Investigate Geological Processes that Shape Landforms

Earthquakes, Volcanoes, Erosion, Deposition

a 3rd Grade Activity Set addressing
New Science Core Curriculum
Standard 30300-03

—October 1996 edition—

Earthquake Education Services

University of Utah Seismograph Stations

Utah State Science Core Curriculum

LEVEL: 3

TOPIC: GEOLOGICAL FEATURES

STANDARD: Students will recognize various geological features and investigate geological processes.

OBJECTIVES

3030-0301 Identify various geological features such as mesa, mountains, streams, oceans, and islands.

- Describe a variety of geological features.
- Build a model showing various geological features.
- Interpret topographic maps to identify the geological features represented.

3030-0302 Identify processes that form geological features.

- Identify effects of erosion.
- Describe the effects of earthquakes on geological features.
- Describe the relationships between active volcanoes and related geological features

This activity packet was developed in 1995 by a team of teachers and geologists for Earthquake Education Services, University of Utah Seismograph Stations with partial funding from Federal Emergency Management Agency. Call Deedee O'Brien @ 581-6201 for workshops or information.

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THE EARTHQUAKE EDUCATION SERVICES ACTIVITY PACKET
on
GEOLOGICAL FEATURES

The Earthquake Education Services* (EES) activity packet addresses the entire topic of Geological Features, Standard 3030-03 in Utah's third-grade State Science Core Curriculum.

The EES **goal** is to provide resources teachers need to teach earthquake science and safety in the classroom. Incorporating earthquake studies in school curricula will help ensure student safety, as well as produce educated citizens who will be able to make responsible decisions in the future. To meet this goal, efforts have focused on developing earthquake lesson plans that match the core curriculum topics in grade levels 3,5, and 9.

The EES aims to excite students about science by providing an opportunity to think and act like scientists as they discover the world around them. Another objective is to enhance your enjoyment and teaching of Geological Features.

This **project**, coordinated with the Utah State Office of Education, began in early 1995. The EES received funding from the Federal Emergency Management Agency (FEMA) to pay a team of teachers and provide materials. Several members from the *Partnership for Earthquake Education Resources* (composed of the University of Utah's College of Mines and Earth Sciences, the Department of Geography, and the Seismograph Stations, the Utah Division of Comprehensive Emergency Management, the Utah Geological Survey, and the Utah Chapter of the American Red Cross) worked with the teachers.

This **third-grade packet** was developed by three third-grade teachers (Janice Flanagan of Orchard Elementary in Granite District, Tina Fox of Dee Elementary in Ogden District, and Kathy Heller of Parley's Park Elementary in Park City District), geologist Sandy Eldredge of the Utah Geological Survey in Salt Lake City, and project coordinator/education specialist Deedee O'Brien of the EES at the University of Utah Seismograph Stations in Salt Lake City. A pilot workshop was held in the Granite School District in May, 1995. Through June, the EES team participated in state-funded "train-the-trainer" workshops as part of Phase II Implementation of the Elementary Science Core Curriculum led by Dr. Marvin Tolman of Brigham Young University. Feedback from participating teachers was incorporated into this final version.

Some materials incorporated into this packet are from *Tremor Troop Earthquakes, A Teacher's Package for K-6*, produced by the National Science Teachers Association with support from FEMA. For a copy, contact FEMA, P.O. Box 70274, Washington, D.C. 20024. Copies of *Tremor Troop* are also distributed in teacher workshops by EES.

*The EES operates out of the University of Utah Seismograph Stations (UUSS) in Salt Lake City. For further information, contact Deedee O'Brien at the UUSS (705 W.C. Browning Building, Salt Lake City, UT 84112, telephone 801-581-6201).

Table of Contents **GEOLOGICAL FEATURES 3030-03**

ALL YOU NEED TO KNOW IN FOUR PAGES
or
SUCCESS TO TEACHING GEOLOGICAL FEATURES

(portions modified from *Teacher Resource Book*)

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.

Utah is a wonderland of geological features. Mountains, plateaus, or canyons are such an everyday part of students' lives that they may not consciously think about the rugged beauty or the ways the features impact their lives. Using this built-in visual aid, students may begin the study of geological features (landforms) and the natural processes that shape them.

Why teach about geological features and processes? Because they affect students' lives, and conversely, society affects these geologic phenomena. Observing and experimenting with the factors that contribute to the formation and changes of landforms present opportunities for students to develop their understanding. This topic allows students to actively explore the building up and wearing down of mountains, the eroding and depositing forces of rivers, and the effects of earthquakes and volcanoes on the earth's surface. Students will be able to identify landforms on maps and discover the effects landforms have on society.

Geological features. Utah contains numerous geological features: mountains, valleys, plateaus, mesas, canyons, volcanic landforms, lake features, and glacial features. Third- grade students need to recognize and identify the landforms they live with.

Geological processes. Many geological features appear to be unchanging and permanent. Yet, processes within the Earth (earthquakes, volcanoes, mountain building) and processes on the Earth's surface (erosion, weathering, and deposition) are constantly creating, changing, or wearing down landforms. If there were no forces within the earth, there would be no mountains or plateaus. The Earths' surface would be flat and relatively featureless. Instead, what we see outside is a magnificent result of plate motions. The stress and strain within the Earth's crust can cause great warps or folds in rock layers. In other places where the rock is strained beyond its limit, it will break and the rock mass on either side will move abruptly and cause an earthquake. In still other places, hot magma from deep within Earth rises to the surface and results in volcanoes. While all of these internal workings are constantly going on, the surface processes of erosion and deposition are actively reshaping the land as well. Students need to understand the concept that *the earth's surface is constantly changing* due to geologic processes.

Personalizing science. The topic of geological features allows for bringing the relevance of science to the students' lives. Utah's landscapes are built-in laboratories to explore geological features and geological processes. In presenting and experimenting with this standard, it is suggested that the information the students learn and discover be processed as "*What difference does this make to me?*" For example: (a) earthquakes are natural geological events in Utah that create some of the state's mountains and valleys, and therefore earthquake science and safety concepts are important for students to explore, (b) volcanoes contributed to fantastic landscapes in Utah. Magma is close to the surface in some areas of the state, which contributes to some of the state's geothermal industry and some recreational hot springs, © erosion, deposition, and weathering are ongoing, daily processes. These surface processes can also be rapid, potentially dangerous occurrences such as the rockfalls in Big Cottonwood Canyon that have caused injuries and a fatality, and the Thistle landslide, which was the costliest landslide in U.S. history.

The EES packet. This packet contains 26 activities that are grouped into four sections: (1) Earth's geological features, (2) processes <u>within</u> the Earth create and change geological features, (3) processes <u>on</u> the Earth's surface create and change geological features, and (4) maps show geological features. Also included is a slide set, vocabulary, and list of resources. Some activities contain modified versions of several in Utah's 3rd-grade *Teacher Resource Book* (available through the Utah State Office of Education homepage [http://www.usoe.k12.ut.us/curr/science]) and in *Tremor Troop*

(1) EARTH'S GEOLOGICAL FEATURES (Activities 1-4)

The principal surface features of the Earth are the continents and ocean basins. Both present a great diversity of surface features. Continental features are addressed in the 3rd grade. Focus is on the major features of **mountains** (folded, faulted, volcanic, and dome), **plateaus**, and **plains**. Students should recognize these features, as well as other landforms, and also understand that a vast variety of mountains, valleys, plateaus, plains, river systems, lakes, hills, mesas, and buttes abound on the continents.

(2) PROCESSES WITHIN THE EARTH CREATE AND CHANGE GEOLOGICAL FEATURES (Activities 5-13)

The primary study of **earthquakes**, **volcanoes**, and **mountain building** is currently found in the third grade curriculum. To understand these internal forces of the Earth, teachers and students usually thrill in the discovery of the concept of **plate tectonics**. Therefore, an introduction on the earth's structure and plates is included (the major study of plate tectonics occurs in the 5th grade and is included in another EES Activity Packet).

<u>Earth's structure</u>. The Earth is comprised of three main layers: the outer crust, the middle mantle, and the inner core. Activity #5 compares the Earth's structure to a hard-boiled egg - the shell is like the crust (hard and very thin), the white is like the mantle, and the yolk is the core. The Earth's crust is fragmented into sections called plates, which make up the Earth's surface like a jigsaw puzzle. These plates move in response to internal heat and convection forces deep within Earth. At the plate boundaries, plates may be moving apart, colliding, or passing by each other. Most earthquakes and volcanoes are found at plate boundaries. However, some areas of earthquake and volcanic activity occur within plates (Utah is one such place).

Earthquakes. Earthquakes are the sudden shaking of the Earth caused when blocks of rock within the crust *move along* a break called *a fault*. Numerous faults exist in Utah, especially in the central and western parts of the state, due to a stretching of the earth's crust. This stretching builds up strain energy in rocks until those rocks suddenly move along a fault, which causes an earthquake. The valley block of rock (such as the Salt Lake Valley) drops down relative to the mountain block of rock moving up (such as the Wasatch Range). This process has resulted in the distinctive topography of western Utah, the Basin and Range physiographic province, which is a series of parallel fault-block mountains separated by valleys (see Activity #7 and the map in Activity #25).

Fault movement. Directions of fault movement vary depending on the forces at work within the crust. The faults in Utah result from stretching forces, and the movement along the faults is predominantly vertical. Other faults can have predominantly horizontal movement, such as along the San Andreas Fault in California, where two plates are sliding by each other (Activity #7).

Utah's earthquakes. Earthquakes occur over the whole state of Utah; over 700 are recorded each year. Only 2% of these are large enough to be felt by people, but students must realize earthquakes can happen anywhere in Utah at any time. Earthquakes about magnitude 5.0 and larger can cause significant damage, and these earthquakes occur about once every 4 years. Less frequently, about once every 100 years, Utah may experience large earthquakes up to about magnitude 7.5. Students need to be aware that when movement along a fault occurs, the ground does not open up and swallow people (like what's shown in those old movies). Instead, they need to realize that the greatest damage from an earthquake comes from the ground shaking. Therefore, it is important for students to know how to prepare for an earthquake, and how to respond safely during an earthquake (Activities #10 & 11).

Volcanoes. Internal forces within Earth cause heated, melted rock (*magma*) to rise to the Earth's surface through cracks (vents) in the crust. When the magma reaches the surface, it loses some of its gases and turns into *lava*. Lava can take on different forms, depending on its chemical composition - the most familiar type of lava is basalt. Volcanoes are created by the release and build up of lava and other materials including ash. Volcanoes have varied shapes due to the type of material that reaches the surface and type of eruption. Eruptions can be *quiet*, such as oozing, flowing basalt, or *explosive*, such as spewing ash, particles, and lava. These explosive eruptions can be dangerous (for example, Mt. St. Helens). Also, poisonous gases may be released. Not all is negative though, for some positive effects of volcanic eruptions include enriching the soil and resulting spectacular mountains.

Utah's volcanoes. Utah has quite a volcanic heritage. About 30 million years ago some of the large (composite) volcanoes erupted in the Tushar Mountains. Some of the volcanic activity in southwestern Utah was as recent as 1,000 years ago. And the most recent volcanic activity was 600 years ago, which resulted in a basalt flow in the Black Rock Desert of west-central Utah. Utah contains the three main types of volcanoes: composite, shield, and cinder cones. For more information on these, see Activities #1, 12, and 13.

(3) PROCESSES ON THE EARTH'S SURFACE CREATE AND CHANGE GEOLOGICAL FEATURES (Activities 14-21)

Many features in Utah are a result of **erosion**, **weathering**, and/or **deposition**. Water, ice, gravity, and wind are agents of erosion. And wherever there is erosion, its partner, deposition, exists somewhere nearby or as far away as a distant delta. Uplifted landforms, such as mountains and plateaus, are subject to increased rates of water erosion. *What does it mean to me*? Lake Bonneville, which covered all of Utah's western valleys has left behind enormous sand and gravel deposits in its deltas and shorelines that contribute to a strong local sand and gravel industry. Shoreline benches have become prime residential areas. Landslides and rockfalls are common geologic processes in Utah's mountains and plateaus that can be affect people's lives and property. Rivers and streams continue to erode in some places, and deposit in others - features of floodplains, meanders, backswamps, deltas, backswamps, alluvial fans, etc. all interplay with society and with the ecosystem. Flooding is an annual, natural occurrence in Utah. Glaciers eroded and beautifully sculpted many of our mountains, as well as left depositional features. Weathering and erosion have created some of the most magnificent geologic features in the state in places like Arches, Bryce, Canyonlands, Capitol Reef, and Zion national parks.

(4) MAPS SHOW GEOLOGICAL FEATURES (Activities 22-25)

Geological features can be identified on a variety of maps. Focus is on shaded relief maps and topographic maps. These maps are useful in planning trips and hiking excursions and locating features. Integration with social studies is recommended - pioneer routes, settlement locations, etc.

THE BIG IDEAS - CONCEPTS TO KEEP IN MIND

On Earth, the only constant is change! Geological processes <u>within</u> the Earth (plate movements and folding, faulting, volcanic activity, earthquake activity) *and* geological processes <u>on</u> the Earth's surface (erosion, deposition) are constantly creating or changing Earth's geological features (landforms).

EARTH'S GEOLOGICAL FEATURES

Activity #1 Mountains (and Valleys)

Mountains are a major geological feature. Different geological processes create mountains.

Activity #2 Plateaus

Plateaus are a major geological feature. Elevated geological features are more subject to erosion.

Activity #3 Plains

Plains are a major geological feature.

Activity #4 Landforms on Display

Identifying and classifying geological features (landforms).

PROCESSES <u>WITHIN</u> THE EARTH CREATE AND CHANGE GEOLOGICAL FEATURES

Activity #5 Earth's Core, Mantle, and Crust - the Egg Model

The Earth is made up of three layers (crust, mantle, and core). The outer layer, the crust, is broken into pieces called plates.

Activity #6 Moving Plates

Plates touch each other and move in different directions. The movements of plates alter the landscape (build mountains, for example) and cause volcanic eruptions and earthquakes. The majority of earthquakes are at plate boundaries, but they can also occur in the middle of plates (in Utah, for example).

Activity #7 Fault Movement causes Earthquakes and creates Mountains and Valleys

The geological processes of faulting (earth's blocks breaking and slipping) causes earthquakes.
Faulting changes geological features, such as displacing streams or raising mountains.
Faulting in Utah causes mountains to rise and valleys to drop.
Faulting occurs in a slipping motion (not opening up and swallowing people).

Activity #8 Earthquakes cause Ground Shaking

An earthquake is ground shaking caused by waves of energy released when rock in the Earth breaks and moves (faulting).
Observing earthquake effects on the Earth's surface and on built structures.

Activity #9 Shaking Sand and Water causes Liquefaction

Earthquakes affect geological features. The process of earthquake ground shaking can cause liquefaction, which alters the landscape.

Activity #10 Earthquake Safety in Utah (recognizing and earthquake)

In an earthquake the ground moves in all directions making it hard to stand up. There may be a roaring sound. An earthquake lasts seconds to minutes - not hours or days!

Activity #11 Earthquakes: What About Me?

Student safety during an earthquake can be improved by taking certain actions before and during an earthquake.

Activity #12 Volcanoes come in different Sizes and Shapes

Volcanoes have different shapes and sizes (due to different types of eruptions).

Activity #13 Volcanoes Erupt in different ways

Observing two different kinds of volcanic eruptions.

PROCESSES <u>ON</u> THE EARTH'S SURFACE CREATE AND CHANGE GEOLOGICAL FEATURES

Activity #14 Water Changes the Earth's Surface

Experiencing the processes of erosion and deposition. Water takes earth material from one place and moves it to another.

Activity #15 How does Water Deposit materials

Experiencing the process of deposition. Moving water carries sediment, and when the movement stops, the sediment drops. Heaviest particles drop first, and layers form.

Activity #16 Weathering Changes the Earth's Surface

Observing the processes of weathering, which aids in wearing down our landscapes, through frost action and plant growth.

Activity #17 Wind Changes the Earth's Surface

Observing the processes of wind transportation of sand and dust.

Activity #18 Surface Processes in Your Yard

Observing the geological processes of erosion, deposition, and weathering on a small scale. Relate the processes to a larger scale (the surrounding environment).

Activity #19 Erosion in Big Steps - Landslides and Rockfalls
Observing fast geological processes of landslides and rockfalls.

Activity #20 How does a Glacier Form?
Glaciers are formed by accumulation and compaction of snow into ice.

Activity#21 Glaciers Change the Earth's Surface
Glaciers erode and deposit, which alters the landscape.

MAPS SHOW GEOLOGICAL FEATURES

Activity #22 United States Shaded Relief Map - what do you see?
Using a shaded relief map to identify various geological features.

Activity #23 Contouring a Landform
Making a topographic map from a model of a landform. Understanding how contour lines are used on maps to show topography.

Activity #24 Finding Geological Features on a Topographic Map
Identifying geological features on a topographic map.

Activity #25 Utah Shaded Relief Map and Corresponding Contours
Visualizing/identifying geological features in Utah on a shaded relief map and on a topographic map.

ASSESSMENT FUN

Activity #26 Assessment Fun - Geological Features Bingo Game
Recognizing names and pictures of geological features.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
02	Identify processes that form geological features.
ILO's	1. Make observations and predictions. 5. Understand science principals. 6. Construct models.

Activity #1

MOUNTAINS
(and Valleys)

Background:

Mountains are landforms which rise above the surrounding area. Most have wide bases, steep slopes, and narrow peaks or ridges. Mountains are formed in several ways and can be classified as different types of mountains: **fold**, **fault block**, **dome**, and **volcanic**. Valleys, and sometimes canyons, are often within or adjacent to mountain ranges.

The Big Idea:

Mountains are a major geological feature.
Different geological processes create mountains.

Vocabulary:

- mountains
- fold mountains
- fault block mountains
- volcanic mountains
- dome mountains
- valleys
- canyons

Fold mountains are caused by compressional movement of the Earth's crust. They are formed when the force of plate movement causes buckling and wrinkling at the earth's surface.

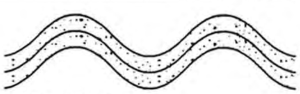
Fault block mountains are the result of a giant block of the Earth's crust being forced upwards along a fault. A fault is a break in the earth's crust.

Volcanic mountains form as hot molten rock material rises and then erupts or flows onto the Earth's surface. Lava, cinder, ash, and rock particles continually build upon each other.

Dome mountains are formed from rising hot molten material that pushes the overlying rock layers upward to form a dome. Unlike a volcano, the molten rock never reaches the Earth's surface.

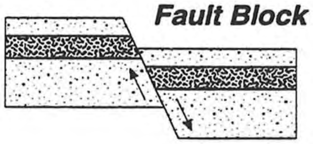
Valleys are low-lying land bounded by hills or mountain ranges. They are often occupied by a stream.

Canyons are steep-walled valleys; the sides are rock cliffs.

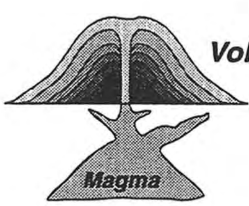


Folded

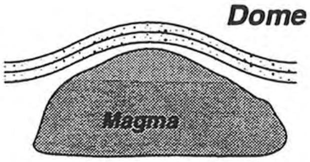
Fault Block



Volcanic



Dome



Materials:
For the Teacher:

· Fault block materials from Activity #7 or a piece of styrofoam @ 15cm wide X 5cm thick (packing material from TVs, radios or computers work well).
· Drop cloth.

For the Student:

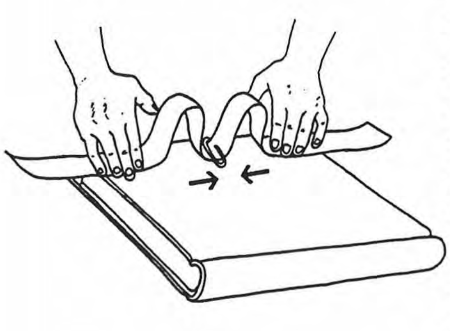
· 1 strip of paper @ 7cm X 28cm.
· 1 paper clip.
· 1 piece of light-weight paper (such as ditto paper).
· Tube of toothpaste *or* can of foam shaving cream.
· Dried grass.
· 2 large index cards (or pieces of cardboard).
· 1 container of white frosting *or* Plaster of Paris.
· 4 different food coloring colors.
· 1 ziplock bag *or* a frosting bag.

Procedures:

1. Look out your window or go out on the playground to observe the view. Begin questioning. What do you see? Have students identify mountains, valleys, etc. Encourage them to think about the definitions. Why is it a mountain? Speculate how they got there. Why do we see differences? Why isn't the land continuously flat? Why do you suppose that the ground in some spots is higher than others? What could have caused that? Brainstorm with the students how mountains got there.

2. When you go back to the classroom, give each student a piece of paper. Let them use any technique they can to create a mountain out of the sheet of paper (compressing, wrinkling, etc.). Let them know that land surfaces would be relatively flat unless mountain building is going on. When they have mountains built, let them share the many ways their mountains were built. How would the earth build mountains the same way?

