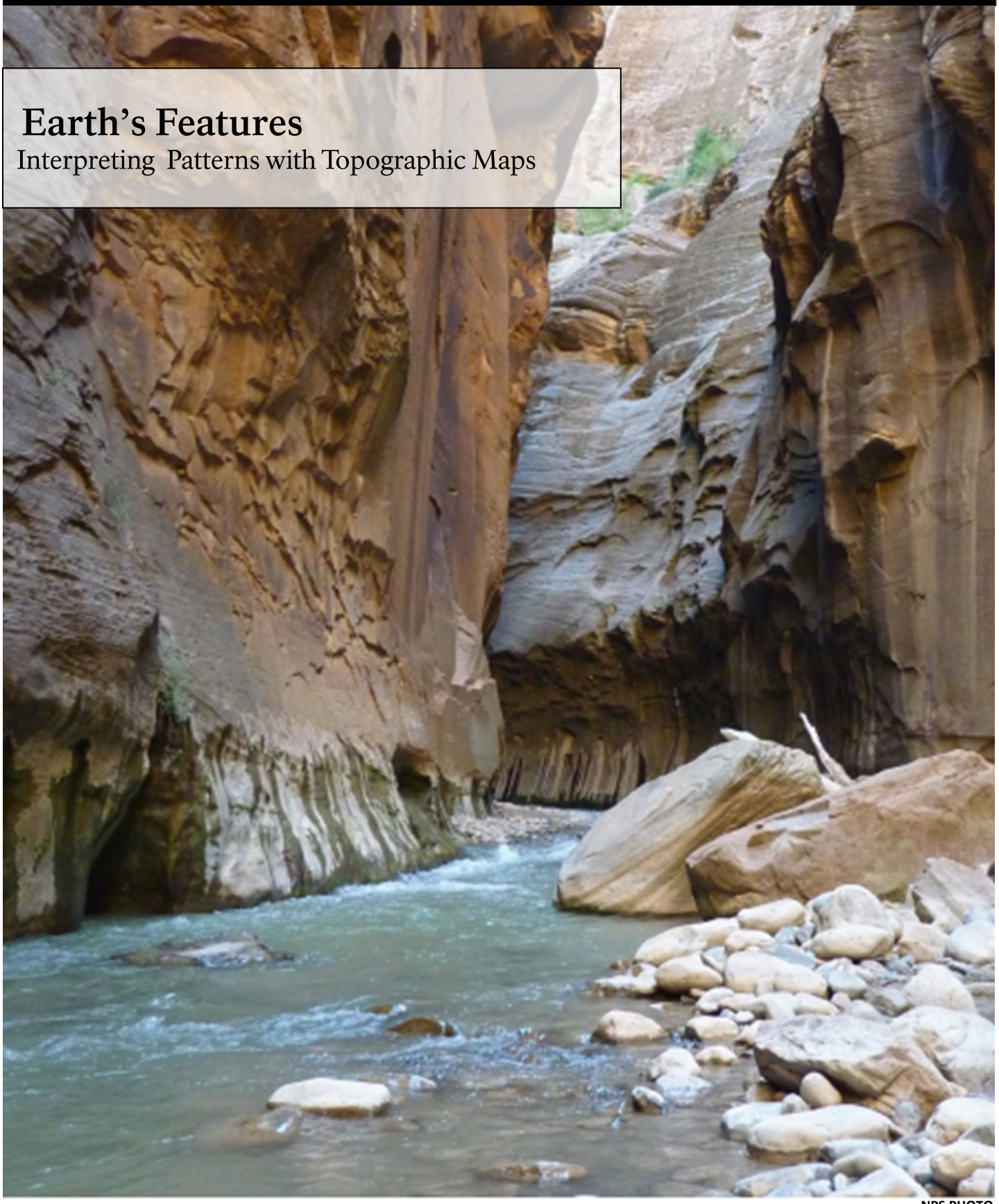
National Park Service
U.S. Department of the Interior

Zion National Park

Earth's Features

Interpreting Patterns with Topographic Maps



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Zion National Park, 2020

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Introduction

This guide contains background information on topography and an activity where students will analyze the data on topographic maps of Zion National Park to better interpret the patterns of Earth's features. This guide is specifically designed for fifth grade, but the activity can be modified for students at other levels.

