GEOLOGY 151
GEOMORPHOLOGY
Fall 2005

Class meets in ROOM 101 DELEHANTY and in the GEOLOGY COMPUTER LAB

Professor: Paul Bierman, Geology Department and School of Natural Resources, Room 307 DELEHANTY HALL, 656-4411

GTF: Luke Reusser, Doctoral Student, Natural Resources, 656-3398

email: pbierman@uvm.edu (absolute best way to find me since I'm teaching two courses, trying to get my lab online after 15 months, developing lots of educational materials for this class, and doing lots of child care for our little and not so little ones!) Luke is lreusser@uvm.edu (pretty good way to find Luke too, since he's often taking classes and doing lab work).

***Class Web Page*:** http://www.uvm.edu/cosmolab/classes/morph/

Webct: There is a course page in webct that you will need to visit frequently. It will have readings, reading questions, and a grade book as well as useful links and a calendar. Go to https://www.uvm.edu/webct/ and log in with your netID and password.

Office hours: Luke and I will announce our office hours after the semester begins. If you need to chat, feel free to stay after class, or better yet email or call us for an appointment. I often work at home writing in the mornings.

This will not be your Average UVM Course

I've taught *Geomorphology* for 12 years at UVM and it is time for a change. Thanks to the National Science Foundation, we have support to completely revamp *Geomorphology* over the next 4 years. This support includes development of a variety of educational materials and approaches, assessment and testing to make sure the new materials and new teaching approach really works, and continual refinement in response to student feedback.

What does this all mean to you? Hopefully, it means a far better and more coherent course with exciting new materials to try out. For us, it means long nights and lots of coffee getting all the new technology, presentations, and labs to work right. It also means that we will be relying on you, as a class, for feedback. We'll do this in various ways. First, we need to ask your permission via a consent form so that we can study your responses to the class work. Second, we will be asking some of you to volunteer to be interviewed during and after you work through web modules. Lastly, we ask for your patience with what will be more than the average number of surveys before, during, and after the semester as well as technical glitches here and there as we try new things.

We hope that you will join in this effort to make *Geomorphology* the best class it can be for all of you and for all the UVM students who take in the future. To see more about what we are doing with this class and why, check the link off of webct site entitled, *NSF Support*.

Why Geomorphology?

Landscapes surround us all and often seem to be static, unchanging backdrops for our day-to-day activities. Yet, if we begin to look closely, landscapes are anything but static features; they are continually evolving at a variety of time and length scales.

So, what then is Geomorphology? Narrowly, it is the study of landscapes, their forms and the history and processes of their development. Broadly, it is what I hope to show you this fall. I'll argue that Geomorphology is one of the most synthetic of all geologic sub-disciplines. Properly done it must consider any number of processes and Earth characteristics: structure, lithology, tectonism, volcanism, weathering, hydrology, and in New England, as over most of the world today, human activity.

My goal for you as students was best expressed by one of my colleagues, "After this class you'll never look at a landscape the same way again. You'll always stop and wonder how and why the land looks the way it does..."

Course Structure

Over the next 14 weeks, we will use a variety of tools and approaches to learn more about Earth's surface. Monday classes will be devoted to a mixture of lecture, activities, and some preparation for Wednesday fieldtrips and labs. Wednesday, we will do lab work and/or take fieldtrips and gather data. We have developed a series of image-based, on-line learning modules that you will be using before coming to class. See uvm.edu/learninglandscapes. For those of you whose Earth Science may be a bit rusty, any of the Introductory Geology texts held by the library should serve you well as a source of information.

Expectations and Responsibilities for the course

Luke and I will be responsible for providing you a well-organized, clearly presented view of Earth's surface and how it works. We will strive to have all assignments posted and returned to you in a timely fashion. We will strive to be available to help you with reasonable notice either in person or by email. As long as the email system is functioning or it's not a weekend, you should expect a response within 24 hours to an emailed question.

