Erodibility of sediments collected from the Northern Gulf of Mexico following laboratory resuspension at the Dauphin Island Sea Lab in 2020

Website: https://www.bco-dmo.org/dataset/875391
Data Type: experimental, Other Field Results
Version: 1
Version Date: 2025-08-25

Project
» CAREER: Mechanisms of bioturbation and ecosystem engineering by benthic infauna (Bioturbation and Ecosystem Engineering)

Contributors	Affiliation	Role
Dorgan, Kelly	Dauphin Island Sea Lab (DISL)	Principal Investigator
Clemo, William Cyrus	Dauphin Island Sea Lab (DISL)	Contact
Rauch, Shannon	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
This dataset describes the erodibility of sediments collected from the Northern Gulf of Mexico, off the Alabama coast at 10 meters depth following laboratory resuspension at the Dauphin Island Sea Lab.

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Coverage

Spatial Extent: **Lat**:30.22222 **Lon**:-88.13913
Temporal Extent: 2020-01-29 - 2020-02-27

Methods & Sampling

Sediment cores were collected from 10 meters (m) depth in the northern Gulf of Mexico offshore of Dauphin Island, Alabama, in cohesive muddy sediment on January 26, 2020 (30° 13.333' N, 88° 8.348' W). Cores were collected from a Dauphin Island Sea Lab vessel, the R/V Alabama Discovery. Polycarbonate sediment cores (9.6 centimeter (cm) inner diameter x 60 cm height) were collected using an MC-400 multicorer (Ocean Instruments, Fall City, WA).

We resuspended the surface 5 cm of natural muddy sediment cores in the lab and compared temporal changes in sediment compaction to changes in surface and subsurface cohesion over 30 days post resuspension. Sediment-water interface (SWI) height and acoustic sound speed through sediment, which depends on bulk density, provided continuous and nondestructive metrics of compaction, and sediment porosity and grain size were measured destructively to characterize sediment physical structure. We determined surface cohesion by measuring both eroded mass and turbidity resulting from increasing shear stress. Subsurface cohesion was determined from the force required for sediments to fail in tension. We compared surface and subsurface exopolymeric substance (EPS) concentrations to surface and subsurface cohesion measurements. We differentiated between water-soluble (colloidal) and sediment-bound EPS as we expected bound EPS to contribute more to sediment-organic matrix development and thus cohesion because they are directly bound to sediment grains rather than dissolved in porewater.

These data include the erosion measurements from this experiment. A summary of data collected on cores processed over time points 0 days (no resuspension), then 1, 2, 3, 7, 14, and 30 days post resuspension is given in dataset 1. Repeated non-destructive measurements of sediment-water interface height and sound speed on cores processed on day 30 are provided in separate datasets.

To examine changes in sediment surface cohesion, we measured total eroded mass and turbidity using a custom-built Gust erosion chamber (Fig. 2 B, Gust & Muller 1997, Thomsen & Gust 2000, U-GEMS Manual, Green Eyes, LLC, 2015). Cores were capped with the erosion chamber cap in which a rotating disc generated increasing levels of shear stress (0.1, 0.2, 0.3, 0.45, 0.6 Pa). Each stress level was maintained for 20 minutes before increasing to the next level. At each stress level, water and eroded material were removed by a pump at the center of the disc 10 centimeters (cm) above the sediment surface. This effluent passed through a C-Star transmissometer (Sea-Bird Scientific, Bellevue, WA, USA) recording light attenuation coefficient (m-1) at 650 nanometers (nm) to determine turbidity over time and was then captured for later filtration. An initial 0.01 Pa interval was used as a flushing step and not filtered, but seawater used to replace the effluent was filtered to determine background suspended sediment concentration.

Total eroded mass at each stress level was obtained by filtering the effluent through 47-millimeter (mm) Whatman GF/F filters (1.5 micrometer (µm) pore size). Filters were dried at 65 degrees Celsius (°C) for 24 hours, then weighed. We calculated suspended sediment concentration, Cs (kilograms per cubic meter (kg m-3)), for each core at each stress level from the dry mass (kg) of filtered sediment divided by the volume (m-3) of water filtered. Cs was converted to eroded mass per area (E; kg m-2):

(3) $E=(C_s V_c)/A_c$

where Vc is chamber volume (7.24 x10-4 m3), and Ac is sediment surface area within the core (7.24 x 10-3 m2). To generate specific shear stresses, we set cap rotation and pumping rate using calibration equations from the University of Maryland Center of Environmental Science Gust Erosion Microcosm System (U-GEMS) Manual (Green Eyes, LLC, 2015):

(4) $u_{15}^{*}=0.0318n^{0.763}$

(5) $Q=-28.31u_{15}^{*2}+170.2u_{15}^{*}-23.85$

where u*15 is shear velocity at 15 °C (cm s-1), n is rotations per minute, and Q is pumping rate (mL min-1). Shear velocity at 15 °C was converted to shear velocity at the average water temperature measured during the erosion tests (20 °C) as:

(6) $u_{15}^{*}=u_{20}^{*}[1+0.006(20-15)]$

where u*20 is shear velocity at 20 °C (cm s-1) (U-GEMS Manual, Green Eyes, LLC, 2015). Shear stress (τb; Pa) was calculated from shear velocity (u*20; m s-1) and seawater density (ρw; kg m-3) as:

(7) $\tau_b={\rho_w u_{20}^{*}}^2$

(U-GEMS Manual, Green Eyes, LLC, 2015).

