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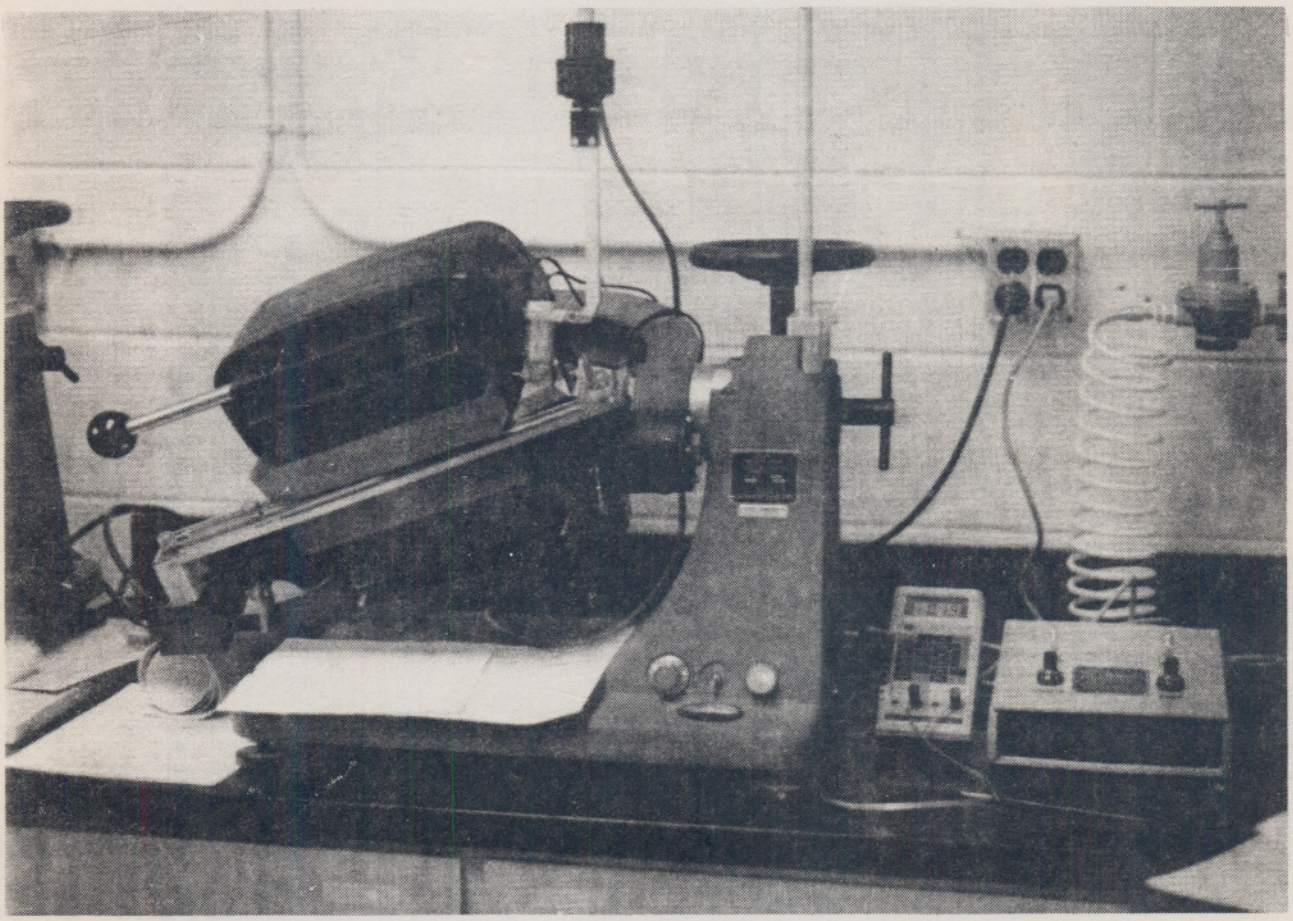
# STUDY OF ECONOMIC HEAVY MINERALS OF THE VIRGINIA INNER CONTINENTAL SHELF

C. R. Berquist, Jr. and C. H. Hobbs, III



**COMMONWEALTH OF VIRGINIA**
DEPARTMENT OF MINES, MINERALS AND ENERGY
DIVISION OF MINERAL RESOURCES
R. C. Milici, Commissioner of Mineral Resources and State Geologist

CHARLOTTESVILLE, VIRGINIA

December 1988

FRONT COVER: Frantz magnetic separator used to separate minerals according to their magnetic susceptibility.

# Study of Economic Heavy Minerals of the Virginia Inner Continental Shelf

by

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This report updates contribution No. 1425 of January, 1988, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia.

DEPARTMENT OF MINES, MINERALS AND ENERGY
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# STUDY OF ECONOMIC HEAVY MINERALS OF THE VIRGINIA INNER CONTINENTAL SHELF

C. R. Berquist, Jr.
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## ABSTRACT

The Virginia Division of Mineral Resources and the Virginia Institute of Marine Science have been investigating the occurrence of heavy minerals in the offshore sediments of Virginia over the past four years. The U.S. Minerals Management Service and the Subaqueous Minerals and Materials Study Commission, Commonwealth of Virginia, combined, provided over $400,000 of funding for these studies. This is the final report to the Subaqueous Minerals and Materials Study Commission and concludes 2 years of Commission supported studies.

The investigations were initiated because of high heavy-mineral concentrations reported from earlier reconnaissance studies. Our work not only confirms the previously reported mineral values but also has located additional high concentrations of heavy minerals up to 37 kilometers offshore. Furthermore, we have shown that potentially economic mineral values are not restricted to surficial sediments of the inner continental shelf, but are found in the upper 4.5 to 6 meters of shelf sediments at several core-sampled localities.

Several samples from cores of potentially economic sediments were clustered offshore of Hog Island, Smith Island, Virginia Beach, and False Cape. These areas are likely targets for future detailed studies for resource assessment, not only for heavy minerals but also for sand to nourish eroding beaches. The high heavy mineral concentrations suggest further investigations are warrented. The current effort to investigate heavy-mineral resources offshore is in an area that comprises only 3 percent of the Exclusive Economic Zone off Virginia.

Samples are located along the entire Atlantic coastline of Virginia and in the entrance to Chesapeake Bay, and nearly all are within 9 kilometers of land. Three hundred and ninety large-volume samples were analyzed, 284 of which came from vibracores; over 3 tons of sediment were processed. The total heavy mineral concentration of 78 samples equals to or is greater than 5 percent. Fifty-two samples have concentrations of one or more economic minerals equal to or greater than threshold values for land-based deposits (ilmenite 45%, leucoxene 5%, rutile 2%, zircon 5%, monazite 1%, and total heavy mineral concentration 5%; Garnar, 1978). The total heavy mineral concentration for all samples averaged 3.3 percent and the highest value was 14.7 percent.

Offshore sediments sampled by vibracores average about 5 meters thick and are probably Holocene in age. In places, penetration into Pleistocene or Tertiary sediments is suspected because of oxidized sediment in the cores. Microfauna were not studied. Analysis of side-scan sonar and seismic records covering 673 kilometers of trackline is continuing.

Procedures used to determine heavy mineral concentrations were designed to provide information helpful to mineral industries. The average weight of samples was 7.2 kilograms. Samples from vibrocores were derived by processing 2-meter (average) sections. Concentration of heavy minerals was done with a three-turn Humphry spiral and tetrabromoethane. The heavy-mineral concentrate was magnetically subdivided into six fractions; the mineral composition of each fraction was estimated by using transmitted- and reflected-light microscopes. The heavy-mineral composition of the sample was determined by combining the analyses of the six fractions through the use of a computer spread-sheet progam.

## INTRODUCTION

The Virginia Division of Mineral Resources (VDMR) and the Virginia Institute of Marine Science (VIMS) collected and analyzed core and grab samples, and made sidescan sonar and subbottom profile surveys from April 1986 through September 1988

on the inner continental shelf of Virginia. The project was funded by the U.S. Minerals Management Service (MMS) and the Commonwealth of Virginia. Work performed with funding from the U.S. Minerals Management Service emphasized research in the Exclusive Economic Zone (EEZ) seaward of 5.6 kilometers from land (the 3 nautical mile limit of Virginia territorial waters); work done with funding from the Commonwealth of Virginia's Subaqueous Minerals and Materials Study Commission emphasized evaluation of resources within the Commonwealth's territorial waters. This report combines the results of the total effort in describing the heavy mineral occurrences offshore of Virginia. This is a final report to the Subaqueous Minerals and Materials Study Commission following their two years of funding. Over the past three years there have been several investigations of offshore heavy minerals. The first began with funding from MMS.

The Virginia Division of Mineral Resources and the Virginia Institute of Marine Science entered into a cooperative agreement with the Bureau of Economic Geology, University of Texas at Austin (the Bureau acting as agent for the Minerals Management Service) and began a studyt in January 1985. Geophysical surveys (sidescan sonar and high-resolution shallow seismic) were made and sediment samples were taken from offshore areas of reported high concentrations of heavy minerals (Nichols, 1972; Goodwin and Thomas, 1973; Grosz and Escowitz, 1983). The project was supported by the Minerals Management Service year-two program (1985) and with funds from Virginia Division of Mineral Resources and Virginia Institute of Marine Science. A report was delivered to the Minerals Management Service in early 1986, and the results were published by the Virginia Division of Mineral Resources (Berquist and Hobbs, 1986).

Based on the 1986 data and surveys, the Subaqueous Minerals and Materials Study Commission solicited and received proposals from the Virginia Institute of Marine Science and the Virginia Division of Mineral Resources to expand the work initiated with Minerals Management Service support. The Commission recommended a research program to the General Assembly and the Governor (Subaqueous Minerals and Materials Study Commission Report, 1987). The Commonwealth program to assess the heavy-mineral potential offshore of Virginia was funded for the period July 1986 through June 30, 1988.

In January 1986, the Virginia Division of Mineral Resources and the Virginia Institute of Marine Science began work with Minerals Management Service year-three support (January 1986 - December 1987). We obtained vibracores at several sites, analyzed the cores for heavy minerals, and made geophysical surveys of these and additional sites. In April 1986, we acquiredcores at Smith Island Shoals, within the Chesapeake Bay mouth, and east of Virginia Beach.

In July 1986, with the funding from the Commonwealth, materials were analyzed from existing cores and from 100 new grab and boxcore samples taken off the Virginia coast. We made geophysical surveys at the new sample sites and recieved thirty-five cores, taken from the Chesapeake Bay entrance, from the U.S Geological Survey. Both these and the Minerals Management Service samples were processed and analyzed. The results of this work were published both as an interim report to the Subaqueous Minerals and Materials Study Commission and as a final report to the Minerals Management Service for the year-three project (Berquist and Hobbs, 1988).

With continued Commonwealth funding (second year), we took 50 new vibracores during the summer of 1987 from offshore Assateague Island to North Carolina. The results of the previous years' efforts guided the selection of core sites. An additional 510 kilometers of seismic and side-scan sonar data were collected off Virginia Beach. The Commonwealth's funding supported research personnel at Virginia Institute of Marine Science, laboratory equipment and supplies, travel, research vessel charges, and contracted services for core acquisition and sample preparation.

This report combines the results of the Minerals Management Service year-three project and the two years of Commonwealth-funded efforts. The work included the analysis of 390 samples from core and surface grabs and the partial analysis of records from 673 kilometers of geophysical surveys. Figure 1 shows the locations of samples and geophysical track lines used in this study,with the exception of the location of detailed geophysics from 1987 off Virginia Beach.

## GEOPHYSICAL METHODS AND ANALYSIS

### Introduction

The geophysical surveys for both the Commonwealth and Minerals Management Service projects included high-resolution, shallow, seismic profiling and side-scan sonography were made on small areas. The Commonwealth survey provides (acoustic) stratigraphic information over broad areas. These data combined with heavy-mineral concentrations were used to select coring sites for the Commonwealth project during the summer of 1987.

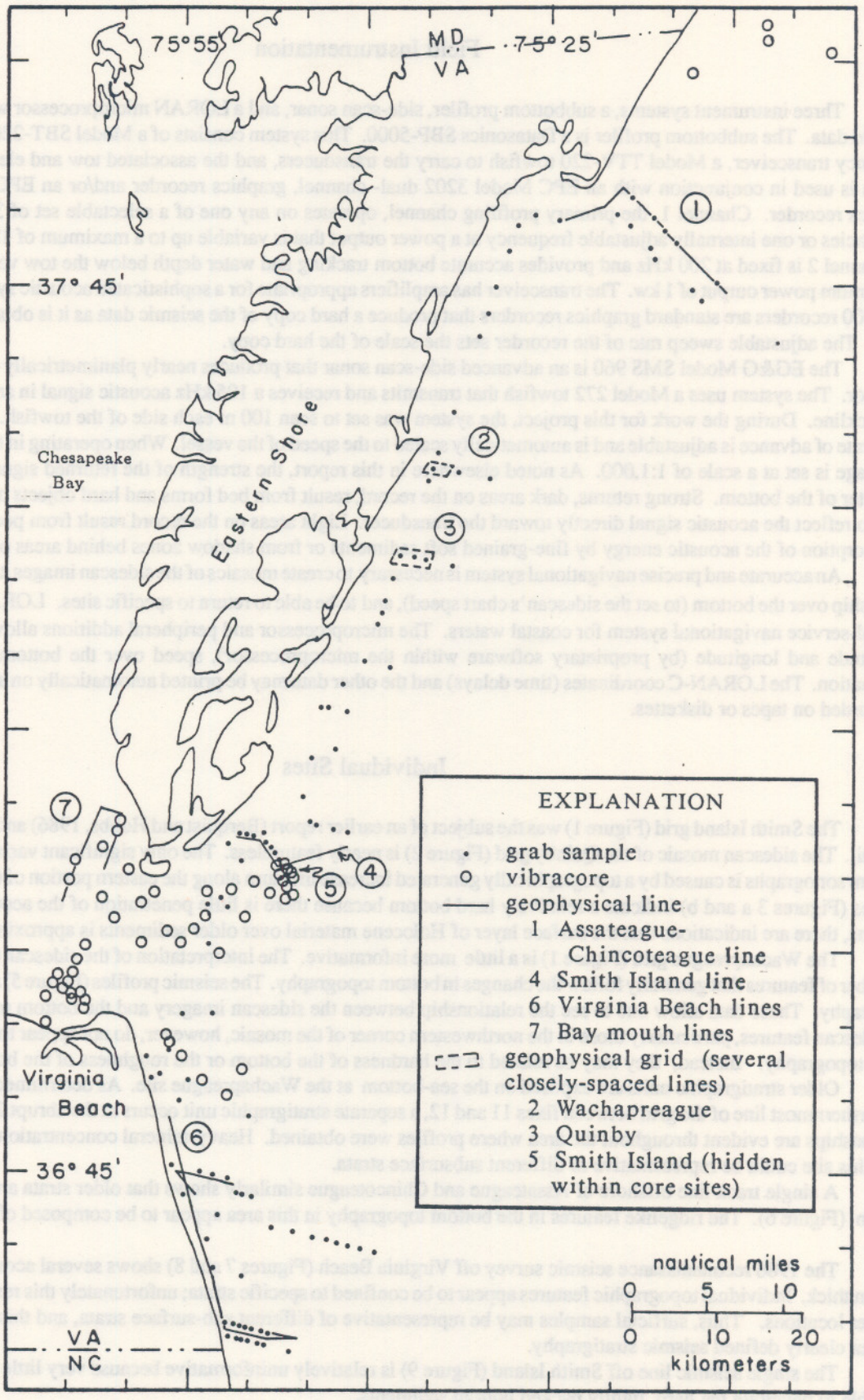



Figure 1. Location of samples and geophysical tracklines.

## Field Instrumentation

Three instrument systems, a subbottom profiler, side-scan sonar, and a LORAN microprocessor were used to acquisre the field data. The subbottom profiler is a Datasonics SBP-5000. This system consists of a Model SBT-220, two-channel, dual-frequency transceiver, a Model TTV-220 towfish to carry the transducers, and the associated tow and electronics cables. The system is used in conjunction with an EPC Model 3202 dual- channel, graphics recorder and/or an EPC 4800 three-channel graphics recorder. Channel 1, the primary profiling channel, operates on any one of a selectable set of 3.5, 5.0, and 7.0 kHz frequencies or one internally adjustable frequency at a power output that is variable up to a maximum of 12 kw. The frequency for channel 2 is fixed at 200 kHz and provides accurate bottom tracking and water depth below the tow vehicle. Channel 2 has a maximum power output of 1 kw. The transceiver has amplifiers appropriate for a sophisticated acoustic system. The EPC 3202 and 4800 recorders are standard graphics recorders that produce a hard copy of the seismic data as it is obtained on electrostatic paper. The adjustable sweep rate of the recorder sets the scale of the hard copy.

The EG&G Model SMS 960 is an advanced side-scan sonar that produces nearly planimetrically correct images of the sea floor. The system uses a Model 272 towfish that transmits and receives a 105 kHz acoustic signal in an arc that is normal to the trackline. During the work for this project, the system was set to scan 100 m each side of the towfish. The system's chart-paper rate of advance is adjustable and is automatically scaled to the speed of the vessel. When operating in the 100-m half-width, the image is set at a scale of 1:1,000. As noted elsewhere in this report, the strength of the returned signal is indicative of the character of the bottom. Strong returns, dark areas on the record, result from bed forms and hard objects or sediments oriented so as to reflect the acoustic signal directly toward the transducer. Light areas on the record result from poor backscatter caused by absorption of the acoustic energy by fine-grained soft sediments or from shadow zones behind areas of relief.

An accurate and precise navigational system is necessary to create mosaics of the sidescan images, to determine the speed of the ship over the bottom (to set the sidescan's chart speed), and to be able to return to specific sites. LORAN-C is the standard, general-service navigational system for coastal waters. The microprocessor and peripheral additions allow instant calculations of latitude and longitude (by proprietary software within the microprocessor), speed over the bottom, heading, and other information. The LORAN-C coordinates (time delays) and the other data may be printed automatically on associated equipment, or recorded on tapes or diskettes.

## Individual Sites

The Smith Island grid (Figure 1) was the subject of an earlier report (Berquist and Hobbs, 1986) and will not be discussed in detail. The sidescan mosaic of the Quinby grid (Figure 2) is nearly featureless. The only significant variation on the otherwise uniform sonographs is caused by a topographically generated increase in return along the eastern portion of the grid. The seismic profiles (Figures 3 a and b) indicate a relatively hard bottom because there is little penetration of the acoustic signal. In some sections, there are indications that the surface layer of Holocene material over older sediments is approximately 5 meters thick.

The Wachapreague grid (Figure 1) is a little more informative. The interpretation of the sidescan data (Figure 4) shows a number of features that generally follow the changes in bottom topography. The seismic profiles (Figure 5) also depict the bottom topography. These data allow one to see the relationship between the sidescan imagery and the bottom morphology. Some of the sidescan features, particularly those in the northwestern corner of the mosaic, however, do not appear to have a direct relation to the topography. Instead, they may be related to the hardness of the bottom or the roughness of the bottom sediment.

Older stratigraphic units are exposed on the sea-bottom at the Wachapreague site. As determined from seismic data in the northernmost line of the grid between fixes 11 and 12, a separate stratigraphic unit occurs at the abrupt 2- to 3-m rise. Similar relationships are evident throughout the area where profiles were obtained. Heavy-mineral concentrations in surficial samples from this site could be representative of different subsurface strata.

A single track line offshore of Assateague and Chincoteague similarly shows that older strata are exposed on the sea-bottom (Figure 6). The ridgelike features in the bottom topography in this area appear to be composed of discrete sedimentary units.

The 1986 reconnaissance seismic survey off Virginia Beach (Figures 7 and 8) shows several acoustic layers between 2 and 5m thick. Individual topographic features appear to be confined to specific strata; unfortunately this resolution is not as clear in other locations. Thus, surficial samples may be representative of different sub-surface strata, and this would not be known without clearly defined seismic stratigraphy.

The single seismic line off Smith Island (Figure 9) is relatively uninformative because very little of the acoustic signal was able to penetrate the hard, tightly packed bottom sediments.

In the summer of 1987, 534 kilometers of line was surveyed between the mouth of Chesapeake Bay and the seaward extension of the Virginia - North Carolina boundary. The subbottom profiler and side-scan sonar systems used both LORAN-

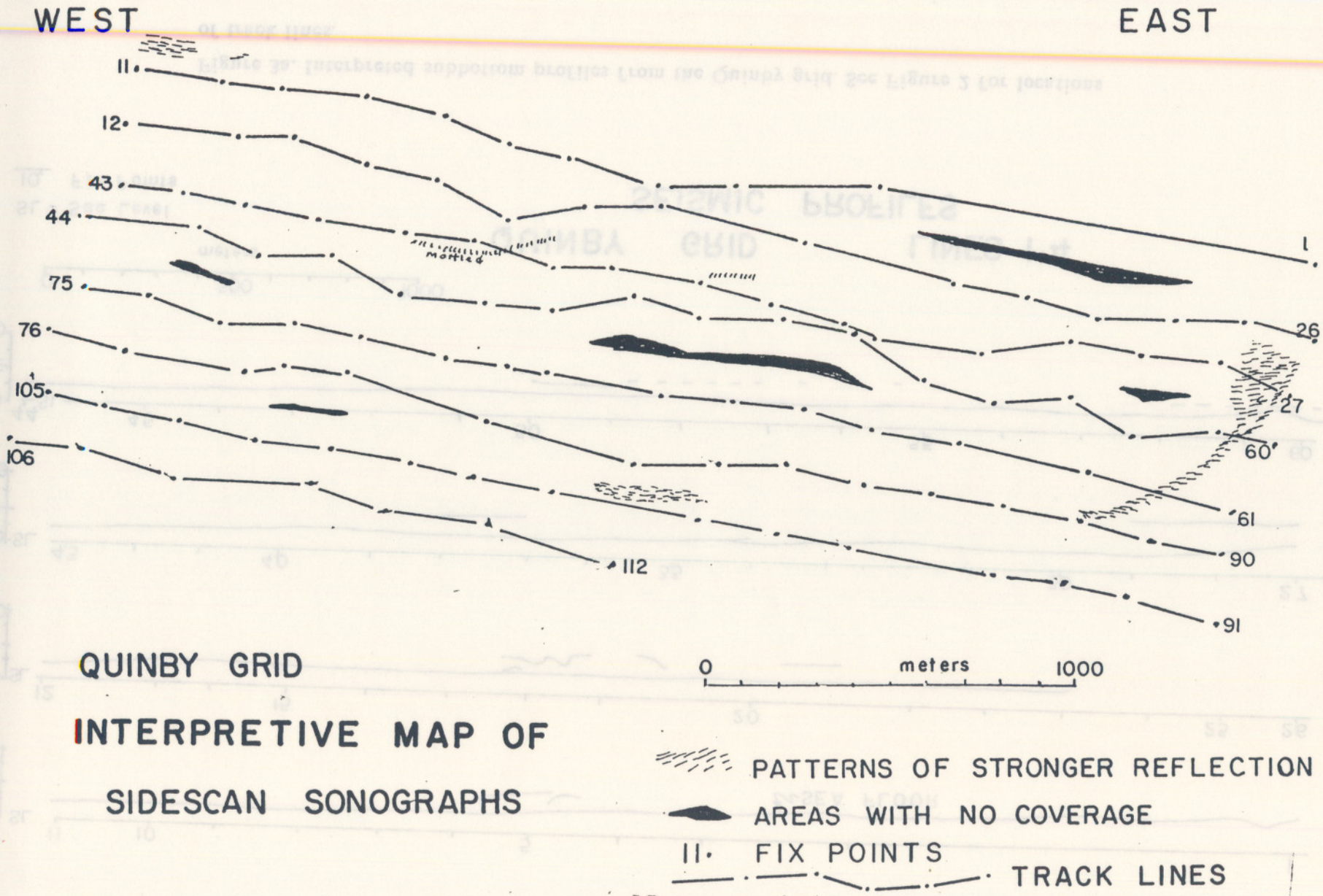



Figure 2. Interpretation of Quinby grid sidescan mosaic.

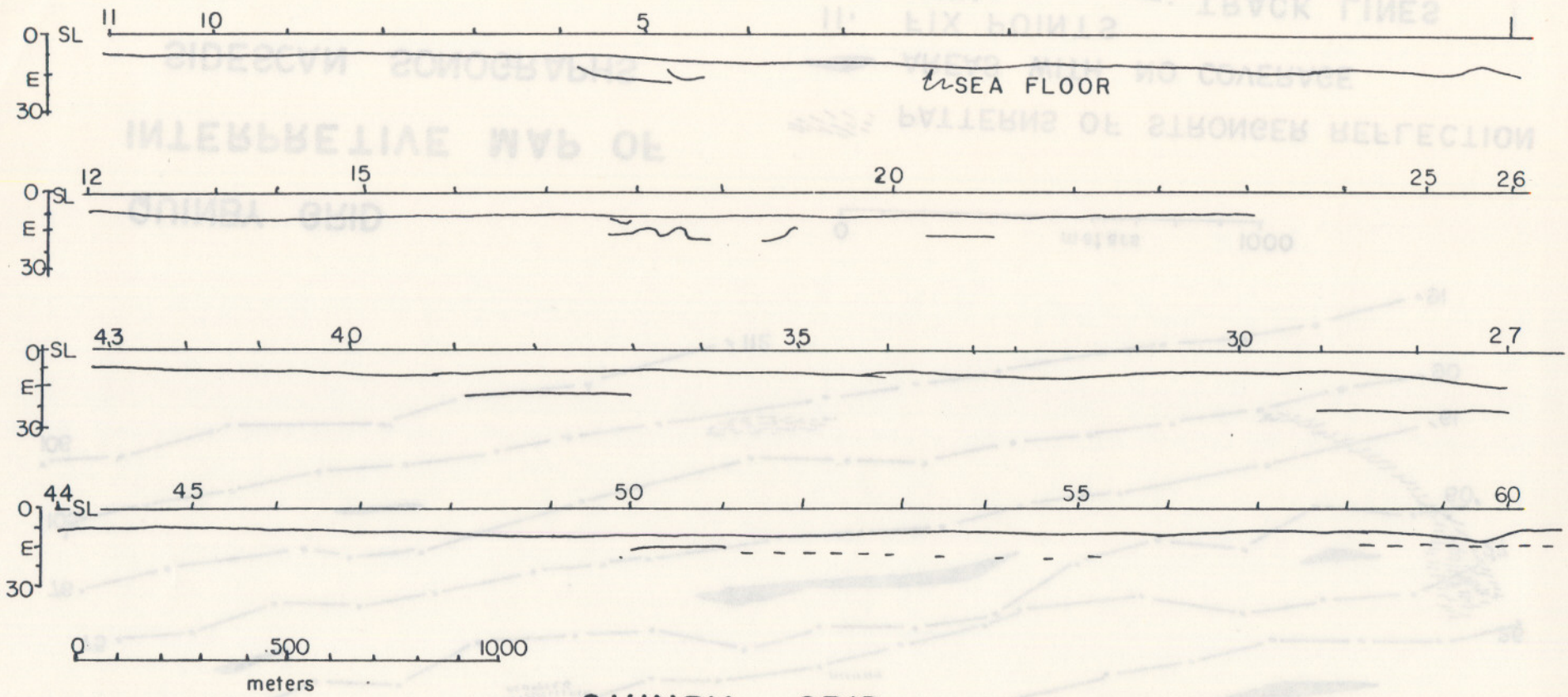



Figure 3a. Interpreted subbottom profiles from the Quinby grid. See Figure 2 for locations of track lines.

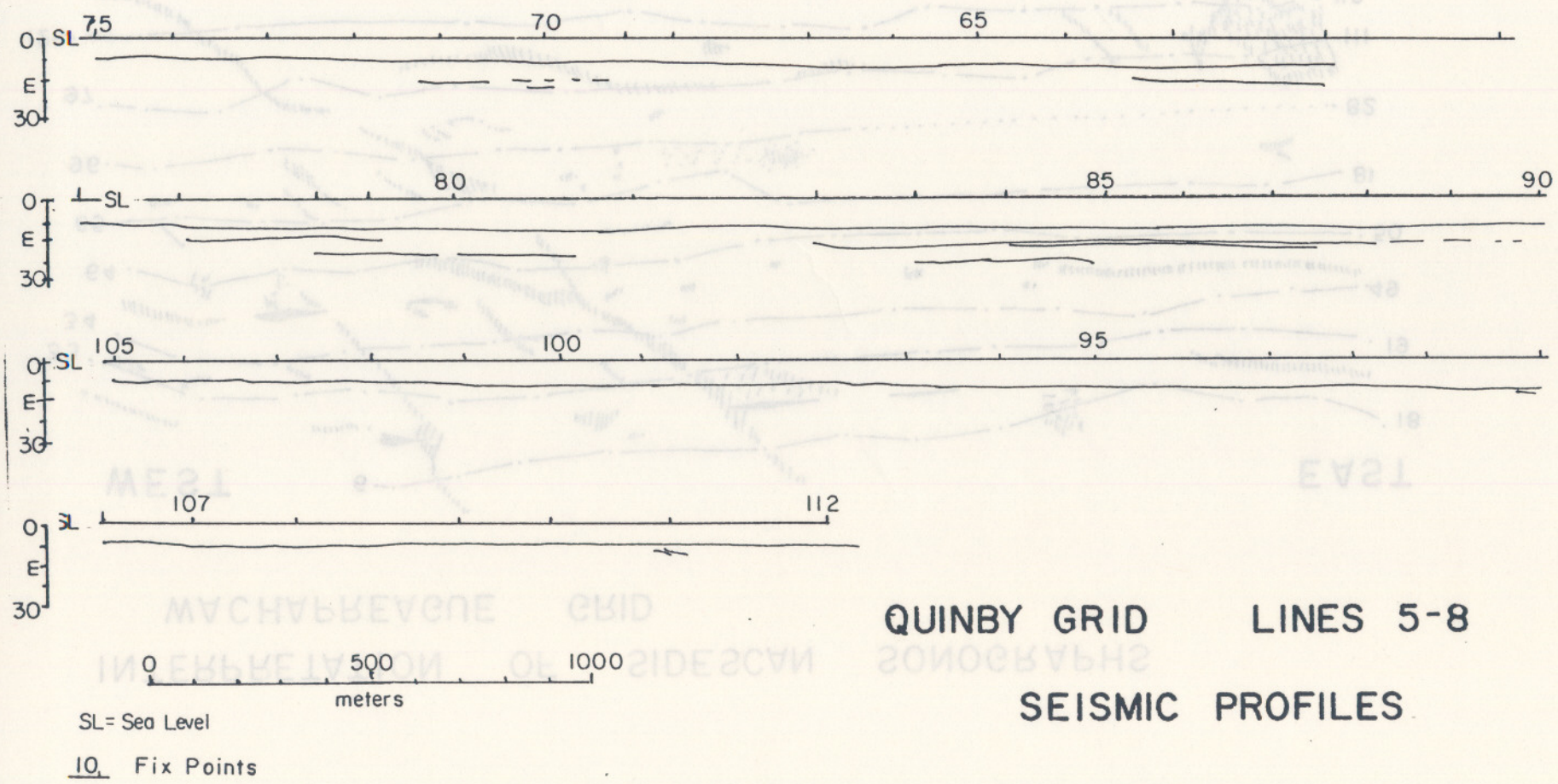



Figure 3b. Interpreted subbottom profiles from the Quinby grid. See Figure 2 for locations of track lines.

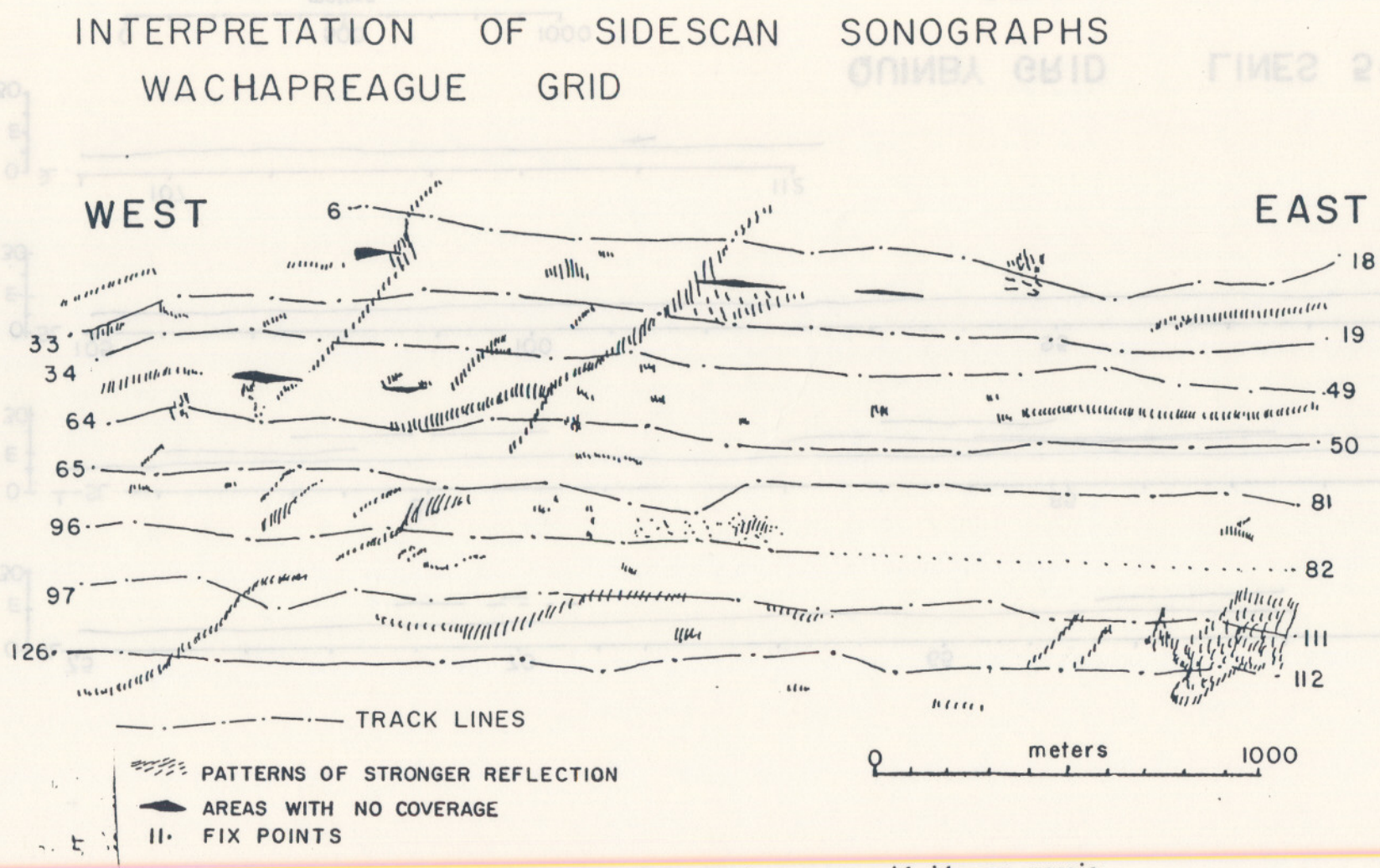



Figure 4. Interpretation of the Wachapreague grid sidescan mosaic.

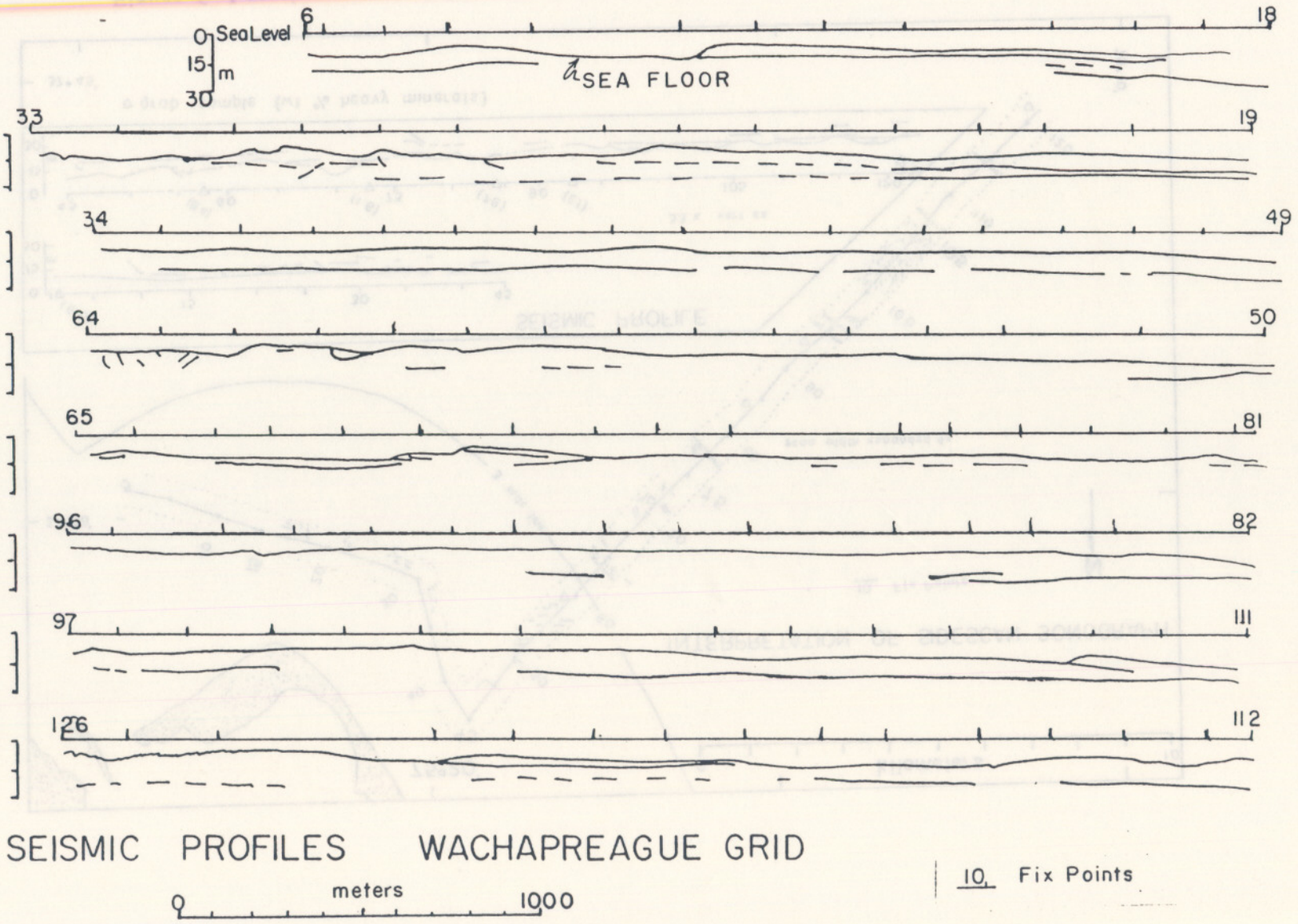



Figure 5. Interpretation of the Wachapreague grid subbottom profiles. See Figure 4 for locations of track lines.

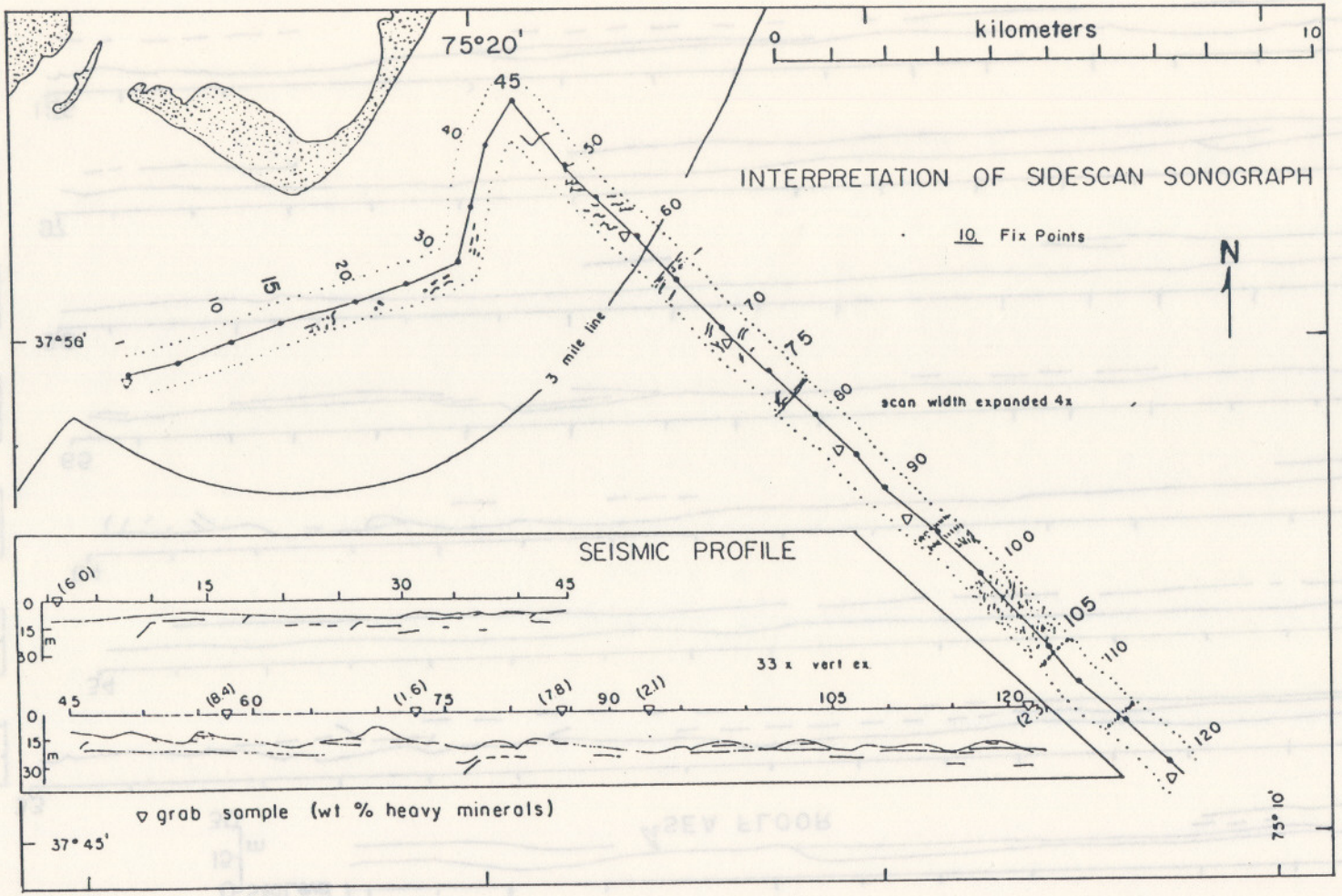



Figure 6. Location map and interpretation of subbottom (seismic) profiles and sidescan sonographs from the Assateague-Chincoteague area. See Figure 2 for explanation of sidescan sonograph patterns. Width of sidescan record is marked by dotted lines parallel to track lines.

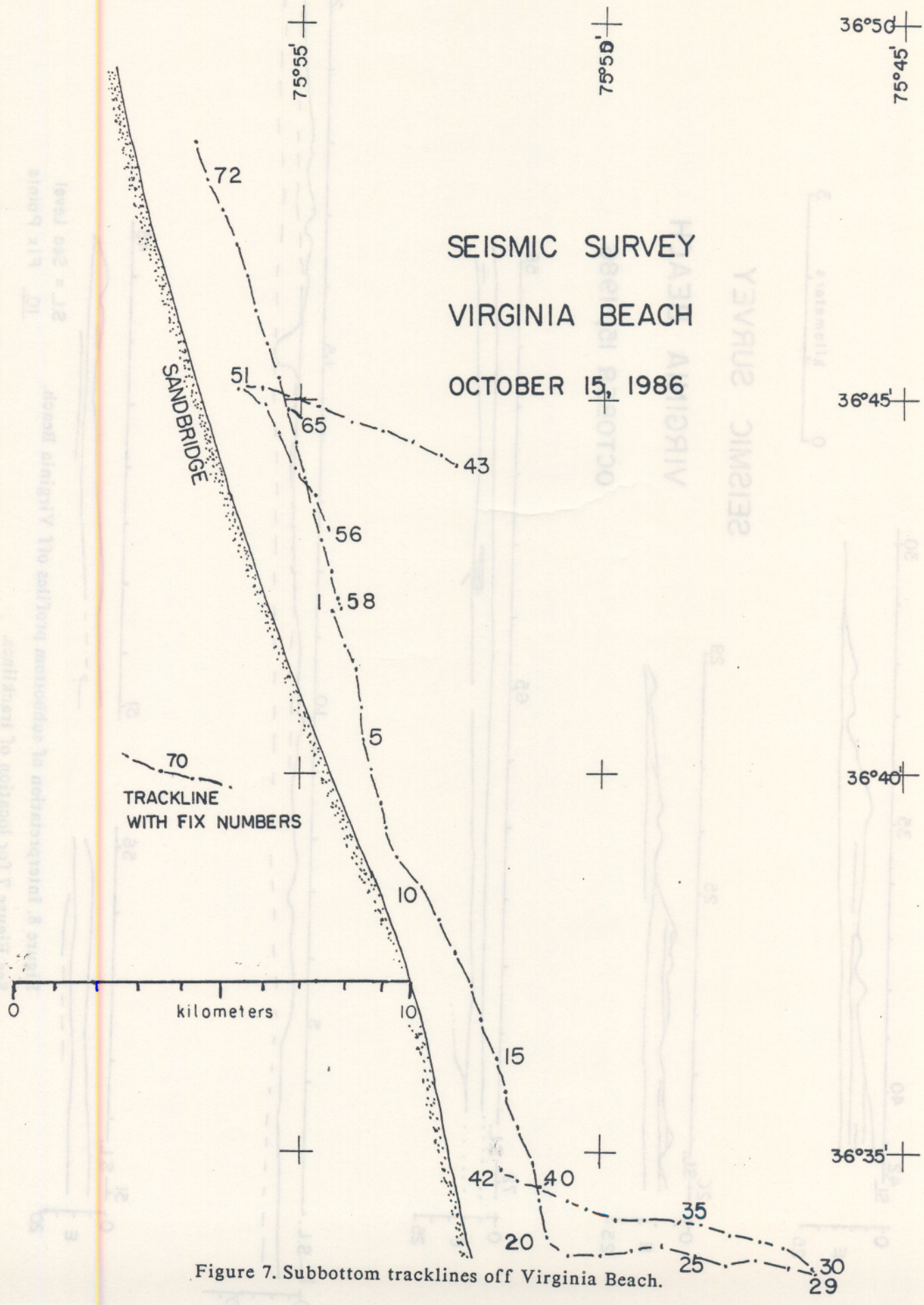



Figure 7. Subbottom tracklines off Virginia Beach.

