INTEGRATION OF SEAFLOOR POINT DATA IN usSEABED

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INTRODUCTION

Sediments of the beach, nearshore, and continental shelves record a complex interplay of processes including wave energy and direction, currents, beach erosion or accretion, bluff or cliff retreat, fluvial input, sediment longshore and cross-shelf transport processes, geologic history and processes, contaminant content and transport, sediment sources and sinks, and others. In turn, sediments and rocks modify wave patterns, affect recreation and tourism, and provide habitat for fish, epifauna, and infauna. Character of the surficial seafloor also influences navigation, commercial and recreational fishing and gathering of other food sources, communication, pipelines, national defense, and provides geologic resources including sand and gravel aggregates, minerals, and real or potential energy sources. The beaches, nearshore, and continental margins fall under overlapping levels of managerial responsibility between Federal, State, regional, and local government agencies and consortia. In addition, universities and other academic institutions investigate these places for pure or applied scientific reasons.

Mapping is usually the first step in understanding any issue and is often comprised of remotely gathered geophysical data such as bathymetry and backscatter imagery, and groundtruthing; that is, the collection of physical or virtual samples to tie the remotely gathered data to reality. The physical samples are described and (or) carefully analyzed for grain-size information – which records both the site's physical conditions and geologic past – and commonly, for constituent components such as mineral and rock types (to determine onland sources and *in situ* chemical processes), carbonate and organic content and microfossils (for biological and oceanographic influences), and structure such as layering and bioturbation (for physical influences). The samples may also be subjected to physical tests such as compaction analyses, liquefaction or plasticity limits, and other parameters important when considering construction of offshore structures. In recent years, virtual sampling of the seafloor has become popular, through the use of towed video or photographic equipment and the addition of cameras to oceanographic equipment such as corers and tripods.

Before about ten years ago, most maps were made by hand. Recently, with the advent of desktop GIS packages, map making and resource analysis can be done nearly "on-the-fly" if geographically located data exist. While the problems of projection, scale, and resolution of digitized paper maps are commonly known amongst GIS-users, access to the original underlying point data allows for maps to be regenerated for digital use using statistically proven methods, provides increasing data density by including multiple studies, as well as allows the point data to be used in other ways than just mapping

These point data may be available in raw or refined numbers or in worded descriptions. Raw data such as granulometric analyses can be manipulated through the use of known equations or empirical relationships to provide information about other parameters of the sediment, such as mean grainsize, sorting, erodability, or rugosity. If refined data are presented such as gravel, sand, and mud percentages, the parameters noted earlier may be estimated. In the case of worded descriptions, values for geologic terms can be assigned, for example, “fine sand” equates to 0.2 mm sized particles, to provide numeric terms for GIS or modeling purposes.

ABOUT usSEABED

The USGS and its collaborators are compiling and mining seabed observations and analyses from existing reports and datasets into usSEABED (http://walrus.wr.usgs.gov/usseabed), a nation-wide integrated seafloor characterization GIS-friendly database (figure 1). usSEABED holds numeric point data for surficial and subbottom samples such as texture and statistical values, values based on descriptive data, selected geochemical and geophysical parameters, compositional information, for example, phosphorite, glauconite, heavy minerals, and sulfide odor, and biologic data, for example, as seagrass, shells, brittlestars, and siliceous oozes (table 1). The database is available through USGS Data Series publications (Reid and others, 2005; Buczkowski and others, 2006; Reid and others, 2006).

