Utah's Geological History

Standard I I :

Students will understand that volcanoes, earthquakes, uplift, weathering, and erosion reshape Earth's surface.

Objective 2:

Explain how volcanoes, earthquakes, and uplift affect Earth's surface.

Objective 3:

Relate the building up and breaking down of Earth's surface over time to the various physical land features.

Intended Learning Outcomes:

1. Use science process and thinking skills
2. Manifest scientific attitudes and interests
4. Communicate effectively using science language and reasoning

Content Connections:

Social Studies 11-1; Use maps to analyze physical features

Science Standard II

Objectives 2 & 3

Connections

Background Information

Earth's surface is constantly changing. Some changes happen very slowly over long periods of time, such as weathering, erosion, and uplift. Other changes happen abruptly, such as landslides, volcanic eruptions, and earthquakes. All around us, we see the visible effects of the building up and breaking down of Earth's surface.

Most students grasp an understanding of weathering and erosion, but they do not understand geological forces and process that have occurred on Earth over long periods of time. Common misconceptions are that Lake Bonneville was the only lake that existed in Utah; volcanoes are the only things causing Earth's surface to uplift; and Earth is not changing. While it is true that Earth will not change very much in their lifetime, Earth is changing all the time. These activities are designed to help students understand that erosion and uplift are forces that are active right now and they have and will continue to change Earth's geological face.

This activity is designed to familiarize the students with the vocabulary, investigate the geological changes that Utah has gone through over time, and develop an understanding that uplift creates the mountains and valley areas on Earth's surface and that fault lines are often in earthquake zones.

Research Basis

Sutton,]. & Krueger, A. (Eds.). (2002). *Thoughts: What we know about science teaching and learning*. How does teacher pedagogical knowledge impact instructions? Aurora,

How does teacher pedagogical knowledge impact instruction CO: Mid-continent Research for Education and Learning 28-29

This article stresses that different teaching methods accomplish different goals. High-quality science teaching should include a deep knowledge of subject matter, incorporates inquiry, and focuses on skills of observation, information getting, predicting, and testing. It should be carefully aligned to curriculum, assessment, and high standards. Building on real-life situations that apply concepts (hands-on) deepens understanding. Varied opportunities for discussion and reflection are incorporated in science teaching.

TAN, Kok Siang Qune, 2007) Using "What if' questions to teach science. *Asia-Pacific Forum on Science Learning and Teaching,* Volume 8, Issue 1, Article 16. Accessed January 5, 2008 http://www .ied.edu.hk/apfslt/v8_issuel/tanks/tanks5.htm

Using "what *if'* questions are a reflective learning strategy that can be effective in classroom situations. Students are actively engaged in thinking up possibilities, talking about ideas and developing deeper insights. Through "what if" questions social interaction occurs and real life problem solving skills are employed.

Invitation to Learn

Invite students to hypothesize: What geological change has Utah has gone through over time? Ask what they might know about Utah's area was once filled with water (Lake Bonneville). At this time if students are unable to use correct terminology, review vocabulary. Two ways are provided: *Vocabulary Match* and *Vocabulary Whip.* Directions for Vocabulary Whip - Ask one person to start; he/she reads their card exactly as written. The next person to read has the card that has the vocabulary word for the definition read. Students continue to read their cards until it returns to the first person that read. (It does not matter which definition is read to start the game.)

Materials

- ❑ *Blank Utah Map*
- ❑ *Vocabulary Match Answers*
- ❑ *Vocabulary Match*
- ❑ *Vocabulary Whip*
- ❑ Poster —Utah: A Geologic History
- ❑ *Utah Cutout Descriptions*
- ❑ *Fault Blocks*
- ❑ *ABC Fault Blocks*
- ❑ *Wasatch Fault Figure*
- ❑ Utah Relief Map
- ❑ 3D Stereo Topographic Map of Utah
- ❑ 3D Glasses

Instructional Procedure

1. Ask the Big idea question: "What geological processes has the Utah area gone through over time?" What made the mountains? What made the valleys? How long did it take?

