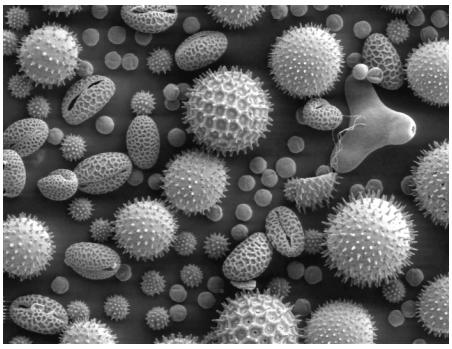
PALYNOLOGY AND PALEOPALYNOLOGY

Geos 453/653 Course Syllabus

Lectures: MWF 11:45 AM –12:45 PM
233 Reichardt

Labs: T 2:00-5:00 PM
229 Reichardt



4 Credits
Prerequisites: Geos 315 *or* Biol 115

Professor: **Sarah J. Fowell**
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Office Hours: **T 11:00 –12:30 & W 1:00-2:30**

Required Text:

- Traverse, A., 2008. Paleopalynology, 2nd ed. Springer, Dordrecht, 813 p.

Go to amazon.com to purchase, rent, or download the Kindle Edition of this textbook.

Recommended Text:

- Moore, P.D., Webb, J.A., and Collinson, M.E., 1991. Pollen Analysis. Blackwell Scientific Publications, Boston, 216 p.

Palynology is a field with diverse applications, which employ a wide variety of techniques. Fundamentally, however, studies of climate change, biostratigraphy, or paleoecology all rely upon the preparator's ability to process the sample and identify constituent palynomorphs. Consequently, this course will emphasize practical skills such as identification and sample preparation. Demonstrations of new techniques will be held during the lab sessions. It is particularly essential that you attend demonstrations of laboratory procedures, as you will not be able to complete the exercise if you haven't first been introduced to the techniques. Demonstrations in the wet lab will last approximately one hour. The remainder of the lab time is available for you to work on the exercises. However, it is likely that additional time will be required in order to complete the labs. The amount of extra time you spend in lab will depend on how excited you are about palynology, but plan to invest ~4 hours/week minimum in order to learn and understand the material. The bulk of the lab work can be done whenever you please, once you have attended the demonstration.

Lecture and Discussion Format: I will not spend all the time talking while you take notes! The best way to learn and retain the material is by active participation. During lectures I will encourage you to take part in class activities, including group discussions and individual "clicker questions". Your participation will be rewarded with a better grasp of the material and credit toward your participation grade. Please try to remain punctual! If you arrive late, you may miss activities that will document your presence. In other words, if you are late, you may be counted absent.

Course Objectives: The primary mission of this course is to provide you with a set of practical skills that will allow you to date a rock sample and reconstruct the climate at the time of deposition, based on constituent palynomorphs. To meet this goal, there are three primary course objectives: **1)** Explore the function and morphology of pollen and spores, using modern specimens as the primary examples. **2)** Examine the organic evolution of plants, from the Cambrian colonization of the land to the Cretaceous rise of flowering plants, as recorded by fossil pollen and spores. **3)** Understand the relationships between temperature, precipitation and vegetation cover.

Learning Outcomes: This course places a strong emphasis on laboratory skills and microscope techniques. Class discussions will introduce and reinforce new vocabulary, while labs will allow you to practice extraction, description, and identification of modern and fossil palynomorphs. Upon completing this course, you will be able to:

- Compare and contrast the function and morphology of pollen and spores
- Describe and illustrate modern and fossil spores and pollen grains
- Recognize and identify 20 modern North American pollen genera
- Make type slides from dried herbarium specimens
- Extract palynomorphs from sedimentary rocks and mount them for study
- Date any palynomorph-bearing sample to the correct geologic period
- Reconstruct vegetation and paleoclimate based on palynomorph assemblages

Final Project (Undergraduates) or Paper (Graduate Students):

Undergraduates: Midway through the semester, you will be given an "unknown" sample of rock from an undisclosed location. For your final project, you will process the sample, make at least two strew slides of constituent palynomorphs, photograph and identify a minimum of 5 pollen or spore species, and date the sample as precisely as possible (at <u>least</u> to the level of geologic period). At the end of the semester, you will turn in your slides, photos and names of identified palynomorphs, your age assessment, and a list of references used to make your identifications.

