A GEOLOGICAL INVESTIGATION OF THE OFFSHORE AREA ALONG FLORIDA'S NORTHEAST COAST

YEAR 1

ANNUAL REPORT TO

THE

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A Geological Investigation of the Offshore Area along Florida's Northeast Coast
Year 1 Annual Report to the United States Department of Interior Minerals Management Service

Introduction

The beaches and dunes of the Florida coasts provide buffers between the forces of the sea and urban coastal regions. They also provide valuable recreation areas, the enjoyment of which results in an integral part of Florida's economy. The need to maintain as well as reestablish critically eroding beaches requires large volumes of beach-quality sand. It has become increasingly necessary to look further afield for new offshore resources of suitable sand. This report documents the findings of the Year 1 cooperative agreement between the Minerals Management Service (MMS) of the U.S. Department of Interior and the Florida Geological Survey (FGS). The primary goal of the agreement is to locate and characterize beach-quality sand found in Federal waters adjacent to state submerged lands off the northeast coast of Florida. The Year 1 study area includes Federal waters extending from three to approximately ten miles offshore of Nassau and Duval Counties (Figure 1). Succeeding years will investigate submerged lands beneath federal waters offshore of St. Johns, Flagler and Volusia Counties and may ultimately include an area off of the northern half of Brevard County.

Information derived from this study will assist the MMS in making decisions concerning the future use of these deposits. Additionally the identification of available suitable offshore sand resources now will serve to expedite the replenishment of sands on beaches impacted by future hurricanes and/or winter storms.

Year 1 Scope of Work. Data collection in Year 1 of this study concentrated primarily on offshore Nassau and Duval Counties. Year 1 tasks included:

- The compilation of a bibliography (References Cited and References of Interest) referencing both previously completed work in the study area in general and in Nassau and Duval Counties in particular, as well as more general publications germane to this study,
- The collection of subsurface acoustic profile data off Nassau and Duval Counties,
- The collection of cores on the ebb tidal delta of the Nassau River,
- The initiation of a beach sampling program designed to establish a baseline characterization of "native" beach sands in the study area, and;
- The initiation of an offshore reconnaissance sampling program.

Both beach and offshore sediment samples were collected, processed, analyzed and interpreted. Beach sample locations visited in Year 1 were spaced at an approximate one mile interval along the beaches of Nassau and Duval Counties. Two locations peripheral to this reach of coastline, to the north in Georgia's Camden County on Cumberland Island and to the south on the northern border of St. John's County, were included in this sampling program. Offshore sampling locations were chosen based on the review of previously published work and analysis of bathymetric trends. Results of the offshore sample analysis will be used to aid in the picking of sampling locations for the ensuing vibracore program to commence in Year 2.

This paper is a cooperative agreement progress report.

Year 1 Data Acquired. During Year 1 the following data were obtained:

- Over 230 miles of seismic data were collected and are being interpreted to determine locations thought to be favorable for the deposition of beach-quality sand,

- A total of 34 beach sampling locations were identified and 106 surface samples collected,

- Seabed samples were also collected from offshore locations to determine the presence of surficial restoration-quality sand,

- 3 push cores were collected on Bird Island, an island which is part of the ebb tidal delta of the Nassau River.

Additional offshore seabed grab sample locations, based on the subsurface acoustic profile data, are currently being chosen. These samples will be collected during the Year 2 field season and evaluated to help pick locations for the Year 2 vibracoring program.

Sediment samples were collected at the outset of the field season and returned to the FGS laboratory for sample description and granulometric analysis. Granulometric analyses were conducted using general guidelines of the American Society for Testing and Materials (2000a, 2000b) and specific procedures advanced by the FGS sedimentology laboratory (Balsillie, 1995, 2002a, 2002b,; Balsillie and Tanner, 1997, 1999; Balsillie, Tanner and Williams, 1997, 1999; Balsillie, Dabous, and Fischler, 2002; Balsillie et.al. 2002; Balsillie and Dabous, 2003). All sample descriptions and granulometric data were entered into the FGS database. Appendices A through G, (Appendices), link via their respective sample indices to the beach, grab sample and push core photographs, descriptions and the results of the granulometric analyses.

