Chapter 26

Pediments point to a Late Cenozoic Flood/post-Flood Boundary

A pediment is a: "A broad sloping rock-floored erosion surface or a low relief plain typically developed by sub aerial [at the surface] agents (including running water), in an arid or semiarid region at the base of an abrupt and receding mountain front or plateau escarpment…"[1] This is the formal definition, but a very broad one and subject to disagreement over terms.[2,3] Essentially a pediment is a planation surface that lies at the foot of a mountain, mountain range, ridge, or plateau. It is assumed that the pediment is being eroded into the high terrain. Pediments are most evident in dry climates. This has led many geologists to ascribe their origin to a dry environment, as the definition above implies. This may only be a selection artifact since deserts have slower erosion rates, and the lack of vegetation makes it easier to observe and describe them.[4] But, pediments are *not* restricted to dry areas and may be found in *any* climate, cold or warm, wet or dry.[5]

Properties of Pediments

Although pediments are generally flat, they slope gently away from the mountain range, ridge, or plateau with a slightly concave upward profile, steepening slightly toward the adjacent mountains.[6,7] The slope within about a half-mile (1 km) from the mountain front generally ranges from 1° to 6°[8] and flattens farther away from the mountains where it blends into the lower piedmont. The size of pediments varies from less than 0.25 mi^2 (1 km^2) to large planation surfaces of a few hundred mi^2 (hundreds of km^2).[9] Sometimes, there are two or more levels of pediments in valleys.

Pediments sometimes erode rock similar to that found in the adjacent mountains,[9] while in other areas, like in southwest Montana, it appears the pediments mostly cut across valley-fill sedimentary rocks and not the rocks at the edge of the mountains. Pediments bevel all types of rocks,[6,10] but are most commonly cut in granitic rocks.[11,12] In sedimentary rocks, pediments often

---

[1] Neuendorf, K.K.E., J.P. Mehl, Jr., and J.A. Jackson, 2005. *Glossary of Geology*, Fifth Edition. American Geological Institute, Alexandria, VA, p. 477.
[2] Thomas, M.F., 1994. *Geomorphology in the Tropics: A Study of Weathering and Denudation in Low Latitudes*, John Wiley & Sons, New York, NY, p. 244.
[3] Dohrenwend, J.C., 1994. Pediments in arid environments. In, Abrahams, A.D. and A.J. Parsons (editors), *Geomorphology of Desert Environments*, Chapman & Hall, London, U.K., p. 322.
[4] Summerfield, M.A. 1991. *Global Geomorphology*, Longman Scientific & Technical, New York, NY, p. 347.
[5] Whitaker, C.R., 1973. *Pediments: A Bibliography*. Geo Abstracts Ltd, University of East Anglia, Norwich, England, p. 95.
[6] Mammerickx, J., 1964. Quantitative observations on pediments in the Mojave and Sonoran Deserts (Southwestern United States). *American Journal of Science* 262:417-435.
[7] Hadley, R.F., 1967. Pediments and pediment-forming processes. *Journal of Geological Education* 15:83-89.
[8] Twidale, C.R. and J.A. Bourne, 1998. Origin and age of bornhardts, southwest Western Australia. *Australian Journal of Earth Sciences* 45:903-914.
[9] Ritter, D.F., 1978. Pediments. In, *Process Geomorphology,* Wm. C. Brown, Dubuque, IA, pp. 290-299.
[10] Melton, M.A., 1965. The geomorphic and paleoclimatic significance of alluvial deposits in southern Arizona. *Journal of Geology* 73:1-38.
[11] Tuan, Y.-F., 1959. Pediments of Southeastern Arizona, *University of California Publications in Geography 13*, University of California Press, Berkeley, CA, pp. 113-114.

shear the layers at an angle.[13] Figure 26.1 shows a pediment at the edge of the Ruby River Valley along the western slope of the Gravelly Mountains of southwest Montana. Note the sedimentary layers tilt down to the right (east) at a low angle, while the surface of the pediment has been beveled to the left (west) at a low angle. The pediment was carved evenly across sedimentary rocks of varying resistance and angles.[14,15,16] Erosion today erodes the softer rocks faster, leaving behind valleys in soft and ridges on hard rocks.