We determined turbidity, as suspended sediment concentration (kg m-3), from light attenuation coefficient, measured continuously throughout each stress level. We calibrated the transmissometer with muddy seawater of 4 suspended sediment concentrations (0.0038, 0.018, 0.030, and 0.050 kg m-3) made from sediment from the coring site. We then filtered each muddy water sample following the steps above to determine suspended sediment concentration and determined the relationship of light attenuation and suspended sediment concentration:

(8) $C_s=0.17c+0.0015$

where Cs is suspended sediment concentration (kg m-3) and c is light attenuation coefficient (m-1).

Instruments:
These data were collected using a custom-built Gust chamber. For more detail, see Clemo et al., 2022.

BCO-DMO Processing Description

- Imported original file "ClemoResuspensionExperiment2020Erosion.csv" into the BCO-DMO system.
- Renamed fields to comply with BCO-DMO naming conventions.
- Converted date column to YYYY-MM-DD format.
- Rounded numeric columns to 4 decimal places.
- Saved the final file as "875391_v1_sediment_resuspension_erosion.csv".

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Data Files

File
875391_v1_sediment_resuspension_erosion.csv(Comma Separated Values (.csv), 9.62 KB) MD5:d1d66ea6bfca5a76e4ddfb82ffb0533c Primary data file for dataset ID 875391, version 1

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Related Publications

Clemo, W. C., Giles, K. D., & Dorgan, K. M. (2022). Biological influences on coastal muddy sediment structure following resuspension. Limnology and Oceanography. Portico. https://doi.org/10.1002/lno.12213
Results

Green Eyes, LLC. 2015. U-GEMS Manual Version 3.0. 0-44.
Methods

Gust, G., and V. Muller. 1997. Interfacial hydrodynamics and entrainment functions of currently used erosion devices, p. 149–174. In N. Burt [ed.], Cohesive Sediments : 4th Nearshore and Estuarine Cohesive Sediment Transport Conference, INTERCOH '94, 11-15 July 1994: Wallingford, England, UK. Wiley.
Methods

Thomsen, L., & Gust, G. (2000). Sediment erosion thresholds and characteristics of resuspended aggregates on the western European continental margin. Deep Sea Research Part I: Oceanographic Research Papers, 47(10), 1881–1897. https://doi.org/10.1016/s0967-0637(00)00003-0 https://doi.org/10.1016/S0967-0637(00)00003-0
Methods

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Related Datasets

IsRelatedTo

Dorgan, K., Clemo, W. C. (2025) **Acoustic properties of sediments collected from the Northern Gulf of Mexico following laboratory resuspension at the Dauphin Island Sea Lab in 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-08-25 doi:10.26008/1912/bco-dmo.875501.1 [view at BCO-DMO]

Dorgan, K., Clemo, W. C. (2025) **Sediment surface elevation change of sediments collected from the Northern Gulf of Mexico following laboratory resuspension at the Dauphin Island Sea Lab in 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-08-25 doi:10.26008/1912/bco-dmo.875514.1 [view at BCO-DMO]

Dorgan, K., Clemo, W. C. (2025) **Sediment surface elevation, erodibility, and acoustic properties of sediments collected from the Northern Gulf of Mexico following laboratory resuspension at the**

Dauphin Island Sea Lab in 2020. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-08-25 doi:10.26008/1912/bco-dmo.875373.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
core	core ID named as "D_samplingday(max30)_replicate(A-E)"	unitless
latitude	Latitude of sample collection	decimal degrees
longitude	Longitude of sample collection	decimal degrees
water_depth_m	Water depth in meters	meters (m)
date	Date of sample collection	unitless
time_day	time in days since sediment disturbance was performed	days
timepoint	time point of experiment (max 30)	unitless
replicate	replicate identifier	unitless
shearstress_Pa	bottom shear stress in Gust chamber	Pascal (Pa)
erodedmass	eroded mass for shear level	kilograms per square meter (kg m-2)
cumerodedmass	cumulative eroded mass for core	kilograms per square meter (kg m-2)
timeturbidity_maxedout	amount of time the reading from the turbidity sensor was maxed out	minutes
timeturbidity_maxedout_fraction	fraction of time the turbidity sensor was maxed out	unitless
MaxSuspSedConc	maximum suspended sediment concentration (turbidity sensor reading if not maxed out)	kilograms per cubic meter (kg m-3)

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Instruments

Dataset-specific Instrument Name	a custom-built Gust chamber
Generic Instrument Name	Gust chamber
Dataset-specific Description	These data were collected using a custom-built Gust chamber. For more detail, see Clemo et al., 2022. A DC-motor-controlled rotating disc 10 cm above the core sediment-water interface generates increasing levels of shear stress for 20-minute intervals. Water and suspended material are pumped out of the center of the disc with an adjustable peristaltic pump and passed through a transmissometer to record turbidity.
Generic Instrument Description	A Gust chamber is a specialized testing facility used to apply controlled shear stress to sediment samples, often to study erosion and sediment transport in various environments. It helps researchers understand how different conditions affect soil erosion and sediment stability.