Graduate Students: Midway through the semester, you will have a choice of processing a suite of samples from your field area or an "unknown" rock sample from an unspecified location. Regardless of the sample type, your task will be to process the sample(s), make at least two strew slides of the palynomorphs, identify a minimum of 10 pollen species (if diversity permits), and photograph representative specimens of each taxon. Students with Pleistocene or Holocene projects will be expected to display their data in a pollen diagram. Students with pre-Quaternary samples (thesis data or unknowns) are required to date the rock(s) to the period and, if possible, age. At the end of the semester, you will turn in a paper describing your results. This paper will be a publication-quality document, including an introduction, methods, photos, paleoclimatic and/or biostratigraphic interpretations, and a complete list of references. Your microscope slides are to be submitted with the paper.

Disabilities Services: The Office of Disability Services implements the Americans with Disabilities Act (ADA) and ensures that UAF students have equal access to the campus and course materials. I will work with the Office of Disabilities Services (474-7043) to provide reasonable accommodation to students with disabilities. Please let me know if accommodations should be provided.

Course Policies: The final exam will be given only on the day and time scheduled by the university, so make travel and work plans accordingly. Make-up examinations will be given *only* under extenuating circumstances; a written explanation from your doctor or dentist will be required in the case of a medical emergency. The **Student Code of Conduct** (p. 52 in the UAF 2013-2014 Catalog) outlines your rights and responsibilities, as well as prohibited forms of conduct. Please be aware of the contents of the code.

Grading: Grades will be weighted as follows:

2 Exams: 30% (15% each)	Laboratory Exercises: 30%
Participation: 10%	Final Paper and/or Project: 30%

Grade Scale: Laboratory exercises, projects, and participation will be graded according to the following scale: 100-91% = A, 90% = A-, 89% = B+, 88-81% = B, 80% = B-, 79% = C+, 78-71% = C, 70% = C-, 69% = D+, 68-61% = D, 60% = D-, <60% = F. Exams and final weighted scores will be graded on a curve.

Lecture and Lab Schedule

Day	Topic	Reading	Lab Exercise	Due
Friday 9/6	Introduction: Why count pollen? Applications of palynology	Traverse Chapter 2		

Part I Palynomorphs: Morphology and Function

Monday 9/9	What are palynomorphs? A survey of acide-resistant microfossils	Traverse Ch 1		
Tuesday 9/10			Lab #1: The Care and Feeding of Your Microscope	**Lab 1**
Wednesday 9/11	Chemistry of sporopollenin, chitin, and pseudochitin	Traverse Ch 3		
Friday 9/13	Pollen vs. spores: Form and function among palynomorphs	Traverse Ch 4		

Monday 9/16	Morphology I: Apertures and orientation of modern spores	Traverse Ch 5: 87-128		
Tuesday 9/17			Lab #2: "Top 50" Modern Spores and Pollen	
Wednesday 9/18	Morphology II: Pollen apertures – pores versus colpi			
Friday 9/20	Morphology III: Exine sculpture and structure	Traverse Ch 5: 128-154		

Part II Land Plant Evolution and Palynostratigraphy

Monday 9/23	Precambrian acritarchs: Enigmatic marine microfossils	Traverse Ch 6: 155-173		
Tuesday 9/24			Lab #2 Continued; Lab #3: Herbarium sheets	
Wednesday 9/25	Spores of the Cambrian and Ordovician: Terrestrial?	Traverse Ch 6: 173-188		
Friday 9/27	Land ho! Silurian vegetation and spores	Traverse Ch 7		

