

# How a New Glacial History Paradigm Explains Northeast Alabama's Tennessee River-Gulf of Mexico Drainage Divide Area Topographic Map Drainage System Evidence

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## Abstract

A new and fundamentally different glacial history paradigm (developed by using Missouri River drainage basin topographic map evidence) is tested by using topographic map drainage system and erosional landform evidence located along and near the northeast Alabama Tennessee River-Gulf of Mexico drainage divide (Tennessee Valley Divide). The new paradigm describes a thick North American continental ice sheet (located where continental ice sheets are usually reported to have been) which was erosive and heavy enough to create and occupy a deep "hole" and which produced massive meltwater floods which first flowed across the deep "hole's" rising southern rim and which were subsequently forced by deep "hole" rim uplift to flow inside the deep "hole" rim and finally to flow northward into the deep "hole" itself. Northeast Alabama topographic map evidence including divide crossings (low points along drainage divides), barbed tributaries, and other unusual drainage features verify new paradigm predictions that large and prolonged south-oriented floods first flowed across the northeast Alabama Tennessee Valley Divide (which was a segment of the new paradigm's deep "hole" southern rim) and were subsequently diverted along the rising deep "hole" rim and finally reversed to reach the Mississippi River valley (which became the deep "hole's" only remaining southern exit) and to form what is today the southwest-, northwest-, and north-oriented Tennessee River.

**Keywords:** Coosa River, Locust Fork Black Warrior River, Lookout Mountain, Mulberry Fork Black Warrior River, Tennessee Valley Divide

## 1. Introduction

### 1.1 Statement of Research Problem

A new Cenozoic glacial history paradigm (new paradigm) described in Clausen (2020a) has shown a remarkable ability to explain previously difficult to explain Missouri River drainage basin topographic map drainage system evidence. The new paradigm requires an initial thick North American continental icesheet (located where most researchers consider such icesheets to have been), which deeply eroded the underlying bedrock (the accepted paradigm does not recognize comparable continental icesheet erosion) and which (by its weight) raised surrounding regions so as to create and occupy a deep "hole" (the accepted paradigm does not recognize comparable continental icesheet caused uplift nor does the accepted paradigm see evidence for a continental icesheet created and occupied deep "hole"). The southwest rim of the new paradigm's deep "hole" was located along today's Montana, Wyoming, and northern Colorado east-west continental divide and continued eastward roughly along the present-day Arkansas River drainage basin location (see figure 1). The southeast deep "hole" rim would have been located along today's Ohio River-Atlantic Ocean drainage divide and continued westward along the Tennessee River-Gulf of Mexico drainage divide (or the Tennessee Valley Divide). Massive south-oriented meltwater floods first flowed across the rising deep "hole" rim but were systematically blocked by deep "hole" rim uplift which enabled valleys to erode headward across and along the large meltwater floods so as to divert the floodwaters toward the Mississippi River valley, which eventually became the deep "hole's" only southern outlet. Finally, as thick icesheet melting progressed, north-oriented valleys eroded headward from newly opened up deep "hole" space and systematically captured the massive icesheet-marginal floods.

The new paradigm's ability to explain detailed topographic map drainage system and erosional landform

evidence has been successfully tested in many different Missouri River drainage basin geographic locations. For example, Clausen (2020b) demonstrates that topographic map evidence documents how massive south-oriented floods crossed Wyoming's Great Divide Basin by flowing from today's north-oriented Wind-Bighorn River drainage basin into the Colorado River drainage basin. Clausen (2021) follows the floods southward across today's Yampa River-Colorado River drainage divide while Clausen (2019a) uses topographic map evidence to describe how Sweetwater River valley development diverted the south-oriented floodwaters in an east direction along the deep "hole" rim. Finally, topographic map evidence documenting how deep "hole" rim uplift caused massive flood flow reversals to create today's north-oriented Wind-Bighorn River is discussed in the above cited papers and also in Clausen (2019b). While the new paradigm's ability to explain topographic map drainage system and erosional landform evidence has been successfully tested in some regions beyond the Missouri River drainage basin boundaries the new paradigm's ability to explain topographic map evidence in southeastern United States geographic regions has yet to be demonstrated. The purpose of this paper is to test the new paradigm prediction that northeast Alabama topographic map drainage system and erosional landform evidence records how massive south-oriented meltwater floods first flowed across the deep "hole" southern rim (now the Tennessee Valley Divide) and then were subsequently forced by deep "hole" rim uplift to flow along the deep "hole" rim and then in a north direction as the present-day Tennessee River drainage route evolved.

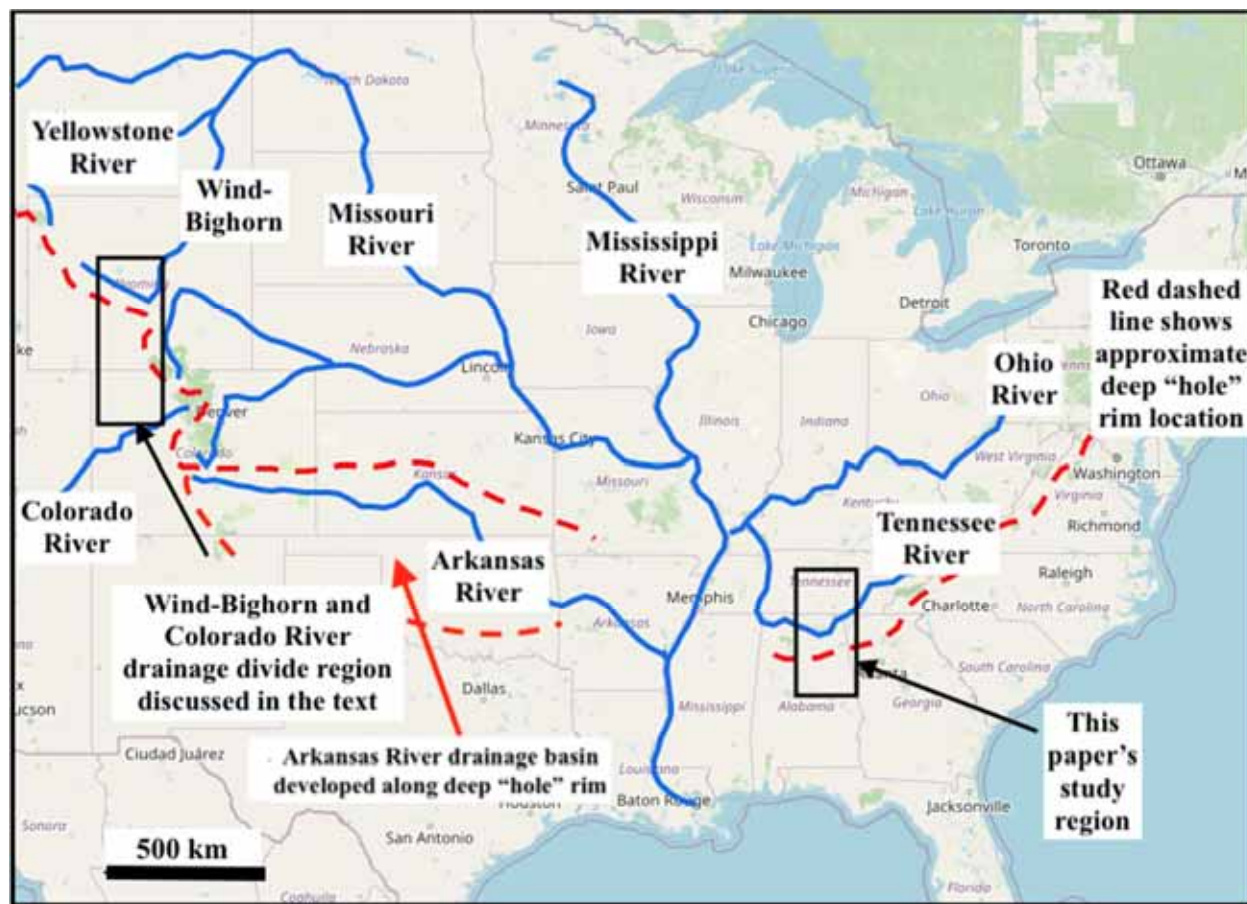


Figure 1. Modified map from United States Geological Survey (USGS) National Map website showing approximate deep "hole" rim location (red dashed lines) and this paper's study region in relation to the Wind-Bighorn-Colorado River drainage divide area discussed in the text.

