Ohio Geology

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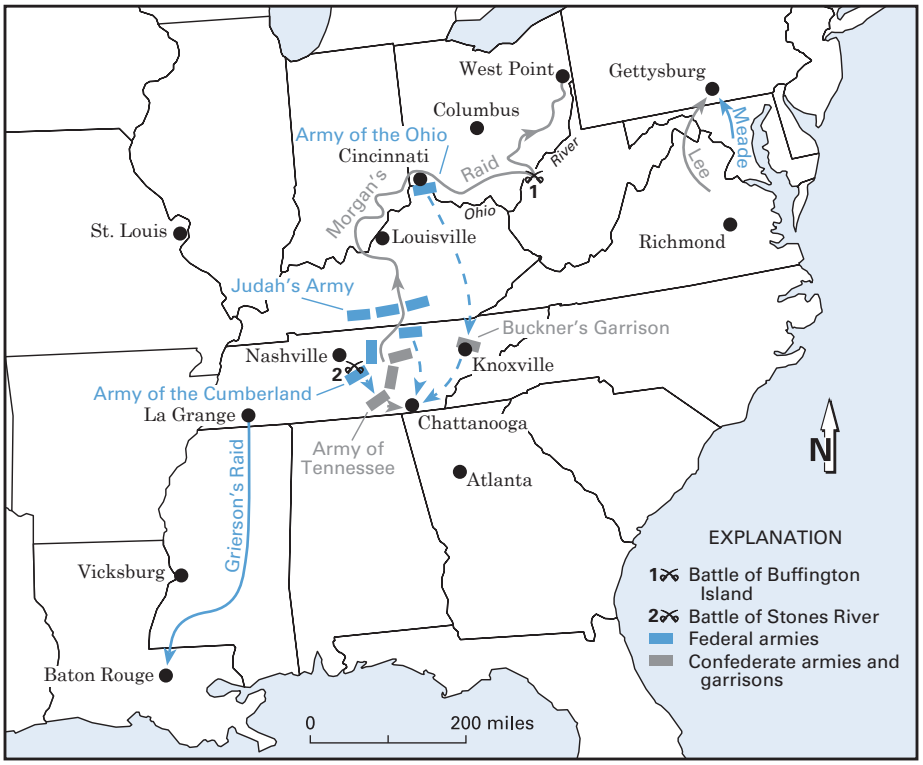
THE ROLE OF GEOLOGY AND TERRAIN IN THE SUCCESS AND DEFEAT OF MORGAN'S RAIDERS

by Gregory A. Schumacher and Donovan M. Powers

The affairs of a nation and its people tend to follow a course with relatively little change until some catastrophic event of epic proportions destroys the status quo and alters the course of history. The surprise attack on Pearl Harbor on December 7, 1941, abruptly ended the Great Depression and thrust the United States into World War II. The horrific terrorist attacks of September 11, 2001, instantly shattered our false sense of national security and changed our lives forever. The citizens of southern Ohio experienced the catastrophic event of their lifetimes beginning on July 13, 1863.

About noon on that fateful day, the residents of Harrison, Ohio were drawn to their windows by the commotion associated with nearly 2,000 Confederate troops riding into town under the command of Brigadier-General John Hunt Morgan. This was the second time Confederate cavalrymen invaded Ohio. Robert Harper in his *Ohio Handbook of the Civil War* provides an excellent summary of the first raid led by Brigadier-General Albert Gallatin Jenkins on September 3 and 4, 1862, through eastern Meigs County, Ohio. In both raids, the Buffington Island Ford across the Ohio River played a critical role. General Jenkins and his 350 troopers used the ford to enter Ohio, and General Morgan and his command hoped to leave Ohio across the same ford.

The firm, sandy riffles at Buffington Island Ford are the product of the Ohio River and its tributaries transporting and depositing sediments eroded from the bedrock and glacial deposits of eastern Ohio, West Virginia, and Pennsylvania. The terrain of southern Ohio crossed by General Morgan's command is also the product of erosion and deposition of sediments over millions of years. In southwestern Ohio, erosion and deposition of glacial sediments produced a gently rolling topography dissected by occasional, deep valleys carved by glacial meltwater. In southeastern Ohio, erosion continued, without interruption by repeated glaciations, for millions of years producing a rugged terrain characterized by narrow, sinuous ridges separated by deep valleys.



The deployment of selected Federal and Confederate forces in June of 1863. Solid lines show movement of forces between April and July, and dashed lines illustrate the possible invasion routes of General Burnside's Army of the Ohio and General Judah's Army.

Did this variable terrain influence the progress of Morgan's Raiders? Our terrain analysis determined that initially Morgan's troops were helped by the terrain to increase their lead over the pursuing Federal troops, but later rugged terrain combined with additional factors slowed them just enough to allow the pursuing Federal troops to catch up and defeat Morgan's command at the Battle of Buffington Island.

Before we examine the role geology and terrain played on Morgan's Raid, however, let's return to Harrison, Ohio to discuss the impact that raiders had on the people and economy of southern Ohio and why the deteriorating military situation of the Confederate Army in Tennessee necessitated Morgan to undertake such a daring raid.