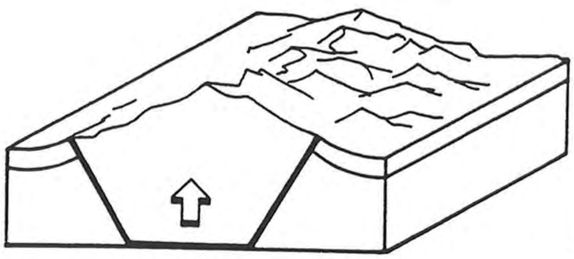
Explore how mountains are shaped:



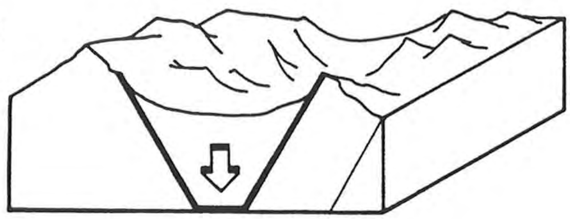
Tremor Troop, p. 74

3. Fold mountains. Pass out a strip of paper about 7 cm wide from a standard sheet of paper to each student. Place it on top of a hardcover book, along the front edge. Hold it in place at the center with a paper clip. Slowly push the paper from both sides toward the center. Notice the hills and valleys that form as it folds. How could the earth make the same kind of movement? Take your sleeve and slowly push it up your arm to get the same wrinkling effect. Lead students to discovery of valleys between the mountains. Could the earth ever move this way? *Yes*. (Classic folded mountains are the Appalachian Mountains, see Activity #23. Some folded mountains in Utah include the Wasatch Range, which is also faulted. Many mountains are a combination of types).

4. **Fault block** mountains. Use either the fault block models from Activity #7 or take a piece of Styrofoam at least 15cm wide and long and 5cm thick. With the styrofoam, cut a wedge-shaped section out of the middle of the block, lift it out and then replace it in its original position. Hold the sides of the block in two hands and pull them slightly apart, allowing the inner wedge to drop (this shows two faults, two bordering mountains, and a valley in between). Could the earth move this same way? How? *Yes, the earth's crust can stretch. If it's pushing together in one place, it will stretch apart in another place.* (Faulted mountains in Utah include the Wasatch Range, and most of the mountain ranges to the west of the Wasatch).



Uplifting (or upwarping) may be caused by convergence.



Downdropping may be caused by convergence or divergence.

Tremor Troop, p. 68 and 82

5. **Dome** mountains. Give each student an index card and let them use their pencil to punch a hole in it. Cover the surface with dried grass to represent rock layers. Let the students place the tube of toothpaste (or can of shaving cream) under the hole and slowly squeeze until the grass pushes up into a small dome over the squeezed toothpaste (alternate method - take the cap off the tube of toothpaste, drill a hole in the cap, place the index card hole over the neck of the toothpaste tube, and place the cap back on so the card is sealed under the cap to the tube). What does the toothpaste represent? *Magma.* What could happen inside the earth that would create the same effect? *Hot molten rock (magma) can squeeze and move like the toothpaste*. Dome mountains are volcanic-type mountains where the lava flow does not break through the earth's crust. (Dome mountains in Utah include Navajo Mountain, and the La Sal, Abajo, and Henry mountains. Navajo Mountain is the most classic dome mountain, because on the other three mountains, the overlying rock layers have eroded off).

6. Volcanic mountains.* (This can be messy, so place a covering on a table or the floor. The frosting bags may be easier to use). Students in groups of two. Punch a small hole on an index card. Divide the frosting (or use Plaster of Paris, mixing it so the mixture sticks to the craft stick, but is somewhat fluid) into 4 bowls and color each a different color. Cut a corner of the ziplock bag to make a small hole. Put each frosting into a baggie. Place the baggie under the hole in the card. Squeeze slowly and let the frosting move up through the hole onto the card. Choose a second color and repeat (if using Plaster of Paris, let the first "eruption" harden a little before the second "eruption"). Use all four colors, letting them build up on each other. How does lava flow out of the Earth the same way? How does it build up over time? *Lava hardens after it cools on the surface. Then the volcano can erupt again and again, and other layers build up on the lower layers.* (Some volcanic mountains in Utah include several in the Tushar Mountains, Pavant Butte, and Black Rock Volcano). Note the different consistencies of the Plaster of Paris will result in different "lava flows" and different looking "volcanoes." For example, thin, watery plaster will result in a shield volcano, which is made out of flowing basalt-type lava. Connect the type of lava with the resulting type of volcano.

* Warning. Brought to our attention is a popular item used in some schools - "Sensational Erupting Volcano Construction Kit." Use of this kit puts minuscule particles in the air that are dangerous to breathe - therefore the kit has been declared unsafe for school use by the State Office of Risk Management.

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OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
02	Identify processes that form geological features.
ILO's	1. Make observations, identify and use categories. 2. Describe relationships. 6. Construct models.

Activity #2

PLATEAUS

Background:
A **plateau** is a large, relatively flat tableland area (made of horizontal rock layers) that stands above the surrounding land. Plateaus cover about one third of the Earth's land surface. They are formed as a result of the broad upwarp of the Earth's crust. Although plateaus usually have some boundaries of steep slopes, they are sometimes difficult to actually see. More evident are the **mesas, buttes,** and **canyons** that form in plateaus as a result of the erosion processes happening. (Some plateaus in Utah include the Wasatch, Sevier, and Colorado plateaus).

The Big Idea:
Plateaus are a major geological feature.
Elevated geological features are more subject to the processes of erosion.

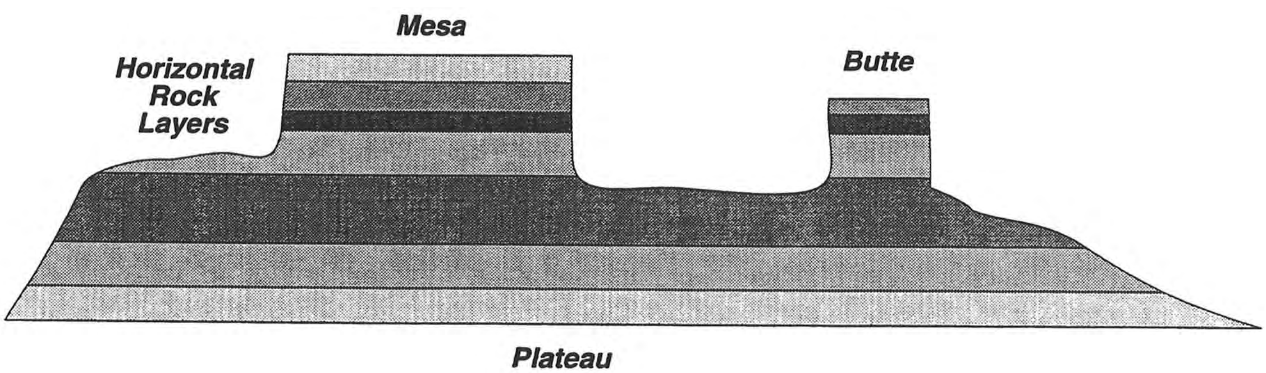
Vocabulary:

- plateau
- mesa
- butte
- canyon

Mesa A flat tableland higher than the surrounding land, with at least one side being a steep cliff. It is smaller than a plateau. Mesas are wider than they are high.

Butte An isolated flat tableland higher than the surrounding land with steep cliff sides. It is smaller than a mesa. Buttes are as high as they are wide.

Canyon A steep-walled valley, the sides are rock cliffs.



Materials:
For the Teacher:
· Master of the Colorado Plateau outline.

For the Student:
· Clay (four different colors).*
· Colorado Plateau outline.
· Craft stick.

Procedure:

1. Place clay in colored layers on the Colorado Plateau outline. Shape into a plateau.

2. With the craft stick, create mesas, buttes, and canyons in the plateau. Mesas, buttes, and canyons are erosional features, so to create them, the students will need to "erode" into the plateau. In other words, a plateau is formed through deposition of many layers of rock. Then it erodes from the top on down, into mesas, buttes, etc.

3. Have the students describe each landform as they are shaping it. Explain what they are, how they are different and how they are similar.

4. How do you suppose the areas on the Earth's surface that look like this are made? (*water erodes the raised rock layers).*

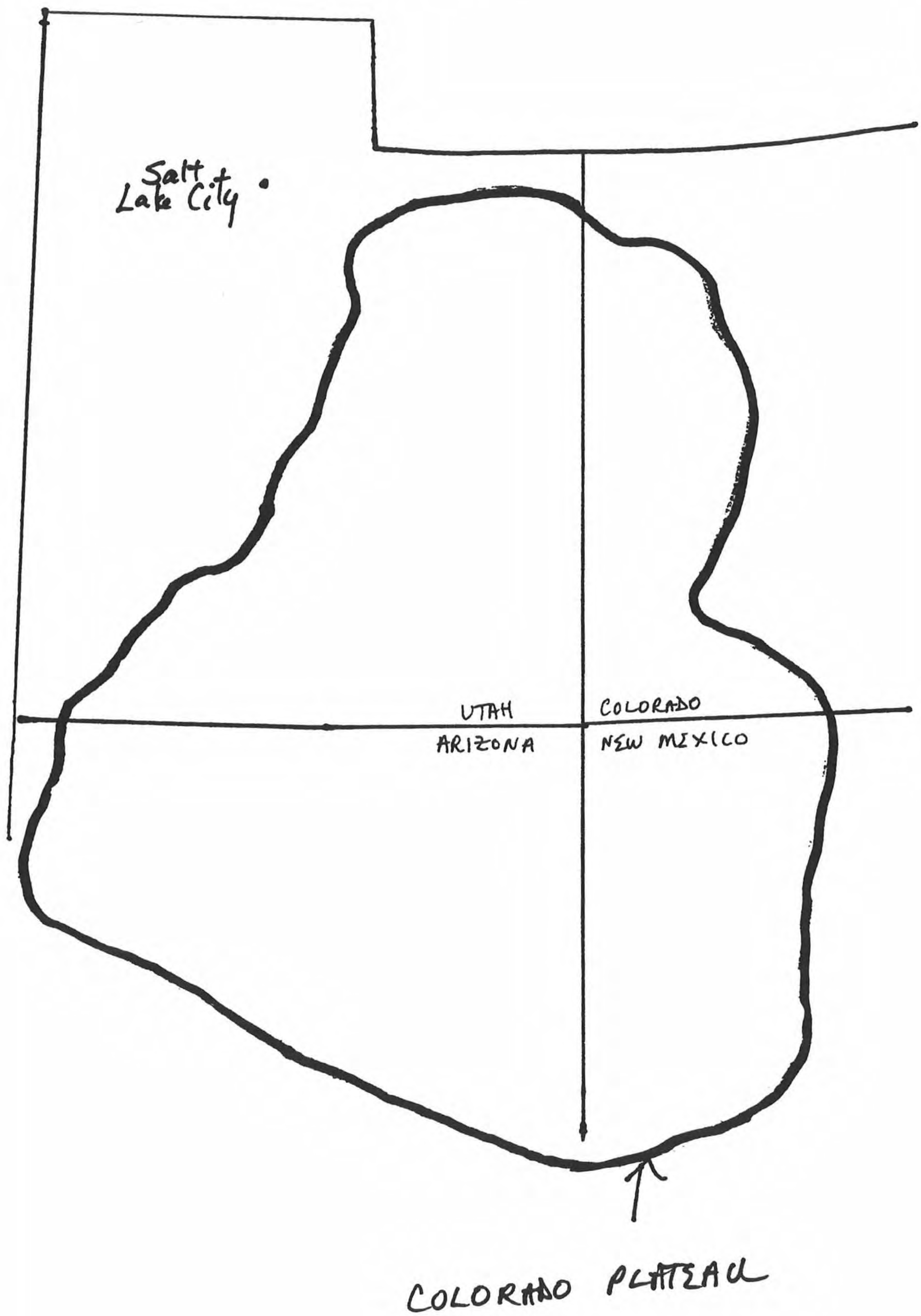
Extension:

<u>Compare and contrast mountains and plateaus</u>.
Ask students what do mountains and plateaus have in common. *Both have high elevations and are uplifted. Both are subject to erosion.* Use four different colors of clay to build a plateau and a folded or faulted mountain. Each color represents a rock layer. Although both mountains and plateaus are built by uplifting forces, the plateaus are formed by a broad, gentle lifting. The rock layers of the plateaus remain horizontal, whereas the rocks layers of the mountains are folded and faulted. Illustrate the differences by lifting the plateau up horizontally on a book, and pushing in on the mountain model to illustrate a folded mountain.

<u>Toothpick labels</u>.
Label mesa, butte, etc. with paper on toothpicks and stick into the appropriate place on the plateau.

* Salt dough can be used instead of clay. Add food coloring.
Recipe: 2 cups flour, 1 cup salt, 1 T. alum, 1 T. cooking oil, 1 cup water. Mix dry ingredients together, then add water and stir. Knead slightly. Store in air tight-bags.
Thick layers work best for this activity.

COLORADO PLATEAU
Activity #2



STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
ILO's	1. Identify and use categories. 6. Construct models.

Activity #3

PLAINS

Background:
A **plain** is a large area of flat land, often at a lower elevation than surrounding areas. It is often covered with grasses. Plains cover about 55% of the earth, with more than half the world's population living on them. Some plains are formed by the natural processes of weathering and erosion, which wear away landforms such as plateaus, mountains, and valleys.

The Big Idea:
Plains are a major geological feature.

Vocabulary:

- plain

Materials:
For the Student:

- 1 box or box lid per student.
- Collection of weeds, pine needles, grasses etc.
- Clay.

Procedure:

1. Let students build a model of a plain on the bottom or inside of a box (the boxes that canned pop come in are great). Have students collect grasses, pine needles, weeds, etc. to be used on the display. The box may be painted, small rolling hills added, a river or pond painted in, and the grasses added (they can be held in place with small pieces of clay).

2. Begin questions as the students are building their examples. Where in the United States might you see this landform? *The middle of the continent - Great Plains, and south and southeastern coastal areas - coastal plains.* Why would the Earth have large areas of flat land? *Plains are usually originally formed by relatively level/flat deposition of sediments, which are now being slowly eroded, and the areas have not been uplifted very much - at least not as much as plateaus are uplifted.*

3. When the students have completed their projects, compare what is alike and what is different about them. Would the plains on the Earth's surface be alike or different? Why? *Coastal plains and interior plains are different, several reasons are location and climate.*

4. How is a plain like a plateau? *They are both relatively flat.* How is it different? *A plain is lower elevation than a plateau.*

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
ILO's	1. Develop and use categories to classify observations. Use reference sources to obtain information.

Activity #4

LANDFORMS ON DISPLAY

Background:
With a general explanation of the three major landforms (mountains, plains, plateaus), students can start to identify pictures of such features all over the world. They may also discover numerous other geological features, such as mesas, buttes, islands, canyons, etc. This activity can be used as an introduction, ongoing, or culminating activity. Depending on its use, the students will need a knowledge of what the landforms are.

The Big Idea:
Identifying and classifying geological features (landforms).

Materials:
For the Teacher:
- 1-3 sheets of poster board.
- Magazines (*National Geographic* is especially useful).

For the Student:
- Scissors.
- Glue.

Procedure:
1. Let each student explore a magazine and discover pictures that they feel are of the major landforms. Let them cut out the pictures and glue them onto a sheet of poster board to make a class collage. Laminate and display throughout the course of study.

Extensions:
Each student could make a mini-mural (about 18" X 36"). Sketch out a landscape with at least 5 different landforms. Complete the picture with magazine cutouts (like a collage) or colored paper. Or...it may be water colored or glued with colored art tissue to create an attractive scene. A small amount of sand may be glued on for the foreground. Have students label their landforms.

Legends. Explore various legends that are developed to explain geological features and geological processes. For example, Native Americans have explanations about certain features and processes, as do other cultures.
Ask students to create their own stories about the formation of landforms.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	5. Know basic science facts.

Activity #5 **EARTH'S CORE, MANTLE, and CRUST - THE EGG MODEL**

(modified from: *Tremor Troop*, p. 41-43)

Background:

The Earth is separated into three main layers according to density: crust, mantle, and core. The outer layer (crust) is broken into pieces called **plates**. (Teachers Note* In 5th grade, students will learn that plates are actually part of the lithosphere, which comprises of the crust and the upper part of the mantle. For now, "crust" will suffice). The movement of the plates creates much of the Earth's landscape. Plate movement builds mountains, causes earthquakes and volcanic eruptions.

The Big Idea:

Earth is made up of three layers (crust, mantle, and core).
The outer layer, the crust, is broken into plates.

Vocabulary:

- core
- mantle
- crust
- plate

Core The center of the Earth and is the hottest part of the Earth (2000+ miles thick).

Mantle The middle layer; part of it is semisolid, or something like silly putty (1,700+ miles thick).

Crust The top layer of the Earth; a hard and very thin layer compared to the other layers (average 25 miles thick).

Plate A huge moving piece of the Earth's crust.

Materials:

For the Teacher:

- Transparency made from Master 15, Earth Layers, *Tremor Troop*.
- Overhead projector.
- Hard-boiled egg with the Earth's plates outlined in permanent marker.
- Kitchen knife.

For the Student (individual):

- Worksheet, Master 15, Earth Layers, *Tremor Troop*.
- Crayons (blue, red, yellow and brown).

Procedure:

1. Show the transparency on the overhead projector. Cover up the words at the bottom, and ask students to name the different layers of the Earth (may be able to give them hints, such as the "core" of an apple, the "crust" of bread, etc.) Ask them what they think the Earth is like below the surface. Accept various opinions. Then clearly point out and describe each layer.

2. Show students the egg and point out the marks that indicate the plates. Explain that the Earth's top layer is broken into pieces called plates. The plates are always moving, but usually very slowly - about as fast as your fingernails grow. Sometimes, when the plates move away from each other, bump into each other, or grind past each other, we experience earthquakes. We may feel shaking or hear rumbling.

3. With a sharp knife, slice the egg, shell and all, and show students the layers inside. Explain that the crust is something like the shell, the white is something like the mantle, and yolk is something like the core.

4. Have students color their worksheets.

Option:

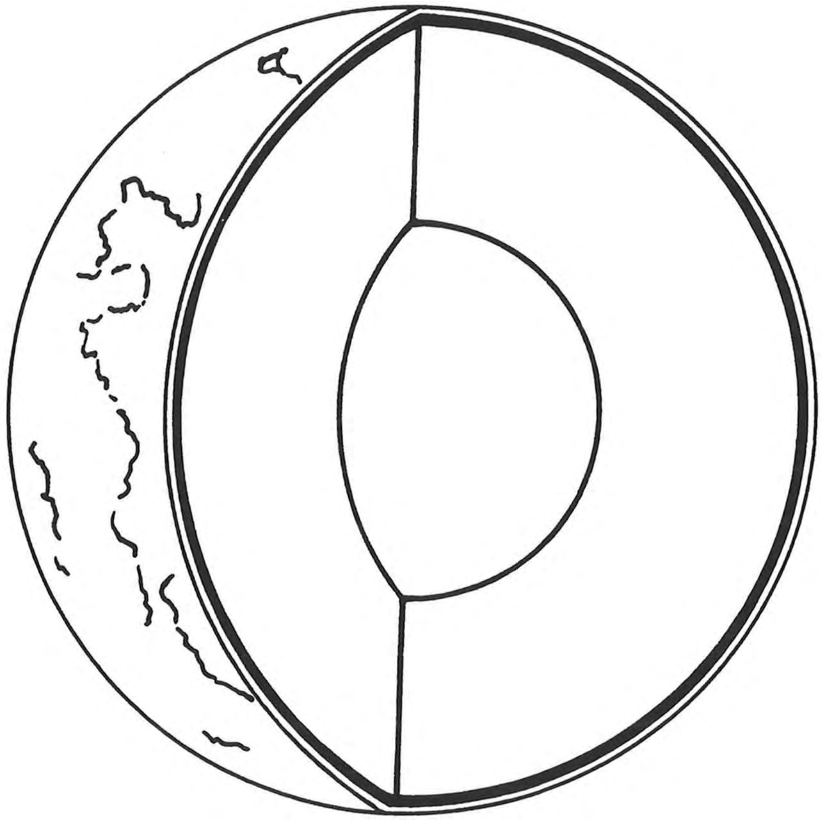
Each group/pair of students has their own egg.

Extension:

Assign students to bring home playdough recipes and make either red, yellow, or blue playdough (recipe in Activity #2, page 10). Collect the results, form into balls, and place in baggies in a refrigerator (you will need more yellow than the other colors). After the egg exercise (the egg will give an excellent frame of reference for making the crust very thin, etc.), students work in pairs to build a model of the Earth with the red core, yellow mantle, and blue crust. Use dental floss to cut the Earth in two parts and send the halves home with the students.

