

Geos 493 - Paleopedology (3 Credits)

Lectures: Tues., Thurs. 2:00-3:30 p.m. – NSCI 306

Prerequisites: Geos 322 or Geog 205 or NRM 380W or permission of instructor

Instructor: Dr. Paul McCarthy

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Office Hours: Monday & Friday 9:00-10:30 a.m., or by appointment

Recommended supplementary reading:

There is no required text for this course. Students may find information in some of the following references helpful. This is NOT a required reading list.

Retallack, G.J., 2001. *Soils of the Past: an introduction to paleopedology*. Blackwell Science, London.

Schaetzl, R. and Anderson, S., 2005. *Soils: genesis and geomorphology*. Cambridge University Press, Cambridge.

Birkeland, P.W., 1999. *Soils and Geomorphology*. Oxford University Press, London.

Course description:

A survey course focusing on the recognition and use of paleosols (fossil soils) as paleoenvironmental indicators, stratigraphic markers, and in paleogeographic reconstructions from Precambrian to Holocene. Examination of theories of soil formation, major soil processes and approaches to soil classification. Review of geochemical, mineralogical, morphological and micromorphological techniques. Use of paleosols for paleolandscape evolution and basin analysis. Geological, tectonic, archaeological and environmental applications of paleosols are discussed.

Course goals:

This is a lecture course designed to provide students with basic pedological and geological tools so that they can interpret the fossil soil record. By the end of the course, students will understand basic soil processes and soil types, be aware of analytical methods that can be used in identifying these processes in ancient soils, and understand the uses and limitations of paleosols for paleoenvironmental interpretation, stratigraphy and paleogeographic reconstructions. Students will also be aware of tectonic, environmental and archaeological applications of paleosols. Analysis and interpretation of paleopedological data through a major term project.

Tentative Class Schedule:

Week 1: Soil profiles and horizonization

- Definition of soil & paleosol
- Profiles, pedons, solum
- Soil horizon nomenclature

Week 2: Models and concepts of soil formation

- Functional-factorial model
- Process-systems model
- Energy model
- Soil thickness model
- Soil evolution model
- Other models

Sept. 14 - Consultation with instructor concerning paper topic

Week 3: Soil genesis and profile differentiation

- Eluviation-illuviation
- Process bundles
- Surface additions and losses

Week 4: Soil and Paleosol classification

- Approaches to soil classification
- Soil taxonomy
- Duchaufour
- Paleosol classification

Sept. 28 - Term paper topic with annotated reference list due

Week 5: Recognition of fossil soils

- Root traces
- Soil horizons
- Soil structure
- Bioturbation and trace fossils

Week 6: Chemical and mineralogical analysis of paleosols

- Pre-Quaternary paleosols – molecular ratios, concentration ratios, mass balance
- Quaternary paleosols – bulk geochemistry, organic matter, extractable elements
- Clay mineralogy
- Parent material uniformity – chemical and mineralogical methods

October 12 - Annotated outline for research paper due

Week 7: Micromorphological analysis of paleosols

- Sampling and thin section manufacture
- Systematic thin section description
- Micromorphological characteristics of soil orders
- Presentation and interpretation of micromorphological data

October 19 - Mid-term examination

Week 8: Alteration of paleosols during burial

- Burial decomposition of organic matter
- Burial gley
- Alteration of iron oxides and hydroxides
- Cementation of primary porosity
- Compaction
- Illitization

Week 9: Soil hydrology, geomorphology and paleolandscape reconstruction

- Catenas and pedofacies
- Soil geomorphology case studies, models & paradigms
- Soil hydrology and landscape evolution

November 2 – 1st draft of body of research paper due

Week 10: Soil stratigraphy

- Stratigraphic terminology, principles and geomorphic surfaces
- Pedostratigraphic units (geosols, pedoderms)
- Soil-forming intervals
- Soil facies

November 9 – 1st draft of introduction and conclusion of research paper due

Week 11: Paleoenvironmental reconstruction

- Environmental pedo-signatures
- Reconstruction of past climates from paleosols
- Reconstruction of paleo-atmospheres from paleosols
- Caveats and complications

November 16 - First draft of abstract of research paper due

Week 12: Time: soil development and surface exposure dating

- Soil development indices
- Chronosequences
- Numerical dating techniques

Week 13: Geologic applications of paleosols

- Paleosols in aggradational systems
- Paleosols at unconformities
- Paleosols and sequence stratigraphy
- Sediment accumulation rates

Week 14: Fossil record of soils

- Precambrian paleosols
- Paleozoic paleosols
- Mesozoic paleosols
- Quaternary paleosols

December 12 – Term paper due

December 13 – 1-3 pm - Final examination

Evaluation:

Students in the course will be evaluated on the basis of two examinations and a term paper of approximately 10-15 pages length. The term paper will be based on library research into a paleopedological topic of interest to the student that examines the topic in more detail than class time will allow. Students will discuss their choice of topic with the instructor by the end of the 2nd week of class. Students will turn in a paragraph describing their proposed term paper topic with an annotated bibliography by the end of the 4th week of term. Drafts of various sections of the paper will be handed in throughout the term. These drafts will be critiqued, graded, and returned to the students within one week. Students will incorporate instructor feedback and suggestions for revision into the final term paper. The final paper is due at the end of the last week of term. Students who have not made significant progress on their term papers by the 10th week of class will be dropped from the class.

Grading scheme:

Mid-term examination – 25%

Final examination – 25%

Term paper – 50% total, broken down as follows:

Topic with annotated bibliography – 5%

Annotated outline – 5%

1st draft of body of paper – 10%

1st draft of Introduction & Conclusion – 10%

1st draft of Abstract – 5%

Final draft of research paper – 15%