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Geology and History of a 19th and Early 20th Century Industrial Complex: The Nuttall Mine and Nuttallburg, West Virginia

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Introduction

The area between the site of Nuttallburg, West Virginia, and Keeney’s Creek in the New River Gorge bounded by the river and the canyon rim at first appears to be a pristine, natural, and largely untouched environment (fig. 1), but in reality the area is an example of the environmental recovery of a late 19th through 20th century industrial complex (fig. 2), owing to proper climatic conditions and benign neglect. At the same time, subtle and sometimes not so subtle evidence of past mining practices and transportation remains and must be taken into account in creating both surficial and bedrock geologic maps and in considering possible future land use. Areas like this are common in West Virginia, given the State’s mining and logging heritage.

This project began as we were conducting bedrock geologic mapping on the Fayetteville, WV 7.5-minute quadrangle, in cooperation with the National Park Service in the New River Gorge National River area. Within this quadrangle is the New River Gorge Bridge, the third longest

Figure 1. “Endless Wall” area with study area in center. The term “Endless Wall” originates in the rock climbers community and, although it is formed along a very long cliff line, the term appears to refer to the “endless” number of climbing routes along the cliffs between the New River Gorge Bridge and Keeney’s Creek formed by the Upper and Lower Nuttall Sandstones.

Figure 2. Photo of an early 1900s coke oven battery in the New River Gorge obtained from the National Park Service in the mid-1980s. Between the 1870s and the 1980s the Gorge was an industrial area producing both coal and coke using almost exclusively old style "beehive" coke ovens although coke production ended long before mining in the 1980s. The photograph may have been taken in the lower foreground of figure 1, as the topography matches and Nuttallburg had a battery of 46 coke ovens. The New River Gorge had many similar coke oven batteries in the late 1800s and early 1900s.

arch bridge and the fifth highest vehicular bridge in the world. Statistics compiled by the West Virginia Division of Highways indicate the bridge averages 16,200 vehicle crossings per day (Wikipedia, 2012). One local event is Bridge Day, on the third Saturday in October. During this event the bridge is closed to traffic and open for pedestrians, various vendors, base jumpers, and those who wish to rappel from the bridge deck to the bottom of the gorge. This event is preceded by several weeks of preparation, including security sweeps around and under the bridge. We had started working in the bridge area in late 2010, but decided to work elsewhere nearby until after the event. The Nuttall Mine area is between 2 and 3 miles from the bridge, so we focused our efforts there. During the same period, we were taking a surficial geologic mapping course at West Virginia University. One course requirement was to produce a "local surficial map or map project in student area of interest." We were intrigued with the Nuttall Mine, Nuttallburg, and the Keeney's Creek area. We also had access to a new light detection and ranging (LiDAR)-derived digital elevation model (DEM) dataset (U.S. Army Corps of Engineers, 2010), so we decided to propose a joint map in the area. This material will become part of the next version of our New River Gorge field trip guide, but it is also, to an extent, a class project that got out of hand.

We would like to offer particular thanks to J. Steven Kite of West Virginia University for persevering in offering his surficial geologic mapping course when his schedule became very full as he assumed the duties of Chairman of the Department of Geology and Geography. It allowed two geologists who had spent much of their careers trying to look past, and visualize through, surficial deposits to better understand and appreciate these materials. Indeed, in this study area, we found the surficial geology much more fascinating than the bedrock.

Basic Data

In the Appalachian Plateau portion of West Virginia, along with our own field observations, we generally have access to large amounts of surface and subsurface geologic information. West Virginia geology was originally mapped at scale 1:62,500, in the period between around 1900 and 1939. The published data are still useful, but many changes in both geologic theory and technology have occurred in the last 70 years. In addition to the West Virginia Geological Survey's County Report Series, we have access to large numbers of unpublished oil and gas well logs, coal exploration core logs, a few additional logs of cores drilled for scientific purposes, thousands of coal mine maps, and data collected during various field studies subsequent to the county reports. We also have access to many sets of aerial photographs, remotely sensed imagery, and DEMs, including statewide photograph-derived 1/9 arc second DEMs. Along with basic geologic data, the most useful data available for this project have been a collection of very early aerial photographs completed in 1946 (fig. 3) and a newly completed extensive LiDAR dataset collected and processed by the U.S Army Corps of Engineers as part of a flooding study for the Bluestone Lake that provided data along the gorge. The Corps has released LiDAR-derived DEMs, photographs, and point clouds and generously processed much more data than necessary for their original purpose in response to interest from West Virginia's user community (U.S. Army Corps of Engineers, 2010).