Theme

Zion has many different geologic features; their patterns can be better understood through the use of topographic maps.

Focus

The activities focus on learning about the different aspects of topographic maps and how to read them.

Activities

Mapping Ups & Downs PowerPoint
This PowerPoint introduces students to the concept of topographic maps and uses these maps to explore the geologic features of Zion National Park.

Making Mountains, Cutting Contours:
Students build a mountain out of playdough and divide the mountain into sections, which they use to make a topographic map that shows contour lines, elevation changes, and gradients.

Background

All over the planet landscapes are made up by varying elevations. These differences in elevation make up the features of the earth: hills, mountains, valleys, canyons, rivers, and more. Upon closer examination of these features, patterns begin to emerge. Rivers always flow from high elevation to low elevation. Young mountains are often sharp and steep, while old mountains are usually soft and rounded. Valleys have different shapes depending on whether they were carved by rivers or glaciers.

Unless you have personally walked all over a landscape, it can be challenging to visualize its features' specific shapes and elevations. In order to better do this, topographic maps were invented.

A topographic map is different than a regular map in that it does not just show the outline of a landmass, but it shows the three-dimensional shape of a landmass . In other words, shows three dimensions on a flat screen or paper. Contour lines and labels have certain meanings , which must be read in a certain way.

When you properly learn how to read a topographic map, you can use this information to pick out in advance a nice flat place for your tent on a backpacking trip, figure out how much elevation gain you will have on a hike, decide on the safest pace to build your home, or plan military strategy for ground troops in unfamiliar territory.

Zion National Park is a wonderful example of diversity in landscape, elevation, and topography. It is precisely because of this diversity that such a national treasure exists. Without the gradient of high elevation near the Narrows and lower by the Visitor Center, the Virgin River would lose some of its downcutting power. In addition, Zion's steep cliffs allow rainwater to gather the velocity needed to create the raging flashfloods that continue to carve this glorious canyon.

Looking at topographic maps of Zion's features, you can identify patterns that give you insights into the geologic history of the area as well the current geologic hazards, like flood and rockfall zones.

Education Standards

Utah SEEd 5th Grade

Strand 5.1 Characteristics & Interactions of Earth's Systems

Standard 5.1.1 Analyze and interpret data to describe patterns of Earth's features. Emphasize most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans while major mountain chains may be found inside continents or near their edges.

NGSS Middle School

Strand 4-ESS2 Earth's Systems

Standard 4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.

Mapping Ups & Downs

Duration
~15 minutes

Location
Inside

Key Vocabulary
Topography, Landform, Topographic Maps, , Elevation, Contour Line, Index Contour Line, Contour Interval, Cinder Cone

Objectives
Students will be able to be able to analyze and interpret data to describe patterns of features in Zion National Park.

They will be able to identify the following features on a topographic map:
- A contour interval
- The highest and lowest elevation points
- The steepest and flattest slopes
- The flow direction of rivers/streams

