New Hampshire Continental Shelf Geophysical Database: 2002-2005 Jeffreys Ledge Field Campaign – Seafloor Photographs and Sediment Data

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Database Viewing

The database is available for viewing at the University of New Hampshire (UNH) Center for Coastal and Ocean Mapping and Joint Hydrographic Center (CCOM/JHC) website. See "High Resolution Seafloor Bathymetry, Surficial Sediment Maps and Interactive Database: Jeffreys Ledge and Vicinity".
http://ccom.unh.edu/project/jeffreys-ledge

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Introduction

Jeffreys Ledge is a major physiographic feature in the western Gulf of Maine (WGOM) located ~50 km off the coast of New Hampshire, although coming within ~10 km of shore by Cape Ann, Massachusetts (Figure 1). Jeffreys Ledge rises up as much as ~150 m from the seafloor of the adjacent basins (i.e., Scantum Basin or Wilkinson Basin) to depths less than 50 m on the ridge surface. The ridge extends over 100 km along its north-northeast to south-southwest axes while generally only being 5 to 10 km in width (~20 km maximum). Jeffreys Ledge and the surrounding region, like many features in the Gulf of Maine, most likely owes its origin and morphologic and sedimentologic features to a combination of fluvial erosion in the late Neogene (formerly Tertiary) which left topographic highs, subsequent glaciations and sea-level fluctuations in the Quaternary, and late Pleistocene and Holocene marine processes (Uchupi, 1966; Oldale and Uchupi, 1970; Oldale et al., 1973; Ballard and Uchupi, 1974; Schnitker et al., 2001; Uchupi, 2004; Barnhardt et al., 2007; Uchupi and Bolmer, 2008).

In 1998, the National Marine Fisheries Service established the WGOM Closure which encompasses the northern and middle reaches of Jeffreys Ledge (Figure 1). The closure, one of the largest in the world, extends ~110 km north-south and is ~30 km in width. A year-round prohibition of bottom gillnets and otter trawls was implemented in an effort to help rebuild the groundfish stocks in the WGOM (e.g., cod, haddock, other gadids, and flatfish), as well as to help protect habitat (Grizzle et al., 2009).