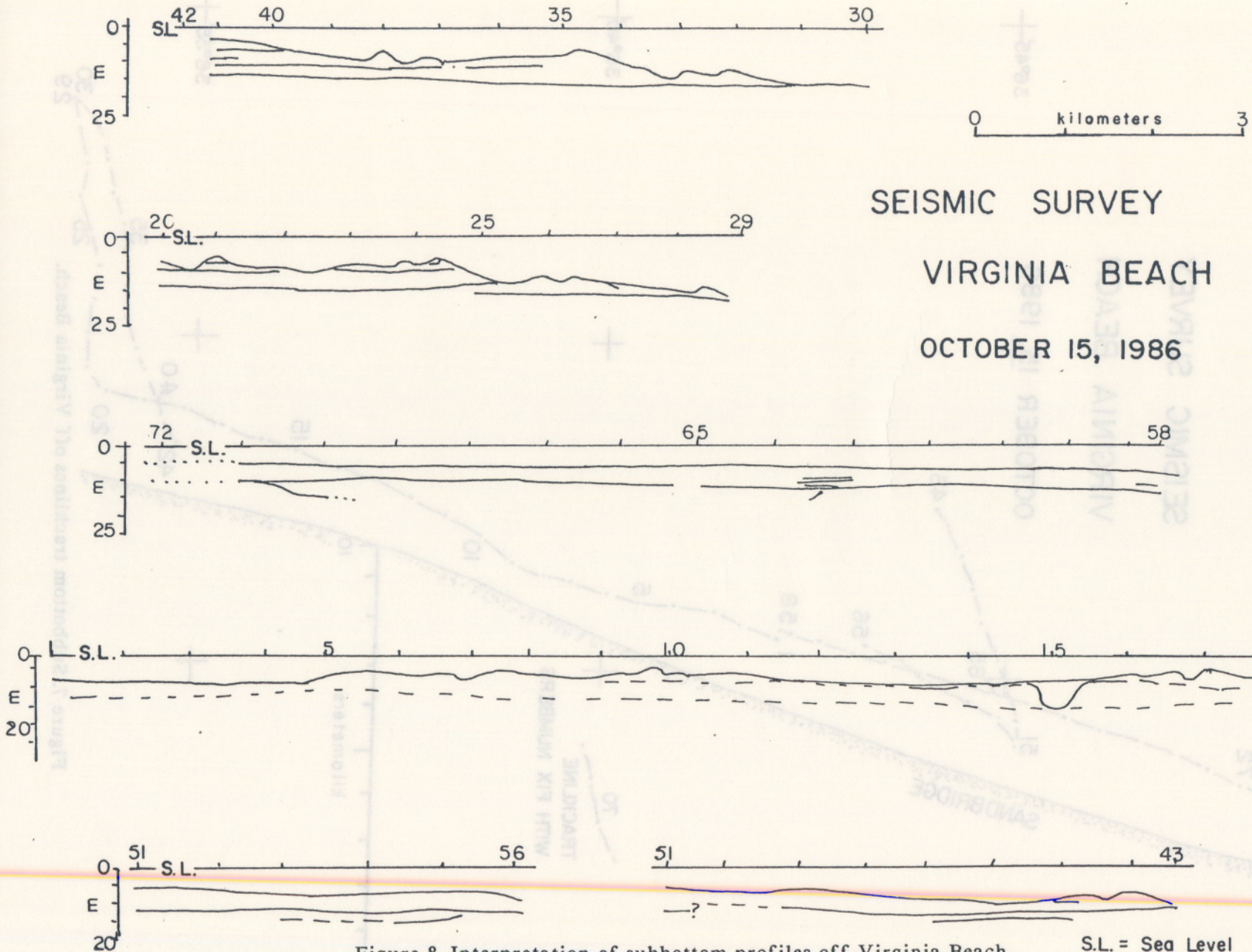
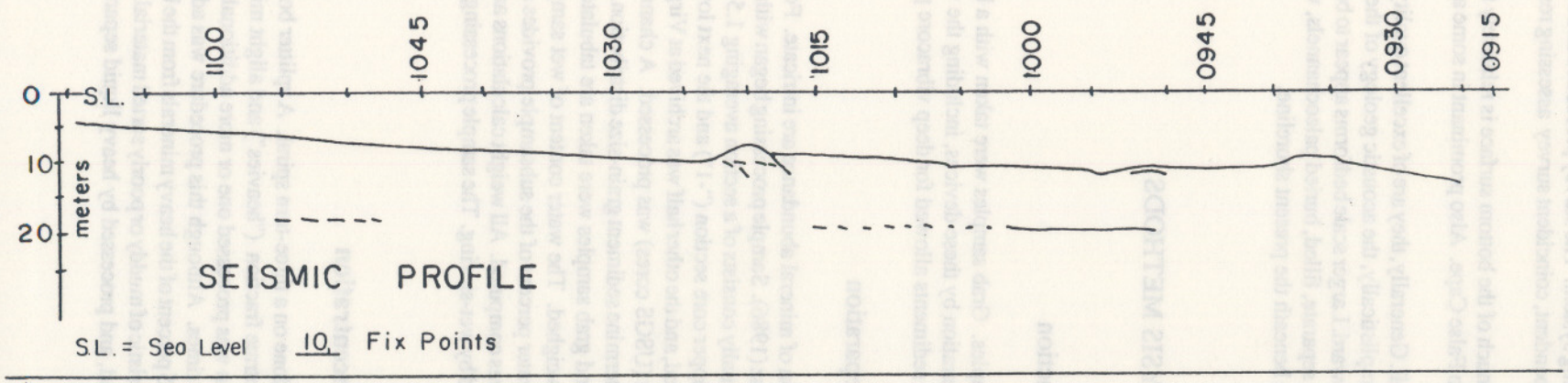



Figure 8. Interpretation of subbottom profiles off Virginia Beach.
See Figure 7 for location of tracklines.

S.L. = Sea Level
10 Fix Points



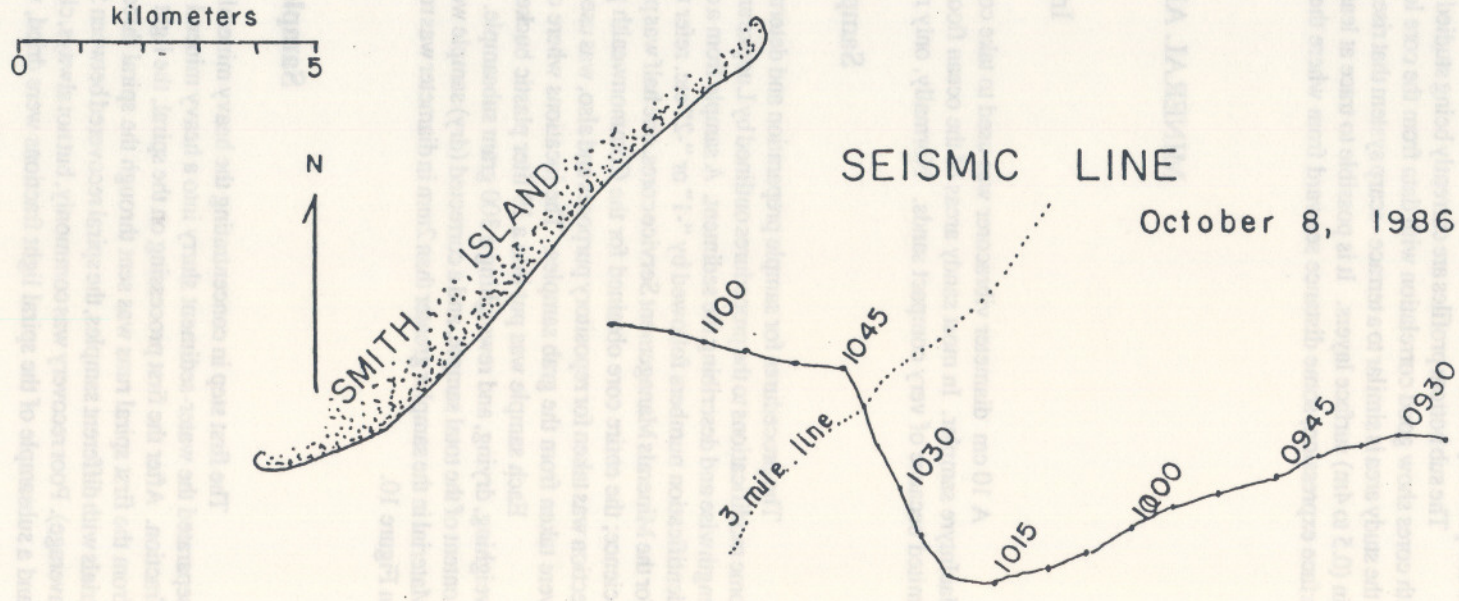




Figure 9. Interpretation of seismic line off Smith Island.

C and, for part of the work, a locally configured Del Norte positioning system. The survey preceeded and followed the summer's coring program. This work was significantly enhanced by an independent, coincident survey assessing resources of sand for use in beach nourishment.

Initial review of the side-scan sonographs indicates that much of the bottom surface is relatively featureless. There are areas of both small and large scale bedforms, especially adjacent to False Cape. Also prominant in some areas are "drag marks" that are probably indicative of commercial bottom-trawl fishing.

The sub bottom profiles are currently being studied in detail. Generally, they are of excellent quality and where coincident with cores show good correlation with data from the core logs. Simplistically, the acoustic geology of the southernmost portion of the study area is similar to a terrace - scarp system that rises shoreward. Larger scale bedforms appear to be confined to relatively thin (0.5 to 4m) surface layers. It is possible to trace at least two, separate, filled, buried paleochannels, which have no obvious surface expression, some distance seaward from where they pass beneath the present shoreline.

## MINERAL ANALYSIS METHODS

### Introduction

A 10 cm diameter vibracorer was used to take core samples. Grab samples were taken with a box-corer and a Smith-MacIntyre sampler. In most sandy areas of the ocean floor, penetration by these devices, including the vibracorer, was greatly limited because of very compact sands. Normally, only muddy sediments allowed for deep vibracore penetration.

### Sample Preparation

The procedures for sample preparation and determination of mineral abundance are intricate. For this project, we made some modifications to the procedures outlined by Luepke and Grosz (1986). Sample processing began with splitting the vibracores lengthwise and describing the sediment. A sample from a core usually consists of a section averaging 1.5 meters in length. Core identification numbers followed by "-1" or "-2" etc. refer to the upper core section ("-1") and the next lower core section ("-2"). For the Minerals Management Service cores, one half was processed, and the other half was archived at Virginia Institute of Marine Science; the entire core obtained for the Commonwealth project (USGS cores) was processed. A channel sample of each core section was taken for repository purposes and also, was used to determine sediment grain-size distribution. No repository samples were taken from the grab samples. The locations where cores and grab samples were taken are tabulated in Appendix I.

Each sample was put into a 19 liter plastic bucket and weighed. The water content of wet samples was determined by weighing, drying, and reweighing a 300 gram subsample. The water percent of the subsample provides an estimate of the water content of the total sample, and a corrected (dry) sample weight was computed. All weight calculations are based on dry samples. Material in the sampler greater than 2mm in diameter was removed by wet-sieving. The sample processing procedures are outlined in Figure 10.

### Sample Concentration

The first step in concentrating the heavy minerals was done on a three-turn spiral. A splitter box at the end of the spiral separated the water-sediment slurry into a heavy mineral concentrate fraction ("heavies") and alight mineral fraction ("lights") fraction. After the first processing on the spiral, the light fraction was processed one or more additional times. The concentrate from the first spiral runs was sent through the spiral three more times. Although this procedure was adopted after a number of trials with different samples, the spiral recovered between 5 and 95 percent of the heavy minerals from the bulk samples (55 percent average). Poor recovery was commonly, but not always, characteristic of muddy or poorly sorted material. The spiral concentrates and a subsample of the spiral light fractions were dried, weighed, and processed by heavy liquid separation techniques.

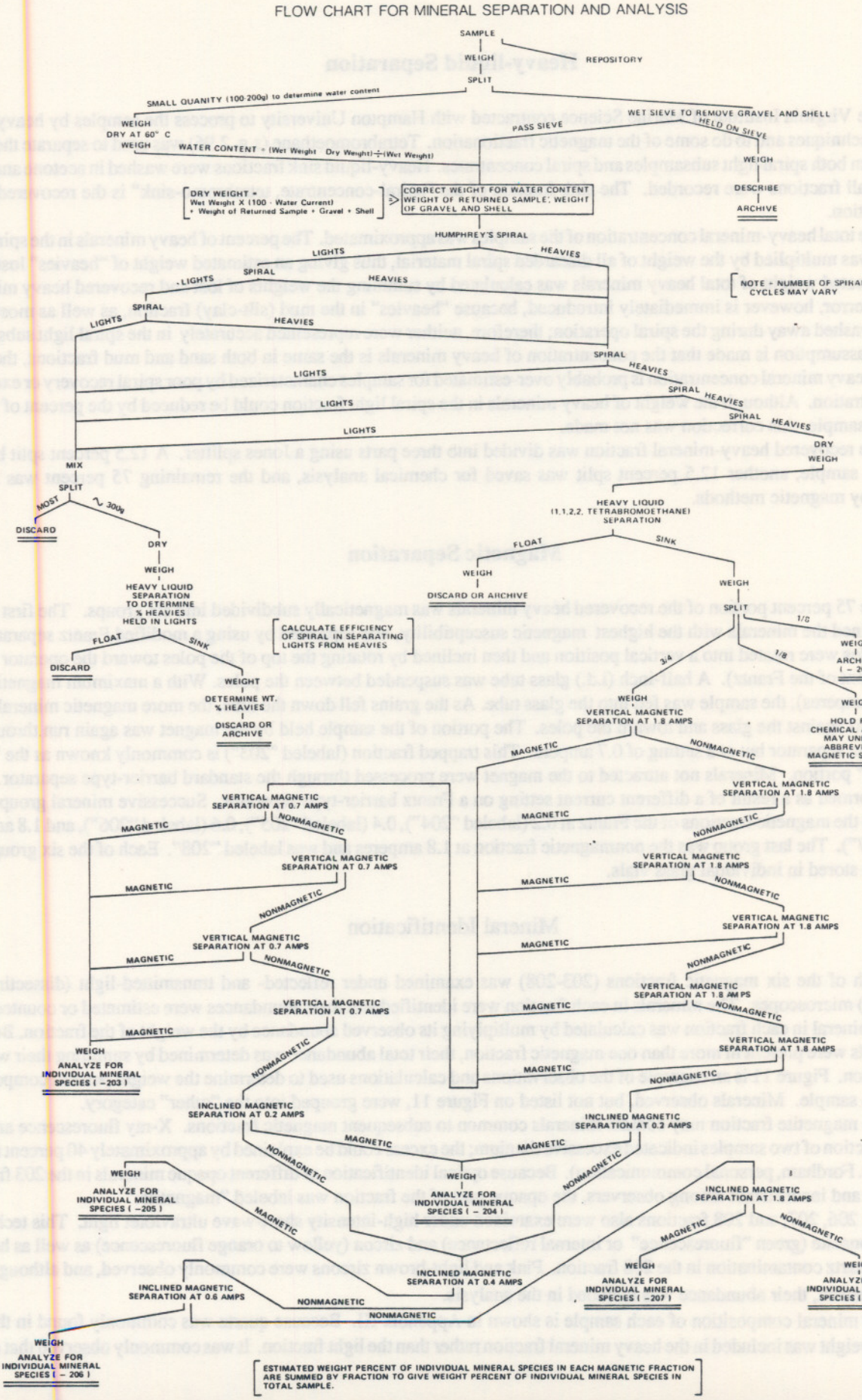



Figure 10. Flow chart showing the scheme of sample analysis.

## Heavy-liquid Separation

The Virginia Institute of Marine Science contracted with Hampton University to process the samples by heavy-liquid separation techniques and to do some of the magnetic fractionation. Tetrabromoethane (s.g. 2.96) was used to separate the heavy minerals from both spiral light subsamples and spiral concentrates. Heavy-liquid sink fractions were washed in acetone and dried. Weights of all fractions were recorded. The sink fraction of the "spiral-concentrate, tetrabromo-sink" is the recovered heavy mineral fraction.

The total heavy-mineral concentration of the samples was approximated. The percent of heavy minerals in the spiral light subsample was multiplied by the weight of all discarded spiral material, thus giving an estimated weight of "heavies" lost by the spiral. Estimated weight of total heavy minerals was calculated by summing the weights of lost and recovered heavy minerals. A source of error, however is immediately introduced, because "heavies" in the mud (silt-clay) fraction, as well as most of the mud, were washed away during the spiral operation; therefore, neither were represented accurately in the spiral light subsample. Because an assumption is made that the concentration of heavy minerals is the same in both sand and mud fractions, the result is that total heavy mineral concentration is probably over-estimated for samples characterized by poor spiral recovery or excessive mud concentration. Although the weight of heavy minerals in the spiral light fraction could be reduced by the percent of mud in the original sample, this correction was not made.

The recovered heavy-mineral fraction was divided into three parts using a Jones splitter. A 12.5 percent split became a repository sample, another 12.5 percent split was saved for chemical analysis, and the remaining 75 percent was further subdivided by magnetic methods.

## Magnetic Separation

The 75 percent portion of the recovered heavy minerals was magnetically subdivided into six groups. The first group, which contained the minerals with the highest magnetic susceptibility, was separated by using a modified Frantz separator; the magnetic poles were rotated into a vertical position and then inclined by rotating the top of the poles toward the operator (while facing the front of the Frantz). A half-inch (i.d.) glass tube was suspended between the poles. With a maximum magnetic field setting (1.8 amperes), the sample was fed into the glass tube. As the grains fell down the tube, the more magnetic minerals were pulled upward against the glass and toward the poles. The portion of the sample held by the magnet was again run through the vertical Frantz separator but at a setting of 0.7 ampere. This trapped fraction (labeled "203") is commonly known as the "hand-held magnet" portion. Minerals not attracted to the magnet were processed through the standard barrier-type separator. Each group was formed as a result of a different current setting on a Frantz barrier-type separator. Successive mineral groups were derived from the magnetic fractions of the Frantz at 0.2 (labeled "204"), 0.4 (labeled "205"), 0.6 (labeled "206"), and 1.8 amperes (labeled "207"). The last group was the nonmagnetic fraction at 1.8 amperes and was labeled "208". Each of the six groups was weighed and stored in individual glass vials.

## Mineral Identification

Each of the six magnetic fractions (203-208) was examined under reflected- and transmitted-light (dissecting and petrographic) microscopes. The minerals in each fraction were identified and their abundances were estimated or counted. The weight of a mineral in each fraction was calculated by multiplying its observed abundance by the weight of the fraction. Because some minerals were present in more than one magnetic fraction, their total abundance was determined by summing their weights in each fraction. Figure 11 is an example of the observations and calculations used to determine the weight percent composition for the entire sample. Minerals observed, but not listed on Figure 11, were grouped into the "other" category.

The magnetite fraction may contain minerals common to subsequent magnetic fractions. X-ray fluorescence analysis of the 203 fraction of two samples indicated excessive titanium; the excess could be explained by approximately 40 percent titano-magnetite (O. Fordham, personal communication). Because optical identification of different opaque minerals in the 203 fraction was difficult and inconsistant among observers, the opaque part of the fraction was labeled "magnetite."

The 206, 207, and 208 fractions also were examined under high-intensity short-wave ultraviolet light. This technique identified monazite (green "fluorescence" or internal reflectance) and zircon (yellow to orange fluorescence) as well as helping to estimate quartz contamination in the 208 fraction. Pink and light-brown zircons were commonly observed, and although they are not fluorescent, their abundance was included in the analysis.

The mineral composition of each sample is shown in Appendix III. Because quartz was commonly found in the 208 fraction, its weight was included in the heavy mineral fraction rather than the light fraction. It was commonly observed that quartz

made up at least 90 percent of the 208 "other" fraction. A correction was made to the weight percent of the total heavy minerals by subtracting the weight of quartz contamination and is included in the calculation of data under column headings "WT % THM" in the appendices. The decrease ranged from 2 percent to 18 percent and averages 2,6 percent of the uncorrected value.

**SAMPLE 54** wt of heavy minerals in sample 453.3g

| fraction wt= | 51.26g | 163.92 | 165.55 | 2.75 | 14.93 | 54.89 | |
|---|---|---|---|---|---|---|---|
| MINERAL | 203 | 204 | 205 | 206 | 207 | 208 | sum wt/ hm wt |
| MAGNETITE | 98% | | | | | | 50.23 |
| wt | 50.23g | | | | | | 453.3 =11.08% |
| ILMENITE | | 73% | 7% | 4% | | | 131.3 |
| wt | | 119.7 | 11.6 | 0.1 | | | 453.3 = 28.9% |
| GARNET | 1% | 19% | 36% | 8% | 8% | | 92.6 |
| wt | 0.5 | 31.1 | 59.6 | 0.2 | 1.2 | | 453.3 = 20.4% |

Figure 11. Partial record of observed mineral abundances in each magnetic fraction. Calculations to determine sample composition are computed in the spreadsheet program, but are shown here as an example.

## Data Base

All calculations and data entry were made on the Virginia Institute of Marine Science PRIME computer, using the 20/20 spreadsheet modeling program. For each step in the preparation of samples for mineral identification, the sample and its many fractions were weighed. The spreadsheet program stored and calculated weights and other characteristics throughout the analysis. Out of approximately 436 samples, 390 were completely analyzed through the heavy-mineral identification phase. Of the remaining 46 samples, one was lost by contamination and the others did not contain enough heavy minerals to allow for satisfactory processing.

The completed data base contains about 70,000 cells of information. Copies of the data base are not included in this report, but are available for inspection at the Virginia Division of Mineral Resources and the Virginia Institute of Marine Science; Appendices II through VI contain the resultant sample compositions.

# RESULTS

## Sample Composition

Appendix III shows the mineral composition for the heavy mineral fractions of all samples. The data are subdivided into two groups: cores, and grab samples. Because surface grab samples are of little valuein predicting economic mineral potential (A. E. Grosz, personal communication), the grab sample data were separated from core data. Appendix III includes separate statistics for each group. Appendix IV shows statistics for all samples treated as one group.

Another way of characterizing mineral abundance is to calculate mineral composition relative to the entire sample rather than to the heavy- mineral fraction. This is shown in Appendix V. The data have been "weighted" by the total heavy mineral concentration so that mineral abundance per ton, for example, may readily be estimated.

Tables 1 and 2 show average and highest values for the more economic minerals by group and all samples. The total heavy mineral (THM) concentration (average and highest value) of grab samples is at least 50 percent greater than for cores. Mineral compositions, however, were nearly the same for cores and grab samples, with the exception of zircon and monazite. Therefore, based on data in this report, grab samples may be useful in predicting offshore mineral composition, but they do not appear to be good indicators of total heavy mineral concentration. The economic potential of sediments can be established accurately only by analyses of cores.

TABLE 1. Average concentrations of selected minerals as a percentage of the heavy-mineral fraction; 106 grab samples, 284 core samples = 390 total.

| | WT% THM | WT % ILMENITE | WT % LEUCOXENE | WT % RUTILE | WT % ZIRCON | WT % MONAZITE |
|---|---|---|---|---|---|---|
| core samples | 2.9 | 24.0 | 1.7 | 1.4 | 3.8 | 0.1 |
| grab samples | 4.4 | 28.6 | 1.8 | 1.2 | 2.8 | 0.3 |
| all samples | 3.3 | 25.2 | 1.8 | 1.3 | 3.6 | 0.1 |

TABLE 2. Maximum concentrations of selected minerals as a percentage by weight of the heavy-mineral fraction.

| | WT % THM | WT % ILMENITE | WT % LEUCOXENE | WT % RUTILE | WT % ZIRCON | WT % MONAZITE |
|---|---|---|---|---|---|---|
| core samples | 9.1 | 60.3 | 7.9 | 3.2 | 9.2 | 2.5 |
| grab samples | 14.7 | 58.8 | 8.2 | 2.8 | 5.4 | 1.8 |

## Economic Potential

The average values for the minerals in Table 1 are lower than industry standards for mining on land but the maximum values in Table 2 exceed that minimum. Although market conditions may alter the following values, the minimum concentrations of the heavy-mineral fraction of a hypothetically economic land deposit should be: ilmenite, 45 percent; leucoxene, 5 percent; rutile, 2 percent; zircon, 5 percent; staurolite, 20 percent; monazite, 1 percent; garnet/epidote, 15 percent; kyanite/ sillimanite, 7 percent; and a total heavy mineral concentration of 4 or 5 percent (Garnar, 1978). Because there is no offshore production of a similar suite of heavy minerals within U.S. waters, a direct economic comparison to Virginia's offshore mineral potential cannot be made. It has been suggested that offshore concentrations may need to have twice the value of economic land deposits in order for development to proceed (U.S. Congress, 1987). Additionally, several factors make it difficult to assess the commercial potential of marine minerals: the erratic performance of domestic and global mineral economies and changing technologies affecting both demand and production being but two (U.S. Congress, 1987). There is also a lack of a detailed geologic analysis of an offshore site, including an environmental and resource assessment and a feasability study. The economic potential of the offshore heavy-minerals may depend also on the volume of other marketable material (including sand and gravel) present.

The economic minerals found in abundance offshore of Virginia are those containing titanium (ilmenite, leucoxene, and rutile) and minerals containing rare-earth elements (monazite and zircon). Zircon is used as a refractory material. The sum of these minerals plus the sillimanite/kyanite (also refractory minerals) fraction forms the "ECON" (economic interest) group of heavy minerals.

We have identified with concentrations of one or more of the "ECON" minerals equal to or greater than Garnar's threshold values, assuming a THM of 5 percent in more than 52 samples. These samples are marked by underlining in Appendice V and are indicated on Figure 12. Eleven of these or other samples are summarized in Table 3; two are graphically shown in Figure 13. Although total heavy mineral concentration may be low in some samples, an exceptional abundance of an individual mineral(s) in these samples may encourage further investigation.

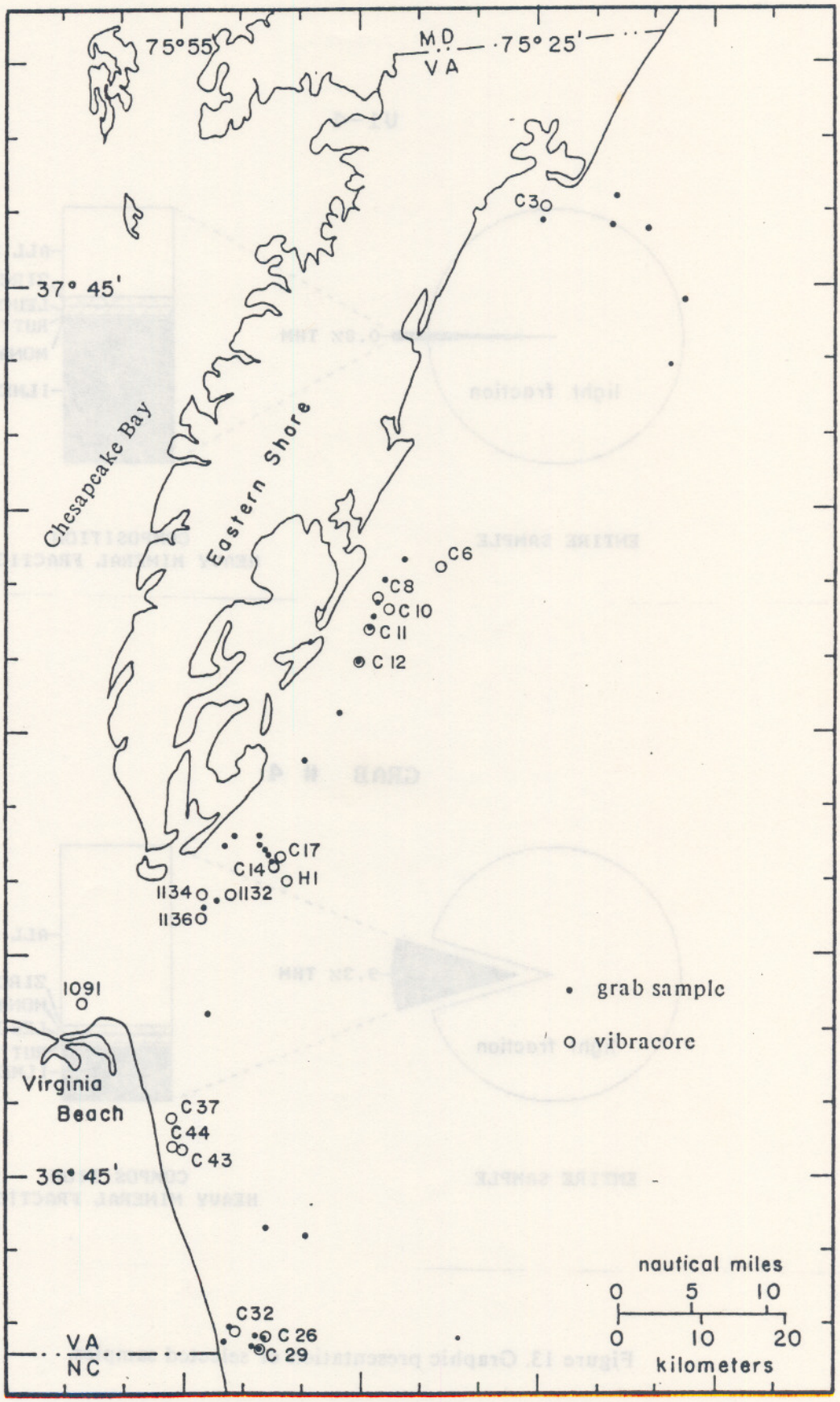
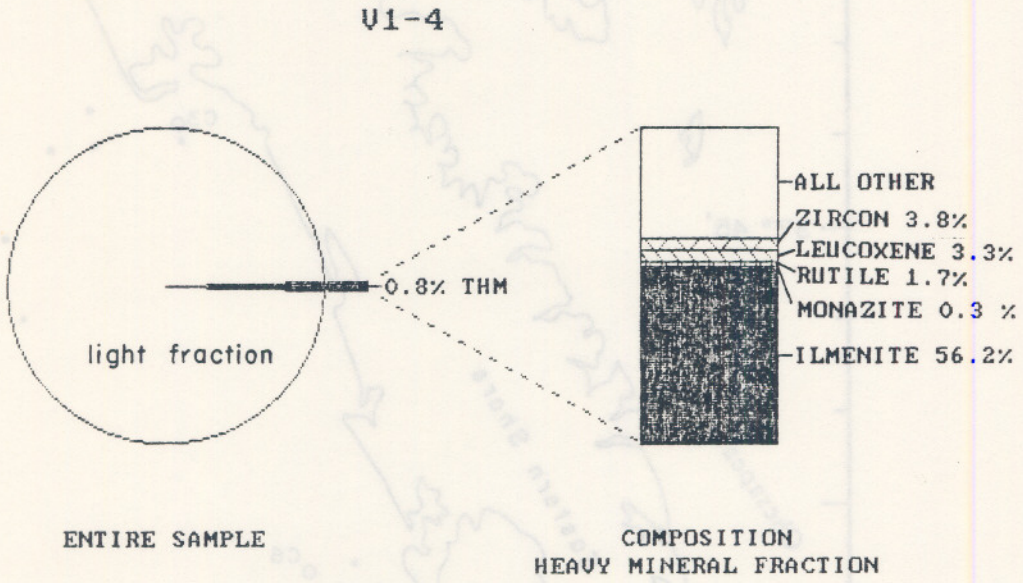



Figure 12. Map showing the location of samples with apparant economic potential.



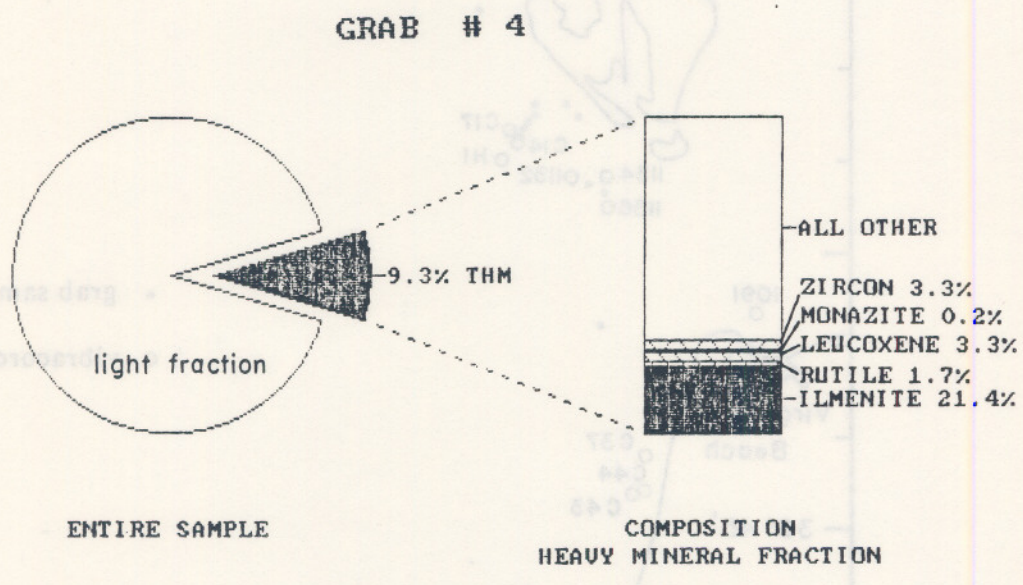




Figure 13. Graphic presentation of selected samples.

TABLE 3. Several samples with possible economic potential selected from Appendix III. Composition in weight percent is relative to the heavy mineral fraction. P = present; see Appendix III for additional explanation of tabulated data.

| Sample | WT % THM | WT % il | WT % rut | WT % leucx | WT % mon | WT % zr | WT % ECON |
|---|---|---|---|---|---|---|---|
| H01-3 | 5.4 | 17.4 | 2.7 | 0.3 | 1.4 | 7.6 | 32.2 |
| V1-4 | 0.8 | 56.2 | 1.7 | 3.3 | 0.3 | 3.8 | 66.1 |
| 4 | 9.3 | 21.4 | 1.4 | 3.0 | 0.2 | 3.3 | 30.8 |
| 33 | 5.1 | 58.8 | 0.8 | 0.6 | 0.1 | 4.1 | 65.8 |
| 54 | 14.7 | 29.0 | 1.1 | 0.2 | 0.4 | 4.5 | 35.9 |
| 59 | 11.0 | 34.9 | 1.5 | 0.6 | 0.1 | 4.3 | 42.4 |
| 85 | 10.8 | 54.9 | 2.4 | 1.8 | 0.1 | 3.8 | 63.1 |
| 1134-1 | 8.8 | 34.0 | 1.8 | 0.3 | 0.2 | 4.6 | 41.1 |
| 1136-1 | 9.0 | 28.7 | 1.1 | 1.0 | P | 3.5 | 34.7 |
| C27-3 | 2.7 | 44.4 | 2.0 | 3.0 | P | 3.9 | 56.1 |
| C42-4 | 3.2 | 49.4 | 2.0 | 2.0 | 0.2 | 6.7 | 62.2 |

The decision as to which samples to include in Table 3 was based on several criteria. For land deposits, the average THM concentration should be at least 3 percent. Several samples were noted where THM exceeds this, even though the abundences of individual mineral s may be less than the threshold values suggested by Garner (1978). These were included because the same volume of a mineral may be available at twice the THM concentration but at half the abundance of the heavy mineral fraction (THM of 5 percent and ilmenite of 60 percent = THM of 10 percent and ilmenite of 30 percent). Appencix V is provided to show the "absolute" abundance of economic minerals. Also included in Table 3 are samples with THM values less than 4 percent but where certain ECON minerals were in great abundance; these samples may suggest a depositional environment with selective enrichment and might to nearby sediments of economic value.

As an aid to further assessment of the economic potential of the samples, Appendix V presents the weight percent of selected minerals with respect to the total sample. Mineral compositions in Appendix V were calculated by multiplying the concentrate composition of a sample (Appendix III) by its THM concentration. Garner's values can likewise be converted to "threshold" values with respect to the entire sample by assuming a THM concentration of 5 percent and multiplying his concentrations by 5 percent. This results in the following mineral concentrations: ilmenite= 2.25 percent, leucoxene and zircon = 0.25 percent, rutile = 0.1 percent, monazite = 0.05 percent. Data presented in this way eliminates the need to know THM concentration while examining the tabulated data for high-grade samples.

## CONCLUSIONS

Results of this study indicate that sediments offshore of Virginia contain occurrences of potentially economic heavy minerals. High total-heavy-mineral (THM) concentrations coupled with high concentrations of ilmenite, zircon, and to a lesser extent monazite and rutile, are encouraging and justify further investigation.

Mineral concentrations from cores alone provide the data from which economic potential is determined. Mineral data from surface grab samples were used as a guide for locating nearly all vibracore sites. However, surficial mineral data may be misleading because a relationship between surface and subsurface concentrations is not yet established. This means that areas characterized by low surficial mineral concentrations may remain as potential sites for coring.

Mineral concentrations are only part of the multifaceted data base needed to plan for economic recovery of the resource. National need, market conditions, advanced technological requirements (superconducting alloys for example), environmental concerns and mining costs are other factors to be considered. Consideration of offshore mining should assess all materials. It may be possible to dredge sand for construction or beach nourishment and extract heavy minerals as a part of the same operation.

This study is intended to be a reconnaissance survey and therefore precluded the extensive coring required to locate economic mineral deposits. In the future, others may attempt such an exploration program by acquiring many closely spaced seismic lines and deep cores. Most of our samples are located within five miles of the shoreline and the broadest coverage of the offshore is based only on grab samples. Although submarine topographic ridge-fields may be the locus of high mineral concentrations, too little is known to ignore other regions of the continental shelf. The shelf seaward of Commonwealth

jurisdiction is largely unexplored. Based on the high concentrations of minerals revealed in this report (STA054 and STA094, Appendix III), additional surveys further offshore in the Exclusive Economic Zone are recommended.

Finally, more work could be done within five miles of the coast. From a research perspective, a process responsible for concentrating offshore heavy minerals has not been identified; a defensible model could be used to predict other areas of high mineral content. New geophysical techniques, such as induced polarization, are available and their use may diminish the need for as many deep cores. The effect of dredging on biological resources should also be determined. If sediments were removed and not replaced from offshore, the effect of the changed bathymetry on waves reaching the shoreline should be evaluated. To date, no public economic resource assessment (tonnage and grade) or feasability study has been made for the U.S. offshore based on heavy-mineral data. There are several sites off Virginia (Smith Island Shoals, Hog Island, Virginia Beach, and False Cape, for example) each with a number of cores having high concentrations of minerals. These sites are candidates for more detailed analysis.

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Timely completion of the combined projects required the cooperation and effort of many people. Dr. A. E. Grosz (USGS) loaned equipment and guided us in establishing analytical procedures; he also assisted in mineral identification procedures and in the design of the data base. With some modifications, we used many of his suggestions and methods. W. J. Swean of the U.S. Army Corps of Engineers loaned equipment and provided access to vibracores.

From Virginia Institute of Marine Science, S. A. Skrabal, L. J. Calliari, S. M. Dydak, H. D. Evans, H. Ozalpasan, and C. T. Fischler cut and logged cores, processed samples, and identified and estimated mineral abundance. J. K. Dame helped process cores and analyze seismic data. C. T. Fischler was responsible for managing the sediment laboratory; her responsibility extended to daily attention to equipment and supply orders, work schedule coordination, and computerized data compilation. R. A. Gammisch assisted in sample collection and participated in relevant discussions throughout the projects. Captains C. E. Machen and L. D. Ward, and Mate S. H. George from vessel operations provided expertise in data collection aboard the R/V Langley, R/V Bay Eagle, and R/V Captain John Smith. Many of the surface grab samples were collected from the chartered vessel Anthony Anne with the help of Captain J. A. Penello. Vibracoring was accomplished on the R/V Atlantic Twin by contract with Alpine Ocean Seismic Survey, Inc. Dr. G. P. Burbank of Hampton University performed the heavy- liquid and some magnetic separations under contract from the Virginia Institute of Marine Science.

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## GLOSSARY

**Box-corer:** A device to collect a sample of uniform depth across an area approximately 6" x 9". The sampler is driven into the bottom by its own weight and ballast; depending upon the hardness of the bottom, penetration ranges up to 18 inches.

**Core, core sample:** A sample collected with an aim to acquire information over depth. See box-corer, vibracorer.

**Exclusive Economic Zone (EEZ):** A zone extending offshore from 3 nautical miles (separating state from federal jurisdiction) to usually 200 nautical miles in which the federal government has jurisdiction. (Referenc Presidential Proclamation No. 5030, 1983)

**Frantz magnetic separator:** A commercially marketed device used for separating minerals according to their magnetic susceptibility. Usage serves to aid in the identification of individual mineral species.

**Grab sample:** A sample taken from the surface of the bottom sediment without concern for the penetration depth or uniformity. Usually grabs are the most easily obtained samples of the bottom; however, their value is limited to information on the sea bottom only.

**Heavy-liquid separation:** A laboratory procedure for separating minerals based on their specific gravities (density). Minerals with a density greater than the liquid will sink and minerals with a density less than the liquid will float. "Heavy" liquids used in this process are usually toxic.

**Humphrey Spiral:** A commercially marketed device for making a rough separation of the heavy minerals from bulk sediment samples.

**Magnetic susceptibility:** The ratio of induced magnetization to the strength of the magnetic field causing the magnetization. Material that shows no magnetic properties while it is not is a field may show magnetic properties if placed in a magnetic field.

**Mineral:** A naturally occuring, inorganic substance with a characteristic chemical composition and usually possessing a definite crystalline structure, which is sometimes expressed in external geometric forms.

**Sand:** A size classification of sediments. Sand grains are rock fragments or detrital particles wuth diameters between 0.0025 and 0.08 inch (1/16 to 2 mm).

**Sidescan sonar:** An acoustic device which produces an image or depiction of the surface and texture of the subaqueous bottom over an area on each side of the ship's track. The image provides information on the roughness of the bottom and the nature of the bottom surface sediment.

**Surface or surficial sample:** A sample with very limited penetration of the sediments of the bottom surface. See grab sample.

**Subbottom or seismic profile:** A depiction of the layering or stratigraphy underlying the sea floor. The data acquired from the reflection of the acoustic signals back to the surface from sediment layers of differing degrees of compaction.

**Vibracorer:** A device which obtains relatively long or deep, usually continuous samples of the bottom sediment. The samples generally are less than 4 inches in diameter but may be many feet long. The name derives from the vibrating action used to drive the core tube into the bottom. See core.

# APPENDIX I

## LOCATION OF SAMPLES

Loran coordinates are slaves of the 9960 chain. Latitude and longitude were obtained from automatic conversion of loran coordinates by the shipboard loran receiver-processor. Data not available are noted by "*".

