Radiocarbon Data

for

Pennsylvania Soils

by

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Agronomy Series Number 146

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INTRODUCTION

Radiocarbon dating of material has given scientists a major tool to determine the age of materials that have incorporated carbon from the atmosphere into various organic as well as inorganic forms. The technique was first developed by Willard F. Libby in the late 1940's and is based on the fact that there are three principal isotopes of carbon, which occur naturally (C12 and C13, which are stable, and C14, which is radioactive and unstable). C14 is formed in the upper atmosphere through the effect of cosmic ray neutrons on N14 (N14 + neutron → C14 + proton). Libby determined the half-life of C14 to be 5568 $\pm$ 30 years (Libby half-life) and developed the method to date material by the diminishing amount of C14 in a sample. Recent work indicates Libby's half-life age was slightly in error, and a more accurate C14 half-life is 5730 $\pm$ 40 years (Cambridge half-life). To convert Libby half-life to Cambridge half-life multiply the Libby half-life age x 1.03. A basic assumption in the Libby method is that the N14 to C14 conversion in the atmosphere is a constant. The dating of wood back to about 11,000 years ago indicates that this is not completely true. The C14 content of the air has changed over time, and it has short-term variations. Thus, corrections need to be made to accurately determine the correct calendar date. Radiocarbon data from laboratories is reported using the Libby half-life and is given in years BP (before present-1950). For further information on radiocarbon dating, see WWW site (C14.sci.waikato.ac.nz/webinfo/index.html) and Taylor et al. (1992).

A number of soil genesis investigations in Pennsylvania have utilized radiocarbon dates as a part of the study. In addition, a number of dates have been gathered at other soil sites and have not been published. Thus, a publication on the data from these sites is essential in order that these data not be lost to future scientists. In addition to the unpublished data, all published dates known to the author with added information are also included in this report. All

radiocarbon ages in the listing are Libby half-life BP dates (e.g., BP 1950). A USGS 7 ½ minute Quadrangle map with the exact location of the listed sites is on file with the Pennsylvania State University Agronomy Department Soil Characterization Laboratory.

1. Spring Creek I

Location and Material	Centre County, College Township, State College Quadrangle, on the floodplain of Spring Creek. The site was located about 350 meters down stream from the Farm Lane bridge located 70 meters west of the sheep barn on Penn State pasture land adjacent to Houserville. The material sampled was wood in the stream bank resting on the A horizon of a buried paleosol at a depth of about 50 cm. The sample was collected by Al Bilzi and Tom Simpson on September 7, 1974.
Laboratory and Date	The white oak wood sample was analyzed by Teledyne Isotopes, Inc. of Westwood, New Jersey (Lab. No. I-8274). The sample was pretreated for the removal of carbonates and humic acids. The age of the wood was calculated using the Libby half-life of C14 at 470 $\pm$ 80 years BP.
Comments	The site (Nolin soil; S1974-PA-014-097) was one of Al Bilzi's MS thesis sites (Bilzi, 1976; Bilzi and Ciolkosz, 1977) and indicated that the upper 0.5 to 1 meter of material on the floodplain postdated white man's occupation and clearing of the upland and the subsequent accelerated erosion and deposition on the floodplain. The study also indicated that after an initial pulse of erosion, the floodplain has received much less material. It is assumed that better land management lead to the decrease in erosion and deposition. This conclusion is supported by the observation than no buried A horizons were found between the buried A that the wood rested on and the present soil surface. Additional support for this conclusion was a metal horseshoe found at a depth of 84 cm on a buried A horizon in a soil pit dug for a field tour (Ciolkosz et al., 1980) adjacent to the creek in 1980. The horseshoe site was approximately 100 meters upstream for Bilzi's sampling site. The soil (Nolin) was also sampled at the Bilzi site, and the soils data are a part of the Penn State Soil Characterization Lab Database System (Ciolkosz, 2000). Its soil number is S1974PA-014-097. This site showed the development of a cambic horizon (Bw), and indicates that cambic horizons can develop in these type of sediments in about 200 years.

