Geology 165: Geology of California

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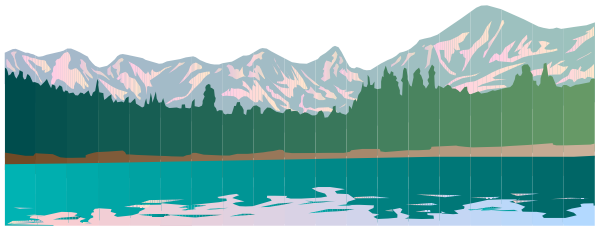


California is a state of many superlatives, and the geology is no exception: it has the highest point in the lower forty-eight states, and the lowest point in the western hemisphere. It has within its boundaries the oldest living thing, and the largest living thing on the earth. It contains examples 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 Geology*, Harden, 2nd edition, 2004

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.

"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

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

Week	Date	Topics	Reading
1	Jan 13-15	Introduction, Science, California Provinces	Handouts
2	Jan 20-22	Earth Materials: Minerals and Igneous Rocks	Chapter 2
3	Jan 27-29	Sedimentary and Metamorphic Rocks, Lab Exercise	Chapter 2
4	Feb 3-5	Geologic Time	Chapter 3
5	Feb 10-12	Plate Tectonics(Thursday TBA)	Chapter 1
6	Feb 17-19	Plate Tectonics	Chapter 1
7	Feb 24-26	Geologic Framework of California, **Midterm Exam**	Chapter 18
8	March 3-5	Cascades\Modoc Plateau	Chapter 5
9	March 10-12	Cascades, Intro to Sierra Nevada	Chapters 7-8
10	March 17-19	Sierra Nevada	Chapter 8
11	March 24-26	Sierra Nevada, Klamath Mountains	Chapters 8-9
12	Mar 31-April 2	California Deserts and Basin and Range	Chapters 6-7
13	April 7-9	Mojave and Colorado Deserts, Great Valley	Chapters 7, 11
14	April 14-16	Coast Ranges, Earthquakes, San Andreas Fault	Chapters 12-15
15	April 21-23	Peninsular Ranges, Transverse Ranges	Chapters 16-17
16	Final Examination	Tuesday, April 28, 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:

Projects and Assignments

Midterms and Final:

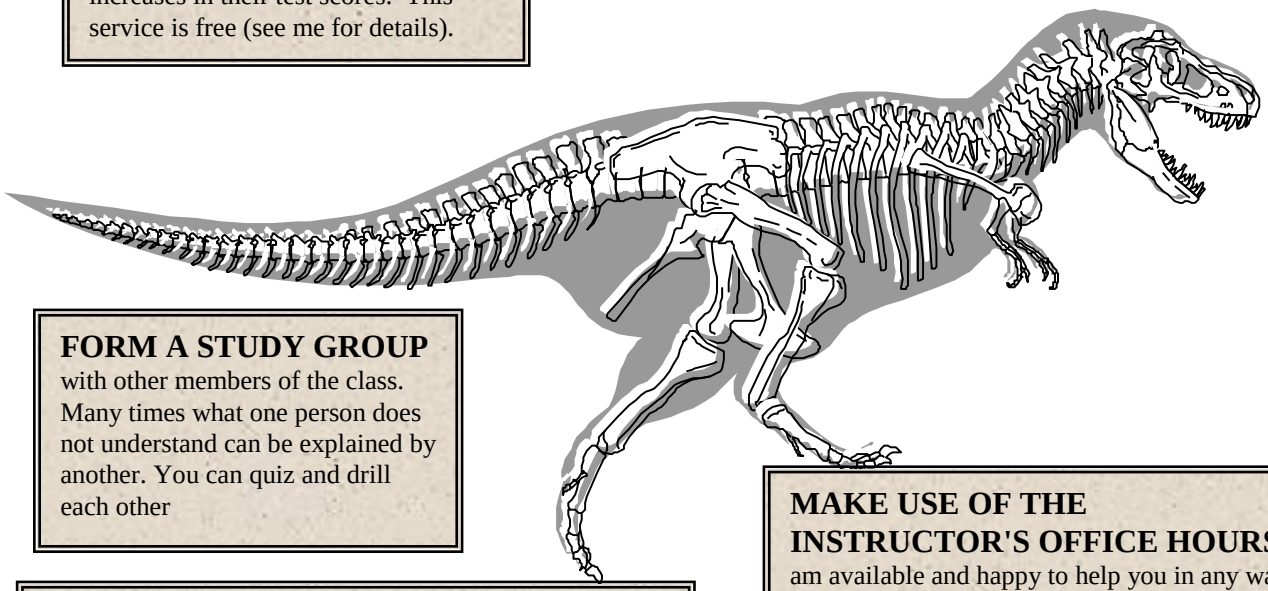
There is no substitute for effort.
Do not come to my office two weeks before the end of the course asking how you can pass the class. You will know long before then that you are in trouble.

