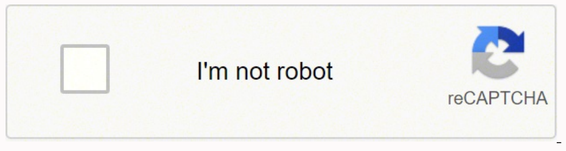

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"The Büyük Menderes River: Origin of Meandering Phenomenon". Online Etymology Dictionary. ISBN 978-3-642-41713-9 ^ Shaw, Lewis C. The maximum gradient is along the down-valley axis represented by a hypothetical straight channel. Meandering valleys and underfit rivers. (1988). p. 50. The result of this coupled erosion and sedimentation is the formation of a sinuous course as the channel migrates back and forth across the axis of a floodplain.[1][2] The zone within which a meandering stream periodically shifts its channel is known as a meander belt. The course at that point is the apex. "Near the bed, where velocity and thus the centrifugal effects are lowest, the balance of forces is dominated by the inward hydraulic gradient of the super-elevated water surface and secondary flow moves toward the inner bank." ^ Bowker, Kent A. Secondary flow: A force balance exists between pressure forces pointing to the inside bend of the river and centrifugal forces pointing to the outside bend of the river. Leopold, Luna B.; Langbein, W.B. (June 1966). This produces helicoidal flow, in which water moves from the outer to the inner bank along the river bed, then flows back to the outer bank near the surface of the river. ^ Sam Boggs Jr. (2003). It is produced as a watercourse erodes the sediments of an outer, concave bank (cut bank) and deposits sediments on an inner, convex bank which is typically a point bar. The index is a measure also of stream velocity and sediment load, those quantities being maximized at an index of 1 (straight). Scientific American. pp. 430–434. The meander is two consecutive loops pointing in opposite transverse directions. For example, the stream might be guided into a fault line (morphotectonic).[25] Associated landforms Cut bank Main article: Cut bank A cut bank is an often vertical bank or cliff that forms where the outside, concave bank of a meander cuts into the floodplain or valley wall of a river or stream. (pp. 377–391. Doctoral dissertation, Columbia University, New York, New York, 172 pp. A meander cutoff, also known as either a cutoff meander or abandoned meander, is a meander that has been abandoned by its stream after the formation of a neck cutoff. This type of slip-off slope is located opposite the cutbank.[44] This term can also be applied to the inside, sloping bank of a meandering tidal channel.[45] In case of an entrenched river, a slip-off slope is a gently sloping bedrock surface that rises from the inside, concave bank of an asymmetrically entrenched river. Instead, they argue that as fluvial incision of bedrock proceeds, the stream course is significantly modified by variations in rock type and fractures, faults, and other geological structures into either lithologically conditioned meanders or structurally controlled meanders.[33][35] Oxbow lakes Main article: Oxbow lake The oxbow lake, which is the most common type of fluvial lake, is a crescent-shaped lake that derives its name from its distinctive curved shape.[37] Oxbow lakes are also known as cutoff lakes.[1] Such lakes form regularly in undisturbed floodplains as a result of the normal process of fluvial meandering. Meanders of the Rio Cauto at Guamo Embarcadero, Cuba A meander is one of a series of regular sinuous curves in the channel of a river or other watercourse. 183–244). Calgary, Alberta: Canadian Natural Resource Limited. Washington DC: Island Press. Israel Physical Society (IPS) (7). Intrenched meanders of the North Fork of the Shenandoah River, Virginia. See also Baer's law Billabong Crevasse splay Helicoidal flow Jet stream Meander cutoffs in Avulsion (river) Meander scar Riffle-pool sequence References and notes ^ a b c d e f g h i Neuendorf, K.K.E., J.P. Mehl Jr., and J.A. Jackson, J.A., eds. Retrieved July 12, 2012. The distance of one meander along the down-valley axis is the meander length or wavelength. ^ Scheffers, A.M., May, S.M. and Kelletat, D.H., 2015. ISBN 9783642962912 ^ a b Chant, Robert J. Sustainable Management of Headwater Resources: Research from Africa and India. Retrieved from Ideals. Even channels that appear straight have a sinuous thalweg that leads eventually to a sinuous channel. Either a river or stream forms a sinuous channel as the outer side of its bends are eroded away and sediments accumulate on the inner side, which forms a meandering horseshoe-shaped bend. ^ a b c d Reineck, H.E. and Singh, I.B., 2012. Fine-grained Alluvial Deposits and Their Effects on Mississippi River Activity. ^ Davis, W.M., 1913. p. 137. As a result, even in Classical Greece (and in later Greek thought) the name of the river had become a common noun meaning anything convoluted and winding, such as decorative patterns or speech and ideas, as well as the geomorphological feature.