

PS LIDAR and Gravity Data Combined to Establish Cross-Cutting Relationships of Features on the Surface of the Prairie Allogroup near Lafayette, Louisiana*

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Search and Discovery Article #41091 (2012)**

Posted November 30, 2012

* Adapted from a poster presentation given at Gulf Coast Association Geological Societies 2012 Convention, Austin, TX, October 21-23, 2012

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Abstract

Airborne LIDAR data have previously been utilized to determine the relative ages of many of the depositional, erosional and fault features on the surface of the Prairie Allogroup near Lafayette, Louisiana by their cross-cutting relationships. The overbank deposits of a Pleistocene Mississippi River meander have been interpreted to overlay and obscure the topography of a fault where the fault trends toward the meander scar. The fault is elsewhere well imaged in the LIDAR data.

The surface expression of the fault in question is difficult to trace accurately in the field because of its low relief. In 3D virtual reality, we have created a technique that involves georegistering and intersecting a planar satellite image of the region with the 3D LIDAR data. As the elevation of the satellite data image is increased, the intersection of the two images moves up the topography of the 3D LIDAR data image. The intersection of the fault scarp within the satellite data precisely establishes the location of the fault scarp. With this knowledge of the geographic location of the fault scarp, we surveyed several topographic and gravity profiles across the fault. These profiles characterize the topographic and gravity signatures of the exposed portion of the fault. Further gravity profiles across the proposed extension of the fault beneath the meander deposits establish that the fault does extend beneath the deposits. Therefore, the faulting is strictly older than the Mississippi River meander. In fact, in this region we have no evidence that there has been discernible creation of surface topography by faulting since about 85,000 years ago.

LIDAR and Gravity Data Combined to Establish Cross-cutting Relationships of Features on the Surface of the Prairie Allogroup Near Lafayette, Louisiana

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ABSTRACT:

Previously, Kinsland and Borst utilized a 3D virtual reality system to investigate the topography of the surface of the Prairie Allogroup with LIDAR data of the area near Lafayette, Louisiana. They documented the relative ages of many of the depositional, erosional and fault features by their cross-cutting relationships. They reported an interpretation that the overbank deposits of a Pleistocene Mississippi River meander overlay and obscure the topography of a fault where the fault trends toward the meander scar. The fault is elsewhere well imaged in the LIDAR data.

The surface expression of the fault in question is difficult to trace accurately in the field because of its low relief. In 3D virtual reality we have created a technique which involves georegistering and intersecting a planar satellite image of the region with the 3D LIDAR data. As the elevation of the satellite data image is increased the intersection of the two images moves up the topography of the 3D LIDAR data image. The intersection of the fault scarp within the satellite data precisely establishes the location of the fault scarp. With this knowledge of the geographic location of the fault scarp we surveyed several topographic and gravity profiles across the fault. These profiles characterize the topographic and gravity signatures of the exposed portion of the fault. Further gravity profiles across the proposed extension of the fault beneath the meander deposits establish that the fault does extend beneath the deposits. Therefore, the faulting is strictly older than the Mississippi River meander. In fact, in this region we have no evidence that there has been discernible creation of surface topography by faulting since about 85,000 years ago.

Figure 1A. General location and features of study area. Opelousas, Louisiana is near the top of the figure and Lafayette, Louisiana is near the bottom of the figure. The blue points mark the trace of the subject fault scarp (the scarp “termination” is located near latitude 30.4 N and longitude 92.1 W). The fuchsia points mark a fault scarp to the north near Opelousas. White points mark meander scars of two sets of the Pleistocene Mississippi River meanders. The yellow points mark present drainage which is incised surrounding the meander set near Grand Coteau, Louisiana. Whether this incision is at the base of over bank deposits or within an actual meander scar is uncertain; however, in either case the deposits interior to the curvature of the yellow points are from the Pleistocene Mississippi River meander. Elevation is colored in 5 ft (2 m) increments. The elevation near Grand Coteau is 50 to 55 ft (about 15 m). (Modified after Kushiya, 2010)

