

UNIVERSITY OF WYOMING
GEOL/ESS 2000 (4 credit hours with lab), Spring Semester 2019
Geochemical Cycles and the Earth System
On campus, Geology Building 216
MWF 11:00-11:50, Starts Jan. 28 2019; last class is May 10, 2019
Final Exam: Wednesday May 15, 10:15 to 12:15

Instructor: Carrick M. Eggleston, GE 122/124, 307-223-1027, carrick@uwyo.edu.

Office hours and/or open door policy: Office hours: Mon. 2:10-3:00, Thur. 9-11, other times by prior arrangement. *I am happy to talk with you at any time when I'm available, but sometimes I must prepare for other classes or have meetings, so a prior appointment is recommended.*

TA: Andrew Flaim, GEOL 126, aflaim@uwyo.edu; Office hours: Mon. 2-3 pm, Th 11-12 am

Course prerequisites, co-requisites, enrollment restrictions: Prerequisites include a 4-credit 1000-level science course with lab; for geology majors this must be a 1000-level geology lab course. For ESS majors this is be a 1000-level lab course that meets ESS requirements. CHEM 1020 must be taken prior to, or concurrently with, this course.

Course Description: This course introduces the Earth system, bringing together elements of the solid Earth, hydrosphere, biosphere and atmosphere to achieve a more integrated view of the Earth's major interacting parts – in other words, the Earth as a system. First, we explore the origins of the elements, the solar system, and the Earth. We then cover systems concepts in the context of Earth science. We examine the interactions between the components of the Earth system, along with their major past changes, recognizing that rocks provide a long-term record of past conditions and are thus key to understanding how the Earth system works. This knowledge helps us understand where our resources come from, and the effects that their utilization have on the system. Understanding the Earth system helps us understand today's global issues such as resource availability (water, food, materials, and energy), global climate change, and such other phenomena as decreased biodiversity. An understanding of Earth's past changes helps us understand Earth's present – and likely future- changes.

Student Learning Outcomes:

- Be able to explain the basics of nuclear strong and weak forces, the origin of the elements and their isotopes, the Big Bang, and the origin of the Solar System, and the origin of the Earth.
- Understand radioactive decay, half-life, exponential decay, and concepts surrounding radiometric dating of geologic materials.
- Be able to refer to and explain major global change events in Earth's history
- Understand the major components of the Earth System, their internal behavior, and their interaction with other components of the earth system.
- Understand the concept of steady-state. Understand system component linkages, feedbacks, and positive and negative feedbacks.
- Understand the causes, timescales, and outcomes of atmospheric, ocean, ice, and rock (tectonic) circulation
- Be able to construct systems models using appropriate software – STELLA or InsightMaker.

- Understand the inputs, outputs, and characteristics of the global carbon cycle.
- Understand basic concepts of oxidation and reduction
- Understand the influence of life on Earth's physical and chemical conditions, systems, and elemental cycles.
- Understand how Earth's climate is regulated on different time scales, including system linkages and feedbacks.
- Understand the facts of and root causes of Pleistocene glaciations, from longer-term trends since the end of the Cretaceous, specific feedback systems including iron and other nutrient cycling on land, on continental shelves, and in the oceans.
- Understand the concepts behind today's climate change, human energy systems, and likely or reasonable projections into the future.

Required texts, readings, and special tools or materials: The Earth System, 3rd edition, by Kump, Kasting and Crane, Pearson Prentice-Hall, 2010. In addition to the textbook, we will hand out supplements covering subjects that the textbook does not cover. You are expected to read all chapters that are covered in class along with the supplements. In addition, you will be assigned problems from the book, usually from the "Critical Thinking Problems" at the end of each chapter.

General requirements and expectations for the course:

Format: GEOL/ESS 2000 consists of 3 lectures per week, a laboratory exercise on all but the first and last weeks of class, and homework problems handed out or assigned from the book every Monday and due every Friday except the first and last weeks of class. There will be a "practice" problem set the first week of class that must be turned in (it will not be graded formally, but credit will be lost from the subjective evaluation as noted below). There are three exams during the semester, in class, and a final exam.

Note Taking: Taking notes is a skill. It helps your mind to go over new information, to pick the most important points from a lecture, to remember more of the content later, and to develop writing skills. It is therefore expected that you will bring to the class a means of taking notes on each lecture. Do not hesitate to stop us, to ask questions, to slow us down so that you have time to take in what you need to take in!! If we are not stopped, we will forge ahead! We will sometimes provide materials that are not in the textbook, but whether we are working from the text or from written materials that we provide you are expected to take your own notes in whatever fashion is most useful to you. Again, we do this for you to develop note-taking as a skill. We do you no favors by doing otherwise. The lecture materials are available on the web (see below), and you can print them to take notes on if you wish.

