

SYLLABUS
Structure & Formation of Terrestrial Planets: 3 credits
(cross-listed as 460:506 and 460:441)

Instructors: Professor Katherine R. Bermingham and Professor Vadim Levin, Department of Earth and Planetary Sciences

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Office Hours: WL-301 (KRB) or WL-205 (VL); TAB (at least 2 hours per week)

Course Description

The solid Earth has an internal structure that consists of well-organized lithological and chemical parts that have been identified by seismological and petrological observations. Many of the physical characteristics of the Earth's interior are also expected to exist within other terrestrial planets. This course will review current understanding of planetary formation processes, planetary compositions, observations reflecting interior structure, and hypotheses of planetary evolution in the solar system.

Outline

Course meets once a week for 3 hours (2 periods).

1 period devoted to a lecture on the fundamentals of the topic being studied.

1 period devoted to seminar-style discussion of assigned reading (students leading the discussion).

Prerequisites

01:460:302 (Petrology), 01:460:304 (Intro to Geochemistry), 01:460:306 (Intro to Geophysics) or permission of instructor. And also note that credit not given for both this course and 16:460:506.

Week 1: Overview of the class topics, survey of participants' interests, logistics

Period 1: Class organization

Bermingham and Levin

Period 2: Paper review examples done by instructors

Bermingham and Levin

- Levin presents Walker et al. (2015) *Chemical Geology*
- Bermingham presents Levin et al. (2016), *Geophys. Res. Lett.*
- 2 papers on planetary accretion will be assigned for the following week

Week 2: Planetary formation I

Period 1: Lecture: The solar nebula and planetary accretion

Bermingham

- **Homework #1 assigned.**

Period 2: Discussion of papers on planetary accretion

Bermingham and Levin

- 2 papers on the formation of the Earth will be assigned for the following week

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Week 3: Planetary formation II

Period 1: Lecture: Formation of Earth's internal structure and late-stage accretion
Birmingham

Period 2: Discussion of papers on the formation of the Earth
Birmingham and Levin

Week 4: Planetary cores

Period 1: Lecture: Earth's core – evidence for the size and composition
Levin

- **Homework #1 DUE.**
- 2 papers on Earth's core will be assigned for the following week

Period 2: Lecture: Cores of the terrestrial planets, asteroids, and iron meteorites
Birmingham

- 2 papers on other planetary cores will be assigned for the following week

Week 5: Literature review of papers on planetary cores

Period 1: Discussion of papers on Earth's core
Levin

Period 2: Discussion of papers on cores of other planetary bodies
Birmingham

- 2 papers on the structure of Earth's mantle will be assigned for the following week

Week 6: Earth's mantle

Period 1: Lecture: Earth's mantle
Levin

Period 2: Discussion of papers on elements of Earth's mantle structure
Levin

- 2 papers on the mantles of other planetary bodies will be assigned for the following week
- **Homework #2 assigned.**

Week 7: Mantles of other terrestrial bodies

Period 1: Lecture: Mantles of other terrestrial planets
Birmingham

Period 2: Discussion of papers on other planetary mantles
Birmingham and Levin

- 2 papers on the structure of Earth's lithosphere will be assigned for the following week

Week 8: Earth's lithosphere: Oceans & continents

Period 1: Lecture: Origin and current structure of Earth's lithosphere
Levin

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Period 2: Discussion of papers on Earth's lithospheric structure

Levin

- 2 papers on planetary magnetism will be assigned for the following week
- **Homework #2 DUE.**

Week 9: Planetary magnetism

Period 1: Lecture: planetary dynamo fields and remnant crustal magnetism

Birmingham and Levin

Period 2: Discussion of papers on planetary magnetism

Birmingham and Levin

Week 10: Mantle convection

Period 1: Lecture: mantle convection

Levin

- 2 papers on mantle convection and plate tectonics will be assigned for the following week

Period 2: Lecture: Initiation of plate tectonics

Birmingham

- **Homework #3 assigned.**

Week 11: Discussions of convection + plate tectonics interplay

Period 1: Discussion of papers on plate tectonics and mantle convection

Levin

Period 2: Student independent work on final paper (in class – computer lab?)

