Chapter 65

Pediments Common but Not Forming Today

Pediments are so unique it seems they should be rare but they are common, all over the Earth. Interestingly, they are not forming today. Evidence suggests they were formed by water sometime in the distant past.

Pediments Common Worldwide

Geologists have written extensively on the subject of pediments.^{1,2,3} They are found in a variety of climates and probably number in the thousands all over the earth (Figure 65.1).⁴ Pediments are common across Africa, Australia, eastern South America, and the Andes Mountains.¹ There is little information available on pediments in Asia, but they are reported in at least western China.⁵Hundreds can be found in the western United States, including Montana (see Chapters 68 and 69).¹ They are commonly found in the valleys of the Rocky Mountains and in Southwest United States (Figures 65.2 and 65.3). Gravel-capped pediments are also in the western Andes⁶ and near the coast of Brazil⁷. They are found in Europe as well, around monadnocks (a type of inselberg) in Scandinavia,⁸ in Spain, southwest of Madrid,⁹ the Pyrenees,¹⁰ the Iberian Massif,¹¹ the Baetic Cordillera of southeast Spain, and ¹² in the Sudetes Mountains of southwest Poland.¹³I would not be surprised to learn there are pediments below the ice sheet of East Antarctica.

Geomorphology of Europe, John Wiley & Sons, NewYork, NY, pp. 55-74

¹ Whitaker, C.R., 1973. *Pediments: A Bibliography*. Geo Abstracts Ltd, University of East Anglia, Norwich, England.

² Hadley, R.F., 1967. Pediments and pediment-forming processes. *Journal of Geological Education* 15:83–89.

³ Ritter, D.F., 1978. Pediments. In, *Process Geomorphology*, Wm. C. Brown, Dubuque, Iowa, pp. 290–299. ⁴ Whitaker, Ref. 1, p. 95.

⁵ Fothergill, P.A. and H. Ma, 1999. Preliminary observations on the geomorphic evolution of the Guide Basin, Qinghai Province, China: implications for the uplift of the northeast margin of the Tibetan Plateau. In, Smith, B.J, W.B. Whalley, and P.A. Warke (editors), *Uplift, Erosion and Stability: Perspectives on Long-Term Landscape Development*, Geological Society Special Publication No. 162, The Geological Society of London, The Geological Society, London, U. K., pp. 183–200.

⁶ Mortimer, C., 1973. The Cenozoic history of the southern Atacama Desert, Chile. *Journal of the Geological Society, London* 129:505–526.

⁷ Klammer, G., 1981. Landforms, cyclic erosion and deposition, and Late Cenozoic changes in climate in southern Brazil. *Zeitschrift für Geomorphologie N.F.*25:146–165.

⁸ Rudberg, S., 1984. Fennoscandian Shield: Finland, Sweden and Norway. In, Embleton, C. (editor),

⁹ Borger, H., 1997. Environmental changes during the Tertiary: the example of palaeoweathering residues in central Spain. In, Widdowson, M. (editor), *Palaeosurfaces: Recognition, Reconstruction and Palaeoenvironmental Interpretation*, Geological Society of London Special Publication No. 120, The Geological Society of London, London, U.K., pp. 159–173.

¹⁰ Sala, M., 1984. Pyrenees and Ebro Basin complex. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, NewYork, NY, pp. 268–293.

¹¹ Sala, M., 1984. Iberian Massif. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, NewYork, NY, pp. 294–322.

¹² Sala, M., 1984. Baetic Cordillera and Guadalquiver Basin. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, NewYork, NY, pp. 323–340.

¹³ Migoń, P., 1997. Tertiary etchsurfaces in the Sudetes Mountains, SW Poland: a contribution to the pre-Quaternary morphology of Central Europe. In, Widdowson, M. (editor), *Palaeosurfaces: Recognition, Reconstruction and*

Figure 65.1 does not show all of the pediments. It leaves out those in the Yukon Territory of northwest Canada, and the many pediments in the John Day Country of north-central Oregon (see Figures 64.8). Dohrenwend wrote:

Clearly, pediments are *azonal, worldwide phenomena* ... pediments are most conspicuous in arid and semi-arid environments where vegetation densities are low and deep weathering is limited (emphasis mine).¹⁴

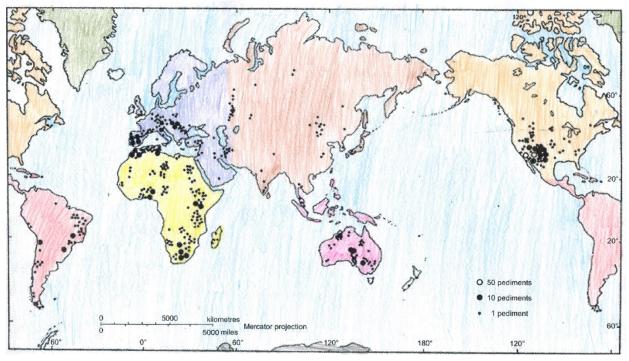


Figure 65.1. World map of pediments as described in the literature from over 900 references as of 1973 (from Whitaker, 1973). Note that the map does not include all known pediments, for instance in the Yukon Territory of northwest Canada.

Pediments Formed in the Past by Water

Although there are thousands of pediments around the world, they have been most extensively studied in the western United States. Their origin is in the misty past, and pediments are considered relict features by most geologists. So, pediments are not forming today, which goes against the main principle used to interpret rocks, fossils, and geomorphology, and that is the principle of uniformitarianism. Furthermore, no mainstream geological explanation for their origin has proven satisfactory (see Chapter 66).

