PLAY-DOH TECTONICS
Activity 11: Play-doh Structure

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Grades 4-5 NMA Activities, Nevada State Science Education Standard Correlation. Referencing Science Standards 2005 http://www.doe.nv.gov/standards/standscience.html			
	N.5.A.6	N.5.B.3	E.5.C.3
Playdoh Structure	X	X	X

Objectives: To learn to recognize geologic structures including flat-lying strata, erosion effects, anticlines, synclines, and a variety of faults. To recognize the order in which layers of the earth were deposited, using practical, hands-on modeling techniques. To gain the ability to look at solid materials in three dimensions and to draw maps and cross-sections to scale.

Materials:
- Play-doh or clay, set of 4 colors
- Waxed paper
- Knives (plastic picnic knives will work)
- Colored pencils--colors match Play-doh colors
- Rulers
- Rolling pins (3/4" wood dowels, 1 foot long)
- Handout with stratigraphic column
- Handout with cross-sections and map view blocks
- Handouts of fault and fold drawings

Procedure: Students will model a variety of geologic structures and prepare cross-sections and maps at a given scale for each of the structures.

PART 1

1. Lay a sheet of waxed paper at least 5" by 10" on table.

2. Select one color of Play-doh from the set. Remove about 2/3 from the container and place on waxed paper. Roll the Play-doh out to about 1/4" thick and approximately 3" wide by 6" long. Use the ruler to measure and, if desired, trim the clay to 3" by 6".

3. Repeat the process using the other 3 colors of Play-doh. Stack the layers and trim so the edges are even.

4. Using the Stratigraphic Column handout, color in the appropriate squares with colors matching the Play-doh, in the order you have stacked them. The

bottom layer in your model should be the same color as the bottom box in the Stratigraphic Column, etc. Note that the bottom color represents the first layer you "deposited" on the waxed paper, therefore it is the "oldest". The top layer is the last or "youngest" layer you deposited. If you were looking at a road-cut along a highway and saw 4 different colors of rocks in flat layers or "beds" exposed, you would be looking at a "big-time" version of your model.

5. Using Block 1 in your handout, make a cross-section the match the side (vertical) appearance of your model. You will draw the side view along the 6" long side of your model and draw it at a scale of 1:1, that is: 1 inch equals 1 inch. **Start at the bottom of the Cross-section Block with your oldest layer and measure up from there with the younger beds.**

6. Label the oldest and youngest beds.

7. Measure the length of your model. How long is it?

PART 2

Simulate the erosion of a canyon by cutting through successive layers of the Play-doh. Make the canyon in the middle, across the surface of the model on the 3-inch dimension:

1. Slice the top layer vertically at 2" from either end, being careful to cut into the top layer only.

2. Slice the next layer on a gentle slope inwards (toward the center), beginning at the point where the cut in the top layer touches the second layer.

3. Make vertical cuts in layer 3 from the points where the slope of layer 2 touched it.

4. Slice layer 4 (the bottom layer) inwardly (toward the center of the model) at a very shallow angle.

   BE SURE TO SAVE THE REMOVED CLAY PIECES. DON'T SQUASH OR DEFORM THEM!!!!!

5. Using Block 2, draw a map of the topography that you see. Use your ruler to measure the widths of each exposed layer on each side of the canyon you created.

6. Using Block 3, draw a cross-section showing the canyon, using the same methods employed in Part 1.

7. Label the youngest and oldest layers on both the map and cross-section.

8. Why might a canyon have the "stepped" topography?

PART 3

1. "Heal" the canyon made in Part 2 by replacing the clay removed from each layer, keeping the color layers as they were.

2. Place your hands on the ends of the model and press gently together horizontally. Let the waxed paper slide with the model. You should end up with an anticlinal and a synclinal fold (See Fold and Fault handouts). Stabilize the folded layers by adding clay beneath the bottom layer, is needed. You may want to give your model a little additional hand-shaping to obtain the desired fold shapes.