Previous Work in the Study Area

Meisburger and Field (1975, 1976) conducted studies of the Florida inner continental shelf from Cape Canaveral to the Georgia border which are valued antecedents to our study. In their studies they collected and analyzed more than 1,153 nautical miles of high resolution seismic-reflection profiles and 197 vibracores as part of the Inner Continental Shelf Sediment and Structure (ICONS) study. Nocita et.al. (1991) further analyzed the vibracores collected for the ICONS study and, based on low mud to high sand percentages, suggests that the region has several concentrated sites with low mud percentages that may be good potential borrow sites. These studies discussed the geomorphology and shallow sub-bottom structure of the continental shelf as well as the surficial and sub-bottom sediments in the study area. These historical studies served as the springboard for our investigations in that a conscious attempt has been made to address issues they raised regarding the need for further investigation of possible accumulations of beach-quality sand on the inner continental shelf in the study area.

Field and Laboratory Procedures: an Overview

The initial exploratory phase of this multiyear program involved the use of continuous seismic reflection profiling also known as subsurface acoustic profiling, and the collection of beach samples and bottom samples off Nassau and Duval Counties. Survey track lines for the subsurface acoustic profiling were laid out in a reconnaissance grid, with a north/south line spacing of one statute mile. This spacing provides sufficient density to determine where additional subsurface acoustic profiling and later reconnaissance bottom sampling and vibracoring should be conducted in Year 2. Selection of vibracore sites will be based on the analysis of this seismic data as well as bottom samples yet to be obtained.

A simple alphanumeric scheme was utilized to identify sediment samples. All beach samples proceed with a two letter designation NA for Nassau County, DU for Duval County, SJ for St. Johns County and GA for the single sample location in Georgia. This is followed by consecutive beach location numbers, 1, 2, 3, 4 etc. and completed by a two letter designation for the sample's

sample point on the beach. Thus samples collected from the swash zone, berm, mid beach and back beach are designated SS, B, MB, and BB, respectively. For example a sample collected in Nassau County at sample location 1 in the swash zone would be delineated as NA-1-SS. All grab samples collected offshore with an Ekman dredge clam-shell sampler, are labeled with the beginning two letter designation geographic code referenced above, a multi digit location number beginning with 1 and ending with a two letter designation CG. Thus a sample collected off Duval County might be designated DU-101-CG. The numbering scheme utilized for the push cores collected at the single location on Bird Island off Nassau County varies slightly from the above referenced scheme. The samples are labeled NA-201 with a subsequent numerical designator of 1, 2 or 3 referring to the actual core number and a letter designation of T, M, B, and C to indicate top, middle, bottom vertical positioning in the core, respectively, or C for a composite sample. A sample collected from the top of the first core would be labeled NA-201-1-T the position of deeper samples within individual cores are further identified by their depth within the core.

Beach Sample Collection. Beach samples were collected from December 3 to 5, 2002, and on January 28 and 29, 2003, at a sample location spacing of approximately one mile, (Figure 1). Photographs of these samples are provided in in these web pages and can be reached using either the online map, Arcview project or the sample index. Where possible at each sampling location, surface samples were collected from the swash zone, the beach berm, mid-beach and back beach. GPS fixes were obtained for each of these sampling points at each sampling location. While the elevation of the sediment surface respective to mean sea level was not recorded, at no time did such elevations exceed 3 feet. At those locations where no discernable beach berm was noted, no beach berm sample was obtained (Figure 2/photo). At a few locations, the beach was so narrow that only samples from the swash zone and back beach were obtained (Figure 3/photo). At one location on Talbot Island, where active erosion is taking place and no "beach" was present (Figure 4/photo), only a single sample was obtained (Figure 5/photo). At each sampling point within an individual sampling location four individual duplicate samples, each totaling approximately 50 grams of sediment, were obtained for sieving analysis. Samples were collected by scooping up sediments from within the first 30 millimeters of the beach surface at each sample point using a 50 gram scoop.