### VIBRACORES

| CORE ID | WATER DEPTH (FT) | LORAN C COORDINATES Y | X | LATITUDE deg | min | LONGITUDE deg | min |
|---|---|---|---|---|---|---|---|
| H1 | 38 | 41405.1 | 27132.7 | 37 | 05.00 | 75 | 45.99 |
| H2 | 38 | 41406.1 | 27133.8 | 37 | 05.12 | 75 | 46.19 |
| H3 | 37 | 41408.0 | 27134.9 | 37 | 05.31 | 75 | 46.37 |
| H4 | 38 | 41409.8 | 27136.1 | 37 | 05.50 | 75 | 46.58 |
| H5 | 34 | 41412.2 | 27137.2 | 37 | 05.74 | 75 | 46.74 |
| H6 | 37 | 41392.9 | 27131.0 | 37 | 03.94 | 75 | 46.03 |
| H7 | 36 | 41398.8 | 27134.9 | 37 | 04.56 | 75 | 46.70 |
| H8 | 30 | 41402.0 | 27136.7 | 37 | 04.89 | 75 | 46.98 |
| H9 | 32 | 41405.3 | 27138.6 | 37 | 05.22 | 75 | 47.29 |
| H10 | 35 | 41408.5 | 27137.4 | 37 | 05.44 | 75 | 46.90 |
| H11 | 30 | 41410.7 | 27139.3 | 37 | 05.69 | 75 | 47.25 |
| H12 | 29 | 41411.5 | 27139.7 | 37 | 05.77 | 75 | 47.31 |
| H13 | 38 | 41412.8 | 27140.9 | 37 | 05.92 | 75 | 47.54 |
| H14 | 38 | 41414.6 | 27138.8 | 37 | 05.99 | 75 | 47.01 |
| H15 | 30 | 41413.6 | 27138.3 | 37 | 05.89 | 75 | 46.93 |
| B1 | 25 | 41399.5 | 27202.9 | 37 | 07.03 | 76 | 01.97 |
| B2 | 22 | 41415.2 | 27200.0 | 37 | 08.20 | 76 | 00.74 |
| B3 | 15 | 41423.1 | 27200.1 | 37 | 08.84 | 76 | 00.47 |
| B4 | 35 | 41385.3 | 27210.2 | 37 | 06.13 | 76 | 04.17 |
| B5 | 25 | 41369.8 | 27210.1 | 37 | 04.87 | 76 | 04.71 |
| V1 | 48 | * | * | 36 | 54.53 | 75 | 56.56 |
| V2 | 46 | * | * | 36 | 53.15 | 75 | 55.29 |
| V3 | 49 | * | * | 36 | 51.80 | 75 | 53.84 |
| V4 | 52 | * | * | 36 | 50.51 | 75 | 51.55 |
| V5 | * | * | * | 36 | 54.04 | 75 | 56.39 |
| V6 | 47 | * | * | 36 | 52.41 | 75 | 50.41 |
| 1090 | * | * | * | 36 | 56.25 | 76 | 03.32 |
| 1091 | * | * | * | 36 | 56.76 | 76 | 03.27 |
| 1092 | * | * | * | 36 | 57.20 | 76 | 03.60 |
| 1093 | * | * | * | 36 | 56.88 | 76 | 04.45 |

LOCATION OF VIBRACORES, continued

| CORE ID | WATER DEPTH (FT) | LORAN C COORDINATES Y | X | LATITUDE deg min | LONGITUDE deg min |
|---|---|---|---|---|---|
| 1094 | * | * | * | 36 57.20 | 76 04.40 |
| 1095 | * | * | * | 36 57.55 | 76 05.20 |
| 1096 | * | * | * | 36 57.98 | 76 05.92 |
| 1097 | * | * | * | 36 58.50 | 76 05.60 |
| 1098 | * | * | * | 36 57.98 | 76 04.80 |
| 1099 | * | * | * | 36 58.18 | 76 04.80 |
| 1100 | * | * | * | 36 58.63 | 76 04.42 |
| 1103 | * | * | * | 37 00.55 | 76 03.35 |
| 1106 | * | * | * | 37 00.72 | 75 58.70 |
| 1107 | * | * | * | 37 02.34 | 76 01.00 |
| 1109 | * | * | * | 37 03.75 | 76 02.00 |
| 1111 | * | * | * | 37 05.62 | 75 59.80 |
| 1116 | * | * | * | 37 03.42 | 75 58.69 |
| 1119 | * | * | * | 37 01.55 | 75 56.58 |
| 1120 | * | * | * | 37 00.70 | 75 55.48 |
| 1121 | * | * | * | 37 01.60 | 75 54.30 |
| 1122 | * | * | * | 36 59.95 | 75 52.25 |
| 1127 | * | * | * | 37 02.40 | 75 50.05 |
| 1129 | * | * | * | 37 03.70 | 75 46.85 |
| 1130 | * | * | * | 37 04.00 | 75 47.91 |
| 1131 | * | * | * | 37 04.75 | 75 49.32 |
| 1132 | * | * | * | 37 04.24 | 75 51.18 |
| 1134 | * | * | * | 37 04.12 | 75 53.28 |
| 1136 | * | * | * | 37 02.50 | 75 53.40 |
| 1139 | * | * | * | 37 04.10 | 75 57.60 |
| 2000 | * | * | * | 36 57.05 | 76 06.62 |
| 2001 | * | * | * | 36 55.35 | 76 06.62 |
| 2002 | * | * | * | 36 59.52 | 76 04.02 |
| 110 | * | * | * | 37 59.25 | 75 13.34 |
| 115 | * | * | * | 38 02.38 | 75 07.15 |
| 116 | * | * | * | 38 01.44 | 75 07.08 |
| 117 | * | * | * | 38 00.59 | 75 01.80 |
| C1 | 50 | 27082.8 | 41961.6 | 37 49.72 | 75 16.37 |
| C2 | 45 | 27093.2 | 41974.0 | 37 51.00 | 75 18.02 |
| C3 | 35 | 27047.9 | 41974.9 | 37 50.02 | 75 09.01 |
| C4 | 36 | 27129.7 | 41669.5 | 37 26.61 | 75 36.08 |
| C5 | 36 | 27130.0 | 41670.0 | 37 26.68 | 75 36.12 |
| C6 | 36 | 27130.0 | 41668.0 | 37 26.51 | 75 36.19 |
| C7 | 56 | 27114.8 | 41668.1 | 37 26.07 | 75 32.97 |
| C8 | 32 | 27134.5 | 41629.2 | 37 23.45 | 75 68.51 |

LOCATION OF VIBRACORES, continued

| CORE ID | WATER DEPTH (FT) | LORAN C COORDINATES Y | X | LATITUDE deg min | LONGITUDE deg min |
|---|---|---|---|---|---|
| C9 | 34 | 27133.5 | 41626.6 | 37 23.21 | 75 38.39 |
| C10 | 32 | 27128.6 | 41628.0 | 37 23.17 | 75 37.29 |
| C11 | 32 | 27134.9 | 41610.0 | 37 21.88 | 75 39.27 |
| C12 | 28 | 27134.9 | 41580.1 | 37 19.43 | 75 40.32 |
| C13 | 31 | 27134.8 | 41539.8 | 37 16.11 | 75 41.72 |
| C14 | 32 | 27139.9 | 41415.1 | 37 6.06 | 75 47.21 |
| C15 | 28 | 27144.9 | 41423.9 | 37 6.96 | 75 48.01 |
| C16 | 29 | 27144.0 | 41420.0 | 37 6.61 | 75 47.95 |
| C17 | 33 | 27140.5 | 41420.0 | 37 6.48 | 76 47.17 |
| C18 | 37 | 27144.7 | 41284.9 | 36 55.61 | 75 52.85 |
| C19 | 27 | 27155.0 | 41229.9 | 36 51.53 | 75 57.15 |
| C20 | 53 | 27120.0 | 41210.0 | 36 48.50 | 75 49.81 |
| C21 | 50 | 27122.0 | 41210.9 | 36 48.66 | 75 50.24 |
| C22 | 60 | 27088.0 | 41229.9 | 36 48.61 | 75 41.26 |
| C23 | 44 | 27135.0 | 41830.0 | 37 40.03 | 75 31.52 |
| C24 | 60 | 27092.5 | 41230.6 | 36 49.07 | 75 42.85 |
| C25 | 33 | 27119.8 | 41109.6 | 36 40.26 | 75 53.18 |
| C26 | 47 | 27089.6 | 41049.9 | 36 33.97 | 75 48.14 |
| C27 | 45 | 27095.7 | 41050.0 | 36 34.26 | 75 49.56 |
| C28 | 8 | 27102.2 | 41039.9 | 36 33.73 | 75 51.41 |
| C29 | 37 | 27090.3 | 41040.0 | 36 33.18 | 75 48.62 |
| C30 | 33 | 27105.0 | 41050.1 | 36 34.70 | 75 51.73 |
| C31 | 25 | 27102.7 | 41040.0 | 36 33.76 | 75 51.52 |
| C32 | 35 | 27101.4 | 41049.9 | 36 34.52 | 75 50.89 |
| C33 | 37 | 27099.0 | 41040.0 | 36 33.59 | 75 50.66 |
| C34 | 31 | 27098.0 | 41039.8 | 36 33.52 | 75 50.43 |
| C35 | 41 | 27094.8 | 41039.9 | 36 33.38 | 75 49.68 |
| C36 | 25 | 27092.2 | 41040.5 | 36 33.31 | 75 49.05 |
| C37 | 29 | 27146.0 | 41201.1 | 36 48.83 | 75 56.09 |
| C38 | 34 | 27140.0 | 41200.0 | 36 48.50 | 75 54.74 |
| C39 | 34 | 27140.0 | 41189.8 | 36 47.67 | 75 55.10 |
| C40 | 30 | 27142.5 | 41190.0 | 36 47.78 | 75 55.67 |
| C41 | 29 | 27145.1 | 41190.2 | 36 47.91 | 75 56.26 |
| C42 | 30 | 27145.0 | 41179.9 | 36 47.06 | 75 56.60 |
| C43 | 32 | 27142.6 | 41180.0 | 36 46.97 | 75 56.04 |
| C44 | 33 | 27140.0 | 41180.0 | 36 46.87 | 75 55.44 |
| C45 | 32 | 27140.0 | 41160.0 | 36 45.24 | 75 56.13 |
| C46 | 36 | 27135.1 | 41159.9 | 36 45.03 | 75 55.00 |
| C47 | 41 | 27130.0 | 41159.9 | 36 44.81 | 75 53.82 |
| C48 | 29 | 27125.0 | 41160.0 | 36 44.61 | 75 52.66 |

LOCATION OF VIBRACORES, continued

| CORE ID | WATER DEPTH (FT) | LORAN C COORDINATES Y | X | LATITUDE deg min | LONGITUDE deg min |
|---|---|---|---|---|---|
| C49 | 35 | 27125.1 | 41170.0 | 36 45.43 | 75 52.35 |
| C50 | 39 | 27125.0 | 41150.0 | 36 43.79 | 75 53.01 |
| WB063 | 12 | 27248.9 | 41305.6 | 37 01.10 | 76 16.02 |

number of cores = 113

## GRAB SAMPLES

| GRAB ID | DEPTH (FATHOMS) | LORAN C COORDINATES | | LATITUDE | | LONGITUDE | |
|---|---|---|---|---|---|---|---|
| | | Y | X | deg | min | deg | min |
| 1 | 5.5 | 41372.0 | 27153.0 | 37 | 03.03 | 75 | 51.69 |
| 2 | 4.5 | 41377.0 | 27156.0 | 37 | 03.55 | 75 | 52.19 |
| 3 | 4.5 | 41408.2 | 27153.4 | 37 | 05.99 | 75 | 50.49 |
| 4 | 4.0 | 41432.9 | 27149.1 | 37 | 07.85 | 75 | 48.65 |
| 5 | 13.0 | 41901.9 | 27048.0 | 37 | 43.78 | 75 | 11.51 |
| 6 | 13.7 | 41920.7 | 27049.7 | 37 | 45.43 | 75 | 11.25 |
| 7 | 12.5 | 41945.3 | 27070.3 | 37 | 48.03 | 75 | 14.54 |
| 8 | 10.0 | 41931.1 | 27076.8 | 37 | 47.00 | 75 | 16.32 |
| 9 | 9.6 | 41937.5 | 27079.9 | 37 | 47.62 | 75 | 16.72 |
| 10 | 9.9 | 41953.0 | 27076.4 | 37 | 48.83 | 75 | 15.50 |
| 11 | 8.6 | 41961.6 | 27082.8 | 37 | 49.71 | 75 | 16.48 |
| 12 | 7.7 | 41974.0 | 27093.2 | 37 | 51.01 | 75 | 18.14 |
| 13 | 7.4 | 41959.5 | 27097.8 | 37 | 49.90 | 75 | 19.54 |
| 14 | 6.0 | 41952.5 | 27090.9 | 37 | 49.15 | 75 | 18.41 |
| 15 | 6.0 | 41947.9 | 27119.8 | 37 | 49.49 | 75 | 24.33 |
| 16 | 5.0 | 41949.0 | 27130.0 | 37 | 49.82 | 75 | 26.35 |
| 17 | 5.0 | 41939.2 | 27135.0 | 37 | 49.12 | 75 | 27.71 |
| 18 | 6.0 | 41918.9 | 27134.8 | 37 | 47.43 | 75 | 28.40 |
| 19 | 7.4 | 41890.6 | 27135.0 | 37 | 45.08 | 75 | 29.44 |
| 20 | 8.0 | 41869.5 | 27134.9 | 37 | 43.33 | 75 | 30.17 |
| 21 | 7.9 | 41850.0 | 27135.1 | 37 | 41.72 | 75 | 30.91 |
| 22 | 5.0 | 41789.2 | 27135.1 | 37 | 36.69 | 75 | 33.05 |
| 23 | 6.0 | 41751.2 | 27134.0 | 37 | 33.52 | 75 | 34.17 |
| 24 | 6.0 | 41739.4 | 27134.2 | 37 | 32.55 | 75 | 34.63 |
| 25 | 5.0 | 41729.8 | 27134.6 | 37 | 31.77 | 75 | 35.06 |
| 26 | 8.7 | 41740.0 | 27124.6 | 37 | 32.32 | 75 | 32.59 |
| 27 | 4.0 | 41739.6 | 27112.0 | 37 | 31.92 | 75 | 29.97 |
| 28 | 9.7 | 41668.1 | 27114.8 | 37 | 26.07 | 75 | 33.01 |
| 29 | 6.0 | 41669.3 | 27125.2 | 37 | 26.49 | 75 | 35.19 |
| 30 | 6.0 | 41669.5 | 27129.7 | 37 | 26.64 | 75 | 36.13 |
| 31 | 5.0 | 41669.4 | 27135.1 | 37 | 26.80 | 75 | 37.28 |
| 32 | 5.0 | 41650.1 | 27134.7 | 37 | 25.19 | 75 | 37.88 |
| 33 | 5.0 | 41629.2 | 27134.5 | 37 | 23.45 | 75 | 38.55 |
| 34 | 5.0 | 41619.5 | 27134.3 | 37 | 22.64 | 75 | 38.84 |
| 35 | * | 41420.4 | 27160.1 | 37 | 07.22 | 75 | 51.55 |
| 36 | * | 41429.9 | 27157.5 | 37 | 07.90 | 75 | 50.64 |
| 37 | * | 41430.2 | 27154.9 | 37 | 07.83 | 75 | 50.04 |
| 38 | * | 41430.0 | 27152.4 | 37 | 07.73 | 75 | 49.49 |
| 39 | * | 41426.9 | 27147.4 | 37 | 07.30 | 75 | 48.49 |
| 40 | * | 41423.9 | 27144.9 | 37 | 06.97 | 75 | 48.04 |

LOCATION OF GRAB SAMPLES, continued

| GRAB ID | DEPTH (FATHOMS) | LORAN C COORDINATES Y | X | LATITUDE deg min | LONGITUDE deg min |
|---|---|---|---|---|---|
| 41 | * | 41419.8 | 27142.7 | 37 06.56 | 75.47.70 |
| 42 | * | 41415.1 | 27139.9 | 37 06.07 | 75 47.23 |
| 43 | * | 41446.8 | 27120.0 | 37 07.97 | 75 41.73 |
| 44 | * | 41447.0 | 27125.5 | 37 08.18 | 75 42.94 |
| 45 | * | 41447.7 | 27131.9 | 37 08.46 | 75 44.32 |
| 46 | * | 41449.6 | 27134.9 | 37 08.71 | 75 44.91 |
| 47 | * | 41466.8 | 27140.0 | 37 10.31 | 75 45.44 |
| 48 | * | 41500.0 | 27142.0 | 37 13.09 | 75 44.71 |
| 49 | * | 41510.1 | 27134.9 | 37 13.68 | 75 42.81 |
| 50 | * | 41539.9 | 27134.9 | 37 16.12 | 75 41.76 |
| 51 | * | 41540.1 | 27142.0 | 37 16.37 | 75 43.30 |
| 52 | * | 41540.1 | 27145.0 | 37 16.47 | 75 43.96 |
| 53 | * | 41560.1 | 27139.9 | 37 17.95 | 75 42.15 |
| 54 | * | 41580.1 | 27134.9 | 37 19.42 | 75 40.35 |
| 55 | * | 41579.9 | 27125.0 | 37 19.09 | 75 38.23 |
| 56 | * | 41610.0 | 27134.9 | 37 21.88 | 75 39.30 |
| 57 | * | 41369.8 | 27159.9 | 37 03.10 | 75 53.31 |
| 58 | * | 41339.9 | 27154.8 | 37 00.49 | 75 53.23 |
| 59 | * | 41284.9 | 27144.7 | 36 55.63 | 75 52.89 |
| 60 | * | 41279.7 | 27154.9 | 36 55.60 | 75 55.39 |
| 61 | * | 41249.6 | 27154.9 | 36 53.16 | 75 56.46 |
| 62 | * | 41241.9 | 27162.0 | 36 52.81 | 75 58.36 |
| 63 | * | 41226.7 | 27157.4 | 36 51.40 | 75 57.84 |
| 64 | * | 41229.9 | 27155.0 | 36 51.56 | 75 57.18 |
| 65 | * | 41229.9 | 27144.9 | 36 51.15 | 75 54.85 |
| 66 | * | 41209.8 | 27144.9 | 36 49.52 | 75 55.56 |
| 67 | * | 41209.9 | 27120.0 | 36 48.51 | 75 49.83 |
| 68 | * | 41149.9 | 27109.9 | 36 43.16 | 75 49.55 |
| 69 | * | 41149.7 | 27113.0 | 36 43.28 | 75 50.27 |
| 70 | * | 41149.9 | 27115.1 | 36 43.38 | 75 50.74 |
| 71 | * | 41159.9 | 27119.9 | 36 44.41 | 75 51.51 |
| 72 | * | 41159.9 | 27125.1 | 36 44.64 | 75 52.72 |
| 73 | * | 41159.7 | 27129.9 | 36 44.82 | 75 53.83 |
| 74 | * | 41160.0 | 27140.0 | 36 45.26 | 75 56.16 |
| 75 | * | 41129.5 | 27119.0 | 36 41.88 | 75 52.33 |
| 76 | * | 41109.9 | 27119.9 | 36 40.31 | 75 53.22 |
| 77 | * | 41089.5 | 27115.0 | 36 38.42 | 75 52.75 |
| 78 | * | 41089.8 | 27104.9 | 36 37.99 | 75 50.39 |
| 79 | * | 41050.1 | 27105.0 | 36 34.72 | 75 51.73 |
| 80 | * | 41049.9 | 27101.8 | 36 34.55 | 75 50.99 |
| 81 | * | 41049.9 | 27099.8 | 36 34.46 | 75 50.52 |

LOCATION OF GRAB SAMPLES, continued

| GRAB ID | DEPTH (FATHOMS) | LORAN C COORDINATES Y | LORAN C COORDINATES X | LATITUDE deg | LATITUDE min | LONGITUDE deg | LONGITUDE min |
|---|---|---|---|---|---|---|---|
| 82 | * | 41049.8 | 27097.8 | 36 | 34.36 | 75 | 50.05 |
| 83 | * | 41050.0 | 27095.6 | 36 | 34.27 | 75 | 49.53 |
| 84 | * | 41049.9 | 27092.3 | 36 | 34.10 | 75 | 48.76 |
| 85 | * | 41049.9 | 27089.9 | 36 | 33.99 | 75 | 48.20 |
| 86 | * | 41039.6 | 27080.7 | 36 | 32.70 | 75 | 46.39 |
| 87 | * | 41039.9 | 27090.0 | 36 | 33.17 | 75 | 48.56 |
| 88 | * | 41039.9 | 27092.3 | 36 | 33.28 | 75 | 49.10 |
| 89 | * | 41039.9 | 27095.5 | 36 | 33.42 | 75 | 49.84 |
| 89A | * | 41039.7 | 27098.0 | 36 | 33.53 | 75 | 50.44 |
| 90 | * | 41039.9 | 27099.0 | 36 | 33.59 | 75 | 50.66 |
| 91 | * | 41039.8 | 27102.0 | 36 | 33.72 | 75 | 51.37 |
| 92 | * | 41039.8 | 27103.0 | 36 | 33.78 | 75 | 51.60 |
| 93 | * | 41129.9 | 27067.5 | 36 | 39.38 | 75 | 39.29 |
| 94 | * | 41129.7 | 27067.6 | 36 | 39.59 | 75 | 40.48 |
| 95 | * | 41129.9 | 27072.3 | 36 | 39.82 | 75 | 41.54 |
| 96 | * | 41129.9 | 27076.1 | 36 | 40.00 | 75 | 42.42 |
| 97 | * | 41129.9 | 27080.0 | 36 | 40.18 | 75 | 43.32 |
| 98 | * | 41129.9 | 27085.0 | 36 | 40.41 | 75 | 44.47 |
| 99 | * | 41130.0 | 27092.1 | 36 | 40.73 | 75 | 46.10 |
| 100 | * | 41129.6 | 27100.0 | 36 | 41.05 | 75 | 47.94 |
| 101 | * | 41139.8 | 27132.9 | 36 | 43.32 | 75 | 55.21 |
| 51-1 | * | * | * | 36 | 23.00 | 75 | 49.36 |
| 51-2 | * | * | * | 36 | 22.00 | 75 | 49.30 |
| 51-3 | * | * | * | 36 | 10.55 | 75 | 45.52 |
| 51-4 | * | * | * | 35 | 50.21 | 75 | 33.38 |

number of grab samples = 106

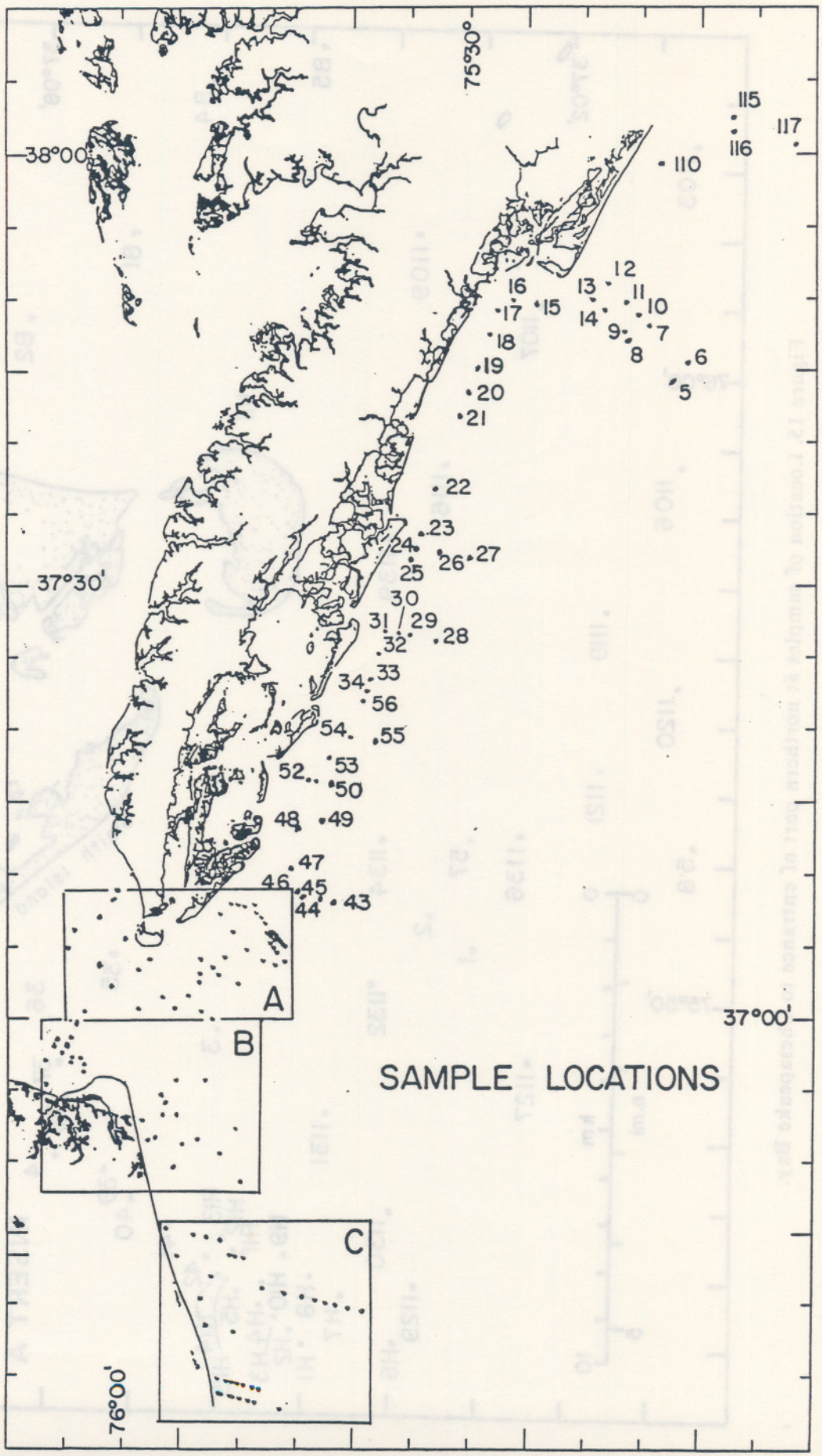


Figure 14. Location of samples off the Eastern Shore and index map of sample locations south of the Eastern Shore.

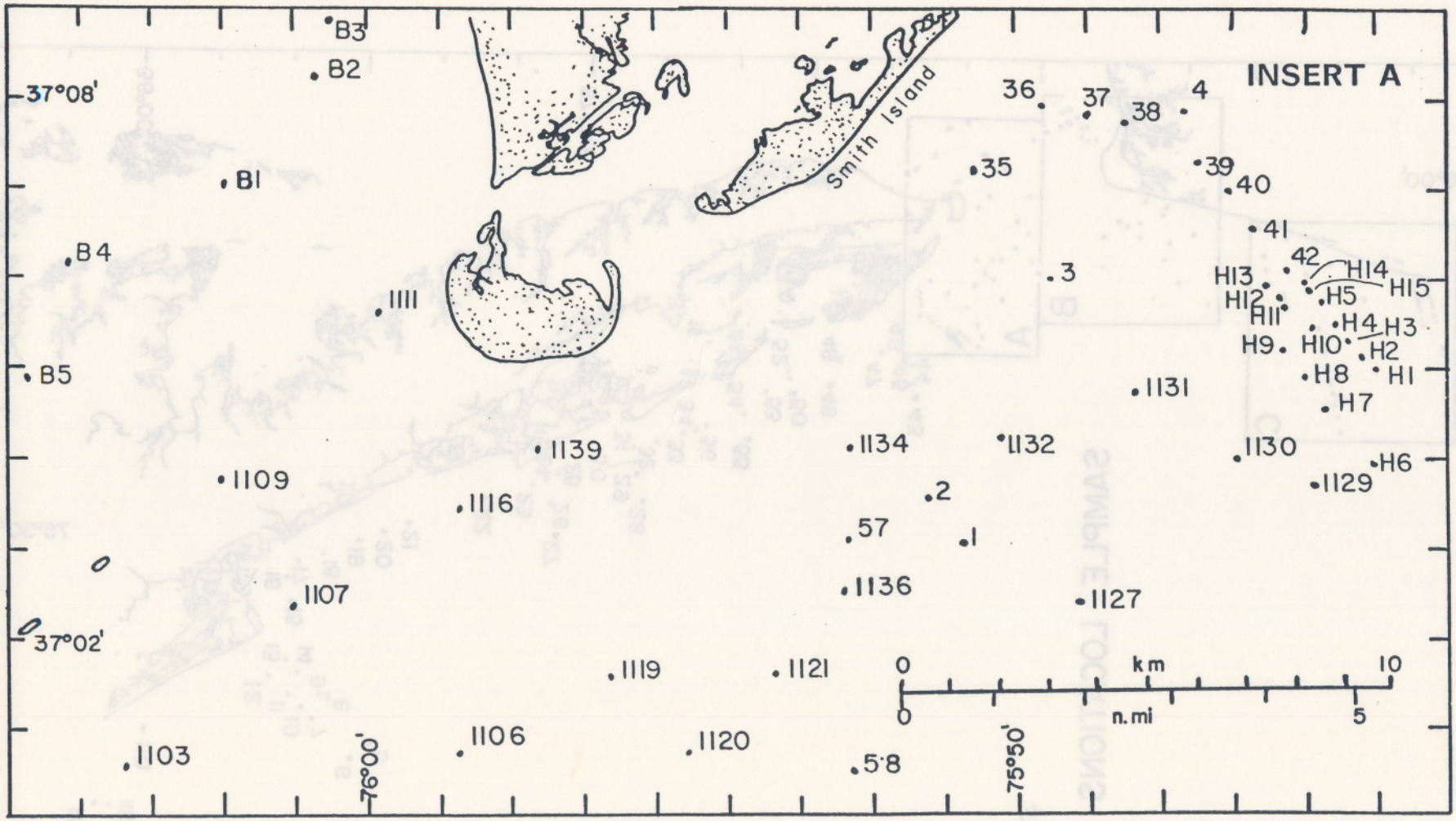


Figure 15. Location of samples at northern part of entrance to Chesapeake Bay.

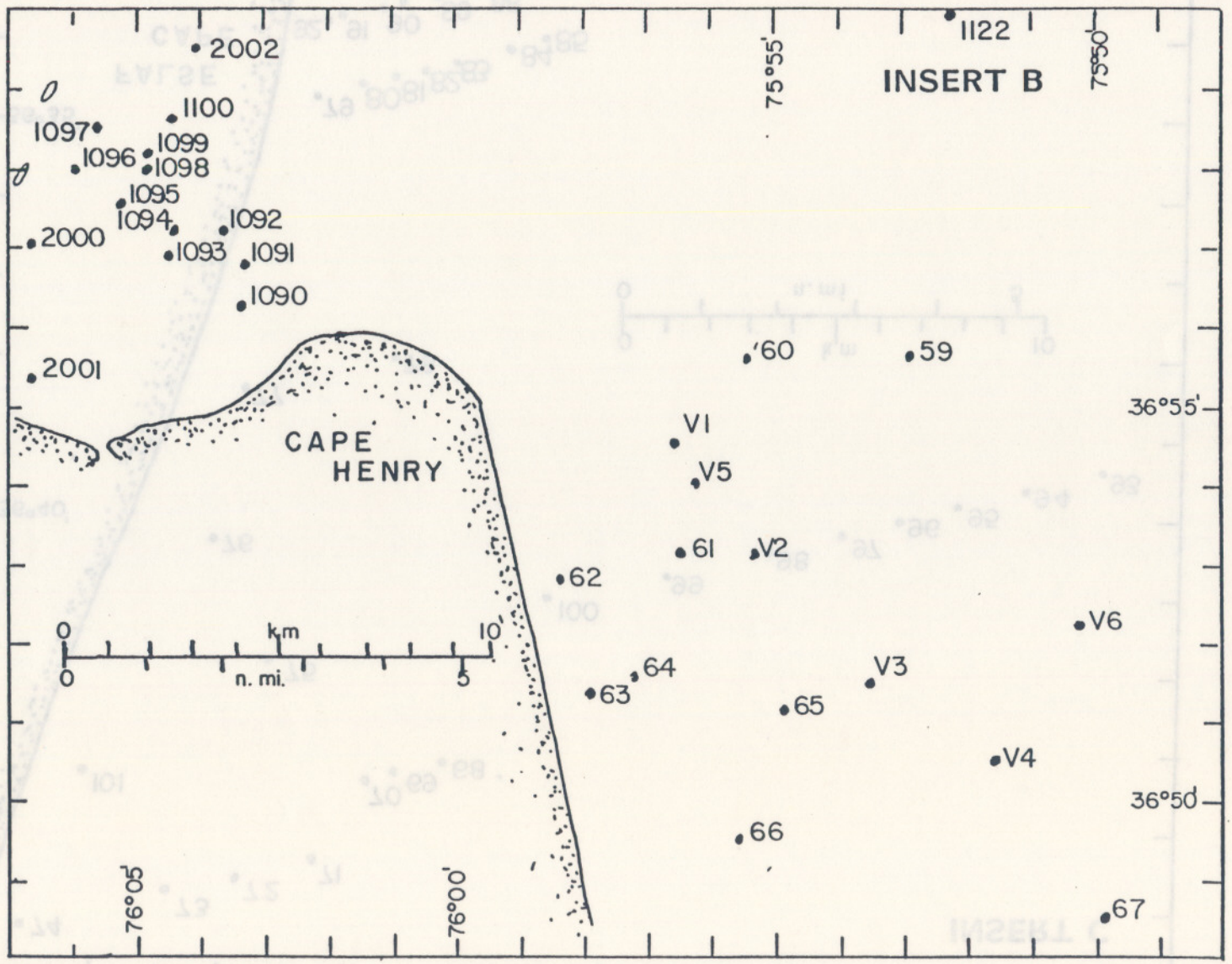


Figure 16. location of samples at southern part of entrance to Chesapeake Bay and off Virginia Beach.

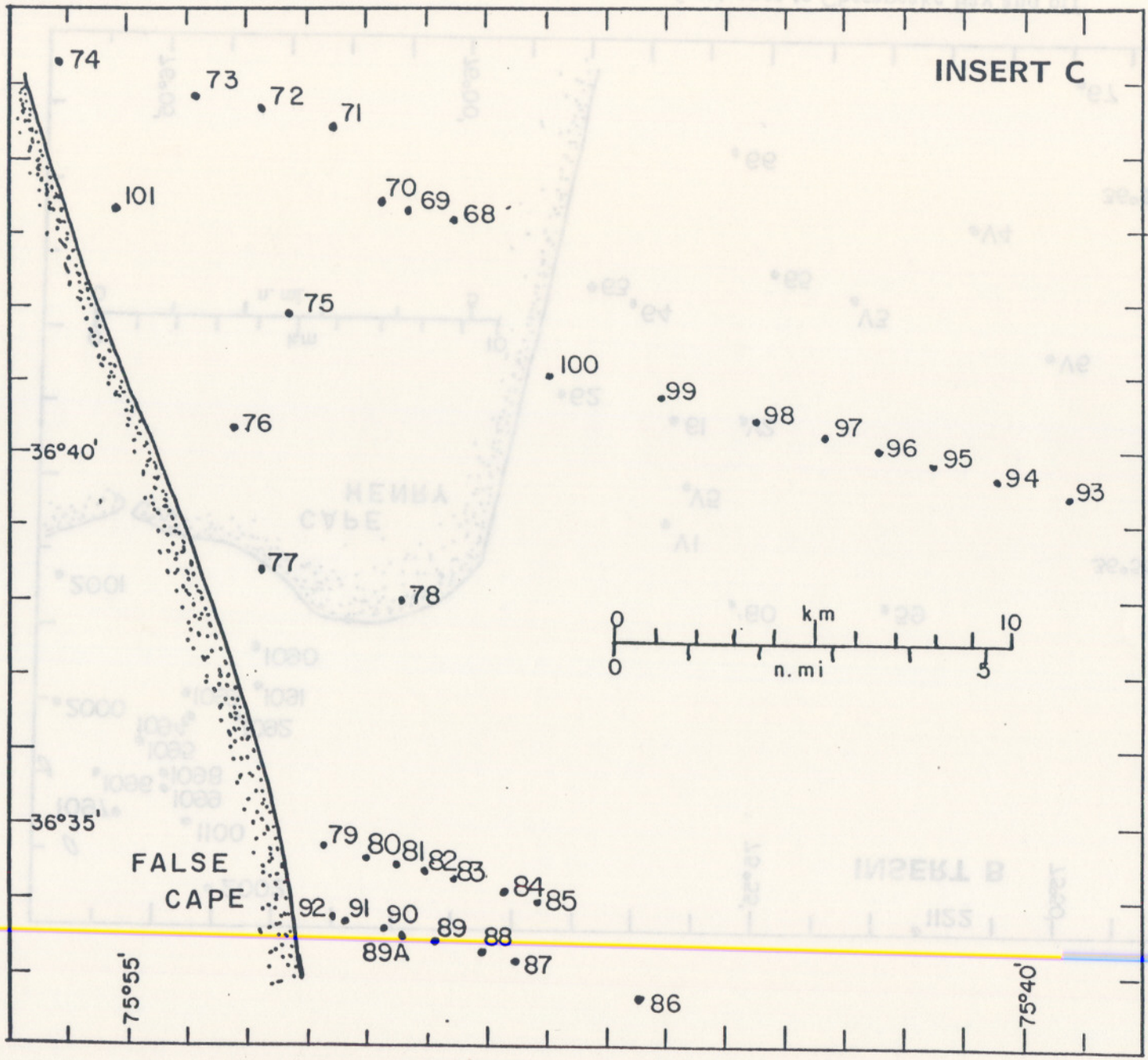


Figure 17. Location of samples off Virginia Beach to North Carolina.

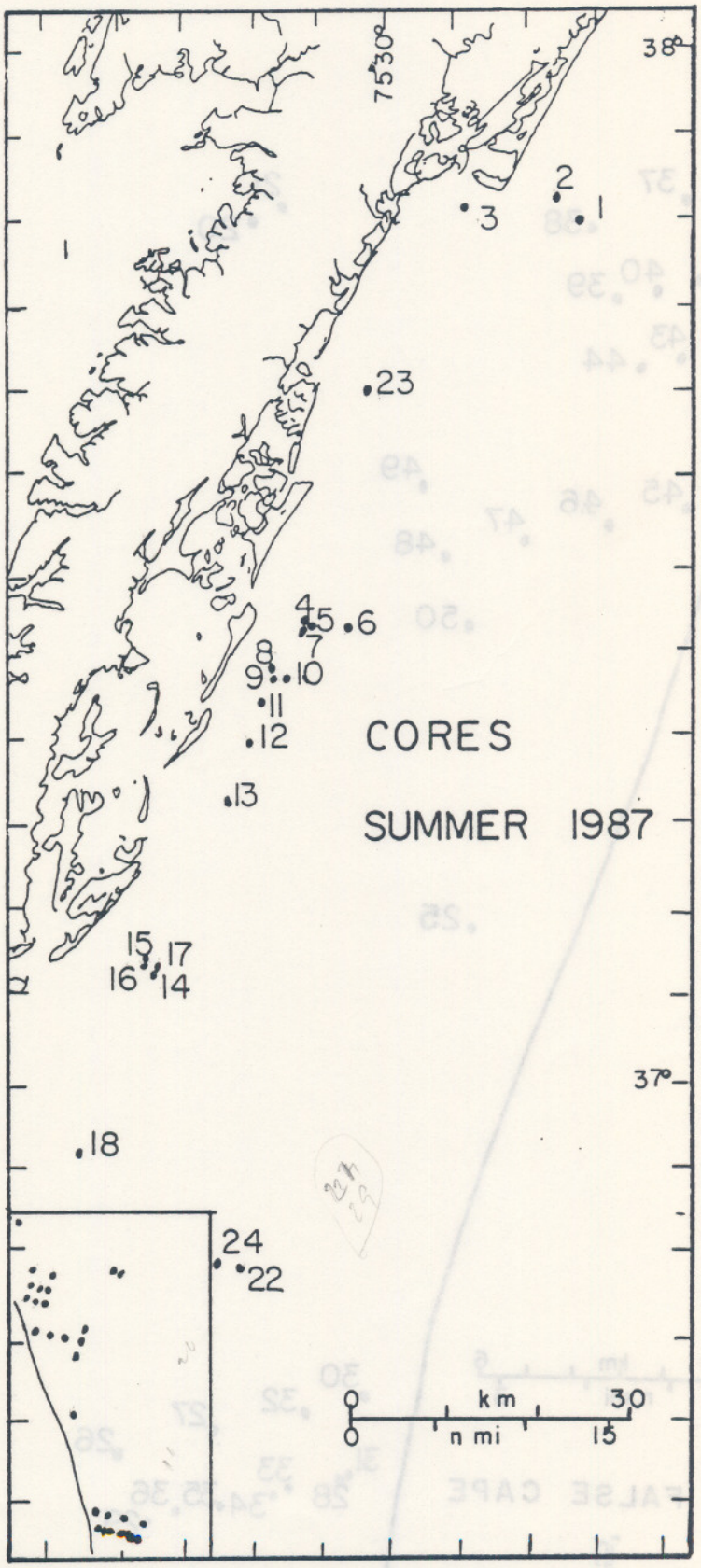


Figure 18. Location of cores taken during the summer of 1987.

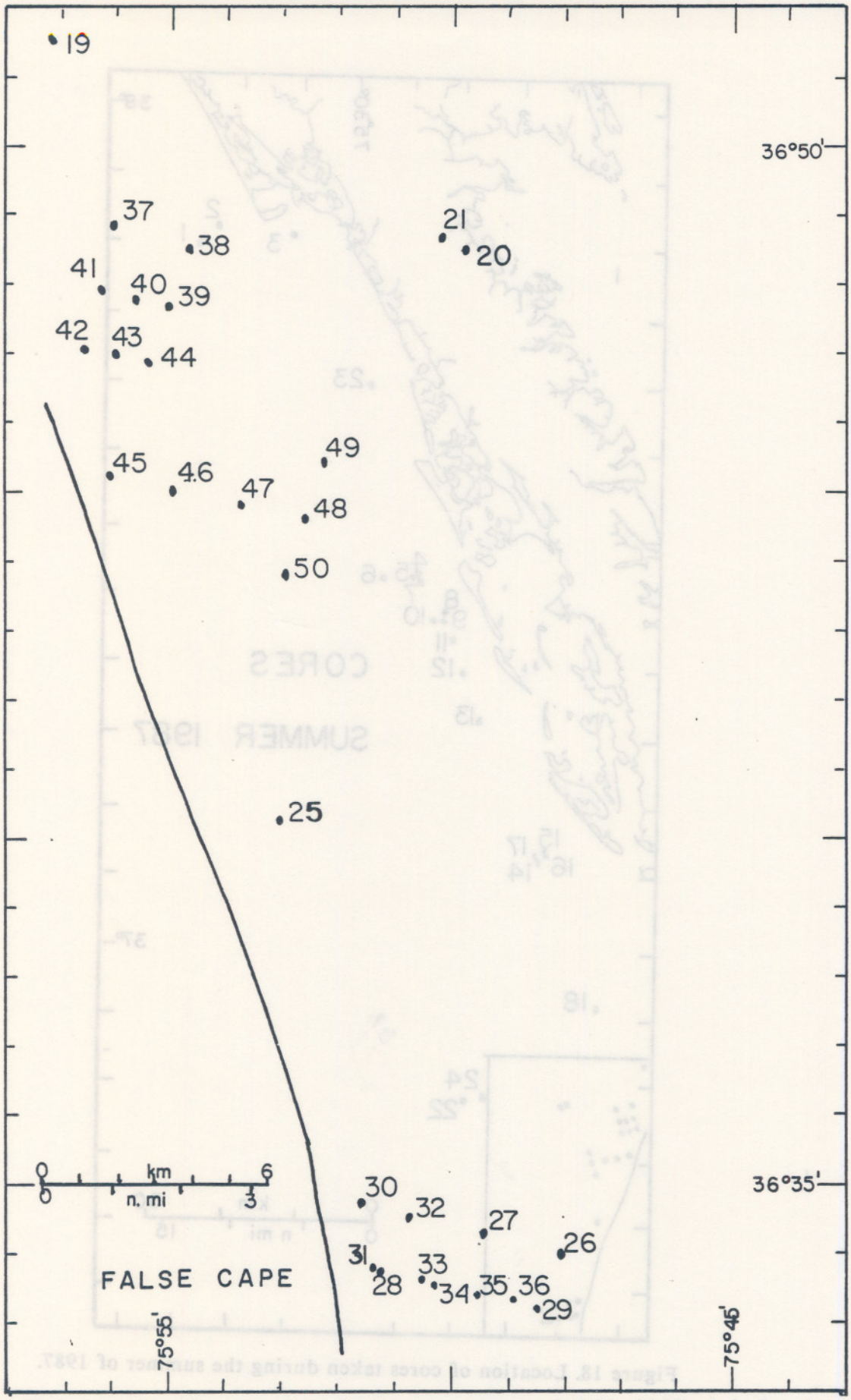


Figure 19. Location of cores taken during the summer of 1987 off Virginia Beach to North Carolina

APPENDIX II
GENERAL CHARACTERISTICS OF SAMPLES
A. CORES

Data not available are noted by "*"; total heavy minerals = "THM"
Dry sample weight is in grams.

| SAMPLE NAME | CORE LENGTH (CM) | DRY SAMPLE WT | % SAND | % MUD | % GRAVEL | WT% THM |
|---|---|---|---|---|---|---|
| B01-1 | 140 | 5530 | 94 | 6 | 0 | 3.91 |
| B01-2 | 130 | 6247 | 93 | 7 | 0 | 2.88 |
| B02-1 | 137 | 5447 | 98 | 2 | 0 | 2.42 |
| B02-2 | 131 | 6222 | 97 | 3 | 0 | 3.88 |
| B03-1 | 122 | 5036 | 97 | 3 | 0 | 3.20 |
| B03-2 | 122 | 6038 | 96 | 3 | 0 | 3.33 |
| B03-3 | 113 | 5147 | 95 | 5 | 0 | 3.26 |
| B04-1 | 289 | 7882 | 94 | 6 | 0 | 2.53 |
| B05-1 | 261 | 7522 | 94 | 6 | 0 | 1.86 |
| B05-2 | 146 | 6888 | 95 | 5 | 0 | 1.82 |
| H01-1 | 128 | 6329 | 98 | 0 | 2 | 3.86 |
| H01-2 | 137 | 8475 | 96 | 1 | 3 | 5.10 |
| H01-3 | 111 | 6371 | 89 | 3 | 8 | 5.48 |
| H02-1 | 86 | 3000 | 96 | 3 | 1 | 2.32 |
| H02-2 | 154 | 5826 | 59 | 41 | 0 | 1.09 |
| H02-3 | 142 | 9853 | 73 | 27 | 0 | 1.34 |
| H03-1 | 130 | 6272 | 95 | 1 | 4 | 2.14 |
| H04-1 | 133 | 6099 | 84 | 16 | 0 | 3.06 |
| H04-2 | 158 | 7882 | 70 | 30 | 0 | 1.37 |
| H04-3 | 151 | 4773 | 80 | 19 | 1 | 1.57 |
| H05-1 | 185 | 7031 | 92 | 5 | 3 | 3.67 |
| H06-1 | 167 | 6525 | 85 | 15 | 0 | 3.13 |
| H06-2 | 145 | 6569 | 81 | 19 | 0 | 1.70 |
| H06-3 | 152 | 6278 | 75 | 25 | 0 | 1.49 |
| H06-4 | 140 | 5228 | 66 | 34 | 0 | 0.74 |
| H07-1 | 112 | 3607 | 78 | 22 | 1 | 3.75 |
| H07-2 | 128 | 4222 | 54 | 27 | 19 | 1.87 |
| H07-3 | 132 | 5433 | 79 | 21 | 0 | 1.54 |
| H08-1 | 134 | 5799 | 97 | 2 | 1 | 5.52 |
| H08-2 | 144 | 7567 | 88 | 12 | 0 | 2.85 |
| H09-1 | 131 | 5675 | 82 | 18 | 0 | 3.62 |
| H10-1 | 165 | 6524 | 87 | 13 | 0 | 2.74 |
| H10-2 | 174 | 7300 | 83 | 17 | 0 | 3.21 |
| H11-1 | 189 | 8912 | 91 | 6 | 3 | 4.00 |
| H12-1 | 107 | 5749 | 98 | 1 | 1 | 6.88 |
| H12-2 | 121 | 5809 | 95 | 2 | 3 | 5.34 |
| H13-1 | 204 | 8324 | 93 | 5 | 3 | 2.23 |

CHARACTERISTICS OF CORES, continued

| SAMPLE NAME | CORE LENGTH (CM) | DRY SAMPLE WT | % SAND | % MUD | % GRAVEL | WT% THM |
|---|---|---|---|---|---|---|
| H14-1 | 148 | 5771 | * | * | * | 0.52 |
| H14-2 | 142 | 5942 | 81 | 16 | 4 | 1.49 |
| V1-1 | 149 | 7513 | * | * | * | 1.17 |
| V1-2 | 151 | 7267 | * | * | * | 0.82 |
| V1-3 | 152 | 4400 | * | * | * | 0.61 |
| V1-4 | 148 | 5245 | * | * | * | 0.83 |
| V2-1 | 113 | 4272 | * | * | * | 2.72 |
| V2-2 | 152 | 5530 | * | * | * | 1.67 |
| V2-3 | 156 | 6910 | * | * | * | 3.90 |
| V2-4 | 139 | 6593 | * | * | * | 2.12 |
| V4-1 | 190 | 4721 | * | * | * | 1.77 |
| V4-2 | 134 | 7979 | * | * | * | 1.06 |
| V4-3 | 163 | 4606 | * | * | * | 1.39 |
| V4-4 | 153 | 3766 | * | * | * | 1.35 |
| V3-1 | 152 | 7305 | 93 | 5 | 2 | 1.42 |
| V3-2 | 143 | 6432 | 64 | 34 | 2 | 0.50 |
| V5-1 | 108 | 2317 | 88 | 12 | 0 | 1.95 |
| V5-3 | 155 | 5565 | 95 | 5 | 0 | 1.26 |
| V5-4 | 110 | 3610 | 94 | 5 | 1 | 1.20 |
| V5-5 | 128 | 6424 | 90 | 3 | 7 | 1.44 |
| V6-1 | 147 | 5843 | 94 | 6 | 0 | 2.48 |
| V6-2 | 148 | 7051 | 91 | 7 | 2 | 1.71 |
| 1090-1 | 165 | 8649 | 83 | 17 | 0 | 2.46 |
| 1090-2 | 189 | 15448 | 86 | 14 | 0 | 1.91 |
| 1091-1 | 150 | 10348 | 85 | 15 | 0 | 2.36 |
| 1091-2 | 150 | 11148 | 85 | 15 | 0 | 1.71 |
| 1091-3 | 170 | 13447 | 78 | 22 | 0 | 1.61 |
| 1092-1 | 236 | 14850 | 91 | 2 | 7 | 1.70 |
| 1092-2 | 242 | 10450 | 89 | 2 | 9 | 1.03 |
| 1094-1 | 158 | 14049 | 92 | 8 | 0 | 1.15 |
| 1094-2 | 179 | 13151 | 76 | 24 | 0 | 1.01 |
| 1095-1 | 160 | 12648 | 87 | 13 | 0 | 2.51 |
| 1095-2 | 150 | 12949 | 91 | 9 | 0 | 2.30 |
| 1096-1 | 150 | 11850 | 87 | 12 | 0 | 1.84 |
| 1096-2 | 150 | 13049 | 73 | 26 | 1 | 2.23 |
| 1097-1 | 200 | 17950 | 93 | 7 | 0 | 2.60 |
| 1097-2 | 180 | 16951 | 76 | 19 | 6 | 1.39 |
| 1097-3 | 146 | 13450 | 75 | 22 | 3 | 1.26 |
| 1098-1 | 191 | 14849 | 75 | 0 | 25 | 1.78 |
| 1098-2 | 190 | 14051 | 65 | 33 | 2 | 0.58 |
| 1099-1 | 257 | 15550 | 73 | 24 | 3 | 1.18 |
| 1099-2 | 200 | 15849 | 78 | 5 | 17 | 1.78 |

