Coastal Sedimentology MS 544

Marine Semester – 1st Block

Fall 2022

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Course Overview

Coastal Sedimentology is a course designed to teach Sedimentological concepts and processes so that students will be able to interpret present day and ancient coastal depositional environments and landforms. There will be occasional Zoom lectures, but learning will be primarily achieved through a variety of field activities and firsthand exposure to diverse physical processes and coastal settings, stretching from central Maine to Cape Cod. The highly variable nature of the New England coast and Eastern Seaboard, in terms of bedrock and glacial histories, sediment supply, tidal range, wave energy, sea-level trends, storm exposures, and coastal landforms, make this an ideal region in which to study Sedimentology. The principles learned in this course can be

applied directly to many other non-marine depositional environments. Finally, global warming and the attendant accelerating sea-level rise and increased storminess are preferentially impacting the coastal zone causing frequent flooding, wide scale erosion and shoreline recession, and storm-induce damage and loss of infrastructure. The information gained in this course will aid the student's ability to make informed decisions about managing coastal resources and the expenditure of taxpayer funds.

Through this course, students will:

- Gain an understanding of physical processes, resulting in the erosion, transportation, and deposition of sediment. Determination of where the sediment comes from.

- Learn about the major processes operating in different depositional environments and the physical, biological, geochemical signatures that define these environments.

- Participate in the acquisition of sedimentological data using Ground Penetrating Radar, Vibra-coring equipment, Ponar grab-sampling, water sampling using Niskin bottles, Real Time Kinematics, current meters, Optical backscatter instrument, tide gages, GPS, etc.

- Produce generalized areal sedimentologic-geomorphic maps and stratigraphic sequences that characterize different coastal depositional environments.

- Learn how coastal systems are being impacted by global warming, sea-level rise, and increased storminess, as well as human development.

- Gain an appreciation of the interrelationships among different components of broad coastal systems such as how sand reservoirs comprising barrier islands, tidal deltas, backbarrier are controlled by tidal prism.

- Define how coastal sedimentological science can produce a better understanding of threats of global warming along coasts and what the socioeconomic consequences are.

- Learn how anthropogenic features (jetties, groins, seawalls, etc.) and practices (dredging, beach nourishment, thin layer deposition, poldering, etc.) affect sedimentolgical processes and erosional-depositional trends.

- Improved field, lab, written and oral communication skills.

Grading:

Performance in the field	10 points
Field and Laboratory exercises	90 points
Total:	100 points

Because of the unique nature of the Marine Semester where each day represents about one week in a traditional semester, students who miss" three or more "days of class will miss significant course content and will be encouraged to consider withdrawing from the course.

Prerequisites

Admission to the Marine Semester, Introductory Earth Science course, Oceanography, or Consent of Instructor

Course Structure

The course will consist of numerous field excursions (several of which will be some distance away from the Boston University campus) and will be complemented by morning and evening lectures. At each of the four major field excursions, students will study different sedimentary processes and environments and will be given a field exercise(s) or gather data that they will analyze in the Sedimentology Lab. In addition, students will be given readings, writing assignments, and do a final project that will be presented as a poster and given as an oral presentation to the class. Students will also be required to keep a logbook in which they chronicle detailed observations of what they learn and see each day at each field site. These logs are to be complimented with photographs and diagrams. The field notes, figures, and annotated photos will be turned in at the end of the course. The final grade will be based performance in the field (including field logbook), lab and field exercises, and final project poster and presentation.

