EARTH SCIENCES - MAPS AS TOOLS
TEACHER GUIDE

MATERIALS:

5 different topographic maps
clay, rolling pin
wood board, scissors
knife or sharp edge

Objective: Identify landforms using topographic maps.

What is a landform?

Teacher note

There are many different landforms that can be identified. Using a map of the United States show the different landforms. The continental United States can be divided into three major parts, mountains in both west and east, with a plain in central U.S.

Maps with contours can help interpret these landforms. A mountain on a topographic map would have contours with high elevations. A steep mountain would have contours that are very close together. The following reader helps students to learn about landforms as they learn to identify them on a map.

You are on vacation and you want to take a long hike. The map you are using shows a direct **route** to where you want to go. As you walk, you find yourself talking to your friend and "splash!" You are in a lake. The map you had did not show **landforms**, so you weren't paying attention to where you were going.

Understanding landforms can help you interpret maps. It is easy to walk up a gentle sloping mountain, but difficult to walk up a very steep **canyon**. A road can easily be built on flat land, but difficult to make a tunnel if you want to get through a **mountain range**.

Let's learn more about different types of landforms and how they are created.

What creates landforms?

Teacher note

Landforms are created by two different types of forces acting on the land: (1) those that affect the original surfaces and (2) erosional elements. Volcanic and tectonic forces are the major contributors to the changing or "refacing" of original surfaces. The erosional elements (wind, water, ice, and heat) are responsible for dislodging, transporting, and depositing materials from the Earth. Most landforms are erosional.

You may want to discuss the different landforms in the United States in more details. The most notable in the west are the Cascades, Sierra Nevada, Basin and Range, Colorado Plateau, and rocky Mountains. The central part includes the Great Plains and Central lowlands. The east has the Appalachian Plateau, the Piedmont and coastal plains.

As you take a hike you can notice different land features. But how did these landforms get that way? A landform is any feature of the Earth's surface that is produced by nature. This includes **plains**, **plateaus**, mountain ranges, or **valleys**. Roads and streets produced by humans are not landforms.

The forces of nature that create landforms include **water**, **ice**, **wind**, **volcanoes**, and **earthquakes**. They are divided into landforms created by erosion and landforms created by **tectonic** activity.

As nature works its magic on the surface of the Earth, we get many spectacular views. It is our job to determine how they were created.

Landforms and Topographic Maps

Teacher note

Contour maps can show many different landforms and can give you an insight on how that landform was created. For instance, a river will form "V" shape valleys and you can see this "V" pattern on the contours.

Water is a powerful erosional process that cuts through rocks and soil. A poorly sedimented sandstone will erode faster than an hard igneous rock. Flowing water is powerful, but as we will see ice is more powerful at grinding away rocks.