Monday 9/30	Devonian vegetation and spores: Size matters!	Traverse Ch 8		
Tuesday 10/1			Lab #2 Continued; Lab #3: Acetolysis	
Wednesday 10/2	Megaspores, microspores, and the evolution of seeds	Traverse Ch 8: 211-219		
Friday 10/4	Classification of organ fossils: Potonie's turmal system	Traverse Ch 9: 229-264		

Day	Topic	Reading	Lab Exercise	Due
Monday 10/7	Wetland vegetation of the Carboniferous and Permian	Traverse Ch 9: 264-273		
Tuesday 10/8			Lab #2 Continued; Lab #3: Making slides	
Wednesday 10/9	Road to nowhere: Spores of the Carboniferous and Permian			
Frida 10/11	Saccate and striate morphologies: Hallmarks of the Permo-Triassic	Traverse Ch 10		
Monday 10/14	Fall of the primeval forest: The Paleophytic/Mesophytic transition	Gastaldo et al., 1996		
Tuesday 10/15			Labs #2 Continued; Lab #3: Photomicrography	
Wednesday 10/16	Dinoflagellates, fungal spores and the Permian mass extinction	Visscher et al., 1996		**Lab 2**
Friday 10/18	Triassic pollen and the evolution of angiosperms	Traverse Ch 11		
Monday 10/21	Spores, circumpolloid pollen, and the Triassic mass extinction	Fowell et al., 1994		**Lab 3**
Tuesday 10/22			Lab #4: S-D Palynology; HF Safety Training	
Wednesday 10/23	Macrofossil and microfossil records of the angiosperm radiation	Traverse 13: 347-361		
Friday 10/25	**Midterm Exam**			
Monday 10/28	Cretaceous pollen I: Projectates and pillboxes	Traverse 13: 367-379		
Tuesday 10/29			Lab #5: C-P Palynology; Maceration and Dissolution	
Wednesday 10/30	Cretaceous pollen II: The *Normapolles* group	Traverse 13: 361-367		
Friday 11/1	Spores and soot: How did the K/T extinction affect the vegetation?	Wolfe and Upchurch, 1986		
Monday 11/4	Paleogene paleoclimates and floral associations	Traverse Ch 14		
Tuesday 11/5			Lab #6: Tr/J Palynology; Gravity Separation	
Wednesday 11/6	The Paleocene-Eocene thermal maximum	Brinkhuis et al., 2006		
Friday 11/8	Alaskan floras of the PETM	Sunderlin et al., 2011		

Day	Topic	Reading	Lab Exercise	Due
Monday 11/11	Neogene grasslands and the steppe-forest index	Traverse Ch 15		
Tuesday 11/12			Lab #7: K Palynology; Counting Techniques	
Wednesday 11/13	Of grasslands and grazers: C3 versus C4 plants	Cerling et al., 1997		
Friday 11/15	Interior floras and the Rise of the Alaska Range	Reinink-Smith & Leopold, 2005		

Part III Pollen Analysis: Extracting a Climate Signal

Monday 11/18	Pollen production, dispersal, and deposition	Traverse Ch 17, 18		
Tuesday 11/19			Lab #8: T Palynology; Project Conferences	
Wednesday 11/20	Collecting data in the field: Tools and techniques	MWC Ch 3		
Friday 11/22	Extracting a climate signal from palynological data	MWC Ch 8		

Monday 11/25	Constructing a pollen diagram	MWC Ch 7		
Tuesday 11/26			Labs 4-8 and Final Projects Continued	
Wednesday 11/27	Quaternary climates: Ice ages and marine oxygen isotope stages	Traverse Ch 16		**Labs 4-8**
Friday 11/29	**Thanksgiving Break No Class!!!!!**			