   Group Activity: Use the cutouts from the Utah: A Geologic History poster. In this activity students will look at cutout pictures of Utah's geological past. Pass out the cutouts. Ask each group to hypothesize what is going on in their cutout pictures. Then using the Utah: A Geologic History poster, have each group try to determine where the cutout fits into the poster. It should be

very difficult for them to determine where to place their cutout. Have all the students be seated and invite several students to read the Utah Cutouts information card set. Start at #1. As the card is being read, the group that has that cutout will come and put it on the poster. Discuss what geological forces are apparent in the cutout and what happened at that stage of Utah's development. Focus on what processes would have been working on the Utah area at that particular time. (Volcanoes, uplift, erosion) Encourage open discussion about the geological processes that would have caused the changes the picture represents and how Earth's surface has been built up (uplift) and eroded away (erosion). Close this part of the activity by asking, "How do scientists know this information?" "What evidences do they use to determine what Utah used to look like?"

2. Show the Utah Relief Map. Invite students to come up and point out geological features they can see.
3. Develop understanding by using the cardstock *Fault Blocks*. Use the blocks to show how mountains and valleys are formed. Point out that mountain uplift is occurring on one or both sides of the fault blocks and a valley is being made in the middle. Discuss, "What if only one side of the fault is uplifted?" Handout *ABC Fault Block* page to students. Have them cut out the blocks and use them as you demonstrate what the questions are asking on the handout. Develop the idea that A and C moving away from each other create mountains (A, C) and the B area would become a valley. Then move A and C together. Help students understand that uplift would occur (B area). Show *Wasatch Front* figure. Ask questions to correlate how the figure and the fault blocks are similar. (Students should discover that where the mountains and valley meet there is a fault line.)
4. Hypothesize – What if there were no uplift forces or erosion, what would happen to Earth? Have a few students respond to this. Direct the discussion until students understand that Earth would be flat and unchanging without these acting upon it.
5. Use the 3D Stereo Topographic Map of Utah and 3D glasses. Allow students to view the map with the glasses so they can see how topographic map lines show physical features of Earth. Invite several students to find areas where uplift has occurred. Find areas were drainage and erosion has had an effect. Have students locate rivers and have them trace or hypothesize how water flows down mountains into rivers and finally into drainage areas.

6. Introduce the idea that Utah has a fault line. This is an area where forces from plate tectonics have compressed Earth. Use a long sleeve of someone in the group. Push up the sleeve and see how the material wrinkles, and then as the force is released it spreads out more, but still has lines in it. Use the Utah Relief Map to analyze area5 where Earth has been compressed, uplifted, eroded, etc. Direct students to look at the area west of the Great Salt Lake and into Nevada. Have them find the lines that show where uplift has occurred because of compression and how it has spread out as the compression has released.
7. The final step in the lesson is to locate fault lines in Utah. Use *Blank Utah Map* and have students draw a faint line where they think the fault line might be located. Draw the shape of Utah on a whiteboard or chalkboard. (Teacher refers to Wasatch Fault booklet for information on fault line.) Have an open discussion to develop the idea that this is why Utah is in an earthquake zone and has frequent earthquakes. Discuss that there are many faults all over Earth's surface and help students understand that fault zones are one reason for frequent earthquakes throughout the world.

Assessment Suggestions

- Participation in vocabulary activities and Utah Geological timeline.
- Use *ABC Fault Blocks* to show how a valley and mountains are made. Journal activity, draw ABC Fault Blocks in book and label with arrows uplift, valley, mountain.
- Correctly identify the Utah fault line on the blank map.
- Journaling activity – either written or pictorially, list several answers to the big idea question of

  "What geological processes has the Utah area gone through over time?"
  (Some things that should be in the journal would be fault blocks, uplift, mountains, valleys, other changes, fault lines and earthquakes.)

Curriculum Extensions/Adaptations/ Integration

- *Utah Geological Survey Activity 21* – which is a lesson about locating geological features on United States Shaded Relief Map
- Invite students to learn about the hazards of earthquakes in Utah, e.g., liquefaction.

- Invite students to learn about seismographs and how they are used with earthquakes.
- Allow students to draw pictures of vocabulary words in a journal so they can make associations with vocabulary words.
- Make a Social Studies connection by having students predict what physical features of Utah helped it become a part of the United States. (e.g. migration trails, Great Salt Lake, desert, mineral deposits – mines in Utah).
- Use a World Map and draw the major plates of plate tectonics.
- Research natural resources that are unique to Utah and how those resources are used in everyday life.
- In a newspaper or travel magazine find articles about Utah's geology.
- To reinforce vocabulary, use *Capitol Reef* web page handout. Students (group or individual) highlight any vocabulary words that can be found in the document. Have several volunteers share the vocabulary words they found in the document.

