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Eastern Continental Divide Origin in the Blacksburg, Virginia Area Determined by Topographic Map Interpretation, USA

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Abstract

Published geology literature addresses only a small fraction of the Blacksburg, Virginia region topographic map drainage divide evidence. This situation probably arises because the accepted geology and glacial history paradigm (accepted paradigm) does not explain most topographic map drainage divide evidence (anywhere). A new and fundamentally different geology and glacial history paradigm (new paradigm) which appears to explain most topographic map drainage divide evidence sees the Eastern Continental Divide in the Blacksburg area as being located along the rim of a continental ice sheet created and occupied deep “hole” with the rim being uplifted as immense and prolonged southwest-oriented meltwater floods flowed across the region. From the new paradigm perspective northwest-oriented New River valley headward erosion into the rising deep “hole” rim (from the deep “hole”) upon reaching the Blacksburg region beheaded and reversed southwest-oriented floodwaters (probably aided by deep “hole” rim uplift) to create today’s northeast- and northwest-oriented New River. Headward erosion of the southeast-oriented Roanoke River valley and subsequently the southeast-oriented James River valley (both from the Atlantic Ocean) then created the Roanoke River-New River and James River-New River drainage divides (both are Eastern Continental Divide segments) and the James River-Roanoke River drainage divide by beheading and reversing southwest-oriented floodwaters which had been flowing in diverging and converging channels (which had been eroded headward in northeast directions along less resistant bedrock units from the New River valley). This scenario explains most through valleys (valleys crossed by drainage divides), barbed tributaries, river direction changes, and water gaps seen on Blacksburg area detailed topographic maps and does not see significant changes taking place since the southwest-oriented floods ended. The accepted and new paradigms are incommensurable which according to Thomas Kuhn means one paradigm should not be used to judge the other.

Keywords: Blue Ridge Escarpment, drainage divide origin, geomorphology, James River, New River, Roanoke River

1. Introduction

1.1 Statement of the Problem

The Eastern Continental Divide (Mississippi River-Atlantic Ocean drainage divide) in the Blacksburg, Virginia region (see figure 1 for the Blacksburg, Virginia location) can be easily located on detailed topographic maps. Yet studies discussing Blacksburg, Virginia region geomorphology and alluvium by Prince et al (2010), Prince et al (2011), Stokes et al (2023), and Houser (1980) fail to address much of the Blacksburg region topographic map drainage divide evidence. This failure is somewhat puzzling because the authors involved appear to have made extensive use of other types of topographic map evidence. The problem is not limited to the mentioned authors or to Blacksburg region geomorphology research, but prevails throughout the geologic literature. According to Clausen (2023a) the problem results because most topographic map drainage divide evidence (everywhere) is what Thomas Kuhn (1970) considers to be anomalous evidence or in this case evidence the accepted geology and glacial history paradigm (accepted paradigm) does not satisfactorily explain. Abundant anomalous evidence if not eventually addressed according to Kuhn can lead to the development of new and fundamentally different paradigms and to a battle over which paradigm should be used.

Blacksburg region stream capture evidence has caused researchers such as Prince et al (2010), Prince et al (2011), and Stokes et al (2023) to suggest that on-going stream captures especially along the Roanoke River-New River drainage divide (an Eastern Continental Divide segment) is causing Eastern Continental Divide inland migration.

While the Blacksburg region contains excellent stream capture evidence those researchers are not heeding a Bishop (1995, p. 449) warning that "The key process in stream capture, namely, drainage head retreat, is difficult to envisage as a normal part of drainage net evolution.... Stream capture may therefore be a relatively rare event in drainage net evolution.... [and] should not be routinely invoked in interpretations of long-term drainage evolution." If Bishop is correct abnormal conditions such as massive continental ice sheet meltwater floods were required to accomplish the Blacksburg region stream captures and to form the present-day Blacksburg region drainage divides.

Figure 1. Modified map from the United States Geological Survey (USGS) National Map website showing where the Blacksburg region is located in the continental United States and in relation to a new paradigm's continental ice sheet created deep "hole" rim which the Eastern Continental Divide now helps to define.

The Eastern Continental Divide in the Blacksburg area includes the New River-Roanoke River and James River-New River drainage divides. Another important Blacksburg area drainage divide is the James River-Roanoke River drainage divide. Roanoke and James River waters flow directly to the Atlantic Ocean while New River water flows on a much longer route to the Ohio and then Mississippi Rivers before reaching the Gulf of Mexico. The primary research question asked here is can previously ignored topographic map evidence be used to reconstruct a logical Blacksburg region drainage history that consistently explains most if not all of the Blacksburg region detailed topographic map drainage divide evidence? If so, a secondary research question is does that reconstructed Blacksburg region drainage history support the commonly claimed hypothesis that the Eastern Continental Divide is now actively migrating inland?

1.2 Geographic Setting

This paper's overlapping study regions (seen in figures 2, 4, and 6) are located in the Appalachian Mountain valley and ridge region and are crossed by three major drainage divides: 1) the New River-Roanoke River drainage divide which is an Eastern Continental Divide segment, 2) the James River-New River drainage divide (also an Eastern Continental Divide segment) and 3) the James River-Roanoke River drainage divide (the southeast-oriented James River is located to the north and east of figure 2). Blacksburg (seen in figure 2) straddles the New River-Roanoke River drainage divide. South of figure 2 the New River has a northeast orientation, but in figure 2 after flowing past Radford the river turns and flows in a northwest direction with its water eventually reaching the Gulf of Mexico. South-oriented Little River headwaters seen in the figure 2 southeast quadrant flow near the Blue Ridge Escarpment crest before turning in a west and eventually northwest direction to join the New River. Many secondary streams flow on the floors of northeast-to-southwest oriented through valleys (valleys crossing drainage divides) some of which extend from the James River to the New River.

The Roanoke River originates at the confluence of its North and South Forks which as seen in figure 2 is to the west of the 300-600-meter high Blue Ridge Escarpment (and of south-oriented Little River headwaters) and then flows in a northeast direction before turning in a southeast direction to the city of Roanoke. Southwest-oriented North Fork Roanoke River headwaters originate in a through valley which on the other side of a drainage divide is drained by northeast-oriented Catawba Creek, which flows to the southeast-oriented James River (north and east of figure 2). After flowing in a southwest direction, the North Fork Roanoke River makes a U-turn so as to flow in a northeast direction before being joined by the north-northwest oriented South Fork Roanoke River which has southwest-oriented headwaters (Bottom Creek). Southwest-oriented Bottom Creek headwaters begin on an upland surface and are linked by gaps across the Blue Ridge Escarpment crest with northeast-oriented Back Creek headwaters (Back Creek joins the Roanoke River to the east of Roanoke). The North Fork Blackwater River is a Blackwater River tributary with the Blackwater River joining the Roanoke River to the southeast of figure 2.

2. Background

2.1 Accepted Paradigm Literature

The failure of almost all geomorphologists who use the accepted geology and glacial history paradigm perspective to address most topographic map drainage divide evidence was traced by Clausen (2023b) back to an often-cited W.M. Davis (1889a) "River Pirate" paper in which Davis did not address most drainage divide and other erosional landform evidence shown on a then newly published Doylestown, PA topographic map. While Davis was not responsible for most accepted paradigm interpretations and assumptions, he was certainly in a position to say that most of the Doylestown map drainage history did not fit his previously published erosion cycle ideas (see Davis, 1885). Following publication of his "River Pirate" paper Davis ignored most of the then newly available topographic map drainage divide and erosional landform evidence and instead submitted his influential "Rivers and Valleys of Pennsylvania" paper (1889b) in which the concept of Eastern Continental Divide inland migration was introduced. In that paper Davis argued that east-oriented drainage basins have captured drainage areas from older west-oriented drainage basins.