[6] Strabo said: '…its course is so exceedingly winding that everything winding is called meandering.'[7] The Meander River is south of Izmir, east of the ancient Greek town of Miletus, now Milet, Turkey. The result of all the physical factors acting at random is channels that are not straight, which then progressively become sinuous. Bulletin No. 16. Because of the decreasing velocity and strength of current from the thalweg of the channel to the upper surface of point bar when the sediment is deposited the vertical sequence of sediments comprising a point bar becomes finer upward within an individual point bar. When looking down the river valley they can be distinguished because the point-bar scroll patterns are convex and the eddy accretion scroll bar patterns are concave.[43] Scroll bars often look lighter at the tops of the ridges and darker in the swales. Wikimedia Commons has media related to Meanders. World Geomorphological Landscapes: 509–519. In general the meander length is 10–14 times, with an average 11 times, the fullbank channel width and 3 to 5 times, with an average of 4.7 times, the radius of curvature at the apex. The sediment comprising some point bars might grade downstream into silty sediments. Its modern Turkish name is the Büyük Menderes River.[8] Governing physics Straight channel culminating in a single bend Meanders are a result of the interaction of water flowing through a curved channel with the underlying river bed. "The questionable inventions of the clever Dr. Einstein: József Illy: The practical Einstein: Experiments, patents, inventions. Fluvial Sedimentology (6 ed.). "River channel patterns: Braided, meandering, and straight". (2003). Some Earth scientists recognize and use a finer subdivision of incised meanders. S2CID 134826361. ^ K. ^ Shoemaker, E.M. and Stephens, H.G., 1975. Alexandria, Virginia, American Geological Institute. 779 pp. This in turn increases carrying capacity for sediments on the outer bank and reduces it on the inner bank, so that sediments are eroded from the outer bank and redeposited on the inner bank of the next downstream meander.[9] When a fluid is introduced to an initially straight channel which then bends, the sidewalls induce a pressure gradient that causes the fluid to alter course and follow the bend. Journal of Geophysical Research. ^ D'Alessandro, Leandro; Miccadei, Enrico; Piacentini, Tommaso (November 2008). {{cite book}}: Missing or empty |title= (help) ^ Wood, Elizabeth A. For a river to meander, secondary flow must dominate. In that case the valley index is the meander ratio of the valley while the channel index is the meander ratio of the channel. Concave bank and convex bank, Great Ouse Relief Channel, England. They are predictable obstacles that instigate meander formation by deflecting the stream. 3–28. ISBN 92-808-1108-8. Pennsylvania Gazetteer of Streams Part II. The maximum distance from the down-valley axis to the sinuous axis of a loop is the meander width or amplitude. ^ Hack, J.T., and Young, R.S., 1959. Nathan (2005). "Interface drainage analysis of a water divide". As a result, oxbow lakes tend to become filled in with fine-grained, organic-rich sediments over time.[28][38] Point bar Main article: Point bar A point bar, which is also known as a meander bar, is a fluvial bar that is formed by the slow, often episodic, addition of individual accretions of noncohesive sediment on the inside bank of a meander by the accompanying migration of the channel toward its outer bank.