Sediments and Shallow Stratigraphy of a Portion of the Continental Shelf of Southeastern Virginia

by

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Virginia's Inner Continental Shelf:
Continued Studies Relative to the Potential for Aggregate Mining

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The following document, *Sediments and Shallow Stratigraphy of a Portion of the Continental Shelf of Southeastern Virginia*, is the complete text of the author's Ph.D. dissertation at the University of Mississippi. As much of the work was performed with funds provided by the Office of International Activities and Marine Minerals of the Minerals Management Service of the U. S. Department of the Interior, the dissertation also serves as a report of work accomplished as part of Cooperative Agreement 14-35-001-30740. The work was conducted at the Virginia Institute of Marine Science of the College of William & Mary.

Portions of the dissertation have appeared in earlier reports.

ABSTRACT

SEDIMENTS AND SHALLOW STRATIGRAPHY OF A PORTION OF THE
CONTINENTAL SHELF OF SOUTHEASTERN VIRGINIA

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    Robert Woolsey.

A network of high-resolution, seismic-reflection
profiles and grab samples of the surficial sediments of the
inner continental shelf of southeastern Virginia demonstrate
that the Quaternary geology of the region is more complex
than indicated by earlier studies. The spatial variability
of the surficial sediments depicts active processes, such as
outflow from Chesapeake Bay, as well as the underlying
geology in outcrops of finer grained sediments near False
Cape.

The complexity of the Quaternary geology results from
large and small scale fluctuations in sea level.
Individual, relatively large-scale, seismostratigraphic
units are separated by erosional surfaces formed during the
major changes in sea level that created the Cape Charles,

Eastville, Belle Haven, and Exmore paleochannels in Chesapeake Bay. The low amplitude, high frequency variations in sea level that occurred during the mid-Pleistocene impacted the inner shelf forming several thin depositional strata separated by local erosional surfaces.

Substantial resources of sand exist on the inner shelf and are suitable for use in beach nourishment and construction aggregate. The deposits occur in three distinct stratigraphic settings: discrete shoals on the surface, filled channels, and laterally variable stratigraphic facies. The three types of filled paleochannels within the inner shelf have different origins: 1) riverine flow, 2) back-barrier or lagoonal channels, and 3) migration of (Holocene?) tidal inlets.

ACKNOWLEDGMENTS

Many persons have participated in the actual work of the several projects that I have herein attempted to draw together. My co-investigators and co-workers on the various projects, C. R. Berquist, Jr, S. M. Kimball, C. S. Hardaway, R. A. Gammisch, and D. A. Milligan, among others, each had a role in some aspect of the work. My graduate students Z.-Q. Chen, S. M. Dydak, and H. Ozalpasan helped with the work and helped me continue to learn.

The several projects that are included in this work were funded by the Minerals Management Service of the U. S. Department of the Interior and by the Commonwealth of Virginia. Throughout this exercise I have been a full-time faculty member of the Virginia Institute of Marine Science of the College of William & Mary. I thank the administration for its indulgence as I have pursued this effort within and around my more regular duties.

This dissertation would not have been written were it not for my major professor, J. Robert Woolsey. Without his encouragement to seek admission to the program at the

University of Mississippi it is unlikely I would have made or had the opportunity to synthesize the information into what I hope is a coherent presentation. Since entering the program he has been a continuing source of encouragement and advice.

Dr. Robin C. Buchannon of the Marine Minerals Technology Center at the University of Mississippi provided an enormous amount of help in all areas as she guided me through administrative and logistical requirements and made cogent suggestions about my work. The members of my committee, Gary Gaston, Jim Harding, and, Dave Bazard have provided advice, assistance, and encouragement.

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INTRODUCTION

The inner continental shelf, herein defined as that portion of the continental shelf in water depths 30 m or less, is a geological, geomorphic, and geographic region that is the subject of new or renewed interest to the oceanographic and geologic communities. As sediments move from continental highlands to the abyss, they must cross the continental shelf. A subset of the sediments makes a relatively quick passage across the continental shelf through submarine canyons, a second subset moves more slowly under the influences of wave driven currents and other dynamic processes, and a third subset never fully crosses the shelf but remains on it, building the shelf upward or outward.

The sediment wedge forming the continental shelf on the east coast of North America began to develop during the Cretaceous and continued to grow during the Tertiary and the Quaternary. Uchupi (1970) described the geologic history of the shelf as the up- and out-building on the slope atop subsiding Triassic and Jurassic rocks. The inner continental shelf bears substantial evidence of the changes

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wrought by several great changes in sea level during the Pleistocene.

It is the physical story outlined by the sediments and strata that is the basis of this dissertation. The specific spatial focus of which is the inner continental shelf adjacent to southeastern Virginia (Figure 1).

As the continental shelf is the submarine portion of the larger wedge of sediment that also includes the coastal plain, any complete study of the shelf cannot ignore the latter. Much of the present coastal plain was submerged during Pleistocene high-stands of sea level during which it was part of the continental shelf. Conversely, much of the present inner shelf was emergent and part of the coastal plain during the intervening low-stands. Although the emphasis of this dissertation is the current inner continental shelf, the investigation requires reference to the coastal plain. Today the surface of the continental shelf slopes gently to the east and is marked with shoals (Figure 2).
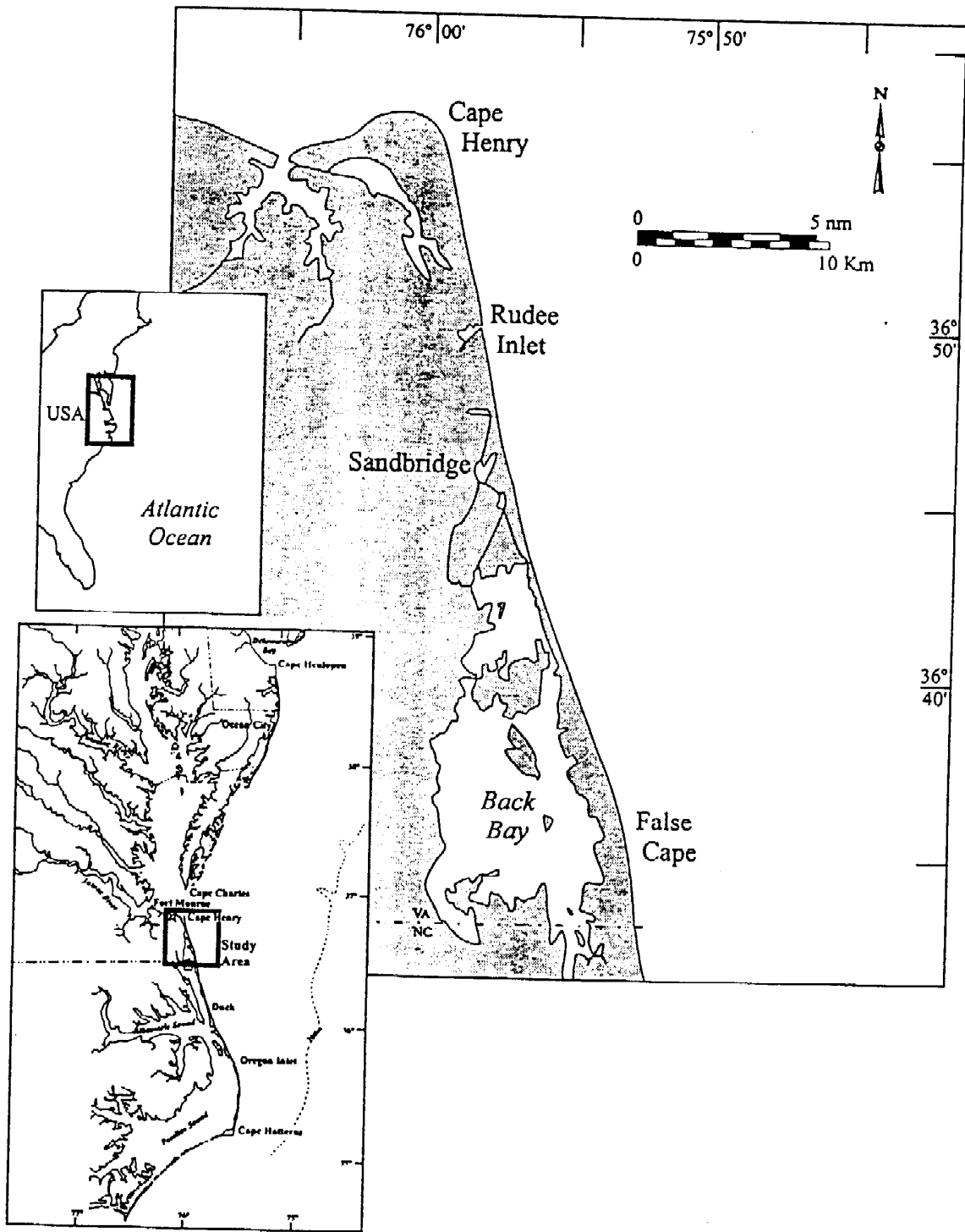
Figure 1: Location map depicting the location and extent of the study area.
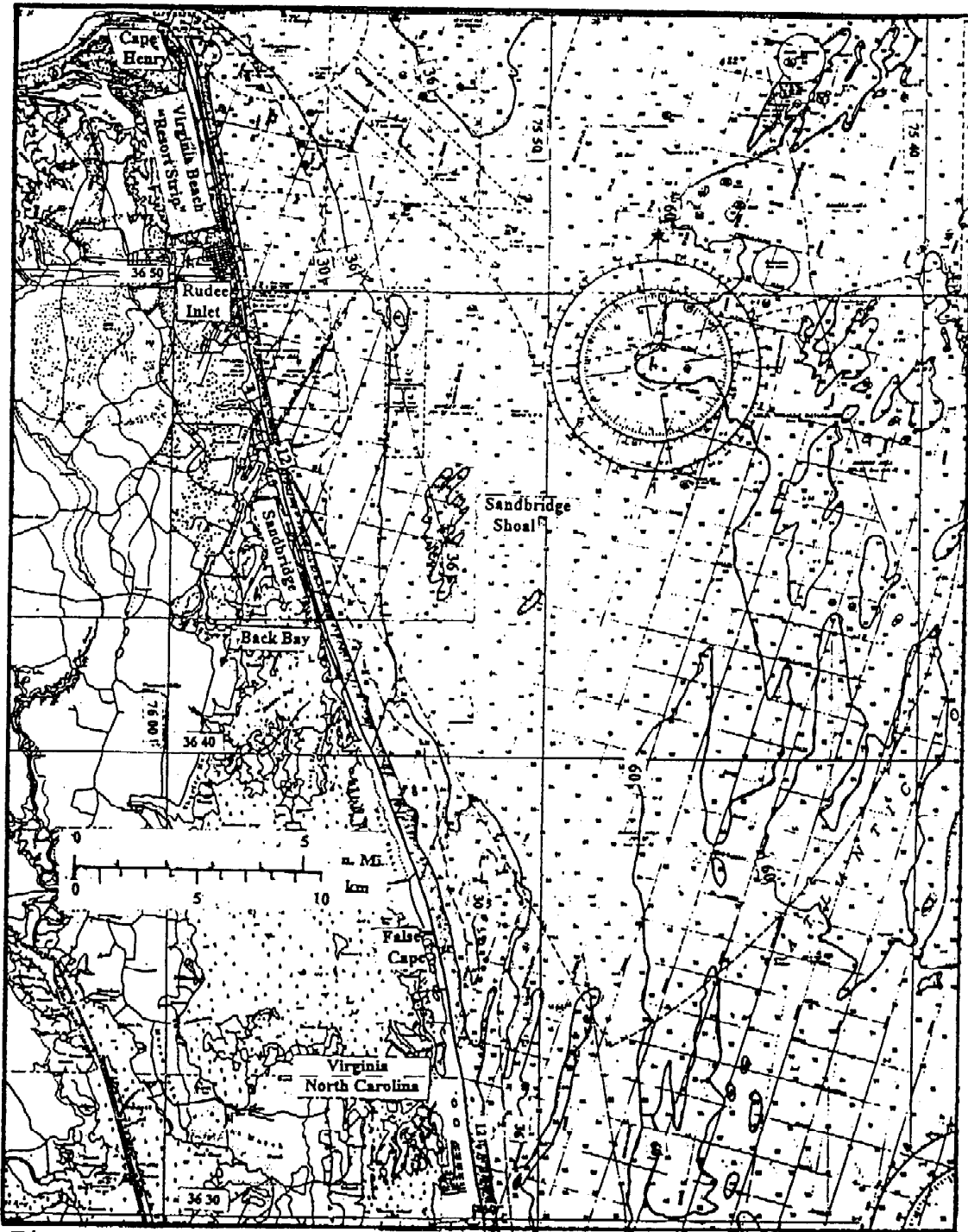
Figure 2: Bathymetry of the inner part of the continental shelf adjacent to southeastern Virginia as shown on NOS Chart 12207 (reduced). The 12, 30, 36, and 60 ft contours are shown.

GOALS AND OBJECTIVES

It is the intent of this study to review the evidence pertaining to the Pleistocene and Holocene geological history of the inner continental shelf adjacent to southern Virginia with the primary goal of developing a coherent interpretation thereof. Part of the interpretive process involves mapping the three dimensional patterns of sediment bodies. As there are many practical uses for specific types of sediment, another objective of this study is to characterize the distribution of sand potentially suitable for use in civil works such as beach nourishment or in commercial applications such as construction aggregate. A lower-level objective is a discussion of the distribution of various species of heavy minerals within the sediments.

The specific area of study is that region of the inner continental shelf between Cape Henry at the mouth of Chesapeake Bay and the boundary between Virginia and North Carolina. The study area extends offshore a variable and indefinite distance to a water depth of approximately 30 meters.

PREVIOUS WORK

The earliest modern reference to the sediments of the southern Virginia inner continental shelf was Shepard (1932), who depicted the area's sediments as being "shells, sand & gravel," "gravel," near the Virginia - North Carolina border, and "shells & sand" near the mouth of Chesapeake Bay. Shepard based the distribution on information recorded on navigation charts augmented by examination of samples collected by the United States Coast Survey but provided no indication of the number or spacing of samples.

Milliman and others (1972) and Milliman (1972), using a grid of grab samples with an 18 km (10 n mi) spacing, described the sediments of the Atlantic continental shelf of the United States. The reports mentioned a plume of very fine sand with coarse silt extending seaward from Chesapeake Bay and a band of arkosic sediments in the sand portion also extending outward from the bay. With ten or so samples within the present study area, the reports described the nearshore subarkosic to arkosic fine-grained sediments and sands as being derived from modern, nearshore, fluvial sources and the similarly-composed materials found farther offshore as relict fluvial sediments. Hollister (1973),

using the same samples as Milliman and others (1972), also provided information on the sediments from New Jersey to Florida.

Amato (1994), in describing the sand and gravel resources of the Atlantic Continental Shelf, provided a summary and review of earlier works and included maps showing the distribution of sediment types. As is the nature of a compilation and review, his work basically echoes the above-referenced studies but does specifically consider the sediments as a resource.

Uchupi (1970) discussed the "shallow structure" of the shelf. However, in that his study extended from Maine to Florida and the data were acquired using a sparker system with an energy peak at around 100 Hz, the data are better attuned to answering questions relating to epochal (series in chronstratigraphic terminology (North American Commission on Stratigraphic Nomenclature, 1983) or longer time periods, than to the stage (age) or substage levels of this dissertation. Uchupi's seismic profiles depict two-way travel times of a full second or more, an order of magnitude longer than some of the data used in the present study. Although his study was more concerned with the outer shelf

and slope, its figures portray the Quaternary section of the
inner slope as a sequence of nearly parallel beds.

Richards (1967, 1974) provided further information on
the structural setting of the Atlantic Coastal Plain. The
present study area is near the crest of the Fort Monroe
High, a structural high between the Salisbury Embayment and
the Pamlico Basin or Hatteras Low. Beneath Fort Monroe,
just inside the mouth of Chesapeake Bay at the entrance to
the Hampton Roads harbor, crystalline rocks were encountered
in a well at -681 m (-2,234 ft). At Ocean City, Maryland in
the Salisbury Embayment a well bottomed in Lower Cretaceous
sediments at -2,350 m (-7,710 ft). Crystalline rocks were
reached at -3,041 m (-9,978 ft) beneath Cape Hatteras in the
Pamlico Basin (Richards, 1967, 1974).

Swift, Shideler, and their co-workers (Shideler and
others, 1972; Shideler and Swift, 1972; Swift and others,
1970; 1971; 1972a,b; 1974; 1977) performed a series of
studies of the Virginia continental shelf. Shideler and
others (1972) proposed a standard stratigraphic section for
the area (Figure 3) which most subsequent workers have used.
The standard section consists of a sequence of four
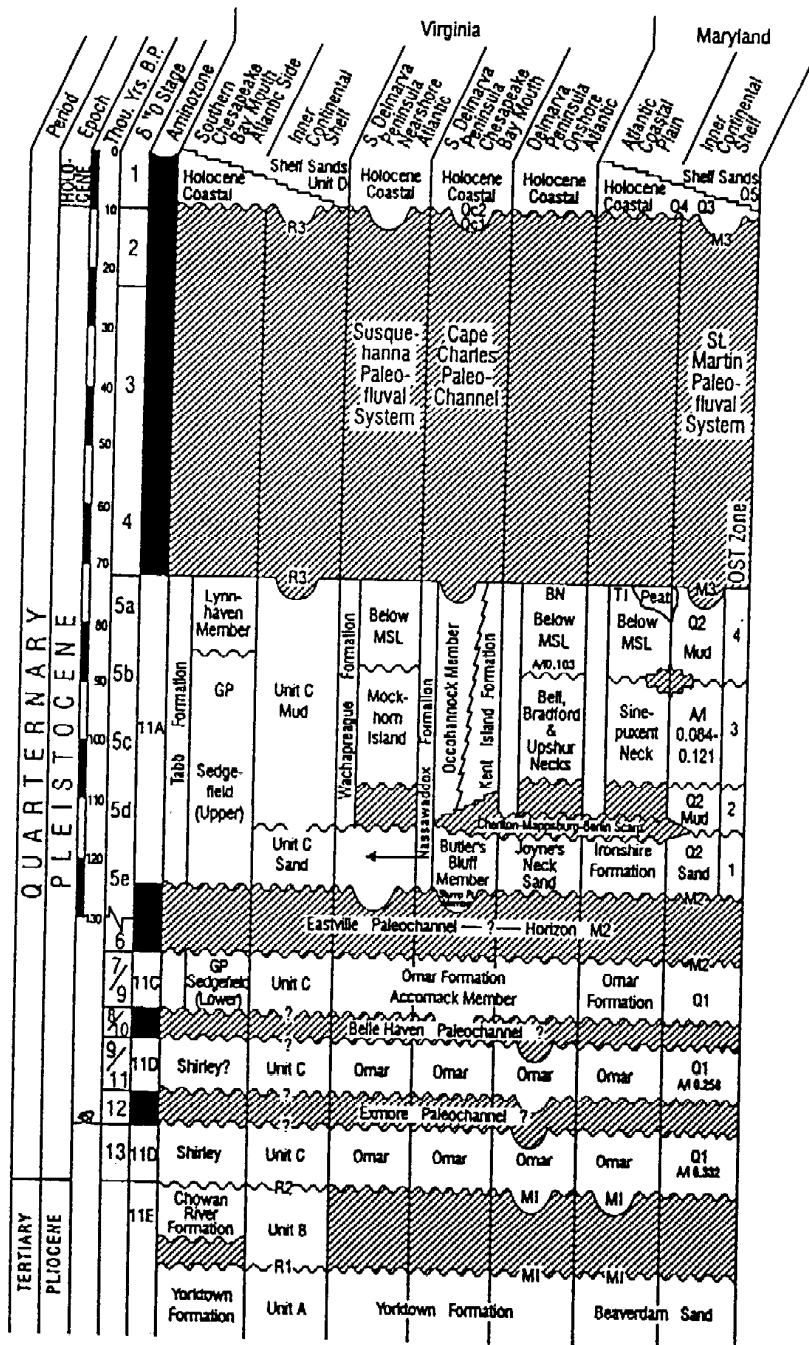
Figure 3: Correlation chart for the middle Atlantic Coastal Plain and inner continental shelf, modified from Toscano and York (1992). Chronological data from Hays and others (1976) and Toscano (1992).

stratigraphic units, termed units A, B, C, and D, separated
by major reflectors.

Unit A is "the deepest and oldest sedimentary sequence
detected within the study area, which can be considered a
discrete stratigraphic entity ... . This unit is defined as
the sequence whose upper boundary is reflector 1, the
deepest prominent acoustic discontinuity observed during the
study" (Shideler and others, 1972). Although several later
workers have been able to identify and utilize unit A and
reflector 1, the seismostratigraphic elements are somewhat
problematical as they are dependent upon the geophysical
equipment used, "deepest observed," and a subjective
interpretation. Different equipment or different
operational conditions might provide greater penetration and
allow observation of deeper reflectors. Indeed, Poag and
others (1994), working just inside the mouth of Chesapeake
Bay, depicted reflectors down to a pre-Lower Cretaceous
"basement," and work in mid-1996 by Hobbs (unpublished)
revealed the stratigraphy down to 200 ms two way travel time
(about 150 m) well below reflector 1. Shideler and others
(1972) suggested that reflector 1 is the Miocene--post-
Miocene boundary. Since publication, one of the authors (J.
H. Johnson, oral communication) has suggested that unit A is

the Yorktown Formation, which now is considered of Pliocene, not Miocene, age or another Pliocene formation, thus perhaps making reflector 1 the Pliocene-Pleistocene boundary. Shideler and others (1972) further described reflector 1 as a widespread, regional, angular unconformity, dipping eastward at an average apparent rate of 1 m km^{-1} and having local relief of up to 3 m. On one profile, reflector 1 dipped from 30 to 75 m below sea level, 10 to 44 m below the sea floor.

Shideler and others (1972) defined unit B as the "sequence above reflector 1, whose seismic profiles are characterized by commonly lenticular stratification and prominent local channeling. The upper boundary is generally reflector 2, ... in the absence of unit C, the upper boundary consists of reflector 3 ... ." Considering the channels, there is as much as 18 m of local relief evident in unit B. They further "surmise that fluvial, estuarine, and lagoonal tidal channels, and barrier ridges are present; ... portions of unit B occur in a coast-parallel belt which may be a barrier complex (submarine extension of Oaks (1964) sand-ridge complex) ... ." They go on to suggest an early Wisconsin age for the upper portion of unit B.

Shideler and others (1972) described unit C, the next younger stratigraphic unit as "the sequence with uniform horizontal stratification, whose basal and upper boundaries are reflectors 2 and 3 ... ." Reflector 2 occurs within the depth range of 17 to 39 m below sea level and 1 to 19 m below the seafloor. It has an eastward dip of 0.48 m km^{-1} and has local relief of up to 5 m. In the eastern portion of their study area, reflector 2 is truncated by reflector 3. Unit C itself ranges in thickness from zero to 14 m and "is characterized by relatively uniform horizontal stratifications throughout, with only occasional indications of minor local channeling."

The youngest sedimentary unit described by Shideler and others (1972) is unit D, the sequence above reflector 3. They state that reflector 3 occurs intermittently within the study area, is the shallowest prominent subsurface reflector, and variously is exposed or buried as much as 9 m below the sea floor. Unit D is composed of modern surficial sediments of the sea floor, its thickness usually being a function of surface topography.

Meisburger and Williams (1987) and Meisburger and others (1989), studying the nearshore at Duck, North

Carolina, south of the present study area, described a unit
E. This unit is the modern beach and dune sediments,
discrete from unit D.

Oaks and others (1974) described the terrestrial, post-
Miocene geology (more recent interpretations (Johnson and
others, 1985) consider the same sequence to be post
Pliocene) of southeastern Virginia. Oaks and others (1974)
discuss ten stratigraphic units that were formed during "6
distinct periods of submergence" and "6 important periods of
emergence." According to this scheme (Table 1), the
sedimentary units atop the Yorktown Formation are the
Sedley, Bacons Castle, Moorings, Windsor, Great Bridge,
Norfolk, Kempsville, Londonbridge, Sandbridge Formations,
and modern, Holocene deposits. The major sea-level lows
occurred before the Sedley, Moorings, Windsor, Great Bridge,
Londonbridge, and modern units.

Johnson and Berquist (1989) summarized the stratigraphic
nomenclature used since 1928 in studies of Virginia's coastal
plain. Table 1 compares Johnson and Berquist's (1989)
terminology, modified with the inclusion of the Chowan
Formation from Johnson and others (1985), with the
stratigraphy discussed by Oaks and others (1972).

Table 1

Comparison of Nomenclature for the
Stratigraphy of Virginia's Coastal Plain

Oaks and Coch (1973) Oaks and others (1974)		Johnson and Berquist (1989) (inc. Johnson and others (1985))		
HOLOCENE	Unnamed Holocene and Dismal Swamp peat	Unnamed Holocene deposits		HOLOCENE
	Sandbridge Fm.	T	Poquoson Mbr	
		a F		
	Londonbridge Fm.	b m	Lynnhaven Mbr	
		b		
	Kempsville Fm. Norfolk Fm.		Sedgefield Mbr	
PLEISTOCENE		Shirley Fm.		PLEISTOCENE
	Great Bridge Fm.			
		Chuckatuck Fm.		
	Windsor Fm.	Charles City Fm.		
		Windsor Fm. (restricted)		
PLEISTOCENE AND/OR	"Moorings" unit	"Moorings" unit		
PLIOCENE	Bacons Castle Fm.	Bacons Castle Fm.		
				PLIOCENE
	Sedley Fm	Chowan River Fm. Yorktown Fm		
MIOCENE				
	Yorktown Fm.	Eastover Fm.		MIOCENE

Toscano and others(1989) and Toscano (1992) discussed the Quaternary history of inner continental shelf offshore of Maryland and the inner shelf of the mid-Atlantic. One facet of these studies that has specific bearing to the inner shelf off southeastern Virginia is the set of small-scale fluctuations of sea level, -23 to + 6 m, during Oxygen Isotope Stage 5, roughly 75,000 to 130,000 years B.P. (Figure 4). This period corresponds to the North American Sangamon (Richmond and Fullerton, 1986). These oscillations, three highs and two intervening lows within 23 m of today's sea level, should be evident on the inner shelf. Those sections of the shelf less than 20 m in depth would have been exposed and the areas at slightly greater depth would have been subjected to shallow-water wave and current energy.

Table 2 is a listing of oxygen isotope stages and respective dates. The ratio of ^{16}O and ^{18}O in tests of planktonic foraminfera is a function of global ice volume during the time the organism was alive. Changes in the oxygen isotope ratio correlate with glacially controlled variations in sea level.
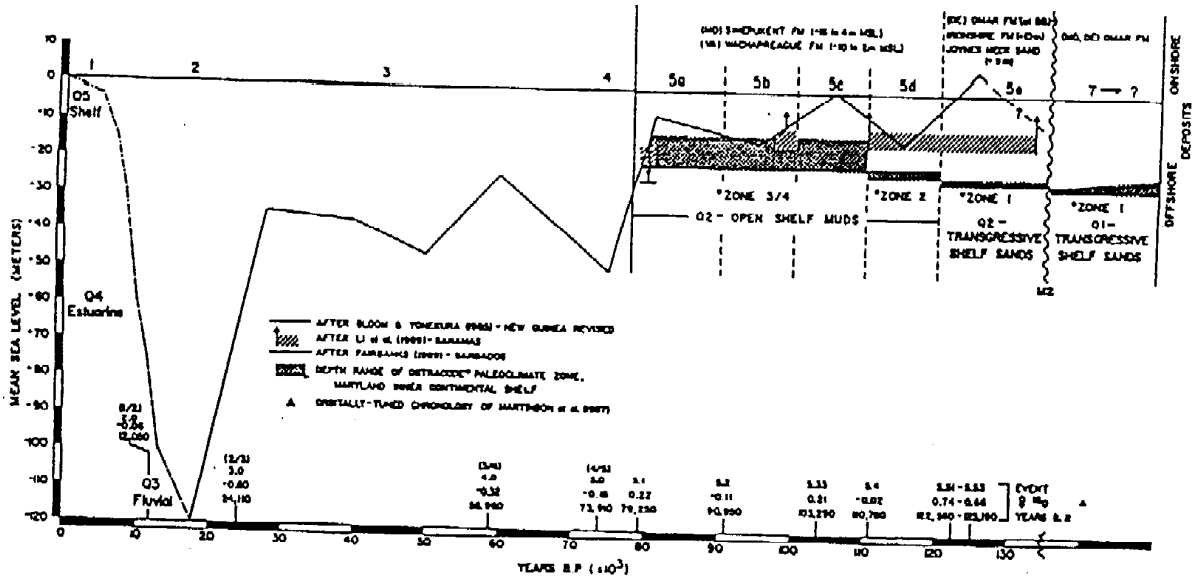
Figure 4: Late Pleistocene sea-level curve (from Toscano and York, 1992 and Toscano, 1992). The range of sea level during Oxygen Isotope Ratio Stage 5 is from -23 to +6 m.

Table 2

OXYGEN ISOTOPE STAGES AND DATES

from Hays, J. D., J. Imbrie & N. J. Shackelton, 1976

BOUNDARY

STAGE	YEARS BP
1	
---------	10×10^3
2	
---------	29 "
3	
---------	61 "
4	
---------	73 "
5	
---------	127 "
6	
---------	190 "
7	
---------	247 "
8	
---------	276 "
9	
---------	336 "
10	
---------	356 "
11	
---------	~425 "
12	
---------	~457 "
13	

Toscano and York (1992) further developed the geologic history of the Maryland inner continental shelf and proposed correlations with adjacent areas. Their "revised correlation chart for the middle Atlantic Coastal Plain and inner continental shelf" (Figure 3), is a regional correlation which includes interpretations from other studies. The figure also suggests some of the questions or problems of interpretation and correlation. Specifically, the correlation shows the "unit C" (Shideler and others, 1972) as existing across major regressions; that is unit C continues in time through the formation of the Exmore and Eastville (and by extension, Belle Haven (Oertel and Foyle, 1995))paleochannels. This lack of differentiation in unit C possibly results from the inability of their (Shideler and others's, 1972) equipment to image or resolve some reflectors. To the north of the present study area, the terrestrial Omar Formation shows a similar continuum.

Chen (1992) and Chen and others (1995), using some of the same data used in the present study, described three sets of paleochannels buried in the Quaternary of the inner continental shelf offshore of southeastern Virginia (Figure 5). They equated the ages of the channel systems to the Cape Charles, Exmore, and Eastville paleochannels of
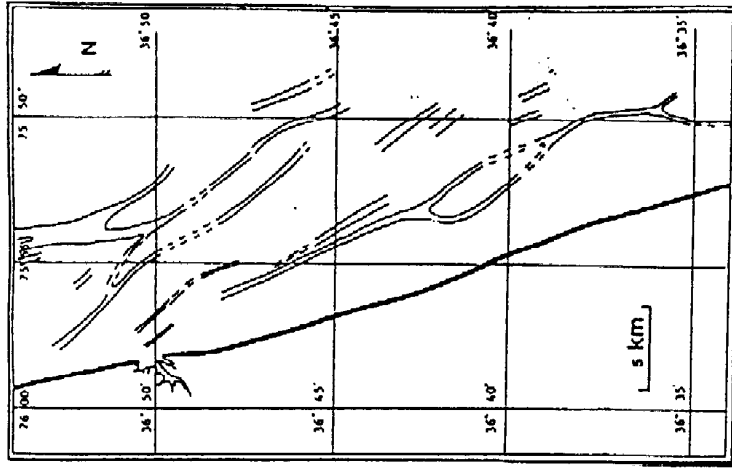
Cape Charles Aged Paleochannels
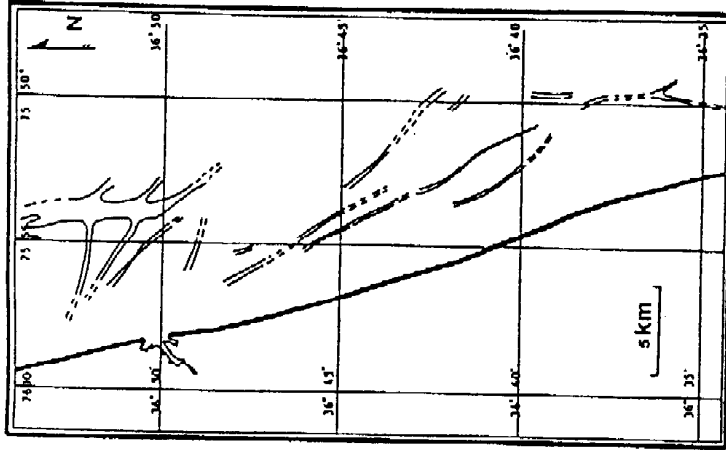
Eastville Aged Paleochannels
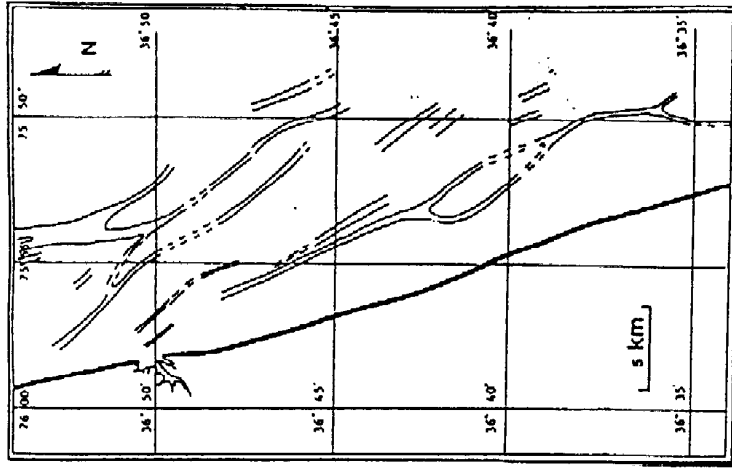
Exmore Aged Paleochannels

Figure 5: Maps of paleochannels of Cape Charles, Eastville, and Exmore ages presented by Chen (1992).

Chesapeake Bay defined by Colman and Hobbs, 1987, 1988;
Colman and Mixon, 1988; and Colman and others, 1990.

Foyle (1994) and Oertel and Foyle (1995) discussed the
Quaternary geology of the inner continental shelf adjacent
to the lower Delmarva Peninsula, the region immediately to
the north of the present study area. As would be expected,
their analyses portray a geological history similar to that
of the Maryland shelf. They describe a previously
unidentified paleochannel system running under the Delmarva
Peninsula from Chesapeake Bay. This newly recognized
paleochannel, called the Belle Haven, is physically and
chronologically between the more northerly and older Exmore
and the more southerly and younger Eastville paleochannel as
identified and described by Colman and others (Colman and
Hobbs, 1987, 1988; Colman and Mixon, 1988; Colman and
others, 1990). The chronology, defined by the series of
channels and prograding spits that form the Delmarva
Peninsula (Mixon, 1985), provides much tighter control on
the sequence of Quaternary transgressions and regressions
that have formed and modified the continental shelf and
coastal plain in the mid-Atlantic region of the United
States.

Riggs and others (1992) reviewed the Quaternary depositional patterns in northeastern North Carolina considering the transition from fluvial to estuarine systems. Snyder (1993)presented seismic data but little stratigraphic interpretation from an area offshore of North Carolina south of the present study area.

Mirecki and others (1995) addressed the Quaternary geochronology of coastal plain deposits near the study area. Using aminostratigraphic and electron spin resonance data from outcrops of Quaternary materials, they discerned two transgressive units overlying the Pliocene and cite evidence of a third. Their discussion supports the chronology of Foyle (1994) and Oertel and Foyle's (1995), with the Belle Haven channel having been formed during a lowstand between the excavation of the Exmore and Eastville Channels.

Wright (1995)described the variation in energy impacting the bottom ("excess wave-induced bed stress for fine sand transport") during the late Quaternary. By characterizing the cumulative duration of the periods during which wave energy was sufficient to resuspend bottom sediment as determined by sea-level history for conditions of different storm-waves, he indicates how dynamic the shelf

has been during the last 140,000 years. The historic distribution of energy across the shelf indicates areas where the bottom sediments were more mobile and, thus, provides an indication of which portions of the shelf might have experienced erosion and which might have been sites of accumulation, perhaps in the form of bars or shoals.

According to Wright (1995) the cumulative period of "activity", increases with depth to about 45 m, where, given waves with a 1 m height and a 10 s period, there have been about 55,000 years of activity on the bottom during the past 140,000 years. There is a second peak of about 70,000 years cumulative activity between 85 and 95 m depth. For larger waves, 5-m height and 10-s period, which resuspend sea-floor sediment at a greater water depth, the cumulative duration of activity increases from a minimum at present sea level to a maximum at about 90 m depth of almost 120,000 years of the total 140,000 year interval.

The same general pattern holds true for the last 18,000 years. The cumulative period of activity increases rapidly from a minimum of a few hundred years in very shallow water to about 6,000 years of activity at 10 m depth then increasing less rapidly to a peak of 9,500 years between 40

and 50 m for the smaller waves. The cumulative period of activity falls rapidly to less than 4,000 years of activity beyond 55 m (Wright, 1995).

In a series of studies, Kimball and Dame (1989), Dame (1990), and Kimball and others (1991) investigated sand resources potentially available to Virginia Beach and described the morphology and history of Sandbridge Shoal. The two most recent of those reports discuss a two-stage formation of the shoal, the lower bed within the shoal possibly being the reworked remains of a barrier or submerged bar formed during a Pleistocene sea-level high-stand and which survived the subsequent marine transgression. The second stage in the formation of the shoal was the deposition of the upper unit during the Holocene transgression. Hardaway and others (1995) and Hobbs (1996) continued studies of the area's offshore sand resources.

The distribution of heavy minerals in the sediments of the Virginia continental shelf has been the focus of much work (Swift and others, 1971; Nichols, 1972; Goodwin and Thomas, 1973; Firek, 1975; Firek and others, 1977; Grosz and Eskowitz, 1983; Berquist, 1986, 1990; Berquist and Hobbs,

1986, 1988a, b, 1989; Ozalpasan, 1989; Berquist and others, 1990 a, b, c; Calliari and others, 1990; Dydak, 1991). Goodwin and Thomas (1973) analyzed the heavy mineral content of the sand fraction (0.062 to 1.0 mm (4 to 0 phi)) of 112 grab samples collected from the Virginia shelf north of the mouth of Chesapeake Bay. The samples ranged between 0 and 18 weight percent heavy minerals, with an average of 5.3 percent, and included garnet, magnetite-ilmenite, hornblende, and epidote with lesser proportions of kyanite, sillimanite, tourmaline, rutile, and zircon. Grosz and Eskowitz (1983) specifically addressed the potentially economic marine heavy minerals and identified some areas as having concentrations in excess of 10 weight percent heavy minerals. Their work highlighted the concentrations of the titanium minerals rutile, ilmenite, and leucoxene.

A subsequent series of studies, culminating in Berquist (1990), Berquist and others (1990), and Calliari and others (1990), characterized the heavy-mineral occurrence and distribution offshore of Virginia. The analyses also utilized the whole sample (Grosz and others, 1990) in contrast with the more common analyses of just the sand fraction or a sub-part thereof. In twenty percent of 390 samples (100 surficial grabs and 290 core segments) the

heavy mineral content equaled or exceeded 5 percent and 13 percent of the samples had heavy mineral concentrations above Garnar's (1978) threshold economic values for terrestrial deposits. Ilmenite, leucoxene, rutile, zircon, and monazite were the minerals of interest.

Ozalpasan (1989), using 129 surficial grab samples from the mouth of Chesapeake Bay north along the Delmarva Peninsula, applied Q-mode factor analysis and identified 3 factors. In Q-mode factor analysis, individual factors can be likened to end-members of a suite of samples in which each end-member represents a group of samples that are more alike one-another than they are like the samples in other groups of the suite of samples. According to Ozalpasan (1989), his Factor 1 suggested that there was movement of the amphibole, pyroxene, and epidote mineral associations from the bay to the shelf. His Factor 2 suggested that Chesapeake Bay and an area off the Delmarva Peninsula were potential sources for zircon, garnet, and amphiblole. Factor 3 suggested transportation of sediments toward the bay mouth.