Class Schedule

List of Field Excursions

1. **Winthrop and Yirrell Beaches**
   Drive to Winthrop Beach, visit during a low tide to explore effects of coastal structures.
   a. Investigate: Five Sisters Breakwaters, various types of groins, seawalls, rip-rap, major structure in front of Winthrop Head Standpipe
   b. Gravel bars and tombolo off Winthrop Head, why gravel movement onshore and sand movement offshore
   c. Yirrell Beach grain size trends, effects of low seawall, Blizzard of 1978
   d. History of Shirley Gut and why it closed.
   e. Deer Island, look at exposures to storms
   f. **Exercise:** relate gravel beach morphology to storm and tidal elevations and gravel grain size trends

2. **Acadia National Park & Blueberry Fields, ME (12-14 Sept)**
   a. Leave BU at 7:00 am, arrive at Cherryfields, ME at 1:00 pm
   b. Visit Blueberry Fields to view 60 m highstand delta and dip slope
   c. Demonstrate GPR and view delta foreset bedding
   d. Discussion theories of emplacement of giant boulders on top of delta
   e. Travel to Bar Harbor and spend two nights
   f. Acadia National Part to visit Sandy Beach, Brackish Marsh, Boulder Beach, Thunder Hole, 60-m high cave, Carriage Trails and Mt Cadillac
   g. Drive to Rockport, ME and spend the night of the 14th

3. **Popham Beach (15th Sept)** 9:13 am low-tide
   1-hour 20 minute drive to Popham Beach, will meet at the fort, talk about estuarine processes, during the day, we'll look various environments and processes including:
   a. Kennebec River dynamics- spring freshets
   b. Trench digging along Riverside beach to look at bedding and structure
   c. Atkins Bay tidal flats
   d. Wood Island bar and South Beach (bedforms, dunes, ridge and runnels)
   e. Morse River
   f. **Exercise**: Determine sand circulation map for outer beac

4. Castle Neck Barrier (19th Sept)

a. Marsh zonation
b. GPR profile of parking lot to look at barrier evolution
c. Auger core to look at what is causing seaward dipping layers
d. Vibracore of marsh next to parking lot to study early evolution of Castle Neck
e. Walk to Ipswich River to look at inlet system
f. Drumlin sampling to investigate mineralogy
g. 1978 erosional scarp
h. RTK profile stations for comparisons to June work
i. Beach protuberance- grain size changes, process of inlet sediment bypassing
j. Southern recurved-spit erosional history, study grain size changes
k. **Exercise:** what are the major processes affecting the erosional-depositional processes and resulting morphology

5. Boat trip to Essex Bay and Great Marsh (20th & 21st Sept)

Groups 1 & 2 leave BU at 8:00 on the 20th and arrive at Essex at 9:00. Return to BU by 4:00 pm
Group 3 and 4 leave BU at 8:00 on 21st Return to BU by 4:00 pm

a. Essex Inlet, waves and tidal current
b. Visit spit platform and inlet morphology
c. Grab sampling
d. Marsh ecology: types and zonation of grass types, function of creeks, grain size trends
e. Marsh edge erosion (demonstrate shear vane, sampling for BD and LOI)
f. Discuss Ditch filling and Runneling
g. Auger coring to observe marsh stratigraphy
h. **Exercise:** Construct a geomorphic map of different sedimentary environments

6. South Shore and Cape Cod (22nd Sept)

All day fieldtrip to South Shore and Cape Cod. Leave BU 8:00 am, return by 6:30 pm

a. First stop is 4th Cliff at New Inlet in Marshfield- drumlin composition, boulder retreat lag and look at effect of structures on the way
b. New Inlet, history of formation, ebb-tidal delta features, wave refraction inside inlet, transgressive processes.
c. **Exercise:** Using Google maps and other information describe how New Inlet formed, why it became stable, what happened to the old inlet site and why, and the impacts of New Inlet.
d. Manomet Point. Look at the glacial cliffs
e. Sandy Neck- evolution and sediment source, influence of Cape Cod Canal jetties, bimodal beach sediment, Aeolian ramp development, dune grasses
f. First Encounter Beach, transgressive spit, marsh evolution, bedforms
g. Pamet River Inlet- jetty development, former glacial scarp, relationship between bay infilling and inlet size
h. Provincetown Dunes- early settlers, parabolic dune formation
i. **Exercise:** Provide a broad evolutionary history of Cape Cod and include the features and processes viewed at the various fieldtrip stops in your discussion.

