

# Geology 165: Geology of California

**Instructor:** Garry Hayes - Science Community Center 336

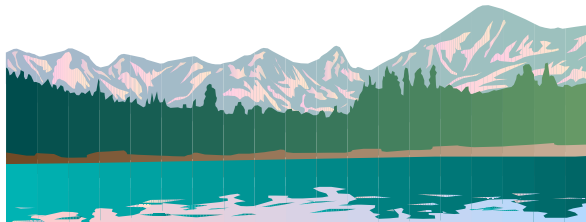
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California is a state of many superlatives, and the geology is no exception: it has the highest point in the lower forty-eight states, and the lowest point in the western hemisphere. It has within its boundaries the oldest living thing, and the largest living thing on the earth. It contains examples of every kind of tectonic plate boundary (don't worry, you'll learn what this means), and rocks from every geological time period. It has some of the most unique minerals and rocks found anywhere, including some that are found nowhere else on earth. It includes some of the driest and hottest and wettest places in North America, and some of the most active faults and volcanoes found anywhere. In this course, we will learn how the state evolved throughout geologic time, about some of the geologic hazards that face the state, and how we might deal with some of the worst environmental problems facing California.

**Text:** *California's Amazing Geology*, Donald Prothero, 1<sup>st</sup> Edition

## Grading Policy (Subject to change due to extenuating circumstances):

Task	Points Possible	Percentage of Grade
Chapter Quizzes, Special projects	200	50%
Midterms	100	25%
Final	100	25%
Total	400	100%

A: 400 - 360

B: 359-320

C: 319-260

D: 259-220

F: Less than 220

## Extra Credit

You may earn extra credit by answering the review questions that will be provided for each chapter. Each chapter assignment will be worth 3 points, and will be due at the time of the quiz for that chapter. **No late extra credit assignments will be accepted.**

## Class Guidelines:

Attendance in this class is important. **You are responsible** for knowing class announcements, even if you haven't been to class. Three (3) consecutive absences will be considered grounds for dropping you from the course. **Quizzes cannot be made up for any reason unless arranged in advance with the instructor.** Quizzes and final may be a combination of multiple-choice, fill-in, and essay questions. The final will be comprehensive.

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**“After sleeping through a hundred million centuries we have finally opened our eyes on a sumptuous planet, sparkling with color, bountiful with life. Within decades we must close our eyes again. Isn’t it a noble, an enlightened way of spending our brief time in the sun, to work at understanding the universe and how we have come to wake up in it? This is how I answer when I am asked—as I am surprisingly often—why I bother to get up in the mornings.”**

**Richard Dawkins**

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**When does it all happen? (This schedule is tentative...)**

Week	Date	Topics	Reading
1	Aug. 29-31	Introduction, Science, California Provinces	Ch. 1, Handouts
2	Sept. 5-7	Earth Materials: Minerals and Igneous Rocks	Chapter 2
3	Sept. 12-14	Sedimentary and Metamorphic Rocks, Lab Exercise	Chapter 2
4	Sept. 19-21	Geologic Time	Chapter 3
5	Sept. 26-28	Plate Tectonics	Chapter 4
6	Oct. 3-5	Plate Tectonics	Chapter 4
7	Oct. 10-12	Geologic Framework of California, <b>Midterm Exam</b>	Chapter 15
8	Oct. 17-19	Cascades\Modoc Plateau	Chapter 6
9	Oct. 24-26	Cascades, Intro to Sierra Nevada	Chapters 8
10	Oct. 31-Nov 2	Sierra Nevada	Chapter 8
11	Nov. 7-9	Sierra Nevada, Klamath Mountains	Chapters 8-9
12	Nov. 14-16	California Deserts and Basin and Range	Chapters 7
13	Nov. 21-23	Mojave and Colorado Deserts, Great Valley	Chapters 7, 10
14	Nov. 28-30	Coast Ranges, Earthquakes, San Andreas Fault	Chapters 5, 11, 12
15	Dec. 5-7	Peninsular Ranges, Transverse Ranges	Chapters 13-14
16	Final Examination	Tuesday, Dec. 12, 7:00-9:50 AM	Comprehensive