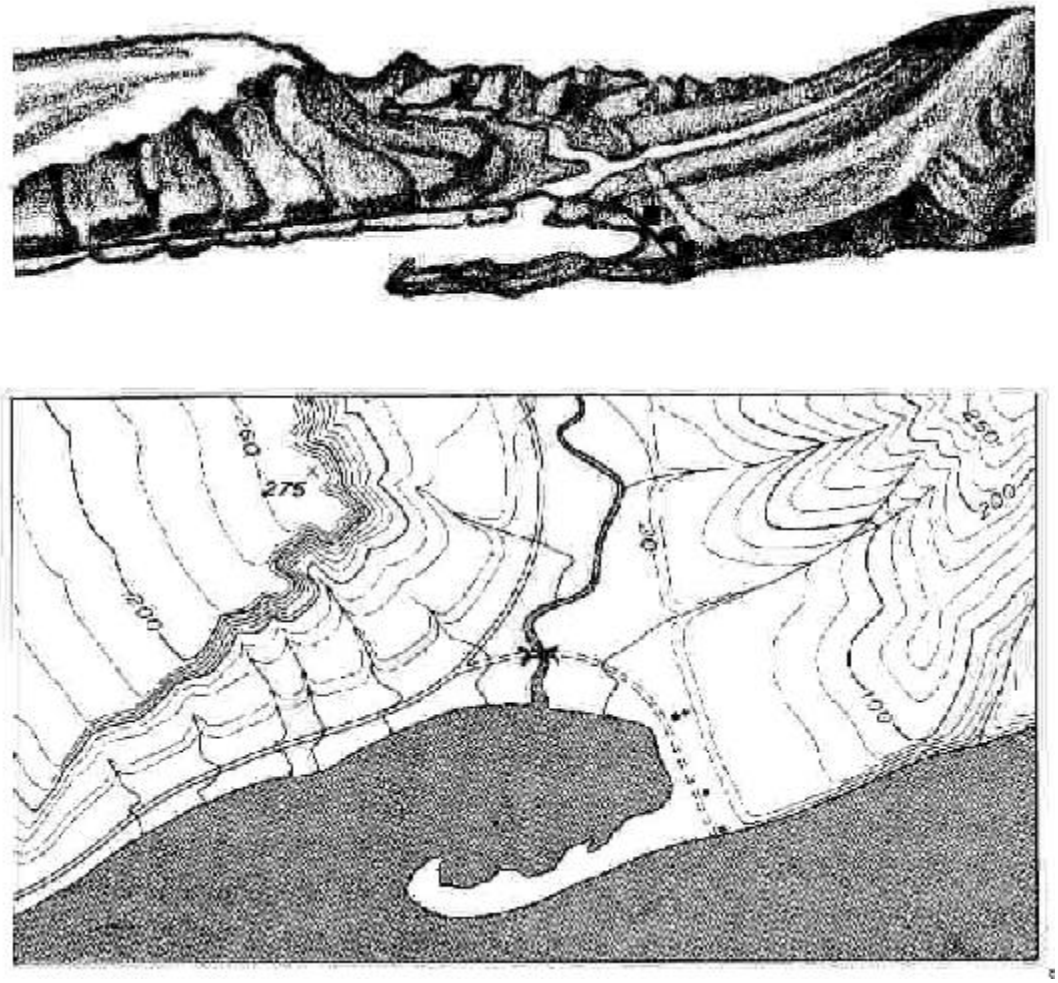
The quick activity is for students to look at a topographic map and a picture of what they should see if they read the contours correctly. Recognizing landforms using contours takes practice and imagination. This activity is from the U.S. Geological Survey.

ANSWERS: 1. Church has a cross; 2. Bridge is at the mouth of the river; 3. The steep cliff is on the right with the very close contours; 4. Where the river meets the ocean; 5. Hill is steep on the east side and gently sloping on the west. 6. Hill on the right is very steep on the south face and less steep on the east side, with streams. 7. The contours have a V shape.

Running water along **rivers**, **streams**, or **creeks** can cause valleys with a "V" shape. Water cuts along a center line as it **erodes** the rocks and soil as the water flows over. As soon as the water in a river erodes the Earth's surface, the river it also wants to deposit the **sediment** it created. If the energy in the water is high enough, the sediment will continue to stay in the water. However, if the water slows down, the sediment will drop out or be deposited because there is not enough energy to hold the sediment in the water. This process of eroding and **depositing** is called **weathering.**

A topographic map can help identify landforms if you can interpret the contours. Look at the contours that reflect a **coastline** on Quick Activity - Interpreting Contours. Contours can help us a three-dimensional world on a flat piece of paper!

QUICK ACTIVITY - INTERPRETING CONTOURS



Look at the picture on the top and its representative topographic map at the bottom. Can you locate on both maps the following:

1. a church (circle)
2. a bridge over the river (star)
3. an oceanside steep cliff (rectangle)
4. The mouth of the river (X)
5. Describe the hill on the left:

6. Describe the hill on the right.

7. How can you tell that there is a stream coming from the hill on the right? (Hint: contours)

LANDFORMS CREATED BY ICE

Teacher note

Ice can be found in only cold places on Earth. In the high countries you can find glaciers that last all year round. In Alaska there are many glaciers. In Antarctica you can find sheet glaciers, which are so large, they cover the entire continent all year round. The movement of glaciers occurs because of the pull of gravity on the mass of ice.