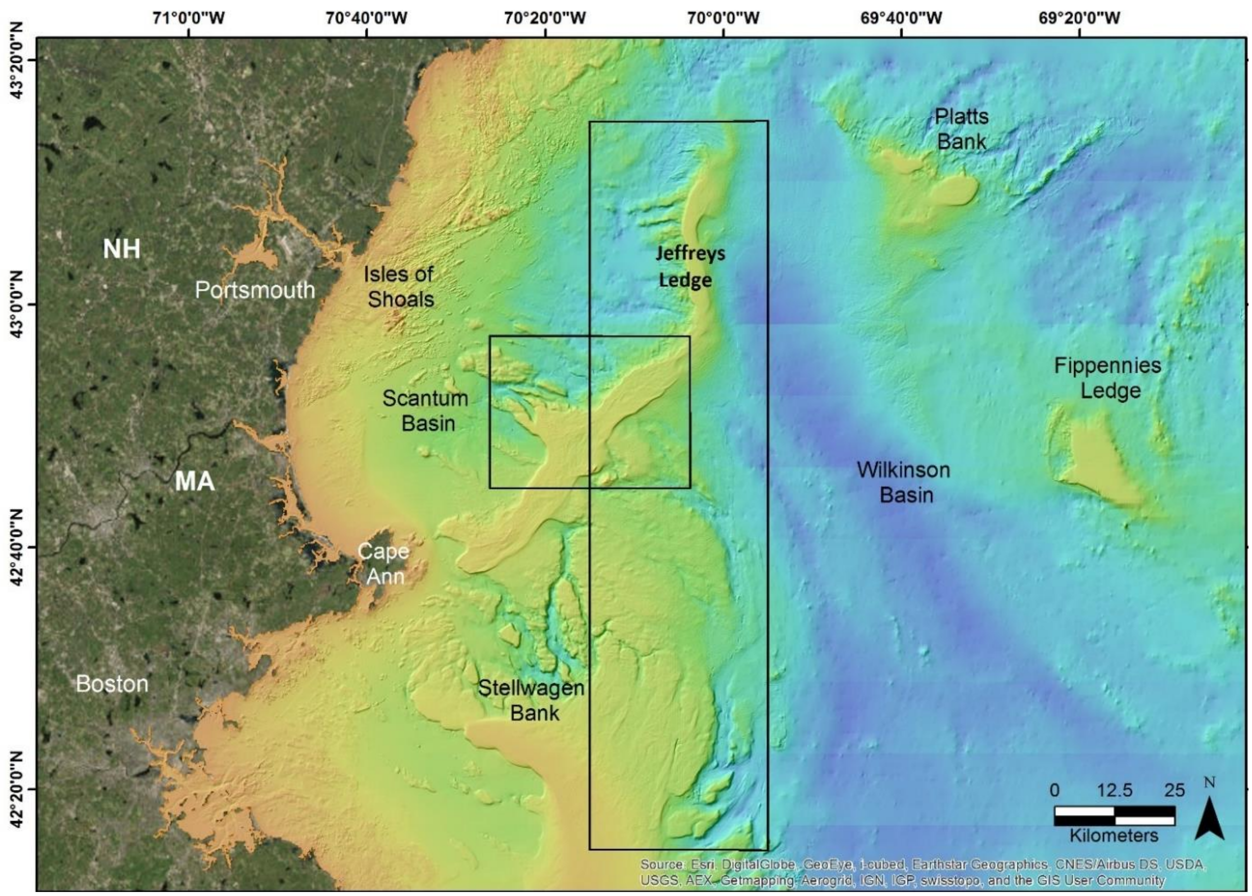

Figure 1. Location map for the University of New Hampshire study area (smaller rectangle) and the Western Gulf of Maine Closure area (larger rectangle).

From 2002 to 2004, the University of New Hampshire (UNH) Center for Coastal and Ocean Mapping (CCOM) was part of an interdisciplinary effort to evaluate the effect of the WGOM Closure on bottom habitats. The study focused on an approximately 18.5 by 27.8 km area (~515 km^2) on Jeffreys Ledge – referred to as the UNH Study Area – that encompassed similar seafloor types inside and outside of the closure (Figure 2). During this study, high resolution multibeam echosounder (MBES) surveys were completed, bottom sediment samples were collected and processed for grain size, and seafloor video was obtained along bottom transects.

The "New Hampshire Continental Shelf Geophysical Database: 2002-2005 Jeffreys Ledge Field Campaign – Seafloor Photographs and Sediment Data" presented here was developed by the UNH Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) and includes 687 seafloor photographs, grain size data and classifications for 123 bottom sediment samples, and bottom sediment classifications based on video for 142 stations from the UNH Study Area.

