

The Giles County Earthquake of 1897 — Virginia's Largest Temblor

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The period from May 3 to June 6, 1897, was especially disturbing for the residents of Giles County in western Virginia and the surrounding area. During that time interval, there was a continuing occurrence of earthquakes, the largest of which was a damaging, magnitude 5.8 shock on May 31. Many of these seismic events were accompanied by acoustic phenomena known as "earthquake sounds." These low-pitched sounds are usually reported by people as being subterranean in origin and are very frightening to the general populace. Clearly, New River Valley residents had to have been alarmed and concerned at this state of affairs.

Unlike California, Virginia is not a seismically active state; thus, the occurrence of multiple earthquakes there over a protracted time interval was truly unique. Additionally, that May 31st shock is the largest known earthquake during Virginia's long recorded history, and it is the second largest seismic shock in the ten southeastern states. (The largest southeastern U.S. earthquake was a magnitude 7.3 event near Charleston, South Carolina, in 1886.) It caused damage to buildings in Pearisburg and was felt over an area of some 300,000 square miles in a dozen states from Ohio to South Carolina and from the Atlantic coast to Kentucky.

The late 19th century was at the beginning of the instrumental period of seismology; *i.e.*, seismographs were just being invented. Accordingly, the study of earthquake occurrences during that period relies almost entirely on such qualitative data sources as newspaper accounts, diaries, and journals. Fortunately, newspaper journalism has a long history in Virginia, and an extensive collection of microfilms of pre-1900 newspapers exists within the state. Additional archival sources found to be very useful were the *American Journal of Science* and the *Monthly Weather Review*. A compilation of the data obtained from all these sources is fully tabulated in a separate paper.¹ That tabulation lists ten different

data sources that report on 115 different localities distributed throughout the region.

Measures of Earthquake Size

From a description of the effects reported for each site, seismologists assign an “intensity” level to those effects. Such a designation gives a numerical rating, according to a special scale, of the severity of the earthquake shaking that was reported. This rating is done routinely by seismologists in addition to their calculation of the more familiar measure of earthquake size — magnitude — from seismographic recordings.

The magnitude measure of the size of an earthquake is well-known and often referred to as the “Richter magnitude” after the California Institute of Technology professor, Charles F. Richter, who developed the scale in the mid-1930s. It is a quantitative measure and, because it is corrected for the distances from the epicenter to the various recording seismographs, the determinations at various observatories are, within experimental error, the same for a given shock. Thus, there is only one magnitude value (number) associated with each earthquake. As a general guideline, structural damage begins but is slight at the 4.5 magnitude level, becomes moderate at the 5.5 level, and from 6.5 up can be great. Below a magnitude 4.5 an earthquake is generally felt but causes no damage. At a magnitude 5.8, the 1897 Giles County temblor would be classified by seismologists as being “moderate” in size. However, it was so much larger than anything in the locals’ prior experience that it was much more than moderate to them.

As previously noted, the intensity measure of earthquake size is qualitative. It is intended to specify the severity of earthquake motion at a given site by its effects on people, the structures, and the landscape at that location. It will be largest near the epicenter and will decrease with distance from that point. Thus, there are many possible intensity values (numbers) associated with each shock. A typical use of intensity data is to plot all of the values at their respective locations on a map and then to contour them. The resulting map, which depicts those areas that experienced each varying level of shaking effects, is termed an “isoseismal map” or an “intensity map”. Such maps have been developed for the 1897 shock.

The reference intensity scale in use in the United States is termed the Modified Mercalli Intensity Scale. It has 12 degrees or levels, ranging from I (felt by only a few people) to XII (total destruction). Structural damage usually begins at intensity VI, becomes pronounced at VIII and

great at X and higher. Because there are two earthquake size measures, convention dictates that Arabic numbers are used for magnitudes and Roman numerals for intensity values. At the 1897 shock's intensity VIII, considerable building damage, fall of chimneys, disturbance to wells and springs, overturning of heavy furniture items, and similar effects on structures and the environment would be expected to occur in the epicentral area.

