

Introduction/Contact

Course name: Tectonic Evolution of North America
Times: T, R 1:30-2:45 pm
Instructor: Brandon Lutz, blutz@nmsu.edu; zoom meetings by appointment

Course Description

This is a capstone course for the NMSU Geology Program. It is designed to synthesize and reinforce the core skills learned during an NMSU undergrad geology degree. We will use North America as a mobile.

Student outcomes:

1. Understand how different geological, geophysical, and geochemical data are used to inform the structure, composition, and tectonic evolution of continental lithospheres
2. Improve scientific reading and writing skill
3. Learn new & practice old skills for analyzing, modeling, and visualizing plate tectonics
4. Define the key processes that shape the lithosphere from the surface to the asthenosphere
5. Grasp the tectonic history of North America
6. Identify rock units in New Mexico and understand their tectonic setting/history

Grading

Exercises	30% (300 pts/10 = 30 pts per exercise)
Reading Responses	10% (100 pts/10 = 10 pts per exercise)
Reading Guides	10% (100 pts/10 = 10 pts per exercise)
Participation/Quizzes	10% (100 pts/10 = 10 pts per exercise)
Term Paper	30% worth 300 pts
Final Exam	10% worth 100 pts
Total:	100%/1000pts

Course Structure

Tuesdays by 12:30 pm: Complete Reading Responses (RR) and Reading Guides (RG)

- RR: ½ page summaries of assigned academic literature
- RG: specific questions from assigned reading (from literature and Blakey book)

Tuesdays 1:30-2:45 pm:

- Lecture and in-class discussion of the topics covered in readings (mostly ppt & whiteboard)
- Usually a quiz toward the end of class about learned material (made easy)
- Bring up any questions related to previous week's exercise

Thursdays by 12:30 pm:

- Exercises from previous week turned in

Thursdays 1:30-2:45 pm:

- Some lecture; introduce method and begin new exercise

Weekly Reading Responses

Due Tuesdays @ 12:30 pm. They should only take 1 hour if done properly. Submit as .pdf via canvas

- Read assigned academic journal article
 - DO NOT READ LIKE A NOVEL
 - Key to effective science reading/writing = brevity
 - ABSTRACT, SKIM, FIGURES/CAPTIONS, CONCLUSIONS (MAYBE GO BACK)
 - Do not get lost in the details. “don’t miss the forest for the trees”
- Write a succinct, 1/2 page summary of the article, answering the following prompts:
 - What is the main problem of purpose of the paper/study?
 - How was this problem addressed/purpose served?
 - What are the main conclusions and implications of the study? Why important?

Weekly Reading Guides

Due Tuesdays @ 12:30 pm. They should take 1-2 hours. Submit via Canvas

- Read assigned academic journal article & chapters from Blakey book
 - Answer questions (short answer mostly)

Exercises

Due Thursdays @ 12:30 pm. These will take 2-4 hours from start to finish.

- Assigned and worked on partly during Thursday class.
- Submitted the following Thursday @ 12:30 pm
- Submissions will vary.
 - Most will involve a simple write-up (length will vary but probably 1-4 p)
 - what you did and how and what you found
 - **Format for write-ups (USE GSA Manuscript Style Template)**
 - Introduction
 - summarize the whole project/exercise succinctly
 - provide any important background information
 - 1-2 paragraphs maximum
 - Method
 - What did you do?
 - How?
 - A few paragraphs maximum
 - Include figures and captions
 - Results
 - What did you find?
 - Could be presented in a table or in a figure
 - 1 paragraph maximum
 - Discussion and Conclusions
 - What does it all mean?
 - Why is it important?
 - Give a 1-2 sentence summary at the end
 - Length will vary
 - Include figures and captions

More about exercises:

Whereas reading guides and reading responses help with scientific literacy, exercises develop and cement your science approach (curiosity, data collection, analysis, interpretation, hypothesis-driven research). The exercises feed off of the general topics of each week, and require you to use the core skills developed during a geology undergrad major (e.g. sed-strat, structure, min-petrology, some geophysics/Geochem).

Tentative Examples of Exercises:

- Use GPLATES to reconstruct the opening of the Atlantic Ocean & estimate spreading rates
- Interpret a seismic reflection profile and P-wave velocity model along a passive margin
- Interpret a sequence of events from an outcrop
- Use GPLATES to estimate the convergence rate between the Farallon and NAM Plates
- Build a lithosphere-scale cross-section through one of North America's Margins
- Find an outcrop of limestone close to Las Cruces; determine its place in NAM tectonic history
- Create a balanced, upper-crustal cross-section through a normal & reverse fault system
- Draw a conceptual diagram of a shear zone from the surface of the Earth to the Asthenosphere
- Create an isopach map of the Cretaceous interior Seaway
- Determine the petrological setting for the Organ Mountains; Potrillo Volcanic Field
- Build a case for active subduction in the Pacific Northwest

Term Paper

March 2nd: **Topic**
April 6th: **First Draft**
April 27th: **Second Draft**

- 5-10 pages of text double-spaced, not including figures and captions or references
- will be much longer including these
- Topic is open. I can give you one of interest that is tangible or you can choose your own.
 - Topics can be broad and general (process-related)
 - Or Topics can be focused on a local to regional aspect of North American geology
- Use GSA Manuscript Template for formatting.
- Must include a reference list with proper in-text citations.
- Must include figures with captions.

