acid hydrolysis seems to be the best method, but laborious sample preparation methods prohibit routine use.
- Blackburn, G., Sleeman, J. R. and Scharpenseel, H. W. 1979 Radiocarbon measurements and soil micromorphology as guides in the formation of Gilgai at Kaniva, Victoria. *Australian Journal of Soil Research* 17: 1–15.
- Four Vertisol profiles, sampled in 10-cm intervals; one mound and one depression profile each from Lillimur and Miram were ^{14}C -dated. Mound samples are superior in carbon residence time to depression samples.
- Meyer-Spasche, H. and Scharpenseel, H. W. 1980 Die Grundbelastung von Böden mit ^{14}C und dessen Transfer zum Menschen. *Zeitschrift für Pflanzenernährung und Bodenkunde* 143(5): 537–545.
- Bomb-carbon curve up to 1980, mainly from wine and grass
 - Bomb-carbon transfer pCi/gC in grass, milk and human hair
 - Natural ^{14}C activity by layer in a pine forest, pasture and cropland, also as ^{14}C activity pCi/gC
- Stephan, S., Berrier, J., De Petre, A. A., Jeanson, C., Kooistra, M. J., Scharpenseel, H. W. and Schiffman, H. 1983 Characterization of in situ organic matter constituents in Vertisols from Argentina, using submicroscopic and cytochemical methods. First report. *Geoderma* 30: 21–34.
- Carbon dating of Vertisol profiles as part of very detailed soil investigations
- Schleser, G. H., Bertram, H. G. and Scharpenseel, H. W. 1983 Aussagen über Bildungsprozesse tunesischer Kalkkrusten mittels $^{13}\text{C}/^{12}\text{C}$ -Isotopenanalysen. *Mitteilungen der Deutschen Bodenkundlichen Gesellschaft* 38: 573–578.
- Checking the *ad ascensum* and *ad descensum* hypothesis of calcrete formation by changes in ^{13}C concentration throughout a profile

- Scharpenseel, H. W. and Neue, H. U. 1984 Use of isotopes in studying the dynamics of organic matter in soils. *Proceedings on the Conference of Humus in Rice Soils*. IRRI, Philippines: 273–310.
- Comprising overview of tracer and low-level (^{14}C dating) studies in relation to organic-matter turnover and SOM-C residence time in terrestrial and submerged soils
- Scharpenseel, H. W. and Schiffman, H. 1985 Natürliche Radiokohlenstoffmessungen als Beitrag zur Definition rezent- oder paläoklimatischer Leithorizonte in Tunesien. *Zeitschrift für Pflanzenernährung und Bodenkunde* 148(2): 113–130.
- Large list of ^{14}C -dated paleosols and geomorphological indicator horizons; histogram of all soil and groundwater ^{14}C dates from Tunisia
 - Reflection on carbon residence time in different climate zones and on climate fluctuations favoring formation of soils and phreatic groundwater deposits
- Becker-Heidmann, P. and Scharpenseel, H. W. 1986. Thin layer $\delta^{13}\text{C}$ and D^{14}C monitoring of “Lessive” soil profiles. In Stuiver, M. and Kra, R., eds., Proceedings of the 12th International ^{14}C Conference. *Radiocarbon* 28(2A): 383–390.
- Thin layer scanning of ^{14}C and $\delta^{13}\text{C}$ in two well-analyzed forest soils (Hapludalfs) for tracing of carbon dynamics
- Mtimet, A., Freytag, J. and Scharpenseel, H. W. 1986 Investigations isotopiques ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) des croûtes calcaires et encroûtements des Matmata et de la Plaine de Jeffara en Tunisie. Extended abstract accompanying poster in Proceedings of the 13th International Soils Conference, Hamburg, Germany: 1217.
