

Course Syllabus

Geomagnetism, Paleomagnetism and Environmental Magnetism MWF 6th Period

Instructors:

Dr. Joseph Meert (M), Dr. Courtney Sprain (S), Dr. Robert Hatfield (H)

Office Hours:

TBD

Contact Information:

Joseph Meert: 361/112 Williamson Hall, jmeert@ufl.edu (<mailto:jmeert@ufl.edu>) (352-870-4642, Cell) (352-846-2414, Office)

Courtney Sprain: XXX Williamson Hall, csprain@ufl.edu (<mailto:csprain@ufl.edu>) (651-757-8324, Cell), (352-294-6319, Office)

Rob Hatfield: 220 Williamson Hall, rhatfield1@ufl.edu (<mailto:rhatfield1@ufl.edu>) (352-XXX-XXXX, Office)

Textbooks:

Robert Butler: Magnetic Domains to Geologic Terranes (free [download](https://www.geo.arizona.edu/Paleomag/) [↗](https://www.geo.arizona.edu/Paleomag/) (<https://www.geo.arizona.edu/Paleomag/>),)

Lisa Tauxe: Essentials of Paleomagnetism (free [online](https://earthref.org/MagIC/books/Tauxe/Essentials/) [↗](https://earthref.org/MagIC/books/Tauxe/Essentials/) (<https://earthref.org/MagIC/books/Tauxe/Essentials/>),)

Software: Download [GMAP](http://www.earthdynamics.org/earthhistory/gmap_info.html) [↗](http://www.earthdynamics.org/earthhistory/gmap_info.html) (http://www.earthdynamics.org/earthhistory/gmap_info.html) and [IAPD](http://www.iggf.no/resources.html) [↗](http://www.iggf.no/resources.html) (<http://www.iggf.no/resources.html>)

Software, <https://paleointensity.org/>, [↗](https://paleointensity.org/) (<https://paleointensity.org/>), python and pmagpy (instructions for download [here](https://earthref.org/PmagPy/cookbook/) [↗](https://earthref.org/PmagPy/cookbook/) (<https://earthref.org/PmagPy/cookbook/>),)

Matlab (get access with [UFApps](https://info.apps.ufl.edu/) [↗](https://info.apps.ufl.edu/) (<https://info.apps.ufl.edu/>)); [Gplates](https://www.gplates.org/) [↗](https://www.gplates.org/) (<https://www.gplates.org/>)

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Books of Interest: The Road to Jaramillo (William Glen) Discusses the combined advances in paleomagnetism and geochronology that led to the plate tectonic revolution.

Course Description

This course will serve as a comprehensive overview of Geomagnetism (how the magnetic field is generated, how we use models to assess how it has changed in recent and ancient time), Paleomagnetism (using rocks to interpret the magnetic field and past history of continental motion and true polar wander, in addition to evolution of the deep interior) and Magnetostratigraphy and Environmental magnetism (how we can use the magnetic information encoded in sediments and rocks to tell us about changes in earth history). It is intended for junior/senior level undergraduates and graduate students. While there are no prerequisites, useful background courses/familiarity with physics (electromagnetism in particular), statistics and calculus (the more the merrier) will be helpful.

Part 1a- Intro to Rock Magnetism (Hatfield)

Part 1b- Basics of Paleomagnetism (Meert)

Week 1 - Basic Structure of the Geomagnetic Field, Geocentric Axial Dipole model, Principles of magnetism basics, basics of magnetism in rocks

Lecture 1 (MSH)- Introduction to course Meert, Sprain, Hatfield. History of UF paleomagnetism

Lecture 2 (M)- Overview of origins of the Geomagnetic field, GAD axial dipole, secular variation.

Lecture 3 (M)- Principles of magnetism in natural materials, domain sizes and magnetic mineralogy-1 Reading- Butler Chapter 2

Week 2 (Jan 18 MLK no school)- Domain theory, types of magnetic remanence, common rocks and minerals used in paleomagnetism, Sampling, measurement and instrumentation. Butler Chapter 1-3

Lecture 4 (M)- domain sizes and magnetic mineralogy, hysteresis, Curie temps-2

Lecture 5 (M)- Common minerals and rocks, the alphabet soup of RM's (remanent magnetizations).

