Earth History

ERTH 206 & ERTH 206L

Lectures: M/W 9:00-9:50 AM, Weir 132
Labs: T 2:00-5:00 PM, MSEC 241

Instructors: Ryan Leary and Daniel Jones

Contact info

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Course overview: The origin of life on Earth was one of the most important events in our planet's history. 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 4.5 billion year history. Topics will include the geologic timescale, the formation and chemical evolution of Earth, tectonic evolution of continents, the origin of 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. Laboratory exercises will allow students to delve deeper into concepts and methods in paleobiology, including sedimentology and stratigraphy, the Phanerozoic fossil record, phylogenetic analysis, and preservational biases and their impact on the fossil record.

Place in curriculum: This course is a required course for most undergraduate degrees offered in the Earth and Environmental Science Department.

Course learning outcomes: By the end of this course, students will have come to understand that the Earth and its life have been far more dynamic than our short attention spans allow us to easily recognize, and will have developed an appreciation for how the geosphere and biosphere have evolved together over Earth's history. Students will be exposed to feedbacks in the Earth system, and some of the linkages between plate tectonics, life, and climate. Students will learn

the geological timescale, how it has been developed and refined, and how changing views of geologic history have impacted the science of geology. Students will learn to recognize marine invertebrate fossils and appreciate some of the preservational and other biases that impact our interpretation of the fossil record. Students will integrate and synthesize material from the primary literature in class discussions and a writing assignment.

Program learning outcomes: Learning outcomes for undergraduate and graduate degrees in Earth and Environmental Science: https://nmt.edu/academics/ees/Outcomes.php

Prerequisites: ERTH 101 (Earth Processes) and its accompanying laboratory (ERTH 101L) are prerequisites for this course. If you have not yet taken ERTH 101 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 to develop working collaborations with other students to help you get up to speed.

Lab: Enrollment in the accompanying lab section (ERTH 206L) is required for this course.

Field trips: There will be two or more field trips during the course, one of which will be on a weekend. Attendance and participation in field trips is required, and in the event of a schedule conflict, we will find alternative activities. Details will be provided in lecture.

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. If you don't want to purchase it, a copy is on reserve at the Skeen Library and 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.
- *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), and two paper copies will be placed on reserve.

Other required readings: Additional readings will be taken from the scientific literature or other sources. Electronic versions will be made available through the course webpage.
Skeen library reserve: The following references are placed on reserve at the Skeen library:

- *Earth System History*, by Stanley and Luczaj. A copy of both the 4th and 3rd editions are on reserve. (These are personal copies, so please treat them gently!)
- *T. Rex and the Crater of Doom*, by Walter Alvarez. An electronic copy is available (link provided on Canvas), and two hard copies are on reserve.
- *Evolution of the Earth (7th ed.)*, by Prothero and Dott (2004). This is an older version of another popular Earth History textbook that provides useful background on Earth history topics.

Writing: Effective communication to both a broad audience and to your scientific peers is

paramount for a successful career. Students will be asked to write one paper for this course, a 5 page review paper. A description of the writing assignment is given below, and additional details will be provided in class.

Grade basis:

Exams (best 2 of 3)	25%
Timescale quizzes (best 2 of 3)	10%
Fossil ID quiz	10%
Review paper (and peer review)	25%
Lab participation and reports	25%
Final presentation	5%

Exams: We will have three exams during the semester that will cover lecture and reading material. These will be at the start of lab periods, and will last up to an hour. You may drop the lowest of your exam scores.

Timescale and fossil ID quizzes: You will be quizzed on the geologic timescale three times over the term. You may drop your lowest timescale quiz score. There will also be a fossil ID quiz, which will last approximately 30 minutes. You will schedule a time to take this with your TA and/or instructors during week 12.

Laboratory activities: Most laboratory write-ups will be due by Friday of the week they are assigned, although the deliverables for most lab activities will be completed during the lab period.

Presentations: At the end of the term, you will give a short presentation on your review paper topic. Presentations will last 5-10 minutes, and details will be discussed in class. Breaking down a complex topic into a brief presentation that is appropriate and easily digestible for your target audience is a tall order, but one that is important for your success as a scientist, whether you are talking to a scientific peer, neighbor, state senator, or funding agency representative.

Review paper and peer review: The final paper for the class will be a review paper, due on the last day of class. The text of your paper should be 5 pages in length (12 point font, 1 inch margins, single-spaced), with figures and references on subsequent pages. You are encouraged to incorporate original figures that you have drafted yourself. You should expect to cite a minimum of 15 articles from the primary or secondary literature.

In addition to feedback from your instructors, you will have an opportunity to provide and receive feedback from your fellow students. Each student will be assigned three drafts to review at two points during the term. Details will be provided in class.