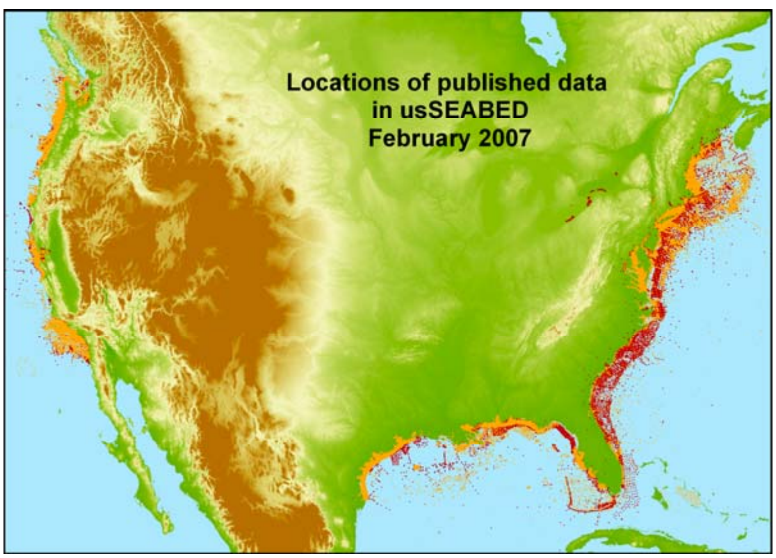

Figure 1. Locations of published usSEABED data for the contiguous United States. Values from lab or shipboard analyses in red; values from worded descriptions in orange. Puerto Rico not shown. Total records 535,000. Figure created in ArcMap®

usSEABED consists of five relationally linked, comma-delimited, numerical data files, including data directly reported from lab or shipboard analyses, data parsed from descriptions by the application of fuzzy set theory to geologic terms and descriptions, data calculated using known equations or empirical relationships, individual constituent components, and combined constituent components (table 1). For the first three data files, filters in the data-mining software, (http://instaar.colorado.edu/~jenkinsc/dbseabed), test for completeness and appropriate limits for each parameter. For the latter two files, only those samples with written descriptions can report information and only that information that was noted by the original researcher can be included.

Table 1. Data fields in usSEABED.

Site information:	Latitude, longitude, water depth, sample top/bottom, site name, sampler type.
Textural information:	Percent gravel, sand, mud, clay.
Statistical information:	Grainsize (median/mean), sorting, ternary memberships.
Dominant characteristics and membership:	Rock, weed, other.
Geochemical information:	Carbonate, organic carbon, hydrates, methane, gas, odors, hydrogen sulfide, coal, bitumen, peat, charcoal, oil.
Geophysical information:	Shear strength, porosity, P-wave velocity, critical shear stress.
Other information:	Bottom roughness, Munsell color code.
Mineral components:	Quartz, feldspar, sulfide, calcite, barite, phosphorite, manganese, mica, clay minerals, glauconite and, heavy, ferruginous, undifferentiated metamorphic, mafic, ultramafic, and metalliferous minerals.
Rock types:	Andesite, basalt, schist, slate, mudstone, siltstone, sandstone, limestone carbonate, chert, dolomite, gabbro, gneiss, granites, undifferentiated igneous and volcanic rocks, pumice, crusts, nodules.
Sediment form & biotic effects:	Laminations, deformation, faults, grading, lumps, oozes, nodules, crusts, scours, ripples, bedding, bioturbation, mottles, pits, borings, burrows, worm tubes, trails, feces.
Microfauna/flora:	Foraminifera (benthic, planktonic), diatoms, radiolaria, pteropods, nannofossils.
Macrofauna/flora:	Barnacles, bivalves, brachiopods, corals, crustaceans, crinoids, mollusks, undifferentiated shells, bryozoa, Halimeda, algae, echinoids, echinoderms annelids and scaphopods, clams, mollusks, kelp, seagrass, undifferentiated plants, root structures.
Other components:	Artificial, spoils, wood, “terrigenous”, “pelagic”.

The five data files are also relationally linked to a file that lists the original sources. As usSEABED is comprised of samples collected, described, and analyzed by many different organizations and individuals over a span of years, metadata are provided in the data publications for each source report as well as the usSEABED files themselves.

As currently published, the usSEABED database contains more than 535,000 records of data about the sea floor for the contiguous U.S. (figure 1) and Puerto Rico (Reid and others, 2005; Buczkowski and others, 2006; Reid and others, 2006). New data are being added for Alaska, Hawaii, and the Great Lakes, as well as additional data for the contiguous U.S that will be included in planned updates of the current publications.

