The Field Trip to Bear Hole in Upper Bidwell Park

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Dates/Times: See your syllabus for dates. Note that lab will run an extra hour on field trip day; please plan carefully for this. Specifically,
- 9–11 labs meet an hour early, at 8 a.m.
- 12–2 labs meet an hour early, at 11 a.m.
- 11–1 labs go an hour late, until 2 p.m.
- 2-4 labs go an hour late, until 5 p.m.

Place: We will meet at the bus-loading zone on the east side of Holt Hall, across from the Bidwell Mansion (the same place here BIOL 142 meets for field trips). We will be taking the vans to Bear Hole in Upper Bidwell Park (see map on next page).

What to Bring: Be prepared for rough trails and a short but steep uphill hike. Bring…
- This lab and a clipboard or other hard surface to write on.
- pencil
- water (the MOST important thing--you will be miserable without it)
- hat (light colors are best) to protect your head from the sun and to keep you cool; baseball caps are fine but visors will not do. VERY IMPORTANT! If you do not wear a hat, you will be EXTREMELY hot and miserable. There is no shade out there--don't forget your hat!
- sturdy shoes (hiking boots and athletic shoes are best; sandals, flats, & high heels will NOT do)
- sunglasses
- camera (optional)

Objectives
The primary purpose of this field trip is to see geology at its most real--in context instead of isolated in the lab--all around you instead of just in front of you. Secondary objectives include…
- to learn a little about topographic maps.
- to see several major rock formations of the Chico area.
- to identify rocks in outcrop.
- to understand where Chico’s municipal water supply comes from.
- to use geologic reasoning to figure out how this area has changed over time.
- to get outside and have a good time.

*Supported by NSF Grant #9455371. Permission is granted to reproduce this material for classroom use.
Map to Bear Hole in Upper Bidwell Park

Driving Directions:

• From campus, take 2nd St. east; follow it across Big Chico Creek as it turns into Vallambrosa.
• Continue to follow Vallambrosa until it ends at Manzanita Ave.
• Turn left onto Manzanita Ave.
• Pass the Hooker Oak recreation area on your right; cross a bridge (over the Lindo Channel)
• Turn right onto Wildwood Ave., the entrance to Upper Bidwell Park (marked by a large wood sign).
• Follow the park road past the golf course and through a gate.
• Continue 2 miles past the end of the pavement; turn right into the Bear Hole parking lot.
Stop #1 (Bear Hole Parking Lot): Introduction to the Topographic Map

Examine your topographic map of the Bear Hole area (on the back page of this lab). The gray lines that wiggle all over the map are topographic contour lines. Each topographic contour line connects points of a certain elevation above sea level. If you were to walk along one of these lines, you would never go up hill or down hill. To help you keep track of all these lines, every fifth contour line is extra thick. Only the extra thick lines are labeled but you can determine the exact elevation of each line if you know the contour interval, the vertical drop (or climb) between two contour lines.

1. Find the Bear Hole parking lot on the topographic map; plot your location (label it Stop #1) on the map.

2. Determine your elevation ____________________.

3. Wherever topographic contour lines are close together, the slope of the land is steep / gentle (circle the correct answer).

4. Wherever topographic contour lines are far apart, the slope of the land is steep / gentle (circle the correct answer).

5. Look across the creek and up to the cliff on the top of the ridge. Find that cliff on the topographic map. Circle the spot on the map that represents the cliff. How do you know, from the map, that this is a cliff?

6. Notice that each topographic contour line forms a “V” where it crosses Big Chico Creek.
   a. The point of each “V” points upstream / downstream (circle the correct answer).
   b. Could you start from here and cross the creek without ever going uphill or downhill? If not, why not? If so, what route would you take? Draw a diagram to illustrate your answer.
Walk down to the creek and follow the trail (an old flume) a little ways upstream.

**Stop #2 (Bear Hole itself): The smooth black rock**

7. Plot the location of Stop #2 on the topographic map.

8. This rock type is called the Lovejoy Formation and it is about 16 million years old. What kind of rock is this?

9. This rock is **igneous** / **sedimentary** / **metamorphic** (circle the correct answer).

10. How did this rock form?

11. Note the vertical cracks in the rock (see diagram). They formed at the same time that the rock formed; in fact, they are characteristic of this type of rock. What made these cracks form?

(Source of Diagram: Guyton and DeCourten, 1978, p. 6)

Return to the parking lot and follow a trail downstream until you reach some creek-side outcrops that are clearly not the smooth black rock.

**Stop #3 (Downstream from Bear Hole): A Different Type of Rock**

12. Plot the location of Stop #3 on the topographic map.
The rocks you see here are an outcrop of a layer in a sedimentary rock unit called the Tuscan Formation. Describe this outcrop by answering the following questions:

a. What size(s) of sedimentary “particles”\(^1\) make up this rock (boulders, gravel, sand, mud)?

b. What kind of rock is this?

c. The sedimentary particles in these rocks are well-sorted by size / poorly sorted by size (circle the correct answer)

Note: To be considered well-sorted, all of the particles in any one layer must be about the same size; there can be major sediment size differences between layers.

d. The edges of the sedimentary particles in this rock are

somewhat angular / very worn and smoothly rounded. (Circle the correct answer)

e. Some of the sedimentary particles are pieces of rock. What kinds of rocks can you identify (We're looking for names of rocks here, not minerals)?

f. Which of these rock types is the most common? ________________________________

g. Are any of the sedimentary particles in this rock actually pieces of the smooth black rock you saw at the last stop? Explain.

