9-1993

Virginia Beach offshore sediment study

C. R. Berquist Jr.
Virginia Institute of Marine Science

Naomi Gomillion
Department of Geology - William & Mary

Virginia Beach Offshore Sediment Study

for the

1992-1993 Shore Erosion Research and Technical Analysis Program
Virginia Institute of Marine Science
School of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

funded by

Department of Conservation and Recreation
Division of Soil and Water Conservation

By

C.R. Berquist, Jr.
Associate Research Scientist
Virginia Institute of Marine Science
College of William and Mary

Naomi Gomillion
Geology Department
College of William and Mary

Virginia Beach Offshore Sediment Study

C.R. Berquist, Jr.*
Associate Research Scientist
Virginia Institute of Marine Science
College of William and Mary

Naomi Gomillion
Geology Department
College of William and Mary

September 1993

*Current address: Virginia Division of Mineral Resources, Department of Geology, College of William and Mary, Williamsburg, VA 23187

Introduction

This investigation was initiated from discussions among members of the Minerals Management Service-Virginia Task Force in an effort to locate a nearby and offshore source of beach-quality sand for the resort strip at Virginia Beach. Because of the increasing difficulty of relying upon land-based material, attention has been focused on investigating offshore sources. Previous work (Kimball and others, 1991) suggests an offshore deposit of beach-quality sands is located on a shoal between 3 and 8 km east of Sandbridge. Planned vibracoring on this shoal during the fall of 1993 should establish the viability of the sand occurrence. Although material from this site could be used to nourish the resort strip, the dredging and transportation costs for an offshore resource would be decreased if another source could be located closer to the strip.

Procedure

The goal of this investigation was to characterize the shallow stratigraphy and seafloor sediments adjacent to the resort strip (20th to 40th streets) at Virginia Beach while searching for beach-quality sand. Geophysical tracklines were run parallel and perpendicular to the beach (Figure 1) during July 1992 from the R/V Bay Eagle. Both side-scan sonar and very-high-resolution seismic records were collected on these lines. Twenty-three sediment samples were taken from the seafloor with a Smith-Macintyre sampler. Grain-size data were determined with the rapid sediment analyzer (RSA) at VIMS and the results are summarized in Table 1. Locations of samples are also shown on Figure 1. Both Loran C and a Global Positioning System (GPS) were used for navigation. Samples and original geophysical records are archived at VIMS. Details of the methodology and equipment used in this project are explained in greater detail by Gomillion (1993).

Results

Side-scan sonar records show that the seafloor, with the exception of two areas, is nearly featureless. Inlet-channel morphology and pebbly coarse sands (sample VB13) related to Rudee Inlet appear as dark patterns on the records from shore-parallel tracklines. More importantly, the eastern ends of records from lines VBNRG 52 and VBNRG 25 (seaward of lines VBNRG 12 and VBNRG 13) show greater variation in gray tones than records toward the shore. The mean grain size of sediment is also more variable in this eastern area. Each of these records requires a separate explanation. First, the eastern end of line VBNRG 52 shows patterns (Figure 2) commonly attributed to sand waves (wavelength approximately 20 m). The sand waves indicate active transport on the seafloor, however thickness and laterial extent of this sand is unknown. Second, an explanation of the irregular-shaped light patches on the record from VBNRG 25 (Figure 3) must account for non-reflectance of the acoustic pulse from the side-scan sonar. Possibly the light areas may be depressions on the sea floor, and/or they are areas containing muddy sediments. Again, they may be related to sand waves on the other adjoining record (Figure 3).

The shallow stratigraphy off of Virginia Beach is represented by an interpreted seismic record VBNRG 25 (Figure 4). There are two acoustically defined layers (Unit I and Unit II) that are found on each of the east-west trending track lines. The relationship of these layers to one another are similar on each trackline; Unit II is exposed on the seafloor to the east, but lies below Unit I close to shore. Each layer is likely composed of differing sediments. No correlation to acoustically defined units or stratigraphic units defined by previous work in this area is made at this time.

