GG 103 GEOLOGY OF THE HAWAIIAN ISLANDS

Three Credits
Fall, 2015
Tues. Thurs. 11:30 – 12:45
Hale Imiloa 113 (Geology Laboratory)

INSTRUCTOR:	**Dr. Floyd W. McCoy**
OFFICE:	**Hale Imiloa 115**
OFFICE HOURS:	**Mon.,Tues. 2:00 – 4:30; Th. 2:00-3:30**
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EFFECTIVE DATE:	**Fall, 2015**

WINDWARD COMMUNITY COLLEGE MISSION STATEMENT

Windward Community College is committed to excellence in the liberal arts and career development; we support and challenge individuals to develop skills, fulfill their potential, enrich their lives, and become contributing, culturally aware members of our community.

CATALOG DESCRIPTION

Hawaiian geology and geological processes: origin of Hawaiian Islands, volcanism, rocks and minerals, land forms, stream and coastal processes, landslides, earthquakes and tsunamis, ground water, geological and environmental hazards. Field trips arranged. (3 hrs. lect.) WCC:DP

Additional Activities Required Outside of Class

Additional resources besides the textbook are needed such as a series of color brochures, books and magazines in the WCC library, in addition to websites and other sources – these will be discussed and identified in class.

STUDENT LEARNING OUTCOMES

Your learning outcomes from successfully completing this course are:

1. Students can explain the relevance of geology and geophysics to human needs, including those appropriate to Hawaii, and be able to discuss issues related to geology and its impact on society and planet Earth.
2. Students can apply technical knowledge of relevant computer applications, laboratory methods, and field methods to solve real-world problems in geology and geophysics.
3. Students use the scientific method to define, critically analyze, and solve a problem in earth science.
4. Students can reconstruct, clearly and ethically, geological knowledge in both oral presentations and written reports.
5. Students can evaluate, interpret, and summarize the basic principles of geology and geophysics, including the fundamental tenets of the sub-disciplines, and their context in relationship to other core sciences, to explain complex phenomena in geology and geophysics.

And the heat from them both gripped the purple sea, the heat of thunder and lightning and of fire from such a monster, the heat of fiery storm-winds and flaming thunderbolt; and the whole earth… and sea boiled. And long waves spreading out in circles went seething over the headlands, and unquenchable earthquakes broke out…
[Hesiod, Archaic Period, Greek poet, ca. 750-650 BCE; Theogony]

To be ignorant of what occurred before you were born is to always remain a child…
[Marcus Tullius Cicero, Roman statesman, orator, senator, philosopher: 106 – 43 BCE]

COURSE CONTENT

Concepts or Topics

- Structure of the earth
- Plate tectonics
- Hot spot/midplate volcanoes
- Geography of Hawaiian volcanoes
- Structure of Hawaiian volcanoes
- Rocks and minerals
- Extrusive and intrusive igneous
- Hawaiian-type eruptions
- Predicting Hawaiian eruptions
- Types and classification of igneous rocks
- Formation & crystallization of igneous rocks
- Types of eruptions
- Stages of Hawaiian volc. & island evolution
- Geologic history of Oahu
- Mechanical and chemical weathering
- Ground water
- Mass wasting; aeolian processes
- Glaciers, glaciation and sea-level changes
- Landscape evolution; geomorphic cycle
- Rock cycle
- Absolute and relative dating
- Age of the Hawaiian Islands
- Geologic time
- Volc. hazards: identification, management, mitig

Skills or Competencies

1. Understand the scientific method, and how it is used and applied.
2. Understand the metric system.
3. Apply an understanding of physical, chemical, and biological processes to interpreting geological events and processes.
4. Use basic mathematical statements to describe geological properties and processes.
5. Distinguish and reject *faux* science and misrepresentations of science.
6. Appreciate the technology behind the science of geology.
7. Develop an appreciation for geology and rocks good for jocks.
8. Appreciate the spectrum of science and engineering endeavors that underlie the study of the earth.
9. Appreciate the history, literature, music, and mythology of the earth.
10. Comprehend the benefits and dangers of volcanism to society, and the mitigation of geological hazards.

COURSE TASKS, ASSESSMENT AND GRADING

Type of examination: written; questions require essays of varying length from short (single sentence) to longer (no more than a 10 minute composition); some questions may involve the use of maps and cross-sections.

Examination schedule:
One midterm: 1 hour, covering all material discussed up to the examination date; if this examination is not taken on schedule, a re-test exam. can be given but will have different and more difficult questions.
Final exam.: 2 hours, concerned with the entire course, with some emphasis on the last half of the course; must be taken on scheduled date – no retakes or early-takes are possible except in exceptional cases.
Extra/special credit: none routinely awarded; no term papers are required; extra/special credit can be devised via consultation with the instructor.
Re-tests: allowed for the midterm examination; may be taken at the WCC Testing Center; realize that each retest will be one notch more difficult than the previous re-test [details announced in class].