Levin

THANKSGIVING WEEK - NO CLASS

Week 12: Planetary space missions

Period 1: Learn and discuss InSight mission

Birmingham and Levin

Period 2: TBD

- **Homework #3 DUE.**

Week 13: Student-led workshop on outstanding questions in the field

Period 1

Period 2

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Text

None, readings assigned from current peer-reviewed literature.

Learning Goals

Students will be introduced to the current state of knowledge about the processes underlying the formation and evolution of rocky planets in the Solar System. Students will:

a) Learn the methods used to investigate interiors of solid/rocky planets and develop an understanding their inherent limitations; b) acquire a working knowledge of the interior properties of terrestrial planets and, most importantly, c) develop a familiarity with outstanding research questions in the field. Students will have an opportunity to critique published results and practice discussing complex multidisciplinary research problems.

Assessment

Student performance will be evaluated on the basis of weekly in-class presentations, general course participation and an end-of-term written/oral presentation project on the subject of an outstanding research topic.

- 30% class participation: This part of the grade consists of regular attendance and turning in two questions about each paper assigned to read. Students with excused absences must make arrangements with the instructors for make-up work.
- 20% student-led presentation of at least 2 research papers over the course of the semester (creating a PowerPoint describing the background, methods, outcomes, and implications of the paper, as well as leading the class in discussion of the paper).
- 20% final review paper (for undergraduates) or research proposal (for graduate students) – details to be provided in class.
- 20% 3 homework assignments.
- 10% in-class presentation of final project.

Basis for grade

A: 90-100; B+: 85-90; B: 80-85; C+: 75-80; C: 70-75; D: 60-70; F: <60.

Course Policies

The rules related to exams, attendance, and integrity are provided below and are supplemented by Rutgers University policies.

Exams & Quizzes: Exams and quizzes must be taken as scheduled, otherwise a failing grade will be given. Exceptions are limited to officially verified emergencies that prohibit participation in assessment, or instructor preapproved request (such as school-sanctioned athletic matches or religious observances) to reschedule. Rare cases of extreme emergency preventing timely communication are to be discussed with the Undergraduate Director and/or Department Chair.

SYLLABUS
Structure & Formation of Terrestrial Planets: 3 credits
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Attendance: All students must attend all classes, arrive on time, remain in class until the end of the class period, and participate in class discussions. Instructors may require signed attendance sheets and may count attendance as part of the grade. Reasonable accommodations for excused absences (as defined by Rutgers University policy) will be provided where appropriate. For an absence to be excused, timely notification is required via official Rutgers University communication portals. Cell phones must be turned off in class. If policy is not adhered to, you will be asked to leave and be deducted grade points.

Communication: As per Rutgers University policy, all out-of-class communication must be conducted via your official Rutgers email and/or Canvas. You will be able to view your scores for quizzes and exams on Canvas.

Academic Integrity: Our department endorses a no-tolerance cheating and plagiarism policy. If you are caught cheating, the instructor may fail you and request disciplinary action.

Attitude and behavior: As per Rutgers University policy, instructors and students must display the appropriate respect and consideration for each other and the pursuit of knowledge at the university level. If not, individuals will be dismissed from the course with a failing grade.

Your Rights: We are all human and instructors and students both make mistakes. If you feel that you have been treated unfairly, contact the Undergraduate Program Director or the Department Chair.

Student Wellness Services <http://codu.co/cee05e>

Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

Counseling, ADAP & Psychiatric Services (CAPS) (848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901 <http://health.rutgers.edu/medical-counseling-services/counseling/>

CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offer a variety of services that include individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Violence Prevention & Victim Assistance (VPVA) (848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901 www.vpva.rutgers.edu/

The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking

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to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

Disability Services (848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 <https://ods.rutgers.edu/>

The Office of Disability Services works with students with a documented disability to determine the eligibility of reasonable accommodations, facilitates and coordinates those accommodations when applicable, and lastly engages with the Rutgers community at large to provide and connect students to appropriate resources.

Scarlet Listeners (732) 247-5555

<https://rutgers.campuslabs.com/engage/organization/scarletlisteners>

Free and confidential peer counseling and referral hotline, providing a comforting and supportive safe space.

Report a Concern: <http://health.rutgers.edu/do-something-to-help/>