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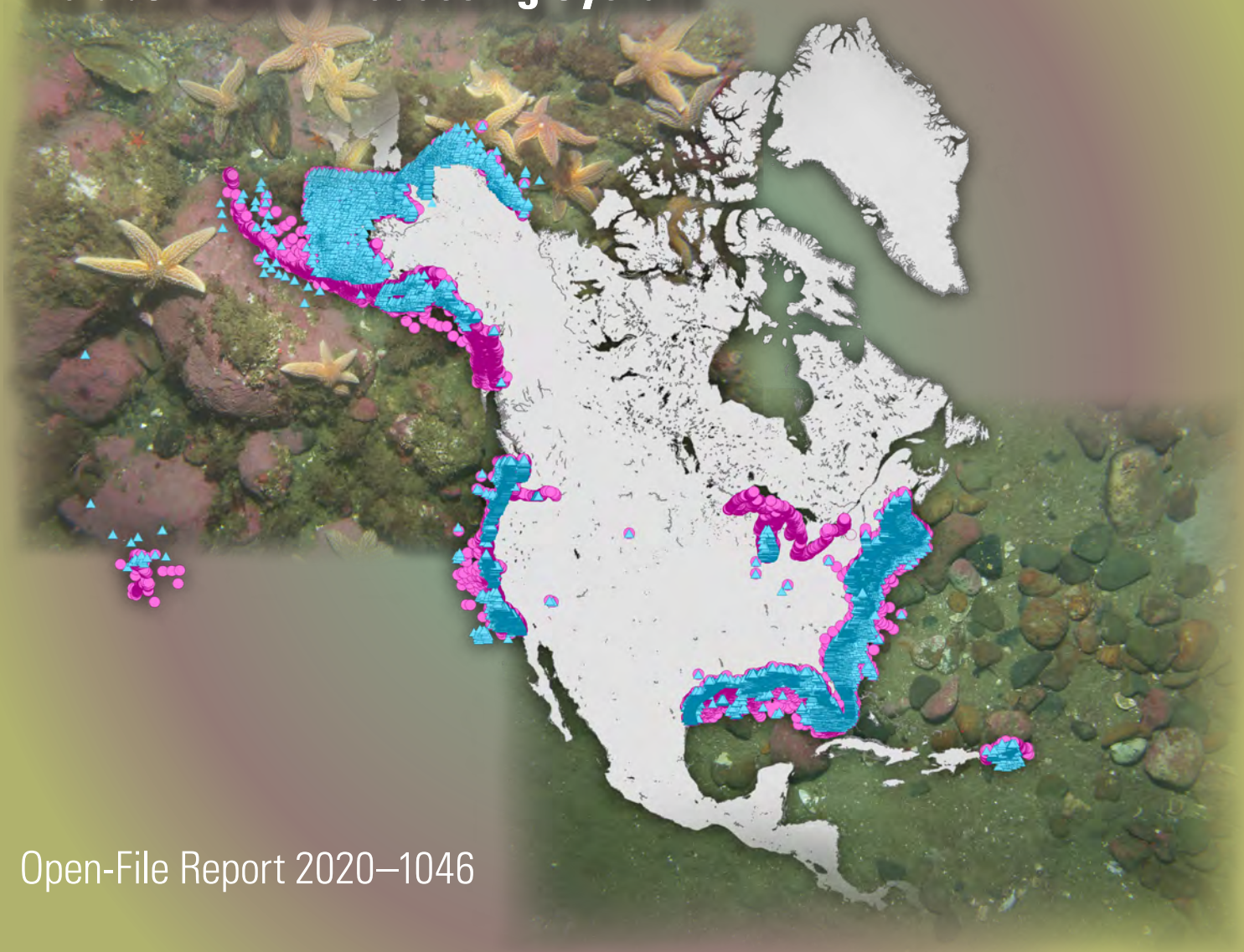
Sediments and the Sea Floor of the Continental Shelves and Coastal Waters of the United States—About the usSEABED Integrated Sea-Floor-Characterization Database, Built With the dbSEABED Processing System



Open-File Report 2020–1046

U.S. Department of the Interior
U.S. Geological Survey

Cover. Bottom photographs collected on U.S. Geological Survey Woods Hole Coastal and Marine Science Center Field Activity 2007–003–FA. Map image showing the distribution of usSEABED data output files US9_EXT (blue triangles) and US9_PRS (pink circles) around the continental United States, Hawai'i, and Puerto Rico.

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U.S. Department of the Interior
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DAVID BERNHARDT, Secretary

U.S. Geological Survey
James F. Reilly II, Director

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Abbreviations

CLC	calculated [data]
CMP	component [data]
EXT	extracted [data]
FAC	facies [data]
GIS	geographic information system
IOW	Institute für Ostseewissenschaften-Warnemünde
NOAA	National Oceanic and Atmospheric Administration
PRS	parsed [data]
SRC	source [data]
USGS	U.S. Geological Survey

Sediments and the Sea Floor of the Continental Shelves and Coastal Waters of the United States—About the usSEABED Integrated Sea-Floor-Characterization Database, Built With the dbSEABED Processing System

By Brian J. Buczkowski,[1] Jane A. Reid,[1] and Chris J. Jenkins[2]

Abstract

Since the second half of the 20th century, there has been an increase in scientific interest, research effort, and information gathered on the geologic sedimentary character of the continental margins of the United States. Data and information from thousands of sources have increased our scientific understanding of the character of the margin surface, but rarely have those data been combined and integrated. Initially, the U.S. Geological Survey (USGS), in cooperation with the Institute of Arctic and Alpine Research at the University of Colorado Boulder, created the usSEABED database to provide surficial sea-floor-characterization data for USGS assessments of marine-based aggregates and for studies of sea-floor habitat. Since then, the USGS has continued to build up the database as a nationwide resource for many uses and applications.