**What will you know when you finish this course? What new skills will you have? The following items are the Student Learning Outcomes (SLO's) for California Geology. Upon successful completion of the course, you will be able to:**

- A. Distinguish the elements of the scientific method and discover how these principles apply to the study of California geology.** All sciences share a common methodology of attaining knowledge that seeks to eliminate bias and prejudice in research. You will know the difference between a hypothesis and a theory (and it may very well not be what you think!).
- B. Demonstrate the ability to use basic geologic principles and the examples of present-day geologic processes to explain geologic events of the past, as revealed by fossils and rocks.** Many people are surprised that a geologist can look at a few rocks in a roadcut or mountainside and then immediately tell a complete story of how those rocks came about. In this class, you will learn to identify the basic rocks and minerals, and the set of principles that geologists use to tell the story of the rocks. You will have the ability to interpret the story in the rocks yourself, either in pictures and diagrams, or by visiting the localities yourself.
- C. Reconstruct and summarize the major geologic events in the history of the California region and each of its provinces.** You will be using your skills to figure out how California came into being. Different parts of California have different stories, from the volcanoes of the Cascades, to the granite peaks of the Sierra Nevada, to the ancient rocks of the Mojave Desert to the very strange and convoluted sediments of the Coast Ranges. Not to knock pop culture, but you will know more about California geology than literally any television or newspaper reporter. You will be criticizing and critiquing the news regularly, especially when they make mistakes about earthquakes and volcanoes.
- D. Explain volcanism, faulting, stream and glacial erosion, mass-wasting, and other geologic processes active in California.** California is one of the most diverse landscapes in the world: there are few places where you can start driving in a hot desert, go up and ski for a few hours, and then go to the beach to work on your tan. Almost every important geologic process has an example taking place in this state, and you will understand how they work.
- E. Assess and criticize competing hypotheses regarding the origin and tectonic history of the different provinces of California.** Geologists are still arguing about things going on in California. This is how science is meant to work, so we will be learning how controversies and arguments are settled in geologic research.
- F. Analyze and assess geologic hazards that threaten inhabitants of California.** Perhaps this is the most important objective in the class. No matter where you live, be it in California or anywhere else, geological processes can kill and injure people, cause property damage, and just make life miserable. You will know the chances of earthquakes, volcanic eruptions, landslides, and floods in given areas of the state, and how best to deal with such hazards.

Are you the kind of person who ignores handouts? Don't do that: **Read all of this!**

**Surviving California Geology**

**ALWAYS ATTEND CLASS** - This shouldn't have to be said, but it is truer for science courses than for many others: You will miss a tremendous amount of information if you aren't there. If you **have** to miss a class, you are **still responsible for all that occurs, including test and quiz announcements**. Call me or get notes from someone else in the class. (Also, three (3) consecutive absences will be considered sufficient grounds for dropping you from the course)

**READ THE TEXT BEFORE THE LECTURE** - Read the text after the lecture. And read it before tests. Do the practice quizzes at the end of the chapters. Books are required for a reason. I've found some of the best ones available; make use of them.

**ALWAYS TAKE COMPLETE NOTES** - and rewrite them after referring to your text. You will remember only 10% of what you hear, 20% of what you write, but more than 40% of what you hear and rewrite. Practice your drawing skills; a picture may truly be worth a thousand words.

**DON'T BE A CLASS DISRUPTION** – Arriving late to class, leaving your phone on, texting or websurfing in class, talking in class, eating in class; I'm sure you can think of a few others. These behaviors are *simply rude*.

