THE PRE-HISTORIC AND HISTORIC GEOLOGIC IMPACTS OF ICE AND WATER WITHIN THE PA WILDS: A STUDY OF THE SURFICIAL DEPOSITS IN THE RICH VALLEY 7.5-MINUTE QUADRANGLE, CAMERON COUNTY, PENNSYLVANIA

Aaron D. Bierly, aabierly@pa.gov, Dept. of Conservation and Natural Resources: Pennsylvania Geological Survey

ABSTRACT

Located within the non-glaciated Salamanca Re-entrant, the headwaters of the Driftwood Branch Sinnemahoning Creek bears two recognizable surficial deposits: periglacial derived boulder-choked hollows, and Holocene-aged alluvium.

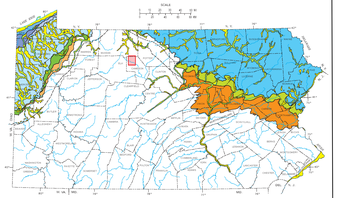
In the headwaters of several hollows, large boulders of Pottsville Formation-derived sandstone and conglomerate fill in the ravine bottoms. These boulder fields commonly can be traced straight to the bedrock source on the top of the mountains. Though more thorough geologic mapping is needed to confirm, it appears that in some hollows the Pottsville Formation has been completely eroded away, leaving only the boulders as remnants.

Alluvial cuts along the main valley bottom bear alluvial exposures less than seven feet thick, and water wells commonly show alluvial deposits less than 40 feet. In the main valley bottoms, the alluvium is a moderate yellowish brown to pale brown silt; underlying this silt is a mottled light-olive-gray and grayish orange clayey silt ranging from approximately 0.5-foot to 1.7 feet thick. In the base of the mottled silt horizon, woody debris is commonly observed. Radiocarbon dates from two samples along the Driftwood Branch Sinnemahoning Creek are 605 +/- 15 years BP and 2000 +/- 20 years BP. One sample on North Creek was dated at 1335 +/- 15 years BP. The wide range of ages suggest that the mottled silt lithology is not unique to a single stratigraphic horizon or erosion of older stream deposits upstream allow reworking of woody debris into younger strata. Stream-deposited gravels underlie the mottled silt.

In the headwater streams of Moon Run and Cooks Run, similar-looking mottled silts bear a significantly younger age of 90 +/- 15 years BP. These headwater deposits correlate well with historical logging operations in the county. X-ray diffraction analysis shows the dominant minerals in the mottled silt are quartz and muscovite with minor concentrations of kaolinite, albite, clinochlore, and magnetite.

Introduction

During routine mapping of the Rich Valley quadrangle's bedrock geology, the author encountered two major surficial deposits, alluvium and sandstone/conglomerate-boulder colluvium (boulder-choked hollows). The goal of this presentation is to discuss the characterization and development of these deposits. Other minor surficial deposits observed but not reported in this poster include alluvial fan deposits, debris-flow deposits, shale/sandstone colluvium, and reservoir legacy sediments.



Above: Map of Pennsylvania displaying extent of glacial deposits and the location of the Rich Valley 7.5' quadrangle as the red rectangle. Map modified from Sevon, W. D., and Braun, D. D., 2006, Map 59 Glacial Deposits of Pennsylvania, Pennsylvania Geological Survey, 4th ser., Plate 1.

Left: Preliminary geologic map of the Rich Valley 7.5' quadrangle. Geologic contacts based off current field work of author.

Mineralogy of the Alluvium in the Rich Valley Quadrangle

Sample	Latitude (NAD83)	Longitude (NAD83)	Lithology	Quartz	Muscovite	Biotite	Kaolinite	Albite	Clinochlore	Magnetite
RV035	41.56659°	-78.27970°	Mottled Silt	65	22	0	7	6	0	0
RV42A	41.59629°	-78.28727°	Mottled Silt	64	23	0	0	<1	12	1
RV073	41.53440°	-78.28828°	Mottled Silty Sand	82	13	0	5	0	0	0
RV125B	41.55095°	-78.32114°	Silty Sand	77	23	0	0	0	0	0
RV142	41.54992°	-78.34742°	Silty Sand	90	0	1	9	<1	0	0
RV142	41.54992°	-78.34742°	Silty Sand	98	0	2	0	0	0	0
RV143	41.54972°	-78.34570°	Mottled Silt	86	0	1	13	<1	0	0
RV143	41.54972°	-78.34570°	Sand	92	0	8	<1	<1	0	0

Table on the alluvial sediment's mineralogy based on X-ray diffraction analysis. All values to be considered semi-quantitative. All mineral values are in percent.