   NOTE: You have modeled the effects of <u>compressive</u> stress upon horizontal rock layers.

3. Make a cross-section of your folded model using Block 4. It should be at a scale of 1:1 as in Part 1, Step 5. Be sure to use the ruler to measure accurate distances and thicknesses of layers.

4. Label the oldest layer ("bed") and the youngest layer ("bed") on your cross-section.

5. Measure the length of the model. Is it shorter or longer than the unfolded model?

PART 4

1. Use the knife to make a **slanting** cut from top to bottom through the Play-doh model, parallel to the model's short axis.

2. A block on one side of the cut will be lower than the other side. Place some of the left-over Play-doh beneath the <u>lower</u> block so that the block will be raised to a slightly higher elevation than the other block. Push the two halves of the model together so they just barely touch.

3. Draw the resulting model in cross-section using Block 5 and the scale of 1:1. The structure you have drawn is called a "Normal Fault".

4. Measure the length of the model. Is it shorter or longer than it was before you "faulted" the model?

PART 5

1. Peel off the left-over Play-doh from the bottom of the lower block and place it beneath the bottom of the higher block. Now this block will stand just slightly higher than the other block. Push the two halves of the model together so they just barely touch.

2. Draw the resulting model in cross-section using Block 6 and using the 1:1 scale. The structure you have drawn is called a "Reverse Fault".

3. Measure the length of the model. Is it shorter or longer than the previous fault model? Is it shorter or longer than it was before you "faulted the model?

PART 6

1. For this part of the activity, you will be looking down on the model, rather than looking at it in cross-section. (If desired, you can remove the folds from your model by gently flattening each of the blocks.) Do not re-join the two blocks separated by the fault, simply push them together so that they just barely touch. Scratch a lengthwise line on the top layer of the model. This could represent a road, stream, fence-line, or some other linear feature.

2. Move the two halves of the model horizontally in opposite directions so that the scratch (road, etc.) is separated by about a quarter to a half inch. You have created a "Strike-slip Fault".

3. Turn the model so the "fault line" is parallel to the edge of the table where you are sitting. Look at the portion of the model on the far side of the "fault". Is it to the right or to the left of the portion of the model nearest you?

   If the far side is moved to the left, then your "Strike-slip Fault" is left-lateral. If the far side is moved to the right, then the fault is right-lateral.

4. Draw the right-lateral and left-lateral faults you have modeled using Blocks 7 and 8 of the handout. NOTE: These drawings are known as "Map" or "Plan" view drawings. If drawn at the 1:1 scale, portions of the fault blocks will go outside the lines on the handout.

STRATIGRAPHIC COLUMN

YOUNGEST	
OLDEST	

BLOCK 1

BLOCK 2

BLOCK 3

BLOCK 4

BLOCK 5

BLOCK 6

BLOCK 7

BLOCK 8

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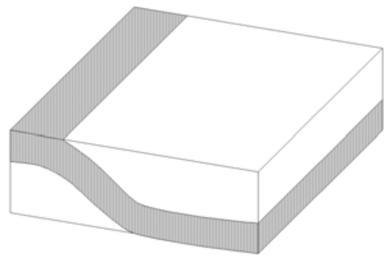
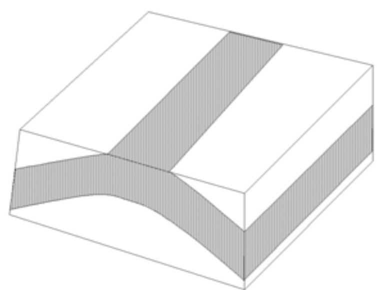
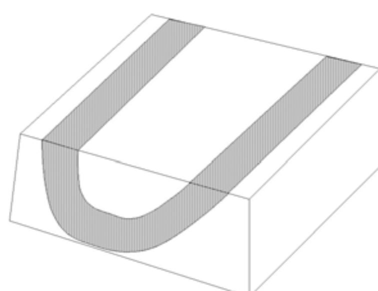
EXAMPLE OF FOLDS

