Scientific Research Publishing

Open Journal of Geology, 2023, 13, 1220-1239
https://www.scirp.org/journal/ojg
ISSN Online: 2161-7589
ISSN Print: 2161-7570

Use of the 1893 Cranberry, North Carolina Topographic Map to Determine Blue Ridge Escarpment Area Drainage System and Erosional Landform Origins, USA

Eric Clausen

Independent Investigator, Jenkintown, PA, USA
Email: eric2clausen@gmail.com

How to cite this paper: Clausen, E. (2023) Use of the 1893 Cranberry, North Carolina Topographic Map to Determine Blue Ridge Escarpment Area Drainage System and Erosional Landform Origins, USA. *Open Journal of Geology*, **13**, 1220-1239.
https://doi.org/10.4236/ojg.2023.1311052

Received: October 12, 2023
Accepted: November 19, 2023
Published: November 22, 2023

Abstract

A new and fundamentally different geology and glacial history paradigm (new paradigm) is used to interpret previously ignored and unexplained drainage system and erosional landform evidence shown on the 1893 United States Geological Survey Cranberry, North Carolina 1:125,000 scale topographic map (which has a 100-foot or about a 30-meter contour interval). In most regions including the Cranberry map area, geomorphologists have never been able to use the accepted geology and glacial history paradigm (accepted paradigm) to explain most of the topographic map drainage system and erosional landform evidence. Probably for that reason, drainage system and erosional landform evidence shown on the 1893 Cranberry topographic map and its adjacent topographic maps has been ignored for 130 years. This study demonstrates how a new geology and glacial history paradigm (new paradigm) which was developed by using Great Plains and Rocky Mountain topographic map evidence explains the 1893 Cranberry map drainage system and erosional landform evidence (and similar evidence from a small area on the adjacent 1905 Morgantown map). The new paradigm sees the Cranberry map area as being located along the southeastern rim of a continental ice sheet created and occupied deep "hole" with regional erosion occurring and present-day drainage systems developing when the headward erosion of southeast-oriented valleys from the Atlantic Ocean and of northwest-oriented valleys from the developing deep "hole" into the gradually rising deep "hole" rim captured massive and prolonged south- and southwest-oriented meltwater floods. The new paradigm permits explanations for most drainage divides, named and unnamed gaps, barbed tributaries, through valleys extending across drainage divides, isolated erosional remnants, diverging and converging valleys, and unusual river and stream direction changes which the 1893 Cranberry topographic map shows.

Keywords

Eastern Continental Divide, Geomorphology, Linville Gap, South Fork New River, Yadkin River, Watauga River

1. Introduction

1.1. Statement of the Research Problem

The United States Geological Survey (USGS) 1:125,000 scale Cranberry, North Carolina topographic map [1] with a 100-foot (about 30 meters) contour interval was first published in 1893 and showed enough drainage system and erosional landform evidence that many of the drainage divides and other landform features could be identified. One year later Hayes and Campbell] [2], who probably studied that newly published map, interpreted the Blue Ridge Escarpment (which extends across the Cranberry topographic map area) to be an eroded monocline. Improved and more detailed topographic maps now cover the region. Yet, during the 130 years since the map was released geomorphologists who have discussed Blue Ridge Escarpment origins never published explanations for most of the Cranberry topographic map drainage system and erosional landform evidence. This paper explores how a new and fundamentally different geology and glacial history paradigm (new paradigm) based on a previously unrecognized continental ice sheet created and occupied deep "hole" (see **Figure 1**) and immense and prolonged meltwater floods explains the 1893 Cranberry topographic map drainage system and erosional landform evidence.

Drainage divides, unusual drainage route direction changes, barbed tributaries, through valleys (valleys crossing drainage divides), underfit rivers, diverging and converging through valley complexes, asymmetric drainage divides and basins, water and wind gaps, and similar erosional landform features (as seen on topographic maps) represent evidence needed when interpreting a region's drainage history. Yet the accepted geology and glacial history paradigm (accepted paradigm) does not satisfactorily explain most such topographic map evidence. For that reason, Clausen [3] noted that when developing regional geomorphic histories researchers typically ignore the difficult to explain topographic map erosional landform evidence. This practice began in 1889 when William Morris Davis in his "River Pirate" paper [4] ignored most erosional landform evidence shown on the then newly published Doylestown, PA topographic map. Three years later a Davis student and assistant, R. D. Ward [5], also ignored most of that same map's erosional landform evidence (see Clausen [6]). After ignoring much of the Doylestown map evidence Davis published his influential "Rivers and Valleys of Pennsylvania" paper [7] and subsequent papers which pointed geomorphologists toward a paradigm which does not explain most of the topographic map drainage divide and erosional landform evidence.

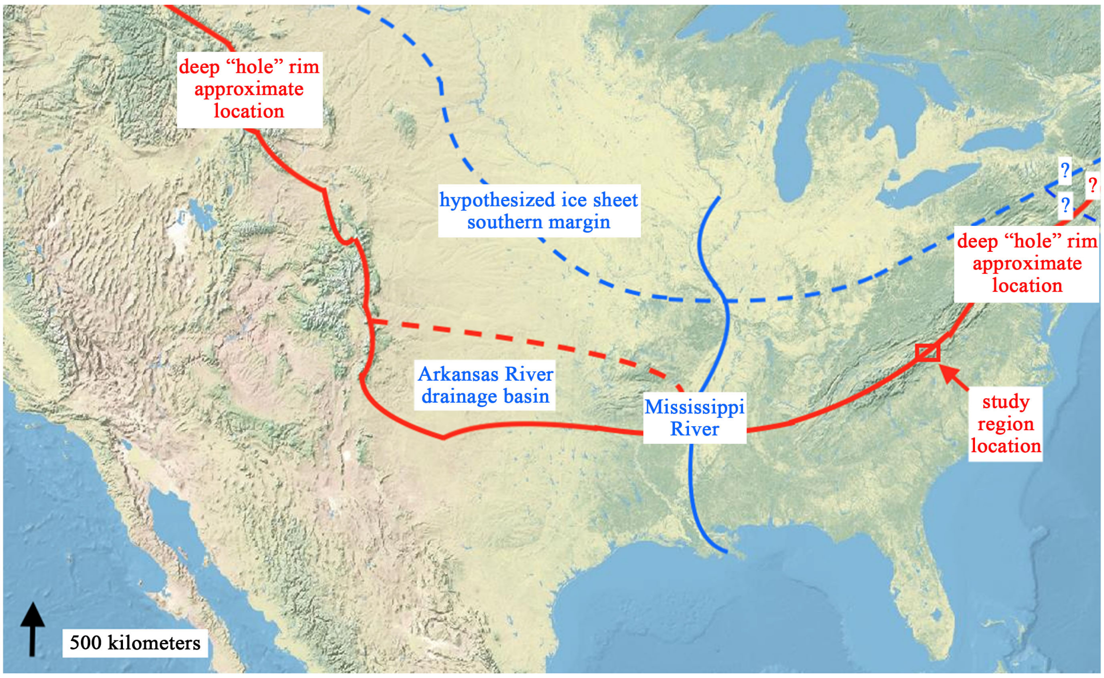

Figure 1. Modified map from the United States Geological Survey (USGS) National Map website showing this paper's study region location in relation to the new paradigm's deep "hole" rim and the new paradigm's hypothesized continental ice sheet southern margin.