The availability of LiDAR-derived and other high resolution DEMs provided the opportunity to experiment with sun angles for hillshading (fig. 4) and computing and classifying slope (fig. 5) to aid in surficial mapping. This approach, coupled with field observations, allowed better interpretations of landforms than just a single hillshade. The hillshading we utilized is the standard methodology available in ArcGIS. Due to the depth and narrowness and meandering nature of the gorge, many slopes require experimentation in terms of sun angle and to bring out surficial features. In the study area (fig. 4) the image is oriented with the north up, and the best sun angles were fairly high from the southwest. Figure 4 afforded the best overall view for our poster. Experimentation with various sun angles in this range brought out both natural and manmade features quite well, but generally left the north-facing slope totally in the dark (fig. 4). Slope classification was also subject to experimentation to see what best portrayed recognizable surficial features. Figure 5 shows what seemed to work best for display with cool colors (mostly blues) for steep slopes and warm colors (mostly reds and yellows) for flat areas and gentle slopes.

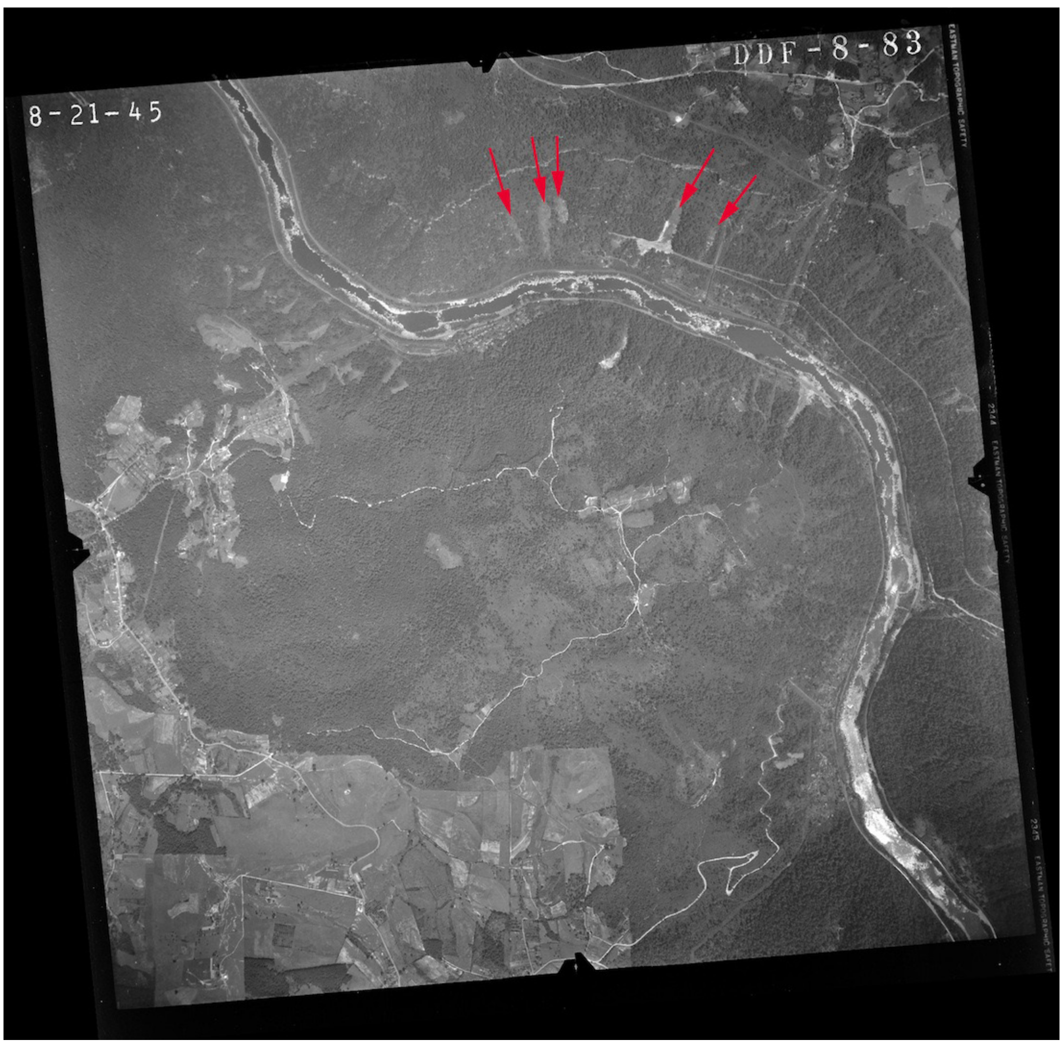

Figure 3. Aerial photograph (1946, by U.S. Department of Agriculture Soil Conservation Service) showing mine dumps (marked by red arrows).

