Ge 1: Earth and Environment
http://web.gps.caltech.edu/classes/ge1/index.html
and on canvas
Spring 2021 **online edition!**
COURSE INFORMATION and SYLLABUS (as of 2/25/21)

Instructor:
Paul Asimow (he/him/his; asimow@gps.caltech.edu,
https://caltech.zoom.us/j/6654932078?pwd=UitPR2VSQlVPMVZUVFJzeW1WT2JOQT09)

Teaching Assistants
Rebecca Wipfler (rwipfler@caltech.edu; Office hours TBD, Zoom code TBD)
Ojashvi Rautela (orautela@caltech.edu; Office hours TBD, Zoom code TBD)
Daniela Osorio Rodriguez (dosorior@caltech.edu; Office hours TBD, https://caltech.zoom.us/j/3247359659)
Yuan-Kai Liu (ykliu@caltech.edu; Office hours TBD, Zoom code TBD)
Yan Yang (yanyang@caltech.edu; Office hours TBD, Zoom code TBD)
Emily Miaou (emiaou@caltech.edu; Office hours TBD, https://caltech.zoom.us/j/3806262128)
Haoyu Li (haoyu.li@caltech.edu; Office hours TBD, https://caltech.zoom.us/j/5567757546)
Rui Cheng (rui.cheng@caltech.edu; Office hours TBD, Zoom code TBD)
Yongzhao Guo (yzguo@caltech.edu; Office hours TBD, Zoom code TBD)
Molly Crotteau (mcrottea@caltech.edu; Office hours TBD, https://caltech.zoom.us/j/6318209421)
Jina Lee (jinalee@caltech.edu; Office hours TBD, Zoom code TBD)
Andrew Chan (amchan@caltech.edu; Office hours TBD, Zoom code TBD)
Allyson Trussell (atrussell@caltech.edu; Office hours TBD, https://caltech.zoom.us/j/9826520517)

Administrative Assistant:
Leticia Calderon (calderon@gps.caltech.edu)

***Meeting times and course structure*:**
Lectures: Three lectures per week will be pre-recorded and posted on Canvas for you do download and watch **before** 2 PM PDT on each Monday, Wednesday and Friday.

Discussion sessions: 2:00 – 3:00 PM, MWF, *except* Monday 5/31 (Institute Holiday), at this Zoom code: https://caltech.zoom.us/j/86708713461?pwd=YTZiMFNlOWRqbExOekx1b1ZGcG1LQT09. Here we will gather to talk about each lecture and discuss as many of your questions as we can! These sessions will allow us delve much more deeply into the subject material than we would manage in a regular in-person class and given us a chance to interact and get to know each other. These sessions will be recorded.

Labs: Four Tuesdays spaced through the term (**3/30, 4/13, 5/11, 5/25**). Some of these will be interactive in the T/A Zoom rooms (watch for instructions for which times and T/As), some will be pre-recorded and posted on Canvas. Write-ups will be due 5 PM PDT on the Friday after the lab day (4/2, 4/16, 5/14, 5/28).

Problem Sets: There are five problem sets, to be posted on nearly-alternating Fridays and due the following Friday at 5 PM PDT (due dates: 4/9, 4/23, 5/7, 5/21, 6/4). T/A's will hold office hours in their Zoom rooms generally on the Wednesday and Thursday of Problem Set weeks.

Field substitute activity: The lectures will include plenty of Google Earth flyovers and slide show tours of notable field sites in California. But as a replacement for the field trip we will have a major project centered around the topography and hydrology of the landscape wherever in the world you are. You will get to know your watershed and drainage path to the sea, as well as the general properties of Earth's geomorphology and the self-organization of drainage networks. Week 9 will be dedicated to work on this project.

Text (required)

Langmuir, Charles H. and Broecker, Wally (2012) How to Build a Habitable Planet, Revised and Expanded Edition. Princeton University Press. ISBN 978-0-691-14006-3.