Earth Layers Worksheet

Name ______________________________



1. Color the core red.
2. Color the mantle yellow.
3. Color the crust blue.
4. Put a brown line around the very hot layer.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predict. 5. Understand science concepts.

Activity #6

MOVING PLATES

Background:
The Earth's crust is broken into large pieces called **plates.** The movement of the plates creates much of the Earth's landscape. Plate movement builds mountains, creates valleys, causes earthquakes and volcanic eruptions. The plates are always moving, but usually very slowly - about as fast as your fingernails grow. Sometimes, when the plates move away from each other, bump into each other, or grind past each other, we experience earthquakes. We may feel shaking or hear rumbling.

The Big Idea:
The movements of plates alter the landscape (geological features) of the Earth and cause earthquakes.
The majority of earthquakes are at plate boundaries, but they can also occur in the middle of plates (in Utah, for example).

Vocabulary:

- earthquake
- plate

Earthquake The sudden shaking of the Earth caused by the release of energy stored in rocks.

Plate A huge moving piece of the Earth's crust.

Materials:
For the Teacher:
- Transparency made from Master 19, Plate Boundaries Map, *Tremor Troop.*
- Overhead projector.

Procedures:

1. Show the transparency of the Earth's plates to the students. Discuss how they move in different directions from the plate beside it. Point out that the plates are not of the same shape or size.

2. Have three students come up to the front and stand side by side. Have them touch each others' arms (the "outside" arms of the outside students will not be touching anyone else), and instruct them to keep their arms rigid. They represent three plates. Instruct the outer two students to move inward toward the middle person. Observe and ask questions: What happened? *The middle person's arms and the inside arms of the other two students were pushed together.* What would be the effects of real plates meeting like this? *Colliding causes* *compression stresses in the Earth's crust.* Have the two outer students move apart from middle person, but keeping their arms touching. They may stretch their arms out to a horizontal position. What happened? *The middle person's arms and the other two students inside arms were being pulled apart.* What happens when plates move like this? *Pulling apart causes extension stresses in the Earth's crust.*

3. Have four or more students come up to the front. Have each put their arms in any position they want. Each student now represents a plate. The plates (students arms) must all be touching. Have the students slowly move in different directions, always maintaining contact. What happens? (You may need to give each "plate" specific directions - for example, one moves left, one moves right, one slowly turns around, and so on). What are the students' observations? *They should experience bumping, rubbing, crowding (compression), stretching (extension).*

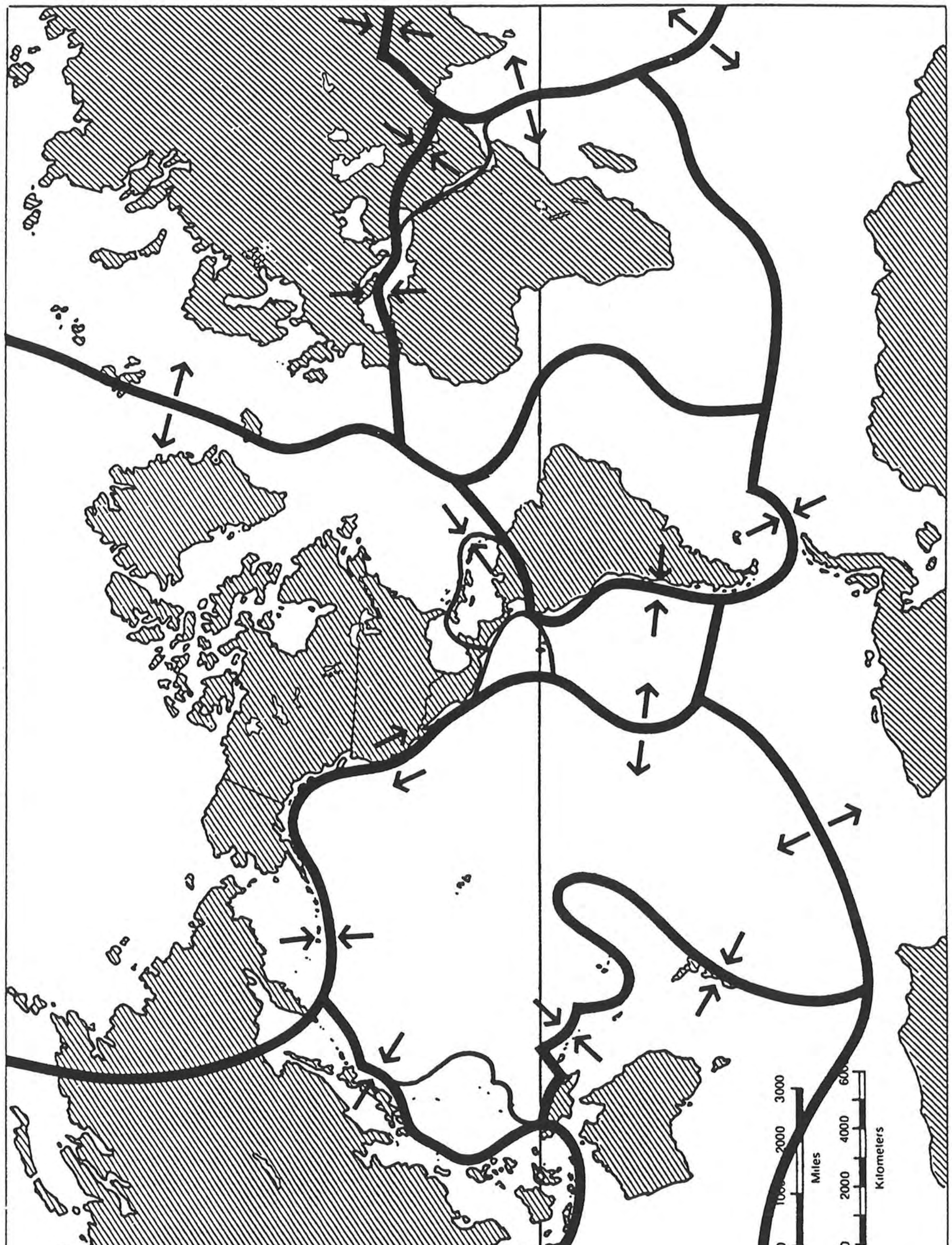
4. Ask the students how this relates to Earth's plates? *When the plates move away from each other, bump into each other, or move (grind) past each other, the movements stress the Earth's crust. In some cases we can experience earthquakes, in which we may feel the ground shaking or hear rumbling.*

5. Relate plate movement to **Utah**. Ask the students where they mostly felt, or observed, "plate" interactions. They will probably say their arms. Lead them into discovery that their insides may have felt squashed or stretched. Experience this again. Have three students in a line touching arms. Have each outside student move away - yet stay in touch with the middle person. What does the middle student observe? *Their whole body will feel stretched.* Do the same thing with compression. Have each outside student move inward. What do you observe? *The inside person feels squashed - the student's shirt may even wrinkle -fold- as he/she is compressed.* Some students may know that Utah is not on a plate boundary. Yet why are there earthquakes in Utah? Why are there fault block mountains in Utah? Why are there folded mountains in Utah? *Partly for the reason the students just discovered - that stresses of plate movements can be felt on the interior of plates as well as at the plate boundaries.*

6. Follow up by showing the overhead of the plates. Review the ways in which plates move in different directions from the plate beside it. Locate Utah on the map and point out that Utah is not on a plate boundary. Yet, enforce the idea that Utah experiences earthquakes due to the results discovered in procedure 5.

Plate Boundaries Map

Name ______________________



STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predict. 2. Maintain an open and questioning mind. 5. Know basic science terminology and facts. Explain science concepts and principals in own words. 6. Construct models.

Activity #7

FAULT MOVEMENT CAUSES EARTHQUAKES and CREATES MOUNTAINS AND VALLEYS

Background:
Earthquakes occur where strain builds up in the crust and is suddenly released as two blocks of Earth slip by each other. This process is common at plate boundaries and is also found in the interior of plates where strain occurs. There are several types of faults; they are classified according to the direction of movement along them. Two types are illustrated with the blocks in this activity, and can be compared to fault movement in Utah and California. Movement along faults in Utah is up and down (**vertical**), as opposed to the side by side (**horizontal**) movement in California. Therefore, in Utah, repeated earthquakes along faults have created mountains (fault block mountains). When there is movement along a fault in Utah, the mountains (mountain block) move up fractions of an inch or inches, and at the same time the valley (valley block) drops a little. Whether in Utah or California, anything that's built on the fault line could be displaced or damaged. Natural features, such as streams, can be altered.

The Big Idea:
The process of Earth's blocks breaking and slipping causes earthquakes.
Faulting affects geological features, such as displacing streams.
Faulting in Utah causes mountains to rise relative to the valleys dropping.
The geological process of faulting occurs in a slipping motion (not opening up and swallowing people).

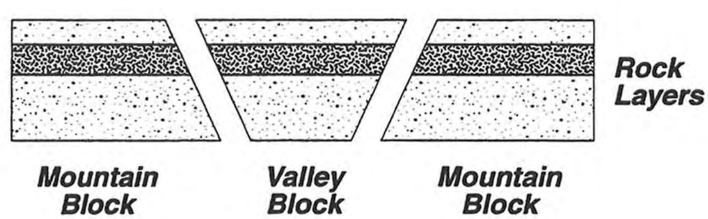
Vocabulary:

- fault
- fault scarp
- fault block mountains

Fault A break in the Earth's crust along which earthquake movement has taken place.

Fault scarp A steep change in slope (like a short cliff) caused by vertical fault movement from an earthquake.

Materials:
For the Teacher:
· Three assembled fault blocks (2 mountain blocks, 1 valley block) made out of cardstock or stiffer paper.



For the Student (individual):

- Three handouts of the fault blocks (2 mountain blocks, 1 valley block) on regular or cardstock paper.
- Scissors.
- Scotch tape.

Procedure:

1. Teacher: assemble your fault blocks before class. You may want to make your fault models larger than the students' models, by enlarging the copies provided on a photocopy machine. You also may want to color yours, i.e. blue stream, green tops on the sides of the stream, and browns or grays for the rock layers. Assemble each block and fasten with tape. The blocks may be laminated to help preserve them.

2. Ask students what happens to the ground during an earthquake (various answers are possible - the ground shakes, settles, cracks; landslides or rockfalls can happen; and in a large earthquake, which in Utah would be about magnitude 6.5 to 7.5, a fault scarp could form).

3. Write the definition of a fault on the board.

4. Before you illustrate the two main types of fault movement, display the three blocks as a flat surface. Explain that without plate movements, earthquakes wouldn't happen, and the land would remain fairly flat without many changes. Show where the fault lines are, both under the ground and on the ground surface. Explain that the three colored (if you colored them) or shaded layers represent rock layers underneath the ground surface. Ask students how many different ways the blocks can move while still touching each other (various answers are possible - look for the main two of vertical and horizontal movement).

5. Illustrate the two main fault movements.
Horizonal: With two blocks, show the horizontal movement and how it affects the surface (the stream is displaced sideways). Ask students where this might happen. *California*. Vertical: Using all three blocks, with the valley block in the middle, illustrate vertical fault movement by pulling the blocks slightly apart. The middle valley block will drop slightly in between the two bordering mountain blocks. Ask students where this might happen. *Utah*. This type of fault movement explains the sequence of mountain-valley-mountain topography between the Wasatch Range in Utah and the Sierra Nevada Range in California. This faulting has been happening for about 15 million years.

Fault Scarp: In a large earthquake, a fault scarp may form on the ground surface. The scarp can range in height from fractions of inches to almost 20 feet.

6. Manipulate the blocks to illustrate the slipping movement along the fault plane. Ask questions: What do you observe? Do the blocks open along the fault? Slide? (Note that the movement is a sliding motion along the fault plane, and that the fault doesn't "open up and swallow people").

7. Instruct the students how to make their fault block models.

8. Have students pair up and describe the process of faulting manipulating the blocks.

9. Ask the students what they did to create mountains rising and valley dropping. *Stretching or pulling apart*. This stretching of the Earth's crust has been happening in Utah for at least 15 million years. This stretching and dropping of the valley floor can also be illustrated by having two students stand up and place a clipboard between them, parallel to the floor, at shoulder height. Each student represents a mountain range, and the clipboard represents the valley floor. What happens when the students move slightly apart. *The clipboard drops, like the valley floor.*

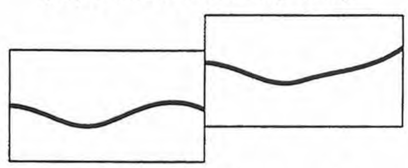
Extension

If possible, take the students outside to look at their surroundings. If you are along the Wasatch Range or west, you can probably see one or several fault block mountains (ranges) and a valley (such as the Salt Lake Valley, Tooele Valley, etc.) that represents the valley fault block in between the mountain ranges.

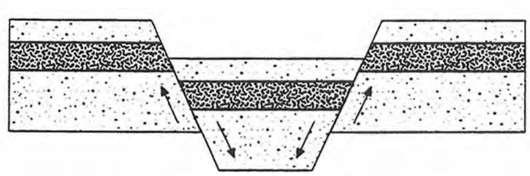
Where is your school in relation to the nearest fault? *Many schools along the Wasatch Front, as well as those tracing along Interstate 15 through Nephi, Cedar City, and St. George are in a valley, which is often the valley block in their models.*

As a little assignment have them take the blocks home and explain it to their parents.

(Top View: stream is displaced)



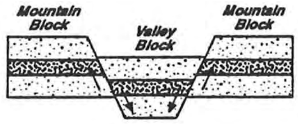
Horizontal Movement



Vertical Movement

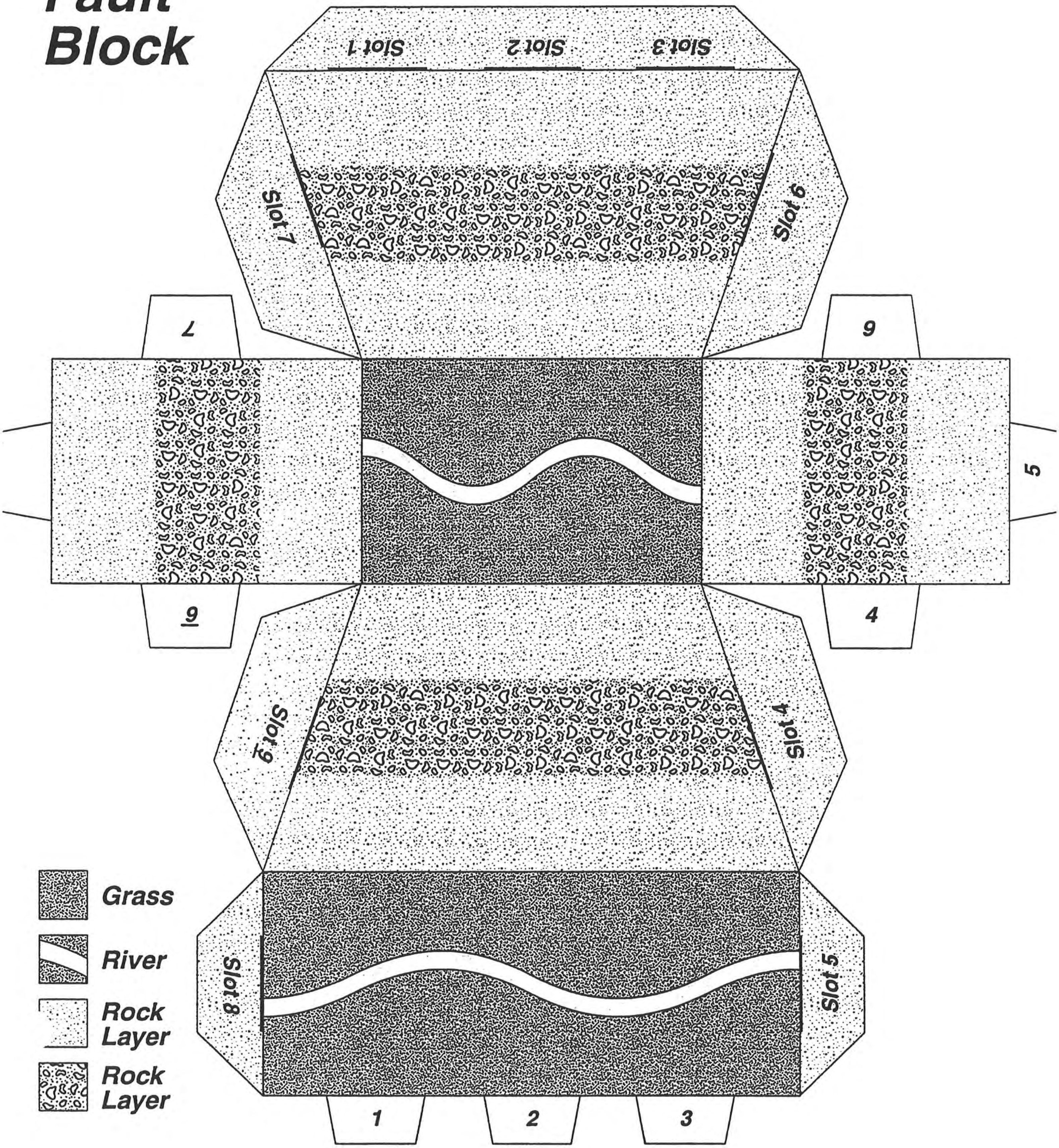
Activity #7

Valley Fault Block



Instructions:

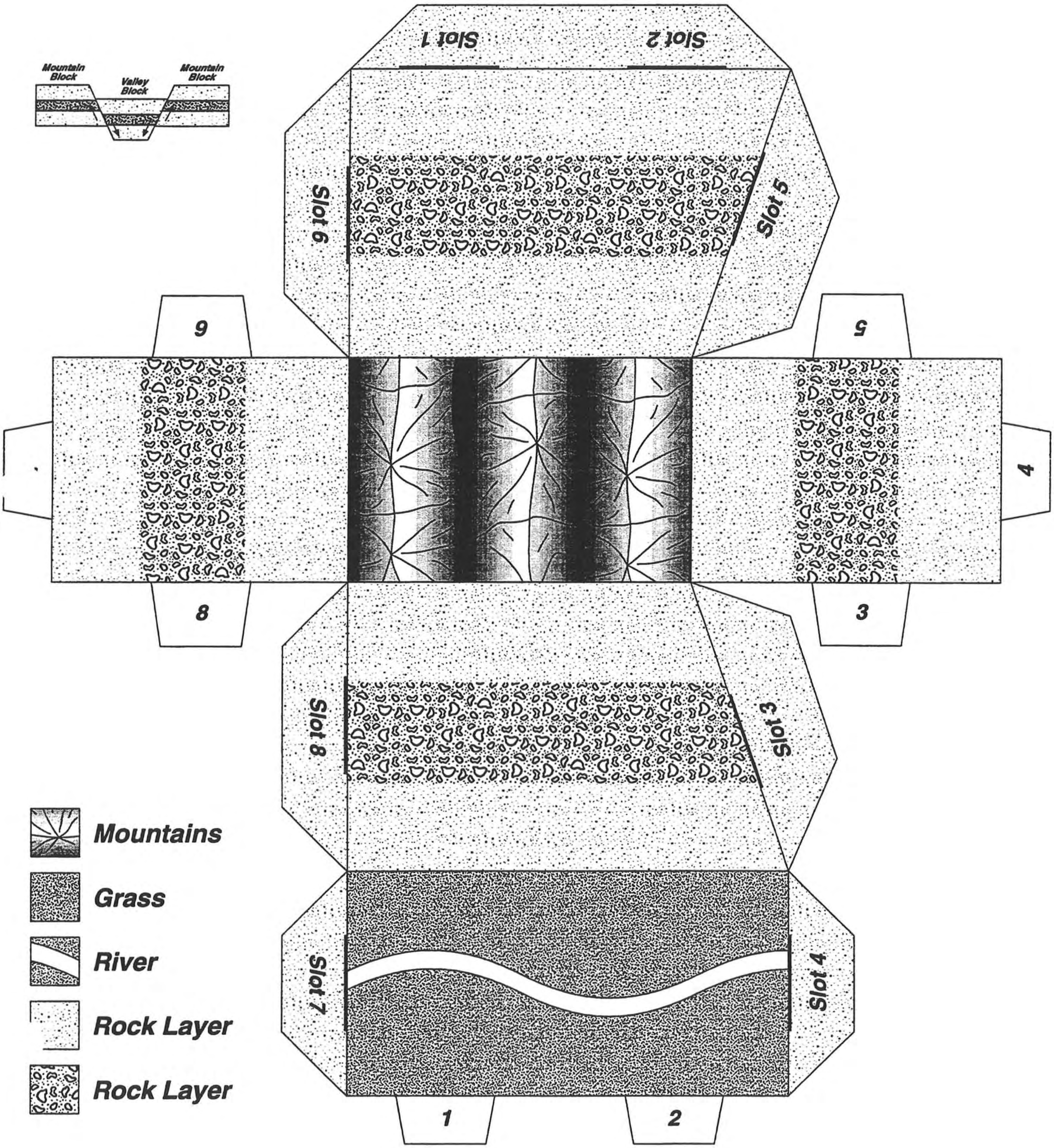
1. Cut out object along the perimeter.
2. Cut thin slits along thick lines of numbered slots.
3. Fold and crease along all solid lines.
4. Color the cutout.
5. Assemble. Slide numbered tabs into respective slots.
6. Tape the block along assembled edges.