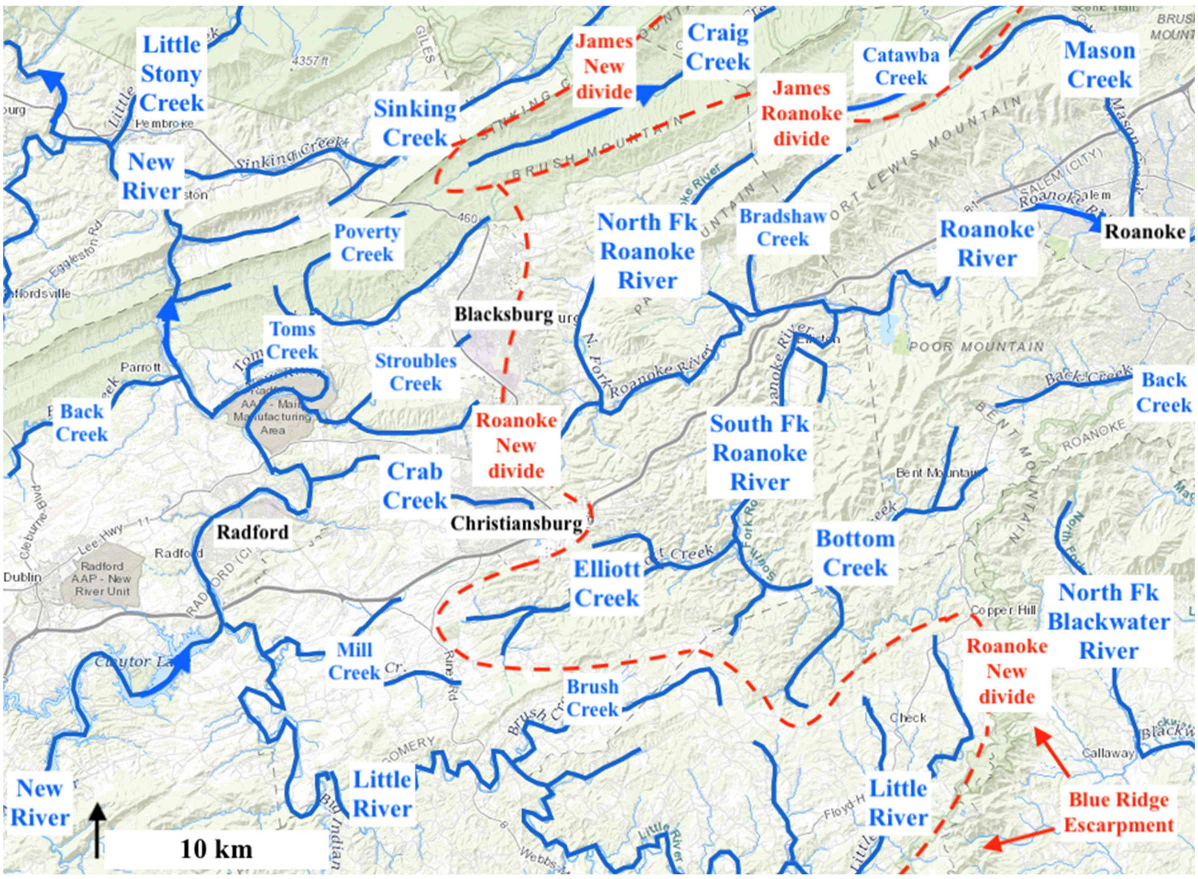

Figure 2. Modified map from the USGS National Map website showing the James River-New River, James River-Roanoke River, and Roanoke River-New River drainage divides with red dashed lines and some of the drainage routes discussed in the text. Figures 4 and 6 show additional and overlapping study regions. See figure 1 for the Blacksburg area location in the United States.

Davis (1903) viewed the Blue Ridge Escarpment as a divide between two peneplains drained by river systems of different length which were working simultaneously to reach the same baselevel and he thought a sharp escarpment should be the boundary between the peneplains. While the Davis theory gained support including from Johnson (1906) and Wright (1928, 1931), White (1950, p. 1312) objected and said "Actually–far from being a peneplain adjusted to sea level–the Asheville surface [in North Carolina] is rapidly being dissected by the young west-flowing streams which are pushing gorges eastward from the western scarp of the Blue Ridge Upland where it rises above the Appalachian Valley of the Tennessee. Witness, for instance the gorges of the Hiwasse, the Little Tennessee, the Pigeon, the French Broad, the Nolichucky, the Watauga, and the Toe. On the other hand, the east-flowing streams of the Piedmont show no such rejuvenation except above the line where they enter the Blue Ridge Scarp. This would suggest that the west-flowing streams have undergone an uplift which has not affected the east-flowing streams."

As an alternative White (1950) revived an earlier theory that the Blue Ridge Escarpment is a normal fault scarp which was reactivated during late Tertiary time, although in a follow-up discussion paper Stose and Stose (1951) preferred the Davis interpretation. While taking no position as to how the Blue Ridge Escarpment originated Thornbury (1965, p. 105) presented what is still a dominant accepted paradigm interpretation which is the "front of the scarp may have been considerably further east in Tertiary time" and he supported that interpretation by noting the presence of outliers to the east of the escarpment and by also observing that the Roanoke River now drains an area to the west of the Blue Ridge Escarpment which was formerly part of the New River drainage basin. Since the emergence of the plate tectonics theory researchers such as Spotila et al (2004) and Bank (2001) have been associating the Blue Ridge Escarpment with an eastern North America passive margin and suggest a significant but underdetermined amount of Cenozoic erosional escarpment retreat has taken place.

In a detailed study related to part of this paper's study region Houser (1980) used alluvial deposits and an accepted paradigm perspective (which included ignoring much of the topographic map drainage divide evidence) to reconstruct some previous regional drainage systems. More recently Ward et al (2005), Prince et al (2010), Prince et al (2011), and Stokes et al (2023) used an accepted paradigm perspective to study some of this paper's study region drainage system evidence. Each of those studies assumed the Eastern Continental Divide is retreating inland as valleys of east-oriented rivers such as the Roanoke River erode headward into the New River drainage basin. In the first study Ward et al (2005) used cosmogenic ^{10}Be exposure dating, mapping, and the examination of terrace sediments at locations (on either side of the three prominent New River water gaps shown in this paper's figures 2 and 3) to suggest New River incision and aggradation may be related to late Cenozoic climatic variations. In the second study Prince et al (2010) suggest the Blue Ridge Escarpment is an ancient passive continental margin and has evolved by inland erosional retreat. Based on evidence obtained from fluvial (terrace) alluvial deposits located along or near the Blue Ridge Escarpment crest (several are located within or near the Little River drainage basin seen in this paper's figure 2) they interpret their data to show "the potential for stream capture and divide migration to sustain passive margin escarpment evolution long after the cessation of rifting."

Prince et al (2011) in the third paper used alluvial deposits located along or near the Eastern Continental Divide (one located in the Crab Creek headwaters area and another just to the north of the Brush Creek headwaters) to document how the Roanoke River has captured drainage areas from the New River. In both cases the alluvium was sourced to outcrops now in the Roanoke River drainage basin and was interpreted to have been transported in southwest directions. The authors conclude by predicting that Roanoke River drainage basin headward erosion will capture the New River at some time during the next three million years. Stokes et al (2023) in the fourth study used several methods including obtaining^{10}Be derived erosion rates and simulation studies to determine whether and how divide migration is occurring along the Blue Ridge Escarpment. They determined erosion rates for three Eastern Continental Divide locations with their Elliott Creek location being within this paper's study region. The Elliott Creek site contains quartz and chert cobbles which based on the roundness of the cobbles were used to estimate transport of about 25 km in a southwest direction. They also describe hook-shaped Elliott Creek headwaters to suggest the creek once flowed westward and not eastward as it does now.