Offshore Seabed Grab Sample Collection. Sample collection for the FGS/MMS survey of offshore Duval and Nassau Counties, Florida, was initiated on August 5, 2002. Samples were recovered using the FGS vessel research vessel R/V GeoProbe (Figure 6/photo). Photographs of these samples are provided in these web pages and can be reached using either the online map, Arcview project or the sample index. While nineteen locations were visited eighteen grab samples, six and twelve samples collected off Nassau and Duval Counties respectively, were collected. GPS fixes were obtained for each sampling location. A six-inch Ekman dredge clam-shell sampler was used for sample retrieval. Water depths of these sample locations was obtained by reference to bathymetric charts.

Push Core Collection. Push cores were collected on Bird Island on January 29, 2003. The samples were collected by driving a two (2) inch diameter sampling tube into the sediments to the point of refusal at an approximate depth of five to six feet. The tube was then filled with water, capped with an air tight plug and extracted. Use of this method alleviated the need for the placement of a core catcher at the base of the core tube. Three cores were collected in a line from the surf zone to the back beach with the intent of acquiring samples representative of the sediments comprising the modern ebb tidal delta at the mouth of the Nassau River. GPS fixes were obtained for each of the sample coring points at the sampling location. While the elevation of the sediment surface respective to mean sea level was not recorded, at no time did such elevations exceed 3 feet. Photographs of these cores are provided in these web pages and can be reached using either the online map, Arcview project or the sample index..

Sediment Sample Processing. The sieve nest used in sample processing is delinated on Table 1 which includes a photograph (Figure 7). All grain size distribution analyses were conducted using

general guidelines of the American Society for Testing and Materials (2000a, 2000b) and specific procedures advanced by the FGS sedimentology laboratory (Balsillie, 1995, 2002a, 2002b,; Balsillie and Tanner, 1997, 1999; Balsillie, Tanner and Williams, 1997, 1999; Balsillie, Dabous, and Fischler, 2002; Balsillie et.al. 2002; Balsillie and Dabous, 2003). Each sample was initially weighed after oven drying. The sample was then wet sieved through a #230 (0.63 mm or 4 phi) sieve, oven dried and reweighed with the weight loss being assigned to the fine fraction. The sample was then dry sieved with the portion of the pan fraction obtained during dry sieving also assigned to the fine fraction. The sample was then digested with a 4 Molar hydrochloric acid solution, rinsed, oven dried, resieved and reweighted.

Sodium hexametaphosphate, per the procedures of Folk (1974) and Galehouse (1971) was used to disperse clay particles when deemed necessary. The density of this solution was measured for the single beach sample location exhibiting a significant percentage of clays and that sample was pipetted after it was wet sieved. The significance of fines in the selection sediments for beach nourishment is further discussed below.

The cumulative grain size distribution curves reflect the total grain size distribution (GSD) of the sample. The weight of the fine fraction (weight loss from wet sieving and weight of the pan fraction combined) was assigned to the finer than the 4 phi fraction. The ASTM recommends a display format showing the largest sieve sizes to the left of the horizontal axis and the highest cumulative weight percent in the top left corner of the display. The geological presentation is a mirror image of the ASTM format with the highest cumulative weight percent on the top right portion of the display. Separate GSD's were determined for the carbonate and non-carbonate fractions of each sample along with the combined GSD of the entire sample. The grain size distribution curves are provided within the analysis (excel spreadsheet) a link is provided in the grain size analysis column on the index for beach, offshore grab samples and push cores respectively.

For beach samples, sample #1 of the set was processed as described above. Sample #2, subsequent to being dried, was described and then photographed and can be accessed via the index under the photo page column. Sample #3 was dried and 10% of these samples were processed like sample #1, for the purpose of quality control, for granulometric analysis (Appendix H). Those samples not selected for processing were archived. Sample #4, subsequent to being dried, was thus archived as well.

