FLUVIAL PROCESSES AND LANDFORMS
Streams as Geomorphic Agents

July 28th, 2021

Fluvial Geomorphology

Geomorphology

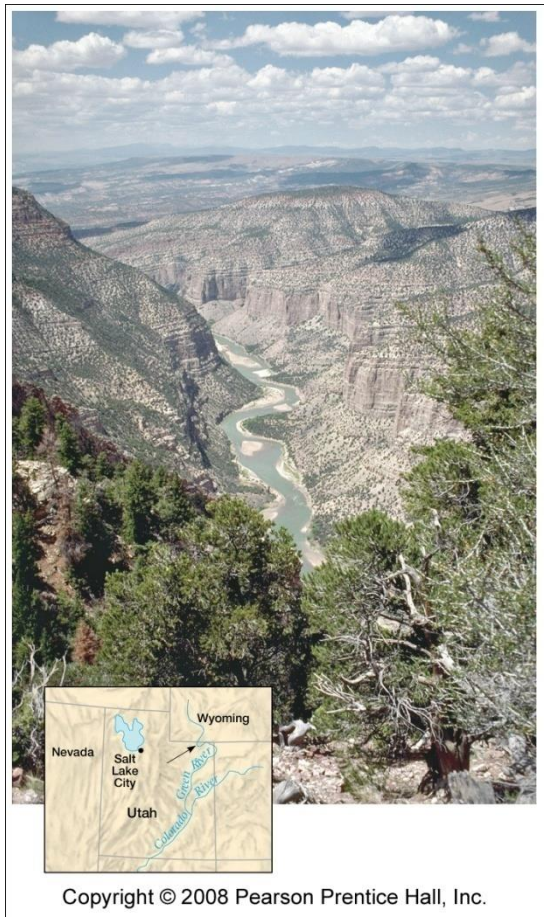
Geomorphology: the science that analyses and describes the origin, change over time, form, classification, and spatial distribution of landforms.

Fluvial Geomorphology: stream-related processes; from the Latin *fluvius* for "river" or "running water"

Processes involving the work of running water on the surface of Earth.

The Impact of Fluvial Processes on the Landscape

- Fluvial processes involve running water
- Running water is Earth's most important external agent
- ***Ubiquitous (everywhere except in Antarctica)***



– Gorge carved by the Green River, northeastern Utah.