Radiocarbon Dates from Alluvial Deposits in the Driftwood Branch Sinnemahoning Creek Watershed

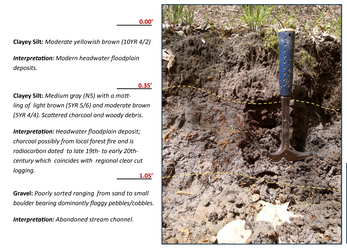
PSUAMS#	Sample ID	Location (NAD83 Datum)	Material	Fraction Modern	±	$D^{14}C$ (‰)	±	^{14}C age (BP)	±
2751	RV035	41.56659°, -78.27970° (Moon Run)	Charcoal	0.9891	0.0018	-10.9	1.8	90	15
2752	RV073	41.53440°, -78.28828° (Driftwood Branch Sinnemahoning Creek)	Wood	0.9272	0.0014	-72.8	1.4	605	15
2753	RV077	41.53705°, -78.29080° (Driftwood Branch Sinnemahoning Creek)	Wood	0.7797	0.0017	-220.3	1.7	2000	20
2754	RV119	41.54097°, -78.30898° (Cook Run)	Wood	0.9891	0.0016	-10.9	1.6	90	15
2755	RV130	41.57053°, -78.28878° (North Creek)	Wood	0.8469	0.0015	-153.1	1.5	1335	15

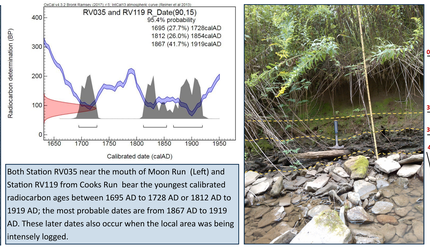
Radiocarbon concentrations are given as fractions of the Modern standard, $D^{14}C$, and conventional radiocarbon age, following the conventions of Stuiver and Polach (Radiocarbon, v. 19, p.355, 1977).

Sample preparation backgrounds have been subtracted based on measurements of ^{14}C-free wood.

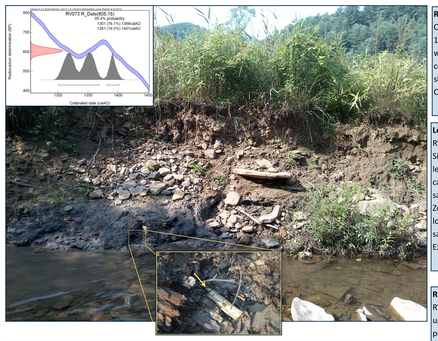
All results have been corrected for isotopic fractionation according to the conventions of Stuiver and Polach (1977), with $\delta^{13}C$ values measured on prepared graphite using the AMS. These can differ from $\delta^{13}C$ of the original material, if fractionation occurred during sample graphitization or the AMS measurement, and are not shown.

Analysis conducted by Penn State AMS ^{14}C Facility, Institutes of Energy and the Environment



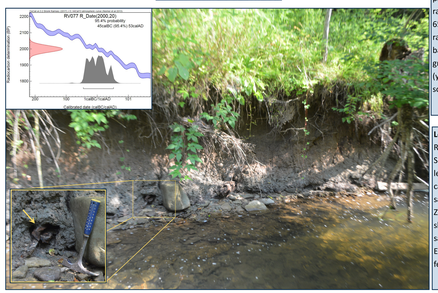


Both Station RV035 near the mouth of Moon Run (Left) and Station RV119 from Cooks Run bear the youngest calibrated radiocarbon ages between 1695 AD to 1728 AD or 1812 AD to 1919 AD; the most probable dates are from 1867 AD to 1919 AD. These later dates also occur when the local area was being intensely logged.



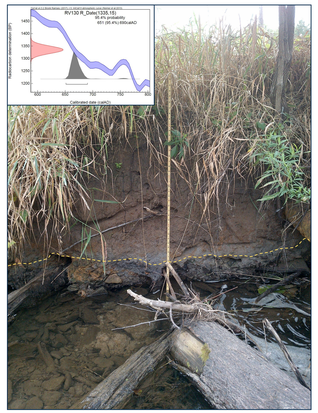
Right: Photo of the mouth of North Creek in the Rich Valley quadrangle in 1896. Note largely deforested hillsides would have increased erosion rates compared to modern-day forested slopes. Photo courtesy of the Cameron County Historical Society.

Left: Stream bank exposure at station RV073 along the Driftwood Branch of Sinnemahoning Creek. Figure in upper left corner of photo displays probable calibrated age-range of the radiocarbon sample between 1301 AD to 1401 AD. Zoomed in photo at bottom shows the location of the birch (*Betula*) twig sampled for radiocarbon dating. Exposure is 5.45 feet thick.



Right: Stream bank exposure at station RV130 along North Creek. Figure in upper left corner of photo displays probable calibrated age-range of the radiocarbon sample being between 651 AD to 690 AD. Wood sample for radiocarbon dating was taken below the basal contact of the mottled medium gray and grayish orange clay horizon (yellow dashed line) within the poorly sorted gravel. Exposure is 4.3 feet thick.

Left: Stream bank exposure at station RV077 along the Driftwood Branch of Sinnemahoning Creek. Figure in upper left corner of photo displays probable calibrated age-range of the radiocarbon sample between 45 BC to 53 AD. Zoomed in photo in bottom left corner shows the location of the wooden log sampled for radiocarbon dating. Exposure is 6.35 feet thick (with 1.45 feet underwater).