Grading scheme: letter grades calculated from an average of all test scores, with the midterm = 40%, and the final = 60% of the total grade; letter grades assigned with:
A = 90 - 100% **D** = 60 - 69% **N** = course not completed due to unforeseen difficulties
B = 80 - 89% **F** = < 60% **C/NC** = credit/no credit option, assigned only via registration
C = 70 - 79% **I** = incomplete due to unusual circumstances.

Attendance: This is a university course that you have selected and paid for. The presumption is that you will attend lectures. Accordingly, attendance is not taken – simply stated: given the wonderful and spectacular geological story of how a Hawaiian island is formed then decays, and given that there is no adequate textbook, there is little prospect of passing this course without attending lectures.

Na pelepele nna pali o Kalalau
i kawili o ka makani

The cliffs of Kalalau are crumbling
because of stirring by the winds

[Ancient Hawaii proverb]

"Civilization occurs with the consent of geology."
[Will Durant, American historian]

LEARNING RESOURCES

There is no adequate text book for this course - the book listed below remains the basic source of information concerning the geology of Hawaii but is considerably out-of-date, yet continues to provide the basic foundation on processes of constructing and denuding a Hawaiian island.

Macdonald, Abbott and Peterson; *Volcanoes in the Sea, The Geology of Hawaii*; Univ. Hawaii Press, 1983 (2nd edition)

Please see the attached sheets for resources that discuss Hawaiian geology.

Supplementary, non-required reading is in libraries at all campuses, both on reserve and on open shelves; you are encouraged to peruse this literature. Numerous seminars, talks, symposia and exhibits occur throughout the university system and at various museums, you are particularly encouraged and welcomed to these. Additional announcements will be made in class, posted on the Marine Option Program bulletin board in Hale 'Imiloa at WCC, or listed on the website; posters depicting various aspects of geology and field trips are on bulletin boards in the Hale 'Imiloa hallway.

ADDITIONAL INFORMATION

Field Courses: Not required but highly recommended; 1 credit awarded for each course. To obtain credit for neighborhood island field trips, you must participate on every day of the trip, either pass a written final examination or submit a report on a field exercise. Each course involves a one-day field exercise, with data analyses done after the trip, and a complete report submitted prior to the end of the semester. The Oahu field-trip course has different requirements that are noted below. Complete course descriptions are given in the WCC catalog and on the WCC website. All require physical prowess - none are handicap accessible.

GG 210 – Oahu Field Geology: every fall semester; Wednesday afternoons, 1430–1730, meet in Hale 'Imiloa Building (WCC) or at field site; short, easy hikes throughout the island to observe, discuss and map geologic features, field activities are mixed with laboratory exercises; transportation to field sites via private cars; course grade is a function of participation and satisfactory completion of laboratory and field exercises [offered fall, 2015].

GG 211 – Big Island Field Geology**:** every fall semester; four days during either Veteran's Day week-end or Thanksgiving Day week-end; involves short hikes and two difficult hikes (onto lava flows and on Mauna Kea), with one day on the summit of Mauna Kea (a harsh, cold, high-altitude environment) [offered fall, 2015].

GG 212 – Maui Field Geology: spring semester, 2016; during first four days of spring recess; may involve a difficult one-day hike into Haleakala; also may involve field laboratory exercise in difficult terrain.

GG 213 – Molokai, Lanai and Kaho'olawe Field Geology: spring semester, 2017; during first five days of spring recess; involves hike down to Kalaupapa with a day hike around the Kalaupapa/Kalawao peninsula, and four-wheel driving over rough roads on Lanai; also involves field laboratory exercise(s) in difficult terrain.

GG 214 – Kauai and Ni'ihau Field Geology: spring semester, 2015; first five days of spring recess; involves short easy hikes; also involves field laboratory exercises.

Note: All field classes require medical clearance and legal waiver forms; all involve hiking over irregular ground and can be difficult with potentially dangerous conditions; students are responsible for their personal expenses during the trip including transportation to and from an outer island, hotel room, food, etc. A course/lab fee covers admission fees, van/car rentals, gasoline, and any other expenses related to field activities and laboratory excercises.