Family Connections

- For extending learning at home invite families to identify geologic features in their own area.
- Collect rocks near students' homes and determine what geological forces have created that rock.
- Identify earthquake hazards in their own town.
- Learn what to do during an earthquake at home and other places.
- Invite families to find rocks or other formations that show changes that Utah has gone through.
- Look through a Utah Travel guide and find places in Utah that t have unique geology.
- Plan a visit to a geological museum in their area.
- Find what geological features Utah is famous for and try to locate and collect postcards of that area.
- Provide a set of *Vocabulary Match* for practice at home.

Additional Resources

Booklet

The Wasatch Fault, Utah Geological Survey Public Information Series 40, 1996; ISBN 1-55791-387-0 available PDF http://ugs.utah.gov/online/pdf/pi-40.pdf

Earthquake hazards and safety in Utah (pdf), Public Information Series #6 http://ugs_utah. gov/online/pdf/pi-6,pdf

Photo essay offour Utah earthquakes, 1921-1972 (pdf) Public Information Series #72 http:// ugs_utah.gov/online/pdf/pi- 72 .pdf

Media

Vocabulary PowerPoint , by Gennie Kirch developed using Microsoft Office, 2008

Utah: A Geologic History, Utah Geological Survey; Public Information Series #54

Wasatch Front poster and Faull Blocks, Utah Geological Survey, UGS office at the Department of Natural Resources (DNR) Building at 1594 West North Temple, Suite 3110, Salt Lake City. 801.537.3300; http·//www.ugs state.ut.us/

Web sites

How was Utah's Topography Formed? http://geology.utah.gov/surveynotes/gladaskedl gladtopoform.htm

Recent Utah Earthquakes, University of Utah Seismograph Stations http://www.quake. utah. edu/recactivity/recent.shtml

Capitol Reef - http://www.nps.gov/archive/care/geologyl.htm

USGS National Map Viewer http://nmviewogc.cr.usgs.gov/viewer.htm

USGS Earthquakes http://earthquake.usgs_gov/

U of U Seismograph Stations Research: Basic Information about Active Faults of Utah

http://www.seis,utah .edu/edservices/EES/ActiveFaultlnfo .shtml

Utah Museum of Natural History http://www.umnh.utah.edu/

Organizations

Utah Geological Survey , UGS office at the Department of Natural Resources (DNR) Building at 1594 West North Temple, Suite 3110, Salt Lake City. 801.537.3300; http://www.ugs. state.ut.us/

Local Earth-Science Resources for Utah Teachers http://geology .utah.gov/teacher/teacher resources.htm

Teaching Kits

Rock, mineral, and fossil; grade 4 (can also be used for grades 2 [rocks], and 8 and 9 [extinction]).
Landforms; grade 5
Dinosaurs; grades K-6.
Ice Age; grades 4, 8, and 9 (includes extinction and climate change).

All kits are available at the UGS for a refundable deposit. Call 801-537-3300 or http :// geology.utah.gov/teacher/teachkits.htm for more information about these kits.