**SCORE CARD:**

**Quizzes:**

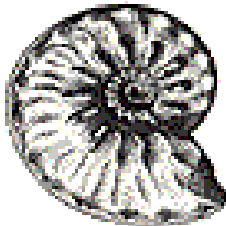
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**Projects and Assignments**

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**Midterms and Final:**

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**Every student is unique with different strengths and weaknesses.**  
Some of you may find this to be a difficult course, while others may find it to be relatively easy. The most important point to know is that you **can pass this course!** It may, however, be necessary to change some of your study habits and learning strategies, especially if you are just beginning your college education.

**There is no substitute for effort.**  
Do not come to my office two weeks before the end of the course asking how you can pass the class. You will know long before then that you are in trouble.

## Class got you unnerved? Need ideas to survive this course?

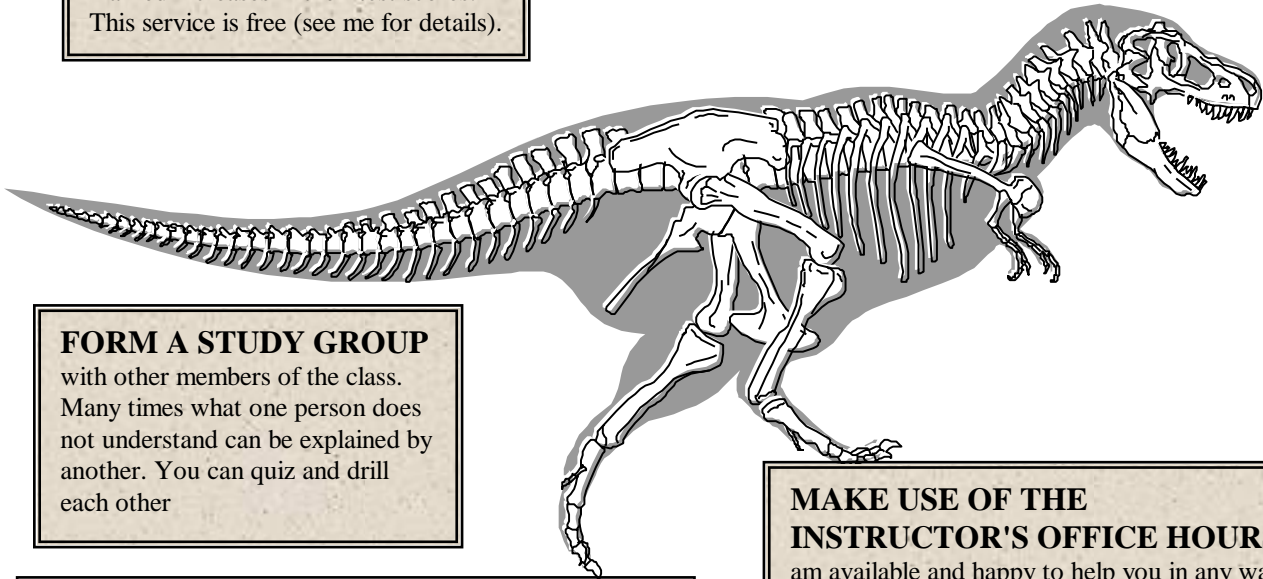
### GET THE HELP OF A TUTOR OR LAB

**ASSISTANT.** Too few students take advantage of the tutoring program here at MJC. The tutors are students who received 'A's when they took the course, and students who have received tutoring have had marked increases in their test scores. This service is free (see me for details).

### USE THE WEB PAGE RESOURCES AND COMPUTER TUTORIALS

available in the geology lab, Science 132. The computers provide an excellent alternative to the usual lecture and lab style of learning. It takes only minutes to learn how, even if you haven't dealt with computers before. Explore the department web page to see what resources are available there:

<http://hayesg.faculty.mjc.edu/Geology165.html>



### FORM A STUDY GROUP

with other members of the class. Many times what one person does not understand can be explained by another. You can quiz and drill each other

**SET ASIDE STRICT STUDY HOURS.** Students often rebel at the concept of study time outside the classroom (at least I did while in school!) This is unfortunate, since most learning occurs during study time. Make it a habit to give 2 hours of study for every hour of class lecture. If you are working, it may be harder to schedule study time, and yet all the more critical. Don't neglect lunch hours for study time (I got my degree while selling shoes at a department store!).