[1][26] This process is called lateral accretion. (March 2014). As it turns out some numerical parameters can be established, which appear in the formulae. ^ Gordon, Nancy D.; Thomas A. The length of the stream is measured by channel, or thalweg, length over the reach, while the bottom value of the ratio is the downvalley length or air distance of the stream between two points on it defining the reach. doi:10.3133/pp282B. ^ Hickin 2003, p. 432. The bankfull width is the distance across the bed at an average cross-section at the full-stream level, typically estimated by the line of lowest vegetation. "Sedimentary architecture of abandoned channel fills." Earth Surface Processes and Landforms, 37(4), pp. ^ a b Leopold, Luna; Wolman, M. The origin and significance of sinuosity along incising bedrock rivers. 39 (2): 243–249. Certain types of stream valleys and their meaning. Retrieved 2016-07-01. Earth Science History. The sediment eroded from a cut bank tends to be deposited on the point bar of the next downstream meander, and not on the point bar opposite it.[28][26] This can be seen in areas where trees grow on the banks of rivers; on the inside of meanders, trees, such as willows, are often far from the bank, whilst on the outside of the bend, the tree roots are often exposed and undercut, eventually leading the trees to fall into the river.[28][29] Meander cutoff Main article: Meander cutoff The Rincon on Lake Powell in southern Utah. Forms by Flowing Water (Fluvial Features). p. 8. Therefore, in the absence of secondary flow we would expect low fluid velocity at the outside bend and high fluid velocity at the inside bend. pp. 41–42. Springer, Berlin, Germany. Lateral accretion occurs mostly during high water or floods when the point bar is submerged. "Alluvial channels and their landforms". This initiates helicoidal flow: Along the river bed, fluid roughly follows the curve of the channel but is also forced toward the inside bend; away from the river bed, fluid also roughly follows the curve of the channel but is forced, to some extent, from the inside to the outside bend. In addition concepts are utilized from Graf, Walter (1984). Commonwealth of Pennsylvania, Department of Environmental Resources. Encyclopedia of Earth Sciences Series, Vol. Science from Your Airplane Window: 2nd Revised Edition. ^ Fisk, H.N., 1948. This type of slip-off slope is often covered by a thin, discontinuous layer of alluvium. "Meandering Channels". doi:10.1038/scientificamerican0666-60. The greater the curvature of the bend, and the faster the flow, the stronger is the cross-current and the sweeping.[18] Due to the conservation of angular momentum the speed on the inside of the bend is faster than on the outside.[19] Since the flow velocity is diminished, so is the centrifugal pressure. Streams can be placed in categories arranged by it; for example, when the index is between 1 and 1.5 the river is sinuous, but if between 1.5 and 4, then meandering. 369–379. ^ Leopold, L.B.; Langbein, W.B. (1966). ^ Martínez, Alberto A. The sinuosity of a watercourse is the ratio of the length of the channel to the straight line down-valley distance. In the words of Elizabeth A. In the context of meandering rivers, a boundary layer exists within the thin layer of fluid that interacts with the river bed. "River Meanders". United States Geological Survey Professional Paper no. (2005) Glossary of Geology (5th ed.). The radius of the loop is the straight line perpendicular to the down-valley axis intersecting the sinuous axis at the apex. He argues that the symmetrical valley sides are the direct result of rapid down-cutting of a watercourse into bedrock.[1][33] In addition, as proposed by Rich,[34] Thornbury argues that incised valleys with a pronounced asymmetry of cross section, which he called ingrown meanders, are the result of the lateral migration and incision of a meander during a period of slower channel downcutting. The cross-overs are marked by riffles, or shallow beds, while at the apices are pools. Distinctions may become even more subtle.[51] Sinuosity Index has a non-mathematical utility as well. doi:10.1029/2001jc001082. 