Chapter 79

Water Gaps on Other Continents

Water gaps are common to all continents. If it weren't for the ice cover, they could probably be seen in Antarctica and Greenland as well. Most of the information I have gathered comes from the scientific literature. I have only actually explored the U.S., eastern Australia, and southern England.

Australian Water Gaps

Australia has a number of water gaps. In southeast Australia, the Molonglo River passes through an uplifted fault block just east of Canberra.[1,2] Farther to the west, the Murray River cuts deep gorges through uplifted fault blocks.[3] Ollier and Pain assumed the antecedent stream hypothesis (see Chapter 80) to account for why the river passes through multiple gorges:

> Headwaters of the upper Murray (e.g. the Mitta Mitta River) rise on a plateau and drain north. The rivers encounter a series of faulted tilt blocks, through which they have cut gorges in antecedent courses. Fault displacements were in the range of 200 to 400 m.[4]

The Pascoe River of northern Queensland ignores structural barriers. Its gaps are assumed to be caused by superposition from sediments that were supposedly deposited during a Cretaceous marine transgression.[5] The Fitzroy River of Queensland starts a considerable distance from the coast and passes through a range of high coastal mountains,[6,7] as does the Burdekin River of Queensland.[8]

Other rivers passing through ridges or mountains in Australia include the Tradour River near Barrydale, the Finke River in central Australia that flows through the James Ranges toward Lake Eyre, and rivers in the Mt Lofty Ranges.[9] Drainage is remarkably unusual with a number of water gaps through the Macdonnell Ranges of central Australia.[10] The Krichauff Ranges in central Australia also have transverse drainage.[11] A stream cuts through uplifted sedimentary rocks in the Carr Boyd Range of Western Australia.[12]

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[1] Ollier, C., 1991. *Ancient Landforms,* Belhaven Press, New York, NY, pp. 165-167.
[2] Jennings, J.N., 1972. The age of Canberra landforms. *Journal of the Geological Society of Australia* 19(pt. 3):371-378.
[3] Ollier, C.D. and C.F. Pain, 1994. Landscape evolution and tectonics in southeastern Australia. *AGSO Journal of Australian Geology & Geophysics* 15(3):335-345.
[4] Ollier and Pain, Ref. 3, p. 340.
[5] Ollier, Ref. 1, p. 33.
[6] Ollier, C.D., 1978. Tectonics and geomorphology of Eastern Highlands, In, Davies, J.L. and M.A.J. Williams (editors), *Landform Evolution in Australasia,* Australian National University Press, Canberra, Australia, p. 24.
[7] Ollier, C. 1981. *Tectonics and Landforms*, Longman, New York, NY, p. 167.
[8] Ollier, Ref. 7, p. 24.
[9] Twidale, C.R., 1976. *Analysis of Landforms,* John Wiley & Sons Australasia Pty Ltd, New York, NY, pp. 433-439.
[10] Mabbutt, J.A., 1966. Landforms of the Western Macdonnell Ranges. In, Dury, G.H. (editor), *Essays in Geomorphology*, Heinemann, London, U.K., pp. 83-119.
[11] Twidale, C.R., 2004. River patterns and their meaning. *Earth-Science Reviews* 67:193.
[12] Ollier, C.D., G.F.M. Gaunt, and I. Jurkowski, 1988. The Kimberley Plateau, Western Australia: a Precambrian erosion surface. *Zeitschrift für Geomorphologie N. F.* 32:239-246.

Figure 79.1. Water gap through a low ridge on Nepean River near Sydney, Australia (courtesy of James Waterhouse).

Figure 79.2. Wheeny Gap looking west southwest, as seen from the eastern side. The depth of the gorge ranges from 1,300 to 1,800 feet (400-540 m) deep. The mountain in the distance about 12 miles (20 km) farther west beyond the gap is Mt Tomah, 3,300 feet (1000 m) ASL (courtesy of James Waterhouse).

There are several water and wind gaps in the vicinity of the Blue Mountains west of Sydney.[13] Figure 79.1 shows a small water gap through a ridge on the Nepean River near Sydney. Wheeny Gap (Figure 79.2) is a water gap over 1,300 feet (400 m) deep that passes through the Lapstone Monocline in the lower northern Blue Mountains.