The fear and panic that gripped Harrison's citizens caused by Morgan's troops was soon shared by thousands of other Ohioans as news of the invasion spread rapidly throughout southern Ohio. Governor David Tod declared martial law. Cincinnati Mayor Len Harris closed businesses, called for militia volunteers, and directed citizens to stay home. Major-General Ambrose Burnside hurriedly prepared the 30,000 partially trained troops of the Army of the Ohio to defend Cincinnati.

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Thomas M. Berg, Division Chief and State Geologist

From The State Geologist...

Thomas M. Berg

SEEING WILLIAM SMITH'S MAP

Fortunately, my parents, teachers, and college professors instilled in me a love and great respect for history and finding the beginnings of things. Indeed, when we can find the time for it, my wife and I greatly enjoy genealogy and filling in our family tree.

A couple of years ago, I read *The Map that Changed the World: William Smith and the Birth of Modern Geology* by Simon Winchester. It was so fascinating that I couldn't put the book down until I had finished it. This account of William Smith's deciphering the stratigraphy of England, Wales, and southern Scotland and producing the first true geologic map is absolutely marvelous. I highly recommend it. The book left me with a strong desire to actually see Smith's map, which was issued in 1815.

Small portion of Smith's map showing geology around London. £ coin for scale.

On a recent visit to London, England, my wife and I visited the British Natural History Museum. We stopped by a publication outlet of the British Geological Survey at the museum where I purchased a scanned, full-color, reduced copy of William Smith's 1815 map. When I asked if I could see a copy of the original, I was told that I needed to make an appointment and view it at the Geological Society of London. ("Make an appointment?" It was bad enough trying to remember everything else for our trip—toothbrush, passport, etc.). Pressing on, I asked if the museum itself had a copy I could view. "Well, yes, but you can't see it today because the gentleman in charge of it is away." I said to my wife, "Let's go talk to the folks in the museum's science library." Accustomed to my stubborn persistence, she followed along. We had a similar exchange with the kindly science librarian. "The gentleman in charge is not in." Continuing my doggedness, I asked, "Is there anyone else who might know of the map's availability." A friendly young lady was called upon the scene. "Do you know if there is another copy of William Smith's map here in the museum?" She responded, "Oh sure, we have a folio copy." I was on cloud nine.

About 400 copies of Smith's original map were produced. Each was hand painted with 20 shades of watercolor. Coloring of the different formations is unique; the base of each stratigraphic unit is rich and dark, and fades to a pale intensity near the top. Each map comprised 15 sheets, and when mounted, was about 9 feet high by 6 feet wide. The unmounted folio-bound version handed to me retained the original, brilliant, unfaded colors and I could examine it with my hand lens. I was also permitted to photograph the map up close (after I was enrolled as an official researcher). One of the sheets bore an original signature, "Wm. Smith." My wife looked at me like I was a kid with a new toy. What a thrill it was to see an original of the "map that changed the world!" William "Strata" Smith would have smiled. All should get to know the roots of their profession.

New map of oil and gas fields in Ohio

The Division of Geological Survey has released a new map illustrating Ohio's areas of oil and gas production since the 1860's. On the map, oil and gas fields are color-coded, based on the geologic formation from which the oil or gas is derived. The map includes a list and brief description of all known oil-and-gas-production fields. The map will be useful to petroleum explorationists and producers, geologists, academicians, geotechnical consultants, and city and regional planning departments.

Digital databases and Geographic Information System (GIS) files associated with the map allow users to create custom maps, and to extract specific kinds of information such as production by year, type of production (oil vs. gas), and production by formation. These digital files also can be used with other Geographic Information System (GIS) files (e.g. political boundaries, digital elevation models, etc.) to create an unlimited number of layered scenarios.

The map is available digitally or as a wall-size (53 by 41 inches), full-color, paper map. Copies of the wall-size map may be ordered for $15 plus $1.02 tax (Ohio addresses only) and $4 handling (add $1.50 for mailing tube when requesting a rolled copy). The digital version of the map (including PDF file, and ESRI shape files) on CD-ROM may be ordered for $25 plus $1.69 tax (Ohio addresses only) and $4 handling. Send payment to: ODNR, Division of Geological Survey, 2045 Morse Road, Bldg. C-1, Columbus, OH 43229-6693. Visa and Mastercard are accepted.

A page-size version of the *Oil and Gas Fields Map of Ohio* is available for viewing or downloading from the Division of Geological Survey's Web site <http://www.ohiodnr.com/geosurvey/>.

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For the next 13 days, messengers rode ahead of Morgan's columns shouting: "the rebels are coming!" or "Morgan's coming!" Ohioans hastily hid their money, gold and silver, and horses. Many abandoned their homes and businesses seeking safety in the nearby woods and hollows with their valuables. The raiders, more often than not, treated those who stayed in their homes with great respect—politely asking for food, fodder, and drink. In some cases, however, they paid their "host" for the meal and promptly rode away with every horse in sight.