CHARACTERISTICS OF CORES, continued

| SAMPLE NAME | CORE LENGTH (CM) | DRY SAMPLE WT | % SAND | % MUD | % GRAVEL | WT% THM |
|---|---|---|---|---|---|---|
| 1100-1 | 162 | 12651 | 94 | 6 | 0 | 2.64 |
| 1100-2 | 180 | 16249 | 88 | 11 | 1 | 2.51 |
| 1103-1 | 160 | 7851 | 84 | 12 | 5 | 1.80 |
| 1103-2 | 125 | 4651 | 69 | 22 | 8 | 1.62 |
| 1103-3 | 215 | 12851 | 93 | 6 | 2 | 1.74 |
| 1106-1 | 145 | 13450 | 99 | 1 | 0 | 3.59 |
| 1106-2 | 151 | 14148 | 99 | 1 | 0 | 2.63 |
| 1107-1 | 165 | 15450 | 99 | 1 | 0 | 4.35 |
| 1107-2 | 167 | 15048 | 98 | 2 | 1 | 1.83 |
| 1109-1 | 238 | 11050 | 91 | 9 | 0 | 3.08 |
| 1111-1 | 148 | 11450 | 92 | 8 | 0 | 2.76 |
| 1111-2 | 186 | 15110 | 90 | 10 | 0 | 3.20 |
| 1116-1 | 193 | 10850 | 88 | 12 | 0 | 4.39 |
| 1116-2 | 217 | 15751 | 83 | 14 | 2 | 4.00 |
| 1119-1 | 205 | 19051 | 99 | 1 | 0 | 2.43 |
| 1119-2 | 123 | 19666 | 96 | 4 | 0 | 2.39 |
| 1120-1 | 160 | 12650 | 98 | 2 | 0 | 1.95 |
| 1120-2 | 175 | 15449 | 95 | 4 | 0 | 3.05 |
| 1121-1 | 236 | 19649 | 96 | 4 | 0 | 3.44 |
| 1122-1 | 145 | 12251 | 92 | 7 | 1 | 5.67 |
| 1127-1 | 140 | 11348 | 92 | 8 | 0 | 5.51 |
| 1127-2 | 138 | 11850 | 82 | 18 | 0 | 2.70 |
| 1129-1 | 145 | 11648 | 95 | 5 | 0 | 7.65 |
| 1129-2 | 145 | 12849 | 86 | 14 | 0 | 6.11 |
| 1130-1 | 125 | 10848 | 91 | 6 | 3 | 7.17 |
| 1130-2 | 128 | 9448 | 66 | 34 | 0 | 1.96 |
| 1131-1 | 182 | 15648 | 85 | 11 | 4 | 5.92 |
| 1132-1 | 164 | 14450 | 93 | 6 | 1 | 6.32 |
| 1134-1 | 181 | 16649 | 97 | 3 | 0 | 8.79 |
| 1134-2 | 169 | 15997 | 94 | 6 | 0 | 6.82 |
| 1136-1 | 150 | 12650 | 95 | 4 | 0 | 9.01 |
| 1136-2 | 150 | 12448 | 94 | 5 | 0 | 6.42 |
| 1136-3 | 185 | 15850 | 91 | 8 | 0 | 3.34 |
| 1139-1 | 184 | 13950 | 99 | 1 | 0 | 2.44 |
| 2000-1 | 160 | 6050 | 78 | 22 | 0 | 2.00 |
| 2000-2 | 160 | 9748 | 64 | 36 | 0 | 2.39 |
| 2001-1 | 164 | 10048 | 73 | 27 | 0 | 2.02 |
| 2002-1 | 177 | 9750 | 95 | 5 | 0 | 3.75 |
| 2002-2 | 162 | 11051 | 88 | 12 | 0 | 3.01 |
| 110-1 | 215 | 7850 | 84 | 16 | 0 | 2.60 |
| 110-2 | 161 | 3950 | 88 | 11 | 1 | 2.21 |
| 110-3 | 156 | 3950 | 73 | 26 | 2 | 1.41 |

CHARACTERISTICS OF CORES, continued

| SAMPLE NAME | CORE LENGTH (CM) | DRY SAMPLE WT | % SAND | % MUD | % GRAVEL | SAND PHI MEAN | WT% THM |
|---|---|---|---|---|---|---|---|
| 115-1 | 184 | 5348 | 58 | 42 | 0 | * | 0.74 |
| 116-1 | 85 | 3450 | 97 | 0 | 3 | * | 0.58 |
| 116-2 | 275 | 9251 | 61 | 38 | 1 | * | 0.54 |
| 116-3 | 190 | 6848 | 96 | 2 | 2 | * | 2.17 |
| 116-4 | 176 | 6450 | 97 | 1 | 2 | * | 0.92 |
| 116-5 | 94 | 1948 | 99 | 1 | 0 | * | 1.66 |
| 117-1 | 150 | 5649 | 92 | 3 | 6 | * | 1.26 |
| 117-2 | 140 | 6351 | 79 | 3 | 18 | * | 3.87 |
| 117-3 | 145 | 5050 | 89 | 2 | 9 | * | 3.95 |
| 117-4 | 150 | 5251 | 98 | 1 | 1 | * | 2.84 |
| C1-1 | 154 | 6661 | 94.5 | 2.1 | 3.4 | * | 2.18 |
| C1-2 | 155 | 6332 | 93.0 | 6.2 | 0.8 | 2.31 | 3.18 |
| C1-3 | 155 | 6516 | 93.9 | 5.8 | 0.2 | * | 2.09 |
| C1-4 | 157 | 7682 | 81.3 | 18.7 | 0.0 | * | 1.95 |
| C2-1 | 145 | 6579 | 67.0 | 32.1 | 0.9 | 2.69 | 4.12 |
| C2-2 | 155 | 6186 | 34.9 | 65.1 | 0.0 | * | 1.80 |
| C2-3 | 145 | 5802 | 49.8 | 50.1 | 0.1 | * | 2.65 |
| C2-4 | 115 | 3712 | 64.9 | 34.3 | 0.8 | * | 1.41 |
| C3-1 | 154 | 4543 | 55.3 | 44.5 | 0.3 | 3.25 | 3.99 |
| C3-2 | 129 | 4244 | 76.3 | 23.6 | 0.1 | 3.14 | 4.21 |
| C3-3 | 155 | 5087 | 54.6 | 45.2 | 0.2 | 3.24 | 3.54 |
| C3-4 | 189 | 7341 | 53.4 | 46.4 | 0.1 | 3.09 | 3.36 |
| C4-1 | 156 | 4863 | 50.4 | 47.9 | 1.7 | * | 2.65 |
| C4-2 | 154 | 5783 | 78.3 | 21.3 | 0.4 | * | 2.40 |
| C4-3 | 142 | 7339 | 94.0 | 6.0 | 0.0 | * | 2.66 |
| C5-1 | 151 | 6692 | 87.3 | 7.6 | 5.1 | * | 2.03 |
| C5-2 | 155 | 7526 | 74.4 | 25.3 | 0.4 | * | 2.91 |
| C5-3 | 155 | 7033 | 75.8 | 23.9 | 0.3 | 2.61 | 3.51 |
| C5-4 | 149 | 6290 | 65.5 | 30.6 | 4.0 | 2.77 | 3.31 |
| C6-1 | 155 | 4727 | 51.5 | 46.8 | 1.7 | 2.76 | 4.38 |
| C6-2 | 154 | 3391 | 18.1 | 81.9 | 0.0 | * | 2.55 |
| C6-3 | 176 | 5643 | 58.7 | 40.8 | 0.5 | 3.19 | 5.78 |
| C7-1 | 152 | 5787 | 73.1 | 24.5 | 2.4 | 3.05 | 3.14 |
| C7-2 | 110 | 4759 | 65.2 | 32.5 | 2.3 | * | 1.45 |
| C7-3 | 111 | 4291 | 60.2 | 39.4 | 0.4 | * | 2.35 |
| C8-1 | 72 | 2669 | 83.0 | 5.3 | 11.6 | 2.08 | 3.45 |
| C8-2 | 177 | 6820 | 88.8 | 11.2 | 0.0 | 3.02 | 6.75 |
| C8-3 | 153 | 5747 | 45.9 | 54.0 | 0.1 | 2.99 | 3.65 |
| C8-4 | 131 | 5615 | 71.3 | 28.3 | 0.4 | 3.13 | 3.56 |
| C9-1 | 155 | 6388 | 80.2 | 14.2 | 5.6 | 2.76 | 4.63 |
| C9-2 | 152 | 6099 | 85.8 | 14.2 | 0.0 | 2.92 | 3.84 |
| C9-3 | 173 | 5206 | 75.1 | 24.6 | 0.3 | 2.74 | 3.16 |

CHARACTERISTICS OF CORES, continued

| SAMPLE NAME | CORE LENGTH (CM) | DRY SAMPLE WT | % SAND | % MUD | % GRAVEL | SAND PHI MEAN | WT% THM |
|---|---|---|---|---|---|---|---|
| * C10-1 | 147 | 4808 | 57.9 | 40.6 | 1.5 | 2.47 | 3.22 |
| * C10-2 | 160 | 8318 | 69.8 | 29.4 | 0.8 | 3.06 | 4.07 |
| * C10-3 | 139 | 6195 | 79.7 | 19.6 | 0.7 | 3.08 | 4.98 |
| * C10-4 | 143 | 5815 | 58.9 | 40.6 | 0.5 | 3.18 | 4.53 |
| * C11-1 | 118 | 5641 | 88.4 | 5.5 | 6.2 | * | 1.88 |
| * C11-2 | 114 | 4900 | 94.5 | 4.7 | 0.9 | * | 1.81 |
| * C11-3 | 159 | 5919 | 37.9 | 62.0 | 0.0 | 3.20 | 3.53 |
| * C11-4 | 157 | 4455 | 56.3 | 43.7 | 0.0 | 3.20 | 3.08 |
| C12-1 | 155 | 6746 | 89.5 | 10.2 | 0.3 | 2.93 | 5.62 |
| * C12-2 | 142 | 5474 | 60.7 | 39.3 | 0.0 | 3.15 | 5.32 |
| C12-3 | 126 | 2801 | 76.0 | 24.0 | 0.0 | 3.19 | 9.12 |
| * C12-4 | 123 | 5713 | 83.3 | 14.9 | 1.8 | 3.15 | 7.40 |
| * C13-1 | 223 | 10455 | 89.5 | 7.3 | 3.3 | 2.35 | 3.21 |
| C13-2 | 191 | 9619 | 86.8 | 13.2 | 0.0 | * | 2.64 |
| C13-3 | 171 | 7196 | 89.0 | 11.0 | 0.0 | * | 1.73 |
| C14-1 | 143 | 6350 | 81.2 | 18.4 | 0.4 | 3.04 | 4.47 |
| * C14-2 | 131 | 4084 | 33.2 | 66.8 | 0.0 | * | 1.99 |
| C14-3 | 220 | 8595 | 56.7 | 43.3 | 0.0 | 3.35 | 5.95 |
| * C14-4 | 185 | 6625 | 61.3 | 38.7 | 0.0 | 3.40 | 5.61 |
| * C15-1 | 188 | 6711 | 78.0 | 22.0 | 0.0 | 3.06 | 5.70 |
| C15-2 | 210 | 9208 | 77.8 | 22.2 | 0.0 | 3.27 | 6.57 |
| C16-1 | 169 | 7624 | 85.7 | 13.2 | 1.1 | 3.02 | 6.91 |
| C16-2 | 96 | 3937 | 70.1 | 29.9 | 0.0 | 3.19 | 5.36 |
| C17-1 | 155 | 6583 | 88.1 | 11.9 | 0.0 | 2.97 | 3.80 |
| C17-2 | 130 | 5722 | 70.1 | 29.8 | 0.1 | 3.21 | 4.26 |
| * C17-3 | 89 | 3211 | 50.8 | 49.0 | 0.2 | 3.25 | 4.03 |
| C17-4 | 100 | 3223 | 79.5 | 20.5 | 0.0 | 3.20 | 5.27 |
| * C17-5 | 150 | 5281 | 58.1 | 41.9 | 0.0 | 3.36 | 5.72 |
| * C18-1 | 209 | 8689 | 90.3 | 9.6 | 0.1 | 2.67 | 2.92 |
| * C18-2 | 50 | 5757 | 87.4 | 12.2 | 0.4 | 2.84 | 3.50 |
| * C19-1 | 190 | 7996 | 79.8 | 12.9 | 7.3 | 2.97 | 4.06 |
| C19-2 | 155 | 6435 | 87.0 | 12.3 | 0.7 | * | 2.05 |
| C19-3 | 208 | 8423 | 90.0 | 9.8 | 0.2 | * | 2.08 |
| * C20-1 | 258 | 12131 | 41.9 | 56.3 | 1.7 | * | 1.29 |
| * C20-2 | 150 | 5957 | 57.5 | 25.2 | 17.3 | * | 1.75 |
| * C20-3 | 151 | 6511 | 18.9 | 81.1 | 0.0 | * | 0.97 |
| * C20-4 | 210 | 7489 | 28.9 | 71.1 | 0.0 | * | 1.93 |
| C21-1 | 220 | 8954 | 31.7 | 60.4 | 8.0 | * | 1.11 |
| * C22-1 | 150 | 6886 | 93.5 | 4.4 | 2.2 | * | 1.54 |
| C22-2 | 155 | 6157 | 93.9 | 5.4 | 0.7 | * | 1.76 |
| C22-3 | 115 | 4660 | 84.5 | 15.2 | 0.3 | * | 2.38 |
| * C22-4 | 125 | 5913 | 87.8 | 10.4 | 1.8 | * | 1.22 |

CHARACTERISTICS OF CORES, continued

| SAMPLE NAME | CORE LENGTH (CM) | DRY SAMPLE WT | % SAND | % MUD | % GRAVEL | SAND PHI MEAN | WT% THM |
|---|---|---|---|---|---|---|---|
| C23-2 | 151 | 7368 | 47.8 | 52.2 | 0.0 | * | 1.43 |
| C23-3 | 155 | 7505 | 76.4 | 19.0 | 4.6 | * | 1.59 |
| C23-4 | 155 | 8563 | 86.9 | 5.8 | 7.3 | * | 0.95 |
| C24-1 | 160 | 5552 | 89.2 | 3.9 | 6.9 | * | 1.05 |
| C24-2 | 155 | 7354 | 93.3 | 6.4 | 0.4 | * | 1.49 |
| C25-1 | 155 | 7111 | 57.7 | 34.5 | 7.8 | * | 0.41 |
| C25-2 | 136 | 6072 | 80.8 | 16.5 | 2.7 | * | 1.39 |
| C25-3 | 137 | 7887 | 70.7 | 20.4 | 8.9 | * | 1.77 |
| C26-1 | 171 | 8910 | 92.4 | 7.1 | 0.5 | 2.39 | 3.53 |
| C26-2 | 173 | 6898 | 57.0 | 41.3 | 1.8 | * | 2.60 |
| C26-3 | 164 | 7093 | 24.3 | 72.8 | 2.9 | 3.25 | 5.11 |
| C27-1 | 173 | 5973 | 44.7 | 52.8 | 2.5 | * | 2.28 |
| C27-3 | 183 | 7626 | 46.2 | 41.2 | 12.6 | * | 2.66 |
| C28-1 | 159 | 5817 | 98.7 | 1.3 | 0.0 | 1.98 | 1.88 |
| C28-2 | 151 | 7552 | 93.6 | 6.4 | 0.1 | 2.44 | 3.27 |
| C28-3 | 154 | 6419 | 90.3 | 9.2 | 0.6 | 2.56 | 3.08 |
| C28-4 | 149 | 6537 | 79.3 | 20.6 | 0.1 | * | 2.40 |
| C29-1 | 193 | 8102 | 93.9 | 3.7 | 2.4 | 2.26 | 4.53 |
| C29-2 | 170 | 6691 | 27.0 | 72.9 | 0.2 | * | 1.29 |
| C30-1 | 177 | 5162 | 52.1 | 47.5 | 0.5 | * | 2.96 |
| C31-1 | 140 | 5757 | 97.8 | 1.9 | 0.3 | 1.56 | 0.72 |
| C31-2 | 165 | 6361 | 97.1 | 2.5 | 0.5 | 2.07 | 1.52 |
| C31-3 | 135 | 5290 | 85.6 | 14.1 | 0.3 | 2.86 | 3.14 |
| C31-4 | 150 | 5327 | 71.4 | 28.0 | 0.5 | 2.93 | 3.99 |
| C32-1 | 156 | 6304 | 86.7 | 12.3 | 1.0 | * | 2.71 |
| C32-2 | 154 | 5486 | 56.0 | 42.8 | 1.1 | * | 2.73 |
| C32-3 | 144 | 11583 | 62.1 | 36.9 | 1.0 | 2.80 | 3.39 |
| C33-1 | 154 | 6265 | 77.5 | 22.4 | 0.0 | * | 1.95 |
| C33-2 | 155 | 7031 | 62.2 | 32.5 | 5.3 | * | 2.50 |
| C33-3 | 154 | 5604 | 54.0 | 45.5 | 0.5 | * | 2.42 |
| C33-4 | 156 | 5610 | 21.3 | 29.3 | 49.4 | * | 1.24 |
| C34-1 | 171 | 6675 | 97.7 | 2.0 | 0.3 | 1.72 | 1.08 |
| C34-2 | 153 | 8136 | 93.8 | 5.9 | 0.3 | 2.24 | 3.77 |
| C34-3 | 153 | 7062 | 81.1 | 16.5 | 2.4 | * | 2.14 |
| C35-1 | 156 | 6198 | 16.6 | 83.4 | 0.1 | * | 1.78 |
| C35-4 | 142 | 6189 | 61.0 | 38.9 | 0.0 | * | 1.31 |
| C36-1 | 125 | 7861 | 93.2 | 1.9 | 4.9 | 1.11 | 0.62 |
| C36-2 | 138 | 6703 | 96.7 | 2.0 | 1.3 | 1.51 | 0.73 |
| C36-3 | 136 | 3207 | 95.8 | 3.7 | 0.5 | * | 0.86 |
| C36-4 | 100 | 5024 | 96.5 | 2.2 | 1.3 | 2.06 | 0.80 |
| C37-1 | 173 | 9625 | 88.6 | 11.0 | 0.4 | 3.05 | 4.40 |
| C37-2 | 173 | 9367 | 86.6 | 11.8 | 1.6 | * | 2.22 |

CHARACTERISTICS OF CORES, continued

| SAMPLE NAME | CORE LENGTH (CM) | DRY SAMPLE WT | % SAND | % MUD | % GRAVEL | SAND PHI MEAN | WT% THM |
|---|---|---|---|---|---|---|---|
| C37-3 | 150 | 7881 | 84.6 | 15.3 | 0.1 | 2.42 | 2.16 |
| C38-1 | 156 | 7625 | 84.7 | 14.9 | 0.5 | * | 1.99 |
| C38-2 | 154 | 5232 | 39.5 | 50.3 | 10.2 | * | 2.32 |
| C39-1 | 181 | 8642 | 91.7 | 8.2 | 0.1 | 3.09 | 4.40 |
| C39-2 | 182 | 11016 | 87.3 | 10.1 | 2.6 | 2.45 | 4.13 |
| C39-3 | 180 | 6805 | 88.3 | 9.8 | 1.9 | 2.51 | 2.60 |
| C40-1 | 145 | 5965 | 91.4 | 8.4 | 0.1 | 3.13 | 4.56 |
| C40-2 | 153 | 5942 | 83.9 | 15.2 | 0.9 | 2.82 | 4.18 |
| C40-3 | 148 | 4916 | 89.0 | 10.9 | 0.1 | 2.67 | 2.75 |
| C41-1 | 136 | 5733 | 91.0 | 8.5 | 0.6 | 3.07 | 3.86 |
| C41-2 | 127 | 4435 | 62.0 | 34.8 | 3.2 | * | 1.83 |
| C41-3 | 139 | 6148 | 96.6 | 3.4 | 0.0 | 2.07 | 2.65 |
| C42-1 | 157 | 6202 | 71.2 | 22.1 | 6.7 | 2.29 | 3.56 |
| C42-2 | 154 | 7423 | 78.7 | 20.9 | 0.5 | 2.29 | 4.35 |
| C42-3 | 152 | 6223 | 59.4 | 40.6 | 0.0 | 2.88 | * |
| C42-4 | 149 | 5803 | 48.6 | 51.2 | 0.2 | * | 3.17 |
| C43-1 | 177 | 7165 | 89.1 | 8.5 | 2.4 | 2.79 | 6.38 |
| C43-2 | 173 | 4961 | 90.8 | 8.7 | 0.4 | 2.50 | 3.55 |
| C43-3 | 167 | 6385 | 78.1 | 21.9 | 0.0 | 3.07 | 6.72 |
| C44-1 | 177 | 7886 | 86.6 | 13.3 | 0.1 | 3.09 | 6.49 |
| C44-2 | 175 | 5891 | 93.8 | 6.2 | 0.0 | 2.44 | 3.50 |
| C44-3 | 172 | 4742 | 84.2 | 15.4 | 0.4 | * | 1.74 |
| C45-1 | 145 | 4886 | 28.9 | 70.0 | 1.0 | 2.08 | 3.01 |
| C45-2 | 145 | 5272 | 86.0 | 11.0 | 3.1 | * | 2.63 |
| C45-3 | 131 | 8007 | 83.5 | 5.4 | 11.1 | * | 2.85 |
| C46-1 | 155 | 7107 | 77.2 | 21.6 | 1.2 | 2.43 | 3.36 |
| C46-2 | 155 | 7049 | 72.4 | 26.3 | 1.3 | * | 2.20 |
| C46-3 | 152 | 5843 | 47.1 | 52.5 | 0.4 | 2.01 | 2.19 |
| C46-4 | 151 | 7186 | 83.6 | 16.0 | 0.4 | 1.95 | 3.04 |
| C47-1 | 195 | 8006 | 37.9 | 61.3 | 0.8 | 2.43 | 4.47 |
| C47-2 | 160 | 6466 | 64.4 | 24.4 | 11.1 | * | 1.62 |
| C48-1 | 188 | 8141 | 96.5 | 1.5 | 2.0 | * | 0.89 |
| C48-2 | 202 | 7573 | 97.9 | 1.9 | 0.3 | 1.64 | 0.91 |
| C48-3 | 195 | 9661 | 96.2 | 2.5 | 1.4 | 1.48 | 0.74 |
| C48-4 | 118 | 3750 | 93.8 | 2.4 | 3.8 | * | 1.79 |
| C49-1 | 161 | 8588 | 98.8 | 1.2 | 0.0 | 1.46 | 1.00 |
| C49-2 | 154 | 8152 | 92.3 | 4.5 | 3.2 | 1.57 | 0.82 |
| C49-3 | 142 | 6892 | 89.7 | 6.3 | 4.0 | * | 1.66 |
| C49-4 | 117 | 4366 | 70.5 | 22.6 | 6.9 | 1.99 | 4.14 |
| C50-1 | 154 | 4832 | 36.8 | 63.2 | 0.0 | * | 2.66 |
| WB063-1 | 105 | 4867 | 92.0 | 7.9 | 0.1 | * | 2.07 |
| WB063-2 | 152 | 5720 | 87.3 | 12.7 | 0.0 | * | 2.13 |

CHARACTERISTICS OF CORES, continued

| SAMPLE NAME | CORE LENGTH (CM) | DRY SAMPLE WT | % SAND | % MUD | % GRAVEL | SAND PHI MEAN | WT% THM |
|---|---|---|---|---|---|---|---|
| WB063-3 | 153 | 5667 | 78.8 | 21.1 | 0.1 | * | 2.53 |
| SUM | | 2232476 | | | | | |
| AVERAGE | | 7698.19 | 79.07 | 18.99 | 1.94 | 2.67 | 2.87 |
| STD | | 3407.28 | 18.30 | 17.96 | 4.43 | 0.54 | 1.66 |
| MAX VALUE | | 19666.46 | 99.13 | 83.36 | 49.36 | 3.40 | 9.12 |
| MIN VALUE | | 1948.00 | 16.58 | 0.30 | 0.00 | 1.11 | 0.41 |

B. CHARACTERISTICS OF GRAB SAMPLES

| SAMPLE NAME | DRY SAMPLE WT | WT% THM |
|---|---|---|
| 1 | 5139 | 7.28 |
| 2 | 8707 | 6.08 |
| 3 | 3681 | 5.29 |
| 4 | 4224 | 9.30 |
| 5 | 5219 | 7.62 |
| 6 | 5754 | 2.29 |
| 7 | 4819 | 2.10 |
| 8 | 7372 | 1.67 |
| 9 | 6865 | 1.74 |
| 10 | 4550 | 7.68 |
| 11 | 7128 | 1.53 |
| 12 | 2436 | 8.13 |
| 13 | 2323 | 3.01 |
| 14 | 5399 | 5.51 |
| 15 | 3551 | 5.94 |
| 22 | 1760 | 4.53 |
| 23 | 1892 | 1.99 |
| 24 | 2226 | 3.78 |
| 25 | 3025 | 5.64 |
| 27 | 3369 | 0.73 |
| 28 | 915 | 2.69 |
| 29 | 2016 | 4.33 |
| 30 | 3967 | 7.00 |
| 31 | 1986 | 3.03 |
| 32 | 3291 | 8.06 |
| 33 | 2160 | 5.12 |
| 34 | 2135 | 7.70 |
| 35 | 2443 | 7.12 |
| 36 | 7242 | 9.07 |
| 39 | 4873 | 8.35 |
| 40 | 4037 | 5.25 |
| 41 | 4940 | 8.62 |
| 42 | 4807 | 11.06 |
| 43 | 6902 | 2.94 |
| 44 | 4871 | 4.12 |
| 45 | 3058 | 2.35 |
| 46 | 5008 | 6.80 |
| 47 | 5440 | 6.18 |
| 48 | 7457 | 9.39 |
| 49 | 4147 | 6.32 |

CHARACTERISTICS OF GRABS, continued

| SAMPLE NAME | DRY SAMPLE WT | WT% THM |
|---|---|---|
| 50 | 5221 | 6.30 |
| 51 | 7310 | 6.49 |
| 52 | 6758 | 5.90 |
| 53 | 4421 | 7.79 |
| 54 | 8332 | 14.66 |
| 55 | 5705 | 7.87 |
| 56 | 4445 | 7.95 |
| 57 | 5197 | 7.79 |
| 58 | 4521 | 5.44 |
| 59 | 4225 | 11.02 |
| 60 | 3268 | 4.51 |
| 61 | 4354 | 6.08 |
| 62 | 6037 | 2.93 |
| 63 | 5352 | 3.65 |
| 64 | 4969 | 5.32 |
| 65 | 7957 | 1.53 |
| 66 | 4451 | 6.79 |
| 67 | 9247 | 2.55 |
| 68 | 7737 | 1.14 |
| 69 | 3984 | 0.83 |
| 70 | 8017 | 0.65 |
| 71 | 5209 | 1.19 |
| 72 | 5858 | 1.94 |
| 73 | 3682 | 4.92 |
| 74 | 3265 | 4.40 |
| 75 | 6309 | 0.55 |
| 76 | 9407 | 0.48 |
| 77 | 3685 | 1.51 |
| 78 | 10006 | 1.04 |
| 79 | 9230 | 0.14 |
| 80 | 5224 | 4.74 |
| 81 | 3607 | 4.39 |
| 82 | 7652 | 1.31 |
| 83 | 7693 | 0.70 |
| 84 | 6450 | 0.51 |
| 85 | 5742 | 10.75 |
| 86 | 5499 | 1.31 |
| 87 | 4884 | 4.16 |
| 88 | 4114 | 0.44 |
| 89 | 4047 | 5.22 |
| 89A | 7306 | 4.38 |
| 90 | 11051 | 0.80 |
| 91 | 6650 | 4.52 |

CHARACTERISTICS OF GRABS, continued

| SAMPLE NAME | DRY SAMPLE WT | WT% THM |
|---|---|---|
| 93 | 6291 | 0.97 |
| 94 | 8021 | 0.82 |
| 95 | 7902 | 0.42 |
| 96 | 6542 | 0.79 |
| 97 | 6502 | 1.12 |
| 98 | 7250 | 6.25 |
| 100 | 5395 | 4.48 |
| 101 | 4760 | 3.47 |

| SAMPLE NAME | DRY SAMPLE WT | % SAND | % MUD | % GRAVEL | SAND PHI MEAN | WT% THM |
|---|---|---|---|---|---|---|
| STA054 | 5074 | 97.1 | 2.8 | 0.1 | 2.20 | 5.12 |
| STA055 | 5806 | 98.0 | 1.4 | 0.6 | * | 0.50 |
| STA056 | 6034 | 98.3 | 1.4 | 0.3 | * | 0.83 |
| STA093 | 6635 | 94.1 | 5.9 | 0.0 | 2.80 | 5.64 |
| STA094 | 6323 | 96.8 | 3.0 | 0.2 | 2.47 | 7.45 |
| 51-1 | 19715 | * | * | * | * | 0.79 |
| 51-2 | 14692 | * | * | * | * | 0.09 |
| 51-3 | 19892 | * | * | * | * | 0.08 |
| 51-4 | 17330 | * | * | * | * | 9.99 |
| SUM | 583373 | | | | | |
| AVERAGE | 5833 | 96.8 | 2.9 | 0.3 | 2.49 | 4.43 |
| STD | 3210 | 1.7 | 1.8 | 0.2 | 0.30 | 3.14 |
| MAX VALUE | 19891 | 98.3 | 5.9 | 0.6 | 2.80 | 14.66 |
| MIN VALUE | 915 | 94.1 | 1.4 | 0.0 | 2.20 | 0.08 |

## EXPLANATION OF MINERAL COMPOSITION DATA
for Appendices III, IV, and V

"P" means several grains of the mineral were observed; that is, the mineral was present in the sample.

Mineral names not spelled completely in column heading have been abbreviated as follows: IL = ilmenite, MAG = magnetite, GAR = garnet, EP = epidote, STAUR = staurolite, PYROBOLE = pyroxene and amphibole minerals combined, SILL/KY = sillimanite and kyanite, TOUR = tourmaline, LEUCOX = leucoxene.

"ECON" is the sum of the weight percents of ilmenite, rutile, leucoxene, sillimanite/kyanite, monazite and zircon.

"RHM" is recovered heavy minerals and "THM" is total heavy minerals.

"MAG" (magnetite) contains an undetermined amount of titanomagnetite.

"*" means data not available.