Thomas Kuhn [8] observed that when faced with anomalous evidence which their accepted paradigm cannot satisfactorily explain scientists have three choices. The first choice is to find a way to use the accepted paradigm to explain the evidence in which case the accepted paradigm will survive. The second choice is to describe (or map) the evidence and set it aside for future scientists to explain (which is what happened, although geomorphology publications never mention what was being done). The third choice is to develop a new paradigm which is able to explain what the accepted paradigm cannot explain.

The first research question asked here is does the new paradigm explain most of the previously unaddressed and unexplained drainage divide and erosional landform evidence shown on the 1893 Cranberry, North Carolina topographic map (**Figures 2-4** show sections of that map)? Early topographic maps became obsolete during the mid-20th century as newer topographic maps became available, although the 1893 Cranberry map for all practical purposes shows the same geomorphic features as the newer maps now show. The second question asked is that by ignoring what was then newly available topographic map evidence did late 19th and early 20th century geomorphologists point the geology research community toward a flawed geology and glacial history paradigm?

1.2. Geographic Setting

The 1893 Cranberry, North Carolina topographic map (82˚W, 36˚N; 81˚30'W, 36˚N; 81˚30'W, 36˚30'N; 82˚W, 36˚30'N; 81˚30'W, 36˚N) was chosen because it shows an area located along the new paradigm's deep "hole" southeastern rim

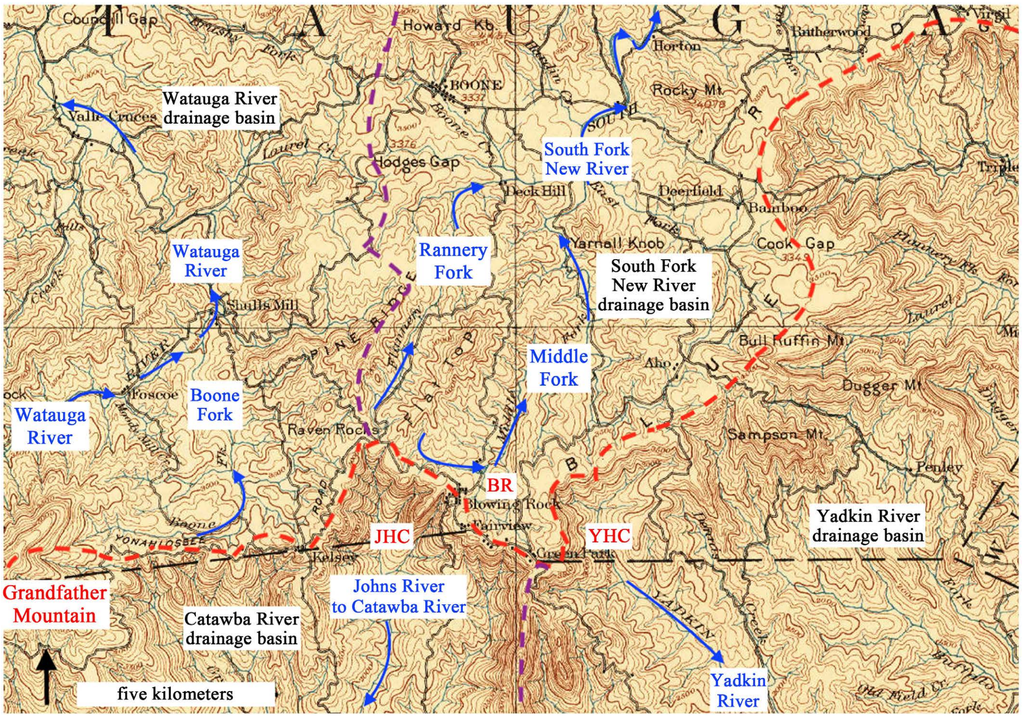

Figure 2. Modified section from the 1893 (USGS) Cranberry, North Carolina topographic map. The map scale is 1:125,000 and the contour interval is 100 feet (about 30 meters). The red dashed line shows the Eastern Continental Divide and purple dashed lines show other major drainage divides. Blue arrows highlight flow directions. BR identifies the town of Blowing Rock. JHC and YHC identify abandoned headcuts discussed in the text.

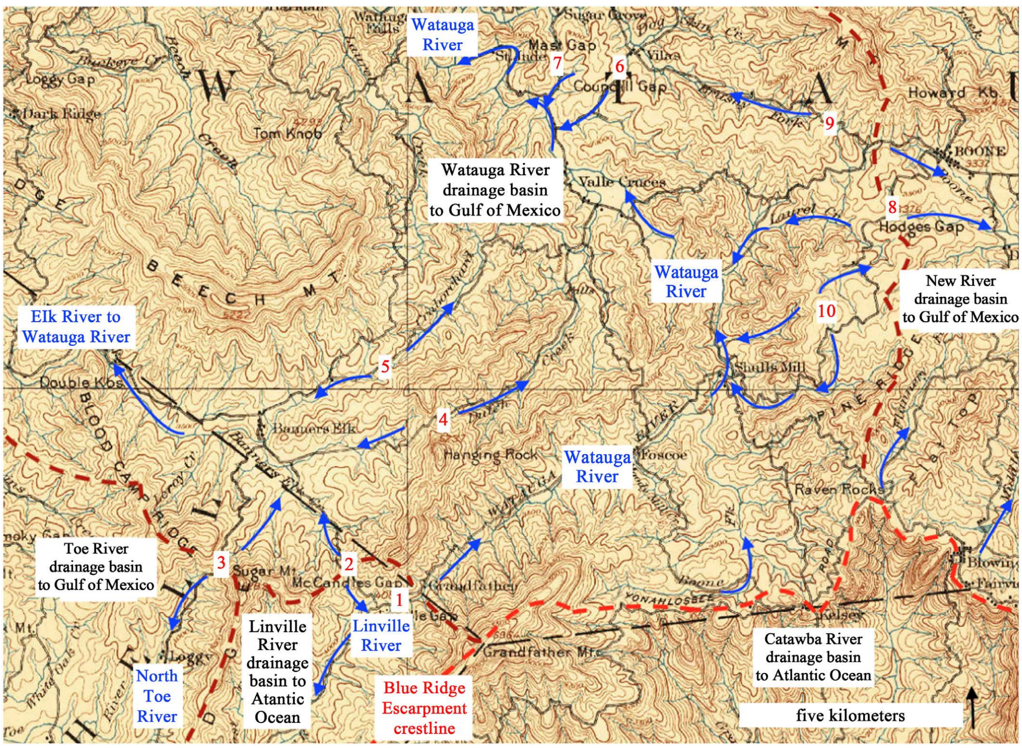

Figure 3. Modified section of USGS 1893 Cranberry map showing drainage divides surrounding the Watauga River drainage basin southern end. Red numbers identify gaps discussed in the text and dashed lines show major drainage divides. The contour interval is 100 feet (about 30 meters).