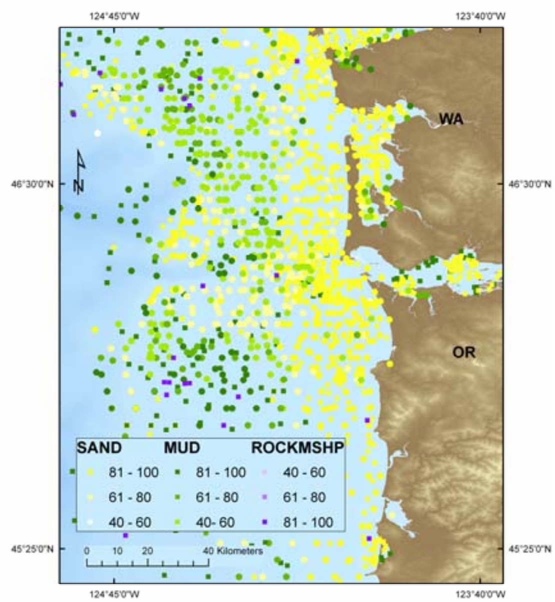

Figure 2. Point distribution of usSEABED data off the Columbia River margin (Reid and others, 2006 plus unpublished data). Samples dominantly sand are in yellows; those dominantly mud in green. Rocks or consolidated seafloor in purples (Rockmshp). Figure created in ArcMap®

Data from usSEABED can be used to investigate the distribution of rocks and muds in the mid shelf north and south of the Columbia River (figure 2) or the dominance of medium and fine sands along the south shore of Long Island, for example (figure 3).

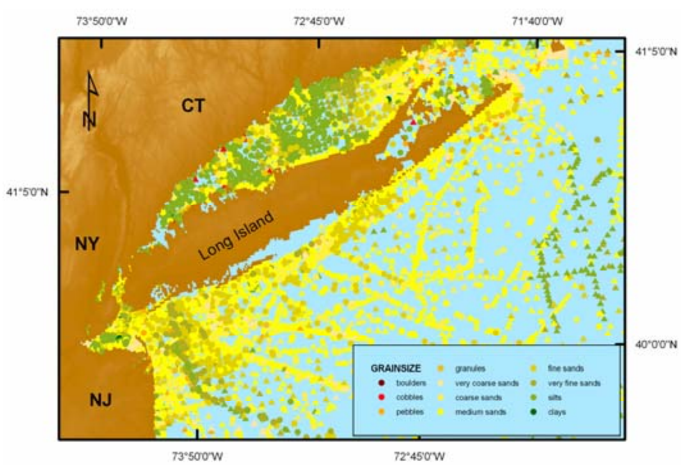

Figure 3. Point distribution of usSEABED data in Long Island Sound and New York Bight (Reid and others, 2005), classified by grainsize (Wentworth, 1922). Data from lab analyses in circles; data derived from worded descriptions in triangles. Figure created in ArcMap®

Within the collaborative group building usSEABED, it is being used in coastal sand and aggregate resource analysis, surficial seafloor sediment distribution and benthic habitat mapping, studies on groundfish distribution and seafloor trawlability, and sediment mobility and acoustic response of the seabed under different oceanographic conditions, amongst others. The marine science community and other users can apply it in other ways such as research ocean observation and monitoring, coastal zone and ocean management and planning, Homeland security, military applications, sea-floor engineering planning and design, ocean disposal site placement and monitoring, cultural resources investigations, fisheries management and marine-protected areas, determination of seabed roughness and bedform distribution, sediment transport and mobility and others.

CONCLUSION

The compilation of existing ground-truthing data from the beach, nearshore, and offshore provides the coastal and oceanic scientific and resource-manager communities with integrated information about the character and composition of the ocean bed. These data can be used in maps, data analyses, and models to investigate the complex interplay of natural and anthropogenic influences on the sea floor at nearly any scale. usSEABED provides both a source and an ongoing repository for sea-floor data including geological, geophysical, sedimentological, biological, surficial and subbottom, linked to metadata about the original report. The ongoing inclusion of data from diverse sources strengthens and expands the usefulness of usSEABED, providing a national resource of information about the crucial land off our coasts and the resources they contain.

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