Soil Formation: Earth Surface Processes and Biogeochemistry
PLSC 467/667, GEOL 467/667, Fall 2006
Syllabus
http://udel.edu/~kyoo/SoilFormation/
(Web link will be available when the semester starts.)

Course Information: Soil Formation is a course designed for upper-level undergraduate and graduate students. The course will be offered in the fall of even numbered years. Students are required to have taken introductory courses in soil science or geology. Whereas students will be exposed to mathematical modeling exercises, background in calculus is not assumed. Basic experience with spread sheet software (like MS Excel) will be helpful in completing several questions in homework problem sets but are not required.

Course Hours, Location and Instructor: Class will meet from 11:00 AM-12:15 PM Tuesday and Thursday at ***Fisher Greenhouse 103 (Note the change from Worrilow 203)***. I will be available at my office from 1:30 pm to 2:30 pm on Tuesday and Thursday. However, as long as you let me know beforehand and I don't have pressing issues, I will be happy to talk to you besides during the regular office hours. Here are my name and contact info.

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Texts and Readings: The textbook is ***Soils: Genesis and Geomorphology, Schaetzl and Anderson, Cambridge, 2005, p.817. Cambridge University Press.*** I understand that the textbook covers overwhelmingly diverse materials. You should, however, be relieved that attached course schedule lists the specific subsections of Schaetzl and Anderson as required readings for each class. Every textbook has its own strengths and weaknesses. For the materials that are not sufficiently addressed in Schaetzl and Anderson (eg., soils and climate change), I will provide handouts of which contents are drawn from other published books and scientific papers.

If you are interested in reading a gracefully written essay about soils and the science of soils, I highly recommend "Dirt: the ecstatic skin of the earth" by William Bryant Logan. In case you might want to read the chapters which are relevant to class materials, I listed some of the directly related chapters in the attached reading schedule.

I will often use the materials from the following books. Italicized books are currently on reserve for this course at Agricultural Library in Towsend Hall, and the rest of the books

will become available on reserve by the 4th week of the semester. Library is purchasing the updated editions. You are *NOT* required to read those books.

- Birkeland, P. W. (1999). Soils and geomorphology. New York, Oxford University Press.
- Bormann, F.H. and Likens G.E. (1994). Pattern and processes in a forested ecosystem, Springer-Verlag.
- *Cox, P. A. (1995). The elements on earth: inorganic chemistry in the environment. Oxford, Oxford University Press.*
- Chapin-III, F. S., P. A. Matson and H. A. Mooney (2002). Principles of terrestrial ecosystem ecology, Springer.
- *Schlesinger W. H. (1997). Biogeochemistry: an analysis of global change, Academic Press.*
- Selby, M. J. (2000). Hillslope materials and processes. Oxford, Oxford University Press.
- *Sposito, G. (1989). The chemistry of soils, Oxford University Press.*
- *Vitousek P. (2004). Nutrient cycling and limitation: Hawai'i as a model system. Princeton University Press.*

Course Description: The course addresses soils as historical objects in natural and human-managed ecosystems. The class materials include the findings from century-old studies to cutting-edge scientific discoveries which have formed our knowledge of how physical, chemical, and biological processes shape the surprisingly diverse soils on the earth and the role that soils play in local to global biogeochemical cycles across diverse time scales. Whenever possible, I will use most recent studies as examples. This course emphasizes holistic, quantitative, and process-based approach toward understanding how soils affect and are affected by the evolution of landforms and regional to global biogeochemical cycles.

The course is structured to entertain students from diverse backgrounds and interests. Students in soil science programs will appreciate how soil chemistry, physics, and microbiology contribute to soil formation and the biogeochemistry of the terrestrial ecosystems. Students with geology or geography backgrounds will learn how the evolution of landscapes and global climates are coupled to soil forming processes. Lastly, students interested in environmental science will discover that soils are deeply involved in many of the pressing regional to global environmental issues we face today.

The course largely centers on the lectures by the instructor. Class materials, however, are prepared to stimulate students to tackle real world issues of which examples are given as homework problem sets. Thus homework problem sets are an extension of the lectures.