In summary it is difficult to use the accepted paradigm literature when trying to reconstruct a Blacksburg region drainage history. For example, Houser (1980) used alluvium to reconstruct three Blacksburg area ancestral rivers although no subsequent accepted paradigm literature appears to have been built on her interpretations. Her map of the ancestral Clover Hollow River shows it flowed in a southwest direction across today's James River-New River drainage divide from what is today the northeast-oriented Johns Creek valley to the southwest-oriented Clover Hollow Creek valley, which today drains to southwest-oriented Sinking Creek (although her ancestral Clover Hollow River did not follow the present-day Sinking Creek route to the New River but instead turned in a northwest direction). Her ancestral Blacksburg and County Line Rivers while crossing what is now the Roanoke River-New River drainage divide also crossed what is today rugged valley and ridge topography. It is difficult to determine from her map how those latter two ancestral rivers evolved into what are now the Blacksburg area drainage systems. The alluvium studies mentioned in Prince et al (2010), Prince et al (2011), and Stokes et al (2023) also found evidence that water once flowed in a southwest direction across the Roanoke River-New River drainage divide, although those researchers appear to have developed their interpretations independently of Houser's work and their interpretations do not appear to recognize the existence of most regional topographic map drainage divide and erosional landform evidence and do not lead to an easily understood regional drainage history.

2.2 New Paradigm Literature

Anomalous topographic map drainage divide evidence in the Missouri River drainage basin led Clausen to develop a new and fundamentally different geology and glacial history paradigm (new paradigm) able to explain that evidence. The new paradigm (described in more detail in Clausen 2023a) when applied to the eastern United States sees the Eastern Continental Divide (which in places is located along or near the Blue Ridge Escarpment crest) as the southeastern rim of a thick continental ice sheet created and occupied a deep "hole (see figure 1). The deep "hole" eastern rim is shown in figure 1 as continuing northeastward along today's Saint Lawrence River-Atlantic Ocean drainage divide although the thick ice sheet may have spilled across that hypothesized rim location into what are now the New England states. The deep "hole" rim in the eastern United States was gradually uplifted as immense and prolonged southwest-oriented continental ice sheet meltwater floods flowed across the rising region. As the rim gradually rose headward erosion of southeast-oriented valleys from the Atlantic Ocean (in sequence from southwest to the northeast) diverted floodwaters more directly to the Atlantic Ocean and headward erosion of northwest-oriented valleys from the deep "hole" diverted floodwaters into the developing deep "hole" (also in sequence) where floodwaters moved toward southern exits which rim uplift gradually closed until the Mississippi River valley became the deep "hole's" only southern exit.

Four papers written from the new paradigm perspective have explained topographic map drainage divide and other erosional landform evidence located along or near the Eastern Continental Divide. Clausen (2023c) used massive and prolonged southwest-oriented floods to explain topographic map drainage divide evidence in the French Broad River drainage basin (upstream from Asheville, North Carolina). Clausen (2022a) used large and prolonged south- and southwest-oriented floods flowing across an emerging valley and ridge region to explain previously unexplained topographic map drainage divide and erosional landform evidence in what is now the north-oriented Monongahela River drainage basin (within the larger Ohio River drainage basin). Of interest to the study reported here south-oriented floodwaters moved through the Monongahela River drainage basin and into the south-oriented Greenbrier River which now joins the northwest-oriented New River as a barbed tributary (to the north of this paper's figure 2). Those floodwaters must have continued in a southwest direction along what are now northeast-oriented New River headwaters (to the south of this paper's figure 2) to reach southwest-oriented Tennessee River headwaters. Clausen (2021) described how large and prolonged southwest-oriented floods flowing across an emerging valley and ridge region explain Casselman River drainage basin topographic map evidence (in the larger Monongahela River drainage basin and along the Eastern Continental Divide). And Clausen (2022b) used long-lived southwest-oriented floods as Tennessee River-Gulf of Mexico drainage divide uplift was occurring to explain northern Alabama topographic map drainage divide evidence.

In summary the new paradigm predicts southeast-oriented valleys from the Atlantic Ocean and northwest-oriented valleys from an ice sheet created and occupied deep "hole" eroded headward into the Blacksburg region (in a southwest to northeast sequence) to capture immense and long-lived southwest-oriented meltwater floods that were flowing along and across a rising deep "hole" rim. Based on these predictions, northwest-oriented river segments should now have southwest-oriented barbed tributaries and southeast-oriented rivers should have northeast-oriented barbed tributaries. Headward erosion of deep southeast-oriented (or northwest-oriented) valleys should have reversed the flow direction on the northeast ends of beheaded diverging and converging southwest-oriented flood flow channels so as to create drainage divides between what are now southwest-oriented and northeast-oriented secondary streams. The new paradigm further predicts northeast-oriented streams should have barbed southwest-oriented tributaries.

3. Methods

The new paradigm, unlike the accepted paradigm, asks researchers to look on detailed topographic maps to find and explain through valleys (valleys crossed by drainage divides), unusual river and stream direction changes, barbed tributaries, water and wind gaps, and similar features. Such evidence is abundant in the Blacksburg region so an organizational strategy was required. For this study the search for pertinent topographic map evidence used detailed topographic maps available at the United States Geological Survey National Map website. The topographic map evidence was then subdivided into the following categories: 1) topographic map evidence related to New River barbed tributaries, direction changes, and water gaps, 2) topographic map evidence related to through valleys crossing the James River-New River drainage divide, and 3) topographic map evidence related to through valleys crossing the James River-Roanoke River drainage divide. In addition, topographic map evidence related to previously undescribed (in detail) stream captures along the Roanoke River-New River drainage divide was discussed using both accepted and new paradigm perspectives.

Topographic map evidence (unless otherwise indicated) was viewed from a new paradigm perspective which interpreted landscape features to have been carved by the headward erosion of deep valleys into a rising deep "hole" rim as immense and prolonged southwest-oriented floods eroded complexes of diverging and converging channels along the rising deep "hole" rim. Headward erosion of the northwest-oriented New River valley from the deep "hole" into a rising region of probably low relief was interpreted to have captured southwest-oriented flood flow in a northwest-to-southeast progression and to have lowered the regional base level. The lowered base level initiated southwest-oriented valley headward erosion in a northeast direction along less resistant bedrock units from the newly eroded New River valley (forming the valley and ridge topography now found to the north and east of the New River valley). Headward erosion of the southeast-oriented Roanoke and James River valleys was interpreted to have subsequently beheaded and reversed the southwest-oriented flood flow channels in southeast-to-northwest progressions and to have created the Eastern Continental Divide.

The goal was to develop explanations for as much of the observed detailed topographic map drainage divide and other erosional landform evidence as possible. The first type of landform feature needing explanations were valleys crossing drainage divides (referred to here as through valleys). Through valleys were interpreted to have been formed when a flood flow channel was dismembered, probably by the headward erosion of a deeper valley across it (which was probably aided by deep "hole" rim uplift) which caused a reversal of flow on the flood flow channel's beheaded end (with the flow reversal creating the drainage divide that now crosses the through valley floor). Geologic maps were checked to determine if other drainage divide origin interpretations should be considered. River and stream direction changes were considered to be important evidence and to require explanations which could include reversals of flow on specific drainage route segments. Water and wind gaps were interpreted to have been eroded as valleys were eroded in a headward direction to capture the massive and long-lived southwest-oriented floods (as deep "hole" rim uplift was occurring and as the present-day valley and ridge topography was emerging).

