Stream Movement Slide Show

Adapted from: "Stream Table Investigations: Lab Manual for the Earth Science Stream Table" by Gregory Beckway, published by Hubbard Scientific. 1998.

Grade Level: Basic, intermediate

Duration: 45 minutes, but depends on level of discussion.

Setting: classroom

Summary: Students will watch a slide show about stream movement and development, and how waterways carve the landscape.

Objectives: Students will learn some of the common characteristics of stream movement as it carves its way through a landscape.

Vocabulary: valley, channel, floodplain, youthful stream, mature stream, meander, levee, cutbank, cutoff, oxbow lake, deposition, point bars, braided stream, old-age stream, alluvium, alluvial fan, delta, terraces, entrenched valley, drainage patterns.

Related Module Resources:
- Stream Table activity

Materials (Included in Module):
- Printed Presentation with Script

Additional Materials (NOT Included in Module):
- Projector and screen or smart board
- Find presentation online on the stream geology module page

ACADEMIC STANDARDS: ENVIRONMENT & ECOLOGY

10th Grade
4.1 A Describe the changes that occur from a streams origin to its final outflow.

4.1 B Explain the relationships among landforms, vegetation, and the amount and speed of water.
- Analyze a stream's physical characteristics.
- Explain how the speed of water and vegetation cover relates to erosion.

4.1 C Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.
- Describe and explain the physical factors that affect a stream and the organisms living there.
- Identify the types of organisms that would live in a stream based on the stream's physical characteristics.

CONCEPTS COVERED:

Valley development, channel, floodplain, youthful stream, mature stream, meander, levee, cutbank, cutoff, oxbow lake, deposition, point bars, braided stream, old-age stream, alluvium, alluvial fan, delta, terraces, entrenched valley, drainage patterns.

SCRIPT:

1. Streams go through many changes as they become bigger and move through the landscape. This small stream is French Creek toward its headwaters (start).

2. Now much larger, French Creek south of Meadville, behaves differently because of the increased water volume and velocity. A larger stream interacts differently with the land than a small stream. This slide show will review many concepts in stream development and movement. You will see streams that are representative of regional waterways and you will see streams and rivers from other parts of the United States that do things to the landscape that we do not see around here.

3. Let us begin with a small stream or river. Geologically speaking, many small waterways that do not have tributaries that flow out of upland areas are considered youth streams. This diagram shows some of the characteristics of a youth stream/valley. The stream usually flows quickly in a relatively straight channel. Because of its velocity, it is constantly carving downward creating a V-shaped valley. A youthful stream exhibits many rapids and riffles, due to the steepness, and maybe some waterfalls. A youthful stream usually does not exhibit a floodplain, a flat area around the waterway where excess water that spills out of the stream channel spreads out onto.

4. You have probably hiked past a small stream in a ravine on a hillside that could be considered a youthful waterway. But a youth waterway does not have to be small. This is the canyon of the Yellowstone River is considered to be youthful. Note it is a V-shaped valley leading down to the river, has a steep gradient, and has rapids and fast water and even a small waterfall.

5. This is Upper Yellowstone Falls, an example of a youthful waterfall in a V-shaped valley. Valley walls are composed of consolidated rhyolite ash. Rock slides and mass wasting are common in youth stream valleys.

6. Not all waterfalls are along youthful waterways. The Niagara River is not youthful, but it contains our most famous falls - Niagara Falls. A waterfall can form when there is a resistant, hard rock layer on top of a softer, and more brittle, less resistant rock layer. In the case of Niagara Falls, dolomite bedrock (strong) sits atop less resistant shale that breaks away as water falls over the dolomite. This breaking away undercuts the dolomite causing it to collapse also. In fact Niagara Falls retreats upstream approximately 1 meter per year.

7. Our next step in the stream maturity process moves from youth stream to mature stream. A mature stream is common. It will have a larger volume of water, higher flow rate/discharge, and will have tributary waterways feeding into it (including youthful waterways). A mature stream is surrounded by quite a different landscape as compared to a youth stream and has the potential to make big impact on the surrounding land by eroding it. A mature valley is less steep, wider, and the stream moves around more in this valley.

8. In fact, a mature stream meanders. This means curves back and forth. This slide shows Cherry Creek in the Ochoco Mountains of Central Oregon. Note how it meanders through the landscape. Note also that a mature stream usually has a well-developed, wide floodplain. Once again, this is the flat area surrounding a waterway where excess water will go if it leaves that creek’s main channel. Not all mature streams have such a wide floodplain however.