Mountain Fault Block

Instructions:

1. Cut out object along the perimeter.
2. Cut thin slits along thick lines of numbered slots.
3. Fold and crease along all solid lines.
4. Color the cutout.
5. Assemble. Slide numbered tabs into respective slots.
6. Tape the block along assembled edges.



STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predictions. 5. Understand science principals. 6. Construct models.

Activity #8 **EARTHQUAKES CAUSE GROUND SHAKING**

(modified from *Tremor Troop*, p. 25-26)

Background:
An earthquake is the sudden, rapid shaking of the Earth caused by the release of energy stored in rocks. We can feel the ground shaking. Ground shaking can cause thing in a house to fall down or fall off shelves. To discover safety measures, see Activity #12.

The Big Idea:
An earthquake is ground shaking caused by waves of energy released when rock in the Earth breaks and moves (faulting).
Observing effects on the Earth's surface and on built structures.

Materials:
For the Teacher:
- Gelatin dessert in a metal pan.

For the Students (groups):
- Materials for buildings (sugar cubes, marshmallows, dominoes)

Gelation Dessert
. Two 170-g (6-oz) boxes of red or purple gelatin dessert
. Two one-serving envelopes of unflavored gelatin
. Four cups boiling water
. Four cups cold water
. One 23 x 30 cm (9 x 12 in.) metal baking pan

Empty the gelatin dessert and the unflavored gelatin into the baking pan. Add the boiling water and stir until all the powder is dissolved, then add the cold water and stir to mix. Chill on refrigerator shelf at least three hours or until set.
* The pan must be metal and it must be full nearly to the top with the gelatin mixture.

Procedures:

1. Prepare gelatin dessert in advance and refrigerate. These ingredients will make one pan. Prepare more if you wish to have several small groups performing the demonstration simultaneously.

2. Ask the students if they know what an earthquake is and what it does. Record their ideas and suggestions on the board.

3. Write the definition of an earthquake on the board.

4. Explain that during an earthquake, the energy is released in the form of waves. Using this jello, we can simulate an earthquake. Gently tap the side of the pan of gelatin, while holding the pan firmly with the other hand. Students should be able to see the waves traveling through the gelatin. Compare the jello to the ground, the tap of your hand to fault movement (an earthquake), and the waves in the jello to earthquake waves (picture ripples that form in water when a rock is thrown in, the ripples=energy waves moving through the Earth).

5. Ask questions: Does the jello keep shaking after it's tapped? *Yes, so do earthquake waves deep traveling through the ground and cause ground shaking after the jolt caused by fault movement.*

6. Encourage the students to come up with their own questions and discover answers. For example, what will happen when you tap the pan with more force?

7. Cover the top of the gelatin with plastic wrap so it will be clean enough to eat later. Be sure the wrap touches the gelatin. Place some "buildings" (sugar cubes, etc.) on the plastic wrap. Ask the students what they think happens to buildings during an earthquake. *Buildings shake because the ground beneath them shakes.* Tap the pan again. Ask students what they observed. How is this similar to what happens to real buildings in an earthquake? How is it different? *Some buildings do fall or collapse in an earthquake; and many do not.*

8. Remove the plastic wrap and serve the jello to the students (unless you are going to do the *Extension*). While they are eating, discuss with students what may happen not only to buildings, but inside buildings during an earthquake.

Extension:

Allow students to construct different kinds of buildings and predict their resistance to the "earthquake." Then let them distribute their "buildings" over the plastic wrap. Ask them which buildings will stand longer and why. You could make a game of it, and see who can make the most resistant building.

Show pictures of buildings damaged and undamaged in earthquakes.

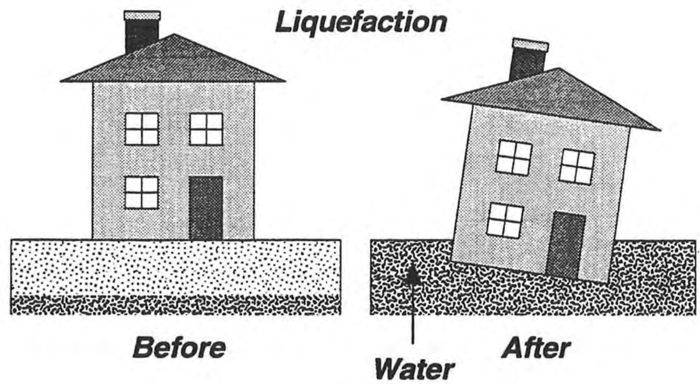
Research and discuss earthquake legends (narrative explanations of earthquakes) developed in other cultures. *Tremor Troop* contains legends.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predict. 3. Maintain an open and questioning mind. 7. Understand science terminology.

Activity #9 **SHAKING SAND AND WATER CAUSES LIQUEFACTION**

Background:

Liquefaction is a soil condition induced by ground shaking in areas of sandy soils and a high (shallow) groundwater table. When water-saturated sandy soils are shaken, they act like a viscous liquid (similar to quicksand) rather than a solid. The water pushes upward within a soil (sediment) layer. One of the effects of liquefaction is on flat ground, where the liquefied soils cannot support the weight of buildings, so buildings sink into the ground or tilt. Conversely, empty buried tanks can "float" to the surface. Another liquefaction effect on very gentle slopes (can be almost level ground) - the liquefied soil moves downslope, breaking underground pipes, roads, and buildings. This is called lateral spreading. Old lateral spreads can be seen as hummocky land out on the otherwise flat areas west of Farmington in Davis County.



The Big Idea:

Earthquakes affect geological features.

The process of earthquake ground shaking can cause liquefaction which alters the landscape.

Vocabulary:

· liquefaction

Liquefaction The process in which soil or sand suddenly loses the properties of solid material and instead behaves like a liquid.

Materials:

For the Students (pairs):

- 1 small, clear plastic tub/bowl (salsa containers, etc.)
- Sand.
- 1 Monopoly hotel or piece of wood representing a building (rectangular-shaped "high-rises" work well).
- Water.

Procedure:

1. Teachers may want to illustrate the activity before the students try it.

2. Fill the students containers halfway with sand.

3. Add water, a small amount at a time. Add enough water so that sand is completely wet, but no standing water appears at the surface when you pull outward on the edges of the tub. Observations? The students may be able to see that the water settles in the lower portion of the container (hence, the clear containers are the best).

4. Have the students place a "building" on the surface. Push them into the sand enough to anchor them against ground shaking (buildings should not be tossed around when you shake the tub).

5. With the container on a flat surface, place both hands around it. Use your thumbs and fingers to push the tub back and forth rapidly to simulate ground shaking. You may have to demonstrate this to the students before they try it. Have the students do this for as much as 30 seconds (some earthquakes do not shake this long, and some earthquakes last longer).

6. Stop and examine the results. Ask what happened or lead with questions: What happened to the water? *It rose up to the surface, it ponded around the buildings - shaking causes water to rise to the surface, especially around the foundation of buildings and the edges of the tub.* What happened to the buildings? *They tilted, they tipped over, they sank slightly.**

7. See if the students can come up with a definition for liquefaction.

Extension

Try different types of buildings (heavy, light, large, small). What effects did you observe? *If the building is heavy enough, it may settle (sink somewhat) more than lightweight structures.*

Experiment with a buried empty structure (try an empty film canister) in a larger container. Does it rise to the surface?

*Students may question if it is just the shaking of the tub that causes the building to tip. Have them experiment with dry sand (*if the building is anchored enough in the dry sand, it will not tip over from shaking*).

Maps showing where liquefaction is likely to occur are available for Salt Lake, Davis, Weber, and Utah Counties at the Utah Geological Survey (free, 1 per teacher, color, 8 x 11).

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predict. 5. Recognize the personal relevance of science in daily life.

Activity #10

EARTHQUAKE SAFETY in UTAH
Recognizing an Earthquake

Background:
Utah is "earthquake country." More than 700 earthquakes are recorded every year in Utah. About 12-13 of those are large enough to be felt by humans, and some of those are damaging. More than a dozen damaging earthquakes have occurred since the turn of the century. Some particularly notable ones (estimated magnitude 5.0 to 6.6) occurred in 1902 and 1992 in the St. George area, 1901 and 1921 in central Utah, 1934 and 1962 in northern Utah. Although Utahns have not experienced a large earthquake (magnitude 7.0 - 7.5) since settlement, geologists know that numerous large earthquakes have occurred on a number of faults in Utah. The most recent occurred approximately 400 years ago (fraction of a second in geologic time) near Nephi. The largest earthquakes expected in Utah would be about magnitude 7.5.

Earthquakes - when, where, or how big - cannot be predicted with any accuracy. But, based on the data gathered from seismograph recordings (the University of Utah Seismograph Stations network has been in place since 1962) and from geologic studies, scientists believe that there is a 20% chance of a magnitude 7.0 - 7.5 earthquake occurring in Utah in the next 50 years.

So... what do we, in Utah, do about it? We **prepare**. We learn what to expect in an earthquake and what actions to take to ensure safety. **This is the most important preparedness action**. Quickly recognizing an earthquake when it occurs allows a person to react faster in finding a safety spot. Activities that give students experience with the ground shaking under their feet, the sounds of an earthquake, and how long an earthquake lasts will begin the process of empowering them to handle a real earthquake experience.

The Big Idea:
In an earthquake the ground moves in all directions making it hard to stand up. There may be a roaring sound. An earthquake lasts seconds to minutes — not hours or days!

Materials:
For the Teacher:
- Wooden board approximately 2' x 12" x 1".
- Small rounded rock (approximately fist-sized).
- "*Earthquake Sounds Tape*" from State PTA Office.
- Watch.

Procedure:

1. Elicit student ideas about what an earthquake might **feel** like. (common answers: like trying to keep your balance while walking on a trampoline or waterbed; like the shaking you feel when a big truck passes by; like an airplane flying overhead or thunder in the distance.)

2. Rock & Board Activity: Place a rounded rock (approximately fist-sized) on the floor and a 2' long board on top of the rock. Invite your students, one at a time, to experience the "ground moving under their feet." Hold the student's hands during the entire experience. He/she should step onto the board facing you and place one foot near each end. Then push and pull the student in all directions—back & forth, side-to-side. Ask student if he/she would have a hard time standing up if you weren't holding hands. Could you run if the floor were moving like this? So what should you do when the real thing happens? *Move to the nearest safety spot, preferably under something sturdy, and hold on; if outside move into open space and sit down.* Teacher Note: This activity can be a good lead-in to a discussion about what can hurt you in an earthquake and what to do about it (see Activity #8 in *Teacher Resource Book*).. Hold the board up in the air so all can see. Move it in all directions. Ask: What would happen in this room if our floor were moving like this board? *Things would fall.*

3. What might you **hear** in an earthquake? *Often hear low rumbling noise coming from the earth; then may hear things falling, breaking, dogs barking, etc.* Play "Earthquake Sounds Tape" available from Utah State PTA Office. This tape simulates earthquake sounds - it is not a real earthquake, but is realistic. Ask students to describe what they heard. This "earthquake" lasts approximately 40 seconds — a rather long time for an earthquake.

4. **How long** does an earthquake last? Invite multiple responses. (Young students typically guess anywhere from a second to hours or even days.) Tell them that although an earthquake may seem like it is lasting forever, it really only lasts a few seconds to a few minutes. One of the longest lasting earthquakes known occurred in Alaska in 1964. It lasted 4 minutes. Most earthquakes last less than one minute — a typical earthquake might last 15 seconds. To get an ideas of how short and how long 15 seconds is, try the following activity.

5. Shaking to the Quake Activity: Tell students that they are going to put their arms in the air and shake them for 15 seconds. You will tell them when to start shaking and when to stop. While they are shaking their arms they should think about how long or short the "earthquake feels." Ask them to share their thoughts. Was it a long time? or a short time? (both; any time is long when the ground is shaking!)
ALTERNATIVE: See p. 128-129 in *Tremor Troop* for additional "how long" activity suggestions.

Extension:

Simulate an earthquake and have students quickly take their safety positions. A simulation can include the lights flickering on and off, tables/desks shaking; books dropping onto floor, etc. (get creative). Groups of students can take turns providing the earthquake effects while everyone else ducks under their desks and hold on.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	4. Recognize personal relevance of science. 5. Solve problems by applying scientific principles.

Activity #11

EARTHQUAKES: "WHAT ABOUT ME?"

(*Teacher Resource Book,* Activity #8)

Background:
Earthquakes can damage buildings and could cause injury to people in or just outside those buildings. Therefore students need to consider and discuss possible actions and consequences of being in an earthquake. Teachers can interject specific procedures for practicing earthquake drills.

The Big Idea:
Student safety during an earthquake can be improved by taking certain actions before and during an earthquake.

Materials:
For the Student (individual):
· Science journal or paper and pencil.

Procedure:

1. Ask students to look around the classroom and predict what might happen to objects in the classroom if the ground began to shake. Discuss and create a list of the objects that are most likely to be affected.

2. Have students determine the objects that would be the most important to stay away from, such as filing cabinets, tall unattached bookshelves, glass, or mirrors. Have the students determine the areas or objects that may provide the best protection in the event of an earthquake and demonstrate how they would locate themselves for safety. *Braced in a door frame, under a sturdy desk, against an inside wall away from windows, etc.*

3. Discuss safety procedures for the restroom, media center, cafeteria, gym, or hallways. Have students role play the safety procedures to take during an earthquake drill or the actual event.

4. Conduct at least one earthquake drill. Stress the importance of protecting your head in the event of an earthquake. Remind students that many objects are likely to be displaced in the shaking of an earthquake.

5. Brainstorm ways to make the room more safe before an earthquake happens. *Move heavy objects from high places to lower areas, eliminate tall objects (such as bookcases) or anchor them to a wall, place plastic film on windows to prevent broken glass from flying, use plastic*

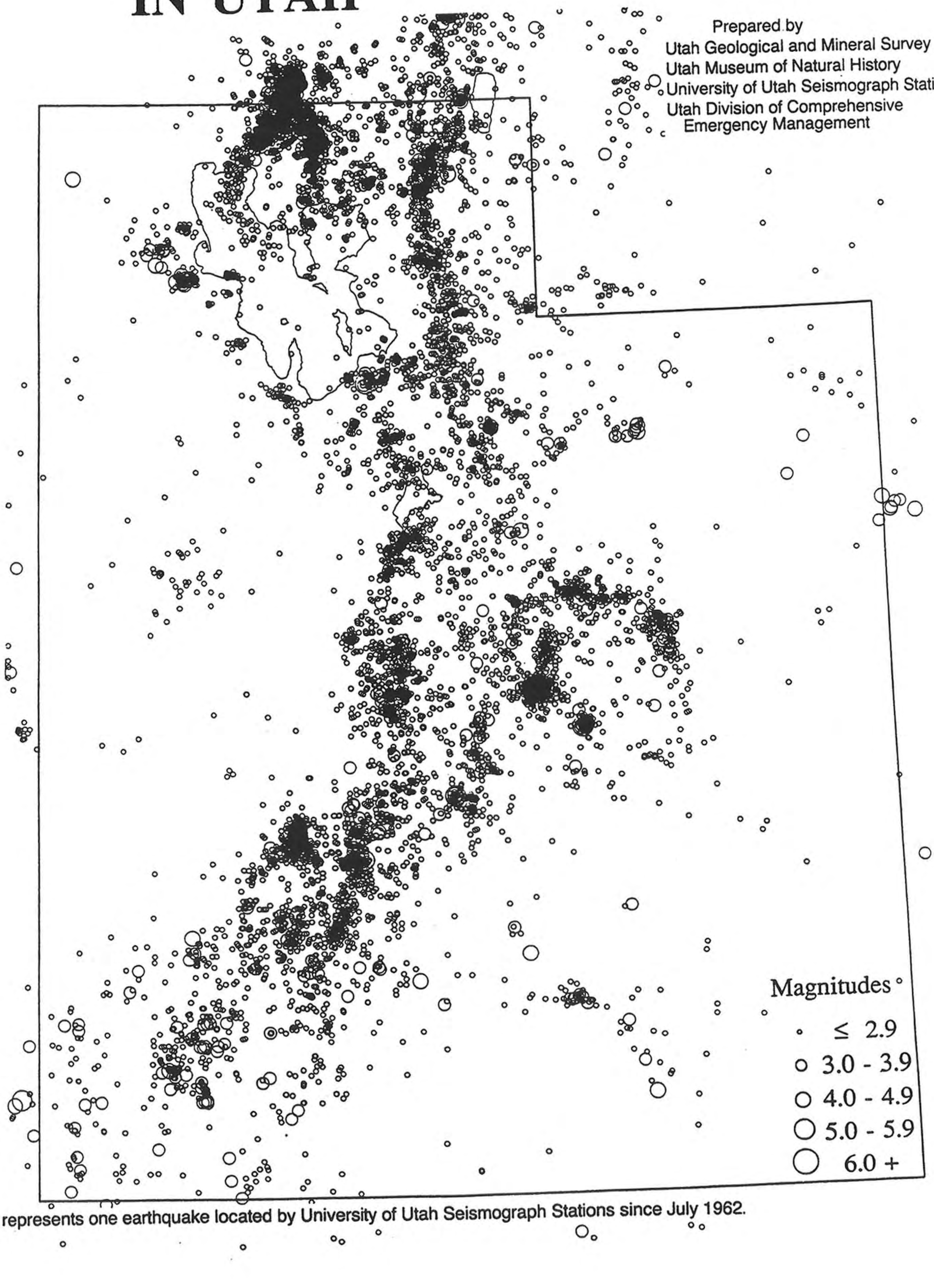
plant pots instead of clay pots, etc.

6. Have students write a summary of safety behaviors in an earthquake. Have each student create a diagram of his/her room at home and list possible safe or dangerous areas within the room.

EARTHQUAKE HAZARDS & SAFETY IN UTAH

Utah Geological & Mineral Survey
Public Information Series 6
Revised to May 1990

Prepared by
Utah Geological and Mineral Survey
Utah Museum of Natural History
University of Utah Seismograph Stations
Utah Division of Comprehensive Emergency Management



Each dot represents one earthquake located by University of Utah Seismograph Stations since July 1962.

UTAH'S EARTHQUAKES

An earthquake is a shaking of the ground caused by the sudden movement of blocks of rock along a break in the earth's crust **(fault)**.

Hundreds of earthquakes occur throughout Utah each year, but only about 2% are felt by humans.

The **Richter Magnitude Scale** is used to measure the size of an earthquake. Each whole number increase in magnitude represents a tenfold increase in recorded ground motion. A magnitude 7.0 earthquake is ten times larger than a magnitude 6.0 event and 100 times larger than a magnitude 5.0.

Large earthquakes of up to magnitude 7.5 can occur in Utah. Large events can cause considerable damage.

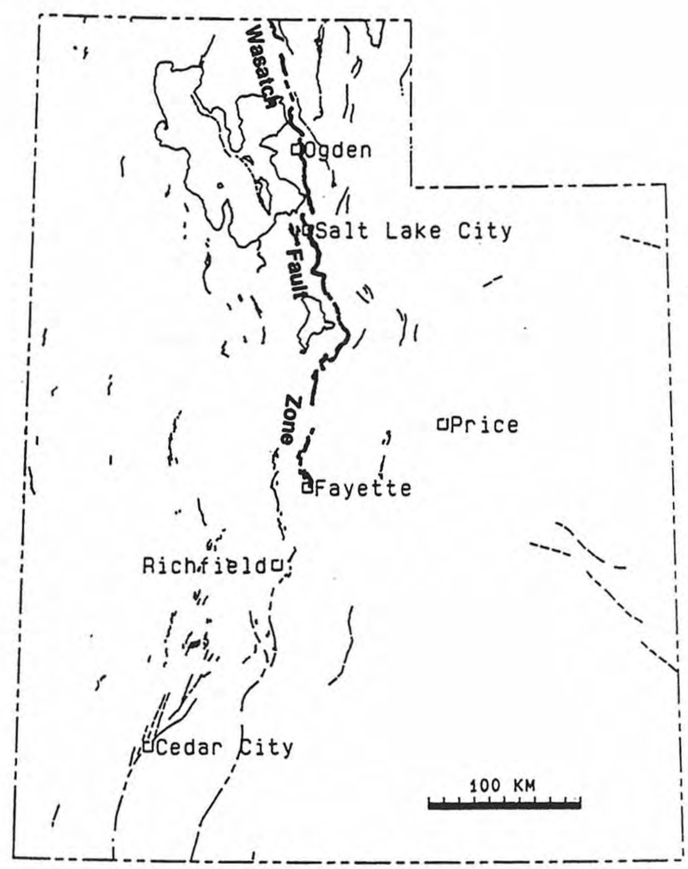
Moderate earthquakes of magnitude 5.5 to 6.5 occur somewhere in Utah on the average of once every 7 years. If these earthquakes occur under cities and towns, they can cause considerable damage depending on the area's geology and the construction of nearby structures.