Website: We will use WyoCourses for this course – I will post lecture materials there, along with problems assigned for the week (*which may differ from those listed below in the tentative class schedule!!*) supplemental materials/readings, review sheets, problem sets, and possibly sample exams or problems. It is recommended that you check the WyoCourses site for GEOL 2000 regularly, several times per week. The lecture materials are not intended as a substitute for note-taking, but rather as something that you can take notes *ON* if it is helpful to you to do so – we look at a lot of diagrams, and it may be helpful to have the diagram to take notes upon.

Other Expectations: While almost all of you already know and understand this last point, we find it useful to point out that expectations in a college course are different from those that may have been the norm in some peoples' K-12 experience. We find that in some cases, people have grown used to "having their hands held" through even fairly simple problems and complexities and have come out unaccustomed to having to figure things out independently, without a step-by-step procedure provided. This may seem obvious, but we are not doing you a favor by holding your hand so tightly that you never have to think your way through a problem independently. True independent thinking and problem solving is a learned skill – and you should seize the opportunity to practice whenever possible! That said, we are happy to answer questions – but you should not be deprived of the opportunity to grapple with each problem yourself first. I am not pleased when students essentially ask me to solve problems for them rather than asking specific questions about sticking points. I have a few other more specific expectations:

- 1) I assume that you are here to learn and will behave accordingly. If you are not here to learn, please do something else.
- 2) I assume that you have learned algebra at some time during the 6th to 9th grades. I also assume that you know a bit about chemistry, chemical elements, what a mole is, and basic chemical equations. You will need to use these skills.
- 3) I assume that you do not need me to re-teach basic algebra, and that you will apply your knowledge to the problems and labs in this course as needed.
- 4) I assume that you have sufficient self-motivation to apply your excellent mental skills to the problems in this course. By this, one of the things I mean is that you will not simply read a problem and throw up your hands in frustration without trying. I assume instead that you will take the problem as far as you can without help – and think about how to get past stumbling blocks.
- 5) I assume that you are a grown-up. This is nothing like high school, and that's a good thing. What comes with this is the expectation that you will apply yourself to your studies without a teacher making you. For most of you this is obvious, but a few of you may never have thought of the world in this way yet. I admit that many so-called grown ups in our society do not set a very good example, but that's no excuse – our personal expectations of ourselves are always evolving, and they should always set a high standard.
- 6) Don't sell yourself short. The world is headed in a direction that has many dangers for your future career unless you use your learning skills to stay current and move with the times. Don't get left behind.
- 7) The taxpayers of Wyoming generously support the only 4-year university in the state. They do not do so only to make a second-rate institution. Despite the many headwinds that universities in small places like Wyoming endure, UW is ranked among the top 400 universities in the world out of thousands. The Geology and Geophysics department Ph.D. programs have ranked as high as 12th in the nation (on a list that had Harvard at 13th). You get access to this expertise at a small fraction of the cost of Harvard and places like it. Take full advantage of such opportunity. I have lived and worked internationally, hold a PhD from Stanford, and know what it is like to compete on a global stage. This course represents an opportunity to take advantage of that experience. I don't want to hear "but I'm just a Wyoming student..." and neither do Wyoming taxpayers. We all want and need you to succeed – and success will only come with hard work. There's no secret to it.

Evaluation/Grading: The basis for grading will be 3 in-class hour exams, a final exam, lab performance, and homework performance. In addition, there is a subjective evaluation that we call “professionalism”.

Hour Exams: Exam I: Friday Feb. 22
Exam II: Friday Mar. 29
Exam III: Friday Apr. 26 (all exams in classroom)
Final Exam: Wednesday, May. 15, 10:15-12:15 am, in classroom (Knight 216)

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|--------------------------------|------------------|-------------|---------------|
| Hour Exams: | 100 points each | 300 | (30%) |
| Final Exam: | 200 points | 200 | (20%) |
| Homeworks | 200 points total | 200 | (20%) |
| Labs | 250 points total | 250 | (25%) |
| Professionalism: | 50 points total | 50 | (5%) |
| TOTAL POINTS AVAILABLE: | | 1000 | (100%) |

Note that content from the labs is in part meant to reinforce material introduced in class and therefore may – possibly - be included on the tests. Lab subject material is also meant sometimes to familiarize you with material *not* covered in class, i.e., to supplement class. **Please note there are no scheduled make-up tests.** If you have to miss a test for a medical or other emergency let the instructor know *prior* to the test date to make alternative arrangements.