Calliari and others (1990) also employed Q-mode factor analysis in a larger study of the spatial distribution of

heavy minerals on the continental shelf offshore of Virginia. They identified three factors or end members in the suite of samples. One factor was within the mouth of Chesapeake Bay and decreased in concentration seaward. This factor suggested a source of amphibole and pyroxenes within the Chesapeake Bay drainage basin with probable transportation toward the sea. The second factor showed two probable sources, one within the bay, the other south of the bay mouth (the area of the present study). This factor was comprised of zircon, garnet and amphibole. The third factor, a garnet, amphibole, epidote assemblage, primarily occurs north of the bay mouth along the Eastern Shore. The distribution of the concentration of this factor suggested transport into the bay-mouth and that (at least within 5 km of the shore) the sediment transport system did not carry sediments across the bay mouth.

Earlier studies discussed the transport of sediment into Chesapeake Bay from the inner shelf. Harrison and others (1967) reported on a study that used bottom-drifters deployed on the shelf and recovered within Chesapeake Bay. Meade (1969 and 1972) addressed the landward transport and deposition of suspended sediments. Hobbs and others (1992) determined that the continental shelf is the greatest

individual source of sediments deposited within the bay and suggest substantial transport into the bay from the shelf.

Use of the sand resources whether in civil or coastal engineering projects requires knowledge of specific characteristics of the sand. The criteria for aggregate used in construction projects varies widely with the application. Aggregate used in concrete must meet specific standards of grain-size distribution, mineral composition, and, sometimes, grain shape. Other uses have other criteria.

In beach nourishment projects "the most important borrow material characteristic is the sediment grain size. Borrow material grain size matching the native material is considered synonymous with quality" (Committee on Beach Nourishment and Protection, 1995, page 97). Although "almost any offshore borrow source near the shore will include some suitable size materials," (Coastal Engineering Research Center, 1984, page 5-10), the likely efficiency of the nourishment project can be estimated with the use of overfill factors and renourishment ratios (James, 1975, Hobson, 1977, and Coastal Engineering Research Center, 1984). These parameters are calculated using grain-size data

from both the natural beach that is to be nourished and the borrow areas. The median grain size (Md), also frequently referred to as D_{50}, is the most widely used measure of sand size (Norfolk District, 1992) in the context of beach nourishment. In addition to the median grain size, calculations of the overfill and renourishment factors use simple measures of the sorting of the native and borrow materials (Hobson, 1977). Sediments used for beach nourishment also must be free from appreciable quantities of very-fine-grained sediments and organic matter (Coastal engineering Research Center, 1984)

As part of a larger study for the Norfolk District of the U. S. Army Corps of Engineers, Waterway Surveys & Engineering, Ltd (1986) determined that the finest sand on the subaerial beach in the vicinity of Sandbridge had a D_{50} of about 0.25 mm (2 phi) and that occurred only locally on the foreshore. The study concluded that material used to nourish the beach at Sandbridge should have a D_{50} greater than 0.20 mm (2.3 phi). Wright and others (1987) reported that the D_{50} for sediment in the foreshore increased from 0.25 to 0.75 mm (2 to 0.7 phi) from Rudee Inlet north toward Cape Henry and that sediment at less than a 3 m water depth seaward of the foreshore also increased in grain size toward

the north. They also reported a small seasonal variation in grain size.

Kimball and Dame (1989) and Kimball and others (1991) discussed three areas on the inner continental shelf offshore of southeastern Virginia with the potential for beach quality sand. The first area they described is a set of linear shoals near False Cape containing over 2.5×10^6 m^3 of clean, medium- to coarse-sand. They concluded that the shoals were too far from areas that would need to be nourished to be used in most cases. The second area they considered was a possible filled channel southeast of Rudee Inlet. They dismissed the area has having an insufficient reserve of suitable material. The third area they examined was a large shoal approximately 5 km east of Sandbridge. They concluded that this shoal contains several million cubic meters of clean sand suitable for use in beach nourishment projects.

METHODS

High-resolution, seismic-reflection profiling is the primary tool that was used in obtaining the evidence presented in this study. Side-scan sonography provided additional information about the surface of the sea floor. These sets of data were augmented by information from cores and grab samples. All of the data were collected as parts of numerous individual projects over the past several years. To date, there was not an opportunity to draw the interpretations from the projects together and view them as a coherent whole.

High-resolution, seismic-reflection profiling is an acoustic, remote-sensing technique in which a short pulse of sound is directed toward the sea floor and the reflected portions of that signal are recorded and presented in a visual display (Hobbs and Dame, 1992). Depending upon the physical properties of the sediments, especially sharp contrasts in sediment bulk-density, varying portions of that signal are reflected by the sediments and by the interfaces between different bodies of sediment. The common working assumption in the interpretation of the resultant graphic

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displays is that continuous reflectors represent specific
stratigraphic features such as bedding planes and
unconformities.

As the system measures strength of the acoustic signal
versus time since transmission of the pulse, it is necessary
to relate the "two way travel time" (TWTT) of the signal
representing a particular feature to depth below the water
surface and below the sea floor. In lieu of specific
measurements of the speed of sound in the various media,
standard arbitrary values can be assumed. An acoustic
velocity of 1,500 m s^{-1} is widely used for sea water and
shallow, saturated, unconsolidated sediments (Hobbs and
Dame, 1992). Should the signal penetrate sufficiently far
into the sediment column that consolidation would have
increased the bulk density, various arbitrary and increasing
values are assigned to specific strata (Colman and Halka,
1989). Other authors (Meisburger, 1990; Snyder, 1993) use
1,500 m s^{-1} for the water column and a greater velocity for
the sediments. Throughout this study, 1,500 m s^{-1} is used
for both water and sediment.

Although employing a constant value does introduce
error, the errors are expected and do not compromise the

stratigraphic interpretations. If the actual acoustic velocity in the sediment is 1,700 m s^{-1}, not 1,500 m s^{-1}, the error is 1 m per each 0.01 s of two-way-travel-time. Individual acoustically defined strata will be calculated as slightly thinner than they are and depths from the sea or sediment surface to individual reflectors will be slightly underestimated as will calculated volumes.

The seismic records used in the present study were obtained during the course of several independent studies on the southern Virginia inner continental shelf (Hobbs and others, 1986; Colman and Hobbs, 1987; Kimball and Dame, 1989; Dame, 1990; Hobbs, 1990; Kimball and others, 1991; Hobbs and Dame, 1992; Hardaway and others, 1995, and Hobbs, 1996). These records were developed with a Datasonics SBP-5000 system, which utilizes a signal generator-transmitter-receiver-processor-amplifier capable of producing a 3.5, 5.0, or 7.0 kHz primary signal connected to a set of four transducers. The transducers transmit and receive the acoustic signal. Most of the work was performed using 3.5 kHz except where empirical observation indicated that one of the other frequencies provided a better record. The processed signal was conveyed to either or both an EPC 3202 or EPC 4800 graphics recorder for production of the profile.

The signals were not captured for storage on either tape or disk. The system usually was operated with a sweep rate of an eighth or a sixteenth of a second (0.125 or 0.063 s) with a trigger or repetition from the sweep-rate to a fourth or a half second. These sweep rates resulted in the full scale of the graphic record being 94 or 47 m, respectively, although bottom penetration rarely exceeded 30 m.

All work was conducted aboard the Virginia Institute of Marine Science (VIMS) *R/V Bay Eagle* which was steered along track lines usually following lines of constant loran-C time delay. Positioning data were automatically recorded at time intervals never exceeding 5 minutes and frequently 2 minutes or less. Early projects relied upon conversion of loran-C coordinates to latitude and longitude by the on-board loran processor, whereas the more recent data-sets were recorded from a GPS (Global Positioning System) reporting geographic coordinates in the 1983 North American Datum (NAD 83). Differences between the datum used in the loran conversions (assumed to be NAD 27) and NAD 83 are on the order of a few tens of meters and have been ignored.

A total of 1,100 km (595 nautical miles) of track were run. Figure 6 depicts the track lines.
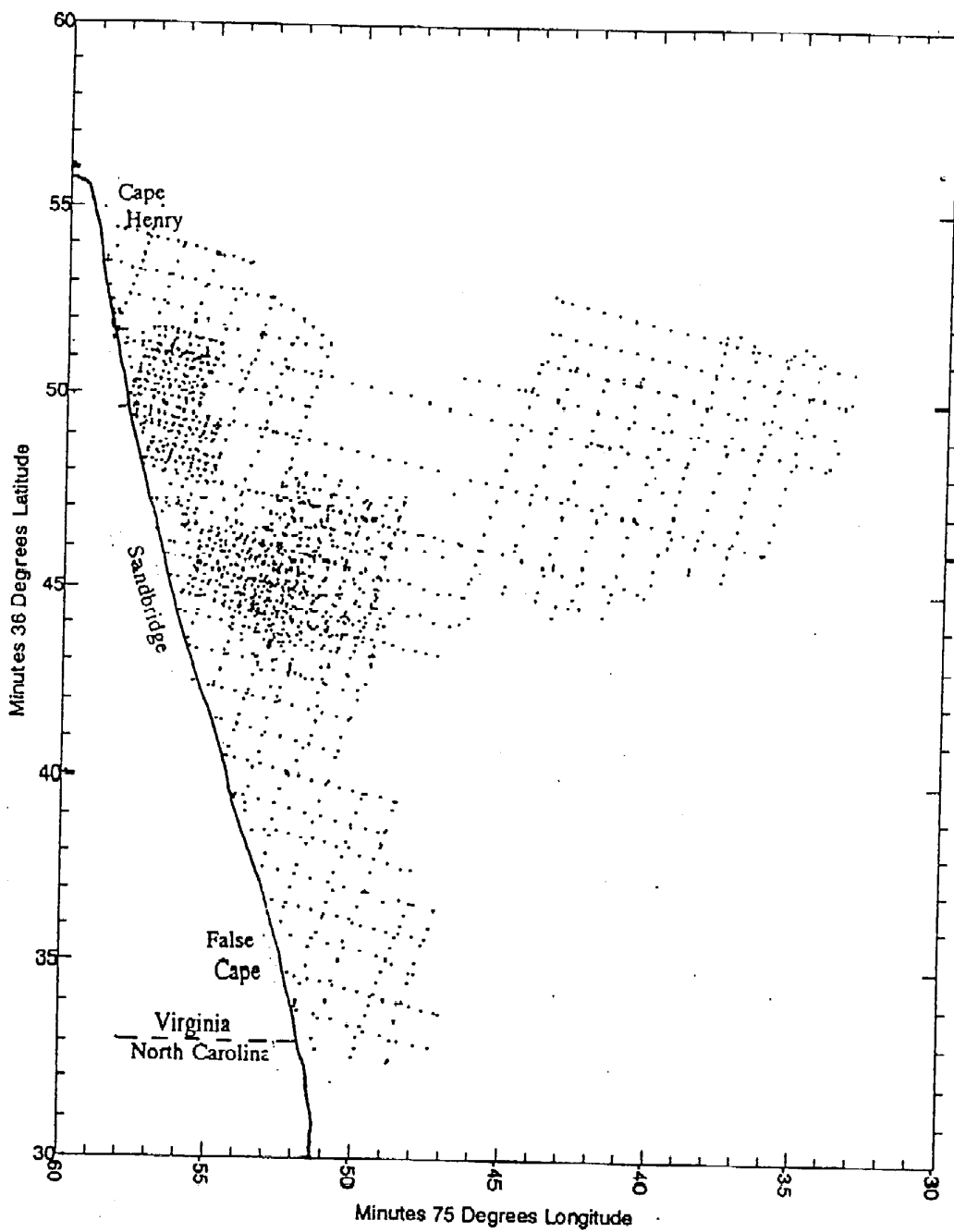
Figure 6: Track lines of seismic-reflection profiles.

As the transducer was towed at various depths (usually between 1 and 3 m), the water depths depicted on the seismic profile are inaccurate. These differences as well as tidal variations were ignored. These errors are additive with the error resulting from the assumption of a constant acoustic velocity.

The side-scan sonar used was a 105 kHz, EG&G SMS-960 set to record a 100 m swath either side of the towed transducer. Through a graphic depiction of the intensity of the back-scattered return of a shaped acoustic signal, side-scan sonar indicates the general condition or character of the bottom (Flemming, 1976; D'Olier, 1979; Williams, 1982; Duane, 1987; Duane and Stubblefield, 1988; Hobbs, 1990; Hobbs and Dame, 1992)

The seismic records were interpreted manually and the data plotted on maps of the track lines. Specific elements noted were water depth, depth to specific reflectors, and location of thalwegs of paleochannels. Thickness of sedimentary units was determined either by measurement on the profile or by subtraction of the recorded depths of the reflectors bounding the bed.

The side-scan records also were interpreted and features observed were plotted on maps of the track lines. Apparent gross changes in sediment type or surface condition were cross-checked with the sub-bottom profiles to see if the surface changes mirrored stratigraphic changes.

Grab samples were collected using a variety of samplers. The largest individual set of samples consisted of 380 grab samples obtained during the fall and spring of 1994-1995 (Figure 7). All were obtained with a Smith-McIntyre grab, most from VIMS R/V Langley with the remainder from the R/V Bay Eagle. Duplicates of the samples in this set remain available to other researchers. Samples were placed in plastic bags in the field. On return to the laboratory, splits of the samples were taken for various analyses. Location and grain-size data are presented in Appendix 1.

Two sets of cores were obtained during the course of these studies. The first were 9 cm (3.5 in) diameter vibracores up to 6 m (20 ft) in length taken in 1987 under contract by Alpine Ocean Seismic Survey aboard the R/V Atlantic Twin. The second group, 7.5 cm (3 in) diameter
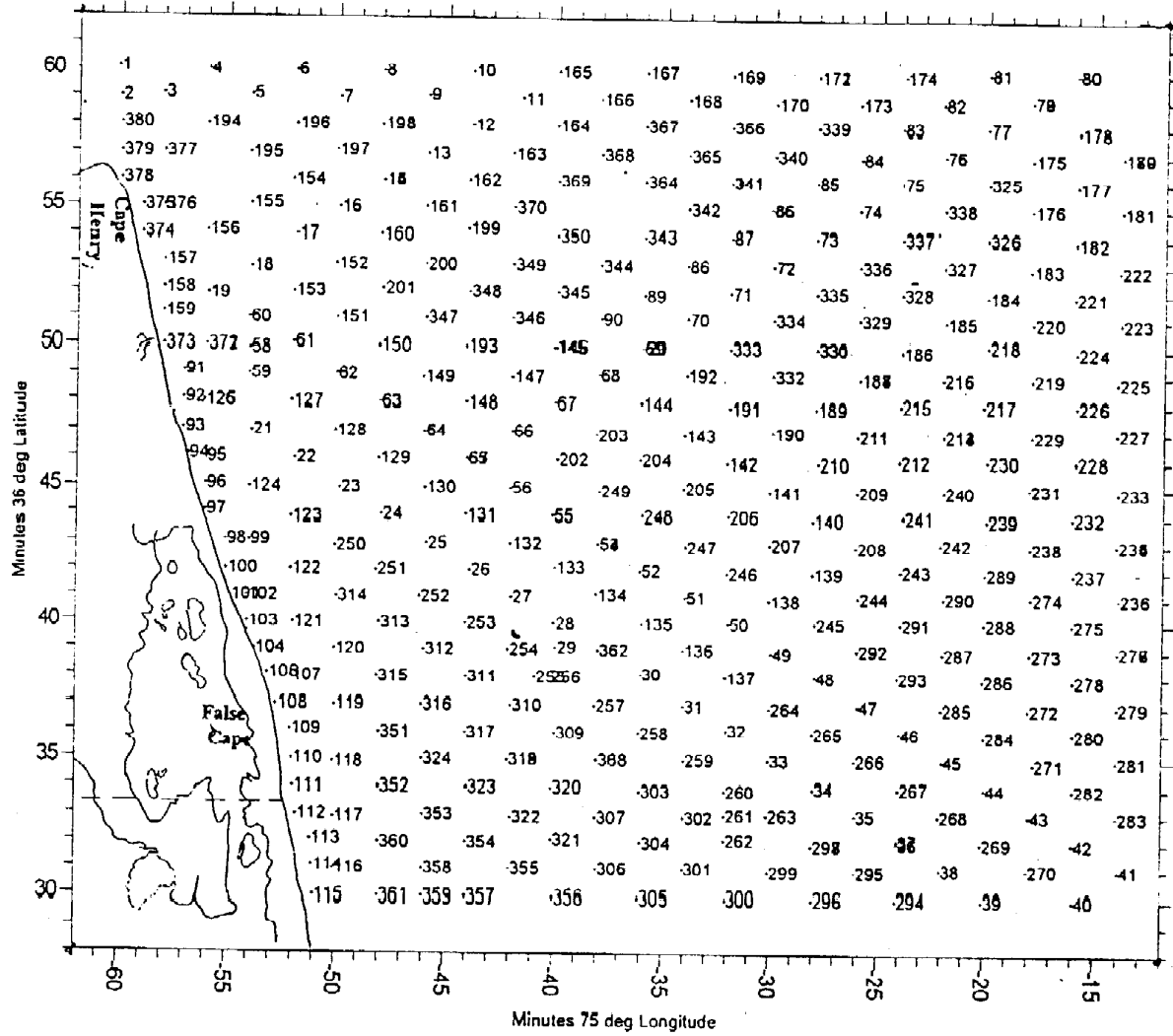
Figure 7: Locations of the grab samples collected in 1994-1995. The numbers shown by each location-dot indicate the sample number. Overprinted numbers indicate duplicate samples at the same site.

vibracores, up to 9 m (30 ft) in length, was taken in 1994 under contract with Exmar from a chartered barge. In both cases, the cores were cut into 1.5 to 2.5 m lengths aboard ship for handling and returned to the laboratory where they were split, logged, and sampled. Loran-C was the primary positioning system in both coring exercises. Copies of the logs and listing of location and grain-size data for the second set of cores are in Appendix 2.

Grab and core samples selected for grain-size analyses were wet-sieved to separate granules, sands, and fines. The coarser fractions were oven-dried at approximately 60°C to remove interstitial water and weighed on an electronic balance. The fines were pipetted following the procedures of Folk (1974) to determine the quantities of silt and clay and to allow the calculation of the sand:silt:clay ratio. Most sand samples were further processed in a Rapid Sediment Analyzer (settling tube) to determine the grain-size distribution of the sand fraction. Mineralogical analyses were performed on some samples as part of some of the preceding studies using methods generally described in Luepke and Grosz (1986) and detailed in Grosz and others (1990).

Electronic processing of the data has been an integral part of the work. Desk-top computers using standard, commercially available software have facilitated virtually all aspects of the work. Spread sheets, plotting programs, a simple Geographic Information System (GIS) (Golden Software's *Surfer*), and coordinate and datum conversion programs purchased from NOAA (*Corpscon* version 3.01), have been most useful.

RESULTS

SURFICIAL SEDIMENTS

Figures 8 - 12 are contour plots of the weight percents of granule, sand, silt, clay, and granules plus sand. The contour lines were drawn by the computer software using an inverse distance squared algorithm. A contour plot of the mean grain size of the sand fraction of the samples and simple x-y plots of depth, latitude, or longitude vs. textural characteristics suggest no relationships. Appendix 1 contains position and grain-size data for each sample,

The region is dominated by coarser sediments, most of the area having in excess of 90 or 95 percent sand or granule. Most of the sands are medium to coarse sands (coarser than 2 phi) with finer sands occurring generally south of False Cape and in a large area adjacent to the bay mouth, roughly analogous to the bay mouth shoals or the shoal retreat massif of Swift (1975). If plotted on Shepard's (1954) ternary classification, all but five of the 380 grab samples would plot as "sands." These five include two

40
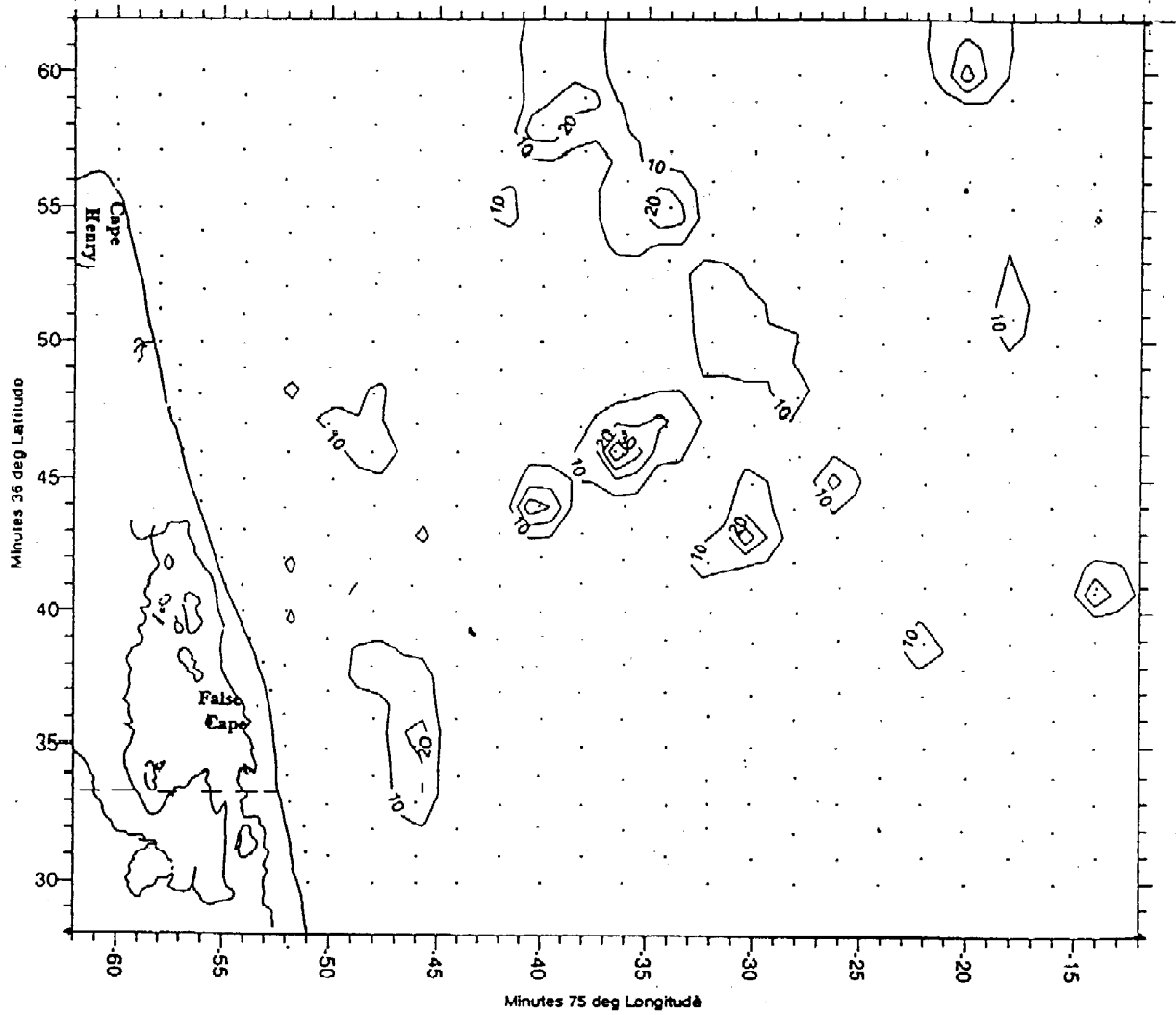
Figure 8: Contour plot of the weight percent granule of the grab samples collected in 1994-1995. The contour interval is 10 percent.
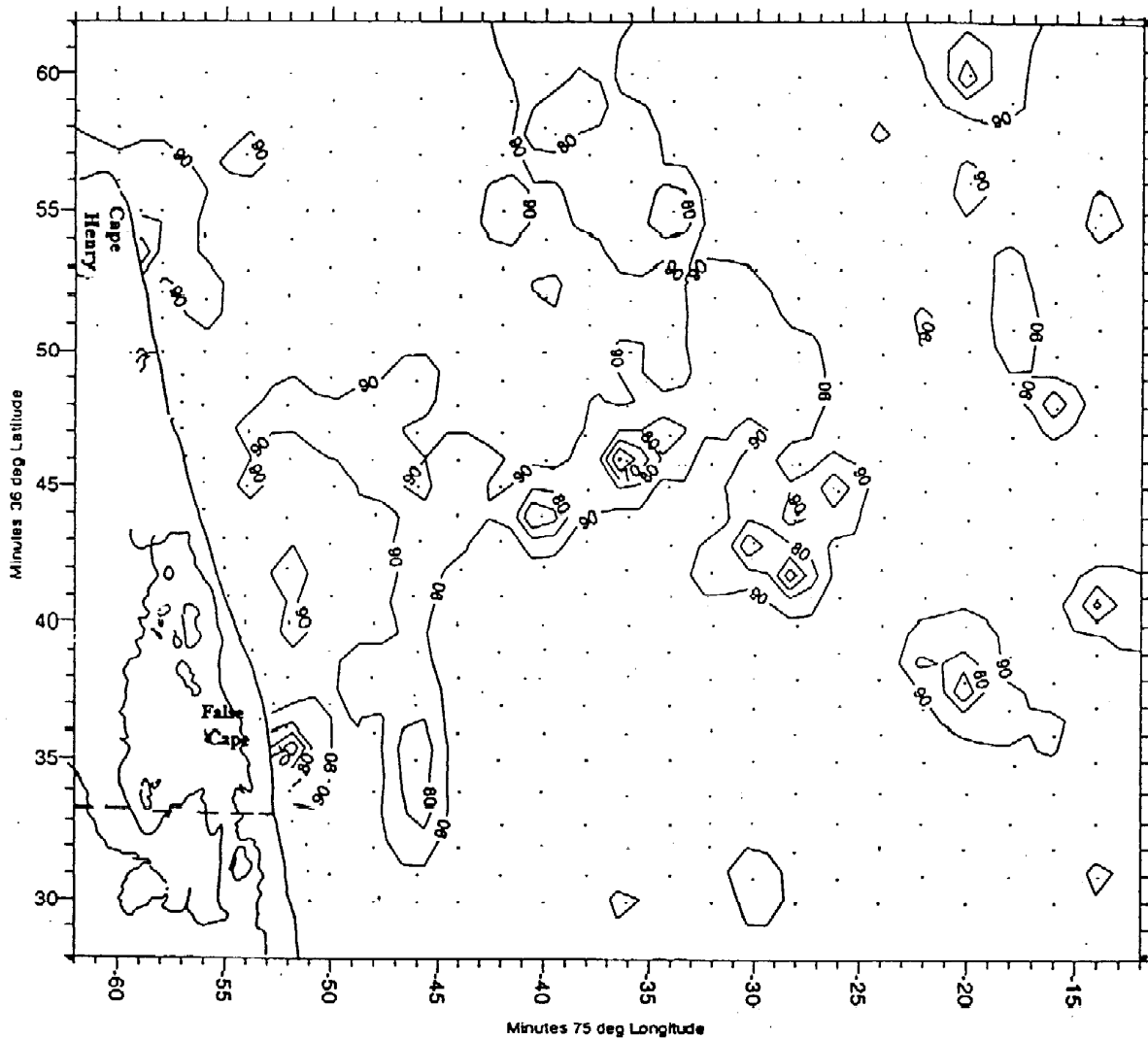
Figure 9: Contour plot of the weight percent sand of the grab samples collected in 1994-1995. The contour interval is 10 percent.
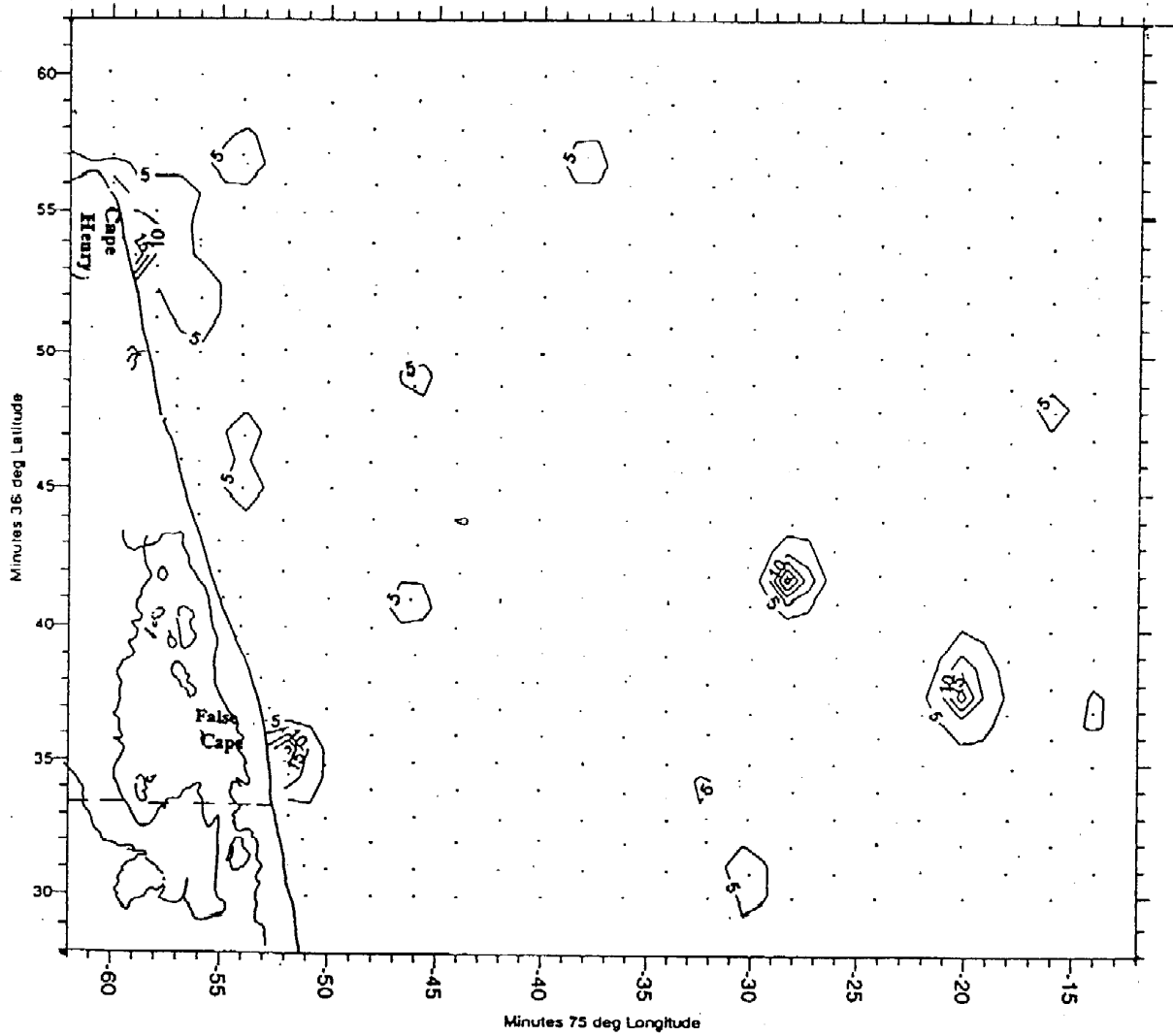
Figure 10: Contour plot of the weight percent silt of the grab samples collected in 1994-1995. The contour interval is 5 percent.
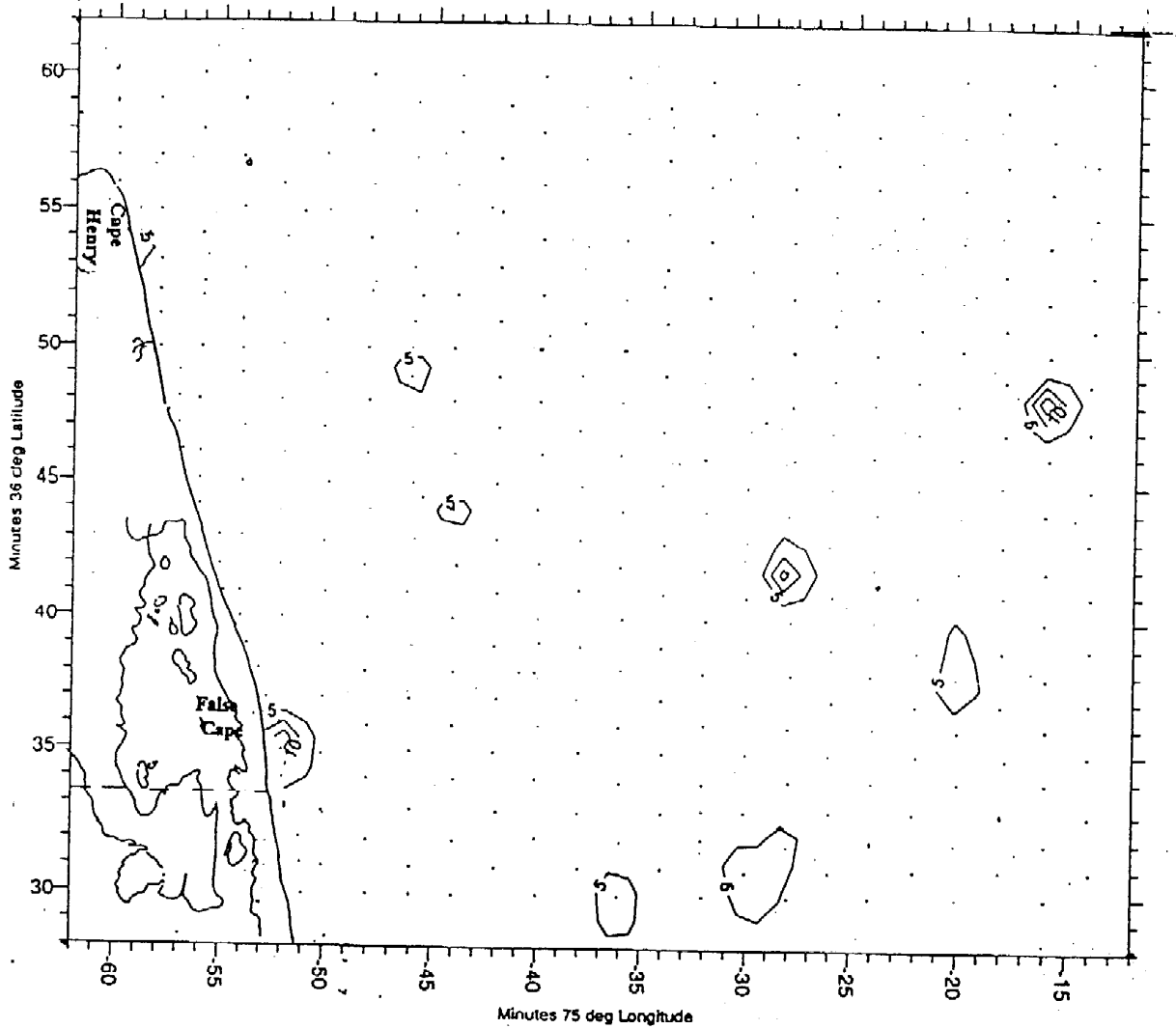
Figure 11: Contour plot of the weight percent clay of the grab samples collected in 1994-1995. The contour interval is 5 percent.
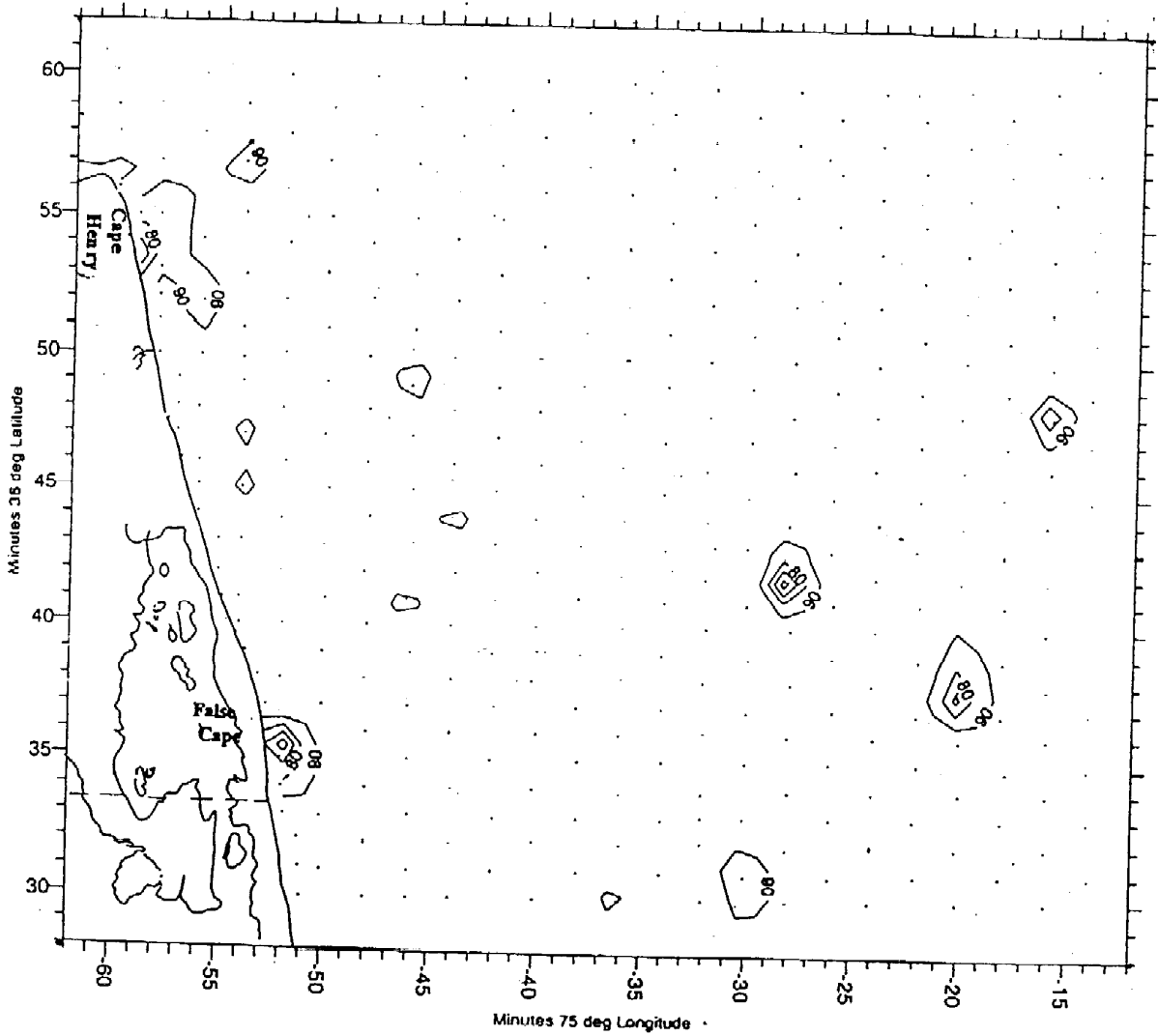
Figure 12: Contour plot of the weight percent granule plus sand of the grab samples collected in 1994-1995. The contour interval is 10 percent.

sandy-silts and one each clayey-sand, sandy silt, and clayey-silt.

SUBSURFACE GEOLOGY

The high-resolution, shallow-penetration, seismic records demonstrate a complex stratigraphy within which the many relationships are difficult to define. Data from the thirteen 3.5 kHz lines surveyed in 1988 (Figures 13 through 26) exemplify this complexity. The surficial sand shoal or sheet, unit D of Shideler and others (1972), is clearly depicted on most of the lines. Several of the lines show at least one major filled paleochannel. Additionally, two or more parallel, near-horizontal reflectors are evident near the surface on several of the lines. Figure 27 is a sketch map of the locations of three, large channels found in the 1988 survey.