Also available as an e-book. The library has both physical and e-versions (https://caltech.tind.io/record/981582) on reserve, but you should buy the book. Since it is a mainstream press and not a textbook, it is super-cheap as these things go. This is an interesting book, and over the course of the term, we will read it all, but it is not really a textbook for the class. We won't be able to move through material at the same pace as the book. It is written for a general audience and lacks quantitative rigor; we will add that with the other elements of the class. Also, it is rather sloppily edited. As such it contains a lot of *mistakes*. It will be your job to find those mistakes…see below. *NOTE: in 2016, a revised printing was issued incorporating corrections reported by Ge 1 students over the previous four years. Try to get the new version (5th printing or later).*

Synopsis. This course introduces the Earth as a planet and Earth Science as a discipline of science. It is designed for students concurrently taking freshman mathematics, physics and chemistry but with no prior knowledge of Earth sciences. The components of the course include recorded lectures, live discussion sections, interactive reading, 5 problem sets, 4 laboratory exercises, a field exercise, and a final exam (see terms for skipping final, below). The learning goals of this class are:

- You will learn to apply your knowledge of physics, chemistry, mathematics, and biology to quantitative and qualitative understanding of the Earth and planets;
- You will understand how the Earth operates as a network of interacting dynamical systems and how it became and continues to be a habitable planet (for terrestrial life);
- You will use the unifying themes of uniformitarianism, plate tectonics, and evolution to make sense of the history of the Earth and terrestrial life.
- You will gain a deeper appreciation for observation of natural phenomena and landscapes across a wide range of scales as well as an appreciation of the role of Earth science in contemporary environmental, energy, hazard, and climate-related issues.

Lectures. It is critical that you watch the lectures for this class, because the class isn't just "from the book". There is no other way to experience the full spectrum of class content and we'll be looking at specimens and landscapes as well as text. I also hope you will join as many of our discussion sections as you can, to get additional enrichment and have an opportunity to interact with me and the class and ask all your questions. To encourage both reading and lecture-watching, there is an **incentive** (see below under "grading"). Associated with each lecture day there is a small quiz, which has three parts: (1) Report *up to four errors you found in the textbook*! One point for each of up to 4 distinct textbook errors (errors of content rather than format preferred) with page numbers (if not using print edition *specify page numbering scheme* somehow, please) [sometimes the same error is repeated so you can only report the same error once per page; if you can't find errors in the chapter, check the glossary – it's full of them; if you find more than 4 you can save them for next lecture; and if you can't find any errors then you may report bullet points that summarize the main points of the reading … but I really prefer errors!]. (2) A two-question quiz (two points for each correct answer) on the lecture content. At least one correct answer on the quiz is required to get attendance credit for the lecture.

Problems Sets and Labs. In alternating weeks (except midterm week), there will be either a problem set or a lab. Problems are typically presented in a style that "narrates" the solver through an important application of physics or chemistry to the earth sciences. The labs are meant to be completed in about two hours. For the labs with an interactive T/A demonstrator, choose the lab time-slot that works for you.

Field Activity. This is obviously the hardest part of a typical Ge 1 experience to capture online. I have designed a project that uses Google Earth to help you explore the properties of Earth's topographic surface and, in particular, the drainage network of whatever watershed you live in. This is a fairly large-scale project and we will dedicate Week 9 to discussing and doing it.

Course policies:
Collaboration. For problem sets, laboratory work, and virtual field trip responses, collaboration among students is encouraged, but all written materials turned in must be your own work. For textbook error reporting, lecture quizzes, and the final exam, collaboration is not permitted. Check the full collaboration policy on Canvas.

Personal Privacy and Intellectual Property. In an online learning environment, students must respect the privacy of their classmates and not share personal information about other students beyond the online classroom. Students must not share class recordings, transcripts, or links to lectures and discussion sessions with anyone who is not enrolled in, teaching, or supporting the class. While each student enrolled in a course should have access to all course materials and learning options, they should also remember they have an ethical responsibility as members of the Caltech community to keep this information private. Violations of these expectations may be considered violations of the Honor Code and of the Caltech Code of Conduct. The lectures include copyrighted material.

Honor Code. While many of you will be working at a distance from Caltech, you remain members of the Caltech community. It is still the case that "No member of the Caltech community shall take unfair advantage of any other member of the Caltech community." Students should be thoughtful and deliberate as they adjust their work habits and collaborative practices to an online learning environment. Review course collaboration policies carefully and consult a course instructor or T/A if you have questions or concerns.

Late work. *As radioactive decay is such a central phenomenon in geochemistry, late lab and problem set scores decay exponentially after the due time with a half-life of two days (20 days late? Then the maximum score would be* $2^{-(20/2)}*100\% \sim 0.1\%$*).* <u>However, extensions will generally be granted if requested in advance.</u>

Accessibility. We are committed to making this course accessible to all students. Students in need of accommodation, whether for disability or circumstances, please contact Prof. Asimow, the Dean's office, or CASS at your earliest convenience.

