

**GLACIAL GEOLOGY 51-335/535
FALL SEMESTER, 2009**

- COURSE OBJECTIVES:**
1. To understand glacier processes including: formation and deformation of ice; response to climatic change; glacial flow regimes and basal sliding; glacial deposition, erosion, and associated land-forming processes; glacier temperature, meltwater production, and meltwater circulation.
 2. To recognize and interpret various glacial sediments and facies associations.
 3. To recognize and interpret glacial landforms.
 4. To understand glacial and non-glacial evidence for Quaternary environmental change.
 5. To integrate what you have learned and, as a liberally educated person, to understand implications of glacial geology and climate change for societal issues such as land use and energy policy.
- INSTRUCTOR:** Dr. William N. Mode **OFFICE:** Harrington 214 **WEB PAGE:**
http://www.uwosh.edu/faculty_staff/mode/
- TELEPHONE:** 424-4460
- OFFICE HOURS:** 9:10 - 10:10 a.m., M, W, F; 10:20 to 11:20 a.m., T, Th; or by appointment or chance.
- REQUIRED TEXTS:** *Glaciers and Glaciation*, D. I. Benn and D. J. A. Evans
Quaternary Environments, 2nd ed., M. Williams, D. Dunkerley, P. De Deckker, P. Kershaw, and J. Chappell
Glacial Geology Course Manual, 2009 edition, W. N. Mode
- RECOMMENDED TEXTS:** *The Glacial World According to Wally*, W. S. Broecker (**on reserve**)
Quaternary Geology, D. Q. Bowen (**on reserve**)
- HANDOUTS:** You should download and print handouts for lecture and bring them to class. They can be printed from the library's **E-Reserve** Web page (<http://eres.uwosh.edu/eres/>).
- MEETING HOURS:** Lecture: 8:00 to 9:00 a.m., Tuesday, Thursday
Laboratory: 9:10 a.m. to 10:10 a.m., Tuesday, Thursday
- ROOM:** Harrington 217
- FIELD TRIP:** The required field trip is Saturday, September 26. A quiz on the trip will be given in lab.
- EXAMS:** Three essay exams will be given: EXAM #1 - October 15
EXAM #2 - November 12
EXAM #3 - December 17
- RESEARCH PAPERS:** A 10-15 page research paper is required. It is due November 17. No extensions will be given. Paper scores will be reduced according to degree of lateness by 10 points per day. A list of topics and deadlines for outlines and drafts is contained in the *Course Manual*.
- GRADING:** One-sixth of the grade will be determined by each exam, one-sixth by laboratory quizzes and exercises, one-sixth by the course project, and one-sixth by the research paper. You must pass the three lecture exams (averaged), lab, the term paper, and the course project in order to receive a passing grade for the course.
- LABORATORY:** A laboratory schedule is included in the *Course Manual*.
- GRADUATE CREDIT:** Students enrolled for graduate credit (51-535) must meet with me to plan and then execute a laboratory or field research project.
- GRADE SCALE:** The grade scale will be no more rigorous than the following:
A 92% and up
AB 87 - 91