2. Spring Creek II

Location and Material	Centre County, College Township, State College Quadrangle, on the floodplain of Spring Creek. The site is located just 25 meters west of the Farm Lane bridge noted under the Spring Creek I site. It presently is under the underpass for US Route 322. The material sampled was two logs 25 cm in diameter (the one at a 125 cm depth showed marks indicating it had been cut off with an ax (14-50s SAX), and the second at a depth of 175 cm showed no ax marks (14-70d NAX). The wood was sampled by Ed Ciolkosz in September 1975.
Laboratory and Date	The wood samples were analyzed by Teledyne Isotopes, Inc. (Lab No. I-9225, 14-70s NAX and I-9226, 14-50s SAX). Both samples were pretreated to remove carbonates and humic acids. The age of the wood was calculated using the Libby half-life of C14 and was 230 $\pm$ 75 (14-50s SAX) and 220 $\pm$ 75 (14-70d NAX). No soil description or soils data was taken at the site. At the time of sampling, the water table was 175 cm.
Comment	The site was an excavation for a farm underpass being constructed for the US 322 highway just below downslope to the northeast of the Centre Community Hospital in State College. No buried soil was noted at the time of sampling. For a field trip in 1985 (Parizek and White, 1985), a soil pit was excavated in the soil adjacent to the underpass; and a buried soil was observed at about 190 cm below the surface. The buried soil can be traced to the stream bank and is undoubtedly the same buried soil noted in Bilzi's study (Bilzi, 1976; Bilzi and Ciolkosz, 1977). This land surface is a small fan that heads in a drainage way near the hospital. The conclusion from these radiocarbon dates supports that given in the comments for Spring Creek I.

3. Philo

Location and Material	Centre County, Potter Township, Centre Hall Quadrangle, on an unnamed intermittent tributary to Boal Gap Run 0.9 km southeast of US 322 on Township Road 411 adjacent to the road. The material sampled was wood from a soil pit just above a buried A horizon at about a 99 cm depth. The sample was collected by Al Bilzi and Tom Simpson on September 5, 1974.
Laboratory and Date	The eastern red cedar wood sample was analyzed by Teledyne Isotopes, Inc. of Westwood, New Jersey (Lab No. I-8273). The sample was treated for the removal of carbonates and humic acids. The age of the wood was 320 $\pm$ 80 years BP.

Comments	The site (Philo; S1974-PA-014-098) was one of Al Bilzi's MS thesis sites (Bilzi, 1976; Bilzi and Ciolkosz, 1977) and indicates a major erosional event at the time of settlement of this area. This site showed cambic horizon (Bw) development. The soils data is available in Ciolkosz (2000).

4. Rowland

Location and Material	Juniata County, Walker Township, Mifflintown Quadrangle, on a floodplain of an unnamed tributary to the Juniata River 1.8 km east of Mifflintown along SR 3002 (old US 322) on the northeast side of the road. The material was small pieces of charcoal that were collected from the BC (B3) horizon of the soil at a depth of 41-77 cm. A buried A horizon was found at a depth of 77 cm. The samples were collected by Al Bilzi and Ed Ciolkosz on September 2, 1974.
Laboratory and Date	The charcoal material was analyzed by Teledyne Isotopes, Inc. of Westwood, New Jersey (Lab No. I-8275). The sample was not pretreated for carbonates or humic acids because the samples could not withstand the treatment. The age of the charcoal sample was < 205 BP.
Comments	The site (Rowland; S1974-PA-034-099) was one of Al Bilzi's MS thesis sites (Bilzi, 1976; Bilzi and Ciolkosz, 1977), and as with the previous Bilzi sites, indicates major erosion after settlement. This site showed cambic horizon (Bw) development. The soils data is available in Ciolkosz (2000).