To witness a great eruption closely is an awesome privilege. To survive is a bonus.
[Alwyn Scarth, "Vulcan's Fury: Man against the Volcano"]

Ke pahu nei ka honua. ***The earth rumbles and explodes.***
[Ancient Hawaii proverb]

Schedule of lectures:

Week	**Subject**
1	Introduction; geology as a science; scale, rates and time; metric system; Marine Option Program (MOP) Structure of the earth
2	Structure of the earth (continued) Plate tectonics
3	Plate tectonics (continued) Hot spot/midplate volcanism
4	Geography of Hawaiian volcanoes Structure of Hawaiian volcanoes
5	Rocks and minerals Extrusive and intrusive igneous rocks
6	Extrusive and intrusive igneous rocks (continued) Extrusive igneous rocks: lava flows
7	Extrusive igneous rocks: pyroclastic debris and rocks Hawaiian-type eruptions
8	Predicting Hawaiian Eruptions Types and classification of igneous rocks Formation and crystallization of igneous rocks
9	Types of eruptions
10	Types of eruptions (continued), Review
11	Midterm examination Stages of Hawaiian volcanism and island evolution
12	Stages of Hawaiian volcanism and island evolution Geologic history of Oahu Sea level changes
13	Hydrologic cycle Ground water Mechanical and chemical weathering
14	Mass wasting; aeolian processes Landscape evolution Geomorphic cycle
	---------- Thanksgiving recess GG 211 Big Island geology field course ----------
15	Rock cycle Absolute and relative dating
16	Volcanic hazards: identification, management, mitigation

Note: This schedule is likely to change as geologic events (eruptions, tsunami, earthquakes, etc,) occur during the semester. There will be a Hawaiian Geology word-of-the-week posted – this is a course in geology in Hawaii and it is appropriate that the Hawaiian language, legends, and myths be components in this course.

Some Goals for You

This course will provide you with a new view of the world, with a special focus on Hawaii. For the rest of your life you will carry a special perspective that only an understanding of geology can provide. A geology course can make you a better member of your community because you will understand your home planet, you will know how to avoid natural hazards, you will know how to sustain natural resources, you will become an informed voter, and you will improve your critical thinking skills.

Earth is the product of billions of years during which geologic processes have carved the land, mixed the seas and air, and shifted the continents—and continue to do so.

All life on Earth is the product of natural selection. Preserving biodiversity and natural habitats is critical to the continuation of Earth's natural resources. Natural resources are geologically renewed but humans use resources faster than they can be naturally renewed. Today humans use 1.5 Earths; that is, the resources we use in 1 year, will take 1.5 years to replace. In the U.S. we use 5 Earths. This is not sustainable. To ensure that heavily used resources are still here for future generations means that we must ultimately find alternative resources, augment the rate of natural renewal, or reduce our rate of consumption (or all the above). This is can lead to *sustainability*.Regardless of your lifework, the science of geology can provide you with a level of awareness that will serve you in your career, your personal life, and your role as a community member of planet Earth. Here are 5 "Enduring Understandings" of geology that serve as semester-long learning goals.

1. The study of Earth encompasses a vast range of time and space. Geologists study nature from the length of the Solar System (trillions of kilometers) to the bonding of atoms (0.00000001 centimeters). We stretch our minds to understand the megascopic to the microscopic. Massive planets are constructed of the smallest minerals. Eons of time consist of long periods of slow and gradual change punctuated by short intervals of sudden violent convulsions in nature (i.e., earthquakes, floods, landslides). This immense span of time and space is one of the fundamental characteristics of the geological sciences.

2. Plate tectonics controls the geology of Earth's surface. The theory of plate tectonics has far reaching implications for the organization of the planet and its history. As plates move they perpetually change the way our planet looks. Mountain ranges rise when plates collide only to be worn by erosion down to the sea. Ocean basins open and close as continents rift and collide again. Nearly every aspect of geology is related to how plates interact and change through time.

3. Geologic systems are the product of interactions between solid Earth, oceans, atmosphere, and living organisms. Earth is organized into overlapping *geologic systems* that influence and react to each other. Geologic systems consist of interdependent materials (such as rocks, sediments, organic compounds, and water) that interact with natural physical and chemical processes. In a broad sense, these interactions occur because solar energy, geothermal energy, and gravitational energy are at work mixing the air, ocean, and solid Earth.

4. Change is ever present and accumulates over vast time. **Humans are powerful agents of change.** You live upon an ancient and restless landscape that is changing under your feet. All forms of life have evolved partially in response to geologic change over time. Today's Earth is the product of both gradual and instantaneous change accumulating over 4.6 billion years. Hence, our planet looked very different in the past and it will look different in the future.

5. Rocks and sediments are pages in the book of Earth history. Geologists read the story of past events in the crust and piece together the history of the restless planet. These materials teach us that Earth is very old, that evolution is responsible for life's incredible diversity, that ever-present change is a characteristic of geologic systems, and that geologic processes operate on an immense stage of time and space.

[Courtesy Dr. Chip Fletcher, Prof. Geology & Geophysics, UHM]

You Might Be a Geologist If ...

