

# Investigation of an Incipient River Anticline Downstream of Moab, UT

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## Background

Much of the eastern Colorado Plateau, including the Canyonlands district, is underlain by the Paradox Formation, which includes thick bodies of salt that flow under pressure gradients. The mobilization of Paradox salts has formed bedrock ridges (anticlines) and collapsed valleys (graben) that are prominent in this landscape (Trudgill, 2011). In special situations, recent local erosion and unloading causes Paradox salts to flow upward under canyons along the Colorado River, deforming the overlying rocks into "river anticlines" (Huntoon, 1982).

## Research Questions

1. Is part of the dome structure observed in the northern half of Shafer Basin caused by an incipient, actively forming river anticline? Or is it the older form of the Cane Creek anticline?
2. What is the stratigraphic depth of river incision into the regional sedimentary layers, especially the Honaker Trail Formation, along Meander Canyon? Is there a consistent threshold of incision that initiates the formation of a river anticline?

This research seeks to help complete the story of landscape evolution in the Canyonlands district of Southern Utah. It explores the connection between climatic processes and large scale geologic deformation. This research has implications in petroleum exploration in the area and elsewhere because anticlines typically collect and store local petroleum.

## Geologic Setting

This study examines three river anticlines in Meander Canyon: the hypothesized Shafer Basin Meander anticline (SBMA), the subtle Lockhart Canyon Meander anticline (LCMA), and the archetypal Green River Confluence Meander anticline (GRCMA). Both of the verified river anticlines were described by Huntoon (1982). During the Pennsylvanian period (323-298 mya) thick packages of salt accumulated within the Paradox Basin as the waters of restricted inland sea rose and fell, forming the Paradox Formation. The building of the Colorado Plateau continued to the near present as the Colorado river formed about 2 mya. While the Colorado river has been eroding canyons, Paradox salts have formed valleys and ridges across the landscape, including river anticlines.