You will be responsible for completing a variety of assignments over the course of the semester. There will be occasional readings in John McPhee's books, *The Control of Nature* and *Encounters with the Archdruid*, readings that we will refer to in class. There will be exerts from textbooks and the occasional journal paper to read. There will be assignments related to the fieldtrips and each of you will be part of a group research project. There will be in class exercises to do. There will be on-line learning modules to do for the first 5 weeks of class. We will suggest web-sites for you to review to deepen you understanding of the material covered in class.

We expect that all assigned readings and on-line modules in *Learning Landscapes* will be done prior to coming to class or lab– without the readings, you'll find yourself quite lost in our discussions and you won't get as much out of class/lab. There is a detailed week-by-week syllabus that you should refer to and technology permitting, we will reproduce in webct. We will post a large copy on the class bulletin board outside Paul's office (Delehanty 307). Attendance in class is expected and will be graded. If you know in advance that you will miss a class, please let me know. Also, I will abide by and hold you all to the Arts and Sciences guidelines for classroom behavior. Respect and courtesy are top priorities.

Group Research Projects:

A research project is an integral part of this class. It will be done in groups of two and will require the collection of data, and the analysis and interpretation of the your data in the context of the published work of others. The purpose of this project is many-fold including: an introduction to the geologic literature, experience in data collection and interpretation, honing your writing and presentation skills, and practice in collaboration and hypothesis testing. All parts of the research project should be submitted using Adobe Acrobat as PDF files (this allows full cross platform readability). We'll show you how to make a PDF and help you as needed through the semester. The final presentations will be done as a poster session with the poster created in PowerPoint. Again, we'll help you out with this.

Readings:

There are two required texts for the course, available at the UVM bookstore or through your favorite on-line or other bookseller.

McPhee, J., *The Control of Nature*
McPhee, J., *Encounters with the Archdruid*

There is no text book for the course. Rather, we have compiled a group of readings that you will need to download from the class web site or from webct. For each reading, there is a set of questions that you need to answer in web-ct after you have done the reading and before the reading is due. The questions are available from the class web site and from webct so that you can see them before reading and use them as a guide for study. The questions are designed to focus your reading and thinking and provide a vehicle for in-class discussion of material.

Field Trips:

Field trips make up an integral part of this course. All trips will include some amount of walking and sturdy shoes are a necessity. Of course, since it will be fall in Vermont, the weather will be cool and clear but make sure you are prepared for cold, wet conditions. Unless the weather is extreme enough to present a hazard, we will go out in the, rain, fog, snow, wind. For each trip you MUST have:

waterproof raingear
sturdy footwear
a sweater or fleece for warmth
a waterproof field notebook and pencil
perhaps a small knapsack to carry all this.
money for bakery and store stops
some food to stave off hunger pangs

There will be substantial communication for this class via email. I will be using the registrar's blast email so you will need to check your UVM email address regularly. Some of your assignments will be due electronically so email is a must.

Course Goals

We have structured both the classroom and field portions of this course to give you the best chance of achieving the following broader goals by the end of the class.

- Understand and be able to interpret the landscape of Vermont in which you live in terms of both geologic history and surface process,

- Predict how a landscape will respond to both human and natural perturbations,
- Improve your ability to read, understand, and discuss scientific and popular literature relevant to the topics and places we study,
- Improve your ability to do, document, and present independent and original scientific research,
- Experience the power of peer review and revision in the production of high quality scientific reports and presentations,
- Learn and be able to explain the important topics and tools of Geomorphology as a field of study,
- Master data collection techniques with wide application including surveying and GPS,
- Increase you ability and comfort with quantitative calculations,
- Improve your ability to collect quantitative and qualitative field data in adverse conditions,
- Recognize the value of simple models to represent physical systems and apply such models to data we collect or situations we observe,
- Improve your ability to reduce field data and write meaningful summaries of your observations,
- Begin to understand linkages between processes active at Earth's surface with processes in the deep Earth.

Early in the class, we will ask you to take a *knowledge survey*. This is a battery of over 100 questions about Earth's surface. You can also think of the *knowledge survey* as a list of specific learning goals for the class. You won't need to answer these questions to take the survey; rather, you will be self-assessing your ability to answer each question. Once you have taken the knowledge survey, we will give you a copy that will function both as a class outline and as a study guide for you. As you approach the first hour exam, you should be able review the first half of the knowledge survey and feel confident about answering the questions. If you can't answer all the questions, then it's time to start talking with your classmates and see Luke and Paul until you feel confident that you know the answer to every question.