Erosion by glaciers can occur by plucking and abrasion. Plucking is when large blocks of rock are carried by the moving ice. Abrasion or grinding is when the ice uses other rock fragments embedded in the ice to abrade the surface of other rocks.

Ice can carve the Earth's surface by cutting and grinding away slowly as the ice moves over an area. It is a powerful form of erosion. The areas where glaciers have eroded the Earth's surface you can find "U" shaped valleys. Look at top map and locate a **glacier** on the map. Look at the contours, do you see the "U?"

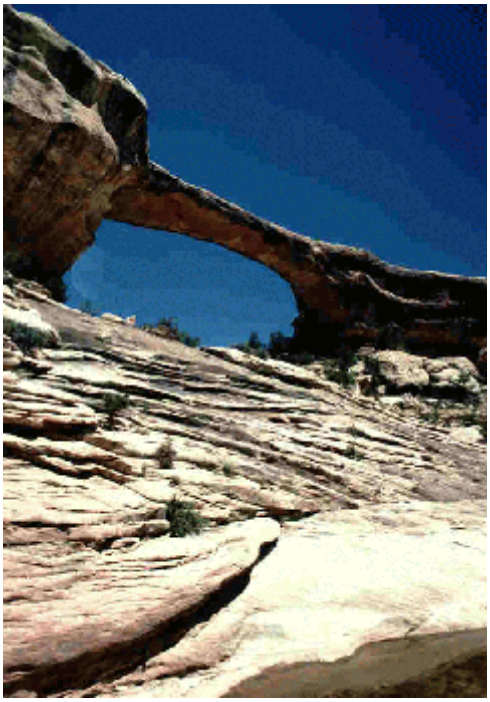
LANDFORMS CREATED BY WIND

Teacher note

Wind is a powerful erosive force in arid areas. The ability to "sandblast" an area can carve different landforms. If the rock that the wind is blowing on is "soft" it can erode bizarre smaller features that can pot mark a rock.

Wind erosion can occur in many different climates, but it is the most powerful in desert conditions.

Wind picks up loose **debris** and rocks and it can hit other particles. Although one grain of sand would not do much damage. Many grains will. This is the principle of **sandblasting**, which construction workers use to help clean large area. Wind is more **destructive** in arid or hot climates. Particles constantly blowing causes very weird desert landforms. Desert pavement is when all the small grains are removed leaving only the larger cobbles. The wind also "shines" the rocks by its constant polishing. Sand dunes are also another landform associated with wind erosion.



LANDFORMS CREATED BY TECTONIC ACTIVITY

Teacher note

Tectonic activity causes a shifting of the Earth's surface. Students will learn about the processes in later chapters. Faulting due to earthquakes causes valleys, mountains, and offset rivers. Volcanoes can cause large flows of lava and sometimes ash flows. Sometimes volcanoes can "blow their top" and cause parts of the mountain to be blown away.

Tectonic activity including earthquakes and volcanoes can change different landforms. Movement along an earthquake **fault** can cause mountains and valleys to form over a long period of time.

Volcanoes can cause a visible difference after an eruption. Hawaii is an example of a **landscape** shaped by volcanoes. The lava acts like a very slow moving river of water as it drapes itself over existing land.

