Journal of the Minnesota Academy of Science

Volume 46 | Number 3 Article 3

1980

Seismic Survey of Buried Bedrock Topography in the Cannon River Valley

Timothy D. Vick
Carleton College

Glenn Greilich
Carleton College

Geoffrey O. Seltzer
Carleton College

Seismic Survey of Buried Bedrock Topography in the Cannon River Valley

TIMOTHY D. VICK*, GLENN GREILICH**, GEOFFREY O. SELTZER***

ABSTRACT—A seismic survey of the Cannon River Valley between Northfield and Cannon Falls, Minnesota, revealed the presence of a 30-meter deep buried river valley under or near the Cannon River. The buried channel emanates from the Spring Creek Valley in Northfield, makes a 90-degree turn to the northeast at the confluence of Spring Creek and the Cannon River, and follows the Cannon to Cannon Falls. Buried tributary valleys appear to join the main buried channel at several locations. There may be buried tributary valleys or a network of abandoned Cannon River channels eroded into bedrock under the lake plain north of Lake Byllesby. The material of this survey also was reported by Timothy D. Vick, one of the three researchers, at the 1980 meeting of the Institute on Lake Superior Geology.

The bedrock topography in a portion of the Cannon River valley was mapped with the purpose of locating and describing a buried valley suspected to be in the area. This buried valley may have an ancestral relationship to the modern Cannon River.

The study area lies in Townships 112 and 113 North, Ranges 18 and 19 West, in Rice, Dakota and Goodhue counties of Minnesota (Figure I). It is underlain by flat-lying Ordovician carbonates and sandstones. The major formations in order of decreasing age are the Prairie du Chien Group (dolomites), the St. Peter Sandstone, the Glenwood Formation, and the Platteville Formation. The Prairie du Chien-St. Peter contact is thought to be conformable in the study area (Austin, 1972) although it is not in other localities. Thicknesses of these units vary throughout southeastern Minnesota as a result of several broad structural arches and basins. The Prairie du Chien ranges from 350 feet in thickness in the center of the Hollandale Embayment to 100 feet in the Twin Cities Basin, and averages about 250 feet in Northfield at the southwest end of the study area. The thickness of the partially eroded St. Peter Sandstone ranges from zero in some areas around Northfield to over 100 feet near Cannon Falls. The relatively hard Platteville carbonates are present locally as caprock on the St. Peter Formation, and form the numerous mesas in the region. The Cannon River valley is croded into the Prairie du Chien group with St. Peter Sandstone forming the upper valley walls and erosional remnants in the valley.

Pleistocene glacial deposits, primarily of Wisconsin age, blanket the area. The thickness of these deposits varies according to both relief on the pre-Pleistocene erosional surface and the morphology of proglacial and englacial deposits. Pre-Wisconsin drift of the Kansan and Illinoisan glaciations are present in Dakota County (Ruhe and Gould, 1954). During Wisconsin time, glacial material from a complex series of ice advances was deposited in the region. Much of the present topography in central Dakota County is formed on outwash deposits related to the St. Croix advance of the Superior Lobe and the advance of the Des Moines Lobe (Savina, Jacobson and Rodgers, 1979). Proglacial features of the Des Moines Lobe have been described in an area immediately south and west of Northfield (Swanson, 1979).

Glacial deposits partly conceal a bedrock surface which, if exposed, would have considerably more relief than the present surface topography. Deep valleys carved into bedrock to elevations as low as 520 feet exist in Minneapolis and St. Paul (Bloomgren, Olsen and Walton, 1979) and central Dakota County (Savina, Jacobson and Rodgers, 1979). The presence of these valleys speaks of a time when local base levels were considerably lower than at present. Sea level was as much as 130 meters lower 15,000 years ago than it is now. Therefore, portions of the Mississippi Valley were scoured deeply into bedrock (Schumm, 1977). Subsequent glacial melting released runoff water and sediments sufficient to both raise sea level and partially fill river valleys with alluvium. The extent of the buried Mississippi and tributary valleys could only be found by surveying the buried channels to their heads.