9. So a mature stream meanders through the wide valley and floodplain. An old age stream, the next step in the stream maturation process, is pretty similar to a mature stream except the velocity of water decreases as the steepness (gradient) is reduced even more. The floodplain may be larger for an old-age stream. For BOTH a mature stream and old age stream, even though the gradient of the stream is less, there is still a lot of force and power behind the water. This force can really be noticed on the curves.

10. Here is a close up look at a typical stream curve. Water does not flow uniformly through a meander. Depth-wise, as depicted by the cross section, water flows slower toward the stream bottom because contact with the bottom rocks and sediments slows down water. Width-wise, the flow rate or velocity in a straight stretch is quickest in the middle. Along a curve, it is quicker toward the outer edge or outer 3/4. Right along the outer edge, contact with the channel edges slows down the water. But overall, there is more water force along the outer edge of a curve.

11. The greater force along the outer edge causes higher levels of disturbance (erosion) and turbidity. Disturbance and turbidity is greater along stream channel edges rather than in the middle, as shown in this illustration by the purple areas.

12. In this photo of a typical Western PA stream, where would the most water force be located? Answer: Outer edge. The outer edge is often called a cutbank.

13. In areas of the stream with less disturbance and force, an opportunity for deposition (settling out of sediments) exists. This occurs on the inside bank of a curve. You will often see sand bars or point bars accumulate here. This slide shows both places where deposition would occur and where erosion would occur.

14. Because of this erosive force on the outside curve, if you have a meandering waterway, there is a chance that the channel will change through time. Instead of water flowing around a large loop, it may erode a short cut called a cutoff, and the water flows through the shortcut and abandons the long loop. Eventually this loop might completely disconnect from the main channel, creating an oxbow lake (upper part of the slide). A curve may keep growing outward making a bigger loop, and the old, shorter, straighter channel can be called a chute. Old channels may also create backswamp areas (lower part of slide), which are great places for excess water to go.

15. Let’s take a look at some of these concepts using photographs. This slide of the Red River near Shreveport, Louisiana shows a meandering river. If you look closely, there are also meander scars, where old meanders have been abandoned and filled in with sediments. This mature river also has a wide migration path back and forth and a broad flood plain. This photo was taken by Apollo 9 of NASA.

16. It is easy to see the meander scars on this photo of the Mississippi River meandering through the area where the states of Mississippi, Arkansas, and Tennessee meet, near Memphis. This photo is a little different though. It is a LandSat infrared color view of the river, which helps show disturbance / changes in the land easily - like the old channels of the river.

17. Sometimes as a mature stream meanders, it will have long side channels. These side channels are often the old river channel that now receives less flow because the force of the river has created a newer, somewhat straighter path. Can you image in this photograph of the Gambia River (Gambia, West Africa), which of the multiple channels shown was probably the original, older channel?

18. This photo is of the Little Deschutes River meeting the Deschutes River south of Bend, Oregon. Both meander greatly. Can you identify any spots that might become oxbow lakes one day? <Pause> If you looked at aerial photographs or topographic maps of French Creek, you would notice that French Creek meanders through much of it path. You will also see side channels, oxbow lakes, and back channel swampy areas.

19. When a stream erodes the banks, it carries the sediments with it in the water column. This is called suspended load. Suspended load increases as water discharge and flow rate increase, as shown on this graph. Suspended load amount increases from right to left along the X axis as the discharge increases up the Y axis. This graph is an example of a scatter plot graph.

20. Suspended load can be composed of very fine particles like clay and bigger particles like sands. This slide shows that heavier sands tend to stay toward the bottom of a river (Missouri River in this case) in the suspended load while finer clays can be found throughout the water column. Fine sands are at the highest concentration (parts per million) in the suspended load for this particular study.

21. This chart shows the stream velocity necessary to lift sediments of differing size (clay, silt, sand, gravel, and boulder) off the stream bed. It also shows the deposition velocities for a given particle size. As you can see, it is much easier to lift and transport smaller particles like clay and silt. The larger the particle, the more difficult it is to transport. It takes fairly high energy to transport and erode large gravel and boulders.

22. Under high flow conditions, sediments great and small can be picked up and moved. Note the sediments at the bottom of the San Juan River at low flow. What happened to them after the discharge increased because of a flood? Answer: Higher flow equaled greater potential for particle movement.

23. Suspended load, perhaps created by erosion occurring as a river curves through the landscape, can cause water to be cloudy/turbid. This photo is just downstream of a meeting of two rivers. The Little Colorado River carries large amounts of silt and clay and entered from the top. It mixes with the Colorado River, which was less silty and had more green algal growth. This type of mixing is often commonly seen in Pittsburgh where the Allegheny River and Monongahela River meet to form the Ohio River. The Monongahela River can often be more turbid, so the southern half of the Ohio River will be murky brown, while the other half fed from the Allegheny River is clearer.