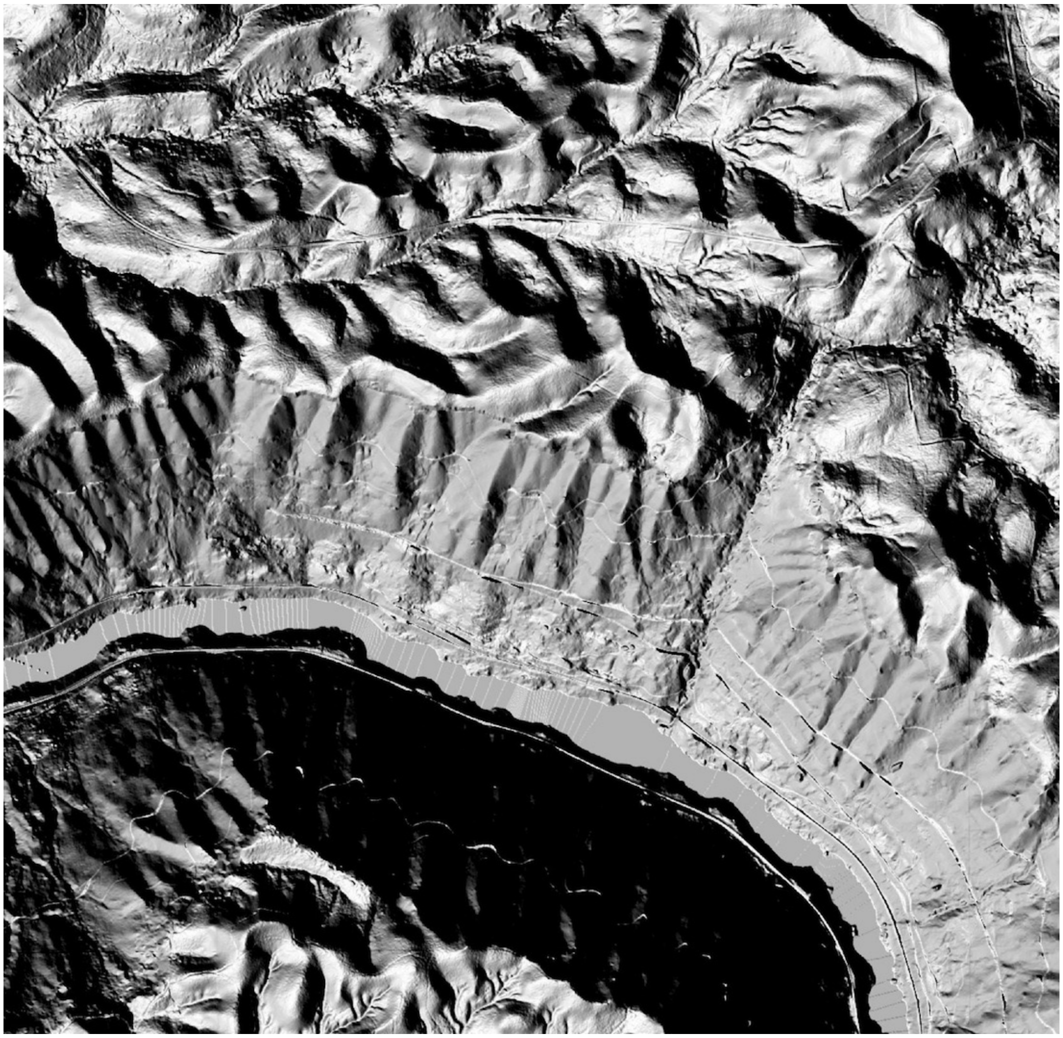

Figure 4. Hillshade of a portion of the study area.