Previously published data derived from the usSEABED database have been released as three USGS data series publications containing data covering the U.S. Atlantic margin, the Gulf of Mexico and Caribbean regions, and the Pacific coast. An updated USGS data release unifies the three publications, incorporates additional data and sources including data from Alaska, Hawaii, and U.S. overseas territories, and provides revised output files that fix known errors and add known or inferred sampling dates. This report accompanies the data release and contains information on the methodology and products of the usSEABED database.

Introduction

The usSEABED integrated database created by the U.S. Geological Survey (USGS), in cooperation with the Institute of Arctic and Alpine Research at the University of Colorado Boulder, offers data on surficial sediment and other characteristics of the U.S. continental shelves, coastal and large inland waterways, and other areas of the U.S. Exclusive Economic Zone. The associated USGS data release (Buczkowski and others, 2020) provides online access to usSEABED data and offers an expanded dataset that both includes updated data originally in prior publications (Reid and others, 2005; Buczkowski and others, 2006; Reid and others, 2006) and additional data from dozens of new sources.

usSEABED is a digital, numerical, and georeferenced database that integrates measurements and observations of the surficial sea floor, including textural, statistical, geochemical, geophysical, and compositional information of the sediment cover, across multiple original sea-floor datasets. The database is generated by using the most recently available version of the dbSEABED data mining and processing software, which extends the coverage of information in areas where data coverage is more descriptive than quantitative (Jenkins, 1997, 2002). This accompanying report describes the structure of the usSEABED integrated database and explains how it is built, how the data should be interpreted, and how they are best used.

Applications

The usSEABED database is a large compilation (more than 1 million points, nationwide) and contains complex assortments of data and geologic information on the surficial character of the sea floor. Although the database was initially developed for use in studies of offshore sedimentary character for assessing marine aggregates and characterizing benthic habitats, it has potential for broader application by the marine science community and other users. Users are encouraged to generate their own queries and extract information to meet specific needs. Some possible applications where data and maps from the usSEABED database are useful include the following:

- Observation and monitoring research
- Management and planning of coastal zones

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- Homeland security and military applications
- Sea-floor engineering, planning, and design
- Placement and monitoring of ocean disposal sites
- Cultural resource protection
- Fisheries management and marine protected areas
- Scientific studies and seabed mapping requiring data on seabed roughness, bedform distribution, critical shear stress, and sediment transport flux
- Educational activities requiring illustrations or datasets
- Coastal change hazard predictive models requiring determination of sea-floor bottom-friction values for calibration

The Data in usSEABED

The usSEABED database is based on published and unpublished laboratory measurements and descriptive observations that have been processed and extended by using the dbSEABED processing software (for detailed information on dbSEABED software, please refer to the information provided in Reid and others, 2005; Buczkowski and others, 2006; and Reid and others, 2006). The usSEABED database includes not only standard forms of numerical data but also a vast store of data about the sea floor derived from word-based descriptions that can be rich in information but, in their original form, are difficult to quantify, map, plot, or use in comparative analyses or models. The database provides numerical values for typical seabed characteristics that are based on these descriptive data. The usSEABED database differs from other marine databases in that it not only incorporates a variety of information about sea-floor sediment texture but also includes information on composition, color, biota, and rocks, as well as sea-floor characteristics such as hardness, acoustic properties, and geochemical and geotechnical analyses where available.

Although the dbSEABED software makes data coverage more comprehensive for mapping and analysis, the inclusion of sites geospatially located by now outmoded navigational techniques and sampled with a variety of sampler types adds locational uncertainty for some sites. Furthermore, the process of unifying the data into common units, combining data with different lab protocols, and creating numerical data from imprecise word-based descriptions means that absolute data precision is unavailable. Users of usSEABED data are encouraged to use the data on small scales (that is, over large areas) and make their own assessments of data reliability.

These reliability assessments can be made by reading this entire document, as well as detailed information on "dbSEABED (processing)" included in each of Reid and others (2005), Buczkowski and others (2006), and Reid and others (2006), before downloading the data files from the data release (Buczkowski and others, 2020). Source citation information is available on the usSEABED project website and includes information about individual sources' methods and procedures, estimates of accuracy, dates of collection, and other pertinent information.

The database can be queried online and the downloaded output files are provided as comma-delimited text files for ease of use. These files are ready for inclusion into many different geographic information system (GIS), relational database, and other software applications.

How usSEABED is Built

The usSEABED database is generated by using the dbSEABED processing software created at the University of Sydney (Australia) and the University of Colorado. It has companion databases built along similar lines, including the Australian auSEABED, Baltic Sea balticSEABED, and a global database, goSEABED. Each of these databases relies on preexisting data from a variety of sources to mine and extrapolate useful information about the seabed.

The dbSEABED software allows these source datasets to be compiled in a standardized format and integrates information across a series of data themes (table 1). Each data theme holds multiple fields of numerical and (or) word-based information. Original data are from samples collected with physical equipment (grabs, cores, or probes), are from observations that are remotely sensed (such as descriptions from photographs and videos), or are gathered through geophysical methods. Source data may be numerical lab- or instrument-based textural, acoustic, geochemical, or geophysical data; verbal (linguistic) descriptions of grabs, cores, or photographs; or a combination of any of these.

In building the usSEABED database, many data sources are processed by dbSEABED software to determine associated data beyond what is provided in the source document, such as statistical parameters from a series of grain-size analyses. The additional information increases the spatial and thematic completeness of the database. Even with the extra fields produced through the dbSEABED processing, few source reports contain all data types reportable in the usSEABED database; null values are given in those fields without data.

Sources of Data

usSEABED relies on previously collected data, both published and unpublished, from Federal, State, regional, and local agencies and consortiums, as well as research institutions. For the offshore areas within the U.S. Exclusive Economic Zone, many of the data are from the USGS, including published and unpublished data from the 1960s to the present.

Table 1. Key to data themes in usSEABED output files and examples of the types of data that may be included in the themes.