10 (1): 129–158. ^ Callander, R.A. (1978). External links Look up rincón in Wiktionary, the free dictionary. There is a cut-off meander at right center.As noted above, it was initially either argued or presumed that an incised meander is characteristic of an antecedent stream or river that had incised its channel into underlying strata. Centrifugal force, which depends on velocity, is also therefore effectively zero. As a waveform the meandering stream follows the down-valley axis, a straight line fitted to the curve such that the sum of all the amplitudes measured from it is zero. Sinuosity indices are calculated from the map or from an aerial photograph measured over a distance called the reach, which should be at least 20 times the average fullbank channel width. (1984). The meander is then said to be free—it can be found anywhere in the flood plain. ISBN 1-55963-042-6. ISBN 0-521-52970-0. In the context of meandering rivers, its effects are dominated by those of secondary flow. McGraw-Hill Company, Inc., New York, New York, 1295 pp. If there is a flood plain, it extends beyond the meander belt. It is an incised cutoff (abandoned) meander. 1549 pp. Classic examples of incised meanders are associated with rivers in the Colorado Plateau, the Kentucky River Palisades in central Kentucky, and streams in the Ozark Plateau.[33][35] Goosenecks of the San Juan River, SE Utah. Metascience. Baltimore: Johns Hopkins University Press, 2012, xiv+202pp, $60.00 HB". If there is no flood plain, the meanders are fixed. Geomorphology. doi:10.1007/978-3-030-03515-0_29. ^ Woolfe and Purdon; Purdon, Richard (1996). Archived from the original on 2017-11-19. For example, it is typical for point bars to fine upward from gravel at the base to fine sands at the top. This added sediment in addition to water that catches in the swales is in turn is a favorable environment for vegetation that will also accumulate in the swales. 78 pp. S2CID 169290222. Landscapes and Landforms of Turkey. First photographs of the Canyon Lands. 111–122, Canyonlands Country, A Guidebook of the Four Corners Geological Society Eighth Field Conference — September 22–25, 1975. It typically ranges from 15 to 18 times the width of the channel. ^ Gürbüz, Alper; Kazancı, Nizamettin (2019). ^ Strabo, Geography, Book 12 Chapter 8 Section 15. Cambridge University press. 234 pp. The presence of meanders allows the stream to adjust the length to an equilibrium energy per unit length in which the stream carries away all the sediment that it produces. Wasser (2005). "A Comparison Of Meandering River Deposits From The Middle Belly River And Horsefly With Recent Milk River Valley Deposits; Central And Southern Alberta". The river length is the length along the centerline.[15] Formation Life history of a meander Once a channel begins to follow a sinusoidal path, the amplitude and concavity of the loops increase dramatically. Therefore, within the boundary layer, pressure force dominates and fluid moves along the bottom of the river from the outside bend to the inside bend. As the loop is not ideal, additional information is needed to characterize it. Dictionary by Merriam-Webster: America's most-trusted online dictionary. One of a series of curves in a channel of a matured stream For other uses, see Meander (disambiguation). In Fairbridge, R.W., ed., pp 548–550, The Encyclopedia of Geomorphology. Bibcode:2002JGRC..107.3131C. Scroll-bar sediments are characterized by cross-bedding and a pattern of fining upward.[41] These characteristics are a result of the dynamic river system, where larger grains are transported during high energy flood events and then gradually die down, depositing smaller material with time (Batty 2006). A loop at the apex has an outer or concave bank and an inner or convex bank. New Zealand Journal of Geology and Geophysics. This radius is 2–3 times the channel width.[14] Meander of the River Cuckmere in East Sussex, Southern England A meander has a depth pattern as well. At any cross-section the flow is following the sinuous axis, the centerline of the bed. Equilibrium theory In the equilibrium theory, meanders decrease the stream gradient until an equilibrium between the erodibility of the terrain and the transport capacity of the stream is reached.