Rift and Glacier Geology of the Upper Arkansas Valley

Arkansas Headwaters Recreation Area

Ver. 2.0

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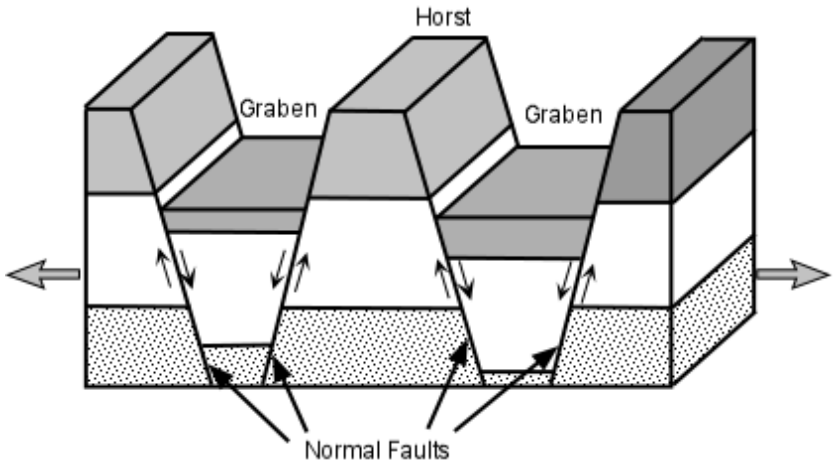
Geological Sections of AHRA

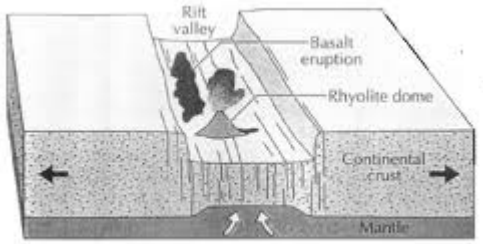
- Upper Arkansas River Valley
  - Leadville to Salida
  - Segment of the Rio Grande Rift
- Upper Big Horn Sheep Canyon
  - Salida to Coaldale
  - Canyon through the east horst of the Rio Grande Rift
- Lower Big Horn Sheep Canyon / Royal Gorge
  - Coaldale to Canon City
  - Canyons through the Front Range uplift of the southern Rocky Mountains

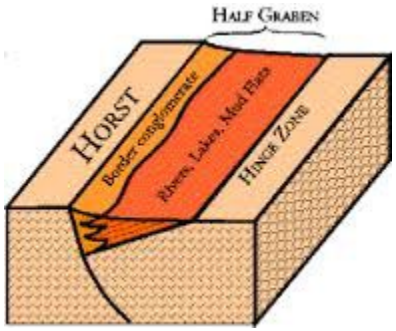
Upper Arkansas River Valley

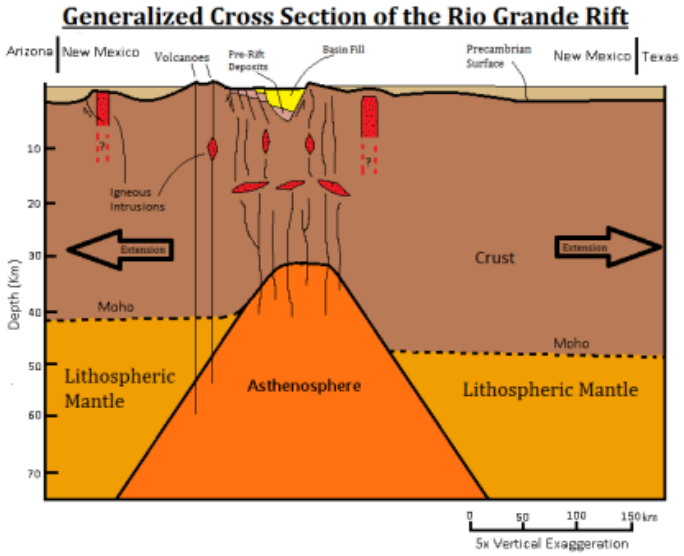
- A portion of the Rio Grande Rift running from southern Wyoming south into Mexico
  - **Rift** – a portion of Earth's crust where spreading has occurred
    - Caused by tensional forces from the flat-subducting Farallon Tectonic Oceanic Plate activity below the crust
    - Elongated blocks of crust (**horsts**) parallel to and on both sides of a rift rotate and uplift, here to over 7K feet above the graben, while spreading apart
    - The area between the spreading blocks (**graben**) drops along the uplifting fault-bounded blocks forming a valley, here 15K thick with post-rift fill
    - The uplifting exposes rocks lower in the rift's horst walls from thousands of feet deep within the crust
    - The spreading allows hydrothermal and volcanic activities from deep within the earth to rise to the surface
      - Causing hot spring activity on the west from Cottonwood Creek south to Poncha Pass and Salida
      - Causing related volcanic activity on the east from Buffalo Peaks south to Salida and on the west from Independence Pass to Monarch Pass

