

Geology 354 GLACIAL AND QUATERNARY GEOLOGY Autumn, 2015

[Class Meets M-W-F at 10:00 a.m. in Mudd 103; Labs are 1:00-4:00 p.m. Wednesdays, same room]

Instructor: Prof. Robert E. Nelson
("Dr. Bob")

Basic Text: *Glacial Geology: Ice Sheets and Landforms (2nd Ed.)*
by Bennett & Glasser (B&G)

Office: Mudd 215 (phone ext. 5804)
e-mail: renelson@colby.edu

Office hours: general open-door policy
and by appointment

TENTATIVE CLASS SCHEDULE

Date	Subject(s)	Reading(s); (B&G)=Text
9 September	Introductory remarks	Introduction, <i>incl.</i> Boxes 1.1 & 1.2 (B&G)
	LAB: Video: Chasing Ice, followed by a glacial stroll around campus	
11	Video: Cracking the Ice Age (NOVA)	
14	History of glacial geology; possible causes for late Cenozoic glaciation	Papers by Raymo <i>et al.</i> (2006) and Wortmann & Paytan (2012)
16	Making a glacier; glacial distribution	Chap. 2 (B&G)
	LAB: modern glaciers	
18	Glacier hydrology, mass balance, and flow	Chap. 3 (B&G)
21	Glaciology (cont.)	Chap. 4 (B&G)
23	Glaciology (cont.)	paper by Kamb <i>et al.</i> (1985)
	LAB: field trip to Horse Point (Belgrade) and Smithfield	
25	Glacial erosion	Chap. 5 (B&G)
27 September →	SUNDAY field trip to Cherryfield (Washington County) READ Borns and Hughes (1977) and Kaplan (2007)	
28	Glacial erosional features	Chap. 6 (B&G)
30	Glacial debris transport	Chap. 7 (B&G)
	LAB: No lab – to compensate for Sunday field trip	
2 October	Glacial deposits and landforms	Chap. 8, to p. 235 (B&G)
5	Glacial deposits and landforms (cont.)	Chap 9 (B&G) and papers by Bothner and Spiker (1980) and by Hughes <i>et al.</i> (1977)
7	Glaciofluvial deposits and processes	Chap. 8, p. 235-end (B&G)
9	Glaciofluvial deposits	paper by Weddle (1992)
	LAB: Field trip to Summerhaven (Sidney/Manchester/Augusta)	
12 *****	NO CLASS – FALL SEMESTER BREAK *****	
14	Glaciolacustrine processes and sediments	Chap. 10, to p. 315 (B&G)
	LAB: Field trip to New Sharon	
16 *****	Mid-Term Exam *****	
19	Glaciomarine deposits – fjords	Chap. 10, p. 315-end (B&G); and papers by Folger <i>et al.</i> (1972) and Pettigrew <i>et al.</i> (1997)
21	Glaciomarine and glaciomarine landforms	Chap. 11 (B&G)
	LAB: Field Trip to Norridgewock, Bingham and Moscow	
23	Glaciomarine deposits in the open sea (cont.)	papers by Domack and Domack (1991) and by Bond and Lotti (1995)
26	Late Cenozoic Climates	Paper by Mayewski <i>et al.</i> (1994)
28	Late Cenozoic Climates (cont.)	Paper by Melles <i>et al.</i> (2012)
	LAB: Field Trip to Norridgewock Sand Plain & Martin Stream READ paper by Nelson <i>et al.</i> (ms.)	