Figure 26.1. Pediment in the Ruby River Valley along the western slope of the Gravely Range of southwest Montana. Note that the sedimentary layers of the valley fill dip right (east), while the pediment surface dips left (west) and shears the sedimentary layers evenly at a low angle.

Some of the early geologists actually thought pediments were alluvial fans, since they looked similar,[8] but were greatly surprised to discover hard rock surfaces below a thin veneer of mostly rounded rocks.[17] Sometimes there was no veneer at all. So, the pediment is in reality a surface left after the erosion of rock.

---

[12] Oberlander, T.M., 1972. Morphogenesis of granitic boulder slopes in the Mojave Desert, California. *Journal of Geology* 80(1):1-20.
[13] Miller, V. C., 1950. Pediments and pediment-forming processes near House Rock, Arizona. *Journal of Geology* 58:634-645.
[14] Paige, S., 1912. Rock-cut surfaces in the desert ranges. *Journal of Geology* 20:442-450.
[15] Johnson, D., 1931. Planes of lateral corrasion. *Science* 73:174-177.
[16] Small, R.J., 1978. *The Study of Landforms: A Textbook of Geomorphology*, second edition, Cambridge University Press, London, U.K., p. 319.
[17] Rich, J.L., 1935. Origin and evolution of rock fans and pediments. *GSA Bulletin* 46:999-1,024.

Figure 26.2. Coarse gravel veneer capping the pediment shown in Figure 26.1. Note that the rocks are rounded to subrounded, and most of them are exotic quartzite.

The flat surface often found at the base of the mountains usually goes unnoticed when viewing the landscape, since mountains are much more picturesque. Pediments are easy to spot when a person is aware of their significance. Sometimes pediments can be confused with other flat depositional surfaces like alluvial fans and bajadas, which are coalesced alluvial fans. Usually there is a dip between adjacent alluvial fans that indicates the nearly flat surface is a bajada. Sometimes pediments are disguised by the covering from an alluvial fan or bajada from the mountains. This hinders recognition in a few cases, as well as any determination of whether the capping debris originated during the formation of the pediment or was added later.[18]

Pediments are often *remarkably flat* across the broad scale (Figure 26.1).[19,20] Finer scale channels and rills leading from the mountains often incise the surfaces of a pediment. In fact, most pediments are dissected,[8] but the original planation surface can still be recognized by mentally filling in the channels and examining the tops of the uneroded portions. Generally, the remarkable smoothness is enhanced and protected by the deposition of a thin veneer of gravel, which may include cobbles and boulders (Figure 26.2).[21,22] Although the pediment surface may be smooth due to the veneer of gravel, the relief below the gravel is also generally smooth and can be described as a planation or erosion surface.[23] This gravel is often composed of rounded rocks indicating water was responsible for cutting the pediment and is a lag from when the currents decreased.

---

[18] Blackwelder, E., 1931. Desert plains. *Journal of Geology* 39:133-140.
[19] Johnson, D., 1932. Rock fans of arid regions. *American Journal of Science* 23(137), fifth series:389-416.
[20] Howard, A.D., 1942. Pediment passes and the pediment problem (Part I). *Journal of Geomorphology* 5(1):3-31.
[21] Twidale, C.R., 1981. Origins and environments of pediments. *Journal of the Geological Society of Australia* **28**:423-434.
[22] Thomas Ref. 2, p. 245.
[23] Bourne, J.A., R. Hillis, M. Rutty, and C.R. Twidale, 2002. Fan, fill or covered pediment? Seismic investigation of alluvial cover thickness, Hayward 'pediment', Flinders Ranges, South Australia. *Zeitschrift für Geomorpholgie N. F.* 46(2):193-201.

Figure 26.3. A pediment from southwest U.S., 6 miles (10 km) southeast of Hoover Dam, Nevada (photo courtesy of Ray Strom).

Thousands of Pediments Defy Uniformitarianism

Currently, there is an extensive scientific literature written on the subject of pediments.[5,7,9] Pediments are found all over the Earth, number in the thousands, and are found in a variety of climates. Pediments are common in the valleys of the Rocky Mountains and in the Southwest United States (Figures 26.3).