In the vicinity of Australia, there are also some amazing water gaps in Papua, New Guinea.[14] Two rivers rise about one-half mile (1 km) from the south coast below 260 feet (80 m) msl and *flow north* through the Owen Stanley Mountain Range (Figure 79.3) that rises over 3,330 feet (1,000 m) high to empty into Milne Bay on the north coast! Cotton noted a number of water gaps in the Otago region on the southern South Island of New Zealand.[15]

Figure 79.3. Owen Stanley Range central Papua, New Guinea.

African Water Gaps

Southern Africa is marked by relatively low land in the central part surrounded by highlands toward the coast. These highlands drop off precipitously toward the ocean in a Great Escarpment that rings southern Africa (see Chapter 11). Many rivers start in the interior of Africa and cut through the higher terrain on their way to the coast.[16,17] The Orange and Vaal Rivers, which join downstream, originate on the western slopes of the eastern escarpment in interior Africa along the western Drakensberg (Figure 79.4 and see Chapter 12). They flow west across the lowland most of the length of southern Africa and pass through a water gap in the western escarpment (Figure 79.5).[18]

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[13] James Waterhouse, personnel communication.

[14] Ollier, Ref. 1, pp. 30-31.

[15] Cotton, C.A., 1917. Block Mountains in New Zealand. *American Journal of Science* 44(Fourth Series):249-293.

[16] Ollier, C.D. and M.E. Marker, 1985. The Great Escarpment of Southern Africa. *Zeitschrift für Geomorphologie N. F.* 54:37-56.

[17] De Swardt, A.M.J. and G. Bennet, 1974. Structure and physiographic development of Natal since the late Jurassic. *Transactions of the Geological Society of South Africa* 77:309-322.

[18] Ollier, C.D., 1985. Morphotectonics of continental margins with great escarpments. In, Morisawa, M. and J.T. Hack (editors), *Tectonic Geomorphology*, Allen & Unwin, Boston, MA, pp. 3-25.

