

## 2003 Dynamic Planet Event

## Topic: Rivers

Below is an outline of the essential concepts of the 2003 Dynamic Planet Event of the Science Olympiad. Source: *Physical Geology: Earth Revealed*, Third Edition; Chapter 16, pages 350 – 383; David McGearry and Charles C. Plummer; © 1998 McGraw-Hill ISBN 0-697-37649-4; www.mhhe.com

- I. Hydrologic Cycle
  - A. ~ 50% of rain returns to the atmosphere through evaporation or transpiration from plants
  - B. ~ 15% to 20% of rain normally ends up as surface runoff in rivers
- II. Channel flow
  - A. A **stream** is a body of running water confined in a channel and moving downhill under the influence of gravity.
  - B. Geologists use the term “**streams**” for any body of running water, from a trickle to a huge river.
  - C. **Headwaters** are the upper part of a stream near its source in the mountains.
  - D. The **mouth** is where a stream enters the sea, a lake, or a larger stream.
  - E. The cross profile of a stream in steep mountains is usually a V-shaped valley cut into solid rock.
  - F. Near its mouth, a stream usually flows within a broad, flat-shaped valley.
  - G. The stream channel is surrounded by a flood plain of sediment deposited by the stream.
  - H. The sides of a channel are called its **banks**; the bottom of the channel is called the **stream bed**.
  - I. Water may run off as **sheetwash**, a thin layer of unchanneled water flowing downhill. Sheetwash, along with the impact of raindrops on the land surface, can produce sheet erosion.
  - J. Tiny streams, called **rills**, merge to form small streams.
- III. A **drainage basin** is the total area drained by a stream and its tributaries.
  - A. A **tributary** is a small stream flowing into a larger one.
  - B. A drainage basin can be outlined on a map by drawing a line around the region drained by all the tributaries to a river.
  - C. A **drainage basin** is a ridge or strip of high ground dividing one drainage basin from another.
- IV. Flooding
  - A. A **recurrence interval** is the average time between floods of a given size.
  - B. Flood erosion is caused by the high velocity and large volume of waters in a flood.
  - C. Flood deposits are usually silt and clay; good for agriculture, but bad for cities.
  - D. Flood control structures
    1. Upstream dams
    2. Artificial **levees** that are embankments built along the banks of a river channel.
    3. **Riprap** is protective walls of stone constructed along riverbanks.

- V. Erosion and deposition
- Stream velocity** is the speed at which water travels in a stream.
  - A stream reaches its maximum velocity near the middle of a channel.
  - Friction near a stream's banks and bed slows the water.
  - When a stream goes around a curve, the region of maximum velocity shifts to the outside of the curve.
  - Velocity is the key factor in a stream's ability to erode, transport or deposit.
- VI. Gradient
- Stream gradient** refers to the downhill slope of a bed.
  - Channelization refers to artificially steepening a gradient to increase the speed of runoff to help control flooding and improve navigation on a river.
- VII. Channel shape and roughness
- The shape of the channel controls stream velocity.
  - Hard, resistant rock is difficult to erode, so a stream may have a narrow channel in such rock resulting in more rapid flow.
  - Softer rock erodes more easily thus widening the channel and slowing the water which, in turn causes the deposition of sediments.
  - Roughness of the channel
    - Streams can flow rapidly over a smooth channel.
    - A boulder-strewn channel creates more friction causing water flow to slow.
    - A ripply, wavy sand bottom is rougher than a smooth sand bottom.
- VIII. Discharge
- The **discharge** of a stream is the volume of water that flows past a given point in a unit of time.  $\text{Discharge} = \text{width} \times \text{depth} \times \text{velocity}$ .
  - $\text{Discharge (cfs)} = \text{channel width in feet}$   
 $\times \text{average channel depth in feet}$   
 $\times \text{average velocity (feet per second)}$
  - Example:  $100 \text{ ft.} \times 15 \text{ ft.} \times 6' / \text{sec} = 9000 \text{ cubic ft/sec}$
  - Discharge increases downstream
    - Water flows out of the ground into the river through the streambed.
    - Small tributaries flow into larger streams.
- IX. Stream erosion
- Hydraulic action is the ability of flowing water to pick up and move rock and sediment.
  - Water may slowly dissolve rocks, especially limestone.
  - Abrasion** is the grinding away of a stream channel by the friction and impact of the sediment load.
- X. Stream transportation of sediment
- Bed load** is large or heavy sediment particles that travel near or on the streambed.
    - Traction** refers to rolling, sliding or dragging.
    - Saltation** refers to short leaps or bounces off the bottom.

- B. A **suspended load** is sediment light enough to remain lifted indefinitely above the bottom of a stream by water turbulence.
- C. The **dissolved load** is the soluble products of chemical weathering processes.
- XI. Stream deposition
  - A. **Bars** are ridges of sediment deposited in the middle or along the banks of a stream.
  - B. **Deltas** or **alluvial fans** are deposits of sediments near the ends of streams.
- XII. Braided streams
  - A. Bars may divert stream flow to cause a stream to widen. Many such diversions may create a **braided stream**, a network of interconnected rivulets around numerous bars.
  - B. Braided streams form particularly well in streams laden with sediments.
- XIII. Meandering streams and point bars
  - A. **Meanders** are formed by fine-grained silt and clay.
  - B. Meandering is more common in the lower reaches of a river where sediments tend to be finer.
  - C. Meanders develop because a stream's velocity is highest on the outside of curves where erosion is promoted.
  - D. Low velocity on the inside of a curve promotes deposition. These become **point bars**.
  - E. A **meander cutoff** is a new, shorter channel across the narrow neck of a meander. The cutoff meander becomes an **oxbow lake**.
- XIV. Flood plains
  - A. A **floodplain** is a broad strip of land built up by sedimentation on either side of a stream channel.
  - B. Flood plains may be composed almost entirely of horizontal layers of fine-grained sediment interrupted by coarse-grained channel deposits.
  - C. Other flood plains are dominated by meanders shifting back and forth.
- XV. Deltas
  - A. **Deltas** are bodies of sediment deposited near the mouths of rivers.
  - B. **Distributaries** are small, shifting channels that carry water away from the main river channel and distributes it over the surface of a delta.
- XVI. Alluvial fans
  - A. An **alluvial fan** is a large fan-shaped or cone-shaped pile of sediment that usually forms where stream velocity decrease as it emerges from a narrow mountain canyon onto a flat plain.
  - B. On large fans, deposits are graded in size within the fan, with the coarsest sediments dropped nearest the mountains and the finer materials deposited progressively farther away.
- XVII. Valley development
  - A. **Downcutting** is the process of deepening a valley by erosion of the streambed.
  - B. **Base level** is the theoretical limit for erosion of the earth's surface. For those streams that reach the ocean, base level is close to sea level.

XVIII. Graded streams

- A. **Graded streams** exhibit a delicate balance between its transporting capacity and the sediment load available to it.
- B. **Lateral erosion** widens a valley by undercutting and eroding valley walls.
- C. **Headward erosion** slows uphill growth of a valley above its original source through gullying, mass wasting, and sheet erosion.

XIX Drainage patterns

- A. **Dendritic patterns** resemble branches of a tree or the veins in a leaf. Dendritic patterns develop on uniformly erodable rock.
- B. **Radial patterns** resemble the radiating spokes of a wheel. These form on high, conical-shaped mountains.
- C. **Rectangular patterned** tributaries have frequent 90° bends and tend to join other streams at right angles.
- D. **Trellis patterns** are formed by parallel main streams with short tributaries meeting at right angles.