Finding Fault
Geologic History from a Road Cut

Elisabeth M. Price, DD LaPointe, and Jonathan G. Price
4 July 2005

Introduction

Earth science is an important science to present to students because it directly affects people in their everyday lives. This activity focuses on faults because these are involved in earthquakes such as the ones that caused the tsunami in Indonesia, and because faults have formed or affected much of the Nevada landscape.

The tools and thought processes applied in these activities – investigating geologic history from a road cut – are essentially the same as those used by geologists to decipher the geologic history of any part of the Earth's crust.

Introductory activity

1) List ways your life is defined or affected by the physical Earth.
    a. If possible, go outside to a place where mountains and the flat valley floor can be seen.
    b. Have participants describe what they see.
        i. Are there any places where faults may have formed the landscape?
        ii. In what way may faults be involved?
        iii. In the discussion, point out (if necessary) that faults drop the valleys down relative to adjacent mountains (or move the mountains up relative to the adjacent valleys).

Activities

2) Activity 1 Identify local faults
    a. Materials: Photographs (overheads to simulate viewing a real road cut), drawing paper, pencils, notebook to record ideas, chart paper to record results of discussions.
        i. The photographs here are of a road cut on West Fourth Street and a cut for the construction of a water ditch in western Reno, Nevada.
        ii. Alternatively, use clear photographs of the road cuts or copies of such photographs and trace the features.
    b. The shape of the land determines much about the placement of towns, for example. Through these photographs of a road cut, we can see the land under houses or roads.
    c. Individually, investigate that land by drawing the features you see.
        i. The dark and light lines represent layers of rock, which dip (are inclined) about 35 degrees from horizontal.

   ii. Places where the layers suddenly shift from one level to another are faults.
d. Develop questions about the features of the road cut
   i. Expect such questions as
      1. How did the rock layers get there?
      2. How did the faults get there?
      3. Are there different types of faults?
      4. Do the faults move?
      5. What makes the faults move?
      6. Always include questions: "So what?" and "Who Cares?"

3) Activity 2 Types of faults
   a. Materials: Templates of fault blocks from USGS activity on sturdy paper (http://interactive2.usgs.gov/learningweb/teachers/faults.htm), colored pencils or crayons, tape or glue, scissors, paper
   b. Build model fault according to the USGS activity (http://interactive2.usgs.gov/learningweb/teachers/faults.htm) or AGI activity.
      i. Color the fault model that is included according to the color key provided. Rock layer X—green; Rock layer Y—yellow; Rock layer Z—red; River—blue; Road—black; Railroad tracks—brown; Grass—green.
         1. Cut out the fault model and fold each side down to form a box with the drawn features on top.
         2. Tape or glue the corners together. This box is a three-dimensional model of the layers of the Earth's crust.
         3. Using some of the scraps of paper, cut out covers for the open sides of the box that represent the fault plane. Glue or tape that into place, leaving the bottom of the block open to represent the idea that more rock is found below the bottom of the block model.
      ii. Investigate the types of faults with the blocks: What ways might the blocks move with respect to each other? Each of these types of movements results in a type of fault named by geologists: normal fault, reverse fault, and strike-slip fault. (A thrust fault is a type of reverse fault that has a dip of less than 45 degrees from the horizontal.)
         1. Look at the situation if the blocks move such that point A lines up with point B, and point K lines up with point J (normal fault).
         2. Compare the situation if the blocks move such that point C aligns with point D, and point H lines up with point L (reverse fault).
         3. Compare again the situation if the blocks move such that point F aligns with point G (right-lateral strike-slip fault) and if the blocks move such that point F aligns with point E (left-lateral strike-slip fault).
      iii. As you investigate the movements of the blocks, consider the effects of each of the types of movements:

1. How did the blocks have to move relative to each other to get to the new position?
2. What happens to the rock layers when the blocks move; are the layers still continuous?
3. What might have happened to the surface features with such movements?
4. What type of force could have caused the blocks to get into the new positions?

4) Activity 3: Local effects
   a. Relate the models of types of faults to the drawings of the features of the road cut.
      i. Determine the forces involved and identify the type of faults in the photos.
   b. How can such faulting affect people?
      i. Buildings
      ii. Roads
      iii. Landscapes

Elaboration

1) Develop further questions to answer. Some questions may require library or Internet research.
2) Activity 1:
   a. Materials: rocks from the road cut.
   b. Look at rocks from the road cut. How could these rocks have formed?
3) Activity 2: Consult local topographic and geologic maps to discuss effects.
   a. Materials
      i. Topographic and geologic maps of the specific area in a great detail as possible.
   b. Specifically, how did the rocks get here?
   c. Important geologic concepts include
      i. The Law of Superposition
      ii. The Law of Cross-Cutting Relations
      iii. The Law of Original Horizontality
   d. Write a brief account of the geologic history of these rocks.
4) Activity 3: Evaluate the earthquake hazard of your location.
   a. Materials
      i. Web sites with information on faults and earthquakes in Nevada:
         U.S. Geological Survey's Quaternary Fault and Fold Database (http://qfaults.cr.usgs.gov/). Quaternary is the geologic time period covering the last 1.8 million years.
         Nevada Bureau of Mines and Geology Education Series E-30, Generalized Geologic Map of Nevada, including Quaternary faults, the ones that are most likely to move during large earthquakes in the future.