[24] A mass of water descending must give up potential energy, which, given the same velocity at the end of the drop as at the beginning, is removed by interaction with the material of the stream bed. ISBN 0-13-099696-3. The pressure of the super-elevated column prevails, developing an unbalanced gradient that moves water back across the bottom from the outside to the inside. 3. Springer Science & Business Media, New York, New York. and Bucksch, H., 2014. Tokyo, New York: United Nations University Press. A perfectly straight river would have a meander ratio of 1 (it would be the same length as its valley), while the higher this ratio is above 1, the more the river meanders. The source of the sediment is typically upstream cut banks from which sand, rocks and debris has been eroded, swept, and rolled across the bed of the river and downstream to the inside bank of a river bend. ISBN 978-3-030-03513-6. Deposits for meandering rivers are generally homogeneous and laterally extensive unlike the more heterogeneous braided river deposits.[42] There are two distinct patterns of scroll-bar depositions; the eddy accretion scroll bar pattern and the point-bar scroll pattern. 102 (1): 145–158. Stochastic theory Meander scars, oxbow lakes and abandoned meanders in the broad flood plain of the Rio Negro, Argentina. Smith and John Rogers (1999). "One of the important consequences of helical flow in meanders is that sediment eroded from the outside of a meander bend tends to move to the inner bank or point bar of the next downstream bend." ^ Hickin 2003, p. 434. Kluwer Academic Encyclopedia of Earth Sciences. The channel sinuosity index is the channel length divided by the valley length and the standard sinuosity index is the channel index divided by the valley index. Four Corners Geological Society, Durango, Colorado. ISBN 978-94-017-9712-2 ^ Keck, R., Maurer, D. ^ Merriam-Webster, Incorporated, 2017. Geography, Physics and Chemistry. The higher velocities at the outside bend lead to higher shear stresses and therefore result in erosion. Natural surfaces are rough and erodible to different degrees. Retrieved from " Over time, meanders migrate downstream, sometimes in such a short time as to create civil engineering challenges for local municipalities attempting to maintain stable roads and bridges.[1][2] The degree of meandering of the channel of a river, stream, or other watercourse is measured by its sinuosity. Thus meander bends erode at the outside bend, causing the river to becoming increasingly sinuous (until cutoff events occur). The Journal of Geology, 68(4), pp. in Fassett, J.E., ed., pp. 2 Vols., 82 pp. Oxford University Press. Bibcode:1978AnRFM..10..129C. Streams or rivers with a single channel and sinuosities of 1.5 or more are defined as meandering streams or rivers.[1][3] Origin of term The term derives from the winding river Menderes located in Asia-Minor and known to the Ancient Greeks as Μαίανδρος Maiandros (Latin: Maeander),[4][5] characterised by a very convoluted path along the lower reach. doi:10.1016/j.geomorph.2007.06.019. doi:10.1146/annurev.fl.10.010178.001021. 1015p. Two consecutive crossing points of sinuous and down-valley axes define a meander loop. Annual Review of Fluid Mechanics. On the inside bend, this sediment and debris is eventually deposited on the slip-off slope of a point bar.[1][26][27] Scroll-bars Scroll-bars are a result of continuous lateral migration of a meander loop that creates an asymmetrical ridge and swale topography[39] on the inside of the bends. JSTOR 24930965. New York: Courier Dover Publications. River Channel Patterns: Braided, Meandering, and Straight. 391 pp. Encyclopedia of Sediments and Sedimentary Rocks. Dordrecht; Boston: Kluwer Academic Publishers. 469–497. ^ G. Meanders develop, which lengthen the course of the stream, decreasing the gradient. Wiley. pp. 87–106. Surface Processes and Landscape Evolution. Morphotectonic means having to do with the deeper, or tectonic (plate) structure of the rock. Berlin, New York: Springer. ^ Leong, Goh Cheng (1995-10-27). Similarly, lower velocities at the inside bend cause lower sheer stresses and deposition occurs. Fundamentals of fluvial geomorphology. ISBN 0-918334-56-X. ^ "Meander". "Deposits of a rapidly eroding meandering river: terrace cut and fill in the Taupo Volcanic Zone". "River meanders". From here, two opposing processes occur: (1) irrotational flow and (2) secondary flow. This establishes a positive feedback loop. Various mathematical formulae relate the variables of the meander geometry. Professional Paper 282-B. ^ Callander, R A (January 1978). The sinuosity index plays a part in mathematical descriptions of streams. (1975). ^ Crickmay, C.H., 1960. 