Acronym	Meaning and examples
ACU	Acoustic properties (measured P- and S-wave velocities; acoustically derived density, porosity, and void ratio data)
AGE	Sample ages (carbon-14 age dates, upper and lower age confidence limits, sedimentation rates)
BIO	Biota descriptions (size, type, abundance, and form of biota, including infauna and epifauna)
CLS	Landform classifications (landform and reef structures; proportions of rocky, sandy, and muddy coasts)
CMP	Sediment composition analyses (weight percent of carbonate and nitrogen, as well as iron, titanium, and aluminum oxides)
COL	Sediment colors (color descriptions, Munsell color codes)
DIV	Diver reports (current, turbidity, wave period and height, seabed description)
DYN	Experimental hydrodynamic analyses (settling velocities; experimental bedload grain sizes; statistical data, including mean and standard deviation grain sizes, and graphical skewness and kurtosis)
ENV	Environmental observations (pH, reduction potential, carbon to nitrogen ratios)
GCM	Geochemistry analyses (constituent chemical components and their abundances)
GRZ	Grain-size analyses (coarse and fine grain-size limits, abundances of coarse and fine fractions)
GTC	Geotechnical properties (penetrometer strength, thermal conductivity, plasticity, shear strength)
IMG	Imagery interpretations (type of image, number of photos, height above sea floor)
ISO	Isotopic analyses (18O, 13C, 15C, and 210Pb ratios)
LTH	Lithologic descriptions (lithologic descriptions, including compaction, texture, layering, structure, sorting, and alteration); may include Folk codes (Folk, 1954)
MSL	Analyses from multisensor core loggers (P-wave amplitudes and velocities, gamma ray densities, acoustic impedance, and fractional porosities)
OCE	Oceanographic data (temperatures, salinities, pHs, currents, dissolved oxygen levels)
PAL	Paleontological observations (descriptions of fossil components, preservation, and mode of occurrence)
PET	Grain petrographic analyses (grain types, shapes, sorting, character)
PRB	Field data from electronic probes (penetrometer bearing strengths and ranges)
SDT	Sediment thickness data (unit thicknesses, top and basal horizon descriptions)
SFT	Sea-floor type descriptions (descriptions of the sea floor, including wavelength, height, and slope of the seabed)
TRB	Turbidity observations (Secchi disk observations, suspended sediment concentrations, transmissivity)
TXG	Graphical texture statistics (grain-size percentiles, Inman (1952), Folk and Ward (1957) grain-size statistics, including mean and median grain sizes, skewness, and standard deviation)
TXN	Taxonomic observations (taxonomic names)
TXR	Texture statistics (grain-size data, including gravel, sand, silt, clay, and mud weight percent; grain-size statistical data, including mean and median grain sizes, skewness, and kurtosis)
XRD	X-ray diffraction analyses (mineral names and calculated abundances, peak counts and spacings)

Data gathered by the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service during its many sounding surveys in the 1800s to 2000s are included, as archived by the Smithsonian Institution and as provided by the National Geophysical Data Center. Theses and dissertations from many universities, U.S. Army Corps of Engineers reports, local and regional coastal management agencies, state geological surveys, and U.S. Navy reports are also included. Large data compilations also contribute to the database, including the joint USGS–NOAA Gulf of Alaska National Ocean Service digitization project (Golden and others, 2016) and the U.S. Geological Survey East-Coast Sediment Texture Database (Poppe and others, 2014). A citations list for usSEABED sources contributing to the data release is in the usSEABED source file, US9_SRC.

Efforts have been made to reduce data duplications within usSEABED that may result if data from the same field activity or site are published in more than one source report or data compilation. For example, the National Geophysical Data Center's Seafloor Surficial Sediments (Deck 41) compilation contains information from several sources. If data from original and more complete sources are included in the usSEABED database, data for those same sites are not imported into the usSEABED database from the National Geophysical Data Center's Deck 41 dataset. (See the section "dbSEABED (processing)" included in Reid and others, 2005; Buczkowski

and others, 2006; and Reid and others, 2006, for information on how data are incorporated by the dbSEABED software.) In other instances, data from multiple sources for a given site are included in the usSEABED database if additional data fields are included as a result. For example, one source may report only grain size for a particular site, but another source may include geophysical properties for the same site.

Output Files

The USGS data release for the usSEABED database (Buczkowski and others, 2020) enables search and download of six interlinked files of output data and a seventh file that provides linked information about the original data sources (table 2).

These files can be downloaded in their entirety and are also searchable through an online interface that allows for search and selection either through a GIS display or through a web form. Both options query and export selected portions of the usSEABED database.

Relational Keys

Values in the usSEABED data file types are linked relationally by three relational keys: DataSetKey (for source datasets), LocnKey (for individual sites), and the ObsvnKey (for individual analyses). The DataSetKey field gives the relationship of the data to the original source using the information provided in the US9_SRC file. When files are loaded into a relational database or GIS, the keys-in-common can be used to construct relationships between the tables, thereby joining the data across files.

Source Data (US9_SRC)

Information about the original data is in the source (US9_SRC) file. Each value in the output data files discussed below is linked to the corresponding item in the US9_SRC file by the DataSetKey field. Information on data sources is also provided with the online data portal in a more traditional bibliographic format.

Textural and Other Basic Information (US9_EXT, US9_PRS, US9_CLC, and US9_ONE)

Textural, statistical, geochemical, geophysical, dominant component, and color data are available in three data files, which represent the three ways the data were obtained. The US9_EXT data file contains data categorized as extracted from lab-based analytical data and generally represents statistical results as given by the original source. The US9_PRS data file contains so-called parsed data; that is, numerical information determined within the dbSEABED software through processes based on fuzzy-set theory, applied to written descriptions. The US9_CLC data file contains calculated data created through the application of known relationships between analytical values or through the application of empirical relationships (see "Parsing Description: A simplified description of dbSEABED processing" in Reid and others, 2005; Buczkowski and others, 2006; and Reid and others, 2006). In some samples where subsample depths are not provided by the original data source, assumptions are made about sediment-layer thickness within the dbSEABED software, based on the sampler type. Many original datasets include information that fits into more than

Table 2. usSEABED output files.