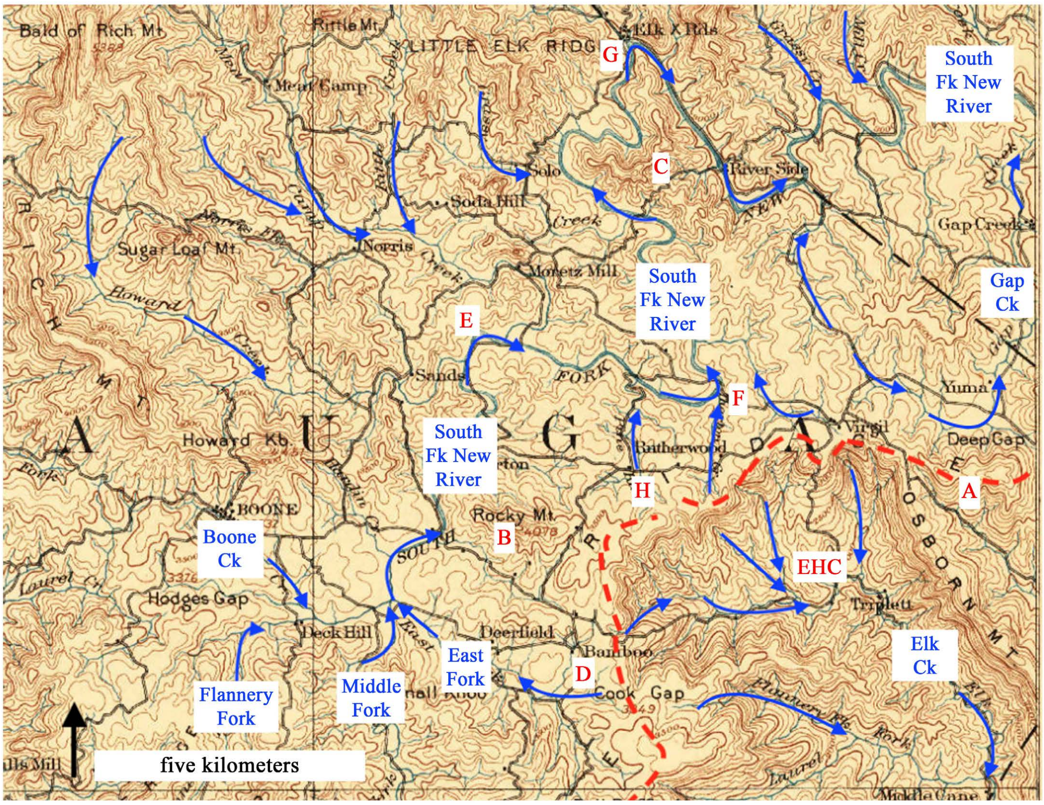

Figure 4. Modified section from the USGS 1893 Cranberry topographic map showing the South Fork New River to the northeast of **Figure 2**. The red dashed line shows the Eastern Continental Divide. The contour interval is 100 feet (about 30 meters).

and also because the Eastern Continental Divide and the New River-Tennessee River drainage divide cross the map area. The Eastern Continental Divide (Atlantic Ocean-Gulf of Mexico drainage divide) is shown in **Figure 2** with a red dashed line and is located along or near the Blue Ridge Escarpment rim. Extending in a north direction from the Eastern Continental Divide is the drainage divide between the northeast-oriented South Fork New River and the northeast- and northwest-oriented Watauga River. Water in the Watauga River flows to the southwest- and north-oriented Tennessee River while water in the South Fork New River flows to the northeast- and northwest-oriented New River. While water on both sides of the South Fork New River-Watauga River (or New River-Tennessee River) drainage divide eventually ends up in the Ohio River (in the Mississippi River drainage basin) the routes taken are different. The third major drainage divide seen in **Figure 2** is between the Yadkin River and the Johns River (which flows to the Catawba River). Yadkin and Catawba River water flows along different, but much more direct routes to reach the Atlantic Ocean. Another feature seen in **Figure 2** is the Blue Ridge Escarpment which is a 500-meter high or higher scarp located immediately to the south and east of the Eastern Continental Divide. The study region was expanded slightly beyond the 1893 Cranberry topographic map area so as to better interpret some Cranberry map landform features which extend onto the adjacent 1905 Morgantown [9] and 1889

Wilkesboro [10] topographic maps.

1.3. Accepted Paradigm Literature

The published geology literature is not known to have addressed or explained most drainage system and erosional landform evidence shown on the 1893 Cranberry, 1905 Morgantown, and 1889 Wilkesboro, North Carolina topographic maps. Davis [11] who developed and promoted the erosion cycle concept proposed (by ignoring most of the detailed topographic map evidence) that the Blue Ridge Escarpment, which extends from Virginia to Georgia, is the boundary between two peneplains which are being drained in different directions. The Blue Ridge Escarpment slope and the Piedmont region (to the southeast) are drained to the nearby Atlantic Ocean while much longer routes to the Gulf of Mexico drain the higher elevation region to the northwest of the Escarpment. White [12] preferred a fault scarp origin hypothesis and objected to the peneplain interpretation and noted that except for along the Escarpment slope itself west-flowing rivers appear to be eroding more actively than east-flowing rivers. Stose and Stose [13] objected to the White fault scarp interpretation and preferred the Davis peneplain interpretation. More recently the Blue Ridge Escarpment has been described as a passive continental margin [14] [15].

In spite of White's observations, accepted paradigm literature usually claims that stream piracies enabled by the much steeper gradient along the Blue Ridge Escarpment slope are actively moving the Eastern Continental Divide westward. For example, Thornbury [16] describes how as the result of stream piracies the southeast-oriented Roanoke River in Virginia drains an area of almost 500 square kilometers to the west of the Blue Ridge Escarpment. More recently Prince *et al.* [17] [18] and Stokes *et al.* [19] used a variety of different methods (but not an interpretation of the topographic map drainage system and erosional landform evidence) to suggest that stream piracies along the Blue Ridge Escarpment (to the north of this paper's study region) are on-going and that the Eastern Continental Divide is actively retreating inland. The prediction is even made that in the Blacksburg, Virginia region stream piracies during the next few million years will capture the northeast-oriented New River headwaters. Within this paper's study region, Thornbury [16] briefly commented that stream piracy diverted the Linville River from a westerly course to an eastern one. More recently Johnson [20] described alluvial deposits and other evidence which supports the previously proposed Linville River capture hypothesis.

1.4. New Paradigm Literature

Clausen's book [3] lists more than 40 demonstration papers in which the new paradigm explains topographic map drainage divide and other erosional landform evidence in modestly-sized geographic regions (similar in size to this paper's study region) in states other than North Carolina. In a recent exception Clausen [21] addresses topographic map drainage divide and erosional landform evidence in the French Broad River drainage basin located upstream from Asheville, North Carolina (which is located to the southwest of this paper's study region). Like the Watauga and South Fork New Rivers seen on the 1893 Cranberry map, the French Broad River flows in a northeast direction along or near the Blue Ridge Escarpment rim before turning in a north and northwest direction. Among the evidence that paper addresses are barbed tributaries joining a much larger valley than the present-day northeast-oriented French Broad River requires, diverging and converging valley complexes, through valleys crossing drainage divides, and deep gaps located along the Eastern Continental Divide, all of which are interpreted to be evidence for massive and prolonged southwest-oriented floods that once flowed across what was probably a rising region. In another relevant new paradigm demonstration paper [22] Clausen demonstrates how the headward erosion of north-oriented valleys across immense and prolonged southwest-oriented floods (which had been flowing toward today's northeast-oriented New River headwaters) explain the origins of previously unexplained Monongahela River drainage basin topographic map evidence such as barbed tributaries, through valleys, water and wind gaps, drainage route direction changes, and drainage divides.