Across southern Ohio, detachments from Morgan's nine cavalry regiments fanned out in a 5 to 10 mile-wide swath, pillaging homes and businesses for provisions and valuables. Lester V. Horwitz, author of *The Longest Raid of the Civil War*, notes that occasionally the raiders "borrowed" some very unusual merchandise such as bolts of cloth, ladies hats, veils, and dresses, pairs of ice skates, and even a bird cage with three canaries. Businessmen commonly paid large sums of money to the raiders to spare their businesses from being burned to the ground. All along Morgan's route, key railroad stations, sections of railroad track, telegraph lines, covered bridges, and selected businesses were destroyed. Robert Harper in his *Ohio Handbook of the Civil War* stated that approximately 2,500 horses were stolen and nearly 4,375 homes and businesses were raided. Morgan's Raid cost Ohio tax-payers nearly $600,000 in damages and over $200,000 in wages paid to the 49,357 Ohioans called up to man 587 companies of local militia.

Morgan's troops fought 23 skirmishes with Federal troops and local militiamen during their 13 days in Ohio. On July 19, 1863, General Morgan and his men were defeated on the banks of the Ohio River north of Portland, Ohio in the Battle of Buffington Island. This was the first and only major Civil War battle fought on Ohio soil. This greatest of all Civil War raids ended on July 26, 1863, near the village of West Point, Ohio when General Morgan and 335 surviving raiders unofficially surrendered to Captain James Burbick commanding a local militia. Shortly thereafter, General Morgan officially surrendered to Major George W. Rue of the United States 9th Kentucky Cavalry. Morgan's casualties, during his 13 days in Ohio, amounted to nearly 1,600 men killed, wounded, or captured. Only 400 men escaped into West Virginia to later rejoin the Confederate Army.

Why would General Morgan, contrary to direct orders from his commander, cross the Ohio River, to conduct one of the most successful cavalry raids of the Civil War? To answer this question, we must leave southern Ohio, move to central Tennessee, and review the strategic situation of the western theater of the Civil War. On December 31, 1862, and January 2, 1863, the Federal Army of the Cumberland, commanded by Delaware County resident Major-General William Rosecrans, fought the Confederate Army of Tennessee, commanded by Louisiana plantation owner General Braxton Bragg, along the banks of Stones River near Murfreesboro, Tennessee. The Battle of Stones River was nearly a decisive victory for Bragg, but ended in a stalemate due to the excellent leadership of Rosecrans and the determined resistance by the Army of the Cumberland. The heavy casualties suffered by both armies would take months to replace with new soldiers, equipment, and fresh supplies. So for nearly six months, both armies remained largely inactive with the Army of the Cumberland encamped in the vicinity of Murfreesboro, Tennessee, and the Army of Tennessee dug in along the banks of Duck River between Tullahoma and Shelbyville, Tennessee.

In early June of 1863, General Bragg met with his commanders to discuss the deteriorating military situation faced by the Army of Tennessee. General Bragg feared encirclement and destruction by Federal forces in the summer of 1863. He envisioned General Rosecrans and the Army of the Cumberland attacking the Army of Tennessee. Simultaneously, the Army of the Ohio under the command of General Burnside would invade eastern Tennessee and capture Knoxville after defeating the small Confederate garrison under Major-General Simon Buckner. The Army of the Ohio would move quickly through southeastern Tennessee to capture Chattanooga. The Army of Tennessee would be powerless to send reinforcements while engaged with the larger Army of the Cumberland. The fall of Chattanooga would cut the supply lines of the Army of Tennessee and sandwiched between two Federal armies lead to complete destruction. A wild card in General Bragg's scenario was the Federal army numbering about 10,000 troops, including 5,000 cavalry troops, under the command of Major-General Henry Judah stationed in northern Tennessee and southern Kentucky. He feared Judah's Army would either reinforce the Army of the Cumberland, attack his right flank, or attack the disorganized columns of the Army of Tennessee should it be forced to retreat from the banks of the Duck River.

General Bragg's plan to avoid destruction was a strategic retreat to Chattanooga in order to use the excellent defensive positions behind the Tennessee River to stop future Federal advances. A diversion was needed to draw General Judah's troops away from central Tennessee and to slow General Burnside's invasion of eastern Tennessee if this very hazardous operation was to be successful. General Bragg turned to newly promoted Brigadier-General John Morgan, commander of the 2nd Kentucky Cavalry, and asked if his troops could carry out a successful diversionary raid into Kentucky. General Morgan confidently replied that his troops would successfully raid Kentucky and proposed that the raid should be extended across the Ohio River into Indiana and Ohio. He explained this would cause Judah's Army to chase him and would likely divert General Burnside's troops to also join the pursuit. He reminded General Bragg of Colonel Benjamin H. Grierson's highly successful raid just 7 weeks earlier.

In April of 1863, Colonel Grierson's 1,700 Federal cavalry troopers rode through Mississippi into Louisiana, disrupting communications, burning bridges, tearing up railroad track, and destroying valuable supplies needed by the defenders of Vicksburg, Mississippi. More importantly, his raid diverted thousands of Confederate troops away from the defense of Vicksburg, thereby paving the way for the Federal siege and capture of that strategic city. General Bragg flatly rejected General Morgan's proposal and ordered him to go anywhere in Kentucky, but under no circumstances to cross the Ohio River.

General Morgan returned to his men and personally issued orders that they were raiding Kentucky beginning the next morning. Repeated cheers rose from the men. In private, General Morgan confided to his most trusted subordinates that he intended to disobey General Bragg's orders. They would cross the Ohio River and raid southern Indiana and Ohio. In Ohio, they would meet again to decide whether to continue the raid across Pennsylvania, joining General Robert E. Lee's invading Army of Northern Virginia, or to cross the Ohio River and return to the Army of Tennessee at Chattanooga.