214 (6): 60–73. Stream Hydrology: an Introduction for Ecologists: Second Edition. McMahon; Christopher J. 2010 photo from ISS. Bibcode:1966SciAm.214f..60L. Wood:[16]'…this process of making meanders seems to be a self-intensifying process…in which greater curvature results in more erosion of the bank, which results in greater curvature…' The cross-current along the floor of the channel is part of the secondary flow and sweeps dense eroded material towards the inside of the bend.[17] The cross-current then rises to the surface near the inside and flows towards the outside, forming the helical flow. The thalweg hugs the outer banks and returns to center over the riffles. Certificate Physics And Human Geography; Indian Edition. p. 45. This is due to the effect of helical flow which sweeps dense eroded material towards the inside of the bend, and leaves the outside of the bend unprotected and vulnerable to accelerated erosion. The topography is generally parallel to the meander, and is related to migrating bar forms and back bar chutes,[40] which carve sediment from the outside of the curve and deposit sediment in the slower flowing water on the inside of the loop, in a process called lateral accretion. pp. Ideal waveforms, such as a sine wave, are one line thick, but in the case of a stream the width must be taken into consideration. The orientation angle is the angle between sinuous axis and down-valley axis at any point on the sinuous axis. ^ Singh, R.Y. (2005). Hydraulics of Sediment Transport. The shortest distance; that is, a straight channel, results in the highest energy per unit of length, disrupting the banks more, creating more sediment and aggrading the stream. The Journal of Geology, 22(5), pp. These delta-like features block either end of the cutoff meander to form a stagnant oxbow lake that is separated from the flow of the fluvial channel and independent of the river. Gippel; Rory J. pp. 179–184. Virtual Luna Leopold Thonemann, P., The Maeander Valley: A historical geography from Antiquity to Byzantium (Cambridge, 2011) (Greek Culture in the Roman World Series). NJ: Pearson Prentice Hall. A stream bed following a tilted valley. United States Geological Survey Professional Paper 354-A, 10 pp. Bibcode:2008Geomo.102..145D. Routledge, New York, New York. The index may require elaboration, because the valley may meander as well—i.e., the downvalley length is not identical to the reach. As a result, the meander erodes and migrates in the direction of the outside bend, forming the cut bank.[26][27] As the cut bank is undermined by erosion, it commonly collapses as slumps into the river channel. Tidal stream development and its effect on the distribution of the American oyster. Water Resources Publications. Irrotational flow: From Bernoulli's equations, high pressure results in low velocity. Cutoff meanders that have cut downward into the underlying bedrock are known in general as incised cutoff meanders.[1] As in the case of the Anderson Bottom Rincon, incised meanders that have either steep-sided, often vertical walls, are often, but not always, known as rincons in the southwest United States.[30] Rincon in English is a nontechnical word in the southwest United States for either a small secluded valley, an alcove or angular recess in a cliff, or a bend in a river.[31] Incised meanders Main article: Entrenched river Glen Canyon, US The meanders of a stream or river that has cut its bed down into the bedrock are known as either incised, intrenched, entrenched, inclosed or ingrown meanders. In Middleton, Gerard V. Deposition at the inside bend occurs such that for most natural meandering rivers, the river width remains nearly constant, even as the river evolves.