Part X

All Uniformitarian Hypotheses Fail

We have surveyed planation surfaces around the world. With planation surfaces so common, one would think that uniformitarian scientists would have a viable theory for their origin—if uniformitarianism is a true principle for the subfield of geomorphology. But, there is no viable hypothesis for the origin of planation surfaces. There have been several hypotheses, which seemed plausible for awhile, but were later discovered to be untenable. Uniformitarian scientists do not like a theoretical vacuum, so the weathering hypothesis seems to be the most popular, default mechanist at present, although it too has series problems. This part will summarize William Morris Davis's once very popular "cycle of erosion," since it is still believed and taught by some scientists today. The deficiencies of the weathering hypothesis will be pointed out with a summary chapter showing that all uniformitarian hypotheses fail.

Chapter 50

Davis's Failed "Cycle of Erosion"

For much of the mid 1800s, planation surfaces were thought to have been caused by marine erosion, as the sea rose over the land (see Appendix 19). But in the late 1800s, William Morris Davis of Harvard University had a flash of brilliance, or so he thought. Like so many before him, he threw out the Genesis Flood as an explanation of geology and geomorphology. Davis believed that a key transformation in thinking was required to understand landforms, and that was to throw out the Genesis Flood, which lingered into the late 1800s in a greatly weakened state.[1] Davis concluded:

> The emancipation of geology from the doctrine of catastrophism [the Genesis Flood] was a necessary step before progress could be made towards an understanding of the lands.[2]

Once the Genesis Flood was gone, Davis audaciously predicted the understanding of planation surfaces and other aspects of geomorphology was just around the corner:

> It cannot be doubted, in view of what has already been learned today [sic], that an essentially explanatory treatment must in the next century [twentieth century] be generally adopted in all branches of geographical study…[3]

Instead of progress, history now shows that Davis' antipathy to the Flood resulted in a dead end. He ended up throwing out the key to understanding landscapes, and eventually his hypothesis ended up on the trash heap of hypotheses.

Davis' Lucky Break

Davis developed the "cycle of erosion" hypothesis in the late1800s. For many years it was the most popular hypothesis for the formation of erosion surfaces, but it did not apply to planation surfaces.

Davis was born into a liberal Quaker home. His father was expelled from the church so his religious views ended up mainly being moral sentiments. This eventually led him into Unitarianism and an unshakeable faith in the hypothesis of evolution. His real interest was geology. He joined the geology department at Harvard University, despite having no field experience in geology.[4] After an inauspicious start, he was given a strong hint by the president of Harvard University that he should look for employment elsewhere. He might have disappeared into obscurity, except for one lucky break.

In 1883, Davis was given the chance to conduct a geological survey of the route for the Northern Pacific Railway in Montana. He described his summer on the High Plains of central Montana as a lifesaver, for it was on these plains that he visualized the "cycle of erosion," or the "geographical cycle" as it is also called.[5,6] Chorley and colleagues described his "revelation":

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[1] Mortenson, T., 2004. *The Great Turning Point: "The Church's Catastrophic Mistake in Geology—Before Darwin"*, Master Books, Green Forest, AR.
[2] Davis, W.M., 1954. Geographical essays. In, Johnson D.W. (editor), Dover Publications, Mineola, NY, p. 77.
[3] Davis, Ref. 2, p. 272.
[4] Chorley, R.J., R.P. Beckinsale, and A.J. Dunn. 1973. *The History of the study of Landforms or the Development of Geomorphology—Volume Two: The Life and Work of William Morris Davis*, Methuen & Co LTD, London. U.K.
[5] Chorley *et al*., Ref. 4, p. 135.
[6] Crickmay, C.H., 1974. *The Work of the River: A Critical Study of the Central Aspects of Geomorphology*, American Elsevier Publishing Co., New York, NY, p. 171.

Although Davis constantly acknowledged his debt to such predecessors as Powell, Jukes, Dutton and Gilbert, in later life he came to refer to his first notion of the cycle of erosion, while working on the Northern Pacific Railroad Survey in Montana in 1883, as rather like the blinding flash of understanding experienced by a prophet in the wilderness.[7]

Figure 50.1. Flat planation surface east of Fort Benton showing Missouri River and the railroad tracks that Davis worked on.

