

Earth History

ST 589-01D, Spring 2023

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Course overview: The origin of life was one of the most important events in the geologic history of our planet. The evolution of life has affected the chemical composition of the atmosphere and ocean, changed the nature and rate of geological processes such as weathering and sedimentation, and fundamentally altered global elemental cycles. Throughout this course, we will explore the history of the Earth and its life, and consider the many interactions between biological and geological processes over Earth's 4.6 billion year history. Topics will include the geologic timescale, the formation and chemical evolution of Earth, tectonic evolution of continents, early evidence for life on Earth, and long-term interactions between the geosphere, atmosphere, and biosphere. We will explore the diversity of life over geologic time and the patterns and processes that contributed to that diversity, including some of evolution's greatest hits like the Cambrian explosion, the origin of the major lineages of modern animals, and mass extinctions that nearly wiped out animal life on Earth. Class activities will allow students to delve deeper into concepts of geologic time, paleobiology, and evolution.

Place in curriculum: This course is an elective for the MST degree.

Course learning outcomes: Upon successful completion of this course, students will be able to:

- Describe some of the major events that shaped our planet's life, landscape, and climate.
- Describe the formation and tectonic evolution of the Earth.
- Describe relative versus absolute dating and explain how geologists determine the ages of rocks, fossils, and the Earth.
- Explain some important feedbacks in the Earth system, and some of the linkages between plate tectonics, life, and climate.
- Describe the process of natural selection and evolution.
- Discuss the scientific process that led to our current understanding of the end-Cretaceous extinction event (dinosaur extinction), and recognize or explain some of the major mass extinctions recorded in the fossil record and discuss their potential causes and effects.
- Recognize and explain major changes in Earth's climate during the Cenozoic, and how humans have and currently are impacting Earth's climate.
- Adapt various activities on geologic time and Earth history for the K-12 classroom.

Program learning outcomes: Learning outcomes for the MST program can be found online at: <https://www.nmt.edu/academics/psych-ed/graduate.php>

Prerequisites: ST 525 Survey of Geology is a prerequisite for this course, and ST 523 Survey of Biology is recommended. If you have not yet taken one of these courses and have arranged to take the course anyway, you should expect to work harder than usual to catch up on material that would have been covered in the prerequisite. You may find it useful to pick up an introductory geology textbook and/or take advantage of the suggested background reading from your text.

Time on task: You can expect to complete roughly 45 hours of "time on task" per credit hour. For this course, this is a total of 90 hours. This time on task may include watching lectures, completing class readings, discussions, completing assignments and quizzes, and the final projects.

Mode of instruction and communication: In order to accommodate everyone's busy schedules, this course will be remote, with asynchronous pre-recorded lectures that you watch on your own time. However, there will be opportunities to interact with your instructor and classmates that we expect you to take advantage of. You can communicate with your instructor over email, during office hours (Zoom), and by appointment. We will also have regular "live" class meetings during the semester, including (but not limited to) an introductory meeting the first week, 1-2 meetings for class discussions, and a meeting during the last week for final presentations (details below). In addition, we will use Discord (<https://discord.com>) as a class discussion forum. Discord offers an accessible way to discuss readings, share relevant resources, and connect with your classmates from your phone, tablet, or computer.

Course website: Canvas course website, <http://learn.nmt.edu>

Readings:

Required texts:

- *Earth System History (4th ed.)*, by Stanley and Luczaj (2014, W.H. Freeman, ISBN 978-1429255264). *Earth System History* is the main text for this course. Used copies of the 3rd edition are available; if you choose to use an earlier edition, you will need to translate the page number for reading assignments.
You may also substitute *The Evolving Earth* by Prothero (2020, Oxford University Press, ISBN 978-0190605629); you will need to translate the chapters and page number for reading assignments.
- *T. Rex and the Crater of Doom*, by Walter Alvarez (1997, Princeton University Press, rereleased in 2008 & 2015, ISBN 978-0691131030). An electronic copy is available through the Skeen library (link available on Canvas).

Grading: For this course, I am using a philosophy of assessment called "specifications grading," which has been shown to reduce the impact of grades on the learning process. Students are provided a guide to the work required to achieve a particular grade. Grades are directly tied to learning objectives through satisfactory achievement of assignments, often with opportunities to revise the assignments to achieve a satisfactory score. If you're curious to learn more about this grading philosophy, see *Specifications Grading* by Linda Nilson (2015), or short pieces such as those by Johanesen et al. 2022 (<https://doi.org/10.1130/abs/2022AM-382375>) or Bayraktar 2020 (<https://higheredpraxis.substack.com/p/tip-specs-grading>).