Figure 1B. Image from 3D system with “volumetric lens” utilized to display the LIDAR data with another attribute algorithm. Inside the lens the color scheme is narrowly tuned to display fine details of the topography. The subject fault strikes southwest and then west-southwest from the “termination.” Scale and orientation should be deduced by comparison to Figure 1A. (Modified after Kushiya, 2010)

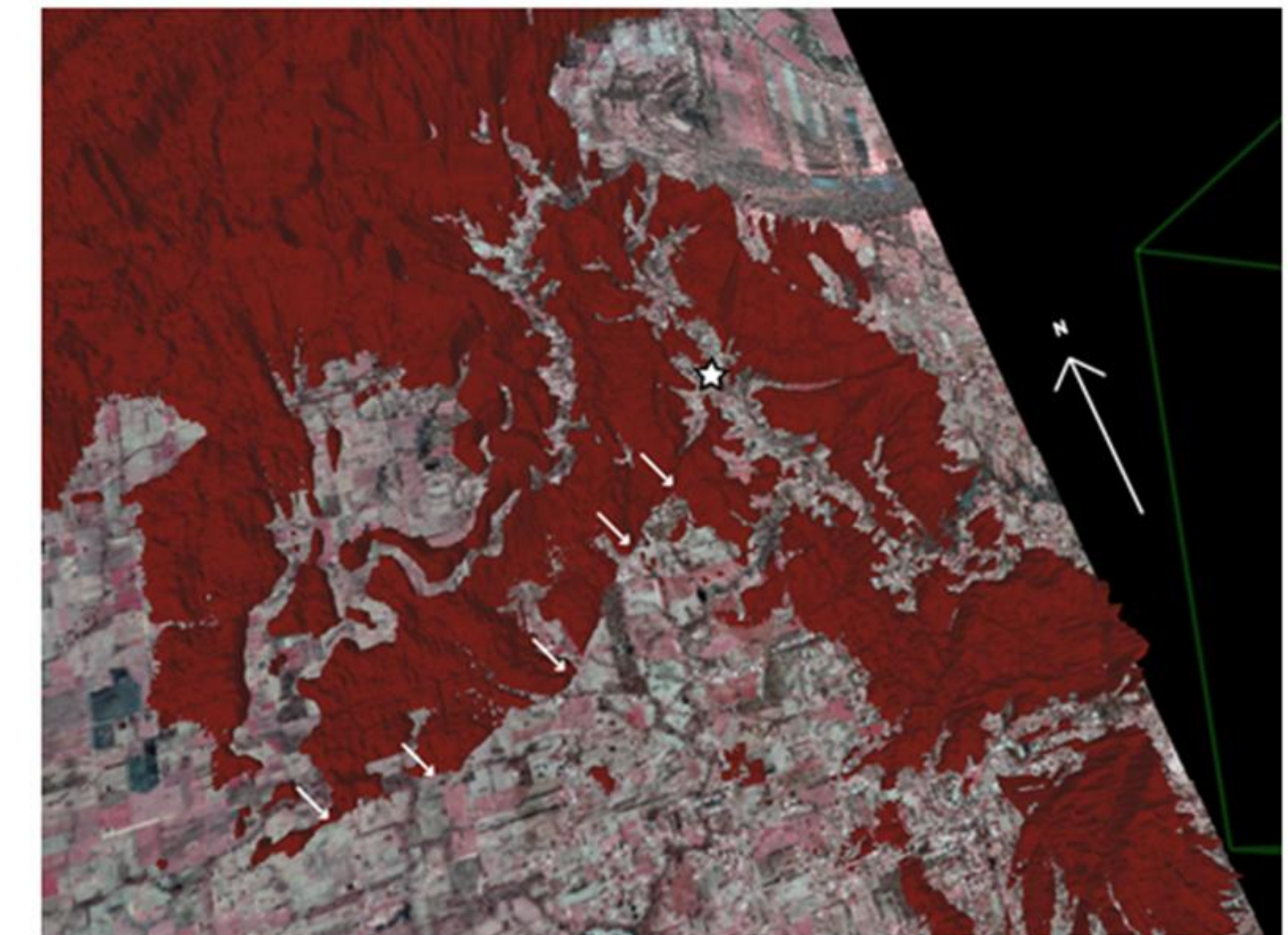
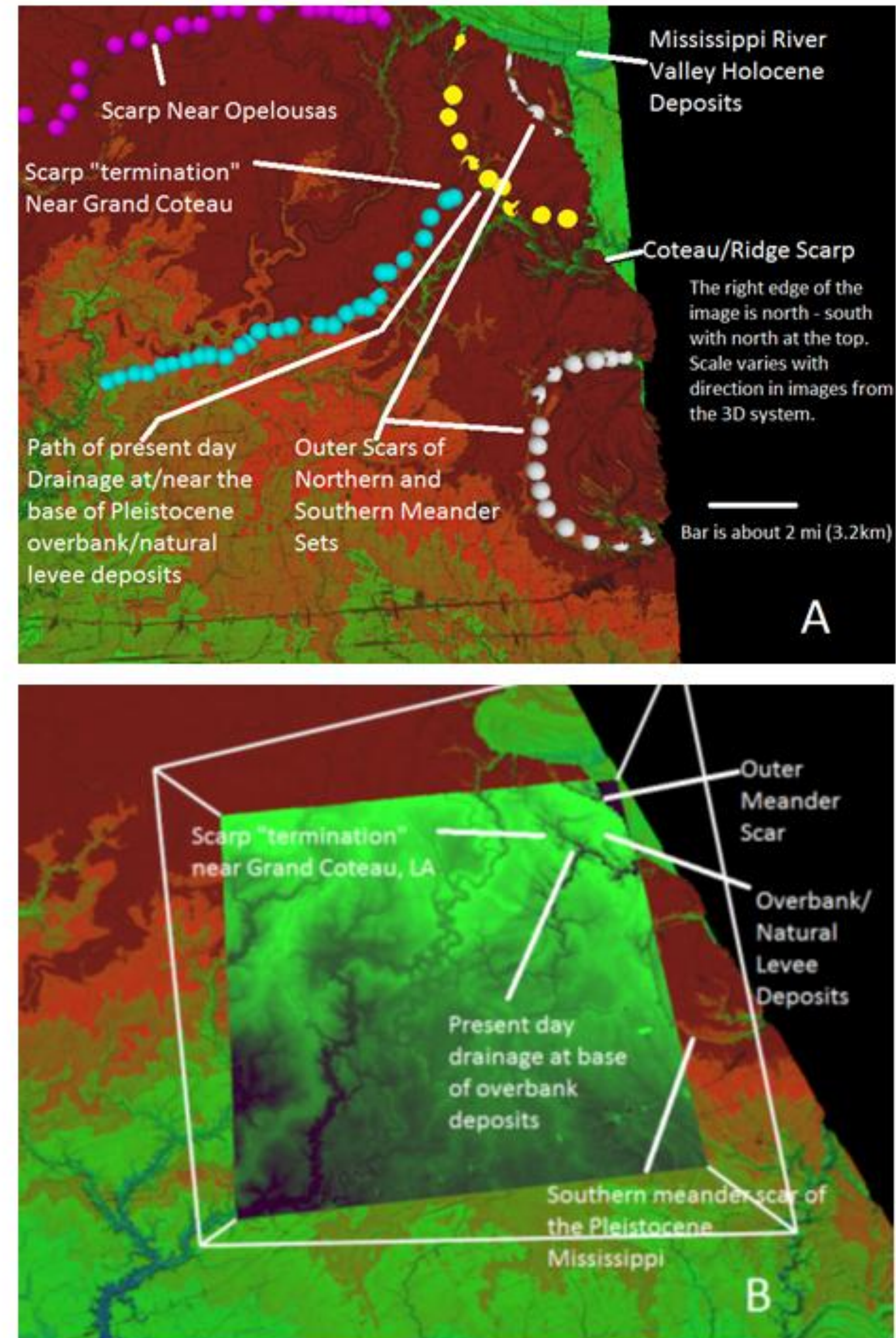