[10] In a speech before the Prussian Academy of Sciences in 1926, Albert Einstein suggested that because the Coriolis force of the earth can cause a small imbalance in velocity distribution, such that velocity on one bank is higher than on the other, it could trigger the erosion on one bank and deposition of sediment on the other that produces meanders[11] However, Coriolis forces are likely insignificant compared with other forces acting to produce river meanders.[12] Meander geometry Uvac canyon meander, Serbia Meanders on the River Clyde, Scotland The technical description of a meandering watercourse is termed meander geometry or meander planform geometry.[13] It is characterized as an irregular waveform. ^ Scheidegger, Adrien E. Dictionary Geotechnical Engineering/Wörterbuch GeoTechnik: English-German/Englisch-Deutsch. 278. 1 (1). 107 (C9): 3131. The stochastic theory can take many forms but one of the most general statements is that of Scheidegger: 'The meander train is assumed to be the result of the stochastic fluctuations of the direction of flow due to the random presence of direction-changing obstacles in the river path.'[23] Given a flat, smooth, tilted artificial surface, rainfall runs off it in sheets, but even in that case adhesion of water to the surface and cohesion of drops produce rivulets at random. 551 pp. A cutbank is also known either as a river-cut cliff, river cliff, or a bluff and spelled as cutbank.[1] Erosion that forms a cut bank occurs at the outside bank of a meander because helicoidal flow of water keeps the bank washed clean of loose sand, silt, and sediment and subjects it to constant erosion. The waveform depends ultimately on the characteristics of the flow but the parameters are independent of it and apparently are caused by geologic factors. ^ a b Toonen, W.H., Kleinhans, M.G. and Cohen, K.M., 2012. blackwell publishing. In Landforms of the World with Google Earth. ISBN 3-540-20017-7. D., 1954, Principles of Geomorphology, John Wiley & Sons, New York, New York. Lateral activity in a river of northwestern Canada. "River Meandering". In a pool direction of flow is downward, scouring the bed material. River Mechanics. 1. p. 113. The final break-through of the neck, which is called a neck cutoff, often occurs during a major flood because that is when the watercourse is out of its banks and can flow directly across the neck and erode it with the full force of the flood.[28][38] After a cutoff meander is formed, river water flows into its end from the river builds small delta-like feature into either end of it during floods. The curvature varies from a maximum at the apex to zero at a crossing point (straight line), also called an inflection, because the curvature changes direction in that vicinity. The flow is supplied by a counter-flow across the surface from the inside to the outside.[20] This entire situation is very similar to the Tea leaf paradox.[21] This secondary flow carries sediment from the outside of the bend to the inside making the river more meandering.[22] As to why streams of any size become sinuous in the first place, there are a number of theories, not necessarily mutually exclusive. "Morphotectonic study of the lower Sangro River valley (Abruzzi, Central Italy)". In case of a freely meandering river on a floodplain, a slip-off slope is the inside, gently sloping bank of a meander on which sediments episodically accumulate to form a point bar as a river meanders. Hydrobiologia, 42(4), pp. "River Meandering and a Mathematical Model of this Phenomenon". An antecedent stream or river is one that maintains its original course and pattern during incision despite the changes in underlying rock topography and rock types.[32][33] However, later geologists[36] argue that the shape of an incised meander is not always, if ever, "inherited," e.g., strictly from an antecedent meandering stream where it meander pattern could freely develop on a level floodplain. This axis represents the overall direction of the stream. A treatise on limnology, v. In contrast to sine waves, the loops of a meandering stream are more nearly circular. ^ Herrmann, H. The meander belt is defined by an average meander width measured from outer bank to outer bank instead of from centerline to centerline. It is calculated as the length of the stream divided by the length of the valley. Movshovitz-Hadar, Nitsa; Alla Shmuklar (2006-01-01). 