Week 3 (Jan 25)- Demagnetization, Analysis of vector components (PCA, Linefind etc, Great circle analysis), statistical methods in paleomagnetism, Butler Chapters 4-6

Lecture 6 (M)- Sampling techniques and strategies, lab instrumentation available at UF.

Lecture 7 (M)- Demagnetization and analysis of vector components (Z-plots).

Lecture 8 (M)- Basic statistical methods applied to paleomagnetic data, great circle analysis-1

Week 4 (Feb 1)- Paleomagnetic poles, euler poles, APWP's, statistics, Butler Chapter 6-7 Appendix

Lecture 9 (M)- Statistical analysis of paleomagnetic data-2

Lecture 10 (M)- Vector space to pole space, VGP's, paleomagnetic poles

Lecture 11 (M)- euler pole rotations, Apparent polar wander paths, importance of age control-1

Week 5 (Feb 8)- Apparent polar wander paths, reconstructions, reliability criteria, Butler Chapter 10, Meert et al., 2020

Lecture 12 (M)- Apparent polar wander paths, True polar wander and euler poles-2

Lecture 13 (M)- Reliability criteria

Lecture 14 (M)- Continental reconstructions using paleomagnetism

Week 6 (Feb 15)- Dr. Sprain & Meert

Lecture 15 (M)- Using GMAP as an introduction to making reconstructions.

Lecture 16 (S)- The geodynamo and dynamo theory pt. 1

Suggested reading: [Essentials of paleomagnetism Chapter 1](https://earthref.org/MagI/books/Tauxe/Essentials/#x1-30001) [↗](https://earthref.org/MagI/books/Tauxe/Essentials/#x1-30001) (<https://earthref.org/MagI/books/Tauxe/Essentials/#x1-30001>), Bonus if you want to know the calculus ([Bonus 1](https://ufl.instructure.com/courses/470922/files/74679261?wrap=1), <https://ufl.instructure.com/courses/470922/files/74679261?wrap=1>) [Bonus 2](https://ufl.instructure.com/courses/470922/files/74679260?wrap=1) (<https://ufl.instructure.com/courses/470922/files/74679260?wrap=1>))

Lecture 17 (S)- UFApps and Matlab

Week 7-(Feb 22)

Lecture 18 (S)- The geodynamo and dynamo theory pt. 2

Lecture 19 (S)- Geomagnetism and secular variation, what's the field doing today? pt. 1

Suggested reading: [Essentials of Paleomagnetism Chapter 2 sections 2.2-2.3 and Chapter 14 through section 14.3](https://earthref.org/MagI/books/Tauxe/Essentials/#x1-1690014) [↗](https://earthref.org/MagI/books/Tauxe/Essentials/#x1-1690014) (<https://earthref.org/MagI/books/Tauxe/Essentials/#x1-1690014>), [Bonus](https://ufl.instructure.com/courses/470922/files/74679191?wrap=1) (<https://ufl.instructure.com/courses/470922/files/74679191?wrap=1>) if you want more detail.

Lecture 20 (S)- Geomagnetism and secular variation, what's the field doing today? pt. 1/Archaeomagnetic dating activity

Week 8- (Mar 1)

Lecture 21 (S)-Introduction to Paleointensity Part 1

Suggested reading: [Essentials of Paleomagnetism Chapter 10](https://earthref.org/MagI/books/Tauxe/Essentials/#x1-1160010) [↗](https://earthref.org/MagI/books/Tauxe/Essentials/#x1-1160010) (<https://earthref.org/MagI/books/Tauxe/Essentials/#x1-1160010>), (<https://ufl.instructure.com/courses/470922/files/74679184?wrap=1>) [Bonus reading](https://ufl.instructure.com/courses/470922/files/74679183?wrap=1) (<https://ufl.instructure.com/courses/470922/files/74679183?wrap=1>) for more detail