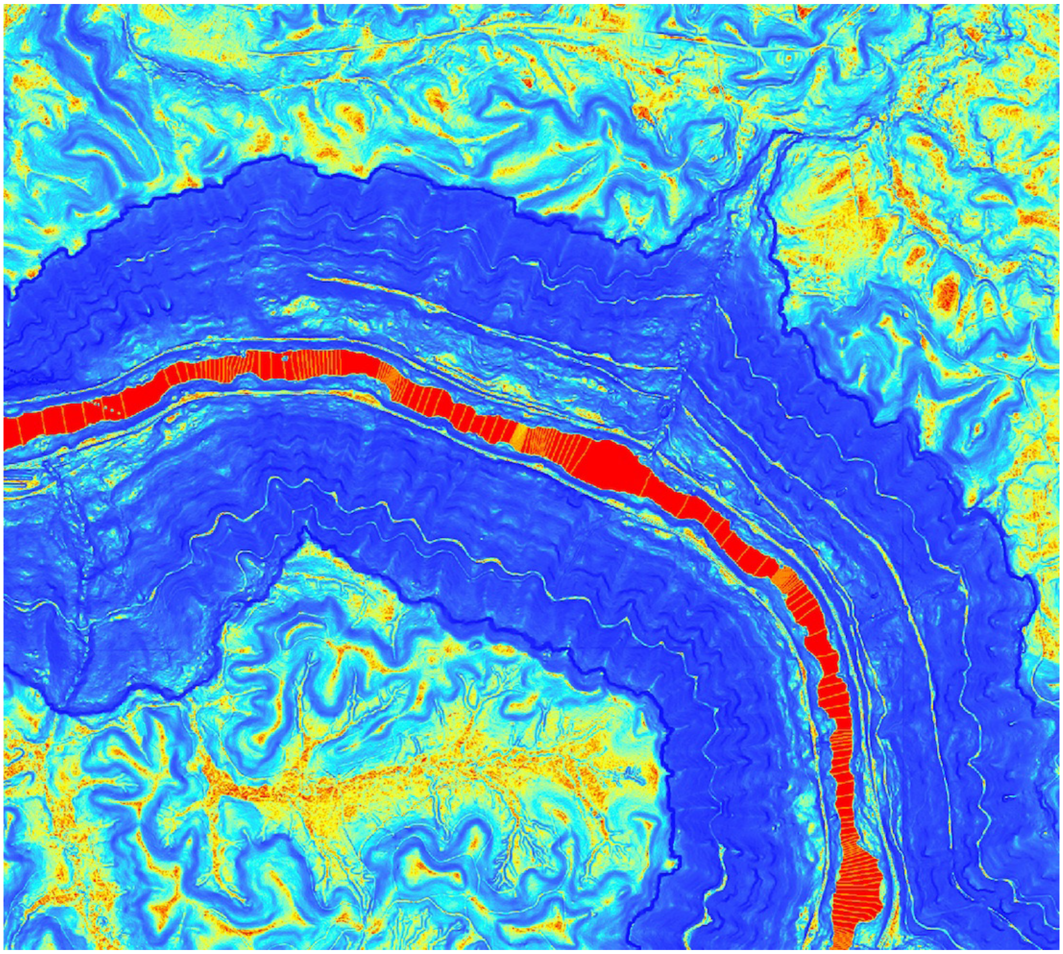

Figure 5. Slopeshade of a portion of the study area (red and yellow areas near horizontal, blue areas near vertical).

Preliminary Bedrock Geology

Preliminary mapping of bedrock geology in the study area also was portrayed in our study (fig. 6). The biggest problem encountered is that deep in the gorge, bedrock exposures are well covered by surficial materials that sometimes bury the bedrock tens of feet deep. Good bedrock exposures are limited to railroad cuts, cliffs high in the walls of the gorge, and occasional exposures along the few permanent roads. Contacts frequently have to be projected for several miles based on structure contours and topography. We have high-quality data, but these projections are sometimes necessarily distant enough to be somewhat unsettling. One gap in bedrock data generally occurs in the relatively shallow subsurface between the bottom of available core logs and the depths in oil and gas well geophysical logs where data collection begins; this is the case in the study area. Our projections indicate that the unnamed sandstone in the upper Bluestone Formation exposed around Thurmond might occur in the banks of the New River in the eastern part of the study area, but so far we have not been able to find an indisputable bedrock exposure. It is likely that the exposure is buried by surficial deposits or railroad fill. This unit was projected downriver, based on good exposures far upstream and across the river near the Park Service's Cunard river access facility.