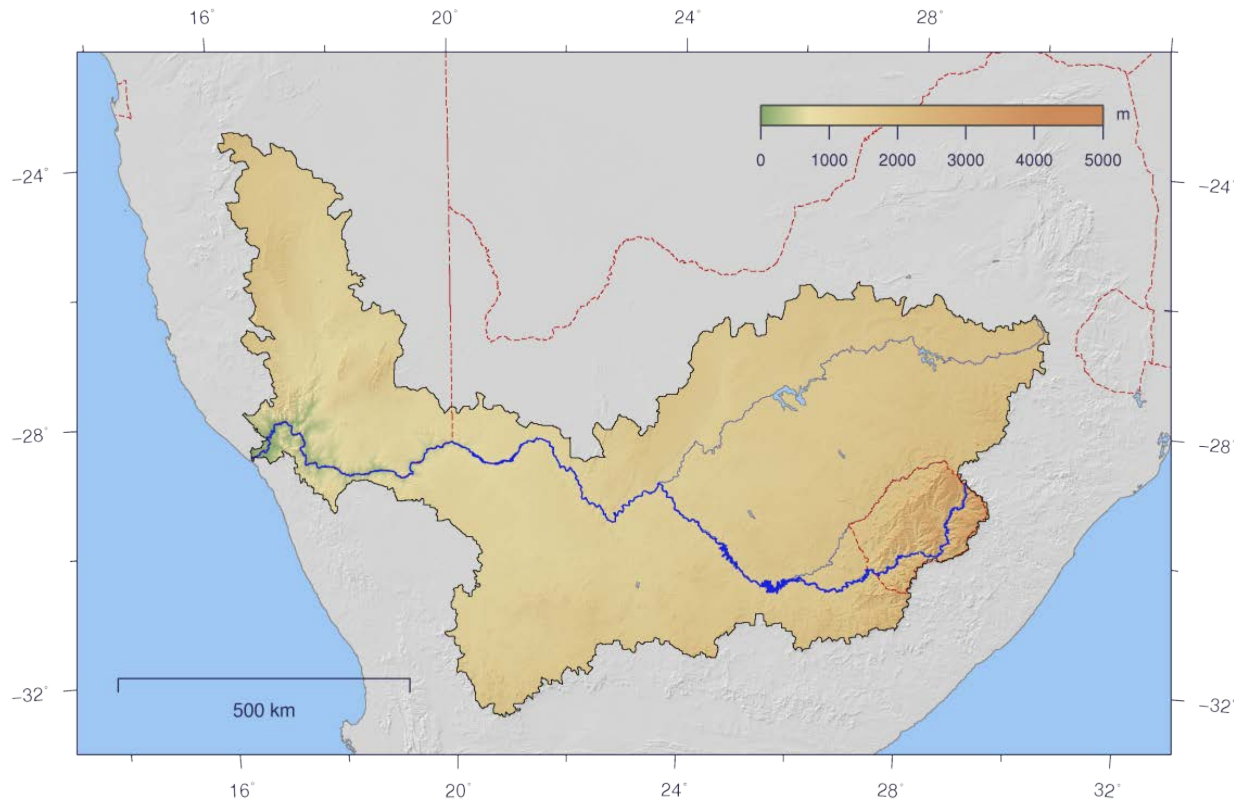

Figure 79.4. Course and watershed of the Orange River, southern Africa (Wikipedia). The more northerly Vaal River joins the Orange River in the central part of its course.

The Limpopo River cuts through the northeastern Drakensberg Escarpment through a water gap.[19] The Pongolo River flows through a gap in hard rhyolite lava in southeast Africa to reach the coastal plain, but even after reaching the coastal plain it turns north, parallel to the coast, and flows many more miles than necessary to reach the sea.[20] Breached anticlines are common in the Cape Fold Belt, and water gaps occur in the south-facing escarpment of extreme southern Africa.[21,22] There are also a number of wind gaps reported in southern Africa.[23]

Farther north, the Niger, Zambezi, and other rivers pass through water gaps.[24] Several large rivers in central Tanzania have anomalous courses.[25]

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[19] Partridge, T.C. and R.R. Maud, 1987. Geomorphic evolution of southern Africa since the Mesozoic. *South African Journal of Geology* 90(2):198.
[20] King, L.C., 1982. *The Natal Monocline*, second revised edition. University of Natal Press, Pietermaritzburg, South Africa, p. 117.
[21] Twidale, Ref. 9, p. 433.
[22] Moon, B.P., 1988. Structural control. In, Moon, B.P. and G.F. Dardis (editors), *The Geomorphology of Southern Africa*, Southern Book Publishers, Johannesburg, South Africa, pp. 235.
[23] Moore, A.E., 1999. A reappraisal of epeirogenic flexure axes in southern Africa. *South African Journal of Geology* 102(4):363-376.
[24] Summerfield, M.A., 1985. Plate tectonics and landscape development on the African continent. In, Morisawa, M. and J.T. Hack (editors), *Tectonic Geomorphology*, Allen and Unwin, Boston, MA, pp. 27-51.
[25] Eriksson, M.G., 1999. Influence of crustal movements on landforms, erosion and sediment deposition in the Irangi Hills, central Tanzania. In, Smith, B.J., W.B. Whalley, and P.A. Warke (editors), *Uplift, Erosion and Stability: Perspectives on Long-Term Landscape Development*, Geological Society of London Special Publication No. 162, The Geological Society, London, U.K., pp. 157-168.

The Tibesti is a dissected sandstone plateau in the western Sahara Desert that possesses several dry water gaps.[26] Water gaps are observed through the Atlas Mountains of northwest Africa.[27,28] After describing water gaps in the Atlas Mountains, Stokes and others remark: "Transverse drainages [water gaps] are found throughout the mountain belt regions of the world, particularly those characterized by active (neo)tectonic processes…[29]