7. Boat trip to Thompson Island & Boston Harbor Islands (27 & 28 Sept)

Leave BU at 8:00 am and travel UMass campus to get aboard the boat

a. Travel around islands comparing erosion rates to island morphology, fetch directions
b. Compare inner island morphology and exposure to outer island morphology and exposure
c. Relate depositional features to drumlin sources
d. Discuss formation of salient
e. Visit Lowells Island and walk shoreline, discuss processes of scarp development
f. Explain formation of paleo-scarp and subsequent cuspate foreland
g. **Exercise:** Take sediment samples of Drumlin sediment to determine major grain size fractions (mud, sand, gravel)
h. **Exercise:** determine the susceptibility of the islands to future SLR and increased storminess using synthetic storm data, wind data, wave forecasting equations

8. **Ogunquit and Wells Research Reserve (29th Sept)**
   Arrive at Ogunquit Parking Lot by early morning
   a. Bedrock control of inlet location
   b. Spit erosion and sand transport trends
   c. **Exercise:** map bedform type and orientation and grain size estimates of the Flood tidal delta
   d. Go to Wells jetties and look at effects of the structures and wave propagation into inlet
   e. Drake Island and visit Little River Inlet.
   f. Investigate inlet changes as evidenced by morphology and stratigraphy

Readings

Readings will be assigned daily from papers put on Blackboard

In addition, there will be a number of books put on reserved in the Sedimentology Lab

Beaches and Coasts, Davis and FitzGerald, 2nd Ed. Wiley Press, New York. 2020

Paola, C., 2016, Quantitative models of basin filling, Sedimentology, vol. 47, p. 121-178.

Hsu, K.J., 2017, Physics of Sedimentology, 3rd Edition, Springer, 240 p.

Reading, H.G., 2009, Sedimentary Environments and Facies, (4th ed.), Blackwell Press.

Prothero, D.R. and Schwab, F., 2005, Sedimentary Geology, Freeman Company, New York.

Leeder, M.R., 2014, Sedimentology, Allen & Unwin.

Collinson and Thompson, 2002, Sedimentary Structures, (2nd ed.), Unwin & Hywam

Folk, J.R., 1968, Petrology of Sedimentary Rocks, University of Texas.

Adams, MacKenzie, & Guilford, 1996, Atlas of Sedimentary Rocks Under the Microscope, Longman.

Tucker, 2002, Field Description of Sedimentary Rocks, Halstead Press.

Middleton and Southard, 1994, Mechanics of Sediment Transport, SEPM Short Course.

POLICY STATEMENT

I stress the importance of your familiarity with, and adherence to, Boston University's *College of Arts and Sciences Academic Conduct Code*, in particular those portions dealing with cheating and plagiarism. Please refer to:
http://www.bu.edu/academics/policies/academic-conduct-code/

DIVERSITY AND INCLUSION

Diversity enriches all research and education, and is realized only with all voices, views, and perspectives operating within a supportive and respectful community. For this reason, the Department of Earth & Environment, including myself and the students in this course, are committed to fostering diverse, inclusive, and equitable living, learning, and working environments that are supportive and free from violence, harassment, disruption, and intimidation. Further, the Department of Earth & Environment recognizes that creating a safe environment and a culture of respect is the shared responsibility of all members of our community. To ensure an equitable environment that values and respects the unique experiences and perspectives of our community, the Department, including myself and the students in this course, are dedicated to promoting diversity, inclusion, and equity among all

members of our departmental community and encouraging open, honest, and compassionate communication. http://www.bu.edu/earth/about/diversityinclusion/

1. Academic Conduct Code
http://www.bu.edu/academics/policies/academic-conduct-code/

2. University Policy on Religious Observance
http://www.bu.edu/chapel/religion/

3. Multi-faith Calendar
http://www.interfaithcalendar.org/