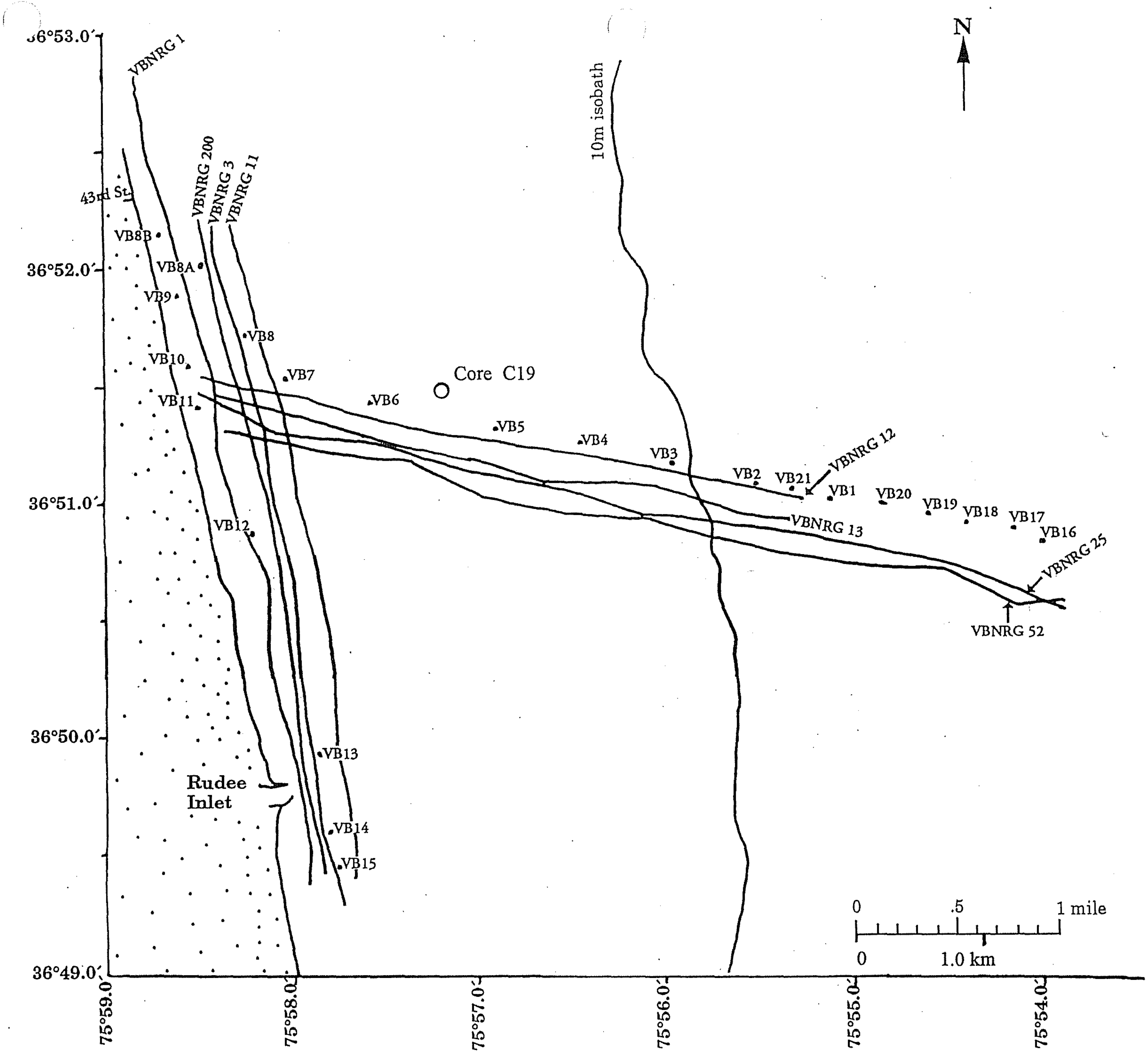

Figure 1. Location of tracklines and sediment sample locations off of the Virginia Beach resort strip.

TABLE 1

Location, mean (MZ) and sorting [Inclusive Graphic Standard Deviation (SI)] of samples with an explanation of measurement units.