# APPENDIX III

## A. COMPOSITION OF CORE SAMPLES

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| BO1-1 | 9.36 | 14.30 | 15.01 | 9.42 | 0.28 | 32.84 |
| BO1-2 | 7.06 | 14.70 | 20.42 | 8.84 | 4.33 | 38.31 |
| BO2-1 | 5.44 | 19.96 | 25.41 | 5.87 | 3.37 | 35.94 |
| BO2-2 | 5.40 | 20.09 | 15.99 | 8.14 | 0.21 | 34.58 |
| BO3-1 | 4.70 | 16.71 | 11.37 | 11.91 | 0.10 | 35.04 |
| BO3-2 | 7.01 | 13.69 | 18.71 | 9.06 | 0.25 | 34.33 |
| BO3-3 | 4.95 | 15.23 | 14.38 | 7.08 | 0.39 | 32.58 |
| BO4-1 | 5.25 | 12.60 | 14.80 | 8.10 | 0.56 | 32.72 |
| BO5-1 | 4.83 | 21.03 | 17.06 | 8.37 | 6.14 | 37.23 |
| BO5-2 | 5.05 | 25.54 | 12.42 | 7.51 | 4.86 | 34.11 |
| HO1-1 | 3.15 | 29.89 | 22.02 | 8.10 | 2.77 | 32.21 |
| HO1-2 | 9.26 | 17.22 | 17.52 | 4.73 | 0.06 | 33.66 |
| HO1-3 | 11.00 | 17.39 | 9.32 | 3.80 | 2.54 | 31.97 |
| HO2-1 | 3.96 | 15.86 | 12.14 | 6.39 | 0.37 | 34.15 |
| HO2-2 | 9.28 | 20.44 | 8.89 | 7.50 | P | 40.66 |
| HO2-3 | 4.00 | 13.39 | 11.76 | 4.63 | 0.27 | 30.40 |
| HO3-1 | 4.37 | 17.15 | 12.49 | 5.46 | 0.73 | 36.04 |
| HO4-1 | 7.74 | 15.32 | 16.07 | 8.58 | 0.07 | 34.51 |
| HO4-2 | 10.82 | 13.24 | 8.52 | 3.91 | 6.72 | 49.39 |
| HO4-3 | 13.11 | 14.84 | 11.60 | 7.62 | 0.71 | 37.24 |
| HO5-1 | 8.67 | 15.89 | 15.02 | 6.43 | 0.34 | 33.52 |
| HO6-1 | 6.45 | 14.35 | 19.44 | 6.91 | 0.06 | 33.70 |
| HO6-2 | 3.36 | 20.23 | 19.09 | 7.82 | 4.52 | 36.40 |
| HO6-3 | 2.40 | 15.31 | 14.20 | 6.65 | 0.03 | 35.00 |
| HO6-4 | 5.25 | 10.02 | 11.81 | 7.45 | 0.29 | 35.24 |
| HO7-1 | 8.04 | 19.23 | 17.29 | 7.60 | 0.35 | 34.09 |
| HO7-2 | 3.33 | 13.19 | 18.54 | 4.33 | 2.94 | 44.46 |
| HO7-3 | 12.80 | 9.92 | 12.22 | 6.93 | 0.03 | 33.52 |
| HO8-1 | 7.28 | 20.72 | 14.97 | 6.47 | 0.07 | 33.81 |
| HO8-2 | 9.09 | 14.52 | 16.64 | 7.80 | 0.07 | 31.93 |
| HO9-1 | 17.07 | 7.65 | 14.76 | 5.20 | 0.31 | 33.29 |
| H10-1 | 17.56 | 9.36 | 12.73 | 7.74 | 0.11 | 35.07 |
| H10-2 | 18.03 | 8.76 | 15.05 | 6.24 | 0.44 | 32.22 |
| H11-1 | 10.78 | 15.48 | 19.57 | 7.61 | 0.01 | 34.02 |
| H12-1 | 6.68 | 20.71 | 15.84 | 5.41 | 0.27 | 32.41 |
| H12-2 | 8.09 | 12.69 | 11.58 | 4.88 | 0.22 | 31.59 |
| H13-1 | 9.35 | 20.24 | 6.75 | 2.22 | 2.30 | 35.81 |
| H14-1 | 4.20 | 14.59 | 20.26 | 8.96 | 3.27 | 35.80 |
| H14-2 | 12.36 | 9.25 | 11.34 | 4.83 | 2.82 | 36.09 |
| V1-1 | 2.69 | 19.44 | 17.81 | 8.49 | 0.19 | 34.32 |
| V1-2 | 1.42 | 50.71 | 6.69 | 12.80 | 2.34 | 29.96 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| V1-3 | 1.44 | 45.72 | 2.54 | 12.81 | 3.81 | 29.98 |
| V1-4 | 1.68 | 56.22 | 6.29 | 6.12 | 1.86 | 28.88 |
| V2-1 | 4.07 | 23.85 | 15.24 | 7.40 | 0.95 | 33.76 |
| V2-2 | 3.09 | 45.22 | 9.76 | 9.11 | 0.63 | 28.86 |
| V2-3 | 0.51 | 37.16 | 14.73 | 15.08 | 1.95 | 28.81 |
| V2-4 | 1.68 | 50.09 | 4.82 | 7.51 | 0.85 | 30.02 |
| V4-1 | 5.72 | 23.83 | 12.95 | 4.96 | 1.23 | 36.09 |
| V4-2 | 0.85 | 38.30 | 9.62 | 9.92 | 2.48 | 32.46 |
| V4-3 | 2.21 | 32.38 | 10.96 | 17.14 | 1.35 | 29.97 |
| V4-4 | 2.21 | 45.16 | 8.87 | 13.37 | 1.17 | 29.71 |
| V3-1 | 2.34 | 32.51 | 12.71 | 7.18 | 2.52 | 33.54 |
| V3-2 | 0.81 | 36.21 | 3.37 | 15.10 | 2.59 | 28.55 |
| V5-1 | 3.03 | 18.17 | 15.98 | 8.77 | 2.19 | 35.64 |
| V5-3 | 1.55 | 42.75 | 6.65 | 12.18 | 2.97 | 31.82 |
| V5-4 | 3.10 | 44.27 | 5.72 | 13.65 | 1.81 | 29.68 |
| V5-5 | 8.86 | 45.79 | 9.50 | 3.69 | 2.81 | 31.12 |
| V6-1 | 6.92 | 24.09 | 18.17 | 4.01 | 0.35 | 32.21 |
| V6-2 | 4.28 | 24.97 | 14.86 | 7.81 | 1.44 | 29.91 |
| 1090-1 | 8.30 | 26.15 | 14.81 | 9.05 | 0.39 | 36.92 |
| 1090-2 | 5.13 | 25.84 | 16.38 | 9.67 | 0.79 | 36.26 |
| 1091-1 | 3.67 | 24.11 | 15.31 | 8.10 | 0.52 | 34.57 |
| 1091-2 | 2.57 | 30.41 | 14.36 | 8.63 | 0.38 | 32.75 |
| 1091-3 | 6.14 | 37.86 | 10.46 | 6.19 | 0.90 | 30.89 |
| 1092-1 | 0.85 | 45.28 | 9.81 | 13.01 | 1.48 | 31.69 |
| 1092-2 | 0.76 | 46.82 | 3.69 | 14.91 | 1.23 | 31.81 |
| 1094-1 | 3.24 | 36.10 | 13.20 | 7.20 | 1.13 | 32.68 |
| 1094-2 | 1.36 | 47.67 | 9.06 | 10.53 | 0.62 | 30.20 |
| 1095-1 | 10.29 | 23.13 | 18.31 | 6.16 | 0.81 | 33.79 |
| 1095-2 | 1.15 | 46.39 | 4.67 | 16.89 | 2.29 | 30.43 |
| 1096-1 | 5.82 | 25.74 | 13.69 | 10.06 | 0.77 | 32.56 |
| 1096-2 | 2.83 | 39.03 | 8.67 | 18.06 | 1.25 | 32.07 |
| 1097-1 | 5.62 | 30.25 | 14.61 | 9.00 | 0.80 | 37.59 |
| 1097-2 | 1.15 | 46.66 | 5.15 | 17.61 | 1.41 | 29.53 |
| 1097-3 | 1.25 | 53.25 | 8.56 | 4.52 | 0.76 | 31.03 |
| 1098-1 | 0.75 | 49.89 | 5.39 | 15.01 | 2.63 | 30.97 |
| 1098-2 | 1.43 | 60.33 | 2.01 | 6.96 | 1.34 | 29.13 |
| 1099-1 | 6.62 | 34.19 | 12.61 | 8.61 | 0.76 | 31.52 |
| 1099-2 | 1.40 | 51.02 | 6.31 | 11.53 | 1.48 | 28.54 |
| 1100-1 | 10.58 | 24.72 | 13.15 | 5.16 | 0.58 | 36.55 |
| 1100-2 | 2.78 | 45.03 | 7.06 | 10.58 | 1.64 | 33.82 |
| 1103-1 | 2.55 | 38.64 | 14.57 | 6.16 | 0.77 | 35.62 |
| 1103-2 | 1.37 | 40.50 | 12.30 | 7.54 | 0.51 | 32.42 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| 1103-3 | 12.07 | 21.50 | 18.01 | 7.39 | 0.66 | 36.49 |
| 1106-1 | 3.78 | 37.70 | 22.82 | 7.69 | 0.05 | 31.94 |
| 1106-2 | 4.67 | 29.36 | 20.27 | 7.10 | 1.19 | 38.59 |
| 1107-1 | 4.00 | 30.76 | 17.18 | 6.55 | 1.03 | 37.21 |
| 1107-2 | 5.07 | 19.67 | 19.91 | 6.98 | 0.60 | 37.12 |
| 1109-1 | 7.27 | 22.70 | 15.94 | 10.86 | 0.88 | 37.54 |
| 1111-1 | 12.52 | 24.43 | 17.48 | 6.26 | 0.13 | 35.32 |
| 1111-2 | 10.98 | 29.74 | 19.42 | 6.08 | 0.25 | 33.39 |
| 1116-1 | 13.45 | 25.36 | 15.21 | 5.66 | 0.46 | 32.82 |
| 1116-2 | 9.73 | 27.64 | 17.18 | 6.12 | 0.51 | 31.31 |
| 1119-1 | 4.89 | 21.87 | 20.14 | 7.07 | 0.84 | 32.27 |
| 1119-2 | 6.97 | 28.19 | 19.36 | 4.85 | 0.34 | 33.00 |
| 1120-1 | 4.41 | 24.62 | 16.08 | 8.01 | 0.85 | 35.57 |
| 1120-2 | 8.29 | 32.17 | 20.13 | 5.62 | 0.42 | 33.66 |
| 1121-1 | 15.07 | 21.04 | 21.66 | 1.60 | 1.00 | 33.41 |
| 1122-1 | 13.18 | 27.39 | 13.92 | 7.39 | 0.62 | 33.67 |
| 1127-1 | 13.28 | 24.63 | 17.10 | 5.51 | 0.76 | 32.72 |
| 1127-2 | 7.22 | 28.96 | 15.72 | 9.49 | 0.04 | 35.05 |
| 1129-1 | 12.25 | 23.13 | 16.71 | 8.69 | 0.34 | 33.15 |
| 1129-2 | 13.83 | 18.66 | 15.93 | 7.88 | 0.48 | 37.66 |
| 1130-1 | 18.35 | 21.58 | 21.30 | 6.54 | 0.16 | 30.99 |
| 1130-2 | 10.01 | 23.01 | 14.21 | 9.11 | 0.13 | 45.84 |
| 1131-1 | 27.58 | 26.69 | 10.79 | 6.68 | 0.33 | 30.98 |
| 1132-1 | 20.71 | 21.69 | 18.36 | 5.14 | 0.32 | 31.50 |
| 1134-1 | 12.12 | 33.99 | 21.54 | 3.57 | 0.52 | 30.56 |
| 1134-2 | 15.29 | 30.93 | 19.10 | 3.51 | 0.20 | 34.37 |
| 1136-1 | 11.98 | 28.72 | 19.54 | 3.18 | 0.50 | 31.64 |
| 1136-2 | 11.98 | 28.09 | 15.74 | 7.23 | 0.21 | 31.46 |
| 1136-3 | 8.19 | 29.35 | 19.01 | 8.10 | 0.65 | 33.63 |
| 1139-1 | 4.98 | 26.64 | 22.64 | 4.65 | 0.81 | 34.04 |
| 2000-1 | 3.28 | 26.55 | 16.97 | 9.61 | 0.22 | 34.63 |
| 2000-2 | 2.54 | 21.59 | 17.11 | 8.66 | 0.06 | 39.30 |
| 2001-1 | 3.77 | 20.24 | 18.92 | 8.61 | 0.33 | 36.17 |
| 2002-1 | 5.07 | 29.15 | 17.49 | 9.24 | 0.29 | 33.79 |
| 2002-2 | 4.72 | 29.41 | 13.72 | 10.77 | 0.39 | 38.62 |
| 110-1 | 3.54 | 32.48 | 12.77 | 8.34 | 1.46 | 30.62 |
| 110-2 | 7.16 | 18.77 | 17.97 | 9.98 | 0.46 | 35.14 |
| 110-3 | 1.60 | 20.25 | 15.16 | 9.40 | 2.78 | 34.25 |
| 115-1 | 1.21 | 28.03 | 16.83 | 6.19 | 2.74 | 32.16 |
| 116-1 | 0.90 | 31.50 | 14.06 | 7.52 | 3.28 | 32.91 |
| 116-2 | 0.75 | 31.64 | 14.78 | 6.13 | 2.50 | 30.24 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| 116-3 | 1.38 | 35.92 | 13.50 | 10.10 | 2.70 | 29.68 |
| 116-4 | 0.37 | 36.39 | 13.97 | 6.34 | 2.37 | 31.58 |
| 116-5 | 0.23 | 31.24 | 15.21 | 7.60 | 2.04 | 31.43 |
| 117-1 | 0.29 | 29.86 | 15.12 | 5.09 | 3.17 | 33.32 |
| 117-2 | 0.07 | 27.72 | 30.70 | 4.54 | 3.13 | 32.07 |
| 117-3 | 0.09 | 28.32 | 27.00 | 5.09 | 2.68 | 30.95 |
| 117-4 | 0.14 | 22.80 | 23.07 | 6.55 | 3.76 | 30.85 |
| C1-1 | 0.29 | 29.94 | 22.57 | 5.35 | 3.52 | 10.75 |
| C1-2 | 0.67 | 17.44 | 15.46 | 5.54 | 7.72 | 33.54 |
| C1-3 | 0.65 | 17.08 | 20.91 | 5.94 | 1.80 | 30.95 |
| C1-4 | 0.70 | 15.87 | 15.13 | 4.82 | 1.86 | 39.82 |
| C2-1 | 4.21 | 27.13 | 23.98 | 4.91 | 1.27 | 18.11 |
| C2-2 | 3.71 | 19.63 | 21.77 | 6.09 | 0.69 | 20.84 |
| C2-3 | 3.67 | 20.60 | 15.93 | 4.97 | 3.67 | 31.30 |
| C2-4 | 1.58 | 25.01 | 18.05 | 6.50 | 3.86 | 17.79 |
| C3-1 | 4.72 | 10.67 | 19.11 | 9.62 | 0.59 | 20.49 |
| C3-2 | 5.16 | 20.91 | 17.98 | 5.35 | 0.12 | 12.76 |
| C3-3 | 7.56 | 19.59 | 17.74 | 7.80 | 0.81 | 10.55 |
| C3-4 | 2.48 | 29.90 | 16.26 | 5.51 | 0.19 | 13.63 |
| C4-1 | 5.00 | 17.34 | 23.45 | 4.99 | 2.07 | 29.73 |
| C4-2 | 2.11 | 14.76 | 14.73 | 8.89 | 1.84 | 38.22 |
| C4-3 | 1.66 | 18.43 | 20.78 | 6.01 | 0.15 | 23.40 |
| C5-1 | 1.64 | 29.47 | 18.19 | 7.81 | 4.87 | 19.83 |
| C5-2 | 2.98 | 11.95 | 14.24 | 5.06 | 1.00 | 38.42 |
| C5-3 | 4.18 | 11.15 | 15.86 | 8.85 | 4.57 | 35.23 |
| C5-4 | 9.25 | 10.91 | 16.66 | 8.48 | 5.73 | 24.74 |
| C6-1 | 5.13 | 20.48 | 17.27 | 9.67 | 5.36 | 22.73 |
| C6-2 | 6.31 | 17.09 | 21.36 | 3.53 | 1.10 | 27.13 |
| C6-3 | 12.64 | 8.91 | 22.72 | 4.26 | 4.89 | 24.40 |
| C7-1 | 9.96 | 19.80 | 24.24 | 5.75 | 0.88 | 22.84 |
| C7-2 | 1.84 | 32.86 | 31.94 | 4.90 | 5.76 | 8.76 |
| C7-3 | 13.01 | 24.62 | 21.77 | 6.38 | 0.80 | 17.61 |
| C8-1 | 4.78 | 30.41 | 16.95 | 5.04 | 0.16 | 22.26 |
| C8-2 | 15.33 | 10.70 | 19.11 | 7.17 | 4.34 | 25.32 |
| C8-3 | 10.01 | 8.95 | 23.21 | 4.65 | 0.90 | 35.93 |
| C8-4 | 17.87 | 7.97 | 21.15 | 6.23 | 0.90 | 28.65 |
| C9-1 | 8.47 | 21.17 | 9.81 | 9.05 | 2.99 | 29.10 |
| C9-2 | 4.31 | 21.91 | 17.45 | 5.68 | 1.23 | 33.58 |
| C9-3 | 6.23 | 20.63 | 11.03 | 12.61 | 2.79 | 19.35 |
| C10-1 | 5.88 | 26.28 | 25.34 | 6.85 | 1.10 | 17.29 |
| C10-2 | 15.78 | 9.89 | 13.03 | 10.29 | 2.07 | 29.13 |
| C10-3 | 14.35 | 9.50 | 16.26 | 7.36 | 4.13 | 16.68 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| C10-4 | 14.36 | 6.70 | 12.14 | 5.85 | 1.39 | 24.97 |
| C11-1 | 1.49 | 17.79 | 14.14 | 5.10 | 3.64 | 35.86 |
| C11-2 | 0.80 | 15.44 | 7.87 | 3.61 | 4.78 | 45.26 |
| C11-3 | 8.49 | 14.90 | 20.00 | 2.62 | 0.26 | 19.48 |
| C11-4 | 7.37 | 19.73 | 14.55 | 6.59 | 0.22 | 17.91 |
| C12-1 | 11.20 | 15.53 | 26.46 | 15.50 | 1.45 | 17.67 |
| C12-2 | 20.32 | 9.63 | 13.37 | 11.55 | 1.85 | 19.86 |
| C12-3 | 23.36 | 14.76 | 16.84 | 5.82 | 1.34 | 15.49 |
| C12-4 | 25.36 | 8.14 | 19.82 | 9.50 | 3.33 | 12.12 |
| C13-1 | 6.03 | 15.26 | 19.26 | 10.77 | 7.79 | 21.77 |
| C13-2 | 7.00 | 11.44 | 17.04 | 9.57 | 1.15 | 28.93 |
| C13-3 | 7.07 | 12.58 | 15.32 | 4.28 | 0.52 | 27.47 |
| C14-1 | 13.45 | 9.36 | 15.85 | 7.04 | 1.65 | 37.40 |
| C14-2 | 15.33 | 6.47 | 12.70 | 5.19 | 0.36 | 31.01 |
| C14-3 | 14.16 | 9.07 | 11.25 | 11.56 | 4.24 | 19.86 |
| C14-4 | 22.23 | 3.28 | 18.36 | 6.22 | 0.56 | 27.10 |
| C15-1 | 13.16 | 12.47 | 9.99 | 11.23 | 3.03 | 30.55 |
| C15-2 | 23.12 | 7.32 | 14.71 | 9.34 | 6.39 | 21.93 |
| C16-1 | 13.02 | 13.61 | 19.59 | 13.96 | 8.84 | 11.52 |
| C16-2 | 13.67 | 3.31 | 14.30 | 8.23 | 6.21 | 33.05 |
| C17-1 | 9.64 | 15.47 | 16.53 | 14.36 | 3.61 | 20.59 |
| C17-2 | 16.24 | 8.30 | 17.37 | 7.13 | P | 22.88 |
| C17-3 | 16.05 | 5.16 | 13.63 | 7.13 | 1.17 | 30.96 |
| C17-4 | 17.79 | 6.81 | 16.05 | 11.66 | 1.22 | 29.02 |
| C17-5 | 22.83 | 4.03 | 17.06 | 6.22 | 1.19 | 24.82 |
| C18-1 | 3.89 | 10.79 | 11.02 | 7.69 | 1.91 | 39.39 |
| C18-2 | 5.13 | 8.86 | 20.23 | 14.00 | 4.61 | 24.61 |
| C19-1 | 13.42 | 13.38 | 11.22 | 7.31 | 3.07 | 29.52 |
| C19-2 | 5.72 | 13.82 | 14.45 | 12.86 | 5.78 | 28.16 |
| C19-3 | 1.26 | 17.83 | 14.77 | 12.04 | 6.17 | 29.31 |
| C20-1 | 2.75 | 26.49 | 10.05 | 4.93 | 3.62 | 30.00 |
| C20-2 | 4.12 | 23.58 | 13.71 | 8.09 | 3.69 | 18.92 |
| C20-3 | 6.47 | 18.61 | 4.54 | 15.75 | 9.43 | 15.36 |
| C20-4 | 13.17 | 21.74 | 4.15 | 12.78 | 1.98 | 18.54 |
| C21-1 | 5.29 | 22.12 | 14.20 | 13.09 | 3.37 | 16.54 |
| C22-1 | 2.81 | 25.96 | 9.17 | 7.55 | 2.82 | 28.80 |
| C22-2 | 3.23 | 24.30 | 12.64 | 5.13 | 1.66 | 31.32 |
| C22-3 | 9.41 | 20.86 | 14.05 | 8.19 | 3.78 | 22.63 |
| C22-4 | 5.55 | 24.99 | 11.50 | 4.46 | 4.20 | 29.44 |
| C23-2 | 5.02 | 21.24 | 15.83 | 8.50 | 2.22 | 29.93 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| C23-3 | 1.91 | 24.34 | 14.14 | 5.74 | 2.54 | 33.14 |
| C23-4 | 0.49 | 24.03 | 11.68 | 4.58 | 2.91 | 27.96 |
| C24-1 | 1.70 | 28.92 | 13.41 | 7.11 | 2.17 | 25.15 |
| C24-2 | 4.68 | 24.97 | 12.04 | 8.41 | 6.90 | 19.96 |
| C25-1 | 0.43 | 35.22 | 7.85 | 9.90 | 3.30 | 19.44 |
| C25-2 | 0.84 | 35.87 | 8.30 | 8.09 | 2.84 | 16.51 |
| C25-3 | 0.53 | 27.61 | 13.34 | 8.57 | 2.84 | 18.55 |
| C26-1 | 4.37 | 33.39 | 6.59 | 12.52 | 2.60 | 18.97 |
| C26-2 | 6.95 | 19.76 | 10.47 | 7.67 | 2.11 | 24.98 |
| C26-3 | 17.17 | 8.47 | 13.41 | 6.82 | 2.75 | 25.90 |
| C27-1 | 5.07 | 18.69 | 8.71 | 10.83 | 1.76 | 31.11 |
| C27-3 | 0.69 | 44.43 | 10.58 | 5.97 | 2.02 | 13.76 |
| C28-1 | 0.35 | 34.13 | 10.80 | 9.48 | 3.87 | 20.96 |
| C28-2 | 5.82 | 26.08 | 9.51 | 7.06 | 3.10 | 25.47 |
| C28-3 | 5.26 | 18.20 | 16.89 | 7.98 | 1.93 | 21.39 |
| C28-4 | 4.12 | 28.67 | 6.53 | 9.12 | 1.98 | 21.76 |
| C29-1 | 2.65 | 39.62 | 10.20 | 6.68 | 2.75 | 16.99 |
| C29-2 | 1.43 | 31.61 | 7.00 | 8.92 | 1.56 | 26.50 |
| C30-1 | 2.26 | 24.22 | 11.24 | 8.59 | 4.75 | 22.09 |
| C31-1 | 0.51 | 34.59 | 9.53 | 6.88 | 3.28 | 26.81 |
| C31-2 | 1.20 | 36.77 | 4.77 | 10.96 | 3.36 | 19.05 |
| C31-3 | 5.53 | 30.61 | 14.27 | 7.66 | 4.15 | 13.96 |
| C31-4 | 9.62 | 13.02 | 12.23 | 12.92 | 5.14 | 22.57 |
| C32-1 | 4.79 | 27.79 | 8.15 | 7.34 | 0.42 | 29.83 |
| C32-2 | 7.66 | 16.24 | 13.54 | 8.92 | 3.98 | 24.26 |
| C32-3 | 9.98 | 24.02 | 10.40 | 10.35 | 1.30 | 20.08 |
| C33-1 | 7.52 | 13.39 | 10.45 | 9.23 | 2.65 | 27.56 |
| C33-2 | 7.92 | 13.07 | 12.36 | 8.88 | 1.06 | 26.97 |
| C33-3 | 9.04 | 13.20 | 12.26 | 10.87 | 2.24 | 21.20 |
| C33-4 | 5.24 | 24.95 | 10.96 | 7.91 | 1.62 | 20.18 |
| C34-1 | 0.42 | 32.91 | 10.70 | 5.88 | 1.96 | 31.74 |
| C34-2 | 3.14 | 32.86 | 12.34 | 7.40 | 3.54 | 19.73 |
| C34-3 | 6.44 | 17.64 | 10.05 | 9.08 | 1.43 | 31.16 |
| C35-1 | 3.02 | 20.55 | 10.40 | 6.32 | 1.00 | 22.95 |
| C35-4 | 1.95 | 29.82 | 8.66 | 9.02 | 3.34 | 18.33 |
| C36-1 | 0.90 | 41.83 | 18.96 | 6.44 | 5.01 | 11.08 |
| C36-2 | 0.48 | 34.89 | 11.83 | 5.39 | 5.05 | 22.53 |
| C36-3 | 1.10 | 40.04 | 10.63 | 6.73 | 2.40 | 19.16 |
| C36-4 | 2.03 | 26.01 | 11.89 | 5.89 | 4.79 | 23.76 |
| C37-1 | 11.57 | 13.50 | 18.23 | 8.99 | 2.93 | 21.83 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| C37-2 | 0.69 | 26.93 | 16.73 | 8.68 | 2.79 | 22.79 |
| C37-3 | 1.88 | 30.55 | 11.43 | 3.80 | 3.87 | 25.74 |
| C38-1 | 6.98 | 14.17 | 12.68 | 6.71 | 2.53 | 35.29 |
| C38-2 | 0.92 | 19.75 | 16.99 | 9.74 | 3.31 | 15.77 |
| C39-1 | 9.77 | 18.74 | 16.53 | 4.00 | 0.81 | 31.43 |
| C39-2 | 1.37 | 21.36 | 15.72 | 8.91 | 0.13 | 37.79 |
| C39-3 | 1.30 | 29.26 | 18.63 | 4.06 | 2.18 | 29.39 |
| C40-1 | 10.55 | 19.23 | 16.07 | 10.10 | 4.66 | 19.00 |
| C40-2 | 3.84 | 22.96 | 11.15 | 4.80 | 1.84 | 34.39 |
| C40-3 | 1.20 | 25.74 | 14.87 | 6.61 | 1.56 | 31.43 |
| C41-1 | 8.96 | 19.92 | 19.92 | 13.25 | 3.47 | 14.19 |
| C41-2 | 2.70 | 20.79 | 11.98 | 10.89 | 3.82 | 16.53 |
| C41-3 | 2.53 | 25.50 | 14.00 | 4.10 | 2.21 | 32.40 |
| C42-1 | 1.62 | 34.40 | 11.50 | 10.21 | 3.59 | 18.08 |
| C42-2 | 3.07 | 31.44 | 13.40 | 7.75 | 1.85 | 21.65 |
| C42-3 | 3.33 | 31.18 | 20.43 | 9.26 | 4.88 | 10.48 |
| C42-4 | 1.90 | 49.40 | 5.45 | 7.45 | 2.66 | 13.35 |
| C43-1 | 10.23 | 5.11 | 21.39 | 24.35 | 8.86 | 11.63 |
| C43-2 | 1.51 | 28.84 | 14.77 | 7.69 | 2.49 | 21.97 |
| C43-3 | 4.44 | 18.49 | 18.21 | 3.40 | 2.22 | 33.12 |
| C44-1 | 9.05 | 14.45 | 14.17 | 7.09 | 2.93 | 32.46 |
| C44-2 | 0.40 | 27.87 | 17.28 | 10.48 | 4.74 | 20.12 |
| C44-3 | 3.07 | 24.32 | 11.47 | 6.16 | 7.00 | 23.30 |
| C45-1 | 4.00 | 13.30 | 19.27 | 11.75 | 6.53 | 24.63 |
| C45-2 | 1.20 | 16.99 | 13.92 | 12.37 | 5.72 | 26.76 |
| C45-3 | 0.84 | 22.21 | 13.95 | 5.28 | 2.90 | 22.70 |
| C46-1 | 3.69 | 19.62 | 17.64 | 10.04 | 3.71 | 22.37 |
| C46-2 | 1.14 | 22.84 | 14.30 | 8.07 | 4.44 | 27.48 |
| C46-3 | 2.81 | 17.80 | 12.99 | 5.76 | 4.84 | 26.92 |
| C46-4 | 1.11 | 29.17 | 14.15 | 8.14 | 3.23 | 21.86 |
| C47-1 | 6.49 | 18.15 | 14.37 | 8.80 | 2.67 | 27.94 |
| C47-2 | 0.43 | 33.49 | 10.83 | 8.53 | 5.08 | 18.71 |
| C48-1 | 0.49 | 29.11 | 14.09 | 14.36 | 6.38 | 15.22 |
| C48-2 | 0.77 | 16.89 | 15.21 | 10.54 | 4.60 | 22.29 |
| C48-3 | 1.07 | 27.71 | 13.83 | 8.50 | 5.70 | 17.69 |
| C48-4 | 0.85 | 29.65 | 16.92 | 5.73 | 5.91 | 18.64 |
| C49-1 | 0.69 | 28.89 | 10.56 | 10.32 | 6.48 | 17.97 |
| C49-2 | 0.50 | 30.27 | 9.58 | 12.44 | 8.55 | 16.16 |
| C49-3 | 0.83 | 25.11 | 9.53 | 7.99 | 3.47 | 33.40 |
| C49-4 | 0.62 | 21.71 | 14.72 | 11.86 | 4.63 | 23.87 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| C50-1 | 2.03 | 20.40 | 4.28 | 4.46 | 2.94 | 6.43 |
| WB063-1 | 0.24 | 39.20 | 4.74 | 17.24 | 3.73 | 18.50 |
| WB063-2 | 0.67 | 40.78 | 4.70 | 10.52 | 2.61 | 16.21 |
| WB063-3 | 2.01 | 35.64 | 2.64 | 15.71 | 2.26 | 15.29 |
| AVG | 6.03 | 24.01 | 14.42 | 8.10 | 2.28 | 28.17 |
| STD DEV | 5.37 | 10.71 | 4.95 | 3.14 | 1.95 | 7.57 |
| MAX VALUE | 27.58 | 60.33 | 31.94 | 24.35 | 9.43 | 49.39 |
| MIN VALUE | 0.07 | 3.28 | 2.01 | 1.60 | 0.00 | 6.43 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| B01-1 | 0.97 | 0.85 | 0.57 | 0.57 | 0.78 | P |
| B01-2 | 0.59 | 1.01 | 1.75 | 0.25 | 0.58 | 0.12 |
| B02-1 | 1.04 | 1.66 | 1.54 | 0.19 | 0.25 | 0.46 |
| B02-2 | 0.64 | 0.55 | 0.57 | 0.28 | 1.86 | 0.15 |
| B03-1 | 0.56 | 0.73 | 0.59 | 1.09 | 0.86 | 0.05 |
| B03-2 | 0.70 | 1.20 | 0.40 | 0.72 | 0.70 | 0.04 |
| B03-3 | 1.68 | 1.06 | 0.72 | 1.29 | 1.70 | P |
| B04-1 | 0.94 | 0.50 | 0.00 | 0.33 | 0.74 | P |
| B05-1 | 0.65 | 3.31 | 0.92 | 0.18 | 0.54 | 0.51 |
| B05-2 | 1.81 | 3.01 | 1.85 | 0.40 | 0.70 | 0.99 |
| H01-1 | 0.75 | 3.12 | 1.14 | 0.27 | 1.80 | 1.15 |
| H01-2 | 1.25 | 0.24 | 0.14 | 1.16 | 0.43 | 0.06 |
| H01-3 | 2.66 | 2.83 | 1.44 | 0.12 | 0.30 | 1.44 |
| H02-1 | 0.86 | 1.68 | 0.26 | 0.19 | 1.52 | 0.14 |
| H02-2 | P | 1.75 | 0.63 | 0.23 | 0.12 | 0.45 |
| H02-3 | 1.05 | 3.93 | 0.46 | 1.16 | 0.85 | P |
| H03-1 | 0.78 | 1.31 | 1.08 | 0.67 | 1.98 | 0.33 |
| H04-1 | 1.50 | 0.67 | 0.29 | 1.48 | 0.81 | P |
| H04-2 | 0.70 | 3.91 | 0.70 | 0.05 | 0.05 | P |
| H04-3 | 0.97 | 0.57 | 0.45 | 0.95 | 1.53 | P |
| H05-1 | 1.27 | 1.15 | 0.61 | 0.10 | 1.23 | 0.12 |
| H06-1 | 0.53 | 0.59 | 0.44 | 0.26 | 0.23 | P |
| H06-2 | 1.77 | 3.69 | 1.17 | 0.18 | 0.57 | 0.15 |
| H06-3 | 0.60 | 0.81 | 0.00 | 1.35 | 0.50 | P |
| H06-4 | 0.96 | 0.90 | 0.38 | 0.56 | 1.55 | P |
| H07-1 | 0.71 | 0.57 | 0.50 | 0.66 | 1.15 | 0.06 |
| H07-2 | 1.11 | 1.57 | 0.56 | 1.32 | 0.23 | P |
| H07-3 | 0.97 | 0.32 | 0.03 | 0.58 | 0.37 | 0.03 |
| H08-1 | 0.58 | 0.18 | 0.32 | 0.21 | 0.71 | 0.14 |
| H08-2 | 0.88 | 0.70 | 0.15 | 0.83 | 0.29 | 0.02 |
| H09-1 | 0.20 | 1.57 | 0.47 | 1.83 | 0.45 | 0.05 |
| H10-1 | 0.26 | 1.50 | 0.47 | 0.79 | 0.68 | 0.01 |
| H10-2 | 0.61 | 0.53 | 0.46 | 0.79 | 0.99 | 0.06 |
| H11-1 | 1.08 | 0.14 | 0.14 | 0.50 | 0.58 | P |
| H12-1 | 0.42 | 0.49 | 0.72 | 0.05 | 0.68 | 0.09 |
| H12-2 | 0.20 | 0.86 | 0.60 | 0.50 | 0.55 | P |
| H13-1 | 0.84 | 3.24 | 0.98 | 1.38 | 1.80 | 0.37 |
| H14-1 | 0.98 | 1.15 | 1.03 | 1.96 | 0.93 | 0.59 |
| H14-2 | 1.71 | 5.19 | 2.04 | 0.41 | 0.33 | 1.09 |
| V1-1 | 1.58 | 0.59 | 0.05 | 0.51 | 0.71 | 0.05 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| V1-2 | 1.93 | 2.20 | 0.32 | 0.73 | 1.90 | 0.36 |
| V1-3 | 1.37 | 3.02 | 0.17 | 0.06 | 2.17 | 0.33 |
| V1-4 | 1.69 | 0.76 | 0.05 | 0.98 | 3.31 | 0.29 |
| V2-1 | 0.69 | 1.58 | 0.41 | 0.52 | 1.18 | 0.15 |
| V2-2 | 2.25 | 0.75 | 0.18 | 0.28 | 1.77 | 0.04 |
| V2-3 | 1.25 | 3.81 | 0.21 | 0.34 | 1.80 | 0.29 |
| V2-4 | 1.62 | 0.84 | 0.59 | 0.16 | 1.42 | 0.05 |
| V4-1 | 0.50 | 0.80 | 0.39 | 0.62 | 1.70 | 0.08 |
| V4-2 | 2.09 | 1.43 | 0.77 | 0.10 | 1.86 | 0.04 |
| V4-3 | 1.59 | 1.89 | 0.22 | 0.85 | 2.61 | 0.11 |
| V4-4 | 2.08 | 1.43 | 0.25 | 0.35 | 3.02 | 0.09 |
| V3-1 | 1.37 | 1.85 | 0.18 | 0.46 | 5.39 | 0.10 |
| V3-2 | 1.89 | 3.83 | 0.28 | P | 1.06 | 0.04 |
| V5-1 | 0.91 | 0.62 | 0.56 | 1.31 | 1.73 | 0.03 |
| V5-3 | 1.61 | 2.93 | 0.43 | 0.36 | 2.24 | 0.30 |
| V5-4 | 1.99 | 1.17 | 0.29 | 1.12 | 1.40 | 0.03 |
| V5-5 | 1.37 | 1.50 | 0.13 | 0.88 | 3.50 | 0.16 |
| V6-1 | 1.38 | 0.14 | 0.17 | 0.44 | 0.39 | 0.04 |
| V6-2 | 1.59 | 0.06 | 0.03 | 1.79 | 0.45 | 0.03 |
| 1090-1 | 0.94 | 0.31 | 0.23 | 0.32 | 0.44 | P |
| 1090-2 | 1.23 | 1.04 | 0.52 | 0.57 | 1.33 | 0.07 |
| 1091-1 | 0.56 | 0.81 | 0.88 | 0.73 | 1.43 | 2.47 |
| 1091-2 | 1.63 | 1.02 | 0.32 | 0.09 | 1.98 | 0.15 |
| 1091-3 | 2.31 | 0.92 | 0.21 | 0.79 | 1.16 | P |
| 1092-1 | 1.71 | 1.61 | 0.00 | 0.16 | 1.37 | 0.13 |
| 1092-2 | 1.93 | 1.32 | 0.11 | 0.79 | 3.15 | 0.05 |
| 1094-1 | 1.26 | 0.60 | 0.44 | 0.65 | 1.33 | 0.01 |
| 1094-2 | 1.56 | 1.48 | 0.27 | 0.56 | 1.71 | 0.01 |
| 1095-1 | 0.68 | 0.46 | 0.39 | 0.61 | 1.02 | P |
| 1095-2 | 1.95 | 1.40 | 0.48 | 0.55 | 1.47 | P |
| 1096-1 | 0.36 | 0.98 | 0.26 | 0.66 | 0.86 | 0.05 |
| 1096-2 | 1.63 | 1.27 | 0.16 | 0.18 | 1.35 | 0.03 |
| 1097-1 | 0.67 | 0.99 | 0.22 | 0.34 | 1.08 | P |
| 1097-2 | 1.23 | 1.36 | 0.44 | 0.99 | 2.13 | 0.09 |
| 1097-3 | 2.12 | 0.82 | 0.28 | 0.45 | 1.95 | P |
| 1098-1 | 1.34 | 2.25 | 0.45 | 0.05 | 2.20 | 0.13 |
| 1098-2 | 1.51 | 2.22 | 0.36 | 0.02 | 2.01 | 0.16 |
| 1099-1 | 1.52 | 0.63 | 0.30 | 0.67 | 2.10 | 0.01 |
| 1099-2 | 1.66 | 2.08 | 0.32 | 0.47 | 1.31 | 0.25 |
| 1100-1 | 0.66 | 0.93 | 0.65 | 0.33 | 1.00 | P |

COMPOSITION OF CORES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| 1100-2 | 1.25 | 1.85 | 0.10 | 0.09 | 0.83 | 0.01 |
| 1103-1 | 0.64 | 0.61 | 0.27 | 0.30 | 1.23 | 0.01 |
| 1103-2 | 1.36 | 1.18 | 0.24 | 0.44 | 3.12 | P |
| 1103-3 | 1.21 | 0.85 | 0.04 | 0.55 | 1.31 | 0.11 |
| 1106-1 | 0.81 | 0.68 | 0.28 | 0.32 | 0.77 | 0.09 |
| 1106-2 | 0.85 | 0.36 | 0.24 | 0.20 | 0.43 | P |
| 1107-1 | 0.66 | 0.77 | 0.47 | 0.55 | 0.79 | 0.12 |
| 1107-2 | 1.43 | 0.75 | 0.49 | 0.35 | 1.17 | 0.19 |
| 1109-1 | 0.47 | 0.22 | 0.37 | 0.74 | 0.96 | P |
| 1111-1 | 1.19 | 0.46 | 0.23 | 0.23 | 0.82 | 0.03 |
| 1111-2 | 0.91 | 0.00 | 0.32 | 0.97 | 0.71 | 0.03 |
| 1116-1 | 0.96 | 0.50 | 0.62 | 0.11 | 0.75 | 0.10 |
| 1116-2 | 2.10 | 0.39 | 0.13 | 0.48 | 0.36 | 0.11 |
| 1119-1 | 1.35 | 0.20 | 0.27 | 0.91 | 0.93 | 0.22 |
| 1119-2 | 1.35 | 0.40 | 0.28 | 0.90 | 0.35 | 0.05 |
| 1120-1 | 1.09 | 0.98 | 0.13 | 1.27 | 0.55 | 0.23 |
| 1120-2 | 1.05 | 0.23 | 0.17 | 0.06 | 1.07 | 0.03 |
| 1121-1 | 0.94 | 0.36 | 0.13 | P | 0.80 | 0.04 |
| 1122-1 | 0.90 | 0.55 | 0.34 | 0.71 | 0.84 | 0.09 |
| 1127-1 | 0.89 | 0.25 | 0.27 | P | 0.90 | P |
| 1127-2 | 0.55 | 0.67 | 0.17 | 0.54 | 1.23 | 0.07 |
| 1129-1 | 0.86 | 0.64 | 0.79 | 0.22 | 1.01 | 0.08 |
| 1129-2 | 0.79 | 0.68 | 0.86 | 0.32 | 0.79 | P |
| 1130-1 | 0.59 | 0.51 | 0.49 | 0.29 | 0.58 | 0.08 |
| 1130-2 | 0.45 | 0.47 | 0.28 | 0.35 | 0.91 | 0.03 |
| 1131-1 | 1.06 | 0.48 | 0.34 | 0.30 | 0.70 | 0.37 |
| 1132-1 | 0.68 | 0.52 | 0.63 | 0.44 | 0.84 | 0.01 |
| 1134-1 | 1.79 | 0.20 | 0.39 | 0.24 | 0.30 | 0.17 |
| 1134-2 | 0.95 | 0.55 | 0.36 | 0.06 | 0.57 | P |
| 1136-1 | 1.13 | 0.43 | 0.27 | 0.59 | 0.99 | P |
| 1136-2 | 0.61 | 0.21 | 0.55 | 0.31 | 0.73 | 0.30 |
| 1136-3 | 1.09 | 0.28 | 0.21 | 0.51 | 0.48 | 0.03 |
| 1139-1 | 1.23 | 0.91 | 0.63 | 0.48 | 1.62 | 0.26 |
| 2000-1 | 1.34 | 0.96 | 0.48 | 0.29 | 1.88 | 0.07 |
| 2000-2 | 1.45 | 1.03 | 0.25 | 0.39 | 1.42 | P |
| 2001-1 | 1.23 | 0.59 | 1.00 | 0.30 | 1.75 | 0.05 |
| 2002-1 | 0.49 | 0.44 | 0.21 | 0.45 | 0.21 | P |
| 2002-2 | 0.31 | 0.44 | 0.47 | 0.80 | 0.89 | 0.01 |
| 110-1 | 1.58 | 0.72 | 0.05 | 0.49 | 0.52 | P |
| 110-2 | 1.21 | 0.81 | 0.09 | 0.46 | 1.10 | P |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| 110-3 | 1.15 | 1.45 | 0.93 | 0.47 | 1.21 | 0.10 |
| 115-1 | 1.52 | 1.19 | 0.91 | 1.00 | 1.03 | 0.11 |
| 116-1 | 1.69 | 2.37 | 0.56 | 0.08 | 2.16 | 0.15 |
| 116-2 | 2.05 | 1.78 | 0.35 | 0.54 | 2.66 | 0.10 |
| 116-3 | 1.44 | 2.05 | 0.53 | 0.54 | 1.98 | P |
| 116-4 | 1.95 | 1.65 | 1.45 | 0.17 | 1.55 | 0.14 |
| 116-5 | 3.15 | 1.95 | 0.62 | 0.31 | 2.52 | 0.23 |
| 117-1 | 1.38 | 1.25 | 0.56 | 0.61 | 1.76 | 0.06 |
| 117-2 | 1.70 | 1.65 | 0.88 | 1.34 | 1.08 | 0.10 |
| 117-3 | 1.06 | 1.46 | 1.06 | P | 0.92 | 0.16 |
| 117-4 | 1.26 | 1.57 | 0.69 | P | 1.35 | 0.06 |
| C1-1 | 0.68 | 3.15 | 0.02 | 4.57 | 3.98 | 0.02 |
| C1-2 | 1.48 | 3.37 | 0.19 | 4.00 | 1.45 | P |
| C1-3 | 0.00 | 2.82 | 0.23 | 0.62 | 2.91 | 0.08 |
| C1-4 | 1.60 | 2.75 | 0.53 | 1.20 | 2.69 | P |
| C2-1 | 1.32 | 0.89 | 0.40 | 2.05 | 1.07 | 0.03 |
| C2-2 | 1.16 | 2.12 | 0.56 | 2.65 | 2.00 | P |
| C2-3 | 1.03 | 2.42 | 0.49 | 1.15 | 3.39 | P |
| C2-4 | 1.34 | 1.46 | 0.30 | 2.65 | 4.02 | 0.10 |
| C3-1 | 1.73 | 2.75 | 0.03 | 1.17 | 0.91 | P |
| C3-2 | 1.08 | 4.18 | 0.02 | 1.33 | 0.52 | P |
| C3-3 | 1.77 | 3.86 | 0.08 | 3.32 | 1.21 | P |
| C3-4 | 1.86 | 2.26 | 0.12 | 1.57 | 1.02 | P |
| C4-1 | 1.55 | 1.42 | 0.18 | 1.55 | 1.09 | 0.03 |
| C4-2 | 1.55 | 3.04 | 0.47 | 0.77 | 1.13 | P |
| C4-3 | 0.87 | 2.56 | P | 4.45 | 1.34 | P |
| C5-1 | 1.25 | 3.28 | 0.33 | 3.00 | 2.11 | 0.05 |
| C5-2 | 1.89 | 5.10 | 0.42 | 0.51 | 1.93 | P |
| C5-3 | 1.57 | 3.49 | 0.21 | 2.80 | 0.71 | P |
| C5-4 | 1.39 | 4.62 | 0.26 | 1.31 | 1.62 | P |
| C6-1 | 1.52 | 2.37 | 0.32 | 1.35 | 1.27 | 0.03 |
| C6-2 | 1.37 | 1.65 | 0.05 | 0.41 | 1.15 | P |
| C6-3 | 2.14 | 3.52 | 0.40 | 0.12 | 1.16 | P |
| C7-1 | 0.79 | 0.88 | 0.29 | 0.61 | 0.00 | P |
| C7-2 | 0.70 | 1.03 | 0.14 | 1.58 | 2.21 | 0.32 |
| C7-3 | 0.26 | 1.75 | 0.44 | 0.56 | 1.17 | P |
| C8-1 | 1.16 | 2.50 | 0.40 | 0.59 | 0.50 | 0.06 |
| C8-2 | 1.23 | 2.67 | 0.20 | 1.94 | 0.99 | P |
| C8-3 | 1.89 | 2.40 | 0.64 | 0.66 | 0.49 | 0.00 |
| C8-4 | 1.41 | 1.33 | 0.34 | 1.97 | 0.51 | P |
| C9-1 | 1.73 | 2.45 | 0.12 | 2.80 | 1.99 | P |
| C9-2 | 1.33 | 2.53 | 0.15 | 1.87 | 1.15 | 0.00 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| C9-3 | 1.96 | 2.44 | 0.09 | 2.57 | 1.16 | 0.03 |
| C10-1 | 1.92 | 2.05 | 0.38 | 1.91 | 0.89 | 0.04 |
| C10-2 | 1.43 | 3.27 | 0.27 | 2.27 | 0.71 | P |
| C10-3 | 1.53 | 4.52 | 0.39 | 1.30 | 1.34 | 0.00 |
| C10-4 | 1.87 | 3.64 | 0.42 | 0.70 | 1.86 | 0.00 |
| C11-1 | 1.07 | 3.08 | 0.26 | 1.02 | 2.81 | 0.07 |
| C11-2 | 2.01 | 5.83 | 0.81 | 0.53 | 3.14 | P |
| C11-3 | 0.70 | 2.91 | 0.00 | 2.13 | 0.60 | P |
| C11-4 | 1.34 | 5.56 | P | 1.15 | 0.62 | 0.02 |
| C12-1 | 0.45 | 1.44 | 0.10 | 2.05 | 1.25 | P |
| C12-2 | 1.53 | 2.89 | 0.08 | 0.36 | 0.68 | P |
| C12-3 | 1.17 | 3.72 | 0.20 | 0.74 | 1.17 | 0.00 |
| C12-4 | 1.36 | 3.15 | 0.08 | 0.63 | 0.51 | 0.00 |
| C13-1 | 1.95 | 1.63 | 0.31 | 1.42 | 2.13 | P |
| C13-2 | 1.63 | 3.09 | 2.52 | 2.15 | 3.01 | P |
| C13-3 | 2.15 | 3.79 | 0.21 | 1.11 | 0.96 | P |
| C14-1 | 1.41 | 0.81 | 0.12 | 0.78 | 0.78 | P |
| C14-2 | 1.68 | 3.47 | 0.67 | 1.63 | 0.31 | 0.00 |
| C14-3 | 2.10 | 4.58 | 0.06 | 2.05 | 2.70 | P |
| C14-4 | 1.75 | 2.91 | 0.30 | 0.59 | 1.41 | P |
| C15-1 | 1.20 | 2.47 | 0.13 | 1.55 | 1.17 | 0.00 |
| C15-2 | 1.34 | 2.23 | 0.10 | 0.19 | 1.40 | 0.00 |
| C16-1 | 1.19 | 2.09 | 0.10 | 0.17 | 0.28 | 0.00 |
| C16-2 | 1.69 | 2.21 | 0.25 | 0.22 | 0.31 | P |
| C17-1 | 1.45 | 2.80 | 0.17 | 1.34 | 2.19 | P |
| C17-2 | 1.38 | 3.26 | 0.20 | 1.04 | 0.64 | P |
| C17-3 | 2.18 | 3.63 | 0.20 | 1.89 | 0.51 | P |
| C17-4 | 2.09 | 1.68 | 0.42 | 1.07 | 0.96 | 0.00 |
| C17-5 | 2.09 | 2.02 | 0.12 | 1.07 | 0.46 | 0.00 |
| C18-1 | 0.74 | 4.58 | 0.43 | 1.28 | 1.66 | P |
| C18-2 | 1.23 | 2.80 | 0.17 | 3.56 | 1.49 | P |
| C19-1 | 1.98 | 1.77 | 0.73 | 0.60 | 1.05 | P |
| C19-2 | 1.55 | 3.51 | 0.20 | 0.83 | 0.71 | P |
| C19-3 | 0.84 | 2.80 | 0.29 | 1.55 | 2.06 | 0.04 |
| C20-1 | 1.83 | 2.14 | 0.83 | 0.55 | 4.09 | P |
| C20-2 | 1.22 | 3.01 | 0.00 | 1.75 | 6.93 | P |
| C20-3 | 1.87 | 2.48 | 0.19 | 1.17 | 2.24 | P |
| C20-4 | 1.59 | 2.52 | 0.61 | 1.08 | 3.51 | 0.00 |
| C21-1 | 1.57 | 1.72 | 0.10 | 1.32 | 5.82 | P |
| C22-1 | 1.73 | 3.16 | 0.13 | 0.67 | 7.87 | P |
| C22-2 | 2.04 | 2.93 | 0.28 | 0.59 | 5.59 | P |
| C22-3 | 1.24 | 2.91 | 0.17 | 1.74 | 4.04 | P |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| C22-4 | 1.37 | 4.24 | 0.36 | 0.84 | 3.06 | 0.05 |
| C23-2 | 0.71 | 1.63 | P | 0.63 | 2.61 | P |
| C23-3 | 1.36 | 1.83 | 0.10 | 1.04 | 1.81 | 0.06 |
| C23-4 | 1.06 | 1.79 | 0.98 | 1.09 | 3.23 | P |
| C24-1 | 2.30 | 3.43 | 0.05 | 0.79 | 4.04 | 0.05 |
| C24-2 | 2.03 | 4.10 | 0.41 | 2.18 | 4.08 | P |
| C25-1 | 2.67 | 3.73 | 0.52 | 1.81 | 3.84 | P |
| C25-2 | 1.72 | 2.47 | P | 0.64 | 3.41 | P |
| C25-3 | 1.13 | 3.18 | 0.61 | 0.38 | 2.12 | P |
| C26-1 | 1.83 | 2.25 | 0.15 | 2.37 | 3.59 | 0.03 |
| C26-2 | 2.55 | 3.58 | 0.00 | 1.32 | 2.03 | P |
| C26-3 | 2.68 | 2.76 | 0.37 | 1.76 | 1.36 | P |
| C27-1 | 0.94 | 2.70 | 0.07 | 0.26 | 1.44 | P |
| C27-3 | 2.05 | 2.63 | 0.52 | 0.89 | 3.03 | P |
| C28-1 | 1.93 | 3.06 | 0.74 | 1.27 | 4.28 | 0.13 |
| C28-2 | 1.86 | 2.13 | 0.00 | 1.20 | 2.55 | 0.02 |
| C28-3 | 1.72 | 2.13 | 0.47 | 3.92 | 2.15 | P |
| C28-4 | 1.57 | 3.27 | 0.13 | 3.31 | 3.37 | 0.04 |
| C29-1 | 1.47 | 3.13 | 0.03 | 1.78 | 2.04 | 0.07 |
| C29-2 | 1.81 | 2.35 | 0.34 | 0.87 | 2.09 | 0.09 |
| C30-1 | 2.16 | 3.46 | 0.24 | 1.34 | 2.42 | P |
| C31-1 | 2.07 | 3.53 | 1.61 | 0.39 | 3.15 | 0.05 |
| C31-2 | 2.25 | 4.25 | 0.86 | 2.01 | 4.86 | 0.05 |
| C31-3 | 2.30 | 3.12 | 0.21 | 1.33 | 2.09 | 0.03 |
| C31-4 | 1.60 | 2.47 | 0.82 | 0.30 | 3.00 | P |
| C32-1 | 2.55 | 3.03 | 0.35 | 1.27 | 3.00 | P |
| C32-2 | 1.38 | 2.65 | 0.04 | 1.61 | 3.18 | 0.02 |
| C32-3 | 1.75 | 3.06 | P | 1.48 | 2.60 | P |
| C33-1 | 3.03 | 5.59 | 0.22 | 0.86 | 1.92 | P |
| C33-2 | 1.91 | 2.63 | 0.13 | 1.68 | 1.40 | P |
| C33-3 | 1.69 | 1.81 | 0.69 | 2.21 | 2.34 | P |
| C33-4 | 1.49 | 3.42 | 0.15 | 0.50 | 2.63 | 0.06 |
| C34-1 | 2.04 | 3.31 | 0.64 | 0.87 | 1.84 | 0.10 |
| C34-2 | 1.14 | 3.16 | 0.04 | 1.95 | 2.52 | P |
| C34-3 | 1.55 | 3.68 | 0.31 | 0.87 | 1.90 | P |
| C35-1 | 1.46 | 2.80 | 0.65 | 2.20 | 3.88 | P |
| C35-4 | 2.01 | 2.17 | 0.91 | 1.03 | 4.57 | P |
| C36-1 | 1.73 | 4.08 | P | 0.77 | 2.37 | 0.37 |
| C36-2 | 1.48 | 4.69 | 1.48 | 0.45 | 2.03 | 0.05 |
| C36-3 | 1.79 | 3.20 | 0.97 | 0.71 | 1.56 | 0.12 |
| C36-4 | 1.57 | 4.47 | 0.00 | 4.13 | 3.20 | P |
| C37-1 | 1.18 | 3.23 | 0.05 | 0.69 | 2.54 | P |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| C37-2 | 1.80 | 2.50 | 0.16 | 1.88 | 1.28 | P |
| C37-3 | 2.46 | 2.36 | 1.40 | 0.32 | 2.64 | 0.04 |
| C38-1 | 1.44 | 2.27 | 0.64 | 0.72 | 1.23 | 0.05 |
| C38-2 | 1.40 | 4.20 | 0.25 | 1.67 | 1.59 | P |
| C39-1 | 1.75 | 1.66 | P | 0.72 | 1.23 | P |
| C39-2 | 1.33 | 2.24 | 0.31 | 0.99 | 0.54 | P |
| C39-3 | 2.05 | 2.89 | 0.82 | 0.34 | 1.03 | 0.04 |
| C40-1 | 1.27 | 2.57 | 0.11 | 1.80 | 1.56 | P |
| C40-2 | 2.12 | 3.08 | 0.60 | 0.56 | 3.25 | 0.02 |
| C40-3 | 1.52 | 2.41 | 0.41 | 1.64 | 2.81 | P |
| C41-1 | 1.60 | 3.85 | 0.11 | 1.09 | 1.17 | 0.00 |
| C41-2 | 2.05 | 6.15 | 0.16 | 1.55 | 2.87 | P |
| C41-3 | 2.02 | 2.32 | 1.06 | 1.21 | 2.53 | P |
| C42-1 | 1.64 | 2.06 | 0.07 | 2.86 | 2.88 | P |
| C42-2 | 1.83 | 2.49 | P | 0.71 | 2.11 | 0.03 |
| C42-3 | 2.50 | 2.59 | 0.00 | 0.46 | 0.93 | 0.06 |
| C42-4 | 1.95 | 2.09 | 0.17 | 0.37 | 2.00 | 0.15 |
| C43-1 | 1.72 | 1.97 | 0.18 | 1.23 | 2.48 | P |
| C43-2 | 1.44 | 3.05 | 0.12 | 4.68 | 1.34 | 0.04 |
| C43-3 | 1.28 | 2.31 | 0.06 | 0.98 | 0.77 | P |
| C44-1 | 1.41 | 2.48 | 0.07 | 0.33 | 1.55 | 0.00 |
| C44-2 | 1.25 | 2.89 | 0.22 | 3.21 | 0.60 | P |
| C44-3 | 1.10 | 2.31 | 0.12 | 3.87 | 2.45 | P |
| C45-1 | 1.35 | 2.09 | 0.06 | 0.78 | 2.70 | 0.00 |
| C45-2 | 1.03 | 4.50 | 0.23 | 3.28 | 2.27 | P |
| C45-3 | 2.15 | 4.03 | 0.18 | 2.18 | 2.68 | P |
| C46-1 | 1.37 | 2.63 | 0.07 | 1.38 | 1.43 | P |
| C46-2 | 0.85 | 2.94 | 0.13 | 4.47 | 1.30 | P |
| C46-3 | 1.09 | 3.35 | P | 3.72 | 1.93 | P |
| C46-4 | 1.99 | 3.34 | 0.16 | 3.08 | 1.16 | 0.04 |
| C47-1 | 1.73 | 2.67 | P | 0.25 | 2.63 | P |
| C47-2 | 1.23 | 4.90 | P | 0.88 | 3.06 | 0.04 |
| C48-1 | 2.13 | 3.79 | P | 1.63 | 3.41 | P |
| C48-2 | 1.68 | 3.72 | 0.06 | 2.49 | 3.85 | P |
| C48-3 | 2.28 | 5.64 | 0.38 | 2.59 | 2.31 | P |
| C48-4 | 1.74 | 3.16 | 0.12 | 2.11 | 3.03 | P |
| C49-1 | 1.62 | 4.04 | 2.38 | 0.20 | 3.61 | 0.05 |
| C49-2 | 1.44 | 4.62 | 0.25 | 2.02 | 4.20 | P |
| C49-3 | 1.62 | 3.93 | 0.71 | 0.58 | 1.04 | P |
| C49-4 | 1.33 | 3.05 | 0.03 | 2.36 | 1.38 | P |
| C50-1 | 0.87 | 4.02 | 0.39 | 0.75 | 1.63 | P |
| WB063-1 | 1.81 | 3.67 | 0.12 | P | 1.34 | P |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| WB063-2 | 0.59 | 2.75 | 0.29 | 1.55 | 4.15 | P |
| WB063-3 | 1.10 | 2.65 | 1.13 | 1.80 | 5.71 | 0.04 |
| AVG | 1.40 | 2.17 | 0.39 | 1.05 | 1.73 | 0.08 |
| STD DEV | 0.55 | 1.32 | 0.39 | 0.93 | 1.21 | 0.21 |
| MAX VALUE | 3.15 | 6.15 | 2.52 | 4.68 | 7.87 | 2.47 |
| MIN VALUE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT% THM |
|---|---|---|---|---|---|
| B01-1 | 1.46 | 18.86 | 18.36 | 2.95 | 3.91 |
| B01-2 | 2.36 | 13.32 | 19.35 | 2.17 | 2.88 |
| B02-1 | 3.93 | 11.52 | 27.30 | 2.31 | 2.42 |
| B02-2 | 1.58 | 14.41 | 24.88 | 3.73 | 3.88 |
| B03-1 | 1.56 | 15.55 | 20.46 | 2.85 | 3.20 |
| B03-2 | 3.66 | 13.41 | 19.99 | 2.59 | 3.33 |
| B03-3 | 3.31 | 26.08 | 22.98 | 2.52 | 3.26 |
| B04-1 | 1.63 | 23.81 | 16.41 | 1.87 | 2.53 |
| B05-1 | 3.96 | 10.88 | 30.00 | 1.48 | 1.86 |
| B05-2 | 4.77 | 12.43 | 36.82 | 1.12 | 1.82 |
| H01-1 | 3.10 | 11.04 | 39.81 | 3.57 | 3.86 |
| H01-2 | 2.73 | 19.09 | 21.91 | 4.22 | 5.10 |
| H01-3 | 7.60 | 29.91 | 32.23 | 5.13 | 5.48 |
| H02-1 | 2.46 | 27.88 | 22.51 | 1.53 | 2.32 |
| H02-2 | 2.32 | 20.61 | 25.08 | 0.23 | 1.09 |
| H02-3 | 7.61 | 26.96 | 26.84 | 0.68 | 1.34 |
| H03-1 | 3.13 | 18.78 | 24.68 | 1.85 | 2.14 |
| H04-1 | 3.03 | 17.50 | 21.34 | 2.46 | 3.06 |
| H04-2 | 4.19 | 12.38 | 22.09 | 0.63 | 1.37 |
| H04-3 | 2.27 | 21.40 | 20.18 | 1.15 | 1.57 |
| H05-1 | 3.33 | 18.07 | 22.98 | 3.28 | 3.67 |
| H06-1 | 1.67 | 17.43 | 17.37 | 2.68 | 3.13 |
| H06-2 | 4.47 | 14.35 | 30.88 | 1.46 | 1.70 |
| H06-3 | 3.52 | 26.66 | 20.74 | 1.23 | 1.49 |
| H06-4 | 3.81 | 28.65 | 17.24 | 0.59 | 0.74 |
| H07-1 | 2.07 | 14.66 | 23.77 | 3.08 | 3.75 |
| H07-2 | 3.53 | 16.55 | 19.63 | 1.46 | 1.87 |
| H07-3 | 2.46 | 21.25 | 14.06 | 1.32 | 1.54 |
| H08-1 | 2.25 | 16.91 | 24.58 | 5.21 | 5.52 |
| H08-2 | 3.15 | 17.22 | 19.56 | 2.25 | 2.85 |
| H09-1 | 6.59 | 23.50 | 16.53 | 2.44 | 3.62 |
| H10-1 | 1.79 | 24.03 | 13.61 | 1.71 | 2.74 |
| H10-2 | 3.48 | 25.40 | 14.42 | 1.45 | 3.21 |
| H11-1 | 1.02 | 14.37 | 18.30 | 3.11 | 4.00 |
| H12-1 | 2.17 | 22.14 | 24.55 | 5.51 | 6.88 |
| H12-2 | 1.50 | 37.73 | 15.81 | 4.23 | 5.34 |
| H13-1 | 0.78 | 28.80 | 27.27 | 1.22 | 2.23 |
| H14-1 | 3.93 | 15.92 | 22.18 | 0.31 | 0.52 |
| H14-2 | 3.42 | 27.36 | 20.99 | 0.41 | 1.49 |
| V1-1 | 3.13 | 11.50 | 25.50 | 0.39 | 1.17 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT% THM |
|---|---|---|---|---|---|
| V1-2 | 2.82 | 4.32 | 59.92 | 0.59 | 0.82 |
| V1-3 | 2.74 | 6.41 | 55.34 | 0.34 | 0.61 |
| V1-4 | 3.80 | 7.81 | 66.08 | 0.43 | 0.83 |
| V2-1 | 2.21 | 13.31 | 29.64 | 0.93 | 2.72 |
| V2-2 | 6.16 | 10.22 | 56.19 | 0.36 | 1.67 |
| V2-3 | 2.97 | 6.38 | 47.27 | 0.47 | 3.90 |
| V2-4 | 3.66 | 15.10 | 57.68 | 0.79 | 2.12 |
| V4-1 | 3.06 | 12.36 | 29.98 | 0.71 | 1.77 |
| V4-2 | 2.01 | 8.04 | 45.73 | 0.73 | 1.06 |
| V4-3 | 2.40 | 8.25 | 40.98 | 0.57 | 1.39 |
| V4-4 | 3.09 | 7.71 | 54.87 | 0.72 | 1.35 |
| V3-1 | 3.63 | 10.43 | 44.86 | 0.59 | 1.42 |
| V3-2 | 3.11 | 9.20 | 46.15 | 0.27 | 0.50 |
| V5-1 | 4.26 | 18.60 | 25.71 | 0.88 | 1.95 |
| V5-3 | 3.60 | 4.87 | 53.42 | 0.85 | 1.26 |
| V5-4 | 5.04 | 7.09 | 53.91 | 1.01 | 1.20 |
| V5-5 | 4.30 | 6.99 | 56.61 | 0.84 | 1.44 |
| V6-1 | 4.51 | 16.55 | 30.56 | 1.06 | 2.48 |
| V6-2 | 6.62 | 13.67 | 33.73 | 0.75 | 1.71 |
| 1090-1 | 3.05 | 12.85 | 30.89 | 0.74 | 2.46 |
| 1090-2 | 3.69 | 11.68 | 33.20 | 0.61 | 1.91 |
| 1091-1 | 9.22 | 7.19 | 38.61 | 0.60 | 2.36 |
| 1091-2 | 4.05 | 17.15 | 39.24 | 0.64 | 1.71 |
| 1091-3 | 4.64 | 12.70 | 46.89 | 0.43 | 1.61 |
| 1092-1 | 3.19 | 8.28 | 53.29 | 0.60 | 1.70 |
| 1092-2 | 4.90 | 8.50 | 58.18 | 0.56 | 1.03 |
| 1094-1 | 2.93 | 11.98 | 42.23 | 0.32 | 1.15 |
| 1094-2 | 4.19 | 9.96 | 56.62 | 0.55 | 1.01 |
| 1095-1 | 3.62 | 13.90 | 28.92 | 0.64 | 2.51 |
| 1095-2 | 3.26 | 9.67 | 54.46 | 0.80 | 2.30 |
| 1096-1 | 2.04 | 12.59 | 30.03 | 0.72 | 1.84 |
| 1096-2 | 2.84 | 8.62 | 46.15 | 0.74 | 2.23 |
| 1097-1 | 4.42 | 10.68 | 37.40 | 0.60 | 2.60 |
| 1097-2 | 3.82 | 6.99 | 55.30 | 0.34 | 1.39 |
| 1097-3 | 3.17 | 8.65 | 61.31 | 0.47 | 1.26 |
| 1098-1 | 1.36 | 5.85 | 57.16 | 0.54 | 1.78 |
| 1098-2 | 3.08 | 6.14 | 69.30 | 0.22 | 0.58 |
| 1099-1 | 4.21 | 10.08 | 42.66 | 0.32 | 1.18 |
| 1099-2 | 3.00 | 8.38 | 59.32 | 0.52 | 1.78 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT% THM |
|---|---|---|---|---|---|
| 1100-1 | 3.20 | 11.60 | 30.51 | 0.65 | 2.64 |
| 1100-2 | 3.99 | 8.31 | 52.97 | 0.73 | 2.51 |
| 1103-1 | 1.90 | 8.87 | 43.02 | 1.22 | 1.80 |
| 1103-2 | 2.74 | 11.35 | 48.90 | 0.31 | 1.62 |
| 1103-3 | 4.44 | 9.34 | 29.41 | 0.38 | 1.74 |
| 1106-1 | 2.32 | 6.48 | 42.37 | 1.41 | 3.59 |
| 1106-2 | 1.70 | 9.14 | 32.69 | 0.86 | 2.63 |
| 1107-1 | 2.59 | 9.99 | 35.70 | 0.68 | 4.35 |
| 1107-2 | 2.01 | 9.74 | 25.22 | 0.60 | 1.83 |
| 1109-1 | 1.27 | 13.07 | 25.62 | 0.97 | 3.08 |
| 1111-1 | 3.88 | 9.42 | 30.81 | 0.58 | 2.76 |
| 1111-2 | 2.72 | 11.03 | 34.11 | 0.60 | 3.20 |
| 1116-1 | 2.69 | 12.40 | 30.36 | 1.19 | 4.39 |
| 1116-2 | 3.93 | 12.89 | 34.52 | 1.11 | 4.00 |
| 1119-1 | 2.17 | 11.53 | 26.75 | 1.23 | 2.43 |
| 1119-2 | 3.71 | 10.73 | 34.04 | 1.12 | 2.39 |
| 1120-1 | 2.08 | 11.99 | 29.55 | 0.96 | 1.95 |
| 1120-2 | 2.69 | 11.36 | 37.24 | 1.18 | 3.05 |
| 1121-1 | 4.23 | 15.23 | 27.41 | 1.01 | 3.44 |
| 1122-1 | 2.23 | 10.66 | 32.00 | 1.31 | 5.67 |
| 1127-1 | 3.03 | 11.17 | 29.70 | 1.04 | 5.51 |
| 1127-2 | 3.15 | 11.86 | 34.64 | 0.72 | 2.70 |
| 1129-1 | 2.21 | 10.73 | 27.92 | 2.88 | 7.65 |
| 1129-2 | 2.20 | 12.46 | 23.11 | 0.78 | 6.11 |
| 1130-1 | 2.94 | 9.93 | 26.28 | 2.62 | 7.17 |
| 1130-2 | 0.99 | 16.60 | 25.87 | 0.24 | 1.96 |
| 1131-1 | 2.82 | 12.08 | 32.12 | 1.02 | 5.92 |
| 1132-1 | 5.57 | 8.85 | 29.32 | 1.21 | 6.32 |
| 1134-1 | 4.64 | 9.17 | 41.09 | 1.50 | 8.79 |
| 1134-2 | 3.60 | 10.51 | 36.60 | 1.38 | 6.82 |
| 1136-1 | 3.46 | 13.51 | 34.72 | 1.96 | 9.01 |
| 1136-2 | 3.68 | 13.87 | 33.63 | 1.74 | 6.42 |
| 1136-3 | 3.56 | 9.27 | 34.79 | 0.83 | 3.34 |
| 1139-1 | 2.79 | 7.35 | 33.45 | 1.08 | 2.44 |
| 2000-1 | 2.52 | 9.73 | 33.32 | 0.30 | 2.00 |
| 2000-2 | 3.37 | 11.54 | 28.86 | 0.14 | 2.39 |
| 2001-1 | 2.18 | 11.79 | 26.04 | 0.42 | 2.02 |
| 2002-1 | 3.15 | 18.08 | 33.44 | 0.56 | 3.75 |
| 2002-2 | 2.45 | 12.53 | 33.51 | 0.60 | 3.01 |
| 110-1 | 5.49 | 12.62 | 40.79 | 1.09 | 2.60 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT% THM |
|---|---|---|---|---|---|
| 110-2 | 2.19 | 11.46 | 24.07 | 1.19 | 2.21 |
| 110-3 | 1.35 | 10.49 | 25.51 | 1.07 | 1.41 |
| 115-1 | 2.10 | 10.94 | 33.97 | 0.25 | 0.74 |
| 116-1 | 4.01 | 3.52 | 41.87 | 0.45 | 0.58 |
| 116-2 | 2.73 | 10.89 | 40.97 | 0.19 | 0.54 |
| 116-3 | 3.46 | 7.20 | 44.85 | 1.55 | 2.17 |
| 116-4 | 4.02 | 8.86 | 45.70 | 0.71 | 0.92 |
| 116-5 | 3.31 | 7.31 | 42.41 | 1.36 | 1.66 |
| 117-1 | 2.50 | 8.26 | 36.81 | 1.15 | 1.26 |
| 117-2 | 2.04 | 5.75 | 34.29 | 1.37 | 3.87 |
| 117-3 | 1.86 | 6.22 | 33.77 | 2.62 | 3.95 |
| 117-4 | 1.76 | 4.48 | 28.81 | 1.91 | 2.84 |
| C1-1 | 4.24 | 10.92 | 42.01 | 1.72 | 2.18 |
| C1-2 | 2.89 | 6.25 | 26.62 | 2.42 | 3.18 |
| C1-3 | 0.41 | 15.58 | 23.31 | 1.43 | 2.09 |
| C1-4 | 3.85 | 9.17 | 26.77 | 0.68 | 1.95 |
| C2-1 | 5.34 | 9.26 | 35.80 | 1.63 | 4.12 |
| C2-2 | 4.85 | 13.92 | 29.76 | 0.39 | 1.80 |
| C2-3 | 4.84 | 6.54 | 32.28 | 1.14 | 2.65 |
| C2-4 | 2.75 | 14.60 | 34.68 | 0.71 | 1.41 |
| C3-1 | 3.67 | 24.53 | 19.73 | 0.64 | 3.99 |
| C3-2 | 5.79 | 24.79 | 32.48 | 0.92 | 4.21 |
| C3-3 | 7.03 | 18.70 | 33.46 | 0.61 | 3.54 |
| C3-4 | 4.03 | 21.18 | 39.06 | 0.68 | 3.36 |
| C4-1 | 4.78 | 6.81 | 26.21 | 0.87 | 2.65 |
| C4-2 | 3.46 | 9.04 | 23.93 | 0.91 | 2.40 |
| C4-3 | 3.84 | 16.52 | 27.04 | 1.24 | 2.66 |
| C5-1 | 3.09 | 5.07 | 39.26 | 1.62 | 2.03 |
| C5-2 | 4.51 | 11.99 | 25.38 | 1.53 | 2.91 |
| C5-3 | 3.30 | 8.09 | 20.21 | 1.56 | 3.51 |
| C5-4 | 7.02 | 8.00 | 25.56 | 1.23 | 3.31 |
| C6-1 | 5.54 | 6.96 | 31.21 | 2.02 | 4.38 |
| C6-2 | 7.33 | 11.52 | 28.59 | 0.26 | 2.55 |
| C6-3 | 3.85 | 10.99 | 19.57 | 0.49 | 5.78 |
| C7-1 | 2.93 | 11.05 | 24.39 | 0.61 | 3.14 |
| C7-2 | 1.93 | 6.04 | 39.05 | 1.07 | 1.45 |
| C7-3 | 1.44 | 10.18 | 29.24 | 1.41 | 2.35 |
| C8-1 | 5.13 | 10.06 | 39.76 | 1.85 | 3.45 |
| C8-2 | 4.06 | 6.92 | 19.65 | 2.54 | 6.75 |
| C8-3 | 3.48 | 6.79 | 17.21 | 0.83 | 3.65 |
| C8-4 | 3.67 | 8.00 | 14.89 | 0.67 | 3.56 |
| C9-1 | 3.74 | 6.58 | 31.07 | 2.02 | 4.63 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT% THM |
|---|---|---|---|---|---|
| C9-2 | 2.93 | 5.89 | 29.84 | 1.50 | 3.84 |
| C9-3 | 5.17 | 13.95 | 31.38 | 1.56 | 3.16 |
| C10-1 | 4.80 | 5.28 | 35.98 | 0.76 | 3.22 |
| C10-2 | 4.10 | 7.78 | 19.40 | 1.07 | 4.07 |
| C10-3 | 6.47 | 16.20 | 23.35 | 1.14 | 4.98 |
| C10-4 | 7.85 | 18.26 | 21.91 | 0.75 | 4.53 |
| C11-1 | 4.61 | 9.06 | 29.42 | 1.51 | 1.88 |
| C11-2 | 2.45 | 7.46 | 28.88 | 1.64 | 1.81 |
| C11-3 | 6.64 | 21.27 | 25.74 | 0.73 | 3.53 |
| C11-4 | 8.55 | 16.40 | 35.82 | 0.87 | 3.08 |
| C12-1 | 2.05 | 4.84 | 20.72 | 3.05 | 5.62 |
| C12-2 | 4.21 | 13.69 | 18.93 | 1.75 | 5.32 |
| C12-3 | 7.33 | 8.08 | 28.15 | 3.28 | 9.12 |
| C12-4 | 5.61 | 10.39 | 18.77 | 2.59 | 7.40 |
| C13-1 | 3.39 | 8.28 | 24.36 | 1.64 | 3.21 |
| C13-2 | 3.82 | 8.65 | 22.98 | 1.62 | 2.64 |
| C13-3 | 6.93 | 17.61 | 26.41 | 0.95 | 1.73 |
| C14-1 | 2.28 | 9.07 | 14.64 | 2.11 | 4.47 |
| C14-2 | 5.49 | 15.69 | 17.42 | 0.72 | 1.99 |
| C14-3 | 4.46 | 13.90 | 22.92 | 1.26 | 5.95 |
| C14-4 | 4.52 | 10.78 | 13.87 | 0.64 | 5.61 |
| C15-1 | 3.60 | 9.44 | 20.91 | 1.94 | 5.70 |
| C15-2 | 3.38 | 8.53 | 15.68 | 1.14 | 6.57 |
| C16-1 | 2.77 | 12.85 | 19.95 | 2.53 | 6.91 |
| C16-2 | 4.49 | 12.05 | 12.02 | 1.82 | 5.36 |
| C17-1 | 4.31 | 7.53 | 26.23 | 2.20 | 3.80 |
| C17-2 | 6.41 | 15.15 | 19.99 | 1.24 | 4.26 |
| C17-3 | 3.88 | 13.62 | 15.36 | 0.98 | 4.03 |
| C17-4 | 2.98 | 8.24 | 14.53 | 1.42 | 5.27 |
| C17-5 | 4.07 | 14.02 | 12.66 | 0.89 | 5.72 |
| C18-1 | 2.43 | 14.18 | 20.20 | 2.07 | 2.92 |
| C18-2 | 3.41 | 9.90 | 17.79 | 2.43 | 3.50 |
| C19-1 | 4.62 | 11.34 | 22.79 | 1.20 | 4.06 |
| C19-2 | 3.68 | 8.74 | 23.26 | 0.94 | 2.05 |
| C19-3 | 1.42 | 9.63 | 24.98 | 1.73 | 2.08 |
| C20-1 | 2.94 | 9.76 | 37.50 | 0.56 | 1.29 |
| C20-2 | 2.58 | 12.39 | 37.32 | 1.29 | 1.75 |
| C20-3 | 4.05 | 17.86 | 29.24 | 0.20 | 0.97 |
| C20-4 | 5.51 | 12.83 | 34.86 | 0.33 | 1.93 |
| C21-1 | 7.14 | 7.72 | 38.37 | 0.38 | 1.11 |
| C22-1 | 3.93 | 5.38 | 42.66 | 1.36 | 1.54 |
| C22-2 | 4.10 | 6.20 | 38.95 | 1.50 | 1.76 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT% THM |
|---|---|---|---|---|---|
| C22-3 | 3.51 | 7.46 | 32.56 | 1.85 | 2.38 |
| C22-4 | 2.61 | 7.33 | 36.32 | 0.87 | 1.22 |
| C23-2 | 4.09 | 7.59 | 30.28 | 0.89 | 1.43 |
| C23-3 | 3.82 | 8.17 | 33.22 | 1.47 | 1.59 |
| C23-4 | 3.42 | 16.77 | 33.54 | 0.84 | 0.96 |
| C24-1 | 3.08 | 7.83 | 41.80 | 0.83 | 1.05 |
| C24-2 | 2.86 | 7.37 | 38.05 | 1.16 | 1.49 |
| C25-1 | 7.42 | 3.86 | 52.88 | 0.23 | 0.41 |
| C25-2 | 4.01 | 15.30 | 47.48 | 0.38 | 1.39 |
| C25-3 | 2.39 | 18.75 | 36.43 | 0.57 | 1.77 |
| C26-1 | 4.29 | 7.03 | 45.39 | 1.87 | 3.53 |
| C26-2 | 6.35 | 12.22 | 34.27 | 0.95 | 2.60 |
| C26-3 | 5.65 | 10.91 | 20.92 | 0.49 | 5.11 |
| C27-1 | 4.44 | 13.97 | 28.21 | 0.40 | 2.28 |
| C27-3 | 3.94 | 9.49 | 56.08 | 0.34 | 2.66 |
| C28-1 | 3.89 | 5.10 | 47.42 | 1.39 | 1.88 |
| C28-2 | 7.17 | 8.04 | 39.80 | 1.42 | 3.27 |
| C28-3 | 5.18 | 12.78 | 29.39 | 1.32 | 3.08 |
| C28-4 | 5.14 | 10.99 | 42.06 | 0.98 | 2.40 |
| C29-1 | 5.93 | 6.67 | 52.25 | 4.32 | 4.53 |
| C29-2 | 4.87 | 10.57 | 42.80 | 0.38 | 1.29 |
| C30-1 | 4.92 | 12.31 | 37.18 | 0.67 | 2.96 |
| C31-1 | 3.53 | 4.08 | 46.91 | 0.59 | 0.72 |
| C31-2 | 6.00 | 3.61 | 54.17 | 1.36 | 1.52 |
| C31-3 | 5.10 | 9.65 | 43.24 | 1.48 | 3.14 |
| C31-4 | 5.36 | 10.96 | 25.46 | 0.84 | 3.99 |
| C32-1 | 4.86 | 6.62 | 41.24 | 1.59 | 2.71 |
| C32-2 | 5.01 | 11.49 | 28.49 | 0.79 | 2.73 |
| C32-3 | 7.54 | 7.45 | 38.96 | 0.90 | 3.39 |
| C33-1 | 5.68 | 11.91 | 29.61 | 0.80 | 1.95 |
| C33-2 | 6.63 | 15.36 | 25.64 | 0.65 | 2.50 |
| C33-3 | 6.03 | 16.41 | 25.07 | 0.15 | 2.42 |
| C33-4 | 5.82 | 15.05 | 38.38 | 0.16 | 1.24 |
| C34-1 | 3.04 | 4.57 | 43.23 | 0.96 | 1.08 |
| C34-2 | 4.56 | 7.62 | 44.24 | 2.42 | 3.17 |
| C34-3 | 3.99 | 11.91 | 28.76 | 0.87 | 2.14 |
| C35-1 | 6.40 | 18.38 | 35.09 | 0.13 | 1.78 |
| C35-4 | 5.83 | 12.37 | 44.40 | 0.46 | 1.31 |
| C36-1 | 4.75 | 1.70 | 55.13 | 0.48 | 0.62 |
| C36-2 | 4.64 | 5.01 | 47.78 | 0.59 | 0.73 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT% THM |
|---|---|---|---|---|---|
| C36-3 | 7.07 | 4.52 | 53.78 | 0.73 | 0.86 |
| C36-4 | 4.72 | 7.54 | 39.97 | 0.72 | 0.80 |
| C37-1 | 5.62 | 9.66 | 26.06 | 0.91 | 4.40 |
| C37-2 | 3.54 | 10.23 | 36.05 | 1.52 | 2.22 |
| C37-3 | 3.78 | 9.72 | 41.83 | 1.34 | 2.16 |
| C38-1 | 4.87 | 10.42 | 24.03 | 0.46 | 1.99 |
| C38-2 | 3.16 | 21.26 | 30.09 | 0.29 | 2.32 |
| C39-1 | 5.36 | 7.99 | 28.75 | 0.90 | 4.40 |
| C39-2 | 3.46 | 5.87 | 28.92 | 1.09 | 4.13 |
| C39-3 | 3.12 | 4.90 | 38.38 | 1.09 | 2.60 |
| C40-1 | 4.32 | 8.74 | 28.95 | 0.79 | 4.56 |
| C40-2 | 4.43 | 6.97 | 35.85 | 1.19 | 4.18 |
| C40-3 | 4.48 | 5.33 | 36.96 | 1.42 | 2.75 |
| C41-1 | 4.70 | 7.76 | 31.24 | 0.95 | 3.85 |
| C41-2 | 4.51 | 16.01 | 36.37 | 0.63 | 1.83 |
| C41-3 | 4.66 | 5.46 | 37.04 | 1.27 | 2.65 |
| C42-1 | 3.86 | 7.23 | 44.84 | 1.13 | 3.56 |
| C42-2 | 5.07 | 8.59 | 42.98 | 0.86 | 4.35 |
| C42-3 | 4.33 | 9.59 | 41.58 | 0.60 | * |
| C42-4 | 6.65 | 6.44 | 62.22 | 0.85 | 3.17 |
| C43-1 | 2.72 | 8.13 | 14.00 | 1.17 | 6.38 |
| C43-2 | 3.63 | 8.45 | 38.33 | 1.46 | 3.55 |
| C43-3 | 3.96 | 10.77 | 26.81 | 1.09 | 6.72 |
| C44-1 | 4.53 | 9.47 | 24.42 | 0.90 | 6.49 |
| C44-2 | 3.55 | 7.38 | 36.17 | 1.59 | 3.50 |
| C44-3 | 3.81 | 11.03 | 33.99 | 0.68 | 1.74 |
| C45-1 | 4.49 | 9.05 | 23.92 | 0.31 | 3.01 |
| C45-2 | 2.71 | 9.02 | 27.49 | 1.76 | 2.63 |
| C45-3 | 5.74 | 15.18 | 36.80 | 1.57 | 2.85 |
| C46-1 | 3.16 | 12.88 | 28.21 | 1.08 | 3.36 |
| C46-2 | 2.24 | 9.81 | 30.17 | 0.86 | 2.20 |
| C46-3 | 2.78 | 16.01 | 26.95 | 0.70 | 2.19 |
| C46-4 | 4.74 | 7.83 | 40.45 | 2.28 | 3.04 |
| C47-1 | 3.02 | 11.29 | 28.19 | 0.66 | 4.47 |
| C47-2 | 4.27 | 8.55 | 46.99 | 1.33 | 1.62 |
| C48-1 | 3.54 | 5.85 | 41.99 | 0.55 | 0.89 |
| C48-2 | 1.67 | 16.24 | 27.81 | 0.63 | 0.91 |
| C48-3 | 3.78 | 8.55 | 41.71 | 0.50 | 0.74 |
| C48-4 | 3.09 | 9.04 | 40.67 | 1.27 | 1.79 |
| C49-1 | 2.95 | 10.25 | 41.16 | 0.78 | 1.00 |