2. Research Method

This study was conducted by using topographic map interpretation techniques (which late 19th century and early 20th century geomorphologists developed) to interpret drainage histories for the 1893 Cranberry [1] 1:125,000 topographic map and small adjacent sections of the adjoining 1905 Morgantown [9], and 1889 Wilkesboro [10] 1:125,000 scale topographic maps. Topographic map interpretation techniques included using: 1) barbed tributaries to indicate stream captures and possible drainage reversals, 2) low points along drainage divides to indicate former water-eroded valley locations, 3) unusual river and stream direction changes to indicate possible stream captures and drainage reversals, 4) through valleys (valleys now crossing drainage divides) to indicate former drainage routes, 5) water gaps to indicate either deep regional erosion or erosion into rising geologic structures or regions, 6) isolated erosional remnants to be markers indicating how much regional bedrock had been removed, and 7) evidence of diverging and converging through valley networks to indicate possible flood-formed anastomosing channel complexes.

The 1893 Cranberry, 1905 Morgantown, and 1889 Wilkesboro topographic maps were prepared by the use of ground-based mapping and not by more recently developed mapping techniques. For that reason, features on those maps were compared with the same features on more recently prepared and more detailed topographic maps which are available at the USGS National Map website. These comparisons determined the older and the more recent topographic maps almost always show the same larger-scale drainage system and erosional landform features, although the finer details are sometimes shown differently. Overall, the comparisons determined the 1893 Cranberry, 1905 Morgantown, and 1889 Wilkesboro topographic maps provided adequate drainage system and erosional landform evidence that late 19th- and early 20th-century geomorphologists should have been able to able to interpret the map evidence by using topographic map interpretation techniques which those same early geomorphologists had developed. Based on their interpretations the early geomorphologists should have been able to use the Cranberry map evidence to construct a regional drainage history (if they ever tried to do so it was never published).

3. Results

3.1. Drainage Divides Surrounding the Watauga River Southern End

The Watauga River drainage basin southern end (as seen on the 1893 Cranberry map) is shown in **Figure 3** where added dashed lines show major drainage divides, numbers identify gaps notched into drainage divides, and blue arrows show some of the river and barbed tributary flow directions (not all gaps or barbed tributaries are highlighted). The Watauga River originates at Linville Gap (number 1 on **Figure 3**) and flows in a northeast direction before turning in a north and then northwest direction with its water eventually reaching the Gulf of Mexico. On the other side of 200-meter-deep or deeper Linville Gap are southwest-oriented Linville River headwaters which to the southwest of figure turn in a southeast direction to eventually reach the Atlantic Ocean. Northeast-oriented Watauga River headwaters and southwest-oriented Linville River headwaters oppose each other in a water-eroded through valley (a valley crossed by a drainage divide which in this case is the Eastern Continental Divide). Early 20th century geomorphologists should have recognized that a significant stream of water must have eroded Linville Gap and that the drainage divide was created when for some reason either Watauga River or Linville River headwaters were reversed so as to create the drainage divide that exists today.

McCandles Gap (number 2 in **Figure 3**) is another through valley with more of a northwest-to-southeast orientation crossing the Eastern Continental Divide which links a northwest-oriented Elk Creek tributary valley with southwest-oriented Linville River headwaters (Elk Creek or Elk River on more recent maps is a Watauga River tributary). Sugar Gap (number 3 in **Figure 3**) is another water eroded through valley with a northeast-to-southwest orientation which links the northwest-oriented Elk Creek valley with southwest-oriented North Toe River headwaters. Unlike Linville and McCandles Gaps, Sugar Gap does not cross the Eastern Continental Divide. Instead, the Eastern Continental Divide turns so as to be between southwest-oriented Linville and North Toe River headwaters. Southwest of **Figure 3** Linville River water turns in a southeast direction to reach the Atlantic Ocean while North Toe River water flows to the Gulf of Mexico. Early geomorphologists and more recently Johnson [20] concluded that southwest-oriented Linville River headwaters once flowed to the North Toe River and the Gulf of Mexico, but were captured by southeast-oriented Linville River valley headward erosion. What previous investigators have not addressed is that water from a Watauga River drainage basin area once flowed to the North Toe River or why the Linville and Watauga Rivers originate almost at Linville Gap (number 1) and then flow in opposite directions.

From the new paradigm perspective Linville and Sugar Gaps suggest that large and prolonged southwest-oriented floods crossed the Watauga River drainage basin to reach what are now southwest-oriented Linville River and North Toe River headwaters. In the case of Linville Gap, a southwest-oriented flood flow channel must have eroded today's northeast-oriented Watauga River headwaters valley which means a reversal of flow has occurred. The reversal of flow can be explained by northwest-oriented Watauga River valley headward erosion across southwest-oriented flood flow channels as the deep "hole" rim was rising. Gaps numbered 4 and 5 are notched into the drainage divide between the northwest-oriented Watauga River and Elk Creek valleys. Note how southwest-oriented streams flowing from those gaps join northwest-oriented Elk Creek as barbed tributaries. Drainage divides at Sugar Gap and possibly at McCandles Gap formed when northwest-oriented Elk River valley headward erosion beheaded and reversed southwest-oriented flow channels. Drainage divides at gaps numbered 4 and 5 and Linville Gap (number 1) were created when subsequent headward erosion of the northwest-oriented Watauga River valley beheaded and reversed some of those same southwest-oriented flow channels.

The Cranberry map shows Council and Mast Gaps (numbers 6 and 7 in Figure 3) link the valleys of southwest-oriented streams flowing as barbed tributaries to the northwest-oriented Watauga River with the valleys of north-oriented streams flowing to northwest- and west-oriented Brushy Fork (which then joins south-, west- and south-oriented Cove Creek before that stream joins the Watauga River as a barbed tributary). More recent topographic maps show drainage patterns between Brushy Fork and the Watauga River in more detail and somewhat differently than in Figure 3. However, the added details and corrections found on newer maps do not alter the 1893 Cranberry map barbed tributary evidence which is also seen further to south along the Watauga River where Laurel Creek begins to the north of number 10 and flows in a northeast direction to near Hodges Gap (number 8) before turning in a west and southwest direction to join a north-oriented Watauga River segment as a barbed tributary. Number 10 identifies an area where the Cranberry map shows two shallow gaps which link northeast-oriented Laurel Creek headwaters with southwest-oriented Watauga River tributaries. Newer maps show interconnected dry valleys crossing that ridge and strengthen Cranberry map evidence that diverging and converging channels once crossed that ridge. Number 9 in Figure 3 identifies a gap in an area better shown on more recent maps, but which may be where the northwest-oriented Brushy Fork valley eroded headward across the region to behead and reverse southwest-oriented flood flow which had been moving to a newly-eroded Watauga River valley.

T. C. Chamberlin published his classic "The Method of Multiple Working Hypotheses" paper [23] in 1897 which then became required reading for many graduate level geology students. In that paper Chamberlin argues that when faced with unexplained evidence and prior to favoring any hypothesis (or explanation) good geological research requires equal consideration be given to every possible hypothesis the researcher can reasonably develop. Early geomorphologists who almost certainly had read Chamberlin's paper should have been able to use the 1893 Cranberry map evidence to recognize that multiple southwest-oriented barbed tributaries join the north- and northwest-oriented Watauga River segments and that gaps are located on ridges near where those barbed tributaries originate. While that map evidence can be interpreted in multiple ways one possible interpretation (and consistent with the previously discussed gap evidence) is that the north- and northwest-oriented Watauga River valley segments eroded headward across multiple and low gradient streams of southwest-oriented water. If so, that hypothesis explains why the Watauga River now has barbed tributaries and why Watauga River headwaters now flow in northeast directions. Early geomorphologists should have also been able to recognize that extremely large volumes of water, while regional uplift was occurring, would probably be required to enable the Watauga River valley to erode headward into the region.

