The Geologic History of the Connecticut River Valley

View from Mount Holyoke, Northampton, Massachusetts, after a Thunderstorm—The Oxbow, 1836

- Thomas Cole (American, 1801–1848)
- Oil on canvas; 51 1/2 x 76 in. (130.8 x 193 cm)
CONNECTICUT VALLEY THROUGH GEOLOGIC TIME

Last ice melted out of Connecticut Valley ~12,000 years b.p.

"WISCONSIN" CONTINENTAL GLACIER
(Evidence for earlier Pleistocene glaciations not preserved in Massachusetts)

initiation of Connecticut Valley Faulting

~ 140 m.y. Youngest K/Ar age so far obtained from zone of Mount Toby Fault

Mt. Toby Conglomerate
Turners Falls Sandstone
Deanfield Basalt
Sugarloaf Arkose

~ 250 m.y. K/Ar Mica Cooling Ages (~200°C)

"ACADIAN OROGENY"
Metamorphism to 580-625°C, 6 kbar (depth 14 miles)
Folding, Granite Intrusion

"TACONIC OROGENY" (Effects limited in Connecticut Valley)

Lower Devonian
Erving Formation
Littleton Formation
Clough Quartzite

Silurian

Middle Ordovician
Partridge Formation
Ammonoosuc Volcanics

Appearance of Abundant Invertebrate Animals

Fourmile Gneiss
Pepper Mountain Gneiss
Pepper Mountain Quartzite
Dry Hill Gneiss

Zircons dated at 575 m.y. by U/Pb.

Peter Robinson Oct. 28, 1977
Vocabulary:

Crust:
Lithosphere:
Asthenosphere:
Mantle:
Plate Tectonics:
Mid-Ocean Ridge:
Normal Fault:
Mineral:
Igneous Rock:
Sedimentary Rock:

Metamorphic Rock:
Geothermal Gradient:
Fossil:
Glacier:
Glacial Till:
Moraine:
Meandering River:
Oxbow Lake:
Flood Plain:

Introduction

Go to the top of floor of the museum and make your way to the *Unearthing a Portrait in Time from the Rock Record* display. What are five main phases of geologic activity the Connecticut Valley has undergone in the past 600 million years? List them in order. How long ago did each phase occur?

PHASE 1. __________________________________________________________

When did this occur? : ________________________________________________

PHASE 2. __________________________________________________________

When did this occur? : ________________________________________________

PHASE 3. __________________________________________________________

When did this occur? : ________________________________________________

PHASE 4. __________________________________________________________

When did this occur? : ________________________________________________

PHASE 5. __________________________________________________________

When did this occur? : ________________________________________________

Today we will take a tour through each of these five phases. Along the way you will learn a bit about geologic processes that occur not only in this area but all around the world!
PHASE I - Shallow Inland Seas
(Think about this first. What kinds of organisms live in shallow seas?)

Go to the back corner of the top floor of the museum. Find and read the display titled *Shallow Seas of the Paleozoic*. These seas formed because at this time the world had a different plate tectonic configuration. The oceans were not nearly as deep back then as they are today.

Look at the fossil display. Name and briefly sketch three fossils that support evidence of shallow seas.

1. Name: __________________________ Location/Age __________________________

2. Name: __________________________ Location/Age __________________________

3. Name: __________________________ Location/Age __________________________
PHASE I - Shallow Inland Seas

Why would these fossils likely have been created in shallow seas as opposed to deeper seas?

How is the region from which these fossils were found different than during the time the organisms were living?

Look at the two pictures on the display and read the captions. How did the geologic setting of Amherst change from 510 – 370 million years ago? Do you have a hypothesis for how this happened?
Look immediately left of the Shallow Seas display to find a display titled *Mountain Building in the Paleozoic*. Mountain building begins when one tectonic plate subducts beneath another. This process can result in a continental collision, which shortens and thickens the Earth’s crust.

How were the Appalachians formed?

Why did the formation of the Appalachians coincide with the end of shallow continental seas?
PHASE 2 - Mountain Building and Metamorphism

Look at the metamorphic rocks display. Find the line labeled “Typical Continental Geotherm.” The geotherm (or geothermal gradient) is how increasing temperature corresponds to increasing depth within the Earth’s interior. Deeper in the Earth’s interior the surrounding temperature (as well as pressure) increases.
**PHASE 2 - Mountain Building and Metamorphism**

*Metamorphic rocks* are formed when pre-existing rocks are buried where they are exposed to higher temperatures and pressures. This occurs during mountain building. As rocks are exposed to higher temperatures and pressure metamorphic reactions can occur, where elements in certain minerals recombine to form different minerals.