Sample number	Loran C coordinates		Mean Grain Size (PHI)	Sorting (PHI)
VB1	27145.3	41226.0	0.82	0.54
VB2	27146.9	41226.0	2.37	1.00
VB3	27148.9	41226.1	3.02	0.30
VB4	27150.0	41226.2	3.10	0.30
VB5	27153.0	41226.1	3.07	0.30
VB6	27156.0	41226.3	3.02	0.28
VB7	27157.9	41226.4	3.02	0.39
VB8	27160.3	41231.0	2.90	0.38
VB8A	27161.5	41231.7	2.76	0.30
VB8B	27161.6	41231.6	2.42	0.48
VB9	27160.4	41227.8	2.79	0.35
VB10	27150.0	41225.7	2.71	0.34
VB11	27159.4	41223.7	2.63	0.36
VB12	27157.5	41218.5	2.76	0.55
VB13	27154.5	41210.0	0.11	0.87
VB14	27154.1	41205.1	2.97	0.34
VB15	27153.7	41204.1	2.93	0.37
VB16	27140.1	41226.2	1.77	0.78
VB17	27140.9	41226.4	2.93	0.49
VB18	27142.0	41226.4	2.99	0.30
VB19	27143.0	41226.4	1.63	0.93
VB20	27144.0	41226.3	2.51	0.75
VB21	27146.1	41226.3	1.06	0.58

Sorting Classification from SI (PHI scale)

	SI
Very well sorted	<0.35
Well sorted	0.35 to 0.50
Moderately well sorted	0.50 to 0.71
Moderately sorted	0.71 to 1.00
Poorly sorted	1.00 to 2.00
Very poorly sorted	2.00 to 4.00
Extremely poorly sorted	> 4.00

Grain Size Classification

	Millimeters	PHI
Gravel	2.0 and larger	-1.0
Very coarse sand	1.0 to 2.0	0 to -1.0
Coarse sand	1.0 to 0.5	1.0 to 0
Medium sand	0.5 to 0.25	2.0 to 1.0
Fine sand	0.125 to 0.5	3.0 to 2.0
Very fine sand	0.0625 to 0.125	4.0 to 3.0
Silt and clay	< 0.0625	> 4.0