Rift Diagrams









Upper Arkansas River Valley

- Geology of the Upper Arkansas Rift Valley
  - The Mosquito Range is the east horst and the Sawatch Range is the west horst of the rift valley
  - A significant amount of uplifted Mesoproterozoic metamorphic basement rock (banded and folded gneiss) is exposed at the base of both horst walls
  - Un-metamorphosed Mesoproterozoic basement granites and granite intrusions in the metamorphosed rock are also exposed in the horst walls below the sedimentary rock layers high on the horst walls back to the east and west
  - Significant glaciations have occurred to both horst walls to the north end of the valley and in the Sawatch alone to the south end
    - Where Lake Creek, Clear Creek, and Pine Creek end at the Arkansas River, banks of glacial till are present as remains of glacial moraines
    - Just south of the Granite town site, one or more ice dams that formed during the glacial melt period, creating a 500 foot deep lake, burst to scour out and form the deeper portion of the Granite Canyon area and carry large boulders way downstream (as far as the Spikebuck recreation site)
    - The glacial moraines have forced the Arkansas River tightly against the east horst through much of the Upper Arkansas River Valley
  - Large deposits of volcanic rhyolite and andesite remain along the east horst from Bald Mt., Sugarloaf and Ruby Mountains and Rainbow Rock south to Salida and predominate from Hecla Junction to the lava and ash flow east of Salida from “S” Mountain
  - Along the base of the Sawatch Range south of Mesa Antero, large planation surfaces contain exotic rocks and sorted glacial outwash from flooding that drained from receding glaciers in the Sawatch
  - Mixed with the basement granite and volcanic deposits, the Mesoproterozoic basement metamorphics make a significant appearance near Hecla Junction and east of Salida at the base of the east horst

Upper Big Horn Sheep Canyon

- A fault system in the east horst of the Rio Grande Rift
  - Formed by tensional spreading steeply uplifting huge blocks of crust, forming faults and fractures that the Arkansas River follows
  - The uplift and faults slope downward easterly to Coaldale
  - Later crustal shifting and volcanism possibly diverted the Arkansas River from a southward flow through Poncha Pass to a southeastward flow following faults through the east horst
- Uplifting exposed deep Mesoproterozoic rocks up through successive layers of the lower Paleozoic sedimentary rock layers
  - Deep Meso-Proterozoic Basement metamorphics are exposed just east of Salida
  - Rocks traversed just to the east change abruptly to Cambrian/Ordovician white Sawatch sandstone/brownish Manitou limestone/red-yellow Harding quartzite/gray Fremont dolomite
  - The massive gray cliffs then encountered are Ordovician Fremont Dolomite/Limestone
  - Beyond the dolomite are successive pink Parting Shale/purplish Parting Quartzite/red-yellow Dyer Chert/white-yellow Dyer Dolomite/yellow-green Dyer Shale/grayish Leadville Limestone layers in the Devonian and Mississippian formations severely twisted, faulted, and bent behind Wellsville by crustal east horst uplift
  - From Swissvale to Vallie Bridge, the uppermost sedimentary layer for this region, the purple sandstone/green-brown-black shales/red-white Pennsylvanian/Permian redbeds, are passed
    - The redbeds consist of red and white sandstone/shale/mudstone/conglomerate layers
    - Up to approximately 22,000 feet in thickness
  - Some areas on the tops of the ridges to the north and across the river east of Rincon and west of Howard are capped with Salida Volcano Field andesite flows
  - To the northeast of Howard, beds of white to reddish rhyolite ash cap the Permian redbeds
- Just west of Coaldale (at Vallie Bridge), the sediment layers traversed near Wellsville were caught and bent up nearly vertical by the west edge of the Front Range uplift
- Steeply dipping sedimentary layers to the southwest of Coaldale on the top of the east horst contain coal and gypsum