Grading

Fieldtrip reports and lab exercises (drop lowest or missed lab)	35%
on-line modules (participation)	5%
first and second hour exams (each)	30%
project	15%
reading questions	10%
attendance and effort	5%
beginning and final survey	+1% extra credit each

Luke will be grading your laboratory assignments. On-line modules (*Learning Landscapes* and reading quizzes) will be tracked automatically. I will grade your projects. Luke and I will grade your hour exams, project presentations, attendance, and effort together.

Hour exams will not be cumulative. They will draw from the lectures, the readings, and the laboratory and field exercises. Any question posed on the knowledge survey will be fair game for the hour exams. Indeed, testing yourself against the knowledge survey questions will be the best way to study.

GEOMORPHOLOGY (GEOL 151) -- Class Plan with Learning Goals, Fall 2005

DUE Monday	Date	Monday Class CL = use computer lab	DUE Wednesday (+LAB FROM PREVIOUS WEEK)	Date	Wednesday Class	Specific skills and knowledge gains	Broader learning goals
nothing	29-Aug (CL)	**Introductory class**; we will fill out consent forms as well as complete knowledge and attitude surveys after a brief introduction to the class structure and content.	**Review** http://geology.asu.edu/~sreynolds/topo_gallery/intro_title.htm **Review** http://www.maptools.com/UsingUTM/index.html **Review** http://www.maptools.com/FreeTools http://trimble.com/gps/ **Review** http://maps.google.com/	31-Aug (CL)	**Geolocating techniques lab** - We will use maps, GPS, and walking tour through the gully behind Delehanty Hall and on to the Winooski River as an introduction to the local river landscape and to GPS mapping skills. We will pass landslides, core trees, see a retention pond, use old megaslide images to see change over time and walk back up to campus via the river overlook. We will consider how this landscape has changed over time from 14,000 years ago until today.	By the end of this week, you should be able to use GPS to map locations in field, plot GPS-derived locations on a topographic map, read a topographic map, measure distance on map, measure distance with GPS, be familiar with operation of a Garmin 12, be able to plot, read, and use UTM coordinates to calculate a distance between two points.	By the end of this week, you should understand how GPS technology works, understand map plotting and coordinate systems, see a local example of the slope/stream/river continuum, become aware that landscapes change over time, be able to explain several ways that people influence landscapes and landscapes influence people, and recognize how images can be used as a data source for understanding landscape process, pattern and history.
nothing	5-Sep	**No Class - Labor Day**	**Do** Learning Landscapes, module 1, Why rivers? **Read** *Demands and Disposal*, p. 167-174, from *Water, Rivers, and Creeks*, Leopold **Read** *A River*, from *Encounters with the Archdruid*, McPhee	7-Sep	**Putting rivers in a human context** - We will see both a hydroelectric plant and sewage treatment plant. We will take a tour of these facilities in order to learn how they work and how they effect the river.	By the end of this week, you should begin to be able to parse photographic images and understand their landscape content, begin to be familiar with the *Learning Landscapes* web site, understand how both hydroelectric and sewage treatment plants work, and understand the specific and more general effects of these types of plants on rivers beyond the borders of Vermont.	By the end of this week, you should understand the spectrum of uses of rivers, begin to understand concepts of energy and mass transfer into and out of rivers as well as human impact on river systems.