Dataset-specific Instrument Name	MC-400 multicorer
Generic Instrument Name	Ocean Instruments MC-400 Multi corer
Dataset-specific Description	Polycarbonate sediment cores (9.6 centimeter (cm) inner diameter x 60 cm height) were collected using an MC-400 multicorer (Ocean Instruments, Fall City, WA).
Generic Instrument Description	The Ocean Instruments MC-400 {Hedrick/Marrs} multi-corer is a sediment multi-corer with a series of cores attached to one deployment frame. This model carries four sample tubes. It is designed to retrieve sediment and water samples in lakes and shelf waters. The sample tubes are sealed with a silicone rubber upper door gasket and a neoprene or carpet lower door seal. Each of the four sample tubes can be removed from the coring unit for immediate processing in the laboratory without exposing their contents to the surface environment. It is designed to recover undisturbed surface sediments and is therefore well-suited to study benthic processes. The multi-corer is disposed on a research vessel and is lowered into the water body by a cable. When the multi-corer touches the sediment the units ballast weight pushes the assembled cores into the substrate. Each of the tubes contains a unique sediment core. The multi-corer uses a unique hydrostatic damping system that slows the penetration rate down to approximately 1 cm/s. Provisions have been made to carry up to two 4-liter water bottles that actuate as the frame legs touch bottom. The overall sample tube length is 58 cm, with a maximum penetration of 34.5 cm. The tube diameter is 10 cm.

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Project Information

CAREER: Mechanisms of bioturbation and ecosystem engineering by benthic infauna (Bioturbation and Ecosystem Engineering)

Coverage: Dauphin Island Sea Lab, Dauphin Island, AL

NSF Award Abstract:
Marine sediments are important habitats for abundant and diverse communities of organisms that are important as food sources for higher trophic levels, including commercially important species. Through

burrowing, constructing tubes, and feeding on sediments, these animals modify their physical and chemical environments to such an extent that they are considered ecosystem engineers. Bioturbation, the mixing of sediments by animals, is important in regenerating nutrients and transporting pollutants and carbon bound to mineral grains. Despite its importance, our ability to predict bioturbation rates and patterns from the community structure is poor, largely due to a lack of understanding of the mechanisms by which animals mix sediments. This project builds on earlier work showing that animals extend burrows through muddy sediments by fracture to test the hypothesis that the mechanical properties of sediments that affect burrowing mechanics also affect sediment mixing. More broadly, this project examines the relative contributions of (i) the functional roles of the organisms in the community, (ii) the mechanical properties of sediments, and (iii) factors that might increase or decrease animal activity such as temperature and food availability to bioturbation rates. Burrowing animals modify the physical properties of sediments, and this project quantifies these changes and tests the hypothesis that these changes are ecologically important and affect community succession following a disturbance. In addition to this scientific broader impact, this project involves development of instrumentation to measure sediment properties and includes a substantial education plan to introduce graduate, undergraduate, and middle school students to the important role that technology plays in marine science.

Through burrowing and feeding activities, benthic infauna mix sediments and modify their physical environments. Bioturbation gates the burial of organic matter, enhances nutrient regeneration, and smears the paleontological and stratigraphic record. However, current understanding of the mechanisms by which infaunal activities mix sediments is insufficient to predict the impacts of changes in infaunal community structure on important sediment ecosystem functions driven by bioturbation. This project tests specific hypotheses relating infaunal communities, bioturbation, and geotechnical properties with the ultimate goal of understanding the dynamic changes and potential feedbacks between infauna and their physical environments. This project integrates field and lab experiments to assess the relative importance of infaunal community structure and activities to bioturbation rates. Additionally, this project builds on recent work showing that muddy sediments are elastic gels through which worms extend burrows by fracture to propose that geotechnical properties of sediments mediate bioturbation by governing the release of particles from the sediment matrix during burrow extension. Finite element modeling determines how the release of particles by fracture during burrowing depends on the fracture toughness (cohesion) and stiffness (compaction) of sediments and complements laboratory experiments characterizing the impact of geotechnical properties on burrowing behaviors. The proposed research also aims to determine whether impacts of infauna on geotechnical properties are ecologically important. Changes in infaunal communities and geotechnical properties following an experimental physical disturbance address the hypothesis that ecosystem engineering of bulk sediment properties facilitates succession.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1844910

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