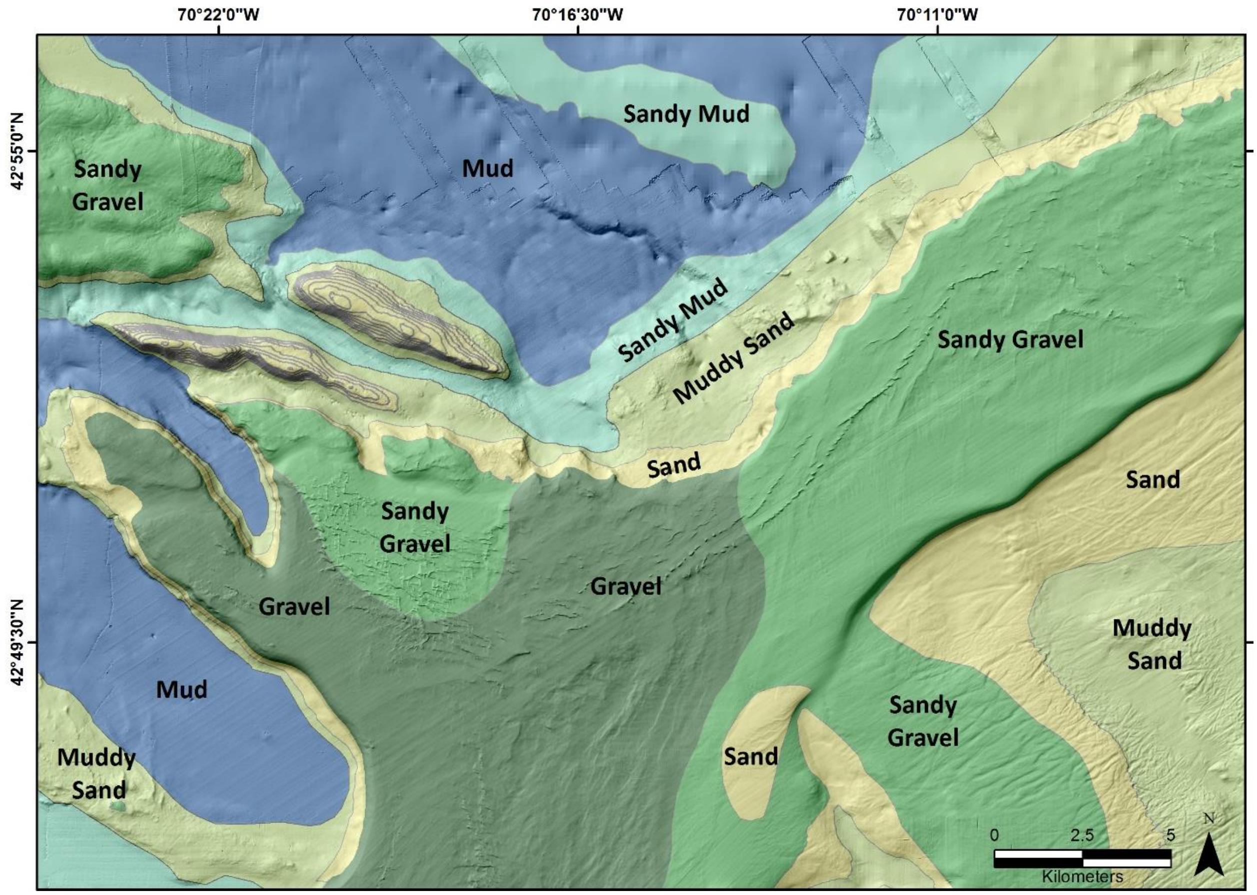

Figure 2. Surficial sediment map for the UNH Study Area. The CMECS Substrate Group sediment classification was applied the "UNH Study Area" based on quantitative analysis of the bottom videography and sediment samples. The Sandy Gravel is a subgroup of the Gravel Mixes. The figure is included with the database (see "Jeffreys_Ledge_Geophysical_Database_Location_Map_Sediment_Class.tiff").

Associated Reports and Databases

The "New Hampshire Continental Shelf Geophysical Database: 2002-2005 Jeffreys Ledge Field Campaign – Seafloor Photographs and Sediment Data" is part of a series of reports and databases for the continental shelf off New Hampshire. The others are listed below.

Reports:

Ward, L.G., McAvoy, Z.S., Vallee-Anziani, M., and Morrison, R.C., 2021, Surficial Geology of the Continental Shelf off New Hampshire: Morphologic Features and Surficial Sediment: BOEM/New Hampshire Cooperative Agreement (Contract M14ACOOO10) Technical Report, Department of Interior, Bureau of Ocean Energy Management, Marine Minerals Division, 45600 Woodland Road, Sterling, VA, 20166, 184pp. https://dx.doi.org/10.34051/p/2021.31

Ward, L.G., Johnson, P., Bogonko, M., McAvoy, Z.S., and Morrison, R.C., 2021, Northeast Bathymetry and Backscatter Compilation: Western Gulf of Maine, Southern New England, and Long Island Sound:

BOEM/New Hampshire Cooperative Agreement (Contract M14ACOOO10) Technical Report, Department of Interior, Bureau of Ocean Energy Management, Marine Minerals Division, 45600 Woodland Road, Sterling, VA, 20166., 23 pp. https://dx.doi.org/10.34051/p/2021.28

Ward, L.G., Morrison, R.C., McAvoy, Z.S., and Vallee-Anziani, M., 2021, Analysis of Vibracores from the New Hampshire Continental Shelf from 1984 and 1988: BOEM/New Hampshire Cooperative Agreement (Contract M14AC00010) Technical Report, Department of Interior, Bureau of Ocean Energy Management, Marine Minerals Division, 45600 Woodland Road, Sterling, VA, 20166, 173 pp. https://dx.doi.org/10.34051/p/2021.26

Ward, L.G., McAvoy, Z.S., and Vallee-Anziani, M., 2021, New Hampshire and vicinity continental shelf: Sand and gravel resources: BOEM/New Hampshire Cooperative Agreement (Contract M14ACOOO10) Technical Report, Department of Interior, Bureau of Ocean Energy Management, Marine Minerals Division, 45600 Woodland Road, Sterling, VA, 20166, 113 pp. https://dx.doi.org/10.34051/p/2021.30

Digital Databases:

Ward, L.G., Morrison, R.C., and McAvoy, Z.S., 2021, New Hampshire Continental Shelf Historical Geophysical Database: 1971 to 2015 - Sediment Data. https://dx.doi.org/10.34051/d/2021.3

Ward, L.G., Morrison, R.C., and McAvoy, Z.S., 2021, New Hampshire Continental Shelf Geophysical Database: 2016-2017 Field Campaign - Stations and Sediment Data. https://dx.doi.org/10.34051/d/2021.2

Ward, L.G., Morrison, R.C., and McAvoy, Z.S., 2021, New Hampshire Continental Shelf Geophysical Database: 2016-2017 Field Campaign – Seafloor and Sample Photographs and Sediment Data. https://dx.doi.org/10.34051/d/2021.1

Ward, L.G., Morrison, R.C., and McAvoy, Z.S., 2021, New Hampshire Continental Shelf Geophysical Database: 2016-2017 Field Campaign – Seafloor Photographs. https://dx.doi.org/10.34051/d/2021.5