1. You own more pieces of quartz than underwear.
2. Your rock collection weighs more than you do.
3. Your rock garden is located inside your house
4. You can pronounce the word "molybdenite" correctly on the first try.
5. You don't think of "cleavage" the same way everyone else does.
6. You have ever uttered the phrase "have you tried licking it" with no sexual connotations involved
7. You think the primary function of road cuts is tourist attractions.
8. You find yourself compelled to examine individual rocks in driveway gravel.
9. You're planning on using a pick and shovel while you're on vacation.
10. Your internet home page has pictures of your rocks.
11. You will walk across eight lanes of freeway traffic to see if the outcrop on the other side of the highway is the same type of rock as the side you're parked on.
12. You can point out where Tsumeb is on a world globe.
13. The baggage handlers at the airport know you by name and refuse to help with your luggage.
14. You have ever found yourself trying to explain to airport security that a rock hammer isn't really a weapon
15. You never throw away anything.
16. You have ever taken a 22-passenger van over "roads" that were really intended only for cattle
17. You consider a "recent event" to be anything that has happened in the last hundred thousand years
18. You have ever had to respond "yes" to the question, "What have you got in here, rocks?"

Geologists are amazing. They know hundreds of words for different sorts of dirt and hundreds of words for things it does when left alone for a few million years.

"Study nature, not books."
[Louis Agassiz, Prof. of Geology, Harvard Univ.]

GG 103 Geology of the Hawaiian Islands

R e s o u r c e s

The list below presents resources that contribute to understanding the geological evolution of the Hawaiian Islands. There is no single adequate and updated source for this information, thus this list. The books and brochures should be in the WCC library.

Books with focus on Hawaiian geology

Macdonald, Abbott & Peterson; *Volcanoes in the Sea, The Geology of Hawaii*; Univ. Hawaii Press, 1983 (2nd edition)

Macdonald and Abbott; *Volcanoes in the Sea, The Geology of Hawaii*; Univ. Hawaii Press, 1970 (1st edition)

[Both editions are dated, lacking much new information although most of the basic premise and story remain the foundation for Hawaii's geological history, and remain the only adequate source published in book form.]

Hazlett & Hyndman; *Roadside Geology of Hawaii*; Mountain Press Publ. Co., 1996

[Good general presentation, albeit increasingly dated and outdated; road logs for every island describe geological sights, unfortunately marred by many mistakes in descriptions of these sights.]

Blay & Siemers; Kauai's Geologic History; TEOK Investigations, 2004

[Nice treatment of the geology of Kauai, also with a brief accounting of the geological history of any Hawaiian Island; book is the text for GG 214, Field Geology of Kauai.]

Natural History Books with chapter(s) on Hawaiian geology

Carlquist; Hawaii A Natural History; SB Printers, 1980

[Dated but nice summary.]

Morgan; Hawaii A Unique Geography; Bess Press, 1996

[Also dated but succinct.]

Ziegler; Hawaiian Natural History, Ecology, and Evolution; UH Press, 2002

[Good summary on geology and geologic evolution of Hawaii]

Websites

http://hvo.wr.usgs.gov/volcanowatch/

[Weekly posting of articles written by U.S. Geological Survey scientists and technicians published in the Hawaii Tribune Herald in Hilo; well-written accounts of current volcanic activity, of tools and techniques used in research; of cultural ties to Hawaiian volcanism; and more; postings to the website are often delayed by on-going volcanic activity.]

http://www.soest.hawaii.edu/GG/index.html

[Website for the Department of Geology and Geophysics at Manoa; often with short articles of current research pertaining to Hawaiian geology; elsewhere on the site are virtual geology tours.]

http://www.higp.hawaii.edu/~scott/GG103/PowerPoints/

[Many PowerPoint presentations of various subjects taught in GG 103 both on this campus and at Manoa, assembled by my colleague teaching the course at UHM – these are excellent as a review resource.]

http://volcanoes.usgs.gov/images/pglossary/index.php

[Glossary of terms used in class, with pictures and text, very nicely done.]

http://hvo.wr.usgs.gov/archive/PPT_Pub_EQ%20in%20Hawaii_FINAL.pdf

[PowerPoint presentation concerning earthquakes with a focus on Hawaii – excellent.]

Powerpoints of lectures from the GG 103 class at UH Manoa:

http://www.soest.hawaii.edu/GG/FACULTY/ROWLAND/GG103/GG103_web.htm

Sites with good discussions of Hawaiian volcanism and volcanoes:

http://volcano.oregonstate.edu/education/hawaii/intro/intro.html

http://volcano.oregonstate.edu/education/vwlessons/lessons/lesson6.html

A photo glossary of volcanological terminology:

http://volcanoes.usgs.gov/images/pglossary/index.php