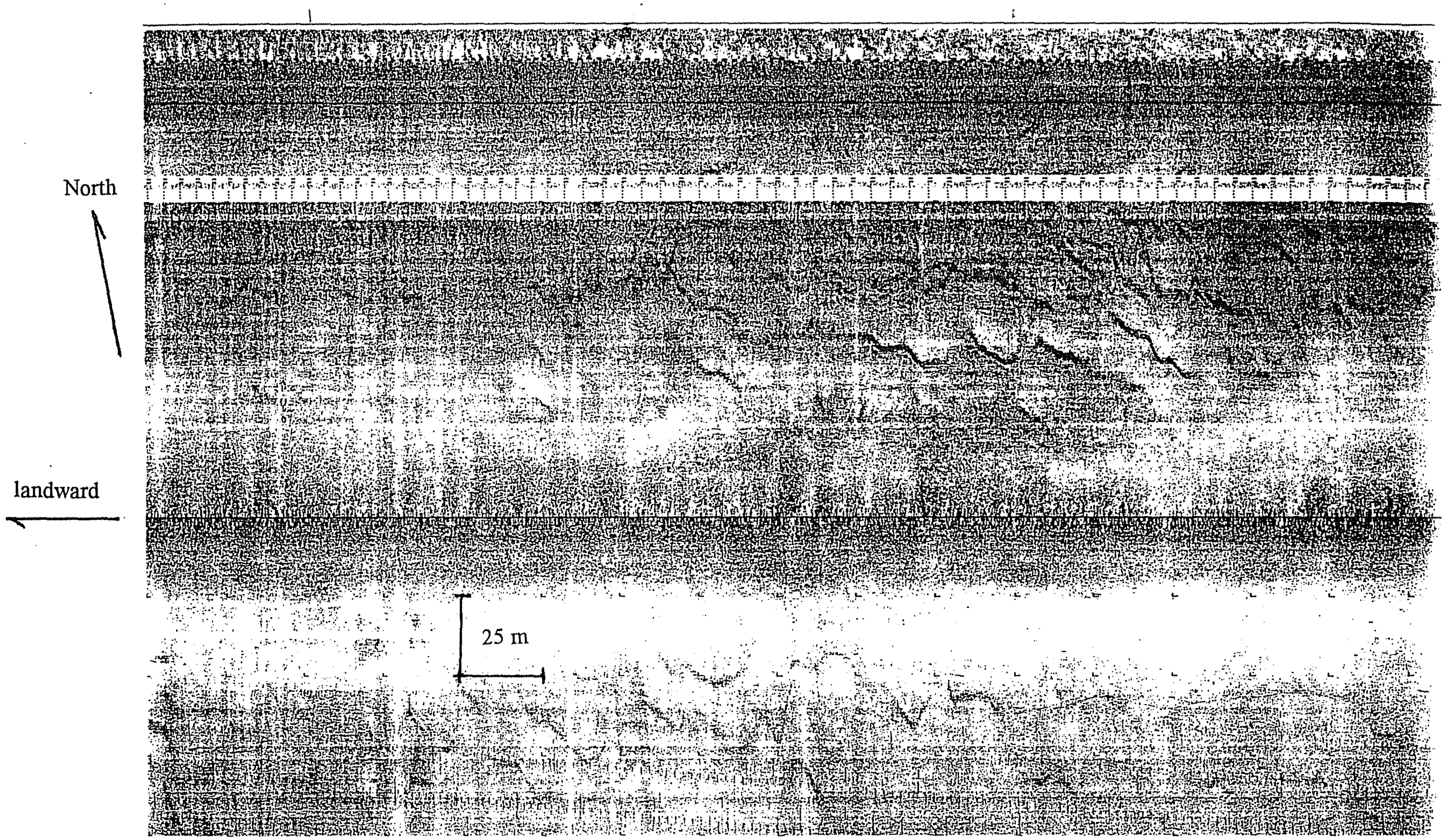

Figure 2. Side-scan sonar record from the eastern end of VBNRG 52. The well-developed dark patterns with adjoining shadows are interpreted to be the steep (lee) side of sand waves, indicating active transport of sand to the south.

