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| --- |
| **Task-level phenomenon:** Students will observe a video about glaciers and glacial trends.  **Synopsis of high-quality task:**  In this task, students construct a visual timeline and written explanation of how the physical geography of the Connecticut River Valley has changed over time. Students use fossil evidence, timelines, and animated and interactive maps to determine the physical changes on the Valley’s formation. The final product will be a series of annotated maps or timelines that show the Connecticut River Valley in three different stages of its geological formation - Prehistory (Late Jurassic), the formation of Lake Hitchcock (20,000 bce - 15,000 bce), and the current Connecticut River Valley (present day). This task can be used as a project based assessment to demonstrate student mastery of the standard at the end of the unit on fossils and geologic change, and to make regional connections by illustrating geologic changes in New England and Massachusetts.  **Anticipated student time spent on task:** Three 90min class sessions  **Type of Task (check one):**  \_\_\_\_ 1. Investigation/experimentation/design challenge  \_\_\_\_ 2. Data representation, analysis, and interpretation  \_**X**\_\_ 3. **Explanation**  **Student task structure(s):** Small group work  **STE Standards and Science and Engineering Practices:**  **STE Standards:**  **6.MS-ESS1-4**. Analyze and interpret rock layers and index fossils to determine the relative ages of rock formations that result from processes occurring over long periods of time.  Clarification Statements:   * Analysis includes laws of superposition and crosscutting relationships limited to minor displacement faults that offset layers. * Processes that occur over long periods of time include changes in rock types through weathering, erosion, heat, and pressure. |
| **7.MS-ESS2-2.** Construct an explanation based on evidence for how Earth’s surface has changed over scales that range from local to global in size.  Clarification Statements:   * Examples of processes occurring over large, global spatial scales include plate motion, formation of mountains and ocean basins, and ice ages. * Examples of changes occurring over small, local spatial scales include earthquakes and seasonal weathering and erosion.   **Science and Engineering Practice:**   * Constructing explanations and designing solutions |
| **Prior Knowledge:**  Previous Standard from [Strand Map](http://www.doe.mass.edu/stem/standards/StrandMaps.html):  **4-ESS1-1**: Use evidence from a given landscape that includes simple landforms and rock layers to support a claim about the role of erosion or deposition in the formation of the landscape over long periods of time. Clarification Statements:   * Examples of evidence and claims could include rock layers with shell fossils above rock layers with plant fossils and no shells, indicating a change from deposition on land to deposition in water over time; and a canyon with rock layers in the walls and a river in the bottom, indicating that a river eroded the rock over time. * Examples of simple landforms can include valleys, hills, mountains, plains, and canyons. Focus should be on relative time.   **4-ESS2-1.** Make observations and collect data to provide evidence that rocks, soils, and sediments are broken into smaller pieces through mechanical weathering and moved around through erosion.  Clarification Statements:   * Mechanical weathering processes can include frost wedging, abrasion, and tree root wedging. * Erosion can include movement by blowing wind, flowing water, and moving ice.   **4-ESS2-2.** Analyze and interpret maps of Earth’s mountain ranges, deep ocean trenches, volcanoes, and earthquake epicenters to describe patterns of these features and their locations relative to boundaries between continents and oceans.  **6.MS-ESS1-4.** Analyze and interpret rock layers and index fossils to determine the relative ages of rock formations that result from processes occurring over long periods of time.  **6.MS-ESS2-3.** Analyze and interpret maps showing the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence that Earth’s plates have moved great distances, collided, and spread apart.  **Previous Topics**.  Students will need to know about the following topics prior to beginning the task lessons:   * + Simple landforms   + Rock layers   + Weathering, erosion, and deposition   + Geologic patterns as represented on maps (mountain ranges, ocean trenches, tectonic plates, etc.)   + Fossils   + Index fossils and relative age of rocks (for 7th grade audience) |
| **Connections to the real-world:**  Our landscape is a direct result of geologic and hydrologic activity in the near and far past. The Connecticut River Valley in Western Massachusetts, Connecticut, Vermont, and New Hampshire is well known as a geographic goldmine for fossil enthusiasts, amateur and professional geologists. From dinosaur tracks to evidence of glacial activity and prehistoric lakes, the Valley’s evidence tells the story of how our place has changed over millions of years. Several museums, universities and history organizations have catalogued this history. |
| **Mastery and Language Goals:**  Learning Objective:   * Use analysis of geologic maps and fossil data to create a model of a visual timeline showing the geology and changes of the Connecticut River valley in Western Massachusetts.   Performance Objective:   * Construct an explanation of the three different types of evidence of geologic history and how they offer important clues to the past. * Analyze map and fossil data to chart changes to the landscape of the Connecticut River valley. * Develop a model of a visual timeline that shows three prehistoric eras of geology in our region.   Language Objective:   * Obtain and evaluate information from maps and fossil evidence to communicate changes in the landscape of the Connecticut River valley. * Construct a written explanation that describes the geologic changes in the Connecticut River valley in Western Massachusetts. |