The individual grab samples were split to obtain a 50 gram sample, photographed and can be accessed via the index under the photo page column., described and processed as referenced above. The grain size distribution curves are provided within the analysis (excel spreadsheet) a link is provided in the grain size analysis column on the index for offshore grab samples. The remainder of the sample was archived.

The push cores were subsequently split, photographed and can be accessed via the index under the photo page column, described and processed as referenced above. Samples were taken at the top of the core, at a distance of two feet down the core, and at the bottom of the core by removing a plug of approximately 50 grams of sediments from those points. These samples were both processed individually, and collectively as a core composite sample. The grain size distribution curves are provided within the analysis (excel spreadsheet) a link is provided in the grain size analysis column on the index for push cores. The other halves of the cores were archived.

It is important to note that the thickness of available restoration quality sand is determined in part by the percent fines content. Thus sand resources available for beach restoration are often limited vertically by the depth at which the fines content exceeded 5% as specified in Florida Administrative Code 62-41.07(5J). Discussions with the Bureau of Beaches and Wetlands Resources of the Florida Department of Environmental Protection have revealed that the 5% limit should be regarded as rough guidance for what is desired. The 5% fines content is thus not

operationally limiting as sediments containing up to a 10% fines fraction are routinely accepted for use in beach restoration. In previous investigations the FGS has concentrated on vibracored locations associated with grab samples containing less than 5% fines. Grain size distributions for all samples collected as a part of this cooperative agreement will be examined with the aim of adjusting prospective sand reserves to include vibracores containing a fines content between 5% and 10%.

The grain size distribution curves presented in the respective indexes for beach, grab sample and push cores are in standard geological format. Separate GSD's were determined for the carbonate and non-carbonate fractions of each sample along with the combined GSD of the entire sample. Digital photographs were taken of all beach and grab samples and push cores with the images being saved in a jpeg format. These files can be accessed via the index for beach, grab samples and push cores under the photo page column.
As a quality control check, approximately ten percent of the beach samples were processed a second time and the results on an individual basis compared with the initial sample processed. A strong correlation between individual samples taken from the same sampling point was noted. The results of these comparisons can be seen in Appendix H.

Seismic Acoustic Profiling. Continuous seismic reflection profiling is a technique used to delineate and define sub-bottom structures and bedding surfaces in sediments underlying the seabed. Continuous reflections are generated by generating repetitive pulses of high energy sound underwater and recording the pulses returned as reflections from the seabed and sub seabed sedimentary and structural features. The resulting acoustical profile is roughly comparable to a geologic cross section.

Seismic reflection surveys such as the one accomplished off Nassau and Duval Counties are made by towing sound pulse generating and receiving instruments behind a survey vessel traversing predetermined survey track lines at a set vessel speed. The sound pulse generator is initiated at a fixed rapid rate and the returning signals are received on a geophone array. The reflections are recorded digitally and the data is amplified, fed to a chart recorder, and graphically plotted out in two way signal travel time as an analog paper record. Assuming a constant speed for sound in both water and the shallow shelf sediments penetrated, a vertical depth scale for the analog record can be created. Horizontal control is achieved by the use of frequent navigational fixes. The resultant digital data set recorded comprises three files for each line: a navigational file, a geophysical response file and a data acquisition parameters file.

More than 230 line miles of subsurface acoustic profile data were acquired during the Year 1 study. All data were acquired in Federal waters off of southern Nassau and Duval Counties. The seismic program consisted of thirty, approximately seven statute mile long, east-west (dip) lines and twenty one, approximately one statute mile long, north-south (strike) lines which connecting consecutively acquired lines. Locations for the east west lines were chosen to provide an approximate one statute mile north-south separation between east-west lines**.** Figure 1 displays the location of all subsurface acoustic profile data collected to date. It was noted in Freedenberg et.al., (2002) in their studies to the south, that the highest quality sand accumulations were associated with bathymetric highs, which they refer to as "subsurface topographic highs". The length of east west lines were therefore determined both by distance from the shore and the eastward extent of bathymetric highs as determined from the available bathymetric charts.