### 1.2 The Tennessee River Direction Change Problem

The Tennessee River in the southeastern United States like the Wind-Bighorn River in Wyoming (see figures 1 and 2) has been particularly difficult to explain. Adams (1928, p. 481) almost a century ago commented "The course of the Tennessee River is anomalous and has given rise to various conjectures concerning its possible previous courses and as to how its present position was established." More recently Mills and Kaye (2001, p. 75)

stated “The strange course of the Tennessee River has mystified observers for more than a century. There are three seemingly unlikely course changes: 1) west of Chattanooga, Tennessee, where the river leaves the Valley and Ridge province and cuts through Walden Ridge; 2) near Guntersville, Alabama, where it leaves the southwestward trending Sequatchie anticlinal valley and assumes a northwesterly course; 3) near the juncture of the Alabama, Mississippi, and Tennessee borders, where it turns north to cross Tennessee and join the Ohio River.” Odom and Granger (2022, p. 325) comment “In discussions ranging over a century, these turns have been attributed to ancient antecedent drainage patterns (e.g., Milici, 1968) or recent capture (e.g., Hayes and Campbell, 1894).” Numerous other hypotheses summarized by Persons (2010, p. 7-28) suggest the Tennessee River and its southwest-oriented Sequatchie River tributary once flowed directly to the Gulf of Mexico, although objections to all proposed routes have been raised. And, if the Tennessee and Sequatchie Rivers did flow to the Gulf of Mexico, it is difficult to understand how and why they changed from flowing in almost straight-line routes to the present-day round-about route.

Investigators have sought to use Tennessee River terrace age dates, Gulf of Mexico sediment types and locations, alluvium distributions and/or faunal distributions on both sides of the Tennessee Valley Divide, and other methods to determine Tennessee River history although no consensus has been achieved. For example, in a recent paper Blum et al (2017) used detrital zircon evidence to suggest a Tennessee River route change occurred in Eocene time. Yet a few years earlier Near and Keck (2005) had used DNA taken from darter species to determine a direct Tennessee River-Gulf of Mexico link lasted until about 9.0 Ma. Most recently Odom and Granger (2022, p. 325) dated terraces along the southern end of the north-oriented Tennessee River segment and suggested “the river’s present path dates back to at least the early Pliocene.” While some of these researchers undoubtedly looked at topographic maps, none of their published research reports mention studying the northeast Alabama detailed topographic map drainage system and erosional landform evidence nor do any of the cited studies mention the possibility that immense floods once flowed across the Tennessee Valley Divide.

## 2. Research Method

Research described here used detailed topographic maps and tools available at the United States Geological Survey (USGS) National Map website which served as this paper’s major reference work. Unlike other research methods which frequently require the collection and interpretation of raw data, the topographic map interpretation research techniques used here have the advantage of using previously mapped and ready to be interpreted high quality drainage system and erosional landform evidence. Subject to the 1:24,000 map scale the USGS topographic maps provide accurate and continuous drainage system and erosional landform evidence extending across the entire United States. Important for this study the detailed topographic maps provide information needed to reconstruct how present-day drainage systems developed by permitting the identification of drainage divides and low points along those drainage divides (referred to as divide crossings). Divide crossings when linked to valleys on both sides of the divide usually represent places where streams of water once flowed across the drainage divide. Topographic map evidence also shows downstream drainage systems on either side of the drainage divide which can be studied to determine why a stream of water no longer flows across the drainage divide (such as a reversal of flow in one of the opposing drainage systems which can be determined from stream capture evidence shown on the maps). Further, the presence of closely spaced divide crossings may indicate that large floods which flowed in anastomosing or diverging and converging channel complexes probably once moved across the region.

For purposes of this study the Tennessee Valley Divide was subdivided into segments separating the Tennessee River drainage from south-oriented Coosa River drainage (Coosa Divide segment), from Locust Fork Black Warrior River drainage (Locust Fork Divide segment) and from Mulberry Fork Black Warrior River drainage (Mulberry Fork Divide segment). Research began by looking for the most obvious divide crossings along each of the identified Tennessee Valley Divide segments and using the spot elevation tool to determine divide crossing floor elevations and approximate depths. Observed divide crossings link north-oriented Tennessee River tributaries with south-oriented streams and were assumed to be places where water once flowed across the Tennessee Valley Divide (although this did not preclude the possibility that water had once flowed across the Tennessee Valley Divide at other or even at all other locations). Closely spaced divide crossings were interpreted to be possible diverging and converging channel evidence. Opposing north- and south-oriented drainage routes were studied to identify barbed tributaries and other drainage reversal evidence (if water had once flowed across the drainage divide, one of the opposing streams must have been reversed to create the drainage divide) and to better understand what appeared to be diverging and converging channel evidence. In addition, areas to the north and south of each Tennessee Valley Divide segment were investigated for drainage system features and other erosional landform evidence supportive of and/or not consistent with new paradigm predictions that massive

south-oriented floods flowing in large complexes of diverging and converging channels had first flowed across the Tennessee Valley Divide and had been subsequently reversed to create north-oriented drainage routes.