| **Teacher Instructions:**  **Day 1**   |  |  | | --- | --- | | Opener/Do Now/Activator | Notes | | Introduce Phenomena -  Watch video on Alaska’s glaciers  <https://www.youtube.com/watch?v=zP8DMwQqc5E>  From: https://www.nps.gov/subjects/aknatureandscience/glaciers.htm  Ask students/track answers:   * What did you notice about glaciers? * What do you wonder about glaciers? * What changes can glaciers make to a landscape? * What examples from the video show this?   Have students share their observations in small groups. Ask them to notice what is similar or different about their observations. | Glaciation is one of the main contributors of New England’s landscape. By observing active continental glaciers, we can collect clues about how the glaciers in New England shaped our landscape. Teachers can return to this opener and the phenomena throughout the task, to check students’ understanding. | | Activity | Notes | | 1. Trace fossils: clues to a different “Pioneer Valley”  * Watch the following two short videos and answer the questions in the student packet   + The Rift Valley: https://dinotracksdiscovery.org/static/special/video/media/brady-rift-valley.webm   + A Rainy Day in the Jurassic: https://dinotracksdiscovery.org/static/special/video/media/rainy-day.webm * Explore the interactive map (https://dinotracksdiscovery.org/map/detail/)   + identify at least two locations where trace fossils (dinosaur tracks) have been found in the CT River Valley  1. Geologic evidence: clues to a changing landscape  * Watch What Happened to Lake Hitchcock? and answer the questions in the student packet https://vimeopro.com/sciencestoryteller/visual-storytelling/video/72262515 or  https://vimeo.com/72262515 | Emphasize the following scientific concepts throughout the lesson:   * Geologic processes of sedimentation and uplift * Specific clues in the rock formation such as ripples, track direction and impression depth * Clues that tell the story of the landscape (ex. Sediments that once were under water) * Clues specific to glacial movement: potholes, varves, dunes and deltas, scrapings * Direct students to notice the types of evidence that show glaciers changed the landscape (ex. Potholes, varves, dunes, deltas) * Direct students to notice the types of evidence that show that glaciers moved through the area (glacial scrapings, bedrock dams) * Note about vocabulary: Create an anchor or reference chart on the classroom wall and add to it with each lesson. Have students write or reference definitions in their own tracker or glossary. This vocabulary will be used throughout the task and will be needed for the final written explanation. Suggested vocabulary:   + Trace fossil   + Glacier   + Glaciation   + Index fossil   + Potholes   + Glacial scraping |   **Day 2**   |  |  | | --- | --- | | Opener/Do Now/Activator | Notes | | Glaciers   * 2nd view: video on Alaska’s glaciers   <https://www.youtube.com/watch?v=zP8DMwQqc5E>  from: https://www.nps.gov/subjects/aknatureandscience/glaciers.htm  Ask students add to their first observations and questions:   * What did you notice about glaciers? * What do you wonder about glaciers?   Have students share their observations in small groups. Ask them to notice what is similar or different about their observations. | * The purpose is to reconnect to the phenomena and add additional observations and questions. * Make an anchor chart with all of the observations and questions for students to refer back. | | Mini Lesson | Notes | | Ask students/track answers: (student worksheet - Lesson 2)   * How do glaciers change the physical landscape? * What evidence exists that demonstrates glacial movement in a region - in Alaska, how do we know that glaciers have changed the landscape (apart from seeing them) * What evidence would we see in New England that glaciers changed our landscape? * Recall the many types of evidence that we have for changes to the CT River Valley landscape | * The purpose of this mini lesson is to reconnect to the phenomena as students will begin to design their timeline and will need to show the physical changes to the landscape. Teachers should help students connect from current day glacial movement to past movement and the evidence we have that glaciers have changed the landscape. * Note about vocabulary: Continue to add and reference vocabulary to anchor chart on the classroom wall and add to it with each lesson. Have students write or reference definitions in their own tracker or glossary. This vocabulary will be used throughout the task and will be needed for the final written explanation. Suggested vocabulary:   + Weathering   + Erosion   + Deposition   + Varve   + Dune   + Delta   + Glacial dam | | Activity | Notes | | Student Handout-  Read through project details and criteria  Read rubric  Student worksheet-  Track on chart  Explore model maps and timelines  Map trace fossils  Make inferences about landscape/watershed  Share findings  Draft timeline/map | Creating a list of sites and images - and/or make copies of timelines - for students to access and analyze. Use these models in conjunction with the rubric to ensure students understand the criteria for a high-quality timeline. |   **Day 3**   |  |  | | --- | --- | | Opener/Do Now/Activator | Notes | | Share drafts of maps/timelines  Describe additions or revisions |  | | Mini Lesson | Notes | | Review the rubric and peer critique protocol |  | | Activity | Notes | | * Student worksheet Lesson 3 * Peer critique protocol * Visual timeline creation part 2 - revisions and final work * Writing a scientific description | This is a simple and precise peer critique protocol that can be used with the rubric. Teachers may want to add more specific questions to specify what they want students to focus on: https://www.engageny.org/file/2711/download/peer\_critique\_protocol.doc?token=s-gvBdnz  Copyright image | |