30	Glacial History of Maine	Papers by Little (1917), Borns and Hagar (1965) and by Stuiver and Borns (1975)
2 November	Glacial History of Maine (cont.)	Papers by Davis (1989) and by Balco <i>et al.</i> (1998)
4	Glacial History of Maine (cont.)	Papers by Lowell (1989), Davis (1999), Kaplan (2007) and Thompson <i>et al.</i> (2011)
	LAB: Alpine Glaciation in Air Photos and Topographic Maps	
6	Postglacial environmental change	Papers by Dyke (2005) and Ridge <i>et al.</i> (2012)
9	Postglacial environmental change in the Northeast	Papers by Anderson <i>et al.</i> (1990) and Faison <i>et al.</i> (2006)
11	Postglacial environmental change (cont.)	Papers by Russell and Davis (2001) and Sanderson and Brown (2007)
	LAB: Continental Glacial Deposits in Maps and Air Photos	
13	Postglacial environmental change (cont.)	Paper by Nelson <i>et al.</i> (2010)
16	Postglacial marine environmental change	Papers by Wanamaker <i>et al.</i> (2011a and 2011b)
18	Proglacial and periglacial environments	Washburn (1980): Chaps. 1-3
	LAB: Continental Glacial Deposits and Depositional Margins	
20	Proglacial and periglacial environments (cont.)	
23	Proglacial and periglacial environments (cont.)	
25, 27	***** NO CLASS – THANKSGIVING HOLIDAY BREAK *****	
30	Pluvial Lakes of the American West	Papers by Smith and Street-Perrott (1983) and by Hostetler <i>et al.</i> (1994)
2 December	A Regional synthesis: Beringia	Paper by Hopkins (1982)
	LAB: Constructing a Glacial Chronology	
4	Modern environmental change	paper by Kutzbach <i>et al.</i> , 2011
7	Modern environmental change	paper by Ruddiman <i>et al.</i> , 2011
9	No class – please concentrate your efforts on your paper presentations	
	LAB: Paper Presentations	
11	Last odds and ends	

6:00 p.m., Wednesday, December 16th : FINAL EXAMINATION in MUDD 103

GRADING

Each lab will be worth 10 points, which should be a default value; they can be awarded fewer points if it becomes clear that the effort expended was minimal and sufficiently only to "get through" as opposed to understanding what is going on. (In general, the more I wind up writing on submitted labs, the fewer points will be found at the end.) Obviously, no lab for a week = 0/10; this applies as well to field trips. You're all advanced students, so attention on field trips is expected - I shouldn't have to pull you back from wandering about.

The mid-term exam will be worth 100 points. General format will be the same as that used in Geomorphology: five question sets of related questions, with you responding to the four of your choice. Each question set is therefore worth 25 points. All lecture material and ALL reading (text and external papers) will be included on the exam.

The **FINAL EXAM** will be worth 200 points, including 50 points of materials based on laboratories and field experiences. ALL materials from the semester will be fair game for the final exam - all lectures, all readings, all labs and field trips. This IS to be the final demonstration of what you've learned over the semester.

TERM PAPER: Each of you will be responsible for researching in depth some aspect of glacial geology that we will not be covering in class in the depth to which I will expect you to delve. This will be 150 points on your semester total. More about this in a specific handout.

*These additional papers will be placed on-line, when possible,
or on reserve in the Science Library (Olin).*

