Chapter 78

Eurasian Water Gaps

Given the assumption of uniformitarianism, water gaps should be rare, but instead are *common* in North America and on other continents as well. Stokes and Mather stated: "Since these early studies [in the late 19th century] transverse drainage has [sic] been identified from *most* major mountain belt regions around the world…[emphasis mine]"[1] There are thousands of examples.[2] Twidale stated: "At the regional scale complexity [transverse drainage] is the rule rather than the exception."[3] On the local scale, rivers often flow in valleys as expected, but on a regional scale they often cut through one or more structural barriers, even when it appears that topography should have caused them to flow around the barrier. Having explored water gaps in North America, I will briefly summarize the more notable ones in Europe and Asia, starting with the deepest on the earth—those found in the Himalaya Mountains.

Himalaya Mountains Water Gaps

Cliff Ollier declared we should expect rivers to drain away from the *axis of Himalayan uplift*.[4] However, they do not. Eleven rivers start on the southern Tibetan Plateau (a planation surface) and pass through the Himalayas through water gaps, when they could have more easily snaked around the uplifts and emptied into the Indian Ocean.[5,6,7,8,9] In fact, all of the major regional rivers pass through water gaps.[10] The Arun River starts on the southern Tibetan Plateau and cuts through the Himalayas east of Mount Everest in a water gap that is tens of thousands of feet deep. Ollier stated:

> These mountains form the highest topographic ridge on earth, and one might expect that rivers would drain away in opposite directions from the axis of uplift. In fact rivers that rise on the Tibetan Plateau north of the Himalayas, such as the Arun, flow south through gorges cut across the Himalayas.[11]

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[1] Stokes, M. and A.E. Mather, 2003. Tectonic origin and evolution of a transverse drainage: the Río Almanzora, Betic Cordillera, Southeast Spain. *Geomorphology* 50:61.
[2] Muhs, D.R., R.M. Thorson, J.J. Clague, W.H. Mathews, P.F. McDowell, and H.M. Kelsey, 1987. Pacific coast and mountain system. In, Graf, W.L. (editor), *Geomorphic Systems of North America*, Geological Society of America Centennial Special Volume 2, Boulder, CO, p. 523.
[3] Twidale, C.R., 2004. River patterns and their meaning. *Earth-Science Reviews* 67:209.
[4] Ollier, C., 1991. *Ancient Landforms*, Belhaven Press, New York, NY, pp. 31-33.
[5] Seeber, L. and V. Gornitz, 1983. River profiles along the Himalayan arc as indicators of active tectonics. *Tectonophysics* 92:335-367.
[6] Lavé, J. and J.P. Avouac, 2001. Fluvial incision and tectonic uplift across the Himalayas of central Nepal. *Journal of Geophysical Research* 106(B11):26,561-26,591.
[7] Oberlander, T.M., 1985. Origin of drainage transverse to structures in orogens. In, Morisawa, M. and J.T. Hack (editors), *Tectonic Geomorphology*, Allen and Unwin, Boston, Massachusetts, pp. 155-182.
[8] Brookfield, M.E., 1998. The evolution of the great river systems of southern Asia during the Cenozoic India—Asia collision: rivers draining southwards. *Geomorphology* 22:285-312.
[9] Fielding, E.J., 2000. Morphotectonic evolution of the Himalayas and Tibetan Plateau. In, Summerfield, M.A. (editor), *Geomorphology and Global Tectonics*, John Wiley & Sons, New York, NY, pp. 201-222.
[10] Fielding, Ref. 9, p. 205.
[11] Ollier, Ref. 4, pp. 31, 33.

Figure 78.1. The Indus River gorge (Wikipedia).