| **Instructional Materials/Resources/Tools:**   * Student directions for completing the task, including scoring rubric * Video and interactive map links within Teacher Instructions * In addition, teachers may use any of the following resources and Timeline Models to extend, supplement or support student learning.   + What happened to Lake Hitchcock? (https://vimeopro.com/sciencestoryteller/visual-storytelling/video/72262515)   + Dinosaur Footprint Reservation (https://en.wikipedia.org/wiki/Dinosaur\_Footprints\_Reservation): Wikipedia article about Dinosaur Footprints Reservation in Holyoke, Massachusetts describing the early Jurassic period of the Connecticut River Valley Copyright image   + U.S.G.S. “Age of the Earth” (https://pubs.usgs.gov/gip/geotime/time.html) Credit: U.S. Geological Survey, Department of the Interior, USGS, U.S. Geological Survey, Poster by Graham, Joseph, Newman, William, and Stacy, John, 2008, The geologic time spiral—A path to the past (ver. 1.1): U.S. Geological Survey General Information Product 58, poster, 1 sheet. (Also available online at <http://pubs.usgs.gov/gip/2008/58/>)   + Great Lakes Formation (https://commons.wikimedia.org/wiki/File:Glacial\_lakes.jpg#file ) This image or file is a work of a U.S. Army Corps of Engineers soldier or employee, taken or made as part of that person's official duties. As a work of the U.S. federal government, the image is in the public domain. |
| **Task Source:**  Students will use materials adapted, and with permission from:   * “Impressions from a Lost World: The Discovery of Dinosaur Footprints in the Connecticut River Valley of New England” The Pocumtuck Valley Memorial Association (PVMA), Deerfield, MA (https://dinotracksdiscovery.org/) * [Beneski Museum of Natural History, Amherst College, Amherst, MA](https://www.amherst.edu/museums/naturalhistory) (https://www.amherst.edu/museums/naturalhistory) Used with permission from Alfred Venne and the Beneski Museum of Natural History, Amherst College * The Geologic History of the Connecticut River Valley, Developed by Rainer Lempert ’15, Amherst College for use at the Beneski Museum of Natural History (Used with permission from Alfred Venne and the Beneski Museum of Natural History, Amherst College |
| **Accessibility and Supports:**   * Visual Timeline Rubric * Vocabulary Tracking * Graphic Organizer: Table for collecting and organizing information for creating timeline * Table for tracking and implementing feedback |
| **Sample Student Work:**  **Tracking the Geologic Change of the Connecticut River Valley**  **Visual Timeline Task - Student Work Samples**  Sample A  Timeline  Student example of hand-drawn Connecticut River Valley  Scientific Description:  The geology and climate of the Connecticut River valley has changed dramatically over the last 250 million years. In the late Jurassic Period (237 million years ago - 201 mya), the valley was a hot, humid lake region with dinosaurs, tropical plants and small mammals living in the area. Scientists have discovered fossilized tracks, a type of trace fossil, throughout the river valley. Other evidence that this area was once a tropical lake bed include plant stem and leaf imprints.  A very different climate existed 20,000 years ago. A continental glacier covered a large part of North America, including New England and Canada. Evidence that shows this glacier existed in this area include glacial erratics (large boulders that seem out of place, but were moved by the power of the glacier), scraping marks on the bedrock and “potholes”, areas where rocks and ice worked together to create holes in the bedrock.  As the glacier retreated beginning about 18,000 years ago, a large dam was created near Rocky Hill, Connecticut. This was made of rocks and glacial till that was pushed into a pile by the glacier. When the glacier retreated, the “dam” was left. This dam prevented the flowing water from the ancient lakebed (now a river) to flow past this point, forming a large lake that covered the entire Connecticut River valley from Rocky Point, CT to northern Vermont and New Hampshire.  In the area near western Massachusetts, this lake was called Lake Hitchcock, named after the geologist that collected scientific evidence that showed that the lake was in that area. This evidence included varves (hardened mud “ripples” that show water flowing on a shoreline), dunes and deltas. These can all be seen today along the Connecticut River valley. Some large delta areas are used are airport landing strips today because they are flat and wide. About 12,400 years ago, the dam broke and the water from Lake Hitchcock was released and flowed into the Long Island sound, creating the Connecticut riverway that we know today.  Sample B  Timeline  Student Sample of hand-drawn timeline of changes in the Connecticut River Valley  Scientific Description  The geology and climate of the Connecticut River valley has not always been what it is today. It has changed many times over millions of years. During the late Jurassic Period (237 million years ago), the valley had a tropical climate. Dinosaurs, tropical plants and small mammals lived in the area. Scientists and others have discovered fossilized trackways, a set of fossils that show the path of a dinosaur. People can still see these today in Holyoke, Massachusetts, Connecticut and other areas throughout the river valley.  By around 20,000 years ago, the climate had cooled dramatically and a continental glacier had covered a large part of North America, including the Connecticut River valley. Scientists have collected evidence that shows that this glacier existed in this area. This includes glacial erratics (boulders that were moved by the power of the glacier), glacial scrapings (marks on the bedrock made by rocks being carried by the glacier) and “potholes”, areas where rocks and ice created holes in the bedrock.  When the glacier retreated about 18,000 years ago, a bedrock dam was created where Rocky Hill, Connecticut is today. After the glacier left the area, the “dam” remained. The dam was preventing the water from an ancient lake, Lake Hitchcock, from the flowing out of the lakebed. Lake Hitchcock was one of several ancient lakes that covered the entire Connecticut River valley from Rocky Point, CT to northern Vermont and New Hampshire.  In western Massachusetts, where Lake Hitchcock was, geologists have collected scientific evidence that showed that the lake was in that area. This evidence includes varves (mud “ripples” showing water flowed at the lake shoreline), dunes and deltas. People can see all this today along the Connecticut River valley. About 12,400 years ago, the dam broke and the water from Lake Hitchcock was released and the present-day Connecticut riverway was created. |