COMPOSITION OF CORE SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT% THM |
|---|---|---|---|---|---|
| C49-2 | 3.73 | 6.26 | 44.25 | 0.61 | 0.82 |
| C49-3 | 2.70 | 9.10 | 34.39 | 0.86 | 1.66 |
| C49-4 | 3.38 | 11.06 | 30.85 | 0.81 | 4.14 |
| C50-1 | 3.70 | 48.10 | 30.63 | 0.32 | 2.66 |
| WB063-1 | 4.22 | 5.19 | 50.25 | 1.49 | 2.07 |
| WB063-2 | 5.30 | 9.88 | 53.56 | 1.18 | 2.13 |
| WB063-3 | 5.11 | 8.90 | 50.25 | 1.19 | 2.53 |
| AVG | 3.84 | 11.72 | 33.22 | 1.19 | 2.87 |
| STD DEV | 1.50 | 5.78 | 11.38 | 0.87 | 1.66 |
| MAX VALUE | 9.22 | 48.10 | 69.30 | 5.51 | 9.12 |
| MIN VALUE | 0.41 | 1.70 | 12.02 | 0.13 | 0.41 |

284 CORE SAMPLES

## APPENDIX III

### COMPOSITION OF GRAB SAMPLES

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| 1 | 10.20 | 16.71 | 21.25 | 5.73 | 0.53 | 34.07 |
| 2 | 6.42 | 31.94 | 19.89 | 6.49 | 1.43 | 32.23 |
| 3 | 17.05 | 19.04 | 29.79 | 3.43 | 2.90 | 32.09 |
| 4 | 9.42 | 21.44 | 16.29 | 2.11 | 1.81 | 34.64 |
| 5 | 1.13 | 24.10 | 21.92 | 8.28 | 0.17 | 31.58 |
| 6 | 0.19 | 22.81 | 37.36 | 2.70 | 9.04 | 31.22 |
| 7 | 4.65 | 18.90 | 16.35 | 6.97 | 1.30 | 34.66 |
| 8 | 0.23 | 34.42 | 22.65 | 1.59 | 7.49 | 34.58 |
| 9 | 0.51 | 25.56 | 20.05 | 2.00 | 5.24 | 32.46 |
| 10 | 0.50 | 25.10 | 26.23 | 7.31 | P | 31.73 |
| 11 | 0.08 | 31.43 | 34.83 | 0.47 | 2.98 | 32.17 |
| 12 | 3.00 | 25.02 | 21.19 | 6.51 | 0.91 | 29.23 |
| 13 | 2.60 | 20.21 | 22.31 | 5.13 | 0.49 | 32.28 |
| 14 | 0.74 | 28.72 | 20.74 | 2.84 | 3.19 | 31.47 |
| 15 | 5.74 | 35.07 | 15.00 | 4.59 | 0.72 | 30.04 |
| 22 | 1.31 | 23.73 | 16.21 | 5.43 | 1.57 | 31.73 |
| 23 | 3.72 | 21.75 | 17.99 | 4.06 | 2.96 | 36.94 |
| 24 | 0.53 | 19.35 | 13.76 | 5.25 | 2.35 | 31.05 |
| 25 | 2.95 | 17.71 | 19.40 | 3.38 | 2.28 | 33.77 |
| 27 | 0.12 | 17.65 | 13.53 | 2.27 | 3.26 | 38.61 |
| 28 | 2.36 | 30.73 | 18.80 | 8.33 | 0.30 | 39.61 |
| 29 | 4.28 | 14.80 | 20.18 | 5.98 | 1.26 | 34.32 |
| 30 | 2.97 | 30.01 | 17.44 | 5.61 | 1.45 | 41.39 |
| 31 | 3.48 | 19.49 | 22.37 | 8.27 | 0.21 | 32.70 |
| 32 | 2.75 | 27.99 | 25.94 | 1.57 | 4.02 | 40.62 |
| 33 | 6.35 | 58.85 | 8.75 | 2.24 | 0.49 | 31.41 |
| 34 | 6.67 | 18.18 | 17.81 | 4.49 | 0.85 | 34.82 |
| 35 | 8.39 | 35.58 | 15.13 | 4.92 | 3.31 | 31.76 |
| 36 | 10.90 | 24.41 | 17.44 | 4.35 | 2.99 | 33.30 |
| 39 | 7.61 | 34.58 | 16.82 | 3.79 | 0.88 | 35.06 |
| 40 | 6.83 | 44.26 | 6.14 | 3.40 | 1.15 | 35.04 |
| 41 | 10.34 | 24.88 | 5.75 | 3.79 | 2.52 | 36.31 |
| 42 | 7.83 | 21.44 | 20.02 | 2.09 | 0.26 | 33.21 |
| 43 | 4.56 | 16.65 | 19.40 | 6.26 | 0.17 | 36.05 |
| 44 | 5.93 | 19.86 | 27.48 | 3.99 | 0.51 | 41.72 |
| 45 | 7.85 | 19.48 | 19.30 | 6.55 | 0.75 | 33.76 |
| 46 | 4.95 | 24.83 | 16.17 | 3.29 | 2.58 | 38.53 |
| 47 | 6.38 | 27.94 | 18.07 | 4.80 | 1.05 | 37.51 |
| 48 | 7.09 | 30.79 | 15.13 | 1.35 | 1.67 | 36.68 |
| 49 | 6.78 | 23.31 | 13.88 | 1.20 | 1.17 | 41.50 |

COMPOSITION OF GRAB SAMPLES. continued

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| 50 | 3.64 | 18.98 | 19.46 | 7.24 | 0.94 | 36.61 |
| 51 | 10.66 | 21.39 | 17.07 | 3.82 | 0.93 | 33.86 |
| 52 | 11.65 | 25.39 | 18.99 | 3.49 | 0.09 | 31.68 |
| 53 | 12.08 | 19.39 | 17.17 | 4.74 | 1.82 | 46.67 |
| 54 | 11.08 | 28.98 | 20.44 | 3.05 | 0.05 | 31.34 |
| 55 | 12.97 | 13.08 | 21.56 | 5.07 | 0.02 | 33.69 |
| 56 | 10.59 | 22.44 | 13.15 | 4.20 | 2.59 | 41.92 |
| 57 | 16.18 | 24.98 | 17.69 | 3.36 | 0.46 | 38.85 |
| 58 | 11.05 | 22.60 | 20.13 | 1.57 | 1.57 | 35.05 |
| 59 | 4.48 | 34.94 | 19.55 | 3.93 | P | 32.05 |
| 60 | 6.55 | 24.63 | 19.89 | 3.11 | 1.34 | 41.61 |
| 61 | 6.85 | 23.86 | 16.81 | 0.72 | 0.40 | 44.41 |
| 62 | 8.81 | 23.09 | 16.97 | 4.38 | 0.85 | 38.17 |
| 63 | 12.94 | 13.58 | 16.86 | 3.98 | 1.87 | 37.53 |
| 64 | 13.56 | 10.17 | 20.68 | 7.98 | 0.02 | 32.99 |
| 65 | 0.87 | 27.44 | 10.54 | 13.90 | 2.91 | 32.52 |
| 66 | 10.13 | 22.23 | 15.69 | 5.61 | 0.04 | 32.67 |
| 67 | 3.40 | 50.28 | 12.42 | 2.13 | 5.68 | 27.98 |
| 68 | 1.08 | 35.93 | 11.78 | 9.41 | 2.73 | 32.16 |
| 69 | 0.28 | 20.47 | 8.56 | 14.31 | 2.96 | 32.14 |
| 70 | 0.42 | 34.69 | 10.78 | 10.73 | 5.95 | 31.18 |
| 71 | 3.19 | 28.81 | 15.16 | 8.96 | 0.91 | 33.28 |
| 72 | 0.34 | 41.63 | 16.84 | 8.20 | 2.96 | 31.76 |
| 73 | 5.91 | 21.11 | 16.93 | 3.98 | 1.15 | 35.69 |
| 74 | 2.63 | 21.08 | 21.89 | 5.08 | 0.06 | 35.69 |
| 75 | 0.52 | 29.78 | 19.75 | 5.51 | 3.77 | 32.56 |
| 76 | 0.33 | 31.24 | 9.29 | 12.76 | 5.07 | 31.52 |
| 77 | 2.25 | 31.18 | 9.58 | 9.91 | 0.44 | 35.54 |
| 78 | 0.44 | 37.19 | 14.50 | 4.70 | 3.06 | 30.85 |
| 79 | 0.26 | 22.13 | 8.67 | 8.17 | 11.78 | 30.70 |
| 80 | 1.47 | 38.22 | 8.14 | 4.19 | 0.80 | 34.44 |
| 81 | 6.17 | 24.58 | 17.49 | 9.06 | 0.40 | 31.42 |
| 82 | 0.31 | 47.30 | 13.36 | 4.85 | 1.67 | 30.47 |
| 83 | 0.36 | 44.71 | 15.00 | 7.52 | 5.31 | 30.02 |
| 84 | 0.26 | 37.74 | 13.52 | 7.73 | 1.96 | 31.80 |
| 85 | 3.48 | 54.88 | 8.40 | 3.96 | 1.24 | 30.14 |
| 86 | 1.32 | 33.13 | 12.26 | 9.94 | 1.82 | 35.73 |
| 87 | 1.65 | 42.77 | 11.69 | 7.77 | 0.55 | 32.10 |
| 88 | 0.34 | 32.51 | 10.81 | 9.46 | 5.44 | 30.80 |
| 89 | 7.18 | 19.35 | 18.72 | 4.08 | 0.78 | 32.51 |
| 89A | 1.24 | 47.00 | 13.81 | 5.70 | 1.35 | 29.30 |
| 90 | 0.43 | 41.73 | 20.64 | 8.09 | 6.35 | 28.27 |

COMPOSITION OF GRAB SAMPLES, continued

| SAMPLE NAME | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| 91 | 0.85 | 49.52 | 9.56 | 7.00 | 1.10 | 29.59 |
| 93 | 0.59 | 30.42 | 18.24 | 10.33 | 3.44 | 33.26 |
| 94 | 0.49 | 36.00 | 11.52 | 9.56 | 5.71 | 33.83 |
| 95 | 0.52 | 18.87 | 14.11 | 14.01 | 4.65 | 35.21 |
| 96 | 0.35 | 43.05 | 12.75 | 10.15 | 7.44 | 30.30 |
| 97 | 0.89 | 39.35 | 11.84 | 5.81 | 2.43 | 34.32 |
| 98 | 0.27 | 41.34 | 11.82 | 8.88 | 2.19 | 31.61 |
| 100 | 2.17 | 42.04 | 12.75 | 9.37 | 0.80 | 29.96 |
| 101 | 5.87 | 23.50 | 15.44 | 7.95 | 0.25 | 38.26 |
| STA054 | 1.51 | 32.88 | 15.39 | 7.07 | 4.27 | 16.24 |
| STA055 | 1.12 | 23.90 | 17.64 | 8.38 | 6.84 | 16.07 |
| STA056 | 0.35 | 30.97 | 16.62 | 10.16 | 5.74 | 12.61 |
| STA093 | 6.00 | 23.71 | 15.33 | 10.72 | 3.89 | 16.72 |
| STA094 | 3.57 | 22.86 | 17.39 | 7.22 | 2.64 | 24.15 |
| 51-1 | 2.80 | 21.72 | 13.21 | 9.04 | 4.42 | 17.69 |
| 51-2 | 2.27 | 27.76 | 8.94 | 7.53 | 4.06 | 18.20 |
| 51-3 | 0.65 | 24.53 | 15.43 | 9.21 | 2.85 | 17.12 |
| 51-4 | 0.37 | 42.81 | 16.88 | 7.76 | 3.20 | 9.94 |
| AVG | 4.35 | 28.51 | 16.66 | 5.99 | 2.34 | 32.47 |
| STD DEV | 4.18 | 9.74 | 5.35 | 3.06 | 2.21 | 6.23 |
| MAX VALUE | 17.05 | 58.85 | 37.36 | 14.31 | 11.78 | 46.67 |
| MIN VALUE | 0.08 | 10.17 | 5.75 | 0.47 | 0.00 | 9.94 |

COMPOSITION OF GRAB SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| 1 | 0.27 | 0.32 | 0.20 | 0.01 | 0.43 | 0.07 |
| 2 | 0.77 | 1.14 | 0.38 | 0.80 | 1.03 | 0.42 |
| 3 | 0.77 | 0.37 | 0.34 | 0.04 | 0.94 | 0.05 |
| 4 | 1.41 | 1.40 | 1.16 | 0.65 | 2.99 | 0.22 |
| 5 | 0.92 | 0.10 | 0.26 | 0.22 | 1.73 | 0.13 |
| 6 | 0.55 | 0.76 | 0.72 | P | 1.15 | 0.57 |
| 7 | 0.52 | 0.39 | 0.40 | 0.48 | 0.79 | 0.04 |
| 8 | 0.82 | 0.86 | 1.03 | P | 1.53 | 0.41 |
| 9 | 0.59 | 0.94 | 0.52 | 1.09 | 0.97 | 0.28 |
| 10 | 0.36 | 0.18 | 0.15 | 0.17 | 0.89 | 0.11 |
| 11 | 1.62 | 0.39 | 0.31 | 0.26 | 1.96 | 1.70 |
| 12 | 0.88 | 0.19 | 0.47 | 0.91 | 1.61 | 0.04 |
| 13 | 0.79 | 0.28 | 0.92 | 0.55 | 0.97 | 0.19 |
| 14 | 0.94 | 1.91 | 1.12 | P | 2.89 | 0.82 |
| 15 | 1.43 | 1.39 | 1.08 | 0.02 | 1.34 | 0.11 |
| 22 | 0.44 | 0.85 | 0.53 | 0.72 | 3.08 | 0.58 |
| 23 | 1.51 | 0.60 | 0.77 | 1.02 | 0.89 | 0.14 |
| 24 | 0.82 | 1.17 | 0.45 | 0.09 | 2.18 | 0.29 |
| 25 | 1.13 | 0.46 | 0.42 | 1.48 | 1.70 | 0.27 |
| 27 | 1.16 | 3.36 | 1.51 | 0.47 | 1.56 | 0.56 |
| 28 | 0.38 | 0.84 | 0.67 | 0.60 | 1.06 | 0.20 |
| 29 | 1.22 | 0.92 | 0.33 | 0.21 | 0.71 | P |
| 30 | 0.86 | 0.86 | 0.99 | 1.15 | 0.88 | 0.39 |
| 31 | 1.13 | 0.23 | 0.26 | 0.19 | 1.02 | 0.46 |
| 32 | 0.91 | 1.00 | 0.59 | 0.09 | 0.90 | 0.41 |
| 33 | 0.83 | 1.22 | 0.47 | 0.10 | 0.65 | 0.14 |
| 34 | 1.01 | 0.46 | 0.50 | 1.24 | 1.95 | 0.44 |
| 35 | 0.80 | 2.51 | 0.19 | P | 0.19 | 0.99 |
| 36 | 0.14 | 0.74 | 0.20 | 0.21 | 1.38 | 0.81 |
| 39 | 0.75 | 1.07 | 0.80 | 0.91 | 1.84 | 0.02 |
| 40 | 0.00 | 0.77 | 0.63 | 0.40 | 0.00 | 0.74 |
| 41 | 0.12 | 0.33 | 0.21 | 0.66 | 2.97 | 0.17 |
| 42 | 0.64 | 0.05 | 0.05 | 0.17 | 0.57 | 0.36 |
| 43 | 0.73 | 0.37 | 0.27 | 0.41 | 1.17 | 0.17 |
| 44 | 1.03 | 1.17 | 0.79 | 0.07 | 0.73 | 0.15 |
| 45 | 0.82 | 0.42 | 0.21 | 0.05 | 0.62 | 0.10 |
| 46 | 0.55 | 0.79 | 0.64 | 0.21 | 1.79 | 0.16 |
| 47 | 0.83 | 0.72 | 0.57 | 1.33 | 0.52 | 0.15 |
| 48 | 0.81 | 0.36 | 0.61 | 1.35 | 2.17 | P |
| 49 | 0.75 | 0.55 | 0.30 | 0.67 | 1.01 | 0.12 |

COMPOSITION OF GRAB SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| 50 | 1.09 | 1.41 | 1.04 | 0.63 | 1.17 | 0.67 |
| 51 | 1.30 | 0.34 | 0.16 | 1.01 | 1.32 | 0.23 |
| 52 | 0.66 | 0.18 | 0.25 | 1.49 | 1.32 | 0.28 |
| 53 | 0.76 | 1.12 | 0.89 | 0.55 | 0.80 | 0.11 |
| 54 | 1.07 | 0.36 | 0.28 | 0.01 | 0.19 | 0.37 |
| 55 | 1.04 | 0.96 | 0.34 | 0.64 | 1.08 | 0.05 |
| 56 | 1.39 | 0.36 | 0.36 | 1.73 | 0.91 | 0.39 |
| 57 | 0.75 | 0.22 | 0.25 | 1.09 | 1.33 | 0.05 |
| 58 | 1.01 | 0.18 | 0.08 | 0.38 | 0.44 | 0.08 |
| 59 | 1.53 | 0.87 | 0.05 | 0.14 | 0.63 | 0.08 |
| 60 | 0.54 | 0.81 | 1.26 | 1.00 | 1.14 | 0.01 |
| 61 | 1.32 | 0.13 | 0.42 | 0.81 | 0.99 | P |
| 62 | 1.09 | 0.54 | 0.21 | 0.85 | 1.25 | P |
| 63 | 1.26 | 0.56 | 0.16 | 0.37 | 1.71 | 0.05 |
| 64 | 0.90 | 0.64 | 0.27 | 0.17 | 0.83 | P |
| 65 | 1.12 | 1.20 | 0.46 | 1.64 | 1.46 | 0.15 |
| 66 | 1.41 | 0.21 | 0.14 | 0.54 | 0.80 | P |
| 67 | 1.01 | 1.93 | 0.10 | 0.41 | 3.03 | 0.57 |
| 68 | 0.57 | 2.20 | 0.38 | 0.63 | 2.79 | 0.51 |
| 69 | 1.50 | 1.85 | 0.28 | 1.73 | 4.41 | 0.33 |
| 70 | 2.13 | 2.20 | 0.35 | 0.79 | 4.25 | 0.54 |
| 71 | 0.97 | 0.88 | 0.59 | 0.54 | 1.70 | 0.02 |
| 72 | 1.40 | 1.87 | 0.45 | 1.18 | 4.05 | 0.44 |
| 73 | 0.69 | 0.54 | 0.48 | 0.37 | 0.59 | 0.08 |
| 74 | 1.07 | 0.12 | 0.24 | 0.72 | 1.10 | P |
| 75 | 1.60 | 1.14 | 0.00 | 1.59 | 2.39 | 0.43 |
| 76 | 2.20 | 1.69 | 0.00 | 1.40 | 1.99 | 0.59 |
| 77 | 1.06 | 1.10 | 0.09 | 0.82 | 2.72 | 0.12 |
| 78 | 1.50 | 1.43 | 0.20 | 0.60 | 2.65 | 0.44 |
| 79 | 2.55 | 4.80 | 1.26 | 3.94 | 4.80 | 1.17 |
| 80 | 0.93 | 0.26 | 0.16 | 0.17 | 1.80 | 0.31 |
| 81 | 1.65 | 0.79 | 0.40 | 0.52 | 1.47 | P |
| 82 | 2.77 | 1.40 | 0.53 | 0.59 | 3.26 | 0.49 |
| 83 | 2.33 | 1.30 | 0.57 | 0.79 | 1.54 | 0.67 |
| 84 | 1.02 | 2.03 | 0.14 | 2.73 | 3.18 | 0.29 |
| 85 | 2.44 | 0.15 | 0.38 | 0.24 | 1.77 | 0.08 |
| 86 | 2.07 | 0.64 | 0.37 | 0.35 | 3.04 | 0.19 |
| 87 | 2.33 | 0.72 | 0.39 | 0.31 | 2.52 | 0.26 |
| 88 | 2.04 | 2.20 | 0.11 | 0.68 | 3.59 | 0.91 |
| 89 | 1.41 | 0.26 | 0.30 | 0.85 | 2.17 | 0.13 |
| 89A | 1.73 | 0.88 | 0.26 | 0.10 | 1.89 | 0.15 |
| 90 | 1.30 | 2.39 | 0.18 | 0.44 | 3.27 | 0.62 |

COMPOSITION OF GRAB SAMPLES, continued

| SAMPLE NAME | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| 91 | 0.93 | 1.15 | 0.12 | 0.39 | 2.60 | 0.22 |
| 93 | 1.50 | 1.19 | 0.00 | 0.52 | 2.93 | 0.73 |
| 94 | 1.88 | 2.32 | 0.00 | 1.08 | 1.87 | 0.56 |
| 95 | 0.87 | 3.51 | 0.04 | 1.41 | 2.14 | 0.67 |
| 96 | 1.59 | 2.07 | 0.26 | 0.55 | 1.65 | 1.80 |
| 97 | 1.57 | 0.83 | 0.04 | 0.31 | 1.35 | 0.10 |
| 98 | 1.69 | 1.65 | 0.00 | 0.09 | 1.95 | 0.67 |
| 100 | 2.02 | 0.71 | 0.04 | 0.07 | 0.99 | 0.04 |
| 101 | 0.88 | 0.55 | 0.18 | 0.61 | 1.24 | 0.03 |
| STA054 | 2.48 | 3.47 | 0.24 | 1.54 | 2.68 | P |
| STA055 | 2.14 | 6.13 | 0.42 | 2.95 | 2.46 | P |
| STA056 | 1.98 | 4.47 | 0.31 | 3.01 | 1.23 | P |
| STA093 | 1.24 | 4.26 | 0.04 | 1.34 | 1.92 | P |
| STA094 | 1.58 | 4.05 | 0.09 | 2.77 | 1.33 | 0.02 |
| 51-1 | 1.80 | 6.15 | 0.70 | 3.83 | 5.64 | P |
| 51-2 | 1.20 | 8.01 | 0.13 | 2.65 | 8.20 | 0.09 |
| 51-3 | 1.18 | 7.67 | 0.00 | 2.97 | 5.98 | P |
| 51-4 | 2.32 | 4.22 | 0.00 | 1.05 | 3.02 | 0.10 |
| AVG | 1.19 | 1.40 | 0.39 | 0.82 | 1.85 | 0.30 |
| STD DEV | 0.58 | 1.56 | 0.33 | 0.83 | 1.31 | 0.34 |
| MAX VALUE | 2.77 | 8.01 | 1.51 | 3.94 | 8.20 | 1.80 |
| MIN VALUE | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 |