Data file	Contents
US9_ONE	Combined information including extracted, parsed, and calculated information about grain size, sediment texture, color, age, and other information about the sea floor derived from quantitative observations and analyses of samples (extracted); information, from written descriptions from cores, grabs, photographs, and videos (parsed); and information from calculations based on empirical relations or known functions performed by dbSEABED software (calculated)
US9_EXT	Extracted information about grain size, sediment texture, color, age, and other information about the sea floor derived from quantitative observations and analyses of samples
US9_PRS	Parsed information about grain size, sediment texture, color, age, and other information about the sea floor derived from written descriptions from cores, grabs, photographs, and videos
US9_CLC	Calculated information about grain size, sediment texture, color, age, and other information about the sea floor derived from calculations based on empirical relations or known functions performed by dbSEABED software
US9_FAC	Concatenated information about components (minerals and rock type), genesis (igneous, metamorphic, carbonate, terrigenous), and other appropriate groupings of information about the sea floor parsed from written descriptions of cores, grabs, photographs, and videos
US9_CMP	Numerical data about selected components (for example, minerals, rock type, microfossils, and benthic biota) and sea-floor features (for example, bioturbation, structure, and ripples) at a given site; values in the attribute fields are measures of membership in that attribute's fuzzy set
US9_SRC	Information about the original source data incorporated into the usSEABED database

one of the extracted, parsed, and calculated categories, giving overlapping results for most samples. US9_ONE combines the information from the three data textural files.

Extracted Data

Extracted data are those data from lab-based, numerical analyses. Most data in this file are listed as reported by the source data report; generally, only minor unit changes have been performed. Typical data themes include textural distributions and statistics (TXR: gravel, sand, silt, clay, mud, and various statistics), phi-based grain-size classes (GRZ), chemical compositions (CMP), acoustic measurements (ACU), color (COL), and geotechnical parameters (GTC). Extracted data are based on lab-determined values and are the most reliable data. Limitations, however, exist when there is uncertainty about how much of the sample has been analyzed. For example, the analysis may have been performed only on the matrix, ignoring larger particles such as shells or pebbles.

Parsed Data

Numerical data derived from verbal logs, core or grab sample descriptions, shipboard notes, and photograph descriptions are classified as parsed data. Verbal input data are maintained in the terms employed by the original researchers but are coded by using phonetically derived abbreviations for easier processing by the dbSEABED software. Data in longer descriptions are sometimes divided by theme (table 1). The descriptions often include information on associated biota, sea-floor features, and structure. Typical data themes for the parsed dataset are lithologic descriptions (LTH), biology (BIO), color (COL), and sea-floor type (SFT, descriptions from photos and videos). Data values are calculated by using the dbSEABED software parser, which uses fuzzy-set theory to assign field values based on the form and content of a description. The application of fuzzy-set theory to verbal descriptions allows a sample or observation to belong partially to an attribute in the database, referred to as a "set." How much an entry in the database is represented by a set is referred to as degree of membership. Fuzzy-set theory suits words because they are often partial carriers of categorical meaning. For example, a sample described as "gravelly mud" is partially gravel and partially mud, with mud being the predominant component (for more details, see "Parsing Description: A simplified description of dbSEABED processing" in Reid and others, 2005; Buczkowski and others, 2006; Reid and others, 2006; and Jenkins, 1997, 2002, and 2003). Similarly parsed verbal information is also used to produce the US9_CMP and US9_FAC data, described in the report section "Component/Feature and Facies Data (US9_CMP and US9_FAC)."

The parsing process was tested and calibrated by comparing the outputs against analytical results for the same samples (see the section "Calibrations" included in each of Reid and others, 2005; Buczkowski and others, 2006; and Reid and others, 2006). The fuzzy-set theory used in the parser produces output data that are degrees of membership in fuzzy sets (Mott and others, 1986). In the example given above, "gravelly mud" applied to fuzzy-set theory would result in degrees of membership assigned for both "Gravel" and "Mud" attributes, where the degree of membership for "Mud" is greater than the degree of membership for "Gravel." Output data are expected to be somewhat close to, but not fully equivalent to, the percent abundance of a characteristic in the sample or seabed being observed. Calibrations within the dbSEABED software provide assurance that the output degrees of membership reflect absolute abundances to some degree of accuracy.

For a laboratory sample of well-sorted fine sediments, the descriptive results in the parsed file will be less accurate than measured values in the extracted file. For complex, living seabeds, the data in the parsed file can be more representative of the sample and seabed as a whole, as they may include description of objects such as shells, stones, algae, and other objects that are a textural component of the seabed and are often left out of laboratory samples that are analyzed, particularly when a machine analysis is employed.

Calculated Data

For the extracted and parsed data sources, the usSEABED database provides some values that are not reported by the original source but can be calculated directly or estimated by standard derivative equations by using assumptions about the conditions or variables (for detailed information, see the section "Summary of the onCALCULATION Methods used in dbSEABED" included in each of Reid and others, 2005; Buczkowski and others, 2006; and Reid and others, 2006). In the usSEABED database, these values are reported as calculated data. Calculated data are the least reliable of the three data types and should be used with caution.

Combined Data

The US9_ONE file provides a single, concise coverage of the sea floor that combines extracted (EXT), parsed (PRS), and calculated (CLC) data. Analyzing information telescoped in the US9_ONE file can be advantageous over comparing extracted, parsed, and calculated files to each other by enabling the user to see data from all three data files together with their data merged into a single output. However, it is important for users to understand the inherent limitations of the original data files (US9_EXT, US9_PRS, US9_CLC) to choose the value, or combination of values, from this combined data file that are most appropriate for a particular use. Each entry in the US9_ONE file contains a "DataTypes" code (produced by the dbSEABED software) to identify which output file (extracted, parsed, or calculated) provided the data listed in each attribute for the sample or observation. This code consists of 20 characters, which represent the following data attributes, in order: Gravel, Sand, Mud, Clay, Grainsze, Sorting, Facies, FacMshp, FolkCde, RckMshp, VegMshp, Carbonate, MunslColr, OrgCarbn, lShearStr, Porosity, PWaveVel, Roughness, lCritShStr, and GeolAge

(table 3). Attributes identified with "E" have data derived from extracted data, attributes identified with "P" have data derived from parsed data, and attributes identified with "C" have data derived from calculated data. Attributes identified with an "x" have no recorded extracted, parsed, or calculated data.