**Student Packet: T****racking the Geologic Change of the Connecticut River Valley**

**Visual Timeline Task - Student Materials**

Learning Targets:

* I can use fossil evidence and geologic maps to create a visual timeline of the Connecticut River valley in Western Massachusetts
* I can create a written explanation that describes the geologic changes in the Connecticut River valley in Western Massachusetts

Overview:

In this task you will construct a visual timeline and written explanation of how the physical geography of the Connecticut River Valley has changed over time. You will use fossil evidence, timelines, and animated and interactive maps to determine the physical changes on the Valley’s formation.

Assessment/Scoring:

The final grade for this task will be a combination of the following four criteria as describe in the rubric below:

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| --- | --- | --- | --- | --- |
| *CRITERIA* | *4* | *3* | *2* | *1* |
| *Knowledge of geologic evidence and geologic processes - overall* | Timeline clearly shows understanding of how the region has physically changed over time. High quality evidence is shown and identified with appropriate labels. | Timeline shows how the region has physically changed over time. Enough evidence is shown and identified with appropriate labels. | Timeline somewhat shows understanding of how the region has physically changed over time. Some evidence is shown and may be identified with appropriate labels. | Timeline does not show an understanding of how the region has physically changed over time. Little to no evidence is shown and is not identified with appropriate labels. |
| *TIMELINE: Visual representation of geologic processes* | The timeline has appropriately selected diagrams, charts or illustrations that show the geologic changes to the region. | The timeline has a set of charts or illustrations that show the geologic changes to the region. | The timeline has one diagram, chart or illustration that show the geologic changes to the region. | The timeline does not have diagrams, charts or illustrations that show the geologic changes to the region, or these features do not show the changes. |
| *TIMELINE: Use of data and evidence - timeline labels* | The timeline has well written labels that use scientific vocabulary and clearly describe each feature and how it serves as strong evidence for geologic changes. | The timeline has labels that describe each feature and how it serves as strong evidence for geologic changes. | The timeline has some labels that describe each feature. | The timeline has little to no written labels but do not describe each feature. |
| *SCIENTIFIC DESCRIPTION* | The scientific description uses proper scientific vocabulary throughout the writing and clearly describes the geologic processes that changed the region over time. | The scientific description uses some scientific vocabulary throughout the writing and describes the geologic processes that changed the region over time. | The scientific description uses a few scientific vocabulary terms throughout the writing and partially describes the geologic processes that changed the region over time. | The scientific description uses little to no scientific vocabulary throughout the writing and attempts to describe the geologic processes that changed the region over time. |