Classroom Materials

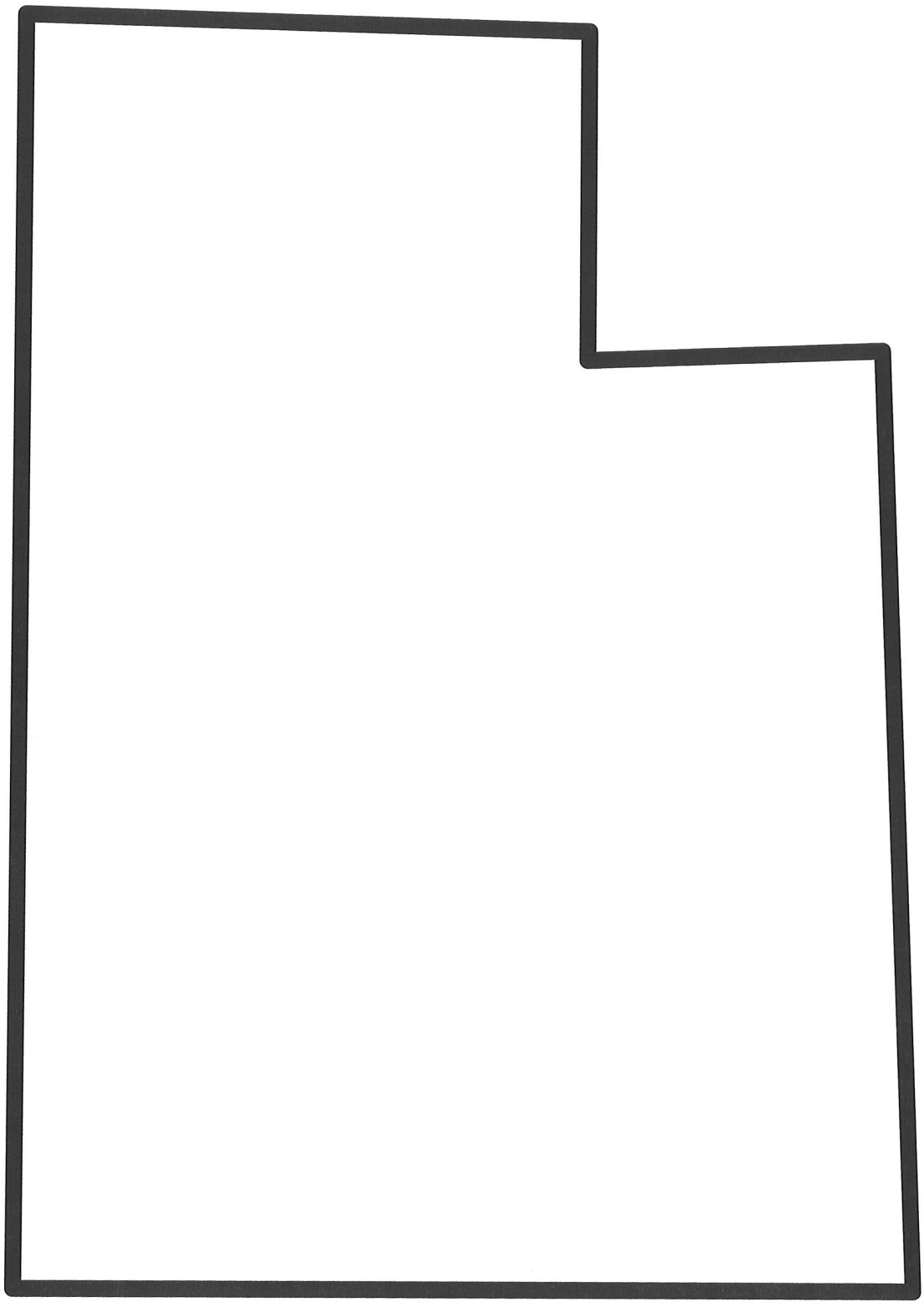
Hands-on Activities

5th-grade landforms and geologic processes (volcanoes, earthquakes, uplift, weathering, erosion, deposition): contact Sandy Eldredge (UGS) at 801-537-3325.

Slide Sets

5th-grade landforms and geologic processes: contact Sandy Eldredge (UGS) at 801-537-3325.

Utah Map



Vocabulary Match (Answers)

Arch Arching landform created by weathering and erosion.	**Erosion** To carry away, to wear away. Removal of rocks and dirt by wind, water and ice.	**Weathering** The process of breaking down rock and other materials into smaller pieces. Weathering breaks it down. Erosion carries it away.
Uplift Upward movement of Earth's crust.	**Earthquake** Shaking or trembling of the earth caused by movement along a fault.	**Volcano** Vents in Earth's crust that lava and steam can travel through.
Glacier Slow-moving masses of snow and ice that carry rock and dirt.	**Flash Flood** A flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours. A flash flood rises rapidly, often with little or no warning.	**Avalanche** A fall or slide of a large mass, as of snow or rock, down a mountainside.

Erode To wear away	**Landslide** A slide of a large mass of dirt and rock down a mountain or cliff.	**Butte** A steep, flat-topped hill created by erosion.
Fault A break or fracture in the crust of Earth.	**Geological** Having to do with geology, the study of Earth.	**Wind Erosion** The wearing away of soil and other sediments by winds that remove soil from one point on the Earth's surface and deposit it elsewhere.
Water Erosion The carrying away of soil and sediments by water that remove sediments from one point to another.	**Deposition** The process of layering sediments.	**Chemical Weathering** Chemical reactions break down the bonds holding the rocks together, causing them to fall apart, and forming smaller and smaller pieces.