B 82 -86
BC 77 - 81
C 72 - 76
CD 67 - 71
D 60 - 66
F <60%

<u>WEEK</u>	<u>BEGINNING</u>	<u>TOPIC</u>	<u>READING ASSIGNMENTS</u>
1	Sept. 9	Introduction	Williams <i>et al.</i> , Chapter 1 (Quaternary Environments: An Introduction)
2	Sept. 14	Classical models of Quaternary glaciation and Glaciology	Williams <i>et al.</i> , Chapter 3 (Quaternary Glaciations: Extent and Chronology); Benn and Evans, p. 43-64 and Chapter 1 (Glacier Systems)
3	Sept. 21	Glaciology	Benn & Evans, Chapters 2 (Snow, Ice, and Climate), 4 (Glacier Motion), and p. 212-216.
4	Sept. 28	Glacial erosion	Benn & Evans, Chapters 5 (Subglacial Processes) and 9 (Erosional Forms and Landscapes)
5	Oct. 5	Glacial Meltwater; END Unit 1	Benn & Evans, and Chapter, 3 (Glaciers and Meltwater)
6	Oct. 12	Ice-Contact Environments; EXAM 1 , Thursday, October 15 covers topics of Weeks 1 through 5	Benn & Evans, Chapter 6 (Supraglacial and Englacial Environments)
7	Oct. 19	Ice-Contact Environments	Benn & Evans, Chapter 7 (Terrestrial Ice-marginal Environments)
8	Oct. 26	Glacial sediments	Benn & Evans, Chapter 10 (Sediment Facies)
9	Nov. 2	Sedimentary Facies and Landforms	Benn & Evans, Chapter 11 (Sediment-Landform Associations)
10	Nov. 9	Sedimentary Facies and Landforms; END Unit 2; EXAM 2 , Thursday, November 12 covers topics since Exam 1 (Weeks 6 through 10).	Benn & Evans, Chapter 11 (Sediment-Landform Associations)
11	Nov. 16	Marine systems	Williams <i>et al.</i> , Chapter 6 (Quaternary Sea-level Changes)
12	Nov. 23	Marine systems	Williams <i>et al.</i> , Chapter 7 (Evidence from the Oceans)
13	Nov. 30	Glaciation	Williams <i>et al.</i> , Chapters 5 (The Milankovitch Hypothesis and Quaternary Environments) and 4 (Quaternary Glaciations: Causes and Feedback Mechanisms)
14	Dec. 7	Nonglacial Environments and Fossils	Williams <i>et al.</i> , p. 152-153 (floods), p. 158-169 (lakes), and p. 182-184 (wind); Williams <i>et al.</i> , Chapter 10 (Evidence from Terrestrial Flora and Fauna)
15	Dec. 14	Geochronology; EXAM 3 on Thursday, December 17 covers all topics since Exam 2 (Weeks 11 through 15).	Williams <i>et al.</i> , Appendix: Dating Methods in Quaternary Research

SELECTED BASIC REFERENCES

- Andersen, B. G., and Borns, Jr., H. W., 1994, The ice age world: Oslo, Norway, Scandianian University Press, 208 p.
- Andrews, J. T., 1970, Glacial systems: Belmont, California, Wadsworth, 191 p.
- Ashley, G. M., Shaw, John, and Smith, N. D., 1985, Glacial sedimentary environments: Tulsa, Oklahoma, Society of Economic Paleontologists and Mineralogists, Short Course No. 16, 246 p.
- Benn, D. I., and Evans, D. J. A., 1998, Glaciers and glaciation: New York, New York, Wiley, 734 p.
- Bennett, M. R., and Glasser, N. F., 1996, Glacial geology: ice sheets and landforms: New York, New York, Wiley, 364 p.
- Bowen, D. Q., 1978, Quaternary geology: New York, New York, Pergamon, 221 p.
- Bradley, R. S., 1999, Paleoclimatology: reconstructing climates of the Quaternary (2nd edition): San Diego, California, Academic Press, 613 p.
- Brodzikowski, K. and van Loon, A. J., 1991, Glacigenic sediments: Amsterdam, Netherlands, Elsevier, 674 p.
- Cronin, T. M., 1999, Principles of paleoclimatology: New York, New York, Columbia University Press, 560 p.
- Dawson, A. G., 1992, Ice age earth: late Quaternary geology and climate: London, U.K., Routledge, 293 p.
- Denton, G. A. and Hughes, T. J., 1981, The last great ice sheets: New York, New York, Wiley, 484 p.
- Drewry, D., 1986, Glacial geologic processes: Baltimore, Maryland, Edward Arnold, 276 p.
- Ehlers, J., 1996, Quaternary and glacial geology: Chichester, U.K., John Wiley and Sons, 578 p.
- , and Gibbard, P. L., (eds.), 2004, Quaternary glaciations, extent and chronology, part II: North America: Elsevier, Netherlands, Developments in Quaternary Science 2, Rose, J., Series editor, 440 p.
- Elias, S. A., (ed.), 2006, Encyclopedia of Quaternary science (four volumes): Netherlands, Elsevier.
- Embleton, C., and King, C. A. M., 1975, Glacial geomorphology: New York, New York, Wiley, 573 p.
- Evans, D. J. A., (ed.), 2003, Glacial landsystems: London, England, Arnold, 532 p.
- Eyles, N. (ed.), 1983, Glacial geology, an introduction for engineers and earth scientists: London, England, Pergamon, 409 p.
- Fairbridge, R. W., (ed.), 1968, The encyclopedia of geomorphology: New York, New York, Rheinhold, 1295 p.
- Flint, R. F., 1971, Glacial and Quaternary geology: New York, New York, Wiley, 892 p.
- Frenzel, B., 1983, Climatic fluctuations of the Ice Age: Cleveland, Ohio, Case Western, 306 p.
- Gillespie, A. R., Porter, S. C., and Atwater, B. F., (eds.), 2004, The Quaternary Period in the United States: Elsevier, Netherlands, Developments in Quaternary Science 1, Rose, J., Series editor, 583 p.