Impact of Human History on Surficial Geology

The history of the Nuttall Mine, which is typical of West Virginia's first generation of large metallurgical coal mines, was relatively long, included several owner-operators, and involved the evolution of mining technology from hand loading with animal haulage to mechanized mining. Details of this history are well documented in Library of Congress documents by Maddex (1991), but a few important historical points bear repeating in order to better understand the three surficial geologic maps that we produced (figs. 7, 8, and 9). At this location, mine site preparation began in 1870, and mining began in February 1873, following completion of the main line of the Chesapeake & Ohio (C&O) Railroad in the gorge. Completion of the railroad allowed the delivery of heavy equipment and shipment of coal and coke to market. The mine, the conveyor route, most roads, and the company town of Nuttallburg were built in the gorge between 1870 and 1873 (Maddex, 1991). Development modified the area of the slope above the north bank of the New River to raise the land elevation enough to prevent the tracks from flooding. This railroad construction, of course, heavily affected the landscape in the area near the tracks. Two natural features directly

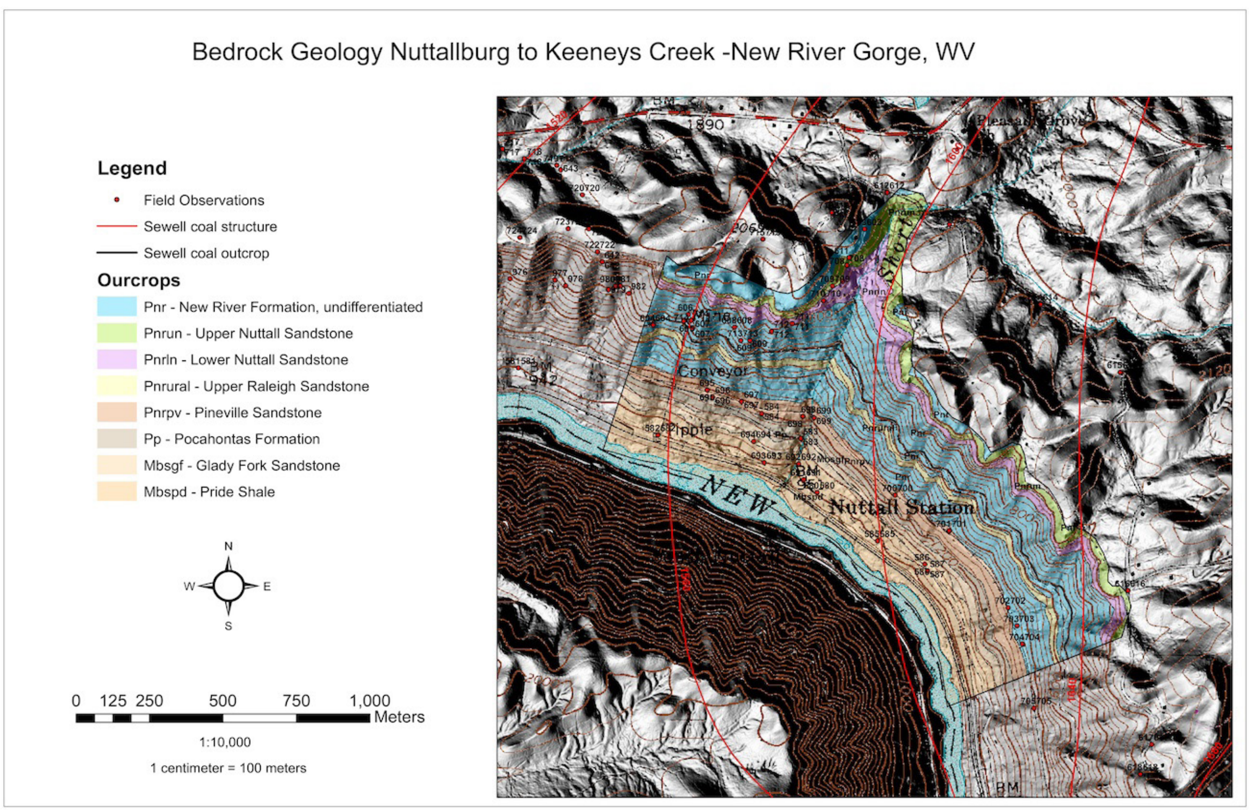

Figure 6. Preliminary bedrock geology, from Nuttallburg to Keeney's Creek – New River Gorge, West Virginia.