Grades will be assigned based on the following criteria:

		<u>Earn C</u>	<u>Earn B</u>	<u>Earn A</u>
Activities (6 total)	Achieve satisfactory for at least	3	5	6
Takehome exams (3 total)	Achieve satisfactory for at least	2	3	3 (HQ on 1)
Time metaphor project		Sat*	Sat	HQ
Final project		Sat*	Sat	HQ
Watch all lectures		✓	✓	✓
Presentation		✓	✓	✓
Class participation (attend a majority of class meetings, participate in Discord discussions)		✓	✓	✓
Pre- and post-class assessments		✓	✓	✓
Reflections	Complete at least	1	2	3

*Students only need to complete one of these projects to earn a grade of C

Achieving satisfactory or high-quality (HQ): Unless otherwise noted, a satisfactory assignment is usually $\geq 75\%$ of possible points, and high quality (HQ) is usually $\geq 90\%$ of points; however, this varies by assignment or exam.

Resubmitting substandard or incomplete work: Activities and projects that do not meet the satisfactory standard may be resubmitted within a week of receiving your score. (This does not apply to scheduled exams.)

+/- letter grade criteria

- A grade of B+ would mean achieving B criteria, but meeting A criteria in at least 2 categories or with a majority of high quality scores on activities; likewise for C+ versus C.
- A grade of B- would mean achieving B criteria in all except one category; likewise for A- versus A and C- versus C.

D/F grades: These grades indicate that most learning objectives were not met, and therefore a fundamental breakdown of expectations. A grade of D represents a meaningful but unsuccessful attempt at earning a C or above. An “F” represents a lack of evidence of meaningful progress.

No extra credit is available outside of designated assignments. I will look over any exam or homework questions you think are not graded correctly and adjust your score as appropriate, but otherwise will not negotiate your final grade. If you are having trouble in class for academic or any other reasons and are concerned about your grade, please see me early on so we can discuss how you can improve your understanding and performance.

Exams: We will have three exams during the semester that cover lecture material. Exams will be take-home format, open book and open note, but NOT open “phone a friend.” (The assigned textbook chapters have important background that is directly and indirectly related to the lectures, but you won’t be tested on topics from the textbook that were not covered in lecture.)

Class discussions and participation: Over the course of the semester, we will discuss the assigned readings from *Alvarez*, using Discord as a discussion forum. You are expected to participate in these discussions by asking and answering questions on the forum, during office hours, and during “live” class meetings. We will also have one or two primary literature discussions associated with class activities, in which you will post a question to Discord and participate in a remote discussion. Details will be provided during the semester.

Tracking participation: You will be asked to track and reflect on your participation through periodic “participation inventories,” typically as part of your learning reflections (see below).

Reflections: Assessing your own learning process (metacognition) is a critical skill for lifelong learners. Three times over the course of the semester, you will be asked to reflect on your learning journey in this course. These reflections will provide important feedback for me as well as for you. Details will be provided during the semester.

Activities and Projects: Activities and projects consist of various exercises that permit deeper exploration of concepts such as geologic time, the configuration of continents, relative and absolute dating, evolution, and literature discussions. Activities will have associated write-ups or other deliverables, with most due at or just after the end of the module. The two projects are due towards the end of the semester (see course schedule for specific due dates). Some of these activities may be adapted for the K-12 classroom or provide inspiration for related activities in your own classes.

Final Project and Presentation: At the end of the term, you will create a written description and give a short presentation on either your geologic time metaphor project or another class activity that you hope to adapt to your own classroom. Writeups should be no more than 2 pages of text, but you may use additional space for figures and references as needed. Presentations will be “lightening talks” that last approximately 5 minutes, with additional time for questions and discussion. (This is an opportunity for your classmates and instructor to learn from you!)

Academic Honesty: New Mexico Tech’s Academic Honesty Policy for undergraduate and graduate students is found in the catalog, which can be found at: <https://www.nmt.edu/registrar/catalogs.php/>. Further information about academic honesty can be found on the Associate Vice President for Academic Affairs website: https://www.nmt.edu/academicaffairs/avpaa/academic_honesty.php
You are responsible for knowing, understanding, and following this policy.