On the morning of July 2nd, the greatest raid of Morgan's career began

as troopers piled their saddles, clothes, and weapons on the few boats and canoes available and plunged into the raging floodwaters of the Cumberland River. General Morgan's command consisted of a 1st brigade of 1,460 men and a battery of two 3-inch Parrot cannons and a 2nd brigade of 1,000 men with a battery of two twelve-pound mountain howitzers. In addition, an assortment of supply wagons accompanied both brigades.

By mid-afternoon, both brigades had crossed the Cumberland River and were advancing into southern Kentucky. General Judah's troops were taken by surprise as they assumed the torrent would stop General Morgan. However, they quickly recovered and followed Morgan's troops into southern Kentucky. Part one of General Bragg's plan fell into place. In a few days, Morgan's command would cross the Ohio River and General Burnside would have his hands full defending against Morgan's invasion of Ohio. Part two would soon fall into place.

General Morgan's surprise crossing of the flood-swollen Cumberland River illustrates how little the terrain of a region deters the movement of cavalry units. These units could easily travel around most natural obstructions and were limited only by the most rugged terrain that could not be crossed by horses. Casual examination of the Division of Geological Survey's *Shaded Elevation Map of Ohio* shows that the terrain of southern Ohio becomes increasingly rugged from west to east. In southwestern Ohio, the upland areas (depicted by lighter colors) are relatively level and are occasionally dissected by major waterways (darker-colored lower-elevation areas). In southeastern Ohio, the lighter-colored upland areas have been thoroughly dissected by a well-developed dendritic drainage pattern thereby creating a landscape dominated by narrow, sinuous hills and ridges, with vertical relief of 200 to 300 feet, separated by numerous deep valleys. The gently rolling terrain of southwestern Ohio offered very few natural obstacles to impede Morgan's progress. The rugged terrain of southeastern Ohio contained more obstacles, but usually a short ride would lead to an easier route around these obstacles. Therefore, terrain should not have been a factor impeding Morgan's progress across Ohio.

General Morgan's brigades included supply wagons and artillery pieces that were both valuable assets and major liabilities during the raid. As assets, the wagons transported supplies and stolen booty, acted as ambulances for the sick and wounded, and provided rides for those soldiers who could not find replacements for worn out horses. The artillery pieces were instrumental in chasing away Federal gunboats and bombarding Federal strongholds. As liabilities, the wagons and artillery were large and heavy vehicles easily mired in swampy areas or the soft ground of plowed fields. They required bridges, boats, or shallow fords to move across rivers and streams and improved roads to traverse farmland and rugged forested terrain. General Morgan's supply wagons and artillery limited his main columns to southern Ohio's improved roads and, as a result, introduced terrain as a possible factor influencing the success or failure of the raid.

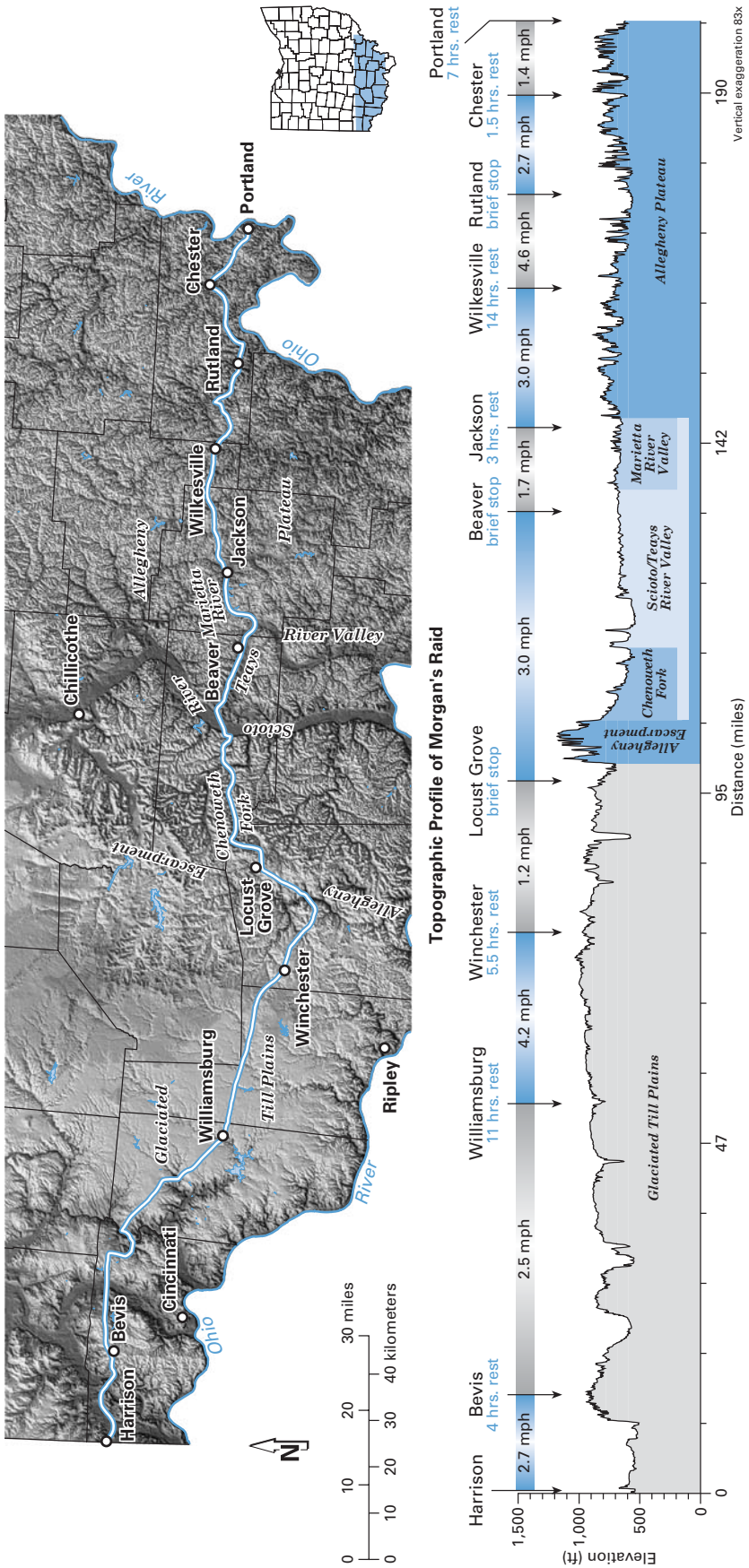
We conducted a terrain analysis to examine whether terrain hindered the progress of General Morgan's columns from Harrison to Portland. We did not examine Morgan's route after their defeat at the Battle of Buffington Island because the survivors, no longer encumbered by supply wagons and artillery, were no longer limited to traveling only on main roads. They used the rugged terrain of southeastern Ohio to their advantage by concealing themselves from pursuing Federal troops and local militias in the rugged, forested terrain away from main roads.

