

California Geology

The class uses an inquiry based approach to learning about the geologic history of California and how this history fits into the global geologic processes. While this syllabus describes the expectations for student learning using traditional geologic jargon, the class will de-emphasize vocabulary and stresses understanding of process.

SPECIFIC COURSE OBJECTIVES

1 Week 1: Geologic Methods

Students should be able to perform simple geologic investigations, beginning with the 3-step approach:

1. Inquiry
2. Observation
3. Interpretation

They understand the fundamental principles of geology, including:

- Principle of Original Horizontality
- Principle of Superposition
- Principle of Cross-cutting relations
- Uniformitarianism and Catastrophism

They can identify examples of these features in photographs or in the field and use them to reconstruct the sequence of events in an area.

1.1 Field Trip:

- Be able to notice differences between geologic features and describe them to other people – through text and pictures. They should practice quantifying things (“3 cm large” rather than saying “big” or “small.”) They should use color, shape (particularly “rounded” v. “angular”), and texture to describe rocks, rock fragments, or rock units (different layers of rock, brick, concrete, or asphalt).

- Be motivated about the geologic setting of San Quentin. They should know about the mountains, the Bay, and the quarry. They should want to know why they exist, and why they are in the places that they are.

2 Week 2: Plate Tectonics

Students will understand the evidence used to support the theory of plate tectonics from:

- Earthquakes, including location and depth
- Age of sea-floor
- Shape of topography and bathymetry
- Global distribution of volcanoes

They will be able to use this evidence to describe the differences between three main categories of plate boundaries and explain why they are different:

- Divergent: Mid-Ocean Spreading
- Convergent (Ocean-Ocean Subduction, Continent-Ocean Subduction, and Convergent: Continent-Continent Collision)
- Conservative: Transform boundaries.

3 Week 3: Rock Cycle

Students will learn how to describe rocks, including the following characteristics: Color, texture, grain size, hardness, homogeneous v. inhomogeneous. Students will understand that many of these features are a direct result of the rock's history and process of formation. They will be able to describe different forces that affect rock history, including: magmatic processes, erosion, sedimentation, lithification/cementation, heating, melting, cooling, and squeezing with high pressure.

Students will use observations of the difference between rocks and their histories to identify three main rock types:

- Igneous (Intrusive & Extrusive)
- Sedimentary
- Metamorphic

They will be able to place these different rocks in the appropriate plate-tectonic context (i.e., which igneous rocks are found at subduction zones, etc.).

4 Week 4: Volcanoes

Students will be able to describe the two end-member examples of volcano types, explain the reason for these differences, and how these differences affect volcano behavior.

- Silica and volatile rich magma produces volcanoes with steep slopes that erupt explosively spewing ash high into the air and often leaving behind massive craters.
- Magmas with more mafic compositions produce broad shield-like volcanoes that have rivers of lava and much less damaging eruptions.

Students will know where different types of volcanoes form in the context of plate tectonics.

Students will be able to identify volcanoes of different types in California, identify coastal California north of Mendocino as a continent-ocean subduction zone, and understand the hazards that California volcanoes pose for the population.

5 Week 5: Great Valley: an introduction to the water cycle

- Students will be able to describe the components of the hydrologic cycle (i.e., where water is stored on earth in gas, liquid, and solid form), including clouds, surface water, groundwater, oceans, and ice. They will understand the processes by which water moves between these states, including precipitation, runoff, infiltration, springs, rivers, evaporation, evapotranspiration, melting, and sublimation.
- Students will know that the vast majority of water on earth is in oceans, that most of the fresh water on earth is stored in snow and ice, and that most of the liquid fresh water on earth is stored in groundwater (98%, 87%, and 96%, respectively, but students will not be expected to know these numbers). Lakes and streams, the familiar parts of the hydrologic cycle are only a tiny amount of the total water but play an important role. Groundwater plays a surprisingly important role.
- A common misconception about groundwater is that there are vast underground lakes and water wells tap into these lakes. Students will learn that groundwater is stored in small spaces between individual grains in rocks that are only millimeters large, and that groundwater behaves much more like a saturated sponge than a vast lake.
- Students will be aware of subsidence problems in California's Central Valley. They will know that parts of the Valley have dropped over 30 feet over 50 years. They will be able to describe the relationship between subsidence and groundwater withdrawal and know that this subsidence is a direct result of irrigation and agriculture.