In order to allow users to use their preferred type of data, the full and independent files of EXT, PRS, and CLC data are also provided in the data release publication. Data may exist in each of the three files for a given subsample, consistent with the original data. The same fields are reported in each file (table 3) and can be linked by the relational keys (DataSetKey, LocnKey, and ObsvnKey).

Component/Feature and Facies Data (US9_CMP and US9_FAC)

Two usSEABED data files (US9_CMP and US9_FAC) contain information about compositional content, biota, and sediment structure present on the sea floor. These data can be relationally linked to data in the four files that contain textural and other typical sea-floor data using the ObsvnKey field. The data reported in US9_CMP and US9_FAC files are class names defined by the thesaurus in the dbSEABED parsing software, which clusters comparable identifying terms together. For example, the "quartz sediment" component can be indicated by the terms "quartz feldspar", "quartzite", "quartzose", "silica sediment", etc. The "granite" facies represents significant use of the words "granite," "aplite," "granodiorite," and "pegmatite"; the "laminated" structure represents "laminated," "laminations," or "lamina." Individual components and features (terms like "feldspar," "phosphorite," "bivalves," "seagrass," and "wood") are held in the US9_CMP data file (table 4). Here, a significant use is defined as a membership of greater than 33 to the component or facies fuzzy set. Combinations of components with significant occurrences in a subsample are held in the facies (US9_FAC) data file (table 5). As with the parsed data in the US9_ONE and US9_PRS file, the values held within the US9_CMP and US9_FAC files are the results of applying functions of fuzzy-set membership to verbal data and represent a measure of veracity about the attribute, not percentages or defined values. (These files indicate only presence, not absence, of material; it is rare that a report might state, "no bivalves" or "no phosphorite.")

The US9_CMP file contains information about compositional content (individual minerals, rocks), genesis (terrigenous, carbonate), and certain biota. These components are evaluated by the dbSEABED software, and the value for each attribute is based solely on the relationships of attributes within the original description. The flora and fauna included in the compositional components are those that may affect textural determinations in the parsed data, such as halimeda, bivalves, or foraminifera (table 6). The values within these attribute fields range between 0 (no membership, possibly due to no information) to 100 (complete membership; for example, shell hash is 100 membership in the shell debris set).

The US9_CMP file also includes information on sea-floor features that appear in more than 0.01 percent of samples, such as odors, including hydrogen sulfide (H2S). Unlike the compositional content information, which is construed as an abundance within the sample, these attributes are not included in the textural determination found in parsed data. Values within the attribute fields range from 0 (no membership, possibly due to no information) up to 100 (maximum feature development). In contrast to the component abundances, the sum of feature memberships in a sample is allowed to exceed 100.

The 44 components and the 3 features (codes tagged with "_F") that appear in more than 0.01 percent of parsed samples within the U.S. Exclusive Economic Zone are given in the US9_CMP file. Table 4 lists the components and gives basic forms of descriptive terms that contribute to membership for each.

The facies file (US9_FAC) summarizes the presence of related groups of components, denoted as facies, such as igneous, metamorphic, ooze, and foraminifera. The dbSEABED facies processing is limited to a maximum of six components per facies; however, not all facies have six defining components. Table 5 lists the most common facies types and the basic forms of components that comprise each facies group.

Again, the US9_CMP and US9_FAC files only indicate presence, not absence, of material; it is rare that a source report states, "no bivalves" or "no phosphorite," for example. The values within this attribute field range between 0 (no membership in the fuzzy set, possibly due to no information) to 100 (complete membership, for example, a schist membership of 100 produces a membership of 100 in the metamorphic set).

Relationship Between Parsed and Component Data

The dbSEABED software recognizes that many skeletonized biota, such as halimeda, rhodoliths, and shells (broken and unbroken), often constitute all or part of a sediment sample. Such biological terms are included in the parsing of the textural values. The selected biota with textural implications are listed in table 6. When using the parsed data, it may be important to cross-check with the component file by using the relational keys (LocnKey, ObsvnKey) to determine if biota are included in the textural outputs.

Within the parsed data textural file (US9_PRS), the "Facies" and "FacMshp" fields indicate the dominant compositional facies and the fuzzy-set membership of a sample in that facies. Other components and observations may also be listed for that sample in the US9_CMP file, linked by the relational keys.

Table 3. Field parameters, format, units, range, meaning, and comments for extracted, parsed, and calculated data in the US9_ONE (extending to US9_EXT, US9_PRS, and US9_CLC) file.

[%, percent; kPa, kilopascal; m/s, meter per second; P/T, high pressure and temperature; V:H, ratio of vertical height to horizontal length]