**USE 3X5 FLASH CARDS** to help memorize terms. Much difficulty in this course results from not learning the language of science. Put the term on the front, and the definition on the back. Carry a few in your pocket or purse, and glance at them when you are standing in line, or during commercials.

### MAKE USE OF THE INSTRUCTOR'S OFFICE HOURS:

I am available and happy to help you in any way I can. If you can't make it during regular office hours, call me and make an appointment. If you can't call me, then e-mail me ([hayesg@mjc.edu](mailto:hayesg@mjc.edu)). If you can't e-mail, then fax me at 575-6696.

**THE PARTING SHOT:** If you successfully read all of the above, you have earned the right to some extra credit points! Get to a computer, and visit the Geology 165 website (you can access through links at <http://hayesg.faculty.mjc.edu/Geology165.html>). Note the location at which the picture was taken, and e-mail me before the second class meeting to receive 5 extra points (handwritten not accepted).

## Why California is Interesting!

**Highest point in the lower 48 states:**

Mt. Whitney, 14,495 feet

**Lowest point in the western hemisphere:**

Badwater, Death Valley, -283 feet

**Largest living things in the world:**

Sequoia Trees

**Tallest living things in the world:**

Coast Redwoods

**Oldest living things in the world:**

Bristlecone Pines (3,000-4,000 years), White Mtns,  
or Creosote Bushes in Colorado Desert (11,000 years?)

**Hottest and Driest Place on the planet:**

Death Valley: 134 degrees, precipitation 1.4"/year

**Snowiest Place in the U.S.:**

Tamarack, Sierra Nevada, 76 feet in one year, 32 feet in one month, 37 feet  
on ground at one time

**Highest Waterfall in North America:**

Yosemite Falls, 2,850 feet

**Second tallest active volcano in the U.S.:**

Mt. Shasta, 14,162 feet

**Second most recently active volcano in lower 48 states:**

Mt. Lassen (1914-21)

**Largest earthquakes in the lower 48 states:**

1906 (San Francisco 8.2), 1872 Lone Pine (8.25), 1857 (Ft. Tejon 8.2)

**One of the most prolific oil and natural gas producing regions in the world:**

Los Angeles Basin, Bakersfield, and Santa Barbara-Ventura Channel

**One of the biggest explosions ever:**

Long Valley Caldera, 750,000 years ago, 125 cubic miles of ash spread all  
over the western states as far east as Nebraska and Kansas

**No other state has the combination of landscapes:**

Coastlines, deserts, mountains, river valleys and plateaus

**All three different kinds of plate margins** (don't panic, you'll learn what they  
are): Divergent, convergent and transform. Few places in the world have this kind  
of diversity