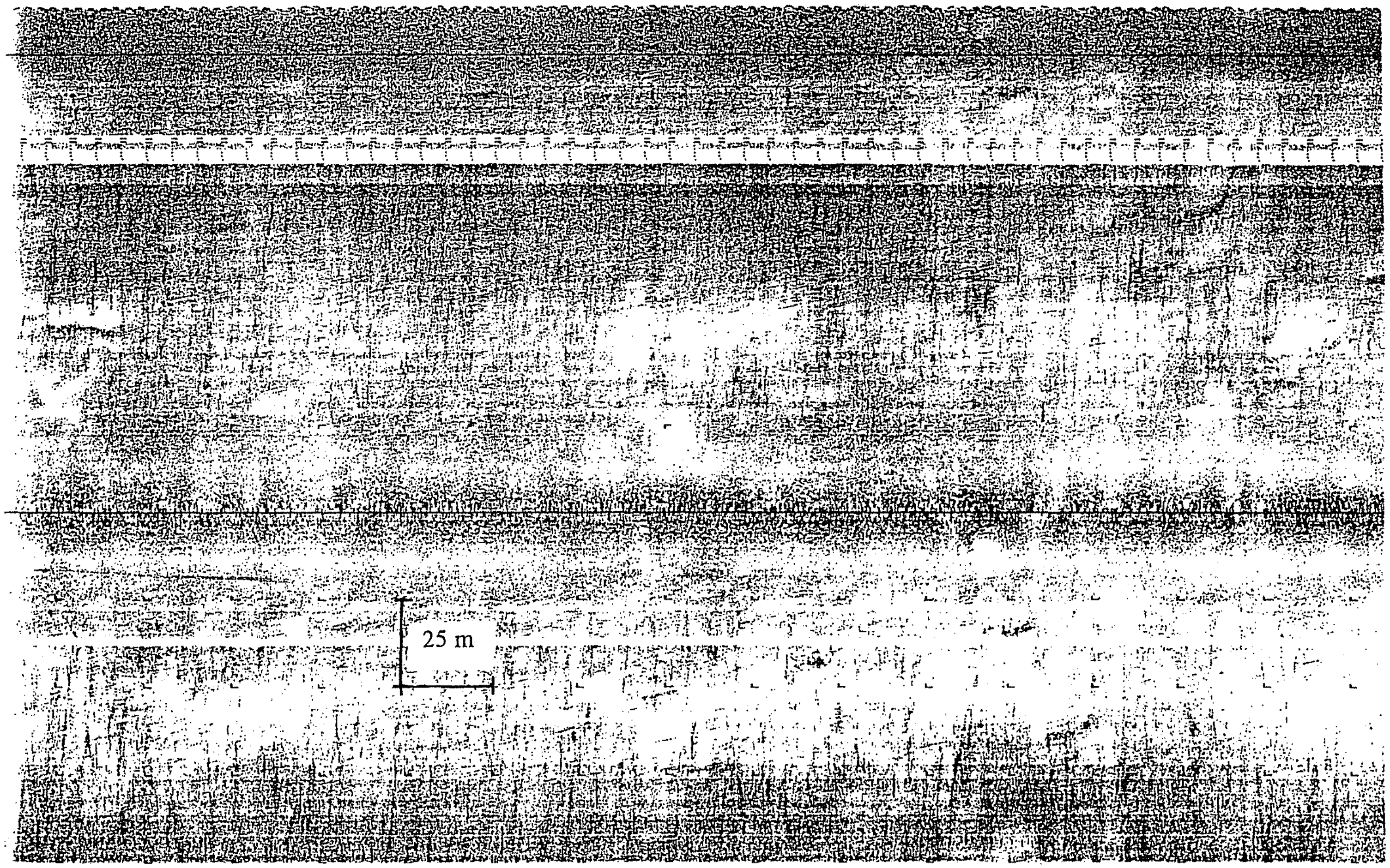

Figure 3. Side-scan record from the eastern end of VBNRG 25. Irregular patches of non-reflected acoustic signal are possibly caused by depressions, muddy sediments or sand waves.

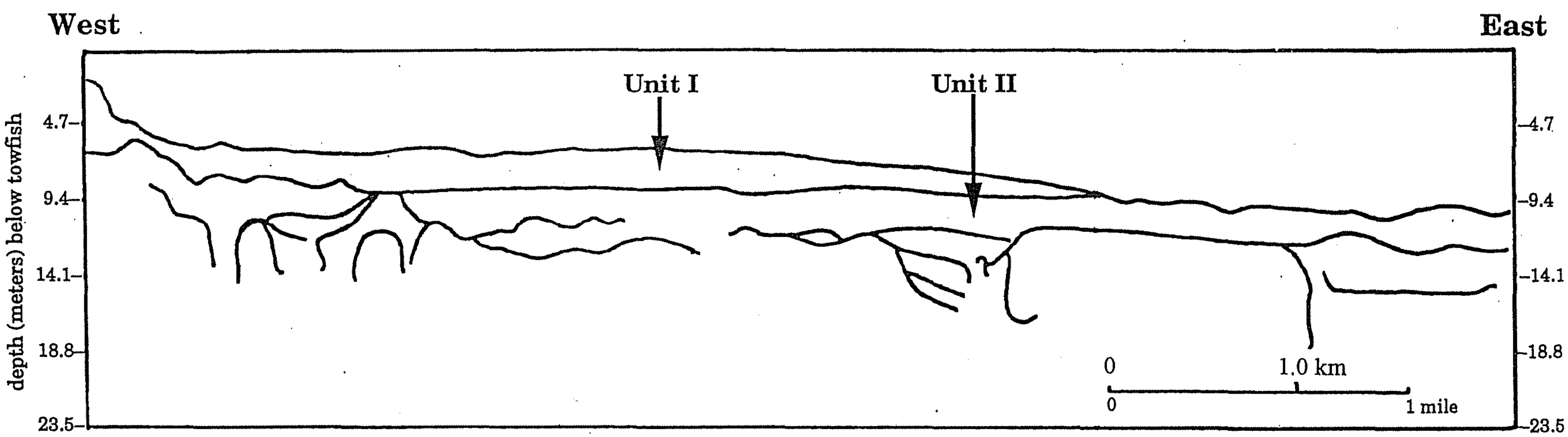

Figure 4. Interpretation of seismic record from line VBNRG 25. The area of the seafloor where Unit II is exposed is characterized by sand waves and a combination of fine- and medium- to coarse-grained sands.