The class significantly differs from the traditional Pedology course in terms of its contents and organization. Rather than starting with the spatial distribution of soil properties and soil classification, we place soils in the biogeochemical and geomorphic context of the earth surface and begin with conceptual framework to quantitatively and functionally related soil forming processes and properties. With this approach, students

are encouraged to question the diversity of soils as the products of physical, chemical, and biological processes.

Course Assignments: Classes are offered to help students to independently undertake homework problems. Problem sets are given not to test if students remember specific points in the lectures but to challenge students to creatively use the class materials to solve real world problems. Each student is expected to complete problem sets independently. Keys to problem sets will be made available when the graded works are returned. In addition to problem sets, students take one midterm and a final exam. While problem sets focus on applying newly-learned concepts to solving problems, the exams are to make sure that students understand and are capable of describing the key processes forming soils and the diversity of soils in relation to various environmental factors.

Course Policies:

- Problem sets and exams are largely based on lecture materials. Make every effort not to miss a class.
- Problem sets are due by the beginning of the class a week later. No late homework will be accepted.
- No early exams will be given.
- Makeup exams will be given only for reasons of illness or family emergencies. Documentation must be provided if requested by the instructor.
- Academic dishonesty in any form will not be tolerated and will be subject to University's Policy on Academic Honesty as described in the Student Guide to Policies (http://www.udel.edu/stuguide/06-07/code.html#honesty).

Course Grading: This is a class for both undergraduate and graduate students. Undergraduate students, however, should not be concerned about being compared to graduate students in being evaluated in class performance. All students' grading is based on the following absolute criteria. Graduate students are required to complete one extra question in each problem set.

Homework problem sets (eight problem sets): 50 %
Midterm exam: 20 %
Final exam: 30 %

Final grades will be assigned as follows:

Percent	Grade	Percent	Grade	Percent	Grade	Percent	Grade
93-100	A	87-89.9	B+	77-79.9	C+	67-69.9	D+
90-92.9	A-	83-86.9	B	73-76.9	C	63-66.9	D
		80-82.9	B-	70-72.9	C-	60-62.9	D-
						<60	F

Study Tips: Again, attending every class is critical to be successful in this course. Make good use of my office hours; I will be happy to discuss your difficulties in class materials, problem sets, and preparing for exams. When studying for exams, you will be more successful by going over the past problem sets and the previous exam. I will not print and

distribute power point slides. Instead, you can download the power point presentation for the next lecture from the course website (http://udel.edu/~kyoo/SoilFormation/), which will reduce your note-taking efforts during classes. If you don't have basic skills in using Excel, many online learning resources are available. One of them is: http://www.usd.edu/trio/tut/excel/.

Course Schedule

Date	Day	Lec	Topic	Problem Set Distribution	Problem Set Due
29-Aug	Tues	1	Course overview		
31-Aug	Thur	2	Biogeochemical context of soils: elemental compositions of rocks, soils, rivers and ocean		
5-Sep	Tues	3	Geomorphic context of soils: tectonics, river incision, erosion, and deposition		
7-Sep	Thur	4	Soil Morphology and Horizons	1	
12-Sep	Tues	5	A visit to a soil in a Piedmont-Coastal transition forest in UD campus		
14-Sep	Thur	6	Soil and Rock Minerals_1		1
19-Sep	Tues	7	Soil and Rock Minerals_2		
21-Sep	Thur	8	Parent material and soil formation	2	
26-Sep	Tues	9	Chemical Weathering in Soils		
28-Sep	Thur	10	Geochemical mass balance model		2
3-Oct	Tues	11	Physical and chemical weathering in Soils	3	
5-Oct	Thur	12	Carbon cycle in soils		
7-Oct	*Sat*		*Field trip to Fairhill State Park (optional): 10 min driving from UD*		
10-Oct	Tues		Bioturbation and mass translocation by organisms	4	3
12-Oct	Thur	13	Soil and Watershed Biogeochemistry		
17-Oct	Tues	14	Soil profile and Hydrology 1		4
19-Oct	Thur	15	Soil profile and Hydrology 2	5	
24-Oct	**Tues**	**16**	**Midterm exam (covers lecture 1 to 13)**		
26-Oct	Thur	17	Describing and Mapping Soil diversity_1		
31-Oct	Tues	18	Describing and Mapping Soil diversity_2		5
2-Nov	Thur	19	Soil diversity along climate gradient	6	
4-Nov	*Sat*		*Field trip to Soldiers'' Delight Natural Environment Area (optional): 2 hrs driving from UD*		
7-Nov	Tues		*Election day: No lecture*		
9-Nov	Thur	20	Soil diversity along time gradient		6
14-Nov	Tues	21	Soil diversity along topographic gradient, catena concept	7	
16-Nov	Thur	22	Co-evolution of soils and landscapes		
21-Nov	Tues	23	Soil processes and the history of the Earth		7
23-Nov	Thur		*Thanksgiving: No lecture*		
28-Nov	Tues	24	Soil and global carbon cycle	8	
30-Nov	Thur	25	Soil and global nitrogen cycle		
5-Dec	Tues	26	Soils and civilization		8
14-Dec	**Thur**		**Final exam (covers lecture 1 to lecture 26) 1:00 PM – 3:00 PM**		