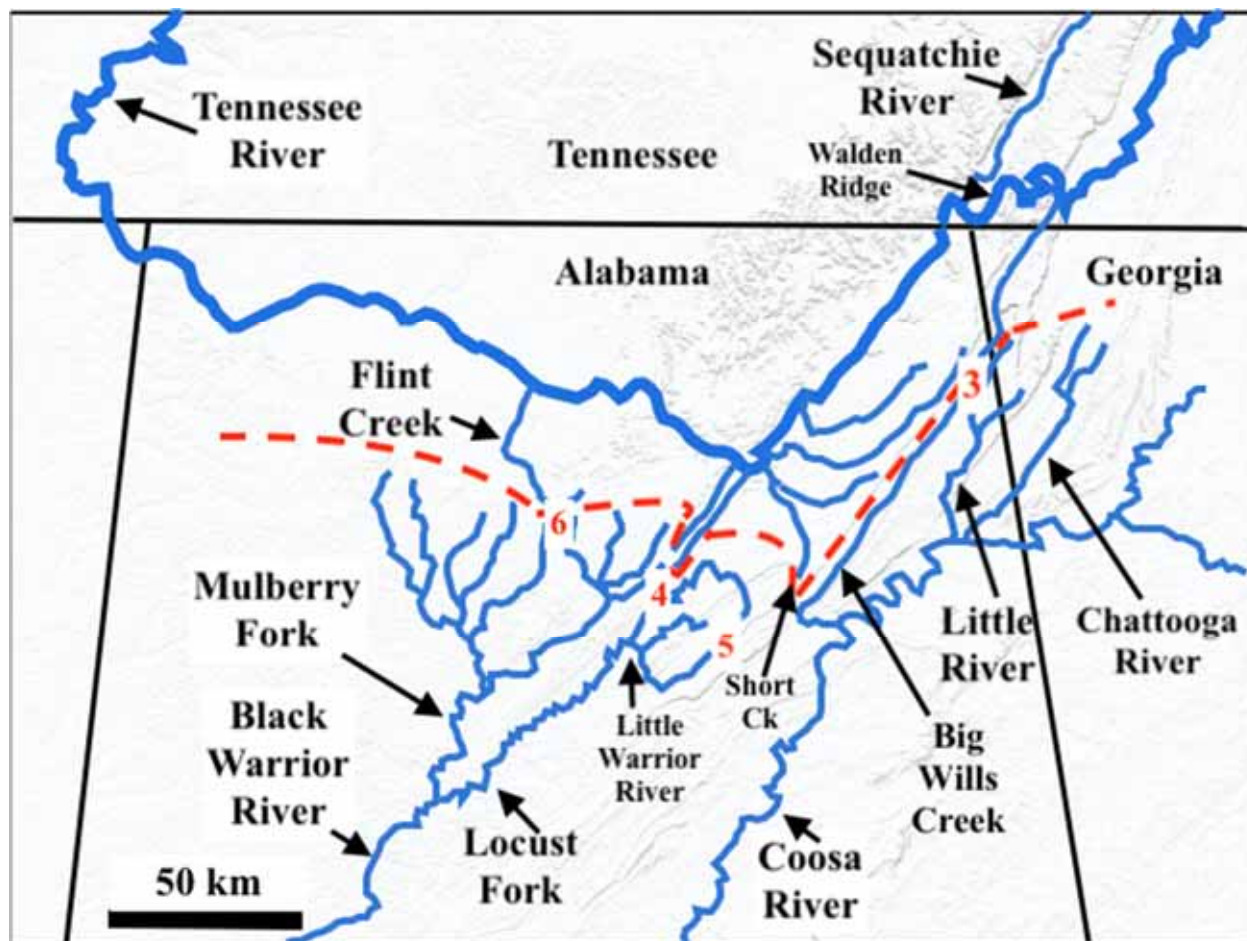


Figure 2. Modified map from the USGS National Map site identifying some rivers and creeks discussed in the text and showing the study region's Tennessee River-Gulf of Mexico drainage divide (Tennessee Valley Divide) approximate location with a red dashed line. Red numbers identify by figure number the locations of this paper's detailed topographic map figures.

### 3. Results

#### 3.1 Tennessee River-Coosa River Drainage Divide Segment (Coosa Divide)

The Coosa Divide crosses the Georgia-Alabama border at an elevation of 580 meters and proceeds in a south-southwest direction almost to the town of Mentone (as seen in figure 3) along a high Lookout Mountain ridge located between north-northeast oriented East Fork Lookout Creek in Railroad Valley and a shallower south-oriented West Fork Little River valley (on the Lookout Mountain top). North of the town of Mentone the Coosa Divide turns in a west direction to cross Railroad Valley, Little Ridge, Big Wills Creek Valley (Big Wills Creek flows south and West Fork Lookout Creek flows north), Big Ridge, Dugout Valley (not named in the figure), another Little Ridge, and Sand Valley before climbing the Sand Valley west wall and turning in a south-southeast direction along the Sand Valley western rim. Lookout Creek follows these linear valleys northward to join the southwest-oriented Tennessee River as a barbed tributary and Big Wills Creek follows these linear valleys southward to join the Coosa River as a normal tributary. The linear ridges and valleys are related to an eroded anticline (Szabo *et al*, 1988) although more important in this paper are the well-defined and obvious divide crossings found where the Coosa Divide crosses each of the four closely spaced linear valleys.

Each of the four linear valleys (crossing the Coosa Divide) had to be eroded by significant and prolonged streams of water flowing from the southwest-oriented Tennessee River valley to the Coosa River although



similar divide crossings linking the Tennessee River drainage system with the Chattooga River in the Coosa River drainage basin with lower floor elevations are located in Georgia to the east of Lookout Mountain. For this reason, the Georgia valleys have been suggested as the former Tennessee River route (e. g. Hayes and Campbell, 1894). Elevations where the Coosa Divide crosses the Big Wills Creek Valley are about 309 meters (compared to about 275 meters at the lowest Georgia divide crossings) while the Railroad Valley divide crossing elevation is about 323 meters, the Dugout Valley divide crossing elevation is about 334 meters, and the Sand Valley divide crossing elevation is about 336 meters. Due to a variety of problems several early researchers rejected the Hayes and Campbell suggested former Tennessee River route and proposed alternate Tennessee River drainage history hypotheses (e. g. White, 1904 and Johnson 1905). One interesting question raised by the Hayes and Campbell proposed route to the Coosa River was and still is, if the Tennessee River once flowed further to the east (in Georgia) to reach the Coosa River, what major river eroded the four linear valleys seen in figure 3? And, even if a local drainage system eroded the deeper Big Wills Creek valley, what drainage system eroded the other three linear valleys? Multiple well-defined linear valleys on both sides of Lookout Mountain link the Tennessee and Coosa Rivers and are best explained by a flood formed south-southwest oriented diverging and converging channel complex.

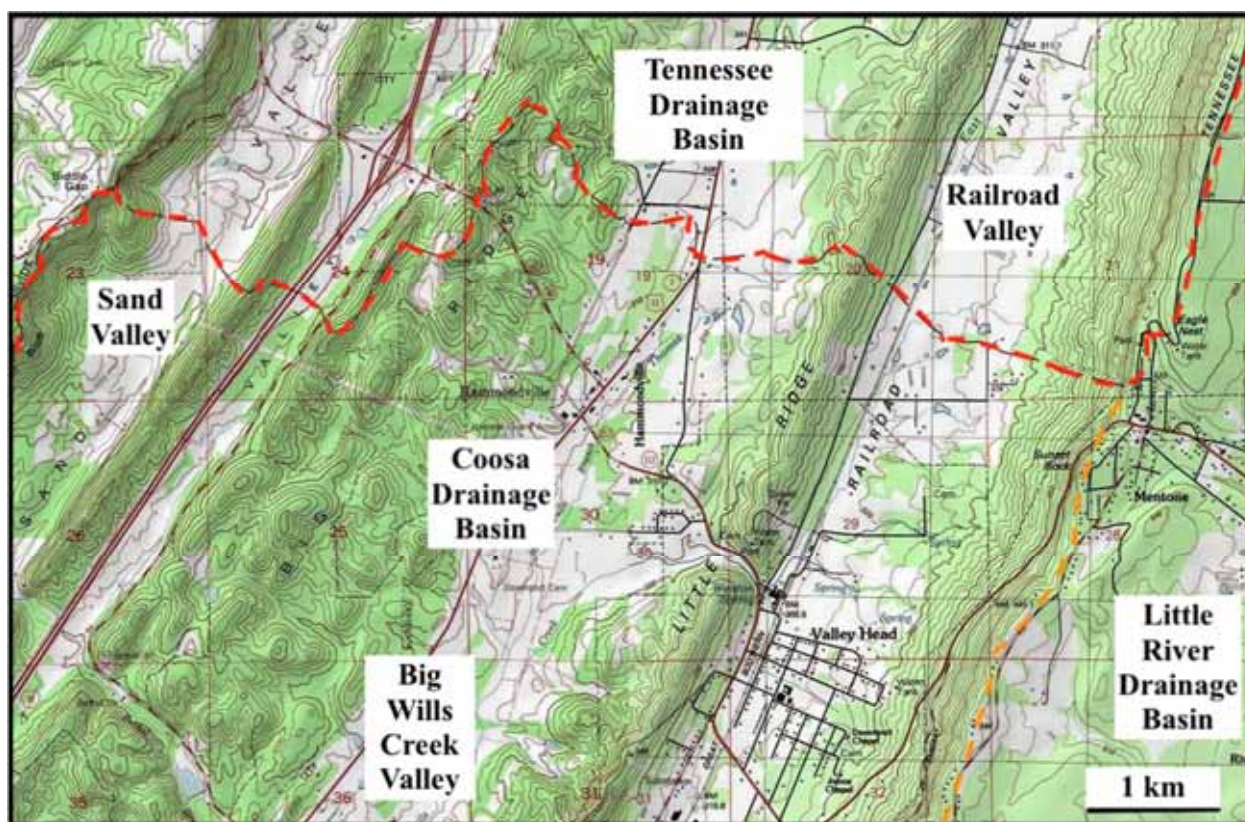


Figure 3. Modified topographic map from the USGS National Map website showing multiple through valleys crossing the Tennessee River-Coosa River drainage divide or Coosa Divide (shown by red dashed line) and the relationship of the through valleys to the higher elevation Little River drainage basin. The contour interval is 10 feet (3 meters).