Lab write-ups are due at the following lab session. Late labs will receive a 10% automatic reduction in grade. Labs more than one week late will receive no credit. If you will miss a lab, contact the TA to make *prior* alternate arrangements.

Homework problems that are up to one week late will also receive a 10% demotion. Homework problems more than one week late will receive no credit.

Attendance and Absence policies. In this course, we adhere to attendance and absence policies in [UW Regulation 2-108 \(Student Attendance Policy\)](#). Among the content of UW Regulation 2-108 is “the student is responsible for regular and punctual attendance and is expected to participate in all classes in which they are enrolled”. In GEOL/ESS 2000, I will not personally use class time to take attendance past the first few days when conflicts (often involving lab times) are being resolved. However, when I return homework and other exercises after grading, I in effect take attendance as well. The TA will periodically take attendance. Which is to say that attendance will not be taken every day, but chronic and obvious absence will be noted and will become part of the professionalism portion of the grade. My philosophy is that you are an adult and are making choices that are well-founded and well-reasoned. The fact that I do not take attendance regularly does not mean that you are allowed to, or encouraged to, not attend. My expectation is that you will attend as many classes and labs as you possibly can.

I had a professor in college who had been an assistant to Einstein, and he would come in on the first day and say “I am very good at what I do, and if you skip class you will waste far more time trying to figure things out afterward.” In general, attending and taking notes will absolutely help you learn things right the first time, and trying to play catch-up after missing class will never be as useful as

simply attending. The simple action of note-taking not only helps you retain the content we cover in class, but also does in fact actually provide you an opportunity to review what we covered in class.

Classroom Behavior Policy: Include a statement of policies to foster a positive learning environment (civility and respectful discussion, for example), including use of cell phones, mobile devices, etc. The following is probably obvious, but just in case it contains any new ideas:

At all times, treat your presence in the classroom and your enrollment in this course as you would a job. Act professionally, arrive on time, pay attention, complete your work in a timely and professional manner, and treat all deadlines seriously. You will be respectful towards your classmates and instructor. Spirited debate and disagreement may be found in any classroom and all views will be heard fully, but at all times we will behave civilly and with respect towards one another. Personal attacks, offensive language, name-calling, and dismissive gestures are not warranted in a learning atmosphere. As the instructor, I have the right to dismiss you from the classroom, study sessions, electronic forums, and other areas where disruptive behavior occurs.

Electronic devices such as mobile phones should be set to silent (I know, I sometimes forget myself though). Laptops are allowed for note-taking and consulting online materials. No video or audio recording is allowed during class in order to protect the privacy of your fellow students.

Classroom Statement on Diversity: The University of Wyoming values an educational environment that is diverse, equitable, and inclusive. The diversity that students and faculty bring to class, including age, country of origin, culture, disability, economic class, ethnicity, gender identity, immigration status, linguistic, political affiliation, race, religion, sexual orientation, veteran status, worldview, and other social and cultural diversity is valued, respected, and considered a resource for learning.

The purpose of this class is to convey a sense of the *scientific view of the Earth System*. This includes the Earth System as it operates in the present, and subjects such as climate change and ocean acidification will be covered. Your job is to understand the scientific view and be able to say through words and calculations what that view is. We do not force you to agree with it – but you will be expected to demonstrate an understanding what science is saying.

Disability Support: The University of Wyoming is committed to providing equitable access to learning opportunities for all students. If you have a disability, including but not limited to physical, learning, sensory or psychological disabilities, and would like to request accommodations in this course due to your disability, please register with and provide documentation of your disability as soon as possible to Disability Support Services (DSS), Room 128 Knight Hall. You may also contact DSS at (307) 766-3073 or udss@uwyo.edu. It is in the student's best interest to request accommodations within the first week of classes, understanding that accommodations are not retroactive. Visit the DSS website for more information at: www.uwyo.edu/udss