The three principal sources of information on these effects are newspaper accounts at the time, a published report by a professional geologist who visited the area soon after the earthquake's occurrence, and a 1975 engineering inspection of buildings in the Pearisburg area that had been constructed prior to 1897. As expected, these data sources tell somewhat different stories. Newspaper accounts must be evaluated carefully, as they are not scientific reports. Similarly, an engineering study conducted almost 90 years after the occurrence of the effects being investigated suffers some loss of credibility. The geological report is probably the most reliable source of information. Its time duration and areal extent were, however, rather limited, and a more extensive study immediately following the shock would have been very useful.

Contemporary Newspaper Accounts

The intensity reached the VIII level in the epicentral area of Pearisburg, Narrows, and Giles County. Structural damage reported from that area included the courthouse at Pearisburg, the county seat, having been badly cracked by the earthquake shock, and numerous chimneys seriously damaged or shaken down completely. In particular, bricks rolled from chimneys onto the county courthouse roof to such an extent that Judge Jackson, who was holding circuit court when the shock occurred, ran from the building, along with the others present. An attorney from Roanoke who was in Pearisburg soon after the shock reported that, within a radius of nearly fifty miles, he saw hardly a sound chimney standing. "In his opinion, if the buildings throughout Giles had been largely of brick, the damage would have been very great, and serious loss of life would have occurred."²

The intensity VIII level of ground shaking is severe enough that it also produces effects on the landscape. In Giles County, tons of rock were thrown down from overhanging cliffs onto the railroad tracks below. In one instance, a freight train was derailed, causing a traffic delay of several hours. Initially, a crack in Angels Rest Mountain was reported but this was later shown to be false.³ For several days following the shock the

waters in many of the springs and branches were muddied. "There were fissures in the ground and small landslides in places where they were easy to start. At Narrows it was claimed that a motion like the ground swell of the ocean was observed."²

In an apparent foreshock sequence of a week or more, the people throughout Giles County were disturbed by series of subterranean noises. On Monday the 31st, the day of the shock, detonations like the explosion of distant artillery were heard throughout the county.^{2,3} The most direct interpretation of these sounds is that the earlier ones were of lower pitch sound level and were, therefore, from more distant and/or deeper sources. The explosive artillery sounds had both higher pitch and greater sound levels and would be nearer and/or shallower to the Giles County residents. There is not enough quantitative data here to attempt an interpretation of this apparent "approach" of the shocks towards the epicentral area.

Reports from the area immediately adjacent to Giles County included those from the communities of Christiansburg, Dublin, Floyd, Pulaski, Radford, and Bluefield, West Virginia.^{2,4} In Christiansburg (Intensity VI), it was reported that a "rumbling noise" preceded the shock. Houses rocked, doors opened, and bricks were thrown down from chimneys. People there "rushed into the streets much excited." The severity of the earthquake "exceeded any in the recollection of the oldest inhabitant." These Christiansburg reports were typical of those in the other communities surrounding the epicentral locale. The effects were uniformly described as "severe." Damage to masonry buildings and walls was common, as were earthquake sounds and general alarm of the populace.

The 1969 Christiansburg *News Messenger*⁵ gave the following quotation from their original 1897 account:

"It was a warm, sunny day in early summer when, without warning, buildings along Main Street began a rocking movement and dry timbers in their frames popped and cracked and the air became full of dust. Many people ran out of houses and into the street, some whitefaced, and stared upward where the dust, shaken from the buildings, was slowly settling to the ground. The tremor lasted only a few minutes before the panic was over and normal business was resumed along the street. This earthquake was felt in several counties adjoining Montgomery, but little damage was reported beyond the cracking of plaster in a few homes."

In the central and eastern parts of the Commonwealth, the general level of effects was recorded in the newspapers from such cities as Lynchburg, Richmond, Norfolk, Portsmouth, Petersburg, Suffolk and Williamsburg.² As expected, the level of damage was absent or greatly

diminished, but the ground vibrations were still severe enough to be felt by and to frighten the residents sufficiently to cause general alarm. There was great excitement, and panic-stricken people rushed into the streets. In Petersburg, "Large factories were quickly emptied of their workmen. Vases were broken, glass globes were shaken from chandeliers, and crockery was moved on shelves. Telephone and telegraph wires were violently shaken."²