Figure 14 (Line 1) depicts a thin layer at the surface that pinches out about halfway across the line and suggests a filled channel on the east end and, perhaps, another channel in the deeper subsurface near the center. Figure 15 (Line 2) presents the same features but also suggests relatively closely spaced, near horizontal reflectors very
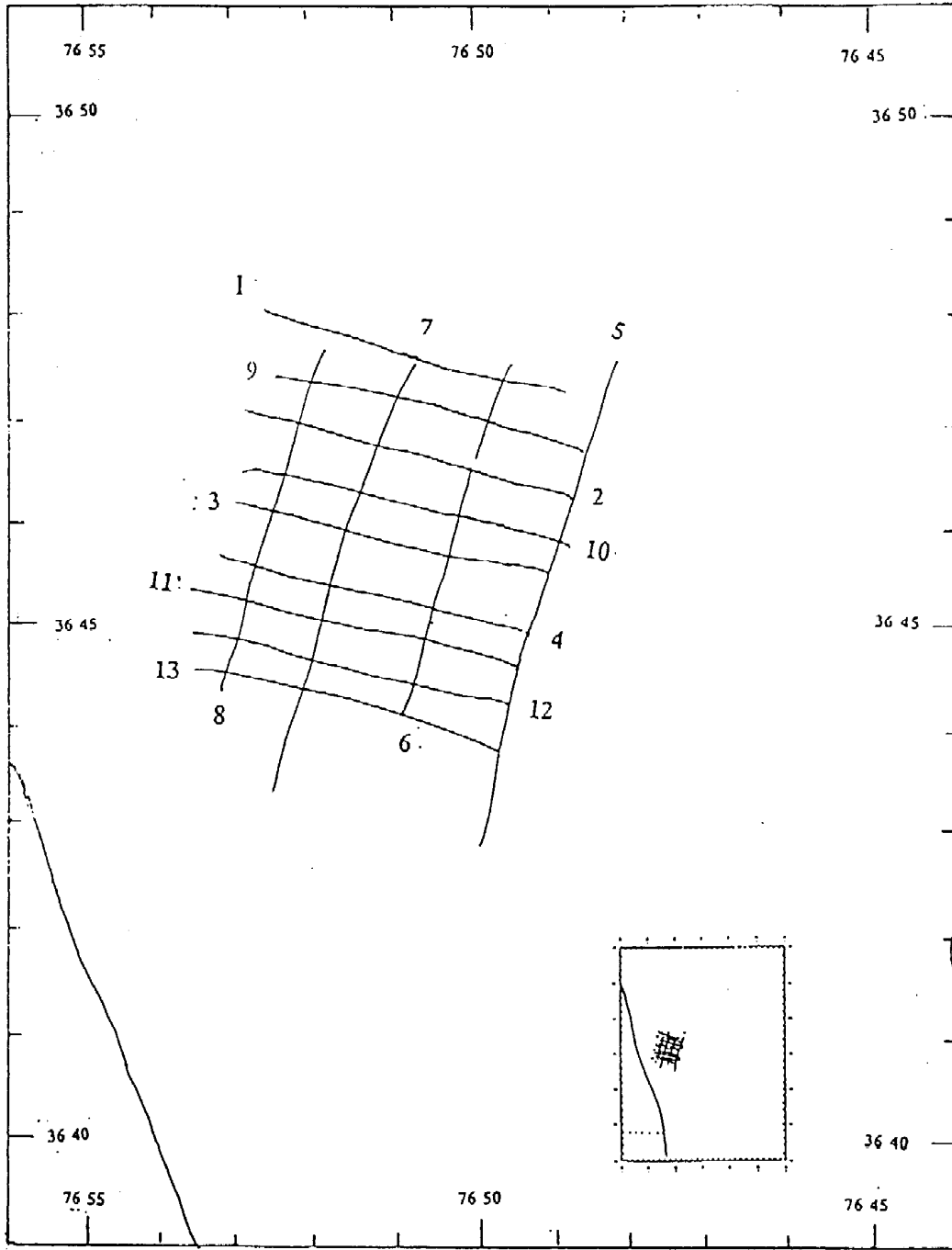
Figure 13: Map of the 13 high-resolution, seismic-
reflection lines run in the summer of 1988.
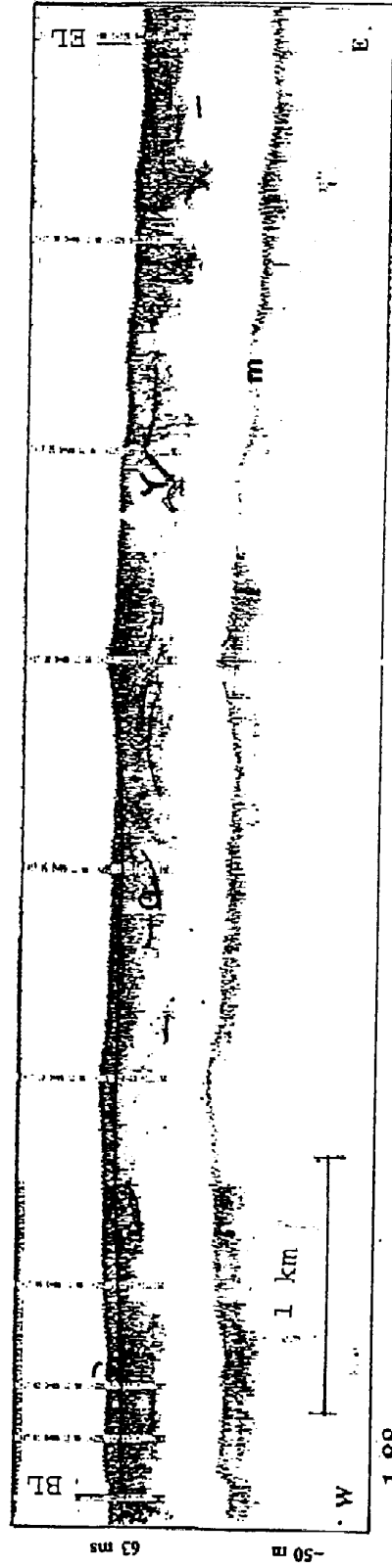
Figure 14: Reduced copy of line 1 from the 1988 survey with selected reflectors emphasized. D is the surficial sand sheet. Y and O are indications of filled paleochannels. m is a multiple of the surface reflector. BL and EL are the beginning and end of the line. Horizontal scale is approximate
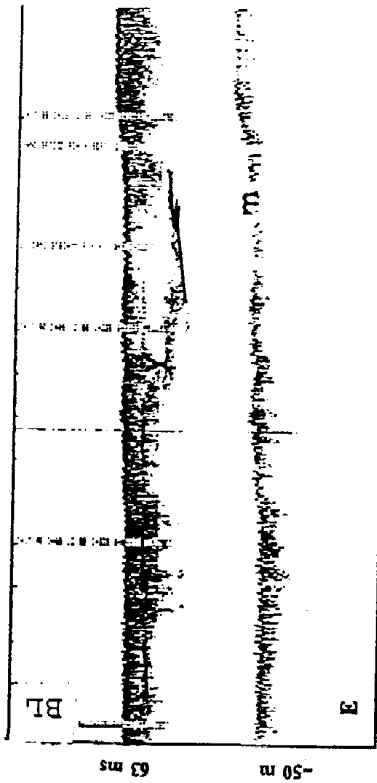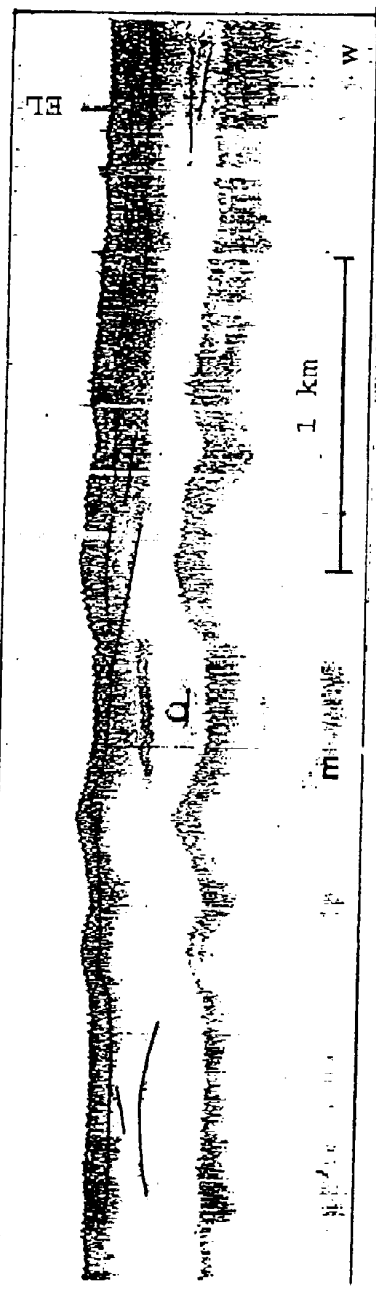
Figure 15: Reduced copy of line 2 from the 1988 survey with selected reflectors emphasized. Y, I, and O indicate the three paleochannels. Immediately under H are the closely spaced reflectors perhaps indicative of rapid oscillations in seal level. The reflectors indicated by m are multiples of the surface reflector. BL and EL are the beginning and end of the line. Horizontal scale is approximate.

2-88

near the surface. Figure 16 (Line 3) very clearly shows the two channel sequences, one at each end of the line, and the character of the surficial sand sheet as it pinches out to the east. Although the eastern channel is not evident on Figure 17 (Line 4), the multiple, sub-parallel, near horizontal reflectors close to the surface and the surficial shoal are apparent.

Figure 18 (Line 5) shows the crosscutting relationship between the two channels on the eastern edge of the 1988 study area. One channel cuts into, and hence is younger than, the other. The profile depicts the shoal atop a specific reflector that becomes the sea floor. Figure 19 (Line 6) shows the separation of the two channels. Figure 20 (Line 7) also shows the spatial relationship between the western and more central channels and the upper parallel reflectors. Line 8 (Figure 21) runs along the course of the western channel, the "steeply" dipping cross-beds, and presents a good cross section of the shoal. The stratigraphy in Line 9 (Figure 22) is among the more complex of the lines showing all three channels and the shoal. Figure 23 (Line 10) also displays the complex stratigraphy in the relationship of the two eastern channels as well as the intermediate age western channel. The surficial shoal
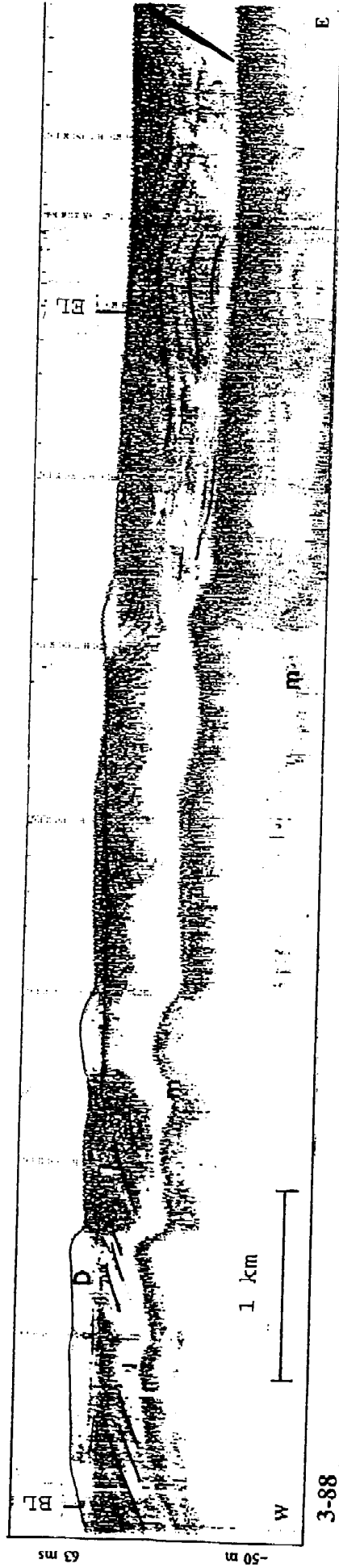
Figure 16: Reduced copy of line 3 from the 1988 survey with selected reflectors emphasized. D indicates the surficial sand sheet. Y and I indicate paleochannels. m indicates multiples of the surface reflector. BL and EL are the beginning and end of the line. Horizontal scale is approximate.
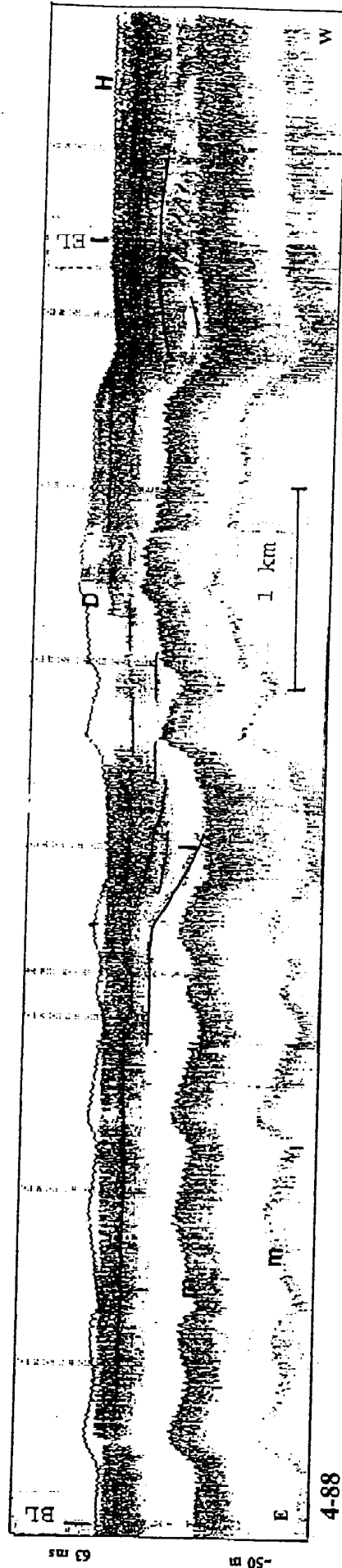
Figure 17: Reduced copy or line 4 from the 1988 survey with selected reflectors emphasized. D indicates the surficial sand sheet. I indicates a filled paleochannel. Immediately under H are closely spaced horizontal reflectors. M shows multiples of the surface reflector. BL and EL are the beginning and end of the line. Horizontal scale is approximate.
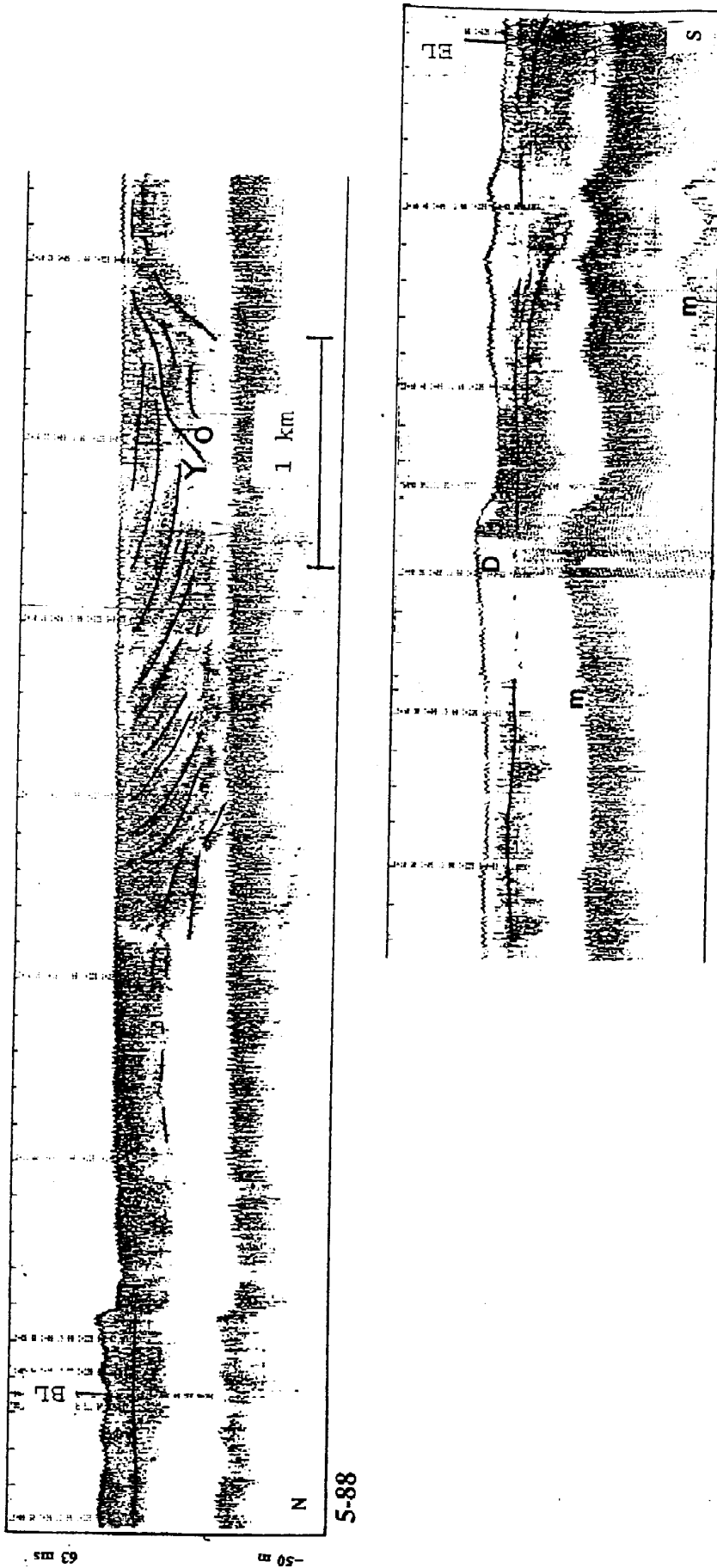
Figure 18: Reduced copy of line 5 from the 1988 survey with selected reflectors emphasized. D indicates the surficial sand sheet. Y and O show paleochannels. Multiples of the surface reflector are shown by m. BL and EL are the beginning and end of the line. Horizontal scale is approximate.
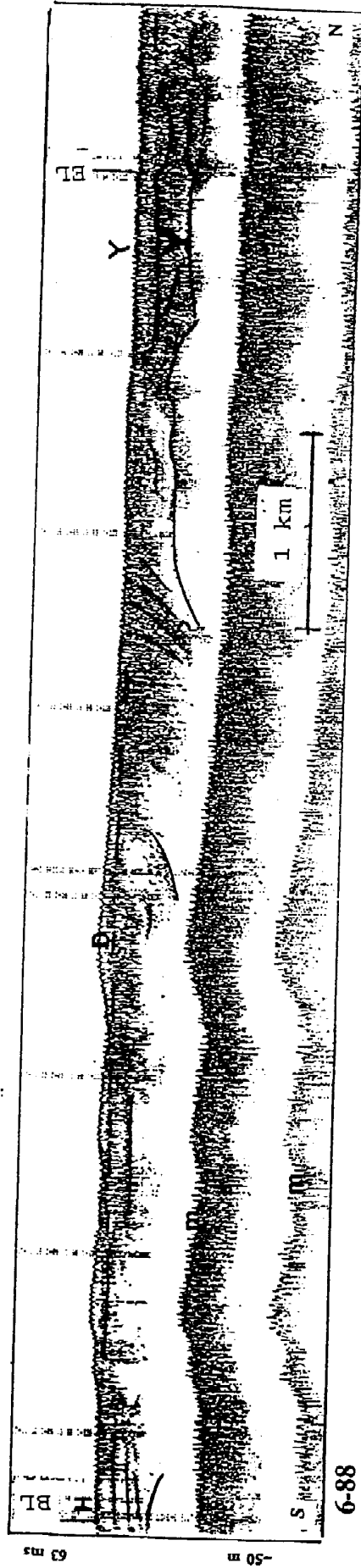
Figure 19: Reduced copy of line 6 from the 1988 survey with selected reflectors emphasized. D indicates the surficial sand sheet. Y and O show filled paleochannels. Note the closely spaced reflectors below H. m marks multiples of the surface reflector. BL and EL are the beginning and end of the line. Horizontal scale is approximate.
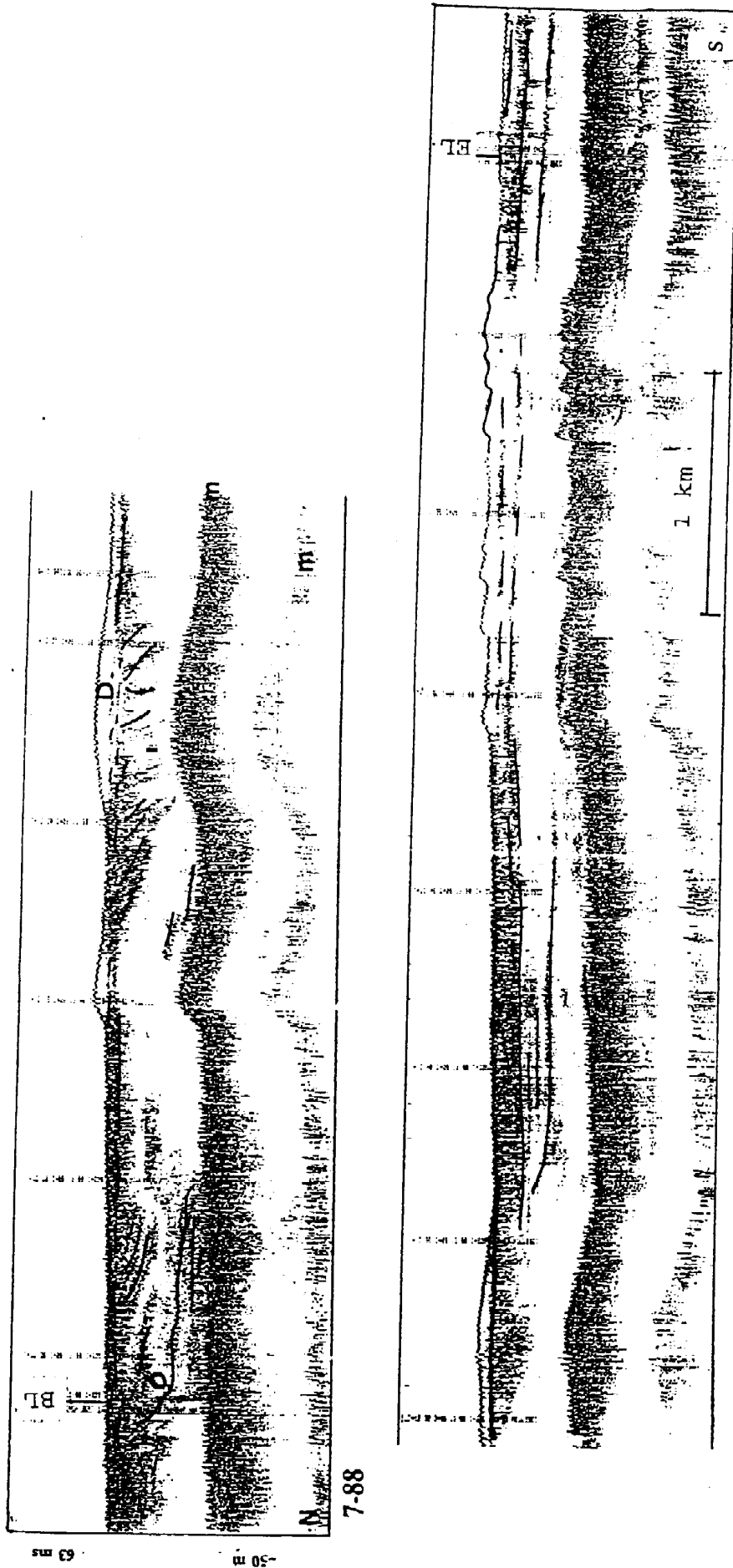
Figure 20: Reduced copy of line 7 from the 1988 survey with selected reflectors emphasized. D indicates the surficial sand sheet. O and I (below D) show filled paleochannels. Multiples of the surface reflector are shown with m. BL and EL are the beginning and end of the line. Horizontal scale is approximate.
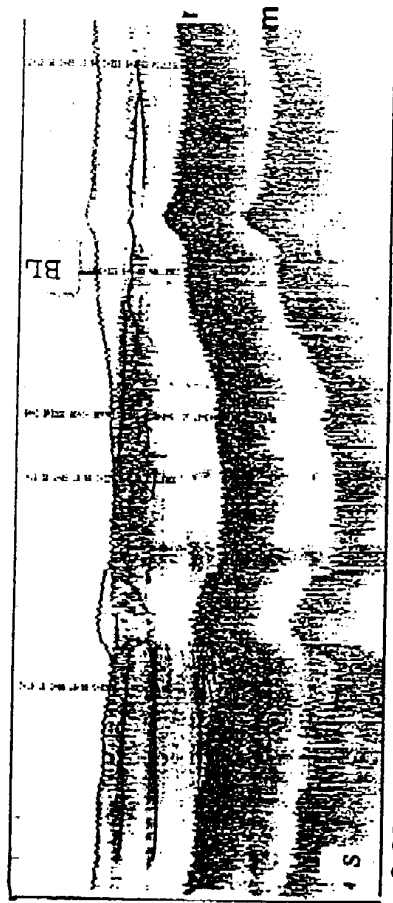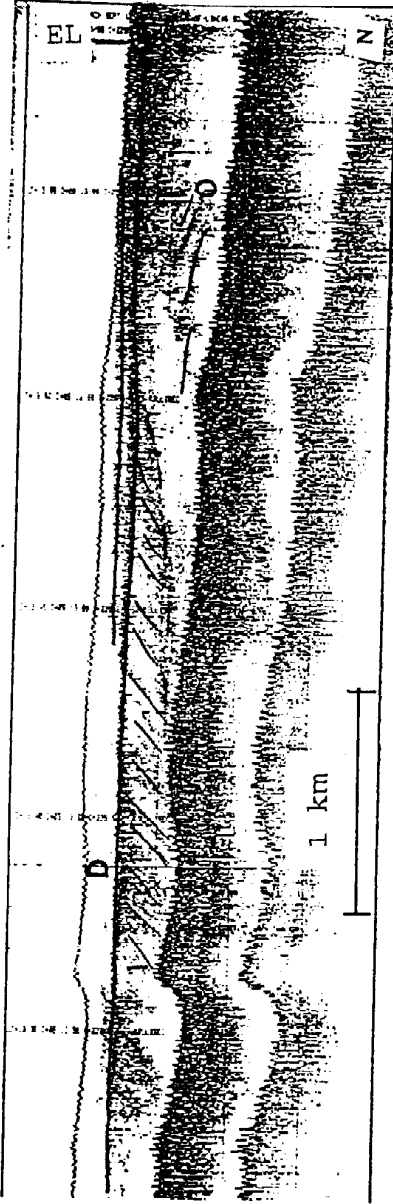
Figure 21: Reduced copy of line 8 from the 1988 survey with selected reflectors emphasized. D indicates the surficial sand sheet. I and O mark filled paleochannels. Multiples of the surface reflector are shown with m. BL and EL are the beginning and end of the line. Horizontal scale is approximate.
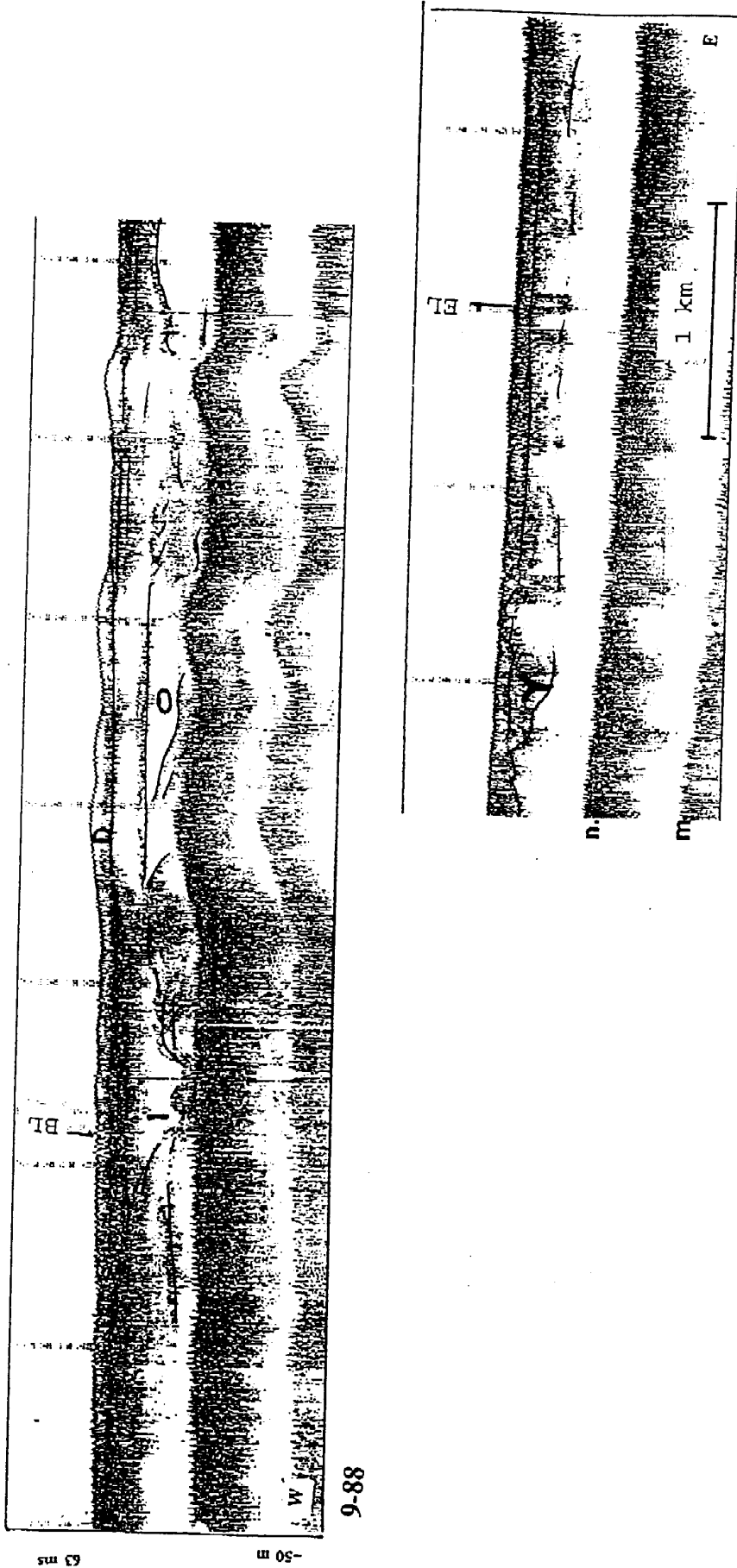
Figure 22: Reduced copy of line 9 from the 1988 survey selected reflectors emphasized. D shows the surficial sand sheet. Y, I and O mark filled paleochannels. Multiples of the surface reflector are shown with m. BL and EL are the beginning and end of the line. Horizontal scale is approximate.
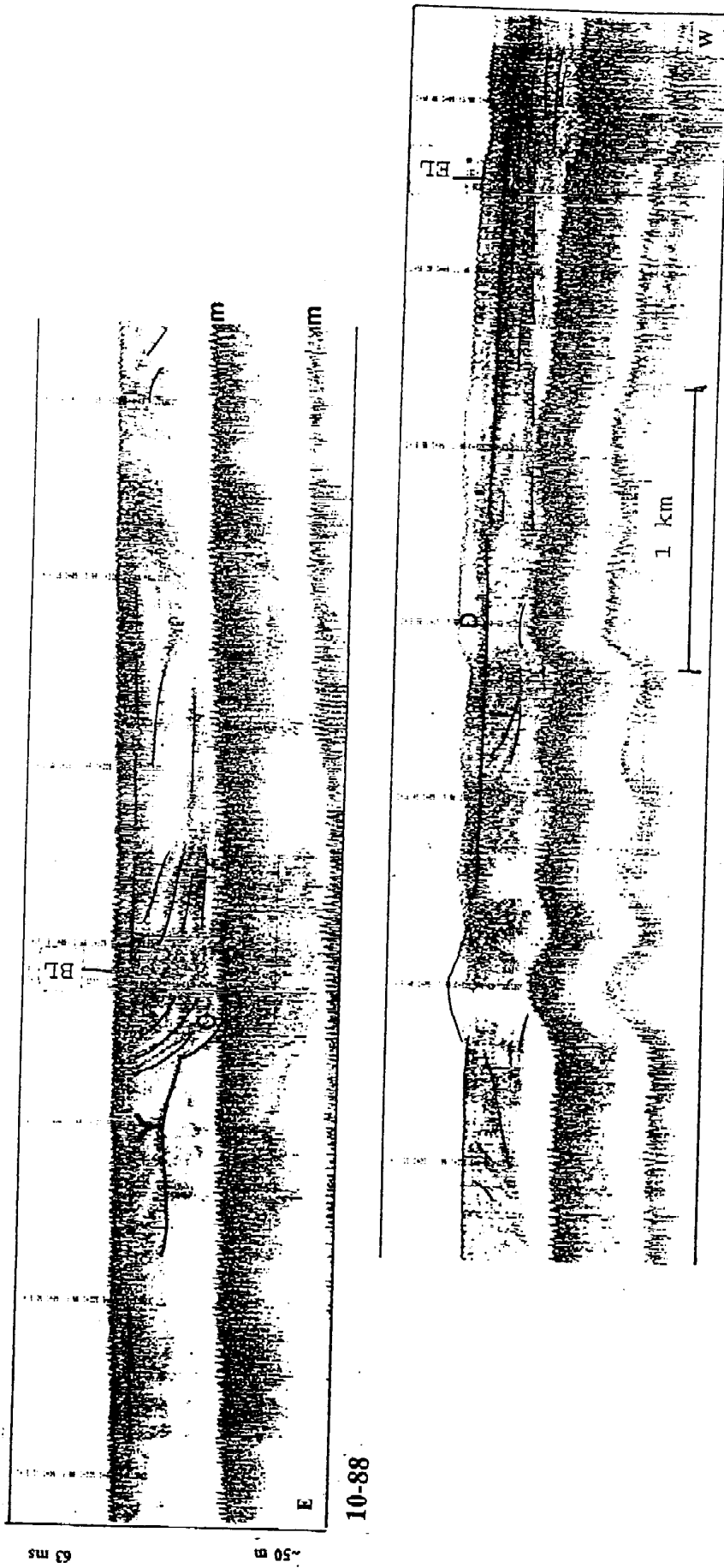
Figure 23: Reduced copy of line 10 from the 1988 survey with selected reflectors emphasized. D shows the surficial sand sheet. Y, I, and O indicate filled paleochannels. Multiples of the surface reflector are shown with m. BL and EL are the beginning and end of the line. Horizontal scale is approximate.

is present but not as strongly evident as on some other
lines. Figure 24 (Line 11) shows only the eastern and
western channels and the surficial sheet. The cross beds at
the western end of the line are strong indicators of the
direction of channel filling or migration. Data from Lines
12 and 13 (Figures 25 and 26) provide further detail.

Viewed together, these 13 seismic-reflection lines
indicate the complexity of the Quaternary stratigraphy of
the continental shelf adjacent to southern Virginia. Figure
27 is a sketch map indicating the approximate locations of
the 3 channels and the limit of the shoal area. Hence the
number of channels shown in Figure 28 and the doubt
associated with the interpretations of the channels are not
surprising.

