

## SPRING 2018-PHYSICS AND CHEMISTRY OF THE SOLID EARTH, GEOL 5001

CLASS TIME AND PLACE: MWF 9AM-9:50AM, BESC 265

### INSTRUCTORS:

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OFFICE HOURS: Farmer; MW 10-11 AM, Benson Earth Sciences Building Room 422A  
Jones MW 1-2 pm BESC 440C

COURSE REQUIREMENTS: (basic chemistry and physics)

GRADING: Based upon a combination of four homeworks (40%), one midterm exam (25%), and final exam (25%) scores, as well as class participation (10%).

### IMPORTANT DATES:

24 January is add day  
31 January is drop day (no charge)  
5 March midterm  
23 March is last day to drop (in CUinfo)  
26-30 March is spring break  
Final: Currently scheduled for Saturday May 5, 4:30-7:00 pm

TEXTBOOK: Anderson, *New Theory of the Earth* (2007), required

Supplemental: Karato, *The Dynamic Structure of the Deep Earth*, is useful for first part of course

Others: Turcotte and Schubert, *Geodynamics*, is helpful for material in the latter part of the course.

Brown and Mussett, *The Inaccessible Earth*, 2<sup>nd</sup> edition (1993) is out of print but will be used for some readings.

Stüwe, *Geodynamics of the Lithosphere: An Introduction* (2007) might be used for some readings.

Another good reference for geochemistry portion of class is White, *Geochemistry* (2013)

All texts should be on reserve in the Earth Sciences Library; Electronic versions of [Brown and Mussett](#) and [Stüwe](#) are available through the library.

STANDARD CAMPUS STATEMENTS ON ACCOMMODATIONS, BEHAVIOR, ETC can be found at  
<<https://www.colorado.edu/academicaffairs/policies-customs-guidelines/required-syllabus-statements>>.

### SYLLABUS/READING LIST:

(subject to change)

#### Week 1: Jan. 17-19

17- Introduction-Why study solid Earth chemistry?  
Starting points; nucleosynthesis, solar system formation, layered nature of solid Earth, and chemical classification(s) of matter (FARMER)

**Reading- Anderson, Ch. 1-3**

19- How to determine the “bulk” composition of whole Earth. “Volatility” classification of elements (FARMER)

#### Week 2: Jan. 22-26

22- Introduction to isotope geology, and application to determining when Earth’s core formed (FARMER)

**Reading-Halliday, A. N., 2000, Space Science Reviews, 92, p. 355-370.**

24- Core (physics-JONES): Seismological and other geophysical constraints, the geodynamo.

**Reading- Anderson, Ch. 10, 26 pp. 344-5 (Karato Ch. 6)**

26- Stress and strain (JONES) **Handout**

#### Week 3: Jan. 29-Feb. 2

29- Convection in the mantle (JONES)

31- Seismological layering of the mantle (JONES)

**Reading- handouts, Anderson Ch. 7, 9 (Karato, Ch. 4 (mainly) + some Ch. 1)**

2- In class paper discussion (papers TBD)

#### Week 4: Feb. 5-9

5- Mineralogy of Earth's mantle. Classification of peridotites (partial mantle melting). Introduction to thermodynamics (FARMER)

**Reading-Anderson, Ch. 8 pp. 102-108, Ch. 11 (as an overview for mantle variations), Ch. 22, Ch. 26 pp. 338-346.**

7- Introduction to phase equilibria, Clapeyron slopes and phase transitions in deep mantle (FARMER)- **HOMEWORK #1 due date**

**Reading Anderson Ch. 14 esp. pp. 168-173, 187-188, Ch. 17, 26**

9- *In class exercise (flipped classroom)*

#### Week 5: Feb. 12-16

12- Magma generation from mantle (heating vs decompression vs compositional changes). Thermodynamic considerations. Introduction to trace element geochemistry (FARMER)

14- Structure and origin of oceanic crust. Hydrothermal processes at mid-ocean ridges. The "depleted mantle" reservoir. (FARMER)