COMPOSITION OF GRAB SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT % THM |
|---|---|---|---|---|---|
| 1 | 1.56 | 12.39 | 19.36 | 6.86 | 7.28 |
| 2 | 2.62 | 14.62 | 37.92 | 4.25 | 6.08 |
| 3 | 1.30 | 11.03 | 22.47 | 4.21 | 5.29 |
| 4 | 3.31 | 16.44 | 30.76 | 5.18 | 9.30 |
| 5 | 4.24 | 11.00 | 31.21 | 5.53 | 7.62 |
| 6 | 1.29 | 7.52 | 27.13 | 1.72 | 2.29 |
| 7 | 3.00 | 12.18 | 23.64 | 0.41 | 2.10 |
| 8 | 2.12 | 5.58 | 40.16 | 1.02 | 1.67 |
| 9 | 1.49 | 11.04 | 29.83 | 1.66 | 1.74 |
| 10 | 0.62 | 6.94 | 27.26 | 6.53 | 7.68 |
| 11 | 2.45 | 5.04 | 39.55 | 1.31 | 1.53 |
| 12 | 3.16 | 16.52 | 30.91 | 4.35 | 8.13 |
| 13 | 1.91 | 17.18 | 24.35 | 1.31 | 3.01 |
| 14 | 1.62 | 7.36 | 36.90 | 4.17 | 5.51 |
| 15 | 5.37 | 15.00 | 44.70 | 0.34 | 5.94 |
| 22 | 1.87 | 12.04 | 30.55 | 3.03 | 4.53 |
| 23 | 2.54 | 11.73 | 27.43 | 0.65 | 1.99 |
| 24 | 2.06 | 14.04 | 25.86 | 3.05 | 3.78 |
| 25 | 1.76 | 12.30 | 23.04 | 4.14 | 5.64 |
| 27 | 2.30 | 6.49 | 26.60 | 0.62 | 0.73 |
| 28 | 1.90 | 11.29 | 35.12 | 1.06 | 2.69 |
| 29 | 2.44 | 19.05 | 20.10 | 3.24 | 4.33 |
| 30 | 2.88 | 10.63 | 35.88 | 4.83 | 7.00 |
| 31 | 2.07 | 10.12 | 24.41 | 2.43 | 3.03 |
| 32 | 1.63 | 9.30 | 32.84 | 5.33 | 8.06 |
| 33 | 4.10 | 11.96 | 65.80 | 3.13 | 5.12 |
| 34 | 1.97 | 11.43 | 24.02 | 3.57 | 7.70 |
| 35 | 1.64 | 16.61 | 41.71 | 3.44 | 7.12 |
| 36 | 2.06 | 14.56 | 29.54 | 4.22 | 9.07 |
| 39 | 1.46 | 15.35 | 39.71 | 4.64 | 8.35 |
| 40 | 4.29 | 18.46 | 50.06 | 2.48 | 5.25 |
| 41 | 3.00 | 21.09 | 31.47 | 3.42 | 8.62 |
| 42 | 5.07 | 22.85 | 28.13 | 5.61 | 11.06 |
| 43 | 3.28 | 13.15 | 22.37 | 2.08 | 2.94 |
| 44 | 3.21 | 14.60 | 26.16 | 2.94 | 4.12 |
| 45 | 1.80 | 12.08 | 23.24 | 1.42 | 2.35 |
| 46 | 3.69 | 16.35 | 31.81 | 4.64 | 6.80 |
| 47 | 1.46 | 15.63 | 31.62 | 4.27 | 6.18 |
| 48 | 3.67 | 18.07 | 37.80 | 4.65 | 9.39 |
| 49 | 2.73 | 17.97 | 28.47 | 3.72 | 6.32 |
| 50 | 1.79 | 9.99 | 25.12 | 4.97 | 6.30 |

COMPOSITION OF GRAB SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT % THM |
|---|---|---|---|---|---|
| 51 | 3.49 | 11.85 | 28.06 | 2.65 | 6.49 |
| 52 | 3.86 | 12.31 | 31.68 | 1.92 | 5.90 |
| 53 | 1.15 | 14.20 | 23.32 | 4.30 | 7.79 |
| 54 | 4.92 | 9.74 | 35.89 | 7.02 | 14.66 |
| 55 | 3.09 | 11.84 | 19.31 | 4.14 | 7.87 |
| 56 | 3.83 | 8.36 | 29.33 | 4.04 | 7.95 |
| 57 | 3.34 | 13.04 | 30.67 | 3.48 | 7.79 |
| 58 | 2.01 | 15.38 | 26.33 | 2.18 | 5.44 |
| 59 | 4.30 | 9.83 | 42.36 | 6.74 | 11.02 |
| 60 | 1.87 | 17.07 | 29.00 | 1.12 | 4.51 |
| 61 | 3.48 | 19.16 | 29.79 | 0.87 | 6.08 |
| 62 | 1.35 | 16.28 | 27.33 | 1.34 | 2.93 |
| 63 | 3.33 | 15.40 | 20.49 | 1.78 | 3.65 |
| 64 | 3.44 | 11.25 | 15.98 | 2.84 | 5.32 |
| 65 | 2.15 | 11.95 | 33.52 | 1.22 | 1.53 |
| 66 | 3.56 | 18.93 | 28.21 | 4.67 | 6.79 |
| 67 | 2.10 | 10.81 | 58.92 | 1.58 | 2.55 |
| 68 | 3.42 | 13.15 | 45.42 | 0.66 | 1.14 |
| 69 | 1.29 | 9.81 | 29.83 | 0.72 | 0.83 |
| 70 | 2.09 | 9.06 | 45.90 | 0.58 | 0.65 |
| 71 | 2.43 | 9.39 | 34.81 | 0.58 | 1.19 |
| 72 | 2.66 | 8.87 | 52.04 | 1.62 | 1.94 |
| 73 | 1.19 | 27.59 | 24.20 | 1.60 | 4.92 |
| 74 | 2.39 | 15.19 | 25.75 | 2.91 | 4.40 |
| 75 | 2.79 | 10.97 | 38.12 | 0.47 | 0.55 |
| 76 | 3.68 | 10.02 | 41.39 | 0.32 | 0.48 |
| 77 | 2.58 | 11.16 | 38.75 | 0.46 | 1.51 |
| 78 | 2.91 | 11.17 | 46.12 | 0.89 | 1.04 |
| 79 | 2.72 | 17.38 | 38.18 | 0.12 | 0.14 |
| 80 | 3.82 | 20.00 | 45.35 | 3.10 | 4.74 |
| 81 | 3.42 | 11.73 | 31.92 | 0.76 | 4.39 |
| 82 | 3.15 | 7.57 | 58.37 | 0.92 | 1.31 |
| 83 | 2.05 | 7.20 | 52.61 | 0.58 | 0.70 |
| 84 | 2.62 | 9.32 | 46.88 | 0.37 | 0.51 |
| 85 | 3.82 | 10.73 | 63.14 | 9.63 | 10.75 |
| 86 | 3.24 | 9.08 | 42.31 | 0.76 | 1.31 |
| 87 | 3.31 | 9.03 | 51.90 | 2.96 | 4.16 |
| 88 | 2.23 | 6.83 | 43.47 | 0.38 | 0.44 |
| 89 | 2.79 | 18.25 | 26.11 | 1.76 | 5.22 |
| 89A | 2.54 | 6.77 | 54.20 | 3.76 | 4.38 |
| 90 | 3.36 | 6.58 | 52.68 | 0.76 | 0.80 |
| 91 | 3.39 | 9.49 | 57.82 | 3.93 | 4.52 |

COMPOSITION OF GRAB SAMPLES, continued

| SAMPLE NAME | WT % ZIRCON | WT % OTHER | WT % ECON | WT% RHM | WT % THM |
|---|---|---|---|---|---|
| 93 | 2.90 | 6.38 | 39.66 | 0.81 | 0.97 |
| 94 | 1.63 | 7.29 | 44.25 | 0.68 | 0.82 |
| 95 | 1.58 | 6.47 | 27.64 | 0.38 | 0.42 |
| 96 | 3.95 | 4.13 | 54.11 | 0.46 | 0.79 |
| 97 | 3.07 | 18.95 | 46.26 | 0.37 | 1.12 |
| 98 | 3.51 | 12.60 | 50.82 | 0.51 | 6.25 |
| 100 | 3.68 | 13.46 | 49.47 | 2.23 | 4.48 |
| 101 | 2.04 | 14.24 | 28.24 | 0.20 | 3.47 |
| STA054 | 4.80 | 7.43 | 46.31 | 4.41 | 5.12 |
| STA055 | 1.85 | 10.08 | 36.49 | 0.39 | 0.50 |
| STA056 | 2.98 | 9.58 | 41.63 | 0.58 | 0.83 |
| STA093 | 4.07 | 10.76 | 35.20 | 3.23 | 5.64 |
| STA094 | 3.26 | 9.06 | 33.11 | 5.23 | 7.45 |
| 51-1 | 2.89 | 10.10 | 38.20 | 0.68 | 0.79 |
| 51-2 | 3.17 | 7.79 | 48.43 | 0.07 | 0.09 |
| 51-3 | 3.99 | 8.42 | 43.35 | 0.05 | 0.08 |
| 51-4 | 4.05 | 4.27 | 56.53 | 7.06 | 9.99 |
| AVG | 2.77 | 12.12 | 36.02 | 2.56 | 4.43 |
| STD DEV | 0.98 | 4.33 | 11.07 | 2.04 | 3.14 |
| MAX VALUE | 5.37 | 27.59 | 65.80 | 9.63 | 14.66 |
| MIN VALUE | 0.62 | 4.13 | 15.98 | 0.05 | 0.08 |

106 GRAB SAMPLES

APPENDIX IV

Composition (with respect to concentrate) statistics for all samples

| | WT % MAG | WT % IL | WT % GAR | WT % EP | WT % STAUR | WT % PYROBOLE |
|---|---|---|---|---|---|---|
| AVERAGE | 5.60 | 25.17 | 14.99 | 7.56 | 2.29 | 29.27 |
| STD | 5.14 | 10.64 | 5.15 | 3.25 | 2.02 | 7.48 |
| MAX VALUE | 27.58 | 60.33 | 37.36 | 24.35 | 11.78 | 49.39 |
| MIN VALUE | 0.07 | 3.28 | 2.01 | 0.47 | 0.00 | 6.43 |
| GARNAR'S VALUES | NONE GIVEN | 45.00 | 15.00 | 15.00 | 20.00 | NONE GIVEN |

| | WT % RUTILE | WT % SILL/KY | WT % SPHENE | WT % TOURM | WT % LEUCOX | WT % MONAZITE |
|---|---|---|---|---|---|---|
| AVERAGE | 1.34 | 1.97 | 0.39 | 0.99 | 1.76 | 0.13 |
| STD | 0.56 | 1.42 | 0.37 | 0.91 | 1.24 | 0.27 |
| MAX VALUE | 3.15 | 8.01 | 2.52 | 4.68 | 8.20 | 2.47 |
| MIN VALUE | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| GARNAR'S VALUES | 2.00 | 7.00 | NONE GIVEN | NONE GIVEN | 5.00 | 1.00 |

| | WT % ZIRCON | WT % OTHER | WT % ECON | CORR WT% REC HM | CORR WT% TOTAL HM |
|---|---|---|---|---|---|
| AVERAGE | 3.57 | 11.82 | 33.94 | 1.55 | 3.27 |
| STD | 1.46 | 5.44 | 11.35 | 1.40 | 2.24 |
| MAX VALUE | 9.22 | 48.10 | 69.30 | 9.63 | 14.66 |
| MIN VALUE | 0.41 | 1.70 | 12.02 | 0.05 | 0.08 |
| GARNAR'S VALUES | 5.00 | NONE GIVEN | NONE GIVEN | NONE GIVEN | 5.00 |

390 SAMPLES (106 GRAB, 284 CORE)

APPENDIX V

SELECTED MINERAL COMPOSITION WITH RESPECT TO THE ENTIRE SAMPLE

Underlined samples have concentrations of one or more ECON minerals equal to or greater than Garnar's values (using THM = 5%). See text for explanation. "<0.01" means less than 0.01%. "*" means data not available.

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| B01-1 | 3.91 | 0.56 | 0.04 | 0.03 | <0.01 | 0.06 |
| B01-2 | 2.88 | 0.42 | 0.02 | 0.02 | <0.01 | 0.07 |
| B02-1 | 2.42 | 0.48 | 0.03 | 0.01 | 0.01 | 0.10 |
| B02-2 | 3.88 | 0.78 | 0.03 | 0.07 | 0.01 | 0.06 |
| B03-1 | 3.20 | 0.53 | 0.02 | 0.03 | <0.01 | 0.05 |
| B03-2 | 3.33 | 0.46 | 0.02 | 0.02 | <0.01 | 0.12 |
| B03-3 | 3.26 | 0.50 | 0.05 | 0.06 | <0.01 | 0.11 |
| B04-1 | 2.53 | 0.32 | 0.02 | 0.02 | <0.01 | 0.04 |
| B05-1 | 1.86 | 0.39 | 0.01 | 0.01 | 0.01 | 0.07 |
| B05-2 | 1.82 | 0.46 | 0.03 | 0.01 | 0.02 | 0.09 |
| H01-1 | 3.86 | 1.15 | 0.03 | 0.07 | 0.04 | 0.12 |
| H01-2 | 5.10 | 0.88 | 0.06 | 0.02 | <0.01 | 0.14 |
| H01-3 | 5.48 | 0.95 | 0.15 | 0.02 | 0.08 | 0.42 |
| H02-1 | 2.32 | 0.37 | 0.02 | 0.04 | <0.01 | 0.06 |
| H02-2 | 1.09 | 0.22 | <0.01 | <0.01 | <0.01 | 0.03 |
| H02-3 | 1.34 | 0.18 | 0.01 | 0.01 | <0.01 | 0.10 |
| H03-1 | 2.14 | 0.37 | 0.02 | 0.04 | 0.01 | 0.07 |
| H04-1 | 3.06 | 0.47 | 0.05 | 0.02 | <0.01 | 0.09 |
| H04-2 | 1.37 | 0.18 | 0.01 | <0.01 | <0.01 | 0.06 |
| H04-3 | 1.57 | 0.23 | 0.02 | 0.02 | <0.01 | 0.04 |
| H05-1 | 3.67 | 0.58 | 0.05 | 0.05 | <0.01 | 0.12 |
| H06-1 | 3.13 | 0.45 | 0.02 | 0.01 | <0.01 | 0.05 |
| H06-2 | 1.70 | 0.34 | 0.03 | 0.01 | <0.01 | 0.08 |
| H06-3 | 1.49 | 0.23 | 0.01 | 0.01 | <0.01 | 0.05 |
| H06-4 | 0.74 | 0.07 | 0.01 | 0.01 | <0.01 | 0.03 |
| H07-1 | 3.75 | 0.72 | 0.03 | 0.04 | <0.01 | 0.08 |
| H07-2 | 1.87 | 0.25 | 0.02 | <0.01 | <0.01 | 0.07 |
| H07-3 | 1.54 | 0.15 | 0.01 | 0.01 | <0.01 | 0.04 |
| H08-1 | 5.52 | 1.14 | 0.03 | 0.04 | 0.01 | 0.12 |
| H08-2 | 2.85 | 0.41 | 0.03 | 0.01 | <0.01 | 0.09 |
| H09-1 | 3.62 | 0.28 | 0.01 | 0.02 | <0.01 | 0.24 |
| H10-1 | 2.74 | 0.26 | 0.01 | 0.02 | <0.01 | 0.05 |
| H10-2 | 3.21 | 0.28 | 0.02 | 0.03 | <0.01 | 0.11 |
| H11-1 | 4.00 | 0.62 | 0.04 | 0.02 | <0.01 | 0.04 |
| H12-1 | 6.88 | 1.43 | 0.03 | 0.05 | 0.01 | 0.15 |
| H12-2 | 5.34 | 0.68 | 0.01 | 0.03 | <0.01 | 0.08 |
| H13-1 | 2.23 | 0.45 | 0.02 | 0.04 | 0.01 | 0.02 |
| H14-1 | 0.52 | 0.08 | 0.01 | <0.01 | <0.01 | 0.02 |

Appendix V, continued

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| H14-2 | 1.49 | 0.14 | 0.03 | <0.01 | 0.02 | 0.05 |
| V1-1 | 1.17 | 0.23 | 0.02 | 0.01 | <0.01 | 0.04 |
| V1-2 | 0.82 | 0.42 | 0.02 | 0.02 | <0.01 | 0.02 |
| V1-3 | 0.61 | 0.28 | 0.01 | 0.01 | <0.01 | 0.02 |
| V1-4 | 0.83 | 0.46 | 0.01 | 0.03 | <0.01 | 0.03 |
| V2-1 | 2.72 | 0.65 | 0.02 | 0.03 | <0.01 | 0.06 |
| V2-2 | 1.67 | 0.76 | 0.04 | 0.03 | <0.01 | 0.10 |
| V2-3 | 3.90 | 1.45 | 0.05 | 0.07 | 0.01 | 0.12 |
| V2-4 | 2.12 | 1.06 | 0.03 | 0.03 | <0.01 | 0.08 |
| V4-1 | 1.77 | 0.42 | 0.01 | 0.03 | <0.01 | 0.05 |
| V4-2 | 1.06 | 0.41 | 0.02 | 0.02 | <0.01 | 0.02 |
| V4-3 | 1.39 | 0.45 | 0.02 | 0.04 | <0.01 | 0.03 |
| V4-4 | 1.35 | 0.61 | 0.03 | 0.04 | <0.01 | 0.04 |
| V3-1 | 1.42 | 0.46 | 0.02 | 0.08 | <0.01 | 0.05 |
| V3-2 | 0.50 | 0.18 | 0.01 | 0.01 | <0.01 | 0.02 |
| V5-1 | 1.95 | 0.35 | 0.02 | 0.03 | <0.01 | 0.08 |
| V5-3 | 1.26 | 0.54 | 0.02 | 0.03 | <0.01 | 0.05 |
| V5-4 | 1.20 | 0.53 | 0.02 | 0.02 | <0.01 | 0.06 |
| V5-5 | 1.44 | 0.66 | 0.02 | 0.05 | <0.01 | 0.06 |
| V6-1 | 2.48 | 0.60 | 0.03 | 0.01 | <0.01 | 0.11 |
| V6-2 | 1.71 | 0.43 | 0.03 | 0.01 | <0.01 | 0.11 |
| 1 | 7.28 | 1.22 | 0.02 | 0.03 | <0.01 | 0.11 |
| 2 | 6.08 | 1.94 | 0.05 | 0.06 | 0.03 | 0.16 |
| 3 | 5.29 | 1.01 | 0.04 | 0.05 | <0.01 | 0.07 |
| 4 | 9.30 | 1.99 | 0.13 | 0.28 | 0.02 | 0.31 |
| 5 | 7.62 | 1.84 | 0.07 | 0.13 | 0.01 | 0.32 |
| 6 | 2.29 | 0.52 | 0.01 | 0.03 | 0.01 | 0.03 |
| 7 | 2.10 | 0.40 | 0.01 | 0.02 | <0.01 | 0.06 |
| 8 | 1.67 | 0.58 | 0.01 | 0.03 | 0.01 | 0.04 |
| 9 | 1.74 | 0.44 | 0.01 | 0.02 | <0.01 | 0.03 |
| 10 | 7.68 | 1.93 | 0.03 | 0.07 | 0.01 | 0.05 |
| 11 | 1.53 | 0.48 | 0.02 | 0.03 | 0.03 | 0.04 |
| 12 | 8.13 | 2.03 | 0.07 | 0.13 | <0.01 | 0.26 |
| 13 | 3.01 | 0.61 | 0.02 | 0.03 | 0.01 | 0.06 |
| 14 | 5.51 | 1.58 | 0.05 | 0.16 | 0.05 | 0.09 |
| 15 | 5.94 | 2.08 | 0.08 | 0.08 | 0.01 | 0.32 |
| 22 | 4.53 | 1.08 | 0.02 | 0.14 | 0.03 | 0.08 |
| 23 | 1.99 | 0.43 | 0.03 | 0.02 | <0.01 | 0.05 |
| 24 | 3.78 | 0.73 | 0.03 | 0.08 | 0.01 | 0.08 |
| 25 | 5.64 | 1.00 | 0.06 | 0.10 | 0.02 | 0.10 |
| 27 | 0.73 | 0.13 | 0.01 | 0.01 | <0.01 | 0.02 |
| 28 | 2.69 | 0.83 | 0.01 | 0.03 | 0.01 | 0.05 |
| 29 | 4.33 | 0.64 | 0.05 | 0.03 | <0.01 | 0.11 |

Appendix V. continued

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| 30 | 7.00 | 2.10 | 0.06 | 0.06 | 0.03 | 0.20 |
| 31 | 3.03 | 0.59 | 0.03 | 0.03 | 0.01 | 0.06 |
| 32 | 8.06 | 2.26 | 0.07 | 0.07 | 0.03 | 0.13 |
| 33 | 5.12 | 3.01 | 0.04 | 0.03 | 0.01 | 0.21 |
| 34 | 7.70 | 1.40 | 0.08 | 0.15 | 0.03 | 0.15 |
| 35 | 7.12 | 2.53 | 0.06 | 0.01 | 0.07 | 0.12 |
| 36 | 9.07 | 2.21 | 0.01 | 0.12 | 0.07 | 0.19 |
| 39 | 8.35 | 2.89 | 0.06 | 0.15 | <0.01 | 0.12 |
| 40 | 5.25 | 2.33 | 0.00 | 0.00 | 0.04 | 0.23 |
| 41 | 8.62 | 2.14 | 0.01 | 0.26 | 0.01 | 0.26 |
| 42 | 11.06 | 2.37 | 0.07 | 0.06 | 0.04 | 0.56 |
| 43 | 2.94 | 0.49 | 0.02 | 0.03 | 0.01 | 0.10 |
| 44 | 4.12 | 0.82 | 0.04 | 0.03 | 0.01 | 0.13 |
| 45 | 2.35 | 0.46 | 0.02 | 0.01 | <.00 | 0.04 |
| 46 | 6.80 | 1.69 | 0.04 | 0.12 | 0.01 | 0.25 |
| 47 | 6.18 | 1.73 | 0.05 | 0.03 | 0.01 | 0.09 |
| 48 | 9.39 | 2.89 | 0.08 | 0.20 | <0.01 | 0.34 |
| 49 | 6.32 | 1.47 | 0.05 | 0.06 | 0.01 | 0.17 |
| 50 | 6.30 | 1.20 | 0.07 | 0.07 | 0.04 | 0.11 |
| 51 | 6.49 | 1.39 | 0.08 | 0.09 | 0.01 | 0.23 |
| 52 | 5.90 | 1.50 | 0.04 | 0.08 | 0.02 | 0.23 |
| 53 | 7.79 | 1.51 | 0.06 | 0.06 | 0.01 | 0.09 |
| 54 | 14.66 | 4.25 | 0.16 | 0.03 | 0.05 | 0.72 |
| 55 | 7.87 | 1.03 | 0.08 | 0.09 | <0.01 | 0.24 |
| 56 | 7.95 | 1.78 | 0.11 | 0.07 | 0.03 | 0.30 |
| 57 | 7.79 | 1.95 | 0.06 | 0.10 | <0.01 | 0.26 |
| 58 | 5.44 | 1.23 | 0.05 | 0.02 | <0.01 | 0.11 |
| 59 | 11.02 | 3.85 | 0.17 | 0.07 | 0.01 | 0.47 |
| 60 | 4.51 | 1.11 | 0.02 | 0.05 | 0.00 | 0.08 |
| 61 | 6.08 | 1.45 | 0.08 | 0.06 | <0.01 | 0.21 |
| 62 | 2.93 | 0.68 | 0.03 | 0.04 | <0.01 | 0.04 |
| 63 | 3.65 | 0.50 | 0.05 | 0.06 | <0.01 | 0.12 |
| 64 | 5.32 | 0.54 | 0.05 | 0.04 | <0.01 | 0.18 |
| 65 | 1.53 | 0.42 | 0.02 | 0.02 | <0.01 | 0.03 |
| 66 | 6.79 | 1.51 | 0.10 | 0.05 | <0.01 | 0.24 |
| 67 | 2.55 | 1.28 | 0.03 | 0.08 | 0.01 | 0.05 |
| 68 | 1.14 | 0.41 | 0.01 | 0.03 | 0.01 | 0.04 |
| 69 | 0.83 | 0.17 | 0.01 | 0.04 | <0.01 | 0.01 |
| 70 | 0.65 | 0.23 | 0.01 | 0.03 | <0.01 | 0.01 |
| 71 | 1.19 | 0.34 | 0.01 | 0.02 | <0.01 | 0.03 |
| 72 | 1.94 | 0.81 | 0.03 | 0.08 | 0.01 | 0.05 |
| 73 | 4.92 | 1.04 | 0.03 | 0.03 | <0.01 | 0.06 |

Appendix V. continued

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| 74 | 4.40 | 0.93 | 0.05 | 0.05 | <0.01 | 0.11 |
| 75 | 0.55 | 0.16 | 0.01 | 0.01 | <0.01 | 0.02 |
| 76 | 0.48 | 0.15 | 0.01 | 0.01 | <0.00 | 0.02 |
| 77 | 1.51 | 0.47 | 0.02 | 0.04 | <0.01 | 0.04 |
| 78 | 1.04 | 0.39 | 0.02 | 0.03 | <0.01 | 0.03 |
| 79 | 0.14 | 0.03 | <0.01 | 0.01 | <0.01 | <0.01 |
| 80 | 4.74 | 1.81 | 0.04 | 0.09 | 0.01 | 0.18 |
| 81 | 4.39 | 1.08 | 0.07 | 0.06 | <0.01 | 0.15 |
| 82 | 1.31 | 0.62 | 0.04 | 0.04 | 0.01 | 0.04 |
| 83 | 0.70 | 0.31 | 0.02 | 0.01 | <0.01 | 0.01 |
| 84 | 0.51 | 0.19 | 0.01 | 0.02 | <0.01 | 0.01 |
| 85 | 10.75 | 5.90 | 0.26 | 0.19 | 0.01 | 0.41 |
| 86 | 1.31 | 0.43 | 0.03 | 0.04 | <0.01 | 0.04 |
| 87 | 4.16 | 1.78 | 0.10 | 0.10 | 0.01 | 0.14 |
| 88 | 0.44 | 0.14 | 0.01 | 0.02 | <0.01 | 0.01 |
| 89 | 5.22 | 1.01 | 0.07 | 0.11 | 0.01 | 0.15 |
| 89A | 4.38 | 2.06 | 0.08 | 0.08 | 0.01 | 0.11 |
| 90 | 0.80 | 0.34 | 0.01 | 0.03 | 0.01 | 0.03 |
| 91 | 4.52 | 2.24 | 0.04 | 0.12 | 0.01 | 0.15 |
| 93 | 0.97 | 0.29 | 0.01 | 0.03 | 0.01 | 0.03 |
| 94 | 0.82 | 0.29 | 0.02 | 0.02 | <0.01 | 0.01 |
| 95 | 0.42 | 0.08 | <0.01 | 0.01 | <0.01 | 0.01 |
| 96 | 0.79 | 0.34 | 0.01 | 0.01 | 0.01 | 0.03 |
| 97 | 1.12 | 0.44 | 0.02 | 0.02 | <0.01 | 0.03 |
| 98 | 6.25 | 2.59 | 0.11 | 0.12 | 0.04 | 0.22 |
| 100 | 4.48 | 1.88 | 0.09 | 0.04 | <0.01 | 0.16 |
| 101 | 3.47 | 0.82 | 0.03 | 0.04 | <0.01 | 0.07 |
| 1090-1 | 2.46 | 0.64 | 0.02 | 0.01 | <0.01 | 0.08 |
| 1090-2 | 1.91 | 0.49 | 0.02 | 0.03 | <0.01 | 0.07 |
| 1091-1 | 2.36 | 0.57 | 0.01 | 0.03 | 0.06 | 0.22 |
| 1091-2 | 1.71 | 0.52 | 0.03 | 0.03 | <0.01 | 0.07 |
| 1091-3 | 1.61 | 0.61 | 0.04 | 0.02 | <0:01 | 0.07 |
| 1092-1 | 1.70 | 0.77 | 0.03 | 0.02 | <0.01 | 0.05 |
| 1092-2 | 1.03 | 0.48 | 0.02 | 0.03 | <0.01 | 0.05 |
| 1094-1 | 1.15 | 0.42 | 0.01 | 0.02 | <0.01 | 0.03 |
| 1094-2 | 1.01 | 0.48 | 0.02 | 0.02 | <0.01 | 0.04 |
| 1095-1 | 2.51 | 0.58 | 0.02 | 0.03 | <0.01 | 0.09 |
| 1095-2 | 2.30 | 1.07 | 0.04 | 0.03 | <0.01 | 0.07 |
| 1096-1 | 1.84 | 0.47 | 0.01 | 0.02 | <0.01 | 0.04 |
| 1096-2 | 2.23 | 0.87 | 0.04 | 0.03 | <0.01 | 0.06 |
| 1097-1 | 2.60 | 0.79 | 0.02 | 0.03 | <0.01 | 0.11 |
| 1097-2 | 1.39 | 0.65 | 0.02 | 0.03 | <0.01 | 0.05 |
| 1097-3 | 1.26 | 0.67 | 0.03 | 0.02 | <0.01 | 0.04 |

Appendix V. continued

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| 1098-1 | 1.78 | 0.89 | 0.02 | 0.04 | <0.01 | 0.02 |
| 1098-2 | 0.58 | 0.35 | 0.01 | 0.01 | <0.01 | 0.02 |
| 1099-1 | 1.18 | 0.40 | 0.02 | 0.02 | <0.01 | 0.05 |
| 1099-2 | 1.78 | 0.91 | 0.03 | 0.02 | <0.01 | 0.05 |
| 1100-1 | 2.64 | 0.65 | 0.02 | 0.03 | <0.01 | 0.08 |
| 1100-2 | 2.51 | 1.13 | 0.03 | 0.02 | <0.01 | 0.10 |
| 1103-1 | 1.80 | 0.70 | 0.01 | 0.02 | <0.01 | 0.03 |
| 1103-2 | 1.62 | 0.65 | 0.02 | 0.05 | <0.01 | 0.04 |
| 1103-3 | 1.74 | 0.37 | 0.02 | 0.02 | <0.01 | 0.08 |
| 1106-1 | 3.59 | 1.35 | 0.03 | 0.03 | <0.01 | 0.08 |
| 1106-2 | 2.63 | 0.77 | 0.02 | 0.01 | <0.01 | 0.04 |
| 1107-1 | 4.35 | 1.34 | 0.03 | 0.03 | 0.01 | 0.11 |
| 1107-2 | 1.83 | 0.36 | 0.03 | 0.02 | <0.01 | 0.04 |
| 1109-1 | 3.08 | 0.70 | 0.01 | 0.03 | <0.01 | 0.04 |
| 1111-1 | 2.76 | 0.67 | 0.03 | 0.02 | <0.01 | 0.11 |
| 1111-2 | 3.20 | 0.95 | 0.03 | 0.02 | <0.01 | 0.09 |
| 1116-1 | 4.39 | 1.11 | 0.04 | 0.03 | <0.01 | 0.12 |
| 1116-2 | 4.00 | 1.11 | 0.08 | 0.01 | <0.01 | 0.16 |
| 1119-1 | 2.43 | 0.53 | 0.03 | 0.02 | 0.01 | 0.05 |
| 1119-2 | 2.39 | 0.67 | 0.03 | 0.01 | <0.01 | 0.09 |
| 1120-1 | 1.95 | 0.48 | 0.02 | 0.01 | <0.01 | 0.04 |
| 1120-2 | 3.05 | 0.98 | 0.03 | 0.03 | <0.01 | 0.08 |
| 1121-1 | 3.44 | 0.72 | 0.03 | 0.03 | <0.01 | 0.15 |
| 1122-1 | 5.67 | 1.55 | 0.05 | 0.05 | <0.01 | 0.13 |
| 1127-1 | 5.51 | 1.36 | 0.05 | 0.05 | <0.01 | 0.17 |
| 1127-2 | 2.70 | 0.78 | 0.01 | 0.03 | <0.01 | 0.09 |
| 1129-1 | 7.65 | 1.77 | 0.07 | 0.08 | 0.01 | 0.17 |
| 1129-2 | 6.11 | 1.14 | 0.05 | 0.05 | <0.01 | 0.13 |
| 1130-1 | 7.17 | 1.55 | 0.04 | 0.04 | 0.01 | 0.21 |
| 1130-2 | 1.96 | 0.45 | 0.01 | 0.02 | <0.01 | 0.02 |
| 1131-1 | 5.92 | 1.58 | 0.06 | 0.04 | 0.02 | 0.17 |
| 1132-1 | 6.32 | 1.37 | 0.04 | 0.05 | <0.01 | 0.35 |
| 1134-1 | 8.79 | 2.99 | 0.16 | 0.03 | 0.01 | 0.41 |
| 1134-2 | 6.82 | 2.11 | 0.06 | 0.04 | <0.01 | 0.25 |
| 1136-1 | 9.01 | 2.59 | 0.10 | 0.09 | <0.01 | 0.31 |
| 1136-2 | 6.42 | 1.80 | 0.04 | 0.05 | 0.02 | 0.24 |
| 1136-3 | 3.34 | 0.98 | 0.04 | 0.02 | <0.01 | 0.12 |
| 1139-1 | 2.44 | 0.65 | 0.03 | 0.04 | 0.01 | 0.07 |
| 2000-1 | 2.00 | 0.53 | 0.03 | 0.04 | <0.01 | 0.05 |
| 2000-2 | 2.39 | 0.52 | 0.03 | 0.03 | <0.01 | 0.08 |
| 2001-1 | 2.02 | 0.41 | 0.02 | 0.04 | <0.01 | 0.04 |
| 2002-1 | 3.75 | 1.09 | 0.02 | 0.01 | <0.01 | 0.12 |
| 2002-2 | 3.01 | 0.89 | 0.01 | 0.03 | <0.01 | 0.07 |

Appendix V, continued

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| 110-1 | 2.60 | 0.84 | 0.04 | 0.01 | <0.01 | 0.14 |
| 110-2 | 2.21 | 0.41 | 0.03 | 0.02 | <0.01 | 0.05 |
| 110-3 | 1.41 | 0.29 | 0.02 | 0.02 | <0.01 | 0.02 |
| 115-1 | 0.74 | 0.21 | 0.01 | 0.01 | <0.01 | 0.02 |
| 116-1 | 0.58 | 0.18 | 0.01 | 0.01 | <0.01 | 0.02 |
| 116-2 | 0.54 | 0.17 | 0.01 | 0.01 | <0.01 | 0.01 |
| 116-3 | 2.17 | 0.78 | 0.03 | 0.04 | <0.01 | 0.08 |
| 116-4 | 0.92 | 0.33 | 0.02 | 0.01 | <0.01 | 0.04 |
| 116-5 | 1.66 | 0.52 | 0.05 | 0.04 | <0.01 | 0.05 |
| 117-1 | 1.26 | 0.38 | 0.02 | 0.02 | <0.01 | 0.03 |
| 117-2 | 3.87 | 1.07 | 0.07 | 0.04 | <0.01 | 0.08 |
| 117-3 | 3.95 | 1.12 | 0.04 | 0.04 | 0.01 | 0.07 |
| 117-4 | 2.84 | 0.65 | 0.04 | 0.04 | <0.01 | 0.05 |
| C1-1 | 2.18 | 0.65 | 0.01 | 0.09 | <0.01 | 0.09 |
| C1-2 | 3.18 | 0.55 | 0.05 | 0.05 | <0.01 | 0.09 |
| C1-3 | 2.09 | 0.36 | <0.01 | 0.06 | <0.01 | 0.01 |
| C1-4 | 1.95 | 0.31 | 0.03 | 0.05 | <0.01 | 0.08 |
| C2-1 | 4.12 | 1.12 | 0.05 | 0.04 | <0.01 | 0.22 |
| C2-2 | 1.80 | 0.35 | 0.02 | 0.04 | <0.01 | 0.09 |
| C2-3 | 2.65 | 0.55 | 0.03 | 0.09 | <0.01 | 0.13 |
| C2-4 | 1.41 | 0.35 | 0.02 | 0.06 | <0.01 | 0.04 |
| C3-1 | 3.99 | 0.43 | 0.07 | 0.04 | <0.01 | 0.15 |
| C3-2 | 4.21 | 0.88 | 0.05 | 0.02 | <0.01 | 0.24 |
| C3-3 | 3.54 | 0.69 | 0.06 | 0.04 | <0.01 | 0.25 |
| C3-4 | 3.36 | 1.01 | 0.06 | 0.03 | <0.01 | 0.14 |
| C4-1 | 2.65 | 0.46 | 0.04 | 0.03 | <0.01 | 0.13 |
| C4-2 | 2.40 | 0.35 | 0.04 | 0.03 | <0.01 | 0.08 |
| C4-3 | 2.66 | 0.49 | 0.02 | 0.04 | <0.01 | 0.10 |
| C5-1 | 2.03 | 0.60 | 0.03 | 0.04 | <0.01 | 0.06 |
| C5-2 | 2.91 | 0.35 | 0.05 | 0.06 | <0.01 | 0.13 |
| C5-3 | 3.51 | 0.39 | 0.06 | 0.02 | <0.01 | 0.12 |
| C5-4 | 3.31 | 0.36 | 0.05 | 0.05 | <0.01 | 0.23 |
| C6-1 | 4.38 | 0.90 | 0.07 | 0.06 | <0.01 | 0.24 |
| C6-2 | 2.55 | 0.44 | 0.04 | 0.03 | <0.01 | 0.19 |
| C6-3 | 5.78 | 0.51 | 0.12 | 0.07 | <0.01 | 0.22 |
| C7-1 | 3.14 | 0.62 | 0.02 | 0.00 | <0.01 | 0.09 |
| C7-2 | 1.45 | 0.48 | 0.01 | 0.03 | <0.01 | 0.03 |
| C7-3 | 2.35 | 0.58 | 0.01 | 0.03 | <0.01 | 0.03 |
| C8-1 | 3.45 | 1.05 | 0.04 | 0.02 | <0.01 | 0.18 |
| C8-2 | 6.75 | 0.72 | 0.08 | 0.07 | <0.01 | 0.27 |
| C8-3 | 3.65 | 0.33 | 0.07 | 0.02 | 0.00 | 0.13 |
| C8-4 | 3.56 | 0.28 | 0.05 | 0.02 | <0.01 | 0.13 |
| C9-1 | 4.63 | 0.98 | 0.08 | 0.09 | <0.01 | 0.17 |

Appendix V. continued

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| C9-2 | 3.84 | 0.84 | 0.05 | 0.04 | 0.00 | 0.11 |
| C9-3 | 3.16 | 0.65 | 0.06 | 0.04 | <0.01 | 0.16 |
| C10-1 | 3.22 | 0.85 | 0.06 | 0.03 | <0.01 | 0.15 |
| C10-2 | 4.07 | 0.40 | 0.06 | 0.03 | <0.01 | 0.17 |
| C10-3 | 4.98 | 0.47 | 0.08 | 0.07 | 0.00 | 0.32 |
| C10-4 | 4.53 | 0.30 | 0.08 | 0.08 | 0.00 | 0.36 |
| C11-1 | 1.88 | 0.33 | 0.02 | 0.05 | <0.01 | 0.09 |
| C11-2 | 1.81 | 0.28 | 0.04 | 0.06 | <0.01 | 0.04 |
| C11-3 | 3.53 | 0.53 | 0.02 | 0.02 | <0.01 | 0.23 |
| C11-4 | 3.08 | 0.61 | 0.04 | 0.02 | <0.01 | 0.26 |
| C12-1 | 5.62 | 0.87 | 0.03 | 0.07 | <0.01 | 0.12 |
| C12-2 | 5.32 | 0.51 | 0.08 | 0.04 | <0.01 | 0.22 |
| C12-3 | 9.12 | 1.35 | 0.11 | 0.11 | 0.00 | 0.67 |
| C12-4 | 7.40 | 0.60 | 0.10 | 0.04 | 0.00 | 0.42 |
| C13-1 | 3.21 | 0.49 | 0.06 | 0.07 | <0.01 | 0.11 |
| C13-2 | 2.64 | 0.30 | 0.04 | 0.08 | <0.01 | 0.10 |
| C13-3 | 1.73 | 0.22 | 0.04 | 0.02 | <0.01 | 0.12 |
| C14-1 | 4.47 | 0.42 | 0.06 | 0.03 | <0.01 | 0.10 |
| C14-2 | 1.99 | 0.13 | 0.03 | 0.01 | 0.00 | 0.11 |
| C14-3 | 5.95 | 0.54 | 0.13 | 0.16 | <0.01 | 0.27 |
| C14-4 | 5.61 | 0.18 | 0.10 | 0.08 | <0.01 | 0.25 |
| C15-1 | 5.70 | 0.71 | 0.07 | 0.07 | 0.00 | 0.21 |
| C15-2 | 6.57 | 0.48 | 0.09 | 0.09 | 0.00 | 0.22 |
| C16-1 | 6.91 | 0.94 | 0.08 | 0.02 | 0.00 | 0.19 |
| C16-2 | 5.36 | 0.18 | 0.09 | 0.02 | <0.01 | 0.24 |
| C17-1 | 3.80 | 0.59 | 0.06 | 0.08 | <0.01 | 0.16 |
| C17-2 | 4.26 | 0.35 | 0.06 | 0.03 | <0.01 | 0.27 |
| C17-3 | 4.03 | 0.21 | 0.09 | 0.02 | <0.01 | 0.16 |
| C17-4 | 5.27 | 0.36 | 0.11 | 0.05 | 0.00 | 0.16 |
| C17-5 | 5.72 | 0.23 | 0.12 | 0.03 | 0.00 | 0.23 |
| C18-1 | 2.92 | 0.31 | 0.02 | 0.05 | <0.01 | 0.07 |
| C18-2 | 3.50 | 0.31 | 0.04 | 0.05 | <0.01 | 0.12 |
| C19-1 | 4.06 | 0.54 | 0.08 | 0.04 | <0.01 | 0.19 |
| C19-2 | 2.05 | 0.28 | 0.03 | 0.01 | <0.01 | 0.08 |
| C19-3 | 2.08 | 0.37 | 0.02 | 0.04 | <0.01 | 0.03 |
| C20-1 | 1.29 | 0.34 | 0.02 | 0.05 | <0.01 | 0.04 |
| C20-2 | 1.75 | 0.41 | 0.02 | 0.12 | <0.01 | 0.05 |
| C20-3 | 0.97 | 0.18 | 0.02 | 0.02 | <0.01 | 0.04 |
| C20-4 | 1.93 | 0.42 | 0.03 | 0.07 | 0.00 | 0.11 |
| C21-1 | 1.11 | 0.25 | 0.02 | 0.06 | <0.01 | 0.08 |
| C22-1 | 1.54 | 0.40 | 0.03 | 0.12 | <0.01 | 0.06 |
| C22-2 | 1.76 | 0.43 | 0.04 | 0.10 | <0.01 | 0.07 |
| C22-3 | 2.38 | 0.50 | 0.03 | 0.10 | <0.01 | 0.08 |

Appendix V. continued

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| C22-4 | 1.22 | 0.31 | 0.02 | 0.04 | <0.01 | 0.03 |
| C23-2 | 1.43 | 0.30 | 0.01 | 0.04 | <0.01 | 0.06 |
| C23-3 | 1.59 | 0.39 | 0.02 | 0.03 | <0.01 | 0.06 |
| C23-4 | 0.95 | 0.23 | 0.01 | 0.03 | <0.01 | 0.03 |
| C24-1 | 1.05 | 0.30 | 0.02 | 0.04 | <0.01 | 0.03 |
| C24-2 | 1.49 | 0.37 | 0.03 | 0.06 | <0.01 | 0.04 |
| C25-1 | 0.41 | 0.15 | 0.01 | 0.02 | <0.01 | 0.03 |
| C25-2 | 1.39 | 0.50 | 0.02 | 0.05 | <0.01 | 0.06 |
| C25-3 | 1.77 | 0.49 | 0.02 | 0.04 | <0.01 | 0.04 |
| C26-1 | 3.53 | 1.18 | 0.06 | 0.13 | <0.01 | 0.15 |
| C26-2 | 2.60 | 0.51 | 0.07 | 0.05 | <0.01 | 0.17 |
| C26-3 | 5.11 | 0.43 | 0.14 | 0.07 | <0.01 | 0.29 |
| C27-1 | 2.28 | 0.43 | 0.02 | 0.03 | <0.01 | 0.10 |
| C27-3 | 2.66 | 1.18 | 0.05 | 0.08 | <0.01 | 0.10 |
| C28-1 | 1.88 | 0.64 | 0.04 | 0.08 | <0.01 | 0.07 |
| C28-2 | 3.27 | 0.85 | 0.06 | 0.08 | <0.01 | 0.23 |
| C28-3 | 3.08 | 0.56 | 0.05 | 0.07 | <0.01 | 0.16 |
| C28-4 | 2.40 | 0.69 | 0.04 | 0.08 | <0.01 | 0.12 |
| C29-1 | 4.53 | 1.79 | 0.07 | 0.09 | <0.01 | 0.27 |
| C29-2 | 1.29 | 0.41 | 0.02 | 0.03 | <0.01 | 0.06 |
| C30-1 | 2.96 | 0.72 | 0.06 | 0.07 | <0.01 | 0.15 |
| C31-1 | 0.72 | 0.25 | 0.01 | 0.02 | <0.01 | 0.03 |
| C31-2 | 1.52 | 0.56 | 0.03 | 0.07 | <0.01 | 0.09 |
| C31-3 | 3.14 | 0.96 | 0.07 | 0.07 | <0.01 | 0.16 |
| C31-4 | 3.99 | 0.52 | 0.06 | 0.12 | <0.01 | 0.21 |
| C32-1 | 2.71 | 0.75 | 0.07 | 0.08 | <0.01 | 0.13 |
| C32-2 | 2.73 | 0.44 | 0.04 | 0.09 | <0.01 | 0.14 |
| C32-3 | 3.39 | 0.81 | 0.06 | 0.09 | <0.01 | 0.26 |
| C33-1 | 1.95 | 0.26 | 0.06 | 0.04 | <0.01 | 0.11 |
| C33-2 | 2.50 | 0.33 | 0.05 | 0.04 | <0.01 | 0.17 |
| C33-3 | 2.42 | 0.32 | 0.04 | 0.06 | <0.01 | 0.15 |
| C33-4 | 1.24 | 0.31 | 0.02 | 0.03 | <0.01 | 0.07 |
| C34-1 | 1.08 | 0.35 | 0.02 | 0.02 | <0.01 | 0.03 |
| C34-2 | 3.77 | 1.24 | 0.04 | 0.10 | <0.01 | 0.17 |
| C34-3 | 2.14 | 0.38 | 0.03 | 0.04 | <0.01 | 0.09 |
| C35-1 | 1.78 | 0.37 | 0.03 | 0.07 | <0.01 | 0.11 |
| C35-4 | 1.31 | 0.39 | 0.03 | 0.06 | <0.01 | 0.08 |
| C36-1 | 0.62 | 0.26 | 0.01 | 0.01 | <0.01 | 0.03 |
| C36-2 | 0.73 | 0.25 | 0.01 | 0.01 | <0.01 | 0.03 |
| C36-3 | 0.86 | 0.34 | 0.02 | 0.01 | <0.01 | 0.06 |
| C36-4 | 0.80 | 0.21 | 0.01 | 0.03 | <0.01 | 0.04 |
| C37-1 | 4.40 | 0.59 | 0.05 | 0.11 | <0.01 | 0.25 |
| C37-2 | 2.22 | 0.60 | 0.04 | 0.03 | <0.01 | 0.08 |

Appendix V. continued

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| C37-3 | 2.16 | 0.66 | 0.05 | 0.06 | <0.01 | 0.08 |
| C38-1 | 1.99 | 0.28 | 0.03 | 0.02 | <0.01 | 0.10 |
| C38-2 | 2.32 | 0.46 | 0.03 | 0.04 | <0.01 | 0.07 |
| C39-1 | 4.40 | 0.83 | 0.08 | 0.05 | <0.01 | 0.24 |
| C39-2 | 4.13 | 0.88 | 0.05 | 0.02 | <0.01 | 0.14 |
| C39-3 | 2.60 | 0.76 | 0.05 | 0.03 | <0.01 | 0.08 |
| C40-1 | 4.56 | 0.88 | 0.06 | 0.07 | <0.01 | 0.20 |
| C40-2 | 4.18 | 0.96 | 0.09 | 0.14 | <0.01 | 0.19 |
| C40-3 | 2.75 | 0.71 | 0.04 | 0.08 | <0.01 | 0.12 |
| C41-1 | 3.86 | 0.77 | 0.06 | 0.04 | 0.00 | 0.18 |
| C41-2 | 1.83 | 0.38 | 0.04 | 0.05 | <0.01 | 0.08 |
| C41-3 | 2.65 | 0.68 | 0.05 | 0.07 | <0.01 | 0.12 |
| C42-1 | 3.56 | 1.23 | 0.06 | 0.10 | <0.01 | 0.14 |
| C42-2 | 4.35 | 1.37 | 0.08 | 0.09 | <0.01 | 0.22 |
| C42-3 | * | * | * | * | * | * |
| C42-4 | 3.17 | 1.56 | 0.06 | 0.06 | <0.01 | 0.21 |
| C43-1 | 6.38 | 0.33 | 0.11 | 0.16 | <0.01 | 0.17 |
| C43-2 | 3.55 | 1.02 | 0.05 | 0.05 | <0.01 | 0.13 |
| C43-3 | 6.72 | 1.24 | 0.09 | 0.05 | <0.01 | 0.27 |
| C44-1 | 6.49 | 0.94 | 0.09 | 0.10 | 0.00 | 0.29 |
| C44-2 | 3.50 | 0.97 | 0.04 | 0.02 | <0.01 | 0.12 |
| C44-3 | 1.74 | 0.42 | 0.02 | 0.04 | <0.01 | 0.07 |
| C45-1 | 3.01 | 0.40 | 0.04 | 0.08 | 0.00 | 0.14 |
| C45-2 | 2.63 | 0.45 | 0.03 | 0.06 | <0.01 | 0.07 |
| C45-3 | 2.85 | 0.63 | 0.06 | 0.08 | <0.01 | 0.16 |
| C46-1 | 3.36 | 0.66 | 0.05 | 0.05 | <0.01 | 0.11 |
| C46-2 | 2.20 | 0.50 | 0.02 | 0.03 | <0.01 | 0.05 |
| C46-3 | 2.19 | 0.39 | 0.02 | 0.04 | <0.01 | 0.06 |
| C46-4 | 3.04 | 0.89 | 0.06 | 0.04 | <0.01 | 0.14 |
| C47-1 | 4.47 | 0.81 | 0.08 | 0.12 | <0.01 | 0.13 |
| C47-2 | 1.62 | 0.54 | 0.02 | 0.05 | <0.01 | 0.07 |
| C48-1 | 0.89 | 0.26 | 0.02 | 0.03 | <0.01 | 0.03 |
| C48-2 | 0.91 | 0.15 | 0.02 | 0.04 | <0.01 | 0.02 |
| C48-3 | 0.74 | 0.21 | 0.02 | 0.02 | <0.01 | 0.03 |
| C48-4 | 1.79 | 0.53 | 0.03 | 0.05 | <0.01 | 0.06 |
| C49-1 | 1.00 | 0.29 | 0.02 | 0.04 | <0.01 | 0.03 |
| C49-2 | 0.82 | 0.25 | 0.01 | 0.03 | <0.01 | 0.03 |
| C49-3 | 1.66 | 0.42 | 0.03 | 0.02 | <0.01 | 0.04 |
| C49-4 | 4.14 | 0.90 | 0.06 | 0.06 | <0.01 | 0.14 |
| C50-1 | 2.66 | 0.54 | 0.02 | 0.04 | <0.01 | 0.10 |
| WB063-1 | 2.07 | 0.81 | 0.04 | 0.03 | <0.01 | 0.09 |
| WB063-2 | 2.13 | 0.87 | 0.01 | 0.09 | <0.01 | 0.11 |
| WB063-3 | 2.53 | 0.90 | 0.03 | 0.14 | <0.01 | 0.13 |

Appendix V. continued

| SAMPLE NAME | WT% THM | WT% IL | WT% RUTILE | WT% LEUCOX | WT% MONAZITE | WT% ZIRCON |
|---|---|---|---|---|---|---|
| STA054 | 5.12 | 1.69 | 0.13 | 0.14 | <0.01 | 0.25 |
| STA055 | 0.50 | 0.12 | 0.01 | 0.01 | <0.01 | 0.01 |
| STA056 | 0.83 | 0.26 | 0.02 | 0.01 | <0.01 | 0.02 |
| STA093 | 5.64 | 1.34 | 0.07 | 0.11 | <0.01 | 0.23 |
| STA094 | 7.45 | 1.70 | 0.12 | 0.10 | <0.01 | 0.24 |
| 51-1 | 0.79 | 0.17 | 0.01 | 0.04 | <0.01 | 0.02 |
| 51-2 | 0.09 | 0.03 | <0.01 | 0.01 | <0.01 | <0.01 |
| 51-3 | 0.08 | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 |
| 51-4 | 9.99 | 4.28 | 0.23 | 0.30 | 0.01 | 0.40 |
| AVERAGE | | 0.78 | 0.04 | 0.05 | 0.00 | 0.12 |
| STD | | 0.68 | 0.03 | 0.04 | 0.01 | 0.10 |
| MAX VALUE | | 5.90 | 0.26 | 0.30 | 0.08 | 0.72 |
| MIN VALUE | | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 |
| GARNAR'S VALUES | 5.0 | 2.25 | 0.10 | 0.25 | 0.05 | 0.25 |

Grab samples 51-1, 51-2, 51-3, and 51-4 were taken from North Carolina barrier island beaches.