Reasonable Accommodations: New Mexico Tech is committed to protecting the rights of individuals with disabilities and providing access and full participation in the educational experience. Students with disabilities who require reasonable accommodations are invited to make their needs known to the Office for Student Access Services (SAS) as soon as possible. Accommodations are not retroactive and may take some time to implement. The process for requesting accommodations can be found at their website <https://www.nmt.edu/ds/academicaccommodations.php>.

You can contact SAS in person at the Fidel Center Room 245, call 575-835-6209, email access@nmt.edu or book through the link on our [website](#).

Counseling Services: New Mexico Tech offers individual and couples counseling, safety assessments, crisis intervention, outreach and consultations through the Counseling Center. These confidential services are provided free of charge by licensed professionals. Please note that changes in the delivery of counseling services may still be on going. For more information on how to access services, please call 835-6619, email counseling@nmt.edu or check out our website at <https://www.nmt.edu/cds/>.

Respect Statement: New Mexico Tech supports freedom of expression within the parameters of a respectful learning environment. As stated in the *New Mexico Tech Guide to Conduct and Citizenship* (Student Handbook): “New Mexico Tech’s primary purpose is education, which includes teaching, research, discussion, learning, and service. An atmosphere of free and open inquiry is essential to the pursuit of education. Tech seeks to protect academic freedom and build on individual responsibility to create and maintain an academic atmosphere that is a purposeful, just, open, disciplined, and caring community.”

COVID-19 and other Health-Related Safety Issues for Face-to-Face Instruction: Please note: provisions on masks, vaccines or other possible COVID-related requirements are subject to change as the situation evolves, based on guidance from the Centers for Disease Control, the State of New Mexico, and university officials (i.e., the President and the Board of Regents). For the most up-to-date guidelines, please consult NMT’s COVID-19 information page: <https://www.nmt.edu/covid19/>.

Students should not come to class if they are feeling ill and should follow any quarantine guidelines that they are given in the event of exposure to COVID-19. If you are sick, you should contact your instructor immediately with a request for making up any missed work and assignments, contact the Student Health Center, and consider getting tested for COVID-19 (as applicable). Please note the Student Health Center does not provide sick notes to students who are not seen by them.

Title IX Reporting: Sexual misconduct, sexual violence and other forms of sexual misconduct and gender-based discrimination are contrary to the University’s mission and core values, violate university policies, and may also violate state and federal law (Title IX). Faculty members are considered “Responsible Employees” and are required to report incidents of these prohibited behaviors. Any such reports should be directed to Tech’s Title IX Coordinator (Dr. Peter Phaiyah, 122 West Hall, 575-835-5953 (O), 575-322-0001 (C), titleixcoordinator@nmt.edu) or reports can be filed online to [Tech’s Title IX & Sexual Misconduct Report](#). Please visit [Tech’s Title IX Website](#) (www.nmt.edu/titleix) for additional information and resources.

Student Success: New Mexico Tech offers numerous peer tutoring services for students who are struggling in their courses, or who just wish to receive friendly advice, including the Office of Student Learning (Skeen Library, <https://www.nmt.edu/osl/>), the Writing and Communication Lab (Skeen Library, <https://www.nmt.edu/academics/class/center.php>), and numerous department-run centers. These services are free of charge to students! Students may also consult

the Associate Dean of Student Success, Elaine Debrine Howell (elaine.debrinehowell@nmt.edu) or may receive emails from her if they are struggling in class.

To read about the services a student will need to be successful visit MyNMT:
<https://www.nmt.edu/mynmt.php>

Land Acknowledgement: We acknowledge that the New Mexico Institute of Mining and Technology campus stands on the unceded ancestral lands of the Pueblo and Apache peoples. These lands were taken by Congress in the Indian land Cession 689 on October 1, 1886, and the people forcibly moved to reservations. These injustices were accomplished under false white-supremacist ideologies such as manifest destiny and the doctrine of discovery. As visitors to these lands we appreciate their millennia of stewardship to the land, water, animals and plants, and the opportunity to live and learn here. Please visit <https://indianpueblo.org/new-mexicos-19-pueblos/> to learn more about these Native nations, their cultures, and sovereignty.