10: 129–58. Physicalplus. ^ a b Barbour, J.R., 2008. Geological investigation of the alluvial valley of the lower Mississippi River. 459–472. Eventually as the result of its meandering, the fluvial channel cuts through the narrow neck of the meander and forms a cutoff meander. "In the absence of secondary flow, bend flow seeks to conserve angular momentum so that it tends to conform to that of a free vortex with high velocity at the smaller radius of the inner bank and lower velocity at the outer bank where radial acceleration is lower." ^ Hickin 2003, p. 432. pp. 261–265. ^ Hutchinson, G.E. 1957. Inside that layer and following standard boundary-layer theory, the velocity of the fluid is effectively zero. It is produced by the gradual outward migration of the meander as a river cuts downward into bedrock.[46][47] A terrace on the slip-off slope of a meander spur, known as slip-off slope terrace, can formed by a brief halt during the irregular incision by an actively meandering river.[48] Derived quantities Meanders, scroll-bars and oxbow lakes in the Songhua River The meander ratio[49] or sinuosity index[50] is a means of quantifying how much a river or stream meanders (how much its course deviates from the shortest possible path). (April 2016). "Secondary circulation in a region of flow curvature: Relationship with tidal forcing and river discharge". Thornbury[32] argues that incised or inclosed meanders are synonyms that are appropriate to describe any meander incised downward into bedrock and defines enclosed or entrenched meanders as a subtype of incised meanders (inclosed meanders) characterized by a symmetrical valley sides. ^ Riley, Ann L. ISBN 1-4020-0872-4. ^ Norman D. ISBN 0-415-33453-5 ^ Leopold, L.B., Wolman, M.G., Wolman, M.G. and Wolman, M.G., 1957. Morphotectonics. "Albert Einstein and Meandering Rivers". This classic fluid mechanics result is irrotational vortex flow. 23 (1): 49–55. The slumped sediment, having been broken up by slumping, is readily eroded and carried toward the middle of the channel. Annals of the Association of American Geographers, 3(1), pp. last accessed November 22, 2017 ^ a b Thornbury, W. Principles of Sedimentology and Stratigraphy (4 ed.). This is because the tops can be shaped by wind, either adding fine grains or by keeping the area unvegetated, while the darkness in the swales can be attributed to silts and clays washing in during high water periods. ISBN 978-0-19-562816-6. 214 (6): 60. 618 pp. ^ Weiss, Samantha Freeman. The meander arc length is the distance along the thalweg over one meander. (1998). Gordon (1957). It flows through series of three graben in the Menderes Massif, but has a flood plain much wider than the meander zone in its lower reach. Restoring Streams in Cities: A Guide for Planners, Policymakers and Citizens. doi:10.1007/s11016-013-9819-x. During floods, the flood waters deposit fine-grained sediment into the oxbow lake. Depositional sedimentary environments: with reference to terrigenous clastics. OCLC 17150333. United States Geological Survey. War Department, Corps of Engineers, Mississippi River Commission, Vicksburg, Mississippi. ^ a b c d Fisk, H.N., 1944. ISBN 0-486-23205-0. ISBN 0-632-05354-2. Geomorphic and morphotectonic theory Geomorphic refers to the surface structure of the terrain. 282B, US Government Printing Office, Washington DC., 47 pp. doi:10.1080/00288306.1996.9514708. Slip-off slope Main article: Slip-off slope Depending upon whether a meander is part of an entrenched river or part of a freely meandering river within a floodplain, the term slip-off slope can refer to two different fluvial landforms that comprise the inner, convex, bank of a meander loop. Typically, the sediment consists of either sand, gravel, or a combination of both. ISBN 0-470-84357-8. Regardless, the formation of both entrenched meanders and ingrown meanders is thought to require that base level falls as a result of either relative change in mean sea level, isostatic or tectonic uplift, the breach of an ice or landslide dam, or regional tilting. Pressure force, however, remains unaffected by the boundary layer. (ed.). pp. 183–184. Meandering River Dynamics (Doctoral dissertation). and Watling, L., 1973. 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