INTERPRETING LANDFORMS
LAB

Teacher note

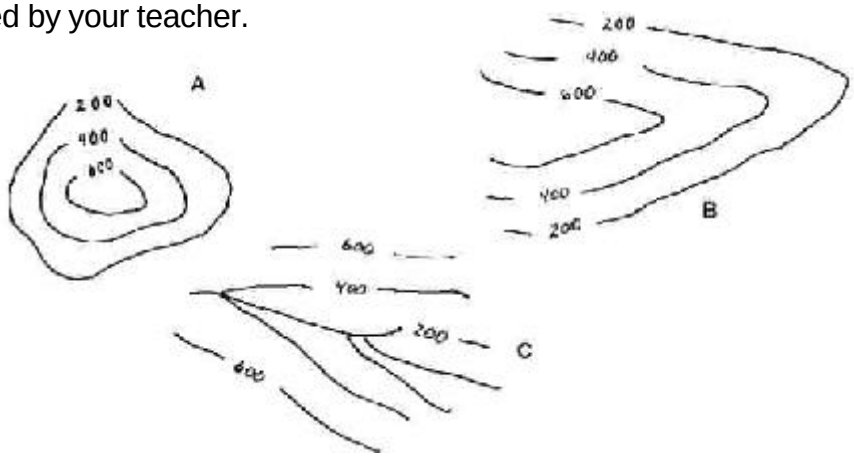
Students are asked to look at different types of maps and globes. Make sure that the maps show mountains and valleys, either through contours or through relief. If you have a hydrographic globe model or other relief maps, we suggest you use them also. We suggest at least 5 different types of maps or globes so the students can see relief. We highly suggest the paper versions of topographic maps so students can compare and contrast. You may want to use the electronic maps included with the reader, but it is difficult to get the entire map electronically. If you purchase maps either from the Math/Science Nucleus or another U.S. Geological Survey dealer by visiting: http://usgs.gov.

Go over scales, legends, and other key portions of the lab that you may have not discussed in previous lectures.

You have learned that a contour are lines of equal elevation. Contours make it possible to tell where mountains and valleys are located. They help us recognize the shape of the land. If the contours are close together, the land rises quickly and the area is steep. If the contours are far apart then the area is a gentle slope.

If you practice reading a contour map, you can learn to visualize the topography in a glance. A hill or mountain for example, is marked by high contours surrounded by lower contours (figure A). A ridge has the higher contours inside the lower contours (figure B). A valley or canyon has lower contours inside the higher contours (figure C).

Complete the following lab sheet to learn more about reading topographic maps with the maps provided by your teacher.



INTERPRETING LANDFORMS
LAB

PROBLEM: What types of landforms can be found in using maps or globes?
HYPOTHESIS:

_____

PROCEDURE:
MATERIALS: 5 different maps or globes
Using the set of various maps answer the questions on the lab sheet.

1. Name the five maps. Give the original publication date, date of last revision, and contour interval.

MAP/GLOBE	DATE (IF LISTED)	REVISION (IF LISTED)	CONTOUR LEVELS

2. Which of the five maps is the oldest?

_____

3. Map scale defines the relationship between the measurements of the features as shown on the map and as they exist on the Earth's surface as a proportion or ratio. Scale is generally stated as a ratio or fraction. The numerator, customarily 1, represents map distance, and the denominator, a large number, represents horizontal ground distance. Therefore, a scale of 1:50,000 in inches means that 1 inch on the map = 50,000 inches on the ground, or 1 meter = 50,000 meters on the ground.

List the scales of each map. State if you can't find a scale.

_____
_____
_____
_____
_____
_____

Which map covers the most area?

_____

Which map covers the least area?

_____

4. What do you think the green and brown colors represent?

_____

5. What is the symbol for a forest?

_____

Which map covers the most forest? _____ the least? _____

6. What is the symbol for a mine shaft? _____ Which map contains the most mine shafts?

_____

7. Which map covers the greatest amount of water?

_____

8. Is the water different colors?

_____Why?_____

_____

9. Why are there contour lines in the ocean?

_____

_____

10. Which map has the most "relief."

_____

_____ Why?_____

_____

11. How can you determine the type of area a topographic map covers by just glancing at it?

_____

_____

12. Which map has the most rivers?

_____

13. Compare all of the maps. How are they different?

14. Do highways and roads seem to follow the topography?

_____
_____

How can topographic maps be useful for planning roads, building sites, and cities?