24. There are areas in lowlands and very flat areas where a stream may deposit a great deal of sediment. This is common in old-age streams, where stream velocity is low. Often when sediments drop out of a creek, they are usually well-sorted in size and uniform in size. Within a stream, the well-sorted material deposited is collectively called alluvium. As discussed already, alluvium may deposit around the inside of a curve, where the water is slower. Deposition can be pushed up into long piles to create natural levees along the waterway sides. This slide shows a cross section of a meander and the buildup of a levee.

25. Deposition of alluvium may also occur creating various islands in the channel. When this occurs, the stream is considered to be braided. This photo of a braided stream is near Tucson, Arizona. The photo was taken from 2000’ (610 m) altitude.

26. The Toutle River draining on the north side of Mt. St. Helens, in Washington shows a few things: meanders, side channels, cutoffs, oxbow scars, and braided channels flowing through andesitic volcanic ash.

27. Sometimes alluvium can be deposited in a fan-like or triangular pattern, called an alluvial fan, especially if a smaller stream enters into larger waterway. These deposition patterns may be created when any waterway that has been moving is greatly slowed down as it reaches the lowest base level and enters a new, bigger waterway, or even an ocean. The alluvial fan is the dropping out of the majority of the sediments in the waterway and the deposition occurs in a fixed order. Large materials fall out first with finer sediments settling out further downstream. An alluvial fan can be referred to as a delta when it is at the end of a waterway as it enters a large lake, as shown in this slide.

28. Or a delta can be formed in the ocean. In this slide, like the last slide, layers of sediments keep layering up on the ocean or lake bottom as deposition occurs.

29. Some deltas get almost completely wiped out immediately by ocean currents, but some deltas like the Mississippi River Delta, as shown in this slide, can be huge.

30. This image of the Mississippi Delta is seen with LandSat infrared color technology. You will see numerous distributaries. Distributaries are opposite of tributaries, which come together bringing water into a main channel. So distributaries diverge out from the main channel carrying water away and into the ocean.

31. This is a photograph of some of the distributaries of the Mississippi River meandering through the marshy landscape.

32. This is a LandSat photograph of the Nile River Delta. This view shows classic triangular delta on the left as the Rosetta Nile branch (left) enters the ocean (covered by clouds) and the Damietta Nile (right) enters.

33. Now back to valleys. On the upper left, you see a valley that we have seen before, with a meandering waterway and nice wide valley. The lower right has an entrenched river. The old river bed flowed through the wider valley, but because of a geological event like a glacier or uplifting, the waterway channel was shifted and began cutting a new, more confined path, creating a new floodplain. The old floodplain creates higher elevation terraces.

34. This illustration shows uplifting of land causing an opportunity for a new river channel to cut into an old river valley. It is cutting a V-shaped valley but will eventually widen and create terraces.

35. Here is a great example of terraces and an entrenched river. This is the White River along Highway 64 near Rangely, Colorado.

36. Here is another well-developed terraced river valley. This is a tight meander in the flood plain of the Gibbon River near Norris, Yellowstone Park, Montana.

37. This photo is an extremely entrenched river. It is the Little Colorado River on the Colorado Plateau. View of a 1,000 ft (305 m) deep canyon with vertical walls leading down to the river.

38. This incised (cut down into) meander of the San Juan River just north of Mexican Hat, Utah is another example of extreme entrenching.

39. So we have been seeing waterways moving across the landscape and seeing specific characteristics of meanders, deposition, and river valleys. Looking at a greater general scheme, all these waterways are supposed to fit into four basic overall drainage patterns. This slide illustrates them: dendritic (most common), trellis drainage, rectangular drainage, and radial.

40. This view, made from the space shuttle, shows the Hadramawt Plateau in South Yemen. It is classic example of dendritic drainage patterns. These drainage patterns are very common in Northwest Pennsylvania and are easy to see on topographic maps and aerial photographs.

41. This slide of waterways in Arizona higher elevations is an example of trellis drainage. Trellis drainage is commonly seen in the mountains of central Pennsylvania as well.

42. This slide is shows a 90 degree bend in a waterway (caused by part of the old channel being filled in by an old lava flow. If waterways commonly exhibit 90 degree bends in the channel, the drainage pattern is considered to be rectangular.

43. This is an example of a landform which would have a radial drainage.

44. Moving water is a major factor in sculpting our landscape. Waterways produce valleys, floodplains, and alluvial fans through the process of erosion and deposition of sediments. This constant carving and settling changes our landscape continuously.

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