Please note the due dates for the paper topic, abstract, outline and bibliography, and partial draft. **You are also welcome to turn in a rough draft at any point up until two weeks before the final paper is due.** If you choose to do this (and we highly recommend it!), do not expect to receive immediate feedback, but within 3-4 days is reasonable. Drafts must be reasonably well

written and not contain egregious spelling errors and typos. (The last date to turn in a draft for feedback is 4/17/2020.)

You are encouraged to take advantage of the resources available at the Writing and Communication Lab, which offers qualified tutors for graduate and undergraduate students to improve writing skills (https://www.nmt.edu/academics/class/center.php).

For your review paper, please select from one of the topics on this list. (You may also come up with your own topic, but please discuss with your instructors first.)

- Preservational biases in the fossil record and their impact on diversity over time
- Causes of the PETM
- The Younger Dryas period
- Hypotheses and evidence for the P-T extinction event
- Hypotheses and evidence for the end Ordovician extinction
- Hypotheses and evidence for the late Devonian extinction
- The fossil record of eukaryotic microorganisms
- Biogenicity of the Apex Chert microfossils
- New developments in the universal tree of life
- Huronian glaciations
- Diversity and lifestyles of the Ediacaran biota
- The Great Oxidation Event
- The cause(s) of Cenozoic global cooling and glaciation
- The relationship between climate and tectonics
- The India-Asia collision

Late work and extra credit policy: Homework assignments such as lab write-ups and peer review assignments may be turned in up to a week late at a 25% penalty. No credit will be given for assignments turned in more than a week late. Writing assignments will be penalized 10% each day they are late. In other words, if you turn in your final review paper two days late, the maximum score you can expect to receive is 80%.

No extra credit is available. We will look over any exam or homework questions you think are not graded correctly and adjust your score as appropriate, but we will not negotiate your final grade for even a fraction of a point. 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.

Academic Honesty: New Mexico Tech's Academic Honesty Policy for undergraduate and graduate students is found in the student handbook, which can be found at: https://www.nmt.edu/academicaffairs/docs/policies/NMT_Student_Handbook_2018-19.pdf. 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. Qualified individuals who require reasonable accommodations are invited to make their needs known to the Office of Counseling and Disability Services (OCDS) as soon as possible. To schedule an appointment, please call 575-835-6619.

Counseling Services: New Mexico Tech offers mental health and substance abuse counseling through the Office of Counseling and Disability Services. These confidential services are provided free of charge by licensed professionals. To schedule an appointment, please call 575-835-6619.

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: "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."

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 Phaiah, 20D Brown Hall, 575-835-5187, titleixcoordinator@nmt.edu). Please visit Tech's Title IX Website (www.nmt.edu/titleix) for additional information and resources.

Language on New Mexico Tech policies from https://www.nmt.edu/academicaffairs/policies.php

ERTH 206: Earth History

Spring 2020, MW 9:00-9:50 AM

Course schedule

ESH is the textbook, *Earth System History* by Stanley & Luczaj
Alvarez is *T. Rex and the Crater of Doom* by Walter Alvarez

Lec					Lecturer
	Week 1: Introductory week				
1	M	13 Jan	Course introduction		DSJ & RL
2	W	15 Jan	Age of the Earth and introduction to the geologic timescale		DSJ
	ESH:	Ch. 1 Earth as a System, Ch. 8 The Theory of Plate Tectonics			
	Alvarez:	Ch 1: Armageddon			
		No lab			
	Week 2: Geological time				
	M	20 Jan	No class (MLK day)		
3	W	22 Jan	Stratigraphy, biostratigraphy, correlation		RL
	ESH:	Ch. 2 Rock-forming Minerals and Rocks, Ch. 6 Correlation and Dating			
	Alvarez:	Ch 2: *Ex Libro Lapidum Historia Mundi*			
	Lab 1:	Field trip: Local stratigraphy and relative dating			
	Week 3: Geological time				
4	M	27 Jan	Radiometric dating		RL
5	W	29 Jan	Assembling the timescale		RL
	ESH:	Ch. 2 Rock-forming Minerals and Rocks, Ch. 6 Correlation and Dating			
	Alvarez:	Ch 3: Gradualist versus Catastrophist			
	Lab 2:	Dating and stratigraphy		Timescale quiz 1 (in lab)	
	Week 4: Origin of Earth				
6	M	3 Feb	Origin of elements: The Big Bang, stellar evolution, origin of solar system		DSJ
7	W	5 Feb	Hadean Earth		RL
	ESH:	Ch. 11 The Hadean and Archean Eons of Precambrian Time, Ch. 5 Sedimentary Environments			
	Lab 3:	Paleogeography and tectonics			
	Week 5: Early Earth				
8	M	10 Feb	Cratons, continents, and Archean rocks		RL
9	W	12 Feb	Plate tectonics continued		RL
	ESH:	Ch. 9 Continental Tectonics, Ch. 11 The Hadean and Archean Eons of Precambrian Time			
	Lab 4:	Primary literature discussion (reading TBA)		Timescale quiz 2 (in lab)	
	Week 6: Early life				
10	M	17 Feb	Chemical characteristics of life		DSJ
11	W	19 Feb	Origin of life		DSJ
	ESH:	Ch. 11 The Hadean and Archean Eons of Precambrian Time			
	Lab 5:	Library and reference lab		**Exam 1 (in lab)**	

