Geology of the Champlain Basin & Watersheds

How did the landscape around me form and how will it impact where I can sail?

Module12: LSR Ch. 3&4

Grade Level

Elementary - Middle School

Module created by:

community sailing center
lake champlain : burlington vermont

Subject Areas

Earth Systems, Geology, History, Water Cycle

Duration

Preparation time: 15 minutes
Lesson Time: 2 hours 45 minutes
Part I: 30 minutes
Part II: 30 minutes
Part III: 15 minutes
Part IV: 45 minutes
Part V: 30 minutes

Setting

This module is best implemented outdoors where students can see the landscape in the area where they live and interpret how it can contribute to what's happening around them. You can implement Part III, and IV in the classroom. Part I is best conducted where they will be sailing or in a place where they can see different landforms. Use a map of your local area to support student observations. Part II is best completed outdoors where students are able to manipulate rocks first hand.

Skills

Making Observations and Drawing Conclusions, Analysis, Recording Qualitative Data, Map Making

Sailing Skills

Preparation, Wind Awareness, Interpreting the Landscape to Determine Weather Patterns, Sailing a Course

Vocabulary

Sedimentary Rocks, Sedimentary Layers, Rock Types, Mountain-Building, Plate Tectonics, Erosion, Weathering, Watershed, Water Cycle, Pollution, Wind Shadows

Standards

Science & Engineering Practices

- Analyzing and interpreting data
- Obtaining, evaluating, and communicating information

Crosscutting Concepts

- Patterns
- Cause and effect
- Energy and Matter: Cycles

Summary

Students use map-making to aid their understanding of their surrounding landscape and community. They will explore concepts relating to sedimentary rocks, mountain-building, erosion, and watersheds. They gain a new perspective on their community and environment by building a watershed and drawing conclusions about the effects of pollution and the water cycle. They can apply their knowledge of the landscape around them to predict weather and determine safe areas to sail.

Objectives

Students will:

- Take sensory observations and notes of the surrounding natural landscape.
- Identify what type of weather and hazards can occur based on the landforms in their sailing area.
- Create maps of their surroundings
- Construct a watershed and understand how the land surrounding it can change.

Materials

- Scrap paper
- Paper for observations
- Pencils/pens/crayons
- Easel-Sized Paper
- Plastic bin at least 4” deep (about 1.5’ by 1’)
- Rocks of all shapes and sizes
- Dirt/hot chocolate mix (if in classroom)
- Tea bag
- Food coloring

- Foil
- Water in spray bottles
- Think of your geographic location specifically and any pollutants/environmental factors that are prominent which could be easily demonstrated with a material not listed here
- Whiteboard and dry erase markers
- If in the classroom for Part I - clear pictures of a close natural area with both obvious geologic features (mountain-building, islands, faults, outcrops) and a prominent body/source of water

Procedure

Part I: Outdoor Classroom (with view of natural landscape)

What Do You See Out There?

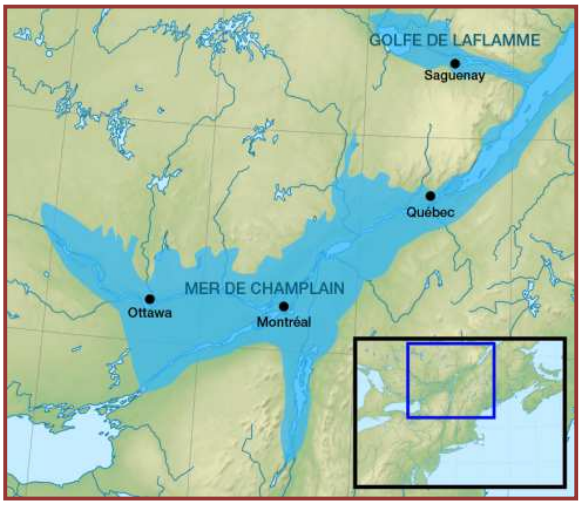
30 minutes

1. Ask students about their surrounding landscape. "What do you see?" Have them write down observations independently for 5 minutes. Tell them not to overlook features of the landscape around them that they may not always notice or think about on a daily basis as well as parts of the landscape that are there seasonally. If there is not access to an area with a view, or if you are completing Part I in a classroom, use photos of a natural area with a water source that the students would be familiar with/have seen before. Either way, have the students take down visual observations about the fact that there are mountains, a river, a lake, islands, coastline, a peninsula, etc. Have students use extra paper or science journals to map out the area. Tell them to think like map makers, who are called cartographers, to think about all parts of the landscape. Pose the question, "If you were reading a map, what would you want to see?"
    a. *Site Specifics*: For the Lake Champlain waterfront, students may write down/draw the Adirondack Mountains, Juniper Island, Rock Point, Oakledge, Lake Champlain, New York, the breakwater, the lighthouse, etc. Remember that from your site there may be big geologic/landscape features that you cannot see. Ideally, the students will be able to gain a new perspective from the sailboat and add to their observations and maps.