Grab samples and a nearby core (C19 from Berquist and others, 1990) (Figure 1) help describe the characteristics of the offshore sediments and interprete the geophysical records. Mean grain size and sorting for grab samples (Table 1) are shown in phi units; larger values represent smaller mean grain diameters. Grab samples VB1, VB16, VB19, VB21 are the most coarse-grained samples (medium- (0.25 mm) to very coarse-grained (2.0 mm) sand) in the offshore area (ignoring VB13), and are located on the seafloor where Unit II is exposed (the area of light and dark patches and sand waves on the side-scan imagery). Landward, and located on Unit I, the bottom sediment is composed of fine- to very-fine-grained sand, and the side-scan sonar records are nearly featureless. The grain size of the coarse material (greater that 0.25 mm) from Unit II falls within material judged to be stable for beach nourishment at Virginia Beach (Wright and others, 1987).

The description of sediments from core C19 (Table 2) is not obvious nor simple to evaluate. Three attempts were made to reach a cumulative final depth of approximately 6 meters. On the first attempt (Run 1), the vibracore could only penetrate through the upper 1.9 meters of sediment. On the second attempt, sea water was pumped through the vibracore (jetted) to reach a depth of 1.8 meters, and coring resumed. A depth of 4.9 meters was reached, but only the top 1.6 meters of cored sediment was recovered. It is common to lose coarse-grained sand from the lower part of vibracores because of low cohesion of the material (and other factors). A third attempt made deep penetration, but again with loss of the lower core material. Combining the three records suggests the upper 4 meters of offshore sediment is mostly fine-grained sand overlying either medium- to coarse-grained sand or interbeds of fine and coarse sands. The record of seismic line VBNRG 25 shows that Unit I may be approximately 4 meters thick in the area of C19, and from the vibracore data one might infer that Unit I is composed of fine-grained sand. Although the vibracore record is not entirely clear, one could also infer that Unit II is composed of the "missing" and presumably coarser-grained sands.

Conclusions

Fine-grained sands compose the seafloor from nearshore to approximately 4.5 km offshore. From the nearshore to the beach there is a gradual and slight coarsening of grain size (samples VB7 through VB8B) of surficial sediment. The nearshore layer, Unit I, is about 4 meters thick, thins to the east and is composed of silty and micaceous fine-grained sand. It is not thought to be of beach quality. Seaward and below the nearshore layer of sediment, another acoustically defined layer, Unit II, extends from the beach eastward for at least 7 km. This layer probably consists of fine- to coarse-grained sands and may also average 4 meters in thickness. Side-scan sonar records and grab samples indicate that the exposed area of Unit II is composed of both fine- and medium- to coarse-grained sands, with active transport of (coarse?) sand on the seafloor (Figure 5). Unit II may be composed wholly or partially of medium- to coarse-grained sand useful for nourishing the beach of the adjacent resort strip. However, it is possible that the surficial coarser sands in the form of waves is being transported over a fine-grained seafloor, and neither a consistant grain-size composition or volume of beach-quality sand is available for extraction by dredging.