The suggestion that there are buried river channels in the Cannon River valley is not new. Sardeson (1933) reported that a buried channel emanated from the present Chub Creek area and passed several miles north of Lake Byllesby joining the present Cannon River three miles downstream of Cannon Falls. He mentioned no buried valley under the present Cannon River. Anderson, Farrell, Broussard and Felsheim (1974) presented a map showing the general trend of a bedrock valley following the Cannon River with tributary buried valleys from the north and south (but none from the area of Chub Creek). This map also shows a tributary buried valley under the present Spring Creek, which flows into the Cannon at Northfield. A map by Kanivetsky (1978) shows a buried valley under Lake Byllesby which emanates from the

*TIMOTHY D. VICK is Technical Director in Geology at Carleton College, Northfield, Minnesota. He received the B.A. degree from Beloit College and the M.A.T. degree from the University of Wisconsin-River Falls.

**GLENN GREILICH is a Geological Field Assistant with the U.S. Geological Survey at Woods Hole, Massachusetts. He received the B.A. degree from Carleton College.

***GEOFFREY O. SELTZER was a student at Carleton College majoring in geology at time of this study.

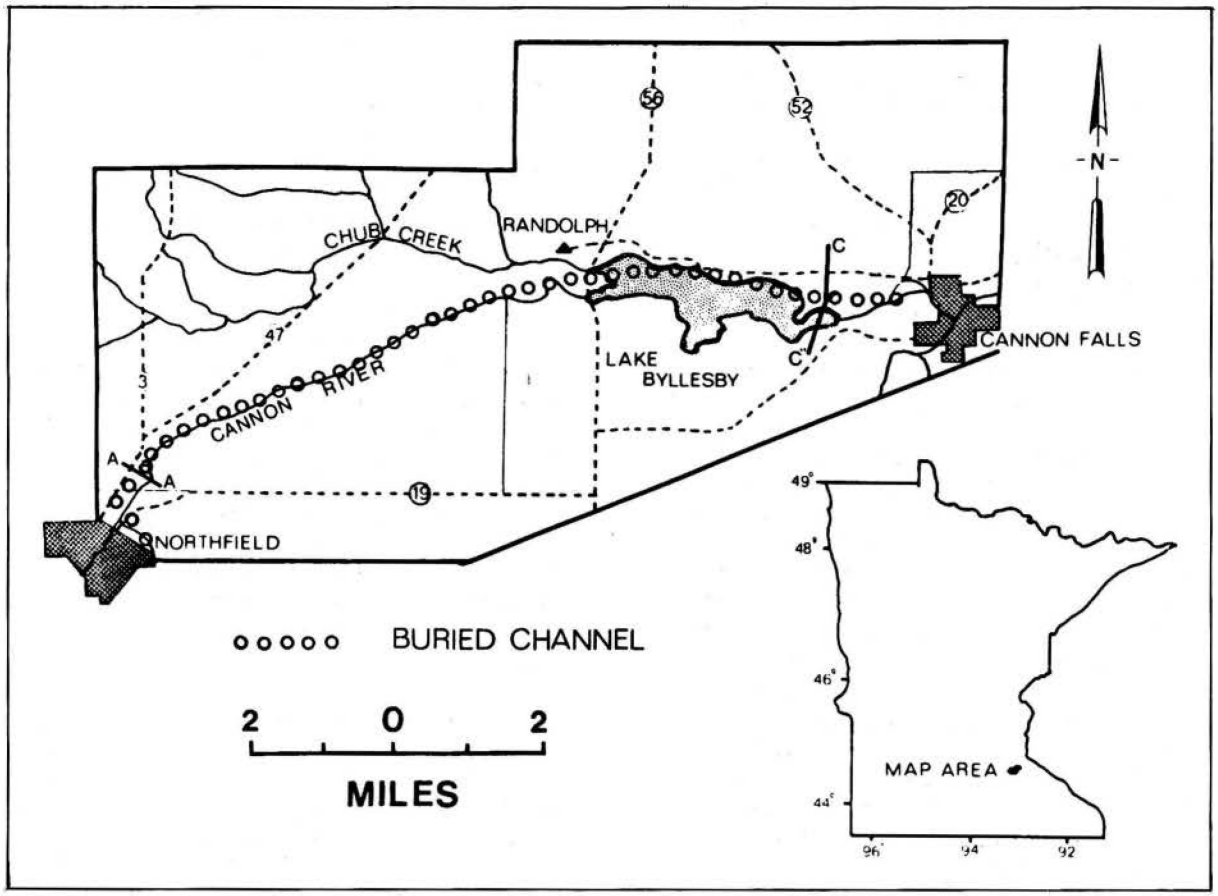

Figure 1. Map of field area showing location of buried channel and cross section lines.

area of Chub Creek, with no buried valley following the Cannon from Northfield. All of these sources agree that there are buried river channels under or near the Cannon River, but agreement is lacking on how many channels there are and where they lie. (The maps in the above papers were intended to show only the general courses of the channels and should not be construed as showing exact locations.)