U.S. Geological Survey's Earthquake Probability Maps (http://eqint.cr.usgs.gov/eq/html/eqprob.html) and the

Nevada-specific Earthquake Probability Maps of most practical use (http://www.nbmg.unr.edu/eqprob/eqprob.htm)

Nevada Seismological Laboratory Web site (www.seismo.unr.edu)

U.S. Geological Survey Earthquakes Web site (http://earthquake.usgs.gov/)

Nevada Bureau of Mines and Geology Map 119 Earthquakes in Nevada, 1852-1998 (1:1,000,000 scale) (http://www.nbmg.unr.edu/dox/dox.htm)

U.S. Geological Survey's Probabilistic Seismic Hazard Maps used in building codes (http://eqhazmaps.usgs.gov/)

ii. Web sites with information on what to do before, during, and after an earthquake:

Publications of the Nevada Bureau of Mines and Geology (www.nbmg.unr.edu), available free on line:

Special Publication SP27, Living with Earthquakes in Nevada (booklet)

Educational Series E-16, Earthquakes in Nevada and How to Survive Them (pamphlet)

b. Find out how close you are to an active fault (using either the Nevada Bureau of Mines and Geology E-30 Generalized Geologic Map of Nevada or the USGS Web site for Quaternary faults.
c. Find out how likely it is to have an earthquake near you (using the USGS Earthquake Probability Map for your area). These maps show the probability of an earthquake of a particular size (say magnitude 5.0, 6.0, 6.5, or 7.0) occurring within 50 kilometers of a chosen location in a given period of time (say 50 years).
d. Find out what to do before, during, and after an earthquake (using the Nevada Bureau of Mines and Geology publications available on line).
e. Write a report on the earthquake hazard of your area.

5) Global importance of faults
   a. Materials: Map of the world that shows the topography on the land surface as well as ocean floor. National Geographic is a source.
   b. Consult a map of the world that shows topography.
   c. Identify spots where faults might be important.
      i. What types of faults may be there, and what forces may be involved?
      ii. Locate some famous faults.

Nevada State Science Education Standards addressed (2005)
http://www.doe.nv.gov/standards/standscience.html
E.5.C.2, E.5.C.3, E.8.C.1, E.8.C.2, E.8.C.4, E.8.C.5, E.12.C.1, E.12.C.2, N.8.A.1, N.8.A.3, N.8.A.5, N.8.A.6, N.12.A.1, N.12.A.2, N.12.A.3, N.12.A.4, N.12.A.5, N.12.A.6, N.2.B.1, N.5.B.2, N.8.B.2, N.12.B.1, N.12.B.2, N.12.B.3, N.12.B.4

The CD to accompany this exercise contains the following files:

Finding Fault location not specific 4July2005 3-15-06.doc = this document.

Faults on Fourth Street in Reno.ppt = a PowerPoint presentation that can be used to accompany this exercise.

Photos 1 and 2, which can be printed in black and white and used to show what the bedded diatomite and sandstone looks like at the road cut on West Fourth Street, west of McCarran Boulevard and east of Mayberry Drive in Reno.

Photos 3 through 8 are pictures of faults in the road cut on West Fourth Street. These can be printed in black and white.

Photo 9, which is immediately east of Photo 5, illustrates an unconformity with younger (Quaternary or Pleistocene) gravels filling channel scoured into older (Tertiary or Miocene), tilted diatomite and sandstone.

Photo 10 is a picture taken from the intersection of McCarran Boulevard and West Fourth Street in Reno, looking south at the Steamboat Ditch, east of McCarran Boulevard. A white layer of diatomite dips to the east and us cut by a west-dipping normal fault in the exposure above the ditch and between houses above and below. Fortunately, we believe this fault and faults at the West Fourth Street road cut are inactive. They do not appear to cut the Quaternary gravels that cap the tilted diatomite and sandstones.

A folder of Earthquake Probability Maps and a file (Earthquake Probability Maps.ppt) from the U.S. Geological Survey's web site (http://eqint.cr.usgs.gov/eq/html/eqprob.html).

A folder of Fault Maps in and near Nevada from the USGS Quaternary Fault and Fold Database (http://qfaults.cr.usgs.gov/).

The Fault Block Model

Model