A few geomorphologists have made a desperate attempt to make a case for the present day formation of pediments because they defy the uniformitarian principle.[24,25,26] Most geomorphologists recognize that pediments are relicts of the past and were formed by water, since most are capped by rounded rocks. George Williams acknowledged:

> A major obstacle to agreement on the origin of modern hard-rock pediments and their relationship to adjacent alluvial deposits is that the mountain front and flanking pediment appear frozen at the present instant of time.[27]

Thomas Oberlander reinforced this observation:

---

[24] 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.

[25] Oberlander, T.M., 1974. Landscape inheritance and the pediment problem in the Mojave Desert of Southern California. *American Journal of Science* 274:849–875.

[26] Oberlander, T.M. 1989. Slope and pediment systems. In, Thomas, D.S.G. (editor), *Arid zone Geomorphology*, Halsted Press, New York, NY, pp. 56–84.

[27] Williams, G.E., 1969. Characteristics and origin of a Precambrian pediment. *The Journal of Geology* 77:183.

> Until recently, these planar surfaces were assumed to be actively expanding in deserts. The processes creating such surfaces have long remained a matter of speculation and controversy.[28]

In fact, the only changes observed on pediments are their *dissection and destruction*.[11,17,19,29,30,31,32,33] Running water in deserts or anywhere pediments exist does not form pediments; they either incise them or deposit debris on their surfaces.[34] Thus, running water is *not* presently forming pediments. Crickmay commented:

> There is no reason to suppose that any kind of wasting ever planes an area to flatness: decrepitation always roughens; *rain-wash, even on ground already flat and smooth, tends to furrow it* (emphasis mine).[35]

Geomorphologists are still searching for reasons why pediments are not being shaped today. There are three main uniformitarian hypotheses for the formation of pediments, all with fatal flaws.[36,37] C.H. Crickmay's superflood hypothesis comes closest, but very few geomorphologists accept it because his hypothesis has serious drawbacks.

Two Difficult Observations for Uniformitarians

Besides, the formation of the mountainside, gravel-capped planation surfaces, there are two more observations that defy uniformitarianism. The first is pediment gravel often contains exotic rocks that do not outcrop in the vicinity. In the northern Rockies I have often found quartzite cobbles and boulders on pediments that were transported a few hundred miles from their nearest source. This indicates the gravel was transported by water flowing *parallel* to the valley and not from streams issuing from the adjacent mountain range, as other geomorphologists except Crickmay contend.

A second observation that challenges uniformitarian principle is pediment passes and domes. Pediments from the opposite sides of a mountain range sometimes *merge with each other at the top of the range*.[20,38] The area of merging is called a pediment pass. The top of the pediment on one side of the mountain range can be *higher* than the one on the other side. Pediment passes are fatal to all ideas that form pediments from streams coming out of the mountains since there is zero catchment on pediment passes for streams that lie at the very top of the mountains. An extreme example of the convergence of pediments up to the topographic crest is the existence of

---

[28] Oberlander, Ref. 26, p. 70.

[29] Mabbutt, J.A., 1966. Mantle-controlled planation of pediments. *American Journal of Science* 264:78–91.

[30] Higgins, C.G., 1975. Theories of landscape development: a perspective. In, Melhorn, W.N. and R.C. Flemal (editors), *Theories of Landform Development*, George Allen and Unwin, London, U. K., pp. 1–28.

[31] Ritter, Ref. 9, p. 293.

[32] Twidale, C.R., 1978. On the origin of pediments in different structural settings. *American Journal of Science* 278:1,142–1,176.

[33] Dohrenwend, J.C., S.G. Wells, L.D. McFadden, and B.D. Turrin, 1987. In, Gardiner, V. (editor), *International Geomorphology 1986*, Proceedings of the 1st International Conference on Geomorphology, Part II, pp. 1,047–1,062.

[34] Garner, H.F., 1974. *The Origin of Landscapes: A Synthesis of Geomorphology*, Oxford University Press, New York, NY, pp. 343–344.

[35] Crickmay, Ref. 24, p. 127.

[36] Oard, M.J., *Earth's Surface Shaped by Genesis Flood Runoff: Volume I Tectonics and Erosion*, http://michael.oards.net/.

[37] Oard, M.J., 2008. *Flood by Design: Receding Water Shapes the Earth's Surface*. Master Books, Green Forest, AR.