Depth to bedrock was determined from seismic data points at intervals of two-tenths to one-quarter mile along public roads, in conjunction with outcrop observations and well log data. Seismic traverses along roads crossing the Cannon River were spaced closer than other series. A heavy concentration of data points supplied extra information in Northfield, where the buried valley turns 90 degrees in leaving the Spring Creek valley and joining the modern Cannon River valley. Extra traverses were done in the area of Chub Creek to verify Sardeson's report (1933) of a buried valley in that area. Well logs were provided by the Minnesota Geological Survey, the Minnesota Department of Transportation, the City of Northfield, Carleton College, and the U.S. Geological Survey.

Field methods recommended by Mooney (1973) yielded good results. Fifty meters was the normal length of traverses, but longer traverses were necessary when depth to bedrock exceeded 50 to 70 feet. A ten-pound sledge hammer or a 300-pound-weight-drop trailer generated seismic shock waves, the choice being determined by the length of the traverse and the level of background noise. While field measurements were all metric, vertical measurements were converted to English units (feet to conform with U.S.G.S. topographic sheets used as base maps.

Materials forming the uppermost layer in the field area transmit seismic waves at apparent velocities from 208 to 655 meters per second with a mean of 388.39 and standard deviation of 85.3 meters per second. These materials probably consist mostly of soil, loose fill, and road gravel.

In about two-thirds of the traverses an intermediate layer was found overlying bedrock. This material transmits seismic waves at apparent velocities from 435 to 2,941 meters per second, with a mean of 1,411.6 and a standard deviation of 521.0 meters per second. The material in this layer in most cases is probably alluvial sand and gravel below the water table. In some cases, however, the second layer may be a thin (twenty feet or less) layer of the St. Peter Sandstone overlying the Prairie du Chien Dolomite. Such occurrances may be present near Lake Byllesby where the top of the Prairie du Chien is at roughly 840 feet above sea level.

The Prairie du Chien Dolomite formed the bottom layer in essentially all of the traverses. The dolomite transmits seismic waves at apparent velocities from 2,235 to 25,000 meters per second, with a mean of 4,829.9 and a standard deviation of 3,379.0 meters per second. The wide range of values for the Prairie du Chien is probably due to sloping bedrock surfaces although it may be due in part to variations in composition or consolidation of the rock.

The topographic surface of the plain north of Lake Byllesby is quite flat. In some areas the relief is only a few feet over entire sections. An abandoned lake shoreline is visible on aerial photos from northeast of the lake through Randolph at an elevation of between 880 and 885 feet above sea level. The bedrock topography under the plain is irregular but generally high relative to the buried Cannon River channel. There was no evidence of a buried Cannon River channel north of the mesa in section 2, T112N, R18W, as Sardeson (1933) suggested. There is probably a buried drainage system in this area which could be composed of tributary valleys to the main buried Cannon valley. The depression

Sardeson (1933) reported near Chub Creek appears to be one of these tributaries.

The seismic survey revealed a buried river channel under or near the Cannon River between Northfield and Cannon Falls. The buried channel is narrow, steep-sided, and over 100 feet deep. The channel appears to follow the Spring Creek Valley through the Carleton campus in Northfield and enter the present Cannon River valley at the confluence of Spring Creek and the Cannon River. From Northfield to Cannon Falls, the valley follows closely the present course of the Cannon River. Between Randolph and the Lake Byllesby County Park the buried valley is probably offset to the north of the present channel, but remains essentially parallel to it. The buried channel has a gradient of roughly five feet per mile. From the confluence of Spring Creek in Northfield to the Lake Byllesby Park the bottom of the valley descends 55 feet from 780 to 725 feet above sea level. In comparison, the modern Cannon River descends 85 feet in the same distance, from 890 to 805 feet above sea level.