We began our analysis with the basic assumption that Morgan's horse-drawn supply wagons and artillery would slow his columns as the terrain became more rugged. To test this assumption, we needed to accurately map General Morgan's route across southern Ohio, generate a detailed topographic profile of his route, determine the distance traveled, and the travel times between rest stops.

In his book, *The Longest Raid of the Civil War*, Lester Horwitz published a detailed description of the history and timeline of General Morgan's route across southern Ohio. Mr. Horwitz used the novel approach of matching the names of raided citizens who submitted damage claims to the State of Ohio after the raid to the names of land and business owners identified on 1860's era plat maps. This approach allowed Mr. Horwitz to produce the first county-by-county maps of General Morgan's route across Ohio. We used Mr. Horwitz's hour-by-hour descriptions and county-by-county maps, together with Basil Duke's historic account of the raid to plot General Morgan's route on the original 15-minute topographic maps of Ohio published by the U.S. Geological Survey between 1900 and 1920. Central to our analysis is the basic assumption that the road system of southern Ohio experienced little change from 1863 to 1920. In most instances, we could easily define the main road connecting the towns and villages visited by General Morgan's troops. In a few cases, two parallel roads were available to Morgan's command for traveling to the next town. In the latter cases, we assumed that the most direct route was used. The route of Morgan's Raiders drawn on each 15-minute quadrangle was transferred onto the *Shaded Elevation Map of Ohio*, using the topographic features on these maps as a guide, and digitized. Geographic Information System methods were used to generate a topographic profile of Morgan's route and to calculate the distance traveled between rest stops. The speed that Morgan's command moved between rest stops was calculated by dividing the distance traveled by the time traveled using Mr. Horwitz's timeline.

Our results indicate that Morgan's columns traveled 200.3 miles between Harrison and Portland, Ohio. The topographic profile confirms earlier observations that the terrain becomes more rugged from west to east. The profile can be subdivided into three major segments that correspond to the major changes of terrain in southern Ohio. These major segments are 1) the glaciated till plains; 2) the Scioto/Teays River System with Chenoweth Fork and the Marietta River Valley; and 3) the Allegheny Plateau beginning with the Allegheny Escarpment. His command was on the move for nearly 85 hours out of a total 135 hours required to traverse southern Ohio. Travel was interrupted by nine rest stops that included overnight stays at Williamsburg (11 hours) and Wilkesville (14 hours) and seven shorter stops. The speed of Morgan's main columns ranged from 1.2 to 4.6 miles per hour with an average rate of 2.4 mph.

As Morgan's columns departed Harrison, they rode across the flat floodplain of the Whitewater River and climbed the high hills in the distance. For the next 99 miles, General Morgan's columns crossed the glaciated portion of southern Ohio. About 1.8 million years ago, the Ice Age began as the climate of North America cooled allowing the development of vast continental glaciers in Canada. Ice sheets repeatedly advanced and retreated across southern Ohio eroding Ordovician and Silurian bedrock. The ancient Teays River system (see Ohio Division of Geological Survey, *Geofacts 10*) was destroyed as advancing ice filled its main valley in west-central Ohio with



The Shaded Elevation Map of Ohio *with the route of General Morgan's supply wagons and artillery plotted between major rest stops. Important terrain subdivisions are identified in italics. Topographic profile of Morgan's Raid illustrating locations of rest stop, speeds between rest stops, length of rest stops, and major stream valleys. Note the dramatic increase in narrow ridges and deep valleys associated with the rugged terrain of the Allegheny Plateau east of Jackson and the progressive slowing of Morgan's command as they traveled between Wilkesville and Portland.*

hundreds of feet of glacial drift. In southern Ohio, the northeast flowing Teays tributaries were modified and reversed to flow southwestward into the newly formed Ohio River. Glacial meltwaters and interglacial erosion caused deep downcutting of selected Teays-age reversed valleys. Blankets of glacial till mantled the scoured bedrock surface leaving a relatively flat to rolling terrain cut by the steep-sided tributaries of the Ohio River.