Palaeoenvironmental Interpretation, Geological Society Special Publication No. 120, The Geological Society of London, London, U.K., pp. 187–202.

¹⁴ 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. 321.



Figure 65.2. Pediment on the near vertical strata on the south limb of the Big Snowy Mountains south of Lewistown, Montana (view east).

But Some Geologists Think Pediments Are Forming Today

A few geologists have simply gone ahead of the evidence and assumed pediments continue to be forming today. After all, it would be logical—if the "present is the key to the past". However, I believe these geologists simply cannot face the fact that so many landforms defy the uniformitarian principle. They also seem to be confusing processes that *modify* an existing pediment with the process that *originated* the pediment:

The assumption underlying such studies is that modern processes are responsible for the pediment. This may well be a case where the origin of the whole form is being confused with the process which is merely retouching the present surface. Modern process studies can tell us something about the mechanics of the modern processes and the sedimentary deposits they produce; their relevance to the overall origin of pediments is far more questionable.¹⁵

Pediments should be forming today, if the uniformitarian principle is correct. The uniformitarian principle (as well as actualism) is the real problem!

¹⁵ Selby, M.J., 1985. *Earth's Changing Surface: An Introduction to Geomorphology*, Clarendon Press, Oxford, U.K., pp. 527–528.



Figure 65.3. A pediment from southwest U.S., 6 miles (10 km) southeast of Hoover Dam, Nevada (photo courtesy of Ray Strom).

Others Face Up to the Evidence of Past Formation

On the other hand, many geomorphologists have honestly faced up to the fact that pediments are *not* currently forming.^{16,17,18} They recognize they are relicts and were formed by water, as verified by their capping of 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.¹⁹

Thomas Oberlander reinforced this observation:

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.²⁰

In fact, the only changes observed on pediments seems to be their *dissection and destruction*.^{21,22,23,24,25,26,27,28} Running water in deserts or anywhere pediments exist does not

¹⁶ 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.

¹⁷ Oberlander, T.M., 1974. Landscape inheritance and the pediment problem in the Mojave Desert of Southern California. American Journal of Science 274:849-875.

¹⁸ 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.

¹⁹ Williams, G.E., 1969. Characteristics and origin of a Precambrian pediment. *The Journal of Geology* 77:183.

²⁰ Oberlander, Ref. 18, p. 70.

²¹ Johnson, D., 1932. Rock fans of arid regions. American Journal of Science 23(137), fifth series:389–416.

form pediments; they either incise them or deposit debris on their surfaces.²⁹ Therefore, 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).³⁰

Geomorphologists Ever Hopeful of Finding a Mechanism

Geomorphologists are still searching for reasons for why pediments are not forming today. Some workers claim that although pediments in a particular area are relict, they were formed in a "different climate in the past." Oberlander attributed deeply-weathered granite in the Mojave Desert to a past wetter climate, since weathering is not happening in the present dry climate.^{17,31} However, the big picture belies this simple explanation. Pediments, as well as planation surfaces in general, are in diverse environments and *all* types of climates. Yet, we do not see pediments forming in *any* of these climates.^{32,33}

Unfortunately, geomorphologists really do not understand how climate affects landforms.^{34,35,36} Thomas demonstrated this climatic confusion when he related how some researchers believe pediments seen in a wet climate formed in a dry climate, and vice versa:

Thus within arguments about climate change, pediments occupy an interesting position, being widely regarded as markers of more humid conditions when found in the arid zones (Busche, 1976; Oberlander, 1974, 1989) and as indicators of drier conditions, where they occur within the humid tropics (Thomas & Thorp, 1985).³⁷

²² Rich, J.L., 1935. Origin and evolution of rock fans and pediments. *GSA Bulletin* 46:999–1,024.

²³ Tuan, Y.-F., 1959. Pediments of Southeastern Arizona, *University of California Publications in Geography 13*, University of California Press, Berkeley, CA.

²⁴ Mabbutt, J.A., 1966. Mantle-controlled planation of pediments. American Journal of Science 264:78–91.

 ²⁵ 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.
²⁶ Ritter, Ref. 3, p. 293.

²⁷ Twidale, C.R., 1978. On the origin of pediments in different structural settings. *American Journal of Science* 278:1,142–1,176.

 ²⁸ 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.
²⁹ Garner, H.F., 1974. *The Origin of Landscapes: A Synthesis of Geomorphology*, Oxford University Press, New

York, NY, pp. 343–344.

³⁰ Crickmay, Ref. 16, p. 127.

³¹ Oberlander, T.M., 1972. Morphogenesis of granitic boulder slopes in the Mojave Desert, California. *Journal of Geology* 80(1):1–20.

³² Chorley, R.J., S.A. Schumm, and D.E. Sugden, 1984. *Geomorphology*, Methuen, London, U.K., p. 489.

³³ Trenhaile, A.S., 1998. *Geomorphology: A Canadian Perspective*, Oxford University Press, Toronto, Canada, p. 1.

³⁴ Derbyshire, E., 1973. Introduction, In, Derbyshire, E. (editor), *Climatic Geomorphology*, Harper and Row, New York, NY, pp. 11-18.

³⁵ Dohrenwend, Ref. 14, p. 336.

³⁶ Trenhaile, Ref. 33, pp. 1–2.

³⁷ Thomas, M.F., 1994. *Geomorphology in the Tropics: A Study of Weathering and Denudation in Low Latitudes*, John Wiley & Sons, New York, NY, p. 247.