Oberlander claimed that the Arun River has actually carved a total of 50,000 feet (15,245 m) through an eroded anticline running perpendicular to the main east-west axis of the Himalaya Range:

> Moreover, at least one of the greatest through-flowing streams of the Himalayan region is known to follow the axis of a transverse ridge in the nappe complex. It has been recognized recently that the massif of Mount Everest itself has been carved out of a deep transverse syncline, with the Arun River, immediately to the east, having cut perhaps 50,000 feet below the crest of a transverse anticline in the nappe ediface.[12]

A nappe is a sheet-like sequence of strata that is believed to have moved on a predominantly horizontal surface.[13] It is possible that the transverse anticline formed after the erosion of the water gap due to isostatic uplift caused by the removal of rock. This is probably the reason why Kalvoda says that the water gap along the anticline was cut only about 19,000 feet (5.8 km).[14]

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[12] Oberlander, T., 1965. *The Zagros Streams: A New Interpretation of Transverse Drainage in an Orogenic Zone*, Syracuse Geographical Series No. 1, Syracuse, NY, p. 152.

[13] Neuendorf, K.K.E., J.P. Mehl, Jr., and J.A. Jackson, 2005. *Glossary of Geology*, Fifth Edition. American Geological Institute, Alexandria, VA, p. 432.

[14] Kalvoda, J., 1992. *Geomorphological record of the Quaternary orogeny in the Himalaya and the Karakoram*. Developments in Earth Surface Processes 3, Elsevier, New York, p. 118.

The rivers at first follow the structures soon after leaving the southern Tibetan Plateau,[15] but then run through deep water gaps:

> The Tsangpo and Indus flow east and west, respectively, for hundreds of kilometers, then turn abruptly south to cut right across the main Himalaya and its structural grain … The Sutlej cuts obliquely across the range. These rivers all have impressive gorges where they cut the High Himalaya…[16]

Ollier adds that the Indus River flows through a spectacular water gap that transects the Himalaya Mountains in a 4-mile (6 km) deep, 13-mile (21 km) wide gorge![17] Figure 78.1 shows a portion of the Indus River gorge. These water gaps are considered to have developed by rivers eroding downward as the Himalayas were uplifted, during the middle Cenozoic.[18,19,20] The antecedent river hypothesis is invoked. Others think the water gaps were formed by stream capture.[8] These popular hypotheses will be discussed in Chapters 80 and 82.

Figure 78.2. View southwest of Zagros Mountains from space (Wikipedia). The Zagros Mountains are a series of ridges with numerous water gaps trough them.

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[15] Wager, L.R., 1937. The Arun river drainage pattern and the rise of the Himalaya. *The Geographical Journal* 89:239-250.
[16] Brookfield, Ref. 8, p. 301.
[17] Ollier, Ref. 4, p. 192.
[18] Dewey, J.F., R.M. Shackleton, C. Chengfa, and S. Yiyin, 1988. The tectonic evolution of the Tibetan Plateau. *Philosophical Transactions of the Royal Society of London* A327:379-413.
[19] King, L.C., 1983. *Wandering Continents and Spreading Sea Floors on an Expanding Earth*, John Wiley and Sons, New York, NY, p. 141.
[20] Chorley, R.J., S.A. Schumm, and D.E. Sugden, 1984. *Geomorphology*, Methuen, London, U.K., p. 21.

The Anomalous Zagros Mountains Water Gaps

The Zagros Mountains rise up to 15,000 feet (4,575 m) msl in western Iran (Figure 78.2). They are 1,000 miles (1,600 km) long and 100 to 200 miles (160 to 320 km) wide. They are considered unique in being very "young", only 2-3 million years old and displaying little erosion. They exhibit many interesting geomorphic features including planation surface remnants on the mountains, plateaus, pediments, and a great thickness of conglomerate shed as a sheet and transported a long distance to the southwest.[21] Their preservation is remarkable, given the relatively high average precipitation of 20 to 40 inches/year (50 to 100 cm/yr), and a maximum of 100 inches/year (255 cm/yr) in the north.

Streams and rivers start near the northeastern margin of the highland and flow southwest through the mountains to Iraq or the Persian Gulf. There are more than *300 water gaps* that split through anticlines, most of which are individual mountain ranges.[21,22] These can be as deep as 8,000 feet (2,440 m).[23] The lower walls of some water gaps are near vertical, sometimes *overhanging*, and several thousand feet (almost 1,000 m) high.[24]

The most impressive aspect of the Zagros drainage is that the streams and rivers appear to *shun* valleys, and instead transect mountains—numerous times! Oberlander introduced this anomalous drainage pattern as follows:

> The Zagros Highland, which occupies the borderlands of Iraq and Iran from eastern Turkey to the Gulf of Oman, is a most remarkable laboratory for the examination of *one of the more perplexing and ubiquitous enigmas* of regional physiography: the anomaly of through-flowing drainage that is transverse to the structure of an orogenic system [mountain range]. Some of the world's most spectacular examples of this phenomenon are found in the Zagros (emphasis mine).[25]

He then goes on to describe this remarkable pattern that makes no sense:

> The Zagros drainage pattern is distinctive by virtue of its disregard of major geological obstructions, both on a general scale and in detail … In a surprising number of instances plunging fold noses are crossed by engorged transverse streams although open valley paths pass the ends of the ridges less than a mile away … Certain streams ignore structure completely; some appear to "seek" obstacles to transect; others are deflected by barriers only to breach them at some point near their termini. Many streams cut in and out of anticlines without transecting them completely, and a few cross the same barrier more than once in reverse direction (emphasis his).[26]

Oberlander expands on this last comment:

> Tributaries cut through mountain ranges to join streams that immediately *cut back* through the same range in the opposite direction. One stream crosses the same anticline *five times*, and several cleave a single range twice (emphasis mine).[27]

No wonder the drainage pattern in the Zagros Mountains is mystifying. Oberlander noted that the crazy drainage pattern of the Zagros is *also* found in the Taurus Mountains of Turkey.[28] In

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[21] Oberlander, T., 1965. *The Zagros Streams: A New Interpretation of Transverse Drainage in an Orogenic Zone*, Syracuse Geographical Series No. 1, Syracuse, NY.
[22] Oberlander, Ref. 7, pp. 162-168.
[23] Oberlander, Ref. 21, p. 45.
[24] Oberlander, Ref. 21, pp. 12-13.
[25] Oberlander, Ref. 21, p. 1.
[26] Oberlander, Ref. 21, pp. 1, 21, 89.
[27] Oberlander, Ref. 21, p. 85.
[28] Oberlander, Ref. 21, p. 16.

fact he emphasized that anomalous drainage is *common*, and that the three most popular explanations (described in Chapters 80 to 82) do *not* explain this enigma:

> The drainage history of this region [Zagros Mountains] is as obscure as is that of *most* of the Cenozoic and older mountain systems of the world whose transverse streams have been deduced, in the absence of evidence to the contrary, to be antecedent, superimposed, or the result of headward extension under unspecified controls.[29]

He mentions the three main hypotheses for the origin of water gaps commenting that they have little or no evidence. Not having a single good explanation for the Zagros transverse drainage, he appealed to multiple mechanisms to explain the water gaps (see Chapter 83).

Figure 78.3. Map of India showing the Western and Eastern Ghats (Wikipedia).

Other Asian Water Gaps

Besides the Himalayan water gaps and the Zagros water gaps, numerous others are found throughout Asia. There are several water gaps on the Deccan Plateau of India through the

[29] Oberlander, Ref. 21, p. 149.

Western Ghats, which is a near coastal erosional escarpment (Figure 78.3 and see Appendix 5).[30] Major drainages also cross the eastern Ghats of Peninsular India through water gaps.[31,32] The Bhadra River of India cuts through five water gaps on its way to the Bay of Bengal.[33]

China has many water gaps:

> For example, Zhang (1950) noted that many rivers, such as the Yongdinghe, Qingshuihe, Yanghe, Baihe, Chaohe, Luanhe, Sangganhe and Guishuihe rivers, in northern China transect the northeastern mountain ranges at high angles…[34]

The Yangtze River flows through three major gaps in its middle reach, the origin of which remains a mystery.[35] The Fen River of northern China also flows through water gaps.[36] Ollier described the anomalous Fen River in China:

> In China the Fen River has a strange course, almost parallel to the Yellow River (Huang Ho), but it flows across a whole series of horsts and grabens, repeatedly leaving the lowland which would provide an easy passage to the Yellow River and plunges into gorges that cross the uplifted blocks.[37]

Small rivers in the Lower Pearl River system of Southeast China transect granitic mountains.[38]

Many rivers along the Mongolian-Siberian frontier pass through structural barriers. Geomorphologist Lester King states: "Many transverse, antecedent gorges were created on the main rivers: Irtysh, Yenisei, Selenga, Vitim, Olekma and Amur."[39] King believes these water gaps were formed by the antecedent river hypothesis, a problematic hypothesis as we shall analyze in Chapter 80.