A chain of soundings and borings showing bedrock at low elevations indicates the course of the buried channel. In the Spring Creek valley on the Carleton campus, bedrock is 845 feet above sea level. At the confluence of Spring Creek and the Cannon a seismic sounding showed bedrock at 780 feet elevation. A boring by the U.S. Geological Survey in 1970 at the site of the Northfield sewage treatment plant hit bedrock at 780. A seismic sounding north of the Cannon but southwest of Randolph detected bedrock at 745. Another in the Lake Byllesby County Park sensed bedrock at 725. A boring by the Minnesota Department of Transportation at the site of the Highway 52 bridge over the Cannon River hit bedrock at 743 feet above sea level.

Surprisingly, the buried valley emanates from the Spring Creek valley in Northfield rather than the Cannon River valley. In the Cannon River valley under the Carleton College football field bedrock is at an elevation of 880. A buried gully begins near the school's football field and enters the major buried valley near the confluence of Spring Creek and the Cannon, but this gully is only a minor tributary to the major buried valley coming from the Spring Creek area.

The buried Cannon River valley appears to be narrow with steep sides near Northfield but broader near Cannon Falls. Cross sections show the shape of the valley at the Northfield Sewage Treatment Plant site (Figure 2) and the Lake Byllesby County Park (Figure 3). Seismic soundings on the edge of the valley yielded bedrock elevations 50 to 75 feet above the valley floor in some locations near Northfield. Confirmation of the steepness of the sides of the valley came from local people who have a knowledge of the bedrock conditions. For example, Charles Gleason, the operator of a gravel pit in the southwest quarter of section 21, T112N, R19W, reported drilling a 65-foot borehole without hitting bedrock only about 100 feet from the nearest outcrop. The cross-sections show the buried valley to be much deeper than the present river valley, and in some places the two are offset from each other. At Lake Byllesby the river is eroding a new gorge into the Prairie du Chien although the erosion of this channel has been temporarily arrested by the Lake Byllesby dam.

It is evident that the major buried river valley associated with the Cannon River was eroded into the Prairie du Chien Dolomite at a time when local base level was considerably lower than it is today. The valley may be part of the same preglacial valley system as the buried deep valleys in Minneapolis, St. Paul and central Dakota County.

The valley is filled with surficial deposits which are related to one or several glaciations. There may be a relationship in age and mechanism of emplacement between the deposits overlying the Prairie du Chien in the Cannon valley and the abandoned shoreline north of Lake Byllesby. The presence of the shoreline suggests the lake remained at the 880-885 level for a long period of time, although the mechanism of water retention is unknown. Whether the surficial material

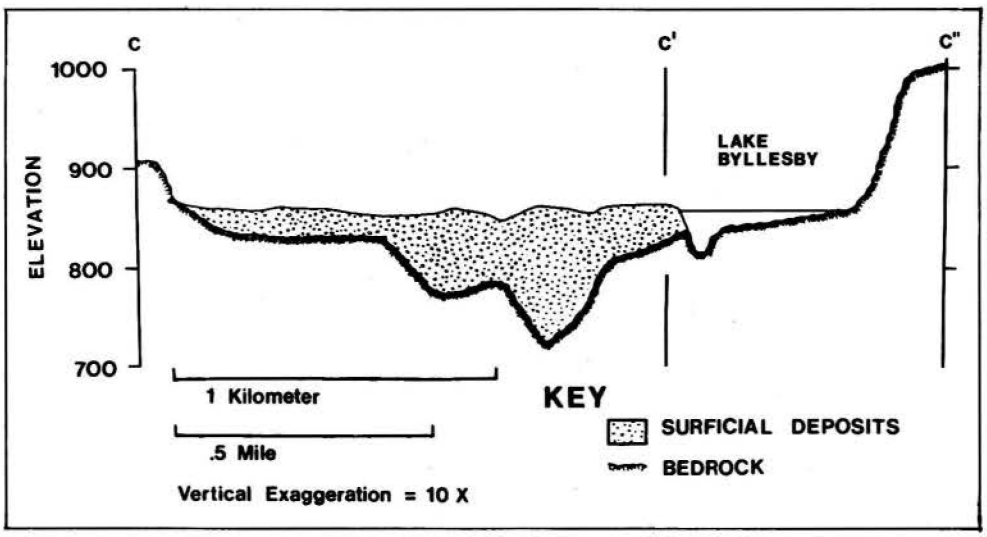

Figure 2. Cross section of buried valley at Northfield Sewage Treatment Plant Site.

was deposited in a lake or directly by outwash streams however, it was sufficient in volume to bury a complex network of rugged channels related to the ancestral Cannon River. Today the valley is filled with up to 130 feet of sediment so only a few bedrock knobs punctuate the otherwise flat plain north of Lake Byllesby.