The West Fork Little River originates on the Lookout Mountain top (north of figure 3) and flows in a south direction along the mountain top for nearly 40 kilometers before joining south-oriented East Fork Little River to form south-oriented Little River which flows another 40 kilometers (including for a considerable distance in a 180-meter-deep canyon) before reaching the Coosa River. The Little River drainage system and its deep canyon are difficult to explain unless massive and prolonged volumes of south-oriented water once flowed across what is now the Lookout Mountain top. Shallow wind gaps (divide crossings) seen on topographic maps suggest south-oriented water crossed from the now deep linear valleys flanking Lookout Mountain to enter the south-oriented Little River drainage system. One such divide crossing can be seen near the figure 3 east center

edge north of Mentone. Further south at De Soto State Park a deeper divide crossing (55-60-meter-deep Wade Gap) links southeast-oriented Sharp Creek (flowing to the West Fork Little River) with northwest-oriented Wade Gulf (which flows to Big Wills Creek by making a south- and west-oriented jog in Railroad Valley and then flowing through a water gap cut across Little Ridge). Similar divide crossings link Little River tributary valleys with each other and with what are today deep valleys flanking Lookout Mountain. These divide crossings suggest the Little River drainage system evolved as massive south-oriented floods eroded what must have been a large-scale flood formed diverging and converging channel complex which first flowed across a regional surface equivalent to the Lookout Mountain top and which eventually eroded the deep linear valleys now flanking the Lookout Mountain upland.

After jogging in a west direction across the figure 3 area the Coosa Divide continues in a south-southwest direction along or near the linear Sand Valley western rim for about 70 kilometers (as the crow flies) before turning in a northwest and north direction. Shallow divide crossings along this Coosa Divide section are generally oriented in southeast directions (with a few exceptions) and suggest multiple streams of south-oriented water once flowed from what is now the Tennessee River drainage basin into Sand Valley. Exceptions may include Winston and Nicholson Gaps which are oriented in northeast directions and may be where water once flowed from Sand Valley into the Tennessee River drainage basin (although other interpretations may be possible). The linear ridge and valley pattern seen in figure 3 continues southward to near the Coosa Divide's southwestern end (with some name changes) and with numerous water gaps cut across the ridges (at least 12 water gaps cross Big Ridge and its southern extension). Most, but not all water gaps are oriented in southeast directions suggesting erosion by south-oriented water. At its southwestern end, the Coosa Divide loops around north-oriented Short Creek headwaters before the Coosa Divide becomes the Locust Fork Divide. Before that change shallow divide crossings with floor elevations of 325 meters or higher suggest multiple streams of water once flowed from the Short Creek drainage basin into Big Wills Creek tributary valleys.

Map evidence to the north and south of the Coosa Divide generally supports the new paradigm prediction that massive and prolonged south-oriented floods once flowed across and deeply eroded the Coosa Divide area until forced by deep "hole" rim uplift to flow in a southwest or west direction which enabled what is now the Tennessee River valley to erode headward in a deep meandering valley across Walden Ridge (which ended all south-oriented flood flow from what is now the upstream Tennessee River drainage basin to the Coosa River). Headward erosion of the Tennessee River valley across Walden Ridge beheaded all of the south-oriented flood flow channels to the Coosa River and caused flow reversals on north ends of those beheaded channels. Today for example north-oriented Lookout Creek has more barbed tributaries than south-oriented Little River and Big Wills Creek suggesting a flow reversal took place in the now north-oriented Lookout Creek valley, but not in valleys to the south of the Coosa Divide such as in the Big Wills Creek and Little River valleys.

### *3.2 Tennessee River-Locust Fork Drainage Divide Segment (Locust Fork Divide)*

The Locust Fork Divide extends across a low relief upland surface from the north-oriented Short Creek drainage basin southern end in a north-northwest direction to Albertville before turning in a west direction to reach the northeast oriented Big Spring Valley eastern rim where the Locust Fork Divide turns in a south-southwest direction to reach the Big Spring Creek drainage basin southern end (see figures 2 and 4). Except for where the drainage divide crosses a plunging anticline's northeast end (south of Boaz) elevations along this drainage divide segment decrease in a westward direction from about 340 meters near Albertville with many Locust Divide elevations being lower than 309 meters (which was the lowest Coosa Divide elevation seen in figure 3) until the elevations rise at the Big Spring Valley eastern rim. While crossed by numerous shallow divide crossings no deep divide crossings are found until Cox Gap (which has been eroded across the north-northeast trending linear ridge now forming the Big Spring Creek Valley eastern rim). Cox Gap (floor elevation 281 meters) links a northwest-oriented tributary to north-northeast oriented Big Spring Creek with a south-oriented Slab Creek tributary (Slab Creek flows in a south direction to eventually reach south-oriented Locust Fork). Three similar divide crossings are found as the Locust Fork Divide continues in a south-southwest direction along the Big Spring Valley eastern rim (where drainage divide elevations range up to 350 meters) before the Locust Fork Divide turns in a west direction to cross the Big Spring Valley where the lowest divide crossing floor elevation is about 256 meters.

As seen in figure 4 the Locust Fork Divide western end follows a northeast-trending linear ridge in a southwest direction and then turns in a west direction to cross the northeast-trending linear valley linking northeast-oriented Big Spring Creek (flowing in the linear valley to the Tennessee River as a barbed tributary) with southwest-oriented Graves Creek (flowing in the linear valley before turning in a southeast direction to join southwest oriented Locust Fork). After crossing the Big Springs Creek-Graves Creek through valley (at an



elevation of 256 meters) the Locust Fork Divide climbs another northeast trending linear ridge and becomes the Mulberry Fork Divide, which crosses additional northeast-trending linear ridges and another linear valley (at an elevation of 260 meters) which links northeast-oriented Browns Creek (paralleling Big Springs Creek and flowing to the Tennessee River) with southwest-oriented Blue Springs Creek (flowing to Mulberry Fork). This pattern of northeast-trending linear ridges and valleys is associated with the northeast-to-southwest oriented Sequatchie Anticline which extends from the Sequatchie River valley in Tennessee southwestward into Alabama and southwestward from figure 4 and which determined the southwest-oriented Tennessee River route (west of Walden Ridge). Previous researchers have suggested that prior to Tennessee River development the Sequatchie River continued in a southwest direction across today's Locust Fork Divide, although how the two deep and parallel valleys were eroded has not been previously explained.