The **largest historical (since 1850) earthquakes in Utah** were the 1901 earthquake near the town of Richfield with an estimated magnitude of 6.5, and the 1934 Hansel Valley earthquake (at the northern end of the Great Salt Lake) of magnitude 6.6.

Faults that have shown movement in the last 1.6 million years (Quaternary) are **considered potentially active**, and could be the source of future earthquakes (see adjacent map).

The **Wasatch fault** is the longest fault in Utah (over 200 miles long) extending from Malad City, Idaho to Fayette, Utah. This fault is made up of 10 to 12 **segments**, averaging 20 miles in length, which move independently.

Large earthquakes occur on the **Wasatch fault** on the average of once every 400 years.

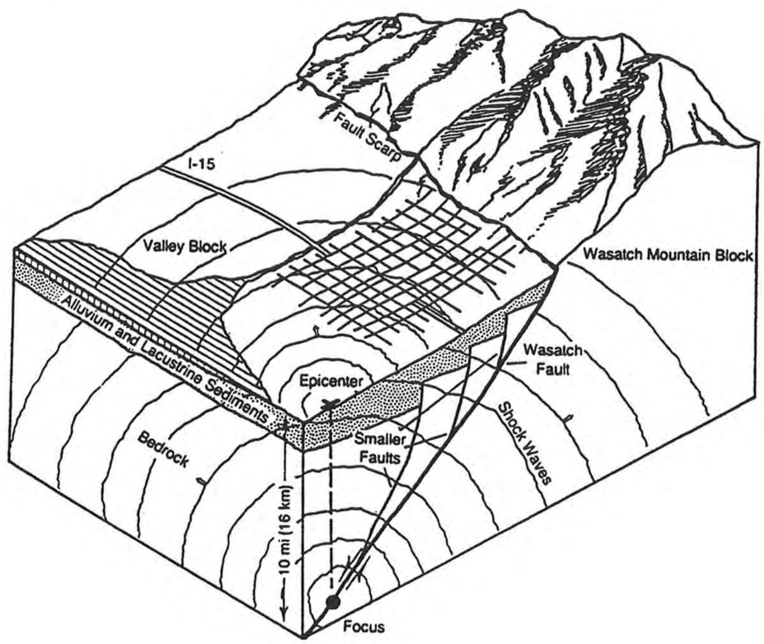


GENERALIZED MAP OF QUATERNARY FAULTS IN UTAH

EARTHQUAKE HAZARDS

The RISK from earthquakes to people and property at a particular location is determined by the following:

1) the **size or magnitude** of the earthquake and the **distance from** the earthquake
2) the **local geology** - underlying rock, soil cover, ground-water conditions
3) the **geologic hazards** produced - rockfalls, landslides, liquefaction, subsidence, floods
4) the **location, design, and construction** of man-made structures



Although numerous faults exist in Utah, the WASATCH FAULT causes the greatest concern because it appears to be the most frequent source of large earthquakes in Utah and 90% of Utah's population live within 20 miles of it.

A major earthquake can occur in Utah at any time. The following could result:

I.GEOLOGIC HAZARDS

A. **Ground shaking** is the one hazard that **will occur,** and it will affect a widespread area.
B. The fault may **rupture** the surface causing displacement of up to 20 feet in limited areas.
C. **Rockfalls** and **landslides** could be triggered by shaking.
D. **Liquefaction** may occur when loose, wet soils react to shaking and change into a thick liquid incapable of supporting buildings. Buildings may tilt.
E. **Flooding** of low-lying areas near lakes may occur due to **subsidence** and **tilting** of the valley floor.

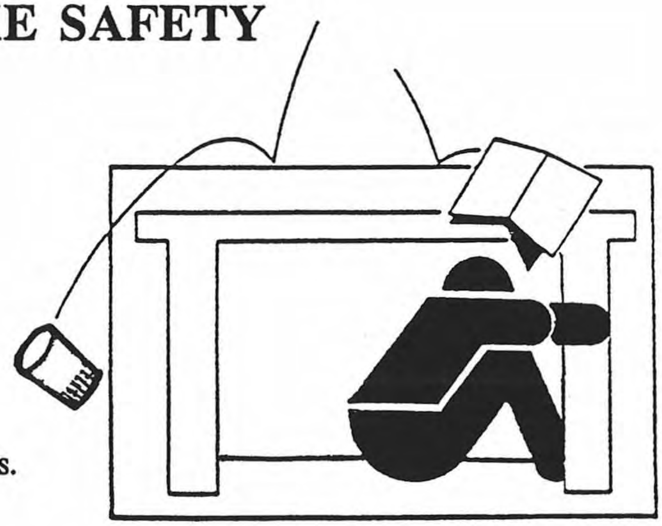
II.PROPERTY DAMAGE

A. **Man-made structures**, such as buildings, highways, bridges, and dams, could be damaged.
B. **Lifelines**, such as gas, electric, communication, water and sewer lines, could be broken, disrupting service for days and causing **fire** hazards.
C. **Falling objects** could cause injuries.

No one knows when or where the next major earthquake will occur, but all earth scientists agree that we must be prepared.

EARTHQUAKE SAFETY

I. KNOW WHAT TO DO DURING



A. STAY CALM

B. DUCK & COVER

1. IF INSIDE, STAY THERE!
Duck under table & hold onto its legs, or stand in interior door frame. If no protective cover is available, sit next to an interior wall & cover head/neck with arms.

2. **IF OUTSIDE, STAY THERE!**
Move into open away from buildings & electric wires.
Park car away from bridges/overpasses. Stay in car until shaking stops.

II. PREPARE AHEAD OF TIME

A. PREPARE YOUR HOME

1. Identify possible hazards & reduce their risk.
   a. Remove heavy objects from high shelves.
   b. Anchor top-heavy furniture with brackets to wall or floor (refrigerators, bookshelves, etc.)
2. Reduce the risk of fire.
   a. Learn how to turn off utilities (gas electricity, water)
   b. Anchor water heater

B. DEVELOP FAMILY RESPONSE PLAN

1. Determine "safe" areas in each room.
2. Hold earthquake drills.
3. Decide on family meeting place.
4. Identify out-of-state contact.

C. PUT TOGETHER A 72 HOUR SURVIVAL KIT

1. WATER (1 gal/person/day)
2. Canned or dried foods
3. Flashlight
4. First-Aid Kit
5. Fire Extinguisher
6. Battery-operated Radio

III. RESPOND AFTERWARD

A. ADMINISTER FIRST AID

B. CHECK FOR UTILITY DAMAGE & TURN OFF ONLY IF NECESSARY

C. USE TELEPHONE ONLY FOR MEDICAL EMERGENCY

D. BE AWARE THAT AFTERSHOCKS MAY CAUSE FURTHER DAMAGE

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
02	Identify processes that form geological features.
ILO's	5. Understand science terminology. 6. Construct models to compare and contrast.

Activity #12 **VOLCANOES COME IN DIFFERENT SIZES AND SHAPES**

Background:
There are three main types of volcanoes: **shield**, **composite**, and **cinder cone**. They are different in shape, size, and make-up, which all result from different types of eruptions. For the purpose of this activity, it is just noted that the three volcanoes have different shapes and sizes.

The Big Idea:
Volcanoes have different shapes and sizes.

Vocabulary:

- magma
- lava
- volcano
- shield volcano
- cinder cone
- composite volcano

Magma Hot liquid rock beneath the Earth's surface.

Lava Magma that reaches the Earth's surface.

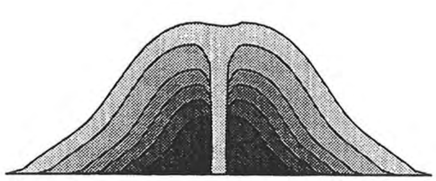
Volcano An opening in the Earth's crust through which materials (including magma, hot gases, ash, and solid rock) erupt.

Shield

Shield volcano A low-profile volcano with gentle slopes (it looks like a warrior's shield). It is formed almost completely from lava.

Cinder Cone

Cinder cone A small cone-shaped volcano with very steep sides. It is formed mostly from cinders (fragments - about 1 centimeter in diameter - of lava).



Composite Volcano

Composite volcano A very tall and large volcano with steep sides. It is formed from many layers of lava, cinders, and other volcanic material.

Materials:

For the Teacher:

· Pictures or drawings of the three types of volcanoes (examples: composite - Mount Fuji and Mount St. Helens; cinder cones - Paricutin and Iceland's Vestmannaeyjar; shields - Mauna Loa and Mauna Ulu).

· Picture of half of a volcano that shows where the magma chamber is, and how the materials from the eruption create the volcano.

For the Student (individual or pairs):

· Clay or playdough.

· 5" x 5" piece of cardboard.

· Notebook for vocabulary words.

Procedures:

1. Discuss with the students what magma and lava are. *Magma is heated, melted rock located beneath the Earth's surface (in the lower crust and upper mantle portions of the Earth). Lava is magma that has reached the surface, which releases many of the dissolved gases it contained upon surfacing. Lava is also the resulting rock, such as basalt, after it has cooled.* Identify where the magma in the volcano is (on the picture of the inside of a volcano). Have the students write the definitions of the parts of the volcano in their vocabulary book.

2. Show the students the different types of volcanoes. Have them write shield, cinder cone, and composite in their book along with the definition of each. Utah has all three types of volcanoes: Fumarole Butte (shield) in Juab County, Tushar Mountains (composite) in Piute County, and Veyo Cinder Cone in Washington County.

3. After going over the definitions hold up the three pictures again and see if the students can identify the shield, cinder cone, and composite volcanoes.

4. Give each student a piece of clay and cardboard. They will need to divide their clay into three sections. With a pencil or crayon have them write the three types of volcanoes on the cardboard. To measure their learning have them make a volcano for each type with the clay.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predictions. 5. Model to compare and contrast.

Activity #13 **VOLCANOS ERUPT IN DIFFERENT WAYS**

Background:
There are two basic kinds of volcanic eruptions: quiet and explosive. **Quiet eruptions** are ones where lava flows out of a volcano's vent (like the shield volcanoes in Hawaii). An **explosive eruption** is one where lava, other particles, and ash are violently blown out of the volcano's vent (like the composite volcano Mt. St. Helens). Different eruptions have different effects on geological features and on people. Lava flows, which are typical of a shield volcano, can destroy the things in their paths, but they are usually slow enough that a person could outrun them. Explosive eruptions, which are typical of cinder cones and composite volcanoes, can be dangerous due to toxic gases and ash, or due to being caught by the eruption (not able to outrun it, such as what happened to some people on Mt. St. Helens).

Vocabulary:

- volcano
- vent

Vent The central opening of a volcano.

The Big Idea:
Observing two different kinds of volcanic eruptions.

Materials:
For the Teacher:
- A home-made volcano (see *Teacher Resource Book*, Activity #4) or a bucket of sand.
- Tray, box lid, or something else on which to place the volcano.
- Small container to use for the center of the volcano.
- 1/4 cup baking soda.
- 1/4 cup red powdered paint.
- 1/4 cup liquid soap.
- 1/4 cup vinegar.
- Hair drier/blower.
- Sieve.
- Paper holes, oatmeal, rice, or something similar.

    or substitute the last three items with
    - Unpopped popcorn and air popcorn popper.

Procedure:

1. Instruct the students to compare and contrast the photos of a lava flow (such as in Hawaii) and an explosive eruption (such as Mt. St. Helens). Lead them to the discovery that there are two main types of volcanic eruptions: quiet and explosive.

2. Make your volcano in class or have it premade. Mix the baking soda, powdered paint, and liquid soap in the container. Place the container under the volcano's vent. Instruct the students to observe and record what they see - add the vinegar when you want an eruption.

3. Ask the students what kind of an eruption they think this is (like the lava flows in Hawaii, or the eruption of Mt. St. Helens). Accept all answers. Have the students discuss the movement of the lava in the demonstration. How could lava flows affect the landscape? *Lava hardens into rock that then stays in the place it hardened. It changes the landscape by filling in valleys, etc.* Affect people? *Houses in the path would be destroyed, but you would be able to leave the area before it got dangerous.*

4. Using the same volcano, demonstrate another eruption with the hair drier and rice and paper holes (or other similar items). Place the rice and paper holes on the sieve or in a colander. With the sieve under the volcano, use the hair drier to blow the rice and paper up through the vent of the volcano. *OR*, pop popcorn in an air popcorn popper without the lid on top. Have the students sit around the popper and watch what happens.

5. Instruct the students to observe and record what they see. Ask the students to share their observations. Ask what kind of an eruption this was. *Explosive*. How could this type of eruption affect the landscape? *The ash and particles could cover a larger area, the paper traveled further than the rice, etc.* Affect people? *Ash or particles could fall on people, etc.*

6. Ask students what positive effects might result from volcanic eruptions. *The rock that forms from lava can be used for buildings, the cinder can be used for decoration stone - students living in southwestern Utah may see this, etc.*

7. To measure their learning have the students write what happens during an eruption and/or draw a picture of what would happen.

Option:

Use a lit candle to illustrate lava slowly flowing down the sides and eventually forming "land" at the base of the "volcano" the longer the candle melts.

THE STORY OF A MOUNTAIN
MEXICO'S PARACUTIN VOLCANO

Can you imagine watching a mountain form before your very eyes? Can you guess what kind of a mountain might form in only a day or two? People actually watched a mountain be born in 1943.

A farmer named Dionisio Pulido was plowing his cornfield on February 20, 1943. It probably seemed like any other day when he started out that morning. As his ox pulled the plow across the grounds, something unusual began to happen. A white smoke began to hiss from a hole under a rock. The Indian farmer felt the ground rumble under his feet. He began to run as the earth cracked open!

The man and his son ran as fast as they could to their village to ring the warning bells in the church tower. As the old bell called out its urgent warning, farmers from all around left their fields and ran to the village. Women and children came, too, to see what was happening.

The farmer Dionisio showed his friends the smoke that was rising in the distance. The villagers were frightened, but they wanted to see this monster spitting fire, ash, and melted rock from a farmer's field. They heard the ground rumble and the exploding volcano boom. It seemed that the earth was coughing steaming lava. Every time it boomed its loud cough into the air, the mountain grew.

Days later the fires grew smaller, but the village was gone. Only the bell tower stood above the cooled lava. No one was killed, but 2000 people had lost their homes. Five miles away from the covered village was a brand new mountain—spewed from deep in the earth.

Today people can visit the volcano in Mexico. They will see the volcanic mountain and the site of the abandoned village under cold lava.

This is the true story of the birth of a mountain!

An easy-to-read book about Paracutin is *Hill of Fire* by Thomas P. Lewis with pictures by Joan Sandin. Harper Collins, New York, 1977.

Video: *A Hill of Fire*

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01 02	Identify various geological features such as mesas, mountains, streams, oceans, and islands. Identify processes that form geological features.
ILO's	1. Make observations, predictions, and classify. 2. Identify variables and describe relationships between them. Formulate research questions and hypotheses. Plan controlled experiments. 3. Maintain an open and questioning mind.

Activity #14 **WATER CHANGES THE EARTH'S SURFACE**

Background:
Running water is the most important eroding agent on Earth, and river systems are the most widespread features/processes on the continents. Using a stream table, students can observe the processes of erosion and deposition in creating and changing landforms (geological features). Erosion is the wearing away and carrying away of the land through moving water, ice, gravity, or wind. Deposition is erosion's partner. The eroded materials are deposited somewhere and alter the landscape.

The Big Idea:
Experiencing the processes of erosion and deposition. Water takes earth material from one place and moves it to another.

Vocabulary:

- erosion
- deposition
- delta

Erosion The wearing away and carrying away of the land through moving water, ice, gravity, or wind.

Deposition The laying down of eroded particles (sediments).

Delta A geological feature created at the mouth of a river where sediments are deposited into a lake or ocean.

Materials:
For the Teacher:

- A stream table. May be purchased or created cheaply by using a box, tray, or plastic sled. If none of these are available, a pile of sand on the playground can substitute.
- Sand.
- Water. The activity works best if the water can move through the table and out through tubing, but this is not absolutely necessary.

Procedures:

1. One end of the stream table should be elevated.

2. Wet sand can be piled and placed to resemble hills and mountains

3. Begin questioning...Where does water for rivers come from? How does it become a river? *Most river water comes from the rain and snow on the mountains, and flowing water seeks low areas - water starts eroding valleys or canyons.*

4. Let students pour, sprinkle, or spray water onto the "mountains" representing rain. In the spring time you can lead the students into discovering that snow melt adds to the rivers. As water is poured onto the mountains, predict--what do you think will happen as the snow melts and more and more water comes down the mountains?

5. Encourage the students to experiment with variables. Then discuss observations (what happens if a lot of water is poured in one place, if water is sprinkled, if the mountains are steep, if the mountains are not steep, how large a stone can the stream move, where do different grain sizes go).

6. Observe how water forms rivers and carries the sand along until it slows. Have students talk about their observations. (You may wish to make a path in the wet sand with your finger to facilitate the quick formation of a river.) All the time have the students predict, observe, and answer their own questions.

7. If you have mountains visible from your school, go outside and talk about the part water played in the way they look. Look for the canyons.

8. Observe forms of deposition. What happens if the river empties into a lake? Make a dam out of sand beyond where the river empties into the flatter area. Let a "lake" form. Observe what happens. *The river drops the sand when it flows into the lake, forming a delta*. (Deltas formed at the mouths of Big Cottonwood, Little Cottonwood, and Parley's Canyons in an old lake - Lake Bonneville, thousands of years ago).
Let the students experiment with variables: how can you form the widest possible delta?
Teachers Note* You may want to find good pictures of deltas from a textbook or magazine to help students visualize a delta first.

9. Experience the process of wave erosion. Create two mountain ranges of sand on each side of the stream table. Fill the "valley" in between with water. Move the pan back and forth to create waves. What happens? *Waves erode shorelines*. If you can - those of you located from the Wasatch Range and west - take students outside and look for Lake Bonneville shorelines on the hillsides.

10. Guide the students to conclude that erosion and deposition help change the face of the Earth.

11. If possible, take the students outside and look for evidence of water erosion or deposition.

Extension:

Continue to experiment, and discover additional geological features - such as **alluvial fans, meanders, oxbows, sand bars, braided** rivers. The vocabulary is not as important os observing what happens when a stream flows out of a steep canyon and meets dry land (the sand is deposited as an alluvial fan); when a river flows on flat land and the path of the river gets more curvy (meanders), it can deposit sand bars, cut off a meander to form an oxbow, or start a braided pattern.

Integration to reading: Read "The Wonders of Rivers" in Journeys reader by Houghton-Mifflin.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predictions.

Activity #15 **HOW DOES WATER DEPOSIT MATERIALS?**

Background:
When moving water is slowed by a bend in its path, a widening of its path, or meeting flat land or body of water (ocean or lake), it drops soil and small rock materials (sediment). Heavier particles drop first. This sediment may build to form new land such as sand bars, deltas, or alluvial fans.

The Big Idea:
Experiencing the process of deposition. Moving water carries sediment, and when the movement stops, the sediment drops. Heaviest particles drop first, and layers form.

Materials:
For the Students (groups):
- A clear jar or beaker filled half-way with water and a few spoonfuls of sand, pebbles, silt.
- Spoon for stirring.

Procedures:
1. Review the discoveries made with the stream table. Ask, "When did the water drop the sand? Why?" Let's discover why this happens.

2. Have the students stir the water/sand mixture. Ask them to predict what will happen when they stop stirring. Observe what happens. When does the sand drop? Why? Is this the same as with the stream table? How? *The sand and other particles settle to the bottom when the water stops moving. The heaviest particles (pebbles) drop first. This is similar to the moving water of a river that carries sediment, and drops that sediment as the river slows down or reaches a standing body of water (ocean, lake).*

3. Apply this to real rivers that carry the sand and deposit the sediments as the water slows.

4. See if any students can describe any water deposition they've seen.

Extension:
Observe mountains, streams, or rivers if possible. Look for signs of deposition. Or...show pictures to illustrate the vocabulary.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predictions. 5. Understand science principals.