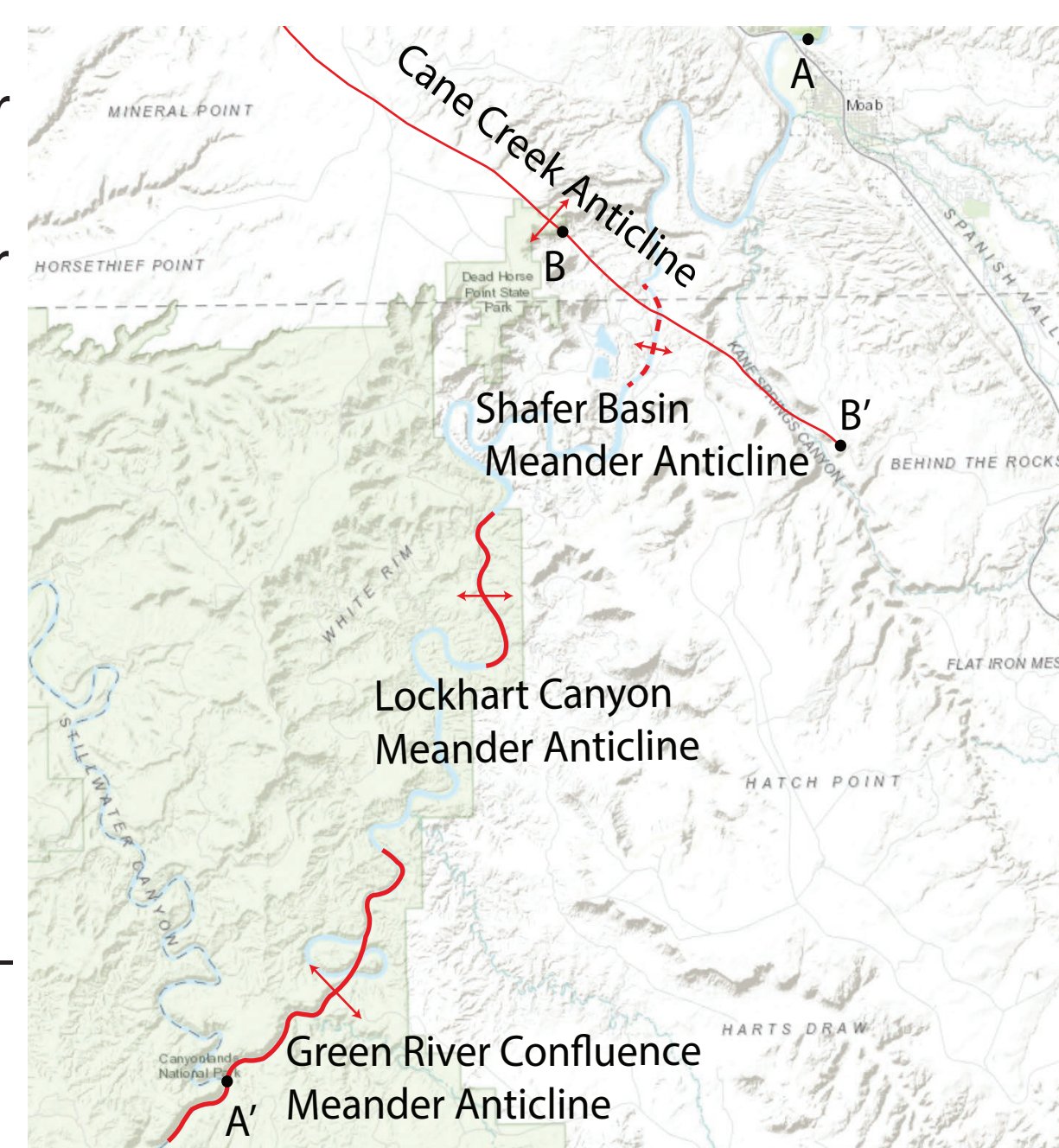


Figure 1: Study site map and structures (upper) Shafer Basin (lower)

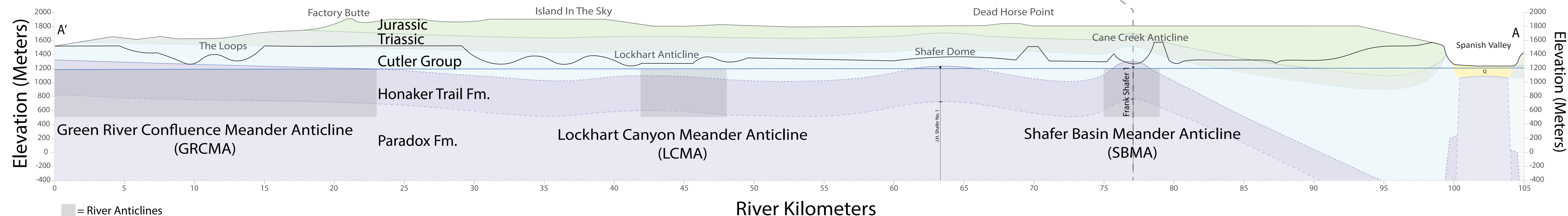


Figure 4: Cross Section along Colorado River between Moab and the Green River Confluence (left) and cross section along the axis of the Cane Creek Anticline (above). 5x Vertical exaggeration

## Methods

### Research Component 1: Surface Bedding Orientations

- Surface bedrock orientations (strike and dip) of the hypothesized river anticline and the two verified river anticlines were collected using virtual-reality photogrammetric methods within set distance intervals on either side of the Colorado River
- SBMA bedding orientations were then rotated to remove the tilt caused by the Cane Creek anticline
- Bedding orientations of the hypothesized SBMA were compared to LCMA and GRCMA using Stereonet software (Figure 3)

### Research Component 2: Stratigraphic Cross Sections

- Compiled subsurface formation contact elevations from local petroleum wells (well logs obtained from the Utah DNR)
- Collected data on the position of upper contact of the Honaker Trail Formation as a stratigraphic marker in the field
- Cross sections constructed by integrating subsurface and field data with geologic maps and cross sections by Doelling et al. (1994) (Figure 4)

## Findings

### Research Component 1:

- Bedding orientations dip away from the river, for all investigated anticlines
- There is no abundantly coherent correlation between river distance and dip magnitude. In general, dip magnitude is inversely related to distance, with exceptions

### Research Component 2:

- The Cane Creek Anticline Cross section shows a distinct arch in the Honaker Trail Fm. and Paradox Fm. beneath the Colorado River.
- The Honaker Trail is exposed in three locations, the hypothesized SBMA, Shafer Dome, and GRCMA (Figure 2). It is ~130 meters below the surface at LCMA

