Investigation: Questioning the Franciscan Rocks (Part 1)

During this activity, students will:

- Investigate the "life histories" of several Franciscan Complex rocks of the San Francisco Bay Area.
- Become familiar with the descriptive language used by geologists to identify rocks.
- Conduct an inquiry for a Franciscan rock of their choosing.

Duration: Two 45-minute class sessions

Materials required:

- Large boxes of Franciscan rock hand specimens (from traveling trunk)
- Rock study cushions (from traveling trunk)
- Private Eye® Loupes (from traveling trunk), 1 per student
- *Describing Rocks* handout for each pair of student investigators
- One set of *Rock Observation Cards*
- One *Franciscan Rock Inquiry Worksheet* for each student
- *Franciscan Rocks of the Golden Gate Headlands* information cards for Pillow Basalt, Radiolarian Ribbon Chert, Graywacke Sandstone, and Diabase
- *Franciscan Rocks of the Marin Headlands Terrane* poster
- *Geology of the Golden Gate Headlands* poster
- *Teacher's Rock Identification Key*

Before the first class session:

- ✓ Hang both posters for reference.
- ✓ Print out the *Teacher's Rock Identification Key* for your use later in the activity.
- ✓ Print out at least one set of the rock observation sheets, and enough *Describing Rocks* handouts for easy student reference. You may wish to laminate these items for use in future class sessions.
- ✓ Make a copy of the *Franciscan Rock Inquiry Worksheet* for each student.
- ✓ Remove all hand specimens of basalt, chert, graywacke, and diabase from their sample bags. Do **not** include the "mystery rock" or serpentinite samples.
- ✓ Place the rocks (except for the "mystery rocks" and serpentinite), in no particular arrangement, on a table.

Directions for first class session:

10 min Explain to students that they will be learning how a geologist accurately describes rocks, and how observation and description provide clues to the rock's origin and "life history." Use the rock observation sheets to guide a discussion of the things a geologist observes to describe a rock. Post the sheets for future reference.

Have each pair of students select a rock that interests them.

Instruct students to keep the rock on the study cushion to minimize wear and tear.

Distribute a *Franciscan Rock Inquiry Worksheet* to each student.

5 min Demonstrate proper use of the loupe:

1. Avoid touching or scratching the lens.
2. Hold the loupe so the wide end is closest to your eye. You do not need to remove your eyeglasses.
3. Hold the rock you are examining in your hand, then bring your hand up to the loupe.

Distribute loupes and *Describing Rocks* reference sheets. Go over the guiding questions on the reference sheet with the class.

15 min Have each student complete the first five tasks of the *Franciscan Rock Inquiry Worksheet*. Remind them to write the rock identification number on their inquiry sheet, since they will be continuing their research in a future class session.

Have several students share their questions and possible answers with the rest of the class.

15 min Now, have everyone begin to research their question from their inquiry sheet. Research should also include how and where their rock was formed, and how plate tectonics has affected it. Research materials include:

1. *Franciscan Rocks of the Golden Gate Information Cards* for Pillow Basalt, Radiolarian Ribbon Chert, Graywacke Sandstone, and Diabase.
2. Geology posters hanging in the room.

After students have had a chance to examine the information cards and posters, they should begin to identify their rock.

Collect rocks, loupes, and inquiry sheets (check for student name and rock identification number).

Directions for second class session:

Redistribute rocks, loupes, and inquiry sheets.

10 min Write the four rock names on the board. Ask students for words they used to describe each rock. As the lists are generated, some students may wish to change their rock identification.

10 min Now have the students form four groups, based on their rock identification: basalt, chert, graywacke, and diabase. Have the students take the rock, loupe, and materials with them to their new group. If, after comparing their rock with other rocks in the group, a student wishes to change their rock identification, ask the student to take you through the process of their decision. If you agree with the new identification, have the student join the new group.

Use your *Teacher's Rock Identification Key* to check student work and to make sure everyone ends up in the correct group.

10 min Have each group report back to the rest of the class about its rock. Each group report should include information that enables the class to answer the following questions:

1. What is the name of this rock?
2. What does it look like?
3. What is the classification of this rock?
4. Where is it formed?
5. What physical characteristics of this rock sample did you see that helped you identify it?
6. How did your research help you answer your inquiry worksheet question?