Academic Dishonesty Policies: Academic dishonesty will not be tolerated in this class. Cases of academic dishonesty will be treated in accordance with UW Regulation 2-114. The penalties for academic dishonesty can include, at my discretion, an “F” on an exam, an “F” on the class component exercise, and/or an “F” in the entire course. Academic dishonesty means anything that represents someone else's ideas as your own without attribution. It is intellectual theft – stealing -

and includes (but is not limited to) unapproved assistance on examinations, plagiarism (use of any amount of another person's writings, blog posts, publications, and other materials without attributing that material to that person with citations), or fabrication of referenced information. Facilitation of another person's academic dishonesty is also considered academic dishonesty and will be treated identically. To be clear: You are not allowed to observe or copy anything from anyone else on exams. Students are allowed to work together to understand labs and problems for homework assignments, but students are **never** allowed to turn in lab or homework material copied from another student's work. Students are never allowed to turn in copied work – this includes direct copies of others' work, photographs of others' work, or simply work hand-copied from another student's (or anyone else's) work. You are only allowed to turn in work that you did yourself – you may get help in understanding what needs to be done, but you do not learn anything by simply copying and therefore any form of copying is not allowed.

Duty to Report: Statement referring to your duty to report status as instructional personnel under Title IX.

While I want you to feel comfortable coming to me with issues you may be struggling with or concerns you may be having, please be aware that I have some reporting requirements that are part of my job requirements at UW.

For example, if you inform me of an issue of sexual harassment, sexual assault, or discrimination I will keep the information as private as I can, but I am required to bring it to the attention of the institution's Title IX Coordinator. If you would like to talk to those offices directly, you can contact Equal Opportunity Report and Response (Bureau of Mines Room 319, 766-5200, report-it@uwyo.edu, www.uwyo.edu/reportit). Additionally, you can also report incidents or complaints to the UW Police Department. You can also get support at the STOP Violence program (stopviolence@uwyo.edu, www.uwyo.edu/stop, 766-3296) (or SAFE Project (www.safeproject.org, campus@safeproject.org, 766-3434, 24-Hour hotline: 745-3556).

Another common example is if you are struggling with an issue that may be traumatic or unusual stress. I will likely inform the Dean of Students Office or Counseling Center. If you would like to reach out directly to them for assistance, you can contact them using the info below or going to www.uwyo.edu/dos/uwyocares.

Finally, know that if, for some reason, our interaction involves disruptive behavior or a potential violation of policy, I must inform the Dean of Students, even when you and I may have reached an informal resolution to the incident. The purpose of this is to keep the Dean apprised of any behaviors and what was done to resolve them.

Substantive changes to syllabus: All deadlines, requirements, and course structure is subject to change if deemed necessary by the instructor. Students will be notified verbally in class, on our WyoCourses page announcement, and via email of these changes. It is highly unlikely that the exam dates will change – so please plan on taking the exams on the designated days, in class, and if there is a conflict that you can foresee will in advance, make arrangements with me as soon as possible.

The course outline and schedule below is an approximation for information purposes. I reserve the right to change materials at any time. There are many reasons why the schedule may change,

including simply the number of questions in class! **This outline should therefore not be used for homework assignments** – attend class and check the WyoCourses site for more up-to-date news. The outline is intended only as a rough guide.

Student Resources:

DISABILITY SUPPORT SERVICES: uds@unwo.edu, 766-3073, 128 Knight Hall, www.unwo.edu/uds

COUNSELING CENTER: uccstaff@unwo.edu, 766-2187, 766-8989 (After hours), 341 Knight Hall, www.unwo.edu/ucc

ACADEMIC AFFAIRS: 766-4286, 312 Old Main, www.unwo.edu/acadaffairs

DEAN OF STUDENTS OFFICE: dos@unwo.edu, 766-3296, 128 Knight Hall, www.unwo.edu/dos

UW POLICE DEPARTMENT: unwpd@unwo.edu, 766-5179, 1426 E Flint St, www.unwo.edu/unwpd

STUDENT CODE OF CONDUCT WEBSITE: www.unwo.edu/dos/conduct

Generalized Class Outline: This is an approximation for information purposes. I reserve the right to change materials at any time. There are many reasons why the schedule may change, including simply the number of questions in class! **This outline should therefore not be used for assignments** – attend class for definitive news, this is intended only as a rough guide.