[38] Howard, A.D., 1942. Pediment passes and the pediment problem (Part II). *Journal of Geomorphology* 5(2):95-136.

domes flanked by pediments on *all* sides. An example of domes that are considered merging pediments is in the eastern Mojave Desert. They are formed on granite, with Cima Dome being the most studied example (Figure 26.4).[6,12,39] Pediment passes and domes are common in the southwest United States.[40]

Figure 26.4. Cima Dome, eastern Mojave Desert, is the rounded dome in the center of the figure. It consists of a pediment formed all around the dome, leaving behind a few erosional remnants (monadnocks) sticking up.

No Viable Uniformitarian Hypothesis

So, there really is no viable uniformitarian hypothesis. Dale Ritter concluded that all three of the main hypotheses are untested, with little observational data to support any of them:

> It is ironic that in spite of the singular attention devoted to pediments, a multitude of untested hypotheses exist concerning the processes of pedimentation, but an amazingly skimpy pool of reliable data to support them. After a century of study, there is still confusion and lingering disagreement about every aspect of pedimentation. Cooke and Warren (1973, p. 188) express this succinctly in their description of the topic as "a subject dominated by almost unbridled imagination.[41]

---

[39] Sharp, R.P., 1957. Geomorphology of Cima Dome, Mojave Desert, California. *GSA Bulletin* 68:273-290.
[40] Strudley, M.W., A.B. Murray, and P.K. Haff., 2006. Emergence of pediments, tors, and piedmont junctions from a bedrock weathering—regolith thickness feedback. *Geology* 34:805-808.
[41] Ritter, Ref. 9, p. 291.

Dowrenwend exclaims:

> Pediments have long been the subject of geomorphological scrutiny. Unfortunately, the net result of this long history of study is not altogether clear or cogent and has not produced a clear understanding of the processes responsible for pediment development.[42]

Simply translated, uniformitarian geologists are clueless as to the origin of pediments. This is why it is called the "pediment problem."[25]

How Could Pediments Form after the Flood?

Pediments are not forming today and uniformitarian scientists cannot explain them. Then why do Flood geologists think they formed after the Flood? Greater rainfall will not produce pediments; more runoff will simply cut small valleys and canyons faster. Besides, how could some post-Flood catastrophe transport exotic rocks, sometimes hundreds of miles, from their source, occasionally even over mountain ranges and deposit them on pediments? And just how were pediment passes and domes formed after the Flood? Post-Flood catastrophism is just as unable to provide a viable hypothesis for the formation of pediments as uniformitarian geologists.

Pediments Readily Cut by Late Flood Channelized Erosion during the Late Cenozoic

Pediments were formed by huge quantities of water, swift enough to move rocks hundreds of miles, initially over mountain ranges and waste away granite to a flat surface. All evidence points to the Genesis Flood. Since pediments are surficial landforms, commonly found in valleys and showing little modification subsequent to the planation that molded them, it is reasonable to place pediments as one of the very last landforms created by the Retreating Stage of the Flood. This would nicely place their origin at the end of the Channelized Flow Phase.[36,37,43,44,45]

I believe that pediments were formed by fast, erosive currents flowing *parallel* to a barrier, such as a mountain range or within a valley, during the very late Genesis Flood.[36] Figure 26.5 summarizes the formation of pediments by valley parallel currents.

Since pediments are almost totally dated as mid to late Cenozoic, a Flood origin of pediments places the Flood/post-Flood boundary in the late Cenozoic.