The Work Streams Do

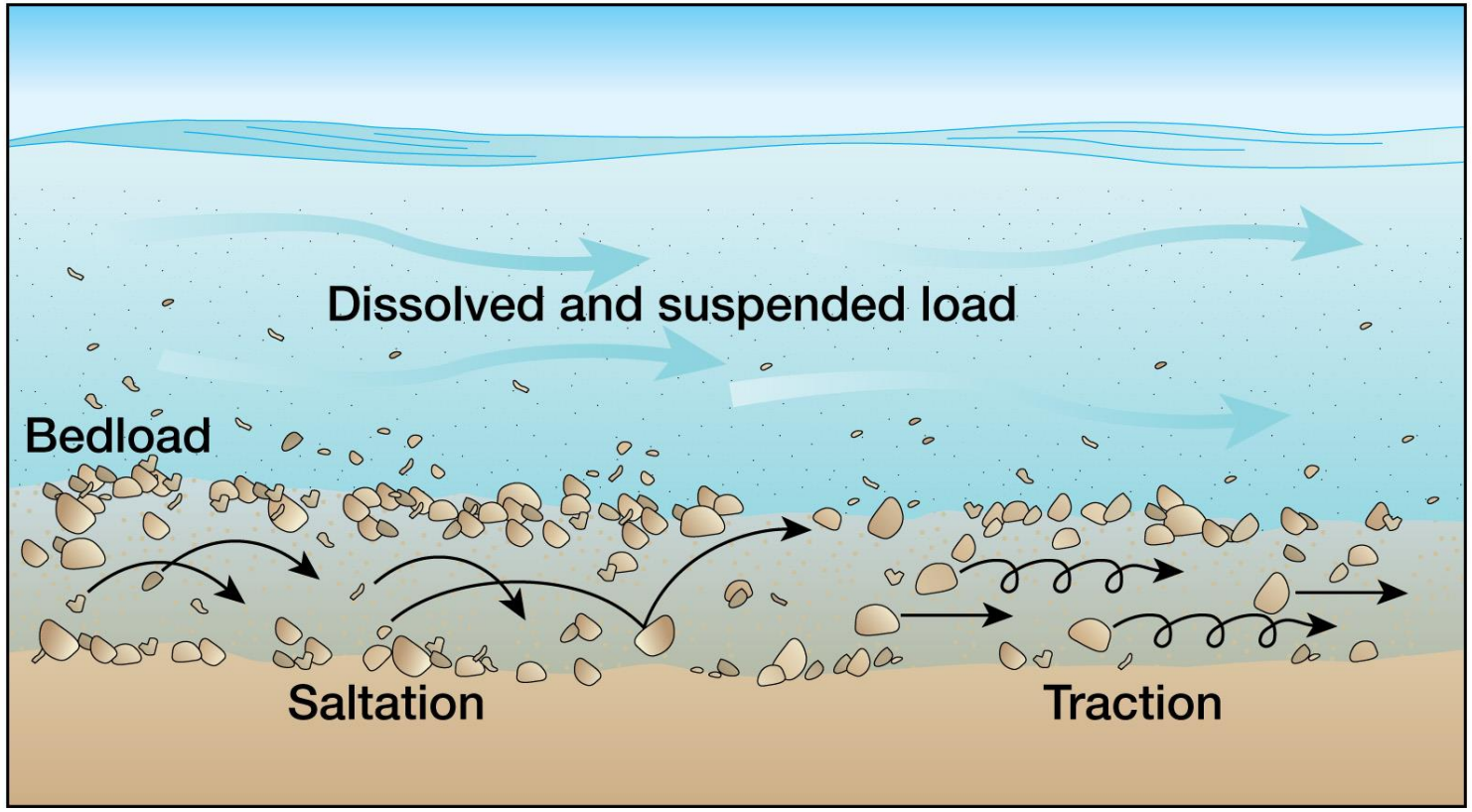
Stream load—solid matter carried by a stream:

1. **Bed load:** sand, gravel, and larger rock fragments moving in a stream by saltation and traction.
   - ***Saltation***—process in which small particles are moved along by **streamflow or wind in a series of jumps or bounces**.
   - ***Traction***—process in which coarse **particles are rolled or slid** along the streambed
     - The energy and turbulences of the flowing water can carry and roll these particulates down stream.
2. **Suspended load:** the very fine particles of clay and silt that are in suspension and move along with the flow of water without ever touching the streambed.
3. **Dissolve load:** the **minerals, largely salts that are dissolved in water and carried invisibly in solution**. These are difficult to, and hardly studied. *Dissolved load have little impacts on shaping landforms*.

Generally, most material is transported in the suspended load; the least is transported in bedload.

The Work Streams Do

Streams work by transporting sediment. The size of sediments vary from rock layer to small sediments that divided into three (3) fractions.



Can a Stream move these rocks?

The Work Streams Do

Competence—the size of the largest particle that can be transported by a stream.

- Depends mainly on flow speed.
  - Size of largest particle varies with the square power of the water speed.
  - Double water speed, size of particle goes up 4-fold (2^2).

Capacity—the maximum total load that a stream could transport under given conditions; its potential.

- Change depends mostly on fluctuation in volume and flow speed but also on characteristics of the load.
- **LOAD = the actual volume of materials carried by a stream**

The Work Streams Do

Deposition inevitably follows erosion.

- Occurs either as flow speed or water volume decreases.
- Flow speed diminishes often with change in gradient or as channel widens or changes direction.
- Deposits are at mouths of canyons, on floodplains, at riverbends.

The Work Streams Do

Material that is carried by a stream and then deposited someplace else is called ***Alluvium*.**

- Most alluvium is deposited into quiet water (ocean or lake).

Materials can be sorted when stream velocity decreases.