DEFORMATION	SHAPE	ORIGIN
Monocline	 A single-limbed bend in rock strata	Compressional forces Vertical motions deeper within the crust
Anticline	 An upward bend in rock strata	Compressional forces
Syncline	 A downward bend of rock strata	Compressional forces

STRUCTURAL GEOLOGY LAB -- EXAMPLES OF FAULTS

adapted from California Geology magazine article, January/February 1992

Dip-Slip Faults

Dip-slip faults are faults on which the movement is parallel to the dip of the fault surface. **Normal Faults*** are dip-slip faults on which the hanging wall** (the rocks above the fault surface) move down relative to the footwall** (the rocks below the fault surface). Normal faults are the result of extension (forces that pull rocks apart).

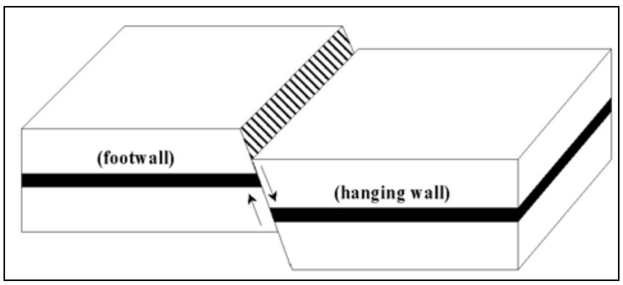


Figure 1 Normal Fault

Where the dip of a normal fault's surface is steep, it is called a **high-angle normal fault**, or simply a normal fault. The Owens Valley in California and the Sierra Nevada Range resulted from high-angle normal faulting. This type of fault-bounded valley is called a **graben**. A fault-bounded ridge is called a **horst**.

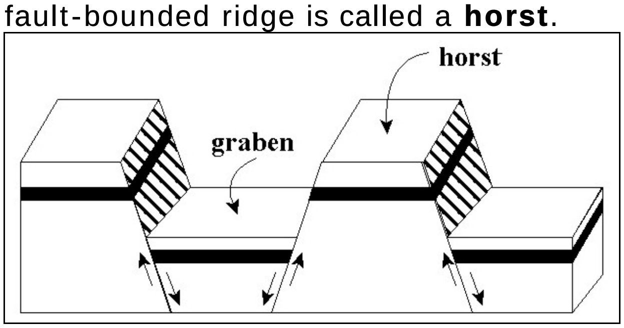


Figure 2 Horst and Graben

Where the dip of a normal fault's surface is very gentle or almost flat, it is referred to as a **detachment fault** or low-angle normal fault. Detachment faults are common in the desert areas of California.

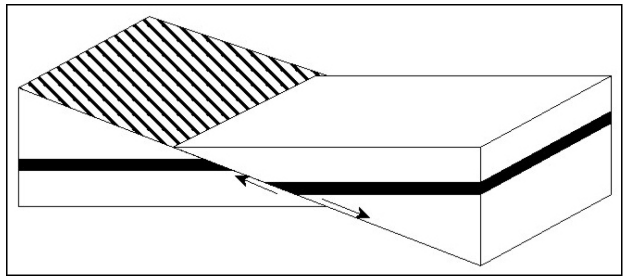


Figure 3 Detachment Fault

Reverse faults* are dip-slip faults in which the hanging wall moves up relative to the footwall. Reverse faults are the result of compression (forces that push rocks together).

The Sierra Madre fault zone of southern California is an example of reverse-fault movement. There the rocks of the San Gabriel Mountains are being pushed up and over the rocks of the San Fernando and San Gabriel valleys. Movement on the Sierra Madre fault zone is part of the process that created the San Gabriel Mountains.