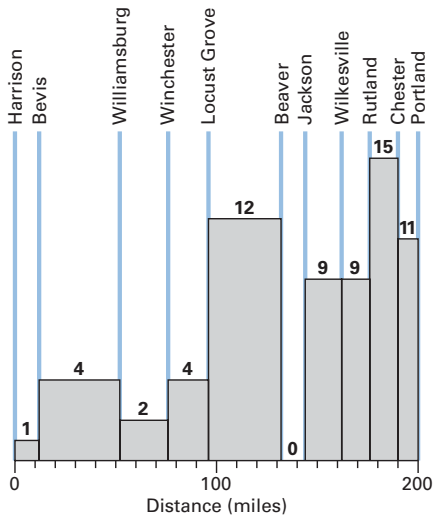
Morgan's supply wagons and artillery easily crossed the flat to rolling glacial terrain from Harrison to Locust Grove at an average rate of 2.3 mph. The only challenging terrains were the steep valley walls of the 11 major tributaries of the Ohio River crossed by Morgan's route. The steep climb out of these valleys caused great strain on the horses pulling the heavy supply wagons and artillery, but the strain was temporary because after short climbs the terrain returned to flat to gently rolling.

The tributaries were minor obstacles compared to the major factors slowing Morgan's advance. These factors include the constant need for food, water, fodder, and fresh horses, in conjunction with skirmishes with Federal troops and local militias, and numbing fatigue from a grueling all-night ride around General Burnside's troops defending Cincinnati. General Morgan's troops were nearing exhaustion when they finally stopped for a well-deserved night's rest at Williamsburg, Ohio.

The following morning, Morgan sent his brother, Colonel Richard Morgan and the 14th Kentucky regiment, to investigate whether the ford across the Ohio River at Ripley, Ohio was defended (it was) and accessible (it wasn't) to his columns. The main column, refreshed by a good night's rest, moved rapidly over the glaciated till plains to Winchester with an average speed of over 4 mph. Nearing Winchester, Morgan's troops noticed an impressive line of hills known as the Allegheny Escarpment stretching northeast and southwest as far as the eye could see.

General Morgan stopped his main column in Winchester and sent many of his men out in the countryside to find supplies, horses, and news concerning the location of pursuing Federal troops. Realizing that Federal troops were closing in, General Morgan's troops departed Winchester moving at a deliberate pace averaging 1.2 mph to allow Colonel Morgan's troops to catch up and rejoin the main column.

At Locust Grove, a local resident



Number of major stream valleys crossed by Morgan's Raiders as they traveled between rest stops. Notice the dramatic increase in the number of stream valleys between Locust Grove and Portland associated with the rugged terrain of the Allegheny Plateau. No major stream valleys occur in the gently rolling terrain of the Marietta River valley between Beaver and Jackson.

was enlisted to guide them through the Allegheny Escarpment over one of the shorter routes through these rugged hills that rose over 300 feet above the till plains. These resistant, sandstone-capped hills are the erosional remnants of vast deltas built from sediments eroded and carried by ancient rivers flowing from the ancestral Allegheny Mountains over 350 million years ago. No doubt Morgan's column slowed to a snail's pace as the horses labored to pull the supply wagons and artillery up these steep hills. However in just a few miles, the rugged Allegheny Escarpment gave way to the wide, level to rolling floodplain of Chenoweth Fork, one of the tributaries of the ancient Teays River and modern Scioto River.

For the next 30 miles, the gently rolling terrain of the Teays/Scioto River system provided an easy east-west route through the rugged terrain of the Allegheny Plateau. Morgan's column took advantage as reflected by their rapid average speed of 3.0 mph. The Teays/Scioto River system drained southern Ohio, Kentucky, and West Virginia for millions of years prior to the Ice Age. Advancing continental glaciers dammed the Teays River near Chillicothe, producing a huge lake, named Lake Tight. The flooded valleys of the Teays River and its tributaries were partially backfilled with thick deposits of lake clays during the 6,000 to 8,000 years that Lake Tight existed. The wide, level floodplains of the Scioto River formed after Lake Tight drained through a breached drainage divide into the Ohio River.

Just east of Beaver, Ohio, Morgan's columns left the main channel of the Teays River and rode up the ancient Marietta River valley to Jackson, Ohio in the wee hours of July 17, 1863. His columns were slowed by downed trees, and were battling fatigue after nearly 15 hours in the saddle. The forward rate slowed to an average speed of 1.7 mph as the column frequently stopped to clear trees felled across the road and search for fresh horses. At Jackson, General Morgan's tired troopers stopped for a short 3-hour rest.