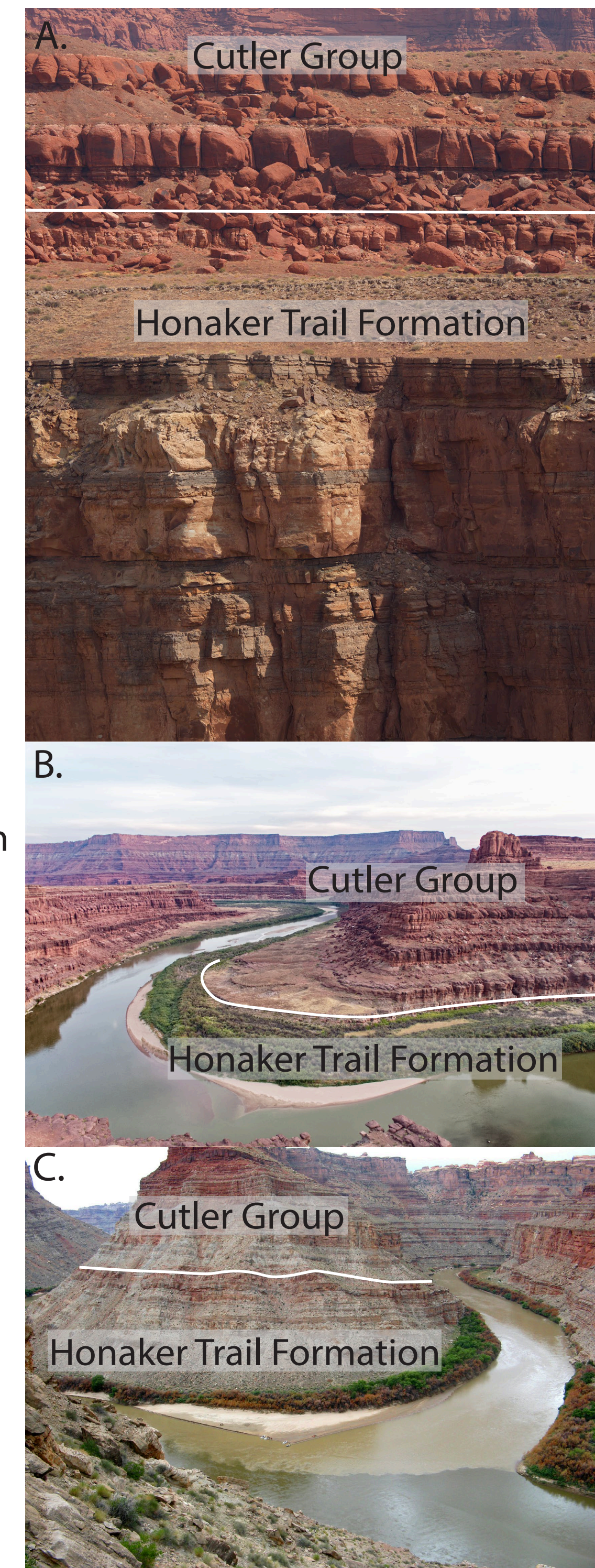