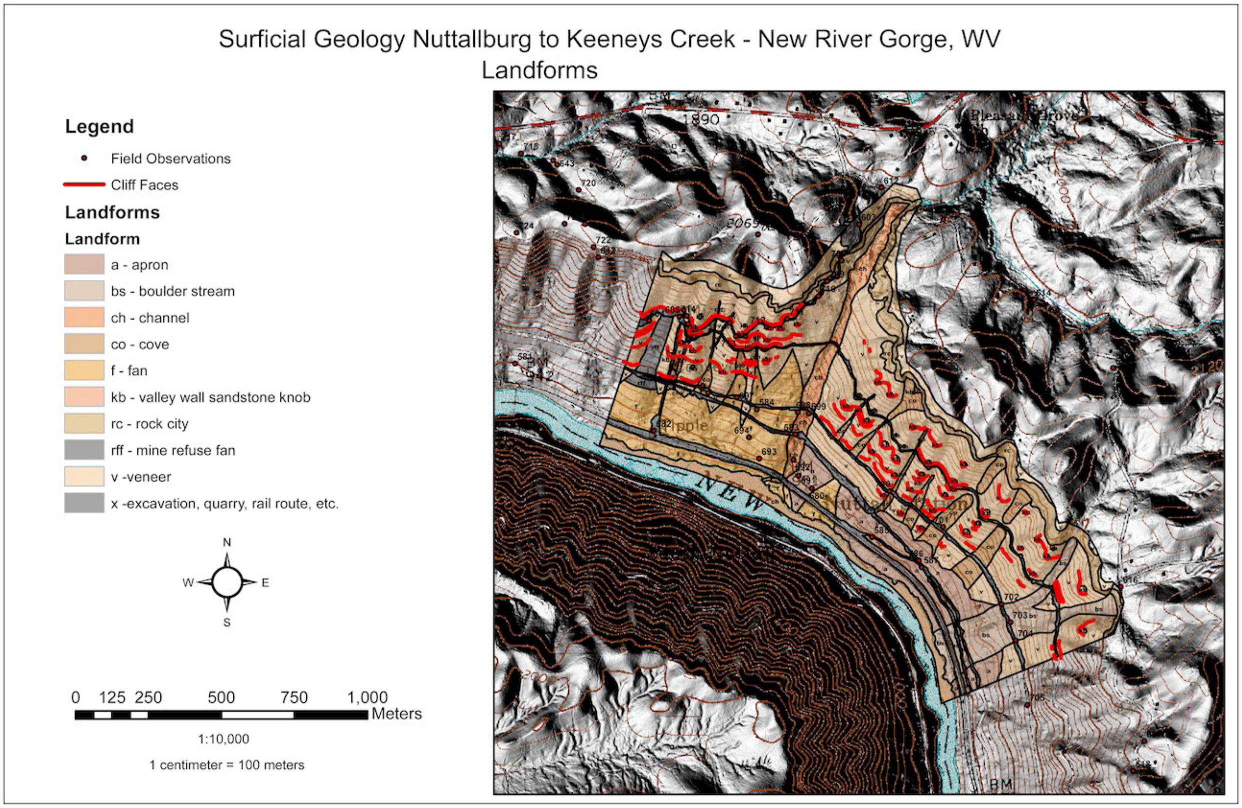

Figure 7. Surficial geology: Landforms.