_____
_____
_____

15. Could a topographic map help you find your way through a city? _____ Why?

_____
_____
_____

16. How does a topographic map differ from a road map?

_____
_____

17. If you were planning on going hiking, would you take a road map or a topographic map?

_____
_____Why?_____
_____

CREATING LANDFORMS
LAB

Teacher note

There are different types of landforms in the U.S. Have students use clay to model the surface of the different topographic maps. Have them try and figure out what the surface would look like if the process that molded the land were rain, ice, heat, or volcanoes.

Group students into 2 or 3 students to work on making a clay model of the different landforms. Give each group a topographic map and have them sketch the area that they are going to model with the clay. By the end of the activity you should have examples of the following: glacial, river, wind, volcanoes, and shorelines.

Discuss with students the features that they created. Check the model to see if it reflects the topographic map. Students should draw a sketch of their model on their lab sheet.

You have learned about different landforms caused by wind, rain, ice, and tectonic activity. Each has it own **characteristics**. Wind smooths an area by sandblasting the surface of rocks. Rain erodes rock and soil as it races downslope. Ice slowly cuts and grinds large mountains as it moves. Volcanoes produce lava that covers everything in its path. The picture on the right is a student example of lava using plaster of Paris.

Using clay or plaster of Paris, mold a landform that you have read and try and make it realistic. If you have questions about what the landform should look like refer back to the reader and topographic maps.

LANDFORMS
LAB

PROBLEM: How do different landforms look as a topographic map?
HYPOTHESIS:

_____

PROCEDURE:
MATERIALS: topographic maps, clay

Look at the topographic map that your teacher has assigned to you from Lab 5. Draw a sketch of what you think your topographic map looks like, and then using the clay provided, try to model the topographic map. Note you do not have to make an exact replica, just close!

DRAW SKETCH:

CONCLUSIONS: Compare your model with some other group that is modeling the same topographic map. How does it compare?

_____
_____
_____
_____

ANGEL ISLAND
A STORY

Teacher note

The lab revolves making a topographic model of Angel Island. This island is the largest island in the San Francisco Bay and has had an exciting history over the last 6000 years. We suggest you have the students read the story of Angel Island and then have them make the topographic model.

For more information on Angel Island consult the official Angel Island website:

EARLY HISTORY OF ANGEL ISLAND

The Miwok Indians enjoyed hunting and fishing for over 6000 years on Angel Island. They would make boats from Tule reeds and construct a boat to go over to the largest island in the San Francisco Bay.

In 1775 the Spaniards under Lt. Juan Manual de Ayala, used the island's harbor to anchor in a cove pictured on the right. They used the harbor to protect their ship from the strong currents, wind, and fog that is common on the San Francisco Bay. These explorers made the first map in California using this island.

MEXICO TO AMERICA

In 1837 Antonio Osio was granted ownership of most of the island by the Mexican governor of California. His herders lived on the island as they watched over about 500 cattle.

After the 1846 war between United States and Mexico, ownership was under dispute. During the American Civil War, Angel Island became a "West Garrison" to prevent any naval attacks. After the war the island became an infantry camp

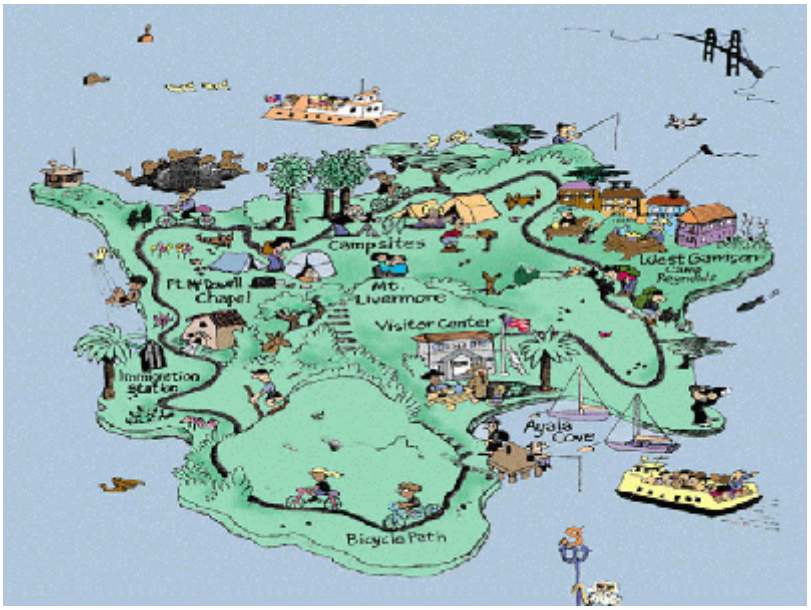
for the U.S. military.