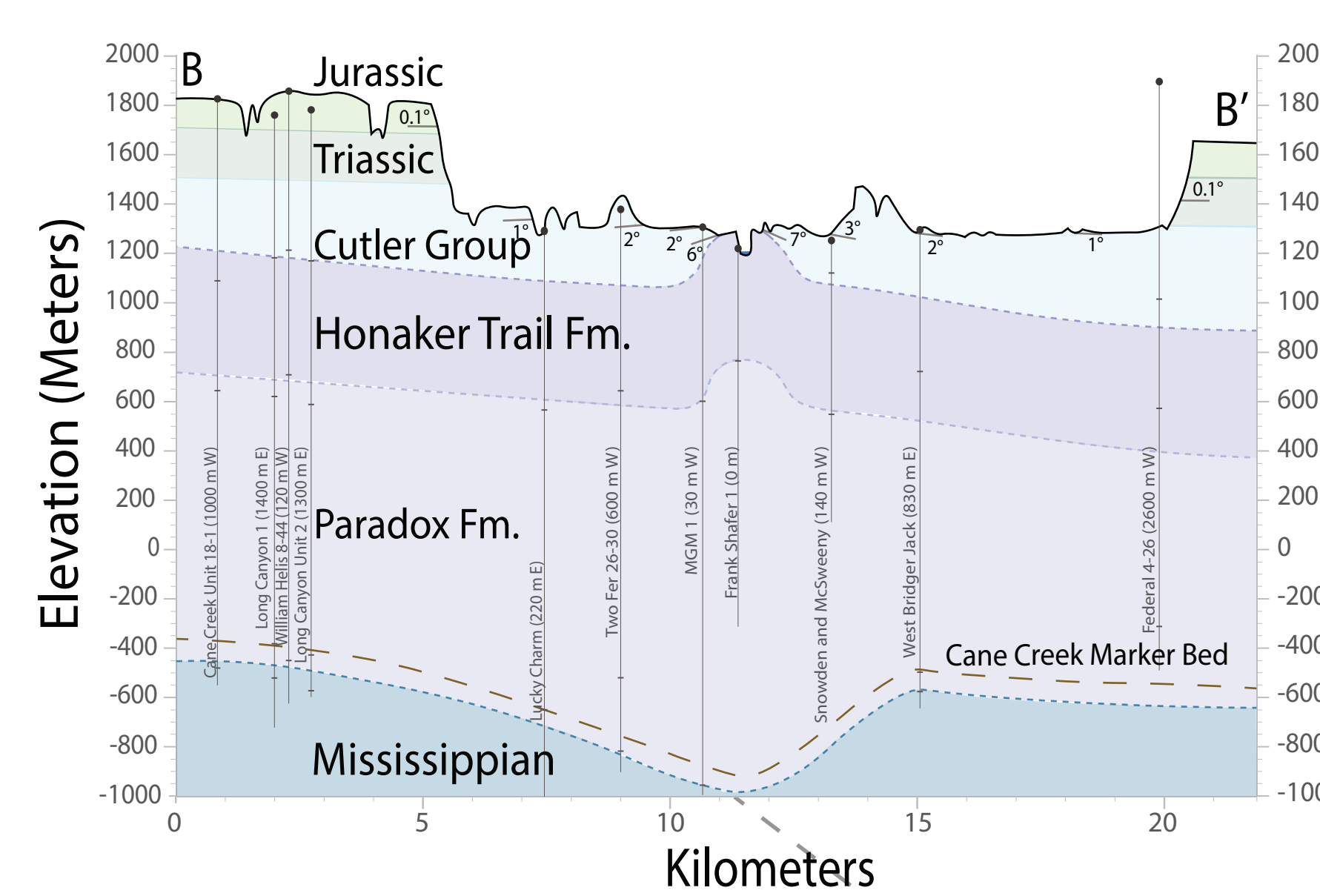