2. Come back together as a group and have students make a complete list of all of the features/observations that the class took down and drew on their individual maps. Separate students into smaller groups and have them use their collected data, both observations and maps, to create one group map. Provide each group with their own poster board or large sheets of paper, crayons, pencils, and markers to add detail and color to their maps. Let

them work for about 15 minutes. Inform them that they will be using these maps again later, so keep thinking about what they could potentially add as we go through the lesson.

3. Come back together as a group and inquire, “How do you think all the features on your maps came to be?” Brainstorm and discuss, adding on, “Do you think that the features you see could impact sailing? How so?” and “Do you think that this place/landscape always looked the way it looks now?” This question will transition the conversation into the history of the area you are discussing (may require research by the instructor prior to teaching. For example – where Lake Champlain is today used to be covered with glacial ice which pressed down on the rock beneath it. At the end of the last ice age, when the glacier melted, the area where Lake Champlain is today was flooded as an inlet of the Atlantic Ocean, called the Champlain Sea. The land rose to create the coast we have today, and Lake Champlain was formed.



4. *Transition* – Ask students, “What is a big part of the landscape that you see?” There are probably going to be a lot of possible responses, but help them get to mountains. Tell them to look at the Adirondack Mountains. “What do you think the Adirondack Mountains made of? What is below the trees and soil?” Rocks. Let’s start there, at the basics and then we’ll talk about how they were formed.

Part II: Outdoor Classroom

How Do Sedimentary Rocks and Layers Form?

30 minutes

Build Background Knowledge

1. Put the word “rocks” on a white board and have the students go outside, if possible, and each pick up a handful of rocks. Bring them back to the area you are meeting and have

them sort their rock collections (do not give further direction). Ask students "What characteristics can you see in your sorted rocks?" (potential answers could be - different colors, different textures, different kinds, solid, heavy, big and small, smooth, rough, etc. Ask, "Why do you think they are like that? How did they become that way? Where do you see rocks like those?" Let students know that there is a lot to understand about rocks, that they are everywhere, and that understanding them can tell us a lot about the physical world.

2. Rocks make the ground we walk on, the mountains we hike up, and the bottoms of the oceans. There are three kinds of rocks: metamorphic, igneous, and sedimentary. For more information about the three rock types, see RESOURCES. About 95% of the Earth's crust is made of metamorphic and igneous rocks; however, almost all of the rock exposed at Earth's surface is sedimentary rock. It is formed at Earth's surface and it is seen at Earth's surface. The study of rocks and earth materials is called geology, and geologists are scientists that study rocks. Geology can tell us a lot about history, weather, water, and so much more. For more details on the four Earth systems, see RESOURCES.

3. One of the most common types of rock is sedimentary rock. These are the rocks that almost all of us see every day in New England. Ask, "What do you think sedimentary rocks are made of?" It's part of the word, sediment! Sediment is anything from mud, to clay, to peddles, to soil, to sand. The fancy definition is a mineral or organic matter deposited by water, air, or ice.

Outdoors

4. Separate the students into groups and give each group a 1-liter bottle. Tell them that their goal is to figure out how the sediment that makes sedimentary rocks is deposited and how these rocks form. Students have 5 minutes to fill the bottle 1/3 of the way full with sediment. Next have students fill the bottle the rest of the way with water and have every group member of each group take a turn shaking it up really well. Before they leave their bottles as them to make a prediction about what will happen if we leave it there for 15 minutes (each group records prediction). Set the shaken up bottles in the sun where they won't be disturbed for about 10-15 minutes. If the environment/weather allows, have the students walk down to the water and fill up the bottles with water themselves.

