

PTYS 512: Planetary Global Tectonics

Fall 2020

Kuiper room 330, Tuesday/Thursday, 12:30-1:45

Course Description

This course will provide an overview of planetary geodynamics. The lectures will focus on developing a theoretical understanding of the physical processes that govern planetary evolution, including the generation of heat, conductive and convective heat transfer, elasticity, stress and strain, flexure of the lithosphere, analysis and interpretation of gravity data, seismology, and fluid dynamics. The theory will be applied to problems related to the evolution and structure of the solid planets and moons in the solar system.

Instructor Information

Dr. Jeff Andrews-Hanna

Kuiper 438

617-833-8754

jcahanna@lpl.arizona.edu (preferred mode of contact)

preferred name: "Jeff"

preferred pronouns: (he, him, his) or (they, them, theirs)*

**In scientific writing, it is standard practice to use non-gendered pronouns in referring to other scientists. Why is the workplace any different?*

Office hours: Tuesday, 2:00-3:00 PM (remote)

I am also available to meet at other times – please e-mail to set up a meeting either during office hours or at another time.

Web information: This course will use a D2L page:

<https://d2l.arizona.edu/d2l/home/945672>

Learning outcomes

Students will gain a quantitative understanding of the physical processes governing planetary evolution.

Students will be able to solve quantitative problems in planetary geodynamics using analytic and numerical methods.

Required texts and materials

Geodynamics (Turcotte and Schubert, 2nd edition)

Available for free in pdf form from the UA library:

<https://www.cambridge->

[org.ezproxy4.library.arizona.edu/core/books/geodynamics/D20BD7359E157591F75CF3BCFEDF88A8](https://www.cambridge-org.ezproxy4.library.arizona.edu/core/books/geodynamics/D20BD7359E157591F75CF3BCFEDF88A8)

Schedule of topics and activities

See course schedule at end of syllabus

Assessments

The different components of the course will be weighted as follows:

Homework: 30%

Midterm exams (2): 20% each

Final exam: 30%

Exams: This course will have two mid-term exams and a final exam. The exam format will depend on the mode of instruction (in-person or on-line) at the time of the exam. More information will be provided at that time. The nominal plan for exams (to be updated as needed) is as follows:

Remote exams: Exams must be completed within a set period of time (nominally 1 hour and 15 minutes for midterms, 2 hours for the final). You may use your course notes or textbook during the exam. Use of the internet is strictly prohibited.

In-person exams: You may bring one page of handwritten notes to the exam.

The university final exam schedule can be found at:

<https://registrar.arizona.edu/courses/final-examination-schedule-fall-2020>

The final exam is currently scheduled for Wednesday, 12/16 from 1:00-3:00.

Homework: Homework will be assigned approximately every other week. Assignments will require quantitative problem solving. You are encouraged to use *Matlab* for these assignments (and some assignments will require *Matlab*-based functions), so that we have a uniform programming language for ease of grading and assistance by the professor. A *Matlab* tutorial will be provided. While many questions could be answered using a spreadsheet-based program such as *Excel*, these programs are not effective for answering most questions and are particularly prone to errors in setting up complex equations. For all problems, show all work, including written-out versions of equations used with explicit statements of the values and associated units used for each variable in the equation. Include any code used in your solution (though the written non-code answers must be complete and stand on their own).

You are permitted to consult with your fellow students or the professor for assistance in completing homework assignments (unless instructed otherwise), but your work must be your own. Exchanging code is not permitted.

Equipment and software requirements: For this class you will need daily access to the following hardware and software:

- Computer or tablet, with a webcam and microphone for on-line participation
- *Zoom* for on-line lectures
- *Matlab* or equivalent program for homework assignments. *Matlab* is available to University of Arizona students free of charge.

<https://softwarelicense.arizona.edu/mathworks-matlab>

<https://www.mathworks.com/academia/tah-portal/university-of-arizona-30356115.html>

If you experience any technology issues that may impede your participation in the course, please let me know as early in the semester as possible

Grading Scale and Policies

Numerical grades will be curved. Letter grades will nominally be assigned based on the following distribution:

- A: 90% and higher
- B: 80-89%
- C: 70-79%
- D: 60-69%
- F: <60%

Meeting times for remote teaching (flex in-person): We will be meeting remotely until the University notifies us that in-person meetings may commence. We will meet Tuesdays and Thursdays from 12:30-1:45 PM MST as regularly scheduled by Zoom for our regular lectures. The Zoom link is provided below:

<https://arizona.zoom.us/j/93698079595>

Meeting times and patterns for in-person teaching: When the COVID-19 situation permits teaching on campus, the instructor will provide additional information on the transition to in-person instruction. At such time:

- **Face coverings are required in our classroom:** Per UArizona's **Administrative Directive**, face coverings that cover the nose, mouth, and chin are required to be worn in all learning spaces at the University of Arizona (e.g., in classrooms, laboratories and studios). Any student who violates this directive will be asked to immediately leave the learning space, and will be allowed to return only when they are wearing a face covering. Subsequent episodes of noncompliance will result in a Student Code of Conduct complaint being filed with the Dean of Students Office, which may result in sanctions being applied. The student will not be able to return to the learning space until the matter is resolved.
- **Physical distancing is required in our classroom:** During our in-person class meetings, we will respect CDC guidelines, including restricted seating to increase physical distancing and appropriately-worn face coverings. Per UArizona's Administrative Directive, face coverings that cover the nose, mouth, and chin are required to be worn in all learning spaces at the University of Arizona (e.g., in classrooms, laboratories and studios). Any student who violates this directive will be asked to immediately leave the learning space, and will be allowed to return only when they are wearing a face covering. Subsequent episodes of noncompliance will result in a Student Code of Conduct complaint being filed with the Dean of Students Office, which may result in sanctions being applied. The student will not be able to return to the learning space until the matter is resolved.
- The Disability Resource Center is available to explore face coverings and accessibility considerations if you believe that your disability or medical condition precludes you from utilizing any face covering or mask option. DRC will explore the range of potential options as well as remote course offerings. Should DRC determine an accommodation to this directive is reasonable, DRC will communicate this accommodation with your instructor.
- **Classroom attendance:**

- If you feel sick, or may have been in contact with someone who is infectious, stay home. Except for seeking medical care, avoid contact with others and do not travel.
- Notify your instructors if you will be missing an in person or online course.
- Campus Health is testing for COVID-19. Please call (520) 621-9202 before you visit in person.
- Visit the UArizona COVID-19 page for regular updates.

Academic advising: If you have questions about your academic progress this semester, or your chosen degree program, please note that advisors at the Advising Resource Center can guide you toward university resources to help you succeed.

Life challenges: If you are experiencing unexpected barriers to your success in your courses, please note the Dean of Students Office is a central support resource for all students and may be helpful. The Dean of Students Office can be reached at 520-621-2057 or DOS-deanofstudents@email.arizona.edu. If you are being directly or indirectly affected by the ongoing pandemic in such a way that it affects your performance in this class, please speak with the instructor.

Physical and mental-health challenges: If you are facing physical or mental health challenges this semester, please note that Campus Health provides quality medical and mental health care. For medical appointments, call (520)-621-9202. For After Hours care, call (520) 570-7898. For the Counseling & Psych Services (CAPS) 24/7 hotline, call (520) 621-3334.

Remain flexible: If pandemic conditions warrant, the University may require that we return to remote operations. If that is the case, we will notify you by D2L Announcement and email that we are moving to remote operations.

Remote / online only after Thanksgiving: After the Thanksgiving holiday, we are scheduled to move to remote teaching. That means that we will continue to meet at our regularly scheduled days/times by Zoom.

Class Recordings: All students are strongly encouraged to attend the live-streamed lectures. However, lectures will also be recorded and posted to the course D2L webpage for viewing. These lecture recordings are not available to anyone without access to the course D2L site. Because of the nature of our class participation, it is possible that these recordings could contain personally identifiable information (PII). Students are not required to reveal PII in the classroom recordings. If you wish to withhold and protect your PII, it is recommended that you turn off your webcam and change your settings on Zoom so as to not reveal your identity. Students may not modify lecture videos or other lecture content or re-use such content for any purpose other than personal educational reasons. All recordings are subject to government and university regulations. Therefore, students accessing unauthorized recordings or using them in a manner inconsistent with UArizona values and educational policies are subject to suspension or civil action.

University policies

All university policies related to a syllabus are available at:

<https://academicaffairs.arizona.edu/syllabus-policies>

Policies pertain to absence and class participation, threatening behavior, accessibility and accommodations, the code of academic integrity, and the non-discrimination and anti-harassment policy.

Land acknowledgement

The University of Arizona resides on ancestral lands of the Tohono O’odham and Pascua Yaqui nations, where many today continuously reside in their ancestral land. I acknowledge the privilege it is to teach and learn in this region and I express my gratitude to these nations. I also acknowledge the historical and present-day injustices that many indigenous peoples have suffered at the hands of those in power, including the loss of their ancestral lands, and the grave inequities that persist today as a result.