Lower Big Horn Sheep Canyon / Royal Gorge

- Canyons through the massive Front Range uplift
  - Major tectonic crustal uplift of deep Precambrian Meso-Proterozoic basement granites and metamorphics
  - The crust here is deeply faulted and fractured by the 10K+ feet of uplift
  - The Arkansas River follows faults and fractures through the uplifted mountains
  - The abrupt west end of the uplift at Coaldale marks the east extent of the east Rio Grande horst and the river enters the Front Range Uplift through a water gap
- Geology of the canyons
  - The west most ridge of the uplift visible approaching Coaldale from the northwest is made up of tan Precambrian granites with a some dark metamorphic rock
  - From Coaldale to Texas Creek, the uplift consists of tan/pink/orange Precambrian granites and black gabbro with metamorphic gneiss and schist
  - To the north, the ridges are capped with 39-mile Volcano Field basalt lava flows
  - Deep in the canyon east of Texas Creek to Parkdale, rocks are primarily Meso-proterozoic metamorphics uplifted from deep within the crust
    - Gneiss, schist, and Proterozoic/Archean metasediments persist, especially around Texas Creek
    - The walls contain few original basement granite masses but many granite intrusions introduced after the metamorphosing of this portion of the crust
  - At Parkdale, a tilted and severely faulted outlier of Mesozoic Morrison, Dakota, etc. sedimentary rock layers are visible trapped by the uplift of the basement rock
  - East and south of Parkdale, the southward continuation of the Front Range uplift from Pikes Peak is visible
  - Royal Gorge rock consists of granites, gneiss, and schist with huge granite masses and black intrusions of gabbro contained in the gneiss

Glaciers

- What is a Glacier ?
  - A thick mass of ice
  - Forms over land
  - The accumulation, compaction, and recrystallization of snow
  - Moves slowly (2 meters per day or less on average)
  - Accumulates, transports, and deposits sediment

Glaciers

- Types of Glaciers
  - Valley Glaciers (or Alpine Glaciers)
    - Glaciers that follow faults, fractures, and former valleys
    - Streams of ice bounded by rock walls
    - Flow downstream from a snow accumulation head zone
    - Width is generally small compared to the length (Hubbard Glacier is 70 miles long)
  - Sheet Glaciers
    - Exist on a much larger scale than Valley Glaciers (sometimes called Continental Ice Sheets)
    - Flow out in all directions from a snow accumulation center
    - Cover all but the highest areas of the underlying terrain
    - Topographic land features guide the flow in certain directions and affect rate of movement
    - Greenland and Antarctica are covered by these ice sheet glaciers

Glaciation

- Erosion
  - Ice scrapes, tears, scours, and tears rock from valley floors and walls and carries it down valley
  - The glacial ice does not let this debris settle out but can transport huge blocks
  - Glacial Erosion
    - Plucking
      - A glacier loosens and lifts blocks of rock and incorporates them into the ice
      - Occurs when meltwater penetrates cracks in the bedrock beneath the glacier and freezes where it expands and pries the rock loose
      - This creates sediments from as fine as flour to blocks as big as houses
    - Abrasion
      - The ice and load of rock fragments slide over bedrock – pulverizing, sanding, and smoothing the surface and creating rock flour and additional fragments
      - Large rock fragments in the ice create long scratches and grooves in the bedrock – **glacial striations**