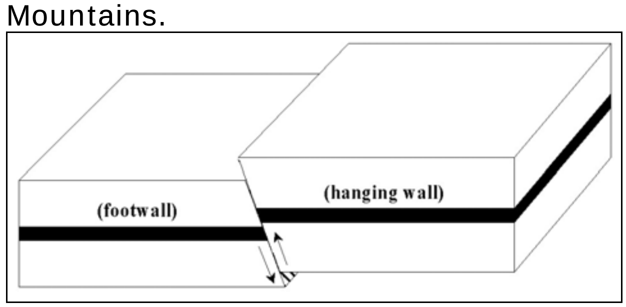


Figure 4 Reverse Fault

A **thrust fault** is a reverse fault with a gently-dipping fault surface. Thrust faults are very common in the Klamath Mountains of northern California.

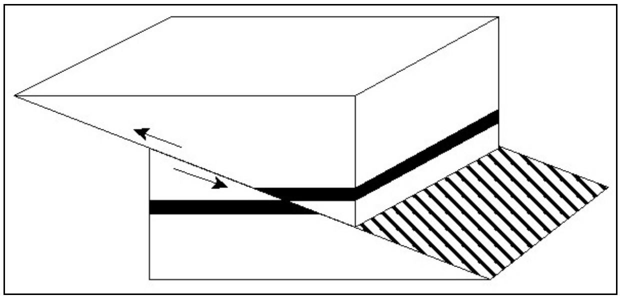


Figure 5 Thrust Fault

Strike-Slip Faults

The movement along a **strike-slip fault** is approximately parallel to the strike of the fault, meaning the rocks move past each other horizontally.

The San Andreas is a strike-slip fault that has displaced rocks hundreds of miles. As a result of horizontal movement along the fault, rocks of vastly different age and composition have been placed side by side. The San Andreas fault is a fault <u>zone</u> rather than a singe fault, and movement may occur along any of the many fault surfaces in the zone. The surface effects of the San Andreas fault zone can be observed for over 600 miles (1,000 km).

