Planation surfaces formed by river piracy?

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The idea of river piracy is that the tributary of a river erodes through a headwater barrier and captures the water from another river or stream (figure 1). As a result, the water increases in the pirating stream and decreases at the downstream end of the captured river. By this process, river piracy or capture is considered one of the main uniformitarian explanations for how a water gap (a deep pass through a mountain, mountain range, plateau, or any other transverse barrier) can be formed.[1–3]

However, despite the presence of thousands of water gaps across the earth's surface there is no concrete evidence that this is an adequate explanation. More surprising, though, is the recent argument that water gaps, apparently derived from river piracy, are also responsible for explaining regional scale planation surfaces. The concept that low-relief landscapes can be formed by river piracy and river network disruptions such as water gaps, put forward in a recent paper, is strongly challenged here.

Observation of river piracy

River piracy has been *inferred* from relief (topography). It has never been observed—until recently.[1,2] The Slims River in the Yukon Territory of Canada flows north and the Kaskawulsh River flows south-east from a very low divide occupied by the outlet of a valley glacier. The snout of the glacier receded back due to what some claim to be recent global warming.[3] In May 2016, the Kaskawulsh River captured the Slims River. It appears that before the Little Ice Age, the water of the Slims River had flowed south into Kaskawulsh River, like it does today. But when the glacier advanced during the Little Ice Age in the 1700s and 1800s, an outwash fan separated the river, allowing the two branches to flow north and south until May 2016. The authors of the original report stated their accomplishment:

> "Furthermore, previous studies of river piracy have dealt with capture over Quaternary or longer timescales, with no one, to our knowledge, having detailed the phenomenon in the modern era."[4]

Although this is the first observation of river piracy, it is a trivial example, especially when river piracy is invoked to account for gorges that transverse barriers hundreds of metres high.

River piracy claimed to cause planation surfaces on south-east Tibetan Plateau

Planation surfaces[5] are common geomorphological landforms found at all elevations all over the earth. They are generally flat surfaces eroded in hard rock with a veneer of mostly rounded rocks capping the surface. The most distinctive planation surfaces are found at the tops of mountains. These are the most challenging for uniformitarian scientists to explain.[6] It is all the more difficult since many active mountains of the world have mountaintop planation surfaces: "Low-relief erosional surfaces have been described in nearly every active orogeny [mountain range]."[7]

For example, the Tibetan Plateau is a 2.5 million km^2 dissected planation surface about 4,500–5,000 m above sea level. The dissected planation surface slopes south-east toward lower elevations.[8] The sloping surface is highly dissected by three rivers that form gorges 3–4 km deep.

The traditional view is that the Tibetan Plateau planation surface was carved near sea level, uplifted, and dissected. Yang *et al.* proposed a new, ingenious hypothesis based on river capture. To explain why planation surfaces lie between the rivers, Yang *et al*. assumed that the surfaces originally formed well above sea level, *in situ* with a little isostatic uplift.[9,10] They suggested that a tributary from one river captured the water from a second river. With decreased flow, the second river was unable to significantly erode its channel bed. Then, as the sides of the second river eroded more, the area occupied by the second river eroded into a nearly flat surface.

New hypothesis untenable

This new hypothesis for the formation of mountaintop planation surfaces at near their current elevation has numerous problems.[11,12] First, Yang *et al*. used only a simple model to verify their hypothesis, but the area is so complicated with three parallel, deep river gorges in close proximity separated by planation surfaces that it demands a more complex model. Even a complex model would not be able to account for the many variables and their nonlinear interactions, such as changing mountain relief due to erosion.

Second, Yang *et al*. need numerous expansions and contractions of river networks. It would take multiple tributary captures to flatten all the interfluves between the present-day modern rivers. Unfortunately for their proposal, it does not appear that significant rivers ever occupied the planation surfaces, yet it is claimed that the rivers originally carved the planation surface.[8]

Third, the planation surface should be at different elevations south-east of the Tibetan Plateau because the rivers would have had different volumes of flow and erosion potential, but instead are of similar elevation, sloping down in a south-east direction. The area generally looks like a huge single, dissected planation surface, as traditionally believed.