In Richmond, a newspaper reported, "The vibrations lasted for several seconds and were so violent that many people ran out of their houses, fearing their collapse." No material damage. Hotel guests "ran out of their rooms under the impression that a boiler had burst." The noise was "Loud and startling." Pictures were shaken, shutters "rattled as if blown by a violent wind," and "furniture was moved in a number of instances." Many became suddenly sick just before the shock was felt, with symptoms "like nausea and swimming of the head." Convicts at the penitentiary were so frightened that they tried to break out. It was "The most serious and alarming earthquake ever experienced here."²

Nausea was also reported at other Piedmont and Coastal Plain communities in Virginia. This type of human response to earthquake vibrations is not uncommon when the shock is large and distant. It is attributed to an inner-ear motion response to the slow ground motions associated with the low-frequency, seismic surface waves, which is similar to sea-sickness. These surface waves become well-developed only at appreciable epicentral distances (100's of kilometers).

Representative reports from the surrounding states include those from Atlanta, Georgia; Indianapolis, Indiana; Louisville, Kentucky; Baltimore, Maryland; Winston, North Carolina; Cincinnati, Ohio; Cleveland, Ohio; Pittsburgh, Pennsylvania; Spartansburg, South Carolina; Knoxville, Tennessee; Wheeling, West Virginia; and Washington, D.C.^{2,6,7} Throughout the twelve states nearest Virginia, the 1897 shock was felt and recognized as an earthquake by residents, but there was no damage to structures. Particularly interesting accounts in that region came from two Ohio locations and the District of Columbia.

At Cincinnati, Ohio (V) the shock was felt "here and in the suburbs ... The printers ran out of the *Times Star* office. The occupants of other buildings were alarmed and at Coney Island, Chester Park, the Zoo Gardens, and elsewhere there was consternation among the holiday crowds. At the Lagoon, on the Kentucky side, there was panic among several thousand people on the grounds. The waters in the Lagoon were so rough that the life-saving crew went to the relief of those out on the electric pleasure boats."² The weather bureau station report gave more

detail on this unusual effect. It stated that at 13:02 (1:02 p.m.) "A wave of water started at the southwest extremity of Ludlow Lagoon, which by the time it reached the eastern shore, was over 3 feet high. The earthquake lasted 1½ minutes. Shock was rarely noticed inside the city."⁶

The lagoonal disturbance sounds very like a "seiche" effect, which is an oscillation response of confined bodies of waters to long-period seismic ground shaking. In this instance, however, it was probably a "tempest in a teacup", as most city lagoons are quite shallow. Similarly, in recent years, Californian residents have reported water being splashed out of their swimming pools following some of the larger shocks in that state.

The 1897 earthquake was recorded on two of the earlier, prototype seismographs. In Cleveland, Ohio (Felt) the seismograph of Professor Edward W. Morley, at Adelbert College, recorded ground vibrations of northeast to southwest orientation and about one-hundredth of an inch in amplitude.⁶ At the weather bureau in Washington, D. C., a Marvin seismograph recorded ground motions beginning at 1:58:15 p.m. and lasting for five minutes.^{6,7}

Geological Report

At the "urgent request of several citizens of Pearisburg," a geologist, M. R. Campbell, with the U.S. Geological Survey in Washington, D. C., visited the Pearisburg region for three days, June 6-8, 1897, and reported his findings in *Science*.³ He stated that the previous reports that Mountain Lake had drained, that the wells at Saltville, Virginia, had ceased to flow, and that large fissures had opened in the earth at various points in Giles County were "found to be grossly exaggerated."

There is, however, an apparent conflict in where he does assign the maximum intensity effects. On the first page of his report (p. 233), he writes that "The shock of May 31 was probably more severe in and about Pearisburg than at any other point for which I have information." Then, on the following page, he states: "Apparently the general shock of May 31st was most severely felt at the Narrows, which is located on one of the most complex and extensive faults of the region." His description of the effects at the two locations indicates that he was probably not simply drawing a distinction between effects to structures (damage at Pearisburg) and effects on people (panic at Narrows). For the Pearisburg area, Campbell reports:

No serious damage was done even here, but old brick houses were badly shaken and many chimneys were cracked and the topmost bricks

thrown to the ground. Much noise accompanied this shock, and many of the inhabitants, already disturbed by the previous heavy shock [probably the Intensity VII foreshock on May 3rd], and the continued rumblings beneath them during the month, were terror stricken. (p.235)³

For the Narrows area, some four miles west, Campbell states:

At this point the surface is said to have rolled like the groundswells of the ocean, springs were muddied and in some cases ceased to flow for a short time after the shock occurred, and a landslide of considerable proportions and a big rock rolled down off the face of Wolf Creek Mountain. The latter is no indication of great intensity for the slopes are so steep that a slide is liable to start at any time, and the blocks of sandstone have frequently such a precarious foothold that they will start with the slightest disturbance. (p.235)³

The epicenter is generally taken by present-day seismologists to have been at Pearisburg, but that may be simply because there were more buildings there to reflect earthquake damage than there were at Narrows. However, the two sites are close enough together to make the point essentially moot. Campbell apparently preferred the Narrows location because of a great fault present there and concluded that the cause of the " ... pronounced disturbance in and around Pearisburg is presumably the cavernous condition of the limestone in that region, apparently causing it to act as a sounding board, magnifying the sounds and vibrations." (p. 235)³

Campbell certainly emphasized the acoustic nature of the aftershock sequence. He describes it as "explosive sounds" which were likened by old veterans [of the Civil War] "... to reports of heavy siege guns fired at frequent intervals during the night." For the May 31 to June 6 time period, Campbell notes that the explosive sounds continued with considerable regularity, with from five to ten slight shocks being about the daily average. He cites a Baptist minister, J.A.H. Shuler, as having estimated the occurrence of at least 250 distinct shocks at Pearisburg since May 3 (presumably until June 6-8). It is clear that Campbell correctly understood that the sounds were indeed caused by earthquakes.

Engineering Study

The size and intensity level of the 1897 shock took on importance once again some eighty years after its occurrence. The early- to mid-1970s was a time of development in the nuclear power industry in this country. In the southeastern United States, such power plants were being built in Virginia, Tennessee, and North and South Carolina. The

U.S. Code of Federal Regulations pertaining to reactor site criteria for nuclear facilities required the consideration of the most severe historically reported earthquakes in the region surrounding the site. These shocks were then used to determine the level of ground vibrations that the reactor should be designed to withstand.

In 1975, a Clinch River Breeder Reactor Plant in eastern Tennessee was in the planning process. The 1897 Giles County earthquake was considered to be the relevant maximum historical earthquake to be used in its design. In part because of the differences between the newspaper accounts and Campbell's report, an engineering firm, Law Engineering Testing of Marietta, Georgia, in conjunction with Burns and Roe, Inc., was commissioned to conduct a study and then prepare a report on all available information and data relating to assignment of a Modified Mercalli level to the 1897 shock.

Law Engineering Testing (now Law Engineering and Environmental Services, Inc.) conducted an exhaustive evaluation of all available data relating to the 1897 earthquake. That evaluation consisted of reviewing all available published and unpublished reports and newspaper articles on the shock, interviews with older residents and historians in the area, on-site physical inspections of pre-1897 buildings that were still available in Giles, Montgomery and Pulaski counties, and discussion with geologists and seismologists in the region who had studied the earthquake. In this process, the engineering personnel added to the number of newspaper accounts originally gathered by Margaret Hopper and Gil Bollinger.¹ Their new data along with on-site building evaluations were published in a 1975 report.⁸

The basic conclusion of this Law Engineering Testing study was that the intensity level for the 1897 earthquake was not at an VIII level but was intermediate between that and the VII level; *i.e.*, it was a VII–VIII intensity (See Figure 1).⁹

Isoseismal Maps and a Magnitude Estimate for the 1897 Earthquake

Two isoseismal maps have been prepared for the historically important shock. The first was published in 1971 in the *Bulletin of the Seismological Society of America* by the author and Margaret Hopper.¹⁰ That map and its supporting data were available to the Law Engineering Testing personnel at the start of their 1975 investigation. As noted above, they added to the available data base and then went on to publish their own isoseismal map based on 217 reports from 101 different localities.