Preferred pronouns

This course affirms people of all gender expressions and gender identities. If you prefer to be called a different name than what is on the class roster, please let me know. Feel free to correct instructors on your preferred gender pronoun. If you have any questions or concerns, please do not hesitate to contact me directly in class or via email. If you wish to change your preferred name or pronoun in the UAccess system, please use the following guidelines:

University of Arizona students may choose to identify themselves within the University community using a preferred first name that differs from their official/legal name. A student’s preferred name will appear instead of the person’s official/legal first name in select University-related systems and documents, provided that the name is not being used for the purpose of misrepresentation. Students are able to update their preferred names and pronouns in UAccess. To change your listed pronoun on UAccess, navigate to the Student Self Service page, go to the personal information section, and click on “Names”. Options include (he, him, his), (she, her, hers), (they, them, theirs), (xe, xem, xyr), and (ze, zir).

Classroom community

My goal is to establish this class as a community of mutual respect. I believe that diversity is a critical part of science – diversity of ideas, diversity of perspectives, and diversity of individuals. I appreciate the fact that each student brings their own history and perspective to the class. I expect that everyone in this class will treat everyone else with respect at all times. If at any time you feel that I have failed to treat you with respect, I ask you to speak with me to help me to understand my failing or to clear up any misunderstanding.

I recognize that many in our campus community have faced discrimination and bias throughout their educations and their lives, particularly people of color and other under-represented minorities. I stand in solidarity with the Black Lives Matter movement, as well as the [Coalition of Black students and Allies](#) at the University of Arizona and their efforts to improve the plight of Black students on our campus.

I recognize that our country was founded by immigrants, and yet many immigrants today face discrimination, persecution, and prosecution. I understand that immigrants from all over the world have helped to make this university a great place of learning, and that they

contribute to the high caliber of the faculty, staff, and students who make up our community. I support the concept of the university as a [sanctuary](#) in which all can learn without fear of prosecution based on immigration status.

Sexual harassment

The University of Arizona is committed to removing educational barriers created by sex discrimination and sexual harassment. Sex discrimination under Title IX can include acts of violence based on sex, such as sexual assault, domestic violence, dating violence, and stalking. If you (or someone you know) has experienced or experiences any of these incidents, you have options for help at the University. The University of Arizona has staff members trained to support you in navigating campus life, accessing health and counseling services, providing academic and housing accommodations, helping with legal protective orders, and more.

Please be aware that UA faculty and instructors who work with students are required to report allegations of sex discrimination to the Title IX Office. This means that if you tell me about a situation involving sexual harassment, sexual assault, dating violence, domestic violence, or stalking that involves another student or employee, or that happens on campus or in a UA program, I must share that information with the Title IX Coordinator. Although I have to make that notification, you will have choices regarding whether or not you want to pursue a formal complaint against anyone on campus. Our goal is to make sure you are aware of the range of options available to you and have access to the resources you need.

If you wish to speak to someone privately, you can contact any of the following on-campus resources:

- Counseling & Psych Services (CAPS), <https://health.arizona.edu/counseling-psych-services>, 520-621-6490, 520-570-7898 (after hours)
- Oasis Sexual Assault, Relationship Violence, and Trauma Services, <https://health.arizona.edu/counseling-oasis> (same phone as CAPS)
- Campus Health, <https://health.arizona.edu/home>, (520) 621-6490
- University of Arizona Ombuds, <https://ombuds.arizona.edu/>, (520)-626-5589
- Title IX section on sexual assault support & resources (<https://titleix.arizona.edu/title-ix/sexual-harassment-violence>) has more information, as well as a link explaining options if you have a concern, need assistance/support, or would like to file a complaint.

Reporting of harassment

If a student has any concerns related to this class or this department, they are encouraged to bring them to either the instructor of this class, Department Head Tim Swindle (tswindle@lpl.arizona.edu), Assistant Department Head Shane Byrne (shane@lpl.arizona.edu), the chair of the Graduate Advising and Admissions Committee Isamu Matsuyama (isa@lpl.arizona.edu), or the chair of the Department Life Committee Jeff Andrews-Hanna (jcahanna@lpl.arizona.edu).

