

Stories of Other Worlds—How to Build a Landscape Rivers and Base Level—Cool Stuff

Earth Science Essentials
by Russ Colson

The River—The state boundary that moves.

The migration of rivers has a long and complex history in human politics and war. The problem arises because rivers were commonly used to mark boundaries of adjacent political entities. When the rivers inevitably migrated, as mature streams are wont to do, disagreements arose about who owned the new land formed on the inside bend of the meanders. It seems like a simple solution would be to keep the boundaries fixed, whether the river migrates or not. That way, the land controlled by a particular political entity is not changed by the vagaries of erosion and deposition. However, suppose that the river is an important defensive barrier against attack? Clearly, in that case the border needs to be maintained along the river. Or, what if the river is important for commerce and transportation? Again, keeping the border along the river makes sense, regardless of the gain or loss of land.

In his 1715 (edition) book *Of the Rights of War and Peace*, Hugo Grotius took the view that many rivers are defensive boundaries and

...the river, by gradually altering its course, does also alter the borders of the territory; and whatsoever the river casts up to the opposite side, shall be under his jurisdiction, to whom the augmentation is made

Although geologists treat the various processes of river migration (such as erosion, deposition, meander cut offs, etc) as part of a single process, courts have often ruled that they are quite different. In the US of the late 1800s and early 1900, disputes arose between states on opposite sides of major rivers, such as the Mississippi or Missouri rivers. In 1918, the US Supreme Court made the following ruling:

...where running streams are the boundaries between states, the same rule applies as between private proprietors – namely that, when the bed and channel are changed by the natural and gradual processes known as erosion and accretion, the boundary follows the varying course of the stream; while if the stream, from any cause, natural or artificial, suddenly leaves its old bed and forms a new one by the process known as avulsion, the resulting change of channel works no change of boundary, which remains in the middle of the old channel, although no water may be flowing in it and irrespective of subsequent changes to the new channel (US, 1918).

With this ruling, the court decreed that progressive erosion and deposition at a meander is intrinsically different from the formation of a meander cut off..

A Great Harbor that Vanished

In the days when Paul the Apostle spent two years preaching in Ephesus on the western coast of Asia Minor, the region of the Great Theater looked out on a beautiful bay much like that at modern Izmir. A grand walkway led from the theater to the harbor.

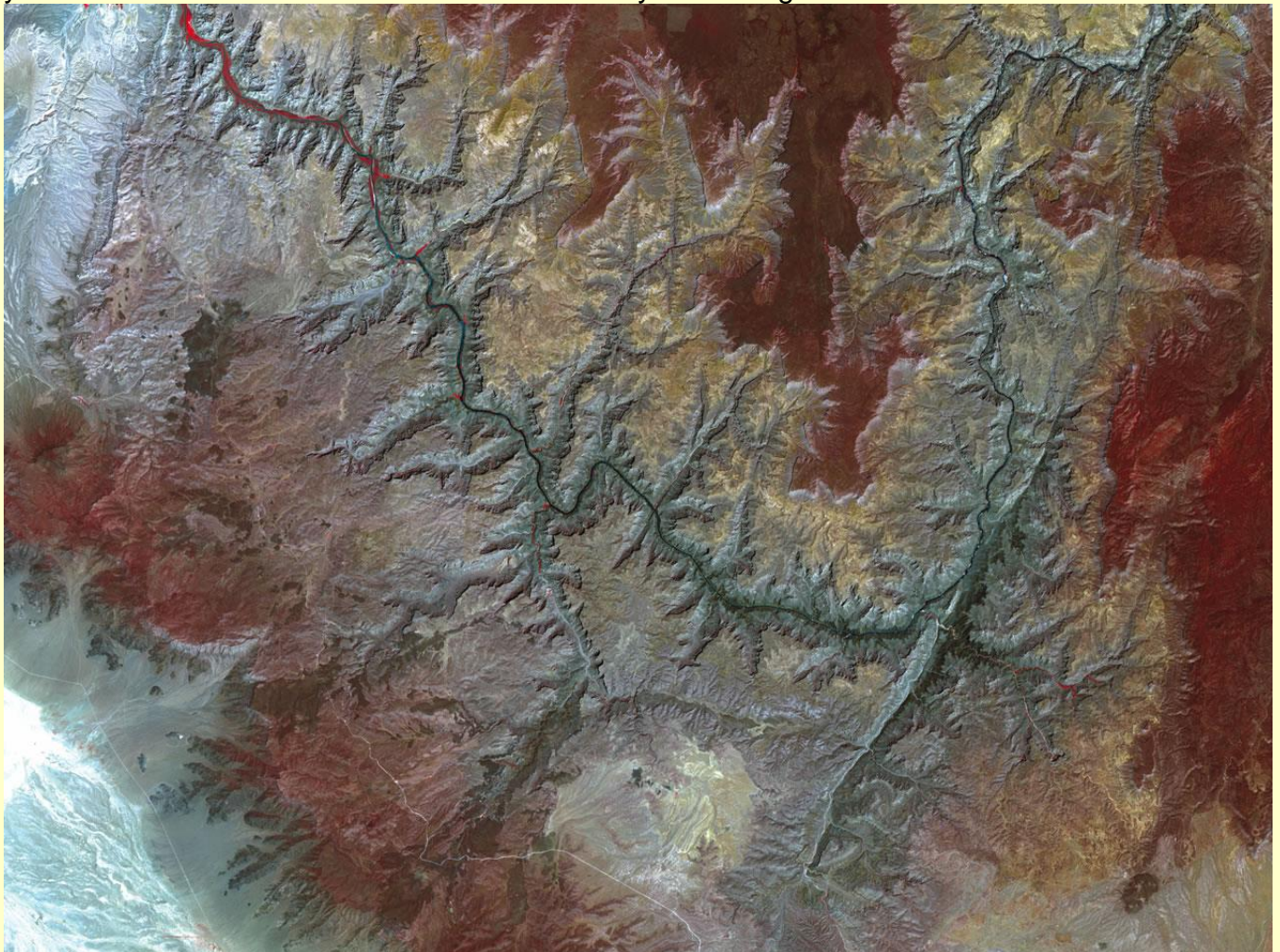
But today, Ephesus is several miles from the sea, landlocked. What happened?

Sediment carried by the river silted up the bay. The bay was below sea level and therefore was filled in with sediment eroded from the land that was above sea level. Agricultural practices in the region probably speeded up the erosion and deposition process.

[Google search:](#)

A Meandering Youthful River

There are a number of youthful rivers with rapid erosion in V-shaped canyons that also meander. For example, consider the image of the Grand Canyon of Arizona below. Do you see all the meanders in the river? It certainly isn't straight. What's with that?



Grand Canyon image courtesy of NASA—Earth Observatory, 2006

This tendency to have traits characteristic of both youthful and mature streams is common among the canyons on the Colorado Plateau. The Goosenecks, a canyon system of the San Juan River in Utah, exhibit even more spectacularly both meandering and youthful characteristics.



Picture courtesy of NASA: Earth Observatory 2005

The geological story told by this juxtaposition of youthful and mature traits is that the rivers were mature, meandering rivers on a broad peneplain at base level when the

Colorado Plateau was uplifted above its base level by tectonic forces. The rivers eroded downward in their already-meandering course, cutting V-shaped canyons into the peneplain. Such rivers are called rejuvenated streams. Notice the flat rim of the Grand Canyon in the pictures below, a remnant of that ancient peneplain.



Grand Canyon National Park, AZ

Last updated July 8, 2015. All text and pictures are the property of Russ Colson except as noted.