The seismic reflection profiles recorded for this study were collected aboard the FGS vessel R/V GeoQuest, Figure 11/photo. Signal energy for the survey was provided by a Huntec boomer sled towed approximately 30 feet behind the survey vessel. An ITI streamer cable was used for signal detection. See Figure 12 for an equipment tow diagram. The sled-mounted Huntec boomer signal source was towed at an approximate speed over the seabed of 4 knots, fired at shooting interval of 500 milliseconds with a record length of 120 milliseconds. The boomer generates its signal the use of a rapidly moving electromagnetically controlled plate there by imparting a pulse into the water column. For this survey the boomer was configured so that most

of the source energy imparted had a frequency of 400 Hz. Field data was sampled and converted to a digital format. All field records were retained on compact disks for long term storage and are available for general distribution.

The realities of the limitations placed by equipment and personnel availability constrained the time window for data acquisition such that data could only be acquired during day light hours and only over an approximate two week period. The time required for both mobilizing and demobilizing the equipment on and off of the vessel at the beginning and ending of the survey period and the daily time required for transit to and from the shooting area coupled with the vagaries of weather further constrained the actual time available for data acquisition. The data quality of the seismic reflection profiles acquired during the marine geophysical survey varies from excellent to poor with most of the data being good to excellent. It is anticipated, that during the marine geophysical survey conducted during Year 2, certain selected lines will be reacquired and some additional infill data off Duval County may be acquired as well thus increasing data density in selected areas of specific interest in the Year 1 study area.

Processing of data was accomplished using the SonarWeb software package developed by Chesapeake Technologies Inc., see Figure 13 and Figure 14 respectively.

Offshore Seabed Grab Sample Analysis

Seabed grab sample locations were chosen to emphasize those areas showing potential for sand accumulation based on the interpretation of bathymetric data. Grain size distribution and percent carbonate content were determined for all grab samples. Seabed grab sample granulometric analysis is provided in Appendix E. Seabed grab sample locations indicative of restoration quality sand accumulations will be investigated further during Year 2.

Geophysical Interpretation: Seismic Stratigraphic Analysis as an Indicator of Sand Resource Potential

Previous Work in the Area. Meisburger and Field (1975) noted two features of primary interest in the study area off Duval County. These features are comprised of a “channel” trending northwest to southeast which they associated with the ancestral mouth of the St Johns River and a low linear shoal trending parallel with the coast line eastward of the “channel” feature. Regarding the shoal, it is important to note that in previous studies on the central east Florida Coast (Freedenburg et. al., 2002) the FGS determined that the highest quality sand accumulations were associated with bathymetric highs and that subsurface acoustic profile data analysis was the predominant tool used to delineate such highs. Information provided by the Army Corps of Engineers has revealed that successful dredging of material for beach replenishment from portions of the shoal has already been accomplished. This area is show on Figure 1 as the pink block off Duval County.

Seismic Stratigraphic Analysis. A preliminary seismic stratigraphic analysis was made of the near seabed features noted in the seismic reflection profiles. Post processed examples of lines which track east/west and north/south are provided as Figure 13 and Figure 14 respectively. As shown on Figure 1, our analysis of the seismic reflection profiles obtained have identified several near seabed features of interest. Associated in part with the channel feature referenced in Meisburger and Field (1975), was interpreted to be a complex of channels and disturbed sediments believed to comprise the remains of river mouth channels and ebb tidal delta/esturine complexes associated with the ancestral St. Johns, Nassau and St. Marys Rivers. This interpretation is consistent with Meisburger and Field’s findings that showed that while portions of the “channel” they identified proved sand-rich other portions contained a significant admixture of finer grained material unsuitable for beach restoration use. This is consistent with the results of the reconnaissance push coring conducted on the modern ebb tidal delta of the Nassau River in that push core # NA-201-3 showed thin layers of fine material present from 1.3 to 3.7 feet, as

shown in this photo. The data suggests that a mantle of reworked sediments of variable thickness which are superimposed on these features. This manifests itself off Duval County as a shoal, originally noted in Meisburger and Field 1975. Seaward of the Duval/Nassau County boundary region, it manifests itself as a blanket of sediments which, while the practical limits of its southern and eastern extent are open to interpretation, thickens northward.