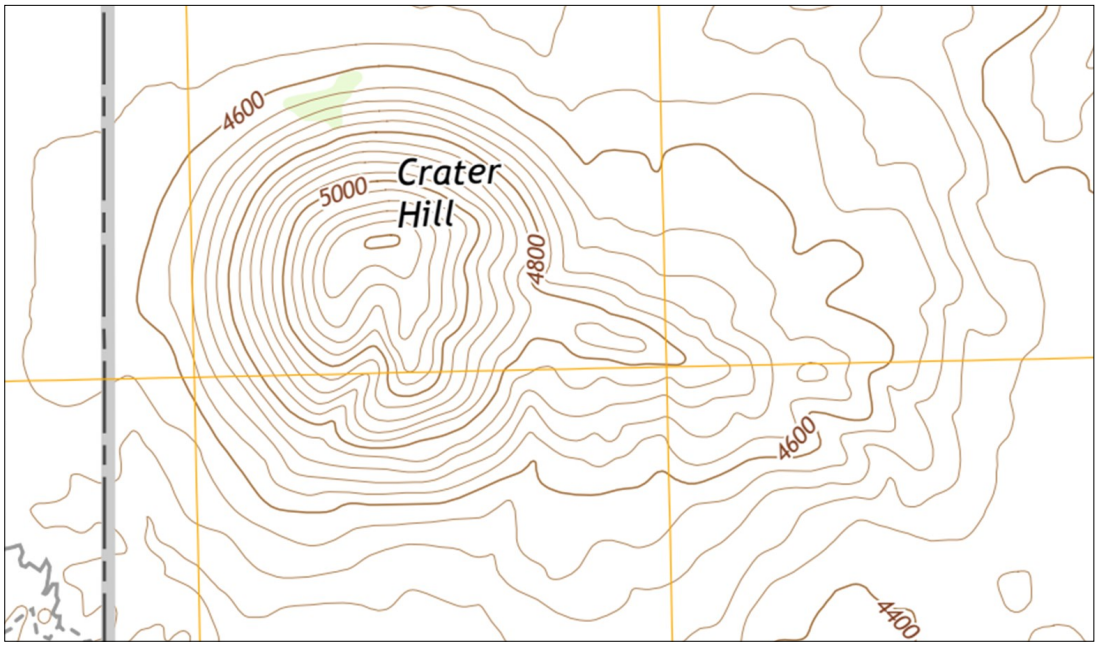
Method
This PowerPoint can be used as a way to disseminate all relevant background information before the Making Mountains, Cutting Contours activity.

Slide images could be used as a projected presentation, a teacher reference, or a single student may sit at a computer and view presentation at their own pace.

Materials
- Window that shows the outside of school or building, or a quick trip outside so students can briefly view the landscape around them
- Microsoft Mapping Ups & Downs PowerPoint

Background
Topography is the study of the shape of the land's surface. This includes the height, shape, and elevation of the rocks and mountains. All elevation is measured in units above sea level. Sea level is the starting point throughout the world that we use to have an accurate measurement of mountains, valleys, and other landforms.

Some maps show political boundaries, roads, or cities, but topographic maps show the Ups and Downs of a landscape. These elevation changes are shown through contour lines. According to the USGS, "Contours are imaginary lines that join points of equal elevation on the surface of the land."[1] Bolded contour lines are called Index Contour lines. They are labeled with the exact elevation of that part of the map.