Ward, L.G., Morrison, R.C., McAvoy, Z.S., and Vallee-Anziani, M., 2021, New Hampshire Continental Shelf Geophysical Database: Vibracore Logs and Sediment Data. https://dx.doi.org/10.34051/d/2021.4

Ward, L.G., McAvoy, Z.S., and Morrison, R.C., 2021, New Hampshire Continental Shelf Geophysical Database: 2012-2013 NEWBEX Field Campaign – Seafloor Photographs and Sediment Data. https://dx.doi.org/10.34051/d/2021.7

Surficial Sediment Grain Size Statistics and Classification

The bottom sediment samples were collected from 2002 to 2005 (primarily in 2002) largely using chartered fishing vessels. Samples were obtained using either a Shipek grab sampler (0.04 m^2 sampling area) or a Wildco box corer (0.0625 m^2 sampling area). All samples collected had an estimated uncertainty for positioning of <30 m. Samples were analyzed with standard sieve and pipette analyses after Folk (1980). The sediment grain size classifications in the data file include: CMECS (Coastal and Marine Ecological Classification Standard; FGDC, 2012); Gradistat (Blot and Pye, 2001); and Wentworth (Wentworth, 1922; described in Folk, 1954, 1980). Statistics are based on the phi scale and include the graphic mean, sorting, skewness, and kurtosis (Folk, 1980). Organic content was estimated by loss-on-ignition (% LOI) after 4 hours at 450°C.

Grain size data, statistics, and classifications based on sediment analysis are presented in the file "Jeffreys_Ledge_Geophysical_Database_Sediment_Data.xlsx", along with a data dictionary describing the fields and a description of the CMECS classifications. The station locations where sediment samples were collected and pie charts representing the percentages of gravel (green), sand (yellow), and mud (blue), as well as the sediment classification abbreviation, are shown in Figure 3.