Figure 29 depicts the lithologies in 18 cores offshore
of the major resort area of Virginia Beach north of Rudee
Inlet. As discussed in Hardaway and others (1995) the cores
show substantial vertical and lateral variability within the
three basic sedimentary facies. The stratigraphically
deepest unit is moderately to very stiff, slightly sandy,
blue-grey clay. The unit contains numerous *Rangia* and
Polynices, especially in cores 10 and 16, and oysters in the
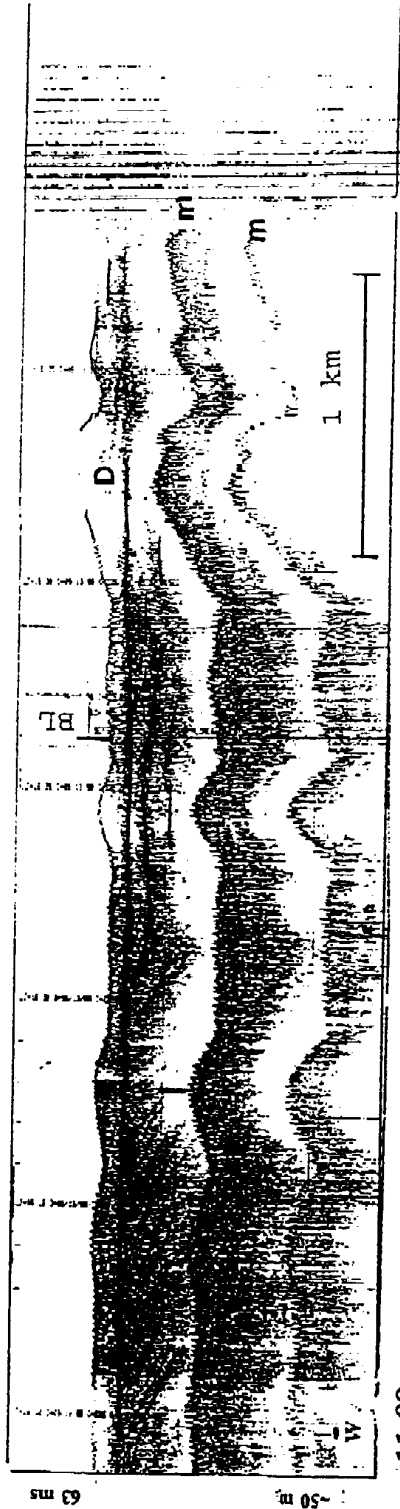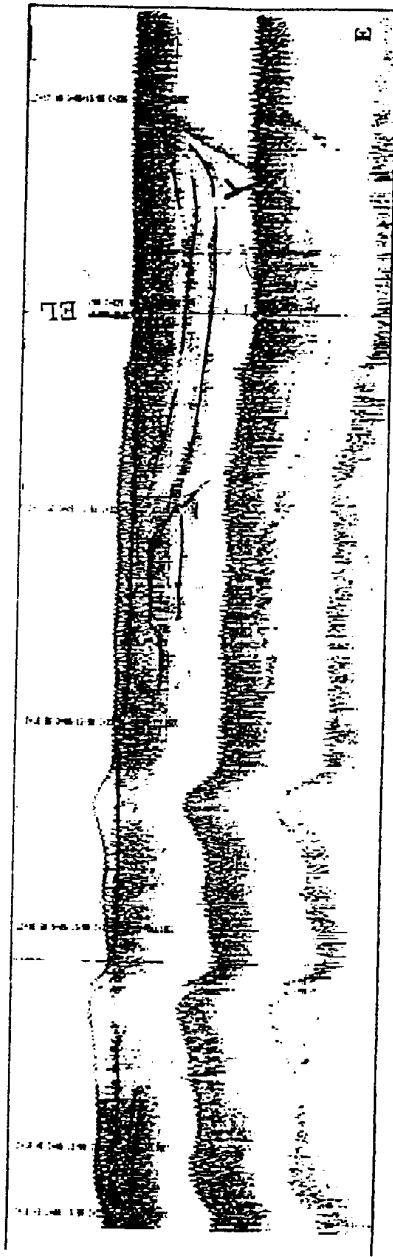
Figure 24: Reduced copy of line 11 from the 1988 survey with selected reflectors emphasized. D marks the surficial sand sheet. Y and I indicate filled paleochannels. Multiples of the surface reflector are shown with m. BL and EL are the beginning and endof the line. Horizontal scale is approximate.
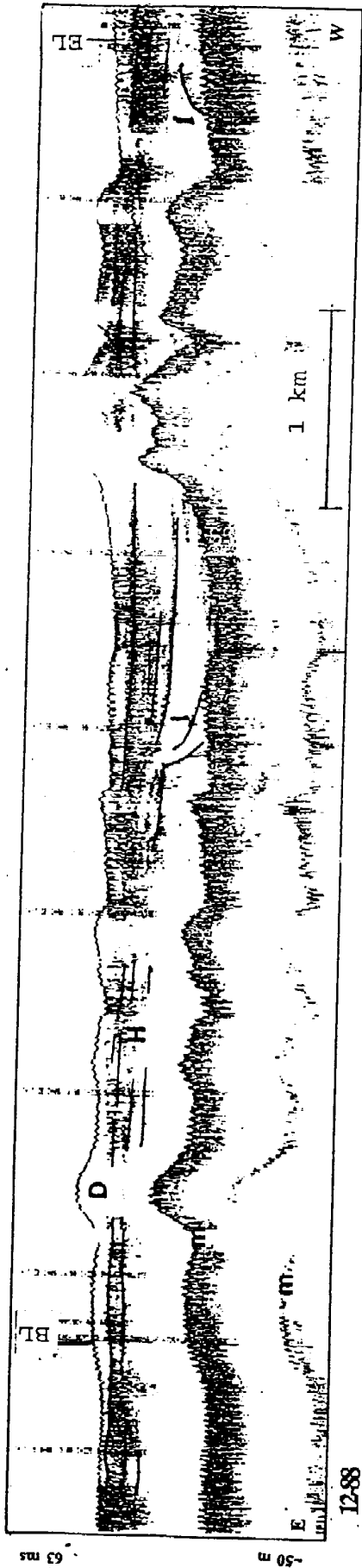
Figure 25: Reduced copy of line 12 from the 1988 survey with selected reflectors emphasized. D marks the surficial sand sheet. I indicates a filled paleochannel. The area around H contains several closely spaced reflectors. Multiples of the surface reflector are shown with m. BL and EL are the beginning and end of the line. Horizontal scale is approximate.
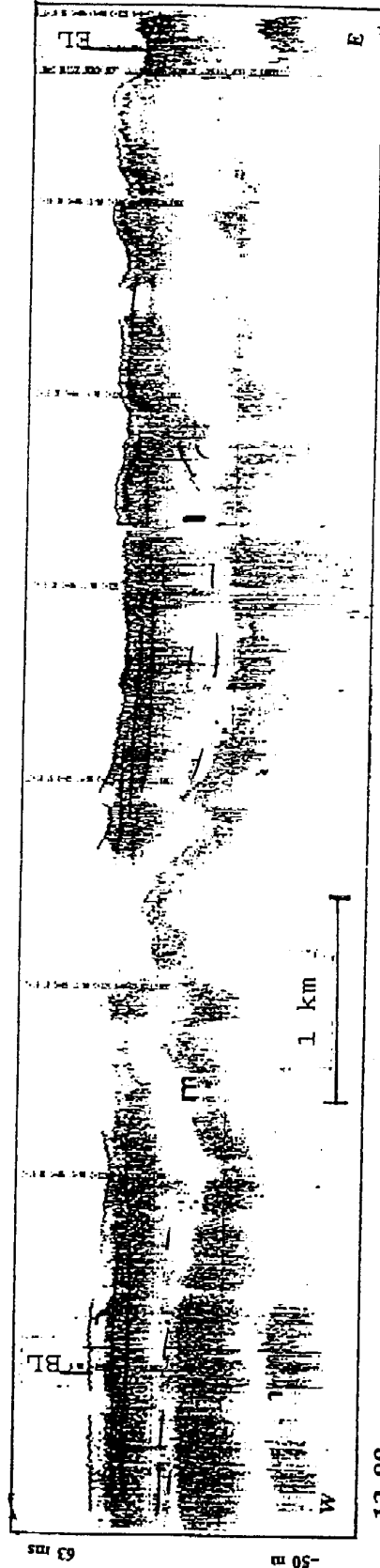
Figure 26: Reduced copy of line 13 from the 1988 survey with selected reflectors emphasized. D shows the thin, surficial sand sheet. I indicates a filled paleochannel. Multiples of the surface reflector are shown with m. Note the closely spaced reflectors in the western and central portions of the profile. BL and EL are the beginning and end of the line. Horizontal scale is approximate.
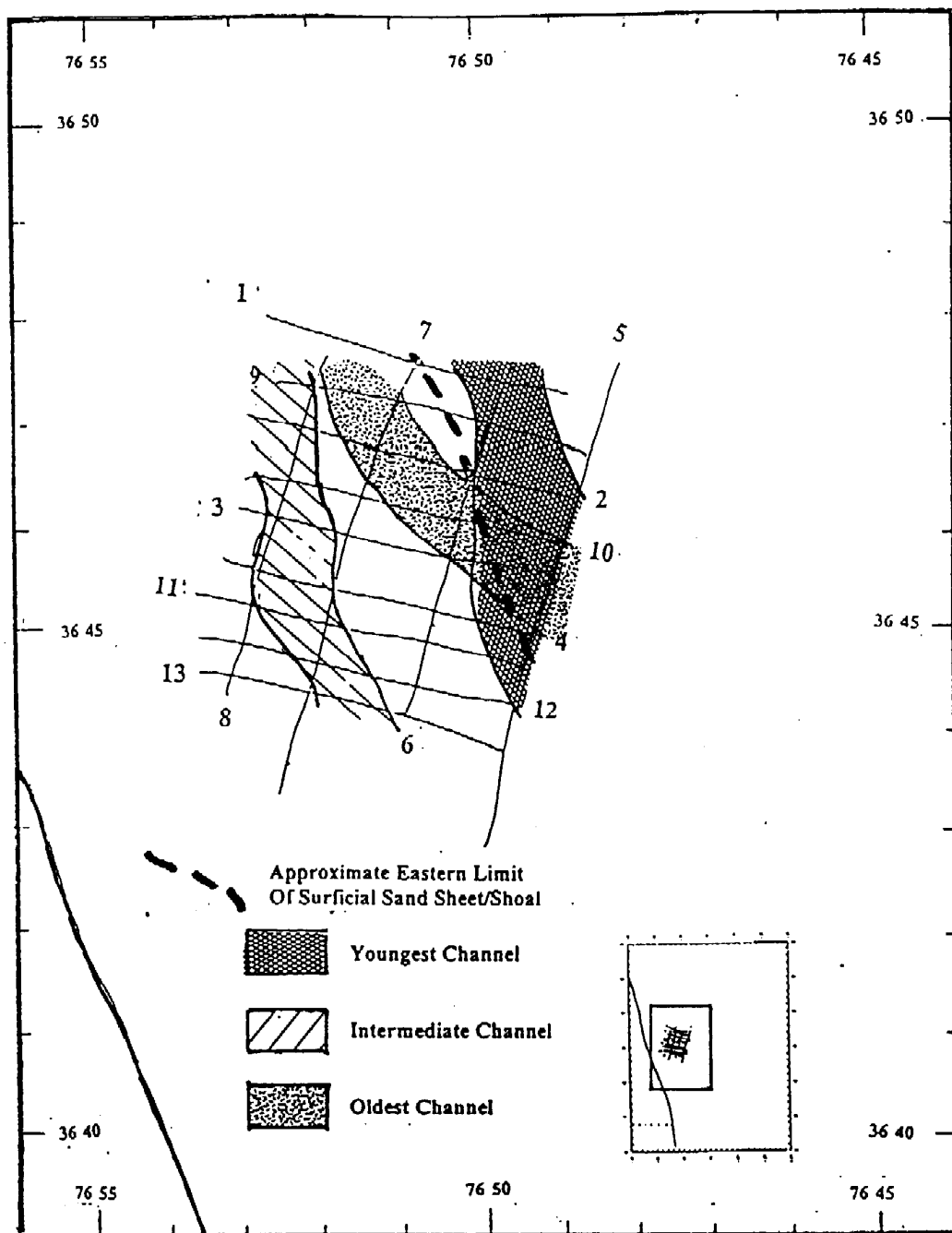
Figure 27: Sketch map depicting the 3 filled paleochannels
identified in the 1988 sub-bottom profiles.
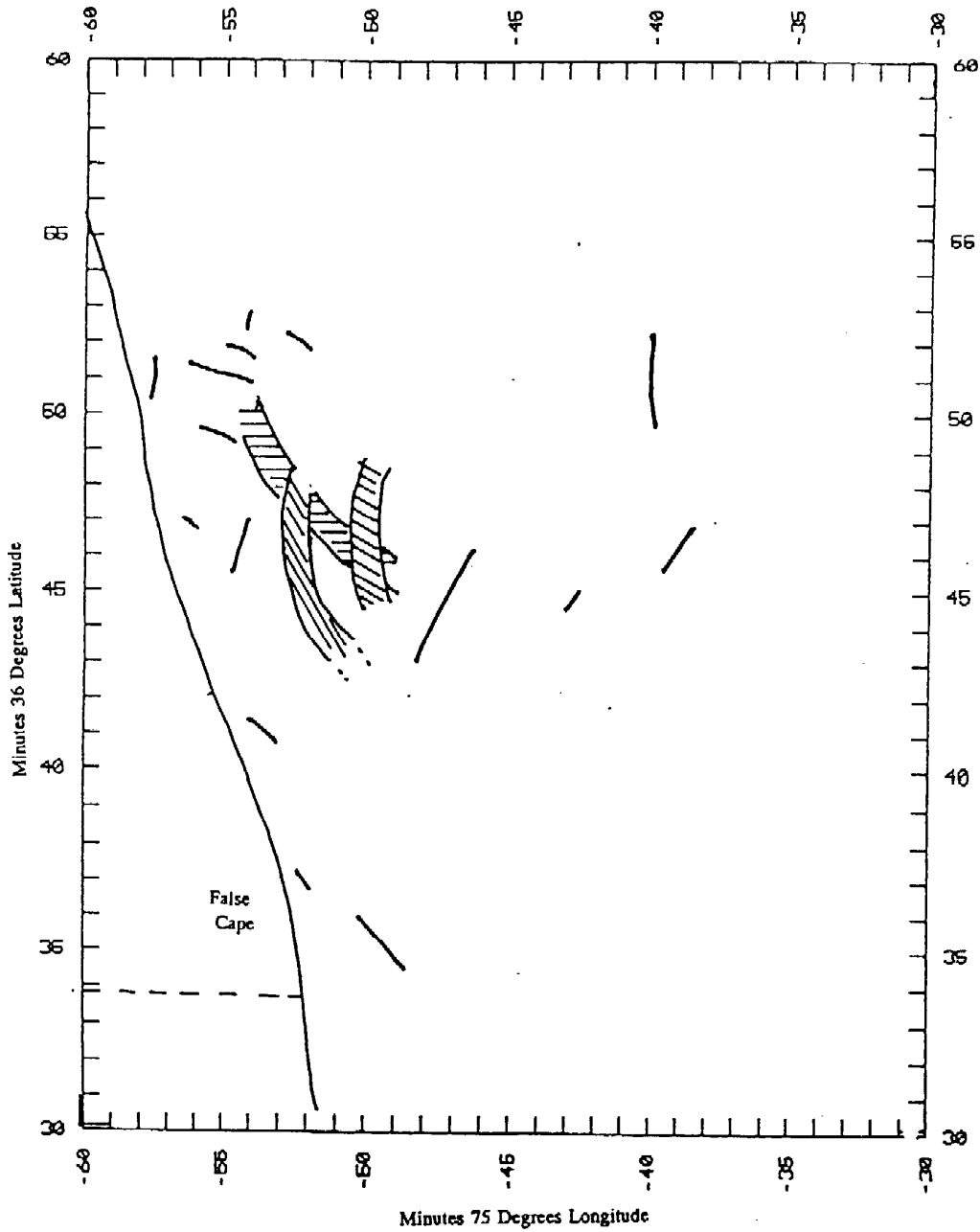
Figure 28: Sketch map indicating the many filled
paleochannels throughout the study area.
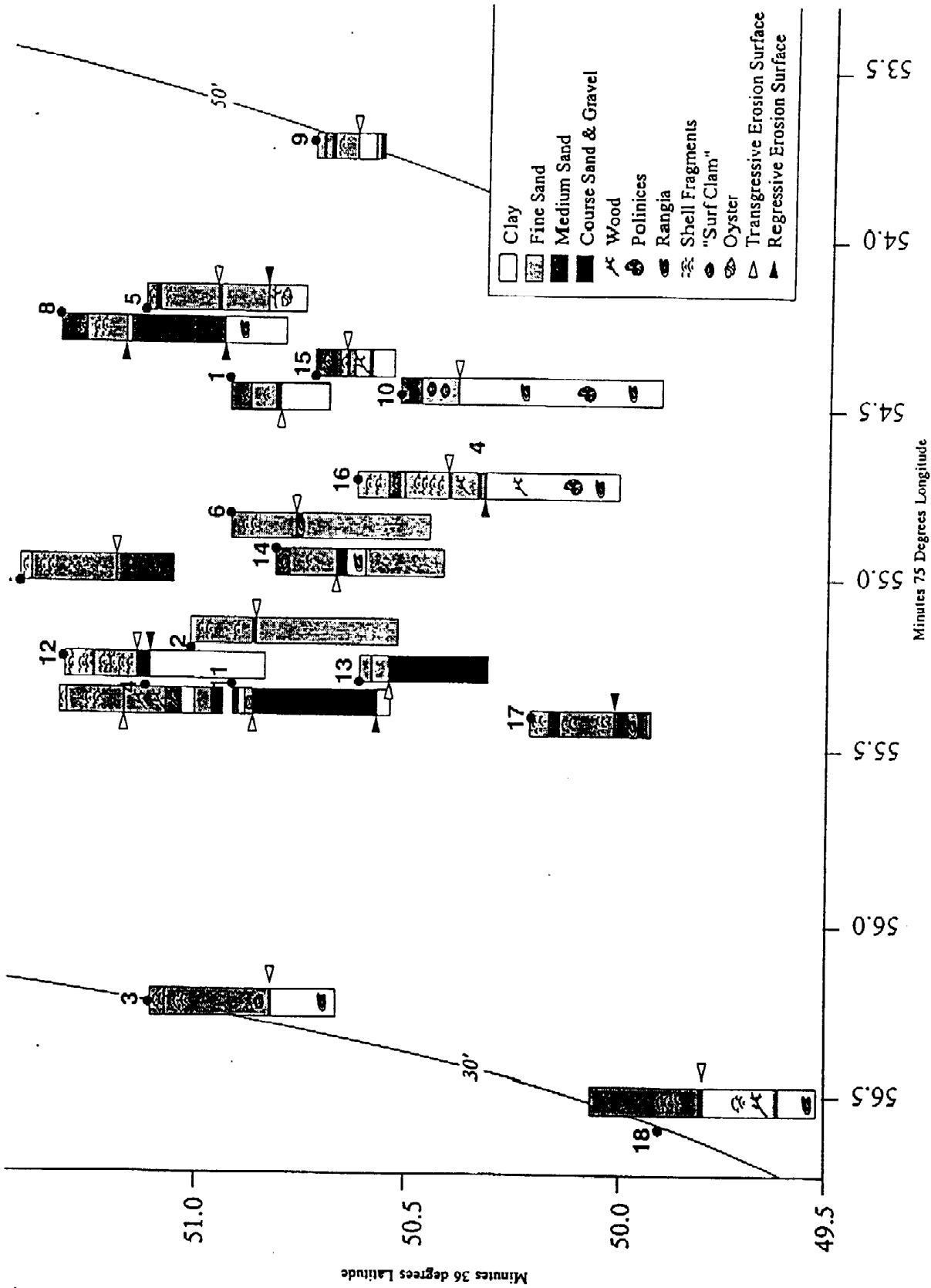
Figure 29. A schematic depiction of 18 cores offshore of the northern portion of Virginia Beach. The 30 and 50 ft. (9 and 15 m) depth contours are shown. From Hardaway and others (1995).

upper portion of core 5. In cores 1, 3, 9, 10, 15, and 18 the clay is unconformably overlain by a marine sand. Fluvial sands and gravel that contain no shells but some wood cap the clay in cores 5, 8, 11, 12, and 16. This non-marine unit is overlain by the marine sand. Cores 11 and 13 have thick lenses (3.4 and 4.3 m, respectively) of coarse sand and gravel. A large fragment of wood from 3.7 m below the seafloor (approximately 15.2 m below sea level) in core 4 had a carbon-14 date of 9,440 $^+/_-$ 50 y BP. Appendix 2 contains logs of the individual cores and grain-size analyses of sediment samples taken from the cores. The logs for the four cores taken offshore of Sandbridge all indicate that the top several feet were "jetted" and not sampled. The driller's field notes state that the upper portion of the sediment column contains "medium sands" that were very difficult to sample.

SIDE-SCAN SONAR

Hobbs (1990) presented the results of the side-scan sonar surveys of the study area (Figures 30 and 31). The northern portion of the area is characterized by a large region of "drag" marks (Figure 32), perhaps caused by
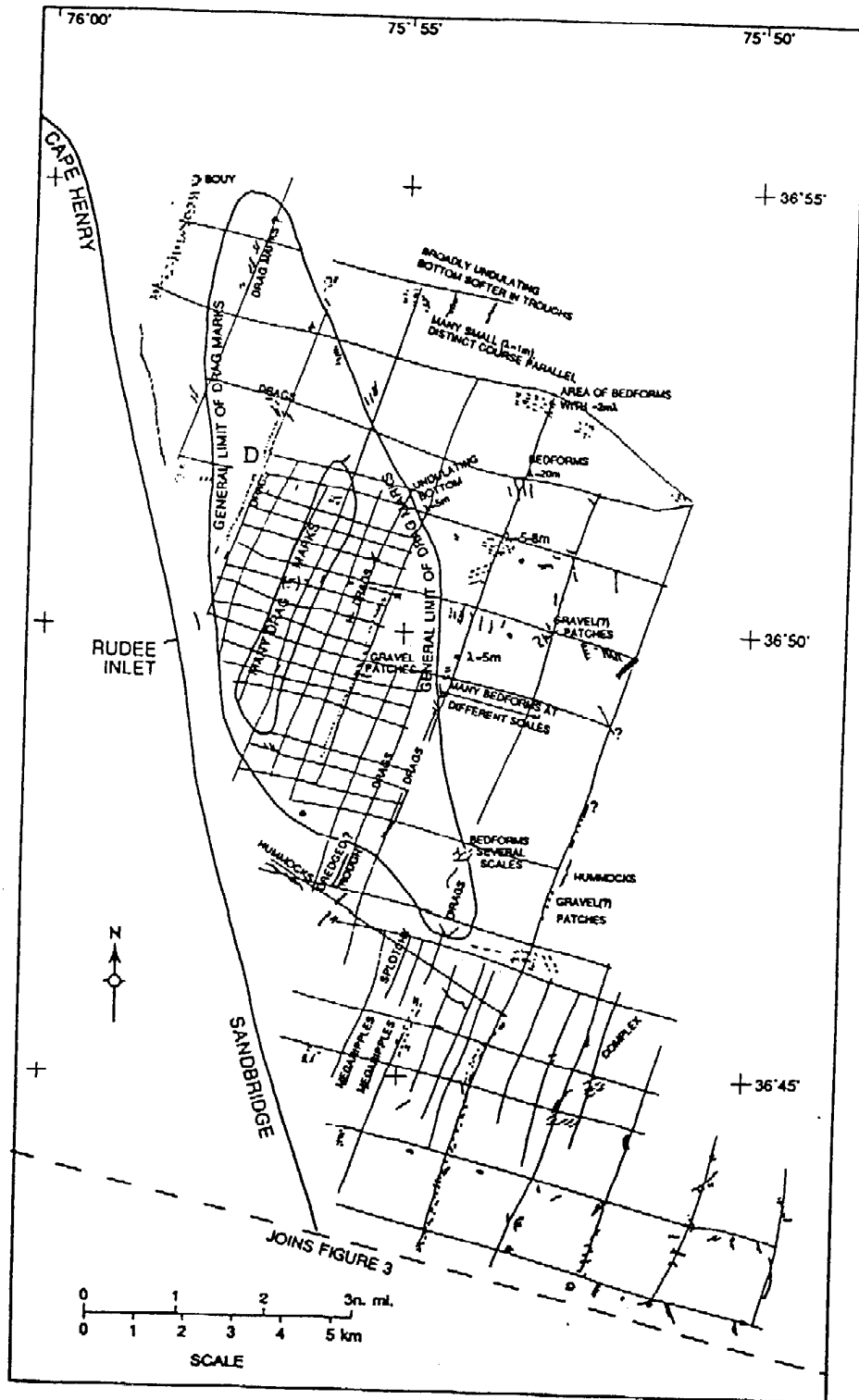
Figure 30: Interpretive map of the side-scan-sonar record of the northern portion of the study area. The areas shown in Figures 32 is indicated by (D).

JOINS FIGURE 2

ROUGH BOTTOM

36°40'

SPLOTCHY

N

FALSE CAPE

SOFT

LIGHT DARK

36°35'

MANY BEDFORMS

0   1   2   3n. mi.

0   1   2   3   4   5 km

SCALE

VA
NC

75°55'

75°50'
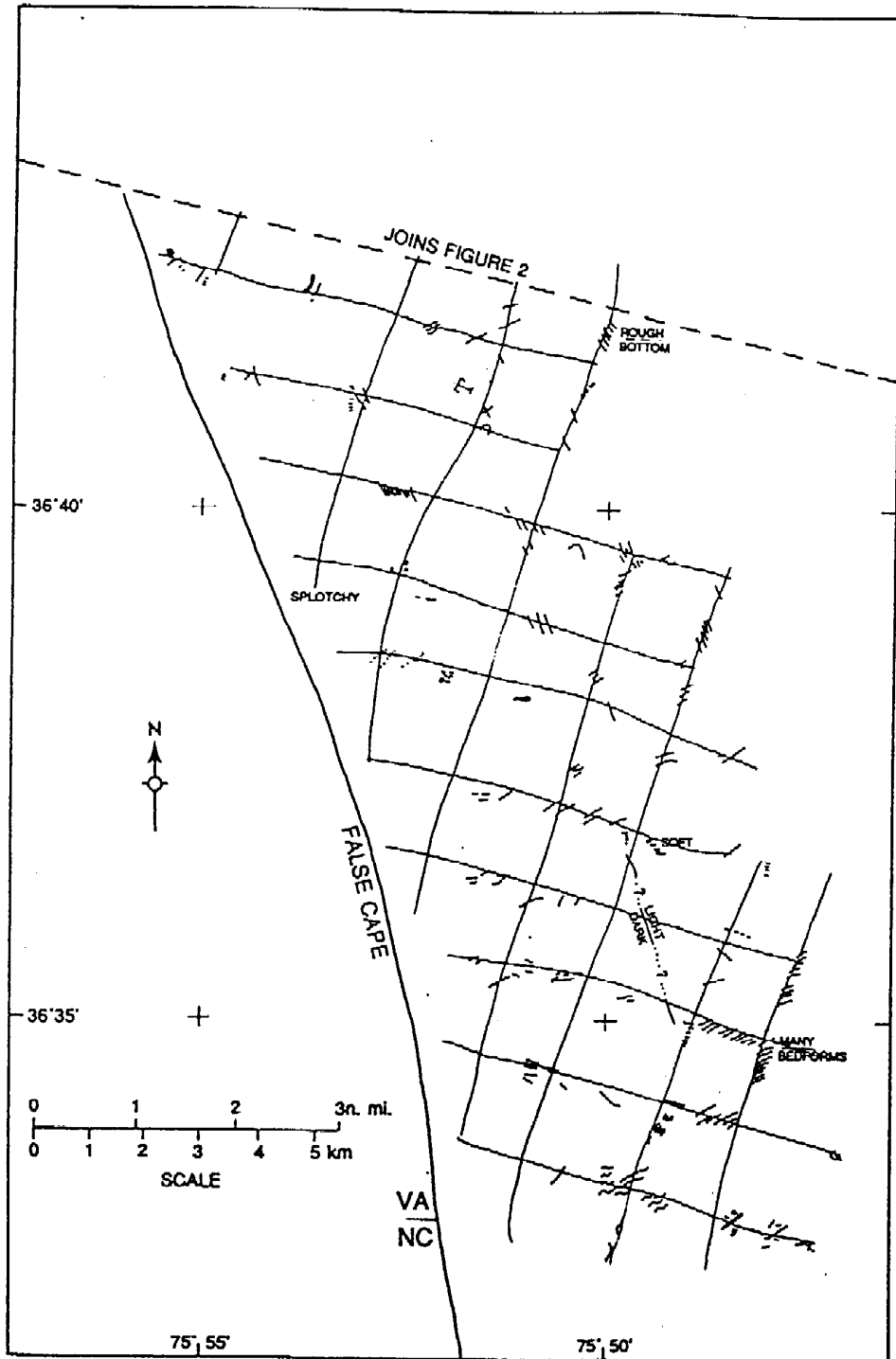
31: Interpretive map of the side-scan-sonar record of the southern portion of the study area. The area shown in Figure 33 is indicated by (T).
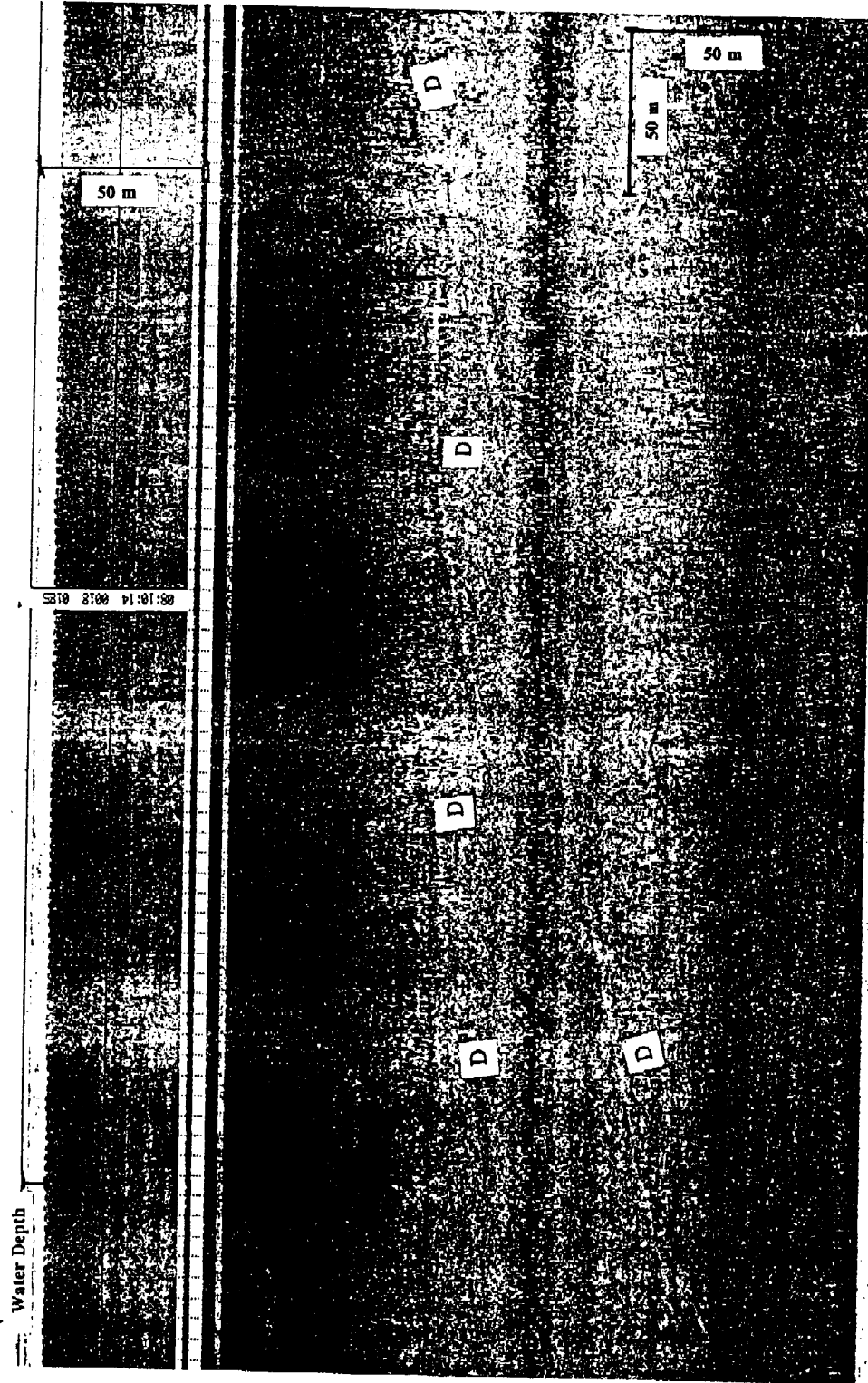
Figure 32: A side-scan sonar image showing several of the linear features thought to be drag marks indicated by (D). See Figure 30 for location.

commercial fishing gear. Throughout the study area there
are dark-to-light changes in the side-scan-sonar record that
appear to be related to rhythmic changes in bottom
topography. Generally darker areas are related to
topographic highs and lighter, less reflective areas to
sides of the between-ridge troughs. Figure 33 is a section
of side-scan sonar image depicting variations associated
with smal scale topographic changes.

Figure 33: A side-scan sonar image depicting variations related to small scale topographic changes. The darker portions of the image indicate finer-grained sediments associated with the lower portions of the area whereas the lighter portions indicate coarser sediments on the topographic highs. Topographic relief is approximately 1 m. See Figure 31 for location.

DISCUSSION

SURFICIAL SEDIMENTS

The surficial sediments of the study area are dominantly sands and granules. The two western (near shore) pockets of slightly elevated content of fine grained sediments (Figures 10 and 11) may result from different causes. The northern patch, identified by seven samples ranging from 5 to 51, average 18, weight percent silt plus clay (Samples SVG-1, 2, 379, 376, 19, and 374) is fine-grained sediment probably transported out of Chesapeake Bay in its "plume." Sample SVG-374, which was taken from very near shore, probably is from an outcrop of muddy sediments or a deposit of dredge spoil. Similarly, sample SVG-110, the fine-grained pocket along shore near the Virginia - North Carolina border, likely represents an outcrop of muddy (back-barrier lagoon?) sediments. Outcrops of once-buried marsh are common along the beach of the False Cape area which is immediately shoreward of the site of SVG-110.

The reasons for the three, small pockets of decreased sand and granule content in the southeastern quadrant of the

study area (Figure 12) are unclear sand interpretation is hindered by their very small size, one or two samples. They may be related to subtle topographic features or they may be related to an outcrop of another facies. The northeastern-most pocket is a single sample with 22 percent clay and 11 percent silt (Sample SVG-226). The southeastern pocket consists of two samples, one with 12 percent clay and 28 percent silt, the other, 6 percent clay and 6 percent silt (Samples SVG-286 and 288, respectively). The western-most of the three pockets also is a single sample (SVG-139) of 19 percent clay and 31 percent silt.

HEAVY MINERALS

Although the present work does not add to the body of data concerning the occurrence and distribution of heavy minerals on the inner continental shelf of southeastern Virginia, it allows a better understanding of previous works. Calliari and others (1990) describe a heavy-mineral population of zircon, garnet, and amphibole, and other heavy minerals (their Factor 2) existing on the shelf south of the mouth of Chesapeake Bay and in the bay itself discrete from populations of amphibole, pyroxene, and other minerals within the bay (Factor 1) and of garnet, amphibole, epidote,

and other minerals north of the bay mouth (Factor 3). The distribution of the sample groups lends itself to suggestion about possible sources and possible routes of transport.

The location of the prime concentration of Factor 2, nearshore, roughly adjacent to the Virginia - North Carolina border, with a lesser concentration in the southern portion of the bay mouth, suggests both that there is a separate source for the minerals in this set of samples and that there is little transportation of sediments across the bay mouth. Thus the sand resources of the southeastern Virginia shelf either are derived locally or have been transported through geologic time from farther offshore. The locus of the factor roughly at the state border might result from the previous existence of a major inlet, Currituck Inlet (Prow, 1977), with a drainage basin potentially extending into the Piedmont of Virginia and North Carolina.

SIDE-SCAN SONAR

The side-scan-sonar records provide information on the impacts of humans on the bottom as well as on the regional marine geology. As stated in Hobbs (1990), the bottom type in the study area fits into the classification of Wright

and others (1987)as Inner-Shelf Shoreface (Type Ia) or
Inner-Shelf Ridge Field (Type Ib). This classification
scheme categorizes estuarine, bay, and shelf bottom types on
the basis of the type and scale of bottom and bed roughness.
As roughness is related to sediment type and wave, current,
and biologically induced bedforms, the classification
affords a comparison of estuarine and marine bottom
conditions on the basis of the source and magnitude of
energy affecting the sediment surface.

The area just offshore of Dam Neck, just north of
Sandbridge, is the type area for the Wright and others'
(1987) Inner-Shelf Shoreface environment. Type Ia (Inner-
Shelf Shoreface) has very little biogenic roughness at the
sediment surface as there is virtually no colonization of
the sediments in the surf zone by benthic organisms. Type
Ib bottoms (Inner-Shelf Ridge Field) has greater current
induced roughness reflecting currents that produce bedforms.
Both Type Ia and Ib have small scale (heights 1 to 10 cm,
wavelength 1 to 50 cm) wave- and current-induced bottom
roughness, mesoscale (height 0.1 to 2 m, wavelength 0.5 to
50 m) current-induced roughness, and little biogenetic
roughness.

The presence of drag marks on the bottom in much of the study area is indicative of an active commercial fishery. The drag marks are near linear scours that most probably are caused by trawl nets or similar fishing equipment dragged along the sea floor.

SUBSURFACE GEOLOGY

The discussion by Wright (1995) of the history of bottom resuspension activity has implications for the study area whether looking at 18,000 or 140,000 year time scales. In the less than 20-m depths within the study area, the cumulative time during which the bottom would have been subject to agitation by waves is directly and strongly proportional to depth. In the very shallow portions, where the cumulative period of activity is short, one would expect little evidence of modern processes and relatively smaller active sand-bodies whereas in deeper water, where there has been more time for resuspension and transportation, dynamic sand bodies, such as unit D of Shideler and others (1972), should be more developed.

Given the present sea level and the last interglacial high about 125,000 years ago, the shallow portion of the

current continental shelf has experienced about 15,000 total years of activity capable of resuspending sediments. That cumulative activity increases with depth across the shelf, suggesting that there might be more evidence of sedimentary processes, hence a more complex stratigraphic record, in deeper water. Again, as most of the study area is in less than 20-m depths, much of the activity would have been farther offshore.

The high frequency, low amplitude sea-level variations of Oxygen Isotope Stage 5 (Figure 4)(Toscano and others, 1989; Toscano, 1992; Toscano and York, 1992; and Riggs and others, 1992) should have had an appreciable effect on the inner shelf, perhaps of sufficient magnitude to compensate for the relative short cumulative time of activity. Fluctuations ranging between -23 m and +6 m of the present sea level would have moved the shoreline completely across the study area with consequence of multiple episodes of erosion that should be evident in the seismostratigraphic record of the inner shelf. The periods of subaerial exposure would have resulted in erosional surfaces which later would serve as the floor across which shoals might develop and move and as the surface upon which new deposition could occur. These erosional surfaces would have

had limited vertical range and relatively small shore-normal extent. Some of the near parallel reflectors in the seismic records likely are indications of such erosional surfaces.

The three sea-level peaks (5a, 5c, and 5e)(Figure 4) and the intervening mini-lows occurred over a period of approximately 50,000 years (80,000 to 130,000 y. B.P.) within 23 m of present sea level. This set of high-frequency fluctuations is on the same order as Mitchum and Van Wagoner's (1991) fifth-order stratigraphic sequences which have a cyclicity of 0.01 to 0.02 m.y. Although they report the presence of fifth-order stratigraphic sequences in areas with very rapid deposition, the strata of slow deposition inner continental shelf of Virginia form similar sequences. The low rates of sedimentation increase the difficulty of discerning and tracing system boundaries.

Because the resolving power of more modern seismic reflection systems provides more detail than was available to Shideler and others (1972), the utility of their proposed standard stratigraphic section (Figure 3) has diminished. Unit C in particular requires reconsideration. The major sea-level low stands associated with the Exmore, Belle Haven, and Eastville channel systems in Chesapeake Bay were

major global changes in sea level, comparable to the late Pleistocene regression that resulted in the Cape Charles channel. The continental shelf of the mid-Atlantic would have been exposed to sub-aerial processes and would have been scoured as the surf zone first retreated and then advanced during the following transgression of each cycle. Compared to the smaller, sea-level fluctuations of Stage 5, the much larger and longer lasting eustatic cycles would have resulted in erosion surfaces of a much broader geographic extent. The major regional non-conformities separate unit C into four depositional units which meet Mitchum and Van Wagoner's (1991) classification as fourth-order stratigraphic sequences. Fourth order sequences have cyclicity of 0.1 to 0.2 m.y., comparable to that of Pleistocene glacial episodes. Again, the low rates of deposition result in strata that are thin and difficult to trace.

The interpretation of the cores further highlights the complexity of the geologic section. The 9,440 y B.P. radiocarbon date from the wood fragment 15 m below present sea level in core 4 (Figure 29) indicates that the fragment was deposited in a fluvial setting approximately 45 m above what then was sea level. Thus there are Holocene fluvial

channels cut into older estuarine or marine strata. The
filled channels are overlain by recent marine sediments.
Indeed it is likely that the channels experienced a
transition from fluvial to marine conditions as sea level
rose and flooded existing drainage systems. Analysis of the
cores demonstrates the mix of fluvial, estuarine, and marine
environments in strata in the continental shelf offshore
southeastern Virginia.

SAND RESOURCES

As previously discussed, if the offshore sediments are
to be used for beach nourishment, it is important that the
offshore sands have grain-size characteristics that closely
match those of the beach. As indicated in Wright and others
(1987), the median grain-size of the foreshore within the
study area varies between 0.25 and 0.75 mm. As the utility
of borrow material for a beach nourishment project is
strongly dependent upon the equality of the median grain-
sizes of the native and borrow sediments, there is broad
leeway in the requirements for borrow material. Many of the
surficial samples have median grain-sizes coarser than 0.25
mm (2 phi). Similarly, portions of the cores in the area
offshore from Rudee Inlet (Figure 29) are medium or coarse

sands with acceptable medians (Appendix 2). The shoal offshore of Sandbridge contains substantial quantities of clean sand with median grain sizes coarser than 0.25 mm (Kimball and Dame, 1989; Kimball and others, 1991; and Appendix 2) that satisfies the grain-size criteria for borrow material.

Of the cores collected offshore of Rudee Inlet, numbers 7, 8, 11, and 13 (Figure 29) contain reasonable sections of medium to coarse sand. Almost two-thirds of the core 7 is coarser than 0.35 mm (1.5 phi), the section of fine sands being between 1 and 7 feet (0.3 to 2.2 m) beneath the surface. Core 8 is similar, with section between 3 and 6.5 feet (1 to 2 m) containing fine sands with a median grain size of 0.08 mm (3.5 phi) but the overlying section consisting of medium sands. The underlying section appears to be medium sands, but several feet of the section was missing, casting some doubt on the overall content. Cores 11 and 13 are dominantly medium and coarse sands with only very lenses of finer material. As the sediments are so variable, the area would have to be much more thoroughly cored before specific portions could be identified for sand mining.

The three of the four cores collected off Sandbridge contain medium sands with median grin sizes between 1.12 and 2.07 phi (0.51 and 0.24 mm). The fourth core, contains fine sands with median grain sizes dominantly coarser than 2.25 phi (0.21 mm), which should be acceptable for beach nourishment on much of the southeastern Virginia's shore.

CONCLUSIONS

The conclusions of this study fall into three topic areas: surficial sediments, geological history of the inner continental shelf, and sand resources. The conclusions address and satisfy the goals and objectives set forth in the Objectives.