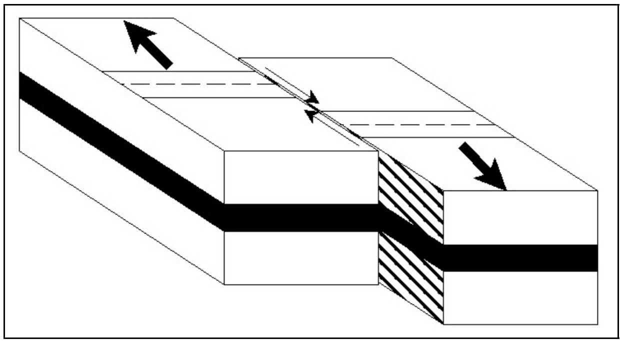


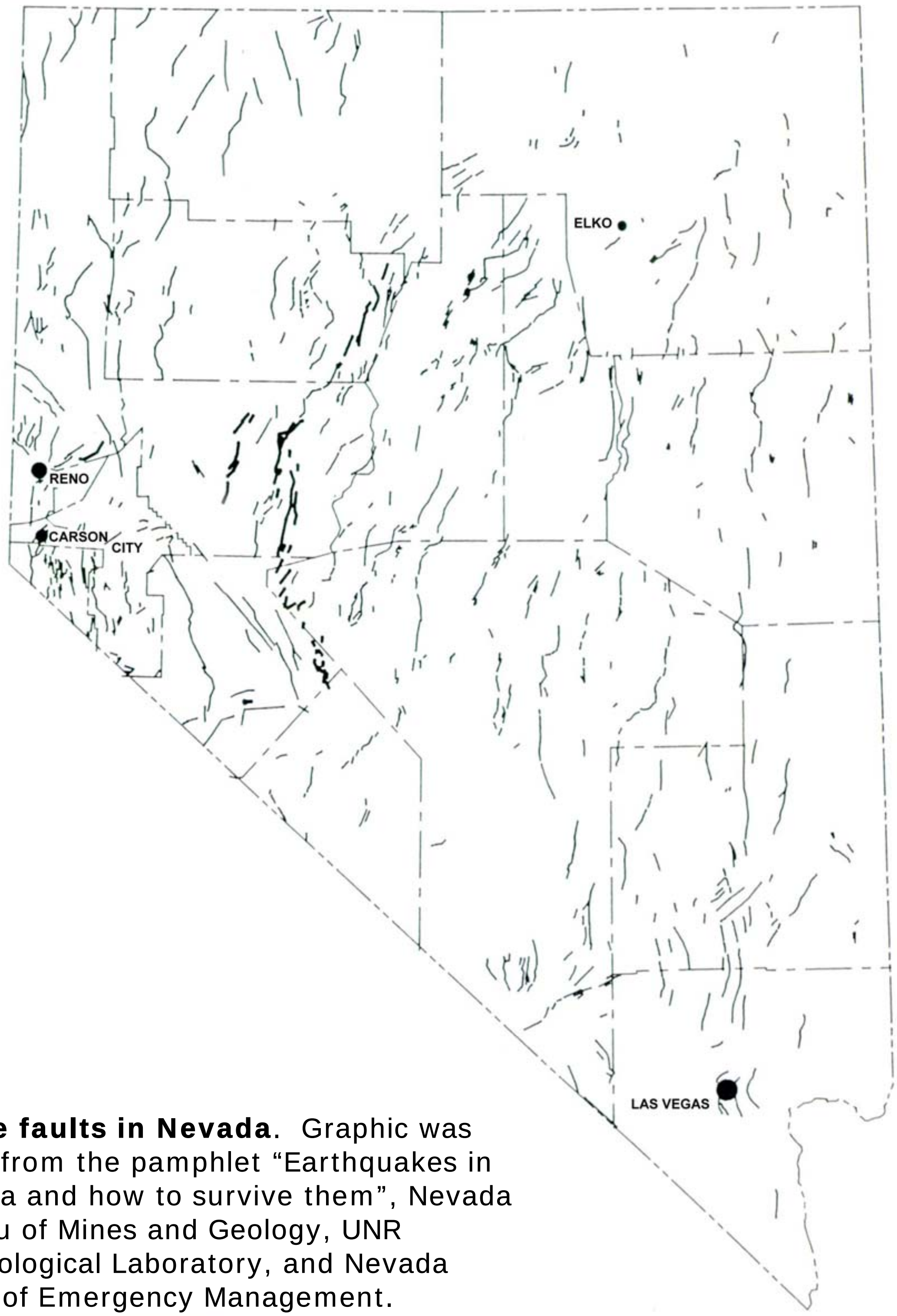
Figure 6 Strike-Slip Fault

* The terms “normal” and “reverse” were first used by English coal miners to describe faults. When working a flat coal bed where it was dislocated by a normal fault, the miners continued the workings either upward or downward on the fault surface in the same, or “normal,” direction. The workings in a seam dislocated by a reverse fault were also continued upward or downward on the fault, but in the opposite, or “reverse,” direction (Ojakangas, 1991).†

** The terms “hanging wall” and “footwall” are also old mining terms. These terms were originally used in inclined underground passageways to refer to the rock “hanging” overhead (the handing wall) and the floor beneath the miners' feet (the footwall) (Ojakangas, 1991).†

†Ojakangas, R.W., 1991. Schaum's outline of theory and problems of introductory geology: McGraw-Hill, Inc., New York, 294p.

STRUCTURAL GEOLOGY LAB -- EXAMPLES OF FAULTS
FAULT MAP OF NEVADA



Active faults in Nevada. Graphic was taken from the pamphlet “Earthquakes in Nevada and how to survive them”, Nevada Bureau of Mines and Geology, UNR Seismological Laboratory, and Nevada Office of Emergency Management.