Attribute	Parameter	Data format	Units, range, meaning	Comment
Latitude	Latitude	Decimal 00.00000	Decimal degrees, 90° to −90° range	Represents a mix of datums; users of the data should note the available information found in the original sources and use their own criteria for assessing the accuracy of the locations.
Longitude	Longitude	Decimal 000.00000	Decimal degrees, −180° to 180° range	Represents a mix of datums; users of the data should note the available information found in the original sources and use their own criteria for assessing the accuracy of the locations.
WaterDepth	Water depth	Integer 00000	Meters	Corrections for tides should not be assumed.
ObsvnTop	Observation top	Decimal 000.00	Meters below seabed surface	Observation top as noted in source report.
ObsvnBot	Observation bottom	Decimal 000.00	Meters below seabed surface	Observation bottom as noted in source report.
LocName	Location name	Character Xxxx….	Survey or laboratory code for the sampling site	Not unique; site name as given in report; sometimes linked to cruise name or other information to decrease site name overlap.
DataSetKey	Dataset number key	Integer 000	Generated by dbSEABED processing software	Relational key linking to data source (US9_SRC) file.
LocnKey	Location key	Integer 0000000	Generated by dbSEABED processing software	Relational key linking to data from the same location in other data files. Each location counted sequentially as total output; core data may have more than one sample per site.
ObsvnKey	Observation key	Integer 0000000	Generated by dbSEABED processing software	Relational key linking to data from same observation or sample in other data files. Each sample or observation site counted sequentially as total output; multiple samples may be at each site (that is, within core).
Device	Device type	Character Xxxx....	Type of sampling or observation device	As given in source report; recovery (“rcvy”) or penetration (“pen”) length appended if given in source report.
DataTypes	Data types	Character xxxxxxxxxxxxxxxxxxxx	Code produced by the dbSEABED processing software to identify which output file (extracted, parsed, or calculated) was used, or data themes recorded during data entry	Code used in two ways. In the US9_ONE file that identifies which type of data (extracted, parsed, or calculated) is provided in the attribute fields for the observation. In the outputs of US9_EXT, US9_PRS, and US9_CLC, this field provides the dbSEABED software’s data themes for the observation.
Gravel	Gravel	Integer 000	Gravel grain-size fraction, %	Textural class.
Sand	Sand	Integer 000	Sand grain-size fraction, %	Textural class.

Table 3. Field parameters, format, units, range, meaning, and comments for extracted, parsed, and calculated data in the US9_ONE (extending to US9_EXT, US9_PRS, and US9_CLC) file.—Continued

[%, percent; kPa, kilopascal; m/s, meter per second; P/T, high pressure and temperature; V:H, ratio of vertical height to horizontal length]

Attribute	Parameter	Data format	Units, range, meaning	Comment
Mud	Mud	Integer 000	Mud grain-size fraction, %	Textural class.
Clay	Clay	Integer 000	Clay grain-size fraction, %	Textural class; output for extracted data only, as clay value can be determined only by analysis.
Grainsize	Grain size	Decimal 00.00	Phi characteristic grain size	Characteristic grainsize, based on mean and median grain size values.
Sorting	Sorting	Decimal 0.00	Phi grain-size dispersion	Standard deviation.
Facies	Sea-floor facies	Character Xxxx....	Facies with the maximum fuzzy-set membership, if above 30%	Output for parsed data only.
FacMshp	Facies membership	Decimal 000	Fuzzy-set membership (%) of the class (or facies), noted above	Output for parsed data only.
FolkCde	Folk classification	Character xx.XX....	Grain-size classification based on the Folk Code (Folk and others, 1970)	
RckMshp	Rock index	Integer 000	Fuzzy-set membership (%)	Degree of membership of sample in the rock fuzzy set; reported only for parsed data.
VegMshp	Vegetation index	Integer 000	Fuzzy-set membership (%)	Degree of membership of sample in the vegetation fuzzy set; reported only for parsed data.
Carbonate	Carbonate	Integer 000	%	For parsed data, this value is a degree of fuzzy-set membership
MunslColr	Munsell color code	Character XXXX….	Standard alphanumeric coding of color partitioned into hue, value, and chroma	Example: “5YR 6/4” (Rock-Color Chart Committee., 1991).
OrgCarbn	Organic carbon	Integer 000	%	For parsed data, minimum value from descriptions is 0.1%.
IShearStr	Log shear strength	Decimal 00.0	kPa, undrained, unconfined	As reported in sources; see source documentation for instrumentation used.
Porosity	Porosity	Decimal 00.00	%	
PWaveVel	P-wave velocity	Decimal 00.0	m/s	Usually not corrected for P/T effects.
Roughness	Roughness	Decimal 0000.00	Coded to express the height and length of the bottom feature with greatest aspect ratio	In a coding that expresses the height and length of the bottom feature with greatest aspect ratio; a coded output representing the V:H of the roughness element with greatest aspect ratio, values expressed as (rounded) integer log2.

Table 3. Field parameters, format, units, range, meaning, and comments for extracted, parsed, and calculated data in the US9_ONE (extending to US9_EXT, US9_PRS, and US9_CLC) file.—Continued

[%, percent; kPa, kilopascal; m/s, meter per second; P/T, high pressure and temperature; V:H, ratio of vertical height to horizontal length]

Attribute	Parameter	Data format	Units, range, meaning	Comment
ICritShStr	Log critical shear stress	Decimal 0000.00	Log10 of tau, in kPa	Log 10 of tau, in kPa, being the shear stress required to initiate easily observable erosion and transport, whether by traction or suspension; taken from a compilation of published relationships ranging from large boulder to muds, through a range of grain shapes (for example, shell) (see the section "Summary of the onCALCULATION Methods Used in dbSEABED" included in each of Reid and others, 2005; Buczkowski and others, 2006; and Reid and others, 2006).
GeolAge	Geologic age	Character Xxxx....	Age of the sample as defined by the geologic time scale	Geologic age of the sample or observed materials.
ObsvnDetai	Observation details	Character Xxxx....	Additional information about the observation	Detailed observations recorded for a sample or observation.
Key	Primary key	Character Xxxx....	Assigned during formatting of the usSEABED database	Unique identifier of the sample entry and primary key for the database table.
ObsvnDate	Observation date	Character Xxxx....	Date provided by the data source or by the persons entering the data into usSEABED	Date of collection, or the start of a range of collection dates for the sample or observation.
DateSrc	Source of date	Character Xxxx....	Date provided by the data source or by the persons entering the data into usSEABED	Source of the date provided for the sample or observation.

Table 4. Components and features processed for the usSEABED database.