3.2. Erosional Landform Evidence in the Southern South Fork New River Drainage Basin

Figure 2 shows where on the 1893 Cranberry topographic map South Fork New River headwaters begin while **Figure 4** shows an overlapping map section to the northeast of **Figure 2** where the South Fork New River zigs and zags in a northeast direction as it flows near and roughly parallel to the Eastern Continental Divide. Almost all South Fork New River tributaries from the north flow in south or southeast directions and join the South Fork New River as barbed tributaries. Shorter north- or west-oriented tributaries originate at or near (and sometimes even flow for a distance along) the Eastern Continental Divide (which in this region closely follows the Blue Ridge Escarpment rim). Early geomorphologists should have recognized the many barbed tributaries from the north suggest some sort of a south-oriented drainage system preceded the present-day northeast-oriented South Fork New River. And they also should have recognized that there must have been reversals of flow in what are today short west- and north-oriented South Fork New River tributaries which begin along or near the Blue Ridge Escarpment crest. However, early geomorphologists ignored such topographic map erosional landform evidence and assumed the South Fork New River has always flowed in a northeast direction.

From the new paradigm perspective, the Elk Creek drainage basin head (EHC in **Figure 4**) is an abandoned headcut. South-oriented floodwaters flowing across a rising deep "hole" rim to the Elk Creek headcut carved a former 100-to-200-meter-deep valley between the letters A and B (in **Figure 4**). Evidence for south-oriented flow through the former valley consists of the north-oriented South Fork New River route from point F to point G (on which flow has been reversed), the east-southeast oriented South Fork New River route from point E to point F, multiple south- and southeast-oriented tributaries joining the South Fork New River, and erosional remnant elevations at letters A and B and at Thomkins Knob which is to the east of Deep Gap (and on the adjacent 1889 Wilkesboro topographic map). The elevation at point A is about 1121 meters. The elevation at Rocky Knob (point B) is about 1229 meters. Thomkins Knob which is east of Deep Gap has an elevation of about 1243 meters. The Deep Gap floor elevation (seen on the Wilkesboro map) is about 955 meters and Eastern Continental Divide elevations for significant distances between points A and B are often not much higher than 1000 meters while shallow gaps in that region have elevations that are slightly below 1000 meters.

The former valley between Rocky Knob (point B) and point A and the somewhat separate and narrower Deep Gap valley was eroded when south-oriented floodwaters split into two powerful diverging streams at the letter G with the eastern stream carving Deep Gap and the western stream carving the much wider valley between letters A and B as it flowed toward the Elk Creek headcut. Evidence for the eastern stream which carved the narrower Deep Gap valley includes the south-southeast oriented South Fork New River segment downstream from point G, the present-day Gap Creek U-turn (from a southeast orientation to a north orientation), the north-northwest-oriented South Fork New River tributary which begins north of the Gap Creek headwaters, and the Deep Gap valley itself.

Large abandoned headcuts similar to the Elk Creek abandoned headcut are scattered throughout the United States. Chapter 3 in Clausen's book [3] describes such large abandoned headcuts as escarpment-surrounded basins. Each large abandoned headcut discussed in that chapter (and the Elk Creek headcut which is briefly mentioned in chapter 8 on page 84) was abandoned when headward erosion of a valley immediately upstream from the present-day escarpment-surrounded basin diverted large floods to flow in a different direction. Headward erosion of the present-day northeast-oriented South Fork New River valley captured the south-oriented flood flow which had been flowing to the Elk Creek headcut and also beheaded and reversed what had been south-oriented flood flow channels leading to the escarpment-surrounded basin rim. The flood flow reversals initiated what are now north- and west-oriented South Fork New River tributaries which begin at or near the Eastern Continental Divide. Many of what looks like South Fork New River incised meanders formed when today's northeast-oriented South Fork New River valley head eroded headward in a southwest direction along and across diverging and converging south-oriented flood flow channels and across underlying bedrock units of differing erosional resistance by first eroding headward along one channel and then eroding headward in an opposite direction along a beheaded and reversed diverging and/or converging channel. An example is seen in the letter G where the South Fork New River changes from flowing in a north direction (from point F) to flow in a south-southeast direction toward Deep Gap.

From the new paradigm perspective, the abandoned Elk Creek headcut evidence shows where deep "hole" rim uplift enabled the headward erosion of the Elk Creek valley to capture southwest-oriented flood flow which had been moving along the rising deep "hole" rim and how headward erosion of the northeast-oriented South Fork New River valley captured south-oriented flood flow that had been eroding the Elk Creek headcut (and Deep Gap). Elk Creek valley headward erosion into the rising deep "hole" rim occurred because deep "hole" rim uplift was creating a significant elevation difference between southwest-oriented flood flow located to the northwest of the present-day Eastern Continental Divide and flood flow located in what is now the northeast-oriented Yadkin River valley. However, before the Elk Creek valley could erode any distance into the rising deep "hole" rim on-going rim uplift combined with headward erosion of the northwest-oriented New River valley into Virginia (to the northeast of **Figure 4**) enabled a reversal of flood flow along the rising deep "hole" rim which led to headward erosion of today's northeast-oriented South Fork New River valley and to the capture of south-oriented flood flow which had been eroding the Elk Creek headcut and Deep Gap.

Had early geomorphologists trusted the then newly available topographic map drainage system and erosional landform evidence they would have recognized that evidence in **Figure 4** records how headward erosion of the zig zagging northeast-oriented South Fork New River valley ended massive and probably prolonged south-oriented floods that had been eroding the Cranberry topographic map area. The flood source cannot be determined from the Cranberry map evidence which would have been a problem for early geomorphologists although erosional remnants such as those at points A and B in **Figure 4** and from Thomkins Knob shown on the adjacent 1889 Wilkesboro map suggest the floodwaters removed at least 200 meters of bedrock from much of the **Figure 4** region located immediately to the north and west of the Eastern Continental Divide. A melting continental ice sheet would have been the only flood source known to early geomorphologists which would have been capable of generating sufficient volumes of water that could reach and then deeply erode what is today a relatively high northwestern North Carolina mountainous region.

3.3. Yadkin-Catawba River Drainage Divide on the 1905 Morgantown Topographic Map

The 1889 Wilkesboro topographic map shows the Yadkin River flowing in a northeast direction along the Blue Ridge Escarpment base and numerous southeast-oriented streams which flow down the Escarpment slope (sometimes after originating near the Escarpment rim) to join the northeast-oriented river. However, the 1905 Morgantown topographic map northeast corner is needed to see where southeast-oriented Yadkin River headwaters (seen in Figure 2) turn in a northeast direction to enter the 1889 Wilkesboro topographic map area (see Figure 5). In other words, three of the early topographic maps are needed to properly understand Yadkin River headwaters area drainage history.

Blowing Rock (BR in Figure 2) is located on the 1893 Cranberry map and is on an upland point that drains in a north direction to the South Fork New River and the Gulf of Mexico. In all other directions steep slopes drain to the Atlantic Ocean and isolate the Blowing Rock upland point. To the east is the southeast-oriented Yadkin River headcut (YHC) and to the southwest is the south-southwest oriented Johns River headcut (JHC). From the new paradigm perspective the Blowing Rock upland point was created when massive amounts of south-oriented floodwaters flowed across the Blue Ridge Escarpment rim and into the Yadkin River and Johns River headcuts with the south-oriented flood flow diverging so some floodwaters flowed in a southwest direction to erode the Johns River valley into the Blue Ridge Escarpment slope while the remaining floodwaters flowed in a southeast direction to erode the Yadkin River valley into the Blue Ridge Escarpment slope.