General Morgan's columns left Jackson with 55 miles to travel to reach the Ohio River ford at Buffington Island. They left the level floodplains of the Teays/Scioto River system behind and began their trek across the rugged terrain of the Allegheny Plateau. Narrow, north-south trending hills and ridges separated by narrow, steep-sided valleys dominate this region and are the result of erosive forces acting over millions of years to remove hundreds of feet of shale, siltstone, sandstone, coal, limestone, and clay. These Pennsylvanian- and Permian-age sediments were deposited between 243 and 322 million years ago in vast deltas fed by sediments transported by large rivers flowing into Ohio from the ancestral Allegheny Mountains. Topographic relief averages 200 feet and 44 deep valleys cross Morgan's route from Jackson to Portland. That translates into one valley for every 1.25 miles of horizontal distance traveled. This compares to one valley for every 6.3 miles for the first 145 miles of Morgan's route from Harrison to Jackson.

Initially, the rugged terrain did not have a great effect on Morgan's columns as they traveled from Jackson to Wilkesville at a respectable average rate of 3.0 mph. A good night of sleep at Wilkesville translated into a rapid move to Rutland, but average forward rate slowed to 2.7 mph as Morgan's columns moved on to Chester and only 1.4 mph between Chester and Portland. Morgan's weary troopers crossed 26 deep valleys in just 24 miles between Rutland and Portland. The struggling horses no sooner climbed out of one valley before the road descended into the next valley. Twenty-six times the supply wagons and artillery were pulled up the steep grades that no doubt exhausted both horse and man. The rugged terrain, in conjunction with 1) the constant need to search for provisions, water, and fresh horses; 2) chronic fatigue; 3) skirmishes with Federal troops and local militia; 4) the lack of local guides; and 5) an unplanned stop for the funeral procession of a local resident, progressively slowed Morgan's advance. Finally, the exhausted column rode onto the floodplain of the Ohio River at Portland late on July 18, 1863.

A quick reconnaissance revealed members of a local militia defending earthworks built to protect the ford at Buffington Island, and the Ohio River was a dangerous torrent. General Morgan decided to rest his troops and avoid needless casualties by waiting until morning to attack the earthworks and

The distribution of the Teays River system and Lake Tight superimposed on the route of Morgan's Raiders across southern Ohio.

cross the Ohio River. As Morgan's men slept, detachments of General Judah's cavalry and other pursuing Federal cavalry units rode through the night arriving at Portland just before dawn. As morning broke, the roar of cannons and muskets signaled the start of the Battle of Buffington Island and the beginning of the end for General Morgan's Raiders.

We conclude that southern Ohio's terrain, like General Morgan's supply wagons and cannons, was both advantageous and detrimental to the success of the raid. The glaciated till plains and Scioto/Teays River systems provided level to rolling terrain that 1) allowed Morgan's columns to move rapidly, build their lead over the pursuing Federal troops, and take long rest periods to combat chronic fatigue; 2) avoided the rugged terrain of the Allegheny Plateau between Chenoweth Fork and Jackson, Ohio; 3) allowed his troops to live off some of southern Ohio's richest farmland; and 4) reduced the fatigue of his men and horses. On the other hand, the rugged terrain between Jackson and Portland combined with logistical, military, and intangible factors resulted in the progressive slowing of General Morgan's columns. These factors provided just enough time to allow the pursuing Federal cavalry and gunboats to overtake and defeat him in the Battle of Buffington Island.

Did General Morgan's Raid accomplish its goals? Colonel Basil W. Duke answers this question in *A History of Morgan's Cavalry*, with the following passages found on page 460: "The objects of the raid were accomplished. General Bragg's retreat was unmolested by any flanking forces of the enemy, and I think that military men, who will review all the facts, will pronounce that this expedition delayed for weeks the fall of East Tennessee, and prevented the timely reinforcement of Rosecrans by troops that would otherwise have participated in the Battle of Chickamauga."

ACKNOWLEDGMENTS

We thank Stephanie Konfal for digitizing General Morgan's route on the *Shaded Elevation Map of Ohio* across southern Ohio. Tom Berg, Roger Cuffey, Lester Horwitz, Dennis Hull, and Mac Swinford greatly improved our manuscript with their thorough reviews.

FURTHER READING

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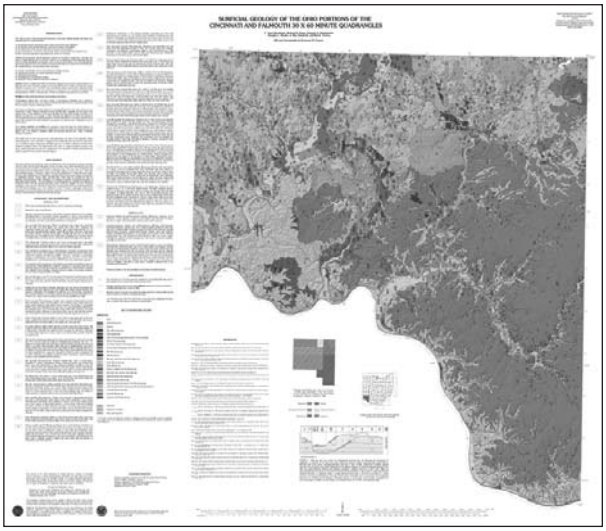
New map showing surficial deposits of southwestern Ohio now available



A new map that shows the surficial geology of the Ohio portions of the Cincinnati and Falmouth 30 x 60-minute quadrangles, including Hamilton, Clermont, and portions of Butler and Warren Counties, is now available from the Division of Geological Survey. Geologists, geotechnical engineers, land-use planners, ground-water specialists, educators, and homeowners will find this new map useful for technical and non-technical applications.