5. While the sediment settles as students to describe what they see happening to the sediment in the bottle. Students will see the sediment slowly separating into layers. Once the sediment has settled completely, lead a discussion and ask them the following questions:

- How many layers are there? Some may not be super defined, but if the bottle sat for longer, how would you guess the layers would form?
- Which material fell to the bottom?
- Which is at the top?
- Why do you think that is?
- Do you think these layers are important?

6. Once they have figured out on their own that these layers form based on the different sediment, explain that sediment separates based on density, composition, size, etc. into layers. Sediment most often is deposited settles and then turns into rock.

Part III: Classroom

Why Isn't the Earth's Surface Flat?

15 minutes

1. Mountains are made of rock. But why aren't they flat like sedimentary layers that form at Earth's surface? The Earth is flat is very flew places, so something must be causing elevation gain and loss. Mountain and elevation gain is the first phenomenon to address.

2. The Earth's crust is made of tectonic plates. To put it simply, these plates (seen in the diagram below) move and shift. The Earth looks the way that is does today based on the movement of these plates. All of the Earth's tectonic plates fit together like a jigsaw puzzle, creating the Earth's surface. For more information on plate tectonics, see RESOURCES. Ask students to put their hands out flat in front of them right beside each other. Tell them that for this demonstration, their hands are the plates and we are going to show how they plates move sometimes.

    - Explain that sometimes the plates slide beside one another in opposite directions. Do so and have them mimic you.
    - Sometimes the plates move apart from one another. Pull your hands apart and have them do the same.
    - "What do you think happens when the plates push into each other? Let's investigate." Students will find that when they push their hands together that the plates cannot stay flat because there's another plate in the way! The event of the plates pushing up onto each other and building upwards is how mountains form! After visualizing with hands, draw this on the board.

3. “How do you think the Green Mountains, Adirondack Mountains, and Champlain Basin came to look the way it does today?” Water! Let’s explore how the mountains and the water we are going to sail on interact.

Part IV (Classroom)
Build a Watershed
45 minutes

1. Separate the students into the groups that they made their maps with. Now the students have the chance to build a watershed and see how water and geology interact. Each group gets a pan for building their watershed and aluminum foil. Ask, “How could you use the aluminum foil to construct a watershed that resembles the Champlain Basin?” Remind them of the maps they made and how using their maps may help. Give them about 10 minutes to build the topography of their watershed with the aluminum foil and tray. Encourage them to also collect materials from outside to build a watershed that reflects the Champlain Basin (rocks for mountains, etc).

2. Allow students to pour a cup of water over their landscape and observe what happens. Discuss where the water when in their bins. Ideally students will say it went down the sides of the mountains and into the middle. You can let them know that’s correct and that they’ve now built a watershed. A watershed is an area of land where all of the water that is under it, or drains into it, collects into the same place. Use the metaphor of a bathtub to explain watersheds and how all water is connected/cycles through the Earth. Ask students, “What are the sides of the bathtub in real life?” The mountains! “What about the water collecting in the bottom of the bathtub?” Lake Champlain or another body of water. A watershed is an area of land that drains water, sediment, and pollutants into a common basin.

3. When water collects at the bottom of a watershed, where does it go from there? Begin to discuss evaporation and the water cycle in very simple terms. Water evaporates into water vapor and makes clouds, wind blows clouds across the sky, where it rains somewhere else or close by. This cycle continues over and over again in different watersheds. This is just one connection between the mountains and rocks (geosphere), which gives the watersheds their shape, to water (hydrosphere).

4. Next, have students brainstorm different things they have seen or could see in a river, stream, lake, or ocean – record on the board. As students to gather materials around them to represent those items. You can also use food coloring to represent different items. Have

the groups put different a different material (trash, dirt, rocks, food coloring). Give each group a spray bottle filled with water. “What do you think this represents?” Precipitation, snowmelt, groundwater, and runoff! Have them mimic rain with their spray bottles and observe what happens when the water and food coloring run down the mountains and wash into the bottom of their watersheds.

Give each group 2-3 minutes to present what they created and how the activity went to the rest of the class and what happened in their watershed when the added other materials and why they think that it happened that way.