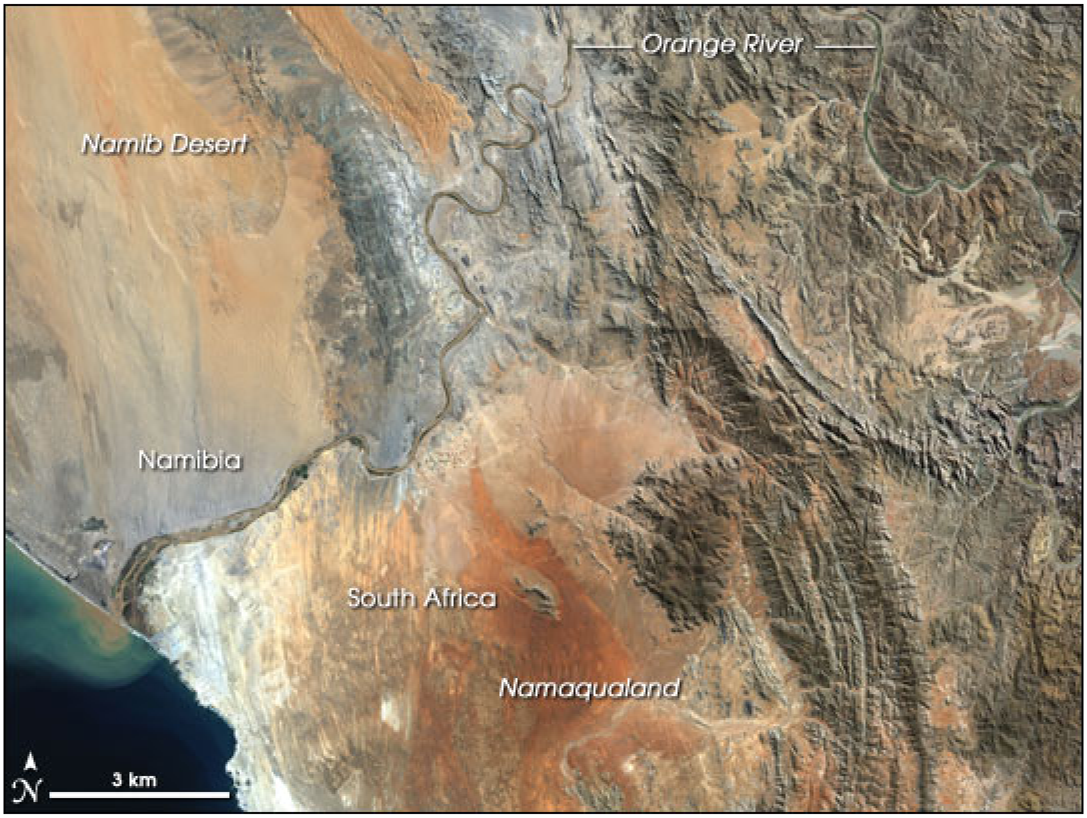

Figure 79.5. The last 60 miles (100 km) of the Orange River as it passes through the Great Escarpment of southern Africa.

South American Water Gaps

Unlike other continents, South America has fewer water gaps,[30] but numerous rivers cut through the Eastern and Western Cordillera.[31] For instance, the Santiago River in Ecuador crosses through the eastern Cordillera to flow into the Amazon Basin. The Santa River in

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[26] Grove, A.T., 1960. Geomorphology of the Tibesti region with special reference to Western Tibesti. *The Geographical Journal* 126:18-31.
[27] Stokes, M., A.E. Mather, A. Belfoul, F. Farik, 2008. Active and passive tectonic controls for transverse drainage and river gorge development in a collisional mountain belt (Dades Gorges, High Atlas Mountains, Morocco). *Geomorphology* 102:2-20.
[28] Baird, A.W. and A.J. Russell, 1999. Structural and stratigraphic perspectives on the uplift and erosional history of Djebel Cherichira and Oued Grigema, a segment of the Tunisian Atlas thrust front. In, Smith, B.J., W.B. Whalley, and P.A. Warke (editors), *Uplift, Erosion and Stability: Perspectives on Long-Term Landscape Development*, Geological Society of London Special Publication No. 162, The Geological Society, London, U. K., pp. 127-142.
[29] Stokes *et al*., Ref. 27, p. 4.
[30] Potter, P.E., 1997. The Mesozoic and Cenozoic paleodrainage of South America: a natural history. *Journal of South American Earth Sciences* 10:331-344.
[31] Ollier C. and C. Pain, 2000. *The Origin of Mountains*, Routledge, London, U.K., p. 118.

northern Peru at first flows in its valley parallel to the regional structure, and then "…it finally escapes to cut its way to the Pacific, through a gorge 10,000 feet deep, across the even ridge of the Cordillera Negra."[32] Many short rivers that originate in the Chilean Andes flow westward to the Pacific by crossing the Great Valley of Chile and then passing through water gaps in a low coastal range instead of flowing north or south within the valley.[33,34,35] A number of water gaps exist in Venezuela and Columbia.[36]

Western South America also has a number of deep gorges that are not water gaps but begin near the tops of the mountains and carve very deeply into the rocks. For example in southern Peru, a 10,000-foot (3,000 m) deep gorge is cut into the 14,750 foot (4,500 m) high mountains of the Western Cordillera.[37] The Cotahuasi—Ocoña River flows in this canyon to the Pacific Ocean.