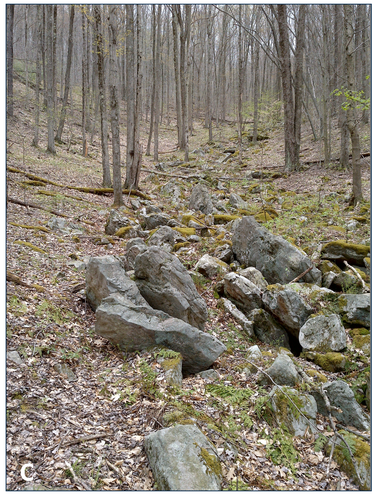


Rock Cities and Boulder-choked Hollows

The Pennsylvanian–aged Pottsville Formation is well known for its towering rock cities. In the Rich Valley 7.5-minute quadrangle most of the Pottsville Formation is located in the southwestern quarter of the quadrangle where the Cowanesque Syncline plunges to the southwest. The basal sandstones and conglomerates range from 10 to 50 feet thick and are the main source of the boulders. Two steeply dipping (79° to 90°) joints orientated 68° to 77° degrees from each other were observed in the field.

Formation of the boulders goes as follows...

1. Near Horizontal bedrock has open joint and bedding plane fractures.
2. Water from precipitation and melting ice fill in the fractures and then refreezes.
3. Repeated periglacial frost riving (aka congelifraction) occurs slowly pushing the rocks apart. *See Photo A.*
4. Boulders eventually slump or fall free of the bedrock exposure and lie on the hillside. *See Photo B.*
5. Congeliflucton slowly pulls the boulders down the steep hillside while at the same time continued weathering of the larger boulders continue.
6. Boulders reach the hollow bottoms and the rate of movement decreases due to a decrease in slope. *See Photo C.*



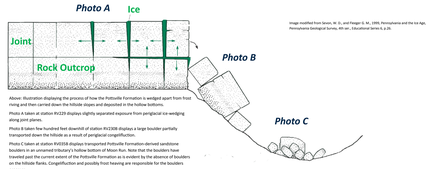


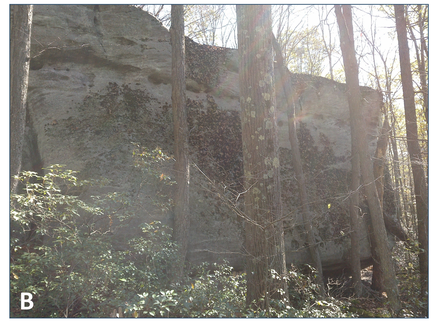
Image modified from Sevon, W. D., and Fleeger, G. M., 1999, Pennsylvania and the Ice Age, Pennsylvania Geological Survey, 4th ser., Educational Series 6, p.26.

Above: Illustration displaying the process of how the Pottsville Formation is wedged apart from frost riving and then carried down the hillside slopes and deposited in the hollow bottoms.

Photo A taken at station RV229 displays slightly separated exposure from periglacial ice-wedging along joint planes.

Photo B taken few hundred feet downhill of station RV230B displays a large boulder partially transported down the hillside as a result of periglacial congelifraction.

Photo C taken at station RV035A displays transported Pottsville Formation-derived sandstone boulders in an unnamed tributary's hollow bottom of Moon Run. Note that the boulders have traveled past the current extent of the Pottsville Formation as is evident by the absence of boulders on the hillside flanks. Congelifraction and possibly frost heaving are responsible for the boulders progress.



Conclusions/Further Work

The radiocarbon dating of the alluvium deposits along the modern stream channels show the deposits in the Rich Valley quadrangle to clearly be Holocene and have been impacted by anthropogenic activities during the late 19th- and early 20th-century during the boom of the logging industry in the county. The author cannot rule out the possibility that the older dated deposits could actually belong to younger logging-era deposits that simply reworked woody debris from older stream channel deposits. Additional radiocarbon testing of different woody debris from the same sampled horizons as well as testing of the shallower horizons will give better resolution on the age-correlation of the deposits.

Boulder-choked hollows in the quadrangle are dominantly the result of frost riving of basal sandstones and conglomerates of the Pottsville Formation presumably from the periglacial activities during the Pleistocene and to a lesser degree due to seasonal fluctuations in the Holocene. Though additional field work and mapping is required, it appears that the periglacial activities in some localities may have completely removed the bedrock source leaving the boulders as the remnant evidence of the Pottsville Formation.

Acknowledgements

The author would like to acknowledge John Barnes for his XRD analysis of the alluvial samples. Cameron County Historical Society for their assistance in the logging history of the study area. Elk State Forest and Seneca Resources Incorporated for granting road access to their properties. Penn State University AMS radiocarbon facility for their radiocarbon dating services. The Pennsylvania Geological Survey for additional funding for the radiocarbon samples. The United States Geological Survey's STATEMAP program which initiated the mapping of the Rich Valley 7.5-minute quadrangle, in which this surficial study was an unforeseen derivative project thereof.