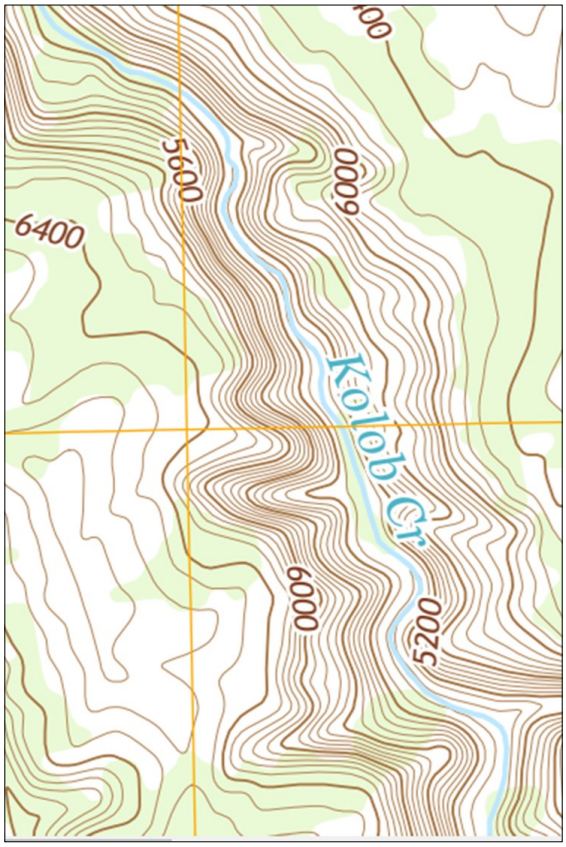


USGS Map

Background (Continued)

Reading labelled index contour lines, we can use math to determine the elevation of the non-bolded contour lines. First, find the total difference in elevation between two index contour lines, then, divide this number by the number of lines between index contour lines. The answer will tell you the distance (in elevation) between each contour line. You can add or subtract to find the elevation of a specific non-bolded contour line.

With this skill, you figure out all kinds of information about the landscape. You can determine the highest, lowest, steepest, and flattest areas on the map. If the contour lines are close together, the land has a steeper gradient; if they are spread out, the land has a less steep gradient (i.e. is flatter). You can determine the flow direction of a river by looking at the index contour lines that it crosses. Because of gravity, water always flows from the higher elevations to the lower elevations. By learning how to correctly read topographic maps, you can analyze its data and interpret the patterns of the Earth's features.



USGS Map

Making Mountains, Cutting Contours

Duration
~45 minutes

Location
Inside

Key Vocabulary
Cinder cone, topographic map, contour lines, elevation

Objectives
Students will analyze and interpret data about Zion's features by creating a topographic map of Crater Hill in Zion National Park.

Method
In this activity, students will sculpt models of a cinder cone, which they will cut, then trace at various elevations in order to make contour lines. At the end, they will have topographic maps of their cinder cones.

Materials
- Two cups dough (see recipe at end or use store brands)
- Two rulers (or one ruler and one pencil)
- Thin string (like dental floss) about 12 inches long
- One pencil
- One toothpick (or sharp pencil point)
- Two sheets of paper, or one poster paper 11 x 14 (card stock recommended)
- Tape
- Optional: Rubber Scraping Spatula

Background
Please refer to the Mapping Ups and Downs PowerPoint for background information on Zion's topography, how to read topographic maps, and why these maps are useful.

Use the following information to expand the lesson to include more about volcanism.

Unlike the usual pattern for volcanism (where volcanoes occur along the boundaries between continents and oceans), Crater Hill and other forms of volcanism in Zion are due to two other geologic phenomena.

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Background (Continued)

The first is Basin and Range crustal extension (collapse and stretching of the crust to the west) that has been going on for 17 million years. The second is Colorado Plateau uplift and melting of its base the last 6 million years.[2]

NPS Photo

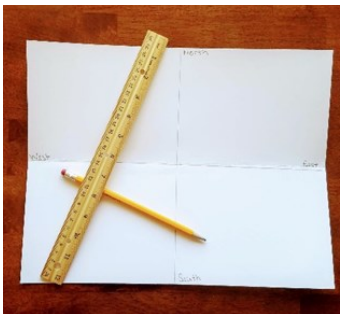
Because of Basin and Range crustal stretching and the rise of the Colorado Plateau, the ground in this region is so fractured that magma has many paths to rise through. These cracks, called joints, can easily be seen in a satellite view of Zion. The roughly north-south cracks are great paths for magma to use. [3]

120,000 years ago, Crater Hill erupted just below the West Temple between Rockville and Virgin. Its lava flow dammed the Virgin River creating a lake that stretched into Zion Canyon perhaps as far as Canyon Junction.[4]