- Anderson, R. S., N. G. Miller, R. B. Davis, and R. E. Nelson, 1990: Terrestrial fossils within the marine Presumpscot Formation: Implications for Late Wisconsinan paleoenvironments and isostatic rebound along the coast of Maine. *Canadian Journal of Earth Sciences*, v. 27, p. 1241-1246.
- Balco, G., D. F. Belknap and J. T. Kelley, 1998. Glacioisostasy and lake-level change at Moosehead Lake, Maine. *Quaternary Research*, v. 49, p. 157-170.
- Bond, G. C., and R. Lotti, 1995. Iceberg discharged into the North Atlantic on millenium time scales during the last glaciation. *Science*, v. 267, p. 1005-1010.
- Borns, H. W., Jr., and D. J. Hagar, 1965. Late-glacial stratigraphy of a northern part of the Kennebec River Valley, western Maine. *Geological Society of America Bulletin*, v. 76, p. 1233-1250.
- Borns, H. W., Jr., and T. J. Hughes, 1977. The implications of the Pineo Ridge readvance in Maine. *Geographie physique et Quaternaire*, v. 31, p. 203-206.
- Bothner, M. H., and E. C. Spiker, 1980. Upper Wisconsinan till recovered on the continental shelf southeast of New England. *Science*, v. 210, p. 423-425 [24 October, 1980].
- Davis, P. T., 1989. Late Quaternary glacial history of Mt. Katahdin and the nunatak hypothesis, p. 119-134 in **Studies in Maine Geology, v. 6, Quaternary Geology** (R. D. Tucker and R. G. Marvinney, eds.); Augusta, Maine: Maine Geological Survey.
- Davis, P. T., 1999. Cirques of the Presidential Range, New Hampshire, and Surrounding Alpine Areas in the Northeastern United States. *Géographie physique et Quaternaire*, vol. 53, no. 1, p. 25-45.
- Domack, E. W., and C. R. Domack, 1991. Cenozoic Glaciation: The marine record established by ocean drilling. Washington, D.C.: Joint Oceanographic Institutions, Inc.; 49 p.
- Dyke, A. S., 2005: Late Quaternary Vegetation History of Northern North America Based on Pollen, Macrofossil, and Faunal Remains. *Géographie physique et Quaternaire*, v. 59, nos. 2-3, p. 211-262.
- Faison, E. K., D. R. Foster, W. W. Oswald, B. C. S. Hansen, and E. Doughty, 2006. Early Holocene Openlands in Southern New England. *Ecology*, v. 87, no. 10, pp. 2537-2547.
- Folger, D. W., R. H. Meade, B. F. Jones, and R. L. Cory, 1972. Sediments and waters of Somes Sound, a fjordlike estuary in Maine. *Limnology and Oceanography*, vol. 17, no.3, pp. 394-402
- Hopkins, D. M., 1982. Aspects of the Paleogeography of Beringia During the Late Pleistocene, p. 3-28 in **Paleoecology of Beringia** (D. M. Hopkins, J. V. Matthews, Jr., C. E. Schweger and S. B. Young, eds.); New York: Academic Press.
- Hostetler, S. W., F. Giorgi, G. T. Bates, and P. J. Bartlein, 1994. Lake-Atmosphere feedbacks associated with paleolakes Bonneville and Lahontan. *Science*, v. 263, p. 665-668.
- Hughes, T., G. H. Denton and M. G. Grosswald, 1977. Was there a late-Würm Arctic Ice Sheet? *Nature*, v. 266, p. 596-602 [14 April, 1977].
- Kamb, B., C. F. Raymond, W. D. Harrison, H. Engelhardt, K. A. Echelmeyer, N. Humphrey, M. M. Brugman and T. Pfeffer, 1985. Glacier surge mechanism: 1982-83 surge of Variegated Glacier, Alaska. *Science*, v. 227, p. 469-479 [1 February, 1985]
- Kaplan, M. R., 2007: Major ice sheet response in eastern New England to a cold North Atlantic region, ca. 16-15 cal ka BP. *Quaternary Research*, v. 68, p. 280-283.
- Kutzbach, J. E., S.J. Vavrus, W.F. Ruddiman and G. Philippon-Berthier, 2011: Comparisons of atmosphere-ocean simulations of greenhouse gas-induced climate change for pre-industrial and hypothetical 'no-anthropogenic' radiative forcing, relative to present day. *The Holocene*, v. 21, no. 5, p. 793-801.
- Little, H. P., 1917. Pleistocene and Post-Pleistocene Geology of Waterville, Maine. *Geological Society of America Bulletin*, v. 28, p. 309-322.
- Lowell, T. V., 1989. Late Wisconsin glacial geology of the eastern portion of Mount Desert Island, p. 103-133 in **Studies in Maine Geology, v. 6, Quaternary Geology** (R. D. Tucker and R. G. Marvinney, eds.); Augusta, Maine: Maine Geological Survey.