REFERENCES

ANDERSON, H.W., FARRELL, D.F., BROUSSARD, W.L. and FELSHEIM, P.E., 1975, Water Resources of the Cannon River Watershed: Hydrologic Investigations Atlas HA-522, U.S. Geological Survey.

AUSTIN, GEORGE S., 1972, Cretaceous Rocks in Sims, P.K. and Morey, C.B., eds, Geology of Minnesota: A Centennial Volume.

BLOOMGREN, BRUCE A., OLSEN, BRUCE M., and WALTON, MATT S. 1979, Bedrock Geology, in Geologic and Hydrologic Aspects of Tunneling In The Twin Cities Area, Minnesota: U.S. Geological Survey Miscellaneous Investigations Series Map I-1157, plate 3.

Dakota County Highway Department, 1975, Bridge No. 19514 (Alta Avenue at the Cannon River) Report, sheet 15A.

KANIVETSKY, R., 1978, Bedrock Hydrogeology, Hydrogeologic Map of Minnesota: Minnesota Geological Survey State Map Series S-2.

RUHE, R.V., and GOULD, L.M., 1954, Glacial Geology of The Dakota County Area, Minnesota: Geological Society of America Bulletin. 65.

SARDESON, F.W., 1933, Glacier Diversion of Cannon River in Minnesota: Pan-American Geologist. 59.

SAVINA, M., JACOBSON, R. and RODGERS, D., 1979, Outwash Deposits of Dakota County, Minnesota: Minnesota Geological Survey (unpublished), 81 p.

SCHUMM, S.A., 1977, The Fluvial System, Wiley.

SWANSON, D., 1979, Glacial Geology of Eastern Rice County, Minnesota: unpublished thesis, Carleton College.

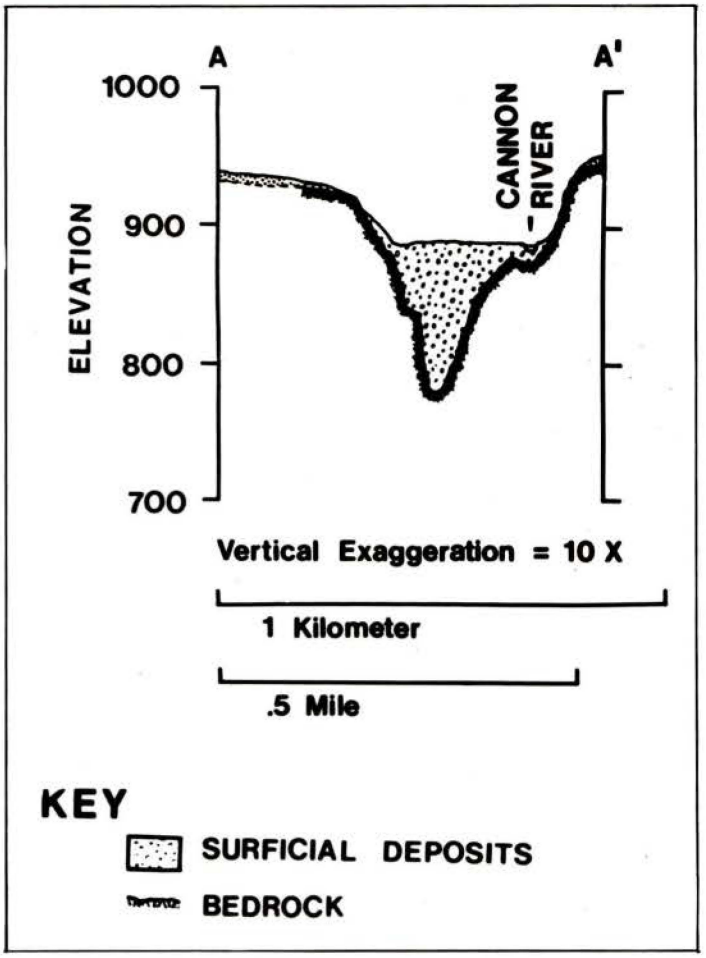

Figure 3. Cross section of buried channel at Lake Byllesby County Park near Cannon Falls.