Activity #16

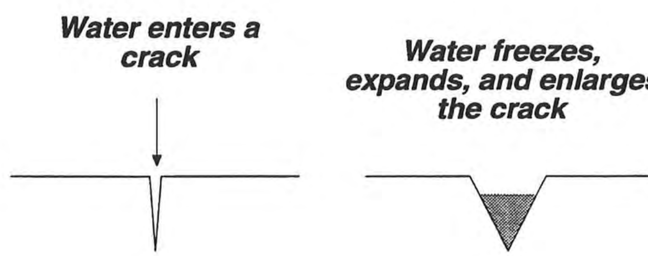
WEATHERING

Background:
Weathering is the breaking down of rocks into smaller pieces by natural processes. Rocks can be broken down by water, air, chemicals, temperature changes (freezing & thawing), and plant and animal activity. Weathering plays an important part, just as erosion does, in wearing mountains or other landforms down. Once rocks are broken down into smaller pieces, they may be easier to erode. One type of weathering is called **frost action**, which breaks down rock by repeated freezing of water and thawing of ice. The arches in Arches National Park are partly formed by frost action. Water, when frozen, expands. When water enters cracks in the rock, and then freezes, the expanding ice enlarges the crack. The larger the crack, the more easily it will erode. Another type of weathering is caused by **plant growth**. Like the expanding ice in frost action, the growth of plant roots in rock crevices breaks rocks apart.

The Big Idea:
Observing the processes of weathering through frost action and plant growth.

Vocabulary

- weathering
- frost action



Materials:
For the Teacher:
- Plastic egg in two halves (like Easter eggs, or silly putty containers).
- Water.
- Freezer.
- Pumpkin seeds planted in a clear plastic cup.
- Plaster of Paris.

Procedure (frost action):

1. Fill the plastic egg with water (by submerging the egg and joining the halves).

2. Freeze the egg.

3. Observe the expansion of the water and the effect it has on the egg.

4. Questions: How do freezing and thawing cause weathering in rocks? How could this change the landscape?

Procedure: (plant growth)

1. Germinate several pumpkin seeds, then plant each in a clear plastic cup.

2. Place a thin layer of Plaster of Paris over the soil. In several days the pumpkin seed should start to grow. Observe the expanding cup, any cracks in the Plaster of Paris, etc.

3. Ask students where they have seen plants weathering rocks outside (roots of trees in sidewalks, etc.)

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	2. Identify variables and describe relationships. 5. Understand science principals.

Activity #17 **WIND CHANGES THE EARTH'S SURFACE**

Background:
Wind is probably the least effective agent of erosion. However, wind does alter the landscape, mostly by transporting loose fragments of sand and dust. Sand dunes, which are constantly shifting, exist in areas of Utah (on Antelope Island and in Coral Pink Sand Dunes State Park are two examples).

The Big Idea:
Observing the processes of wind transportation of sand and dust.

Vocabulary:

- erosion
- weathering

Procedure:

1. Discuss any experiences the students may have had in visiting the sand dunes or having dust blown into their eyes by the wind. Discuss transportation of sand and dust and ask students how this process could change the landscape.

2. If you have an opportunity to take the class outside on a windy day, the students can feel the wind blowing soil particles on their faces.

3. For additional activities about wind, see #11 and #13 in the *Teacher Resource Book.*

Extension:
Utah's beautiful canyons and arches are a good example of erosion and weathering by a combination of moving water and blowing sand. An excellent video, *Experience Utah!*, explains the formation of Bryce Canyon. The video also shows other Utah landforms and discusses the science behind their formation.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predictions. 2. Record. 5. Understand science principals.

Activity #18 **SURFACE PROCESSES IN YOUR YARD**

Background:
Using your school yard, students can observe effects of erosion, deposition, and weathering.

The Big Idea:
Observing the geological processes of erosion, deposition, and weathering on a small scale. Then relate the processes to a larger scale (the surrounding environment).

Procedure:

1. Take the class onto the playground after a rain storm.

2. Look together for signs that the soil has been disturbed by rain or wind. Find cuts (grooves, furrows) and depressions in the soil caused by the runoff of rainwater. Look for sediments that may have been deposited in the running water as the runoff slowed. Raingutter spouts are a good place to look. Look for sand or dirt deposited by the splash effect of the falling rain at the base of the outside walls of the school building. Question: How was soil changed or moved? Find evidence of erosion and deposition.

3. Look for examples of places where erosion did not happen (on a grassy area for example). Discuss how grass prevented the movement (erosion) of soil. Integrate into social studies with a discussion of the Dust Bowl & how much of the soil was "conserved" by the planting of trees and other plants across our country's Great Plains.(Background information can be found in the *Teacher Resource Book*, Activity #11, step 10.)

4. Go on a weathering hunt. What evidence of weathering can anyone find? *Roots pushing up through any concrete or pavement, weathering on buildings or other stone features. Whenever rocks are exposed at the Earth's surface, they begin to change. The longer a rock is exposed to air and water, the more it is weathered. Rocks can become more smooth for example. If you visit a cemetery that has both old and new gravestones, you would notice a different appearance of the two. The older marker would be smoother, possibly hard to read the inscription, etc. It will have a weathered or old appearance.* Look at any "stone" features on the school building, walls, etc. Can you observe weathering? Is part of the school or grounds older than another part?
5. Students can record their observations in a journal. Tie in the activity with the stream table activities to help the students understand erosion and deposition.
6. Ask the students what they have seen outside of the school yard in relation to erosion, deposition, or weathering. Share experiences and observations.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predict, use reference sources to obtain information. 2. Identify variables and describe relationships. 6. Construct models.

Activity #19

EROSION IN BIG STEPS
(Landslides and Rockfalls)
(modified from *Tremor Troop*, p. 75-76)

Background:
Erosion, the moving of material, can happen suddenly and in large steps. **Landslides** and **rockfalls** are two such examples. These can happen all of a sudden for a variety of reasons, including ground shaking from earthquakes. In 1992, a landslide occurred in Springdale, Utah during an earthquake. Rockfalls are the most common type of movement from earthquake ground shaking. Landslides and rockfalls are geological processes that change the landscape instantaneously (a landslide can block a river and form a lake). Both are common occurrences in Utah, and can happen over most of the state where there are cliffs or slopes. Some happen without an earthquake causing them (landslides, for example, are often caused when the ground is saturated with water). For example, the 1983 Thistle landslide in Utah County happened during an extremely wet spring.

The Big Idea:
Observing fast geological processes of landslides and rockfalls.

Vocabulary:

- landslide
- rockfall

Landslide Earth and rock which becomes loose on a slope and slides down.

Rockfall Rock which becomes loose and falls down a slope.

Materials:
For the Teacher:
- Stream table.

For the Students (groups):
- Newspapers.
- Large tray (plastic foam meat trays, soda pop carton boxes, or your stream table).
- Soil.
- Sand.
- Pebbles/gravel.
- Aluminum foil or saran wrap.
- Water.

Procedure:

1. Build a dam (ridge) of sand across your stream table. Start a canyon in the dam, and let the water erode through the new canyon. Ask the students what they observe as more water is added. *The canyon erodes faster and gets wider - sometimes in big steps = landslide where a wide part of the "river bank" slides into the river.*

Alternate Procedure:

1. Cover the work surfaces with newspaper. In the tray, build a hill from moistened sand or soil. It may be any height or shape you choose. You may want to make one side steeper than the other.

2. Wrap a sheet of foil (saran wrap) around your hill to simulate the slippery layer of rock or silt that allows outer layers to slide off during an earthquake.

3. Completely cover the foil with another layer or sand or soil.

4. Predict what will happen when the hill is shaken (which hills will receive the most severe/least damage? Which part of each hill will be most affected by an earthquake?).

5. Hold the tray on which your hill rests with both hands, and slide it back and forth sharply on the table to simulate an earthquake.

6. What did you observe? How did the shape of the hill affect the landslide? (In most cases, the steeper the slope, the more easily the material will slide down). How did the type of material above the foil affect the landslide? (various answers are possible). What would have happened if you had used less/more water in your soil mixture? *Landslides are more likely when the surface is saturated with water.*

7. Experiment with pebbles/gravel on the hills to represent rockfall. Were they more easily shaken down the hill? *Loose rocks are more apt to fall down in an earthquake than land sliding.*

Extension

Discuss what events, other than earthquakes, can cause landslides. (heavy rains, fast snowmelt, freezing and thawing of the ground, erosion).

Have students find pictures of landslides and rockfalls.

Ask students if they have seen any landslides or rockfalls, or evidence of them.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations, measurements, and predictions. 2. Record. 5. Understand science principals.

Activity #20

HOW DOES A GLACIER FORM?

(modified from *Morton-Tolman Science Library Series*)

Background:

Glaciers are large sheets of moving ice that form when layers of snow accumulate and compact the lower layers into ice. Glaciers are located where more snow accumulates each year than is melted during summer months.

Vocabulary:

- glacier

The Big Idea:

How glaciers are formed (how snow compacts into ice).

Materials:

For the Students (groups):

- A tall, narrow jars.
- Large marshmallows.
- Circle of cardboard to fit inside the jar.
- Rocks or other weights.

Procedures:

1. Have students fill the jars ½ or 3/4 full with loosely-packed marshmallows.

2. Cut a cardboard circle to fit inside the jar without rubbing the sides.

3. Place rocks or other weights on the cardboard. You may add weight each day to represent additional snow layers.

4. Have the students mark the jar with masking tape at the level of the cardboard. Twice each day for four days have students check the jar and make a mark at the end of the cardboard.

5. Record observations.

6. How does this help us understand how glaciers are compacted into ice from snow? The rocks in the activity represent added snow weight. How are marshmallows like snow? *They are compacted into a dense mass.* Help students make the connections.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 02	Identify processes that form geological features.
ILO's	1. Make observations and predictions. 5. Know science terminology and basic science facts.

Activity #21 GLACIERS CHANGE THE EARTH'S SURFACE

Background:
Glaciers slowly change the surface of the Earth through the processes of erosion and deposition. There are two kinds of glaciers: **valley** and **continental**. Some of Utah's mountains, including the Uintas and the Wasatch, had valley glaciers. These valley glaciers started high in the mountains, where they carved out **cirques** and **aretes**. As the glaciers moved down preexisting stream valleys, they picked up everything from dirt to huge blocks of rock from the valley's walls and floor. This process of erosion widens the valley into a **U-shaped valley**. When the glacier moves lower down the valley, it reaches a point where it may start melting. When the ice melts, the dirt and rocks are deposited as **moraines**.

The Big Idea:
The processes of how glaciers erode and deposit; changing landforms.

Vocabulary:

- glacier
- continental glacier
- valley glacier
- U-shaped valley
- cirque
- moraine

Continental glacier A glacier that covers large areas of land; found in polar regions (e.g. most of Greenland is covered by a continental glacier).

Valley glacier A glacier that begins high in the mountains and moves downwards through a preexisting valley.

U-shaped valley A valley eroded by a glacier, so it has a wide floor.

Cirque A spoon-shaped depression high in the mountains where a glacier starts forming and cutting back into the walls.

Moraine A glacial deposit of rocks and dirt; often looks like a hill.

Materials:
For the Teacher:
- Freeze water and a tiny amount of sand and gravel in a small paper or plastic cup.

Procedure:

1. Freeze water and a small bit of sand in a small plastic or paper cup. Remove the cup, and show how the sand is "frozen" in the ice.

2. Place the "glacier" on a hill of sand in your stream table. Gently push it down the hill, and observe the shaping of a U-shaped valley. Ask students what they observe. *Eroding a U-shape valley. Teacher's note** by pushing the ice through the sand, sand will gather at the end of the glacier and look like a moraine. A real glacier, however, picks up rock and sand and carries the material in the ice. The moraines form where the glacier is melting, which is where the material is left.

3. For the rest of the day, let the "glacier" melt on a slope (such as your sand hill).

4. What do the students observe? You may see water flowing, erosion, and deposition of the sand and rocks at the bottom (lower end) of the melting glacier. Does a moraine form? Have students liken this to the melting of a real glacier.

Extension:

Show how a glacier carrying rocks and dirt can scratch the surface over which it travels. Move your "glacier" over a piece of aluminum foil. What do the students see? (scratches in the foil). Repeat the process again without letting the students watch. Then show the scratches to the students and ask them if they can tell which way the "glacier" was moving. *The same direction as the scratches.*

Ask the students to make inferences about this effect in the mountains. (You can see these glacial scratches on the rock in areas such as Big and Little Cottonwood Canyons in the Wasatch Range).

You may have pictures or diagrams of other glacier features such as **aretes**, **horns**, **tarns**, etc.

National Geographic has learning kits, filmstrips, and videos that show the effects of glaciers and other surface agents of erosion and deposition.

A "Good Morning, America" video, *The Great Alaskan Adventure*, has wonderful footage of glaciers and scientific information about glacial effects on landforms.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
ILO's	1. Develop and use categories to classify observations. 5. Know science terminology.

Activity #22

UNITED STATES SHADED RELIEF MAP
WHAT DO YOU SEE?

Background:
There are many different types of maps (different maps for different uses - road maps, weather maps, etc.). The following activities focus on two types: shaded relief and topographic. Both maps show topography, or the landscape (shape of the land), but in different ways. Students can identify geological features on these maps.

The Big Idea:
Using a shaded relief map to identify various geological features.

Vocabulary:

- shaded relief map
- topography

Shaded Relief Map A map that shows the land's features by depicting what the area looks like with sunlight shining on it from a particular direction.

Topography The shapes and features of the Earth's surface.

Materials:
For the Teacher:

- Shaded relief map of the United States (U.S. Geological Survey, Relief Map, sheet number 56).
- Overlay of labels.

Procedure:

1. Place the map on the wall. Tell the students to observe the map. What do the students see on this map? (different colors, ocean, land, lakes, rivers, mountains, etc.) Can they see on this map that the United States does not look flat? How? Ask the students why the United States is not flat. *Plate movements, mountain building, plateaus uplifting, erosion, deposition, etc.*

2. Discovery questions to identify the three major types of landforms (mountains, plateaus, plains):

    Where are mountains found in the U.S.? Can students locate them on the map?.
    What kind of landscape region do you live in?
    Where is the nearest plains region to you?
    Where in the U.S. are the Great Plains? Does this area look lower in elevation than

Rocky Mountains to the west? Where are the low plains regions? *East and southeast coastal areas are lowest, and the Great Plains are a little higher.*

Where are some plateaus? *Often found next to mountain ranges - on the west side of Appalachian Mountains is the Cumberland Plateau, east of the southern Rocky Mountains is the Edwards Plateau in Texas, the Ozark Plateau next to the Ouachita Mountains, the Colorado Plateau is adjacent to the Rocky Mountains, etc.* The plateaus may be difficult to distinguish (they are not visible as totally flat, especially near some edges where streams have cut deep canyons). One hint could include instructing students to look for a particular color (because this map is color-coded according to elevation). See if students can discover that plateaus are typically lower than the adjacent mountains and higher than the plains.

What forces create mountains? *Uplift, folding, faulting, etc.* What forces create plateaus? *Uplift, but more gently than mountains, so their rocks remain horizontal and not folded and faulted like mountains.* It makes sense that they are typically near mountain ranges, since both can be created from uplift.

Now you can use the overly to see exactly where each landform is and what it is named.

3. Once the students have mastered identifying mountains through shaded relief, can they find some of the different mountain types? Ask them where they see a large mountain range that appears to be wrinkled (like their pushed-up/wrinkled shirt sleeve), indicating folded mountains. *Appalachian Mountains*. Can they find some volcanoes in the Cascade mountain range? *In the state of Washington - Mt. Rainier, Mt. St. Helens, Mt. Adams, and Mt. Hood are all composite volcanoes that are nicely visible on the map.*

4. Smaller geological features. Have the students locate the major rivers in the central U.S. At least three main rivers drain into one (help them determine which way the rivers are flowing by the color-coded elevations. The rivers lead into the Mississippi River, which then reaches lower elevations in the grayish-green areas of the coast).

5. Can the students find a delta? *Mississippi Delta*. The Mississippi River drains a very large area and carries a lot of sediment that then is dropped when the river reaches the standing water of the ocean.

Extension:

Tie in with social studies. Plot pioneering routes across the U.S. Discuss the relevance of these routes.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
ILO's	1. Make observations and measurements. 5. Demonstrate science principals. 6. Construct models.

Activity #23

CONTOURING A LANDFORM

Background:
Topographic maps show the shape (elevation differences) of the land surface through the use of **contour lines.** Contour lines connect points of equal value; on topographic maps, contour lines connect points on the Earth's surface that have the same elevation. Where contour lines are closely spaced, the terrain is steep. The more closely spaced, the steeper the slope. Conversely, gentle ground slopes are portrayed by contours spaced widely apart. Contour lines never cross each other.

The Big Idea:
Making a topographic map from a model of a landform.
Understanding how contour lines are used on maps to show topography.

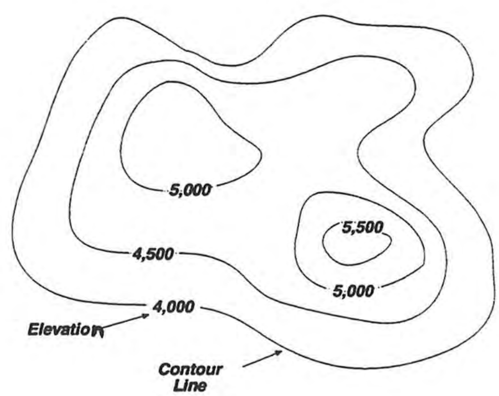
Vocabulary:

. topography
. topographic map
. contour line

Topographic map A map that shows the shape of the land through the use of contour lines to show elevation (height above sea level).

Contour line A line that connects points of equal value; on topographic maps, lines connect points of equal elevation above a specified reference, such as sea level.

Materials:
For the Teacher:
- Large piece of paper/table covering.
- Sand.
- 2-3 rulers.
- 2 different-colored felt tip pens.
- Saran wrap, aluminum foil, paper towels, or cut white plastic bag.
- Masking tape.



Procedure:
1. Discuss: maps are flat, yet they can show mountains, valleys, hills, and flat areas. Tell the students that they will experience making one type of map (topographic) by drawing lines (contour lines).

2. Tell students they are going to learn about a specific type of map called a topographic map.

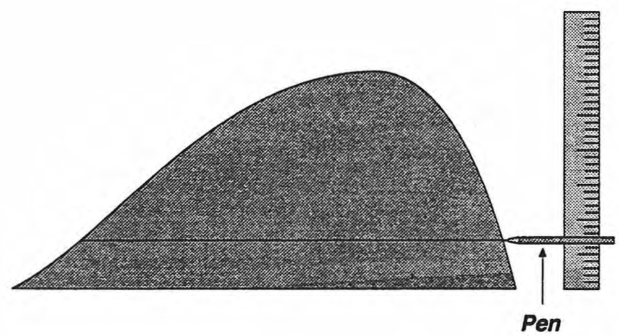
They've already seen one map that shows topography through colors and shaded relief. The topographic map shows topography (the landscape) by lines that represent elevation. Called **contour lines**, they connect points that are the same elevation. The closer together the lines, the steeper the slope.

3. Attach one felt tip pen to a ruler on the ½ inch mark, so that the pen is perpendicular to the ruler. Attach the other color pen to a different ruler on the 1 inch mark.

4. On a table, lay down a large piece of paper or some other table cover to keep the sand off the table. Place sand on the table cover and construct a hill with the sand. For best results, make a very steep side and a gentle side with some sand fanning out on the gentle side at least ½ inch height.

5. Lay the saran wrap (or aluminum foil, paper towel, or plastic bag) over the hill and hold it in place.

6. Have one student hold the ruler with the attached pen on the ½ inch mark on the table, with the ruler perpendicular to the table. Have them slide the ruler around the hill, keeping the ruler on the table, and trace a line all around the landform at the ½ inch height, on the landform covering (e.g. saran wrap).



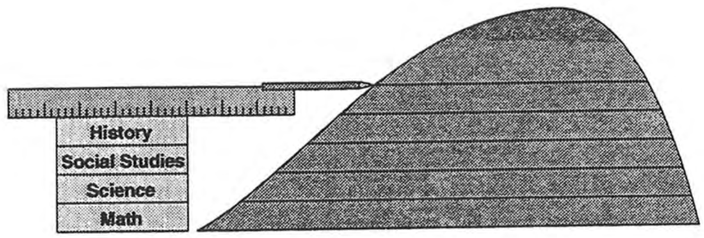
7. With the 2nd ruler and different color pen attached at the 1 inch mark, repeat the previous step.

8. Repeat steps 3,4, and 5 alternating the two pen colors and raising the pens each ½ inch increment until you've reached the top of the landform.*

9. Take the saran wrap off the landform and lay flat on the table. Your flattened paper now represents a topographic map. Compare the contour lines on the map the students made with the landform. Ask for observations. *Contour lines close together represent steep slopes, each line represents a ½ inch increase in height from the table, etc.*

* In order to draw the lines at higher elevations, where the hill top gets smaller in circumference, you may need to change to an alternative way to reach further with the pens. For example, you can use two rulers on each side of the landform and have a student hold another ruler or straight stick between the two rulers to mark where the taped pens could not reach. Or lay books at the height you wish to mark, and with a pen attached to the tip of a ruler

and place on top of the books horizontally, draw the contour lines by moving the books around the landforms.