- $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ scan of calcretes in Tunisia exploring the formation mechanism
 - A few accompanying ^{14}C dates were either obviously rejuvenated or in a deeper position (very old) but not old enough to indicate formation (due to atmospheric C-component)
- Scharpenseel, H. W., Freytag, J. and Becker-Heidmann, P. 1986 C-14 Alterbestimmung und $\delta^{13}\text{C}$ -Messungen an Vertisolen unter besonderer Berücksichtigung der Gezieraböden des Sudan. *Zeitschrift für Pflanzen-ernährung und Bodenkunde* 149: 277–289.
- Assessment of regression curves for 378 ^{14}C dates of Vertisols from 10 countries
 - $\delta^{13}\text{C}$ profile curves indicating change of C_3 (cotton, underlying Nile alluvium) and C_4 vegetation (durra)
 - Carbon migration into clayey smectitic soils
- Scharpenseel, H. W., Tsutsuki, K., Becker-Heidmann, P. and Freytag, J. 1986 Untersuchung zur Kohlenstoffdynamik und Bioturbation von Mollisolen. *Zeitschrift für Pflanzenernährung und Bodenkunde* 149: 582–597.
- Mollisol (from eight countries) ages vs. depth curves; regression and correlation equations; age/profile-top-age vs. depth curves
 - Comparison of ^{14}C dates in different texture fractions of soils
 - ^{14}C dates of earthworm-C from different soil depth layers indicating that body-C of earthworms (*Eisenia*) is fully recent (bomb-C), foreign to the 4500-yr-old C of soil humus
- Becker-Heidman, P., Liu Liang-wu, Scharpenseel, H. W. 1988 Radiocarbon dating of organic matter fractions of a Chinese Mollisol. *Zeitschrift für Pflanzenernährung und Bodenkunde* 151: 37–39.
- Relations between SOM fraction dates and soil depth.
- Scharpenseel, H. W. and Becker-Heidman, P. 1989 Shifts in ^{14}C patterns of soil profiles due to bomb carbon, including effects of morphogenetic and turbation processes. *Radiocarbon* 31(3): 627–636.
- Bomb carbon curve to 1988
 - Admixture of recent C vs. shift from mean residence time to apparent mean residence time
 - Organic matter decomposition
 - Bomb-carbon penetration into depth of profiles of different soil types, humidity
 - Alfisol, Inceptisol, Mollisol, Spodosol, Vertisol ages vs. depth regression curves, regression and correlation factor
 - $\delta^{13}\text{C}$ curve in Vertisol with C_3 and C_4 plant alternation
 - ^{14}C depth curve of earthworms in Mollisol layers

- Scharpenseel, H. W., Becker-Heidman, P., Neue, H. U. and Tsutsuki, K. 1989 Bomb-carbon, ^{14}C -dating and ^{13}C -measurements as tracers of organic matter dynamics as well as of morphogenetic and turbation processes. *The Science of the Total Environment* 81/82: 99–110.
- Bomb carbon in soil profiles
 - Thin-layer scan by ^{14}C dating in terrestrial and submerged rice soil
 - Regression curves for profile dates of different soil types
- Becker-Heidman, P. and Scharpenseel, H. W. 1989 Carbon isotope dynamics in some tropical soils. In Long, A., Kra, R. S. and Srdoč, D., eds, Proceedings of the 13th International ^{14}C Conference. *Radiocarbon* 31(3): 672–679.
- Thin-layer scan of ^{14}C measurements in different profiles of tropical soils.
- Neue, H. U., Becker-Heidman, P. and Scharpenseel, H. W. 1990 Organic matter dynamics, soil properties and cultural practices in ricelands and their relationship to methane production. In Bouwman, A. F., ed., *Soils and the Greenhouse Effect*. New York, Wiley: 456–466.
- Thin-layer scan of rice fields by ^{14}C dating and especially $\delta^{13}\text{C}$, indicating the zone of methanogenesis in submerged soil profiles
- Scharpenseel, H. W., Neue, H. U. and Singer, St. 1992 Biotransformations in different climate belts; source-sink relationships. In Kubat, K., ed., *Humus, Its Structure and Role in Agriculture and Environment*. Elsevier: 91–105.