- Goldthwait, R. P., (ed.), 1971, *Till: a symposium*: Columbus, Ohio, Ohio State University Press, 402 p.
- , 1975, *Glacial deposits*: Stroudsburg, Pennsylvania, Dowden, Hutchinson, and Ross, 464 p.
- Hambrey, M., 1994, *Glacial environments*: Vancouver, Canada, University of British Columbia Press, 296 p.
- , and Alean, J., 1992, *Glaciers*: Cambridge, U.K., Cambridge University Press, 208 p.
- Hooke, R. LeB., 1998, *Principles of glacier mechanics*: Upper Saddle River, New Jersey, Prentice Hall, 248 p.
- Jopling, A. V., and McDonald, B. C., (eds.), 1975, *Glaciofluvial and glaciolacustrine sedimentation*: Tulsa, Oklahoma, Society of Economic Paleontologists and Mineralogists, Special Publication No. 23, Tulsa, Oklahoma, 320 p.
- Knight, P. G., 1999, *Glaciers*: London, U.K., Stanley Thornes, 272 p.
- , (ed.), 2006, *Glacier science and environmental change*: Malden, Massachusetts, Blackwell Publishing, 527 p.
- Lamb, H. H., 1977, *Climate: present, past and future, v. 2*: London, England, Methuen, 835 p.
- Lowe, J. J., and Walker, M. J. C., 1984, *Reconstructing Quaternary environments*: New York, New York, Longman, 389 p.
- Martini, I. P., Brookfield, M. E., and Sadura, S., 2001, *Principles of glacial geomorphology and geology*: Upper Saddle River, New Jersey, Prentice-Hall, 381 p.
- Menzies, J., (ed.), 1995, *Modern glacial environments: processes, dynamics and sediments*: Oxford, U.K., Butterworth-Heinemann, 621 p.
- , (ed.), *Past glacial environments: sediments, forms and techniques*: Oxford, U.K., Butterworth-Heinemann, 598 p.
- , (ed.), *Modern and past glacial environments*: Oxford, U.K., Butterworth-Heinemann, 543 p.
- Molnia, B. F., (ed.), 1983, *Glacial-marine sedimentation*: New York, New York, Plenum, 844 p.
- Nesje, A., and Dahl, S. O., 2000, *Glaciers and environmental change*: London, U.K., Arnold, 203 p.
- Nilsson, T., 1983, *The Pleistocene*: Dordrecht, Holland, D. Reidel, 651 p.
- Patterson, W. S. B., 1994, *The physics of glaciers (3rd ed.)*: Oxford, U.K., Pergamon/Elsevier Science, 480 p.
- Porter, S. C., (ed.), 1983, *Late-Quaternary environments of the United States, volume 1, the Late Pleistocene*: Minneapolis, Minnesota, University of Minnesota Press, 407 p.
- Price, R. J., 1973, *Glacial and fluvioglacial landforms*: Edinburgh, Scotland, Oliver and Boyd, 242 p.
- Ruddiman, W. F., 2000, *Earth's climate: past and future*: San Francisco, California, Freeman.
- , and Wright, H.E., Jr., (eds.), 1987, *North America and adjacent oceans during the last deglaciation*: Boulder, Colorado, Geological Society of America, *The Geology of North America*, v. K-3, 501 p.
- Sharp, R. P., 1988, *Living ice: understanding glaciers and glaciation*: Cambridge, U.K., Cambridge University Press,