IMMIGRATION AND QUARANTINE STATION

In the 1890's Angel Island was used as a quarantine station for immigrants. If ships had any diseased passengers the entire ship would be fumigated with steam and sulfur dioxide. Immigration Station, as Angel Island was called in the early 1900's, was mainly used as a detention center for Asians coming into the United States. It was sometimes referred to as the Ellis Island (in New York harbor) of the west.

During World War II in the early 1940's Angel Island was used as a prisoner of war processing center for Germans and Japanese.

ANGEL ISLAND TODAY



Angel Island is the largest island in the San Francisco Bay with 740 acres and with a height of 781 feet at Mt. Livermore. It is visited by tourist from many countries. As you walk or ride along the trails you can see the old military houses that were converted to detention homes. You can see spectacular rock formation of red sedimentary rock called chert.

The only way you can get to the island is by boat, which stops at the harbor that the first Spaniard ships used.

CREATING A TOPOGRAPHIC MODEL OF ANGEL ISLAND
LAB

Teacher note

A topographic map can be used to make a relief map. The simplified topographic map of Angel Island is ideal for this type of activity. Make at least 8 copies of the simplified sheet, one for each contour. You can have up to 8 people in each group to construct one relief map.

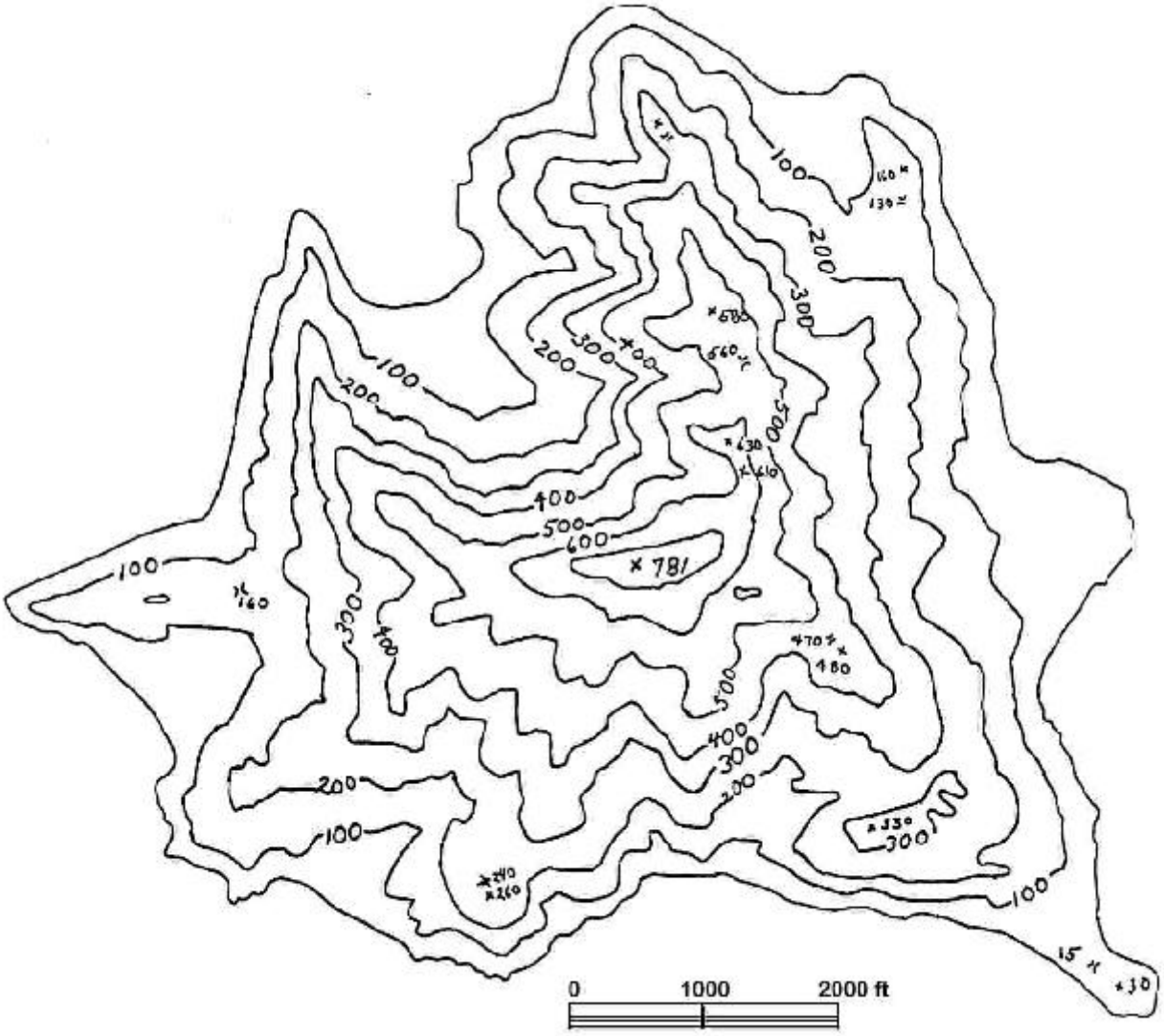
Have students roll out clay on a cutting boards with a rolling pin with two equal height guides on either side of the board (thin wood). Cut out each contours and stack them on each other to reflect the true topography of the area. You may want the students to make the contours more realistic by sculpting the sides to look more natural.

MATERIALS: clay, cutting board, sharp item (knife or piece of metal), 2 pieces of equal side wood, scissor, copy of Angel Island Contour