Do Learning Landscapes, module 2, *Shapes*	12-Sep	**River morphology and process class;** we will review the most important elements of river taxonomy, consider the graded profile and examine the germane processes that control the shape of river channels. We will consider the impact of floods and tectonic setting on river channels.	**Read** *Streams and Drainage Systems* in *The Dynamic Earth*, Skinner and Porter, p. 217-239.	14-Sep	**Winooski River float trip** - We will be floating the Winooski River in canoes in order to practice identifying fluvial forms and processes. We will be mapping the location of these forms and our route using GPS.	By the end of this week, you should be able to recognize important fluvial landforms in photographs and in the field and use GPS to plot their locations on a map. You should be able to recognize evidence for past changes in river discharge and stage as well as current and past uses of rivers. You should be able to identify human modification to a river and river corridor as well as the impacts of one river on human constructs.	By the end of this week, you should be able to understand spatial relationships between different fluvial landforms in the field, tell simple landscape history stories based on observing field evidence, have a better local sense of place, and a sense of how the Winooski River functions as a link between land and lake. You should understand that rivers are dynamic and change over time leaving evidence of past behavior.
Do Learning Landscapes, module 3, *Conveyors*	19-Sep (CL)	**Fluxes of water, sediment, and elements**; we will prepare for lab by introducing the instrumentation we will be using as well as the type of calculations we will be making. We will set our measurements in context by examining flux data from other watersheds.	**Read** *A Manual of Field Hydrology*, Sanders, p. 49-74	21-Sep	**River monitoring lab** - We will visit the Huntington River in order to learn how to characterize the channel and measure the discharge of water, sediment and dissolved constituents.	By the end of the week, you should know how to use an auto level and tape to measure a channel cross-section as well as a flow meter to measure velocity. Using both field and lab data, you should be able to make a discharge calculation for water, suspended sediment, and dissolved load as well as be facile with Manning's equation including the ability to calculate a roughness value. You should be able to identify bankful stage in the field and find evidence of the height to which water rose in past floods.	By the end of the week, you should understand the concepts of flux (for water, sediment, and dissolved load), dimensional analysis, velocity and discharge. You should begin to feel more comfortable with the idea of using simple mathematical models to represent complex natural systems. You should be able to recognize and explain spatial variability of water flow patterns in the field.
Do Learning Landscapes, module 4, *Interactions*	26-Sep	**River interactions;** rivers interact with the solid earth, the atmosphere, the biosphere and human civilization. We'll examine the most important of these interactions including both descriptive features (such as the hydrograph) and the generation of floods in a variety of ways.	**Read** *Atchafalaya*, from Control of Nature, *McPhee* **Read**, *Unearthing New Truths*, Christopher	28-Sep	**River interaction lab** - We will visit a now-abandoned dam site and observe the sediments left in the mill pond. We'll use a variety of techniques to estimate the volume of these materials. We will then examine the stream looking for evidence of more natural means of sediment retention, such as damming by large wood debris.	By the end of the week, you should be able to identify abandoned mill dams in the field and recognize the sediments such dams trap in their ponds. You should be able to recognize woody debris in a stream and know its physical and ecological functions. You should be able to map the extent of a river sediment deposit and estimate its volume.	By the end of the week, you should be able to explain both the immediate and delayed response of a river to damming as well as understand importance of biotic/abiotic interactions in controlling river behavior.