Fourth, the evidence for river capture is equivocal, since the

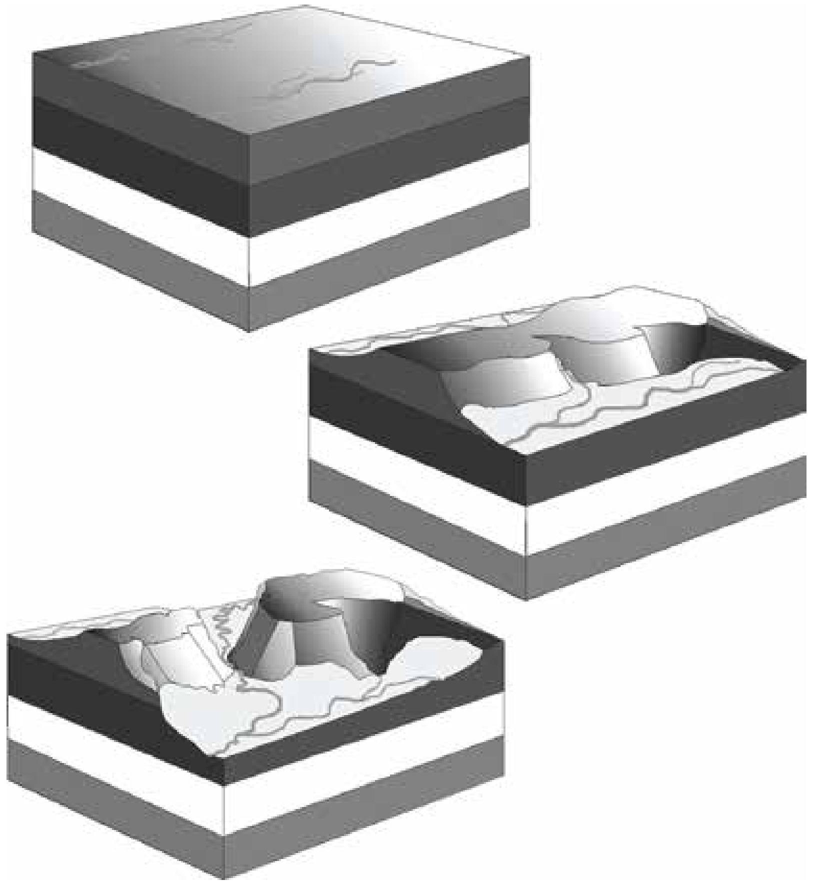

Figure 1. Block diagram of river capture (drawn by Peter Klevberg). Two streams are flowing parallel to each other, and the tributary of one stream erodes through the ridge between the streams and captures the water from the other stream.

suggested evidence can just as well be explained by the uniformitarian mechanism of an uplifted planation surface that is dissected.

Fifth, there may not have been enough time for the planation to occur while the catchment edge of the second river was aggressively incised by neighbouring rivers.

So, it looks as though the traditional explanation of the uplift of a planation surface is still the preferred view. Whipple and colleagues conclude:

> "… [this] demonstrates that the topography [of the south-eastern Tibetan Plateau] is in no way consistent with the drainage network dynamics mechanism and is fully consistent with incision into an elevated, pre-existing low-relief landscape."[13]

Discussion

Planation surfaces do not form today, except along the edge of flooding rivers.[14,15] Instead, they are dissected and destroyed. It is more likely the Tibetan Plateau planation surface was carved by a wide, fast-moving current of water consistent with the sheet flow runoff during the Recessive Stage of the Flood.[16] The fact that the planation surface was carved on variable rock types supports this conclusion.[8]

The planing and dissection of the Tibetan Plateau occurred during the Cenozoic. Clark *et al.* state:

> "The landscape of eastern Tibet is highly unusual; it stands at high elevation and is drained by four of the world's largest rivers, yet it has experienced little erosion in Cenozoic time … ."[17]

Presently, the river channels are rapidly eroding, but the erosion has not worked back to the upstream eastern Tibetan Plateau planation surface. The geomorphology of the Tibetan Plateau and the south-east sloping planation surface between rivers strongly suggests that the time for the Cenozoic is greatly exaggerated. This evidence further confirms that water gaps, supposedly derived from river piracy, were not the formative features of the planation surface.

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