Crater Hill is a cinder cone volcano. Cinder cones develop around volcanic vents when hot, pressurized lava erupts high into the air. When these "drops" of lava encounter cool air, they solidify, preserving miniature bubbles in rock. These light, hole-filled rocks are called cinders. As gravity takes hold, cinders fall and collect around the vent, forming a cone-shaped hill. [5]

Suggested Procedure

1. Briefly review characteristics of a cinder cone and the volcanic history of Crater Hill as well as Zion National Park in general.
2. Distribute the materials to the students. Have the students fold the sheet of paper in fourths (fold once lengthwise, and then widthwise). Once unfolded, have students draw lines with their rulers on the crease lines and then label them NORTH, SOUTH, EAST, WEST.
3. Make sure that students have enough dough to make their model at least 3 inches high. Allow them to sculpt and mold their cinder cones.



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4. Have students place the dough volcano on the center of the piece of paper, where the lines cross.
5. Where the outer edge of the dough meets the paper, the elevation is 0 inches. Use the pencil to trace the outline of the dough. It is best to have students place their pencils straight up and down for the outline, instead of having the pencil draw at an angle. This will reduce the point digging into the dough.
6. Using the toothpick, carve a shallow, vertical (straight up and down) line on the clay, from the top of the peak to the place where the bottom of the volcano meets the line marked SOUTH. This will be your first guideline. Carve a second line from the top of the peak down to the EAST line.
7. Tie one end of the string around each ruler, at the 1-inch mark. Tape the string in place so it won't wiggle. (If there is only one ruler for each student, you can use a pencil instead of the second ruler.)
8. Keeping the short ends of the rulers flat on the ground, pull the string so that it slices through the dough. Put your fingers on the back edge of the dough as you slice front to back, to keep the dough from moving. You will be slicing your mountain into two sections: the bottom inch of your mountain, which is touching the paper, and the top part of your mountain, which is the part higher than one inch.
9. Carefully separate the two sections of dough. Move the bottom section off of the paper and place it elsewhere.
10. Using your guidelines, put the smaller, top piece of dough back on the paper. Make sure both guidelines (SOUTH & EAST) on the dough match up to the guidelines on the paper. Trace this section of dough with the pencil. Write 1" next to this line. All the dough at this line started out one inch above the paper.






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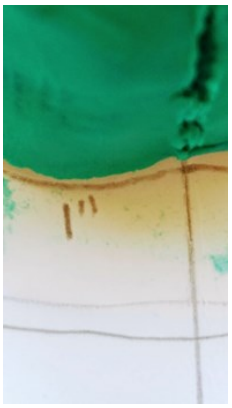
11. Repeat these steps of cutting dough and labeling contour lines until you have reached the top of your mountain. Make sure to label the second cut 2", your third cut 3" and so on.
12. After you are done with each slice of dough, put it back on top of the first slice, using your guideline to get it back in the same orientation. Note: You don't have to adjust the string on the ruler: each slice is one inch above the previous one.
13. Measure tallest point on the volcano and approximately label it on topographic map using a small triangle as a symbol.
14. Congratulations! You now have a contour map of your mountain.
15. Have students determine the steepest and flattest part of their cider cone. You can expand this part having the students do the following:
    - Pretend they are explorers and plan the easiest assent route up the volcano to see where the next town lies.
    - Pretend they are lost in the wilderness and are dreadfully thirsty; have them figure out the most likely location for a stream or lake on their volcano.
    - Pretend they want to build a house at the base of the volcano—where would be the safest from rockslides/falls?
    - Etc.