	Week 7: Early life and the biosphere				
12	M	24 Feb	Life in the Archean	*(Class meets in Jones*	DSJ
13	W	26 Feb	Evolution of the atmosphere and the Great Oxidation Event	*Annex 101 this week)*	DSJ
	ESH:	Ch. 10 Major Chemical Cycles, Ch. 12 The Proterozoic Eon of Precambrian Time			
	Lab 6:	Marine invertebrates 1: Paleozoic			
				Paper topic due Friday 28 Feb	
	Week 8: The Proterozoic Eon				
14	M	2 Mar	Proterozoic continent assembly, Snowball Earth		RL
15	W	4 Mar	Early eukaryoes and the Ediacaran fauna		DSJ
	ESH:	Ch. 12 The Proterozoic Eon of Precambrian Time			
	Lab 7:	Marine invertebrates 2: Paleozoic and Mesozoic			
	S	**7 Mar**	**Saturday field trip: Depositional environments and marine fossils**		
	Week 9: The Cambrian Explosion				
16	M	9 Mar	The Cambrian Explosion		DSJ
17	W	11 Mar	Phanerozoic diversity of marine life		DSJ
	ESH:	Ch. 13 The Early Paleozoic World, Ch. 7 Evolution and the Fossil Record			
	Lab 8:	Primary literature discussion (reading TBA)			
				Draft abstract, outline, bibliography due Friday 13 Mar	
	Week 9: Spring Break				
	M	16 Mar	Spring break		
	W	18 Mar	Spring break		
	No lab				
	Week 10: The Paleozoic Era				
18	M	23 Mar	Phanerozoic diversity of marine life continued		RL
19	W	25 Mar	Assembly of Pangea		RL
	ESH:	Ch. 13 The Early Paleozoic World, Ch. 14 The Middle Paleozoic World			
	Alvarez:	Ch 4: Iridium			
	Lab 9:	Diversity and biases in the fossil record			
				Draft of first 2.5 pages of paper due; peer reviews assigned	
	Week 11: Mass Extinctions				
20	M	30 Mar	Permo-Triassic extinction and mass extinctions		DSJ
21	W	1 Apr	K-Pg extinction 1		DSJ
	ESH:	Ch. 15 The Late Paleozoic World; Ch. 17 The Cretaceous World			
	Alvarez:	Ch 5: The search for the impact site			
	Lab 10:	Marine invertebrates III		**Exam 2 (in lab, start of lab)**	
				Peer reviews due Friday 3 Apr	
	Week 12: Mass Extinctions				
22	M	6 Apr	K-Pg extinction 2		RL
23	W	8 Apr	K-Pg extinction 3 and mass extinctions		DSJ
	ESH:	Ch. 17 The Cretaceous World; excerpts from Powell (1995)			
	Alvarez:	Ch 6 & 7: The Crater of Doom			
	Lab 11:	Impact geology			
				Fossil ID quiz this week (arrange a time with your TA/instructors)	

	Week 13: The Mesozoic Era (and into the Cenozoic)				
24	M	13 Apr	Theories, hypothesis and the scientific method		DSJ & RL
25	W	15 Apr	Cordilleran tectonics		RL
	ESH:	Ch. 18 The Paleogene World			
	Lab 12:	Phylogenetics and tree thinking		Timescale quiz 3 (in lab)	
	Week 14: Cenozoic and Climate				
26	M	20 Apr	PETM		RL
27	W	22 Apr	Ice ages		RL
	ESH:	Ch. 19 The Late Cenozoic World Before the Holocene			
	Lab 13:	Class presentations		**Exam 3 (in lab)**	
	Week 15: Humans and the future of life				
28	M	27 Apr	Human evolution		DSJ
29	W	29 Apr	The future and life elsewhere	**Final paper due (in class, start of class)**	DSJ & RL
	ESH:	Ch. 20 The Retreat of Glaciers and the Holocene			
	Lab 14:	Class presentations			
				Final peer reviews due May 4th	