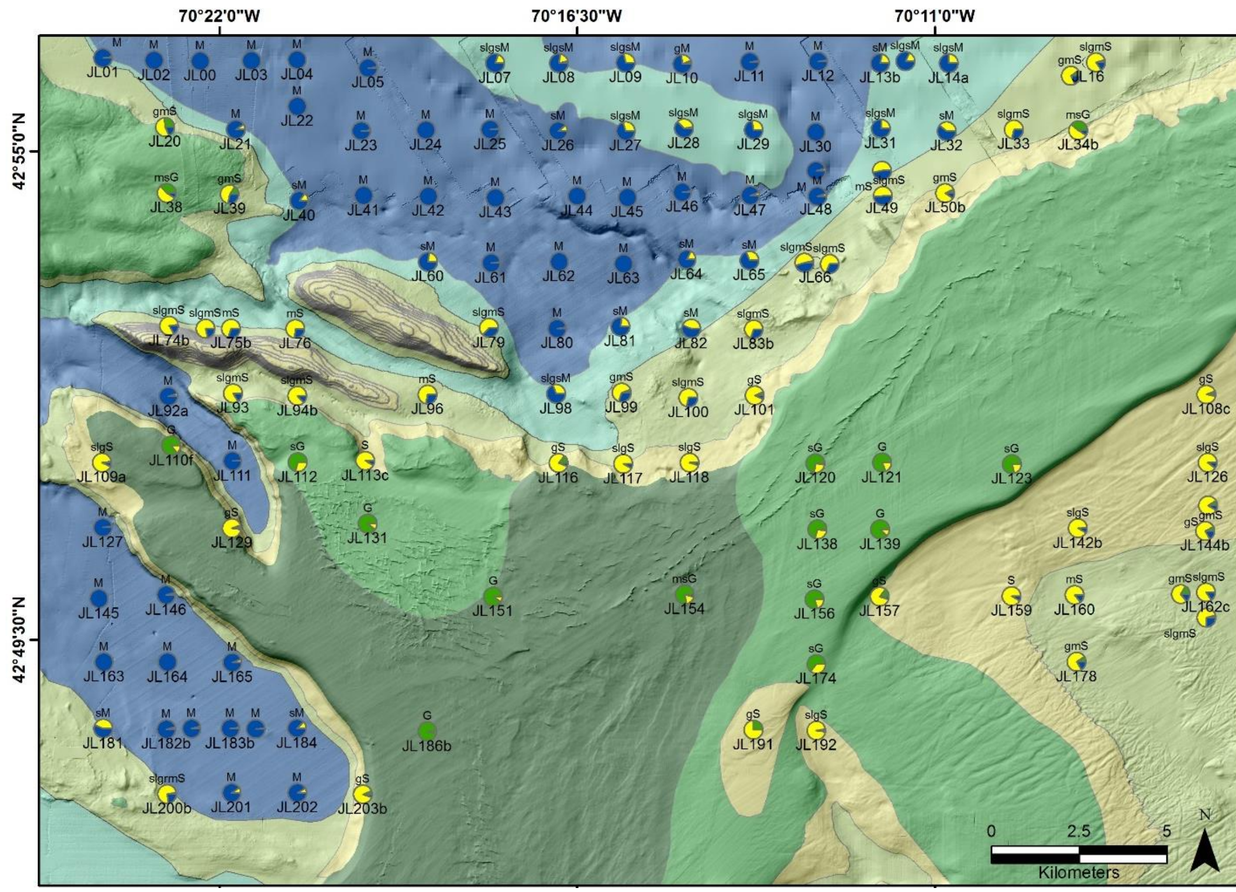

Figure 3. Location map of the bottom sediment sampling stations. Pie charts show percentages of gravel (green), sand (yellow), and mud (blue). The abbreviations for the sediment database are defined in "Jeffreys_Ledge_Geophysical_Database_Sediment_Data.xlsx". The base map depicts the CMECS substrate group sediment classification based on the video analysis and sediment samples (see Figure 2). The figure is included with the database (see "Jeffreys_Ledge_Geophysical_Database_Location_Map_Sediment.tiff").

Seafloor Photographs

Seafloor videography was primarily collected in 2004 with a DeepSea Power and Light Multi SeaCam® 2050 housed in a constructed aluminum frame with synchronized strobe lights (Perkin Elmer Optoelectronics MVS-5000-CE96 Machine Vision Strobes) and an integrated positioning system (Sea-Track Video Overlay) (Figure 4). The Multi Seacam®2050 had a f3.5 wide angle lens with a fixed focus, a depth of field of 10 cm to infinity, and a field of view in water of 79°(H) by 59°(W). The position recorded the location of the support vessel using an onboard differential GPS. The camera was suspended within ~50 cm of the bottom and 6 to 10 minutes of downward-looking, near-vertical video normally recorded at each station as the support vessel drifted. Periodically, the camera was allowed to touch down on the bottom providing vertical views. Three lasers were positioned in a triangular pattern 10 cm apart around the camera lens that were visible on the bottom and allowed quantitative measurements to be made. Locations of videography stations are shown in Figure 5. Photographs extracted from the seafloor videography are provided in the database folder "Jeffreys_Ledge_Photographs". Time, date, and location information are provided on each photograph. A Microsoft Excel file ("Jeffreys_Ledge_Geophysical_Database_Seafloor_Video_Classification.xlsx") is also provided with metadata for each station transect, including geographic location (latitude and longitude), transect length, water depth, and sediment classification based on video (described in the next section).

