Coastal Sedimentology MR 500

Marine Semester – 1st Block

Fall 2020

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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 lectures. At each of the field excursions, students will study different sedimentary processes/environments and will be given a field exercise(s) or gather data that they will analyze in the Sedimentology Lab. 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. A write up of the field notes, with maps, figures, and annotated photos will be turned in 1 -2 days following the field trip (depending on the schedule). 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 is tentative, works around the tide and can be found on blackboard.

List of Field Excursions

1. **Popham Beach** mid-morning low-tide
   3-hour drive (leave BU very early: 6:00 am), 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 beach
   Leave Popham around 5:00 pm and get back to BU around 8:00 pm (get next day off)

2. **Winthrop and Yirrell Beaches (Sept 7th)**
   30-minute 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

3. **South Shore and Cape Cod**
   Leave BU at 8:00 am and get back around 7:30 pm and essentially run the Cape Cod fieldtrip.
   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

4. **Ogunquit and Wells Research Reserve**
   Leave BU at 8:00 am and arrive at Ogunquit Parking Lot at 9:30 am.
   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
   e. Go to Wells Reserve parking lot and take trail to beach
   f. Investigate inlet changes as evidenced by morphology and stratigraphy
   Arrive back at BU 6:30 pm

5. **Castle Neck Barrier**
   a. Walk to Essex or Ipswich River to look at inlet system
   b. Drumlin sampling to investigate mineralogy
   c. 1978 erosional scarp
   d. RTK profile stations for comparisons to June work
   e. Beach protuberance- grain size changes, process of inlet sediment bypassing
   f. Southern recurved spit erosional history, study grain size changes
   g. **Exercise:** what are the major processes affecting the erosional-depositional processes and resulting morphology

6. **Castle Neck Barrier 2**
   h. Marsh zonation
   i. GPR profile of parking lot to look at barrier evolution
   j. Auger core to look at what is causing seaward dipping layers
   k. Vibracore of marsh next to parking lot to study early evolution of Castle Neck
   l. **Exercise:** Looking at the 3rd dimension, describe the timing, periodicity and importance of different erosional-depositional processes. How is morphology preserved in the vertical?

7. **Great Marsh**
   Leave BU at 8:30 and arrive at Stackyard Road in Rowley at 9:30, Return to BU by 5:00 pm
   a. Marsh ecology: types and zonation of grass types, function of creeks, grain size trends, etc.
   b. Marsh edge erosion (shear vane, sampling for BD and LOI)
   c. Ditch filling and runneling
   d. Auger coring
   e. Deploy current meters and Hobos in tidal channels, OBS
   f. **Exercise:** measure amount of sediment being deposited on the marsh surface (using plastic cups)
   g. **Exercise:** determine the stratigraphy of the marsh and relate this to sea level history

8. **Lovells Island**
   Leave BU at 8:00 am and travel to South Boston to get aboard the boat. Back to BU by 5:30 pm
   a. Travel around island comparing erosion rates to island morphology.
   b. Exercise: Take sediment samples of Drumlin sediment to determine major grain size fractions (mud, sand, gravel)
   c. Run GPR and RTK profile across southwest end of island to investigate mode of formation.
   d. Collect sediment samples along south island exposures to determine grain size trends
   e. **Exercise:** use RTK and GPR profile data along with other geomorphic and sedimentologic trends along with SL history to determine Thompson Island evolution.

9. **Boston Harbor Island**
   Leave BU at 8:00 am and travel to UMass Boston to get aboard their research ship. Get back to BU around 5:00
   a. Travel around Boston Harbor to look at different island morphologies and depositional and erosional features.
   b. Compare inner island morphology and exposure to outer island morphology and exposure
   c. Land on several of the islands to investigate environments of deposition and island infrastructure
   d. **Exercise:** determine the susceptibility of the islands to future SLR and increased storminess using synthetic storm data, wind data, wave forecasting equations

10. **Essex Bay**
    Leave BU at 8:30 am and return by 5:00 pm
    a. Leave the dock in the Town of Essex and explore the Essex River
    b. Take samples of bed sediment using ponar grab
    c. Return samples to the lab for analysis with rotap.

Readings

Readings will be 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/

Please read important statements below:

Student Protocols

There was guidance sent out on what to do if students are not following safety protocols. We agreed that this guidance should not be seen to be "discretionary" on the part of the instructor, rather it should be seen as guidance that the instructor, TF, and students are obliged to follow. Please follow this guidance in your classes:

Students who are up to date with testing and attestation will receive a green-colored badge that will appear on their mobile device. Faculty and staff are not required to monitor whether students have a green badge – that will be done on an ongoing basis through the oversight by the Dean of Students Office. If, however, you are concerned about student compliance with the testing and daily attestation requirements, you may choose to utilize some or all of these options:

- Ask students in your classes (or offices) to show you their badges on their mobile devices prior to starting class.
- If a student is unable to show a green badge, ask the student to leave, to rectify any issues with their testing or attestation before their next in-person class, and, if possible, to utilize the remote L*f*A option for that class session.
- Be clear that the student should not come back to that class session and must resolve any issues they have with testing or attestation before attending in-person again.
- If the student refuses to leave, inform the class that you will not proceed with instruction until the student leaves the room.
- If the student still refuses to leave the room, dismiss the class and contact your dean's office (or the office designated by your dean for this purpose).