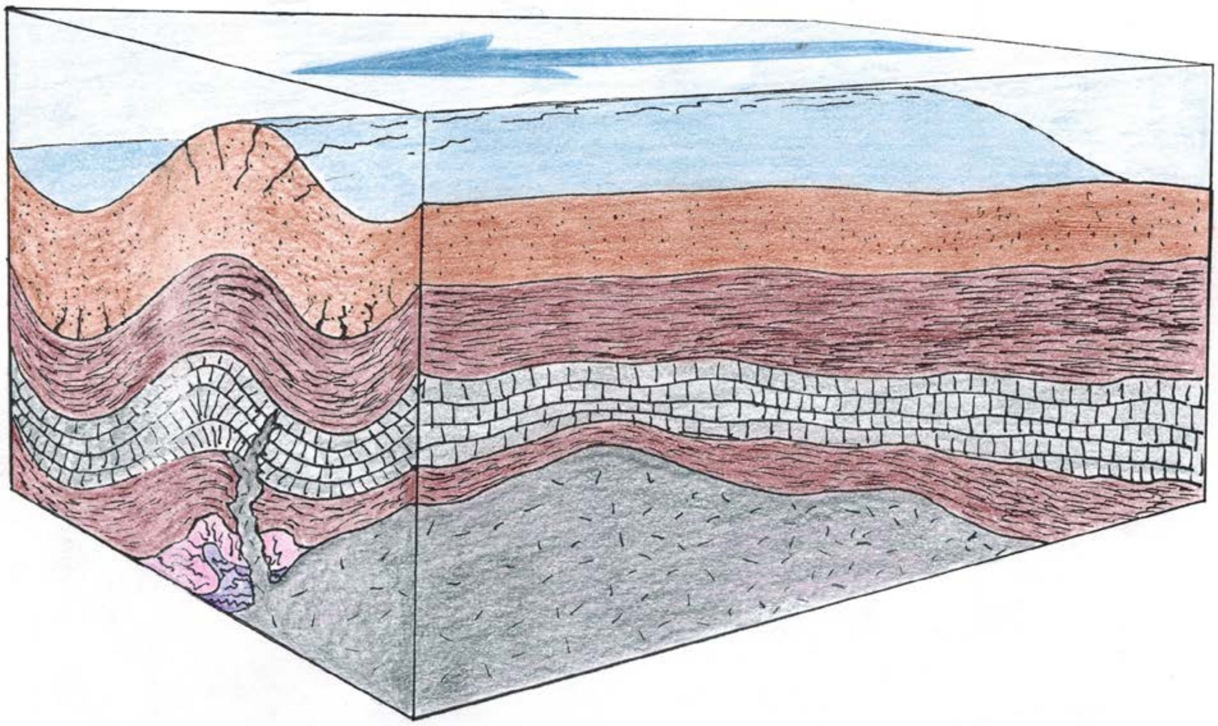
---

[42] Dohrenwend, Ref. 3, p. 321.

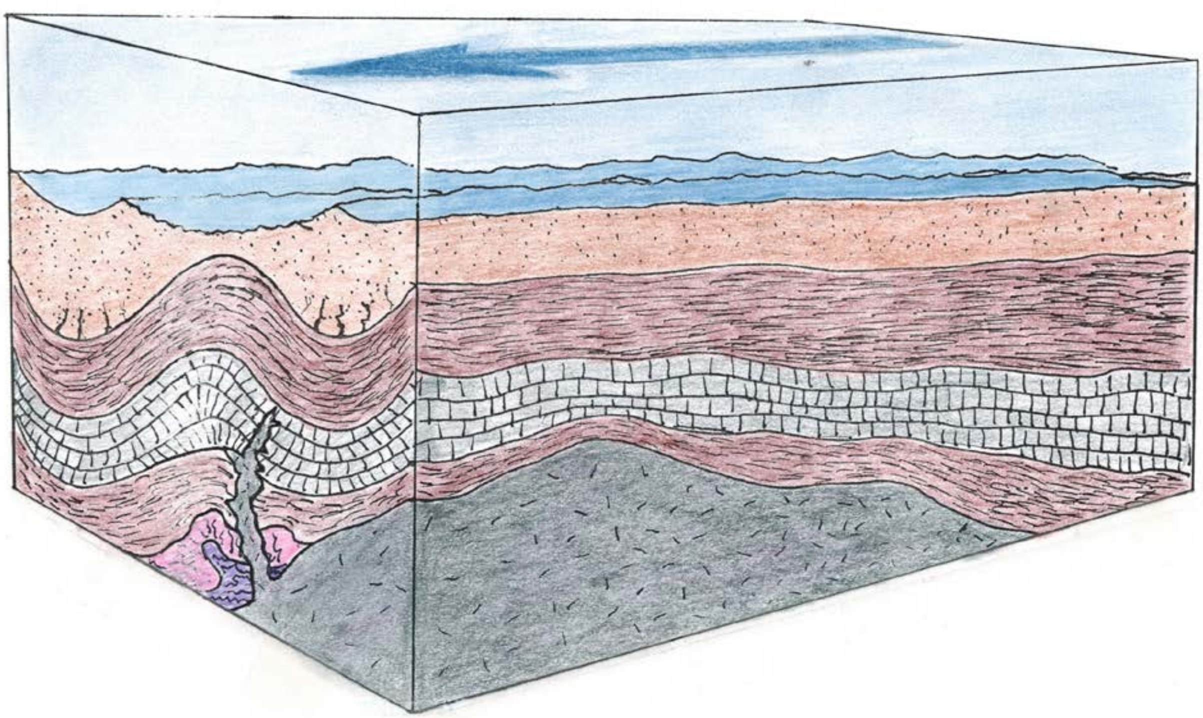
[43] Walker, T., 1994. A Biblical geological model. In, Walsh, R E. (editor), *Proceedings of the Third International Conference on Creationism*, technical symposium sessions, Creation Science Fellowship, Pittsburgh, Pennsylvania, pp. 581-592.