GEOMORPHOLOGY (GEOL 151) -- Class Plan with Learning Goals, Fall 2005

DUE Monday	Date	Monday Class	DUE Wednesday (+LAB FROM PREVIOUS WEEK)	Date	Wednesday Class	Specific skills and knowledge gains	Broader learning goals
		CL = use computer lab					
Do Learning Landscapes, module 5, *Changes*	3-Oct	**Rivers through time**; rivers are dynamic systems that change over time. We'll examine some of these changes and how we as geologists detect them by a variety of direct and indirect dating techniques, including soil development and radiometric dating (14-C and 10-Be). We will explain how soils form and fundamentals of describing soils in the field.	**Read** *Soils and Soil formation*, in *Geology,* Chernicoff **Read,** *Henry's Land*, from *The Earth Around Us*, Bierman	5-Oct	**Terrace and soils lab** - We will work on terraces (paleo-floodplains) of the Huntington River. On each terrace, we will dig and describe a soil pit. We will use the soils to help us learn about time. We will use the stratigraphy exposed in the pits to tell us more about the environment in which the river deposited the sediment we see.	By the end of the week, you should be able to make a basic description of a soil pit including delineating horizons and describing soil textures and colors. You should be able to recognize river terraces in the field, use GPS to map locations in field, and use differential GPS to map elevations in the field with high precision.	By the end of the week, you should be able to understand and describe soil-forming processes, understand what a soil chronosequence is and why it is important, and be able to explain how differential GPS works. You should be able to create a river landscape history based on what you see in a series of soil pits dug on terraces.
nothing	10-Oct	**First hour exam**;	**Do** image description module **Read** *Old images record landscape change through time,* GSA Today, April 2005, Bierman and others,	12-Oct (CL)	**Image analysis workshop** - We will be teaming with graduate students from UVM's historical preservation program for this afternoon and will be working together to refine our image description and interpretation skills. Be prepared to teach historians what you know about rivers and be prepared to learn a lot about the cultural landscape from the historians. Later today, we will introduce the final project, an effort that is designed to help you synthesize what you have learned and improve your public presentation skills.	By the end of the week, you should be able to accurately parse images, describing past and present landscape features and processes. You should be able to begin to date images using cultural clues and should be able to recognize major types of bridges and architecture related to river landscapes. You should understand how and why these particular types of structures, that make up the built environment, were developed in response to river processes.	By the end of this week, you should be able to read a landscape history (both natural and cultural) from both imagery and in the field. You should be able to find clues about how that landscape has changed over time, how people have interacted with the landscape, and how the river landscape will affect people and their constructs in the future.
nothing	17-Oct	**NO CLASS**, GSA - project time	none	19-Oct	**NO CLASS**, GSA - project time	By the end of this week, you should have completed your independent field work, relocated the original image site, done rephotography, and begun your historical research.	By the end of this week, you should have begun collating a diverse body of information into coherent history of the landscape you choose. You should understand the germane processes (both natural and cultural) that shaped that landscape.
Use as a resource: http://landslides.usgs.gov/ **Submit** initial project data	24-Oct	**Hillslopes - erosion: slides and flows;** we will examine the means and rates at which hillslopes erode shedding sediment. We will consider relevant physical processes on a variety of time and spatial scales.	**Read** *LA against the mountains* from *Control of Nature*, McPhee	26-Oct	**Investigating landslides and erosion** - We will visit two local mass movements, Townline Brook and the landslide/debris track behind the former Riverside Glass building. At each, we will examine the geometry of the failure, the material that failed, and the means by which material is removed from the eroding area so as to allow future erosion. We may visit the Stowe gully?	By the end of this week, you should be able to predict the places where hillslopes are most likely to erode, how rates of hillslope erosion are measured, and the processes by which slopes erode. In the field, you should be able to identify the location of active and past landslides as well as describe the geologic materials that are failing. You should be able to describe the processes by which material is removed from the eroding areas.	By the end of this week, you should be able to explain the interactions between earth materials and landscape form that drive erosion. You should be able to link physical processes to specific landscape shapes that you see in the field and estimate the erosion hazard for a landscape based on field observations.
View great simulations: http://walrus.wr.usgs.gov/elnino/landslides-sfbay/photos.html#noborders	31-Oct	**Hillslopes - simple mathematical models of a complex reality;** we will develop from the underlying physics, several analytical models used to describe the stability (or instability) of Earth materials perhaps using some in class demonstrations.	**Read** *Landslides and mass wasting* in *Geology and the Environment*, Pipkin, p.158-187.	2-Nov CL	**Slope stability model construction and sensitivity analysis lab** - We will build a simple slope stability model in Excel then move on to testing more elaborate models for their sensitivity to changing field conditions of slope, water table, and material properties.	By the end of this week, you should understand the simple mathematical equations describing slope stability and be able to translate these equations into a model run on Excel. You should be able to perform and understand a sensitivity analysis of such a model. The importance of water, in terms of head (water level in the soil) should be clear to you.	By the end of the week, you should understand how a simple physical model can be used to understand better a complex natural system. Using sensitivity analysis, you should understand how such models can be applied to understanding specific field situations and the response of landscapes to either human or natural perturbations.