Week 1: Introduction, origin of universe, elements, solar system

Mon. Jan. 28: Introduction, Initial Logistics, Problem Solving

Wed. Jan. 30: Atoms, Fundamental Forces, Atomic Decay

Fri. Feb. 1: Radiometric Dating

Read supplementary material (No lab or *graded* homework, but turn in “practice” Problem 1 on the website)

Week 2: Origins continues, with radiometric dating

Mon. Feb. 4: The Big Bang, Origin of the Elements

Wed. Feb. 6: Origin of the Solar System

Fri. Feb. 8: Chapter 1, Global Change

Read supplementary material

Lab 1: Radiometric age dating and meteorites

Problem 2: Exponential Decay (handout)

Week 3: Systems Introduction

Mon. Feb. 11: Chapter 1, Systems

Wed. Feb. 13: Chapter 2, Systems

Fri. Feb. 15: Chapter 3, Energy

Read Chapters 1 and 2

Lab 2: Rocks and Minerals Review

Problem 3: Steady State (handout), Critical Thinking Problem #4, page 35

Week 4: Energy Balance

Mon. Feb. 18: Chapter 3, Energy Balance

Wed. Feb. 20: Chapter 3, Continued

Fri. Feb. 22: Exam 1

Read chapter 3

Lab 3: Daisyworld – A Systems Model in STELLA

Problem 4: Radiating temperatures of terrestrial planets (handout), and Critical Thinking Problem #6, page 56

Week 5: Atmospheric Circulation, Ocean Circulation

Mon. Feb. 25: Chapter 3, Continued

Wed. Feb. 27: Chapter 4, Atmospheric Circulation

Fri. Mar. 1: Chapter 4, Continued

Read chapter 4

Lab 4: Light Intensity, Energy Balance

Problem 5: Relative Humidity and Dewpoint (handout)

Week 6: Cryosphere, Plate Tectonics

Mon. Mar. 4: Chapter 5, Ocean Circulation

Wed. Mar. 6: Chapter 5, Continued

Fri. Mar. 8: Chapter 6, Cryosphere

Read Chapters 5 and 6

Lab 5: Thermal Steady State

Problem 6: Critical Thinking Problem #1, page 148

Week 7: Plate Tectonics, A Review

Mon. Mar. 11: Chapter 7, Circulation of the Solid Earth.

Wed. Mar. 13: Chapter 7, Continued

Fri. Mar. 15: Chapter 8, The Carbon Cycle

Read Chapter 7, start 8

Lab 6: Using STELLA to model thermal steady state

Problem 7: Critical Thinking Problem #4, page 174

The week of March 18-22 is Spring Break; No Class

Week 8: The Carbon Cycle

Mon. Mar. 25: Chapter 8, Continued

Wed. Mar. 27: Chapter 8, Continued

Fri. Mar. 29: Exam II

Read Chapter remaining 8

Lab 7: Weathering

Problem 8: Rainwater pH (handout)

Week 9: The Biosphere

Mon. Apr. 1: Chapter 9, The Biosphere

Wed. Apr. 3: Chapter 9, Continued

Fri. Apr. 5: Chapter 10, Early Life

Read Chapters 9, 10

Lab. 8: Medicine Bow Rocks

Problem 9: #1, Critical Thinking Problems, page 174

Week 10: The Effects of Life on Earth

Mon. Apr. 8: Chapter 11, Effect of Life on Earth

Wed. Apr. 10: Chapter 11, Continued

Fri. Apr. 12: Chapter 12, Long-Term Climate Regulation

Read Chapters 11, 12

Lab. 9: Life Lab

Problem 10: #1, Critical Thinking Problems, page 232

Week 11: Climate Regulation

Mon. Apr. 15: Chapter 12, Continued

Wed. Apr. 17: Chapter 12, Continued

Fri. Apr. 19: Chapter 13, Biodiversity Through Earth History

Read Chapter 13

Lab 10: STELLA and Population Dynamics

Problem 11: #1, Critical Thinking Problems, page 253 (all parts!)

Week 12: Biodiversity

Mon. Apr. 22: Chapter 13, Continued

Wed. Apr. 24: Chapter 14, Pleistocene Glaciations

Fri. Apr. 26: Exam III

Read up to Chapter 13 again and study!

Lab. 11: Exponential Growth

Problem 12: Critical Thinking Problem #2, page 271

Week 13: Glaciations

Mon. Apr. 29: Chapter 14, continued

Wed. May 1: Chapter 15, Global Warming Part I

Fri. May 3: Chapter 15, continued

Read Chapter 14

Lab 12: Laramie Water Supply

Problem 13: Critical Thinking Problem #3, page 319

Week 14: Global Warming

Mon. May 6: Chapter 16, Global Warming, Part II

Wed. May 8: Supplementary Material: Recent Literature

Fri. May 10: Supplementary Material The Global Energy Supply

Read Chapters 15 and 16

No lab – last week

No problem – last week