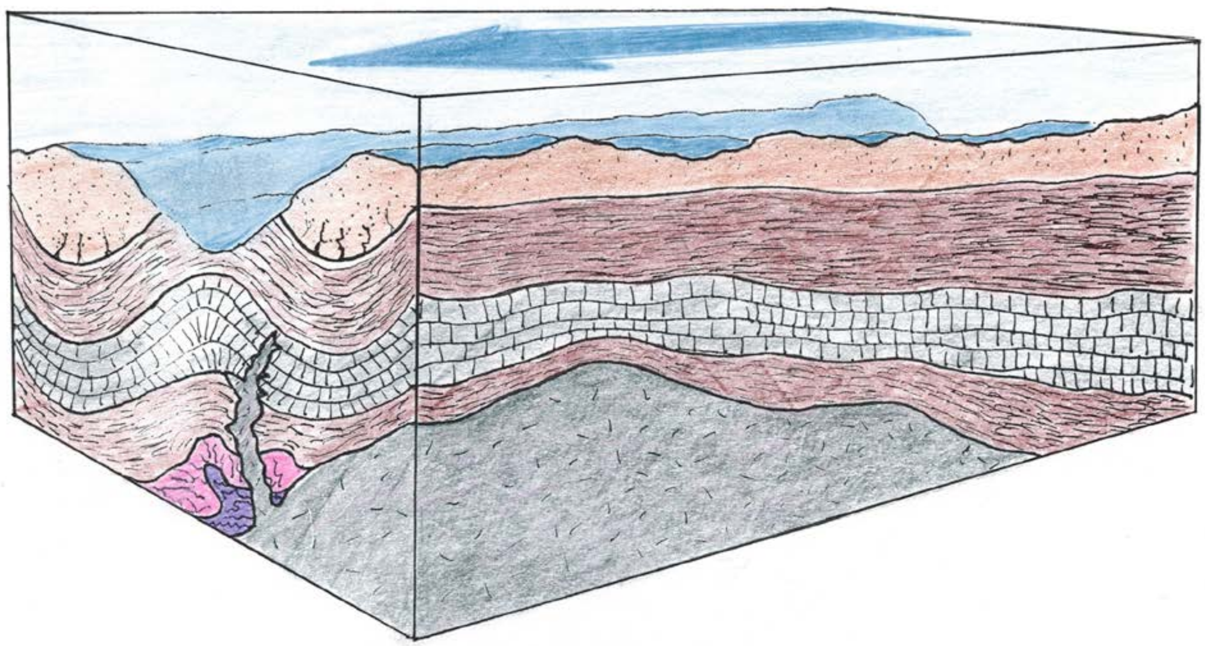
[44] Oard, M.J., 2001. Vertical tectonics and the drainage of Floodwater: a model for the middle and late diluvian period—Part I. *Creation Research Society Quarterly* 38 (1):3-17.