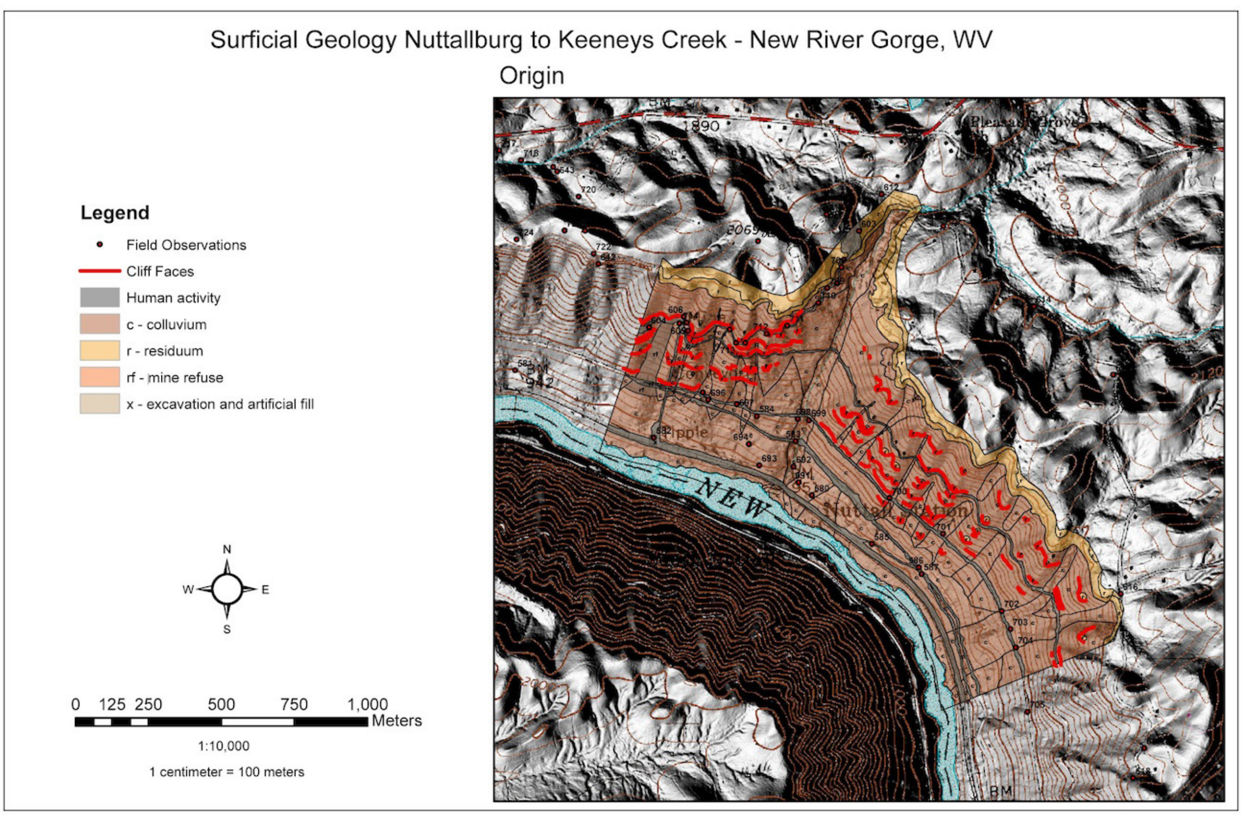

Figure 8. Surficial geology: Origin.

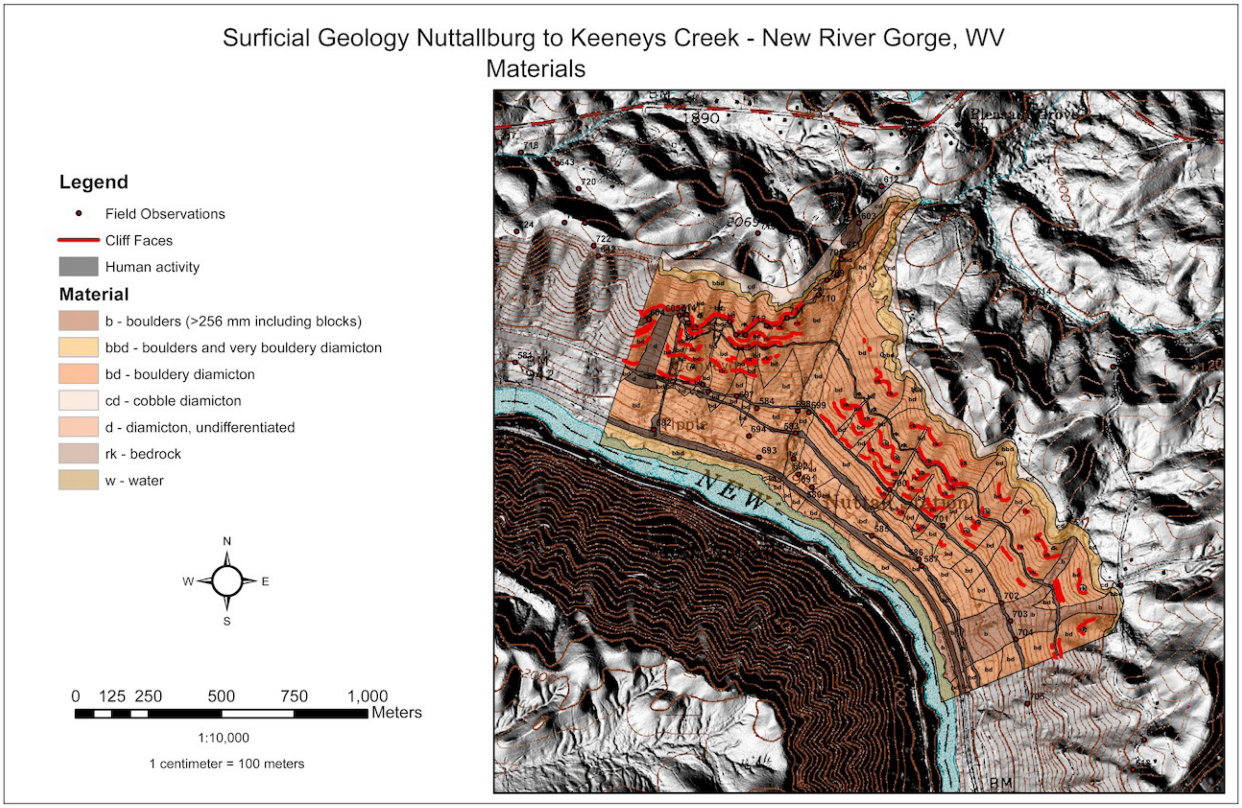

Figure 9. Surficial geology: Materials.