Figure 2. Illustration of the intersection of the satellite imagery with the LIDAR topography so as to demonstrate the location of the fault scarp within the satellite imagery. The white arrows point to various positions along the fault scarp and the white star is located near the scarp “termination.” Compare to Figure 1 for approximate scale. (Modified after Kushiya, 2010)

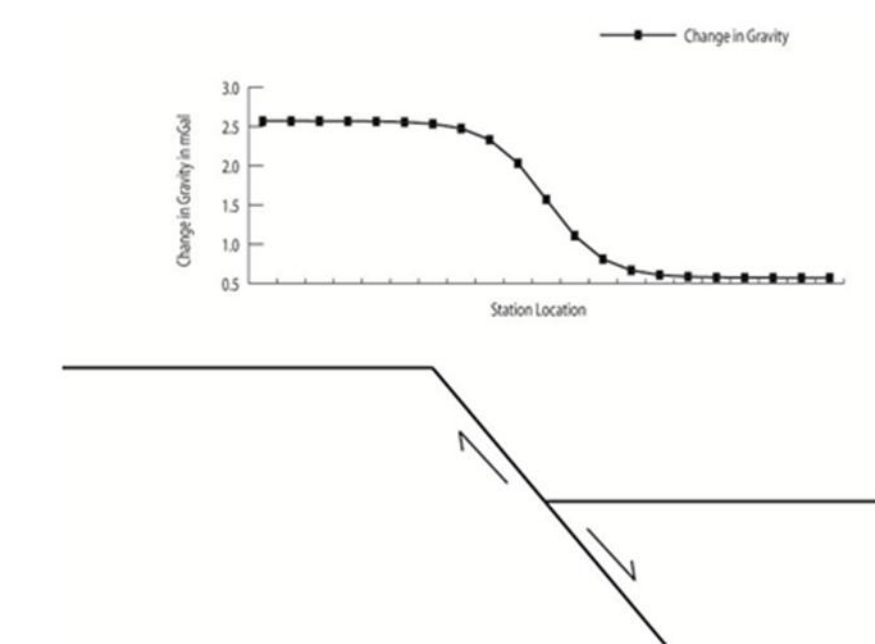


Figure 3. Idealized gravity profile over the scarp of a normal fault. The subject fault scarp has been eroded and draped by loess so that it is not expected that the present topographic expression is as sharp nor that the fault surface is directly beneath the steepest part of the present topographic surface. The gravity profile should, however, be located over the buried fault roughly as shown here. (Modified after Kushiya, 2010)