Vocabulary Match

Arching landform created by weathering and erosion.	To carry away, to wear away. Removal of rocks and dirt by wind, water and ice.	The process of breaking down rock and other materials into smaller pieces. Weathering breaks it down. Erosion carries it away.
Upward movement of Earth's crust.	Shaking or trembling of the earth caused by movement along a fault.	Vents in Earth's crust that lava and steam can travel through.
Slow-moving masses of snow and ice that carry rock and dirt.	A flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours. A flash flood rises rapidly, often with little or no warning.	A fall or slide of a large mass, as of snow or rock, down a mountainside.

To wear away.	A slide of a large mass of dirt and rock down a mountain or cliff.	A steep, flat-topped hill created by erosion.
A break or fracture in the crust of Earth.	Having to do with geology, the study of Earth.	The wearing away of soil and other sediments by winds that remove soil from one point on the Earth's surface and deposit it elsewhere.
The carrying away of soil and sediments by water that remove sediments from one point to another.	The process of layering sediments.	Chemical reactions break down the bonds holding the rocks together, causing them to fall apart, and form smaller and smaller pieces.

Arch	Erosion	Weathering
Uplift	Earthquake	Volcano
Glacier	Flash Flood	Avalanche

Erode	Landslide	Butte
Fault	Geological	Wind Erosion
Water Erosion	Deposition	Chemical Weathering

Vocabulary Whip

I have Chemical Weathering. I am looking for the word that means Arching landform created by weathering and erosion.	**I have Arch.** I am looking for the word that means To carry away, to wear away. Removal of rocks and dirt by wind, water and ice.	**I have Erosion.** I am looking for the word that means The process of breaking down rock and other materials into smaller pieces. Weathering breaks it down. Erosion carries it away.
I have Weathering I am looking for the word that means Upward movement of Earth's crust.	**I have Uplift.** I am looking for the word that means Shaking or trembling of the earth caused by movement along a fault.	**I have Earthquake.** I am looking for the word that means Vents in Earth's crust that lava and steam can travel through.
I have Volcano. I am looking for the word that means Slow-moving masses of snow and ice that carry rock and dirt.	**I have Glacier.** I am looking for the word that means A flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours. A flash flood rises rapidly, often with little or no warning.	**I have Flash Flood.** I am looking for the word that means A fall or slide of a large mass, as of snow or rock, down a mountainside.

I have Avalanche. I am looking for the word that means To wear away.	**I have Erode.** I am looking for the word that means A slide of a large mass of dirt and rock down a mountain or cliff.	**I have Landslide.** I am looking for the word that means A steep, flat-topped hill created by erosion.
I have Butte. I am looking for the word that means A break or fracture in the crust of Earth.	**I have Fault.** I am looking for the word that means Having to do with geology, the study of Earth.	**I have Geological.** I am looking for the word that means The wearing away of soil and other sediments by winds that remove soil from one point on the Earth's surface and deposit it elsewhere.
I have Wind Erosion. I am looking for the word that means The carrying away of soil and sediments by water that remove sediments from one point to another.	**I have Water Erosion.** I am looking for the word that means The process of layering sediments.	**I have Deposition.** I am looking for the word that means Chemical reactions break down the bonds holding the rocks together, causing them to fall apart, and forming smaller and smaller pieces.