affected were the nested alluvial fans located at the mouth of Short Creek in the middle of the study area. The outlines of the original fan can be seen in a shaded relief surface map constructed from LiDAR data. Within this feature, a smaller fan formed when the flow of Short Creek was constricted by the bridge that carries the main C&O Railroad across the creek (fig. 7).

The next big construction project in the area was development of the C&O Keeney's Creek Branch to aid in development of coal resources on Keeney's Creek and in the Lookout, WV, area. Excavations and the remaining bridges for this branch are evident across the lower part of the study area. The lower part of this railroad grade, including bridge improvements, has recently been converted to a mountain bike trail by the National Park Service. The first phase, from Nuttall Station to Rothwell, was completed in 1893 and was approximately 5 miles long (Maddex, 1991). The second phase extended the line 2 miles, to Lookout, WV, in 1903 (Maddex, 1991). This construction appears to have substantially altered the topography and surficial deposits along its route, particularly in the study area. One of the most obvious changes across Short Creek on the lower portion of the slope is the fan deposits west of Short Creek, which are in contrast to the apron with one small remaining fan east of the creek. We suspect the reason for this difference is that much of the material in any eastern fans was either incorporated into the C&O Keeney's Creek Branch, obscured, or further modified by more than a century of erosion influenced by the presence of the railroad grade.

The other geologically important features of human origin found in the study area that are typically not well documented are the mine dumps. One of these has the superficial appearance of a rock glacier, but such a landform is unlikely to be found this far south. We suspected that it might be a mine dump given its location immediately below the Nuttall Mine and its appearance, along with at least five or six other mine dumps (fig. 3) shown on a 1945–46 aerial photography (U.S. Department of Agriculture Soil Conservation Service, 1946), was confirmed by a traverse we conducted along the railroad route to examine all of the mine dumps. It appears that the practice involved dumping mine waste in coves on the slope immediately below a mine railroad that ran from the mine to the ventilation fan house (Maddex, 1991) and then extending roughly along the outcrop of the Sewell coal west of the mine site. The first feature we noted in the mapping area immediately below the mine is probably the oldest as it was initially the easiest place to dump mine waste. We have examined the photographs, mine maps, and various visualizations of the area derived from recently released LiDAR data obtained by the Corps of Engineers (U.S. Army Corps of Engineers, 2010) and have found no clear evidence that substantial mine dumps occur east of the Nuttall Mine. Apparently mine railroad tracks along a bench that approximately follows the outcrop of the Sewell coal east of the mine were only used as storage for empty underground mine haulage cars (Maddex, 1991), which is a reasonable assumption given the danger this would have posed to the C&O Railroad Keeney's Creek Branch line. It also appears that the first dump immediately below the mine might have negatively affected initial construction of the large switchback on this branch line (fig. 3).

We had little time to fully explore some of the harder to reach surficial polygons because our real role in the New River Gorge National River (NERI) mapping project was to produce bedrock geologic maps. One peculiar area is adjacent to and east of the conveyor route. It is a small cove that appears anomalous, and it is possibly an artifact of the conveyor operation or construction.

Unique Natural Features

An unusual landform commonly appears in the New River Gorge, which we have not found noted in the literature; these are rocky knobs that occur on the valley walls on ridges between coves where resistant sandstones crop out (fig. 10). We have called these simply valley wall sandstone knobs, but would welcome a better term.

Figure 10. Small valley wall sandstone knob along the Nuttall Mine access road.

Figure 11. Photograph of boulder stream, taken from trail in former Keeney's Creek Branch railroad bed.

Another apparently natural feature that we observed in the field is a forking boulder stream in the southeastern part of the study area (fig. 11). We do not understand the origin of this feature, but it occurs in the area where the clean, hard Lower Nuttall Sandstone begins to be well exposed above the walls of the gorge on the steeply dipping (maximum ~5 degrees) western limb of the Mann Mountain Anticline. We have encountered similar features in subsequent field work.

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