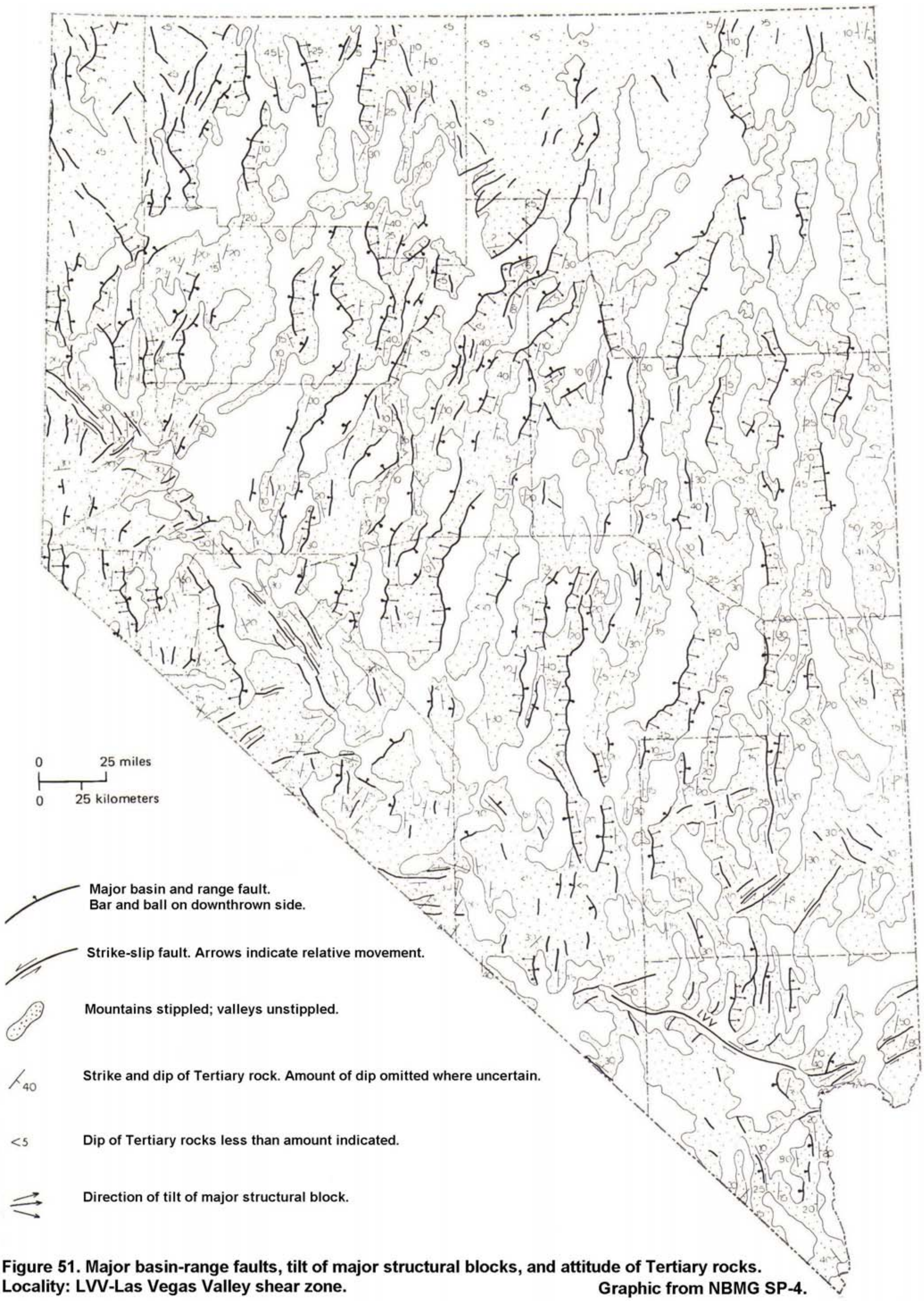


Figure 51. Major basin-range faults, tilt of major structural blocks, and attitude of Tertiary rocks.
Pl **Locality: LVV-Las Vegas Valley shear zone.** **Graphic from NBMG SP-4.**

Activity 11: Play-doh Structure