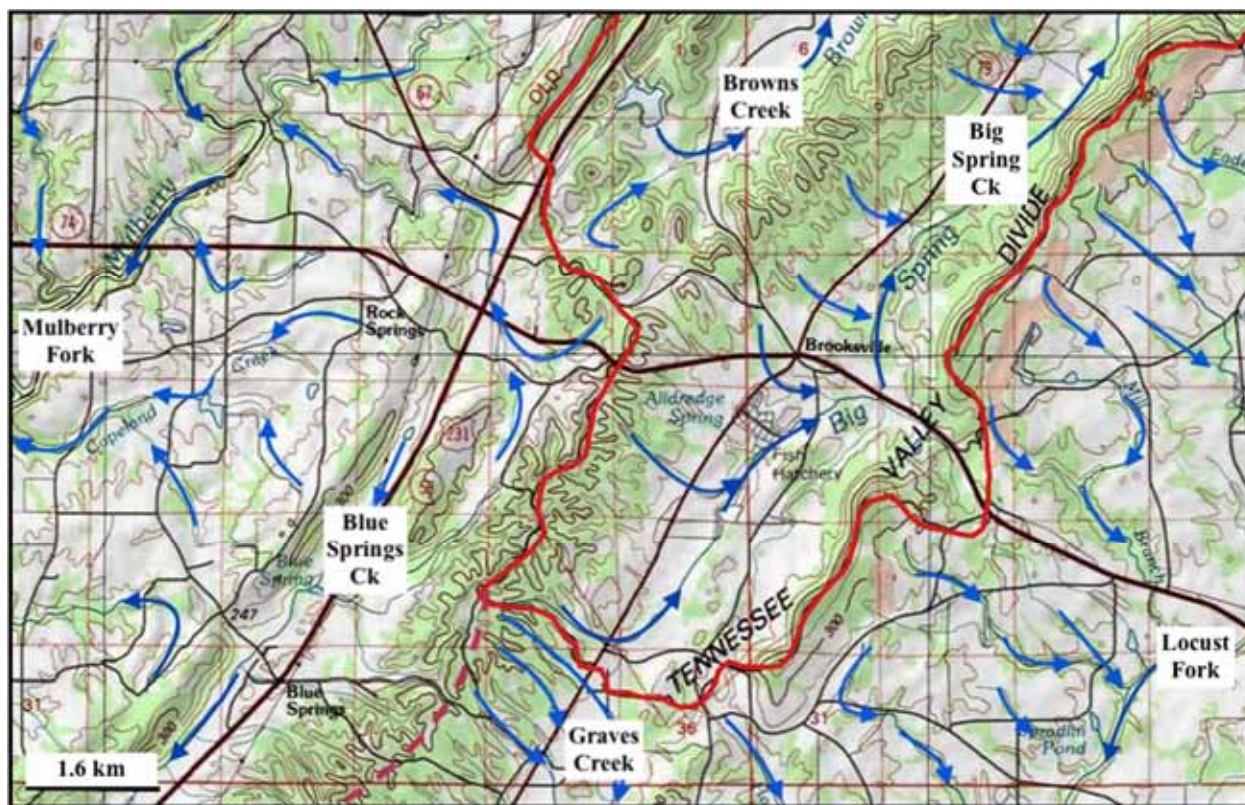


Figure 4. Modified topographic map from USGS National Map website showing Tennessee Valley Divide (solid red line) looping around the northeast-oriented Big Spring and Browns Creek drainage basins. Dashed red line shows the Locust Fork-Mulberry Fork drainage divide. Arrows emphasize present-day drainage route directions. Contour interval is 20 meters.

South of the Locust Fork Divide many Locust Fork tributaries and Locust Fork itself originate in a different region of northeast-trending linear ridges and valleys similar to those seen in figures 3 and 4, but associated with a different northeast-trending plunging anticline. Locust Fork originates as a north-oriented drainage route (seen in figure 5) and flows approximately 15 kilometers (as a crow flies) in a northeast-trending linear valley (between northeast trending linear ridges) before turning in a northwest direction to flow through water gaps cut across four different northeast-trending linear ridges which separate linear northeast-trending linear valleys. Once north and west of the linear valleys and ridges Locust Fork meanders in west and then northwest directions before reaching south-oriented Slab Creek where Locust Fork turns to meander in a south and southwest direction (across the figure 4 southeast corner). Interestingly less than five kilometers southwest of where northwest-oriented Locust Fork cuts across the linear ridges and valleys northwest-oriented Whipperwill Creek parallels Locust Fork by flowing through water gaps eroded across most of the same northeast-trending linear ridges and valleys with its water eventually reaching south-oriented Locust Fork near the figure 4 location.

Perhaps just as intriguing as the Locust Fork Divide is the Locust Fork-Little Warrior River drainage divide



which extends in roughly a northwest direction from figure 5 across the same linear ridges and valleys that Locust Fork and Whipperwill Creek also cross. In figure 5 the Locust Fork-Little Warrior River drainage divide separates north-oriented Locust Fork drainage from south-oriented Blackburn Fork Little Warrior River drainage, although further to the northwest the drainage divide separates Locust Fork drainage from Calvert Prong of the Little Warrior River drainage (with Calvert Prong also flowing in a north and northwest direction across the same previously described northeast-trending linear valleys and ridges before developing a meandering valley and turning in a west and then a south-southwest direction to join Blackburn Fork and to form the west-oriented Little Warrior River). Further to the southwest, Whited and Chitwood Creeks (and tributaries to them) originate in the same linear valleys and flow in northwest directions across the same linear ridges before reaching south-oriented Calvert Fork. In addition, Crump, Sand Mountain, Reid, and Tanyard Gaps are cut across the northwestern linear ridge and have southeast to northwest orientations.

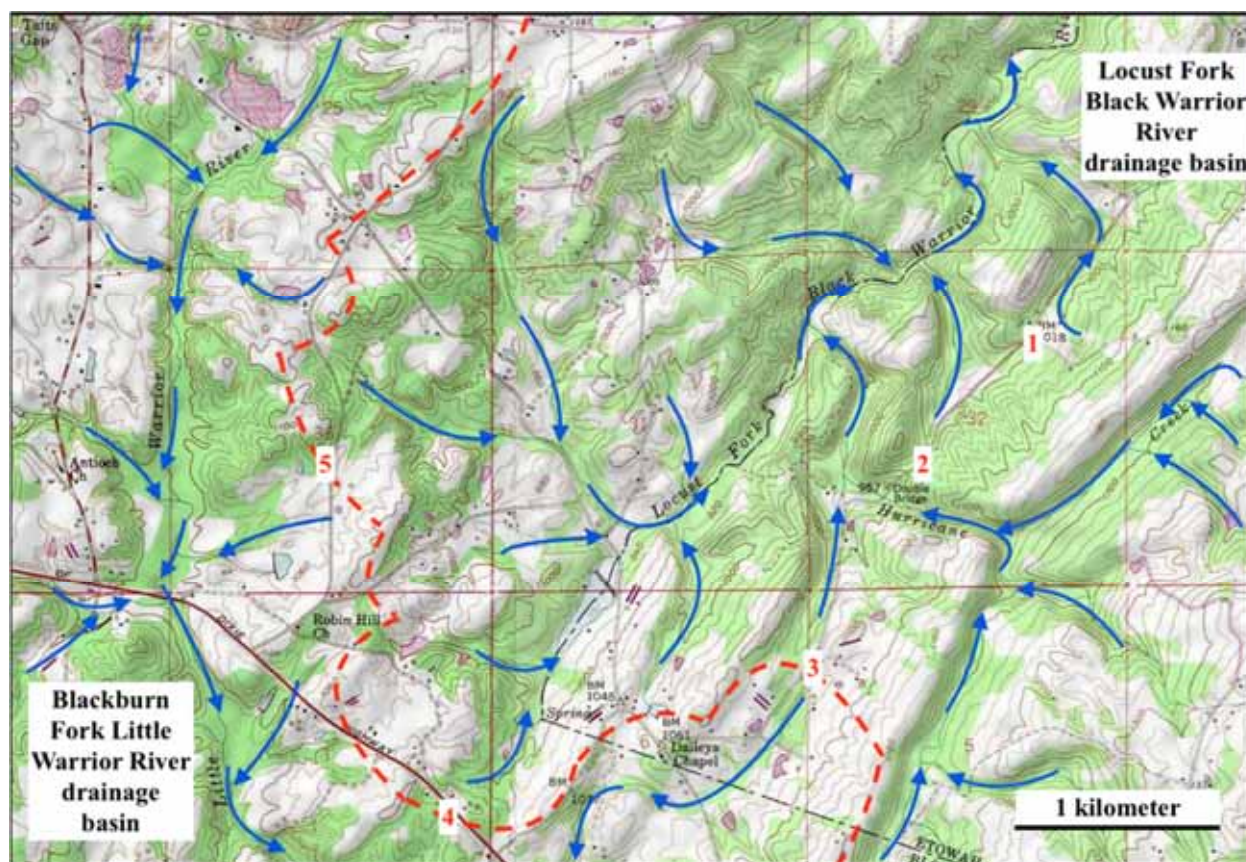


Figure 5. Modified topographic map from USGS National Map website showing north-oriented Locust Fork headwaters adjacent to south-oriented Blackburn Fork Little Warrior River headwaters (in Black Warrior River drainage basin). Arrows show today's drainage directions. Red numbers identify locations discussed in the text. Contour interval is 20 feet (6 meters).