What was so special about the geology of Montana that it would birth the once most popular hypotheses in geomorphology? Davis recognized the vast erosion of the plains of Montana and Wyoming based on igneous mesas and dikes that stand out in bold relief.[8] Devils Tower, Wyoming, described in Chapter 9 (see Figure 9.1) and Square Butte, about 2,000 feet (600 m) above the plains east of the Highwood Mountains of central Montana must have figured prominently in Davis' conclusion. He theorized the multiple erosion surfaces on the plains of Montana (see Chapters 36 and 37) were the work of ancient rivers and streams that snaked across the land, smoothing it, over millions of years, although observational evidence indicates that rivers do not plane. He took special note of the comparative smoothness of the eastern Fairfield Bench (Figure 50.1 and see Figure 37.6) between Fort Benton and Great Falls, Montana.[9] He

[7] Chorley *et al*., Ref. 4, p. 160.
[8] Chorley *et al*., Ref. 4, p. 136.
[9] Chorley *et al*., Ref. 4, pp. 162–163.

headed back to Harvard University the next fall and developed his “cycle of erosion” hypothesis. From then on, he published extensively on this subject into the mid-1900s and became the chief geomorphologist of his time.

Davis wrote 80 articles and one book on meteorology.[10] In fact, Davis began his career as a meteorologist, but soon developed an interest in landforms.[11] Maybe a retired meteorologist from Montana (myself), who developed an interest in landforms, and lived near the eastern Fairfield Bench in Great Falls, Montana, for 27 years, can improve Davis’ understanding of the origin of erosion and planation surfaces by rejecting uniformitarianism.

Davis Applied Evolution to Landforms

The theory of evolution strongly influenced the development of Davis’ hypothesis.[12] Summerfield summarized the influence of evolutionary theory on Davis’ views:

> The model of landscape evolution usually known as the cycle of erosion was developed by W. M. Davis between 1884 and 1899 and owed much to the evolutionary thinking that had permeated both the natural and social sciences in Britain and North America during the latter half of the nineteenth century.[13]

Davis believed, as in living matter, landscapes evolved through a progressive sequence of stages, each stage exhibiting characteristic landforms (Figure 50.2). Mimicking the stages of human life, Davis viewed landscapes as starting from *youth*, a low relief landscape that tectonically uplifts (Figure 50.2a to c); progressing into *maturity* (Figure 50.2d to e), where rivers and streams strongly dissect the land; and finally stagnating in *old age*, where the land is subdued to a low relief *peneplain*, near sea level (Figure 50.2f).[14] Then cycle begins anew (Figure 50.2g).

The peneplain was the beginning and the ending point in Davis’ cycle. Uplift was assumed to be so fast at the beginning of the cycle that little erosion happened until the land came to a standstill at high altitude and which lasted many millions of years. During middle and late youth the valleys developed and enlarged as rivers and streams cut deep and wide. The original peneplain between valleys, called interfluves, shrank with time. By early maturity, the old peneplain had disappeared. The eroded ridges were greatly reduced during maturity and formed the new peneplain in “old age.” There could be renewed uplift at any time, which Davis called *rejuvenation*. Rejuvenation would start the cycle all over again. Davis's theory has been dubbed the “punctuated stillstand” by Flemal.[15]

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[10] Chorley et al., Ref. 4, p. 145.
[11] Powell, J.L., 2005. *Grand Canyon: Solving Earth’s Grandest Puzzle*, PI Press, New York, NY, p. 153.
[12] Flemal, R.C. 1971. The attack on the Davisian system of geomorphology: a synopsis. *Journal of Geological Education* 19:3–13.
[13] Summerfield, M.A. 1991. *Global Geomorphology*, Longman Scientific & Technical, New York, NY, p. 457.
[14] Davis, W.M., 1954. Geographical essays. In, Johnson D.W. (editor), Dover Publications, Mineola, NY.
[15] Flemel, Ref. 12, p. 6.