- Within context of biomass turnover, some minor supplements to low-level studies
- Scharpenseel, H. W. and Becker-Heidman, P. 1993 The dilemma of conflicting interests between CO_2 's and CH_4 's IR trapping capacity and role, in case of CO_2 as limiting factor for plant growth. Proc. Global Warming – A Call for International Coordination. SUPCON International. *World Resource Review* 4(2): 242–258.
- Some thin-layer scanned soil profiles for carbon residence time
- Scharpenseel, H. W. and Becker-Heidman, P. 1992 Twenty-five years of radiocarbon dating soils: Paradigm of erring and learning. In Long, A. and Kra, R. S., eds., Proceedings of the 14th International ^{14}C Conference. *Radiocarbon* 34(3): 541–549.
- Implications of ^{14}C dating of soils: rejuvenation; compartmental exchange; carbon eluviation and illuviation; transfer by turbation
- Scharpenseel, H. W. 1994 Sustainable land use in the light of resilience/elasticity to soil organic matter fluctuations. In Greenland, D. and Szabolcs, I., eds., *Soil Resilience and Sustainable Land Use*. Proceedings of the Symposium, Budapest 28 September to 2 October 1992. Wallingford, CAB International: 249–264.
- ^{14}C dates due to soil profile scan indicating carbon dynamics
 - ^{14}C dates due to profile scan reflecting preferential link of C to clay minerals by clay-organic complexation

APPENDIX 2: PREVIOUSLY UNPUBLISHED SOIL DATES

Lab code	Site	Age (yr BP)
<i>Four samples from Mosbruch, base of Histosol</i>		
HAM 1557	Mosbruch 1	11,760 $\pm$ 435
HAM 1558	Mosbruch 2	11,580 $\pm$ 500
HAM 1559	Mosbruch 3	12,200 $\pm$ 500
HAM 1560	Mosbruch 4	11,980 $\pm$ 435
HAM 1566	Fossil argillic horizon, Tunisia, 50–60 cm, sand dunes 4 km east of Algerian border, south Tozeur	430 $\pm$ 200
HAM 1568	Sample of Vertisol, Argentina, San Gustavo, 130–150 cm	5600 $\pm$ 100
<i>Channel cast, Waldsee</i>		
HAM 1570	Waldsee 1, 99–104 cm, lightly decomposed peat	3440 $\pm$ 80
HAM 1571	Waldsee 2, 199–204 cm, strongly decomposing peat	4200 $\pm$ 80
HAM 1573	Waldsee 4, 209–219 cm, fossil stem material, Alnus	4630 $\pm$ 80
HAM 1572	Waldsee 3, 295–300 cm fine detrital gyttja and plant remains	20,600 $\pm$ 350
<i>Relics found in soil profile</i>		
HAM 1574	Knodl 1, floating wood pieces	9220 $\pm$ 100
HAM 1575	Knodl 2, floating wood pieces	25,500 $\pm$ 900
HAM 1576	Grapel, pine wood at base of low moor	8700 $\pm$ 160
<i>Peat and gyttja samples of palynologically tested profile, Moor (peat) Plidutscha, Canton Graubünden, Switzerland</i>		
HAM 1587	VM 7.3 A, peat, 24–35 cm	2710 $\pm$ 85
HAM 1588	VM 7.2 A, peat, 50–60 cm	910 $\pm$ 140
HAM 1589	VM 7.1 A, peat, 77–87 cm	620 $\pm$ 150
HAM 1590	VM 3.1 B, peat with gyttja, 181–192 cm	2810 $\pm$ 120
HAM 1591	VM 3.1 A, gyttja with peat, 195–207 cm	3380 $\pm$ 120
HAM 1592	VM 4.2, gyttja, 229–242 cm	3820 $\pm$ 150
HAM 1593	VM 4.1, gyttja, 256–270 cm	4990 $\pm$ 140
HAM 1594	VM 5.3, gyttja, 280–292 cm	5130 $\pm$ 145
HAM 1595	VM 6.2 A, clayey gyttja, 382–390 cm	9050 $\pm$ 250
HAM 1597	Sediment from Hamburg harbor basin	1730 $\pm$ 80