Ombudsperson. The class will have a designated ombudsperson whose role is to receive comments or complaints from members of the class, anomymize it, and pass it on the professor. In addition, there will be an anonymous comment box on the Canvas site. Please make use of it if you have anything to suggest or report!

Grading. Of 1000 course points total:

5 Problem Sets	200
4 Labs	200
Reading errors and lecture quizzes	200
Field exercise	200
Final exam	200

<u>Special Bonus terms: Response submitted for every lecture quiz and 750 points = A, without taking Final. Only one missing lecture quiz and 765 points = A, without taking Final (Prorated for seniors).</u>

SYLLABUS

Please note: The **lecture numbers** and **reading chapter numbers** on a given day do not match!

<u>Week 1</u>

1. Introduction (3/29)
2. The Raw Material: Nucleosynthesis [*HBHP Ch. 1*] (3/31)
3. Preliminary Fabrication: Minerals and molecules [*HBHP Ch. 2*] (4/2)

LAB 1 (3/30): Minerals, rocks, and crystal symmetry
LAB 1 due Friday 4/2; PROBLEM SET 1 available Friday 4/2

<u>Week 2</u>

4. Heavy Construction: Planet formation [*HBHP Ch. 3*] (4/5)
5. The Schedule: Radioactivity I [*HBHP Ch. 4*] (4/7)
6. The Schedule: Radioactivity II [*HBHP Ch. 5*] (4/9)

PROBLEM SET 1 due 4/9: Earth structure and radiometric dating

<u>Week 3</u>

7. Interior Modifications: Earth Structure [*HBHP Ch. 6*] (4/12)
8. Interior Modifications: Gross differentiation [*HBHP Ch. 7*] (4/14)
9. Making it Comfortable: Surface temperature I [*HBHP Ch. 8*] (4/16)

LAB 2 (4/13): Randomness and radioactivity
LAB 2 due Friday 4/16; PROBLEM SET 2 available Friday 4/16

<u>Week 4</u>

10. Establishing the Circulation: Plate Tectonics [*HBHP Ch. 9*] (4/19)
11. Internal Circulation: Mantle convection [*HBHP Ch. 10*] (4/21)
12. Plate tectonics and geochemical cycles [*HBHP Ch. 11]* (4/23)

PROBLEM SET 2 due 4/23: Radiative balance and surface temperatures

<u>Week 5</u>

13. Volcanism and volcanology [*HBHP Ch. 12*] (4/26)

14. Structural Geology and earthquakes [*HBHP Ch. 13*] (4/28)
15. Geomorphology [*HBHP Ch. 14*] (4/30)
PROBLEM SET 3 available 4/30

Week 6
16. All about geomagnetism and paleomagnetism [*HBHP Ch. 15*] (5/3)
17. Stratigraphy and Geologic time [*HBHP Ch. 16*] (5/5)
18. The Archaean Earth [*HBHP Ch. 17*] (5/7)
PROBLEM SET 3 due 5/7: Isostasy

Week 7
19. The Great Oxygenation [*HBHP Ch. 18*] (5/10)
20. Interlude: Snowball Earth [*HBHP Ch. 19*] (5/12)
21. Diversification of Macroscopic Life [*HBHP Ch. 20*] (5/14)
LAB 3 (5/11): Geologic superposition
LAB 3 due Friday 5/14; PROBLEM SET 4 available Friday 5/14

Week 8
22. Mass extinctions [*HPHB Ch. 21*] (5/17)
23. Stable isotopes and Climate [*5th IPCC Assessment Part 1*] (5/19)
24. Climate change on various timescales [*5th IPCC Assessment Part 2*] (5/21)
PROBLEM SET 4 due 5/21: Earthquakes and volcanism

Week 9
Project Week – Dedicated time for the Field Project, to do the work, discuss it with T/A's and professor, and present results
LAB 4 (5/25): Stick-slip Friction and Earthquakes
LAB 4 due Friday 5/28; FIELD PROJECT due 5/28; Problem Set 5 available Friday 5/28

Week 10 (Seniors excused from Week 10 and Problem Set 5)
No class Monday 5/31, Memorial Day
25. The chemistry of the oceans [*Intro Oceanography Reading*] (6/2)
26. The chemistry of the atmosphere [*Intro Atmospheric Chemistry Reading*] (6/4)
PROBLEM SET 5 due 6/4: Marine chemistry