Lecture 22 (S)- Introduction to Paleointensity Part 2

Lecture 23 (S)- The determination of paleointensity activity-paleointensity.org

Week 9 (Mar 8)

Lecture 24 (S)- Paleosecular variation and the Time-average field pt. 1

Suggested reading: [Essentials of Paleomagnetism Chapter 14.3-14.7](https://earthref.org/MagI/books/Tauxe/Essentials/#x1-1160010) [↗](https://earthref.org/MagI/books/Tauxe/Essentials/#x1-1160010) (<https://earthref.org/MagI/books/Tauxe/Essentials/#x1-1160010>), [Bonus reading](https://ufl.instructure.com/courses/470922/files/74679259?wrap=1) (<https://ufl.instructure.com/courses/470922/files/74679259?wrap=1>) for more detail

Lecture 25 (S)- Paleosecular variation and the Time-average field pt. 2

Lecture 26 (S)- Paleosecular variation and the Time-average field activity-Determining S and Inclination Anomaly

Week 10 (Mar 15)

Lecture 27 (S)- Connecting long-term magnetic field trends to the evolution of the deep interior pt. 2

Lecture 28 (S)- Connecting long-term magnetic field trends to the evolution of the deep interior pt. 1

Lecture 29 (S)-Connecting long-term magnetic field trends to the evolution of the deep interior: Case study/Activity using geodynamo simulations and real magnetic data.

Week 11 (Mar 22)- Dr. Hatfield

Lecture 30 (H)- Introduction to magnetostratigraphy

Lecture 31 (H)- Sedimentary records of the geomagnetic field

Lecture 32 (H)- Relative Paleointensity pt.1

Week 12 (Mar 29)

Lecture 33 (H)- Relative Paleointensity pt.2

Lecture 34 (H)- Activity: Chronostratigraphic Applications

Lecture 35 (H)- Introduction to Environmental Magnetism

Week 13 (April 5)

Lecture 36 (H)- Fundamental Rock Magnetism pt.1

Lecture 37 (H)- Fundamental Rock Magnetism pt.2

Lecture 38 (H)- Environmental Magnetism: a rock magnetic toolkit

Week 14 (April 12)

Lecture 39 (H)- Using the rock magnetic toolkit (Activity)

Lecture 40 (H)- Particle Size Specific Magnetic Measurements

Lecture 41 (H)- Environmental Magnetic Applications pt.1

Week 15 (April 19)- End of Course

Lecture 42 (H)- Environmental Magnetic Applications pt.2

Lecture 43 (MSH)- Course Summary and Perspectives

Grades:



10% Participation (i.e. attending lectures, participating in class activities)






80% Assignments

Student Honor Code:

We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity by abiding by the Student Honor Code. On all work submitted for credit by Students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment."

Course Summary:

Date	Details	Due
	 University of Florida GatorEvals – Spring 2021 (https://ufl.instructure.com/calendar?event_id=2684849&include_contexts=course_470922)	
	 University of Florida GatorEvals – Spring 2021 (https://ufl.instructure.com/calendar?event_id=2684850&)	

Date	Details	Due
	include_contexts=course_470922	
	 University of Florida GatorEvals – Spring 2021 (https://ufl.instructure.com/calendar?event_id=2684851&include_contexts=course_470922)	
	 University of Florida GatorEvals – Spring 2021 (https://ufl.instructure.com/calendar?event_id=2684852&include_contexts=course_470922)	
	 University of Florida GatorEvals – Spring 2021 (https://ufl.instructure.com/calendar?event_id=2684853&include_contexts=course_470922)	
	 University of Florida GatorEvals – Spring 2021 (https://ufl.instructure.com/calendar?event_id=2684854&include_contexts=course_470922)	
	 University of Florida GatorEvals – Spring 2021 (https://ufl.instructure.com/calendar?event_id=2684855&include_contexts=course_470922)	