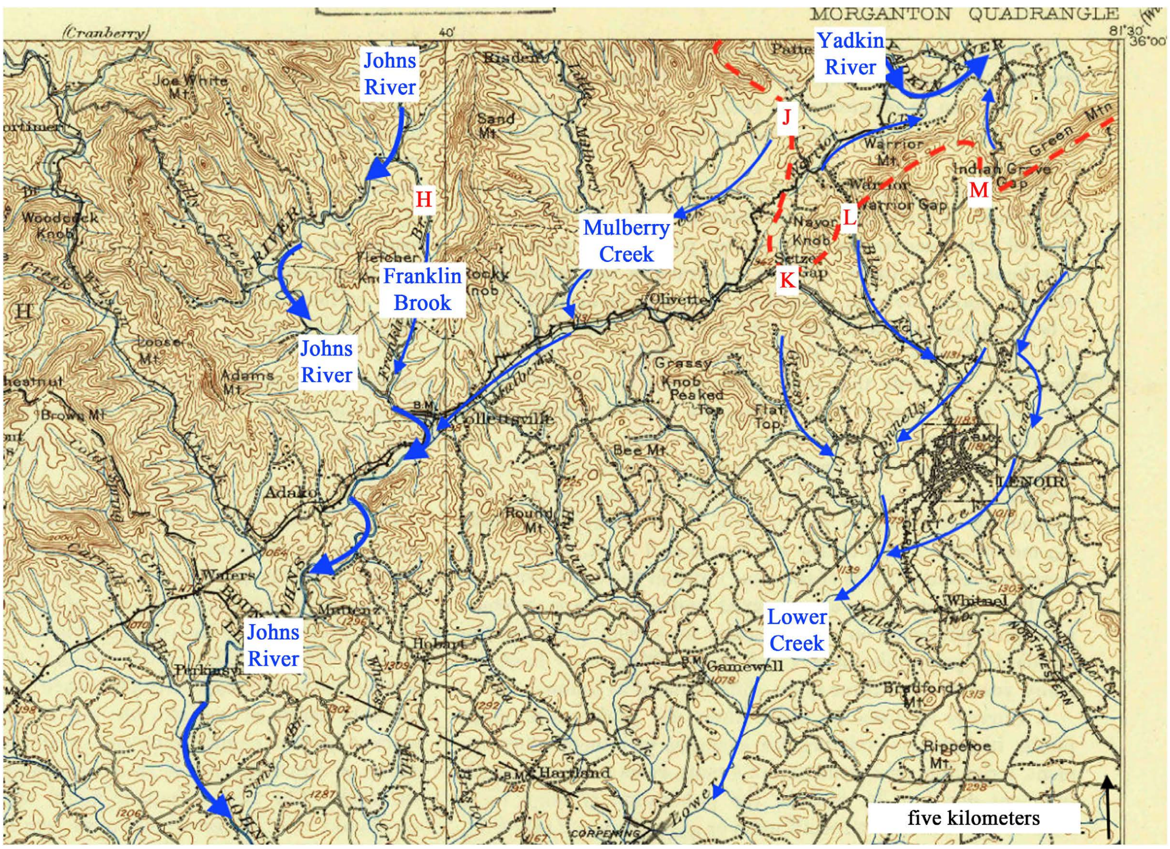

Figure 5. Modified northeast corner of the USGS 1905 Morgantown, NC topographic map. The red dashed line shows the Yadkin River-Catawba River drainage divide, red letters identify gaps discussed in the text and blue arrows emphasize drainage routes discussed in the text. The contour interval is 100 feet (about 30 meters).

The usually accepted paradigm interpretation, which originated with early geomorphologists, suggests valleys (like the Johns River and Yadkin River valleys) are actively eroding headward into the Blue Ridge Escarpment and are causing Eastern Continental Divide inland retreat. Early geomorphologists might have been justified in proposing such a hypothesis had the 1893 Cranberry topographic map shown evidence of south-oriented streams flowing to and across the Johns River and Yadkin River headcut rims. However, as can be seen in Figure 2 north-oriented South Fork New River and Watauga River headwaters begin almost at the Johns River and Yadkin River headcut rims and the map shows no evidence that water now flows across those headcut rims (on newer maps to the east of Deep Gap and of the Cranberry map area there is a short east-oriented stream which drains a small upland area and which flows across the Blue Ridge Escarpment rim to form Cascade Falls). Had early geomorphologists paid attention to what the Cranberry topographic map shows those geomorphologists would have recognized that the Johns River and Yadkin River headcuts, like the Elk Creek headcut seen in Figure 4, are no longer being actively eroded in a headward direction and today represent abandoned headcuts.

However, some geomorphologists have suggested seepage-induced cliff recession as a mechanism for eroding features elsewhere that on topographic maps look similar to the Elk Creek, Yadkin River, and Johns River headcuts [24]. While springs are not shown on the early Cranberry, Wilkesboro, and Morgantown topographic maps it is probably safe to assume that significant seepage does occur along the Blue Ridge Escarpment slope and that springs supply water to most streams that originate along that slope. However, the seepage-induced cliff recession hypothesis does not explain the previously discussed drainage patterns, drainage patterns on the Blue Ridge Escarpment slope itself, or deep erosion of the Yadkin River-Catawba River drainage divide area that Figure 5 evidence documents. In terms of Blue Ridge Escarpment slope drainage patterns the letter H in Figure 5 identifies a through valley drained by south-oriented Franklin Brook which provides a much more direct route down the slope than the southwest and southeast oriented route that the Johns River now uses. Floodwaters spilling across drainage divides explain diverging and converging valleys like the Johns River and Franklin Brook valleys much better than the seepage-induced cliff recession hypothesis.

In terms of the Yadkin River-Catawba River drainage divide area a through valley crosses that drainage divide and is seen in the northeast corner of Figure 5 and is evidence that southwest-oriented floodwaters once flowed along the Blue Ridge Escarpment base. The letter J identifies a through valley that links a northeast-oriented Yadkin River tributary (Warrior Creek) with southwest-oriented Mulberry Creek headwaters. Note how Mulberry Creek flows in a southwest direction along the Blue Ridge Escarpment base until it joins the southeast-oriented Johns River which turns to flow in a southwest direction along the Blue Ridge Escarpment base before turning to flow in a south-southeast direction to join the

Catawba River which flows in an east direction across the Morgantown map (but south of **Figure 5**). The Yadkin River-Catawba River drainage divide (which crosses the Warrior Creek-Mulberry Creek through valley) was formed by a reversal of what had been southwest-oriented flood flow moving along what is today the Blue Ridge Escarpment base (from the new paradigm perspective the Blue Ridge Escarpment developed as massive and prolonged southwest- and south-oriented floods flowed across the region).