GEOMORPHOLOGY (GEOL 151) -- Class Plan with Learning Goals, Fall 2005

DUE Monday	Date	Monday Class	DUE Wednesday (+LAB FROM PREVIOUS WEEK)	Date	Wednesday Class	Specific skills and knowledge gains	Broader learning goals
		CL = use computer lab					
Use as a resource: http://www2.nature.nps.gov/views/KCs/Glaciers/HTML/01_Intro.htm	7-Nov	**Glaciers - climate change and history;** we will examine the last several million years of changing climate concentrating on the record of glaciers as they came and went across North America.	**Read** *Pleistocene Mountain Glaciation*, Wagner, *GSAB,* August 1970. **Read** Loso and others, *Composition, morphology and genesis of a moraine-like feature in the Miller Brook Valley, Vermont* in *Northeastern Geology and Environmental Science*, 1998.	9-Nov	**Examining glacial deposits trip** - We will examine a series of glacial deposits and effects including striated rock, till, outwash, and deltaic material. If snow conditions permit, we will visit an area thought by some to be an alpine glacial deposit.	By the end of this week, you should be able to recognize glacially deposited sediments in the field, be able to tell the late Pleistocene history of New England, recognize striated rock, measure the orientation of striations, and infer the flow direction of now-vanished glacial ice.	By the end of this week, you should understand that Earth's climate changes over time triggering a response on Earth's surface; recognize that sediments and landforms are relict and reflect conditions/processes no longer active; deduce landscape history from fragmentary evidence; argue your point of view based on geologic field evidence and reading of scientific literature.
Use as a resource: http://nsidc.org/glaciers/	14-Nov	**Glaciers - physical behavior;** we will examine the physical behavior of glaciers in terms of accumulation, ablation, and flow. We will investigate the material properties of ice and the simple equations used to describe its behavior.	**Read** *Glaciers and Glaciation*, in Skinner and Porter, *The Dynamic Earth*, p. 263-287.	16-Nov CL	**Modeling glacier behavior lab** - We will use simple mathematical models to recreate the Laurentide ice sheet and topographic map data to determine the dynamics of now-vanished cirque glaciers.	By the end of this week, you should be recognize cirques and moraines on maps and in air photographs. Using these data and your knowledge of glacier behavior, you should calculate climate-sensitive parameters for now-vanished ice as well as model ice sheet profiles.	By the end of this week, you should understand that the behavior and climate sensitivity of complex ice sheets can be modeled by simple equations based on physical parameters. Using map/and or field evidence, you should be able to recreate plausible versions of former ice masses.
nothing	21-Nov	**Second hour exam**	nothing	23-Nov	NO CLASS - Thanksgiving Holiday	NA	NA
Use as a resource: http://vulcan.wr.usgs.gov/	28-Nov	**Endogenic forcing - volcanoes and tectonics;** we will examine how Earth's internal heat engine forces surface processes on a variety of scales, most of them larger than the landscapes we live in.	**Read** *Heimey* from *Control of Nature*, McPhee **Bring** 5 copies of your completed 11x17 poster draft to class	30-Nov	**World mapping exercise** - We will finish the course at the large scale, analyzing remote sensed images and identifying germane patterns and processes of the landscape.	By the end of this week, you should be able to recognize major volcanic and tectonic landforms as well as describe the near-surface processes that form them. You should be able to relate volcanic landforms and products to magma composition and attendant process. Similarly, you should recognize the landscapes common to each of the three major plate tectonic boundaries.	By the end of this week, you should understand how endogenic processes shape the large scale morphology of Earth's surface. You should be able to explain tectonic and volcanic controls on surface processes and resulting landforms.
Submit via webct final PowerPoint printing file for poster	5-Dec	**Feedback** - this period will be dedicated to understanding how the class worked for you and ways to improve it in the future	**Get ready** to explain your poster **Prepare** potluck lunch offering	7-Dec	**Public poster session** - We will gather as a group to present, discuss, critique and celebrate the work you have done over the semester. You will have a chance both the present your work and to inquire of others when they are presenting.	By the end of this week, you should know what it takes to prepare and present a professional poster to your peers for critique. You will gain experience in layout, text writing, and graphics development. You will critique the work of others.	By the end of this week, you will be able to pull together various bits of knowledge and, extracting those which are of importance to others, create a coherent scientific and cultural analysis of a landscape over time.

version 1, 8/31/05