*Language on New Mexico Tech policies from <https://www.nmt.edu/academicaffairs/policies.php>
Language on learning reflections, tracking participation, and some grading topics courtesy of Dr. Katherine Mattaini, Roger Williams University, and Dr. David Clark, Grand Valley State University.*

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ST 589D-01: Earth History

Spring 2023

Course schedule

ESH is the textbook, *Earth System History* by Stanley & Luczaj

Alvarez is *T. Rex and the Crater of Doom* by Walter Alvarez

Module 1: Geologic time and the timescale

Opens T, 1/17

Lecture "0": Course introduction and overview

Lecture 1: Geologic time

ESH: Ch. 1 Earth as a System

Alvarez: Ch. 1 *Armageddon*, Ch. 2 *Ex Libro Lapidum Historia Mundi*

Activity: Geologic time

Due M, 2/6

Lecture 2: Dating and development of the timescale

ESH: Ch. 6 Correlation and Dating (with Ch. 2 and 5 as background)

Alvarez: Ch. 3 *Gradualist versus Catastrophist*, Ch 4 *Iridium* (optional)

Activity: Dating and the timescale

Due M, 2/6

Project assigned: Time metaphor project (proposals due M 2/17; projects due 4/14)

Module 2: The Hadean and Archean Eons

Opens M, 2/6

Lecture 3: Origin of Earth and the Hadean Eon

ESH: Ch. 11 The Hadean and Archean Eons of Precambrian Time (with Ch. 2 as background)

Lecture 4: Tectonics and the Archean rock record

ESH: Ch. 11 The Hadean and Archean Eons of Precambrian Time (with Ch. 8 and 9 as background)

Interlude: What is life?

Lecture 5: Life in the Archean

ESH: Ch. 11 The Hadean and Archean Eons of Precambrian Time (with Ch. 5 and 10 as background)

Activity: Biogenicity

Due date TBA (class discussion, week of 2/13)

Exam 1: F 2/17 - M 2/20

Proposal for time metaphor project due (full project due 4/14)

Due F, 2/17

Module 3: Evolution of the Biosphere in the Proterozoic

Opens M, 2/20

Lecture 6: The Great Oxidation Event

ESH: Ch. 12 The Proterozoic Eon of Precambrian Time (with Ch. 10 as background)

Lecture 7: Snowball Earths

ESH: Ch. 12 The Proterozoic Eon of Precambrian Time (with Ch. 10 as background)

Activity: Paleogeography and supercontinents

Due M, 3/6

Lecture 8: Eukaryotic evolution and the Ediacaran Fauna

ESH: Ch. 12 The Proterozoic Eon of Precambrian Time (with Ch. 3 as background)

Module 4: Life in the Paleozoic

Opens M 3/6

Lecture 9: Evolution

ESH: Ch. 7 Evolution and the Fossil Record (with Ch. 3, 4, and 5 as background)Activity: Phylogeny and tree-thinking**Due M, 3/20**

Lecture 10: The Cambrian Explosion

ESH: Ch. 13 The Early Paleozoic World (with Ch. 7 as background)

Interlude: Paleozoic marine fossils

Lecture 11: Paleozoic marine diversity

ESH: Ch. 14 The Middle Paleozoic World; Ch. 15 The Late Paleozoic World**Exam 2: F 3/17-T 3/21**

Module 5: Mass Extinctions

Opens M, 3/20

Lecture 12: Mass Extinctions 1

Alvarez: Ch 4: *Iridium* & Ch 5: *The search for the impact site**ESH:* Ch. 17 The Cretaceous World (with Ch. 15 and 16 as background)

Lecture 13: Mass Extinctions 2

Alvarez: Ch 6: The Crater of Doom & Ch 7: The World after Chicxulub*ESH:* Ch. 17 The Cretaceous World (with Ch. 15 and 16 as background)

Interlude: Theories, hypothesis and the scientific method

Activity: Literature discussion (Deccan Trap volcanism)**Due date TBA (class discussion, week of 3/27 or 4/3)*****Proposal for final project due (full project due 5/3)*****Due F, 3/31**

Module 6: Climate in the Cenozoic

Opens M, 4/3

Lecture 14: Cenozoic cooling and the PETM

ESH: Ch. 18 The Paleogene World, Ch. 19 The Late Cenozoic World Before the Holocene

Lecture 15: Ice ages

ESH: Ch. 20 The Retreat of Glaciers and the Holocene

Lecture 16: The future and life elsewhere

Time metaphor project due***Due F, 4/14*****Exam 3: F 4/21 - M 4/24**

Final project writeup and presentations**Writeup due 5/3****Presentations: TBA (week of 5/1)**