16- In class paper discussion

**Reading: Anderson, Ch. 4,22**

#### Week 6: Feb. 19-23

19- Oceanic Lithosphere (Physical perspective- JONES)-thermal subsidence and heat flow

21- Forces driving and resisting plate motion (JONES)

23- Class research paper discussion

**Reading- Anderson, Ch. 4 pp. 35-40, 41-49, Ch. 7 78-80, Ch. 11 pp. 134-5, Ch. 26 pp. 333-338, 346-348, (Karato Ch. 2, 4), handouts**

#### Week 7: Feb. 26-March 2

26- Convergent margin magmatic and slab dehydration processes (FARMER)

28- Slab dip, volcanic arcs and fate of slabs (JONES)- **HOMEWORK #2 due date**

2- In class paper discussion (+/- review)

**Reading- handouts, Anderson, Ch. 4 pp. 39-41, 46-49, part of Ch. 14, 23?, (Ch. 22) (Karato, Chapt. 2,4)**

#### Week 8: March 5-9

5- **MIDTERM**

7- Plumes (JONES) **handout, Anderson Ch. 4 (pp. 49-57)**

9- Plumes, ocean island basalts (intraplate magmatism) and mantle "reservoirs". (FARMER)

**Reading- handout, Anderson Ch. 4 (pp. 49-57), parts of Ch. 14 (review Ch. 4 Karato)**

#### Week 9: March 12-16

12- Continental Lithosphere overview. Introduction to mineral based thermometry and barometry (FARMER)

14- Plate reconstructions, Tectosphere observations: Surface waves (JONES) **Anderson , Ch. 8, Ch. 11 pp. 124-137**

16- *In class exercise (flipped classroom)*

**Reading- Anderson , Ch. 8; Brown and Mussett, Ch. 10 (Karato, Ch. 2)**

#### Week 10: March 19-23

19- Continental Mantle Lithosphere. Chemical and petrologic perspective. Dynamic nature of mantle lithosphere and evidence for pervasive metasomatic activity. (FARMER)

21- Continental heat flow and elastic plate thicknesses (JONES)

23- In class paper discussion

**Reading- Handouts. Anderson, Ch. 26 Brown and Mussett, Chapt. 10&11.**

#### Week 11: March 26-30

**NO CLASS – SPRING BREAK**

#### Week 12: Apr. 2-6

22- Origin of Continental Crust – Archean vs. Proterozoic vs. Phanerozoic (FARMER)

4- Strength of continental lithosphere (JONES)

**Reading- Stüwe, Ch. 5. HOMEWORK #3 due date.**

6- In class paper discussion

#### Week 13: Apr. 9-13

9- Vertical compositional variations in continental crust. Lower vs. upper Crust (FARMER)

11- Crustal seismology+ Forces of continental deformation (JONES)

13- In class paper discussion

**Reading- Anderson, Ch. 8 pp. 89-100, Handouts**

#### Week 14: Apr. 16-20

16- Magma production in continental lithosphere-basalts. Large igneous provinces vs. distributed,

small volume volcanic centers. Lithospheric deblobbing and "bakeout" magmatism. (FARMER)

18- Physics of magmatism/ Extensional tectonics (JONES)

20- In class paper discussion

**Reading- Handouts, Farmer chapter from Treatise on Geochemistry, parts of Turcotte and Schubert (9-11, 6-12, 6-2 to 6-6)**

Week 15: Apr. 23-27

23- Magma production in continental lithosphere- andesites and rhyolites. Introduction to crustal anatexis. (FARMER)

25- Physics of earthquakes (JONES)- **HOMEWORK #4 due date.**

27- In class paper discussion

**Reading- Handouts, part of Stein and Wysession**

Week 16: Apr. 30-May 2

30- Magma Production in Continental Lithosphere- origin of granitic rocks (FARMER)

2-Review

**Reading- Handouts**

[Final : TBA]