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.

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

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**). If you can't e-mail, then fax me at 575-6696.

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.

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 the 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	Klamath Mountains
Mojave Desert	Colorado Desert
Peninsular Ranges	Transverse Ranges
Coast Ranges	

Earth Materials: (Harden, 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: (Harden, 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 545-245 million years
  - Mesozoic 245-65 million years
  - Cenozoic 65-0 million years

Structure of the Earth (Harden, chap. 1)

- Inner Core; Outer Core; Mantle; Crust
- Lithosphere: Continental Crust, Oceanic Crust, Upper Mantle
- Asthenosphere

Plate Tectonics: (Harden, chap. 1)

- 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

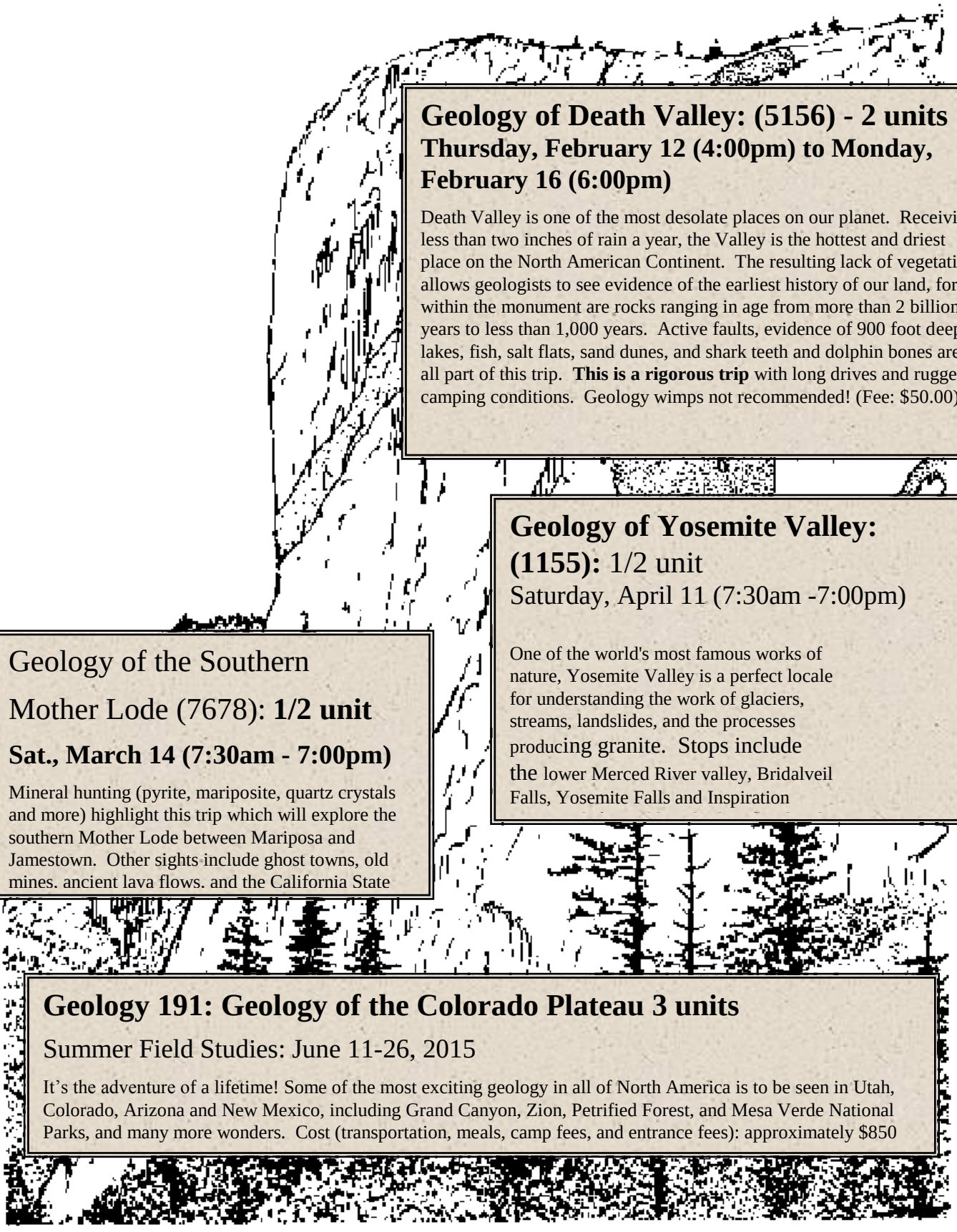
Plate Motions throughout Geologic Time

- Rodinia and Pangaea

Tectonic events in California (Class handouts; Harden, chap. 18)

- 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

Geology Department Field Studies Spring 2015



Geology of Death Valley: (5156) - 2 units

Thursday, February 12 (4:00pm) to Monday, February 16 (6:00pm)

Death Valley is one of the most desolate places on our planet. Receiving less than two inches of rain a year, the Valley is the hottest and driest place on the North American Continent. The resulting lack of vegetation allows geologists to see evidence of the earliest history of our land, for within the monument are rocks ranging in age from more than 2 billion years to less than 1,000 years. Active faults, evidence of 900 foot deep lakes, fish, salt flats, sand dunes, and shark teeth and dolphin bones are all part of this trip. **This is a rigorous trip** with long drives and rugged camping conditions. Geology wimps not recommended! (Fee: $50.00)

Geology of Yosemite Valley: (1155): 1/2 unit

Saturday, April 11 (7:30am -7:00pm)

One of the world's most famous works of nature, Yosemite Valley is a perfect locale for understanding the work of glaciers, streams, landslides, and the processes producing granite. Stops include the lower Merced River valley, Bridalveil Falls, Yosemite Falls and Inspiration