The University of Arizona policy on discrimination and harassment can be found at:

<https://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>

An individual who believes that they have been subjected to discrimination, harassment, or retaliation in violation of this policy should report the matter immediately as set forth below to obtain information about resolving concerns, including complaint-filing options and procedures, and to enable the University to take prompt remedial action. If the alleged policy violator is a University student, the individual who has been the subject of discrimination, harassment, or retaliation in violation of this policy should contact:

Dean of Students, (520) 621-7057, dos-deanofstudents@email.arizona.edu

Director for Equity Compliance, (520) 621-9449, equity@email.arizona.edu

Good Faith Allegations. Because of the nature of discrimination, harassment, or retaliation complaints, allegations often cannot be substantiated by direct evidence other than the complaining individual's own statement. Lack of corroborating evidence should not discourage individuals from seeking relief under this policy. No adverse action will be taken against an individual who makes a good faith allegation of discrimination, harassment, or retaliation under this policy, even if an investigation fails to substantiate the allegation. However, individuals who make dishonest statements or make statements with willful disregard for the truth during an investigation or enforcement procedure under this policy may be subject to disciplinary action in accordance with existing University policies.

Anonymous Inquiries and Complaints. Members of the University community may contact the Office of Institutional Equity or the Dean of Students Office at any time to ask questions about discrimination, harassment, retaliation, or complaint-filing procedures and may provide information without disclosing their names. This provision does not relieve managers, supervisors, instructors, or advisors of their responsibility to promptly report under this policy.

Confidentiality. Employees of the Office of Institutional Equity, employees of the Dean of Students Office, and all responsible administrators who receive reports of discrimination, harassment, or retaliation shall maintain the confidentiality of the information they receive, except where disclosure is required by law or is necessary to facilitate legitimate University processes, including the investigation and resolution of discrimination, harassment, or retaliation allegations.

Reporting Complaints to Outside Agencies. University employees and students have the right to file discrimination, harassment, and/or retaliation complaints with outside agencies as well as with the University's Office of Institutional Equity or the Dean of Students Office. If an individual files a complaint with an external agency, the filing will not affect the University's investigation concerning the same or similar events.

Subject to Change Statement

Work and course requirements are subject to change at the discretion of the instructor with proper notice to the students.

Provisional lecture schedule:

Lec.	date	day	Lecture topic	Contents
1	8/25/20	T	Intro and overview	course organization, requirements; radiogenic heat
2	8/27/20	R	Heat flow - static	Sources of heat, Fourier's law, thermal properties
3	9/1/20	T	Heat flow - static	Conductive temperature profiles, periodic surface variations
4	9/3/20	R	Heat flow - dynamic	diffusion equation, periodic heating, step function
5	9/8/20	T	Heat flow - dynamic	finite difference
6	9/10/20	R	Heat flow - planetary app	Apollo heat flow experiment, PKT, Diviner, tidal heating
7	9/15/20	T	Stress, strain and elasticity	stress, strain, linear elasticity, plane strain, etc
8	9/17/20	R	Stress, strain and elasticity	friction, Mohr's circle
9	9/22/20	T	Flexure	periodic loading, line loading
10	9/24/20	R	Fourier analysis	application to loading and heat flow
11	9/29/20	T	Gravity - basics	overview, types of gravity anomalies
12	10/1/20	R	EXAM 1	Heat flow and elasticity
13	10/6/20	T	Gravity - basics	test cases and problems
14	10/8/20	R	Spherical harmonic gravity	Spherical harmonics
15	10/13/20	T	Gravity and flexure	Crustal thickness modeling, admittance, localization
16	10/15/20	R	Planetary gravity	Moon, Mars
17	10/20/20	T	Planetary gravity	Mercury, Venus
18	10/22/20	R	Tectonics: Principles	Anderson's criteria
19	10/27/20	T	Tectonics: Tectonic styles	Wrinkle ridges, graben, rifts
20	10/29/20	R	Planetary tectonics	Moon, Mercury
21	11/3/20	T	Planetary tectonics	Mars, Venus
22	11/5/20	R	EXAM 2	Gravity and tectonics
23	11/10/20	T	Rheology	flow laws
24	11/12/20	R	Fluid mechanics	overview
25	11/17/20	T	Fluid mechanics	channel flow, pipe flow
26	11/19/20	R	Mantle convection	boundary layers, convection, thermal evolution
	11/24/20	T	Thanksgiving	
	11/26/20	R	Thanksgiving	
27	12/1/20	R	Planetary mantle convection	Stagnant lid, mobile lid
28	12/3/20	T	Magnetic fields and dynamos	Basic principles, observations
29	12/8/20	R	wrap-up	