4. Results

4.1 New River Barbed Tributaries, Direction Changes, and Water Gaps

Accepted paradigm literature rarely addresses New River barbed tributaries, direction changes, or water gaps. Instead, the accepted paradigm has caused many geomorphologists to consider the New River to be a geologically old river. Thornbury (1965, p. 106) commented the "New River is badly misnamed, for it ought to be called 'Old River'; it is probably one of the oldest rivers in the eastern United States. It certainly dates far back into Tertiary time and possibly beyond that." Yet Blacksburg region topographic maps show southwest-oriented barbed tributaries joining the northwest-oriented New River segment, the New River changes from a northeast orientation to a northwest orientation, and prominent water gaps (seen in figures 2 and 3) suggest a much more complex New River history than what the accepted paradigm describes.

Southwest-oriented barbed tributaries which flow to the northwest-oriented New River's study region segment include: 1) Stony Creek (not seen in figure 2 but to the northwest of Little Stony Creek and seen in figure 4), 2) Dry Branch, 3) Little Stony Creek, 4) Doe Creek, 5) Sinking Creek, 6) Spruce Run, 7) Norris Run, and 8) Poverty Creek (flowing to Toms Creek). Thornbury (1969, p. 120) suggests barbed tributaries are evidence that some type of drainage system reversal has taken place. The southwest-oriented streams seen in figure 2 flow in northeast-to-southwest oriented through valleys which cross multiple drainage divides such as the through valley seen in figure 3 which near the New River is drained by southwest-oriented Norris Run and south-oriented Lick Run (which has eroded a south-oriented water gap across Brush Mountain). That same through valley is also drained by Straley Branch and Poverty Creek, both of which have eroded south-oriented water gaps across Brush Mountain (south-oriented water gaps like the barbed tributaries suggest south-oriented drainage prevailed when the valleys and water gaps were eroded).

Figure 4 shows a much larger region to the northeast of figure 3 and how southwest-oriented Poverty Creek and northeast-oriented Craig Creek headwaters flow in that same through valley on opposites sides of the James

River-New River drainage divide. Today multiple low drainage divides cross the floor of that through valley which extends from the James River to the New River suggesting that Craig Creek, Poverty Creek, Straley Branch, Lick Run, and Norris Run are draining a dismembered southwest-oriented drainage route (e. g. no other reason for a drainage divide located at the Poverty Creek-Craig Creek drainage divide location is shown on the Bartholomew et al 2019 geologic map). Headward erosion of the deep southeast-oriented James River valley probably triggered a flow reversal that created northeast-oriented Craig Creek and the James River-New River drainage divide. But prior to that flow reversal headward erosion of the south-oriented Lick Run valley and probably almost simultaneously of the Straley Branch and Poverty Creek valleys across what must have been an emerging Brush Mountain created the three south-oriented water gaps seen today and the Lick Run-Norris Run, Lick Run-Straley Branch, and Poverty Creek-Straley Branch drainage divides. Headward erosion of these valleys across what is today a high ridge is difficult to understand unless regional uplift was occurring as massive southwest-oriented floodwaters were also flowing across the rising region.

Through valleys can be complex such as the southwest-oriented Sinking Creek valley which is linked with the northeast-oriented Meadow Creek valley which extends through a water gap (northeast of figure 4 and seen in figures 5 and 6) to join the northeast-oriented Craig Creek valley. Even more complex are the southwest-oriented Little Stony and Doe Creek valleys which are linked by gaps eroded across Salt Pond Mountain with the northeast-oriented Johns Creek valley which extends through a water gap to join the northeast-oriented Craig Creek valley. Spruce Run (seen in figure 4) is linked with northeast-oriented Greenbrier Branch (shown but not labelled in figures 2 and 4) which flows to southwest-oriented Sinking Creek as a barbed tributary (where Sinking Creek now jogs in a northwest direction and then continues in a southwest direction in the next valley immediately to the northwest of the Spruce Run-Greenbrier Branch through valley). Headward erosion of a deeper southwest-oriented Sinking Creek valley must have beheaded and reversed diverging southwest-oriented flood flow in the Spruce Run valley to create northeast-oriented Greenbrier Branch and the Spruce Run-Greenbrier Branch drainage divide. These diverging and converging through valleys and high elevation gaps cut into Salt Pond Mountain suggest the valley and ridge topography emerged as massive and prolonged southwest-oriented floods flowed toward the lower New River valley created base level on what at that time was the rising deep "hole" rim. In summary, headward erosion of diverging and converging southwest-oriented valleys in northeast directions from the New River valley along less resistant bedrock units created the valley and ridge topography seen today.

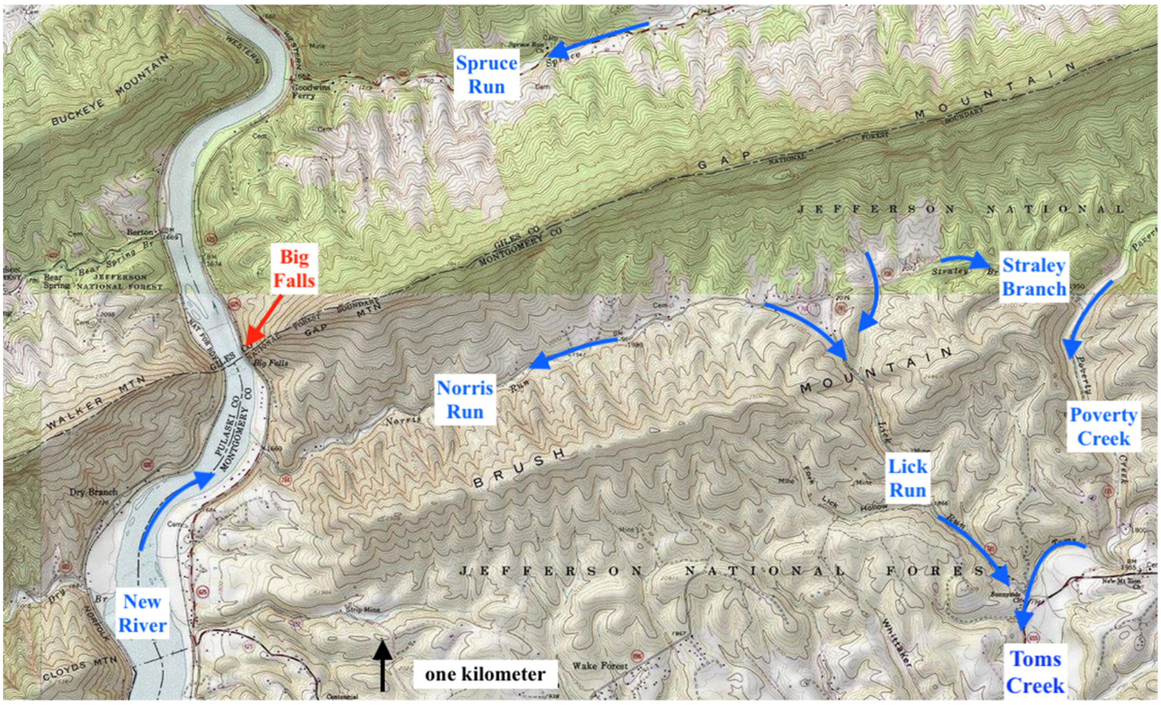

Figure 3. Modified topographic map from the USGS National Map website showing New River water gaps and the southwest ends of valleys now drained by Spruce Run, Norris Run, and Poverty Creek and the Lick Run, Straley Branch, and Poverty Creek water gaps. The contour interval is 20 feet (6 meters).