**LESSON 1**

1. **Vocabulary Tracking**

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| **TERM** | **DEFINITION** | **EXAMPLE/MY WORDS** |
| Trace fossil |  |  |
| Index fossil |  |  |
| Glacier |  |  |
| Glaciation |  |  |
| Potholes |  |  |
| Glacial scraping |  |  |

1. **Questions from “Rift Valley” and “A Rainy Day in the Jurassic”**
   1. Describe some of the geologic changes that have occurred in the Connecticut River valley

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* 1. What evidence do scientists have that the Connecticut River valley was created by a “rift”?

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* 1. Summarize the “plot” of the story that the slab of stone tells us.

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* 1. Describe at least three different pieces of evidence that can be used to interpret what happened on this slab. What does each piece of evidence demonstrate?

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1. **Interactive Map exploration**
   1. List at least two areas where dinosaur track fossils have been located:

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* 1. Use the term “trace fossils” to explain how these tracks give scientists clues about what types of organisms lived in the region in the past.

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* 1. What other clues are described in the videos that tell scientists about the landscape and how it differed from today’s river valley?

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* 1. What was the landscape like during the late Jurassic era when dinosaurs roamed today’s Connecticut River valley? How do we know - what evidence other than trackways do we have to provide this explanation?

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1. **Glaciation and the formation of Lake Hitchcock**
   1. What created the dam, and what caused it to break?

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* 1. What color was the lake? Why?

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* 1. What made the sand dunes on the lake floor, and what do they tell us about ancient climate conditions?

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* 1. How did the lake create waterfalls used today for hydropower?

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* 1. How did the lake shape the landscape that we see around us today?

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**LESSON 2**

1. **Vocabulary Tracking**

|  |  |  |
| --- | --- | --- |
| **TERM** | **DEFINITION** | **EXAMPLE/MY WORDS** |
| Weathering |  |  |
| Erosion |  |  |
| Deposition |  |  |
| Varve |  |  |
| Dune |  |  |
| Delta |  |  |
| Glacial dam |  |  |

1. **Questions after second viewing of glacier video**
   1. How do glaciers change the physical landscape?

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* 1. What evidence exists that demonstrates glacial movement in a region - in Alaska, how do we know that glaciers have changed the landscape (apart from seeing them)?

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* 1. What evidence would we see in New England that glaciers changed our landscape?

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* 1. Recall the many types of evidence that we have for changes to the CT River Valley landscape

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1. **Map exploration and inference sharing**

Complete the table below as you explore the content and format of each map or timeline. This will help you decide how to design your own visual timeline.

|  |  |  |
| --- | --- | --- |
| Timeline Source | Evidence/Information Shown | What I like about this timeline |
| *Ex. “Age of the Earth” https://pubs.usgs.gov/gip/geotime/time.html* | * *Geologic eras* * *Change in life forms on Earth compared to the history of Earth* | * *It is a spiral* * *It has great detail* * *I can read all the information - it shows a large amount of in* * *formation but I can read it all without getting confused* |
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1. Drafting your timeline. Use the chart above, your ideas and the ideas of your classmates to create a draft visual timeline. Use the rubric to make sure you have included all requires parts and are creating a high quality product.

Draft of Timeline

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**LESSON 3**

1. **Giving and Receiving Feedback**

Complete the table below to record the feedback from your partner(s) and what changes you will make to your timeline

|  |  |  |
| --- | --- | --- |
| Keep | Remove | Change/Add |
|  |  |  |

1. **Revision and Final Draft**

Use the appropriate paper or materials to create your final draft

1. **Scientific Description**

Write the draft of your scientific description below. Use the rubric and pay attention to how to format your writing and use scientific vocabulary.

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