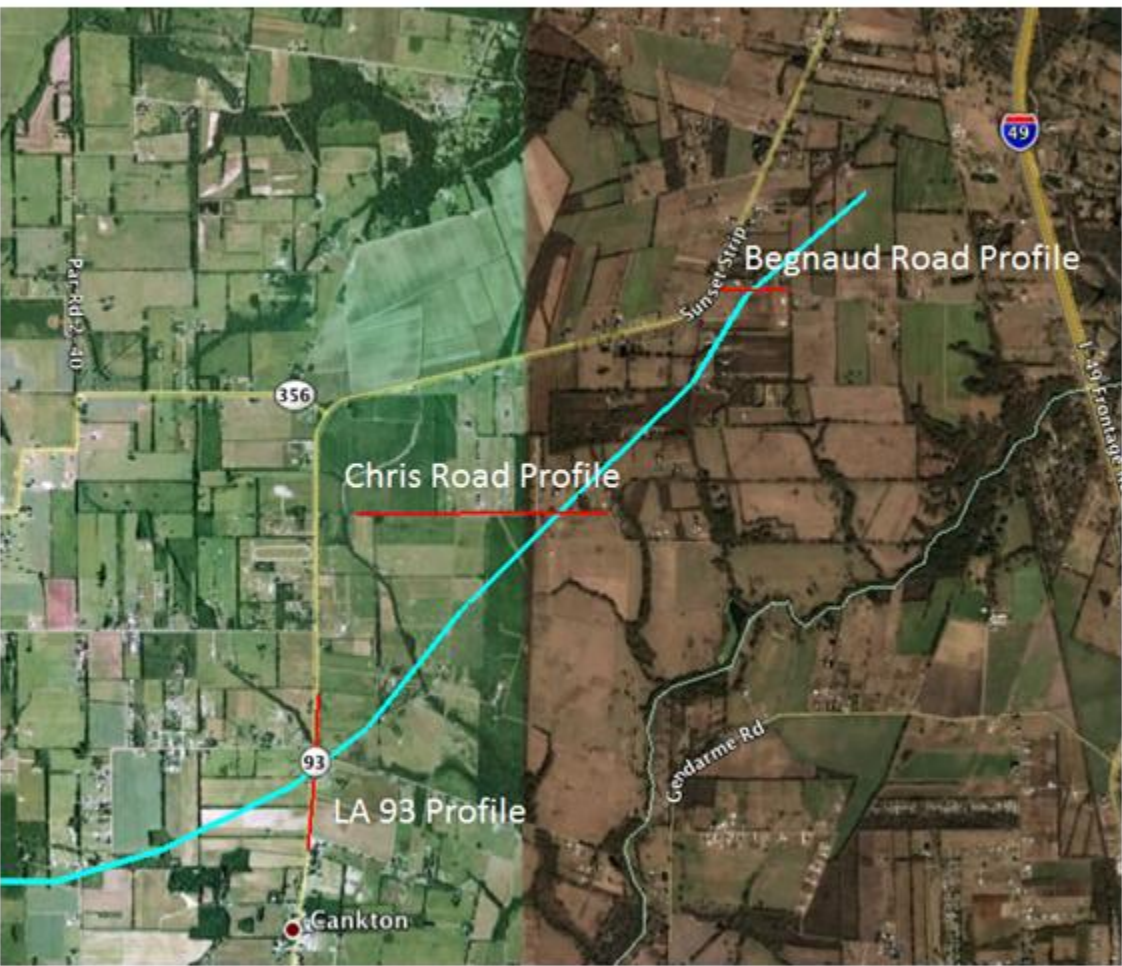


Figure 4. Google image showing the trace of the fault scarp and the three locations of the three profiles collected across the fault scarp. The Chris Road Profile strikes east-west and is 5000 ft (1500m) long. Compare to Figure 2. (Modified after Kushiya, 2010)



Figure 6. Google image showing the end of the trace of the fault, the estimated extrapolated position of the buried portion of the fault and the profiles where data were collected to determine whether the fault does extent where proposed. The figure is oriented with north at the top and the I-49 profile is 1200 m (3900 ft) long. Compare to Figures 2 and 4. (Modified after Kushiya, 2010)