Additional investigations will be necessary to define the required material (the economic deposit). Vibracores should be taken from the area of the seafloor where Unit II is exposed to substantiate suitability for beach nourishment. Analysis of the cores might include information on grain-size, sorting, and thickness, lateral extent and compositional variability of sediment layers. If the volume and quality of material is verified by the vibracores, the environmental effects of creating an offshore depression should be examined. These effects include a change of wave climate on the shoreline because of wave refraction. In addition, there will be some displacement

TABLE 2
Description of core C19

Core C19 Run-1, Run-2, Run-3	**Thickness (meters)**
Run 1	
Sand, dark-gray (2.5Y 4/0), fine- to very fine-grained; lightly scattered shell fragments, 1-2 mm; grades into silty fine-grained sand	1.80
Sand, fine- to coarse-grained; silty and gravel; micaceous; shell fragments up to 3 cm	0.10
Run 2 jetted-1.83 m, penetration-4.88 m, recovery-1.62 m	
Sand, dark-gray (5Y 4/1), fine- to very fine-grained; micaceous; scattered shell fragments up to 6 cm; shell fragments up to 1 cm common this interval at 0.98 - 1.09 m	1.09
Sand, light-gray (5Y 6/1), medium- with some fine-grained; shell fragments up to 6 cm (bivalve); this interval at 0.00 - 0.06 m; pod of fine- to medium-grained sand, slightly silty this interval at 0.39 - 0.43 m	0.46
Run 3 jetted- 3.38 m, penetration- 5.89 m, recovery- 2.10 m	
Sand, medium- with fine-grained; widely scattered gravel and shell fragments; gravel up to 5 cm; shell fragments up to 4 cm; scattered pods of mud (1 cm size); cobble this interval at 1.85 m	1.70
Sand, fine-grained; pod of silty fine sand this interval at 0.03 - 0.07 m	0.38

