

Physics and Chemistry of the Mantle

UT Austin - JSG - GEO 391 - Fall 2019

Profs. Steve Grand, Afu Lin, Thorsten Becker

This class explores the Earth's deep mantle's state and dynamics from an interdisciplinary point of view, focusing on the links between seismology, mineral physics, and geodynamics. After a short series of introductory lectures by the instructors, students will present and lead discussions of a series of topics, guided by assigned reading. We will focus on existing models of the state and dynamics of the mantle, their uncertainties, and ways to possibly address outstanding questions.

Office hours and contact info:

- Becker: 323-286-6160, twb@ig.utexas.edu. Hours: open-door policy, generally at DGS Tue/Thu 9-5, else PRC
- Lin: 512-471-8054, afu@jsg.utexas.edu. Hours: open-door policy, JGB 4.140
- Grand 512-471-3005, steveg@jsg.utexas.edu Hours: open door policy JGB 4.220B

Class meets: Thursdays at 11am-12:30pm (JGB3.116)

Reading: The class reading consists of a mix of regular research and review articles. **All students are expected to read all papers, ahead of the class, regardless if presenting or not.** All material has been uploaded to Canvas.

Grading: 40% class presentations, 30% class participation, 30% final "project" which consists of identifying a compelling problem and a possible approach to addressing it in terms of a concise, two-page proposal.

Class presentations consist of students discussing all three-five assigned papers with the help of a ppt presentation (focusing on content, not style), highlighting most salient results, and exploring connections between the papers and open issues. This task can be challenging and may involve additional background reading, and all three instructors are available to discuss any questions ahead of time. **Allow for several weeks of preparation;** we will assign student names in week 1, and student presentations will start in week 4.

Weekly schedule

<i>Week</i>	<i>Topic/comments</i>	<i>Instructor/ discussion leader</i>	<i>Reading</i>
1 (Sep 5)	Seismic/Geophysical Structure overview	Grand	Dziewonski & Anderson (Phys Earth Planet Int, 1981) Masters & Gubbins (Phys Earth Planet Int, 2003)
2 (Sep 12)	Mantle convection overview	Becker	Davies & Richards (J. Geology, 1992); Tackley (G-Cubed, 2000a), Bercovici and Ricard (Nature, 2014)
3 (Sep 19) - TWB out	Mineral physics and chemistry overview	Lin	Liu (Geophys. J. Int., 1977) Murakami et al. (Science, 2002) Badro et al. (Science, 2003)
4 (Sep 26)	Earth compositional models - equation of state	Suyu Fu	Irifune et al. (Nature, 2008) Cottaar et al. (G-Cubed, 2014); Wang et al. (EPSL, 2014)
5 (Oct 3)	Nature and origin of the asthenosphere	Alexandra Ducatte and Erin Heilmann	Hoink et al. (GJI, 2012) Karato (EPSL, 2012) Chantel (SciAd, 2016) Kawakatsu et al. (Science, 2009) Beghein et al. (Science, 2014)
6 (Oct 10)	Subduction and volatile cycles	Alexandra Ducatte	Peslier et al. (Space Sci Rev, 2017) Abers (EPSL, 2006) Crowley et al. (EPSL, 2011) Kawakatsu & Watada, (Science, 2007)
7 (Oct 17)	Transition zone - phase boundaries and plate dynamics	Suyu Fu and Yanyao Zhang	Frost (Elements, 2008) Yu et al., (EPSL, 2008) Christensen (GJI, 1996) Shearer & Flanagan (Science, 2000)
8 (Oct 24) LIN Out	Transition zone - water and density	Yanyao Zhang	Schmandt et al. (Science, 2014) Bercovici & Karato (Nature, 2003) Sakamaki (Nature, 2006)

			Schmandt et al. (G-Cubed, 2011)
9 (Oct 31)	Plumes and internal heating	Peter Nelson	Zhong et al. (JGR, 2006) Sramek et al., Sci Rep, 2016 Kumagai et al. (2008) French&Romanowicz (Nature, 2015)
10 (Nov 7)	LLSVPs and reservoirs	Peter Nelson and Jesse Gu	Tackley (Earth Sci. Rev., 2012) McNamara (Tectonophysics, 2019) Thomson (Nature, 2019) Koelemeijer et al. (Nature, 2017) Lau et al. (Nature 2017)
11 (Nov 14) - TWB out	Mid mantle spin transition	Jesse Gu	Yang (Sci Rep, 2015) Cammarano (GRL, 2010) Irifune (Science, 2010) Simmons et al. (JGR, 2010)
12 (Nov 21)	Core mantle boundary dynamics	Erin Heilman	Olson (G-Cubed, 2016) Lay et al. (Nature Geo, 2013) Hirose (Science, 2017) Lay & Garnero (Annrevgeophys 2011)
Thxgiving			
13 (Dec 5)	Wrap up discussion		
AGU			
14 (Dec 9)	Semester ends		

Special Note for Students With Disabilities:

The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TDD, or the College of Engineering Director of Students with Disabilities at 471-4321.

Religious Holy Days:

A student who misses an examination, work assignment, or other project due to the observance of a religious holy day will be given an opportunity to complete the work missed within a reasonable time after the absence, provided that he or she has properly notified each instructor. It is the policy of the University of Texas at Austin that the student must notify each instructor at least fourteen days prior to the classes scheduled on dates he or she will be absent to observe a religious holy day. For religious holidays that fall within the first two weeks of the semester, the notice should be given on the first day of the semester. The student may not be penalized for these excused absences but the instructor may appropriately respond if the student fails to complete satisfactorily the missed assignment or examination within a reasonable time after the excused absence.

Class Web sites and Student Privacy:

Web-based, password-protected class sites are associated with all academic courses taught at The University. Syllabi, handouts, assignments and other resources are types of information that may be available within these sites. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of the sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1.

For information on restricting directory information see:
<http://www.utexas.edu/student/registrar/ferpa/ferpa.qs.faculty.htm>

Course documents will be posted on the CANVAS web site.

Honor Code

The Student Honor Code states: "As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity." You will be expected to abide by the Honor Code including but not limited to avoiding any form of plagiarism. This course will instruct you in ways to avoid plagiarism in your writing.