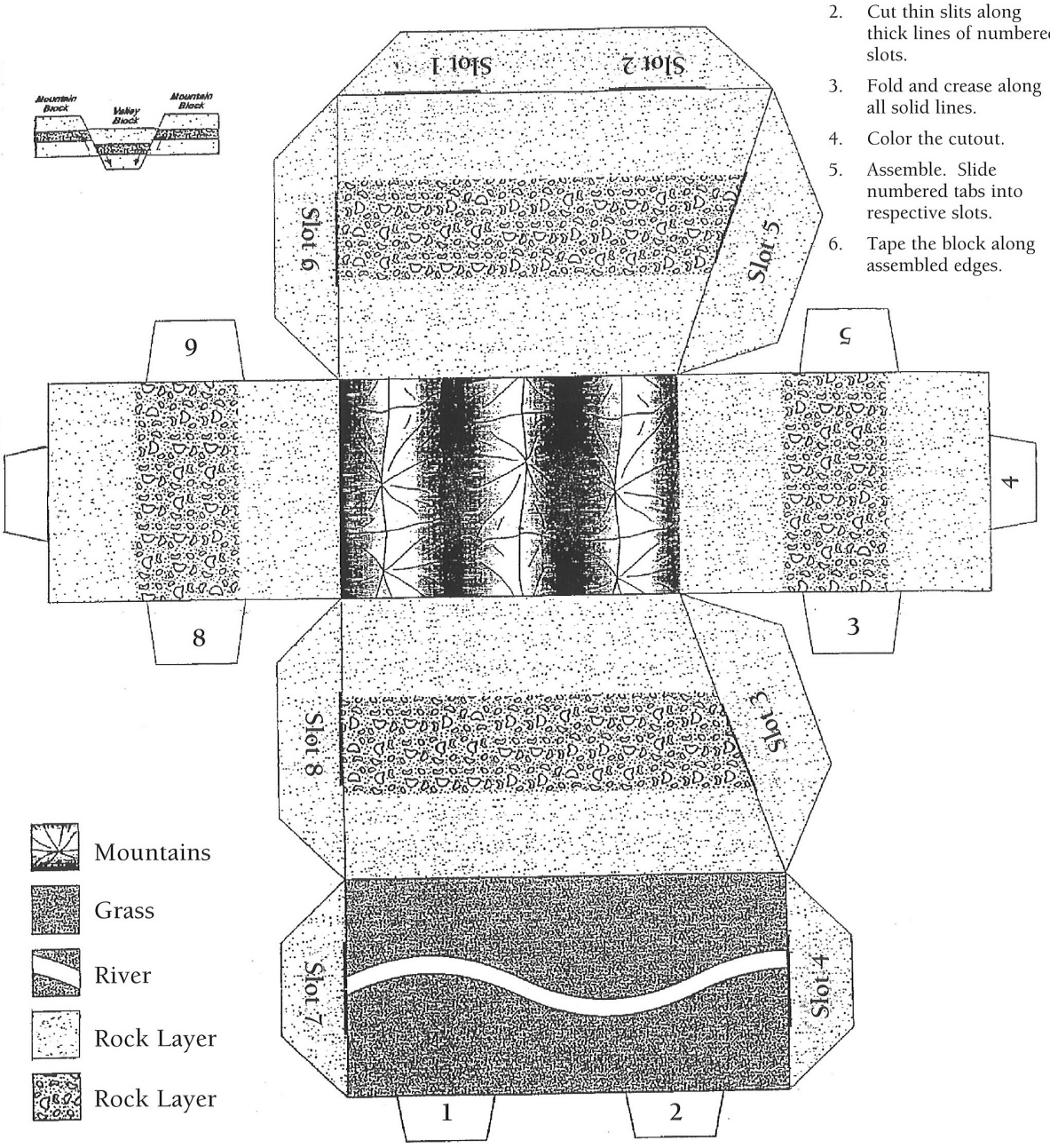
Utah Cutout Descriptions

#1 The Early Years: Paleozoic During this era Utah was at the western edge of North America. The eastern portion of the state was a low plain with little relief at about sea level. What little sediment did reach the ocean was well washed quartz sand. Coral reefs, now exposed as thick limestones in the Wasatch Mountains, marked shallow seas that led to deep oceans in the west.	#2 Wind Deposited Sands: Early Jurassic Cut off from moisture-laden ocean winds by rising mountains to the west, desert sands were blown into Utah from the north and southwest. These blowing sands formed dunes which eventually turned into rock and are preserved in what is now called Navajo Sandstone. These ancient dunes are well exposed at Checkerboard Mesa in Zion National Park and on the San Rafael Swell.	#3 Famous Dinosaurs: Late Jurassic At this time Utah was hot, swampy lowland with mountains and volcanoes to the west and northwest. Meandering rivers and lakes abounded, while dinosaurs roamed the land. Their fossilized bones are preserved and can be seen at famous sites such as the Cleveland-Lloyd Dinosaur Quarry and Dinosaur National Monument.	#4 Coal Formations: Late Cretaceous Pressure from continental collision with the Pacific Plate to the west produced high mountains in western Utah. The eastern portion of the state was covered by an inland sea that stretched from the Gulf of Mexico to the Arctic. The coastal plain between these two areas advanced and retreated as sediment filled the sea and the basin filled the sea and the basin sank. Coal swamps formed behind barrier islands while dinosaurs continued to rule.	#5 Utah Starts to Come Up in the World: Paleocene Erosion worn down the mountains to the west and the sediments filled the inland sea to the east. Continued pressure from the Pacific Plate caused both the Uinta Mountains and the Colorado Plateau to uplift. The Colorado Plateau warped as it rose, marking the beginning of predominate swells and depressions now found in Utah (such as San Rafael Swell). A large freshwater body, called Lake Flagstaff, occupied a depression in what is now central Utah.