SURFICIAL SEDIMENTS

The sediments on the surface of the southeastern Virginia inner continental shelf are more varied than has been indicated previously. Although the surficial sediments within the study area are dominantly sands, the density of the sample grid used in this study allows identification of a greater spatial variability in grain-size characteristics than had been possible previously. The characteristics of the surficial sediments depict both active processes (e.g., the "plume" of generally finer sediments exiting the mouth of Chesapeake Bay) and the underlying geology (e.g., the outcrop of siltier sediments near False Cape).

GEOLOGICAL HISTORY

The Pleistocene history of the inner continental shelf offshore of southeastern Virginia and the resulting stratigraphy are substantially more complex than have been described previously in the literature. The sedimentary structure and stratigraphy of the study area results from the previously unconsidered impact of the Pleistocene sea-level lows associated with the Exmore, Belle Haven, and Eastville channel-forming events on submarine Unit C and the several high-frequency, low-amplitude fluctuations of sea level associated with Oxygen Isotope Stage 5.

The three major sea-level lows, sufficient to carve major channels across the coastal plain would have had marked consequences across the shelf. The Exmore, Belle Haven, and Eastville lows correspond to major Pleistocene glacial maxima. Thus it is reasonable to view unit C as a composite of four fourth-order stratigraphic sequences. The low rate of deposition on the mid-Atlantic continental shelf has limited the thickness of the individual units and thus had made regional correlation of specific strata difficult.

The three Stage 5 peaks (5a, 5c, and 5d) and

intervening mini-lows (5b and 5d), roughly 80,000 to 130,000 years ago, occur within 23 m of today's sea level and thus would have had little impact farther out on the shelf but should be obvious in the strata of the inner shelf.

The shallow-penetration seismic records reviewed for this study depict several reflectors bounding thin strata within the upper 10 m or so of the sediment column. Although vertical control on the original data does not allow specific correlation of these reflectors and strata from line to line, it is most likely that they are associated with the low amplitude fluctuations of the last interglacial episode. These reflectors and strata from which they result are fifth-order sequences that occur within the greater fourth-order units and further confound the correlation of individual elements.

Some of the smaller channels discernable in the seismic profiles may be related to sea-level variations during Stage 5, but larger systems, such as two of the three reported by Chen (1992) and Chen and others (1995), are more likely associated with major regressions.

There are three distinct types of filled paleochannels within the inner continental shelf. Relatively near

surface, generally small, roughly shore normal channels, such as seen near Rudee Inlet, are likely the courses of tidal inlet channels, in this instance dating from the last low-stand of sea level. Small, relatively wide and relatively shallow, generally shore-parallel channels, some of which are evident in the records, may be back barrier or lagoonal channels. The third type of channel results from riverine flow.

SAND RESOURCES

There are substantial resources of sand on the inner continental shelf of Virginia which may be suitable for use in beach nourishment or as construction aggregate. As always is the case, the specific geotechnical and compositional characteristics of the resource must be reviewed for each potential application. Beach nourishment and construction uses have different criteria. As the grain size and shape and mineral composition criteria for construction aggregate vary with the specific application, further discussion of them is beyond the scope of this dissertation. Basic grain-size characteristics of sediments in cores from offshore of Sandbridge, offshore of Rudee Inlet, and elsewhere in the study area indicate that there

are substantial quantities of sand suitable for use in beach nourishment projects.

The deposits occur in three distinct stratigraphic settings. The most easily discernable type of deposit is the discrete, surficial shoal as exemplified by Sandbridge Shoal. The shoals are well-defined topographic features on the surface of the inner shelf. In the seismic records they have clear bottom boundaries. After the grain-size characteristics of such deposits are verified by coring, the physical process of mining should be relatively straight forward; dredge the shoal to the depth of the bottom contact.

Filled channels, as those offshore of Rudee Inlet, are another class of deposit. The fluvial sands filling the channels can be a very clean, high quality sand suitable for use in beach restoration or nourishment and in construction aggregate. Although there is no surface expression of the deposit, the extent of the deposit is fairly clear in sub-bottom profiles. Mining the filled channels is substantially more difficult than the surficial shoals. Any overburden would have to be removed or mixed with the more desirable channel fill. The lateral extent of the deposit is small relative to its length and the boundaries sharp.

Dredging requires careful mapping of the lateral and vertical limits of the deposit through seismic profiling and coring and careful control of the dredge.

The third type of sand deposit, a lenticular facies, is the most difficult to find. A portion of a bed may grade from sediments of unacceptable quality for use to acceptable quality and back to unacceptable. There is no surface expression of the deposit, the top of which could be buried or which could be the sea floor. There are no reliable indicators in the seismic records. This class of deposit is discovered serendipitously and only by coring. However once discovered and defined, again by coring, the process of mining is relatively easy. Changes in sediment type are apt to be gradual with the result that the limits of the area to be dredged are set arbitrarily on the basis of sedimentary characteristics determined by analysis of core samples.

In conclusion, the interaction of the Quaternary history of sea-level changes and low rates of deposition on the continental shelf of southern Virginia has resulted in a complex and vertically condensed stratigraphy. The distribution of grain-size characteristics of the surficial sediments provides some clues about the regional processes and geology but little definitive evidence. There are

substantial quantities of sand available for use as beach fill or construction aggregate. Exploitable deposits occur in three different settings; each setting with its own set of attributes affecting the accessibility of the resource.

Table 3

Inner Shelf Sand Bodies

	Shoal	Filled Channel	Gradational
Visibility	On Surface	Buried	Buried
Lateral Limits	*	Sharp	Undefined
Top	Sea Floor	Varied	Varied
Bottom	Sharp	Usually Sharp	Varied
Seismic Definition	Good	Good	Poor
How Found	Bathymetry	Seismics Geology	Serendipity Geology (?)
How Proved	Coring through Bottom Reflector	Coring	Coring
Dredging	'Easy' Remove Shoal to Predetermined Depth	'Difficult Stay within Channel	'Very Easy' Stay within Broad Vertical and Horizontal Limits

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APPENDIX 1

Position and Grain Size Data of the Surficial Samples

Latitude and Longitude are in Degrees and Minutes, NAD 83, as determined by the ship's GPS.

Depth is the uncorrected depth in feet displayed by the ship's fathometer at the sample site.

% Gravel, Sand, Silt, Clay, Gravel + Sand, and Mud are weight percents.

Mud is silt + clay.

Mz is the Graphic Mean

Md is the Median

Incl Graph St Dev is the Inclusive Graphic Standard Deviation

Samp	#	Latitude	Longitude	Depth ft	Grvl %	Sand %	Silt %
SVG	1 ,	37 0.10 ,	76 0.17 ,	-32 ,	0.1 ,	95.0 ,	1.9 ,
SVG	2 ,	36 59.00 ,	76 0.06 ,	-46 ,	0.2 ,	93.0 ,	3.2 ,
SVG	3 ,	36 59.10 ,	75 58.05 ,	-36 ,	0.1 ,	97.6 ,	0.6 ,
SVG	4 ,	37 0.00 ,	75 55.98 ,	-32 ,	6.8 ,	91.3 ,	0.0 ,
SVG	5 ,	36 59.10 ,	75 54.00 ,	-32 ,	0.3 ,	96.9 ,	0.7 ,
SVG	6 ,	37 0.00 ,	75 51.99 ,	-37 ,	0.1 ,	94.3 ,	2.0 ,
SVG	7 ,	36 59.00 ,	75 49.97 ,	-41 ,	0.8 ,	94.1 ,	2.3 ,
SVG	8 ,	37 0.00 ,	75 47.99 ,	-46 ,	0.1 ,	92.5 ,	3.7 ,
SVG	9 ,	36 59.10 ,	75 45.95 ,	,	0.2 ,	93.2 ,	3.0 ,
SVG	10 ,	37 0.00 ,	75 43.92 ,	-46 ,	0.2 ,	95.6 ,	0.3 ,
SVG	11 ,	36 59.00 ,	75 41.65 ,	-56 ,	0.1 ,	94.4 ,	2.3 ,
SVG	12 ,	36 58.00 ,	75 43.91 ,	-50 ,	0.5 ,	96.2 ,	1.1 ,
SVG	13 ,	36 57.00 ,	75 45.96 ,	-47 ,	2.8 ,	93.2 ,	0.9 ,
SVG	14 ,	36 56.00 ,	75 47.93 ,	-42 ,	0.0 ,	93.3 ,	2.9 ,
SVG	15 ,	36 56.00 ,	75 47.93 ,	-42 ,	0.0 ,	93.1 ,	2.7 ,
SVG	16 ,	36 55.00 ,	75 49.97 ,	-39 ,	0.2 ,	93.7 ,	2.3 ,
SVG	17 ,	36 54.00 ,	75 51.92 ,	-33 ,	0.0 ,	95.6 ,	1.5 ,
SVG	18 ,	36 52.90 ,	75 53.97 ,	-48 ,	1.4 ,	95.1 ,	0.8 ,
SVG	19 ,	36 51.90 ,	75 55.94 ,	-33 ,	0.0 ,	82.6 ,	10.5 ,
SVG	20 ,	36 50.00 ,	75 35.95 ,	-29 ,	0.1 ,	92.6 ,	4.6 ,
SVG	21 ,	36 47.00 ,	75 53.92 ,	-39 ,	0.2 ,	86.8 ,	8.7 ,
SVG	22 ,	36 46.00 ,	75 51.96 ,	-39 ,	1.7 ,	96.7 ,	0.3 ,
SVG	23 ,	36 45.00 ,	75 49.90 ,	-46 ,	0.7 ,	98.0 ,	0.4 ,
SVG	24 ,	36 44.00 ,	75 47.98 ,	-49 ,	5.7 ,	92.1 ,	0.6 ,
SVG	25 ,	36 43.00 ,	75 45.92 ,	-46 ,	13.0 ,	85.3 ,	0.0 ,
SVG	26 ,	36 42.00 ,	75 43.92 ,	-67 ,	0.4 ,	90.8 ,	4.6 ,
SVG	27 ,	36 41.00 ,	75 42.01 ,	-54 ,	1.1 ,	97.3 ,	0.4 ,
SVG	28 ,	36 40.00 ,	75 40.04 ,	-59 ,	3.6 ,	94.7 ,	0.3 ,
SVG	29 ,	36 39.10 ,	75 39.96 ,	-55 ,	1.3 ,	97.2 ,	0.2 ,
SVG	30 ,	36 38.10 ,	75 36.04 ,	-66 ,	0.7 ,	98.5 ,	0.2 ,
SVG	31 ,	36 37.00 ,	75 34.09 ,	-71 ,	0.0 ,	98.8 ,	0.0 ,
SVG	32 ,	36 36.10 ,	75 32.07 ,	-75 ,	0.1 ,	97.2 ,	0.1 ,
SVG	33 ,	36 35.00 ,	75 30.08 ,	-77 ,	0.0 ,	97.5 ,	0.7 ,
SVG	34 ,	36 34.00 ,	75 27.99 ,	-61 ,	0.8 ,	97.6 ,	0.3 ,
SVG	35 ,	36 33.00 ,	75 26.04 ,	-67 ,	0.0 ,	98.4 ,	0.7 ,
SVG	36 ,	36 32.00 ,	75 24.05 ,	-106 ,	0.0 ,	93.7 ,	3.5 ,
SVG	37 ,	36 32.10 ,	75 24.07 ,	-106 ,	0.3 ,	94.5 ,	1.4 ,
SVG	38 ,	36 31.00 ,	75 22.03 ,	-80 ,	1.3 ,	96.7 ,	0.1 ,
SVG	39 ,	36 30.00 ,	75 20.06 ,	-94 ,	2.0 ,	95.7 ,	0.4 ,
SVG	40 ,	36 30.00 ,	75 15.95 ,	-92 ,	1.5 ,	95.0 ,	2.5 ,
SVG	41 ,	36 31.00 ,	75 13.95 ,	-87 ,	9.8 ,	87.4 ,	0.1 ,
SVG	42 ,	36 32.00 ,	75 15.98 ,	-100 ,	0.4 ,	97.3 ,	0.1 ,
SVG	43 ,	36 33.00 ,	75 17.97 ,	-79 ,	0.6 ,	97.6 ,	0.1 ,
SVG	44 ,	36 34.00 ,	75 20.01 ,	-106 ,	0.1 ,	96.8 ,	2.1 ,
SVG	45 ,	36 35.00 ,	75 21.97 ,	-86 ,	1.4 ,	96.3 ,	0.0 ,
SVG	46 ,	36 36.00 ,	75 24.00 ,	-61 ,	1.4 ,	96.7 ,	0.3 ,

Samp	#	Latitude	Longitude	Depth ft	Grvl %	Sand %	Silt %
SVG	47 ,	36 37.00 ,	75 25.96 ,	-72 ,	2.2 ,	95.8 ,	0.3 ,
SVG	48 ,	36 38.00 ,	75 27.96 ,	-63 ,	1.0 ,	95.5 ,	2.1 ,
SVG	49 ,	36 38.90 ,	75 30.01 ,	-62 ,	0.9 ,	96.9 ,	0.1 ,
SVG	50 ,	36 40.00 ,	75 31.99 ,	-52 ,	0.6 ,	97.3 ,	0.1 ,
SVG	51 ,	36 41.00 ,	75 34.03 ,	-59 ,	2.5 ,	95.4 ,	0.2 ,
SVG	52 ,	36 42.00 ,	75 36.10 ,	-72 ,	0.4 ,	95.5 ,	1.3 ,
SVG	53 ,	36 43.00 ,	75 38.04 ,	-65 ,	1.6 ,	95.9 ,	0.0 ,
SVG	54 ,	36 43.00 ,	75 38.04 ,	-65 ,	3.6 ,	93.8 ,	0.1 ,
SVG	55 ,	36 44.00 ,	75 40.13 ,	-66 ,	53.0 ,	43.7 ,	1.9 ,
SVG	56 ,	36 45.00 ,	75 42.06 ,	-64 ,	0.3 ,	92.0 ,	5.2 ,
SVG	57 ,	36 46.00 ,	75 44.05 ,	-59 ,	3.6 ,	92.4 ,	3.2 ,
SVG	58 ,	36 49.90 ,	75 54.03 ,	-31 ,	7.9 ,	88.9 ,	2.2 ,
SVG	59 ,	36 49.00 ,	75 54.02 ,	-34 ,	0.7 ,	96.1 ,	2.0 ,
SVG	60 ,	36 51.00 ,	75 54.07 ,	-37 ,	0.6 ,	95.6 ,	2.3 ,
SVG	61 ,	36 50.10 ,	75 52.07 ,	-48 ,	0.2 ,	92.3 ,	4.1 ,
SVG	62 ,	36 49.00 ,	75 50.07 ,	-50 ,	0.0 ,	92.5 ,	4.8 ,
SVG	63 ,	36 48.00 ,	75 48.05 ,	-57 ,	13.7 ,	84.2 ,	0.7 ,
SVG	64 ,	36 47.00 ,	75 46.04 ,	-57 ,	5.3 ,	93.2 ,	0.1 ,
SVG	65 ,	36 46.00 ,	75 44.09 ,	-56 ,	18.2 ,	80.9 ,	0.0 ,
SVG	66 ,	36 47.00 ,	75 42.00 ,	-58 ,	7.1 ,	90.9 ,	0.8 ,
SVG	67 ,	36 48.00 ,	75 40.05 ,	-44 ,	3.6 ,	94.6 ,	0.3 ,
SVG	68 ,	36 49.00 ,	75 38.05 ,	-72 ,	3.2 ,	92.4 ,	1.5 ,
SVG	69 ,	36 50.00 ,	75 36.05 ,	-56 ,	12.4 ,	85.2 ,	0.0 ,
SVG	70 ,	36 51.00 ,	75 34.00 ,	-56 ,	1.4 ,	96.0 ,	0.0 ,
SVG	71 ,	36 52.00 ,	75 32.01 ,	-76 ,	21.8 ,	75.1 ,	0.1 ,
SVG	72 ,	36 53.00 ,	75 30.03 ,	-78 ,	,	,	,
SVG	73 ,	36 54.00 ,	75 28.03 ,	-79 ,	0.5 ,	96.6 ,	0.1 ,
SVG	74 ,	36 55.00 ,	75 26.02 ,	-88 ,	0.0 ,	94.7 ,	0.5 ,
SVG	75 ,	36 56.00 ,	75 24.03 ,	-86 ,	0.0 ,	97.0 ,	0.0 ,
SVG	76 ,	36 57.00 ,	75 22.03 ,	-92 ,	3.1 ,	93.6 ,	0.2 ,
SVG	77 ,	36 58.00 ,	75 20.02 ,	-96 ,	0.3 ,	95.5 ,	0.0 ,
SVG	78 ,	36 59.00 ,	75 18.04 ,	-96 ,	5.2 ,	92.1 ,	0.5 ,
SVG	79 ,	36 59.00 ,	75 18.04 ,	-96 ,	11.7 ,	85.5 ,	0.0 ,
SVG	80 ,	37 0.00 ,	75 16.01 ,	-105 ,	0.1 ,	94.7 ,	0.5 ,
SVG	81 ,	37 0.00 ,	75 20.01 ,	-90 ,	37.4 ,	59.7 ,	0.3 ,
SVG	82 ,	36 58.90 ,	75 22.11 ,	-100 ,	2.9 ,	95.3 ,	0.4 ,
SVG	83 ,	36 58.00 ,	75 24.05 ,	-82 ,	10.9 ,	87.3 ,	0.2 ,
SVG	84 ,	36 56.90 ,	75 25.98 ,	-82 ,	5.9 ,	92.2 ,	0.4 ,
SVG	85 ,	36 56.00 ,	75 28.03 ,	-87 ,	0.2 ,	97.6 ,	0.6 ,
SVG	86 ,	36 55.00 ,	75 30.11 ,	-74 ,	3.1 ,	95.1 ,	0.6 ,
SVG	87 ,	36 54.00 ,	75 31.98 ,	-73 ,	0.0 ,	97.0 ,	0.9 ,
SVG	88 ,	36 53.00 ,	75 34.03 ,	-60 ,	2.7 ,	95.2 ,	0.5 ,
SVG	89 ,	36 51.90 ,	75 36.01 ,	-52 ,	0.1 ,	97.6 ,	0.6 ,
SVG	90 ,	36 51.00 ,	75 37.98 ,	-62 ,	0.2 ,	97.7 ,	0.5 ,
SVG	91 ,	36 49.10 ,	75 57.02 ,	-30 ,	0.0 ,	92.8 ,	4.9 ,
SVG	92 ,	36 48.10 ,	75 57.04 ,	-31 ,	1.5 ,	91.9 ,	4.0 ,

Samp	#	Latitude	Longitude	Depth ft	Grvl %	Sand %	Silt %
SVG	93 ,	36 47.10 ,	75 57.04 ,	-29 ,	0.1 ,	94.9 ,	2.7 ,
SVG	94 ,	36 46.10 ,	75 56.84 ,	-23 ,	0.1 ,	95.7 ,	2.4 ,
SVG	95 ,	36 46.00 ,	75 56.02 ,	-32 ,	0.0 ,	92.9 ,	3.9 ,
SVG	96 ,	36 45.10 ,	75 56.03 ,	-32 ,	0.0 ,	92.5 ,	4.5 ,
SVG	97 ,	36 44.10 ,	75 56.02 ,	-26 ,	0.0 ,	96.2 ,	1.8 ,
SVG	98 ,	36 43.10 ,	75 55.08 ,	-34 ,	0.2 ,	92.4 ,	4.0 ,
SVG	99 ,	36 43.10 ,	75 53.99 ,	-39 ,	0.0 ,	97.0 ,	1.4 ,
SVG	100 ,	36 42.00 ,	75 55.04 ,	-30 ,	0.2 ,	92.7 ,	4.2 ,
SVG	101 ,	36 41.00 ,	75 54.86 ,	-21 ,	0.2 ,	95.5 ,	2.6 ,
SVG	102 ,	36 41.00 ,	75 54.08 ,	-34 ,	0.0 ,	91.9 ,	5.5 ,
SVG	103 ,	36 40.00 ,	75 54.05 ,	-24 ,	0.0 ,	98.3 ,	0.3 ,
SVG	104 ,	36 39.00 ,	75 53.72 ,	-16 ,	0.0 ,	98.3 ,	0.5 ,
SVG	105 ,	36 38.10 ,	75 53.11 ,	-18 ,	0.0 ,	98.3 ,	0.2 ,
SVG	106 ,	36 38.10 ,	75 53.11 ,	-18 ,	0.0 ,	98.1 ,	0.4 ,
SVG	107 ,	36 38.00 ,	75 52.07 ,	-33 ,	3.3 ,	94.6 ,	0.5 ,
SVG	108 ,	36 37.00 ,	75 52.71 ,	-19 ,	0.0 ,	92.9 ,	3.5 ,
SVG	109 ,	36 36.10 ,	75 52.09 ,	-30 ,	4.3 ,	90.1 ,	2.4 ,
SVG	110 ,	36 35.00 ,	75 52.00 ,	-27 ,	1.2 ,	11.2 ,	53.3 ,
SVG	111 ,	36 34.00 ,	75 51.94 ,	-16 ,	0.2 ,	94.4 ,	2.2 ,
SVG	112 ,	36 33.00 ,	75 51.81 ,	-12 ,	0.1 ,	96.0 ,	0.9 ,
SVG	113 ,	36 32.10 ,	75 51.13 ,	-23 ,	0.0 ,	91.3 ,	5.0 ,
SVG	114 ,	36 31.10 ,	75 51.04 ,	-23 ,	0.0 ,	91.0 ,	5.2 ,
SVG	115 ,	36 30.00 ,	75 50.97 ,	-18 ,	0.0 ,	96.6 ,	1.0 ,
SVG	116 ,	36 31.00 ,	75 50.05 ,	-33 ,	1.3 ,	95.8 ,	0.7 ,
SVG	117 ,	36 32.90 ,	75 50.08 ,	-36 ,	0.0 ,	95.1 ,	3.0 ,
SVG	118 ,	36 34.90 ,	75 50.12 ,	-38 ,	0.2 ,	97.8 ,	0.6 ,
SVG	119 ,	36 37.00 ,	75 50.07 ,	-37 ,	3.8 ,	93.8 ,	0.5 ,
SVG	120 ,	36 39.00 ,	75 50.09 ,	-47 ,	5.8 ,	91.2 ,	0.6 ,
SVG	121 ,	36 40.00 ,	75 52.00 ,	-40 ,	14.5 ,	83.8 ,	0.1 ,
SVG	122 ,	36 42.00 ,	75 52.12 ,	-41 ,	14.2 ,	83.7 ,	0.4 ,
SVG	123 ,	36 43.90 ,	75 52.10 ,	-44 ,	0.2 ,	91.9 ,	5.5 ,
SVG	124 ,	36 45.00 ,	75 54.00 ,	-37 ,	0.0 ,	87.4 ,	8.8 ,
SVG	125 ,	36 48.00 ,	75 56.09 ,	-27 ,	0.4 ,	93.3 ,	3.8 ,
SVG	126 ,	36 48.00 ,	75 56.12 ,	-27 ,	1.6 ,	92.7 ,	3.1 ,
SVG	127 ,	36 48.00 ,	75 52.10 ,	-48 ,	14.5 ,	82.9 ,	0.8 ,
SVG	128 ,	36 47.00 ,	75 50.10 ,	-38 ,	14.9 ,	84.1 ,	0.2 ,
SVG	129 ,	36 46.00 ,	75 48.10 ,	-53 ,	20.2 ,	77.8 ,	0.3 ,
SVG	130 ,	36 45.00 ,	75 46.00 ,	-52 ,	6.5 ,	91.9 ,	0.2 ,
SVG	131 ,	36 44.00 ,	75 44.10 ,	-66 ,	1.1 ,	83.3 ,	7.1 ,
SVG	132 ,	36 43.00 ,	75 42.04 ,	-57 ,	0.4 ,	97.3 ,	0.6 ,
SVG	133 ,	36 42.10 ,	75 40.02 ,	-54 ,	1.1 ,	96.9 ,	0.3 ,
SVG	134 ,	36 41.10 ,	75 38.10 ,	-60 ,	0.4 ,	97.8 ,	0.3 ,
SVG	135 ,	36 40.00 ,	75 36.00 ,	-61 ,	2.7 ,	95.7 ,	0.2 ,
SVG	136 ,	36 39.00 ,	75 34.10 ,	-61 ,	0.5 ,	97.9 ,	0.4 ,
SVG	137 ,	36 38.00 ,	75 32.10 ,	-60 ,	0.0 ,	98.8 ,	0.1 ,
SVG	138 ,	36 40.90 ,	75 30.10 ,	-60 ,	0.9 ,	97.4 ,	0.4 ,

Samp	#	Latitude	Longitude	Depth ft	Grvl %	Sand %	Silt %
SVG	139 ,	36 41.90 ,	75 28.10 ,	-91 ,	0.7 ,	49.0 ,	31.2 ,
SVG	140 ,	36 43.90 ,	75 28.10 ,	-90 ,	0.5 ,	95.2 ,	1.4 ,
SVG	141 ,	36 44.90 ,	75 30.10 ,	-64 ,	11.1 ,	87.8 ,	0.1 ,
SVG	142 ,	36 45.90 ,	75 32.10 ,	-66 ,	1.0 ,	97.4 ,	0.1 ,
SVG	143 ,	36 46.90 ,	75 34.10 ,	-75 ,	27.0 ,	67.7 ,	2.1 ,
SVG	144 ,	36 48.00 ,	75 36.10 ,	-71 ,	1.4 ,	93.7 ,	1.5 ,
SVG	145 ,	36 50.00 ,	75 40.10 ,	-61 ,	8.1 ,	90.4 ,	0.2 ,
SVG	146 ,	36 50.00 ,	75 40.00 ,	-61 ,	0.3 ,	98.1 ,	0.3 ,
SVG	147 ,	36 48.90 ,	75 42.00 ,	-59 ,	5.8 ,	93.1 ,	0.2 ,
SVG	148 ,	36 48.00 ,	75 44.10 ,	-65 ,	0.6 ,	95.6 ,	1.3 ,
SVG	149 ,	36 48.90 ,	75 46.10 ,	-64 ,	0.3 ,	78.5 ,	10.4 ,
SVG	150 ,	36 50.00 ,	75 48.10 ,	-55 ,	0.7 ,	96.7 ,	0.5 ,
SVG	151 ,	36 51.00 ,	75 50.04 ,	-53 ,	0.0 ,	97.2 ,	0.7 ,
SVG	152 ,	36 53.00 ,	75 50.10 ,	-44 ,	0.2 ,	95.7 ,	2.1 ,
SVG	153 ,	36 52.00 ,	75 52.06 ,	-52 ,	0.9 ,	97.7 ,	0.3 ,
SVG	154 ,	36 56.00 ,	75 52.10 ,	-38 ,	0.1 ,	96.2 ,	1.4 ,
SVG	155 ,	36 55.10 ,	75 54.00 ,	-45 ,	0.0 ,	96.7 ,	1.1 ,
SVG	156 ,	36 54.10 ,	75 56.01 ,	-41 ,	1.5 ,	94.1 ,	2.0 ,
SVG	157 ,	36 53.10 ,	75 57.96 ,	-24 ,	0.8 ,	90.1 ,	5.9 ,
SVG	158 ,	36 52.10 ,	75 58.01 ,	-26 ,	0.0 ,	93.0 ,	3.9 ,
SVG	159 ,	36 51.20 ,	75 58.01 ,	-27 ,	0.0 ,	91.8 ,	4.2 ,
SVG	160 ,	36 54.00 ,	75 48.06 ,	-48 ,	0.0 ,	94.4 ,	2.3 ,
SVG	161 ,	36 55.00 ,	75 46.03 ,	-52 ,	0.0 ,	96.0 ,	1.9 ,
SVG	162 ,	36 56.00 ,	75 44.06 ,	-51 ,	0.1 ,	97.7 ,	0.4 ,
SVG	163 ,	36 57.00 ,	75 42.04 ,	-50 ,	0.1 ,	97.8 ,	0.2 ,
SVG	164 ,	36 58.00 ,	75 40.06 ,	-56 ,	40.4 ,	58.0 ,	0.2 ,
SVG	165 ,	37 0.00 ,	75 40.00 ,	-62 ,	14.4 ,	83.8 ,	0.1 ,
SVG	166 ,	36 59.00 ,	75 38.05 ,	-73 ,	29.9 ,	68.5 ,	0.3 ,
SVG	167 ,	37 0.00 ,	75 35.97 ,	-73 ,	0.3 ,	97.8 ,	0.1 ,
SVG	168 ,	36 59.00 ,	75 34.01 ,	-79 ,	4.1 ,	93.9 ,	0.3 ,
SVG	169 ,	36 59.90 ,	75 32.01 ,	-79 ,	0.0 ,	95.4 ,	1.0 ,
SVG	170 ,	36 58.90 ,	75 29.98 ,	-77 ,	8.2 ,	89.5 ,	0.1 ,
SVG	171 ,	36 59.90 ,	75 28.01 ,	-89 ,	3.5 ,	93.4 ,	0.4 ,
SVG	172 ,	36 59.90 ,	75 28.01 ,	-89 ,	0.2 ,	95.3 ,	1.1 ,
SVG	173 ,	36 58.90 ,	75 26.07 ,	-84 ,	0.7 ,	94.3 ,	0.6 ,
SVG	174 ,	36 59.90 ,	75 23.96 ,	-83 ,	0.9 ,	96.9 ,	0.2 ,
SVG	175 ,	36 56.90 ,	75 18.01 ,	-93 ,	2.5 ,	95.4 ,	0.3 ,
SVG	176 ,	36 55.00 ,	75 17.99 ,	-84 ,	3.0 ,	94.8 ,	0.1 ,
SVG	177 ,	36 55.90 ,	75 15.96 ,	-103 ,	2.2 ,	95.0 ,	0.0 ,
SVG	178 ,	36 57.90 ,	75 15.92 ,	-91 ,	1.4 ,	96.9 ,	0.3 ,
SVG	179 ,	36 57.00 ,	75 13.96 ,	-102 ,	1.1 ,	96.0 ,	0.3 ,
SVG	180 ,	36 57.00 ,	75 13.96 ,	-122 ,	0.4 ,	93.7 ,	1.2 ,
SVG	181 ,	36 55.00 ,	75 13.96 ,	-109 ,	12.9 ,	84.3 ,	0.4 ,
SVG	182 ,	36 53.90 ,	75 15.99 ,	-103 ,	1.6 ,	96.2 ,	0.2 ,
SVG	183 ,	36 52.90 ,	75 18.03 ,	-98 ,	13.8 ,	84.2 ,	0.1 ,
SVG	184 ,	36 51.90 ,	75 20.01 ,	-90 ,	0.0 ,	97.3 ,	0.3 ,

Samp	#	Latitude	Longitude	Depth ft	Grvl %	Sand %	Silt %
SVG	185 ,	36 50.90 ,	75 21.93 ,	-82 ,	13.4 ,	85.0 ,	0.2 ,
SVG	186 ,	36 49.90 ,	75 24.00 ,	-88 ,	3.4 ,	94.3 ,	0.4 ,
SVG	187 ,	36 48.90 ,	75 25.98 ,	-74 ,	4.5 ,	93.3 ,	0.4 ,
SVG	188 ,	36 48.90 ,	75 25.98 ,	-74 ,	9.5 ,	88.7 ,	0.0 ,
SVG	189 ,	36 47.90 ,	75 28.00 ,	-67 ,	14.1 ,	84.3 ,	0.2 ,
SVG	190 ,	36 47.00 ,	75 30.00 ,	-67 ,	5.3 ,	93.2 ,	0.1 ,
SVG	191 ,	36 47.90 ,	75 31.99 ,	-67 ,	8.4 ,	90.0 ,	0.3 ,
SVG	192 ,	36 49.00 ,	75 34.04 ,	-75 ,	2.4 ,	97.5 ,	0.1 ,
SVG	193 ,	36 50.00 ,	75 44.13 ,	-63 ,	0.7 ,	96.8 ,	2.3 ,
SVG	194 ,	36 58.00 ,	75 56.00 ,	-28 ,	0.1 ,	99.2 ,	0.5 ,
SVG	195 ,	36 57.00 ,	75 54.06 ,	-37 ,	0.0 ,	81.0 ,	12.7 ,
SVG	196 ,	36 58.00 ,	75 51.96 ,	-36 ,	0.1 ,	98.3 ,	1.0 ,
SVG	197 ,	36 57.10 ,	75 50.10 ,	-40 ,	0.0 ,	99.2 ,	0.7 ,
SVG	198 ,	36 58.00 ,	75 48.04 ,	-45 ,	4.5 ,	94.2 ,	0.8 ,
SVG	199 ,	36 54.20 ,	75 44.09 ,	-67 ,	0.0 ,	94.6 ,	3.2 ,
SVG	200 ,	36 53.00 ,	75 46.02 ,	-57 ,	0.0 ,	99.6 ,	0.4 ,
SVG	201 ,	36 52.10 ,	75 47.96 ,	-60 ,	0.0 ,	98.9 ,	0.5 ,
SVG	202 ,	36 46.00 ,	75 39.95 ,	-74 ,	2.2 ,	96.2 ,	1.6 ,
SVG	203 ,	36 46.90 ,	75 38.15 ,	-64 ,	7.0 ,	92.2 ,	0.3 ,
SVG	204 ,	36 46.00 ,	75 36.14 ,	-66 ,	64.3 ,	35.1 ,	0.3 ,
SVG	205 ,	36 45.00 ,	75 34.15 ,	-77 ,	1.3 ,	95.9 ,	0.8 ,
SVG	206 ,	36 44.00 ,	75 32.04 ,	-67 ,	0.5 ,	98.3 ,	0.3 ,
SVG	207 ,	36 43.00 ,	75 30.10 ,	-71 ,	43.2 ,	55.7 ,	0.4 ,
SVG	208 ,	36 42.90 ,	75 26.10 ,	-68 ,	6.7 ,	92.4 ,	0.2 ,
SVG	209 ,	36 44.90 ,	75 26.05 ,	-81 ,	27.1 ,	66.2 ,	5.1 ,
SVG	210 ,	36 45.90 ,	75 27.90 ,	-76 ,	3.2 ,	95.6 ,	0.5 ,
SVG	211 ,	36 46.90 ,	75 26.07 ,	-77 ,	2.6 ,	95.4 ,	0.2 ,
SVG	212 ,	36 46.00 ,	75 24.09 ,	-81 ,	0.3 ,	98.7 ,	0.2 ,
SVG	213 ,	36 46.90 ,	75 22.01 ,	-78 ,	0.4 ,	98.4 ,	0.3 ,
SVG	214 ,	36 46.90 ,	75 22.01 ,	-78 ,	0.7 ,	98.8 ,	0.3 ,
SVG	215 ,	36 48.00 ,	75 24.05 ,	-77 ,	3.5 ,	95.2 ,	0.2 ,
SVG	216 ,	36 48.90 ,	75 22.04 ,	-76 ,	5.5 ,	93.4 ,	0.2 ,
SVG	217 ,	36 48.00 ,	75 20.14 ,	-78 ,	2.1 ,	96.3 ,	0.7 ,
SVG	218 ,	36 50.10 ,	75 19.98 ,	-81 ,	0.0 ,	98.8 ,	0.3 ,
SVG	219 ,	36 48.90 ,	75 17.93 ,	-89 ,	8.1 ,	89.9 ,	0.5 ,
SVG	220 ,	36 50.90 ,	75 17.94 ,	-95 ,	21.9 ,	77.7 ,	0.1 ,
SVG	221 ,	36 51.90 ,	75 16.04 ,	-94 ,	3.0 ,	95.4 ,	0.3 ,
SVG	222 ,	36 52.90 ,	75 14.07 ,	-94 ,	4.3 ,	93.8 ,	0.1 ,
SVG	223 ,	36 50.90 ,	75 13.97 ,	-94 ,	0.1 ,	98.3 ,	1.4 ,
SVG	224 ,	36 49.90 ,	75 15.94 ,	-89 ,	1.3 ,	97.2 ,	0.1 ,
SVG	225 ,	36 48.80 ,	75 14.10 ,	-84 ,	1.3 ,	96.9 ,	0.4 ,
SVG	226 ,	36 48.00 ,	75 15.91 ,	-95 ,	0.0 ,	67.4 ,	10.7 ,
SVG	227 ,	36 47.00 ,	75 14.10 ,	-88 ,	0.1 ,	99.1 ,	0.5 ,
SVG	228 ,	36 46.00 ,	75 15.95 ,	-99 ,	0.7 ,	97.2 ,	1.5 ,
SVG	229 ,	36 46.90 ,	75 17.93 ,	-89 ,	0.3 ,	98.1 ,	1.2 ,
SVG	230 ,	36 46.00 ,	75 19.98 ,	-89 ,	1.7 ,	96.8 ,	1.3 ,

Samp #	Latitude	Longitude	Depth ft	Grvl %	Sand %	Silt %
SVG 231 ,	36 45.00 ,	75 18.06 ,	-69 ,	5.4 ,	94.3 ,	0.3 ,
SVG 232 ,	36 44.00 ,	75 16.09 ,	-97 ,	1.4 ,	97.3 ,	0.1 ,
SVG 233 ,	36 44.90 ,	75 14.07 ,	-63 ,	0.9 ,	97.3 ,	0.3 ,
SVG 234 ,	36 43.00 ,	75 14.11 ,	-126 ,	0.1 ,	96.9 ,	2.3 ,
SVG 235 ,	36 43.00 ,	75 14.11 ,	-126 ,	0.0 ,	99.5 ,	0.4 ,
SVG 236 ,	36 41.00 ,	75 14.00 ,	-111 ,	34.9 ,	63.4 ,	1.0 ,
SVG 237 ,	36 41.90 ,	75 16.03 ,	-65 ,	2.6 ,	96.4 ,	0.0 ,
SVG 238 ,	36 42.90 ,	75 17.99 ,	-59 ,	4.3 ,	94.7 ,	0.4 ,
SVG 239 ,	36 43.90 ,	75 19.97 ,	-56 ,	0.5 ,	98.4 ,	0.4 ,
SVG 240 ,	36 44.90 ,	75 21.97 ,	-69 ,	0.1 ,	97.8 ,	0.6 ,
SVG 241 ,	36 44.00 ,	75 23.90 ,	-72 ,	0.2 ,	98.0 ,	0.7 ,
SVG 242 ,	36 43.00 ,	75 22.11 ,	-68 ,	5.0 ,	92.8 ,	1.5 ,
SVG 243 ,	36 42.00 ,	75 24.00 ,	-73 ,	1.1 ,	97.8 ,	0.6 ,
SVG 244 ,	36 41.00 ,	75 25.97 ,	-68 ,	1.2 ,	97.3 ,	0.7 ,
SVG 245 ,	36 40.00 ,	75 27.97 ,	-85 ,	0.4 ,	95.9 ,	0.7 ,
SVG 246 ,	36 41.90 ,	75 32.09 ,	-58 ,	16.7 ,	82.4 ,	0.0 ,
SVG 247 ,	36 42.90 ,	75 34.03 ,	-63 ,	0.4 ,	96.0 ,	1.2 ,
SVG 248 ,	36 44.00 ,	75 36.02 ,	-76 ,	0.2 ,	97.1 ,	0.6 ,
SVG 249 ,	36 44.90 ,	75 38.01 ,	-68 ,	7.8 ,	90.4 ,	0.6 ,
SVG 250 ,	36 42.90 ,	75 50.09 ,	-51 ,	0.1 ,	93.7 ,	3.7 ,
SVG 251 ,	36 42.00 ,	75 48.19 ,	-49 ,	0.2 ,	97.6 ,	1.3 ,
SVG 252 ,	36 41.00 ,	75 46.23 ,	-64 ,	0.1 ,	82.9 ,	11.9 ,
SVG 253 ,	36 40.00 ,	75 44.09 ,	-49 ,	0.0 ,	99.2 ,	0.1 ,
SVG 254 ,	36 39.00 ,	75 42.12 ,	-63 ,	0.7 ,	98.1 ,	0.1 ,
SVG 255 ,	36 38.00 ,	75 40.90 ,	-61 ,	1.0 ,	96.9 ,	0.9 ,
SVG 256 ,	36 38.00 ,	75 40.19 ,	-61 ,	0.3 ,	96.6 ,	1.8 ,
SVG 257 ,	36 37.00 ,	75 38.14 ,	-64 ,	1.0 ,	98.8 ,	0.2 ,
SVG 258 ,	36 36.00 ,	75 36.12 ,	-61 ,	0.7 ,	94.1 ,	2.2 ,
SVG 259 ,	36 35.00 ,	75 34.03 ,	-82 ,	3.7 ,	91.1 ,	3.4 ,
SVG 260 ,	36 33.90 ,	75 32.12 ,	-81 ,	3.7 ,	87.4 ,	8.5 ,
SVG 261 ,	36 33.00 ,	75 32.11 ,	-81 ,	0.4 ,	92.9 ,	4.2 ,
SVG 262 ,	36 32.10 ,	75 32.10 ,	-82 ,	4.5 ,	90.1 ,	5.3 ,
SVG 263 ,	36 33.00 ,	75 30.14 ,	-82 ,	0.3 ,	93.8 ,	3.4 ,
SVG 264 ,	36 36.90 ,	75 30.06 ,	-69 ,	1.6 ,	91.7 ,	4.4 ,
SVG 265 ,	36 36.00 ,	75 28.06 ,	-60 ,	1.1 ,	95.0 ,	1.6 ,
SVG 266 ,	36 35.00 ,	75 26.09 ,	-61 ,	2.5 ,	92.4 ,	2.7 ,
SVG 267 ,	36 34.00 ,	75 24.03 ,	-102 ,	0.3 ,	91.1 ,	4.2 ,
SVG 268 ,	36 33.00 ,	75 22.12 ,	-87 ,	0.2 ,	97.5 ,	0.8 ,
SVG 269 ,	36 32.00 ,	75 20.15 ,	-105 ,	0.2 ,	94.5 ,	2.6 ,
SVG 270 ,	36 31.00 ,	75 18.02 ,	-70 ,	0.7 ,	96.6 ,	0.5 ,
SVG 271 ,	36 34.90 ,	75 17.79 ,	-113 ,	4.4 ,	89.5 ,	3.1 ,
SVG 272 ,	36 36.90 ,	75 18.02 ,	-113 ,	3.7 ,	89.1 ,	3.9 ,
SVG 273 ,	36 38.90 ,	75 17.98 ,	-103 ,	0.0 ,	93.0 ,	3.3 ,
SVG 274 ,	36 41.00 ,	75 17.93 ,	-81 ,	1.7 ,	96.5 ,	0.7 ,
SVG 275 ,	36 40.00 ,	75 16.06 ,	-101 ,	0.0 ,	92.8 ,	2.3 ,