Also requiring an explanation is the New River direction change from a northeast orientation to a northwest orientation. To the south of the study region the New River is a northeast-oriented river and its headwaters are linked by northeast-to-southwest oriented through valleys (crossing the New River-Tennessee River drainage divide) with southwest-oriented Tennessee River headwaters. Also, south of the study region many New River tributaries are oriented in southeast, north, or northwest directions rather than southwest and northeast directions that are common to the north of the study region, although there are exceptions. Tributary orientations suggest the study region northwest-oriented New River valley eroded headward across massive and long-lived southwest-oriented floods. Headward erosion of the northwest-oriented New River valley (probably aided by deep "hole" rim uplift) caused the flood flow reversals that created the New River-Tennessee River drainage divide and the northeast-oriented New River drainage system (upstream from or to the south of figure 2). Some New River entrenched meanders may have been formed by zig zagging that probably occurred as the actively eroding northeast-oriented New River valley head encountered bedrock units of differing erosive resistance and/or as the valley head first eroded headward along a beheaded and reversed southwest-oriented flood flow channel and then changed its direction to erode headward along a diverging and/or converging flood flow channel.

4.2 James River-New River Drainage Divide

The James River-New River drainage divide segment of the Eastern Continental Divide (some of which is seen in figure 4) is critical to understanding the Blacksburg region geomorphic history. While mostly located to the north of figure 2 the James River-New River drainage divide loops in a southwest direction around northeast-oriented Craig Creek headwaters (seen in figure 4), then loops in a northeast direction around southwest-oriented Sinking Creek headwaters and next loops in a southwest direction around northeast-oriented Johns Creek headwaters (flowing to Craig Creek) and northeast-oriented Potts Creek headwaters (flowing in a separate through valley which is drained in the other direction to the New River by southwest-oriented Stony Creek). In making these loops the James River-New River drainage divide crosses what are today three deep (300 meters or deeper) diverging and converging through valleys.

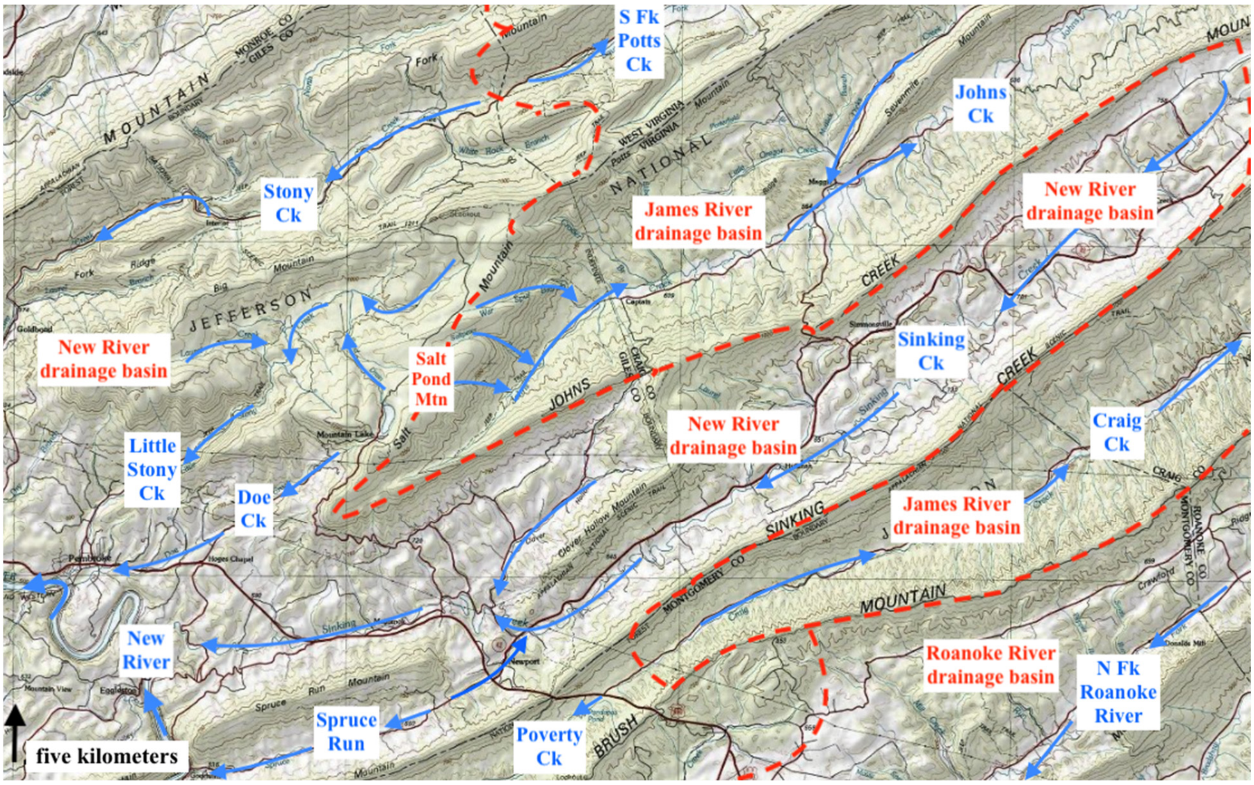

Figure 4. Modified topographic map of a study region area located to the northeast of figure 3 taken from the USGS National Map website showing with a dashed red line the James-New River drainage divide (Eastern Continental Divide) and diverging and converging through valleys crossing that drainage divide. The contour interval is 50 meters.

Figure 5 illustrates a detailed topographic map showing the James River-New River drainage divide at the northeast end of the southwest-oriented Sinking Creek drainage basin and is to the east of the figure 4 northeast corner. Meadow Creek as seen in figure 6 flows in a northeast direction through a water gap to join northeast-oriented Craig Creek. Note in figure 5 the two valleys crossing the drainage divide which link drainage routes now flowing in opposite directions. The valleys are erosional features formed by water that once flowed across the drainage divide. In this case the two separate valleys are evidence that two diverging and converging streams of water once flowed across the drainage divide. A Prince (2019) geologic map shows the northern valley is located along a possible thrust fault. Rather than being explained by the headward erosion of one stream valley into the other stream's drainage basin the map evidence is better explained by a reversal of what was originally southwest-oriented flood flow in the Meadow Creek valley to create a northeast-oriented stream and the present-day drainage divide. Similar evidence is found wherever drainage divides cross the northeast-to-southwest oriented through valleys such as where the James River-New River drainage divide crosses the through valley linking northeast-oriented Craig Creek with southwest-oriented Poverty Creek seen in figure 4.

Northeast-oriented Craig Creek was checked for barbed tributaries to determine if a drainage reversal had occurred. In figure 6 the northeast-oriented Craig Creek valley is joined by southwest-oriented Blood Run and Lick Branch as barbed tributaries, both of which turn in northwest directions once in the Craig Creek valley. No other reason for the Lick Run barbed tributary is shown on the Prince and Henika (2018) geologic map although the map does show a possible fault line along the southwest-oriented Blood Run valley. Northeast-oriented Johns Creek, which flows to northeast-oriented Craig Creek is joined by southwest-oriented Dicks Creek and Big Branch (shown but not labelled in figures 4 and 6) as barbed tributaries. Further downstream Barbours Creek, Mill Creek, and Little Patterson Creek (not seen in figures shown here) flow in southwest directions before joining northeast-oriented Craig Creek, although before reaching Craig Creek, Barbours Creek and Mill Creek change direction. These Craig Creek barbed tributaries and northeast-oriented Johns and Meadow Creeks flow in parallel diverging and/or converging valleys and suggest erosion by massive southwest-oriented flood flow. Headward erosion of the southeast-oriented James River valley captured the southwest-oriented flood flow which, when combined with on-going regional uplift, caused flow reversals that created the James River-New River drainage divide and the northeast-oriented Craig Creek drainage system.