#6 Oil Shale and Fossil Fish: Eocene After spending nearly 500 million years near sea level, Utah continued its rise to nearly a mile high in elevation. Continued warping of the Colorado Plateau produced basins for lakes such as Lake Uinta. Organic-rich accumulations in the bottom sediments include well-preserved fish fossils and oil shales. The western mountains were reduced to relics.	#7 Uplift and Volcanics: Oligocene On the Colorado Plateau the lake basins were filled in and broad plains separated mountain uplifts. The beginning of modern rivers ran across these plains. The continental divide passed through northeastern Utah so the Green River in Wyoming drained to the Mississippi River. With the beginning of extension in western Utah, which would eventually lead to the Basin and Range, extensive volcanic activity started to occur.	#8 Precious Metals Emplaced: Micocene Whereas previous compression has moved the site of San Francisco close to Salt Lake City, extension was now moving the two apart. This extension separated uplifted mountain blocks from down-dropped basins forming the Basin and Range. Volcanic activity continued forming three great metallic mineral belts. From north to south they are: Park-City-Oquirrh, Deek Creek-Tintic, and Wah Wah-Tushar. The Colorado Plateau continued to rise and tilt northeastward.	#9 Water and Ice: Pleistocene The geography of Utah was very close to what it is now. Mountains, canyons, and rivers were all well in place. The climate at this time was wetter and colder and as a result glacial activity took place. Canyons were carved and expanded in the Uinta Mountains as well as in several other mountain ranges throughout the state. A giant water body called Lake Bonneville also formed, stretching from the Wasatch Mountains to Nevada and from the Utah-Idaho border nearly down to Cedar City in southern Utah.	#10 These are the Places: Present The geologic history of Utah has left an indelible mark on the state. It explains why the rocks to the east are brightly colorful while those to the west have somber colors, why there are spectacularly massive canyons on the Colorado Plateau while much of the Basin and Range has no external drainage, and why a high mountain chain, the Wasatch, runs down the middle of the state. This history determines the location of settlements, industry, and recreation sites.