Locations 1 and 2 (in figure 5) are divide crossings linking Locust Fork tributary valleys while locations 3, 4, and 5 are three of several divide crossings along the Locus Fork-Blackburn Fork Little Warrior River drainage divide. Streams of water eroded each of the divide crossings as well as other divide crossings now linking the north-oriented Locust Fork and south-oriented Little Warrior River drainage basins. The number of divide crossings and the nature of the valleys they link suggest a large complex of diverging and converging south-oriented flood flow channels once crossed the region (just as the new paradigm predicts). For example, one south-oriented channel crossed the present-day location 1, 2, and 3 divide crossings with its flow subsequently beheaded and reversed at least three times to create the now north-oriented Locust Forks tributaries beginning at each of those locations. Note how each of those three tributaries curves in a northwest direction to join north-oriented Locust Fork. Each tributary valley represents a former channel where prior to a flow reversal in the north-northeast oriented Locust Fork headwaters valley streams of south-oriented water diverged from the



main south-oriented stream which flowed to location 4. In summary, a complex of south-oriented diverging and converging flow channels eroded the valleys now crossing the Locust Fork-Little Warrior River drainage divide and was subsequently reversed (probably by regional uplift) to flow in a north direction and to create the Locust Fork-Little Warrior River drainage divide.

Recognizing a south-oriented complex of diverging and converging stream channels once crossed the now north-oriented Locust Fork headwaters drainage basin is key to understanding how northeast Alabama drainage systems developed. Since large diverging and converging stream complexes typically form when huge floods overwhelm existing drainage systems with floodwaters spilling across what were previously major drainage divides it is reasonable to assume large and prolonged south-oriented floods also deeply eroded the Locust Fork headwaters drainage basin linear ridge and valley area including what are now the many water gaps cut across northeast-trending linear ridges. Floodwaters would have also eroded the valleys between the more erosion resistant linear ridges and the south-oriented floods eroded the Little Warrior River headwaters drainage basin as well. The large and prolonged south-oriented floods must have originated from an almost unlimited water source located to the north of what is now the Tennessee River valley and the most likely the water source was a large continental icesheet (located where Cenozoic continental icesheets are usually reported to have existed).

Locust Fork after flowing in a north and northwest direction from the figure 5 area enters a 10- to 15-kilometer wide southwest-oriented Sand Mountain lowland (bounded by low linear northeast-trending linear ridges). After meandering in a northwest direction Locust Fork turns in a southwest direction and becomes a southwest-oriented river (seen in the figure 4 southeast corner). Further to the southwest Calvert Prong after flowing in a north direction enters the same Sand Mountain lowland where it turns to meander in a south-southwest direction to meet southwest- and northwest-oriented Blackburn Fork (south-oriented headwaters seen in figure 5 turn in a northwest direction to cross the same linear ridges and valleys Locust Fork and Calvert Prong cross). Calvert Prong and Blackburn Fork then form the Little Warrior River (in the Sand Mountain lowland) which meanders in a northwest direction to join southwest-oriented Locust Fork (as a barbed tributary). Today, Locust Fork, the Little Warrior River, and Calvert Prong flow in entrenched meanders which Lacefield (2013, p. 249) suggests originated when ancestral drainage routes meandered across a nearly level floodplain, but he does not address why southwest-oriented Locust Fork is joined by southeast-oriented tributaries originating along the Sand Mountain lowland's northwestern rim and north- and northwest-oriented barbed tributaries coming from the previously described linear ridge and valley region to the southeast.

From the new paradigm perspective, the southwest-oriented Locust Fork valley eroded headward across large and prolonged southeast- and southwest-oriented floods which were flowing across, along, and between actively rising northeast-trending anticlinal structures. Such an interpretation explains the Locust Fork southeast- and northwest-oriented tributaries with the northwest-oriented tributaries (including the north- and northwest-oriented Locust Fork headwaters) forming as reversals of flow on northwest ends of beheaded southeast-oriented flood flow channels. The linear ridges and valleys (including the broad Sand Mountain lowland in which the meandering Locust Fork valley eroded headward) emerged as floodwaters carved linear valleys into easily eroded bedrock units located between more erosion resistant bedrock units which today remain as linear ridges. Headward erosion of the deep southwest-oriented Locust Fork valley was across numerous southeast-oriented flood flow channels and at times the actively eroding valley head eroded headward along a captured southeast-oriented channel or along a beheaded channel in which flow was moving in a northwest direction before eroding headward across divides between the diverging and converging flood flow channels. This zig-zag pattern of valley headward erosion probably developed the entrenched meander pattern seen today although regional bedrock characteristics probably played a significant role as well.

One intriguing aspect of the Tennessee River-Black Warrior River drainage divide is Locust Fork and Mulberry Fork drainage originates in adjacent linear valleys associated with the Sequatchie Anticline (as seen in figure 4). As described a deep divide crossing (floor elevation 256 meters) links north-northeast oriented Big Spring Creek (flowing to the Tennessee River) with south-southwest oriented Graves Creek (flowing to south-southwest oriented Locust Fork) while a cluster of closely spaced deep divide crossings (lowest floor elevation about 260 meters) link north-northeast oriented Browns Creek (flowing to the Tennessee River) with south-southwest oriented Blue Springs Creek (flowing to southwest oriented Mulberry Fork). Further, the Browns Creek headwaters area suggests water once flowed from the Browns Creek valley into the Big Spring Creek valley (best seen on more detailed topographic maps). Previous researchers suggested an ancestral Sequatchie River flowed in a southwest direction along what is now the southwest-oriented Tennessee River valley between Walden Ridge and Guntersville and then continued in a southwest direction through these linear valleys to the Black Warrior River. Such an interpretation does not explain the multiple streams of diverging and converging

southwest oriented water needed to explain the figure 4 drainage patterns.

From a new paradigm perspective headward erosion of southwest-oriented Sequatchie Anticline related linear valleys across large and prolonged southwest- and southeast-oriented floods also explains other drainage features in the region now found between the southwest-oriented Tennessee River and the Locust Fork Divide. For example, Short Creek flows in a north and northwest direction to join the Tennessee River near Guntersville. The Short Creek drainage basin is asymmetric with long southwest-oriented tributaries, which suggest headward erosion of Sequatchie Anticline related linear valleys beheaded and reversed a southeast- and south-oriented flood flow channel on the now north- and northwest-oriented Short Creek alignment. That beheaded and reversed flood flow channel had southwest-oriented tributaries many of which Scarham Creek valley headward erosion had previously captured (Scarham Creek is a southwest and west-northwest oriented Short Creek tributary). North and east of Short Creek is Town Creek which parallels southwest-oriented Big Wills Creek (but on the Tennessee River side of the southwest-to-northeast oriented Coosa Divide) before turning in a west-northwest direction to join the Tennessee River. The Town Creek drainage basin is also asymmetric suggesting Town Creek valley headward erosion captured southwest-oriented flood flow moving to the Short Creek drainage basin. And, the asymmetric Sauty Creek drainage basin to the north of the Town Creek drainage basin suggests west-oriented Sauty Creek valley headward erosion captured south- and southwest-oriented flood flow moving into the Town Creek drainage basin. These new paradigm interpretations suggest headward erosion of the now meandering Tennessee River valley across Walden Ridge was a progressive step as a series of tributary valleys eroded eastward from the actively eroding southwest-oriented Sequatchie Anticline related linear valleys, however unlike the Short, Town, and Sauty Creek tributary valleys the tributary valley that eroded across Walden Ridge captured all of the southwest-oriented floodwaters that had been previously flowing across the higher elevation Coosa Divide.