In the northeastern extent of the survey area in a relatively limited area, sediments were interpreted to be a lens of material which appear have been laid down in a low energy environment and thus presumed to consist of relatively fine grained sediments.

Interpreted deeper in the geological section, as shown on line 41 (Figure 13), are occasional karst related dissolution features. Individually these features are present on single lines and appear to be of limited areal extent.

Summary, Conclusions, and Recommendations

Summary of Work. The following is a summary of work accomplished to date:

- Over 230 miles of seismic data was collected and interpreted to determine locations thought to have been favorable for the deposition of beach-quality sand,
- A total of 34 beach sampling locations were identified and 106 surface samples collected,
- A total of 10 offshore seabed grab sample locations were visited. Grab samples were collected from 9 offshore locations. At the remaining location no usable sample was recovered,
- 3 push cores were collected on Bird Island, an island which is part of the ebb tidal delta of the Nassau River,
- Descriptions were made and grain size distributions were determined for all beach and offshore seabed grab samples and push cores,
- A preliminary seismic stratigraphic analysis of the sub-bottom profiler data was completed.

Conclusions. As a result of the seismic stratigraphic analysis several features indicative of high potential for the occurrence of beach restoration quality sand in federal waters off Duval County were identified. This analysis was discussed with representatives of the U.S. Army Corps of Engineers Jacksonville District Office and a copy of the preliminary work map delineating those features provided to them. From that data, they will identify vibracoring locations in the study area of particular interest to them.

Recommendations for Work to be Accomplished in Year 2. This research will further investigate the shore and nearshore coastal area off Nassau, Duval and St. Johns Counties, Florida, to identify and evaluate known and potential offshore sand resources for the purpose of beach restoration. Research will include the collection and analysis of bottom samples in the region preparatory to the selection of individual vibracore sites off of Nassau and Duval Counties to be investigated in Year 2 and sites off St. Johns County to be investigated in Year 3. A primary task of Year 2 work will be vibracoring sites offshore Duval County and secondarily off Nassau County. To accomplish this, the FGS has solicited for bid a contract for vibracoring services for the collection of vibracores in Year 2. The FGS will communicate with the United States Army Corps of Engineers (USACE) during the selection process in order to complement the USACE's preparations for the Jacksonville Beach Nourishment Project projected to occur in 2005. Additionally, a comprehensive program of seismic profiling will be conducted offshore St. Johns County as well as additional work offshore Nassau and Duval Counties to supplement data collected in Year 1. That data will be processed as exampled in

Lines 33 and 41. The ICONS seismic data set aquired in Year 1 will evaluated and, if practicable, reviewed, interpreted and the results integrated into the Year 2 report. A program of beach sampling to characterize the existing beach sediments for the purposes of sediment matching will be conducted on the beaches off St. John's County. Previous bottom sampling work on the central Florida east coast to the south of the survey area has shown the following problems when sampling with an Ekman clamshell dredge sampler:

- At numerous sample locations multiple attempts were necessary to obtain sufficient sediment sample for bottom characterization.

- During recovery at several sites the jaws of the dredge were found to be repeatedly propped open by shell material. This allowed much of the sand sized material to escape from the dredge.

These circumstances resulted in the necessity of combining the results of successive dredging attempts at individual locations. Combining of samples so collected might lead to an exaggerated reporting of the coarser grain sized fractions. Therefore a method which offers an opportunity to sample deeper into the surficial sediment cover of the seabed might prove useful. For these reasons the FGS, in addition to grab sampling with the Ekman clamshell dredge sampler, will attempt in Year 2 the recovery of shallow cores, one meter or less in length, with a gravity coring device. The use of this device, if it indeed proves practicable, is not intended to supplant the use of the Ekman clamshell dredge sampler but rather as a supplement to it.

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