- Mayewski, P. A., L. D. Meeker, S. I. Whitlow, M. S. Twickler, M. C. Morrison, P. Bloomfield, G. C. Bond, R. B. Alley, A. J. Gow, P. A. Grootes, D. A. Meese, M. Ram, K. C. Taylor and W. Wumkes, 1994. Changes in Atmospheric Circulation and Ocean Ice Cover over the North Atlantic During the Last 41,000 Years. *Science*, vol. 263, Pages 1747-1751 (25 March, 1994).
- Melles, M., J. Brigham-Grette, P. S. Minyuk, N. R. Nowaczyk, V. Wennrich, R. M. DeConto, P. M. Anderson, A. A. Andreev, A. Coletti, T. L. Cook, E. Haltia-Hovi, M. Kukkonen, A. V. Lozhkin, P. Rosén, P. Tarasov, H. Vogel, and B. Wagner, 2012. 2.8 Million Years of Arctic Climate Change from Lake El'gygytgyn, NE Russia. *Science*, v. 337, p. 315-319. [20 July, 2012]
- Nelson, R. E., C. K. Clark, E. F. Littlefield and N. W. Krumdieck, 2010: Palynology of Three Bog Cores Shows Complex European Impact on the Forests of Central Maine. *Northeastern Naturalist*, v. 17, no. 1, p. 63-76.
- Nelson, R. E., N. W. Krumdieck, D. F. Belknap, and R. T. Meigs, n.d.: Isostatically Induced Fluvial Origin of the Norridgewock Sand Plain, Central Maine, USA. *ms. in prep.*
- Pettigrew, N. R., D. A. Kistner, G. P. Barbin, A. K. Laursen, D. W. Townsend and J. Christensen, 1997: Somes Sound: Fjord or well-mixed estuary? *Northeastern Naturalist*, v. 4, no. 1, p. 35-44.
- Raymo, M. E., L. E. Lisiecki and K. H. Nisancioglu, 2006: Plio-Pleistocene Ice Volume, Antarctic Climate, and the Global $d^{18}O$ Record. *Science*, v. 313, p. 492-495 [28 July, 2006]
- Ridge, John C., Greg Balco, Robert L. Bayless, Catherine C. Beck, Laura B. Carter, Jody L. Dean, Emily B. Voytek, and Jeremy H. Wei, 2012: The New North American Varve Chronology: A Precise Record of Southeastern Laurentide Ice Sheet Deglaciation And Climate, 18.2–12.5 Kyr Bp, and Correlations with Greenland Ice Core Records. *American Journal of Science*, v. 312, pp. 685–722.
- Ruddiman, W. F., J. E. Kutzbach, and S. J. Vavrus, 2011: Can natural or anthropogenic explanations of late-Holocene CO_2 and CH_4 increases be falsified? *The Holocene*, v. 21, no. 5, p. 865-879.
- Russell, E.W.B., and R. B. Davis. 2001. Five centuries of changing forest vegetation in the Northeastern United States. *Plant Ecology* 155:1–13.
- Sanderson, E.W., and M. Brown. 2007. Mannahatta: An ecological first look at the Manhattan landscape prior to Henry Hudson. *Northeastern Naturalist*, v. 14, no. 4, p. 571–588.
- Smith, G. I., and F. A. Street-Perrott, 1983. Pluvial lakes of the Western United States, p. 190-212 in **Late Quaternary Environments of the United States, Vol. 1, The Late Pleistocene** (S. C. Porter, ed.); Minneapolis: University of Minnesota Press.
- Stuiver, M., and H. W. Borns, Jr., 1975. Late Quaternary marine invasion in Maine: its chronology and associated crustal movement. *Geological Society of America Bulletin*, v. 86, p. 99-104.
- Thompson, W. B., C. B. Griggs, N. G. Miller, R. E. Nelson, T. K. Weddle, and T. M. Kilian, 2011: Associated Terrestrial and Marine Fossils in the Late-Glacial Presumpscot Formation, Southern Maine, U.S.A., and the Marine Reservoir Effect on Radiocarbon Ages. *Quaternary Research*, v. 75, p. 552-565.
- Wanamaker, A. D., Jr., S. Hetzinger and J. Halfar, 2011a: Reconstructing mid- to high-latitude marine climate and ocean variability using bivalves, coralline algae, and marine sediment cores from the Northern Hemisphere. *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 302, p. 1-9.
- Wanamaker, A. D., Jr., K. Kreutz, B. Schöne, and D. Introne, 2011b. Gulf of Maine shells reveal changes in seawater temperature seasonality during the Medieval Climate Anomaly and the Little Ice Age. *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 302, p. 43-51.
- Washburn, A. L., 1980. Geocryology (New York: John Wiley & Sons, Inc.); 406 p. [Read chapters 1-3; skim remainder of book, paying particular attention to the illustrations.]
- Weddle, Thomas K., 1992. Late Wisconsinan stratigraphy in the lower Sandy River valley, New Sharon, Maine. *Geological Society of America Bulletin*, v. 104, p. 1350-1363.
- Wortmann, U. G., and A. Paytan, 2012. Rapid variability of seawater chemistry over the past 130 million years. *Science*, v. 337, p. 334-336. (20 July, 2012)