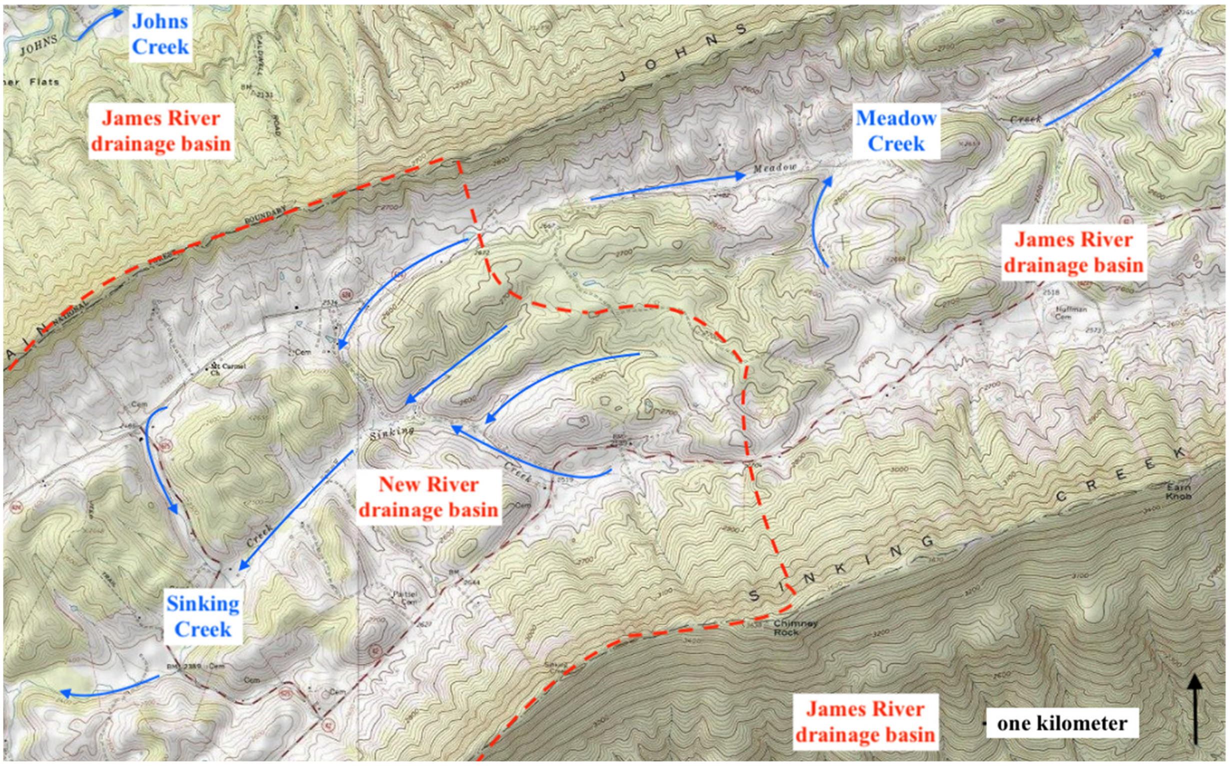

Figure 5. Modified topographic map of an area overlapping the figure 4 northeast corner and the figure 6 northwest quadrant taken from the USGS National Map website which shows the James River-New River drainage divide at the northeast end of the southwest-oriented Sinking Creek drainage basin. The contour interval is 20 feet (about 13 meters).

Topographic maps show the northeast-oriented Potts Creek valley joins a south-oriented Jackson River valley segment near the town of Covington with the Jackson River then turning in a northeast direction to flow to the town of Clifton Forge where the Jackson River turns in a southeast direction to flow through a significant water gap before joining the south-oriented Cowpasture River to form the southeast-oriented James River (which is almost immediately joined by northeast-oriented Craig Creek as a barbed tributary). At least some of the floodwaters that eroded the diverging and converging through valleys across the James River-New River drainage divide must have flowed in a south direction in what is now the Cowpasture River valley, which like through valleys crossing the James River-New River drainage divide is a through valley which the Potomac River-James River drainage divide now crosses. Almost immediately across the low drainage divide from where south-southwest oriented Cowpasture River headwaters begin are north-northeast-oriented South Fork South Branch Potomac River headwaters, which almost certainly represent reversed flow on what had once been a major south-oriented flood flow route.

4.3 James River-Roanoke River Drainage Divide

Figure 6 shows the James River-Roanoke River drainage divide in the region to the north of the city of Roanoke, north and east of the southeast-oriented Roanoke River, and south and west of the southeast-oriented James River (which is located to the east of figure 4 and to the northeast of overlapping figure 2). The Eastern Continental Divide is north and west of figure 6 and is also to the north and west of the usually defined Blue Ridge Escarpment location. Headward erosion of the Roanoke River and James River drainage basins created the valleys, erosional remnants, and ridges seen in figure 6 as massive and long-lived southwest oriented floods flowed along a rising deep “hole” rim. As seen in figure 6 the James River-Roanoke River drainage divide crosses a through valley drained by northeast-oriented Catawba Creek (which as seen in figure 7 is drained in the opposite direction by the southwest-oriented North Fork Roanoke River). The drainage divide then follows Catawba Mountain (between Catawba and Mason Creeks) before turning in an east and southeast direction to cross a broad through valley in the figure 6 northeast quadrant (referred to here as the Tinker Creek through valley) and finally continue in a northeast direction along the Blue Ridge upland. The McGuire (1976) geologic map shows no geologic reason why a major drainage divide should cross the expansive Tinker Creek through valley.

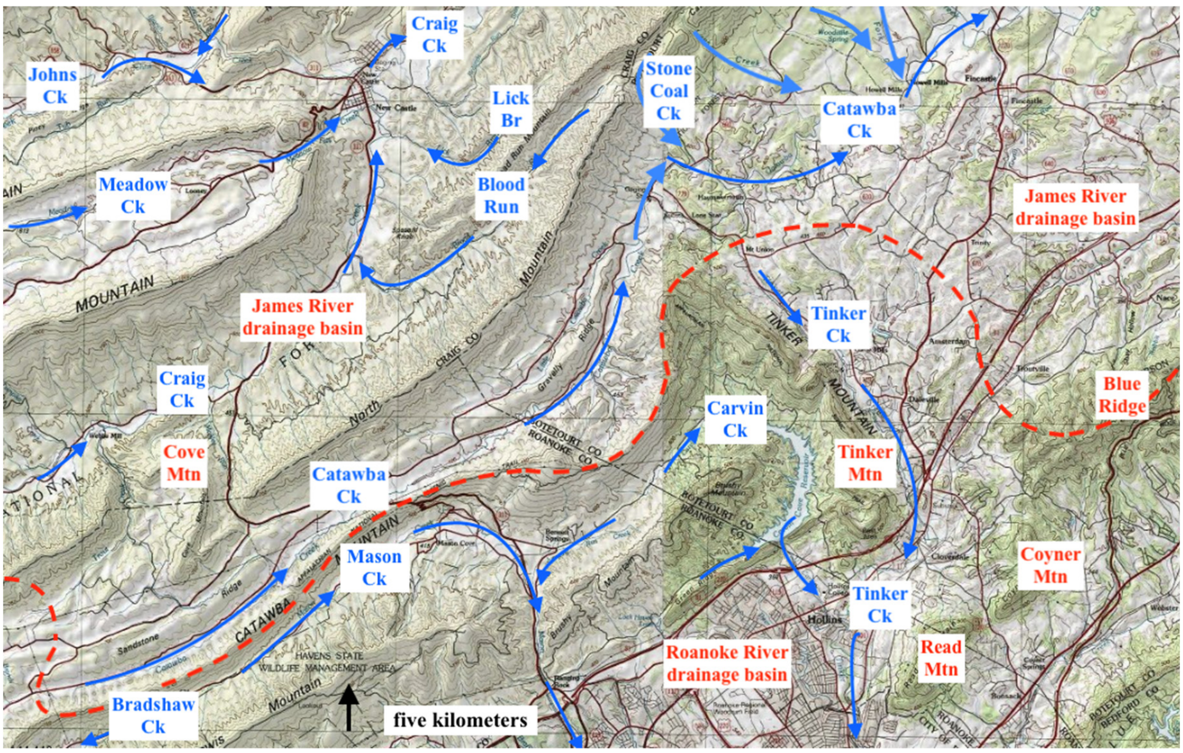

Figure 6. Modified topographic map of a region east of figure 4 and to the northeast of overlapping figure 2 from the USGS National Map website showing the James River-Roanoke River drainage divide with a red dashed line. Note the through valley to the north and east of Tinker Creek. The contour interval is 50 meters.