Samp	#	Latitude	Longitude	Depth ft	Grvl %	Sand %	Silt %
SVG	276 ,	36 39.00 ,	75 14.04 ,	-83 ,	1.1 ,	92.6 ,	2.8 ,
SVG	277 ,	36 39.00 ,	75 14.04 ,	-83 ,	0.8 ,	93.6 ,	5.6 ,
SVG	278 ,	36 37.90 ,	75 15.99 ,	-100 ,	0.2 ,	94.9 ,	0.8 ,
SVG	279 ,	36 37.00 ,	75 14.04 ,	-90 ,	0.1 ,	92.6 ,	7.1 ,
SVG	280 ,	36 36.00 ,	75 15.97 ,	-83 ,	7.9 ,	86.0 ,	4.5 ,
SVG	281 ,	36 35.00 ,	75 14.07 ,	-82 ,	0.8 ,	98.2 ,	0.2 ,
SVG	282 ,	36 34.00 ,	75 15.98 ,	-95 ,	0.1 ,	94.6 ,	5.2 ,
SVG	283 ,	36 33.00 ,	75 14.03 ,	-93 ,	2.7 ,	96.6 ,	0.5 ,
SVG	284 ,	36 35.90 ,	75 20.02 ,	-107 ,	0.0 ,	91.6 ,	4.8 ,
SVG	285 ,	36 36.90 ,	75 22.03 ,	-97 ,	0.8 ,	94.7 ,	3.0 ,
SVG	286 ,	36 37.90 ,	75 20.12 ,	-101 ,	7.6 ,	52.5 ,	28.1 ,
SVG	287 ,	36 38.90 ,	75 21.98 ,	-70 ,	25.0 ,	74.0 ,	0.3 ,
SVG	288 ,	36 40.00 ,	75 20.06 ,	-107 ,	0.6 ,	87.4 ,	5.7 ,
SVG	289 ,	36 41.90 ,	75 20.02 ,	-69 ,	1.6 ,	96.1 ,	1.9 ,
SVG	290 ,	36 41.00 ,	75 21.95 ,	-70 ,	0.1 ,	95.8 ,	0.9 ,
SVG	291 ,	36 40.00 ,	75 23.97 ,	-70 ,	0.4 ,	99.4 ,	0.1 ,
SVG	292 ,	36 39.00 ,	75 26.01 ,	-69 ,	1.0 ,	96.4 ,	1.7 ,
SVG	293 ,	36 38.00 ,	75 24.10 ,	-67 ,	3.9 ,	95.6 ,	0.2 ,
SVG	294 ,	36 30.00 ,	75 24.10 ,	-74 ,	0.0 ,	98.7 ,	0.4 ,
SVG	295 ,	36 30.90 ,	75 26.02 ,	-84 ,	0.2 ,	95.3 ,	4.3 ,
SVG	296 ,	36 30.00 ,	75 28.01 ,	-93 ,	0.5 ,	90.5 ,	3.9 ,
SVG	297 ,	36 31.90 ,	75 28.05 ,	-90 ,	0.2 ,	92.3 ,	0.0 ,
SVG	298 ,	36 31.90 ,	75 28.05 ,	-90 ,	0.4 ,	90.6 ,	2.9 ,
SVG	299 ,	36 30.90 ,	75 30.05 ,	-90 ,	0.9 ,	78.8 ,	9.9 ,
SVG	300 ,	36 30.00 ,	75 32.04 ,	-68 ,	0.2 ,	98.2 ,	0.6 ,
SVG	301 ,	36 31.00 ,	75 34.04 ,	-81 ,	0.2 ,	97.1 ,	2.4 ,
SVG	302 ,	36 32.90 ,	75 34.02 ,	-73 ,	0.0 ,	98.4 ,	0.1 ,
SVG	303 ,	36 33.90 ,	75 36.05 ,	-73 ,	0.7 ,	97.1 ,	0.3 ,
SVG	304 ,	36 32.00 ,	75 36.01 ,	-82 ,	0.2 ,	94.6 ,	0.8 ,
SVG	305 ,	36 30.00 ,	75 36.08 ,	-88 ,	0.4 ,	87.1 ,	3.4 ,
SVG	306 ,	36 31.00 ,	75 38.01 ,	-83 ,	0.4 ,	92.7 ,	6.2 ,
SVG	307 ,	36 32.90 ,	75 38.05 ,	-78 ,	0.1 ,	94.1 ,	2.8 ,
SVG	308 ,	36 35.00 ,	75 38.04 ,	-72 ,	0.2 ,	94.9 ,	2.5 ,
SVG	309 ,	36 36.00 ,	75 39.97 ,	-70 ,	0.3 ,	95.0 ,	2.1 ,
SVG	310 ,	36 37.00 ,	75 41.98 ,	-53 ,	0.0 ,	96.2 ,	2.8 ,
SVG	311 ,	36 38.00 ,	75 44.03 ,	-62 ,	0.4 ,	97.7 ,	1.1 ,
SVG	312 ,	36 39.00 ,	75 46.01 ,	-65 ,	8.2 ,	87.7 ,	1.2 ,
SVG	313 ,	36 40.00 ,	75 48.02 ,	-56 ,	0.0 ,	97.1 ,	0.5 ,
SVG	314 ,	36 41.00 ,	75 49.99 ,	-55 ,	0.0 ,	96.7 ,	1.2 ,
SVG	315 ,	36 38.00 ,	75 48.10 ,	-55 ,	23.8 ,	74.7 ,	0.2 ,
SVG	316 ,	36 37.00 ,	75 46.08 ,	-66 ,	23.6 ,	72.9 ,	1.2 ,
SVG	317 ,	36 36.00 ,	75 44.07 ,	-66 ,	0.0 ,	95.8 ,	0.4 ,
SVG	318 ,	36 35.00 ,	75 42.12 ,	-67 ,	0.0 ,	94.5 ,	1.1 ,
SVG	319 ,	36 35.00 ,	75 42.12 ,	-67 ,	0.0 ,	96.4 ,	0.8 ,
SVG	320 ,	36 34.00 ,	75 40.11 ,	-71 ,	0.0 ,	92.5 ,	2.3 ,
SVG	321 ,	36 32.10 ,	75 40.09 ,	-66 ,	0.0 ,	97.6 ,	0.1 ,

Samp #	Latitude	Longitude	Depth ft	Grvl %	Sand %	Silt %
SVG 322 ,	36 32.90 ,	75 41.93 ,	-61 ,	0.0 ,	95.5 ,	0.5 ,
SVG 323 ,	36 34.00 ,	75 43.97 ,	-68 ,	0.5 ,	95.6 ,	0.7 ,
SVG 324 ,	36 35.00 ,	75 46.07 ,	-68 ,	37.0 ,	61.2 ,	1.5 ,
SVG 325 ,	36 56.00 ,	75 19.98 ,	-96 ,	12.8 ,	85.1 ,	0.1 ,
SVG 326 ,	36 54.00 ,	75 20.00 ,	-85 ,	7.4 ,	90.5 ,	0.3 ,
SVG 327 ,	36 53.00 ,	75 22.01 ,	-101 ,	0.0 ,	93.4 ,	0.8 ,
SVG 328 ,	36 52.00 ,	75 24.00 ,	-79 ,	3.6 ,	92.9 ,	0.1 ,
SVG 329 ,	36 51.00 ,	75 26.01 ,	-76 ,	0.0 ,	96.9 ,	0.0 ,
SVG 330 ,	36 50.00 ,	75 27.99 ,	-68 ,	11.8 ,	85.5 ,	0.1 ,
SVG 331 ,	36 50.00 ,	75 27.95 ,	-68 ,	11.2 ,	86.4 ,	0.1 ,
SVG 332 ,	36 49.00 ,	75 29.99 ,	-69 ,	12.0 ,	82.9 ,	0.9 ,
SVG 333 ,	36 50.00 ,	75 32.00 ,	-87 ,	14.9 ,	80.1 ,	1.0 ,
SVG 334 ,	36 51.00 ,	75 30.00 ,	-83 ,	13.6 ,	84.0 ,	0.1 ,
SVG 335 ,	36 52.00 ,	75 27.99 ,	-95 ,	0.0 ,	96.8 ,	0.1 ,
SVG 336 ,	36 53.00 ,	75 26.00 ,	-82 ,	0.0 ,	97.6 ,	0.1 ,
SVG 337 ,	36 54.00 ,	75 23.99 ,	-95 ,	0.0 ,	97.1 ,	0.1 ,
SVG 338 ,	36 55.00 ,	75 22.00 ,	-86 ,	2.5 ,	95.5 ,	1.9 ,
SVG 339 ,	36 58.00 ,	75 27.99 ,	-79 ,	0.0 ,	98.1 ,	0.0 ,
SVG 340 ,	36 57.00 ,	75 29.99 ,	-87 ,	5.6 ,	92.3 ,	0.0 ,
SVG 341 ,	36 56.00 ,	75 32.00 ,	-69 ,	0.0 ,	99.3 ,	0.0 ,
SVG 342 ,	36 55.00 ,	75 34.00 ,	-72 ,	43.2 ,	55.5 ,	0.4 ,
SVG 343 ,	36 54.00 ,	75 36.00 ,	-76 ,	18.5 ,	79.9 ,	0.3 ,
SVG 344 ,	36 53.00 ,	75 38.01 ,	-70 ,	1.6 ,	96.8 ,	0.1 ,
SVG 345 ,	36 52.00 ,	75 39.98 ,	-67 ,	13.8 ,	84.5 ,	0.2 ,
SVG 346 ,	36 51.00 ,	75 42.00 ,	-70 ,	0.0 ,	96.9 ,	0.0 ,
SVG 347 ,	36 51.00 ,	75 46.00 ,	-62 ,	0.0 ,	97.4 ,	0.1 ,
SVG 348 ,	36 52.00 ,	75 44.00 ,	-70 ,	0.0 ,	93.6 ,	2.9 ,
SVG 349 ,	36 53.00 ,	75 42.00 ,	-69 ,	0.0 ,	94.4 ,	1.4 ,
SVG 350 ,	36 54.00 ,	75 40.00 ,	-71 ,	0.0 ,	95.3 ,	1.0 ,
SVG 351 ,	36 36.00 ,	75 47.99 ,	-48 ,	0.9 ,	97.6 ,	0.2 ,
SVG 352 ,	36 34.00 ,	75 47.99 ,	-48 ,	0.0 ,	96.5 ,	0.5 ,
SVG 353 ,	36 33.00 ,	75 46.00 ,	-62 ,	26.5 ,	68.8 ,	2.3 ,
SVG 354 ,	36 32.00 ,	75 44.00 ,	-59 ,	0.0 ,	97.9 ,	0.2 ,
SVG 355 ,	36 31.00 ,	75 41.99 ,	-71 ,	0.0 ,	96.6 ,	0.5 ,
SVG 356 ,	36 30.00 ,	75 40.00 ,	-77 ,	0.0 ,	91.3 ,	2.9 ,
SVG 357 ,	36 30.00 ,	75 44.00 ,	-59 ,	0.0 ,	97.9 ,	0.2 ,
SVG 358 ,	36 31.00 ,	75 45.99 ,	-44 ,	0.0 ,	90.5 ,	0.4 ,
SVG 359 ,	36 30.00 ,	75 45.99 ,	-44 ,	0.0 ,	98.0 ,	0.2 ,
SVG 360 ,	36 32.00 ,	75 48.00 ,	-48 ,	0.0 ,	92.6 ,	3.6 ,
SVG 361 ,	36 30.00 ,	75 48.00 ,	-50 ,	0.0 ,	89.4 ,	5.5 ,
SVG 362 ,	36 39.00 ,	75 38.00 ,	-53 ,	0.4 ,	97.5 ,	0.5 ,
SVG 363 ,	36 35.00 ,	75 38.00 ,	-68 ,	0.0 ,	93.8 ,	1.4 ,
SVG 364 ,	36 56.00 ,	75 36.00 ,	-57 ,	11.7 ,	86.3 ,	0.6 ,
SVG 365 ,	36 57.00 ,	75 34.00 ,	-79 ,	2.2 ,	93.7 ,	0.5 ,
SVG 366 ,	36 58.00 ,	75 32.00 ,	-76 ,	0.7 ,	95.5 ,	1.0 ,
SVG 367 ,	36 58.00 ,	75 36.00 ,	-72 ,	10.3 ,	87.8 ,	0.8 ,

Samp	#	Latitude	Longitude	Depth ft	Grvl %	Sand %	Silt %
SVG	368 ,	36 57.00 ,	75 38.00 ,	-66 ,	4.4 ,	81.3 ,	12.4 ,
SVG	369 ,	36 56.00 ,	75 40.00 ,	-63 ,	0.0 ,	95.4 ,	1.9 ,
SVG	370 ,	36 55.00 ,	75 41.97 ,	-59 ,	20.6 ,	77.0 ,	0.8 ,
SVG	371 ,	36 50.00 ,	75 56.00 ,	-30 ,	0.0 ,	92.1 ,	5.0 ,
SVG	372 ,	36 50.00 ,	75 56.01 ,	-30 ,	0.0 ,	92.4 ,	4.8 ,
SVG	373 ,	36 50.00 ,	75 57.98 ,	-12 ,	0.0 ,	97.9 ,	1.1 ,
SVG	374 ,	36 54.00 ,	75 58.99 ,	-18 ,	0.0 ,	39.5 ,	40.5 ,
SVG	375 ,	36 55.00 ,	75 58.99 ,	-16 ,	1.9 ,	96.8 ,	0.8 ,
SVG	376 ,	36 55.00 ,	75 57.99 ,	-34 ,	2.1 ,	79.0 ,	9.7 ,
SVG	377 ,	36 57.00 ,	75 57.99 ,	-70 ,	6.3 ,	88.6 ,	2.7 ,
SVG	378 ,	36 56.00 ,	76 0.00 ,	-35 ,	9.8 ,	84.3 ,	2.7 ,
SVG	379 ,	36 57.00 ,	75 59.99 ,	-82 ,	0.0 ,	86.0 ,	6.5 ,
SVG	380 ,	36 58.00 ,	76 0.00 ,	-63 ,	0.0 ,	96.6 ,	1.1 ,

Samp	#	Clay %	Grvl+ Sand %	Mud %	Mz phi	Md phi	Incl Graph St Dv
SVG	1 ,	3.0 ,	95.1 ,	4.9 ,	3.23 ,	3.21 ,	0.27
SVG	2 ,	3.6 ,	93.2 ,	6.8 ,	3.28 ,	3.28 ,	0.31
SVG	3 ,	1.7 ,	97.7 ,	2.3 ,	2.36 ,	2.27 ,	0.48
SVG	4 ,	1.8 ,	98.1 ,	1.8 ,	1.52 ,	1.50 ,	0.55
SVG	5 ,	2.0 ,	97.2 ,	2.7 ,	2.81 ,	2.85 ,	0.51
SVG	6 ,	3.6 ,	94.4 ,	5.6 ,	3.35 ,	3.34 ,	0.80
SVG	7 ,	2.9 ,	94.9 ,	5.2 ,	2.92 ,	3.07 ,	0.64
SVG	8 ,	3.6 ,	92.6 ,	7.3 ,	3.36 ,	3.34 ,	0.56
SVG	9 ,	3.6 ,	93.4 ,	6.6 ,	3.31 ,	3.31 ,	0.24
SVG	10 ,	3.8 ,	95.8 ,	4.1 ,	3.16 ,	3.16 ,	0.31
SVG	11 ,	3.2 ,	94.5 ,	5.5 ,	2.81 ,	2.96 ,	0.63
SVG	12 ,	2.2 ,	96.7 ,	3.3 ,	0.42 ,	0.39 ,	0.63
SVG	13 ,	3.1 ,	96.0 ,	4.0 ,	1.55 ,	1.53 ,	0.64
SVG	14 ,	3.8 ,	93.3 ,	6.7 ,	3.04 ,	3.09 ,	0.50
SVG	15 ,	4.3 ,	93.1 ,	7.0 ,	3.10 ,	3.16 ,	0.36
SVG	16 ,	3.8 ,	93.9 ,	6.1 ,	3.00 ,	3.15 ,	0.52
SVG	17 ,	2.9 ,	95.6 ,	4.4 ,	2.87 ,	2.94 ,	0.42
SVG	18 ,	2.8 ,	96.5 ,	3.6 ,	1.08 ,	1.09 ,	0.70
SVG	19 ,	6.9 ,	82.6 ,	17.4 ,	3.19 ,	3.22 ,	0.62
SVG	20 ,	2.7 ,	92.7 ,	7.3 ,	3.36 ,	3.35 ,	0.41
SVG	21 ,	4.3 ,	87.0 ,	13.0 ,	3.47 ,	3.46 ,	0.41
SVG	22 ,	1.3 ,	98.4 ,	1.6 ,	1.39 ,	1.43 ,	0.51
SVG	23 ,	0.9 ,	98.7 ,	1.3 ,	1.43 ,	1.48 ,	0.51
SVG	24 ,	1.6 ,	97.8 ,	2.2 ,	1.11 ,	1.17 ,	0.71
SVG	25 ,	1.7 ,	98.3 ,	1.7 ,	1.07 ,	1.11 ,	0.72
SVG	26 ,	4.3 ,	91.2 ,	8.9 ,	2.46 ,	2.56 ,	0.83
SVG	27 ,	1.3 ,	98.4 ,	1.7 ,	1.45 ,	1.56 ,	0.61
SVG	28 ,	1.4 ,	98.3 ,	1.7 ,	1.24 ,	1.34 ,	0.65
SVG	29 ,	1.4 ,	98.5 ,	1.6 ,	1.44 ,	1.51 ,	0.63
SVG	30 ,	0.6 ,	99.2 ,	0.8 ,	1.79 ,	1.81 ,	0.44
SVG	31 ,	1.1 ,	98.8 ,	1.1 ,	1.74 ,	1.79 ,	0.43
SVG	32 ,	2.6 ,	97.3 ,	2.7 ,	1.95 ,	2.01 ,	0.47
SVG	33 ,	1.8 ,	97.5 ,	2.5 ,	2.30 ,	2.37 ,	0.37
SVG	34 ,	1.4 ,	98.4 ,	1.7 ,	1.61 ,	1.67 ,	0.48
SVG	35 ,	0.8 ,	98.4 ,	1.5 ,	1.60 ,	1.60 ,	0.40
SVG	36 ,	2.7 ,	93.7 ,	6.2 ,	2.52 ,	2.52 ,	0.44
SVG	37 ,	3.7 ,	94.8 ,	5.1 ,	2.65 ,	2.66 ,	0.51
SVG	38 ,	1.9 ,	98.0 ,	2.0 ,	1.53 ,	1.56 ,	0.58
SVG	39 ,	1.9 ,	97.7 ,	2.3 ,	1.93 ,	1.99 ,	0.46
SVG	40 ,	0.9 ,	96.5 ,	3.4 ,	1.68 ,	1.67 ,	0.60
SVG	41 ,	2.8 ,	97.2 ,	2.9 ,	1.67 ,	1.74 ,	0.62
SVG	42 ,	2.1 ,	97.7 ,	2.2 ,	1.82 ,	1.76 ,	0.45
SVG	43 ,	1.7 ,	98.2 ,	1.8 ,	1.29 ,	1.31 ,	0.54
SVG	44 ,	1.0 ,	96.9 ,	3.1 ,	1.76 ,	1.78 ,	0.47
SVG	45 ,	2.3 ,	97.7 ,	2.3 ,	1.64 ,	1.62 ,	0.48

Samp	#	Clay %	Grvl+ Sand %	Mud %	Mz phi	Md phi	incl graph st dv
SVG	46 ,	1.6 ,	98.1 ,	1.9 ,	1.52 ,	1.54 ,	0.52
SVG	47 ,	1.7 ,	98.0 ,	2.0 ,	1.59 ,	1.64 ,	0.55
SVG	48 ,	1.5 ,	96.5 ,	3.6 ,	1.84 ,	1.89 ,	0.47
SVG	49 ,	2.1 ,	97.8 ,	2.2 ,	1.22 ,	1.30 ,	0.61
SVG	50 ,	2.1 ,	97.9 ,	2.2 ,	1.25 ,	1.29 ,	0.54
SVG	51 ,	1.9 ,	97.9 ,	2.1 ,	1.47 ,	1.54 ,	0.61
SVG	52 ,	2.8 ,	95.9 ,	4.1 ,	2.13 ,	2.19 ,	0.46
SVG	53 ,	2.5 ,	97.5 ,	2.5 ,	1.16 ,	1.29 ,	0.77
SVG	54 ,	2.5 ,	97.4 ,	2.6 ,	1.24 ,	1.30 ,	0.58
SVG	55 ,	1.4 ,	96.7 ,	3.3 ,	0.39 ,	0.35 ,	0.63
SVG	56 ,	2.5 ,	92.3 ,	7.7 ,	2.44 ,	2.32 ,	0.63
SVG	57 ,	0.8 ,	96.0 ,	4.0 ,	1.06 ,	1.08 ,	0.62
SVG	58 ,	1.0 ,	96.8 ,	3.2 ,	1.05 ,	1.11 ,	0.69
SVG	59 ,	1.2 ,	96.8 ,	3.2 ,	1.98 ,	1.99 ,	0.65
SVG	60 ,	1.6 ,	96.2 ,	3.9 ,	2.45 ,	2.89 ,	1.02
SVG	61 ,	3.3 ,	92.5 ,	7.4 ,	3.15 ,	3.22 ,	0.66
SVG	62 ,	2.7 ,	92.5 ,	7.5 ,	3.41 ,	3.40 ,	0.33
SVG	63 ,	1.4 ,	97.9 ,	2.1 ,	1.36 ,	1.43 ,	0.77
SVG	64 ,	1.4 ,	98.5 ,	1.5 ,	1.32 ,	1.36 ,	0.64
SVG	65 ,	1.0 ,	99.1 ,	1.0 ,	0.98 ,	0.99 ,	0.73
SVG	66 ,	1.3 ,	98.0 ,	2.1 ,	1.37 ,	1.57 ,	0.78
SVG	67 ,	1.5 ,	98.2 ,	1.8 ,	1.13 ,	1.19 ,	0.69
SVG	68 ,	2.9 ,	95.6 ,	4.4 ,	2.39 ,	2.54 ,	0.90
SVG	69 ,	2.3 ,	97.6 ,	2.3 ,	1.38 ,	1.47 ,	0.66
SVG	70 ,	2.6 ,	97.4 ,	2.6 ,	1.56 ,	1.64 ,	0.50
SVG	71 ,	3.0 ,	96.9 ,	3.1 ,	1.02 ,	1.08 ,	0.76
SVG	72 ,	,	,	,	,	,	
SVG	73 ,	2.8 ,	97.1 ,	2.9 ,	1.72 ,	1.77 ,	0.43
SVG	74 ,	4.8 ,	94.7 ,	5.3 ,	3.13 ,	3.13 ,	0.30
SVG	75 ,	3.0 ,	97.0 ,	3.0 ,	1.86 ,	2.02 ,	0.74
SVG	76 ,	3.0 ,	96.7 ,	3.2 ,	1.77 ,	1.82 ,	0.78
SVG	77 ,	4.1 ,	95.8 ,	4.1 ,	2.18 ,	2.15 ,	0.53
SVG	78 ,	2.2 ,	97.3 ,	2.7 ,	1.34 ,	1.30 ,	0.65
SVG	79 ,	2.8 ,	97.2 ,	2.8 ,	0.97 ,	0.98 ,	0.73
SVG	80 ,	4.7 ,	94.8 ,	5.2 ,	2.85 ,	2.94 ,	0.45
SVG	81 ,	2.6 ,	97.1 ,	2.9 ,	1.05 ,	1.11 ,	0.76
SVG	82 ,	1.4 ,	98.2 ,	1.8 ,	1.65 ,	1.65 ,	0.48
SVG	83 ,	1.6 ,	98.2 ,	1.8 ,	1.65 ,	1.61 ,	0.64
SVG	84 ,	1.5 ,	98.1 ,	1.9 ,	0.98 ,	0.92 ,	0.65
SVG	85 ,	1.6 ,	97.8 ,	2.2 ,	1.74 ,	1.79 ,	0.59
SVG	86 ,	1.2 ,	98.2 ,	1.8 ,	1.66 ,	1.75 ,	0.98
SVG	87 ,	2.1 ,	97.0 ,	3.0 ,	2.84 ,	2.92 ,	0.50
SVG	88 ,	1.6 ,	97.9 ,	2.1 ,	1.86 ,	1.87 ,	0.57
SVG	89 ,	1.7 ,	97.7 ,	2.3 ,	1.91 ,	1.95 ,	0.41
SVG	90 ,	1.6 ,	97.9 ,	2.1 ,	1.56 ,	1.59 ,	0.53

Samp #	Clay %	Grvl+ Sand %	Mud %	Mz phi	Md phi	incl graph st dv
SVG 91	2.3	92.8	7.2			
SVG 92	2.6	93.4	6.6	3.07	3.10	0.28
SVG 93	2.3	95.0	5.0			
SVG 94	1.8	95.8	4.2	2.88	3.01	0.59
SVG 95	3.2	92.9	7.1			
SVG 96	3.0	92.5	7.5	3.35	3.34	0.46
SVG 97	2.0	96.2	3.8	2.43	2.47	0.78
SVG 98	3.5	92.6	7.5	2.31	3.40	1.42
SVG 99	1.5	97.0	2.9	2.55	2.49	0.54
SVG 100	2.9	92.9	7.1	3.37	3.35	0.30
SVG 101	1.7	95.7	4.3	3.08	3.17	0.47
SVG 102	2.7	91.9	8.2	3.37	3.37	0.31
SVG 103	1.4	98.3	1.7	1.59	1.65	0.58
SVG 104	1.2	98.3	1.7	1.71	1.29	0.99
SVG 105	1.5	98.3	1.7	1.96	1.97	0.37
SVG 106	1.4	98.1	1.8	1.86	1.84	0.44
SVG 107	1.6	97.9	2.1	1.45	1.56	0.75
SVG 108	3.6	92.9	7.1	3.27	3.26	0.29
SVG 109	3.1	94.4	5.5	2.10	1.96	0.92
SVG 110	34.3	12.4	87.6	2.73	3.48	1.42
SVG 111	3.3	94.6	5.5	3.16	3.17	0.30
SVG 112	3.0	96.1	3.9	2.91	3.00	0.59
SVG 113	3.7	91.3	8.7	3.07	3.23	0.61
SVG 114	3.7	91.0	8.9	3.42	3.40	0.26
SVG 115	2.4	96.6	3.4	2.87	3.05	0.60
SVG 116	2.2	97.1	2.9	2.12	2.16	0.54
SVG 117	1.9	95.1	4.9	2.99	2.97	0.58
SVG 118	1.5	98.0	2.1	2.12	2.15	0.63
SVG 119	1.9	97.6	2.4	1.38	1.48	0.86
SVG 120	2.3	97.0	2.9	1.21	1.33	0.78
SVG 121	1.6	98.3	1.7	1.00	1.03	0.71
SVG 122	1.8	97.9	2.2	0.91	0.85	0.74
SVG 123	2.5	92.1	8.0	3.15	3.24	0.85
SVG 124	3.8	87.4	12.6	3.50	3.45	0.29
SVG 125	2.5	93.7	6.3	3.38	3.37	0.39
SVG 126	2.5	94.3	5.6	3.30	3.29	0.58
SVG 127	1.8	97.4	2.6	1.49	1.48	0.69
SVG 128	0.8	99.0	1.0	0.95	0.89	0.80
SVG 129	1.7	98.0	2.0	1.05	1.07	0.88
SVG 130	1.4	98.4	1.6	1.41	1.50	0.83
SVG 131	8.6	84.4	15.7	2.66	2.62	0.89
SVG 132	1.7	97.7	2.3	1.51	1.68	0.93
SVG 133	1.6	98.0	1.9	1.51	1.62	0.92
SVG 134	1.5	98.2	1.8	1.17	1.22	0.80
SVG 135	1.4	98.4	1.6	1.62	1.66	0.66

Samp	#	Clay %	Grvl+ Sand %	Mud %	Mz phi	Md phi	incl graph st dv
SVG	137 ,	1.1 ,	98.8 ,	1.2 ,	1.76 ,	1.81 ,	0.50
SVG	138 ,	1.4 ,	98.3 ,	1.8 ,	1.72 ,	1.77 ,	0.63
SVG	139 ,	19.1 ,	49.7 ,	50.3 ,	2.46 ,	2.34 ,	0.74
SVG	140 ,	2.9 ,	95.7 ,	4.3 ,	2.52 ,	2.48 ,	0.50
SVG	141 ,	1.0 ,	98.9 ,	1.1 ,	1.46 ,	1.51 ,	0.66
SVG	142 ,	1.5 ,	98.4 ,	1.6 ,	1.37 ,	1.42 ,	0.72
SVG	143 ,	3.2 ,	94.7 ,	5.3 ,	2.40 ,	2.50 ,	0.90
SVG	144 ,	3.5 ,	95.1 ,	5.0 ,	2.73 ,	2.73 ,	0.49
SVG	145 ,	1.3 ,	98.5 ,	1.5 ,	1.76 ,	1.77 ,	0.72
SVG	146 ,	1.2 ,	98.4 ,	1.5 ,	2.01 ,	2.03 ,	0.42
SVG	147 ,	0.9 ,	98.9 ,	1.1 ,	1.36 ,	1.43 ,	0.72
SVG	148 ,	2.5 ,	96.2 ,	3.8 ,	2.16 ,	2.18 ,	0.71
SVG	149 ,	10.8 ,	78.8 ,	21.2 ,	2.98 ,	3.07 ,	0.68
SVG	150 ,	2.0 ,	97.4 ,	2.5 ,	2.79 ,	2.72 ,	0.50
SVG	151 ,	2.1 ,	97.2 ,	2.8 ,	1.25 ,	1.17 ,	0.95
SVG	152 ,	2.1 ,	95.9 ,	4.2 ,	3.45 ,	3.45 ,	0.39
SVG	153 ,	1.0 ,	98.6 ,	1.3 ,	3.31 ,	3.30 ,	0.48
SVG	154 ,	2.3 ,	96.3 ,	3.7 ,	3.18 ,	3.23 ,	0.71
SVG	155 ,	2.2 ,	96.7 ,	3.3 ,	2.14 ,	2.20 ,	0.78
SVG	156 ,	2.4 ,	95.6 ,	4.4 ,	1.78 ,	1.99 ,	1.08
SVG	157 ,	3.3 ,	90.9 ,	9.2 ,	3.33 ,	3.31 ,	0.31
SVG	158 ,	3.1 ,	93.0 ,	7.0 ,	1.54 ,	1.45 ,	1.01
SVG	159 ,	4.0 ,	91.8 ,	8.2 ,	3.14 ,	3.16 ,	0.76
SVG	160 ,	3.3 ,	94.4 ,	5.6 ,	3.25 ,	3.26 ,	0.71
SVG	161 ,	2.1 ,	96.0 ,	4.0 ,	3.27 ,	3.28 ,	0.41
SVG	162 ,	1.8 ,	97.8 ,	2.2 ,	2.67 ,	2.73 ,	0.55
SVG	163 ,	1.9 ,	97.9 ,	2.1 ,	2.38 ,	2.39 ,	0.84
SVG	164 ,	1.4 ,	98.4 ,	1.6 ,	0.35 ,	0.19 ,	0.79
SVG	165 ,	1.6 ,	98.2 ,	1.7 ,	1.23 ,	1.15 ,	0.96
SVG	166 ,	1.3 ,	98.4 ,	1.6 ,	0.84 ,	0.97 ,	1.07
SVG	167 ,	1.7 ,	98.1 ,	1.8 ,	1.04 ,	0.64 ,	1.21
SVG	168 ,	1.8 ,	98.0 ,	2.1 ,	1.04 ,	0.64 ,	1.21
SVG	169 ,	3.6 ,	95.4 ,	4.6 ,	3.04 ,	3.06 ,	0.53
SVG	170 ,	2.3 ,	97.7 ,	2.4 ,	0.79 ,	0.85 ,	0.82
SVG	171 ,	2.7 ,	96.9 ,	3.1 ,	1.57 ,	1.58 ,	0.62
SVG	172 ,	3.4 ,	95.5 ,	4.5 ,	2.68 ,	2.69 ,	0.54
SVG	173 ,	4.4 ,	95.0 ,	5.0 ,	2.95 ,	2.97 ,	0.41
SVG	174 ,	2.0 ,	97.8 ,	2.2 ,	2.16 ,	2.17 ,	0.54
SVG	175 ,	1.8 ,	97.9 ,	2.1 ,	1.36 ,	1.39 ,	0.72
SVG	176 ,	2.1 ,	97.8 ,	2.2 ,	,	,	
SVG	177 ,	2.8 ,	97.2 ,	2.8 ,	1.43 ,	1.59 ,	0.80
SVG	178 ,	1.4 ,	98.3 ,	1.7 ,	1.48 ,	1.50 ,	0.58
SVG	179 ,	2.6 ,	97.1 ,	2.9 ,	1.79 ,	1.79 ,	0.59
SVG	180 ,	4.7 ,	94.1 ,	5.9 ,	2.61 ,	2.88 ,	0.79
SVG	181 ,	2.4 ,	97.2 ,	2.8 ,	1.26 ,	1.31 ,	0.79

Samp	#	Clay %	Grvl+ Sand %	Mud %	Mz phi	Md phi	incl graph st dv
SVG	182 ,	2.1 ,	97.8 ,	2.3 ,	1.11 ,	1.12 ,	0.69
SVG	183 ,	2.0 ,	98.0 ,	2.1 ,	1.24 ,	1.29 ,	0.85
SVG	184 ,	2.3 ,	97.3 ,	2.6 ,	2.13 ,	2.16 ,	0.51
SVG	185 ,	1.4 ,	98.4 ,	1.6 ,	1.37 ,	1.42 ,	0.75
SVG	186 ,	1.9 ,	97.7 ,	2.3 ,	,	,	
SVG	187 ,	1.8 ,	97.8 ,	2.2 ,	1.30 ,	1.25 ,	0.65
SVG	188 ,	1.8 ,	98.2 ,	1.8 ,	1.37 ,	1.43 ,	0.65
SVG	189 ,	1.5 ,	98.4 ,	1.7 ,	1.34 ,	1.34 ,	0.66
SVG	190 ,	1.4 ,	98.5 ,	1.5 ,	1.55 ,	1.57 ,	0.55
SVG	191 ,	1.3 ,	98.4 ,	1.6 ,	1.26 ,	1.43 ,	0.76
SVG	192 ,	0.1 ,	99.9 ,	0.2 ,	2.60 ,	2.55 ,	0.43
SVG	193 ,	0.2 ,	97.5 ,	2.5 ,	1.51 ,	1.53 ,	0.65
SVG	194 ,	0.2 ,	99.3 ,	0.7 ,	2.70 ,	2.71 ,	0.35
SVG	195 ,	6.3 ,	81.0 ,	19.0 ,	3.29 ,	3.29 ,	0.44
SVG	196 ,	0.5 ,	98.4 ,	1.5 ,	3.28 ,	3.27 ,	0.31
SVG	197 ,	0.0 ,	99.2 ,	0.7 ,	3.17 ,	3.18 ,	0.51
SVG	198 ,	0.5 ,	98.7 ,	1.3 ,	1.75 ,	1.36 ,	1.22
SVG	199 ,	2.2 ,	94.6 ,	5.4 ,	3.37 ,	3.36 ,	0.50
SVG	200 ,	0.0 ,	99.6 ,	0.4 ,	3.28 ,	3.29 ,	0.43
SVG	201 ,	0.6 ,	98.9 ,	1.1 ,	1.82 ,	1.79 ,	0.61
SVG	202 ,	0.0 ,	98.4 ,	1.6 ,	1.53 ,	1.51 ,	0.76
SVG	203 ,	0.5 ,	99.2 ,	0.8 ,	1.47 ,	1.49 ,	0.79
SVG	204 ,	0.3 ,	99.4 ,	0.6 ,	0.72 ,	0.69 ,	0.80
SVG	205 ,	2.1 ,	97.2 ,	2.9 ,	2.30 ,	2.30 ,	0.86
SVG	206 ,	0.9 ,	98.8 ,	1.2 ,	1.71 ,	1.68 ,	0.68
SVG	207 ,	0.8 ,	98.9 ,	1.2 ,	1.50 ,	1.58 ,	0.87
SVG	208 ,	0.7 ,	99.1 ,	0.9 ,	1.28 ,	1.29 ,	0.78
SVG	209 ,	1.5 ,	93.3 ,	6.6 ,	1.97 ,	2.19 ,	0.77
SVG	210 ,	0.8 ,	98.8 ,	1.3 ,	1.51 ,	1.61 ,	0.69
SVG	211 ,	1.8 ,	98.0 ,	2.0 ,	1.43 ,	1.50 ,	0.70
SVG	212 ,	0.8 ,	99.0 ,	1.0 ,	1.97 ,	2.06 ,	0.81
SVG	213 ,	0.9 ,	98.8 ,	1.2 ,	1.42 ,	1.50 ,	0.74
SVG	214 ,	0.2 ,	99.5 ,	0.5 ,	1.62 ,	1.62 ,	0.54
SVG	215 ,	1.1 ,	98.7 ,	1.3 ,	1.40 ,	1.42 ,	0.70
SVG	216 ,	1.0 ,	98.9 ,	1.2 ,	1.30 ,	1.40 ,	1.08
SVG	217 ,	0.9 ,	98.4 ,	1.6 ,	1.50 ,	1.50 ,	0.70
SVG	218 ,	0.8 ,	98.8 ,	1.1 ,	1.63 ,	1.72 ,	0.73
SVG	219 ,	1.5 ,	98.0 ,	2.0 ,	1.54 ,	1.55 ,	0.60
SVG	220 ,	0.3 ,	99.6 ,	0.4 ,	1.20 ,	1.23 ,	0.63
SVG	221 ,	1.2 ,	98.4 ,	1.5 ,	1.42 ,	1.46 ,	0.81
SVG	222 ,	1.8 ,	98.1 ,	1.9 ,	1.26 ,	1.34 ,	0.62
SVG	223 ,	0.2 ,	98.4 ,	1.6 ,	1.91 ,	2.00 ,	0.67
SVG	224 ,	1.3 ,	98.5 ,	1.4 ,	1.61 ,	1.64 ,	0.80
SVG	225 ,	1.4 ,	98.2 ,	1.8 ,	1.66 ,	1.70 ,	0.75
SVG	226 ,	21.9 ,	67.4 ,	32.6 ,	2.07 ,	2.08 ,	0.56