DIRECTIONS: Roll out clay with a rolling pin on a cutting board. Make sure you roll the clay an even height. Use a thin piece of wood on each side and roll the clay.

Cut out each of the different contour layers. This will act as a guide to cut out each contour on clay. Place the contour on top of the clay and cut the contour in the clay. After all the contours are cut, stack them like the original copy of all the contours of Angel Island.

ANGEL ISLAND CONTOUR



MAPS AS TOOLS-INTERPRETING LANDFORMS
TEACHER OUTLINE AND NOTES

I. What is a landform?

The shape of the Earth's surface that has been accomplished by erosion or tectonic activity.

A. Influenced by climate and rock type

B. Erosion includes water, ice, glaciers and heat

C. Tectonic includes earthquakes and volcanoes

II. Erosion and Weathering

Erosion is the process that loosens and moves sediment to another place on the Earth's surface; weathering is the chemical and mechanical breakdown of rock with little or no transportation

A. Rocks erode at different rates so there are areas that are more resistant than others; this can produce different types of landforms with ridges, cliffs, or gentle slopes

B. Running water erodes areas in predictable stages depending on the amount of rain and the type of rock it is eroding; tectonic activity influences this erosion (i.e. Grand Canyon needed uplifting of rocks for the water to keep eroding downward)

C. Almost every landform on the continent is related to a drainage system as water finds its way to large bodies of water

1. water is an overlay of other features caused by tectonics
2. rivers cause "V" shaped valleys because of the movement of the sediments downstream

D. Ice is important feature in areas where it is cold throughout the year, but this is restrictive to the northern and southern pole areas