Figure 2: Honaker Trail exposures. A. Shafer Basin, B. Shafer Dome, C. Green River Confluence

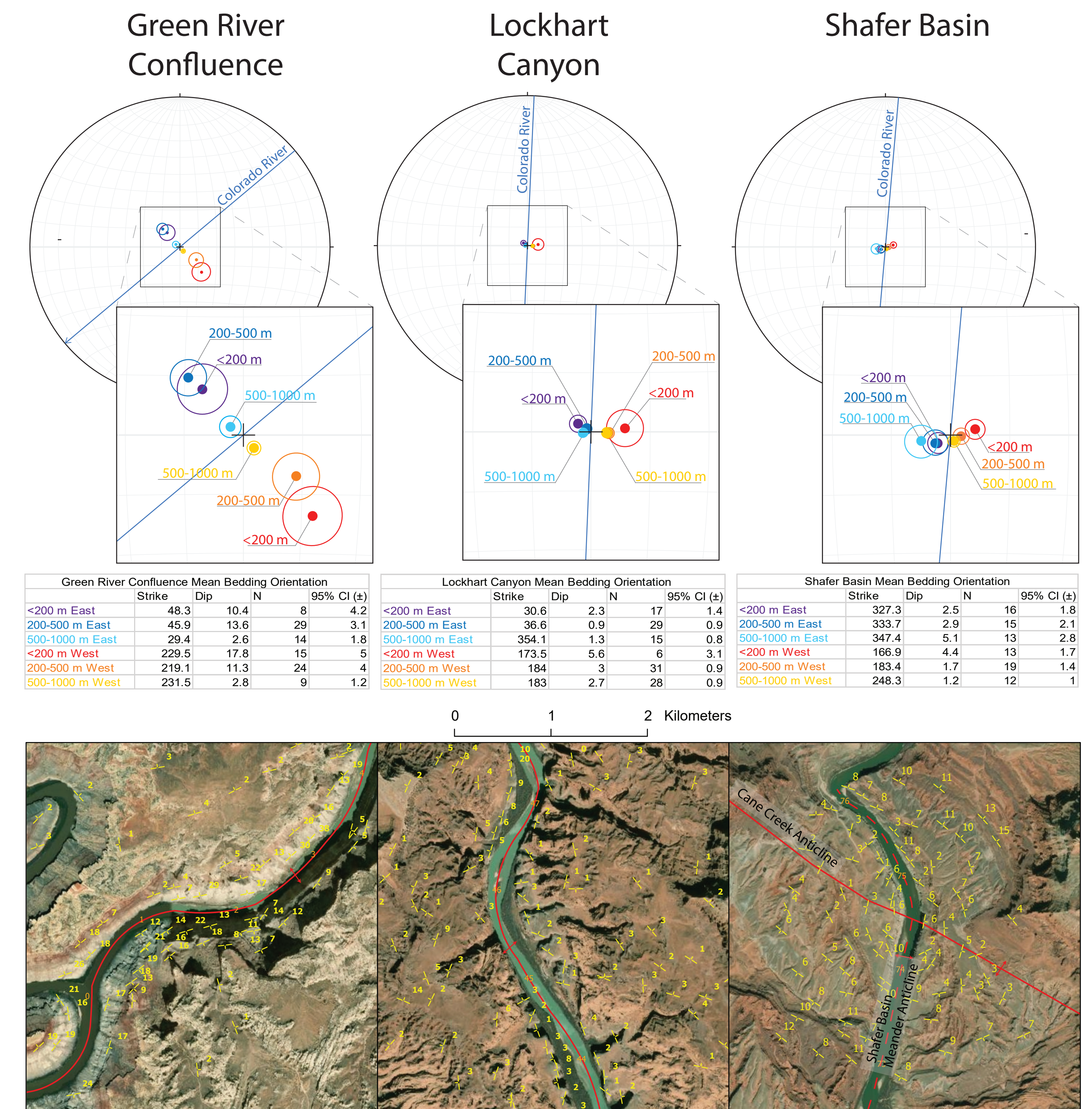


Figure 3: Mean poles to bedding (upper) and mapped bedding orientations (lower)

## Conclusion

### Research Question 1:

The hypothesized Shafer Basin Meander Anticline is supported by findings from research component 1 and 2. Bedding orientations dip away from the river on both sides of the river. This trend is observed in the two verified river anticlines, as well as in the hypothesized river anticline. Because the Cane Creek anticline cross section is coincident with the anticline's axis, it shows bedding orientations independent of the effect the Cane Creek anticline has on bedrock. Therefore, the distinct arch seen in the Honaker Trail Fm. and corresponding thickening of the Paradox Fm. is caused by a different structure. Furthermore, because the Colorado River neatly bisects the dome in Shafer Basin, this structure most likely formed at the same time as canyon incision. The presence of an incipient river anticline at Shafer Basin is the most plausible explanation for these observations.

### Research Question 2:

Findings from research component 2 do not support a consistent stratigraphic incision threshold to initiate the formation of a river anticline. At both the GRCMA and SBMA the Honaker Trail Fm. is exposed above the canyon bottom, but at LCMA it is below. It is possible such a threshold exists where the Honaker Trail Fm. is ~100 meters below the surface and that the GRCMA actually extends several kilometers further upstream than Huntoon (1982) mapped. To prove this will require more detailed mapping of the GRCMA.

## Works Cited

- Doelling, H.H., Yonkee, W.A., and Hand, J.S., 1994, Utah Geological Survey, Gold Bar 7.5' Quadrangle, Map 155, scale 1:24,000.
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- Trudgill, B.D., 2011, Evolution of salt structures in the northern Paradox Basin: controls on evaporite deposition, salt wall growth and supra-salt stratigraphic architecture. Basin Research, v. 23(2), p. 208-238