As *stream competence drops*, **materials are sorted, with the largest being deposited upstream first and more fine-grained materials being carried farther downstream.**

Streams can build (aggrade) up or erode (degrade) the landscape.

Stream Degradation

As streams transport sediment, and removes materials below it, **the stream bed will get lower and lower**, basically **cutting a wedge into the stream bed**.

This process is called ***degradation*.**

It is through this process that the vast majority of valleys are created.

As such, streams are very important in shaping what the Earth's surface looks like.

Stream Aggradation

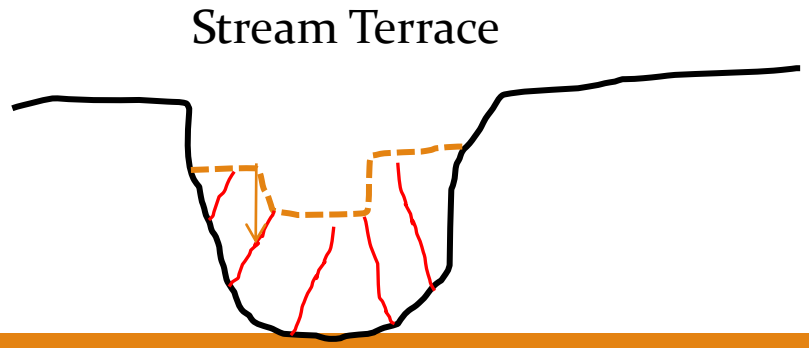
Streams don't always deepen their valleys

Sometimes they add materials to the stream structure – this is called **Aggradation**

Streams have a **cycle of Degradation and Aggradation**.

Deeper valleys filled with alluvium may degrade again and lower the valley, deepening the stream.

If it's not entirely degraded away, there may be shelves that show up where the valley used to be – **creating stream terraces**.



Equilibrium and Change

Definition: The stream has just enough energy to transport the sediment supplied to it without eroding the stream bed or depositing sediments

When the stream is in equilibrium, the landscape surrounding it does not change much. We need a stream "**out**" of equilibrium to change the landscape.

Depends on workload, sediment addition, steepness of the slope.

In the period of the stream trying to get back its energy, **the landscape was changed**.

Equilibrium and Change

The time scale involved in these processes can vary widely.

Bedrock is tough, so it will take a longer time to erode – up to thousands of years.

Grand canyon: the largest valley on earth, took millions of years for the Colarado river to degrade these valleys to produce the wonders we see today.

Degradation of **alluvium** is very fast. This can happen in a week, or as a result of a single flood event.

Small Scale Example: Channel Form

Streams that carry suspended load, will tend to be relatively rapid flowing, narrow and deep.

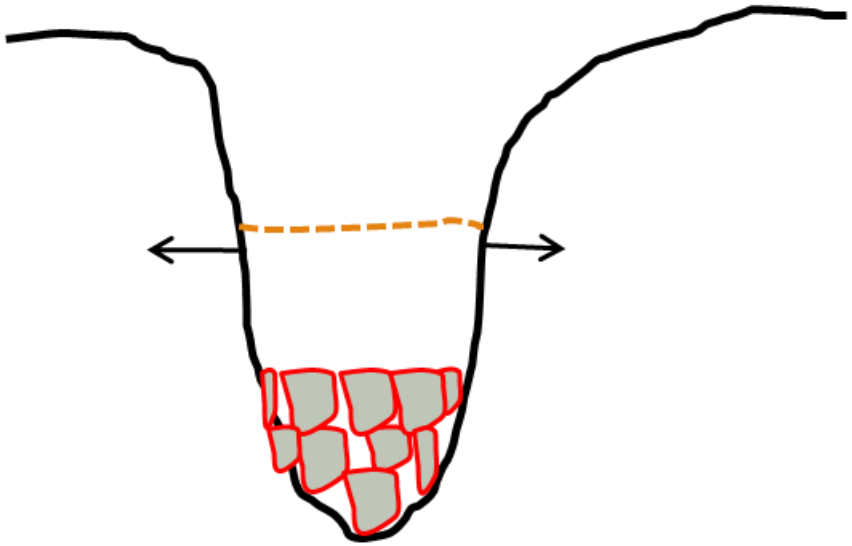
To keep materials in suspension, you need water to move very fast.