5. Atkins

Location and Material	Schuylkill County, Washington Township, Swatara Hill Quadrangle, on the floodplain of an unnamed tributary to Upper Little Swatara Creek east of the intersection of State Route 443 and Legislative Route 53005 on the north side of 443. The material was wood collected from a soil pit at a depth of about 80 cm just above a buried A horizons. The sample was collected by Al Bilzi, Ed Ciolkosz, and Tom Simpson on August 24, 1974.
Laboratory and Date	The American beech wood sample was analyzed by Teledyne Isotopes, Inc. of Westwood, New Jersey (Lab No. I-8272). The sample was pretreated for removal of carbonates and humic acids. The age of the sample was 1955 $\pm$ 80 years BP.
Comments	The site (Atkins; S1974-PA-054-027) was one of Al Bilzi's MS thesis sites (Bilzi, 1976; Bilzi and Ciolkosz, 1977) and was a little older than the other Bilzi sites. The greater age of this site compared to the other sites was confirmed by the greater amount of pedological development of this site compared to the other three sites. This site showed cambic horizon (Bw) development. The soils data is available in Ciolkosz (2000).

6. Pope

Location and Material	Armstrong County, Plum Creek Township, Elderton Quadrangle, on the floodplain of Crooked Creek 3.2 km SE of Elderton on the Kimmel Farm 35 meters north of creek and 1.2 km SW of the buildings. The material was a red oak log 50 cm in diameter. It was located 180 cm below the surface in a sand and gravel zone saturated with ground water. No buried soil was noted, and the sample was collected on July 4, 1968, by Ed Ciolkosz.
Laboratory and Date	The red oak wood sample was analyzed by Teledyne Isotopes, Inc. of Westwood, New Jersey (Lab No. I-3895). The age of the wood was 455 $\pm$ 95 years BP.
Comments	The site (Pope; S1968-PA-003-006) was one of the sites sampled for characterization in Armstrong County in July 1968 (Ciolkosz, 2000). Soils sampled from this site were used in Sharon Waltman's MS thesis (Waltman, 1988; Waltman and Ciolkosz, 1995).

7. Rowland

Location and Material	Lancaster County, Rapho Township, Manheim Quadrangle, on the floodplain of Brubaker Creek 2.4 km SE of Masterville on the west site of the road (Brandt Farm). The wood sample was collected from a soil pit at a depth of 112-132 (2C2 horizon). This zone may be buried A horizon. The wood sample was collected August 2, 1978, by Ed Ciolkosz.
Laboratory and Date	The wood sample was analyzed by Teledyne Isotopes, Inc. of Westwood, New Jersey (Lab No. I-10, 773). The wood was treated to remove carbonates and humic acids. The age of the wood was 810 $\pm$ 75 years BP.
Comments	The site (Rowland; S1978-PA-036-032) was sampled as one of the soil characterization sites for Lancaster County in August of 1978 (Ciolkosz, 2000). It generally fit the range of thickness of materials that date the upper 1 to 2 meters of alluvium on secondary streams (not major river floodplains such as the Delaware, Susquehanna, or Allegheny). Some age dating has been done on the major rivers in Pennsylvania (Engel et al., 1996; Kaktins, 1986). An additional wood sample (a sawed board) was collected on April 18, 1979, on Conowingo Creek about 6.5 km south of Wakefield at a depth of 200 cm, but it was not radiocarbon dated. Additional radiocarbon dating on floodplains of major, as well as secondary, streams has been acquired by archaeologists (please contact the Pennsylvania State Archaeologist—present Kurt W. Carr in Harrisburg).

8. Piedmont

Location and Material

Lancaster County, Martic Township, Conestoga Quadrangle. Three sites were sampled on the same hillslope. Two sites were within 100 meters, and the third was 6,000 meters southwest of the first two (see Pollack, 1992, for the exact locations). In general, the study area was 3.6 km northeast of Pequa. The material sampled was charcoal. Sample (pit 59) was from a depth of 80 cm in a stone line buried by brown silty material. Sample (pit 31) was from a depth of 100 cm at the boundary between upper brown and lower red material. Sample (pit 54) came from a depth of 100 cm in the bottom of an ice wedge cast. The samples were collected by Jon Pollack in the fall of 1990.