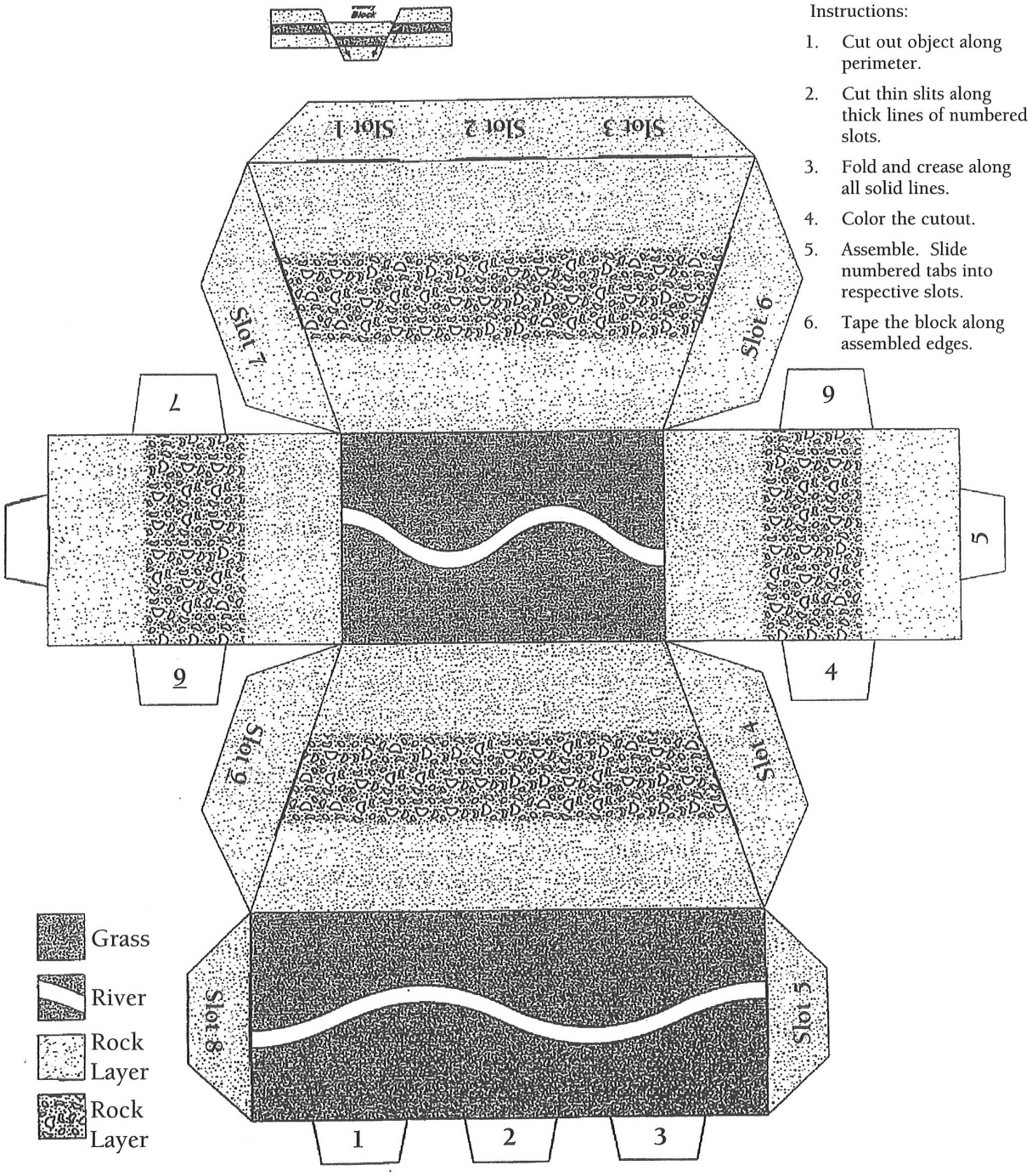
Mountain Fault Block

Instructions:

1. Cut out object along 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 continued



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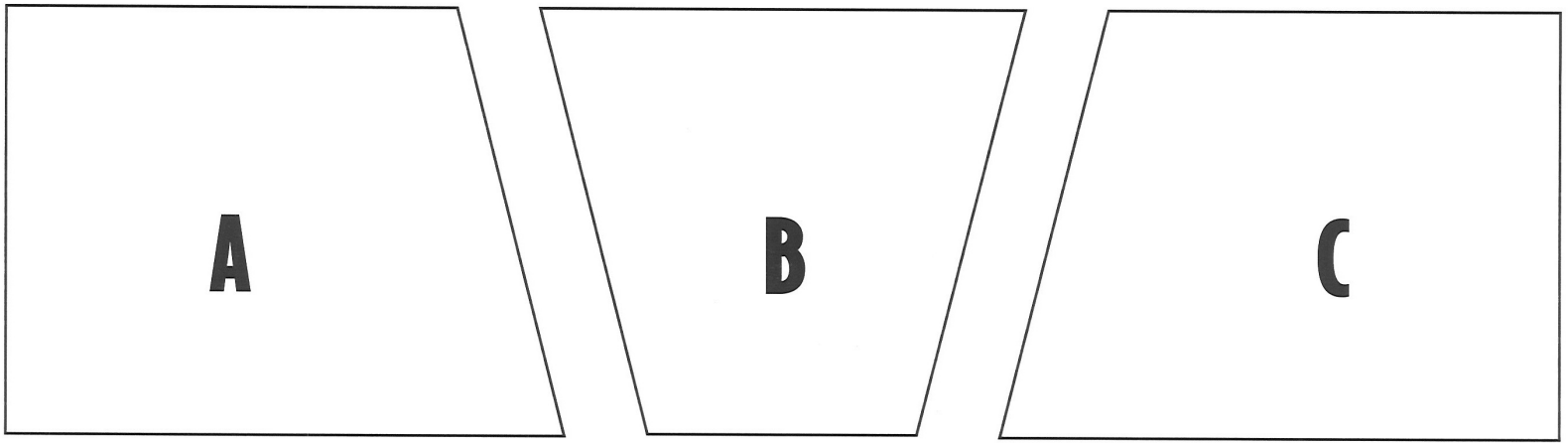
ABC Fault Blocks



Move A and C away from each other, what happens to B?
What does B make?

Move A and C towards each other, what happens to B?

What does B make now?

Can you should how uplift could occur using these pieces?

What would happen if only A moved up and B stayed where it was.

*Can you find any areas in Utah that are similar to these pieces?

Wasatch Fault Figure