[The 48 components with the highest cited occurrences (greater than 0.01 percent) for U.S. waters are given in the US9_CMP file. As usSEABED uses the same thesaurus as its sister data compilations (auSEABED, goSEABED, and so on), some triggering words listed below may not occur for U.S. waters. Only one of the possible word variations is listed below; for example, the word "mollusc" incorporates "mollusk" and "Mollusca," and "chlorite" includes "chloritic". Non-textural or compositional features are indicated by "_F" at the end of the senior synonym]

Senior synonym	Triggering words (word variations not included)
	Terms related to shells
shl	Shell, shell (-bed, -bank, -carpet, -fraction, -content, -material), shellfish, valves
shl_dbr	Shell debris, shell hash, coquina, shell (-bit, -conglomerate, -fragments, -festoon, -grit, -lag, -mash, -material, -piece, -particle)
skl_dbr	Skeletal debris, -sand, -fragment, -carbonate, -calcarenite, -clasts; bioclastic debris, -gravel; biogenic debris, faunal debris
mlsc	Mollusc
biv	Bivalve, arctica, astarte, cardium, chama, chione, chlmys, clam (-shell, -flat material, -hash, -valves), cockle (anadara, -shell), donax, glycymeris, katalysia, lamellibranch, macoma, mercenaria, mulinia, mussel (-bed, -bank, -shell), mya, mytilus, nucula, pelecypod, quahog, rangia, seep mytilid, slipper shells, surf clam, tellina, tellinid, venerid, venus clams, vesicomyid, yoldia
musl	Mussel, mytilus, Atrina
	Terms related to rocks
rck	Rock, outcrop, substrate, reef, pavement, banks, pinnacle, mound, boulder, platform, hard bottom
rck_frg	Rock fragment, rock chips, rock particles
hrdgrond	Hard ground
mudstn	Mudstone, calcareous (-mudstone, -siltstone), clay (-rock, -shale, -stone), marlstone, mud (-rock, -stone), pelite, shale, siliceous shale, siltstone
sed_rck	Terrigenous breccia, sand rock, cemented sand
sndstn	Sandstone, gritstone, graywacke, labile sandstone, sandstone reef, wacke
bluschst	Blue schist, crossite-albite schist, crossite-quartz schist, glaucophane, quartz crossite schist, quartz glaucophane schist
	Terms related to sediments
sed	Sediment, detrital, mud, clay, silt, sand, pebbles, cobbles, gravel, rubble, granule, fraction, moraine, lag deposit, clastic
	Terms related to terrigenous materials
qtz_sed	Quartz sediment, quartz feldspar, quartzite, quartzose, silica sediment, clast, sand, gravel, grit, pebbles,
trrg	Terrigenous, lithic, inorganic
volgls	Volcanic glass, obsidian, hyaloclastite, pyroclastic, quenched, vitric, subvitreous
	Terms related to carbonates
carb	Allogenic grain, authigenic carbonate, biogenic, calcareous, calcilutite, calcarenite, calcirudite, calcareous biogenic, carbonate, limey, marl, skeletal micrite
dolmt	Dolomite, dolostone, ankerite, molar magnesium carbonate
	Terms related to clays
glauc	Glauconite, greensand
claymin	Clay mineral, bentonite, chlorite, collophane, illite, kaolinite
smect	Smectite, bentonite, montmorillonite, nontronite
kaol	Kaolinite
chlort	Chlorite

Table 4. Components and features processed for the usSEABED database.—Continued

[The 48 components with the highest cited occurrences (greater than 0.01 percent) for U.S. waters are given in the US9_CMP file. As usSEABED uses the same thesaurus as its sister data compilations (auSEABED, goSEABED, and so on), some triggering words listed below may not occur for U.S. waters. Only one of the possible word variations is listed below; for example, the word “mollusc" incorporates “mollusk” and “Mollusca,” and “chlorite” includes “chloritic”. Non-textural or compositional features are indicated by “_F” at the end of the senior synonym]

Senior synonym	Triggering words (word variations not included)
	Terms related to corals
crl	Coral, Acropora palmata, brain coral, Dendrophyllia, Madrepore, Manicina, Porite, sea twig
	Terms related to microfossils
rad	Radiolaria
diat	Diatom, diatomite/diatomaceous
frm	Calcareous foraminifera, foraminifera, globigerina bit, planktonic
plnk_frm	Planktonic foraminifera, globerina, globorotalid, planktic foraminifera
bnth_frm	Benthic foraminifera, archaias, bolivina, bulimina, coralline foraminifera, discorbis, eponides, homotrema, hyaline, lenticulina, loxostema, miliolid, nodosirid, nonien, notosirid, peneroplis, porcellanous, rotaiid, uvigerina
	Terms related to minerals
min	Mineral
mica	Mica, biotite, chlorite, muscovite, sericite, talc
qtz	Quartz, arkosic sand, calcareous quartz sand, milky vein quartz, quartz (-content, -fragment, -grain, -granule, -groundmass, -mass, -rich, -vein, -veinlet, -crystal), quartzose, quartzite (-cobble, -gravel, -pebble), sandstone (-chunk, -fragment), silica
zeol	Zeolite, clinoptolite
hvy_min	Heavy mineral, anatase, andalusite, apatite, black sand, brookite, cassiterite, clinozoisite, corundum, dumortierite, epidote, garnet, ilmenite, jadeite, kyanite, leucoxene, magnetite, monazite, ore mineral, piedmontite, rutile, sillimanite, sphene, spinel, staurolite, titanomagnetite, titanite, tourmaline, topaz, zircon, zoisite
maf	Mafic, actinolite, aegirite, amphibole, augite, (brown- green- basaltic-) hornblende, bronzite, clinopyroxene, ferromagnesian, hypersthene, olivine, orthopyroxene, oxyhornblende, pyroxene, titanaugite, titaniferous, tremolite
	Terms related to mineralized deposits
phspht	Phosphate, phosphorite
	Terms related to ooze
ooz	Ooze
calc_ooz	Calcareous ooze, nannofossil (-mud, -ooze), pteropod (-mud, -ooze), foraminiferal (-marl, -ooze, -mud), globigerina (-mud, -ooze)
	Terms related to organic material
orgnc_dbr	Organic debris, -content, -material, -parts, -matter
wood	Wood, bark, twig
peat	Peat, lignite
	Terms related to clast size
cbl	Cobble
bldr	Boulder

Table 5. Field parameters for the US9_FAC file, featuring facies data and their component makeup.