Wind gaps are also noted in Asia, for instance a large wind re numerous large wind gaps have been cut on the crest of the Western Ghats Escarpment (Figure 78.4).[40] The large Palghat

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[30] Rai, R.K., 1986. Evidences of rejuvenation of the Deccan foreland, India, with particular reference to the Meghalaya Plateau. In, Gardiner, V. (editor), *International Geomorphology Part II*, John Wiley and Sons Ltd, New York, NY, pp. 255-266.

[31] Ollier, C.D., 1985. Morphotectonics of continental margins with great escarpments. In, Morisawa, M. and J.T. Hack (editors), *Tectonic Geomorphology*, Allen & Unwin, Boston, Massachusetts, p. 11.

[32] Ollier, C.D. and K.P. Powar, 1985. The Western Ghats and the morphotectonics of Peninsular India. *Zeitschrift für Geomorphologie N. F.* 54:57-69.

[33] Gunnell, Y., 1997. Topography, palaeosurfaces and denudation over the Karnataka Uplands, southern India. 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., p. 259.

[34] Zhang, K., 2008. Planation surfaces in China: one hundred years of investigation. In, Grapes, R.H., D. Oldroyd, and A. Grigelis (editors), *History of Geomorphology and Quaternary Geology*, Geological Society of London Special Publication No. 301, p. 174.

[35] Li, J., S. Xie, and M. Kuang, 2001. Geomorphic evolution of the Yangtze Gorges and the time of their formation. *Geomorphology* 41:125-135.

[36] Li, Y., J.Yang, Z. Xia, and D. Mo, 1998. Tectonic geomorphology in the Shanxi graben system, northern China. *Geomorphology* 23:77-89.

[37] Ollier, Ref. 4, p. 30.

[38] Zhang, K. and R. Grapes, 2006. Relationship between large rivers and granite-cored anticlines in the Lower pearl river System, Southeast china: an example of a long-lived drainage pattern. *Catena* 66:190-197.

[39] 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* 106:123.

[40] Widdowson, M., 1997. Tertiary palaeosurfaces of the SW Deccan, Western India: implications for passive margin uplift. 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. 221-248.

wind gap through the southern portion of the Western Ghats, shown in Figure 78.5, has been interpreted a number of ways but remains a geological enigma.[41]

Figure 78.4. Escarpment of the Western Ghats (Wikipedia).

Figure 78.5. Palghat wind gap is a low point through the Western Ghats (Wikipedia).

[41] Ollier, Ref. 31, pp. 9-10.