The Tinker Creek through valley links northeast-oriented Catawba Creek and other unlabeled northeast-oriented drainage routes in the James River drainage basin with south-oriented Tinker Creek drainage which to the south of figure 6 flows to the southeast-oriented Roanoke River (Catawba Creek and the other northeast-oriented drainage routes flow to the southeast-oriented James River as barbed tributaries). Unlike northeast-to-southwest oriented through valleys crossing the James River-New River drainage divide (and the through valley seen in figure 7) the Tinker Creek through valley is oriented in a north-to-south direction and links two southeast-oriented river valleys. Tinker Creek flows between Tinker Mountain and Coyne and Read Mountains although significant valleys between Read and Coyne Mountains and between Coyne Mountain and the Blue Ridge upland (both within the Tinker Creek drainage basin) suggest the present-day Tinker Creek drainage basin was eroded by diverging and converging streams of south-oriented water flowing to the Roanoke River as the present-day topography emerged.

Headward erosion of the deep southeast-oriented Roanoke River valley into a rising deep “hole” rim along which immense and prolonged southwest-oriented floods were flowing enabled headward erosion of the Tinker Creek valley between Tinker Mountain and Read and Coyne Mountains (and the Blue Ridge upland) and the tributary valleys between Coyne Mountain and Read Mountain and between Coyne Mountain and the Blue Ridge upland. The south-oriented Tinker Creek drainage basin eroded headward in a north direction from the actively-eroding and deep Roanoke River valley to capture southwest-oriented flood flow which initially must have flowed on a surface now preserved (if preserved at all) by ridge crests seen in figure 6. Headward erosion of the south-oriented Tinker Creek drainage basin also enabled headward erosion of the now south-oriented Carvin Creek valley (with its northeast-oriented headwaters formed by a reversal of flow in a beheaded southwest-oriented flood flow channel). Headward erosion of the south-oriented Mason Creek valley from the deep Roanoke River valley eroded the Mason Creek water gap seen in figure 6 and beheaded and reversed flood flow to create northeast-oriented Mason Creek headwaters and the Mason Creek-Bradshaw Creek drainage divide.

Figure 7 provides a detailed map of the through valley (partly seen in the figure 6 southwest corner) which links southwest-oriented North Fork Roanoke River headwaters with northeast-oriented Catawba Creek headwaters. As seen in figure 2 the North Fork Roanoke River after flowing in a southwest direction makes a U-turn to flow in a northeast direction and join the north-northeast oriented South Fork Roanoke River to form the northeast-oriented Roanoke River (which then turns in a southeast direction). Interestingly the elevation in figure 7 where the James River-Roanoke River drainage divide crosses the Catawba Creek-North Fork Roanoke River through valley floor is about the same as elevations of Crab Creek alluvial deposits discussed in Prince et al (2011) and Elliott Creek alluvial deposits discussed in Stokes et al (2023), with those papers claiming the alluvial deposits document that southwest-oriented water crossed the North Fork Roanoke River-New River drainage divide. Figure 7 suggests southwest-oriented water that flowed across the Roanoke River-New River drainage divide to reach the Crab and Elliott Creek areas probably also flowed across the Catawba Creek-North Fork Roanoke River drainage divide and may have come from much further to the north.

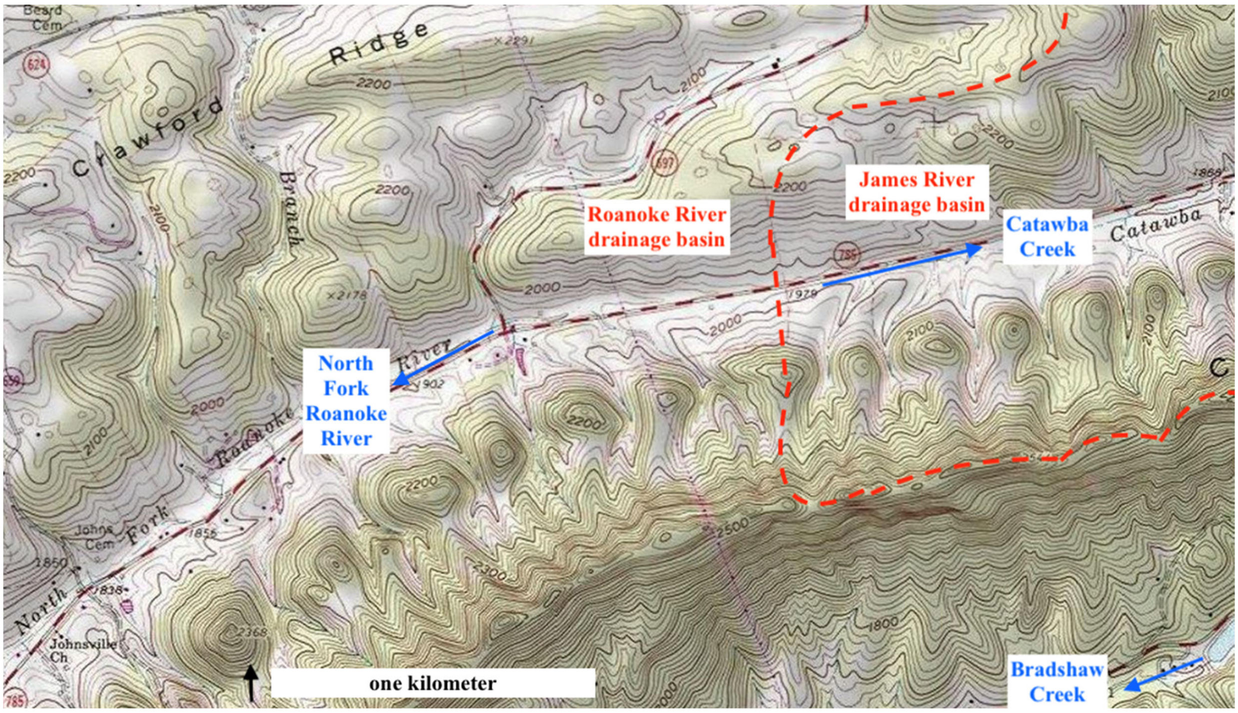

Figure 7. Modified topographic map of an area overlapping the figure 6 southwest corner from the USGS National Map website showing the through valley crossing the James River-Roanoke River drainage divide (which here is also the Catawba Creek-North Fork Roanoke River drainage divide). The contour interval is 20 feet (about 6 meters).

Water in the now northeast-oriented Catawba Creek valley must have initially flowed in a southwest direction to reach southwest-oriented drainage flowing in what is now the northeast-oriented New River drainage basin which is located to the south of figure 2. Eventually headward erosion of the deep northwest-oriented New River valley (from the developing deep "hole") beheaded and (probably with assistance from the deep "hole" rim uplift) reversed flow in the northeast-oriented New River drainage basin to create the northeast- and northwest-oriented New River drainage route and also to significantly lower the regional baselevel which enabled northeast-to-southwest oriented through valleys to emerge as southwest-oriented floodwaters eroded valleys headward in northeast directions. Headward erosion of the southeast-oriented Roanoke River valley beheaded and reversed a southwest-oriented flood channel to create what are now northeast-oriented Roanoke River and North Fork Roanoke River segments and the Roanoke River-New River drainage divide (see figure 2). Reversed flow on what is now the northeast-oriented North Fork Roanoke River segment captured southwest-oriented water flowing across the Catawba Creek-North Fork Roanoke River drainage divide to create the present-day North Fork Roanoke River U-turn. Headward erosion of the deep southeast-oriented James River valley next beheaded and reversed the southwest-oriented flood flow so as to end south-oriented flood flow in the Tinker Creek through valley and to create northeast-oriented Catawba Creek and the Catawba Creek-North Fork Roanoke River drainage divide.