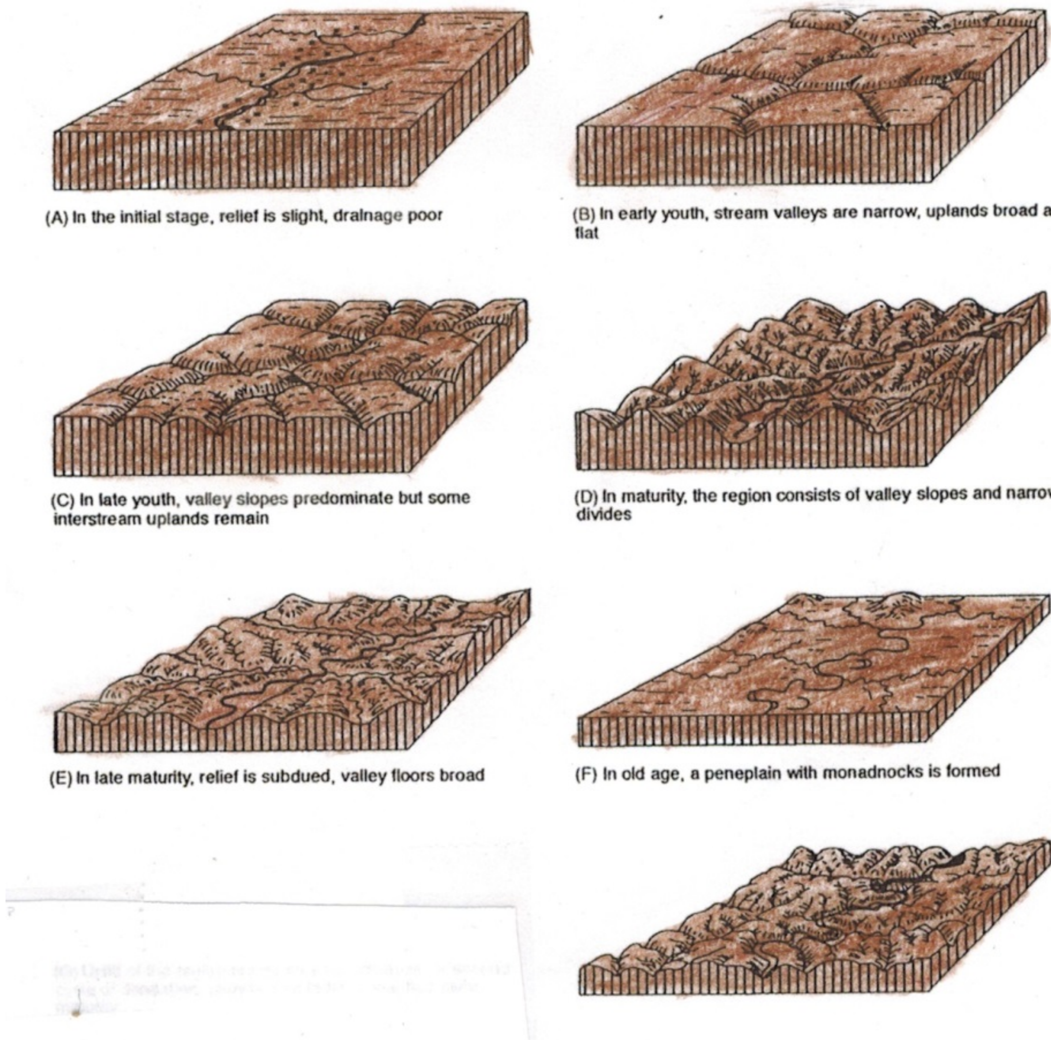

Figure 50.2. Davis's "cycle of erosion" (from Summerfield, 1991, p. 459).

The Hypothesis Rejected

The cycle of erosion had strong appeal. It is easy to see a "mature stage" in the high altitude planation surfaces of the earth today. This is probably why Davis' hypothesis was so popular. He confidently believed that he was laying the foundation for understanding physical geography, and explanatory details would soon follow in the 20th Century.[3] His hypothesis was widely accepted and taught in America (and still is, if only as a popular past hypothesis). Some researchers still use Davis' ideas for modeling.[16] It is easy to understand and seems like common sense from an evolutionary point of view.