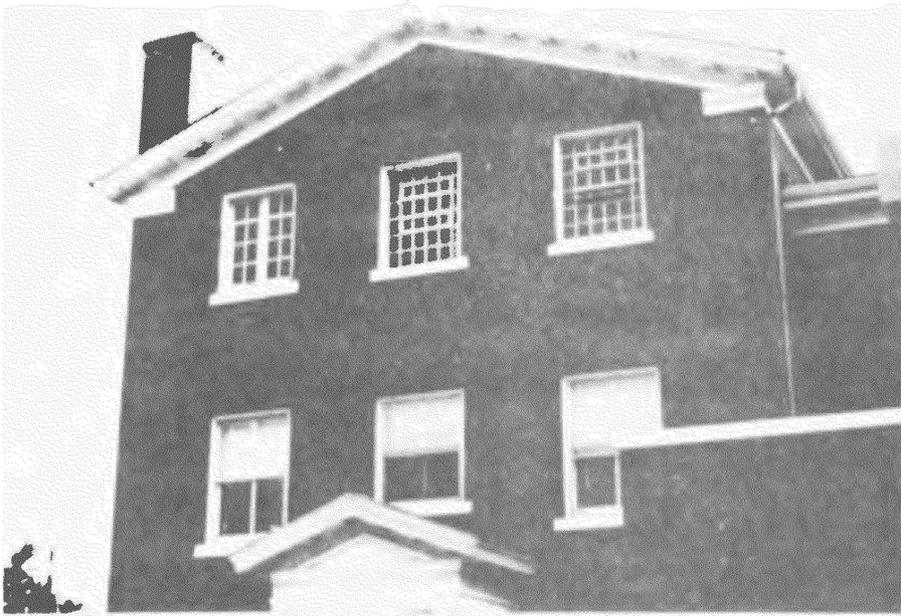


Figure 1. The Giles County Courthouse in Pearisburg, Virginia. This building was constructed in 1836. Law Engineering personnel inspected this structure in 1975 and concluded that there was no damage from the 1897 earthquake except possibly to the upper bricks on one of the chimneys.

Figure 2 presents the Law Engineering Testing map but does not show all of the individual data points. It does, however, depict the configuration and areal distribution of those areas that experienced the different levels of intensity for the 1897 shock. The northeasterly orientation of the innermost isoseismal contours probably reflects the influence of the Appalachian geology and topography, which has a pronounced “grain” in that direction. A felt radius of approximately 300 miles about the (presumed) Pearisburg epicenter is indicated.

To estimate the Richter magnitude for earthquakes that occurred before there was adequate seismographic monitoring, seismologists employ a calibration technique. That technique consists of studying the relationship between isoseismal area size and spatial rate-of-decrease with increasing epicentral distance for modern events for which both magnitudes and isoseismal maps are available. This type of study for the 1897 shock was performed by Dr. Otto Nuttli of St. Louis University and his co-workers in 1979.¹¹ Their magnitude estimate was 5.8, and that value