15 min After the rock reports, have the students return to their inquiry sheets to write a new question about any of the Franciscan Complex rocks. Have several students share and discuss their new questions.

Gather all rocks, loupes, and materials.

Questions for written student reflection or class discussion:

1. What do the Franciscan Complex rocks reveal about the tectonic history of the San Francisco Bay Area?

2. Why are similar rock sequences (pillow basalt, radiolarian chert, graywacke sandstone, diabase) found in other places of the world?

3. How can local rocks affect your life?

4. Why is knowledge of local rocks useful?

5. How is knowledge of local tectonic history useful to communities?

For further exploration:

- The traveling trunk contains bags labeled "mystery rocks." Offer extra credit for students who complete an inquiry investigation of one of the mystery rocks.

Note: While all of the mystery rocks are from the Franciscan Complex at the Marin Headlands, they can be tricky to identify!

- Play the "Subduction Construction" game. The game takes about 20 to 40 minutes to play and provides players with an in-depth look at the rocks formed during the process of subduction. You can find it at: www.nps.gov/goga/forteachers

10 min Have each group report back to the rest of the class about its rock. Each group report should include information that enables the class to answer the following questions:

7. What is the name of this rock?
8. What does it look like?
9. What is the classification of this rock?
10. Where is it formed?
11. What physical characteristics of this rock sample did you see that helped you identify it?
12. How did your research help you answer your inquiry worksheet question?

15 min After the rock reports, have the students return to their inquiry sheets to write a new question about any of the Franciscan Complex rocks. Have several students share and discuss their new questions.

Gather all rocks, loupes, and materials.

Questions for written student reflection or class discussion:

1. What do the Franciscan Complex rocks reveal about the tectonic history of the San Francisco Bay Area?

2. Why are similar rock sequences (pillow basalt, radiolarian chert, graywacke sandstone, diabase) found in other places of the world?

3. How can local rocks affect your life?

4. Why is knowledge of local rocks useful?

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For further exploration:

- The traveling trunk contains bags labeled "mystery rocks." Offer extra credit for students who complete an inquiry investigation of one of the mystery rocks.

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Investigation: Questioning the Franciscan Rocks (Part 2)

During this activity, students will:

- Investigate serpentinite and Franciscan mélange.
- Become familiar with the unique characteristics of serpentine rock and mélange zones.
- Write a question for further investigation.

Duration: Approximately 30 minutes. Since this lesson is primarily self-directed, students may progress through the lesson while other activities are occurring in the classroom.

Materials required:

- Small boxes of serpentinite hand specimens (in traveling trunk)
- Rock study cushions (in traveling trunk)
- Private Eye® Loupes (from traveling trunk), 1 per student
- *Describing Rocks* handout for each student investigator or group
- One set of *Rock Observation Cards*
- One *Franciscan Serpentinite Inquiry* worksheet for each student
- *Franciscan Rocks of the Golden Gate Information Cards* for Serpentinite and Franciscan Mélange
- *Franciscan Rocks of the Marin Headlands Terrane* poster
- *Geology of the Golden Gate Headlands* poster

IMPORTANT CAUTION ABOUT SERPENTINITE:

Handle with care! Serpentinite specimens are often flaky and break apart more easily than the other rock samples. Serpentinite is the source rock of **asbestos**. We have taken care to select pieces for the traveling trunks that are not hazardous with normal handling. Many of the hand specimens are in plastic bags, and can remain in the bag during examination with the loupe. If you bring serpentinite from other sources into your classroom, check the rocks to make sure no fibrous asbestos veining is present. You will find photos of this kind of veining in this lesson's *Describing Rocks* handout and on the *Franciscan Rocks of the Marin Headlands Terrane* poster. More information about serpentinite is available at www.nps.gov/goga/forteachers/serpentinite-faq.htm.