Evidence for a reversal of flow in the Catawba Creek drainage basin can be seen in figure 6 where south-oriented barbed tributaries join northeast-oriented Catawba Creek especially downstream from Stone Coal Creek. South-oriented Stone Coal Creek joins Catawba Creek just to the north of the south-oriented Tinker Creek headwaters at a point where Catawba Creek makes a short southeast jog and is joined by a short north-oriented tributary (at an elevation of about 366 meters). Shallow through valleys with floor elevations of about 439 meters cross the James River-Roanoke River drainage divide and link that north-oriented Catawba Creek tributary valley with the south-oriented Tinker Creek valley which suggests south-oriented water once diverged from the present-day northeast-oriented Catawba Creek valley to flow into the Tinker Creek through valley and then southward to join the southeast-oriented Roanoke River.

5. Discussion

Accepted paradigm literature (with the exception of Houser's alluvium study which did suggest that southwest-oriented water once flowed across what is today the James River-New River drainage divide) typically ignores the James River-New River and James River-Roanoke River drainage divides although the Roanoke River-New River drainage divide origin has received some attention. For example, Prince et al (2011) and Stokes et al (2023), who did not use detailed topographic map drainage system and erosional landform evidence to reconstruct a regional drainage history, did use alluvium and barbed tributaries to document that southwest-oriented water once flowed across the Roanoke River-New River drainage divide. Those researchers also suggested that Roanoke River drainage basin headward erosion is actively capturing New River drainage areas and will eventually capture the New River. This accepted paradigm interpretation implies a sequence of unstated (in the literature) Roanoke River drainage basin capture events which are almost identical to the new paradigm implied capture events, although the accepted paradigm sees the capture events occurring under present-day conditions while the new paradigm sees the capture events occurring during massive and prolonged floods when large amounts of water would have been spilling across most if not all of the then existing drainage divides.

A generalized sequence of Roanoke River drainage basin capture events can be interpreted from drainage patterns seen in figure 2 by using each of the two fundamentally different paradigms. For example, from the accepted paradigm perspective headward erosion of the southeast-oriented Roanoke River valley could have beheaded and reversed a southwest-oriented New River tributary to create the northeast-oriented Roanoke and North Fork Roanoke River segments and the Roanoke River change from a northeast flow direction to a southeast flow direction. Such a capture and reversal event while not impossible is, according to Bishop (1995), extremely unlikely under present day conditions. From the new paradigm perspective headward erosion of the southeast-oriented Roanoke River valley into the rising deep “hole” rim area beheaded and reversed a major southwest-oriented flood flow channel to create the northeast-oriented Roanoke and North Fork Roanoke River segments. The new paradigm described immense and prolonged southwest-oriented meltwater floods make the capture and significant flow reversal much more likely to have occurred.

In another example, the accepted paradigm can explain the capture of southwest-oriented flow in the southwest-oriented North Fork Roanoke River headwaters segment by the headward erosion of a south-oriented valley from reversed flow in what is now the northeast-oriented North Fork Roanoke River valley segment. However, that explanation requires multiple capture events (all of which according to Bishop are unlikely to have occurred). On the other hand, the new paradigm describes immense southwest-oriented floods flowing across what was probably a low relief (but gradually rising) surface. Under such conditions floodwaters could have easily spilled across drainage divides between what were probably shallow and diverging and converging southwest-oriented flood flow channels. Such spillages could easily have been responsible for the headward erosion of a south-oriented valley from the reversed flow in the northeast-oriented North Fork Roanoke River segment which then captured southwest-oriented flow in what is now the southwest-oriented North Fork Roanoke River headwaters segment so as to create the present-day North Fork Roanoke River U-turn.

In another example, northeast-oriented Elliott Creek has been interpreted from the accepted paradigm perspective to be a reversal of flow in what had been a southwest-oriented New River tributary while from the new paradigm perspective Elliott Creek probably is a beheaded and reversed southwest-oriented flood channel. And in another example, from the accepted paradigm perspective Bottom Creek began as a southwest-oriented New River tributary (continuing on the Brush Creek alignment in the Little River drainage basin) which South Fork Roanoke River valley headward erosion captured. While not impossible this capture event is difficult to explain under present-day conditions. From the new paradigm perspective Bottom Creek and Brush Creek are evidence of a dismembered southwest-oriented flood flow channel. And finally, the north-northeast oriented South Fork Roanoke River valley segment is easier to explain as a flow reversal in what had been a south-southwest oriented flood flow channel (which diverged from a southwest-oriented flood flow channel in which the northeast-oriented Roanoke River now flows) than by South Fork Roanoke River valley headward erosion under present-day conditions.

Accepted paradigm literature probably omits Roanoke River drainage basin capture event details because geomorphologists know such capture events rarely occur under present-day conditions. However, the new paradigm describes conditions which could lead to the easily documented Roanoke River drainage basin capture events. Without question the new paradigm provides a better Roanoke River-New River drainage divide origin explanation than the vague explanations that researchers using an accepted paradigm perspective have published. In addition, the new paradigm explains how the previously ignored (in the accepted paradigm literature) James

River-New River and the James River-Roanoke River drainage divides originated. However, the two paradigms are incommensurate and according to Thomas Kuhn (1970) one paradigm should not be used to judge the other. Being incommensurate means the two paradigms cannot be compared by using a common measurement standard (such as the accepted paradigm's geologic time scale).

6. Conclusions

Blacksburg, Virginia region topographic map drainage divide and erosional landform evidence when viewed from the new paradigm perspective suggests that headward erosion of the northwest-oriented New River valley (probably from a developing continental ice sheet created and occupied deep "hole") captured massive and long-lived southwest-oriented floods and lowered the regional base level which enabled southwest-oriented floodwaters to erode diverging and converging northeast-to-southwest oriented valleys headward in a northeast direction along less resistant bedrock units. Map evidence can also be interpreted to show that headward erosion of the southeast-oriented Roanoke River valley (from the Atlantic Ocean) beheaded and reversed the southwest-oriented floodwaters in some of the flood flow channels so as to create the present-day Roanoke River-New River drainage divide. The map evidence can further be interpreted to show that headward erosion of the southeast-oriented James River valley (from the Atlantic Ocean) subsequently captured the southwest-oriented floodwaters and caused reversals of flow on northeast ends of the beheaded diverging and converging southwest-oriented flood flow channels so as to create the present-day James River-Roanoke River and James River-New River drainage divides. Topographic map evidence suggests the captures occurred during immense and prolonged southwest-oriented floods and are no longer actively occurring as some of the accepted paradigm literature claims.

The new paradigm is fundamentally different from the accepted paradigm and for this reason, further work is needed to confirm the new paradigm's ability to explain not only adjacent region topographic map evidence but also to locate field evidence such as alluvium that floodwaters must have transported across previously ignored drainage divides. For example, this paper interpreted topographic map evidence to determine that southwest-oriented floodwaters flowed across the present-day James River-New River and James River-Roanoke River drainage divides. Researchers familiar with Blacksburg region bedrock geology and who have already determined that water transported alluvium in a southwest direction across the Roanoke River-New River drainage divide and in one location across the James River-New River drainage divide might want to test this paper's conclusions by checking to determine if alluvium was also transported in southwest directions across other James River-New River drainage divide locations and across what in the accepted paradigm literature appears to be the ignored James River-Roanoke River drainage divide.

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