Look at the slate, graphite phyllite, and kyanite “log-jam” schist. These three samples (which came from the same protolith, or original rock) illustrate how rocks change as they metamorphose.

What systematic differences can you see between these rocks?

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To the left of the metamorphic rocks display you will see a large piece of marble. Marble is another type of metamorphic rock.

Sketch this sample.

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What evidence of exposure to high pressure (think: horizontal compression) does this sample show?

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How could this concept be related to the creation of the Appalachians? Remember, the Appalachians formed when continental collision caused the crust of the earth to shorten and thicken.
PHASE 3 - Continental Rifting

Make your way to the *Rifting in the Triassic and Early Jurassic* display. Look at the diagram and read the captions. Continental rifting is what broke apart the supercontinent Pangaea and lead to the formation of the Connecticut Valley.

How does rifting occur?

Rifting first starts when a *mantle* plume (an upwelling of hot, ductile (flowing), *asthenospheric* rock from deep within the Earth’s mantle) rises and comes in contact with continental crust. This causes the overlying crust to begin to heat, rise, and eventually stretch out and thin. This crustal extension is facilitated by *normal faulting*, and creates depressions in the surface of the earth. In the diagram below the Connecticut Valley Border fault is a series of normal faults.
PHASE 3 - Continental Rifting

Crustal extension by normal faulting forms a *rift valley*. Rift valleys form over tens of millions of years. Rivers, lakes, floodplains, and alluvial fans are present in the rift basin. As the crust becomes extended, the normal fault displacement grows, which leaves more space for sediment to be deposited in the rift basin.

Look at the sedimentary rock display underneath the painting “The Connecticut Valley in the Early Jurassic.” Pick 2 different sedimentary rocks, and briefly sketch them. What sedimentary environment do you think your rocks were deposited in? Read the display signs for clues.

Rock Name: _____________________________  Rock Name: _____________________________
Depositional Environment: __________  Depositional Environment: __________
______________________________________  ______________________________________

Make your way downstairs to the Hitchcock Collection. The rocks in this collection were formed from sediment deposited ~190 Million years ago – right at the time rifting was occurring. (Can be used with “Effects Nature has on the Earth Lab)

Find one large slab rock and briefly sketch it.

What could have made the impressions in your slab? _______________________________

What sedimentary environment do you think these rocks were deposited in?
(look at the Will Sillin Diorama for clues.)

_______________________________
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PHASE 3 - Continental Rifting

Make your way back upstairs to the rifting display. Along with the deposition and creation of sedimentary rocks, igneous rocks (rocks that cool from a melt) are also formed during rift events.

Look at and briefly sketch the basalt column to the right of the sedimentary rocks display. This rock’s shape was formed naturally.

How do you think this happened? (read the “Lava Flows” display for a hint)

If a rift valley gets large enough, eventually the continental crust splits in two. Spreading continues to happen, and the basalt produced turns into oceanic crust. Creation of oceanic crust occurs at a mid-ocean ridge, a line along which basaltic crust is created. This is how the Atlantic Ocean was formed and is still forming today!

The Connecticut Valley is a rift valley that opened up at around the same time as the Mid-Atlantic Ridge. However, this valley failed to open up into an ocean, and stopped spreading once the Mid Atlantic ridge opened up.
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PHASE 4 - Glaciation

Head to the “Geological Evidence for Glaciation” display, across from the Rifting display. Over much of the past 2.6 million years (which is very recent, geologically speaking) massive ice sheets covered and in part reshaped the entire Connecticut Valley. This glacial ice sheet was 60 times the height of the museum building!

Look at the map of Lake Hitchcock as it was ~14,000 years ago.

Prior to the formation of Lake Hitchcock, in the New England region, how far south did the ice sheet extend? (Name the locations...)

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Glacial Till

As glaciers move, they pick up loose, unconsolidated sediment called till. Find the glacial till display (Column of Rocks). Briefly sketch it.

What is the size range for glacial till (dimensions)?

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Look at the striated bedrock. The scratches on this rock were created when a glacier moved over it.
Briefly sketch this rock.

What in the glacier might have caused these scratches as well as the rock’s overall polish?