What happens if we place materials that are too big to be carried in suspension to this stream?

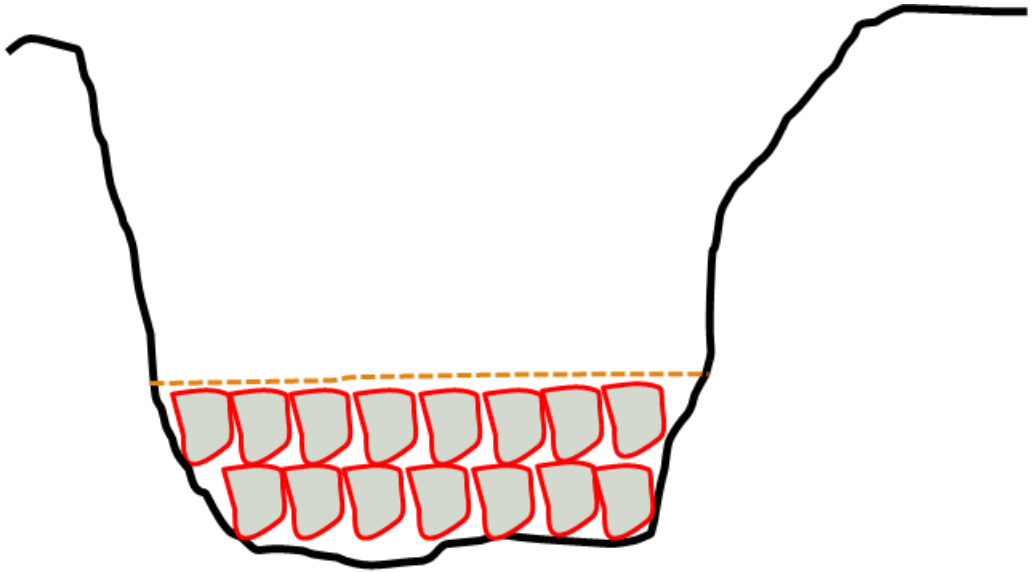
The materials will not be carried downstream, they will be deposited, making the channel shallower.

To get out of this, the stream needs to erode the stream bed, becoming shallower and wider.

Small Scale



Stream dominated by suspended load



Stream with larger materials added

Small Scale

This new form of channel allows the stream to be able to move the bedload that has been added to it.

We may have bedload accumulated in the stream, that except in large flood events, the water does not cover all of the sediments.

This type of channel is called a **braided stream**. These are characterized as bedload dominated streams.

Braided Stream

- Heavily loaded stream
- Gentle gradient slows flow speed
- Slow moving stream chokes channel with alluvium
- Sand and gravel bar deposits divide (braid) the stream

Large Scale Causes of Degradation and Aggradation

Causes of degradation.....

- If energy is greater than workload
- Long time scale – uplift of the earth surface – uplift means the stream needs to work harder to break it down
- More energy could be added:
  - **More frequent floods – this adds more energy to the stream – climate change** could make floods more frequent, adding more energy for degradation
  - Changing conditions in the watershed
  - Decreasing the workload of the stream – reduce sediment production

.....Causes of Aggradation.....

When workload is greater than energy

- Increasing sediment supply
- Changing watershed so that more materials are deposited in the stream
- Decrease in energy – climate change – smaller streams, smaller floods, less energy

Specialized example….

Alluvial fan:

As a stream leaves the narrow confines of a mountain gorge and emerges onto the **open piedmont** (a transition area from the steep slopes of the ranges to the near-flatness of the basins), it abruptly loses both capacity and competence.

It breaks into distributaries that wind their way down the **piedmont slope**, sometimes cutting shallow new channels in the loose alluvium but frequently depositing more debris atop the old.

Channels become choked and overflow, developing new ones.

In this fashion a moderately sloping, fan-shaped landform is constructed at the mouth of the canyon – called an **Alluvial fan**