Course Reading Schedule

Date	Day	Required Reading (Schatzel and Anderson or Handouts)	Optional Reading (Logan)
29-Aug	Tues		
31-Aug	Thur	An earthscientist's periodic table of the elements and their ions http://www.gly.uga.edu/railsback/PTTalk/PTTalk002.html	Stardust (p.7), The first soil, The sand drowns the sea,
5-Sept	Tues	Handouts	
7-Sep	Thur	Ch2: Texture, Color, Bulk density, Structure, Presentation of soil profile data. Ch3: Soil horizon and the solum, Types of soil horizons	Underground horizons
12-Sep	Tues	Handout	Lessons in digging, On digging holes
14-Sep	Thur	Chapter 4: Bonding and crystal structures, Oxides, carbonates/salfates/sulfides/phosphates.	In a landscape of clays,
19-Sep	Tues	Chapter 4: Silicates	Clay and life, Kaolin, The path of a clay crystal
21-Sep	Thur	Ch8: Effects of parent material on soils	The soil man
26-Sept	Tues	Ch9: Chemical and biotic weathering, Products of weathering	
28-Sept	Thur	Ch12: Mass balance analysis, strain and self-weight collapse Handout	
. 3-Oct	Tues	Ch9: Physical weathering	Crevice invasion, Sweet and sour soils
5-Oct	Thur	Ch12:Processes associated with organic matter (p.354-357)	Dio-He-Ko
10-Oct	Tues	Ch6: Larger soil animals (p.101-105), Ch10:Introduction, Pedoturbation/particle size/biomantles (p.242-244)	On gopher humps, Of worms, Perception in earthworms,
12-Oct	Thur	Handout	
17-Oct	Tues	Ch5: Soil water retention and energy, Soil water movement. Ch12: p.359-p.367	Groundwater
19-Oct	Thur	Ch12: p.380-420	
24-Oct	**Tues**	**Midterm exam**	
26-Oct	Thur	Ch7: Introduction, Soil geography/mapping/classification, The system of soil taxanomy	Into the pits
31-Oct	Tues	Ch7:Soil mapping and soil maps	
2-Nov	Thur	Handout	
7-Nov	Tues	*Election day: no lecture*	
9-Nov	Thur	Ch14: Chronosequences (p587-596)	Fire and ice,
14-Nov	Tues	Ch13: The catena concept (p.469-p.514)	
16-Nov	Thur	Handouts	
21-Nov	Tues	Handout	The circulation of stone, the theory of silt
23-Nov	Thur	*Thanksgiving: No lecture*	
28-Nov	Tues	Handouts	Humus, Saint Phocas as fertilizer, The soil of graves
30-Nov	Thur	Handouts	
5-Dec	Tues	Handouts	Virgin soil, The soil and the devil