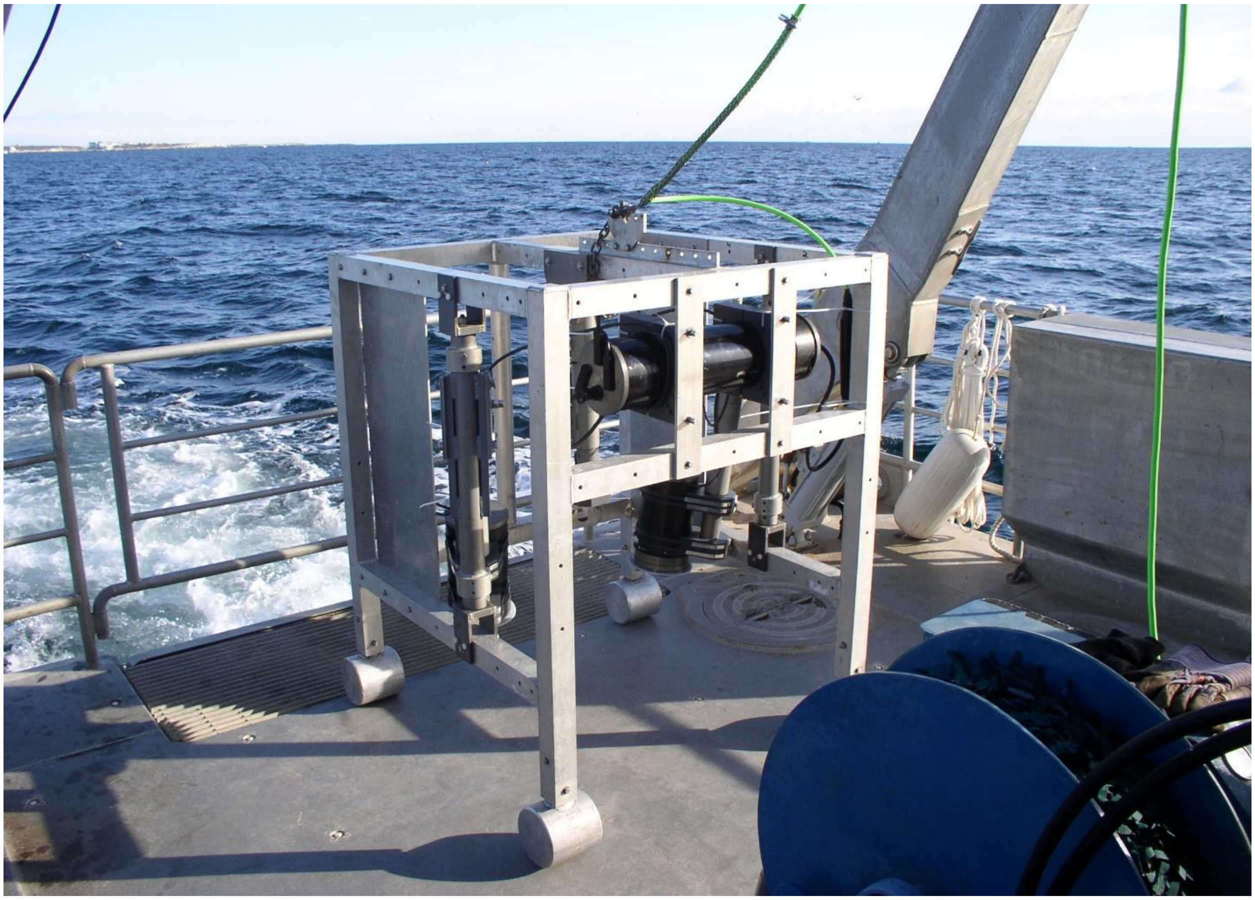

Figure 4. Bottom video camera system used in the Jeffreys Ledge field campaign.

Surficial Sediment Classification Based on Quantitative Analysis of Video

The method for determining the sediment class from video is described in the next section. A descriptive classification for the bottom sediment was developed for this study primarily based on visual inspection of the video and an estimation of grain size (with the aid of the lasers). At each station, a portion of the video transect that typically extended approximately 25 to 50 m in length was isolated for analysis. In some instances, this length of useable video was not available due to field conditions, and therefore a shorter distance was analyzed. Subsequently, the video was subsampled to approximately one frame per second and consecutive frames that did not overlap were analyzed. The number of frames analyzed per station varied depending on the length and quality of the video transect and ranged from 4 (for stations that were subsampled due to unusual features such boulder fields) to 81. However, ~75% of the stations had between 20 and 56 frames analyzed.

The bottom sediment viewed in each frame was first described as mud-sand or gravel. The camera optics did not allow individual particles of mud or sand to be seen. Therefore, the sediment type was considered a mud-sand if individual grains were not visible and little or no gravel was present. The mud-sand class was not differentiated into mud, sandy mud, muddy sand, or sand unless a bottom sediment sample was collected nearby (<100 m), grain size analysis had been conducted, and the seafloor was relatively homogeneous. Gravel bottoms were typically composed of mixtures of pebbles, cobbles, and boulders with varying amounts of sand or granule material. If the gravel size clasts (individual grains or fragments of a rocks that were visible) were largely in contact, the bottom was classified as a gravel with the appropriate modifiers (described below and in Table 1a). If the gravel clasts were separated by sand or granule material, then the seafloor was classified as a sandy gravel with the appropriate modifiers.