Other rivers cut perpendicular to ridges along the east slopes of the Andes, as in northwest Argentina[38] and in 3,330-foot (1,000 m) deep gorges in Bolivia.[39] The La Paz River starts on the Altiplano between the Western and Eastern Cordillera and cuts eastward through the latter mountain range through the narrow La Paz Gorge of Bolivia.[40,41] Bowman described some of the water gaps on the east slopes of the Andes in Bolivia:

> The drainage is established upon the surface in curious disregard of the structure. Forty miles southwest of Tarija, the San Juan and Honda rivers … flow northwest across the folded Silurian and Cretaceous sandstones and Silurian schists in courses that are utterly regardless [sic] of the structure. Even the small Rupasco tributary of the San Juan, after following a northward course in a synclinal valley, turns west against the dip of the more resistant schists and crosses one limb of the next anticlinal [sic] before joining the master stream. The Tarija River itself is represented upon Steinmann's map as crossing four ridges of rock, varying from Silurian schists to Cretaceous sandstones, in a distance of twenty miles. In fact the most striking physiographic feature of this map is the persistent

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[32] McLaughlin, D.H., 1924. Geology and physiography of the Peruvian Cordillera, departments of Junin and Lima. *GSA Bulletin* 35:626.

[33] Potter, P.E., 1997. The Mesozoic and Cenozoic paleodrainage of South America: a natural history. *Journal of South American Earth Sciences* 10:331-344.

[34] Kennan, L., 2000. Large-scale geomorphology of the Andes: interrelationships of tectonics, magmatism and climate. In, Summerfield, M.A. (editor), *Geomorphology and Global Tectonics*, John Wiley & Sons, New York, NY, pp. 167-199.

[35] Mortimer, C., 1973. The Cenozoic history of the southern Atacama Desert, Chile. *Journal of the Geological Society, London* 129:515.

[36] King, L.C., 1950. The study of the world's plainlands: a new approach in geomorphology. *The quarterly journal of the Geological Society of London* 106:116.

[37] Gunnell, Y., J.-C. Thouret, S. Brichau, A. Carter, and K. Gallagher, 2010. Low-temperature thermochronology in the Peruvian Central Andes: implications for long-term continental denudation, timing of plateau uplift, canyon incision and lithosphere dynamics. *Journal of the Geological Society, London* 167:803-815.

[38] Vergés, J., V.A. Ramos, A. Meigs, E. Cristallini, F.H. Bettini, and J.M. Cortés, 2007. Crustal wedging triggered recent deformation in the Andean thrust front between 31°S and 33°S: Sierras Pampeanas-Precordillera interaction. *Journal of Geophysical Research* 112:B03S15.

[39] Barke, R. and S. Lamb, 2006. Late Cenozoic uplift of the Eastern Cordillera, Bolivian Andes. *Earth and Planetary Science Letters* 249:350-367.

[40] Zeilinger, G. and F. Schlunegger, 2007. Possible flexural accommodation on the eastern edge of the Altiplano in relation to focused erosion in the Rio La Paz drainage system. *Terra Nova* 19:373-380.

[41] Walker, E.H., 1949. Andean uplift and erosion surfaces near Uncia, Bolivia. *American Journal of Science* 247:646-663.

> way in which the drainage cuts across ridge after ridge of rock of all degrees of hardness, dip, and trend.[42]

Water gaps are truly challenging to explain when thinking only in terms of natural processes of erosion over millions of years.

Summary of a Remarkable Geomorphological Feature

In summary, water and wind gaps should be rare, but they are *numerous, common, and remarkable* to every continent. They are not forming today, except locally when a low barrier is breached. Their origin is a major puzzle for uniformitarian geomorphology. So many attempts have been made to explain them, but they all have serious difficulty.

[42] Bowman, I., 1909. The physiography of the central Andes: II. the eastern Andes. *American Journal of Science* Fourth Series, 28(166):397-398