1. Ice is more powerful than water for its erosive forces
2. Glaciers can create U shaped valleys as they abrade the rocks around them; their flow pattern is like a river
3. Continental or sheet glaciers erode large area, contours are more difficult to interpret with many different parameters

E. Wind is important is arid areas

1. causes desert polish, where the rocks are smooth on the side that the wind hits
2. desert pavement where there is polished large pebbles and cobblestones left; small sediment is removed by wind
3. sand dunes are created as wind drops the sediment in a predictable pattern

III. Tectonic Activity

A. Movement on the Earth's crust can cause earthquakes. The movement is usually along a fault which can move in many ways.

1. Mountains - one side of the fault can move upwards
2. Offset streams - as a fault slides away from each other the river will compensate and become offset
3. Basin and Range - where basins are pulled apart and cause some areas to go up and some to go down

B. Volcanoes

1. Lava flows can create a landscape that is made of volcanic rocks. It will cover the pre-existing land to create a new landscape.
2. Ash flows from erupting volcano can cover vast areas. They can even cover an entire city (i.e. Pompeii, Italy)
3. Mud flows can form when snow or glaciers are melted and mix with ash. The flow is very large and can cover huge amount of lands that bury everything in its path.

IV. How do maps act as a tool

A. Designing an urban area requires an understanding of relief

1. Example: creating water or sewage flow to and from a house, need to incorporate slopes to help gravity flow the liquid.
2. Designing a road, do not want to make it too steep or trucks cannot drive
3. Do not want to make homes along steep cliffs

B. Workable area

1. A map can be used to develop different models at a scale that humans can work with
2. A map can be modified, where the real land is more difficult to modify after changes have been made

Earth Science - MAPS AS TOOL - Unit Test

Part 1. Definitions Match the number of the term or concept in Column 1 with the letter of the correct definition in Column 2.

Column 1	Column 2
1. Glaciers	a. produce “V” shaped valleys
2. Desert pavement	b. hill or depression
3. Contour lines	c. caused by wind erosion
4. Plateau	d. island in San Francisco Bay
5. Rivers	e. forms faults
6. Closed contours	f. produce “U” shaped valleys
7. Erosion	g. flat area that is elevated from surrounding land
8. Sandblasting	h. wind blasting causes rock polish
9. Tectonic activity	i. Creates sediment
10. Angel Island	j. lines of equal elevation

Part 2. Multiple Choice Choose the best answer to complete each statement.

1. Which of the following is not a landform?
    a. canyon
    b. mountain
    c. houses
    d. deserts

2. Which is a form of nature that forms landforms :
    a. water
    b. wind
    c. volcanoes
    d. all of these

3. The process of eroding and depositing is called
    a. weathering
    b. epicycles
    c. cracking
    d. shoveling

4. Contour lines that are close together represent a
    a. plateau
    b. steep cliff
    c. valley
    d. mountain

5. Mountains and valleys can be caused by
    a. wind
    b. earthquakes and volcanoes
    c. snow
    d. sunshine

6. Contour lines that are far apart represent a
    a. flat area
    b. steep cliff
    c valley
    d. mountain

7. Contour lines that are closed and increase in elevation from the outside line to the inside, represent a
    a. flat area
    b. steep cliff
    c. valley
    d. mountain

8. A valley or canyon has contours
    a. with lower elevation on the inside
    b. with higher elevation on the inside
    c. with no change of elevation
    d. that are closed

9. Which of the following are agents of erosion
    a. wind and worms
    b. ice and polar bears
    c. wind and ice
    d. water and worms

10. Water can form which of the following landforms?
    a. Mountains and valleys
    b. Canyons and mountains
    c. Canyons and valleys
    d. Cliffs and mountains

ANSWERS:

PART I.

1. F
2. H
3. J
4. G
5. A
6. B
7. I
8. C
9. E
10. D

PART II.

1. C
2. D
3. A
4. B
5. B
6. A
7. D
8. A
9. C
10. C