Gaps located at letters K, L, and M provide evidence that southwest-oriented floodwaters were not confined to the Warrior Creek-Mulberry Creek through valley but spilled across what the Morgantown map shows as a significant ridge to reach southwest-oriented Lower Creek (which flows in a remarkably wide valley which suggests much larger flows than occur today). The deepest through valley areas that cross the Warrior Creek-Mulberry Creek (Yadkin-Catawba River) drainage divide at the letter J were eroded by southwest-oriented floodwaters flowing from the present-day northeast-oriented Yadkin River valley (seen on the 1889 Wilkesboro map) and have floor elevations of about 405 meters. Southwest-oriented floodwaters that eroded the three gaps at the letters K, L, and M would have also flowed from what is today the northeast-oriented Yadkin River valley to southwest-oriented Lower Creek which on the 1905 Morgantown map (to the south of **Figure 5**) drains to the east-oriented Catawba River as a barbed tributary. Using data from newer maps floor elevations at Setzer Gap (letter K) are about 435 meters, Warrior Gap (letter L) about 425 meters, and Indian Grave Gap (letter M) about 480 meters. Each gap today is a narrow valley eroded across a ridge that depending on where measurements are made rises 100 meters or more above the gap floors. The ridge into which the gaps are eroded and the gaps are evidence shown on the 1905 Morgantown map (but with less detail than on newer maps) that floodwaters probably initially flowed on a surface that may have been 200 meters or more higher than the lowest points along the Warrior Creek-Mulberry Creek drainage divide before southwest-oriented floodwaters deeply eroded the region.

4. Discussion

With the exception of elevations which were obtained by use of the spot elevation tool on newer maps at the USGS National Map website the 1893 Cranberry, 1889 Wilkesboro, and 1905 Morgantown topographic maps provided all of the evidence used in the study reported here (and less precise elevation data could have been obtained from the 120-to-130-year-old topographic maps). Early 20^{th} century geomorphologists did recognize from map evidence that southwest-oriented Linville River headwaters (seen in **Figure 3** which is from the 1893 Cranberry map) had been captured by south-oriented Linville River valley headward erosion (seen on the 1905 Morgantown map northwest quadrant to the west of **Figure 5**). Yet, early geomorphologists including W. M. Davis ignored almost all of the other carefully mapped and newly available topographic map drainage system and erosional landform features such as the gaps, barbed tributaries, through valleys crossing drainage divides, isolated erosional remnants, diverging and converging valleys, and unusual river and stream direction changes that those three topographic maps show.

Developing hypotheses to explain the gaps, barbed tributaries, through valleys crossing drainage divides, erosional remnants, unusual river and stream direction changes, isolated erosional remnants, diverging and converging valleys and similar features, such as those shown on the 1893 Cranberry topographic map, is not a trivial task even for skilled topographic map interpreters (which some early 20th-century geomorphologists were). A skilled topographic map interpreter trying to decipher the 1893 Cranberry topographic map drainage system and erosional landform evidence will rapidly discover that most of the carefully mapped evidence cannot be explained in the context of typically observed modern-day drainage systems. For early 20th-century geomorphologists like W. M. Davis this discovery probably posed a serious problem because the principle of uniformitarianism (that the present is the key to the past) was and still is one of geology's fundamental rules [25]. Rather than abandon the principle of uniformitarianism (as they understood it) early geomorphologists consciously or unconsciously chose to ignore the difficult to explain topographic map drainage system and erosional landform evidence.

What the early geomorphology research community did was to let their understanding of the principle of uniformitarianism become what T. C. Chamberlin [23] called a ruling theory, which meant early geomorphologists did not attempt to use Chamberlin's method of multiple working hypotheses as a way to explore what the difficult to explain topographic map drainage system and erosional landform evidence might possibly be saying. Further, most of the drainage system and erosional landform evidence seen on the then new topographic maps (like the 1893 Cranberry topographic map) could not be interpreted in ways that supported the then (and the present-day) geology and glacial history paradigm. As described in this paper's results section an interpretation that explains much of the Cranberry map drainage system and erosional landform evidence requires massive south- and/or southwest-oriented floods to have flowed across a tectonically rising region. In the early 20th-century such floods had not been described elsewhere.

It was not until the 1920s that J Harlan Bretz suggested that a gigantic flood (which might have been of the magnitude required to explain at least some of the Cranberry topographic map drainage system and erosional landform evidence) had eroded the eastern Washington Channeled Scablands region [26]. Unfortunately, the geomorphology research community rejected the Bretz hypothesis outright and did not follow Chamberlin's method of multiple working hypotheses advice by viewing the Bretz's hypothesis as a possible explanation for what at that time were vast and growing amounts of difficult to explain and ignored topographic map drainage system and erosional landform evidence. Initially the Bretz hypothesis lacked a flood source, although the rapid draining of Glacial Lake Missoula by one or more ice dam failures was subsequently determined to explain significant amounts of Bretz's eastern Washington Channeled Scablands evidence.

Unlike the Channeled Scablands evidence for which the accepted paradigm provides a possible flood source there is no accepted paradigm recognized flood source able to explain the Cranberry, North Carolina topographic map evidence. From the accepted paradigm perspective preglacial river valleys (further to the north) would have captured any meltwater floods (including huge floods resulting from the rapid drainage of accepted paradigm recognized glacially dammed lakes) before the floodwaters would have reached the higher elevation western North Carolina region (which the accepted paradigm usually considers to have been high when North American continental ice sheets existed). Yet by making comparisons with newer maps there is every reason to believe the 1893 Cranberry topographic map drainage system and erosional landform evidence was carefully mapped and that those landform features actually exist almost as the 1893 Cranberry topographic map shows them. Early geomorphologists should have been curious to explore how those well-mapped drainage systems and erosional landform features originated.

The recognition that continental ice sheet meltwater once flowed across what the accepted paradigm considers pre-glacial north-oriented southwestern North Dakota and eastern Montana river valleys led to the new paradigm which after significant subsequent research involving Great Plains and Rocky Mountain topographic map evidence was used here to interpret the North Carolina 1893 Cranberry topographic map drainage system and erosional landform evidence. To explain the North Dakota and Montana evidence it was necessary to rethink what the accepted paradigm considers to be "pre-glacial" north-oriented drainage systems (some begin in the high Rocky Mountains) in a way that could explain what were vast amounts of previously unexplained topographic map drainage system and erosional landform evidence. The results obtained here suggest that such rethinking of long-standing accepted paradigm interpretations is also badly needed if eastern United States geomorphic history is to be understood. The new paradigm is fundamentally different from the accepted paradigm and challenges many accepted paradigm interpretations and assumptions. But, as illustrated here the new paradigm prediction that immense and prolonged meltwater floods once flowed across a rising deep "hole" rim in the Cranberry map region led to the first known explanations for much of that 1893 map's previously ignored and unexplained drainage system and erosional landform evidence.

5. Conclusions

The 1893 Cranberry North Carolina topographic map and the adjacent 1889 Wilkesboro and 1905 Morgantown topographic maps provided late 19th century and early 20th century geomorphologists with carefully mapped topographic map drainage system and erosional landform evidence. Evidence shown on those maps includes numerous named and unnamed gaps, barbed tributaries, through valleys extending across drainage divides, isolated erosional remnants, diverging and converging valleys, unusual river and stream direction changes, and other types of erosional landform features. In addition, the maps provided the early geomorphologists with adequate information to identify major drainage divides and many secondary drainage divides. To date, in spite of being available to the geomorphology research community for more than a century the accepted geology and glacial history paradigm has not permitted geomorphologists to publish satisfactory explanations for most of that well-mapped drainage system and erosional landform evidence.