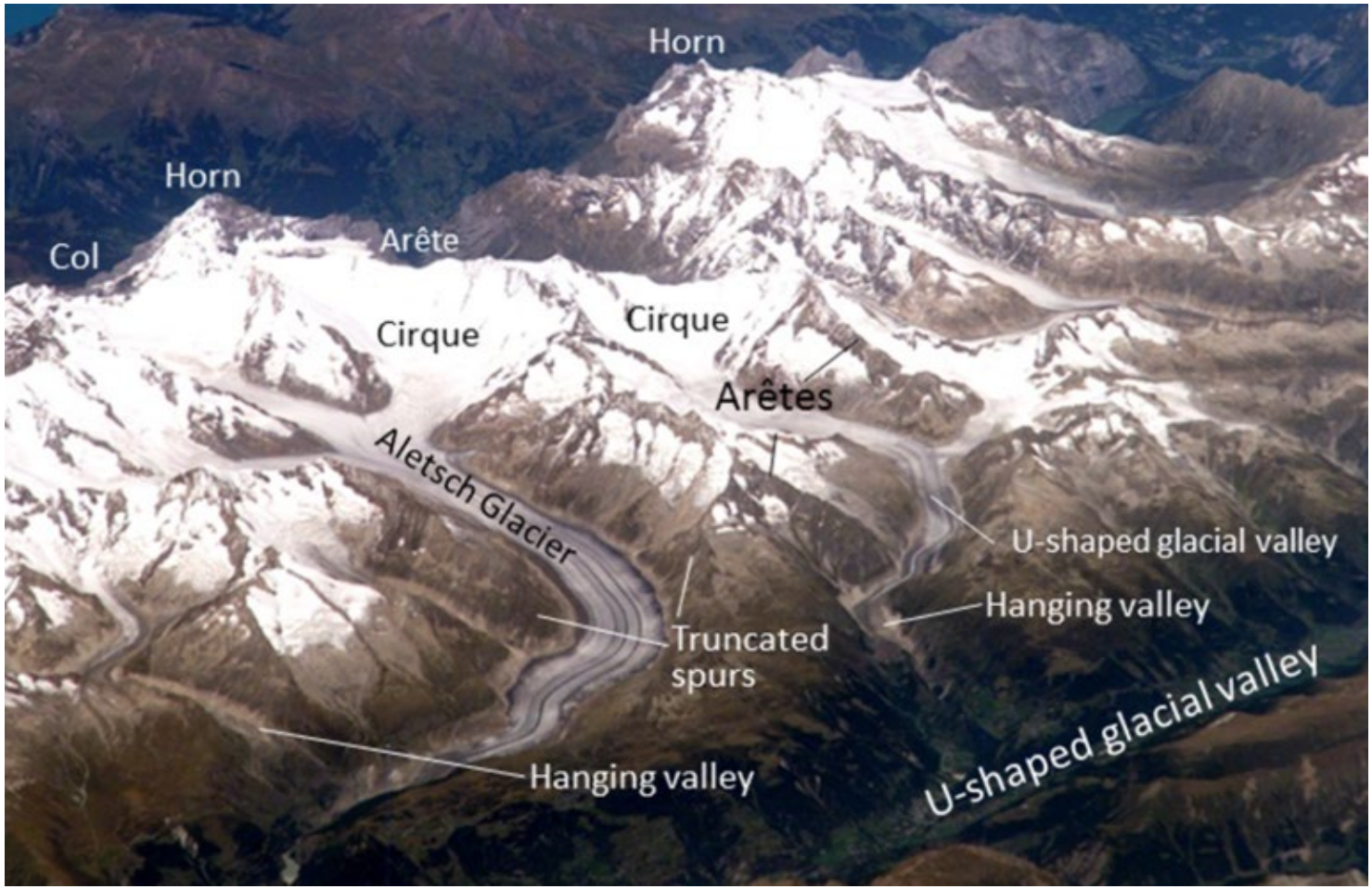
Glaciation

- Landforms
  - Cirque
    - Bowl-shaped depression at the head of a glacial valley with precipitous walls on three sides and open on the downvalley side
    - Focal point for the valley glacier's growth
    - After glacial melt, the cirque basin often has a small lake in it
  - Glacial Trough
    - Where during glaciation, faults, cracks, and narrow valleys are widened, straightened, and deepened, creating a characteristic U-shaped trough
  - Hanging Valley
    - Main glaciers (**trunk glaciers**) cut deeper valleys than their tributary glaciers, leaving the valleys of the tributary glaciers standing above the main trough upon receding of the ice

Glaciation

- Landforms (cont.)
  - Arête
    - Sharp-edged, sinewave-like ridge left from glaciation on both sides of a divide
    - Often caused by the enlargement of cirques, reducing the divide to a narrow knifelike partition or by the reduction of the divide by the movement of two parallel tongues of ice on both sides
  - Horn
    - A sharp pyramid-like peak projecting above the surroundings, often on an arête
    - In the case of a spire like Uncompahgre Peak or the Matterhorn, cirques around a single high area can be the cause

Glacial Landforms



Glaciation

- Moraines
  - Lateral Moraine
    - Large amount of materials from the erosion of the sides of a valley glacier left as ridges when the glacier recedes
  - Medial Moraine
    - Formed when two valley glaciers merge to form one ice stream
    - Till carried along the edges of each glacier joins to form a single dark strip of debris within the enlarged glacier
    - Could not form if the ice did not move downvalley
  - End (or Terminal) Moraine
    - A ridge of till that forms at the terminus of a glacier
    - Deposited when there is a state of equilibrium between ablation and accumulation
    - As ice melts, till is dropped and the end moraine grows
    - The longer the ice front remains stable, the larger the moraine will grow