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PHASE 4 - Glaciation

Glacial Retreat
Look at the model of the Connecticut Valley 15,000 years ago. During this time warming climate caused the ice to melt and retreat northward. The melted ice (water) was restricted in flow by a naturally occurring dam of glacial sediment (called a moraine) and pooled together, forming Lake Hitchcock. As the ice retreated further, the lake grew longer.

Again look at the map of Lake Hitchcock as it was ~14,000 years ago.

Where in the Connecticut Valley was the natural dam located? ______________________

What was the name of the dam? ________________________________

Varves
Look at the glacial varves display. These varves were deposited on the bottom of Lake Hitchcock. Notice pattern of light sediment (silt) and dark sediment (clay). Silt, which is larger and heavier than clay, was deposited in the summer time, when more melting of the ice sheet occurred. Clay was deposited in the wintertime, when less melting of the ice sheet occurred. Think – why would this have happened?

Eventually much of Lake Hitchcock drained. This formed the Connecticut River, which still flows today. What factors could have led to the draining of the lake?

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________________________________________________________________________
PHASE 5 - The Modern Connecticut River

Make your way to the “The Dynamic Modern Connecticut River” display. Since the draining of Lake Hitchcock around 13,000 years ago, the Connecticut River has flowed freely. The Connecticut River is a meandering river.

Briefly describe how sediments are deposited in a meandering river (if you need a hint read the display).

The Oxbow is one of the most distinctive features of the Connecticut River. Amherst professor Edward Hitchcock (who also collected the dinosaur footprint tracks we looked at earlier today) actually observed the formation of The Oxbow! Briefly sketch and explain how an oxbow lake is formed (your sketch should mimic the diagram on display).
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PHASE 5 - The Modern Connecticut River

This picture is a schematic diagram of a flood plain.

What creates the levees on both sides of the flood plain?

Why is flood plain soil fertile for growing produce?
Again, read the display for hints.

The Modern Landscape – Ever changing landscape

Make your way to the Will Sillin painting “The Oxbow on the Connecticut River.” This painting depicts the Connecticut Valley as it would be today without buildings. What notable features do you see in the painting? Make a sketch of the painting labeling key landscape features (Pelham Hills, Holyoke Range, Mt. Tom, The Ct. River and the direction of flow, the Oxbow etc.).
In conclusion, the geologic history of The Connecticut River Valley is quite amazing. To gain some insight we took a journey back some 600 million years in time. It is easier with such spans of time to break things up into smaller chunks.

QUESTION... What are five main phases of geologic activity the Connecticut Valley has undergone in the past 600 million years? List them in order oldest to youngest. Note one important takeaway from each of these five phases.

PHASE 1. __________________________________________________________
Take away:________________________________________________________________________________________

PHASE 2. __________________________________________________________
Take away:________________________________________________________________________________________

PHASE 3. __________________________________________________________
Take away:________________________________________________________________________________________

PHASE 4. __________________________________________________________
Take away:________________________________________________________________________________________

PHASE 5. __________________________________________________________
Take away:________________________________________________________________________________________
Effects Nature has on the Earth  
- Using Primary Sources

Problem: What can we learn about the effects of nature on the Earth using primary sources (A primary source is a document or a physical object which was written or created during the time under study. These sources were present during an experience or time period and offer an inside view of a particular event. Relics and artifacts, such as fossils are one kind of Primary Source)

Hypothesis: By using a visual scanning technique, we should be able to see some effects of nature on Earth in some of the Primary Sources in the museum

Materials:
- Pencil
- Paper
- Primary sources

Procedure: Use the following visual scanning cues to identify the effects that nature has had on the earth. Look for and record the following characteristics of the Primary source being viewed.

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Quantitative</th>
</tr>
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<tbody>
<tr>
<td>Color</td>
<td>Size (how big/long)</td>
</tr>
<tr>
<td>Pattern</td>
<td>Depth</td>
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<tr>
<td>Texture</td>
<td>Number (how many)</td>
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<tr>
<td>Depth</td>
<td>Proximity (how close is what you are noticing to something else?)</td>
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<td>Shape</td>
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Record just what can actually be seen.
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Object/ID

Visual Inventory (factual list of what can be seen)

Questions generated:

Sketch HERE

**Inference:** Conclusion or deduction based on observations, and/or the process of drawing a conclusion from given evidence. (To be done as an additional step)