225 p.

- Sibrava, V., Bowen, D. Q., and Richmond, G. M., (eds.), 1986, Quaternary glaciations in the northern hemisphere: Quaternary Science Reviews, v. 5, 514 p.
- Siegert, M. J., 2001, Ice sheets and late Quaternary environmental change: New York, New York, Wiley, 231 p.
- Sugden, D. E. and John, B. S., 1976, Glaciers and landscape: New York, New York, Wiley, 376 p.
- Wagner, G. A., 1998, Age determination of young rocks and artifacts: Berlin, Springer-Verlag, 466 p.
- Walker, M., 2005, Quaternary dating methods: Chichester, England, John Wiley and Sons, 286 p.
- West, R. G., 1968, Pleistocene geology and biology with especial reference to the British Isles: London, England, Longman, 337 p.
- Williams, M., Dunkerley, D., De Deckker, P., Kerhsaw, P., and Chappell, J., 1998, Quaternary environments (2nd edition): New York, Oxford University Press, 329 p.
- Wright, H. E., Jr., (ed.), 1983, Late-Quaternary environments of the United States, volume 2, the Holocene: Minneapolis, Minnesota, University of Minnesota Press, 277 p.
- , and Frey, D. G. (eds.), 1965, The Quaternary of the United States: Princeton, New Jersey, Princeton University Press, 922 p.

JOURNALS CONTAINING ARTICLES ON GLACIAL AND QUATERNARY GEOLOGY

(Volumes held in Polk Library are indicated by year)

Annals of Glaciology (Cambridge, U.K.)
Arctic (Calgary) (1970-1974)
Arctic and Alpine Research (Boulder); now (since 1999) titled Arctic, Antarctic, and Alpine
Research
Boreas (Oslo)
Earth Surface Processes and Landforms (Chichester, U.K.)
Eiszeitalter und Gegenwart (Oehringen)
Geografiska Annaler (Stockholm) (1968 to date)
Géographie Physique et Quaternaire (Montreal)
Geomorphology (Kidlington, U.K.)
The Holocene (London)
Journal of Glaciology (Cambridge, U.K.) (1968 to date)
Journal of Quaternary Science (Harlow, U.K.)
Polarforschung (Muenster)
Radiocarbon (New Haven)
Quaternary International (Kidlington, U.K.)
Quaternary Research (Seattle) (1970 to 1986 and 1996 to date)
Quaternary Science Reviews (Oxford, U.K.)
Zeitschrift für Geomorphologie (Stuttgart)

General journals carrying numerous relevant papers

(all are currently held and have been for some time)

American Journal of Science (New Haven)
Canadian Journal of Earth Science (Ottawa)
Geological Society of America Bulletin (Boulder)
Geology (Boulder)
Journal of Geology (Chicago)
Nature (London)
Science (Washington, D. C.)

Specialty Abstracts and Indexes

Geographical Abstracts - Part A, Landforms and the Quaternary