### *3.3 Tennessee River-Mulberry Fork Drainage Divide Segment (Mulberry Fork Divide)*

After a low point of about 260 meters at the divide crossing linking northeast oriented Browns Creek (flowing to the Tennessee River) with southwest oriented Blue Springs Creek (flowing to Mulberry Fork) the Mulberry Fork Divide climbs onto and follows in a northeast direction the northeast-oriented linear ridge along the Browns Creek valley west wall with elevations in the 310 to 330 meter range before turning in a northwest direction to reach the town of Arab where Mulberry Fork Divide elevations are in the 335 meter range. To the north of this Mulberry Fork Divide segment the southwest wall of the northwest-oriented Tennessee River valley has been intensely eroded into deep and steep-sided north-, northeast-, and east-oriented valleys. Shallow divide crossings link many of these deep valleys and indicate floodwaters once spilled across the drainage divides. Barbed tributaries and asymmetric drainage basins suggest drainage reversals in the tributary drainage basins took place. For example, south-oriented tributaries flow to south- and east-oriented Peachtree Creek which then flows to north-oriented Shoal Creek.

Westward from the town of Arab shallow divide crossings (generally less than 5 meters in depth) link north- and south-oriented stream valleys as the Mulberry Fork Divide elevation gradually decreases from more than 335 meters to about 305 meters at a divide crossing linking north-oriented Widner Creek with south-oriented Pied Creek. From that low point, proceeding in a westward direction the Mulberry Fork Divide is again crossed by shallow divide crossings as drainage divide elevations seldom exceed 320 meters until after turning in a northwest direction to reach a high Mulberry Fork Divide point of almost 330 meters (about 1 kilometer southwest of the town of Eva). The distance from Arab to Eva is about 25 kilometers as the crow flies although the Mulberry Fork Divide curves around the headwaters of both north- and south-oriented streams. Lower Mulberry Fork Divide elevations between Arab and Eva describe a shallow and very broad divide crossing (from 5 to 25 meters deep) that must have been eroded as vast quantities of south-oriented floodwaters moved from what is now the northwest-oriented Tennessee River valley into and through the Mulberry Fork drainage basin.

The Mulberry Fork Divide proceeds in a southwest direction from Eva to Holmes Gap (cut across Brindley Mountain north of the town of Cullman) which with a floor elevation of 277 meters is a divide crossing linking the north-oriented Flint Creek valley with the south-southeast oriented Adams Branch valley. Between Eva and Holmes Gap two other significant divide crossings (with floor elevations of about 295 meters) link a south and northwest-oriented East Fork Flint Creek valley segment with the south-oriented Moody Branch Eightmile Creek valley (see figure 6-note how south-oriented water from what is now the northwest-oriented East Flint Creek valley flowed through the narrow divide crossing at number 1 and the much wider divide crossing at the two number 2s). From Holmes Gap the Mulberry Fork Divide continues in a northwest direction and is known as Brindley Mountain as it curves around the north-oriented Flint Creek drainage basin and gains elevation to reach a high point of 336 meters near the town of Battleground. While Mulberry Fork Divide elevations vary as it is

crossed by shallow divide crossings between Eva and Battleground most Mulberry Fork Divide elevations in that stretch are significantly lower than the elevations near Eva and near Battleground and document another very broad divide crossing notched into Brindley Mountain, which links the north-oriented Flint Creek drainage basin with the south-oriented Mulberry Fork drainage basin.

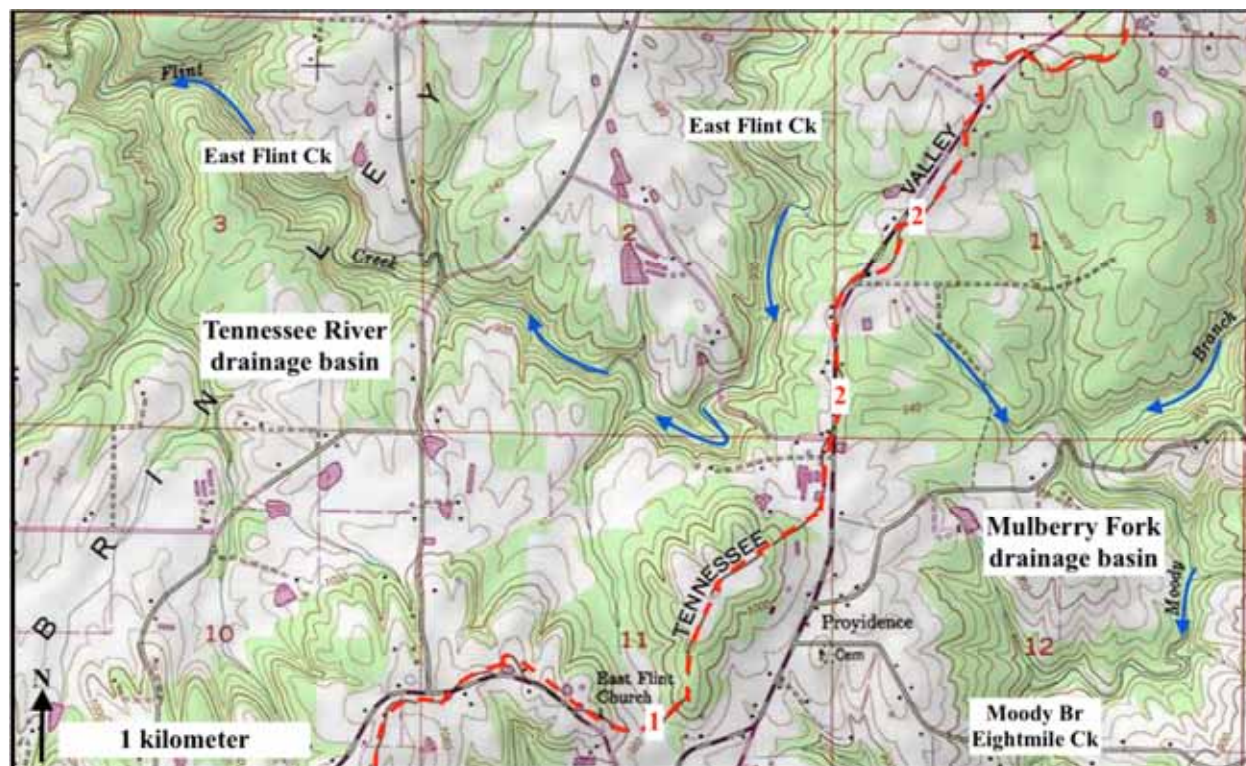


Figure 6. Modified topographic map from USGS National Map website showing divide crossings with red numbers (the number 2 is used twice to show the divide crossing width) along a Mulberry Fork Divide segment adjacent to an East Flint Creek change from a south direction to a northwest direction. The contour interval is 20 feet (6 meters). Top left corner:  $34^{\circ} 17' 37.044''$  N.,  $86^{\circ} 59' 46.623''$  W.

The Mulberry Fork Divide's western end is near Battleground where Brindley Mountain and the drainage divide continue in westward direction but as the Tennessee River-Sipsey Fork (Black Warrior River) drainage divide (Sipsey Fork Divide). Like the Mulberry Fork Divide Sipsey Fork Divide elevations vary and range from more than 320 meters at higher points to less than 275 meters in deeper divide crossings. To the north of the Mulberry Fork Divide western end and the Sipsey Fork Divide eastern end is the north-oriented Flint Creek drainage basin which has a much more extensive tributary network than shown in figure 2. One of the more intriguing tributaries is West Flint Creek which originates just north of Brindley Mountain (and of the Sipsey Fork Divide) and which flows in a west direction before turning in north, northeast, and east directions to join north-oriented Flint Creek near Flint City. To the south of the northeast- and east-oriented West Flint Creek segment is northeast-oriented Business Creek. West Flint Creek and Business Creek both have asymmetric drainage systems with significant south- and southeast-oriented tributary networks. These asymmetric drainage systems combined with numerous south-oriented (barbed) tributaries flowing directly to north-oriented Flint Creek suggest a major drainage reversal has affected the entire Flint Creek drainage basin.