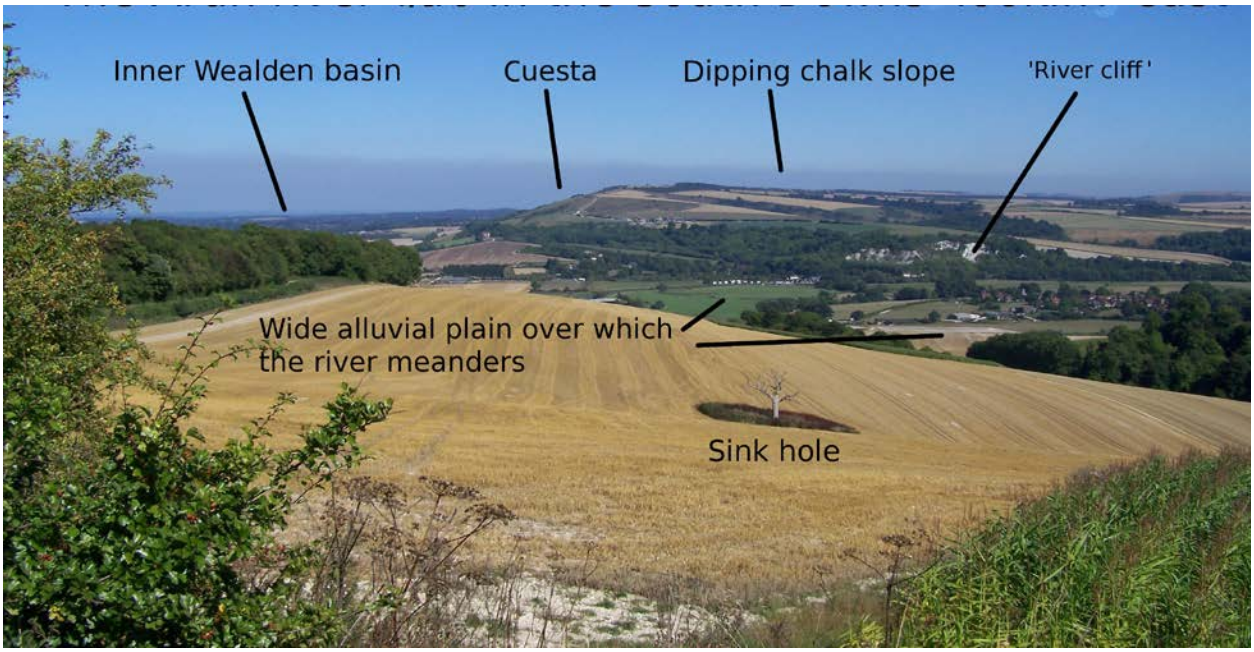

Figure 78.6. Water gap on the Arun River through the South Downs of the Weald, southeast England (view east). The gap is about 700 feet (215 m) deep.

European Water Gaps

The geomorphological literature of Europe documents many water gaps.[42] .The following information could be greatly expanded by creationists who live in Europe.

Scandinavia and the United Kingdom

Starting in the north, water gaps are fairly common in Scandinavia, and are presumed to have formed by superposition,[43,44] discussed in Chapter 81.

Water gaps are found in the Pennines Mountains in northern England,[45] Wales,[46] and southern England.[47,48,49] Most of the rivers draining the Weald, a large eroded anticline in southeast England, flow transverse to the geological structure.[50, 51] There are also wind gaps

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[42] Embleton, C. (editor), 1984. *Geomorphology of Europe*, John Wiley & Sons, New York, NY.
[43] Rudberg, S., 1984. Fennoscandian shield. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, p. 60.
[44] Rudberg, S., 1984. Scandinavian highland. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, p. 95.
[45] Embleton, C., 1984. Pennines and north-eastern England. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 167-172.
[46] Embleton, C., 1984. Caledonian highlands. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 119-125.
[47] Whiteman, C.A. and J. Rose, 1997. Early – Middle Pleistocene beheading of the river Thames. *Géographie physique et Quaternaire* 51(3):327-336.
[48] Embleton, C., 1984. English Lowlands. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 143-154
[49] Gibbard, P.L. and J. Lewin, 2003. The history of the major rivers of southern Britain during the Tertiary. *Journal of the Geological Society, London* 160:829-845.
[50] Oldroyd, D.R. and R.H. Grapes, 2008. Contributions to the history of geomorphology and Quaternary geology: an introduction. In, Grapes, R.H., D. Oldroyd, and A. Grigelis (editors), *History of Geomorphology and Quaternary Geology*, Geological Society of London Special Publication No. 301, p. 2.

through the high points of the Weald. Figure 78.6 shows the water gap of the Arun River through the South Downs in the Weald. There is even a water and wind gap on the small Isle of Wight, just off the coast of south-central England.[52] The Bristol Avon River leaves a lowland and takes a remarkable course through a limestone ridge to form the Clifton gorge.[53] The geomorphologist, Small, listed some notable English water gaps:

> Notable examples of water-gaps are those of the Usk (cutting through the Old Red Sandstone escarpment between Brecon and Abergavenny), the Humber (crossing the Chalk between the Lincolnshire and Yorkshire Wolds), the Witham (through the Jurassic limestone scarp at Lincoln) and the Bristol Avon (which cuts, unusually, against the dip through the southern Cotswolds at Bath).[54]

Many rivers in Ireland *ignore* geological structure.[55,56] The Blackwater River cuts southward through a water gap when it could have very easily flowed east into the ocean.[57] So far, there are no good explanations for the formation of water gaps in Ireland; clearly glaciation was not responsible.