Geology of the Southern Mother Lode (7678): **1/2 unit**

Sat., March 14 (7:30am - 7:00pm)

Mineral hunting (pyrite, mariposite, quartz crystals and more) highlight this trip which will explore the southern Mother Lode between Mariposa and Jamestown. Other sights include ghost towns, old mines. ancient lava flows. and the California State

Geology 191: Geology of the Colorado Plateau 3 units

Summer Field Studies: June 11-26, 2015

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, Petrified Forest, and Mesa Verde National Parks, and many more wonders. Cost (transportation, meals, camp fees, and entrance fees): approximately $850

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 in front of the Science Community Center (north side) on West Campus at 7:30 AM. We generally expect to return about 7:30 PM.

The extended trip to Death Valley involves camping out in fairly rugged conditions which necessitates additional planning and preparation. We will have **an organizational meeting** prior to the trip (**Thursday, February 5 at 5:30 PM in Science Community Center Room 326 on West Campus**), and you will need to prepare some written materials. **Attendance at the meeting is mandatory**.

Looking ahead:

Geology and Archaeology of the Colorado Plateau- June 11-26, 2015 (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, Petrified Forest, and Mesa Verde National Parks, and many more wonders. Cost (transportation, meals, camp fees, and entrance fees): approximately $850

The geology class will be held jointly with the Anthropology 174 Field Studies Course, which will provide an in-depth human history of the region.

We will have several organizational meetings, the first of which will be on **Thursday, April 30th, at 7:00 at MJC in Science Community Center Room 326 (West Campus).** Previous experience in geology or earth science is highly recommended, but not required (be ready to have a crash course in basic principles before we leave). For more info, check out: http://hayesg.faculty.mjc.edu/Geology_174_Colorado_Plateau.html

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…