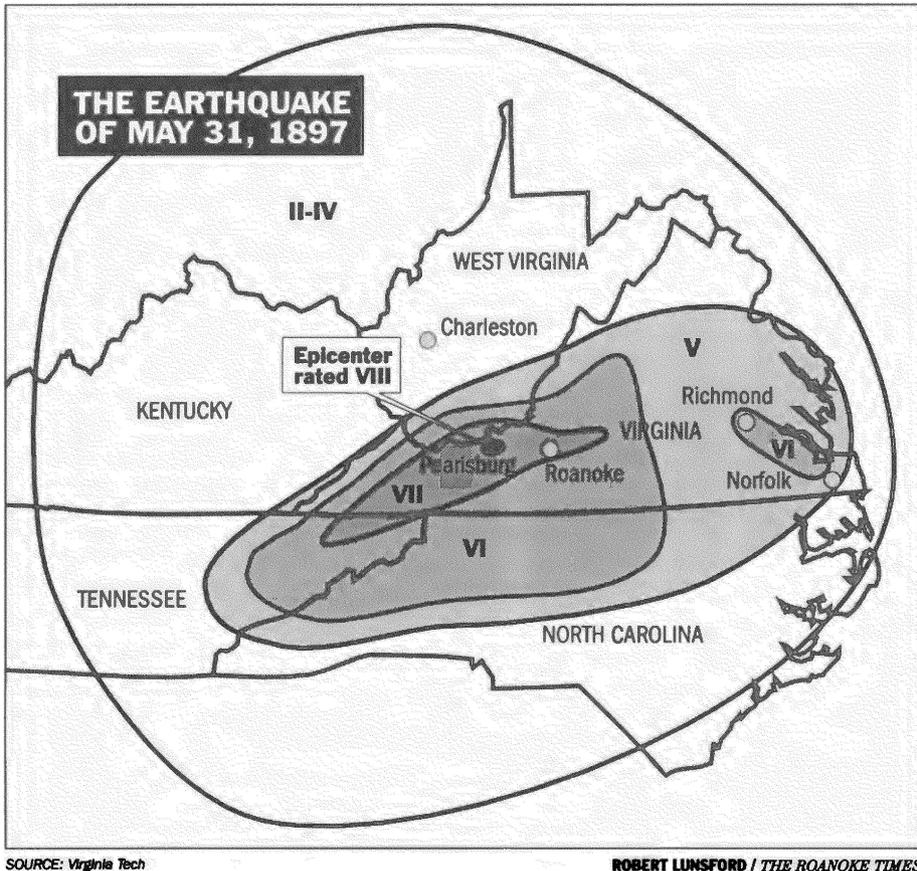


Figure 2. Isoseismal map for the Giles County earthquake of May 31, 1897. Intensity levels shown by Roman numerals, but the 217 individual observation points upon which the isoseismal contours are based are not plotted. Modified after Law Engineering Testing Co.⁷

has subsequently been accepted by the professional community as a valid size measure for this earthquake.

Some Final Comments

The centennial anniversary of the 1897 Giles County earthquake was this past year. It is likely that the many of today's residents in the area are unaware of this important geologic event's occurrence within

their county. In recent times occasional small shocks have been felt in the locality, but nothing nearly as unnerving and damaging as in 1897.

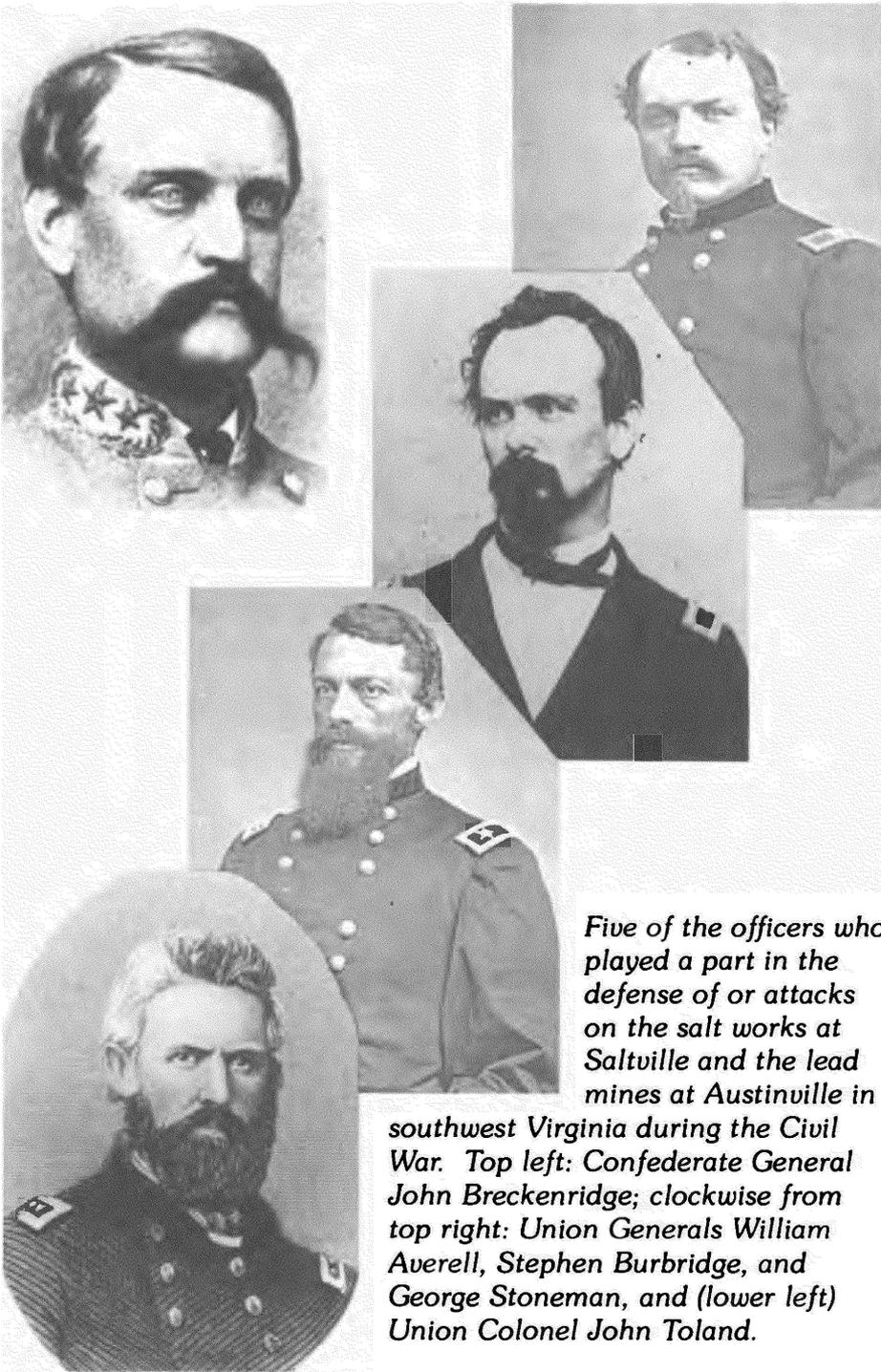
In 1969, Virginia Tech's Department of Geological Sciences personnel installed a modern seismograph in Mill Creek valley at Narrows. That began a program of study of the seismicity of the area that continues today. In the mid-1970s, a Seismological Observatory program was formally instituted at the University. That group can be contacted for the Giles County research results they have obtained over the past three decades.