But, the cycle of erosion is fraught with difficulties. During the early 1900s, despite its popularity, geologists slowly became skeptical of Davis' ideas. By the 1950s, his hypothesis was widely challenged and just as widely rejected. Summerfield considered the hypothesis vague,

[16] Summerfield, M.A., 2000. Geomorphology and global tectonics: introduction. In, Summerfield, M. A. (editor), *Geomorphology and Global Tectonics*, John Wiley & Sons, New York, NY, p. 5.

qualitative, and based on a number of unreasonable assumptions.[17] Other than *observations* of planation surfaces over large parts of the earth, Davis' hypothesis was simply a collection of intuitive deductions that attempted to explain these flat or rolling surfaces, but which were not based on fieldwork:

> While stressing the Victorian character of much of Davis' work it is only fair to note that he departed from the characteristic standards of much nineteenth-century work in the natural sciences in three important particulars; his lack of detailed field measurements, his unconcern with details of processes prompting change and the entirely qualitative nature of his methods.[18]

Davis' deductions were not in themselves bad, it is mainly his failure to test them in the field that was problematic. Davis did not demonstrate how the transition occurred between stages by detailed observations and experimentation. When challenged about his lack of observations, Davis simply pointed out the enumerable flat surfaces that grace the landscape of the earth as evidence for his hypothesis[14,19]—a logical fallacy called *begging the question*.

It is important to understand that Davis actually envisioned the peneplain as a *rolling surface of low relief*, an erosion surface and not a flat planation surface.[20] Peneplain actually means *nearly a plain*, and it has been estimated to take 20 to 200 million years just to achieve this rolling peneplain.[21] But, achieving a flat surface is many times more difficult and time consuming than forming the rolling surface. There has not been enough time, even over 500 million years, to form a planation surface! Some geologists have pointed out that a generally flat plain could never be formed in the "cycle of erosion."[22,23,24] Cliff Ollier claimed that just one-half of Davis' cycle took the last half of the Phanerozoic, or 250 million years, in the highlands of southeast Australia![25] Because many of Davis' peneplains, including the ones in Montana, are actually quite flat,[26] they should more properly be called planation surfaces and not peneplains. According to Davis' hypothesis they should not have formed at all. Jonathan Phillips believes flat planation surfaces are actually an impossibility: "Because some relief must be present and truly flat erosional surfaces would defy geophysical principles, Davis coined the term peneplain, or "almost-plain."[27]But some planation surfaces, such as the African Surface in Africa, are perfectly flat: "Over many areas planation was so perfect that the horizon appears almost as level as the sea."[28]

Davis also failed to provide any examples of the ending stage: a peneplain at sea level.[12,29,30] He once suggested the low altitude plains of the Ob and Irtysh Rivers of western Siberia as a

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[17] Summerfield, Ref. 13, p. 460.
[18] Chorley *et al*., Ref. 4, p. 194.
[19] Chorley *et al*., Ref. 4, pp. 242–243.
[20] Summerfield, Ref. 13, pp. 458–459.
[21] Chorley, R.J., S.A. Schumm, and D.E. Sugden, 1984. *Geomorphology*, Methuen, London, U.K., p. 65.
[22] Crickmay, C.H., 1933. The later stages of the cycle of erosion: some weaknesses in the theory of the cycle of erosion. *Geological Magazine* 70:337–347.
[23] Crickmay, Ref. 6, p. 173.
[24] Hart, M.G., 1986. *Geomorphology Pure and Applied*. George Allen & Unwin, London, U.K., p. 21.
[25] Ollier, C., 1991. *Ancient Landforms*, Belhaven Press, New York, NY, p. 200.
[26] Crickmay, Ref. 6, p. 174.
[27] Phillips, J.D., 2002. Erosion, isostatic response, and the missing peneplains. *Geomorphology* 45:226.
[28] King, L.C., 1956. A geomorphological comparison between Eastern Brazil and Africa (Central and Southern).*The Quarterly Journal of the Geological Society of London* 112:460.
[29] Chorley *et al*., Ref. 4, p. 199.
[30]:Phillips, Ref. 27, pp. 225–241.