Continental Europe

In continental Europe, water gaps are found in the Paris Basin,[58] the western Vosges,[59] the middle Rhine highlands,[59,60] the Ardennes,[59] the Alps,[61] the Jura Mountains,[62] the Pyrenees,[63] the Apennines of Italy,[64] the Carpathian Mountains,[65] the Caucasus Mountains,[66] and even on the island of Corsica.[67] One of the most famous is the Iron Gates where the Danube River cuts

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[51] Jones, D.K.C., 1999b. On the uplift and denudation of the Weald. 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. 25-41

[52] Small, R.J., 1978. *The Study of Landforms: A Textbook of Geomorphology*, second edition, Cambridge University Press, London, U.K., pp. 230, 233.

[53] Ollier, C. 1981. *Tectonics and Landforms*, Longman, New York, NY, p. 167.

[54] Small, Ref. 52, pp. 78-79.

[55] Embleton, C., 1984. Northern and central Ireland. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 125-131.

[56] Davies, G.L. and J.B. Whittow, 1975. A reconsideration of the drainage pattern of counties Cork and Waterford. *Irish Geography: Bulletin of the Geographical Society of Ireland* 8:24-41.

[57] Orme, A.R., 1964. *Irish Geography* 5:48-72.

[58] Joly, F., 1984. Paris Basin. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 154-161.

[59] Demek, J. and C. Embleton, 1984. Rhineland. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 201-210.

[60] Ahnert, F., 1998. *Introduction to Geomorphology*, Arnold, London, U.K., pp. 101-102.

[61] Leser, H., 1984. Western Alps. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 231-243.

[62] Leser, H., 1984. The Jura. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 262-267.

[63] Sala, M., 1984. Pyrenees and Ebro basin complex. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 268-293.

[64] Sestini, A., 1984. Central Appennines. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 345-348

[65] Demek, J. and N.V. Bashenina, 1984. Carpathian Mountains. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 355-373.

[66] Dumitrashko, N.S., 1984. Caucasian Mountains and Armenian highlands. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 393-403.

[67] Demek, J., 1984. Corsica. In, Embleton, C. (editor), *Geomorphology of Europe*, John Wiley & Sons, New York, NY, pp. 198-199.

southward through the southern Carpathian Mountains (Figure 78.7).[60] None of the four major rivers of Germany (the Rhine, Weser, Elbe, and Danube Rivers) closely follow the country's major landforms.[68] River systems in southeast Spain cut across structure.[69,70]

Figure 78.7. The Iron Gates on the Danube River is a water gap with cliffs up to about 1,640 feet (500 m) (Wikipedia).

Several rivers in central Italy pass straight through a number of anticlines in the central Apennine Mountains and just east of the mountains with little deflection before they reach the Adriatic Sea.[71,72] Alvarez believed they were cut under the sea surface requiring a unique mechanism, since all the main mechanisms propose forming on a terrestrial environment. Alvarez rules out the major hypotheses (discussed in Chapters 80 to 82) and realizes just how difficult it is to explain water gaps (from a uniformitarian point of view of course):

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[68] Ollier, Ref. 4, p. 31.
[69] Stokes, M. and A.E. Mather, 2003. Tectonic origin and evolution of a transverse drainage: the Río Almanzora, Betic Cordillera, Southeast Spain. *Geomorphology* 50:59-81.
[70] Harvey, A.M. and S.G. Wells, 1987. Response of Quaternary fluvial systems to differential epeirogenic uplift: Aguas and Feos river systems, southeast Spain. *Geology* 15:689-693.
[71] Alvarez, W., 1999. Drainage on evolving fold-thrust belts: A study of transverse canyons in the Apennines. *Basin Research* 11:267-284.
[72] Nesci, O. and D. Savelli, 2003. Diverging drainage in the Marche Apennines (central Italy). *Quaternary International* 101-102:2-3-209.

> This paper deals with the classic geological and geomorphological problem of the origin of river gorges that cut through topographic barriers … Transverse drainage is impressive and puzzling where it crops through tall anticlines in deep, narrow gorges…[73]

[73] Alvarez, Ref. 71, pp. 267, 276.