Samp #		Clay %	Grvl+ Sand %	Mud %	Mz phi	Md phi	incl graph st dv
SVG	227 ,	0.4 ,	99.2 ,	0.9 ,	1.99 ,	1.98 ,	0.40
SVG	228 ,	0.5 ,	97.9 ,	2.0 ,	1.69 ,	1.79 ,	0.78
SVG	229 ,	0.5 ,	98.4 ,	1.7 ,	1.61 ,	1.75 ,	0.86
SVG	230 ,	0.2 ,	98.5 ,	1.5 ,	0.75 ,	0.70 ,	0.70
SVG	231 ,	0.0 ,	99.7 ,	0.3 ,	1.66 ,	1.66 ,	0.57
SVG	232 ,	1.2 ,	98.7 ,	1.3 ,	1.49 ,	1.58 ,	0.81
SVG	233 ,	1.4 ,	98.2 ,	1.7 ,	1.59 ,	1.61 ,	0.47
SVG	234 ,	0.8 ,	97.0 ,	3.1 ,	2.38 ,	2.35 ,	0.40
SVG	235 ,	0.0 ,	99.5 ,	0.4 ,	2.16 ,	2.24 ,	0.52
SVG	236 ,	0.7 ,	98.3 ,	1.7 ,	0.97 ,	1.04 ,	0.86
SVG	237 ,	1.0 ,	99.0 ,	1.0 ,	1.75 ,	1.79 ,	0.54
SVG	238 ,	0.7 ,	99.0 ,	1.1 ,	1.29 ,	1.43 ,	0.73
SVG	239 ,	0.7 ,	98.9 ,	1.1 ,	1.75 ,	1.74 ,	0.65
SVG	240 ,	1.5 ,	97.9 ,	2.1 ,	2.14 ,	2.08 ,	0.68
SVG	241 ,	1.0 ,	98.2 ,	1.7 ,	1.90 ,	1.93 ,	0.46
SVG	242 ,	0.7 ,	97.8 ,	2.2 ,	1.06 ,	1.29 ,	0.97
SVG	243 ,	0.4 ,	98.9 ,	1.0 ,	1.76 ,	1.82 ,	0.56
SVG	244 ,	0.9 ,	98.5 ,	1.6 ,	1.44 ,	1.46 ,	0.53
SVG	245 ,	3.1 ,	96.3 ,	3.8 ,	2.49 ,	2.49 ,	0.63
SVG	246 ,	0.8 ,	99.1 ,	0.8 ,	1.42 ,	1.45 ,	0.83
SVG	247 ,	2.4 ,	96.4 ,	3.6 ,	1.98 ,	2.00 ,	0.48
SVG	248 ,	2.0 ,	97.3 ,	2.6 ,	1.55 ,	1.53 ,	0.61
SVG	249 ,	1.1 ,	98.2 ,	1.7 ,	1.53 ,	1.57 ,	0.99
SVG	250 ,	2.5 ,	93.8 ,	6.2 ,	2.79 ,	2.66 ,	0.68
SVG	251 ,	0.9 ,	97.8 ,	2.2 ,	1.97 ,	2.00 ,	0.35
SVG	252 ,	5.1 ,	83.0 ,	17.0 ,	3.24 ,	3.35 ,	0.48
SVG	253 ,	0.7 ,	99.2 ,	0.8 ,	1.84 ,	1.90 ,	0.48
SVG	254 ,	1.1 ,	98.8 ,	1.2 ,	1.93 ,	1.92 ,	0.47
SVG	255 ,	1.3 ,	97.9 ,	2.2 ,	1.94 ,	1.95 ,	0.53
SVG	256 ,	1.2 ,	96.9 ,	3.0 ,	1.99 ,	1.99 ,	0.51
SVG	257 ,	0.1 ,	99.8 ,	0.3 ,	2.02 ,	2.05 ,	0.48
SVG	258 ,	2.9 ,	94.8 ,	5.1 ,	1.88 ,	1.89 ,	0.62
SVG	259 ,	1.8 ,	94.8 ,	5.2 ,	2.74 ,	2.72 ,	0.59
SVG	260 ,	0.4 ,	91.1 ,	8.9 ,	2.38 ,	2.56 ,	0.80
SVG	261 ,	2.5 ,	93.3 ,	6.7 ,	2.61 ,	2.63 ,	0.42
SVG	262 ,	0.1 ,	94.6 ,	5.4 ,	2.22 ,	2.27 ,	0.59
SVG	263 ,	2.4 ,	94.1 ,	5.8 ,	2.75 ,	2.70 ,	0.43
SVG	264 ,	2.2 ,	93.3 ,	6.6 ,	1.85 ,	1.89 ,	0.53
SVG	265 ,	2.2 ,	96.1 ,	3.8 ,	1.59 ,	1.66 ,	0.77
SVG	266 ,	2.4 ,	94.9 ,	5.1 ,	1.57 ,	1.57 ,	0.80
SVG	267 ,	4.4 ,	91.4 ,	8.6 ,	2.36 ,	2.91 ,	1.05
SVG	268 ,	1.5 ,	97.7 ,	2.3 ,	2.14 ,	2.22 ,	0.72
SVG	269 ,	2.7 ,	94.7 ,	5.3 ,	1.75 ,	1.73 ,	0.63
SVG	270 ,	2.3 ,	97.3 ,	2.8 ,	1.64 ,	1.64 ,	0.47

Samp	#	Clay %	Grvl+ Sand %	Mud %	Mz phi	Md phi	incl graph st dv
SVG	272 ,	3.2 ,	92.8 ,	7.1 ,	2.39 ,	2.46 ,	0.63
SVG	273 ,	3.7 ,	93.0 ,	7.0 ,	2.73 ,	2.67 ,	0.51
SVG	274 ,	1.2 ,	98.2 ,	1.9 ,	1.49 ,	1.52 ,	0.56
SVG	275 ,	4.8 ,	92.8 ,	7.1 ,	2.52 ,	2.52 ,	0.26
SVG	276 ,	3.5 ,	93.7 ,	6.3 ,	1.67 ,	1.73 ,	0.54
SVG	277 ,	0.1 ,	94.4 ,	5.7 ,	1.73 ,	1.74 ,	0.51
SVG	278 ,	4.1 ,	95.1 ,	4.9 ,	2.14 ,	2.21 ,	0.44
SVG	279 ,	0.2 ,	92.7 ,	7.3 ,	2.06 ,	2.09 ,	0.47
SVG	280 ,	1.6 ,	93.9 ,	6.1 ,	1.24 ,	1.25 ,	0.81
SVG	281 ,	0.9 ,	99.0 ,	1.1 ,	1.75 ,	1.79 ,	0.52
SVG	282 ,	0.1 ,	94.7 ,	5.3 ,	2.33 ,	2.35 ,	0.54
SVG	283 ,	0.1 ,	99.3 ,	0.6 ,	1.67 ,	1.71 ,	0.72
SVG	284 ,	3.6 ,	91.6 ,	8.4 ,	2.76 ,	2.73 ,	0.30
SVG	285 ,	1.4 ,	95.5 ,	4.4 ,	1.96 ,	2.00 ,	0.56
SVG	286 ,	11.9 ,	60.1 ,	40.0 ,	2.01 ,	1.90 ,	0.82
SVG	287 ,	0.8 ,	99.0 ,	1.1 ,	1.05 ,	1.06 ,	0.76
SVG	288 ,	6.3 ,	88.0 ,	12.0 ,	2.69 ,	2.65 ,	0.58
SVG	289 ,	0.3 ,	97.7 ,	2.2 ,	1.53 ,	1.60 ,	0.52
SVG	290 ,	3.2 ,	95.9 ,	4.1 ,	1.93 ,	1.92 ,	0.45
SVG	291 ,	0.1 ,	99.8 ,	0.2 ,	1.93 ,	2.00 ,	0.53
SVG	292 ,	0.9 ,	97.4 ,	2.6 ,	1.69 ,	1.73 ,	0.47
SVG	293 ,	0.3 ,	99.5 ,	0.5 ,	1.61 ,	1.62 ,	0.69
SVG	294 ,	0.9 ,	98.7 ,	1.3 ,	2.39 ,	2.38 ,	0.27
SVG	295 ,	0.2 ,	95.5 ,	4.5 ,	2.72 ,	2.70 ,	0.29
SVG	296 ,	5.1 ,	91.0 ,	9.0 ,	3.04 ,	3.15 ,	0.45
SVG	297 ,	7.5 ,	92.5 ,	7.5 ,	3.06 ,	3.10 ,	0.39
SVG	298 ,	6.1 ,	91.0 ,	9.0 ,	2.94 ,	2.94 ,	0.44
SVG	299 ,	10.5 ,	79.7 ,	20.4 ,	2.96 ,	2.96 ,	0.41
SVG	300 ,	1.1 ,	98.4 ,	1.7 ,	2.52 ,	2.53 ,	0.27
SVG	301 ,	0.2 ,	97.3 ,	2.6 ,	2.85 ,	2.79 ,	0.44
SVG	302 ,	1.5 ,	98.4 ,	1.6 ,	2.20 ,	2.18 ,	0.45
SVG	303 ,	1.9 ,	97.8 ,	2.2 ,	2.43 ,	2.55 ,	0.57
SVG	304 ,	4.4 ,	94.8 ,	5.2 ,	3.01 ,	2.98 ,	0.38
SVG	305 ,	9.1 ,	87.5 ,	12.5 ,	1.88 ,	1.86 ,	0.37
SVG	306 ,	0.7 ,	93.1 ,	6.9 ,	2.71 ,	2.74 ,	0.58
SVG	307 ,	3.0 ,	94.2 ,	5.8 ,	2.90 ,	2.92 ,	0.51
SVG	308 ,	2.4 ,	95.1 ,	4.9 ,	2.57 ,	2.57 ,	0.39
SVG	309 ,	2.6 ,	95.3 ,	4.7 ,	2.41 ,	2.42 ,	0.32
SVG	310 ,	1.0 ,	96.2 ,	3.8 ,	2.02 ,	2.03 ,	0.41
SVG	311 ,	0.7 ,	98.1 ,	1.8 ,	1.78 ,	1.76 ,	0.50
SVG	312 ,	3.0 ,	95.9 ,	4.2 ,	0.91 ,	0.92 ,	0.75
SVG	313 ,	1.2 ,	97.1 ,	1.7 ,	,	,	
SVG	314 ,	1.0 ,	96.7 ,	2.2 ,	2.36 ,	2.32 ,	0.59
SVG	315 ,	0.6 ,	98.6 ,	0.8 ,	1.03 ,	0.97 ,	0.86
SVG	316 ,	1.1 ,	96.6 ,	2.3 ,	1.46 ,	1.33 ,	0.83

Samp	#	Clay %	Grvl+ Sand %	Mud %	Mz phi	Md phi	incl graph st dv
SVG	317 ,	1.9 ,	95.8 ,	2.3 ,	2.28 ,	2.32 ,	0.35
SVG	318 ,	2.2 ,	94.5 ,	3.3 ,	2.53 ,	2.56 ,	0.45
SVG	319 ,	1.4 ,	96.4 ,	2.2 ,	2.50 ,	2.56 ,	0.47
SVG	320 ,	2.6 ,	92.5 ,	4.9 ,	2.59 ,	2.56 ,	0.52
SVG	321 ,	1.2 ,	97.6 ,	1.2 ,	2.16 ,	2.20 ,	0.39
SVG	322 ,	2.0 ,	95.5 ,	2.5 ,	2.45 ,	2.48 ,	0.40
SVG	323 ,	1.6 ,	96.1 ,	2.3 ,	2.43 ,	2.45 ,	0.42
SVG	324 ,	0.1 ,	98.2 ,	1.7 ,	0.96 ,	0.98 ,	0.74
SVG	325 ,	1.0 ,	97.9 ,	1.1 ,	1.33 ,	1.35 ,	0.66
SVG	326 ,	0.9 ,	97.9 ,	1.2 ,	0.95 ,	1.01 ,	0.72
SVG	327 ,	2.9 ,	93.4 ,	3.7 ,	3.20 ,	3.23 ,	0.31
SVG	328 ,	1.7 ,	96.5 ,	1.8 ,	1.46 ,	1.54 ,	0.55
SVG	329 ,	1.5 ,	96.9 ,	1.5 ,	1.77 ,	1.82 ,	0.48
SVG	330 ,	1.3 ,	97.3 ,	1.4 ,	1.02 ,	1.10 ,	0.65
SVG	331 ,	1.2 ,	97.6 ,	1.2 ,	1.05 ,	1.07 ,	0.63
SVG	332 ,	2.1 ,	94.9 ,	3.0 ,	1.00 ,	1.00 ,	0.69
SVG	333 ,	2.0 ,	95.1 ,	2.9 ,	2.63 ,	2.52 ,	0.53
SVG	334 ,	1.2 ,	97.6 ,	1.3 ,	1.31 ,	1.35 ,	0.51
SVG	335 ,	1.6 ,	96.8 ,	1.6 ,	0.81 ,	0.87 ,	0.75
SVG	336 ,	1.2 ,	97.6 ,	1.2 ,	1.68 ,	1.80 ,	0.58
SVG	337 ,	1.4 ,	97.1 ,	1.5 ,	1.72 ,	1.78 ,	0.47
SVG	338 ,	0.1 ,	98.0 ,	2.0 ,	1.33 ,	1.46 ,	0.79
SVG	339 ,	0.9 ,	98.1 ,	0.9 ,	2.53 ,	2.53 ,	0.49
SVG	340 ,	1.0 ,	97.9 ,	1.1 ,	1.29 ,	0.82 ,	1.02
SVG	341 ,	0.3 ,	99.3 ,	0.4 ,	1.89 ,	1.96 ,	0.65
SVG	342 ,	0.5 ,	98.7 ,	0.8 ,	1.06 ,	0.98 ,	1.14
SVG	343 ,	0.6 ,	98.5 ,	0.9 ,	1.33 ,	1.44 ,	0.86
SVG	344 ,	0.7 ,	98.4 ,	0.9 ,	1.49 ,	1.47 ,	0.70
SVG	345 ,	0.8 ,	98.3 ,	1.0 ,	1.07 ,	1.08 ,	0.81
SVG	346 ,	1.5 ,	96.9 ,	1.6 ,	1.64 ,	1.65 ,	0.75
SVG	347 ,	1.3 ,	97.4 ,	1.3 ,	1.82 ,	1.89 ,	0.67
SVG	348 ,	1.7 ,	93.6 ,	4.7 ,	3.35 ,	3.32 ,	0.46
SVG	349 ,	2.1 ,	94.4 ,	3.5 ,	3.18 ,	3.22 ,	0.48
SVG	350 ,	1.9 ,	95.3 ,	2.8 ,	3.02 ,	3.13 ,	0.50
SVG	351 ,	0.7 ,	98.5 ,	0.8 ,	1.78 ,	1.86 ,	0.71
SVG	352 ,	1.5 ,	96.5 ,	2.0 ,	2.60 ,	2.59 ,	0.39
SVG	353 ,	1.2 ,	95.2 ,	3.5 ,	1.49 ,	1.17 ,	1.35
SVG	354 ,	0.9 ,	97.9 ,	1.1 ,	2.53 ,	2.55 ,	0.34
SVG	355 ,	1.5 ,	96.6 ,	1.9 ,	2.64 ,	2.63 ,	0.63
SVG	356 ,	2.9 ,	91.3 ,	5.8 ,	2.82 ,	2.77 ,	0.60
SVG	357 ,	0.9 ,	97.9 ,	1.1 ,	2.25 ,	2.33 ,	0.71
SVG	358 ,	4.5 ,	90.5 ,	5.0 ,	1.92 ,	1.89 ,	0.56
SVG	359 ,	0.9 ,	98.0 ,	1.1 ,	1.81 ,	1.82 ,	0.39
SVG	360 ,	1.9 ,	92.6 ,	5.5 ,	3.04 ,	2.95 ,	0.51
SVG	361 ,	2.6 ,	89.4 ,	8.1 ,	3.46 ,	3.44 ,	0.33

Samp	#	Clay %	Grvl+ Sand %	Mud %	Mz phi	Md phi	incl graph st dv
SVG	362 ,	0.8 ,	97.9 ,	1.3 ,	1.67 ,	1.77 ,	0.66
SVG	363 ,	2.4 ,	93.8 ,	3.8 ,	3.06 ,	3.10 ,	0.37
SVG	364 ,	0.7 ,	98.0 ,	1.3 ,	1.55 ,	1.49 ,	0.70
SVG	365 ,	1.8 ,	95.9 ,	2.3 ,	2.71 ,	3.04 ,	0.90
SVG	366 ,	1.4 ,	96.2 ,	2.4 ,	2.87 ,	3.04 ,	0.66
SVG	367 ,	0.5 ,	98.2 ,	1.3 ,	1.49 ,	1.48 ,	0.90
SVG	368 ,	1.0 ,	85.7 ,	13.4 ,	1.46 ,	1.42 ,	0.85
SVG	369 ,	1.4 ,	95.4 ,	3.3 ,	3.13 ,	3.13 ,	0.32
SVG	370 ,	0.8 ,	97.6 ,	1.6 ,	1.68 ,	1.60 ,	0.72
SVG	371 ,	1.5 ,	92.1 ,	6.5 ,	3.40 ,	3.37 ,	0.39
SVG	372 ,	1.4 ,	92.4 ,	6.2 ,	3.36 ,	3.36 ,	0.45
SVG	373 ,	0.5 ,	97.9 ,	1.6 ,	2.70 ,	2.69 ,	0.46
SVG	374 ,	10.0 ,	39.5 ,	50.5 ,	3.58 ,	3.58 ,	0.45
SVG	375 ,	0.3 ,	98.7 ,	1.0 ,	1.41 ,	1.33 ,	0.68
SVG	376 ,	4.6 ,	81.1 ,	14.3 ,	2.80 ,	3.04 ,	0.98
SVG	377 ,	1.3 ,	94.8 ,	3.9 ,	1.96 ,	1.80 ,	0.83
SVG	378 ,	1.6 ,	94.0 ,	4.3 ,	1.99 ,	1.88 ,	1.01
SVG	379 ,	3.8 ,	86.0 ,	10.2 ,	2.46 ,	3.33 ,	1.50
SVG	380 ,	1.1 ,	96.6 ,	2.2 ,	2.46 ,	2.32 ,	0.58

Appendix 2

1994 Cores

Location Maps
Logs
Grain-size Data
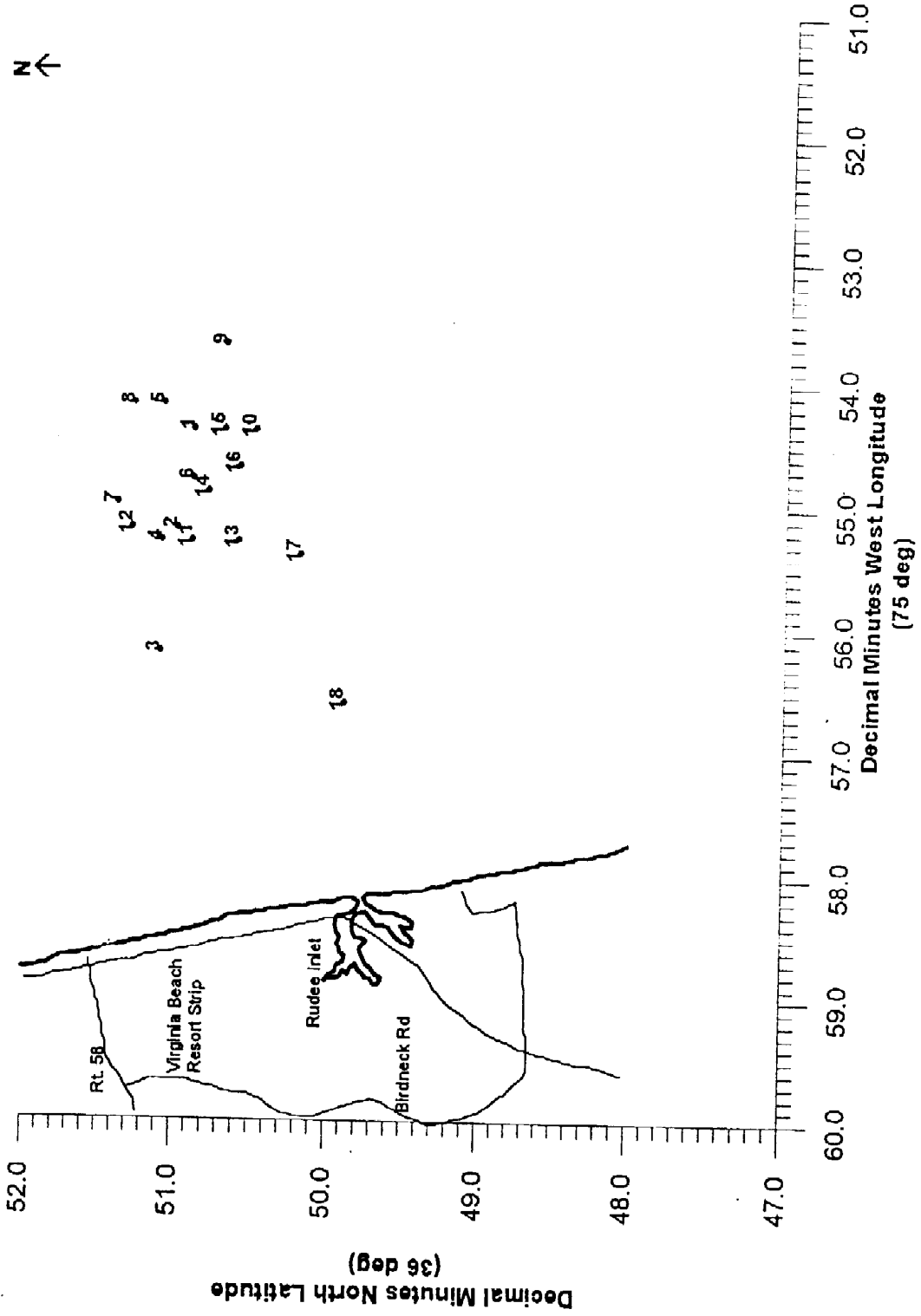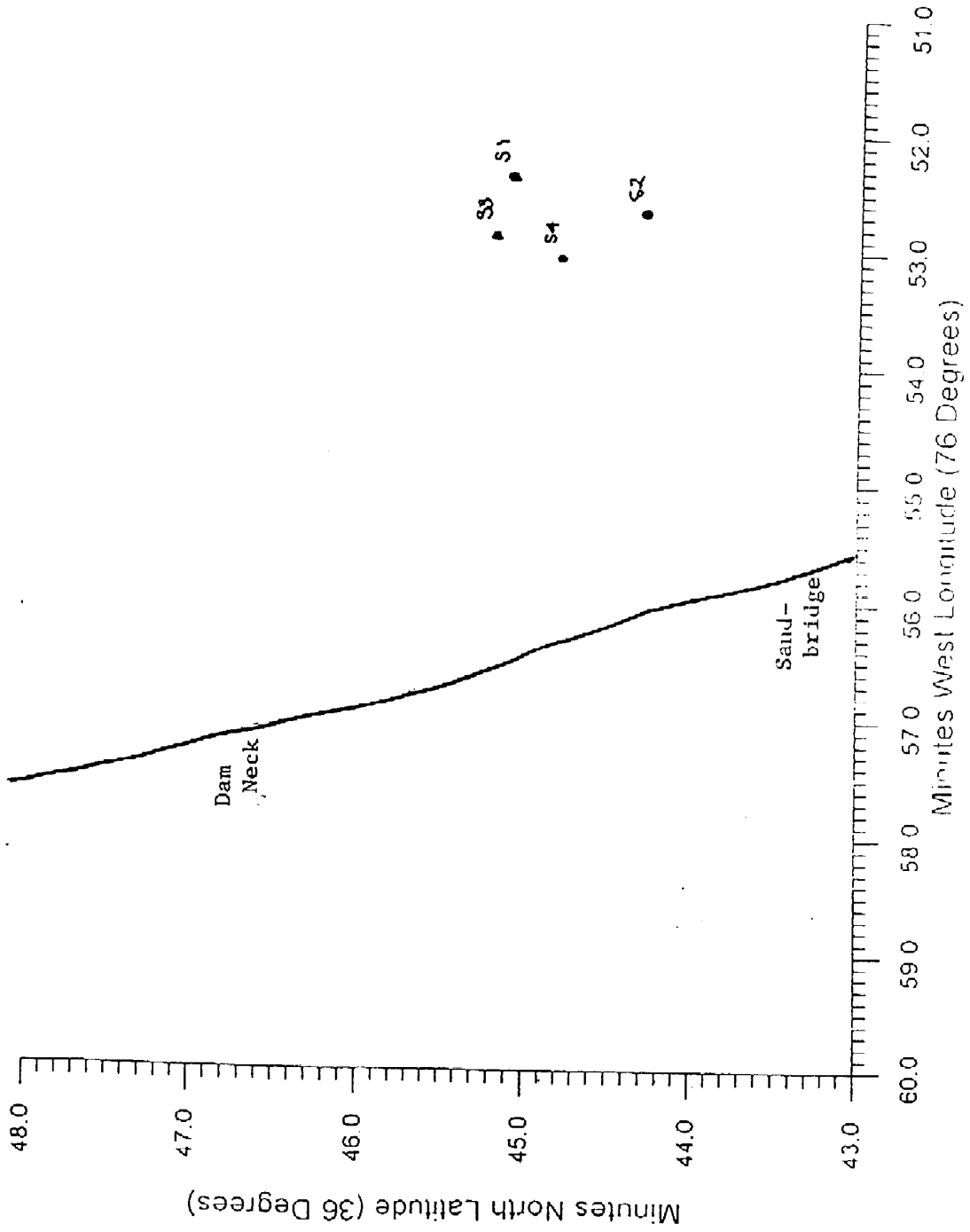
N

Decimal Minutes West Longitude
(75 deg)

Decimal Minutes North Latitude
(36 deg)

Rt 58

Virginia Beach
Resort Strip

Rudee Inlet

Birdneck Rd

Minutes West Longitude (76 Degrees)

Minutes North Latitude (36 Degrees)

CORE: MHS-94-1

PAGE 2 OF 2

clay/mud, gray

6 ft
7 ft
8 ft
9 ft
10 ft
11 ft
12 ft

1"-3" plastic embedded in clay

CORE LOG

PAGE 1 OF 2

CORE LABEL: MHS-94-1

PROJECT: MHS-94

DATE OF CORE: 15 April 94

DRILLER: Elmar

FIELD LOCATION DETERMINED BY: Loran

LAT: ___ LONG: ___ LORAN: 27430, 41726.5

TYPE OF CORE: Vibracore

WATER DEPTH FT: 40'

PENETRATION: 15' RECOVERY: 11.7' JETTED: 0

LOGGED BY: Angela

DATE: 5.17.94

DEPTH	SAMP	DESCRIPTION
0 ft		coarse sand, brown, some shells, some patches of medium sands present
1 ft	A	mud-coarse sands, gray/brown, some coarse sands present, few shells present
2 ft		sands at top of core section appears to have changed from sands at bottom of 1' core section
3 ft	B	fine - v. fine sands, gray, sands along edge of core (parallel) is more brown in color, drying difference?, hardly any shells present, v. small shells
4 ft		
5 ft	C	coarse sands, gray, brown, clay/mud, gray

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B v. fine silty sand, some clay present
   pebble present
C Coarse mud sand - gray, brown, mottled gray
   large pebbles - v. poorly sorted
D v. fine sand
   lt gray
   no shells

CORE LOG

CORE LABEL: MMS-94-2   PROJECT: MMS-94   PAGE 1 OF 3
DATE OF CORE: 15 April 94   DRILLER: Egmann
FIELD LOCATION DETERMINED BY: _____
LAT: _____ LONG: _____ LORAN: 1374.5, 41726.7
TYPE OF CORE: Bier Vibracol   WATER DEPTH FT: 35'
PENETRATION: 13.3   RECOVERY: 13.3   JETTED: 0
LOGGED BY: ASF   DATE: 17 May 94

DESCRIPTION

A coarse sand, brown
   no shells
   dark gray u. dark at top 5"
   gray, dark at it
   v. fine - silty sand
   some small shells present

CORE: MAS 94-2

worm - 3" long - almost like a tube

fine sand
lt. gray
no shells

slate gray
v fine sand - has
no shells present

v hard as cut through
consolidated / hard'nd sand

lt gray
fine sand

Top core log

CORE: MMS-94-3   PAGE 2 of 3

Depth	Description
7 ft	compaction of sediments 4" from top
8	
9	
10	
11	soft muddy shells present
12	compaction of sediments 3" from top
13	
14	clay/mud dark gray - dark greenish gray shells
15	136'

Bottom core log
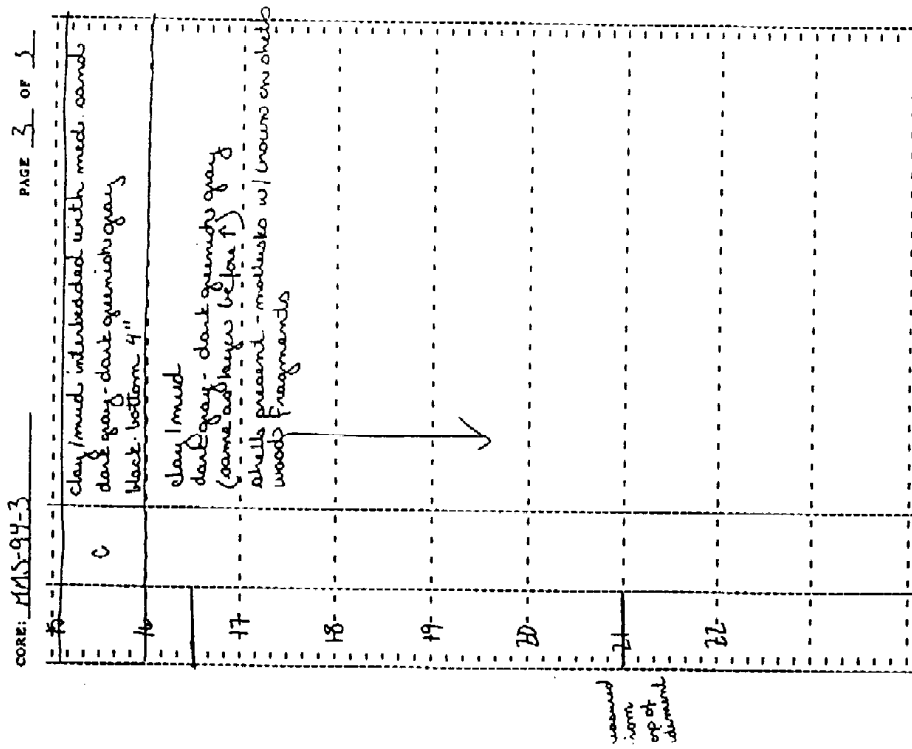
CORE LOG   PAGE 1 of 3

CORE LABEL: MMS-94-3   PROJECT: MMS

DATE OF CORE: 15 April 94   DRILLER: Eykman

FIELD LOCATION DETERMINED BY: Anson

LAT: LONG: LORAN: 27151.0, 41726.2

TYPE OF CORE: 3 m vibracore   WATER DEPTH FT: 30.0

PENETRATION: 21.8'   RECOVERY: 21.8'   JETTED: 0

LOGGED BY: A.S.J   DATE: 18 May 94

DEPTH	SAMPLE	DESCRIPTION
0 ft		
1 ft	A	medium sand into fine sand into small fragments v. dark gray
2 ft		largest or bigger whole shells
3 ft	B	fine - medium sand dark gray - dark greenish gray shells not as many as A layer small fragments as many or larger some whole
4 ft		
5 ft		
6 ft		

1" of white sand and fine sand by level very similar sample measured at top of mud

CORE: _MAS-94-3_   PAGE _3_ OF _5_

CORE LOG

CORE LABEL: MMS-94-4   PROJECT: MMS   PAGE 1 OF 3

DATE OF CORE: 15 April 94   DRILLER: Efman

FIELD LOCATION DETERMINED BY: Sonar

LAT: LONG: LORAN: 23146.7 , 41717.1

TYPE OF CORE: 3 inch vibracore   WATER DEPTH FT: 38.0

PENETRATION: 18.0   RECOVERY: 18.0   JETTED: 0

LOGGED BY: D.S.J   DATE: 19 May 94

DEPTH (ft)	SAMP	DESCRIPTION
0	A	coarse sand grayish brown some organics, shell fragments interbedded dark gray mm of v. fine sand/coarse sand w/ mm of same interbedded?
1		
2	B	fine sand dark gray few shell fragments
3		
4		
5		

CORE: MMS-94-7

D

F

CORE: MMS-94-4   PAGE 3 of 3

v. fine sand
dark greenish gray (5G 4/1)
some v. fine-silt present in patches (grades
a few small pebbles towards top

fine-med. sand
dark greenish gray (5G 4/1)

16.1"

PAGE 1 OF 3

CORE: MMT-91-5

C coarse sand organic shell fragments top 2'
grayish-brown

dark gray some fine dark gray limono
mud-sand

D dark gray clay with some ½ fine sand limono
fine sand
dark gray
shell fragments few
partly non-discrete

vdark clay
whole shell — oyster
some small shell fragments
shells
a few small patches of fine sand

sand patches clay

CORE LOG

CORE LABEL: MMS-94-5

DATE OF CORE: 130 April 94   PROJECT: n/4S   DRILLER: Brennan

FIELD LOCATION DETERMINED BY: Loran

LAT: LONG: LORAN: 27147.8 , 41230.0

TYPE OF CORE: 3 in vibracore   WATER DEPTH FT: 34.5

PENETRATION: 19.0'   RECOVERY: 13.6'   JETTED: 0

LOGGED BY: DATE: 10 May 94

PAGE 1 OF 3

| DEPTH | SAMP | DESCRIPTION |

A ~ 3½" of sediment is missing
fine sand
changing slightly to brown   small shell fragments
- faint color change - dark gray fine sand

a changing difference (vt mud dark gray
gray fine sand - mud sand
organic - shell fragments

B

some interbedded mud- coarse sand

135

CORE LOG

CORE LABEL: MHS-94-6   PAGE __2__ OF __3__

CORE: MHS-94-6   PAGE 2 OF 3

DEPTH	SAMP	DESCRIPTION
-6		~6' coarse sand w/rock, shell, rock fragments
-7	D	v. coarse sand w/gravel, granule; poorly sorted; shelly
-8		v. coarse sand w/dark gray dark gray shells (annual?)
-9	E	fine sand & gray sand, clay, dark gray no shells, fragments
-10		
-11	F	fine sand, v.fine dark (glau) gray, no shells
-12		large indurated mass, hard for 10"
-13		v. fine sand (no more fine sand)
-14		coarse coarse color clay mass
-15		

CORE LOG

CORE LABEL: MHS-94-1a   PAGE __1__ OF __3__

DATE OF CORE: 17 April 94   PROJECT: MHS   DRILLER: Epireo

FIELD LOCATION DETERMINED BY: Joann

LAT: LONG: LORAN: 27945.0 / 41146.2

TYPE OF CORE: Vibracore   WATER DEPTH 35.0

PENETRATION: 11.4   RECOVERY: 11.4   JETTED:

LOGGED BY: JAS   DATE: 10 May 94

DEPTH	SAMP	DESCRIPTION
0	A	mud-coarse sand graylsh brown bits of shells, shell fragments
1	B	med-fine dark gray w/fine sand & fine sand v. coarse w/shell fragments
2		
3		~3'5 dark gray clay line w/
4		
5	C	gray fine sand interbedded with v. dark gray comp v. dark gray silt also fine sand silt also
6		

CORE: MMS-94-6   PAGE 3 OF 3

CORE LOG

PAGE 1 of 3

CORE LABEL: MHS-94-7   PROJECT: MHS

DATE OF CORE: 25 April 94   DRILLER: Epperson

FIELD LOCATION DETERMINED BY: _____
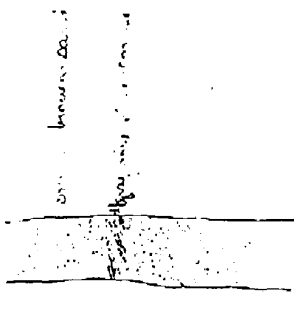
LAT: _____   LONG: _____   LORAN: 27-146.5, 412.32.6

TYPE OF CORE: 3" vibracore   WATER DEPTH FT: 32.0'

PENETRATION: 17.0'   RECOVERY: 8'10"   JETTED: to 9'

LOGGED BY: ASF   DATE: 26 May 94

DEPTH ft	SAMP #	DESCRIPTION
0	A	coarse orange-gray (5Y 4/2) silts, shells, fragments
1	B	v. dk gray (5Y 3/1) silty fine sand, shells, fragments
2		individual layer of medium sand
3		
4		a few sparse clay lenses
5		
6		

CORE: MHS-94-7

PAGE 1 of 3

6		a small patch of light olive gray mud, sand (5Y 4/2)
7		
8	C	lt. gray mud, sand light olive transitions (5Y 4/2) medium sand, coarse silt gray (5Y 6/1), no shell fragments
9		
10		Transitions gradually to light hannah gray (2.5Y 6/2) still mud, sand, w/ a few patches of clay/sand
11		
12		
13		
14		
15		

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CORE: MMS-94-8   PAGE 2 OF 3

D — coarse sand, coarse
(lt. olive gray (5Y 4/2)
pebbles, no shells
mud, gray sands also

E — medium sands, coarse sand and as well
some pebbles entrapped, come as D?
light olive gray (5Y 4/1)
some silty stains (5Y 4/1) patches
no shells

CORE LOG   PAGE 1 OF 3

CORE LABEL: MMS-94-8

DATE OF CORE: 25 April 94   PROJECT: MMS   DRILLER: _____

FIELD LOCATION DETERMINED BY: _____

LAT: _____ LONG: _____ LORAN: 27143.0, 41232.5

TYPE OF CORE: 3in vibracore   WATER DEPTH FT: 46.3

PENETRATION: 11' / 24.5'   RECOVERY: 7.5' / 11'   JETTED: 0-15'

LOGGED BY: ASF   DATE: 31 May 94

DEPTH / SAMP / DESCRIPTION

A — mud, sand
shells, fragments
(5Y 5/2) olive gray

B — mixture with summary no distinct layers
mud, fine sand and shell fragments
black silt
some fine gray mud, sand

C — silty, fine sand
dark gray (5Y 3/1) mud, sand (2")
dark gray (5Y 4/1)
shell fragments
mud, pockets of mud, sand

PAGE 3 OF 3

MMS-94.8

CORE:

15 16 17 18 19 20 21 22 23 24

medium sand still more palestine (5Y 6/3) now...