Laboratory and Date

The charcoal samples were analyzed by Beta Analytic Inc. of Coral Gables, Florida (Beta-40067, pit 59; Beta-40068, pit 31; Beta-41366, pit 54). The samples were pretreated to remove carbonates and humic acids. The ages of the samples were Beta-40067, 600 $\pm$ 60 years BP; Beta-40068, 2,350 $\pm$ 70 years BP; Beta-41366, 2,310 $\pm$ 55 years BP.

Comments

These sites were a part of Jon Pollack's MS thesis study (Pollack, 1992; Pollack, Ciolkosz, and Sevon, 2000). The samples gave dates that appear to be too young. It was expected that the dates would be between 10,000 and 15,000 years BP, and date the last major periglacial landscape truncation and subsequent loess deposition. The dates may be true dates or possibly contaminated with fresh carbon from rootlets that were with or had penetrated the charcoal fragments. Contamination is a real possibility (see Table 1). The only known C14 date to date the brown surface material believed to be loess comes from Maryland where Foss et al. (1978) dated a buried A horizon under loess at 10,520 $\pm$ 240 years BP. More dates are needed to obtain a clearer and firmer chronology of landscape change and loess deposition in SE Pennsylvania.

Table 1. Effect of contamination by modern (pre-bomb) carbon on the true radiometric age (from Watkins, 1975).

True age (years)	Apparent age (years) obtained as result of: 1% contamination	5% contamination	10% contamination
600	540	160	modern
1000	910	545	160
5000	4870	4230	3630
10000	9730	8710	7620
infinitely old	36600	24000	18400

9. Other: In addition to the sites listed previously, three others are as follows:

a. Scranton – In July of 1970, Ed Ciolkosz sampled a wooden log, which protruded from a glacial till roadcut about 3 km north of Scranton, Pennsylvania. The log plus other logs were located about 25 meters below the surface. The wood was dated by Teledyne Isotopes (I-5148) at 470 ± years BP. The date is anomalously young because the glacial till is woodfordian age (~ 18,000 years BP). A possible explanation is that this material was a part of a landslide which occurred about 500 years ago.

b. Lezzer Lumber – On April 4, 1983, Dick Cronce sampled some charcoal from an involution from a toe slope area at the present site of the Lezzer Lumber yard on highway Route PA 26 adjacent to the Nittany Mall just east of State College, Pennsylvania. The samples were collected from a depth of 120 cm and analyzed by Smithsonian Environmental Research Center (SI-6778). The age was 8725 ± 215 years BP. Cronce (1988) provides a description (p. 277) and drawing (p. 356) of the site (S83 PA 14-82). This date, like the one from the log near Scranton, seem anomalously young. The charcoal material was in Wisconsinan colluvium (See Ciolkosz et al., 1986; Clark and Ciolkosz, 1988; and Clark et al., 1993; for further information on involutions and periglacial features in Pennsylvania).

c. Fisher Farm – During the late summer of 1978, Bill Waltman collected hemlock wood (tree branches) from a soil trench on the floodplain of Bald Eagle Creek as a part of an archeological study of the Fisher Farm Site (Hatch, 1980). The site is located about 2.4 km upstream (SW) of Milesburg, Pennsylvania. The sample was collected 300 cm below the floodplain surface just above the shale bedrock. The sampled was dated by Teledyne Isotopes (I-10,772) at 2420 ± 80 years BP. The date indicates that the surface of Bald Eagle Creek was about 4 to 5 meters below the terrace that today stands 1.0 to 1.5 meters above the present floodplain surface. The terrace has a soil that is much better developed than the floodplain soil (see Hatch, 1980). It has an argillic horizon. This is particularly evident on the well-drained terrace sites (Ciolkosz, personal observations, 1990, 1999) and less evident on the poorly drained sites. This terrace is not very high above the floodplain, and it was not flooded by the Agnes flood of June 1972 at the Fisher site or at other sites along Bald Eagle Creek (information gathered from farmers and residents who live along the creek).

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