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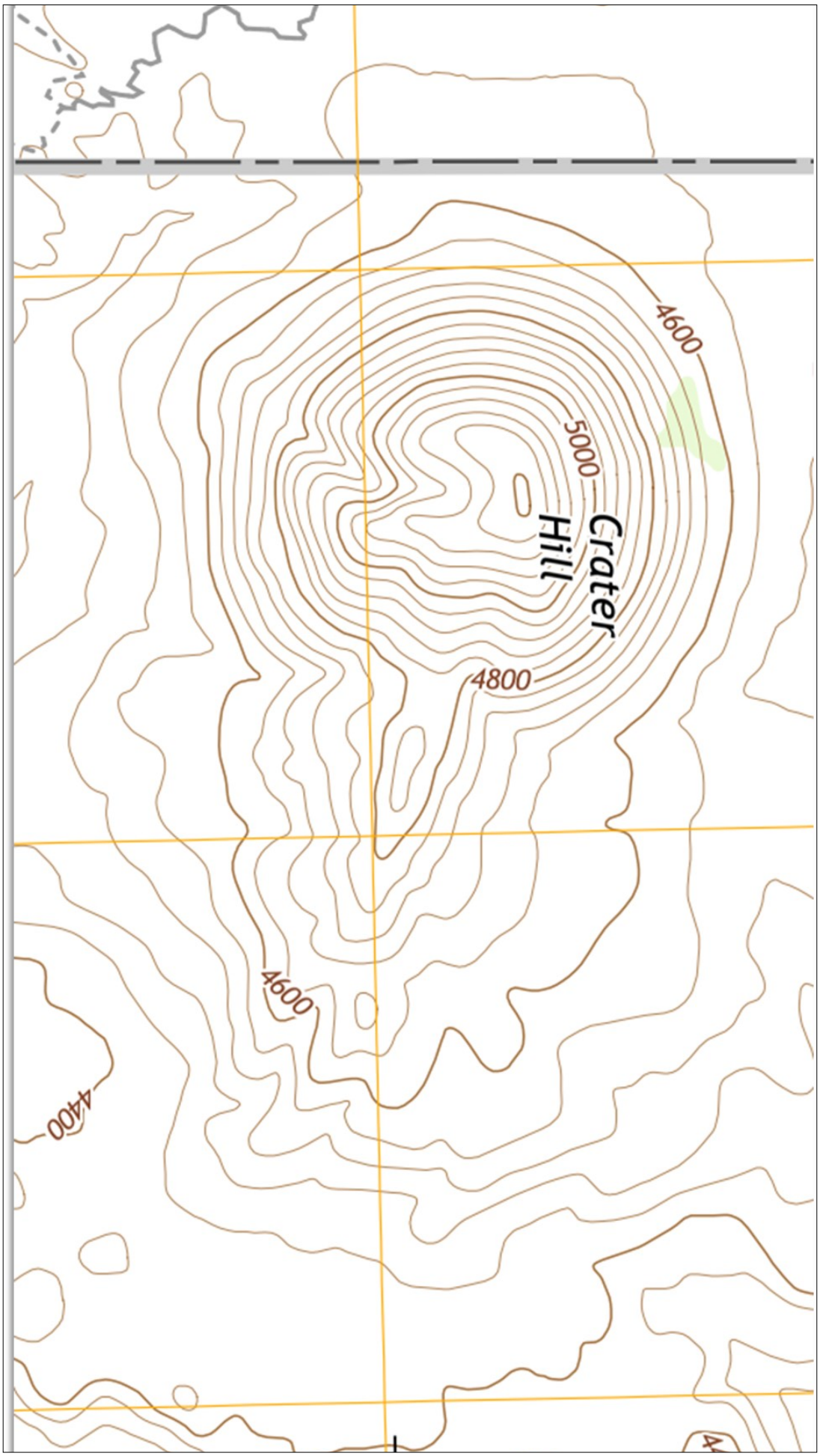

USGS MAP

Resources & References

The following are government websites used as sources for the background information sections of the lesson plan.

These web pages are also good resources for addition information:

[1] **Quote from:**https://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf

[2-4] Paragraphs taken directly from: https://www.nps.gov/zion/learn/nature/volcanoes-of-zion-and-southwest-utah.htm

[5]Paraphrased from: https://www.nps.gov/havo/learn/nature/cinder-cones.htm