light olive gray again pebbles

gray (5Y 4/1) clay
1st 4" orangish color (oxides) looks
1.5" patch of gray medium sand

shell fragments throughout

heavy shell concentration @ some whole shells

shell fragments

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CORE: MMS-94-9   PAGE 2 of 2

CORE LOG

CORE LABEL: MMS94-9   PROJECT: MMS1994
DATE OF CORE: 25 April 1994   DRILLER: Loran
FIELD LOCATION DETERMINED BY: Loran
LAT: LONG: LORAN: 27140.1, 41236.2
TYPE OF CORE: 3 in vibracore   WATER DEPTH FT: 48.6
PENETRATION: 10'   RECOVERY: 6'8"   JETTED: 10
LOGGED BY: Donna Milligan   DATE: 23 June 1994

PAGE 1 of 2

CORE LOG

CORE LABEL: MMS 94-10   PAGE 1 OF 4

DATE OF CORE: 21 Oct 94   PROJECT: MMS
                              DRILLER: Sponson

FIELD LOCATION DETERMINED BY: Sponson

LAT: _____ LONG: _____

LORAN: 27443.0 , 41213.8

TYPE OF CORE: 3" vibracore   WATER DEPTH FT: 40 Meters

PENETRATION: 29.0'   RECOVERY: 2'   JETTED: 0

LOGGED BY: ASF   DATE: 2 June 94

DEPTH	SAMP /	DESCRIPTION

A — medium sand, olive gray (5Y 6/2) shell fragments

— transition to dk. gray (5Y 4/1) med. sand

B — dk gray (5Y 4/1) silt - fine sand (mostly fine sand w/silt present) first 2" shell hash, some dk gray mud. sand some shell, shell fragments

CORE: MMS-94-10   PAGE 2 OF 4

dark gray (5Y 4/1) clay, a few patches of fine sand at fine sand boundary

some small v.dk gray (5Y 3/1) patches of fine sand

CORE: MMS-94-10   PAGE 4 OF 4

CORE: MMS-94-10   PAGE 3 OF 7

CORE LOG

CORE LABEL: MMS-94-11A   PAGE 1 OF 1   PROJECT: MMS

DATE OF CORE: 21 April 94   DRILLER: Edman

FIELD LOCATION DETERMINED BY: Brown

LAT: LONG: LORAN: 27346.6 , 41224.2

TYPE OF CORE: Vibracore   WATER DEPTH FT: 31.0

PENETRATION: 11.0'   RECOVERY: 4.0'   JETTED: 0

LOGGED BY: ASF   DATE: 3 June 94

DEPTH ft	SAMP	DESCRIPTION
0	A	medium sand (lt. olive gray) (5Y 4/1) shell fragments
1	B	medium sand, dk olive gray (5Y 3/1) shell fragments
	C	dk gray (5Y 4/1) silty fine sand, shell fragments, interbedded patches of medium sand (both dk gray)
2	D	(5GY 5/1) greenish gray, fine – v.fine sand, shell fragments
3		
4		
5		

CORE LOG

CORE LABEL: MMS-94-118   PROJECT: MMS 1994   PAGE 1 of 1

DATE OF CORE: 21 April 1994   DRILLER: Esmar

FIELD LOCATION DETERMINED BY: Loran

LAT: _____ LONG: _____   LORAN: 27146.6 41224.2

TYPE OF CORE: 3" vibracore   WATER DEPTH FT: 37.0

PENETRATION: 11 ft   RECOVERY: 4 ft   JETTED: _____

LOGGED BY: Donna Milligan   DATE: 17 June 1994

DEPTH	SAMP #	DESCRIPTION
0 ft		empty
	A	Brown medium sand
1 ft		dk gray slightly sandy clay + few shell frags — abrupt contact
		an area of clayey coarse sand + frags
		med gray silty fine-v.fine sand — transition contact
2 ft	B	a few shell frags + one whole shell
		sample
		silty fine-v.coarse sand w/shell frags (about 1 in) mostly — abrupt contact
		at 2 ft dk greenish gray at longest side — faintly fam transition contact
3 ft	C	fine-coarse sand
		color is lt. brown mottled unevenly with med gray silty fine-coarse sand
		a few scattered pieces of gravel

CORE: MMS-94-11C   PAGE 2 OF 2

Jetted

A — med brown fine-coarse sand

B — med gray fine to coarse sand

C — granosize appears to slightly decrease down the section

12'6"

transit contla

6 7 8 9 10 11 12 13 14 15

CORE LOG

CORE LABEL: MMS-94-11C   PROJECT: MMS   PAGE 1 OF 3

DATE OF CORE: 21 April 1994   DRILLER: Exmar   1994

FIELD LOCATION DETERMINED BY: Loran

LAT: LONG: LORAN: 27146.6, 41224.2

TYPE OF CORE: 3" vibracore   WATER DEPTH FT: 37.0

PENETRATION: 17.5 ft   RECOVERY: 14 ft   JETTED: 5 ft

LOGGED BY: Dana Milligan   DATE: 17 June 1994

DEPTH / SAMP   DESCRIPTION

Jetted

0 ft 1 2 3 4 5 6

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CORE: mms-94-18 PAGE 2 of 3

- 6 ft — 0 (pt) grayish brown silty fine sand mottled with dk gray silty v. fine sand, occ shell frags — marsh contact
- 7 ft — dk gray clayey u. fine sand occ pieces of gravel + shell frags
- 8 ft — v. poorly sorted fine–v. coarse sand + gravel with some rocks over 1" in diam, longest side — fairly abrupt contact
- 9 ft — brown slightly silty fine–coarse sand mottled with gray slightly silty fine–coarse sand; few scattered pieces of gravel; clayballs — abrupt contact
- 10 ft — med gray clay, areas of black med sandy clay increasing down the core
- 11 ft — gray mud layer; area of highest black sandy clay content; shell frag
- 12 ft — tiny shell frags, little sandy areas — 12'0", 12'5"
- 13 ft — no sample; gray clay
- 14 ft — liner + sample stuck in barrel, removed onshore
- 15 ft — this section has many little cores inside it

CORE LOG

CORE LABEL: mms-94-18   PROJECT: mms 1994   PAGE 1 of 3

DATE OF CORE: 25 April 1994   DRILLER: Loran

FIELD LOCATION DETERMINED BY: Loran

LAT: LONG: LORAN: 27147.4, 41222.9

TYPE OF CORE: 3" vibracore   WATER DEPTH FT: 32.0'

PENETRATION: 23'   RECOVERY: 20   JETTED: 20

LOGGED BY: Donna Milligan   DATE: 24 June 1994

DEPTH / SAMP	DESCRIPTION
0 ft	Empty
A, 1 ft	med brown fine sand mottled with med gray slightly silty fine sand, shell frags
	dk gray slightly sandy clay / brown silty fine–v. fine sand
2 ft, B	med brown fine–coarse sand / med gray silty v. fine–fine sand, shell frags; brown layer, some mottling to decrease down the core; silt content appears to decrease down the core; gray clay between brown coarse sand; shells in sand layer (frags)
3 ft, C	brown layer; some mottled gray in section; med gray silty fine–v. fine sand occ shell frags
4 ft	color is mottled with dk gray + lighter grays. Light colors appear to have less silt content
5 ft	in general, silt content appears to increase down the core
6 ft	

— marsh–bay contact
— marsh–mud contact
— abrupt contact
— fairly abrupt contact

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Gray Clay

CORE LOG

PAGE __1__ OF __1__

CORE LABEL: MMS-94-13A   PROJECT: MMS 1994

DATE OF CORE: 25 April 1994   DRILLER: Exxon

FIELD LOCATION DETERMINED BY: Loran

LAT: _____ LONG: _____   LORAN: 27146.5, 4/2030

TYPE OF CORE: 3" vibracore   WATER DEPTH FT: 35

PENETRATION: 10 ft   RECOVERY: 5'6"   JETTED: No

LOGGED BY: Donna Milligan   DATE: 21 June 1994

DEPTH	SAMP	DESCRIPTION
0 ft		mud brown slightly silty v. fine-fine sand w/ thin mud layer on top — abrupt contact
		dk gray v. fine sand/clay mottled with med brown silty fine sand — abrupt contact
1 ft		med brown silty v. fine sand
	1A	Color change to dk gray mottled with med gray silty v. fine sand
2 ft		whole shell found. a few small shell frags through section
		slightly sandy clay ball
3 ft		silt content appears to increase down the core
		not well sorted fine to v. coarse to brown sand — abrupt contact
4 ft		grades (sand w/rock with largest peds)
		slightly sandy clay ball
	1B	color change to grayish brown
		med gray fine-v. coarse sand mottled with dk gray silty fine-coarse sand — transition contact
5 ft		Color: orange to grayish brown
	C	brown med-v. coarse sand w/ gravel — slightly abrupt contact / transition contact
		brownish gray silty fine-v. coarse sand w/gravel
5'6"		

CORE LOG

CORE LABEL: MMS-94-138   PAGE 1 of 1

DATE OF CORE: 25 April 1994   PROJECT: MMS 1994   DRILLER: Exmar

FIELD LOCATION DETERMINED BY: Loran

LAT: LONG: LORAN: 26145.9, 42230

TYPE OF CORE: 3" Vibracore   WATER DEPTH FT: 35 ft

PENETRATION: 14.5'   RECOVERY: 3'6"   JETTED: 10'6"

LOGGED BY: Donna Milligan   DATE: 21 June 1994

DEPTH   SAMP #   DESCRIPTION

Top of core
Shelly
Fine-coarse light brown sand with frequent transitional contact
clay balls
Suppress coarse (against core w/gravel→rocks
No fines at the longest 3cm

Med brown med-v coarse sand
Occasional gravel + clay balls +
clay layers?

CORE: MMS 94-14   PAGE 2 OF 3

DEPTH	SAMP	DESCRIPTION	
6ft		dk gray sandy silt	
7ft		sand is very fine	abrupt contact
	C	Poorly sorted fine-v.coarse lt gray sand + shell frags	
	D	dk gray silty (w/comminuted shells + frags)	
8ft		dk gray clay, several shells about every 2 inches	
9ft		dk gray clay but many, many shells/a lot of frags	abrupt contact
10ft		lt to dk gray v.fine sandy silt, occasionally mottled w/ brown v.fine sandy silt	
	E		
11ft			
12ft			
13ft		lt gray w/rust pattern, dk grayish brown fine sandy silt, a little mottling with lt brown silty sand	
	F		
14ft			
15ft			

1'8.5"
lens of very coarse gray sand
12'8.5"

---

transitional contacts

CORE LOG

CORE LABEL: MMS-94-14   PROJECT: MMS-94   PAGE 1 OF 3
DATE OF CORE: 25 April 1994   DRILLER: Exmar
FIELD LOCATION DETERMINED BY: Loran
LAT: ___   LONG: ___   LORAN: 27145.1, 41204.9
TYPE OF CORE: 3in vibracore   WATER DEPTH FT: 39.0
PENETRATION: 22.0 Ft   RECOVERY: 19.1 Ft   JETTED: 0
LOGGED BY: Dance Milligan   DATE: 13 June 1994

DEPTH	SAMP #	DESCRIPTION
0 ft		Top 4 inches empty
1 ft	A (4")	tan/Brown coarse sand - poorly sorted, transitional to brown silty sand, dark gray + brown silty sand poorly sorted fine-coarse sand
2 ft	B 2")	Dk brown silty sand / sand is fine-med, shell frags, tan/br fine sand mottled with dk gray silty material, dk gray increasing down core
3 ft		gray very fine sand + dk gray silt occasional shell frags
4 ft		
5 ft		
6 ft		

CORE LOG

PAGE 1 OF 2

CORE LABEL: MMS-94-15   PROJECT: MMS

DATE OF CORE: 27 April 94   DRILLER: _____

FIELD LOCATION DETERMINED BY: _____

LAT: _____   LONG: _____   LORAN: 27143.0 , 41775.5

TYPE OF CORE: 3" vibracore   WATER DEPTH FT: 410 _____

PENETRATION: 15.5'   RECOVERY: 8'6"   JETTED: 0

LOGGED BY: ASF   DATE: 25 May 94

DEPTH / SAMP / DESCRIPTION

A medium sand, shells, shell fragments, fine gray (51 5k)

B fine med. sand + a lot of dk gray silt, shell fragments

C (5/4) dk gray + fine sand, w/ fine med shell fragments

D coarsening up sequence, fine gray (51 5/1)

E med. sand, dark gray (51 5/1), oz fine pebbles w/ng

dark gray (51 5/1) clay / med shells w/ silt w/ fine gray (51 5/1) + woody/organic material (¼ mm)

coarse-v. coarse sand w/ pebbles at gray

CORE LOG

PAGE 1 OF 4

CORE LABEL: MAS-94-14   PROJECT: MMS

DATE OF CORE: 13 April 94   DRILLER: Epienor

FIELD LOCATION DETERMINED BY: dream

LAT: _____   LONG: _____   LORAN: 26471.0, 41276.7

TYPE OF CORE: 3" vibracore   WATER DEPTH FT: 4.5 fathoms

PENETRATION: 17   RECOVERY: 79"   JETTED: _____

LOGGED BY: ASF   DATE: 13 May 94

DEPTH	SAMP	DESCRIPTION
0 ft	A	fine sand few r small shell fragments
1		
2		medium sand few small shell fragments
3		
4	B	medium sand shell fragments olive gray (5Y 7/4)
5		v dark gray (5Y 4/1) dark gray (5Y 4/1) olive gray
6		fine sand olive gray (5Y 4/2)
		shell fragments
		fine sand olive gray (5Y 5/2)
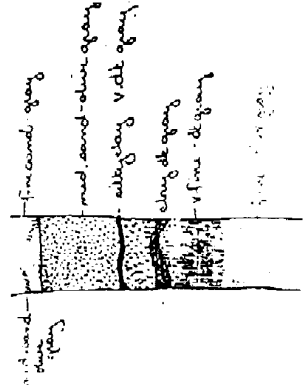
156

CORE: S-94-3   PAGE 3 of 3

15ft — layers of clayey med-coarse gray sand mixed with many shell frags + an occ whole shell

16ft — between layers - dk gray clay with an occ shell frag or whole shell

17ft — pieces of slightly silty fine-coarse med gray sand

dk gray med-coarse sandy clay

A — lt gray coarse sand w/ some gravel

gradational contact

abrupt contact

18ft — B — med gray fine - med sand becoming coarser down the core to med-coarse sand

19ft — C — a few scattered shell frags

19'1"
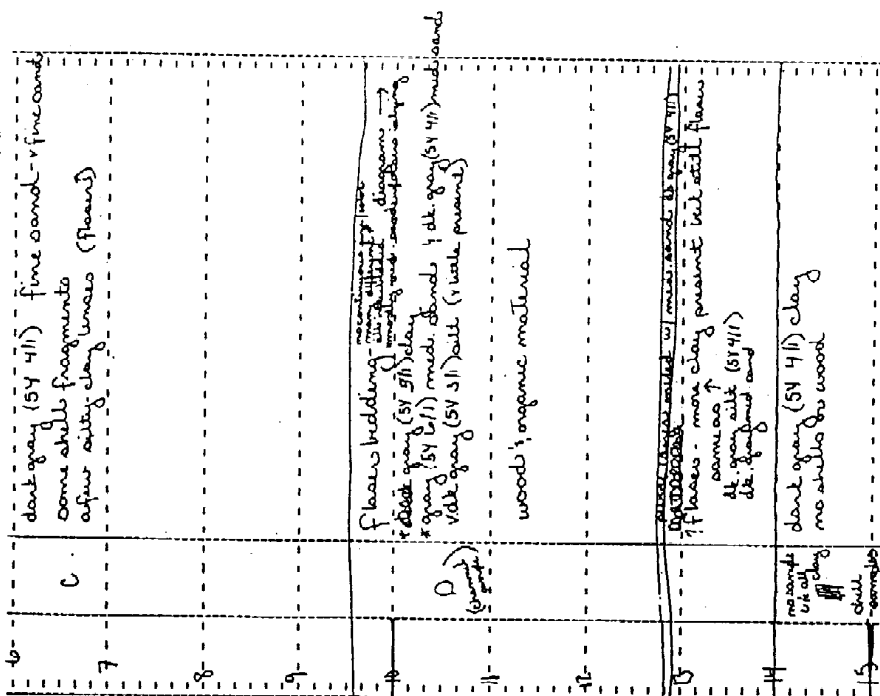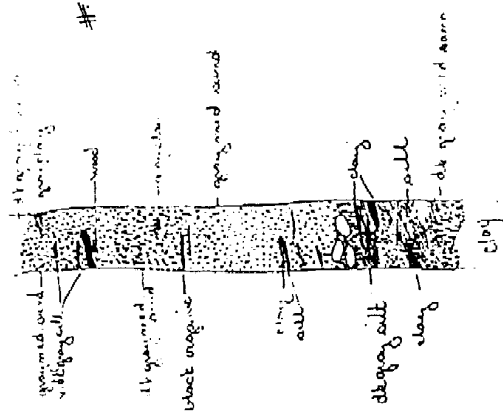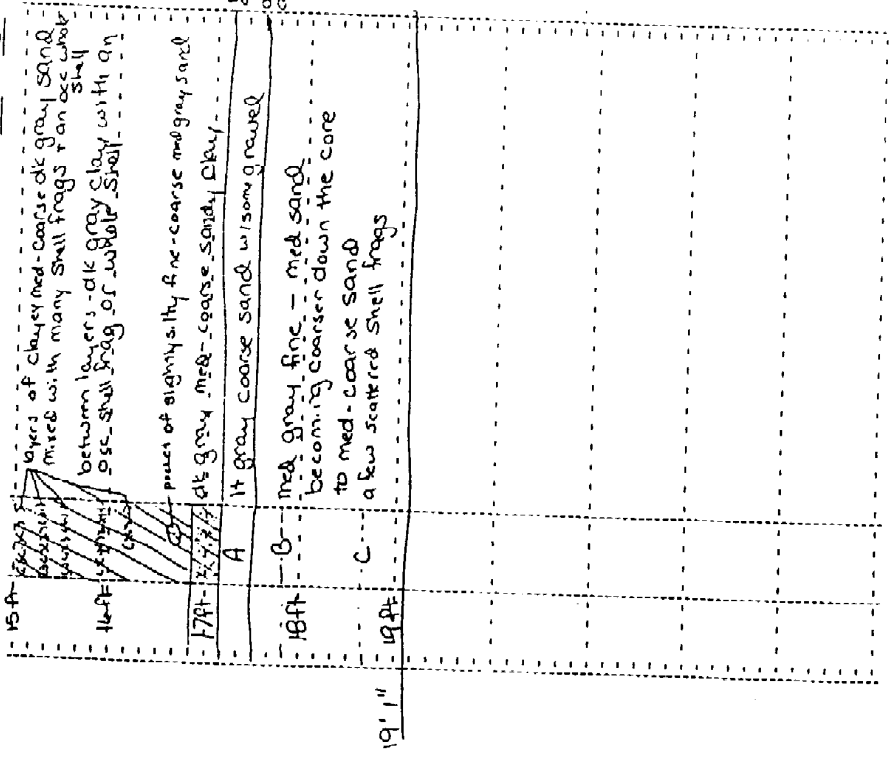
Gravel, Sand, Silt, and Clay percents are weight percents of the entire sample.

Remaining data refer only to the sand portion of each sample as determined by Rapid Sediment Analyzer (settling tube)

M1, M2, M3, and M4 are the moment measures.

Mz is the Graphic Mean
Md is the Median
SI is the Inclusive Graphic Standaard Deviation
SKI is the Inclusive Graphic Skewness
KG is the Graphic Kurtosis

ID	GRV %	SAND %	SILT %	CLAY %
MMS-94-1-A	0.0	95.4	0.6	4.1
MMS-94-1-B	0.0	81.9	10.2	7.9
MMS-94-1-C	24.9	67.0	2.4	5.7
MMS-94-2-A	0.0	83.4	9.0	7.6
MMS-94-2-B	13.8	58.9	14.4	12.9
MMS-94-2-C	39.8	50.4	3.4	6.4
MMS-94-2-D	0.0	71.5	21.8	6.7
MMS-94-3-A	0.0	88.2	5.2	6.6
MMS-94-3-B	0.0	88.4	4.6	7.0
MMS-94-3-C	0.0	79.4	6.9	13.8
MMS-94-4-A	0.1	95.2	2.6	2.1
MMS-94-4-B	0.0	71.4	18.1	10.5
MMS-94-4-D	0.8	78.1	13.3	7.8
MMS-94-4-F	58.2	39.5	1.4	0.9
MMS-94-4-G	0.7	61.1	23.8	14.4
MMS-94-4-H	0.0	92.1	3.9	3.9
MMS-94-5-A	0.0	93.5	2.3	4.2
MMS-94-5-B	0.0	92.8	4.4	0.4
MMS-94-5-C	0.4	95.7	1.6	2.4
MMS-94-5-D	0.0	84.8	9.3	6.0
MMS-94-6-A	0.0	94.6	1.1	4.3
MMS-94-6-A				
MMS-94-6-B	0.0	84.7	8.0	7.3
MMS-94-6-B				
MMS-94-6-B				
MMS-94-6-C	0.0	75.3	15.0	9.7
MMS-94-6-C				
MMS-94-6-D	34.8	51.9	5.5	7.8
MMS-94-6-D				
MMS-94-6-E	1.0	63.1	19.9	16.1
MMS-94-6-E				
MMS-94-6-F	0.0	65.4	20.3	14.3
MMS-94-6-F				
MMS-94-7-A	0.4	95.8	1.1	2.7
MMS-94-7-B	0.0	81.1	10.5	8.4

ID	GRV %	SAND %	SILT %	CLAY %
MMS-94-7-C	1.4	90.9	7.1	0.6
MMS-94-8-A	0.0	94.6	1.1	4.3
MMS-94-8-B	0.0	78.6	9.8	11.7
MMS-94-8-C	0.0	71.5	17.3	11.2
MMS-94-8-D	0.8	93.9	0.6	4.8
MMS-94-8-E	3.4	89.7	1.6	5.2
MMS-94-9-A	0.0	96.1	1.9	2.0
MMS-94-9-B	0.2	94.3	2.4	3.1
MMS-94-10-A	0.7	93.9	2.8	2.6
MMS-94-10-B	0.0	82.2	11.7	6.1
MMS-94-11A-A	0.2	94.6	1.3	4.0
MMS-94-11A-B	0.0	88.8	4.4	6.8
MMS-94-11A-C	1.0	73.7	12.3	13.0
MMS-94-11A-D	0.2	80.2	8.9	10.7
MMS-94-11-B-A	0.0	91.5	5.9	2.6
MMS-94-11-B-B	0.0	81.0	13.4	5.6
MMS-94-11-B-C	4.9	87.7	4.4	3.0
MMS-94-11-B-D	18.5	75.3	3.4	2.8
MMS-94-11-C-A	0.1	94.6	3.1	2.2
MMS-94-11-C-B	0.0	94.2	3.8	1.9
MMS-94-11-C-C	0.0	94.4	3.1	2.5
MMS-94-11-C-D	5.0	89.8	3.7	1.5
MMS-94-11-C-E	2.4	92.6	3.3	1.7
MMS-94-12-A	0.0	93.1	3.9	3.0
MMS-94-12-B	0.4	85.6	9.2	4.8
MMS-94-12-C	0.2	89.4	5.9	4.5
MMS-94-12-D	0.0	93.5	3.5	3.0
MMS-94-13-A-A	0.0	84.1	7.2	8.7
MMS-94-13-A-B	12.8	77.0	2.9	7.3
MMS-94-13-A-C	19.8	73.6	0.8	5.8
MMS-94-13-B-A	10.3	83.5	1.0	5.2
MMS-94-14-A	0.5	89.6	4.3	5.6
MMS-94-14-B	0.0	79.3	10.6	10.0
MMS-94-14-C	3.9	87.3	2.5	6.3

ID	GRV %	SAND %	SILT %	CLAY %
MMS-94-14-D	20.6	60.0	7.3	12.1
MMS-94-14-E	0.0	68.0	17.4	14.6
MMS-94-14-F	0.1	63.1	21.6	15.1
MMS-94-15-A	0.0	97.2	0.5	2.4
MMS-94-15-B	0.0	88.9	4.5	6.6
MMS-94-15-C	0.0	86.1	6.4	7.6
MMS-94-15-D	11.6	81.7	2.5	4.2
MMS-94-15-E	4.4	88.8	2.6	4.3
MMS-94-16-A	0.0	94.2	2.6	3.2
MMS-94-16-B	0.0	91.4	3.6	5.0
MMS-94-16-C	0.0	74.0	16.2	9.8
MMS-94-16-D	0.7	79.0	10.3	10.1
MMS-94-17-A	0.0	86.4	8.5	5.1
MMS-94-17-B	0.4	92.0	3.9	3.7
MMS-94-17-C	0.2	86.8	6.7	6.4
MMS-94-17-D	0.4	87.5	7.9	4.2
MMS-94-17-E	0.0	83.2	10.5	6.3
MMS-94-17-F	0.9	81.9	9.4	7.8
MMS-94-17-G	0.6	82.0	10.1	7.3
MMS-94-17-H	1.4	95.2	2.9	0.5
MMS-94-18-A	0.0	90.3	5.6	4.1
MMS-94-18-B	0.0	89.2	7.3	3.5
MMS-94-18-C	0.0	88.1	7.3	4.6
MMS-94-18-D	3.4	91.0	2.2	3.4
MMS-94-18-E	25.0	63.3	6.9	4.8
S-94-1-A	1.5	95.5	1.2	1.8
S-94-1-B	1.1	96.1	0.9	1.9
S-94-1-C	0.0	95.8	2.0	2.3
S-94-1-D		84.6	7.7	7.3
S-94-1-E	0.2	96.7	1.3	1.8
S-94-2-A	12.5	83.1	0.8	3.6
S-94-2-B	15.5	80.2	0.9	3.3
S-94-2-C	1.0	94.3	1.1	3.6
S-94-2-D	1.6	93.6	0.9	3.9
S-94-2-E	0.4	92.6	1.9	5.1

ID	GRV %	SAND %	SILT %	CLAY %
S-94-3-A	5.0	89.0	1.5	4.5
S-94-3-B	0.1	86.7	4.9	8.2
S-94-3-C	0.7	88.6	6.0	4.7
S-94-4-A	10.5	86.6	2.1	0.7

ID	M1 PHI	M2 PHI	M3	M4	Mz PHI	Md PHI	SI PHI	SKI	KG
MMS-94-1-A	1.671	0.577	0.922	7.281	1.647	1.660	0.517	0.072	0.621
MMS-94-1-B	3.129	0.900	-2.545	9.850	3.346	3.353	0.573	-0.319	0.497
MMS-94-1-C	1.278	0.984	0.111	2.868	1.167	1.316	1.027	-0.083	0.819
MMS-94-2-A	3.366	0.697	-4.787	28.190	3.469	3.442	0.240	0.124	0.156
MMS-94-2-B	2.111	1.537	-0.366	1.664	2.062	2.252	1.502	-0.209	0.549
MMS-94-2-C	1.290	1.259	0.584	2.535	1.236	1.175	1.265	0.176	0.889
MMS-94-2-D	3.187	0.473	-2.453	19.776	3.208	3.172	0.322	0.254	0.244
MMS-94-3-A	3.086	0.918	-2.856	11.273	3.270	3.296	0.682	-0.039	0.611
MMS-94-3-B	3.294	0.833	-3.508	15.971	3.449	3.429	0.570	-0.256	0.539
MMS-94-3-C	2.471	1.050	-1.146	3.847	2.528	2.901	1.007	-0.572	0.583
MMS-94-4-A	1.393	0.733	1.132	5.993	1.305	1.385	0.661	-0.016	0.949
MMS-94-4-B	3.433	0.558	-3.711	20.522	3.520	3.489	0.314	-0.013	0.228
MMS-94-4-D	2.464	0.904	-0.956	4.024	2.486	2.653	0.899	-0.310	0.576
MMS-94-4-F	1.590	1.303	-0.170	1.770	1.588	1.875	1.319	-0.235	0.649
MMS-94-4-G	3.257	0.635	-1.872	10.407	3.309	3.299	0.529	-0.046	0.309
MMS-94-4-H	3.031	0.568	-4.260	26.613	3.094	3.105	0.289	-0.114	0.222
MMS-94-5-A	3.057	0.533	-2.763	17.063	3.104	3.151	0.377	-0.027	0.273
MMS-94-5-B	2.906	0.763	-1.838	8.246	2.959	3.064	0.644	-0.325	0.450
MMS-94-5-C	1.441	0.742	0.190	4.977	1.409	1.445	0.679	0.035	0.736
MMS-94-5-D	3.380	0.765	-4.503	26.646	3.497	3.474	0.256	0.098	0.167
MMS-94-6-A	1.435	0.740	0.492	5.368	1.383	1.468	0.675	-0.110	0.841
MMS-94-6-A	1.629	0.720	0.441	6.527	1.587	1.603	0.588	0.045	0.743
MMS-94-6-B	3.229	0.843	-2.905	11.643	3.413	3.398	0.569	-0.264	0.521
MMS-94-6-B	3.182	1.006	-3.229	13.225	3.418	3.405	0.641	-0.314	0.582
MMS-94-6-B	3.116	1.119	-2.695	9.616	3.412	3.396	0.737	-0.308	0.686
MMS-94-6-C	3.561	0.470	-4.866	36.699	3.606	3.582	0.240	0.167	0.148
MMS-94-6-C	3.462	0.814	-4.390	23.036	3.604	3.572	0.260	0.105	0.171
MMS-94-6-D	0.981	1.325	0.961	2.621	1.020	0.440	1.347	0.592	0.908
MMS-94-6-D	0.871	1.203	1.087	3.318	0.893	0.485	1.241	0.503	1.307
MMS-94-6-E	3.634	0.650	-4.901	31.921	3.717	3.709	0.276	0.007	0.170
MMS-94-6-E	3.271	1.077	-2.626	9.610	3.470	3.565	0.856	-0.506	0.686
MMS-94-6-F	3.651	0.514	-4.051	26.637	3.709	3.681	0.287	0.104	0.175
MMS-94-6-F	3.514	0.694	-3.385	17.195	3.649	3.634	0.555	-0.277	0.471
MMS-94-7-A	1.352	0.761	1.177	6.248	1.275	1.338	0.697	0.036	0.916
MMS-94-7-B	3.195	0.920	-2.951	12.237	3.407	3.386	0.586	-0.234	0.533

ID	M1 PHI	M2 PHI	M3	M4	Mz PHI	Md PHI	SI PHI	SKI	KG
MMS-94-7-C	1.562	0.882	-0.024	3.788	1.561	1.652	0.903	-0.189	0.868
MMS-94-8-A	1.762	0.844	0.066	4.685	1.733	1.731	0.767	0.090	0.746
MMS-94-8-B	2.088	1.010	-0.069	2.826	2.147	1.982	1.031	0.149	0.595
MMS-94-8-C	3.320	0.864	-3.260	14.443	3.508	3.485	0.571	-0.254	0.512
MMS-94-8-D	1.543	0.912	0.200	2.828	1.537	1.514	0.858	0.027	0.558
MMS-94-8-E	1.628	0.791	0.139	3.726	1.628	1.569	0.746	0.101	0.638
MMS-94-9-A	1.981	0.784	-0.725	4.701	1.989	2.074	0.739	-0.170	0.633
MMS-94-9-B	1.615	0.724	0.945	6.959	1.546	1.508	0.587	0.306	0.839
MMS-94-10-A	1.513	0.818	-0.247	4.221	1.512	1.577	0.800	-0.113	0.920
MMS-94-10-B	3.485	0.566	-4.694	31.279	3.551	3.527	0.261	0.151	0.163
MMS-94-11A-A	1.675	0.885	0.679	4.176	1.625	1.529	0.781	0.262	0.943
MMS-94-11A-B	2.034	0.930	0.252	3.036	2.120	1.773	0.911	0.437	0.508
MMS-94-11A-C	2.001	1.081	0.330	1.997	2.029	1.691	1.114	0.343	0.512
MMS-94-11A-D	3.400	0.702	-3.815	16.612	3.516	3.502	0.352	-0.124	0.266
MMS-94-11-B-A	1.839	0.866	0.730	4.142	1.936	1.646	0.850	0.446	0.807
MMS-94-11-B-B	3.462	0.451	-4.846	38.795	3.497	3.465	0.231	0.233	0.149
MMS-94-11-B-C	1.393	0.970	0.744	3.397	1.285	1.309	0.983	0.089	0.944
MMS-94-11-B-D	0.800	1.084	1.150	4.045	0.699	0.600	1.021	0.284	1.060
MMS-94-11-C-A	1.502	0.776	0.515	5.587	1.480	1.472	0.644	0.077	0.735
MMS-94-11-C-B	1.325	0.674	0.228	4.623	1.302	1.306	0.635	0.010	0.811
MMS-94-11-C-C	1.414	0.687	-0.516	7.704	1.434	1.429	0.536	-0.003	0.778
MMS-94-11-C-D	0.531	0.868	1.549	6.465	0.524	0.335	0.766	0.362	1.293
MMS-94-11-C-E	0.747	0.761	0.889	4.658	0.795	0.597	0.704	0.358	1.047
MMS-94-12-A	3.272	0.610	-3.614	20.144	3.353	3.329	0.325	0.017	0.262
MMS-94-12-B	3.318	0.788	-3.089	13.583	3.496	3.474	0.493	-0.221	0.429
MMS-94-12-C	3.314	0.847	-3.602	16.214	3.476	3.445	0.519	-0.241	0.481
MMS-94-12-D	2.402	0.564	-0.795	10.585	2.398	2.310	0.481	0.349	0.379
MMS-94-13-A-A	3.231	0.921	-3.315	13.550	3.439	3.433	0.592	-0.329	0.568
MMS-94-13-A-B	1.423	1.183	-0.052	1.826	1.382	1.505	1.177	-0.126	0.619
MMS-94-13-A-C	0.926	0.900	0.895	3.740	0.848	0.780	0.896	0.226	0.978
MMS-94-13-B-A	0.598	0.839	0.558	3.058	0.563	0.515	0.820	0.102	0.820
MMS-94-14-A	1.422	0.770	-0.364	6.386	1.432	1.477	0.587	-0.130	0.718
MMS-94-14-B	3.116	1.137	-2.708	9.699	3.389	3.399	0.830	-0.373	0.756
MMS-94-14-C	1.965	1.020	-0.553	3.381	0.972	2.097	0.970	-0.230	0.780

ID	M1 PHI	M2 PHI	M3	M4	Mz PHI	Md PHI	SI PHI	SKI	KG
MMS-94-14-D	1.152	0.989	0.532	2.932	1.129	0.964	0.968	0.024	0.769
MMS-94-14-E	3.132	1.193	-2.389	7.873	3.385	3.513	0.882	-0.584	0.757
MMS-94-14-F	3.508	0.739	-3.844	20.447	3.639	3.601	0.431	-0.093	0.321
MMS-94-15-A	1.602	0.626	-0.218	6.658	1.590	1.161	0.514	-0.013	0.573
MMS-94-15-B	2.148	0.762	-0.276	4.972	2.199	2.042	0.696	0.292	0.563
MMS-94-15-C	2.940	0.873	-2.442	10.214	3.047	3.152	0.674	-0.399	0.470
MMS-94-15-D	1.870	0.842	-1.106	4.754	1.906	2.054	0.753	-0.354	0.697
MMS-94-15-E	1.976	0.687	-0.795	5.843	2.011	2.080	0.569	-0.299	0.578
MMS-94-16-A	3.225	0.507	-3.618	26.257	3.268	3.252	0.324	0.038	0.217
MMS-94-16-B	2.178	0.834	0.160	2.886	2.211	2.025	0.885	0.247	0.526
MMS-94-16-C	3.430	0.710	-3.570	16.948	3.560	3.544	0.443	-0.213	0.371
MMS-94-16-D	1.988	0.896	-0.555	3.303	2.013	2.066	0.895	-0.133	0.693
MMS-94-17-A	3.166	0.680	-2.589	12.772	3.282	3.257	0.477	-0.153	0.395
MMS-94-17-B	2.127	0.724	0.230	4.823	2.257	1.904	0.654	0.686	0.579
MMS-94-17-C	3.164	0.717	-2.651	11.754	3.314	3.323	0.442	-0.253	0.360
MMS-94-17-D	3.427	0.534	-4.900	35.099	3.482	3.455	0.237	0.189	0.155
MMS-94-17-E	3.440	0.619	-4.923	30.600	3.512	3.493	0.231	0.155	0.144
MMS-94-17-F	3.335	0.805	-3.299	13.972	3.503	3.488	0.538	-0.283	0.493
MMS-94-17-G	2.628	0.910	-0.881	4.165	2.715	2.572	0.869	0.048	0.526
MMS-94-17-H	1.730	0.716	-0.431	3.306	1.713	1.852	0.708	-0.259	0.556
MMS-94-18-A	3.257	0.634	-3.525	20.025	3.352	3.324	0.385	-0.067	0.324
MMS-94-18-B	3.373	0.550	-4.418	31.167	3.430	3.411	0.296	0.078	0.185
MMS-94-18-C	3.343	0.604	-3.781	21.839	3.426	3.399	0.309	0.024	0.219
MMS-94-18-D	2.203	0.948	-1.038	4.440	2.242	2.407	0.934	-0.344	0.720
MMS-94-18-E	1.273	1.345	0.518	2.143	1.223	0.852	1.363	0.376	0.702
S-94-1-A	2.127	0.835	-1.618	7.143	2.179	2.269	0.722	-0.287	0.714
S-94-1-B	2.242	0.693	-1.578	10.698	2.279	2.302	0.494	-0.064	0.497
S-94-1-C	2.382	0.649	-1.276	10.559	2.389	2.396	0.476	0.023	0.477
S-94-1-D	2.904	0.766	-1.506	7.302	2.973	2.910	0.643	0.033	0.389
S-94-1-E	1.899	0.737	-0.320	3.364	1.881	2.017	0.718	-0.262	0.546
S-94-2-A	1.453	0.827	-0.585	4.284	1.458	1.553	0.743	-0.206	0.828
S-94-2-B									
S-94-2-C	1.817	0.556	-0.710	5.222	1.844	1.865	0.493	-0.131	0.464
S-94-2-D	1.453	0.608	-0.049	3.794	1.474	1.468	0.581	-0.021	0.592
S-94-2-E	2.082	0.558	0.363	5.828	2.076	2.091	0.515	0.016	0.503

ID	M1 PHI	M2 PHI	M3	M4	Mz PHI	Md PHI	SI PHI	SKI	KG
S-94-3-A	1.228	0.780	1.139	5.259	1.177	1.124	0.708	0.244	0.970
S-94-3-B									
S-94-3-C									
S-94-4-A	1.255	0.724	0.645	6.693	1.218	1.282	0.631	-0.049	0.756

BIOGRAPHICAL SKETCH

The author of this dissertation, Carl Heywood Hobbs, III, was born May 3, 1946 to Carl Heywood and Lydia Hewitt Hobbs in New Haven, Connecticut. Following graduation from Hopkins Grammar School in 1964 he matriculated at Union College, Schenectady, New York, graduating in 1968 with a B.S. in geology. Mr. Hobbs studied at the University of Massachusetts, Amherst, from September 1968 to August 1971 receiving a M.S. in Geology in February, 1972. His thesis, *Sedimentary Environments and Coastal Dynamics of a Segment of the Shoreline of Cape Cod Bay, Massachusetts*, was written under the supervision of Miles O. Hayes.

Mr. Hobbs was a graduate student in marine science at the School of Marine Science, Virginia Institute of Marine Science, College of William & Mary from September 1971 until July 1972 when he resigned as a student to accept the staff position which he still holds. He was appointed to the faculty as an Instructor in 1975 and as Assistant Professor in 1977. His research interests include the geological history of the continental shelf including Chesapeake Bay, the natural resources of the shallow waters, and the

influence of the environment on society. He is a Certified Professional Geologist in Virginia and a member of the Board of the International Marine Minerals Society.