Teachers note - your flattened paper model will actually be larger at the base than the landform you traced, which is an inherent error in accurate representation of your hill in this exercise. But, your "flat map" will not be too far off scale, so this should not be a problem for what this activity intends to show.

STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
ILO's	1. Make observations. 5. Know basic science facts. 6. Use the language/concepts of science as a means of thinking and communicating.

Activity #24

FINDING GEOLOGICAL FEATURES ON A TOPOGRAPHIC MAP

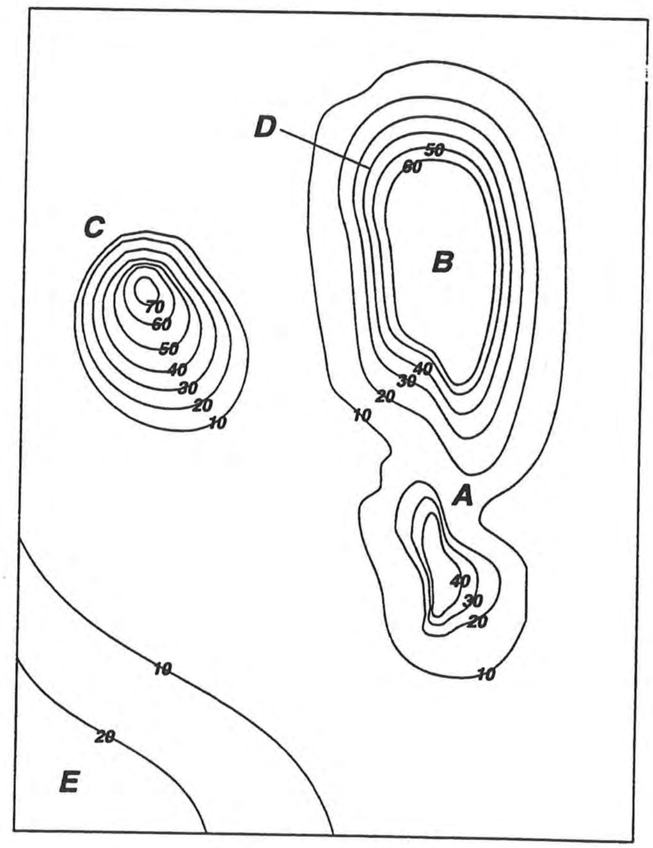
Background:
Topographic maps show the shape (elevation differences) of the land surface through the use of contour lines, which connect points of equal elevation on the earth's surface.

Vocabulary:

- topography
- topographic map
- contour line

The Big Idea:
Identifying geological features on a topographic map.

Landforms can be identified on topographic maps. In this activity, a mesa, two buttes, and a volcano can be identified. A mesa (A) is a flat-topped mountain bordered on at least one side by a steep cliff. Mesas get smaller as their cliffs erode and become small, flat-topped hills called buttes (B). These landforms are common in southern Utah. In parts of western Utah, magma (hot, melted rock) rose to the ground surface and formed volcanoes - shown here is a conical-shaped volcano (C). Contour lines close to each other represent a steep slope or cliff (D). Contour lines spaced further apart represent a gentle slope (E).



Materials:
For the Teacher:
· Overhead transparency of the topographic map.
· Overhead projector.

For the Student:
· Topographic Map Worksheet.
· Crayons or colored pencils (green, dark blue, light blue, orange, red, pink, yellow).

Procedure:

1. To enable students to discover and visualize the mesa, buttes, and volcano, have them color each contour interval (the space between two lines) a particular color.

For the spaces between contour lines representing:
10 and 20 feet in elevation, color green
20 and 30 feet - dark blue
30 and 40 feet - light blue
40 and 50 feet - orange
50 and 60 feet - red
60 and 70 feet - pink
greater than 70 - yellow

(Teachers Note* topographic maps are usually not colored - except to show water bodies in blue, vegetated areas in green, and roads or other features may have varied colors. However, for this activity and the next activity, students will color in areas of different elevations to help them "see" topography through the use of contour lines.

2. Use the overhead transparency as a guide for the following steps.

3. Question: Where is the lowest land? *All of the area not colored is lower than 10 feet in elevation - so it's all of the area between the volcano, the mesa, and the slope at the lower left.* Where is the highest? *The yellow on top of the volcano.*

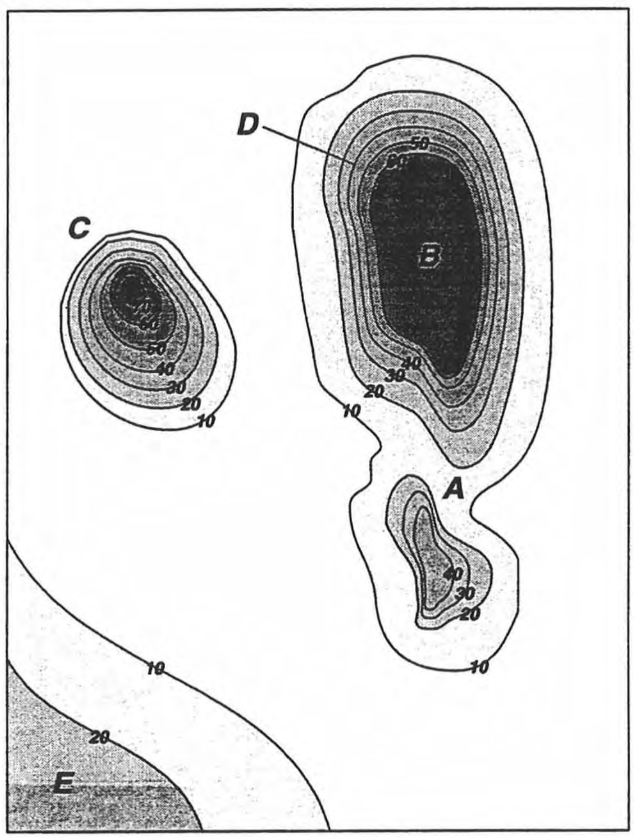
4. Discuss spacing between contours and how spacing shows steep or gentle slopes.

5. Questions. Where are some very steep slopes? Where is the gentlest slope (answers on previous page).

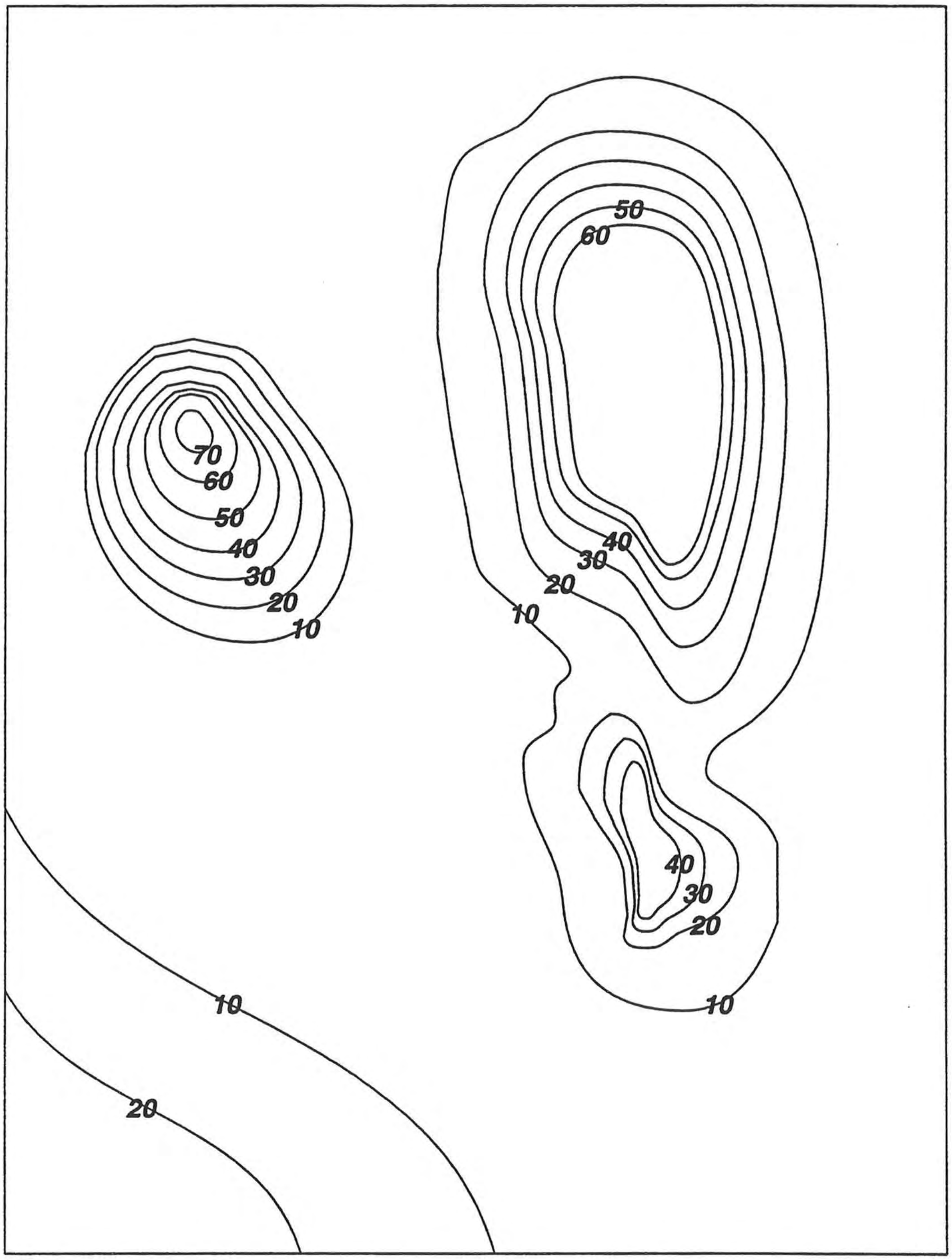
6. Help the students discover the mesa, buttes, and volcano. Which butte is higher? Is the volcano higher than the buttes?

7. If the students wanted to hike up the volcano, which side of the volcano would be the easiest route to hike?

8. Follow up by showing the slide of a mesa and butte.



Activity 24 Master



STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
ILO's	1. Develop and use categories to classify observations. 5. Know science terminology.

Activity #25

UTAH SHADED RELIEF MAP
and corresponding contours

Background:
Shaded relief maps and topographic maps show topography, or the landscape (shape of the land), but in different ways. Students can identify geological features on these maps, although it will be more difficult for them to interpret a topographic map. Comparing the two maps of the same place helps with the identification process.

The Big Idea:
Visualizing/identifying geological features in Utah on a shaded relief map and on a topographic map.

Vocabulary:

- topography
- shaded relief map
- topographic map
- contour line

Materials:
For the Teacher:
- Digital shaded-relief map (green) of Utah (U.S. Geological Survey Map I-1847, sheet 1).
- Master of hand-drawn, 8 ½" x 11' topographic map.
- Overhead transparency of the topographic map.
- Overhead projector.

For the Student (individual):
- A copy of the topographic map.
- Blue colored pencil and other colored pencils.

Procedure:(shaded relief map)
1. Ask students what maps show. (There will be numerous answers). Acknowledge that there can be many different maps of the same place, and not all information about a place can be put on one piece of paper. Have students bring in different maps (some can be cut out of magazines, newspapers, etc.) and develop a bulletin board showing as many different types of maps as possible.

2. Display the green-colored shaded relief map of Utah. Ask students to describe what they see (lakes, land, rivers, roads, towns, mountains, valleys, colors - note that the brown, green, and white colors on this map show elevation).

3. Direct questions to what geological features they see. Hints to locating features on this map include ideas like roads typically go around mountains, but through valleys. To help them see mountains or canyons, use several of the slides (photos) provided, and discuss the "bird's-eye-view" vs. the "street view" of these geological features. The Colorado Plateau is difficult to see, but some students may be able to pick out mesas and buttes. They also may see the river canyons, or at least find rivers and observe the various types of paths rivers take (straight, meander, etc.)

4. Ask questions, such as where are the highest points in the state? *The areas colored white* are all higher than 3048 meters or 10,000 feet above sea level. Where are the lowest land areas in Utah? *The browns in southern Utah* are less than 304.8 meters or 1,000 feet above sea level.

5. Lead students into an understanding how geological features influence where roads and cities are located. Do the roads go around mountains? Why? Where are the major cities? Why? *Water, wood, and other resource availability.*

Procedure (topographic map):

6. Use the overhead transparency of the topographic map to guide the following steps.

7. Hand out the copy of the 8 ½ x 11 topographic map. It is drawn at the same scale (same size) as a portion of the relief map and includes the Great Salt Lake area. Have students describe various things they see (roads, lake, contour lines). The contour lines are numbered 1, 2, 3, or 4 (4 representing the highest elevation contour line). Have them color the Great Salt Lake blue.

8. Looking for the contour lines, which in this case are indicating areas of higher land, have students describe where they see mountains. Comparing their map with the shaded relief map, have them label the Promontory Mountains, Antelope Island, the Oquirrh Mountains, and the Stansbury Mountains.

9. Find Interstate 80. Tell students that I-80 goes west from Salt Lake City near the junction of I-15 and I-80 shown. If I-80 has to start going west at that junction, could it go anywhere else other than where it is (lead to discovery that I-80 and other roads generally have to go around water bodies and around mountain ranges. I-80 would not go over the Oquirrh and Stansbury mountains).

10. Looking at the four mountain areas, can they tell which mountains are the highest? (the *Oquirrhs and Stansburys* are the highest because they have contour lines numbered up to 4. Compare this map with the shaded relief map. Do the same mountains look higher on the relief map? *Yes.*

11. Which side of the Stansbury Mountains is the steepest? *The west side, or left side of the mountain range.*

12. Find Stansbury Island on the relief map. Can they find it on the topographic map?

13. Coloring fun* (Teachers Note* topographic maps are usually not colored - except to show water bodies in blue, vegetated areas in green, and roads or other features may have varied colors. However, for this activity and the previous activity, students will color in areas of different elevations to help them "see" topography through the use of contour lines). Have the students color in the rest of the map, choosing their own colors for each contour interval (the space between two lines):

color A between the lines 1 and 2 (which will be all the area surrounding the Great Salt Lake and surrounding the mountains)
color B between the lines 2 and 3
color C between the 3 and 4
color D above the line 4

Extension:

How come the land is not flat in Utah? *Plate movements → uplifting, folding, faulting, stretching, compressing, etc.*

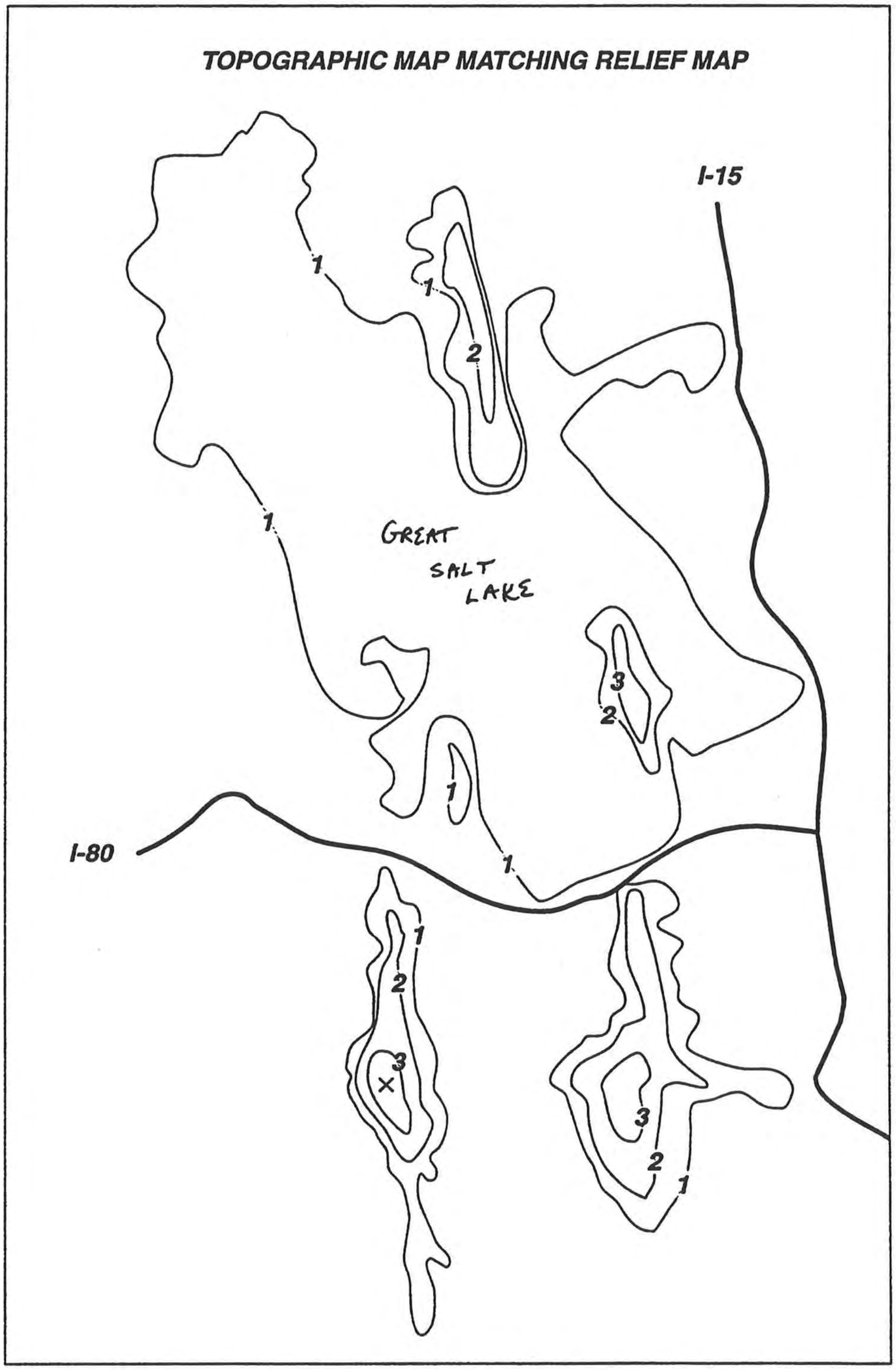
Show other maps of Utah, such as a road map to illustrate another type of map. Ask students what this map shows and what would it be used for. Can they locate any geological features on the map?

Obtain an actual topographic map and display during all your map exercises.

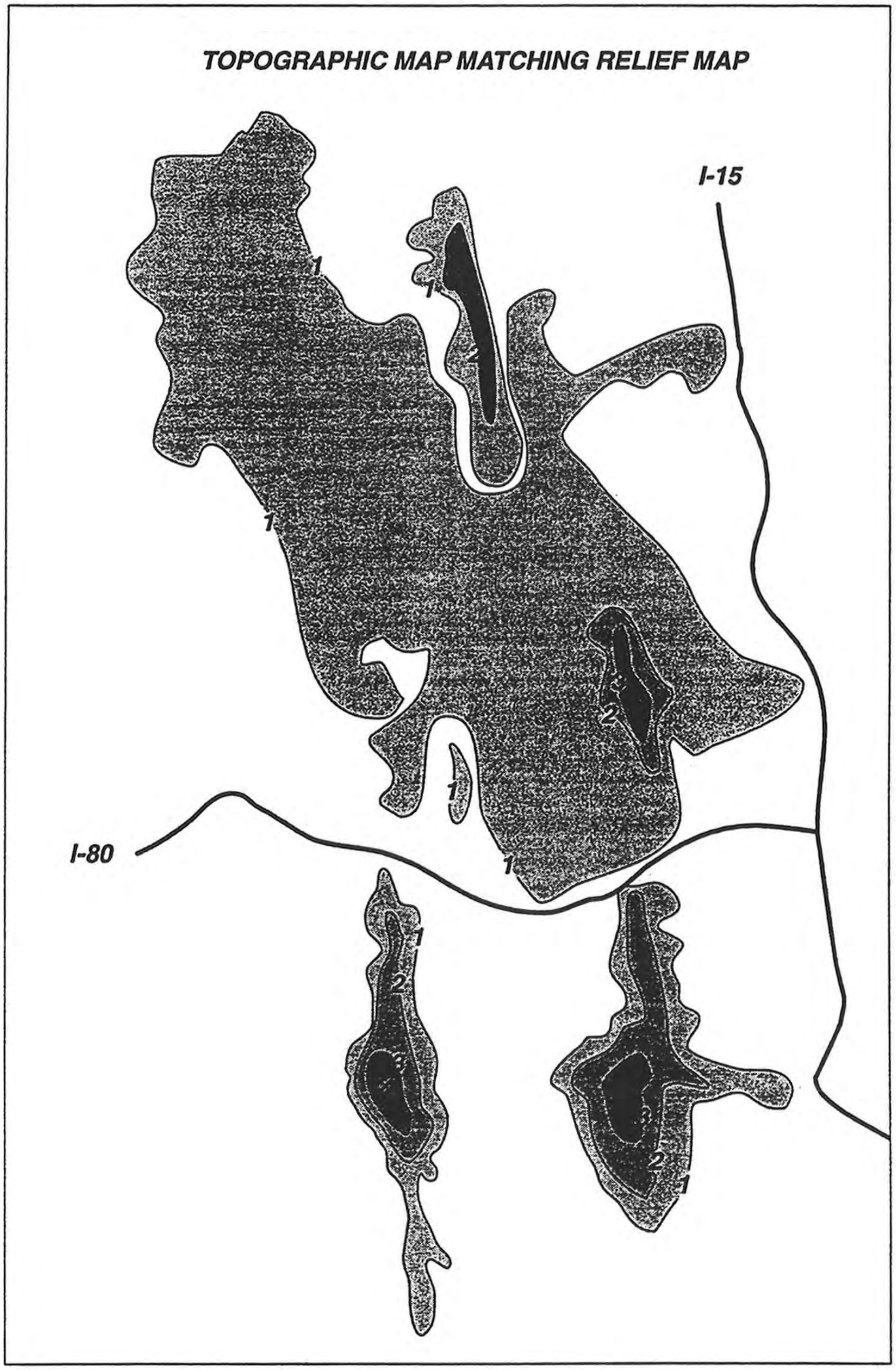
Make a model of a part of the relief map. Build the higher features with salt ceramic (1 c. of salt, ½ c. of corn starch, 3/4 c. of cold water. Mix in double boiler over heat. Stir constantly - thickens in 2-3 minutes. It is done when the dough starts to pull away from the sides and form a ball in the middle of the pan. Knead several minutes after it is cool.) Instruct the students to paint (with powder tempra or water color paints) progressive altitudes with a series of colors to the tops of the mountains.