Part V: Classroom
Bring It All Together
30 minutes

1. Now that the topics of landscape, mapping, sedimentary rocks, erosion, and watersheds have been covered, the class will go and see it all for themselves on the water. Have them take down observations on their boats of elements that they may not have seen in the first activity that they can add to their maps. This will give them a new perspective. Ask them, “Is there more happening in your watershed than what you can see?” Help them make the connection between water, the water cycle, and history as they sail with some of the following questions:

    - Can you believe whales used to swim where we are sailing right now and that there used to be a glacier here?
    - Can you see all of the water draining into the lake?
    - Look up, have you ever thought about the clouds and how they are part of the watershed? Optional: Sing the Water Cycle Boogie: evaporation, condensation, precipitation, RUNOFF!

2. Wind carries evaporated water vapor in the form of clouds through the atmosphere. Have you ever seen weather radar? When they show a storm moving, it is moving because strong winds are pushing the storm, which is just fast moving air and precipitation. The water that rains down on one watershed, whether it is 5 square miles or 100,000 square miles, could potentially contain the pollutants it acquired in another watershed! All water is connected! And water erodes and weathers the rocks that make watersheds.

3. Watersheds form due to the geologic history of the area, weathering, and erosion. Weathering and erosion have all to do with water and wind! Rock is weathered or eroded away to form channels for water to run down and collect. All of this leads hopefully leads you to believe, what you put into your water, where you get your water, and where your water is coming from is all related! There are 200,000 people who rely on Lake Champlain

for their drinking water? So understanding water and geology are all pretty important to our everyday lives and the places in which we live.

4. To finish the activity, have them come back on land and update their maps with the new perspective they gained on the water.

Additional Topics to Discuss While Sailing: implications of land forms on the course we choose to sail and preparing for sailing - thinking about depth, storms coming over mountains, how peninsulas and islands with mountains can affect wind speed and direction. We also discuss man-made features as well and the effect they have on sailing. Lastly if there is erosion because of the interaction between land, rock and water how that would impact sailing locations in our harbor.

Additional Resources

Rock Types – supplemental information about sedimentary, igneous, and metamorphic rocks. (http://www.sandatlas.org/rock-types/)

Earth System Science in a Nutshell – a simplified explanation of Earth's systems. (http://serc.carleton.edu/introgeo/earthsystem/nutshell/index.html)

Plate Tectonics - brief overview of plate tectonics. (http://science.nationalgeographic.com/science/earth/the-dynamic-earth/plate-tectonics-article/) Some plates move apart from one another, a situation which is almost always in the deepest parts of the oceans and called divergent boundaries. Divergent boundaries on land cause landscapes called rift valleys and basins. When these plates move towards each other, called convergent boundaries, it one of the most common ways mountain ranges are formed, because the Earth's crust crumples, buckles, and rises. While teaching, utilize your hands and whiteboard to illustrate convergent boundaries, plate tectonics, and how mountains ranges are formed.

Some locations are known for having a lot of earthquakes. This is because of these plates moving and shifting around. Certain places are located right on the boundary between two plates, making them prone to earthquakes. The plates move very slowly most of the time, less than a centimeter per year for most of them, but even the smallest movement can create an earthquake.

Details on ADKs and Green Mountains

Fun fact - the Adirondack Mountains are extremely rare, and they are not part of the Appalachian Mountains like all of the rest of the mountains on the east coast. They are part of the Canadian Shield. The rocks found at the surface of the Adirondack Mountains are made of materials that geologists have

proven must have formed below 15 miles of overlaying rock! When they were formed they had elevations similar to that of the Himalayan Mountains (home of Mount Everest; 29,029 feet).

The rocks that make the Green Mountains are much younger than the Adirondacks, but they too look much different today than when they formed. A certain form of water that covered the Earth 10,000 years ago has the most to do with it - ice, to be more exact, glaciers.

The last Ice Age last from about 100,000 to 12,000 years ago, at which point the glaciers began melting. During the Ice Age and the great thaw when the glaciers were melting and retreating, the ice and water eroded away the Champlain Valley and the mountain ranges surrounding the valley. The path the glacier in the Champlain Valley took turned into the Champlain Sea and then the land closed off the connection to the Atlantic and it became Lake Champlain. Processes such as this have occurred all over the Earth, molding and shaping the surface of the Earth into what it is today. This connection between rock (geosphere) and water (hydrosphere) defines our landscapes, it is called erosion, and it matters because we live in these landscapes.

Watersheds – a guide to teaching kids about watersheds.
(The ABCs of Ecology: An Educator's Guide to Learning Outside, Ecology Education Inc.)