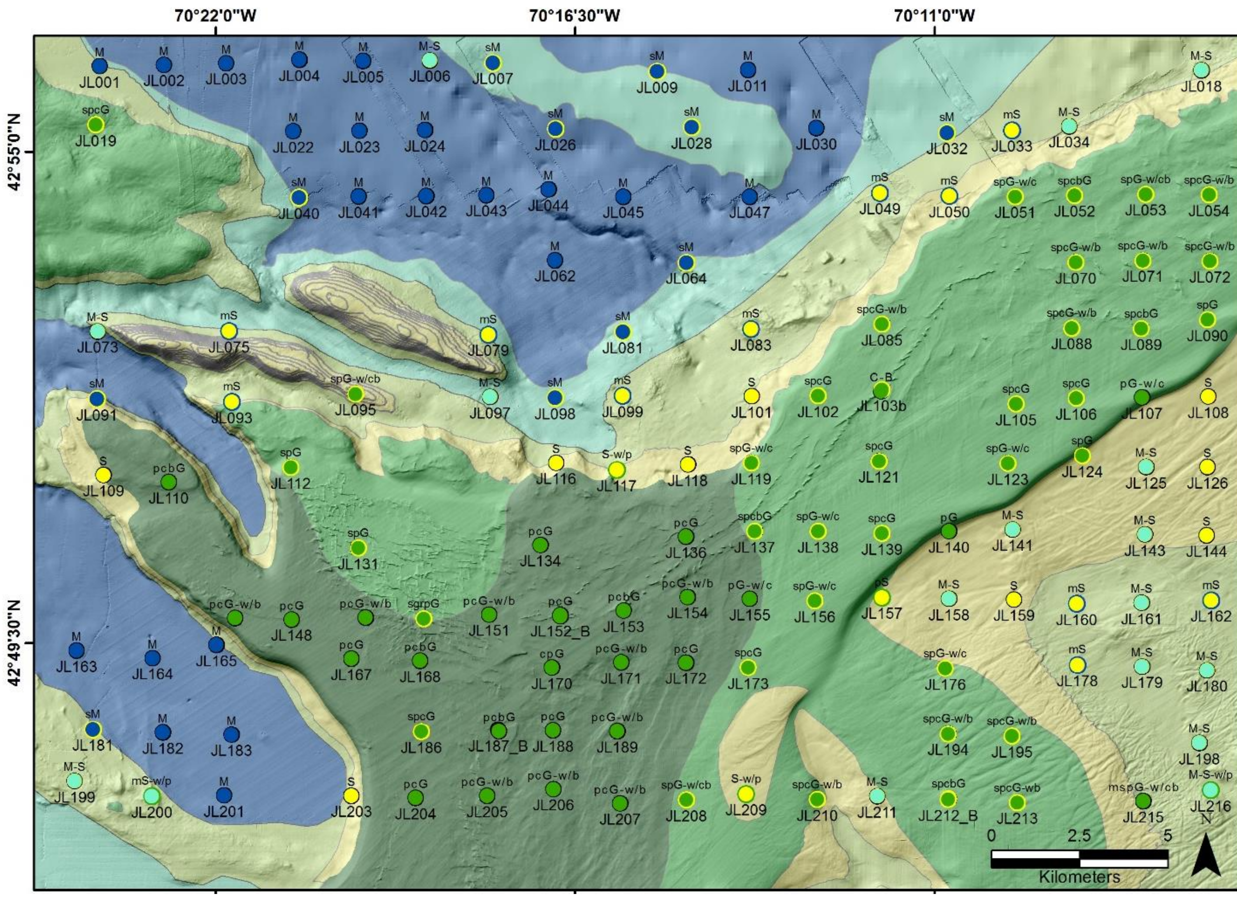

Figure 5. Location map of videography stations at Jeffreys Ledge. The colors of the circles (station markers) indicate the sediment classification based primarily on analysis of the video (solid green is gravel; green with yellow halo is sandy gravel; yellow is sand; blue is mud; and cyan is sand or mud). The complete sediment classification (abbreviations) based on video is given above the station markers; the station number is given below the station marker. The video-based bottom sediment classification was developed for this study. The base map depicts the CMECS substrate group sediment classification based on the video analysis and sediment samples (see Figure 2). The figure is included with the database "Jeffreys_Ledge_Geophysical_Database_Location_Map_Photos.tiff").

To further refine the gravel classification, the presence (or absence) of pebbles, cobbles, or boulders within each frame (that did not overlap) for a station was noted and the percentage of frames containing each of these categories for the entire station transect determined. Note that the actual percentage of the area of a frame composed by a class size (pebble, cobble, or boulder) was not determined, rather simply if any pebbles, cobbles, or boulders were present in that frame. For this study, a pebble was defined as any individual clast that was large enough to be visible in the video and smaller than ~6 cm as determined by comparison to the lasers; cobbles were ~6 to 25 cm; and boulders were larger than ~25 cm. These boundaries approximate the Wentworth Scale (pebbles: 4 to 6.4 mm; cobbles: 6.4 to 25.6 cm;

and boulders: >25.6 cm; see Folk, 1980). Granule size gravel (2 to 4 mm) was not identified due to the limitations of the camera optics.

The classification of the gravel substrate was based on the percent of frames analyzed at a station that contained pebbles, cobbles, or boulders. If any of these size clasts were found in over 50% of the frames analyzed, then the seafloor was considered a pebble, cobble, and/or boulder gravel. If these clasts appeared in 10 to 50% of the frames analyzed, then the seafloor was considered a gravel with pebbles, cobbles, and/or boulders. A gravel bottom could then be any combination of these sizes. For instance, a pebble gravel, a pebble gravel with cobbles, or a pebble cobble gravel with boulders, depending on the occurrence of the different clast sizes. Examples of the bottom sediment classification determined from the quantitative analysis of the seafloor videography is shown in Figure 6.