# California Geology Outline

- Science:** Body of Knowledge  
Way of Solving Problems  
Scientific Method:  
    Observation, Gathering and Organizing Data,  
    Hypothesis, Theory and Law
- Geology:** Study of the Earth  
Physical Geology: Materials and Processes that affect the Earth  
Historical Geology: The sequence of events that formed a landscape
- Geologic Provinces:**
- |                   |                   |
|-------------------|-------------------|
| Great Valley      | Sierra Nevada     |
| Basin and Range   | Cascades Ranges   |
| Modoc Plateau     | Klamat            |
| h Mountains       |                   |
| Mojave Desert     | Colorado Desert   |
| Peninsular Ranges | Transverse Ranges |
| Coast Ranges      |                   |
- Earth Materials:** (chap. 2)  
Crustal Elements: OSiAlFeCaNaKMg  
Rock-forming Minerals: Quartz, Feldspar, Mica, FerroMags, Olivine  
Rock Cycle  
Igneous Rocks  
    Plutonic: Peridotite, Gabbro, Diorite, Granite  
    Volcanic: Basalt, Andesite, Rhyolite, Obsidian, Pumice  
    Plutons: Dike, sill, batholith, stock  
Sedimentary Rocks:  
    Clastic: Conglomerate, Sandstone, Shale  
    Biogenic (Biologic): Limestone, Coal, Diatomite  
    Chemical (Inorganic): Rock Salt, Gypsum  
Metamorphic Rocks  
    Foliated: Slate, Schist, Gneiss  
    Granular: Quartzite, Marble
- Geologic Time:** (chap. 3)  
Relative Dating:  
    Uniformitarianism, Faunal Succession  
    Superposition, Original Horizontality  
    Cross-cutting Relationships, Inclusions  
Absolute Dating:  
Geologic Time Scale:  
    Proterozoic 2.5 billion to 545 million years  
    Paleozoic 540-255 million years  
    Mesozoic 255-66 million years  
    Cenozoic 66-0 million years
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**Structure of the Earth** (chap. 4)

Inner Core; Outer Core; Mantle; Crust

Lithosphere: Continental Crust, Oceanic Crust, Upper Mantle

Asthenosphere

**Plate Tectonics:** (chap. 4)

Evidence for Continental Drift:

Matching coastlines

Matching rock and structures (i.e. mountain ranges)

Matching fossils

Paleoclimatic evidence

Paleomagnetism

Age and thickness of seafloor sediments

Satellite measurements

Plate Boundaries:

Divergent: Oceanic and Continental

Convergent:

Ocean - Ocean

Ocean - Continent

Continent - Continent

Accretionary wedge, fore-arc basin, magmatic arc

Transform: Strike-slip faults

Hot Spots and Mantle Plumes

**Plate Motions throughout Geologic Time**

Rodinia and Pangaea

**Tectonic events in California** (Class handouts; chap. 15)

Mazatzal Orogeny 1.7 by

Continental Rifting 1.2 - .85 by

Atlantic Style Margin 800 - 400 my

Antler Orogeny 400-360 my

Japanese Style Margin 400 - 200 my

Sonoma Orogeny 245 - 200 my

Andean Style Margin 200 - 28 my

Nevadan Orogeny 140 my

Override of East Pacific Plate by North American Continent

California Style Margin 28 my to present



## What is Science?

Science is: the study of all that exists in the natural physical universe;  
a body of factual knowledge;  
a way of solving problems;  
a method, or approach to learning facts.

## How does science gain factual knowledge?

In a way that is meant to be as objective and unbiased as possible:

- Observations** and or curiosity about a phenomena
- Gathering and **analyzing data** about the observation
- Producing **hypotheses** as possible explanations
- Testing** the hypotheses
- If a hypothesis stands up to testing, it becomes **theory**

## A theory represents a very high level of confidence

Sciences may be **logical**, as in mathematics, or they may be **empirical** (based on observations) such as geology, astronomy, or biology.

Assumptions in science: that the physical laws that govern the universe are constant (law of gravity, laws of thermodynamics, etc.). Most, if not all, scientific findings must lie within these physical laws. If they don't, we probably don't understand the laws completely.

Science is not everything. It is not the only way to know or understand the universe. Science properly has no dealings with the supernatural or spiritual universe, since these are domains not subject to physical measurement or observation. (Note however that supernatural claims: ESP, psychokinesis, channeling and astrology, can be tested when they claim to have effects in the physical world). Art and culture often lie outside the realm of science, i.e., science can't judge the relative merits of different kinds of art or music.

Scientific knowledge is amoral (meaning that it lies outside a moral framework). Judgments about the morality of different kinds of scientific research lie within the society where that research is taking place (testing of pain thresholds in humans, cloning, weapons development and so on). That is why a scientifically literate culture is a good and desirable thing.