Directions:

- ✓ Read the ***important caution about serpentinite*.**
- ✓ Hang the *Franciscan Rocks of the Marin Headlands Terrane* and *Geology of the Golden Gate Headlands* posters in the classroom for student reference.
- ✓ Students may work in pairs or small groups during this activity.
- ✓ Explain to students that they will investigate *serpentinite*, one of the more unusual rocks of the Franciscan Complex, and *mélange*, one of the results of massive tectonic forces on landscapes. Since serpentinite is commonly associated with mélange, we will investigate them both in this lesson.
- ✓ Provide each student with a serpentinite inquiry worksheet and loupe. Remind students about the proper use of the loupe, and about placing the rock hand specimens on the rock study cushions when observing them. Instruct students to keep the serpentinite samples in the plastic bags. Have each student complete the first five tasks listed on the inquiry worksheet.
- ✓ Check the students' progress and their initial worksheet questions before having them research the "life history" of serpentinite.
- ✓ Have copies of the *Describing Rocks* handout, *Serpentinite* and *Franciscan Mélange* information cards, and a set of the *Rock Observation* cards available for student use during their research.

- ✓ Post the following questions on the board to help students in their research:

    1. What is the name of this rock?
    2. What does it look like?
    3. What is the classification of this rock?
    4. Where is it formed?
    5. What physical characteristics of this rock sample did you see that helped you identify it?
    6. What is an interesting fact about this rock?

Completed student worksheets may be posted in the classroom so that students can share their serpentinite questions and observations with the rest of the class.

Follow-up questions for class discussion or student written reflection:

- How do the soils produced by rocks affect the plants that grow in them?
- Why do most plants grow less well in serpentine soils?
- Why are some plants unique to California found in serpentine soils?
- Why is it helpful for engineers to know the location of mélange zones before constructing roads.

Name: _____ Franciscan Rock I.D. #_____

✓ ASSIGNMENT

- ____ Examine the rock hand specimen.
- ____ Take notes describing the rock.
- ____ Write a question about this rock.
- ____ Discuss your question with others.
- ____ Write possible answers to your question.
- ____ Research the rock's "life history."
- ____ Identify your rock.
- ____ Write a new question.

ROCK DESCRIPTION NOTES

QUESTION

POSSIBLE ANSWERS

IDENTIFICATION OF THIS ROCK

NEW QUESTION ABOUT A FRANCISCAN ROCK

Name: _____ Franciscan Serpentinite Investigation

✓ ASSIGNMENT

- ____ Examine the serpentinite hand specimen.
- ____ Take notes describing the rock.
- ____ Write a question about this rock.
- ____ Discuss your question with others.
- ____ Write possible answers to your question.
- ____ Research the rock's "life history."
- ____ Write a new question about serpentinite.

SERPENTINITE DESCRIPTION NOTES

QUESTION

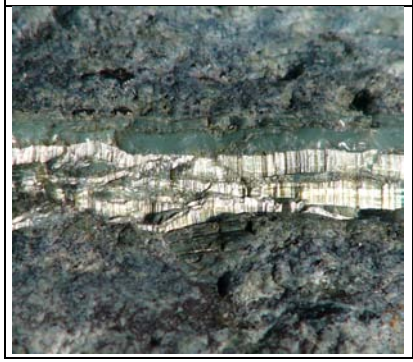
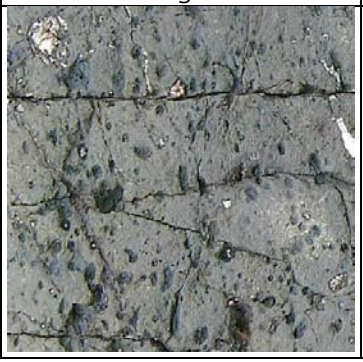
POSSIBLE ANSWERS

NEW QUESTION ABOUT SERPENTINITE

DESCRIBING ROCKS

Some of the characteristics geologists use to describe rocks are color, texture, crystal or grain size, veining, and angularity or rounding. Investigating the following questions can help you identify a rock:

Is the rock made up of interlocking crystals, sedimentary grains, or glassy?
How big are the crystals or grains and are they all the same size or different sizes?
Are there veins or vesicles (gas bubbles), and if so, what are their colors?
Is the rock angular or rounded?

Texture/Grain Size				
Very fine crystals with some larger visible crystals	Uniform visible crystals	Fine sedimentary grains or clay	Sand-size sedimentary grains	Glassy
				
Veins			**Rounding**	
Fibrous veins	White mineral vein and mineral-filled gas bubbles	Gas bubbles with no material filling them	Angular outline	Rounded outline
				

Things to observe

Color

Things to observe

Texture

Things to observe

Grain size

Things to observe

Veining and
gas bubbles (vesicles)

Things to observe

Rounding

Things to observe

Biological and human modifications