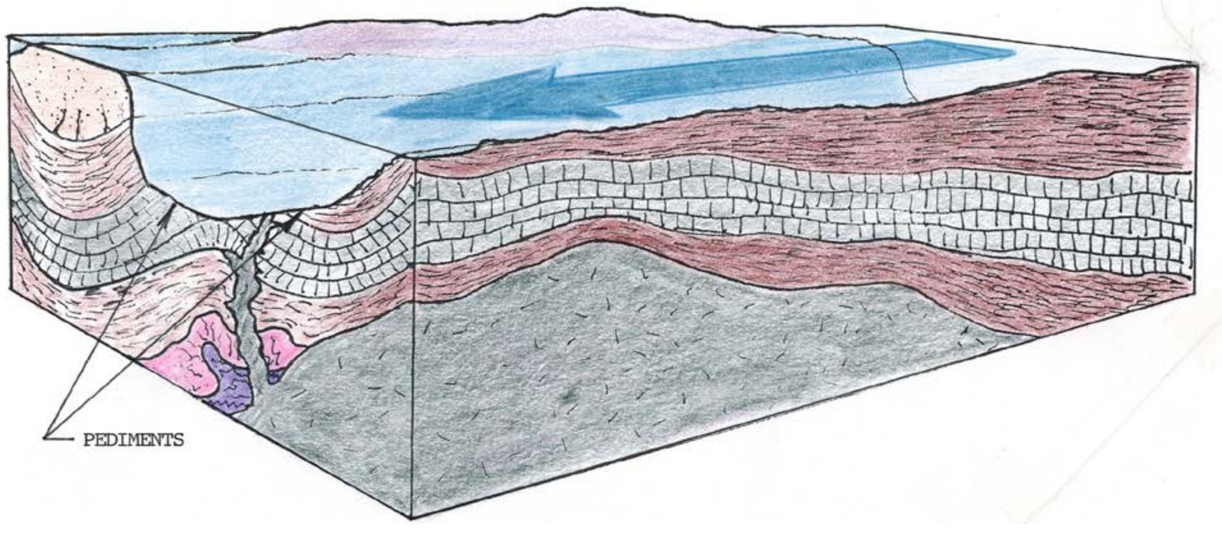
[45] Oard, M.J., 2004. Pediments formed by the Flood: evidence for the Flood/post-Flood boundary in the Late Cenozoic. *Journal of Creation* 18(2):15-27.



A DILUVIAL MODEL FOR THE FORMATION OF






PEDIMENTS

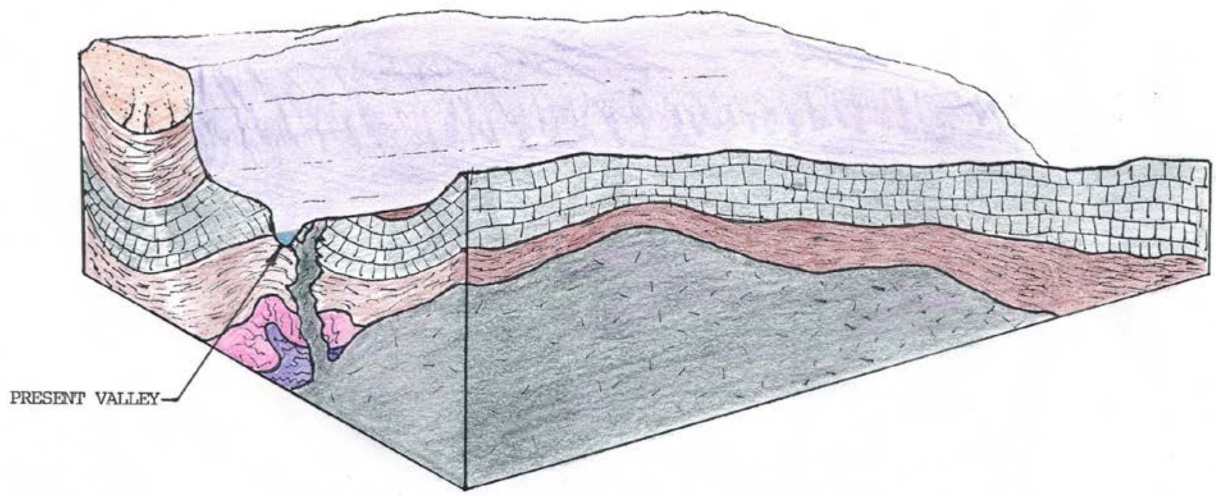


Figure 26.5a-e Block diagram showing the developing of pediments along the sides of mountains during the downvalley drainage of channelized Floodwater (drawn by Peter Klevberg).