In summary the Coosa, Locust Fork, and Mulberry Fork Divide topographic map evidence can be explained if large and prolonged southwest-oriented floods flowed across the Coosa Divide while massive southeast-oriented floods flowed across at least some sections of the Locust Fork and Mulberry Fork Divides. These floodwaters coming from different directions converged in what is now the south-oriented Black Warrior River drainage basin and were responsible for eroding the south-oriented Locust Fork and Mulberry Fork drainage basins. Southwest-oriented floods flowed from what are today southwest-oriented Tennessee River headwaters areas which from the new paradigm perspective is located just inside the deep "hole" southeast rim. Southeast-oriented



floodwaters suggest the now northwest-oriented Tennessee River valley segments originated as south- and southeast-oriented flood flow routes. One possible new paradigm interpretation is the Black Warrior River drainage basin for a time was a deep “hole” exit route, although as deep “hole” rim uplift progressed the floodwaters were blocked and the south-oriented floodwaters were forced to reverse direction so as to reach the south-oriented Mississippi River valley which became the deep “hole’s” only remaining southern exit.

#### 4. Discussion

Detailed topographic map evidence supports previously published interpretations that water from what is now the Tennessee River drainage basin at one time flowed across the northern Alabama Tennessee Valley Divide to reach the Coosa and Black Warrior River drainage basins, however the detailed topographic map evidence also strongly suggests the water flowed in the form of large south-oriented floods as opposed to flowing in rivers like those that exist today. Flood sources cannot be determined from the Tennessee Valley Divide area topographic map evidence nor can the map evidence be used to determine when the floods occurred. What can be determined by studying the map evidence (especially in the Lookout Mountain area) is the floodwaters removed significant bedrock thicknesses from at least some northern Alabama areas and that Tennessee Valley Divide uplift as floodwaters flowed across it probably blocked the south-oriented floodwaters and caused flow diversions and reversals that eventually resulted in the present-day round-about Tennessee River drainage route. These determinations from the northern Alabama topographic map evidence are consistent with new paradigm predictions based on interpretations of Missouri River drainage basin area topographic map evidence.

The new paradigm emerged when Missouri River drainage basin topographic map drainage system and erosional landform evidence forced recognition that what are now north-oriented valleys had diverted immense south- and southeast-oriented meltwater floods toward space a large continental icesheet had once occupied. This observation could only be explained if the continental icesheet from which the large meltwater floods were originating had created and then occupied a deep “hole.” The deep “hole” must have originated because the continental icesheet deeply eroded the bedrock beneath it and because the icesheet was thick and heavy enough to raise surrounding regions and mountain ranges. Further, map evidence forced recognition that the deep “hole’s” western and southwestern rim (located along what is now the Montana, Wyoming, and northern Colorado east-west continental divide) had been rising as massive south-oriented meltwater floods flowed across it. By treating the Ohio River drainage basin as a Missouri River drainage basin mirror image, the deep “hole’s” southeastern and southern rim which includes what are now the Coosa, Locust Fork, and Mulberry Fork Divides was also being uplifted as immense south-oriented meltwater floods flowed across it.

The new paradigm as demonstrated here explains considerable previously unexplained Coosa, Locust Fork, and Mulberry Fork Divide area detailed topographic drainage system and erosional landform evidence (although this finite paper only addresses a small fraction of the available regional detailed topographic map drainage system and erosional landform evidence). The new paradigm’s remarkable ability to explain previously unexplained topographic map drainage system and erosional landform evidence is a powerful argument in the new paradigm’s favor. However, using Kuhn’s (1970) terminology, the new and accepted paradigms are incommensurable, which means they are fundamentally different and cannot be easily compared. Kuhn further notes when two paradigms are incommensurable (as in this case) one of the two paradigms should not be used to judge the other. Instead, Kuhn suggests when faced with two competing paradigms researchers should adopt the paradigm best able to explain their observed evidence and able to offer new and productive research opportunities.

To illustrate the paradigm incompatibility problem the question can be asked, “where are the sediments which topographic map evidence requires to have been eroded when massive and prolonged meltwater floods flowed across the Coosa, Locust Fork, and Mulberry Fork Divides?” Some Missouri River drainage basin topographic map drainage system evidence can only be explained if massive meltwater floods eroded valleys now containing sediments which previous investigators mapped as Oligocene, Miocene, and Pliocene in age. Coastal Plain sediments to the south of the Coosa, Locust Fork, and Mulberry Fork Divides include mapped Oligocene, Miocene, and Pliocene sediments (see Szabo, 1988). Further, Lacefield (2013, p. 216) who describes Alabama’s geology from an accepted paradigm perspective observes “The huge influx of sand and gravel that spread across Alabama’s Lower Coastal Plain during the Miocene and Pliocene epochs suggests that the land farther north was undergoing an episode of tectonic uplift during this final part of the Tertiary Period.” Lacefield’s comment is precisely what the new paradigm predicts, although Lacefield’s book (p. 236) also states “Continental glaciers have advanced and then retreated at least eleven times during the past two million years,” which is significantly different from the new paradigm described glacial history.

The new paradigm uses topographic map evidence to show meltwater floods from a thick continental icesheet (which transported and deposited what previous investigators have mapped as Oligocene, Miocene, and Pliocene sediments) were reversed to create a second and much thinner icesheet which formed after climate change caused by the diversion of large south-oriented meltwater floods onto the deep “hole” floor where the floodwaters flowed between decaying thick icesheet remnants to reach northern oceans. The second and much thinner continental icesheet formed when the north-oriented meltwater and other drainage became trapped on the deep “hole” floor and froze on the floors of what were ice-walled and bedrock-floored canyons which had been carved by giant supraglacial meltwater rivers flowing between what at that time were detached and semi-detached first continental icesheet masses. The two paradigms describe completely different and incompatible Cenozoic glacial histories and also completely different and incompatible Cenozoic geologic histories.

## 5. Conclusions

Detailed topographic map drainage system and erosional landform evidence shows immense and prolonged south-oriented floods flowed across what must have been a rising northeast Alabama Tennessee Valley Divide with Tennessee Valley Divide uplift eventually diverting the floodwaters westward along the rising Tennessee Valley Divide’s northern flank and then northward to the west-oriented Ohio River (and then to the south-oriented Mississippi River). The floodwater source and the timing of this major erosion event cannot be determined from northern Alabama topographic map evidence although the melting of a large continental icesheet is the only known geologic process capable of generating such massive and long-lived floods. The south-oriented floodwaters were probably responsible for deposition of some or all Oligocene, Miocene, and Pliocene Alabama Coastal Plain sediments which is inconsistent with accepted Cenozoic glacial history interpretations and which has prevented previous investigators from explaining topographic map drainage system and erosional landform evidence and from recognizing this significant Alabama erosion, deposition, and drainage history event.

The northern Alabama detailed topographic map drainage system and erosional landform evidence is consistent with a new Cenozoic glacial history paradigm which was developed from Missouri River drainage basin topographic map evidence and which predicts large and prolonged south-oriented meltwater floods flowed across the northern Alabama Tennessee Valley Divide. Numerous and closely spaced divide crossings found along the Tennessee Valley Divide, drainage system orientations, and other drainage system characteristics support the new paradigm prediction that the Tennessee Valley Divide became the southern rim of a continental icesheet created deep “hole” which was being uplifted as immense and prolonged south-oriented meltwater floods flowed across it and that today’s Tennessee River drainage route was created when deep “hole” rim uplift forced the south-oriented floodwaters to make a U-turn to reach what became the deep “hole’s” only remaining southern outlet (the Mississippi River valley).

This study of northern Alabama topographic map evidence shows the new paradigm can successfully explain previously unexplained northern Alabama detailed topographic map drainage system and erosional landform evidence, although the new paradigm describes a fundamentally different Cenozoic glacial history than what the commonly accepted glacial history describes and the new and accepted paradigms are incommensurable and cannot easily be compared. Further work is needed to better understand why the accepted paradigm does not explain most topographic map drainage system and erosional landform evidence and to test the new paradigm’s ability to explain most detailed topographic map drainage system and erosional landform evidence in other yet to be tested geographic regions.

## Conflict of interest

The author declares that there is no conflict of interests regarding the publication of this paper

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