[Facies values are determined by a combination of components and their mined values from word-based descriptions. Numerical textural, geochemical, and geophysical information for word-based descriptions is found in the parsed (US9_PRS) data file. Values are degrees of membership in fuzzy sets, given as numbers between 0 and 100. A minimum membership value of 33 in component presence is required to be included in a given facies, and a component may be included more than one facies. Facies values notes presence only, not absence]

Field name	Parameter	Contributing components
Algae	Algae	Halimeda, rhodolith, coralline algae
Shells	Shells	Shells, shell debris, skeletal debris, mollusc, bivalves, mussels
Carb	Carbonate	Carbonate, marl, chalk, carbonate cementation, calcareous nodules, carbonate ooze
Clay	Clay	Clay minerals, glauconite, smectite, kaolinite, chlorite
Coral	Coral	Coral, coral reef
Fossil	Fossil	Radiolaria, diatom, nannofossil, fish debris, palynomorph
Forams	Foraminifera	Foraminifera (benthic, planktonic, arenitic)
AlSi	Aluminosilicate	Mica, quartz, zeolite, siliceous, opal
Hvy_min	Heavy minerals	Heavy mineral, mineral, mafic, ultramafic
Mineralized	Mineralized	Phosphorite, pyrite, sulfide, barite
Mn/Fe	Ferromanganese	Ferruginous, iron nodule, siderite, manganese nodule, ferromanganese oxide, ferromanganese crust
Organic	Organic	Wood, peat, coal, organic organic debris, organic carbon
Metam_rock	Metamorphic rock	Metamorphic, dolomite, schist, blueschist, gneiss, slate
Generic_rock	Generic rock	Rock, rock fragment, hard ground
Sed_rock	Sedimentary rock	Sedimentary rock, mudstone, sandstone, limestone, chert
Sediment	Sediment	Terrigenous, metamorphic debris, igneous debris, sediment, quartz sediment, volcanic sediment
Plant	Plant	Foliage, plant
Terrigenou	Terrigenous	Terrigenous, quartz, quartz sediment, feldspar, mafic
Seaweed	Seaweed	Seaweed, seagrass, weed

Table 6. Biological components that may have textural implications.

[Listed are only those components that are frequently noted in samples from U.S. waters. Biological components in **bold** appear in more than 0.01 percent of samples and are provided in the US9_CMP file]

Biological components				
barnacles	**clypeasts**	**diatoms**	**nannofossils**	**reefs**
bivalves	coralline algae	echinoids	pteropods	scaphopods
brachiopods	**corals**	**forams**	**radiolaria**	serpulids
bryozoa	crabs	halimeda	razor clams	**shells**
calcareous algae	crustaceans	**molluscs**		

Quality Control

Quality control over the data is an iterative process beginning with visualization of each source file. First, graphical plots of site locations and parameter values are used to detect outliers, which are corrected if possible. Each dataset is viewed in a GIS to ensure that data locations are reasonable relative to survey extents; those sites with unresolvable location issues or known incomplete analyses are not included in the usSEABED database. (Note: the usSEABED database contains a small number of onshore samples.) Old sets may require more scrutiny than newer or well-exercised datasets.

Users of the output data are reminded to note the inherent limitations imposed by the source datasets as to navigational precision, sampler type, and analytical technique. To help inform users about the provenance of the data, sample-collection devices and observation methods, where provided, are recorded for each data entry in the usSEABED data files. The US9_SRC source file includes information pertaining to the original data sources, such as the type of source material the data were taken from (published and unpublished reports, technical memoranda, and theses), as well as navigational methods, if known, and publication or other release dates. Citations for each data source are also available in the source file to direct users to additional information about data-collection methods and analytical techniques found in the original publication or dataset.

Next, built-in filters in the dbSEABED software detect implausible values for numerical fields, unknown verbal terms, incomplete analyses (for example, the total of percentages in grain-size classes is greater than 105 percent or less than 95 percent), and incorrect field types (string or number). The software also detects samples that seem to belong to a core though they are entered as independent samples. Through iterative testing, the detected issues are either fixed or excluded from usSEABED.

Parsing verbal descriptions within the dbSEABED software also includes a number of quality-control devices. The dbSEABED software contains a thesaurus where various terms used to describe the seabed are given lithologic, textural, and biological classes and weightings. If a term is not recognized in the dictionary, the process is aborted and null values are given to all appropriate fields. Likewise, if a description contains more than 32 terms, it is not parsed due to complexity.

Uncertainties in the Data

Users of the usSEABED database are reminded that many sea-floor regions are, by their nature, dynamic environments subject to a variety of physical processes, such as erosion, winnowing, reworking, and sedimentation or accretion, that vary on different spatial and temporal scales, and sea-floor samples represent a moment in time.

Because site locations are as given in the original sources, the usSEABED compilation may include uncertainties resulting from the navigational techniques and datums used. As many reports are decades old, users of usSEABED data should use their own criteria to determine the appropriateness of data from each source report for their particular purpose and scale of interest.

In addition, there are uncertainties in data quality associated with both the extracted data (from lab-based analytical analyses) and parsed data (from word-based descriptions). Some grain-size analyses are done solely on the sand fraction and exclude coarser material, such as shell fragments and gravel. Word descriptions of sediment samples may emphasize the proportion of one sediment fraction over another and may disregard other important textural or biological components. Incomplete data or that data that are known to produce erroneous results are not included in the usSEABED database.

Accessing the usSEABED Database

The usSEABED database is available online (Buczkowski and others, 2020) through an interface that allows download of all the data files that make up usSEABED, as well as search and selection of portions of the database through a GIS display or through a web form at https://cmgds.marine.usgs.gov/usseabed/. Search results are downloaded as comma-separated value files and come with customized metadata.

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