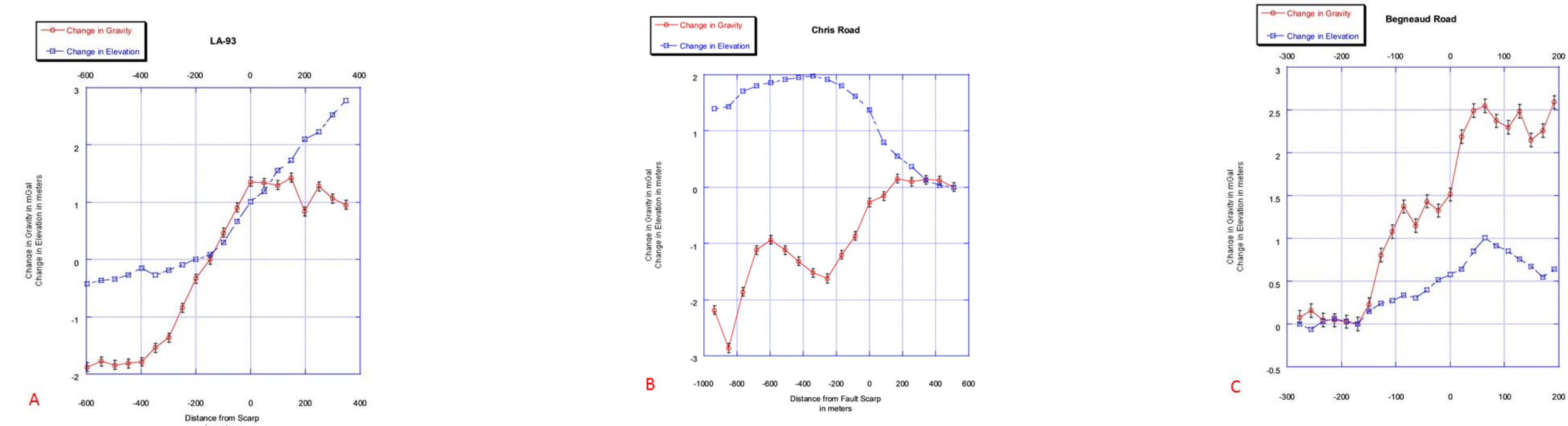


Figure 5. Data from the three profiles over the fault scarp where its scarp is visible in the LIDAR data. A) Data for profile LA-93, B) Data for profile Chris Road and C) Data for profile Begnaud Road. (Modified after Kushiya, 2010)

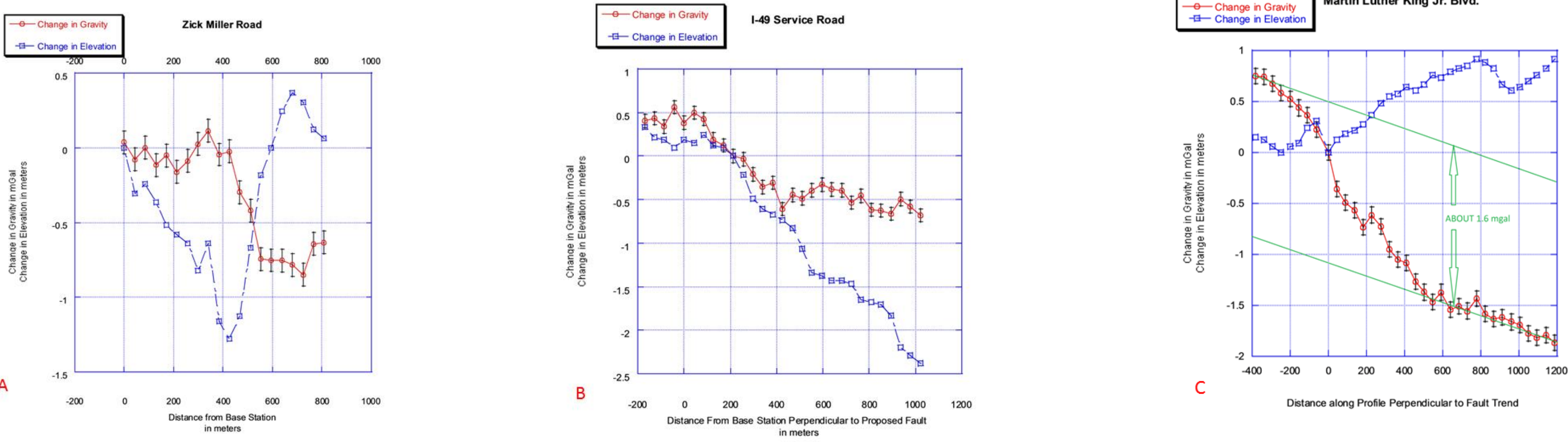


Figure 7. Data from the three profiles over the proposed location of the buried fault. A) Data for profile Zick Miller Road, B) Data for profile I-49 Service Road and C) Martin Luther King, Jr. Boulevard. (Modified after Kushiya, 2010)