Acknowledgments

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Endnotes

1. Margaret G. Hopper and G. A. Bollinger, *The Earthquake History of Virginia — 1774 to 1900* (Blacksburg, Va.: Virginia Tech Press, 1971), p. 87.
2. *The Richmond [Va.] Dispatch*, June 1 and 4, 1897.
3. M. R. Campbell, "Earthquake Shocks in Giles County, Va."[sic], *Science*, 3, no. 161 (1898): 233-35.
4. Gerald R. MacCarthy, "A Descriptive List of Virginia Earthquakes through 1960," *Journal of the Elisha Mitchell Scientific Society*, 80, no. 2 (December 1964): 95-114.
5. *News Messenger, Centennial Edition* (Christiansburg, Va.), December 31, 1969.
6. *Monthly Weather Review* 25 (6): 257-58 (Washington, D.C.: U.S. Department of Agriculture, 1897).
7. *New York Times* (New York, N.Y.), June 1, 1897.
8. Law Engineering Testing Company, *Report on Evaluation of Intensity of Giles County, Virginia Earthquake of May 31, 1897* (Marietta, Georgia., 1975).
9. The Clinch River Breeder Reactor was never built, in part because of concerns for an endangered species of small fish, the Snail Darter, found in streams of the site area.
10. G. A. Bollinger and Margaret G. Hopper, "Virginia's Two Largest Earthquakes — December 22, 1875 and May 31, 1897," *Bulletin of the Seismological Society of America*, 61 (1971): 1033-39.
11. O. W. Nuttli, G. A. Bollinger, and D. W. Griffiths, "On the Relation between Modified Mercalli Intensity and Bodywave Magnitude," *Bulletin of the Seismological Society of America*, 69 (1979): 893-909.



Five of the officers who played a part in the defense of or attacks on the salt works at Saltville and the lead mines at Austinville in southwest Virginia during the Civil War. Top left: Confederate General John Breckenridge; clockwise from top right: Union Generals William Averell, Stephen Burbridge, and George Stoneman, and (lower left) Union Colonel John Toland.