What Do Maps Show? is a teacher packet available from the U.S. Geological Survey (USGS) and includes a color poster and 4 lessons with maps of the Salt Lake area. See Resources on page 63 for contacting the USGS.

Activity 25 Master



Activity 25 - "possible answer sheet"



STANDARD 3030-03	Students will recognize various geological features and investigate geological processes.
OBJECTIVE 01	Identify various geological features such as mesas, mountains, streams, oceans, and islands.
ILO's	5. Know science terminology.

Activity #26

ASSESSMENT FUN
GEOLOGICAL FEATURES BINGO GAME

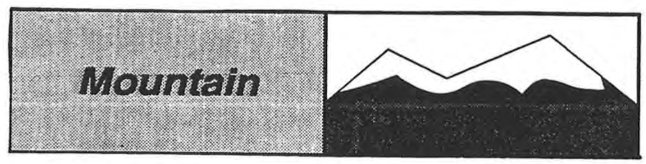
(contributed by Christie Peo)

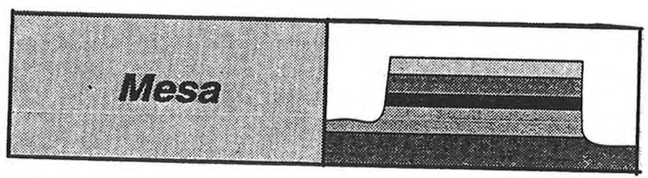
Background:
These 12 geological features should be recognizable to your students.

The Big Idea:
Recognizing names and pictures of geological features.

Vocabulary:

- mountain
- plateau
- valley
- canyon
- delta
- fault scarp
- mesa
- butte
- volcano
- plain
- river
- island





Materials:
For the Teacher:
· Prizes for winners.

For the Student (individual):
· A copy of "Geological Features" bingo grid paper.
· Colored pencils or crayons.
· Markers for bingo.

Procedure:

1. Call out the 12 geological features listed above in the vocabulary box. Have the students write each word at random on their bingo grid.

2. Call out the 12 features again. Have the students sketch the features with crayons or colored pencils in any of the grid squares. All 24 squares (except the free space) should be filled in before beginning the game.

3. Play bingo as usual. When you choose a word, e.g. mountain, the students can only put a marker on the word mountain, not the picture. When you choose a picture, they can only put a marker on the picture.

Name: ______________________________

GEOLOGICAL FEATURES BINGO

		GEOLOGICAL FEATURES FREE SPACE		

VOCABULARY GEOLOGICAL FEATURES 3030-03

Butte An isolated flat tableland higher than the surrounding land with steep cliff sides. It is smaller than a mesa. (buttes are as high as they are wide).

Canyon A steep-walled valley, the sides are rock cliffs.

Cinder cone A small cone-shaped volcano with very steep sides. It is formed mostly from cinders (fragments - about 1 centimeter in diameter - of hardened lava).

Cirque A spoon-shaped depression high in the mountains where a glacier starts forming and cutting back into the walls.

Composite volcano A very tall and large volcano with steep sides. It is formed from many layers of lava, cinders, and other volcanic material.

Continental glacier A glacier that covers large areas of land; found in polar regions (e.g. most of Greenland is covered by a continental glacier).

Contour line A line that connects places on a topographic map which are all at the same elevation.

Core The center of the Earth and is the hottest part of the earth.

Crust The top layer of the Earth. The solid layer that we walk on and is made up of dirt, rock, water, etc. It is a thin layer.

Delta A landform created at the mouth of a river where sediments are deposited into a lake or ocean.

Deposition The laying down of eroded particles (sediments).

Dome mountain Forms from hot molten material pushed up from below. Instead of escaping through a volcano, molten rock rises and pushes the overlying rock layers upward to form a dome.

Earthquake The sudden shaking of the Earth caused by the release of energy stored in rocks.

Erosion The wearing away and carrying away of the land through moving water, ice, gravity, or wind.

Fault A break in the Earth's crust along which earthquake movement has taken place.

Fault block mountain Forms as a giant block of the Earth's crust is forced upwards along a fault.

Fault scarp A steep change in slope (like a small cliff) caused by vertical fault movement from an earthquake.

Fold mountain Forms from the movement of the Earth's crust; when the force of plate movement causes buckling and wrinkling at the earth's surface.

Frost action A weathering process that breaks down rock by repeated freezing and thawing of water.

Glacier A large sheet of moving ice. It forms when layers of snow accumulate and compact the lower layers into ice.

Landslide Earth and rock which becomes loose on a slope and slides down.

Lava Magma that reaches the Earth's surface.

Liquefaction The process in which soil or sand suddenly loses the properties of solid material and instead behaves like a liquid.

Magma Hot liquid rock beneath the Earth's surface.

Mantle The middle layer of the Earth; part of it is semisolid, or something like silly putty.

Mesa A flat tableland higher than the surrounding land, with at least one side being a steep cliff. It is smaller than a plateau. (mesas are wider than they are high).

Moraine A glacial deposit, often looks like a hill.

Mountains are landforms which rise above the surrounding area.

Plain A large area of flat land at low elevation

Plate A huge moving piece of the Earth's crust.

Plateau A large, relatively flat tableland area (made of horizontal rock layers) that stands above the surrounding land.

Rockfall Rock which becomes loose and falls down a slope.

Shaded relief map A map that shows the land's features/elevation differences by depicting what the area looks like with sunlight shining on it from a particular direction.

Shield volcano A low-profile volcano with gentle slopes (it looks like a warrior's shield). It is formed almost completely from lava.

Topographic map A map that shows the shape of the land through the use of drawn contour lines.

Topography The shapes and features of the Earth's surface.

U-shaped valley A valley eroded by a glacier, so it has a wide floor.

Valley A low-lying area bounded by hills or mountain ranges. Usually occupied by a stream.

Valley glacier A glacier that begins high in the mountains and moves downhill through a valley.

Volcanic mountain Forms as hot molten rock material rises and flows or erupts at the earth's surface. Lava, cinder, ash, and rock particles continually build upon each other.

Weathering The breaking down of rocks into smaller pieces by natural processes. Rocks can be broken down by water, air, chemicals, temperature changes (freezing & thawing), and plant and animal activity.

RESOURCES

Videos

Earthquake hazards and safety in Utah, Utah State University. Check your district office, or it is available for purchase ($6.00) at the Utah Geological Survey (UGS).

Hill of Fire, Reading Rainbow.

Experience Utah!, explains the formation of Bryce Canyon. The video also shows other Utah landforms and discusses the science behind their formation.

The Great Alaskan Adventure, Good Morning America, has wonderful footage of glaciers and scientific information about glacial effects on landforms.

National Geographic has learning kits, filmstrips, and videos that show the effects of glaciers and other surface agents of erosion and deposition.

Laser Discs

Windows On Science
Mist (Modular Investigations into Science & Technology)
Science Discovery
Bio Sci I and II
Coronet

Cassette Tapes

Earthquake Sounds Tape, available at State PTA Office, 1037 E. South Temple, SLC, UT 84103; phone: 801-359-3875.

Maps

Specific maps used in this activity packet - Cost per map is $2.40 or $3.20 with education discount.
U.S. Relief Map #56; National Atlas Series.
Utah Digital Shaded Relief Map Packet #I-1847; 1:100,000 (2 maps; 1 green & 1 B/W)
Shaded Relief Map of Utah; 1:500,000.
Topographic Quadrangle maps; 7.5 minute (specify quadrangle or ask for any quadrangle located near your school).

These maps are available from two agencies:
Utah Geological Survey (UGS)
United States Geological Survey (USGS).

20% education discount ($3.20 each map) at the Utah Geological Survey with School Purchase Order on school/district letterhead.

Utah Geological Survey/Department of Natural Resources Bookstore
1594 W. North Temple
Salt Lake City, UT 84124 801-537-3320

40% education discount ($2.40 each map) with a minimum of 5 copies of the same map at the Colorado office of the U.S. Geological Survey. Mail or fax your order on school letterhead and include a purchase order number. Include $3.50/complete order for handling fee.

USGS Information Services
Box 25286
Lakewood, CO 80225
phone: 1-800-HELP-MAP Fax : 1-303-202-4693

What Do Maps Show? (mentioned in Activity #25) includes a color poster with 4 accompanying lessons for geography and map reading appropriate for upper elementary. Also includes lessons, 3 reproducible maps and 3 reproducible activity sheets (available from the USGS address above, or online at http://www.usgs.gov/education/teacher/what-do-maps-show/index.html).

Printed Materials/Pictures:

The Wonders of Rivers in Journeys reader by Houghton-Mifflin.

Planet Earth Understanding Science and Nature; published by Time-Life; Alexandria, VA.

Earthquake; Planet Earth Series by Bryce Walker - Time-Life; Alexandria, VA 1982.

Volcano - The Eruption and Healing of Mount St. Helens buy Patricia Lauber; published by Scholastic, 1986.

The Magic School Bus INSIDE THE EARTH by Joanna Cole; Scholastic Books 1987

Issues of **National Geographic** containing articles, pictures about significant earthquakes and volcanoes:

July 1995 *Kobe Wakes To a Nightmare*
January 17, 1995 Kobe, Japan earthquake

April 1995 *Living with California's Faults*
January 17, 1994 Northridge earthquake; anatomy of Landers quake 1992

May 1990 *Africa's Great Rift Valley*
A look at landscape of extremes being created by plate tectonics in East Africa

California Earthquake—Prelude to The Big One?
October 1989 Loma Prieta earthquake (World Series earthquake); includes rare photos of 1906 San Francisco earthquake devastation

July 1988 — *The Day the World Ended at Kourion: Reconsructing an Ancient Earthquake*
July 21, A.D. 365 earthquake on Cyprus

May 1986 — *When the Earth Moves*
Plate movement that caused Mexico City earthquake and volcanic eruption in Columbia in 1985

Eruption in Colombia
November 13, 1985 volcanic eruption that killed 20,000 in resulting mudflow

Earthquake in Mexico
September 19, 1985 magnitude 8.1 earthquake that collapsed 1% of buildings in Mexico City, 250 miles away from epicenter; includes section on earthquake effects on buildings and earthquake research in California

August 1985 — *Our Restless Planet Earth*
Effect of plate tectonics on earth's surface: earthquake and volcanic hazards, landforms; color chart of life throughout geologic time

The Shaping of a Continent - double map
map of plate movement; effects of plate movement on Western North America

May 1984 — *The Dead Do Tell Tales at VESUVIUS*
Latest excavations in Herculanum and Pompeii allow scientific reconstruction of life in Italy 2000 years ago; relates volcanic activity to plate movement

January 1981 — *St. Helens - Mountain With a Death Wish*
In the Path of Destruction
The Day the Sky Fell
Extraordinary photos of Mt. St. Helens eruption May 18, 1980

Pompeii of Prehistoric Animals in Nebraska
Ten million year old creatures buried in Great Plains by volcanic ash from eruption to the west many times greater than Mt. St. Helens eruption

June 1976 — *Earthquake in Guatemala*
February 4, 1976 magnitude 7.5 earthquake in Guatemala

Can We Predict Earthquakes?
Scientific efforts to learn more about earthquakes

January 1973 *This Changing Earth*
Evidence for theory of plate tectonics; good diagrams of plates; continental drift,"assembly line volcanoes" formed by Hawaiian hot spot

July 1964 *Alaska Earthquake - Horror Strikes on Good Friday*
What Causes Earthquakes
An Alaskan Family's Ordeal
March 27, 1964 magnitude 8.4 earthquake

March 1960 *Fountain of Fire in Hawaii*
Excellent photos, description of eruption of Kilauea Volcano

The Night the Mountains Moved
August 17,1959 Hebgen earthquake in Montana; good description, pictures of a major earthquake in Intermountain Seismic Belt

SLIDE CAPTIONS GEOLOGICAL FEATURES

1. **Composite Volcano**. Mt. St. Helens (foreground) and Mt. Rainier (background) in the Cascade Range, Washington illustrate how large these type of volcanoes are. Mt. St. Helens does not have the more pointed/conical volcano top because this photo was taken after it "blew its top" in the 1980 eruption (photo courtesy Mike Hylland).

2. **Shield Volcano**. Fumerole Butte in Juab County, Utah. You can see the slight "warrior shield" profile of Fumerole Butte in the distance. Standing in the middle is what's left of the main vent of the volcano (photo courtesy Bill Case).

3. **Cinder Cone**. One of several cinder cones in and around Snow Canyon State Park near St. George, Utah. These volcanoes are cone-shaped, and much smaller than the other types of volcanoes (photo courtesy Bill Case).

4. **Dome Mountain**. The Henry Mountains in Garfield County, Utah are an example of a dome mountain (the Henrys are technically called a laccolith). Magma pushed up overlying rocks into a dome-shaped mountain, but the magma never erupted through to the ground surface and did not become a volcano like those seen in the previous slides (photo courtesy Bill Case).

5. **Plateau**. Part of the Wasatch Plateau in Sanpete and Emery Counties, Utah. Note all the characteristics that define a plateau: (a) flat top, (b) horizontal rock layers making up the plateau, © either a canyon eroding the plateau or a steep edge of the plateau in the foreground, and (d) the plateau is higher than the surrounding landscape in the distance (photo courtesy Utah Geological Survey).

6. **Mesa, Butte,** and **Pinnacle** on the **Colorado Plateau**. In the distance is a mesa (wider than high), a butte (width = height) to the right of the mesa, and a pinnacle (higher than wide) in between. You can also see a river eroding a channel in the foreground (photo courtesy Deedee O'Brien).

7. **River Deposition and Erosion**. Most of a river's energy is around the outside bend of a river. Here you can see the river is eroding on the outside (cutbank) and depositing on the inside of the river's bend (photo courtesy Bill Case).

8. **River Meander** and **Floodplain**. Yampa River, Colorado. A river starts to meander on relatively flat land, as this river is. Note the floodplain (deposition area that can easily become flooded) within the older river terraces (photo courtesy Bill Case).

9. **Entrenched Meander**. San Juan River, Utah. The San Juan River flows through classic, textbook entrenched meanders. A meandering pattern was established and as the Colorado Plateau (note the horizontal rock layers characteristic of a plateau) gently uplifted, the meanders began cutting and still carve into the rock layers (photo courtesy Bill Case).

10. **River-eroded Canyon** and **Fault-block Mountain.** Millcreek Canyon in the Wasatch Range near Salt Lake City. This canyon has steep rock walls (definition of a canyon), and has a "**V**" shape, indicating that a river (versus a glacier) cut down through the rock to form the canyon. Notice the steep mountain front, which - in this case - indicates a mountain range raised along a fault (photo courtesy Bill Case).

11. **Valley Glacier**. Before comparing a V-shaped canyon (slide #10) with a glacier eroded U-shaped canyon (slide #13), look at this glacier in the Wind River Range, Wyoming. The glacier begins high up in the mountains, where a **cirque** is forming (this is where the snow accumulates, and the compacted snow - now thick ice - cuts back into the rock walls to form a spoon-shaped depression, called a cirque). As the ice continues to cut back into the surrounding rock walls, the rock walls become sharp rock ridges (called **aretes**). The glacier slowly moves down the valley, via gravity. It picks up rock and dirt as it moves, and drops the material along its side (lateral moraine) and at its end (terminal moraine). A lateral **moraine** is visible in this photo - the rocky "hill" at photo left.

12. **Glacial moraine**. Canada. A moraine is made up of the rocks and dirt the glacier deposited as the ice melted. Typically a moraine takes on the form of a ridge like in this photo.

13. **Glacial features** and the **Wasatch Fault**. Little Cottonwood Canyon in the Wasatch Range near Salt Lake City. This canyon has a "**U**" shape, as opposed to the "V" shape of Millcreek Canyon in slide #10. The "U" shape was created by a glacier that scoured and widened the canyon as it slowly moved down toward the valley. Other glacial features include a **moraine** deposited where the glacier melted. The moraine most evident in this photo is the one deposited on the glacier's left side (technically called a lateral moraine), where it melted at the mouth of the canyon. The moraine is the low ridge in the bottom center of photo, or the right side of Little Cottonwood Canyon as you look up the canyon. It is much like the moraine in the previous photo, except it is older and therefore covered with some vegetation. The **Wasatch Fault** crosses the moraine. At least two fault scarps (there have been numerous large earthquakes to create these large and multiple fault scarps) show in this photo as shadowed lines tracing across the moraine. You can trace the fault scarps all the way across the photo (photo courtesy Utah Geological Survey).

14. **Fault scarp**. Borah Peak, Idaho. This is what a newly created fault scarp would look like. The scarp formed suddenly during the Borah Peak earthquake (magnitude 7.3) in 1983. The two people are standing on the downthrown block. The ground was offset about 8 feet here. Most vertical displacement occurs at the fault scarp, while the overall effects of mountains rising and valleys dropping are less dramatic. From this earthquake, overall, the mountain side of the fault (mountain block) rose 0.7 feet, and the valley side (valley block) dropped 3.9 feet. Fault scarps in Utah are expected with earthquakes over magnitude 6.0 and could range from fractions of inches to 20 feet high. Relative overall effects of mountains

rising and valleys dropping would be similar to what happened in the Borah Peak earthquake (photo courtesy Bob Rasely).

15. **Lake features**. Point of the Mountain (photo left) at the border of Salt Lake and Utah Counties. The flat bench to the right of Point of the Mountain and the drop-off from the bench are old shorelines from ancient Lake Bonneville. Lake Bonneville existed about 30,000 to 12,000 years ago and covered Utah's western valleys and extended into Idaho and Nevada (photo courtesy Sandy Eldredge).

16. **Shoreline** vs. **Fault**. Davis County, Utah. The difference between the Lake Bonneville shoreline and the Wasatch Fault can be seen in this photo. The shoreline maintains a relatively level elevation, whereas the Wasatch fault crosses up and down topography. In this photo, the shoreline is seen across the whole photo at a point where the mountain front gets steeper. The fault here is below the shoreline (this is not always the case) - look for the dark shadow at photo left and trace its curve out further into the valley as you look to the right (photo courtesy Utah Geological Survey).

17. **Big Step Erosion** by a **River**. A flash flood caused this erosion which places this home at risk.

18. **Big Step Erosion and Deposition** by a **Landslide**. Thistle Landslide, Utah County, 1983. A wet spring activated this landslide, which dammed the Spanish Fork River and flooded the town of Thistle. It also crossed railroad tracks and the main road, completely blocking these routes for months. At about $337 million, Thistle Landslide is the costliest landslide in the history of the United States (photo courtesy Utah Geological Survey).

19. **Earthquake causes Landslide**. Springdale Landslide, Washington County. In 1992, a magnitude 5.9 earthquake near St. George caused this landslide in Springdale, 28 miles away. The landslide scarp in this instance looks like a fault scarp. The scarp is the fresh light-brown colored face below the cliff bands, and ranges up to 80 feet in height. The slide moved downslope about 40 feet and crossed the road in several places, surrounding, but miraculously not touching a restaurant seen in the middle of the photo (photo courtesy Utah Geological Survey).

20. **Earthquake causes Rock Falls**. San Rafael Swell, Emery County. Dust from rock falls triggered by the magnitude 5.3, San Rafael Swell, 1988 earthquake (photo courtesy Utah Geological Survey).