The wall-size (42 by 37 inches) map uses color to depict the distribution of the uppermost deposits at the land surface and a map-unit coding system to identify the types and thicknesses of all major unconsolidated-material units from the surface to bedrock. The text and figures provide guidance for interpretation of the map, a list of data sources, and a description of map units.

A particularly interesting aspect of the map is the depiction of the variable types and thicknesses of sediment occupying the valleys of the Great Miami River, the Little Miami River, and Mill Creek, and the wide, ancient river valleys now occupied by Dicks Creek and Little Muddy Creek. Some of these valleys contain thick deposits of sand and gravel, a potential source of aggregate and ground water; others contain landslide-prone deposits of clay and silt, a well-known geological hazard in the Cincinnati region.

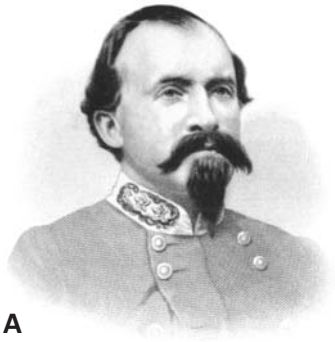
Copies of the Surficial Geology of the Ohio portions of the Cincinnati and Falmouth 30 x 60-minute Quadrangles may be ordered for $15, plus $4 handling (add $1.50 for mailing tube if map is to be sent rolled) and $1.02 tax (Ohio addresses only). Orders for the map can be placed by calling 614-265-6576; or by writing the ODNR, Division of Geological Survey, 2045 Morse Road, Bldg. C-1, Columbus, OH 43229-6693. Visa and Mastercard are accepted.

Survey address change

Construction of a new entrance to the Department of Natural Resources' complex and the move of the Division of Geological Survey offices to a new building within the complex has necessitated a change of address for the Division. The Division's new address is: ODNR, Division of Geological Survey, 2045 Morse Road, Bldg. C-1, Columbus, OH 43229-6693. The Division's new quarters are on the first and second floors of Building C.

TEST YOUR KNOWLEDGE

Test your knowledge is an interactive feature that challenges readers to identify some aspect of Ohio's geology. Below are two photos to identify.



A

B

Answers are given below. Complete answers and additional information will be provided in the next issue of *Ohio Geology*.

Test your knowledge answers for *Ohio Geology* 2004, No. 1

To refresh your memory of the photographs in the last issue see our web site <http://www.ohiodnr.com/geosurvey/oh_geol/04_No_1/tyk.htm>.

A *Shatter cones*. Shatter cones are striated conical structures in rock, and are formed by shock waves generated by the impact of a comet or meteorite. Striated fracture surfaces radiate outward from the apex (pointed end) of the cones in a horsetail fashion. The photo is of shatter cones (pointed upward) in Division of Geological Survey core 3274 (depth 2,735 feet below the land surface) located in the central uplift of the Serpent Mound Disturbance in Adams County, Ohio. For more information on Serpent Mound Disturbance see Ohio Division of Geological Survey Report of Investigations 146, *Subsurface Geology of the Serpent Mound Disturbance, Adams, Highland, and Pike Counties, Ohio*.

B *Mammoth molar*. Mammoths and mastodons were two large, elephant-like, plant-eating animals that roamed Ohio's landscape during the Ice Age. Mammoths had one molar in each jaw compared to 2 or 3 in each mastodon jaw. Mammoth molars consist of a series of enamel plates that form a flat grinding surface adapted to chewing tough, coarse grasses. Mastodon molars contain cone-like cusps separated by v-shaped furrows adapted for crushing and chewing aquatic plants and the tough twigs of conifers. The molar (OSU 12017) was collected from Licking County, Ohio and resides in the collection of The Ohio State University. For additional information see *Ohio Geology*, 2004, No. 1 and Ohio Division of Geological Survey Bulletin 70, *Fossils of Ohio*, p. 298-299.

C *Scioto River valley north of Portsmouth, Ohio*. Prior to the Ice Age, the ancestral Scioto River in southern Ohio was once a north-flowing tributary of the Teays River—an ancient river that was comparable in size to the modern Ohio River and drained most of Ohio. The *Shaded Drift Thickness Map of Ohio* depicts the thickness of glacial deposits that completely infill the Teays Valley in west-central Ohio, and the thinner sediments that partially infill the Teays River valleys beyond the glacial boundary in south-central Ohio (see *Ohio Geology*, 2004, No. 1). The modern, south-flowing Scioto River was born when Lake Tight, formed by ice damming of the Teays, overflowed and lowered the drainage divide near Manchester, Ohio. The Ohio River captured much of the ancient Teays watershed in Ohio as Lake Tight drained.

Test your knowledge answers: A, John Hunt Morgan; B, Allegheny Escarpment.

Ohio Geology

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