A new and fundamentally different geology and glacial history paradigm (developed by using Great Plains and Rocky Mountain topographic map evidence) provides a consistent set of explanations for most if not all of 1893 Cranberry map drainage divides, named and unnamed gaps, barbed tributaries, through valleys extending across drainage divides, isolated erosional remnants, diverging and converging valleys, unusual river and stream direction changes, and other types of erosional landform features. The new paradigm sees the Cranberry map area as being located on the southeastern rim of a continental ice sheet created and occupied deep "hole". From the new paradigm perspective Cranberry map area drainage system and erosional landform features developed during immense and prolonged south- and southwest-oriented meltwater floods which flowed across and along a gradually rising deep "hole" rim. Deep "hole" rim uplift combined with massive and long-lived meltwater floods and the headward erosion of southeast-oriented valleys from the Atlantic Ocean and northwest-oriented valleys from the developing deep "hole" (in southwest to northeast sequences) account for the erosional events and drainage system reversals which the 1893 Cranberry topographic map evidence records.

The new paradigm's success in developing explanations for previously unexplained (at least in the known published geologic literature) 1893 Cranberry, North Carolina topographic map drainage system and erosional landform evidence suggests that early geomorphologists by ignoring what in the late 19th century and early 20th century was readily available topographic map drainage system and erosional landform evidence allowed the larger geology research community to develop what is now an accepted geology and glacial history paradigm which does not explain most of the ignored and well-mapped topographic drainage system and erosional landform evidence. Unlike the new paradigm, which is based on topographic map evidence, the now accepted paradigm does not recognize a continental ice sheet created and occupied deep "hole" nor does the accepted paradigm recognize the immense and prolonged meltwater floods needed to explain the Cranberry map area drainage system and erosional landform evidence. The results of this study strongly suggest that geomorphologists and the larger geology research community need to reinterpret North America's glacial history in a way that can explain what for 120 years has been ignored topographic map drainage system and erosional landform evidence.

Acknowledgements

This paper would not have been possible without the USGS 1893 Cranberry topographic map. Field survey work to produce the map was done in the mid 1880s and in 1892 with Henry Gannet as chief topographer and Gilbert Thompson as chief geographer and with triangulation by W.C. Kerr and S.S. Gannett and topography by Chas. M. Yeats, J.W. Hays, and Hersey Munroe. Preliminary work leading to the new paradigm was done while employed as a geology faculty member at Minot State University where other faculty members, students, and library staff assisted with access to what at that time were needed hard copy topographic maps (the maps can now be accessed at the United States Geological Survey National Map and topoView websites).

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] United States Geological Survey (1893) Cranberry, North Carolina-Tennessee Topographic Map, Scale 1:125,000.

[2] Hayes, C.W. and Campbell, M.R. (1894) Geomorphology of the Southern Appalachians. *Geographical Magazine*, **6**, 63-126.

[3] Clausen, E, (2023) The Topographic Map Mystery: Geology's Unrecognized Paradigm Problem. Xlibris US, Bloomington.

[4] Davis, W.M. (1889) A River-Pirate. *Science*, **13**, 108-109. https://doi.org/10.1126/science.ns-13.314.108

[5] Ward, R.D. (1892) Another River-Pirate. *Science*, **19**, 7-9. https://doi.org/10.1126/science.ns-19.465.7

[6] Clausen, E. (2023) William Morris Davis: Father of Geomorphology or Father of Geology's Unrecognized Paradigm Problem. *Open Journal of Geology*, **13**, 579-597. https://doi.org/10.4236/ojg.2023.136025

[7] Davis, W.M. (1889) The Rivers and Valleys of Pennsylvania. *National Geographic Magazine*, **1**, 183-253.

[8] Kuhn, T. (1970) The Structure of Scientific Revolutions. 2nd Edition, University of Chicago, Chicago, 210 p.

[9] United States Geological Survey (1905) Morgantown, North Carolina-Tennessee Topographic Map, Scale 1:125,000.

[10] United States Geological Survey (1889) Wilkesboro, North Carolina-Tennessee Topographic Map, Scale 1:125,000.

[11] Davis, W.M. (1903) The Stream Contest along the Blue Ridge. *Bulletin of the Geographical Society of Philadelphia*, **3**, 213-244.

[12] White, W.A. (1950) Blue Ridge Front—A Fault Scarp. *Bulletin of the Geological Society of America*, **61**, 1309-1346.

https://doi.org/10.1130/0016-7606(1950)61[1309:BRFFS]2.0.CO;2

[13] Stose, G.W. and Stose, A.J. (1951) Blue Ridge Front—A Fault Scarp. *Geological Society of America Bulletin*, **62**, 1371-1374. https://doi.org/10.1130/0016-7606(1951)62[1371:brffs]2.0.co;2

[14] Bank, G. (2001) Testing the Origin of the Blue Ridge Escarpment. Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg.

[15] Spotila, J.A., Bank, G.C., Reiners, P.W., Naeser, C.W. and Henika, W.S. (2004) Origin of the Blue Ridge Escarpment along the Passive Margin of Eastern North America. *Basin Research*, **16**, 41-63. https://doi.org/10.1111/j.1365-2117.2003.00219.x

[16] Thornbury, W.D. (1965) Regional Geomorphology of the United States. John Wiley and Sons, Inc., New York.

[17] Prince, P.S., Spotila, J.A. and Henika, W.S. (2010) New Physical Evidence of the Role of Stream Capture in Active Retreat of the Blue Ridge Escarpment, Southern Appalachians. *Geomorphology*, **123**, 305-319. https://doi.org/10.1016/j.geomorph.2010.07.023

[18] Prince, P.S., Spotila, J.A. and Henika, W.S. (2011) Stream Capture as Driver of Transient Landscape Evolution in a Tectonically Quiescent Setting. *Geology*, **39**, 823-826. https://doi.org/10.1130/g32008.1

[19] Stokes, M.F., Larsen, I.J., Goldberg, S.I., McCoy, S.W., Prince, P.S. and Perron, J.T. (2023) The Erosional Signature of Drainage Divide Motion along the Blue Ridge Escarpment. *Journal of Geophysical Research*: *Earth Surface*, **128**, e2022JF006757. https://doi.org/10.1029/2022jf006757

[20] Johnson, B. (2020) Stream Capture and the Geomorphic Evolution of the Linville Gorge in the Southern Appalachians, USA. *Geomorphology*, **368**, Article ID: 107360. https://doi.org/10.1016/j.geomorph.2020.107360

[21] Clausen, E. (2023) Use of French Broad River Drainage Basin Topographic Map Evidence Upstream from Asheville, North Carolina to Test a New Geology and Glacial History Paradigm. *Journal of Geography and Geology*, **15**, 1-15. https://doi.org/10.5539/jgg.v15n2p1

[22] Clausen, E. (2022) How a New Cenozoic Geology and Glacial History Paradigm Explains Anomalous Monongahela River Drainage Basin Topographic Map Evidence, PA, WV, MD, USA. *Earth Science Research*, **11**, 47-63. https://doi.org/10.5539/esr.v11n1p47

[23] Chamberlin, T.C. (1897) The Method of Multiple Working Hypotheses. *Journal of Geology*, **5**, 837-848. https://doi.org/10.1086/607980

[24] Higgins, C.G. (1990) Seepage-Induced Cliff Recession and Regional Denudation. In: Higgins, C.G. and Coates, D.B., Eds., *Groundwater Geomorphology*: *The Role of Subsurface Water in Earth-Surface Processes and Landforms*, Geological Society of America Special Paper, Vol. 252, 291-318. http://dx.doi.org/10.1130/spe252-p291

[25] Thornbury, W.D. (1969) Principles of Geomorphology. 2nd Edition, John Wiley and Sons, Inc., New York.

[26] Baker, V.R. (1981) Catastrophic Flooding: The Origin of the Channeled Scabland. Dowden, Hutchinson & Ross, Inc. Benchmark Papers in Geology, Stroudsburg, PA.