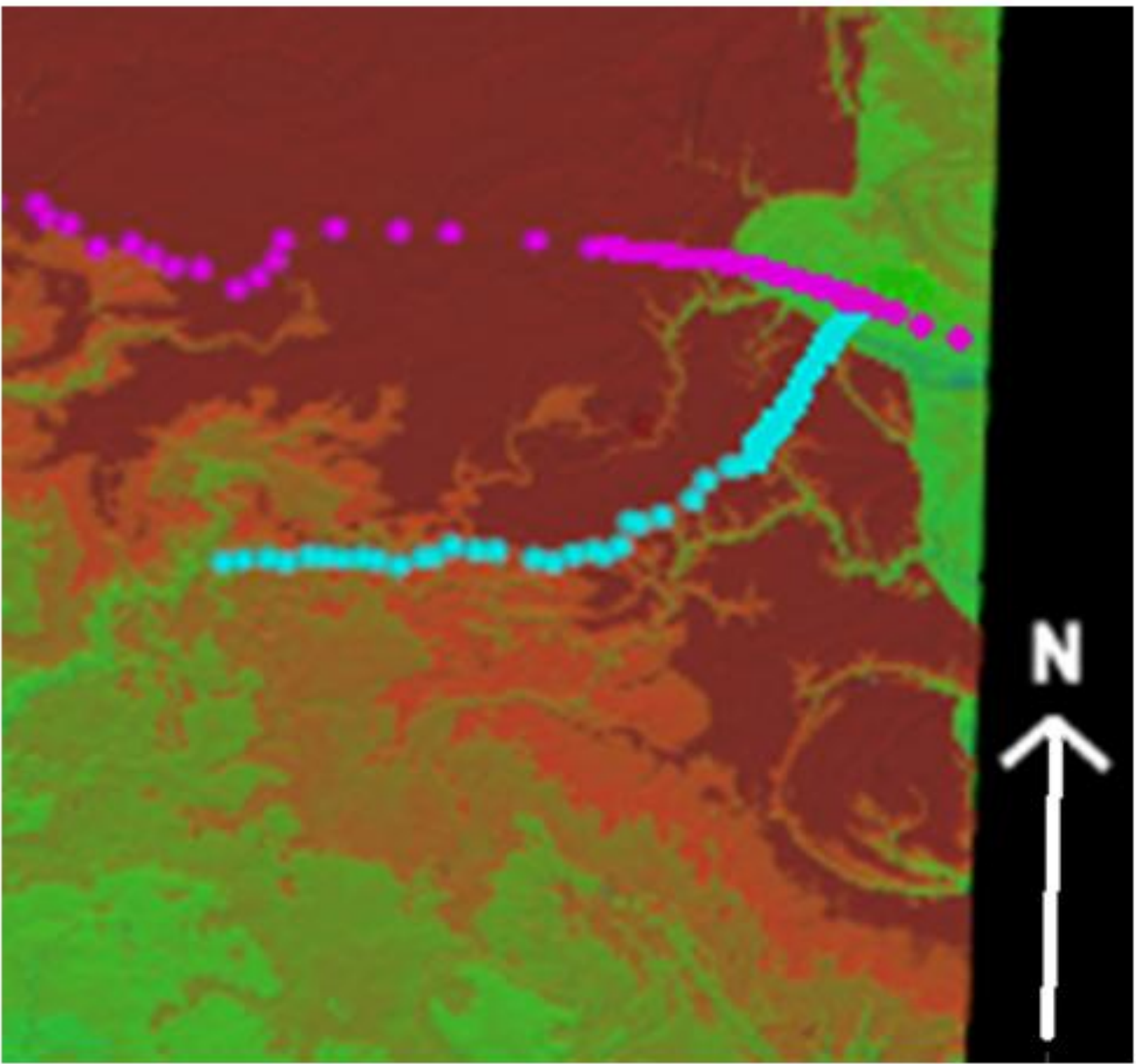


Figure 8. Likely continuation of the subject fault to a connection with the fault to the north and their similarly likely continuation beneath the Holocene deposits of the Mississippi Valley fill. Compare to Figure 1 for scale. (Modified after Kushiya, 2010)

CONCLUSION

Gravity, LIDAR topography and satellite image data have been combined to confirm the interpretation that a fault, whose scarp disappears at the base of Pleistocene Mississippi Meander over bank deposits near Grand Coteau, LA, is actually buried by the deposits and is therefore strictly older than the meander.

Reference: Kushiya, Shawn, 2010, Temporal Relationships of the Topographic Features in the Area of Opelousas and Lafayette, LA: Features Imaged with LIDAR Data Analyzed in 3D Virtual Reality, MS Thesis at The University of Louisiana at Lafayette, 101p.