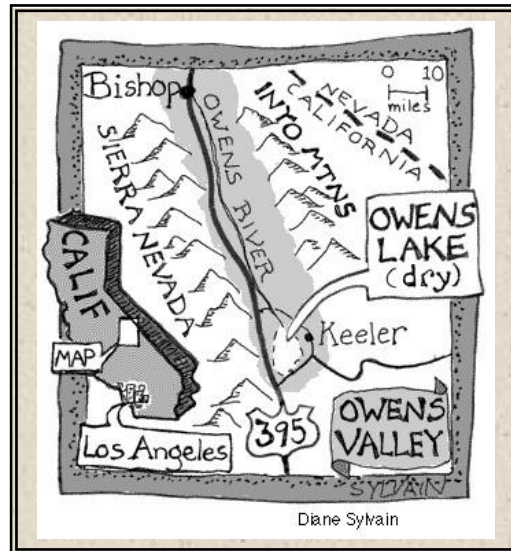
Science also has no proper role in determining the existence or nonexistence of God. Deities have a way of remaining beyond our ability to test and directly observe...

# Geology Department Field Studies Fall 2017

## Geology 186: Geology of the Eastern Sierra Nevada and Owens Valley

**September 28- Oct. 1 (#7172: 2 units)**

The eastern ramparts of the Sierra Nevada are a virtual geological wonderland with active volcanoes, glaciers, hot springs, earthquake faults, and some of the most spectacular scenery found anywhere in the world. Our explorations will include the Mammoth Lakes Caldera, site of the biggest explosion ever in the western United States, as well as the White Mountains, site of the oldest fossils in California, as well as the oldest living things, the Bristlecone Pines. (Fee: \$90)



## Geology 175: Caverns and Karst Topography of the Sierra Nevada

**Saturday, Oct. 21 (#6084: 1/2 unit)**

The Mother Lode, source of California's Gold Rush, holds fascinating geologic secrets: abandoned mines, ghost towns, caverns, and unique and unusual rocks and minerals. We will explore the region between Jackson and Columbia, and spend several hours underground in one of California's unique cave systems and an active gold mine. (Fee: \$20)

## Geology 173: Geology of Pinnacles National Park and the San Andreas Fault

**Saturday, November 18 (#6085: 1/2 unit)**

Will California really fall into the sea? The answer may surprise you! The Pinnacles are the remnants of a volcano that originated near Palmdale in southern California. It is moving north at a rate of 2 inches a year, a fact that we will confirm in Hollister, a town slowly being torn apart by fault motions. The San Andreas fault is one of the most important geological features of the state, and one of the most ominous. Don't miss it! (Fee: \$20)



## **Important Details!**

Each of these field trips is a separate course for academic credit. To enroll, you will need an add card from the instructor. When you apply, a per-credit fee and trip fee will be charged in the admissions/business office. You are expected to take notes and complete a worksheet for each field trip you attend.

**For day trips**, bring a sack lunch, canteen (or small ice chest), notebook, and coat or rain protection if the weather threatens. Rock hammers and cameras are optional. Transportation is provided by the school (private vehicles are not allowed on trips). Each of the two day trips will meet on the north side of the Science Community Center on West Campus at 7:30 AM. We generally expect to return about 7:30 PM.

**The extended trip** to the Eastern Sierra Nevada involves camping out in rugged conditions which necessitates additional planning and preparation. We will have **an organizational meeting** prior to the trip (**Thursday, Sept. 21 at 5:30 PM in Science Community Center 326**), and you will need to prepare some written materials. **Attendance at the meeting is mandatory.**

## **Looking ahead:**

**Geology and Archaeology of the Colorado Plateau- Summer 2018** (Geology 191 - 3 units): It's the adventure of a lifetime! Some of the most exciting geology in all of North America is to be seen in Utah, Colorado, Arizona and New Mexico, including Grand Canyon, Zion, Bryce Canyon, Arches, and Canyonlands National Parks, and many more wonders. This trip will be held jointly with Anthropology department on June 2-17, 2018. Cost: approximately \$850