Types of Term Papers:

- 1) Review paper
 - a. Takes a process, time-period, place, structure, etc
 - b. Reviews what is known about this topic, process, time-period, place, structure
 - c. Attempts to synthesize information and fill in gaps to explain outstanding issues
- 2) Proposal
 - a. Identifies and presents a problem and/or shortcoming in our understanding of process, place, etc.
 - i. This step involves a tight and concise review... (mini-review paper in itself)
 - b. Outlines a procedure for improving understanding of this.
 - c. Predicts results and explains importance.

Final Exam

The Final Exam is tbd. Depending on how the semester goes, I may give you a written exam, a set of concept sketches to draw, a presentation to make, or nothing at all.

The more students keep up with the work each week, the less likely a challenging final will be. I am leaning toward concept sketches.

Late Policy

Please do not fall behind in this class. Late RRs, RGs, and exercises will be accepted at 50%. Late term papers will be accepted. But you won't get as much time to re-draft from the feedback I provide. This will strongly affect your final grade on the term paper.

Weekly Plan (Last update Jan 25th)

Week of	General Topics	Reading	Tuesday	Thursday
1/26/21 1/28/21	<ul style="list-style-type: none"> • Whole-Earth structure • Plate tectonics • Lithospheres 	Skim Ch. 1.Introduction	<ul style="list-style-type: none"> • Quiz • Syllabus • Whole-Earth Structure • Isostasy & Flexure 	<ul style="list-style-type: none"> • Lithospheres (Oceanic/Continental) • Structure, Composition, Rheology • Terminology
		Download GPLATES		Introduction to GPLATES
2/2/21 2/4/21	<ul style="list-style-type: none"> • Plate tectonics review • Structure • Sed basins 	Dickinson_1971 Ch. 3.Foundation (RG1)	<ul style="list-style-type: none"> • Plate boundaries /Proterozoic NAM Ex1 intro • Quiz <p>(RG1 & RR1 due @12:30p)</p>	<ul style="list-style-type: none"> • Euler Pole rotations • Introduction to GPLATES <p>Exercise 1: Introduction to GPLATES; reconstructing Pangaea & opening of the Atlantic Ocean (Due 2/11/21)</p>
2/9/21 2/11/21	<ul style="list-style-type: none"> • Passive margins • Sedimentary facies • Sequence stratigraphy 	Ch. 4.PassiveMargin (RG2) Lister_1986 (RR2)	<ul style="list-style-type: none"> • Cordilleran passive margin • Rifting models • Quiz <p>(RG2 & RR2 due @12:30p)</p>	<ul style="list-style-type: none"> • Interpreting seismic lines <p>Exercise 2: Passive Margins (Due 2/18/21)</p>
2/16/21 2/18/21	<ul style="list-style-type: none"> • Terrane accretion • Subduction zones • Back-Arc spreading • Accretionary prism 	Ch. 5.AntlerOrogeny (RG3) Coney_1980 (RG3) Speed_1982 (RR3)	<ul style="list-style-type: none"> • Suspect terrane accretion • Antler orogeny • Quiz <p>(RG3 & RR3 due @12:30p)</p>	<ul style="list-style-type: none"> • Adobe tricks? <p>Exercise 3: Timescale (Due 2/25/21)</p>