Note: Not all rocks of the same type are alike. For example, some sandstones are made of 100% quartz grains and some sandstones have no quartz grains at all. Just because two rocks are of the same type does not mean that they are identical.

14. Based on your answers to #13 above, make some interpretations of the way these sediments were deposited and in what kind of environment they were deposited. Do this by answering the following questions:

a. Was this sediment deposited on the bottom of a body of water or was it deposited as a debris flow? What evidence led you to this conclusion?

\(^1\)We use the term “particles” here to mean individual pieces of sediment; an individual particle may be 10 feet across!
b. If you could go back in time and stand on this spot right after this sediment was deposited, what kind of landform (canyon, mountain range, volcano, ocean, lake, or river) would you see in the distance if you looked toward the northeast? Explain the reasoning behind your answer. Draw a diagram to illustrate your answer.

c. What kind of major geologic event(s) may have triggered the transportation and deposition of this sediment? Explain.

Follow the creek upstream until you reach the contact between the Lovejoy Formation and the Tuscan Formation.

Stop #4 (Located Between Stops 2 and 3):
The Contact Between the Tuscan Formation and the Lovejoy Formation

15. Plot the location of Stop #4 on the topographic map.

16. Which rock unit is older, the Tuscan Formation or the Lovejoy Formation? How do you know? To illustrate your answer, label each formation and draw in the layers on the side and front of the block diagram below.
Follow a trail back uphill. Stop where the trail begins to level out and turn to the right (where the trees meet the grass lands). There’s a small outcrop on the right.

**Stop #5: The Nomlaki Tuff, A Special Layer within the Tuscan Formation**

17. Plot the location of Stop #5 on the topographic map.

18. The rocks cropping out here are part of the Nomlaki Tuff. This rock layer crumbles easily. Pick up some pieces of this crumbled rock and examine them. Describe its characteristics.

19. What type of geologic event was responsible for forming this layer?

Return to the parking lot and walk along the driveway back to the main park road. Cross the road and walk uphill, through the grass and weeds, to a large prominent gray rock outcrop (visible from the road--when you get to it, it will be about twice as tall as you are).

**Stop #6 (After a long hard uphill hike): A Cliff Formed by a Fourth Type of Rock**

20. Plot the location of Stop #6 on the topographic map.

21. These rocks form layers within the Tuscan Formation. In fact, the Tuscan Formation is made of alternating layers of the type of rock that you saw at Stop #3 and these types of rocks. However, the rocks at this location have a very different origin than the rocks at Stop #3.
   a. What size(s) of sedimentary “particles”\(^2\) make up these rock layers (boulders, gravel, sand, mud)?

   b. The rock layers exposed here are just two basic sedimentary rock types. What are these rock types?

   c. The sedimentary particles in these rocks are well-sorted by size / poorly sorted by size (circle the correct answer)

   **Note**: To be considered well-sorted, all of the particles within any one layer must be about the same size; there can be major sediment size differences between layers.

\(^2\)We use the term “particles” here to mean individual pieces of sediment; an individual particle may be 10 feet across!
d. The edges of the sedimentary particles in this rock are

   somewhat angular / very worn and smoothly rounded. (Circle the correct answer)

e. Some of the sedimentary particles are pieces of rock. What kinds of rocks can you identify (We're looking for names of rocks here, not minerals)?

f. Which of these rock types is the most common? ____________________________

22. Based on your answers to #21 above, make some interpretations of the way these sediments were deposited and in what kind of environment they were deposited. Do this by answering the following questions:

   a. “These layers of sediment were deposited on the bottom of a body of water.”

      Describe specific evidence for this statement and how this evidence can be used to show that the statement is true.

   b. In what kind of body of water were these sediments deposited (circle the correct answer).

      ocean / lake / river in a narrow valley / river in a wide flat valley

      Explain the evidence and reasoning behind your answer.
c. If you could go back in time to when these sediments were being deposited, you would not be able to see the rocks at Stops 1, 2, 3 and 4. Explain why you would not be able to see them. Draw a diagram to illustrate your answer.

23. The rock layer we are standing next to is an excellent aquifer - a layer that can hold a lot of ground water and that allows ground water to flow through it easily. Chico's drinking water is pumped out of wells that tap layers just like this one, hundreds of feet below the city of Chico (see diagram).

(a) The source of our drinking water is rain falling here, in the hills east of town where these layers are exposed at the surface. How does the water get from here to the wells?

(b) Why does this water flow westward, toward Chico, instead of flowing straight down? To illustrate your answer, add to the diagram on the previous page.

(Hint: Do you think that the Lovejoy Formation is a good aquifer?)

24. A few years ago, there was a big controversy about housing development in “Bidwell Ranch,” the land immediately north of Upper Bidwell Park. What do you suppose will happen to the quality and quantity of Chico’s water supply if major development is allowed at Bidwell Ranch?
Return to the Bear Hole Parking Lot (Stop #1)

Second Visit to Stop #1: The Bear Hole Parking Lot

25. Look across the creek and notice several areas of bright-green vegetation. The plants in these spots are fresh and green, even in late summer when it hasn’t rained for months and all of the other vegetation in the area is brown. Obviously, there must be some source of water in these spots that lasts all year.

a. Where is this water coming from?

b. Why is there water year round in these few spots but not everywhere? In other words, what is special about these areas? To illustrate your answer, add to the diagram below.

(Hint: what kinds of rocks make up the bedrock in these locations?)

(Source of Diagram: Guyton and DeCourten, 1978, p. 9)

Topographic Map of the Bear Hole Area, Upper Bidwell Park, Chico, California

Scale: 1 in. = 500 ft.
Contour Interval 40 ft.