Importantly, the video-based classification described here can be used to apply the CMECS classification which has been widely adopted to standardize the description of the seafloor across disciplines (FGDC, 2012). A crossover table relating the seafloor sediment classification developed here based on the analysis of the video and the established CMECS substrate group and subgroup classes is offered in Table 1b.

Table 1a. Classification of gravel bottoms based on videography from Jeffreys Ledge.

Seafloor Classification	**Gravel in Contact or Separated by Sand**	**% of Frames With Pebbles**	**% of Frames With Cobbles**	**% of Frames With Boulders**
Pebble Gravel (pG)	Gravel in Contact	>50%	<10%	<10%
Pebble Gravel with Cobbles (pG-w/c)	Gravel in Contact	>50%	10-50%	<10%
Pebble Gravel with Cobbles and Boulders (pG-w/cb)	Gravel in Contact	>50%	10-50%	10-50%
Pebble and Cobble Gravel (pcG)	Gravel in Contact	>50%	>50%	<10%
Pebble and Cobble Gravel with Boulders (pcG-w/b)	Gravel in Contact	>50%	>50%	10-50%
Pebble Cobble and Boulder Gravel (pcbG)	Gravel in Contact	>50%	>50%	>50%
Sandy Pebble Gravel (spG)	Separated by Sand	>50%	<10%	<10%
Sandy Pebble Gravel with Cobbles (spG-w/c)	Separated by Sand	>50%	10-50%	<10%
Sandy Pebble Gravel with Cobbles and Boulders (spG-w/cb)	Separated by Sand	>50%	10-50%	10-50%
Sandy Pebble and Cobble Gravel (spcG)	Separated by Sand	>50%	>50%	<10%
Sandy Pebble and Cobble Gravel with Boulders (spcG-w/B)	Separated by Sand	>50%	>50%	10-50%
Sandy Pebble Cobble and Boulder Gravel (spcbG)	Separated by Sand	>50%	>50%	>50%

Table 1b. Crossover seafloor sediment classification based on videography developed for this study and the standard CMECS substrate group and subgroup classification (FGDC, 2012). The subgroups in italics are classifications proposed for CMECS, but are not presently incorporated.

Seafloor Classification Based on Video Analysis	**CMECS Group**	**Suggested CMECS Subgroup**
Pebble Gravel	Gravel	*Pebble Gravel*
Pebble Gravel with Cobbles	Gravel	*Pebble and Cobble Gravel*
Pebble Gravel with Cobbles and Boulders	Gravel	*Pebble, Cobble, and Boulder Gravel*
Pebble and Cobble Gravel	Gravel	*Pebble and Cobble Gravel*
Pebble and Cobble Gravel with Boulders	Gravel	*Pebble, Cobble, and Boulder Gravel*
Pebble Cobble and Boulder Gravel	Gravel	*Cobble and Boulder Gravel*
Sandy Pebble Gravel	Gravel Mixes	*Sandy Pebble Gravel*
Sandy Pebble Gravel with Cobbles	Gravel Mixes	*Sandy Pebble Gravel with Cobbles*
Sandy Pebble Gravel with Cobbles and Boulders	Gravel Mixes	*Sandy Pebble Gravel with Cobbles and Boulders*
Sandy Pebble and Cobble Gravel	Gravel Mixes	*Sandy Pebble and Cobble Gravel*
Sandy Pebble and Cobble Gravel with Boulders	Gravel Mixes	*Sandy Pebble and Cobble Gravel with Boulders*
Sandy Pebble Cobble and Boulder Gravel	Gravel Mixes	*Sandy Pebble Cobble and Boulder Gravel*

JL112 – Sandy Pebble Gravel

JL102 – Sandy Pebble Cobble Gravel

JL052 – Sandy Pebble Cobble Boulder Gravel

JL140 – Pebble Gravel

JL134 – Pebble Cobble Gravel

JL187a – Pebble Cobble Boulder Gravel

JL007 – Sandy Mud

JL152a – Cobble Boulder Ridge

JL189 – Pebble Cobble Gravel with Boulders. Note ghost net.

Figure 6. Examples of seafloor classifications based on analysis of the bottom videography developed for this study.

Summary

High-resolution bathymetry, videography, and direct sampling were used to develop detailed descriptions of the morphology and surficial sediments (size, classification, and distribution) of the seafloor for an approximately 515 km² area at Jeffreys Ledge. A sediment classification based on video for gravel-dominated areas (i.e., platform or surface of Jeffreys Ledge based on video), used in conjunction with conventional bottom sediment sampling and analysis in finer-grained sediments (i.e., deeper adjacent areas), facilitated the development of the bottom sediment map (Figure 2). This knowledge, along with the high-resolution bathymetry, is important for managing this environment, as well as understanding the geologic processes at play in and around Jeffreys Ledge.

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