GEOL 491: Tectonic Evolution of North America

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2/23/21	<ul style="list-style-type: none"> Cont-Cont collision 	Ch. 6.Pangaea (RG4)	<ul style="list-style-type: none"> ARM 	<ul style="list-style-type: none"> ARM basins
2/25/21	<ul style="list-style-type: none"> Intraplate stress Flexure 	Dickinson_2003 (RG4) Kluth_1981 (RG4)	<ul style="list-style-type: none"> Sonoma Himalaya/Indo-Arabian Quiz 	<ul style="list-style-type: none"> Strat-sections/Isopach maps
		Leary_2017 (RR4)	(RG4 & RR4 due @12:30p)	Exercise 4: Permian basin map (Due 3/04/21)
3/2/21	<ul style="list-style-type: none"> Ocean-Cont collision 	Ch. 7Wrangelia (RG5)	<ul style="list-style-type: none"> Jurassic Arc system 	<ul style="list-style-type: none"> Analyzing and interpreting geochemical/petrographical data
3/4/21	<ul style="list-style-type: none"> Continental Arcs Fold-thrust belt Foreland basin Intra-arc basin 	Ch. 8Arc (RG5) Erslev_1991	<ul style="list-style-type: none"> Sevier FTB Flexure and Foreland basin Quiz 	<ul style="list-style-type: none">
		Allmendinger_1981 (RR5)	(RG5 & RR5 due @12:30p)	Exercise 5: Sierra Nevada geochemistry (Due 3/11/21)
		Term Paper Topics Due		
3/9/21	<ul style="list-style-type: none"> Ocean-Cont collision 	Ch. 7Wrangelia (RG6)	<ul style="list-style-type: none"> Jurassic Arc system 	<ul style="list-style-type: none"> Building 2D cross-sections
3/11/21	<ul style="list-style-type: none"> Continental Arcs Fold-thrust belt Foreland basin Intra-arc basin 	Ch. 8Arc (RG6) Pang_1995 Fillon_2013	<ul style="list-style-type: none"> Sevier FTB Flexure and Foreland basin Quiz 	<ul style="list-style-type: none"> Reconstructing fold-thrust belts
		Decelles_2009 (RR6)	(RG6 & RR6 due @12:30p)	Exercise 6: Sevier FTB & Foreland Basin (Due 3/18/21)
3/16/21	<ul style="list-style-type: none"> Flat-slab subduction 	Ch. 9Laramide (RG7)	<ul style="list-style-type: none"> Laramide Orogeny-Arc migration 	<ul style="list-style-type: none"> P-wave Tomography
3/18/21		Gutscher_2018 (RG7) Karlstrom_1993 (RG7) Coney_1977 (RG7) Erslev_1986 (RG7) Liu_2010 (RG7)	<ul style="list-style-type: none"> Andean flat-slabs Extension above flat slabs Quiz 	<ul style="list-style-type: none"> Laramide Arches
		Axen_2018 (RR7)	(RG7 & RR7 due @12:30p)	Exercise 7: Visualizing Flat Slabs (Due 3/25/21)
3/23/21	Spring Break	Spring Break	SB 2021	SB 2021
3/25/21				
3/30/21	<ul style="list-style-type: none"> Orogenic Plateau 	Ch. 10Cenozoic1 (RG8)	<ul style="list-style-type: none"> Nevada/Arizona-Plano 	<ul style="list-style-type: none"> The Moho/Pn waves
4/1/21	<ul style="list-style-type: none"> Crustal-thickening Airy Isostasy vs Flexure 	Cassel_2014 (RG8) Chapman_2019 (RR8)	<ul style="list-style-type: none"> Mechanisms of crustal thickening Quiz 	<ul style="list-style-type: none"> Exercise 8: Crustal thickness variations in different tectonic settings (Due 4/08/21)
			(RG8 & RR8 due @12:30p)	
4/6/21		1st Draft Term Paper Due 4/06/21	<ul style="list-style-type: none"> Peer Review of term papers 	<ul style="list-style-type: none"> term paper workshopping
4/8/21				
4/13/21	<ul style="list-style-type: none"> Wide vs. Narrow rifts 	Ch. 10Cenozoic1 (RG9)	<ul style="list-style-type: none"> Phases of extension in W_USA 	<ul style="list-style-type: none"> Exercise 9: Kinematic modeling of normal fault systems (Due 4/21/21)
4/15/21	<ul style="list-style-type: none"> Slab Roll-back Extensional tectonics Metamorphic Core Complexes 	Ch. 11Cenozoic2 (RG9) McQuarrie_2005 (RG9) vanWijk_2010 (RG9) Wernicke_1988 (RR9)	<ul style="list-style-type: none"> Ignimbrite flare-up Metamorphic Core Complexes & Basins Quiz 	
			(RG9 & RR9 due @12:30p)	

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4/20/21	• Intra-continental shear zones	Ch. 11Cenozoic1 (RG10)	• Eastern California Shear zone	Exercise 10: Reconstruction & modeling of intraplate deformation in Eastern California (Due 4/28/21)
4/22/21	• Transform plate boundaries	Ch. 12Cenozoic2 (RG10)	• San Andreas fault zone/Gulf of California	
	• Diffuse plate boundaries	xxxx (RG10)	• Mendocine TJ	
	• Transtension/Transpression	xxxx (RR10)	• Quiz	
(RG10 & RR10 due @12:30p)				
4/27/21		2nd Draft Term Paper	no class	no class
4/29/21		Due 4/27/21		
5/4/21	• Seismicity	Ch. 13Modern (RG11)	• Historic EQ's in W. USA	Exercise 11: What does GPS say about the Ridgecrest EQ sequence? (Due 5/05/21)
5/6/21	• GPS Geodesy	xxx (RR11)	• Fault mechanics	
			• Quiz	
(RG11 & RR11 due @12:30p)				
5/11/21	EXAM week	EXAM week	EXAM week	EXAM week