- Students will learn that California is a huge agricultural producer in the Central Valley, but that only a small portion of the state's water falls as precipitation in its margins. They will be introduced to water politics in California. They will know that most of the precipitation in the state is in the mountains and far north, but most of the population is near the coast and far south. They will know about the extensive aqueduct system and irrigation required to provide water to both people and crops in the state.

6 Week 6: Sierra Nevada: an introduction to glacial erosion

- Students will become comfortable using topographic maps. Students will learn the difference between magnetic north and geographic north. Students will construct topographic profiles and investigate the effects of scale and vertical exaggeration.
- Students will then use topographic maps to identify geomorphic features of glaciated terrain including lateral moraines, U-shaped valleys, and terminal moraines. Students will consider how geomorphology can be used to determine the glacial history of an area.
- Students will consider what effects global temperature rise might have on California's glaciers by reading about current observations of glaciers in the Sierras and on Mt. Shasta and considering factors influence glacier size including both temperature and snowfall.

7 Week 7: Franciscan: an introduction to subduction zone sediments

Students will be able to describe the local geology near San Quentin including source of rocks (from the ocean floor), rock geometry (the completely chaotic nature of the melange), and the reason that plate tectonics explains both of these characteristics (accretionary wedge of an ancient subduction zone).

They will be able to explain why Bald Hill, visible from the lower yard of San Quentin, is "bald"/devoid of vegetation and why it is a hill.

8 Week 8: Earthquakes Hazards and Seismology in the the Bay Area

Students will be able to describe why earthquakes happen, correctly identifying different stages of the earthquake cycle (interseismic strain accumulation along locked faults, coseismic energy release during earthquakes, and postseismic events such as aftershocks) and describe why friction is an important part of the earthquake process.

One of the best ways to learn about earthquakes is to study the shaking released during previous

earthquakes. From records of shaking, we can figure out when, where, and how much faults moved. Our goals for this exercise are:

- Understand how seismic waves travel through the earth, and how seismologists record these waves.
- Learn how to use seismic waves to locate earthquakes and determine their magnitude.
- Understand how the intensity of seismic shaking can vary from place to place, and what factors control these variations.
- Become familiar with typical damage done to structures by earthquake shaking and how building practice can be improved to avoid loss of life in future earthquakes.

9 Week 9: Earthquakes and Tectonics in the LA Basin

Week 9 is a continuation of Week 8 in a slightly more global context.

Students will be able to explain how the location, depth, and direction of motion of earthquakes in California can be explained by plate tectonics, and identify most of California as an active transform fault boundary.

The earth's crust is constantly changing as plate tectonics and surface processes interact to form all sorts of geologic structures. Our goals for this exercise are:

- Observe the deformation process firsthand.
- Describe the geometry of deformation.

In the end, students will be able to extrapolate from this knowledge to explain why Mount Tamalpais, also visible from the San Quentin yard, is such a tall mountain. They will understand that earthquakes related to compression are mountain-building events, and it takes many, many earthquakes to build up a mountain.

10 Week 10: The California Coast

Coastal erosion is a significant problem for many coastal communities. In this exercise, we'll:

- Measure how quickly waves can erode the coastline
- Discover factors that accelerate coastal erosion
- Discuss methods for protecting coastal communities from rapid erosion

- 11 **Week 11: Make-up week**
- 12 **Week 12: Bringing it all together: Review**
- 13 **Week 13: Final Field Trip and Final Exam**