Monday 12/2	Mammoth diets: Pleistocene ice ages and the vegetation of Beringia	Guthrie, 2001		
Tuesday 12/3			Lab #9: Tilia Diagrams Final Projects Continued	
Wednesday 12/4	Palynological evidence for ice-age refugia in Alaska	Brubaker et al., 2005		
Friday 12/6	Vegetation of the emergent Bering Land Bridge	Elias & Crocker, 2008		**Lab 9**

Monday 12/9	The Younger Dryas and NADW circulation	Broecker et al., 1985		
Tuesday 12/10			Final Projects Continued	
Wednesday 12/11	The Younger Dryas in Alaska	Engstrom et al., 1990		**Final Project**
Friday 12/13	Limitations: Recycling, sedimentation, and preparation	Traverse Ch 19		

Day	Topic	Reading	Lab Exercise	Due
Tuesday 12/16 10:15 AM	**Final Written Exam and Laboratory Practicum**			

Required Articles

Brinkhuis, H., and others, 2006. Episodic fresh surface waters in the Eocoene Arctic Ocean. *Nature* 441: 606-609.

Broecker, W.S., Peteet, D.M., and Rind, D., 1985: Does the ocean-atmosphere system have more than one stable mode of operation? *Nature* 315: 21-26.

Brubaker, L., Anderson, P. M., Edwards, M.E., and Lozhkin, A.V., 2005. Beringia as a glacial refugium for boreal trees and shrubs: new perspectives from mapped pollen data. *Journal of Biogeography* 32: 833-848.

Cerling, T., Harris, J.M., MacFadden, B.J., Leakey, M.G., Quade, J., Eisenmann, V., and Ehleringer, J.R., 1997. Global vegetation change through the Miocene/Pliocene boundary. Nature 389: 153-158.

Elias, S., and Crocker, B., 2008. The Bering land bridge: A moisture barrier to the dispersal of steppe-tundra biota? *Quaternary Science Reviews* 27: 2473-2483.

Engstrom, D.R., Hansen, B.C.S., and Wright, H.E., 1990. A possible Younger Dryas record in southeastern Alaska. *Science* 250: 1383-1385.

Fowell, S.J., Cornet, B., and Olsen, P.E., 1994. Geologically rapid Late Triassic extinctions: Palynological evidence from the Newark Supergroup. In: Klein, G. D., ed., Pangea: Paleoclimate, Tectonics and Sedimentation During Accretion, Zenith and Break-up of a Supercontinent. *Geological Society of America Special Paper* 288: 197-206.

Gastaldo, R.A., DiMichele, W.A., and Pfefferkorn, H.W., 1996. Out of the icehouse into the greenhouse: A Late Paleozoic analog for modern global vegetational change. *GSA Today* 6 (10): 1-7.

Guthrie, R.D., 2001. Origin and causes of the mammoth steppe: a story of cloud cover, woolly mammal tooth pits, buckles, and inside-out Beringia. *Quaternary Science Reviews* 20: 549-574.

Reinink-Smith, L., and Leopold, E., 2005. Warm climate in the Late Miocene of the south coast of Alaska and the occurrence of Podocarpaceae pollen. *Palynology* 29: 205-262.

Sunderlin, D., Loope, G., Parker, N., and Williams, C.J., 2011. Paleoclimatic and paleoecological implications of a Paleocene-Eocene fossil leaf assemblage, Chickaloon Formation, Alaska. *Palaios* 26: 335-345.

Visscher, H., Brinkhuis, H., Dilcher, D.L., Elsik, W., Eshet, Y., Looy, C.V., Rampino, M.R., and Traverse, A., 1996. The terminal Paleozoic fungal event: Evidence of terresrial ecosystem destabilization and collapse. PNAS 93: 2155-2158.

Wolfe, J.A., and Upchurch, G.R. Jr., 1986. Vegetation, climatic and floral changes at the Cretaceous-Tertiary boundary. *Nature* 324: 148-152.