modern example of a peneplain, but they are not erosion surfaces but instead are depositional surfaces.[31] Therefore, the final stage of the cycle of erosion is *not* observed in the landscape today; it is imaginary:

> ...the scheme of the cycle is not meant to include any actual examples at all, because it is by intention a scheme of the imagination and not a matter of observation...[32]

Another major problem with the Davis hypothesis is that renewed uplift and rejuvenation would begin long before the old-age stage would begin. So, peneplains should be rare in nature, if uniformitarianism is the guiding principle. Although it is possible that Davis' hypothesis hypothetically could form multiple erosion surfaces at different levels in an area, by rejuvenation,[33] most geomorphologists believe multiple levels are difficult for the hypothesis.[34,35,36] As the lower peneplains developed, the higher "peneplains" should be destroyed by erosion. Multiple levels as observed in northern Montana and southern Canada (see Chapters 36 and 37), should not exist in Davis' hypothesis.

Despite the objections of an increasing number of detractors, Davis did realize that there were many other variables and complications to his simple sequence. His hypothesis was meant to be the *ideal case* that applied in a humid temperate climate on rocks of uniform lithology. He developed a general, or expected, landform evolution model. Most geomorphologists did not understand this. He expected the complications would be dealt with in time by other geologists. Davis later developed a separate cycle of erosion for two special cases, arid and glacial landscapes.

Table 50.1 presents a summary of the many problems with Davis' cycle of erosion. Because of these problems, several alternative hypotheses have been advanced, as presented in Appendix 19. Out of all these hypotheses, it seems the weathering hypothesis is the only one advocated by a significant number of geomorphologists today (see Chapter 51).

1. Vague and qualitative
2. Few areas of the world stable long enough to form a peneplain
3. Rapid uplift with no erosion unlikely
4. Could not account for assumed, frequent, and rapid climate change during many ice ages
5. Geological structure ignored
6. Climate ignored
7. Not enough time to form a planation surface
8. Problem accounting for multiple planation surfaces in an area
9. Spasmodic uplift more likely than continuous uplift
10. Base level (sea level) does not remain constant for very long
11. Examples of peneplains usually too flat
12. High monadnocks should not form

Table 50.1. Problems with Davis' cycle of erosion.

[31] Crickmay, C.H., 1972. Discovering a meaning in scenery. *Geological Magazine* 109:171–177.
[32] Davis, Ref. 14, p. 281.
[33] Garner, H.F., 1974. *The Origin of Landscapes: A Synthesis of Geomorphology*, Oxford University Press, New York, NY, p. 10.
[34] Penck, W., 1953. *Morphological Analysis of Land Forms—A Contribution to Physical Geology*, translated from the German by H. Czech and K.C. Boswell, MacMillan and Co. London, U.K., p. 225.
[35] Crickmay, Ref. 6, pp. 176–178.
[36] Crickmay, C.H., 1975. The hypothesis of unequal activity. In: Melhorn, W.N. and R.C. Flemel (editors), *Theories of Landform Development*, George Allen and Unwin, London, U.K., pp. 103–109.

Hypothesis Believed Mainly Because of Social Variables

Why did Davis' cycle of erosion become so popular in the early 1900s? The success of Davis' hypothesis was in no small measure due to its advantageous educational style:

> The success and general popularity of the Davisian system is in no small measure attributable to its obviously advantageous pedagogical [educational] qualities, both in its coherency and its ready adaptation to simple presentation.[37]

Eventually Davis became such an authority that few dared challenge him, and so his hypothesis lived long—except in portions of Europe as shown in Appendix 19:

> Unfortunately when a person such as Davis becomes an *authority* his hypotheses tend to be uncritically accepted as laws by his lesser disciples, and so may lead to a lessening of scientific investigation (emphasis theirs).[38]

This is part of the reinforcement syndrome, as Crickmay corroborated:

> Geographical old age and peneplanation rest on nothing but pure deduction by a few great masters of geography and geology and a blind acquiescence by the rest of us.[39]

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[37] Flemel, Ref. 12, p. 3.
[38] Chorley et al., Ref. 4, p. 753.
[39] Crickmay, Ref. 22, p. 337.