Location of Core C19 in Loran C coordinates: 27155.0 41229.9

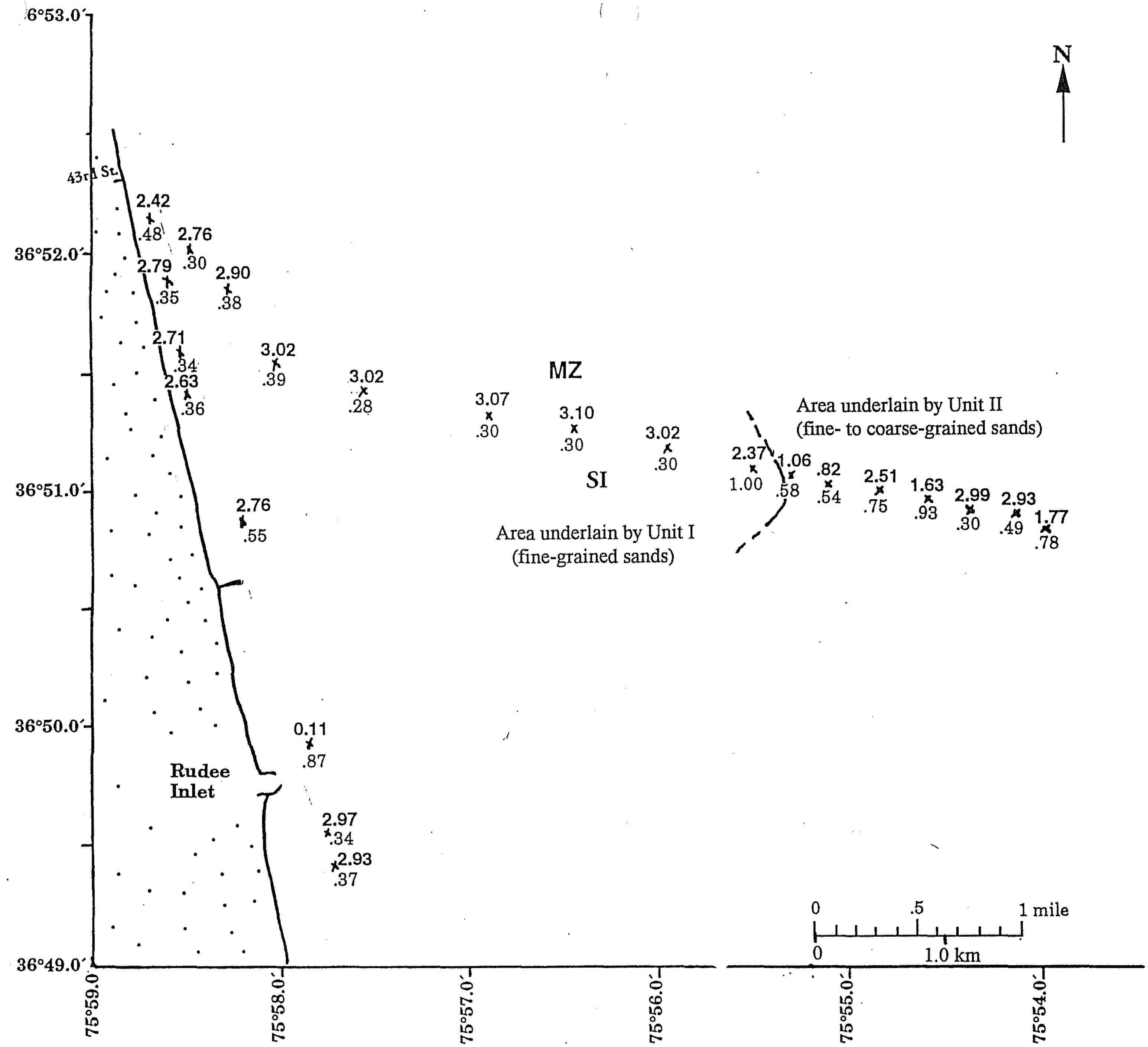

Figure 5. Map showing the approximate boundary between the surficial exposure of seismic units I and II. Mean grain size (MZ) and sorting (SI) of grab samples are noted (MZ above and SI below sample locations). Target area for future vibracoring is in the area underlain by Unit II.

of the benthic community and migratory fauna that will also change with time (Schaffner and Hobbs, 1992).

In addition to offshore beach nourishment sand, construction aggregrate (gravel) and other economic minerals might be present in economic quantities. Co-production and maximum use of dredged and transported materials would lower overall costs of a beach nourishment project by removing gravel or economic minerals prior to placing sand on the beach. A few percent of heavy minerals was noted in several grab samples. Other research at VIMS is examining composition and concentration of minerals in these and other samples near Sandbridge with results in the near future.

Acknowledgements

This work could not have been successful without the expertise and dedication of Durand Ward and Chuck Gerdes, captain and crew of the R/V Bay Eagle. Robert A. Gammish, C.H. Hobbs, III, and Suzette M. Kimball were invaluable in the field and contributed to the collection and analysis of the data. The authors graciously thank these individuals for their efforts.

This report captures some of the work done by Naomi Gomillion, begun while she was an intern at Virginia Institute of Marine Science (VIMS) during the summer of 1992 and continuing as her senior thesis for the Geology Department, College of William and Mary, completing in May 1993. C. R. Berquist, Jr. was her mentor/advisor during this time.

References

Berquist, C.R., Jr, Fischler, C.T., Calliari, L.J., Dydak, S.M., Ozalpasan, H., and Skrabal, S.A., 1990, Heavy mineral concentrations in sediments of the Virginia inner continental shelf, in Berquist, C.R. Jr., [ed.], Heavy-mineral studies - Virginia inner continental shelf, Virginia Division of Mineral Resources Publication 103, p. 95 - 108.

Gomillion, N., 1993, Shallow Stratigraphy and Seafloor Sediment Characteristics: Southeastern Virginia: Unpublished Senior Thesis, Geology Department, College of William and Mary, Williamsburg, Virginia, 34 p.

Kimball, S.M., Dame, J.K., II, and Hobbs, C.H., III, 1991, Investigation of isolated sand shoals on the inner shelf of southern Virginia: Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia, 73 p.

Schaffner, L.C., and Hobbs, C.H., III, 1992, Effects of sand-mining on benthic commuinitites and resource value: Thimble Shoal, lower Chesapeake Bay: Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia, 33 p.

Wright, L.D., Kim, C.S., Hardaway, C.S., Kimball, S.M., and Green, M.O., 1987, Shoreface and beach dynamics of the coastal region from Cape Henry to False Cape, Virginia: Technical Report Obtained Under Contract with the Virginia Department of Conservation and Historic Resources, 116 p.