# APPENDIX VI

Samples are sorted by decreasing abundance (with respect to the total sample) of selected minerals. Only those samples with values equal to or greater than Garnar's values are listed (ilmenite, 2.25%; leucoxene, 0.25%; rutile, 0.1%; monazite, 0.05%; zircon, 0.25%; based on THM = 5%).

| sample | % IL |
|---|---|
| 85 | 5.90 |
| 51-4 | 4.28 |
| 54 | 4.25 |
| 59 | 3.85 |
| 33 | 3.01 |
| 1134-1 | 2.99 |
| 48 | 2.89 |
| 39 | 2.89 |
| 1136-1 | 2.59 |
| 98 | 2.59 |
| 35 | 2.53 |
| 42 | 2.37 |
| 40 | 2.33 |
| 32 | 2.26 |

| sample | % RUTILE |
|---|---|
| 85 | 0.26 |
| 51-4 | 0.23 |
| 59 | 0.17 |
| 1134-1 | 0.16 |
| 54 | 0.16 |
| H01-3 | 0.15 |
| C26-3 | 0.14 |
| 4 | 0.13 |
| STA054 | 0.13 |
| C14-3 | 0.13 |
| 6-3 | 0.12 |
| C17-5 | 0.12 |
| STA094 | 0.12 |
| 56 | 0.11 |
| C17-4 | 0.11 |
| C43-1 | 0.11 |
| C12-3 | 0.11 |
| 98 | 0.11 |
| 1136-1 | 0.10 |
| C12-4 | 0.10 |
| C14-4 | 0.10 |
| 87 | 0.10 |
| 66 | 0.10 |

| sample | % LEUCOX |
|---|---|
| 51-4 | 0.30 |
| 4 | 0.28 |
| 41 | 0.26 |

| sample | % MONAZITE |
|---|---|
| H01-3 | 0.08 |
| 36 | 0.07 |
| 35 | 0.07 |
| 1091-1 | 0.06 |
| 54 | 0.05 |
| 14 | 0.05 |

APPENDIX VI, continued

| sample | % ZIRCON |
|---|---|
| 54 | 0.72 |

| | |
|---|---|
| C12-3 | 0.67 |
| 42 | 0.56 |
| 59 | 0.47 |
| H01-3 | 0.42 |
| C12-4 | 0.42 |
| 85 | 0.41 |
| 1134-1 | 0.41 |
| 51-4 | 0.40 |
| C10-4 | 0.36 |
| 1132-1 | 0.35 |
| 48 | 0.34 |
| 5 | 0.32 |
| C10-3 | 0.32 |
| 15 | 0.32 |
| 1136-1 | 0.31 |
| 4 | 0.31 |
| 56 | 0.30 |
| C44-1 | 0.29 |
| C26-3 | 0.29 |
| C8-2 | 0.27 |
| C17-2 | 0.27 |
| C29-1 | 0.27 |
| C43-3 | 0.27 |
| C14-3 | 0.27 |
| C11-4 | 0.26 |
| 57 | 0.26 |
| 41 | 0.26 |
| 12 | 0.26 |
| C32-3 | 0.26 |
| C14-4 | 0.25 |
| 46 | 0.25 |
| C3-3 | 0.25 |
| C37-1 | 0.25 |
| STA054 | 0.25 |
| 1134-2 | 0.25 |

## APPENDIX VII

## CORE DESCRIPTIONS

The following 39 cores were provided by A.E. Grosz of the U.S. Geological Survey. They were taken by the U.S. Army Corps of Engineers Coastal Engineering Research Center (CERC) and used by Meisburger, 1972. They are arranged by the CERC numbers, so a cross-reference to the USGS-assigned number is provided.

| USGS NUMBER | CERC NUMBER | USGS NUMBER | CERC NUMBER |
|---|---|---|---|
| 110 | 70 | 1111 | 12 |
| 115 | 59 | 1116 | 9 |
| 116 | 58 | 1119 | 54 |
| 117 | D73 | 1120 | 39 |
| 1090 | 5 | 1121 | 40 |
| 1091 | 43 | 1122 | 20 |
| 1092 | 33 | 1127 | 29 |
| 1093 | 4 | 1129 | 25 |
| 1094 | 46 | 1130 | 26 |
| 1095 | 47 | 1131 | 19 |
| 1096 | 48 | 1132 | 28 |
| 1097 | 49 | 1134 | 56 |
| 1098 | 34 | 1136 | 41 |
| 1099 | 35 | 1139 | 16 |
| 1100 | 30 | 2000 | 2 |
| 1103 | 36A | 2001 | 3 |
| 1106 | 53 | 2002 | 31 |
| 1107 | 52 | 2003 | 58 |
| 1109 | 11B | 2004 | 60 |
| 2005 | 61 | | |

USGS CORE 2000 (CERC#2)

Silt, gray (5Y 6/1), clayey; some sand, very fine grained; oyster shell at top of core.....6.30

USGS CORE 2001 (CERC#3)

Empty plastic liner labeled 3A.....2.00

Silt, light olive gray (5Y 6/2); sandy, very fine grained; massively bedded; scattered shell fragments at top and bottom of core; sand, fine to medium grained, laminae thruout core (1-3cm thick); labeled 3B.....1.34

USGS 1093 (CERC #4)

Silt, light olive gray (5Y 6/2); clayey; sandy, fine grained; massively bedded.....3.01

USGS 1090 (CERC #5)

Sand, grayish brown (2.5Y 5/2), fine grained; silty; massively bedded; shell fragments common; many shell fragments at approx.0.95m.....2.45

Sand, grayish brown (2.5Y 5/2), fine to medium grained; massively bedded; grading into sand, medium to coarse grained; some gravel; massively bedded.....1.09

USGS 1116 (CERC #9)

Sand, light brownish gray (2.5Y 6/2), fine grained; silty; massively bedded; Ensis fragments common.....2.50

Sand, coarse grained; and gravel; and shell fragments; including coral (4cm long).....0.25

Sand, light brownish gray (2.5Y 6/2), fine grained; silty; massively bedded; Ensis fragments common.....1.35

USGS 1109 (CERC#11(B))

NOTE: Not the top of the core-only of section B

Sand, light olive gray (5Y 6/2), fine grained, micaceous; massively bedded; shell fragments common.....2.38

USGS 1111 (CERC #12)

Sand, light brownish gray (2.5Y 6/2), fine grained; massively bedded; scattered shell fragments common.....2.00

Sand, light brownish gray (2.5Y 6/2), fine grained; massively bedded; shell fragments common; a small sandy mud pod; from 0.8 to 1.10m in this interval is a higher concentration of shell fragments.....1.34

USGS 1139 (CERC #16)

Sand, light gray (2.5Y 7/2), fine to medium grained; massively bedded; with small shell fragments (a few mm.).....0.45

Sand, light brownish gray (2.5Y 6/2), very fine to fine grained; massively bedded.....1.39

USGS 1131 (CERC #19)

Sand, light brownish grey (2.5Y 6/2),fine grained; massively bedded; abundant shell fragments in this interval at 0.3 to 0.65 m.....0.98

Sand, pale yellow (2.5Y 7/4), fine grained; massively bedded; in this interval at 0.27m Callianassa? tubes (up to 5cm).....0.84

USGS 1122 (CERC #20)

Sand, light brownish gray (2.5Y 6/2) fine grained; massively bedded; abundant shell fragments; shell layer-(.5-.65m) shells up to 6cm...0.65

Sand, light olive gray (5Y 6/2), fine grained; massively bedded; shell fragments common.....0.80

USGS 1129 (CERC #25)

Sand, light brownish gray (2.5Y 6/2), fine grained; massively bedded; sparse shell fragments.....1.93

Sand, coarse grained; with shell fragments.....0.18

Sand, grayish brown (2.5Y 5/2), fine grained; massively bedded.....0.24

Clay and silt, light yellow brown (2.5Y 6/4).....0.12

Sand, grayish brown (2.5Y 5/2) fine grained; massively bedded.....0.43

USGS 1130 (CERC #26)

Sand, light olive gray (5Y 6/2), micaceous, fine grained; massively bedded; with shell fragments.....1.45

Silt, light brownish gray (2.5Y 6/2), slightly clayey; lenses of sand, fine grained.....1.08

USGS 1132 (CERC #28)

Sand, light olive gray (5Y 6/2), fine to medium grained; with shell fragments; Ensis clam at top; oyster shell at 0.45m.....1.64

USGS 1127 (CERC #29)(Cape Charles)

Sand, light olive gray (5Y 6/2), micaceous, fine grained.....2.78

USGS 1100 (CERC #30)

Sand, light olive gray (5Y 6/2), micaceous, coarse to fine grained.....0.53

Sand, coarse grained; and gravel; iron stained.....0.07

Sand, micaceous, fine to medium grained; shell fragments.....0.10

Sand and silt and clay, olive gray (5Y 5/2), massively bedded.....0.83

Silt, light olive gray (5Y 6/2) sandy, fine grained; massively bedded...0.70

Sand, light olive gray (5Y 6/2), medium to coarse grained; and gravel...0.27

USGS 2002 (CERC #31)

Sand, light olive gray (5Y 6/2), fine to very fine grained; massively bedded; shell layer at 0.26-0.30m, shells up to 3cm diameter.....0.30

Sand gray (5Y 6/1), fine to very fine grained; shell fragments common; Ensis fragment in this interval at 0.63m.....1.47

Silt and sand, gray (5Y 6/1), very fine grained; massively bedded shell fragments rare.....1.62

USGS 1092 (CERC #33)(#33a,33b Cape Henry 8/21/68)

Sand, light yellowish brown (2.5Y 6/4), coarse grained; and gravel; massively bedded; local concentrations of clay.....0.75

Sand and gravel, olive yellow (2.5Y 6/6), coarse grained; (increased amounts of gravel).....1.05

Sand, light yellowish brown (2.5Y 6/4), medium to fine grained; some coarse sand; massively bedded.....0.56

Sand, pale yellow (2.5Y 7/4), medium to coarse grained; and gravel massively bedded.....1.49

Sand, light gray (2.5Y 7/2), fine grained; and gravel; plant roots in this interval at 0-0.15m.....0.45

Sand, pale yellow (2.5Y 7/4), medium to coarse grained; and gravel massively bedded.....0.48

NOTE: Bottom of last core liner is threaded

USGS 1098 (CREC #34)

Sand, light yellowish brown (2.5Y 6/4), coarse grained; and gravel; massively bedded; high concentration of pebbles at .45-.60m.....0.70

| | Thickness Meters |
|---|---|
| Sand, yellowish brown (10YR 5/8), coarse grained; and gravel; massively bedded; high concentration of gravel in this interval at .10-.25m and again at .65-.95m | 1.21 |
| Sand, yellowish brown (10YR 5/8), coarse grained; and gravel; and pebbles; iron staining; micaceo; grades into below | 0.68 |
| Sand, light olive gray (5Y 6/2), medium grained; grades into below | 0.16 |
| Silt, light yellowish brown (10YR 6/4); sandy, fine-grained; clayey; micaceous | 1.06 |
| Silt, light yellowish brown (10YR 6/4); clayey; sandy, fine grained; shell fragments; micaceous | 1.89 |

USGS 1099 (CERC #35)

| | |
|---|---|
| Sand, light brownish gray (2.5Y 6/2), fine to medium grained; shell fragments; massively bedded; grades into below | 0.50 |
| Sand, fine grained; muddy; micaceous; grades into below | 1.55 |
| Sand, fine to medium grained; muddy; scattered gravel at bottom of interval | 0.52 |
| Sand, fine to medium grained; muddy; scattered shell fragments | 0.38 |
| Sand, pale yellow (5Y 7/3), coarse to medium grained; gravelly; micaceous | 0.25 |
| Sand, light yellowish brown (2.5Y 6/4), coarse to medium grained; gravelly; micaceous | 0.25 |
| Sand, light brownish gray (2.5Y 6/2), coarse to medium grained; gravelly; micaceous | 0.70 |
| Sand, light yellowish brown (2.5Y 6/4), coarse grained; pebbly; gravelly; iron stained | 0.41 |

USGS 1103 (CERC #36A)

| | |
|---|---|
| Shell fragments; silt; and clay; light olive gray (5Y 6/2); core highly disturbed | 0.25 |

Sand, olive gray (5Y 5/2), fine grained; silt; and clay; shell fragments; core highly disturbed.....0.95

Sand, olive gray (5Y 5/2), coarse grained; silt; and gravel; few shell fragments; core highly disturbed.....0.60

Sand, gray (5Y 5/1), fine to medium grained; gravel; small amount of silt and clay; scattered shell fragments.....1.05

Sand, gray (5Y 5/1), fine to very fine grained; sparse shell fragments..1.80

Sand, gray (5Y 5/1), fine and medium grained; gravel.....0.35

USGS 1120 (CERC #39)

Sand, light gray (2.5Y 7/2), medium to coarse grained; abundant shell fragments (up to 2cm) including Ensis, various other bivalves, and a sand dollar fragment; massively bedded.....0.62

Sand, light olive gray (5Y 6/2), medium to fine grained; massively bedded.....0.70

Sand, light gray (2.5Y 7/2), medium to coarse grained; abundant shell fragments, some large (up to 6cm); massively bedded.....0.18

Sand, light brownish gray (2.5Y 6/2), fine grained; massively bedded....0.10

Sand, light brownish gray (2.5Y 6/2), fine to very fine sand, massively bedded.....1.75

USGS 1121 (CERC #40)

Sand, light olive gray (5Y 6/2), fine to very fine grained; micaceous; massively bedded; widely scattered shells.....2.36

USGS 1136 (CERC #41)

Sand, light olive gray (5Y 6/2), fine to very fine sand; micaceous; massively bedded; widely scattered shells.....1.50

Sand, light olive gray (5Y 6/2), fine to very fine sand; micaceous; massively bedded; shelly layer in this interval at 1.02-1.08m.....3.15

Clay, silty.....0.20
NOTE: iron stain at bottom of core due to rusted core-catcher

USGS 1091 (CERC #43)

Sand, light olive gray (5Y 6/2), fine to very fine grained; silty; micaceous; massively bedded.....4.70

USGS 1094 (CERC #46) CAPE HENRY

Sand, light olive gray (5Y 6/2), fine to very fine grained; micaceous massively bedded; shell fragments rare; well-formed worm tubes in this interval; at 0.25m.; some non-identified fragments coal?...1.58

Sand, light olive gray (5Y 6/2), fine to very fine grained; micaceous; massively bedded; rare shell fragments;.....0.91

Clay, light olive gray (5Y 6/2); silty; massively bedded; iron staining in the surface along the core.....0.88
NOTE: first set photos this core section were unusable the second set of photos are corrected with tape in proper position

USGS 1095 (CERC #47) CAPE HENRY

Sand, light olive gray (5Y 6/2); silty; massively bedded; shell fragments rare; big piece of coal this interval at 0.25m.....1.61

Sand, light yellowish brown (2.5Y 6/4), fine to very fine grained; silty; massively bedded; iron stained; coarse quartz grains rare.....0.44

Sand, light gray (5Y 7/2), (gray color), fined grained; silty; clay; massively bedded.....0.15

Sand, pale yellow (2.5Y 7/3), mixture of fine medium and coarse grained; (poor sorting).....1.08

USGS 1096 (CERC #48)

Sand, light olive gray (5Y 6/2), fine to very fine grained; silty; micaceous; massively bedded; worm tubes in the surface (10cm) some coal fragments in the first 20 cm. layer of shell

fragments this interval at 1.50-1.55m.....1.80

Clay, light gray (5Y 7/1); silty; with some laminations.....0.55

Sand, light olive gray (5Y 6/2), fine, medium and coarse grained; poorly sorted.....0.55

Cobbles (6x3 cm); gravel; coarse sand; poorly sorted.....0.17

Silt, olive yellow (2.5Y 6/6); sand; with clay; iron colored.....1.68

USGS 1097 (CERC #49)

Sand, light olive gray (5Y 6/2), fine grained; micaceous; massively bedded; few scattered shell fragments; grading to sand, medium grained; micaceous; massively bedded; grading to sand, medium with some coarse grained; micaceous; massively bedded; grading to sand, pale yellow (2.5Y 7/4), medium to coarse grained; micaceous massively bedded.....2.78

Sand, coarse grained; and gravel up to 2cm.....0.07

Silt, browish yellow (10YR 6/6), fine sandy, and silty fine sand; iron stained; clam shells common up to 6 or more cm partially dissolved, and casts and molds; micaceous; massively bedded; grades to below..1.65

Sand, yellowish brown (10YR 5/4), fine grained; silty; shells and shell fragments (1/2 cm to several cm); massively bedded.....0.76

USGS 1107 (CERC #52)

Sand, pale yellow (5Y 7/3), medium grained; micaceous; shell fragments; massively bedded.....0.15

Sand, light olive gray (5Y 6/2), fine grained; micaceous; massively bedded shell fragments; grading into below.....0.85

Sand, pale yellow (5Y 7/3), medium grained; micaceous; scattered shell fragments; massively bedded; grading into below.....0.40

Sand, light olive gray (5Y 6/2), fine with some medium grained; scattered shell fragments; massively bedded; micaceous.....1.91

USGS 1106 (CERC #53)

Sand, light olive gray (5Y 6/2), fine grained; micaceous; scattered shell fragments including Ensis; massively bedded.....2.96

USGS 1119 (CERC #54)

Sand, light olive gray (5Y 6/2), medium grained; micaceous; scattered shell fragments; massively bedded; grading into below.....0.70

Sand, light olive gray (5Y 6/2), fine grained; micaceous; scattered shell fragments; concentrated shell fragments up to 1.5cm and some gravel in this interval at 0.72-0.82m; massively bedded; grades to below..2.70

Sand, medium grained; micaceous; scattered shell fragments; massively bedded; grading into below.....0.50

Sand, medium to fine grained; micaceous; scattered shell fragments; massively bedded.....0.28

USGS 1134 (CERC #56)

Sand, light olive gray (5Y 6/2), fine grained; micaceous; widely scattered shell fragments; massively bedded; medium to fine grained sand this interval at 0.25-0.35m.....3.50

USGS 2003 (CERC #58)

Sand, light olive gray (5Y 6/2), fine grained; micaceous; scattered shell fragments; massively bedded.....0.25

Sand, light gray (2.5Y 7/2), coarse grained; shelly; and gravel; (shells to 6 cm) including sand dollar; massively bedded.....0.25

Sand, light gray (2.5Y 7/2), medium to coarse grained; abundant shell fragments (somewhat smaller); massively bedded; grading into below.....0.80

Sand, light gray (2.5Y 7/2), coarse grained; with gravel; abundant shell fragments (to 6cm); gravel is iron-stained; massively bedded.....0.50

Silt, light olive gray (5Y 6/2); sandy, fine grained;

(Pleisto-Yktn); massively bedded.....0.21

Silt, light brownish gray (2.5Y 6/2); slightly clayey; some sand, fine grained; small amount of gravel; massively bedded.....0.39

Sand, light brownish gray (2.5Y 6/2), fine grained; silty; massively bedded; grading into below.....0.85

Sand, fine grained; micaceous; massively bedded; grading into below.....0.13

Sand, light brownish gray (2.5Y 6/2), medium grained; massively bedded..0.33

USGS 2004 (CERC #60)

Silt, pale brown (10YR 6/3); clayey; massively bedded; grades to below..0.60

Sand, light brownish gray (2.5Y 6/2), fine grained; silty; massively bedded; grading into below.....0.25

Sand, light brownish gray (2.5Y 6/2), fine grained; micaceous; massively bedded; grading into below.....0.80

Sand, light brownish gray (2.5Y 6/2), fine grained; silty; massively bedded; grading into below.....0.65
Sand, light brownish gray (2.5Y 6/2), fine grained; massively bedded....0.17

USGS 2005 (CERC #61)

Sand, light gray (5Y 7/2), medium grained; shell fragments; rare massively bedded.....1.40

Sand, light gray (5Y 7/2), fine to medium grained; abundant shell fragments; massively bedded; increased amount of shell fragments in this interval at 0.8-0.93m.....0.93

USGS 116 (CERC #58)(CERC #D58) Delmrva sand

Sand, pale yellow (5Y 7/3), fine to medium sand; micaceous; shell fragments.....0.55

Sand, pale yellow (2.5Y 7/4), coarse grained; and gravel; shelly.....0.30

Clay, gray (5Y 5/1); silty; massively bedded; scattered shell fragments

(well preserved, mostly bivalves, some gastropods and sand dollars up to 1-2cm).....2.76

Sand, light olive gray (5Y 6/2), fine to very fine grained; micaceous; massively bedded; scattered shell fragments (clam and oyster shells to 2cm); numerous shell fragments in this interval at 1.16-1.32m; plant roots at bottom of core - possibly modern contamination.....1.90

NOTE: probably two different cores - no mud-sand contact found

(CERC D-58B) no markings to show top or bottom of core;
Sand, light gray (5Y 7/2), fine to medium sand; massively bedded; shell fragments.....0.80

Sand, light olive gray (5Y 6/2), fine grained matrix with medium to coarse grains; numerous shell fragments (to 2cm).....0.20

Sand, light gray (5Y 7/2), fine to medium grained, coarsening toward botton; shell fragments rare; massively bedded.....0.76

USGS 116-5 D58 A 2/2
Core was broken. Most of the material was absent. Sand, fine grained; micaceous; same sand as the other two sections.....0.94

USGS 117 (CERC #D73)

Sand, pale olive (5Y 6/3), medium to coarse grained; gravel; shells.....0.30

Sand, light olive gray (5Y 6/2), medium grained; micaceous; scattered shell fragments; massively bedded; grading into below.....0.30

Sand, fine grained; micaceous; massively bedded.....0.60

Mud, and sand,fine to coarse grained; and gravel, gray (5Y 5/1); abundant shell fragments.....0.95

Sand, light olive gray (5Y 6/2); fine to medium grained; scattered shell fragments.....0.75

Sand, light olive gray (5Y 6/2); medium grained; micaceous; abundant shell fragments; massively bedded.....0.65

Sand, fine grained; micaceous; abundant shell fragments; massively bedded.....0.15

Sand, medium grained; micaceous; abundant shell fragments; massively bedded.....0.25

Sand, coarse grained; and gravel; poorly sorted shells.....0.10

Sand, pale yellow (5Y 7/3), fine to medium grained; silty; micaceous; massively bedded; shell fragments, well-preserved gastropods.....0.75

Sand, gray (5Y 6/1), medium grained; abundant shell fragments; scattered quartz gravel; massively bedded.....1.05

USGS 110 (CERC #70)

Silt, pale yellow (5Y 7/3); clayey; massively bedded.....0.70

Sand, pale yellow (5Y 6/3), very fine grained; micaceous; massively bedded.....1.65

Sand, gray (5Y 6/1), very fine grained; silty; micaceous; massively bedded.....0.95

Silt, grayish brown (2.5Y 5/2); sandy, very fine grained; shelly.....0.55

Silt, clayey.....0.15

Sand, very fine grained; silty; micaceous.....0.20

Silt, clayey.....0.20

Silt, light brownish gray (2.5Y 6/2); sandy, fine grained; shelly; clayey silt layers in this interval at 0.30-0.35m and 0.48-0.51m...0.60

Silt; clayey; shelly.....0.32

USGS 115 (CERC #59) NOTE: possible missing core section listed below

Silt, coarse grained.....0.05

Silt, light olive gray (5Y 6/2); clayey; shell fragments rare (a few mm); massively bedded.....3.30

Silt, gray (5Y 6/1); clayey; shell fragments rare (up to 2cm); massively bedded.....1.80

The following 25 cores were acquired during the summer of 1986.

THICKNESS
METERS

CORE H01

Sand, light brownish gray (2.5Y 6/2), fine to medium grained; massive; shell fragments up to 1.5cm; oyster shell fragment 2cm; spisula? 1.5cm.....1.80

Sand, very dark gray (5Y 3/1), fine to very fine grained; slightly silty; massive; shell fragments; in this interval shell fragments up to 1.5cm beginning at 1.20m; well preserved shell spisula? 3cm at 1.65m; gastropods 1cm long below 1.70m.....1.96

CORE H02

Sand, coarse to medium grained; with clay balls; shells- oysters, clam, Ensis - up to 5.5cm.....0.17

Sand, fine to very fine grained; massive; grading into below.....0.11

Sand, coarse grained; massive; shell fragments up to 1cm.....0.14

Sand, fine to very fine grained; massive.....0.44

Silt, (5Y 2/1), clayey; small amount of very fine sand; massive; intersperced with clayey silty very fine sand this interval at 0.89m.....2.96

CORE H03

Sand, fine to very fine grained; massive; shell fragments up to 1-2mm grading into below.....0.22

Sand, coarse to fine grained; massive; shell fragments up to 2cm; well preserved clams, Ensis ; grading into below.....0.18

Sand, fine to very fine grained; massive; grading into below.....0.13

Sand, coarse grained; massive; shell fragments up to 1.5cm; grading into below.....0.09

Sand, medium grained; massive; shell fragments several mm; grading into below.....0.08

Sand, fine to coarse grained; shell fragments several mm; grading into below.....0.08

Sand, fine to very fine grained; massive; micaceous.....0.51

CORE H04

Sand, olive gray (5Y 4/2), fine to very fine grained; massive.....1.09

Clay, plastic; massive; very wet.....0.09

Sand, very fine grained; silty; massive.....0.15

Clay, plastic; massive.....0.24

Sand, olive gray (5Y 4/2), fine to very fine grained; silty; massive; in this interval: shell fragments up to .8cm some well-preserved at 1.12-1.16m; abundant shell fragments up to 1.5cm at 1.37-1.57m..2.08

Shelly layer shell up to 1cm.....0.05

Clay, dark gray (5Y 4/1), silty; with stringers of silty fine to very fine sand.....0.41

Sand, very dark gray (5Y 3/1), fine to very fine grained; silty; micaceous.....0.30

CORE H05

Sand, olive gray (5Y 4/2), fine to very fine grained; massive; micaceous; locally slightly silty fine to very fine sand; in this interval: shell fragments in upper 0.75m (up to 6cm long); and layer of medium to fine sand abundant shell fragments up to .5cm (clams, Ensis, oyster shell 6cm long; 2cm long piece of muscovite?? at 0.40m may also be thin shell layer; color changes several times thruout core as follows: very dark gray (5Y 3/1) at 0.16m; olive gray (5Y 5/2) at 0.39m, dark gray (5Y 4/1) at 0.72m.....1.85

CORE H06

Sand, very dark gray (5Y 3/1), fine to very fine grained; micaceous; massive; scattered shell fragments up to 3cm.....0.72

Oyster shell and clam shell fragments up to 7cm long.....0.10

Silt, clayey; slightly sandy; massive; slightly plastic; 3cm long bone?? fragment this interval at 0.67m.....0.84

Sand, very dark gray (5Y 3/1), fine grained; silty; clayey; micaceous; massive; grading into slightly muddy fine sand.....1.46

Sand, very dark gray (5Y 3/1), fine grained; muddy; micaceous; massive; with clay pods interspersed.....1.52

Silt, very dark gray (5Y 3/1), clayey; sandy; micaceous; massive; slightly plastic; grading to clayey silty fine sand; with sparce clay pods 1cm.....1.40

CORE H07

Sand, very dark gray (5Y 3/1), fine grained; massive; scattered shell fragments of several mm.....0.48

Sand, fine to course grained; poorly sorted; abundant shell fragments of several mm; some well-preserved oyster, scallop, and clam shells up to 5cm (which continue into mud layer, abundant to 0.12m depth); not homogenous in color this interval at 0.00-0.05m.....0.12

Clay, dark olive gray (5Y 3/2), silty; plastic; with pods of muddy fine sand; micaceous;color changes to very dark gray (5Y 3/1).....1.17

Mud, fine sandy; plastic; abundant shell fragments 3-4cm; well preserved oyster shell 7cm.....0.05

Clay, silty; fine sandy; plastic; scattered shell fragments.....0.28

Shell layer; plastic fine sandy silty clay; well-preserved oyster shell (7cm); abundant oyster shells; grading into below.....0.10

Clay, silty; micaceous; plastic; some sandy pods, scattered shell fragments; grading into below.....0.20

Sand, dark gray to olive gray (5Y 4/1) (5Y 42), fine to very fine grained; massive; micaceous; intercalcations of silty clay this interval at 0.63-0.76m.....1.22

Clay, silty; with firm clay balls.....0.10

CORE H08

Sand, grayish brown (2.5Y 5/2), fine grained; micaceous; massive; shell fragments.....0.17

Sand, medium to fine grained; shell fragments up to 0.5cm.....0.08

Sand, dark gray (2.5Y 4/0), fine grained; micaceous; massive; shell fragments up to 4cm; in this interval: oyster shell fragment 4cm at 0.75m; coarse sand with shell fragments up to 2cm at 0.93-0.97m; 2.5 cm scallop shell; grading into below.....1.09

Sand, dark gray (5Y 4/1), fine to very fine grained; silty; micaceous; massive; several interspersed discontinious clay pods 0.5cm.....1.11

Shell hash.....0.05

Sand, fine to very fine grained; silty.....0.07

Silt, olive (5Y 5/4), fine sandy; with clay pods.....0.21

CORE H09

Sand, fine to very fine grained; micaceous.....0.28

Sand, dark reddish gray (10YR 4/1), fine grained; sparce shell fragments up to 4cm.....1.03

CORE H10

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; massive; scsttered shell fragments up to 1mm; possible plant stems this interval at 0.55m.....0.95

Sand, coarse grained; shell fragments up to 6cm.....0.08

Sand, dark gray (5Y 4/1), fine grained.....0.04

Sand, fine grained; with silty clay pods (highly indurated); grading into below.....0.16

Sand, olive (5Y 4/3), fine to very fine grained; micaceous; massive; somewhat silty??; color changes to olive gray (5Y 5/2) and olive (5Y 5/3); grading into below.....1.61

Silt, clayey; grading into below.....0.18

Clay, silty; grading into below.....0.15

Silt, fine sandy; slightly micaceous.....0.22

CORE H11

Sand, fine to very fine grained; micaceous; massive; scattered Ensis fragment at top, other shell fragments thruout; in this interval: 4cm oyster shell fragment at 0.41m; poorly sorted coarse sand, abundant shell fragments well-preserved clams, etc. up to 3cm at 0.33-0.36m, and 0.40-0.45m.....1.89

CORE H12

Sand, medium to coarse grained; abundant shell fragments.....0.19

Sand, medium grained; abundant shell fragments up to 1cm; color: dark gray (5Y 4/1) to very dark gray (5Y 3/1); grading into below.....0.81

Sand, very fine to fine grained; micaceous; shell fragments.....0.23

Sand, fine grained; occasiona; shell fragments up to 2cm; shell layer, well-preserved 2cm clam this interval at 0.52m color changes dark gray (5Y 4/1) to very dark gray (5Y 3/1).....1.05

CORE H13

Sand, coarse grained; poorly sorted; abundant shell fragments up to 3.5cm, Ensis, oyster fragments clams; grading into below.....0.27

Sand, light brownish gray (2.5Y 6/2), fine grained; abundant shell fragments up to 5cm (oyster shell).....0.28

Sand, dark gray (10YR 4/1), fine grained; micaceous; sparce shell fragments.....1.49

CORE H14

Sand, coarse to medium grained; poorly sorted; with oyster shells, gastropod (5cm, well-preserved).....0.30

Clay, very dark gray (5Y 3/1), silty; plastic; intercalated with layers of fine micaceous sand; sand 1-2cm thick.....0.28

Sand, dark gray (5Y 4/1), fine grained; massive; micaceous.....0.59

Clay, silty; plastic; intercalated with layers of fine micaceous sand (up to 9cm thick); piece of wood removed for dating this interval at 0.11m.....0.31

Clay, very dark gray (5Y 3/1), silty; plastic; intercalated with micaceous fine sand; well-preserved oyster shell 7.5cm this interval at 0.35m.....0.75

Sand, very dark gray (5Y 3/1), fine grained; micaceous; abundant shell fragments; in this interval: Ensis at 0.05m; well-preserved Ensis, oyster shell, clam at 0.28m; fewer shell fragments at bottom of core.....0.67

CORE B1

Sand, olive gray (5Y 5/2), fine to very fine grained; massive; locally very micaceous; vertical stringer of very dark gray (2.5Y 3/0) at 0.46-0.85m; color changes to gray (5Y 5/1) and thentovery dark gray (2.5Y 3/0); well-preserved clam shell 1cm at 2.33m; few shell fragments about 1mm from 2.33m and down.....2.69

CORE B2

Sand, olive gray (5Y 5/2), fine to very fine grained; micaceous; massive; scattered shell fragments about 1mm; color changesthruout as follows: very dark gray (5Y 3/1) at 0.51m; olive gray (5Y 5/2) at 1.37m; dark gray (5Y 4/1) at 1.62m.....2.68

CORE B3

Sand, olive gray (5Y 5/2), fine to very fine grained; micaceous; massive; scattered shell fragments-some well-preserved articulated Ensis 2cm; color changes thruout as follows: very dark gray (5Y 3/1) at 0.55m; olive gray (5Y 5/2) than very dark gray (5Y 3/1); 1.5cm long piece of wood at 1.83m; gastropod 0.7cm long at 2.20m.....2.44

Sand, very dark gray (2.5Y 3/0), fine to very fine grained; micaceous; massive; scattered shell fragments.....1.13

CORE B4

Sand, olive gray (5Y 5/2), fine to very fine grained; micaceous; massive; scattered shell fragments up to 2cm long, Ensis, clam; clayey silt pod at 0.88-0.94m; color changes to dark gray (5Y 4/1) at 1.00m....1.89

CORE B5

Sand, very dark gray (2.5Y 3/0), fine to very fine grained; micaceous; massive; sparce shell fragments of 1-2mm.....2.00

Sand, very dark gray (5Y 3/1), fine to very fine grained; micaceous; massive; sparce shell fragments of 1-2mm.....1.07

CORE V1

Sand, fine grained; with clay pods.....0.49

Sand, medium grained; with clay pods.....0.83

Sand, coarse grained.....0.17

Sand, coarse grained; coarsening toward bottom.....1.51

Sand, coarse grained; and gravel; iron oxide stain.....1.52

Sand, medium and fine grained.....0.48

Sand, coarse grained; and gravel.....0.40

Sand, medium grained; heavy iron oxide staining this interval at 0.06-0.14m.....0.60

CORE V2

Sand, fine grained; small amount of mud.....1.18

Sand, medium grained; shell fragment 3-4cm this interval at 0.21m.....0.25

Sand, fine to medium grained; laminations of silt and clay.....1.11

Mud layer.....0.03

Sand, fine grained.....0.17

Mud, compact; with rock fragments (5cm).....0.16

Mud, compact; with scattered shells.....0.31

Shell layer with mud.....0.06

Sand, mixed; plastic mud.....0.58

CORE V3

Sand, olive gray (5y 4/2), coarse to medium grained; occasional shell fragments up to 1.5cm.....0.39

Sand, dark olive gray (5Y 3/2), fine grained; silty; massive; some mud balls near bottom; occasional gravel; grading into below.....0.91

Sand, dark olive gray (5Y 3/2), medium to coarse grained; occasional shell fragments (oyster shells to 5cm); some mud near bottom.....0.60

Clay, greenish gray (5GY 5/1), plastic; interrupted by layers of coarse sand 2cm thick this interval at 0.32-0.70m; some iron staining.....0.90

Sand, greenishh gray (5GY 5/1), coarse grained; and mud.....0.24

Sand, olive gray (5Y 5/2), coarse grained.....0.20

Clay, greenish gray (5GY 5/1), plastic.....0.13

Sand, light olive brown (2.6y 5/6), coarse grained; and gravel massive; iron-stained (in part).....0.85

Clay, olive gray (5Y 4/2), plastic.....0.13

CORE V4

Sand, fine to medium grained; occasional shell fragment; whole skate or ray egg case.....0.40

Sand, fine grained; interbedded with medium to coarse sand and large clay pods; 2.5cm clam shell and other shell fragments.....0.50

Sand, fine grained; bottom 10cm includes some coarse sand.....0.35

Sand, medium to fine grained; small clay pods; grading into below.....0.09

Sand, coarse grained.....0.29

Sand, medium to coarse grained; and gravel.....0.22

Sand, medium grained.....0.09

Sand, medium grained; occasional pebbles up to 2cm; becoming coarser and more pebbly.....0.53

Sand, medium grained.....0.18

Sand, medium grained; grading to coarse sand, and gravel; clay pods.....0.39

Sand, coarse grained.....0.12

Sand, fine to medium grained; with clast of pebbles and medium sand; grading into medium to coarse sand with pebbles up to 1cm.....0.59

Sand, fine grained.....0.09

Mud layer; pebbly fine sand below.....0.06

Sand, fine grained.....0.43

Mud, plastic.....0.03

Sand, medium grained.....0.22

Sand, medium to coarse grained.....0.53

Sand, fine grained; silt; wood fragment.....0.07

Sand, fine grained.....0.52

Sand, fine grained; mixed with gravel up to 4cm.....0.07

Gravel, well-rounded; in sand-silt matrix; gravel up to 2cm.....0.24

CORE V5

Sand, gray (5Y 5/1), fine grained; silty; massive; occasional shell fragments; dry.....1.08

Sand, olive gray (5Y 4/2), medium to coarse grained; occasional shell fragments; some clay balls 1cm; grading into below.....0.73

Sand, olive gray ((5Y 4/2) medium grained; massive; occasional shell fragments and clay balls; grading into below.....1.55

Sand, olive gray (5Y 4/2), fiNe8$I RB%'l5ML%Il R8& "!>

The following 50 cores were aquired during the summer of 1988. For this project, deep penetration was attempted at 16 sites. When vibracoring refused to penetrate the offshore sediments, the core was removed and labeled "RUN-1". The vibracorer was placed again on the sea floor and water was pumped through the empty core liner, thus "jetting" down to about the same depth where refusal was previously encountered. Vibracoring began again at this new depth below the sea floor; this core section was labeled "RUN-2". This procedure was repeated to attain a total penetration of up to 20 feet.

| | THICKNESS METERS |
|---|---|
| CORE C1 | |
| Sand, olive gray (5Y 5/2), medium to coarse grained; shell fragments (up to 3cm, bivalves); coarse sand abundant in this interval at 0.40-0.75m; color grading downwards | 0.85 |
| Sand, medium to coarse grained; scattered shell fragments (a few mm) | 0.35 |
| Sand, very dark gray (5Y 3/1), fine grained; micaceous; scattered shell fragments (a few mm) | 0.34 |
| Sand, very dark gray (5Y 3/1), fine to very fine grained; micaceous; shell fragments (up to 2cm); 6cm clam fragment this interval at 0.26m | 0.31 |
| Silt; sandy, very fine grained; scattered shell fragments | 0.05 |
| Sand, very dark gray (5Y 3/1), fine to very fine grained; scattered shell fragments; silty laminae; micaceous | 0.30 |
| Sand, olive gray (5Y 5/2), fine grained; micaceous; shell fragments rare(a few mm); scattered silty laminae | 0.84 |
| Sand, gray (5Y 6/1) dry; fine grained; micaceous; very few shell fragments | 0.91 |
| Sand, dark gray (5Y 4/1), medium to fine grained; scattered shell fragments (up to 1cm); scattered mud pods; grading into below | 0.50 |
| Sand, gray (5Y 5/1), fine grained; micaceous; scattered shell fragments; grading into sand, medium to fine grained | 0.25 |

Sand, dark greenish gray (5GY 4/1) fine to very fine grained; silty; micaceous; abundant pods of clayey silt; scattered shell fragments (a few mm).....1.45

CORE C2

Sand, very dark gray (2.5Y 3/0), fine grained; micaceous; H2S smell; abundant mud pods; shell fragments at top up to 5cm; shell fragments at the bottom.....0.37

Sand, dark gray (5Y 4/1), coarse grained; quartzose; shelly.....0.10

Sand, dark gray (5Y 4/1), fine grained; micaceous; mud pods; shell fragments.....0.78

Silt, dark gray (5Y 4/1), clayey; with sand pods, fine grained; few shell fragments.....0.20

Silt, dark gray (5Y 4/1), clayey; with sand pods; fine grained.....0.30

Silt, dark gray (5Y 4/1), clayey; with scattered pods; gastropod in this interval at 0.75m.....1.22

Sand, very dark gray (5Y 3/1), fine grained; and clayey silt; interlayered - layers about 1cm; micaceous.....0.93

Sand, very dark gray (5Y 3/1), medium grained; shelly; mud pods of silty clay and clayey silt 1cm thick.....0.50

Sand, very dark gray (5Y 3/1), medium grained; shelly.....0.05

Sand, dark gray (5Y 4/1), medium grained; shelly; pods of silty clay....0.45

Sand, shelly; and clayey silt; interlayered.....0.10

Sand, medium grained; shelly.....0.20

Sand; and clayey silt; shelly; interlayered.....0.30

Sand, medium grained; very shelly.....0.10

CORE C3 RUN-1, RUN-2

Run-1
Silt, black (2.5Y 2/0); clayey; fluid mud; strong sulfur smell.....0.10

Sand, very dark gray (5Y 3/1), fine to very fine grained; micaceous.....0.45

Sand, fine to very fine grained; and silty clay; interlayered, (1-4cm); micaceous; slightly shelly this interval at 0.55m.....0.68

Clay, silty.....0.12

Sand, fine to very fine grained; micaceous; few shell hash; gastropod this interval at 0.09m.....0.19

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; some mud; scattered shell fragments.....0.36

Sand, fine to very fine grained; clay and silt; interlayered.....0.12

Sand, dark gray (5Y 4/1), fine grained; micaceous; shell fragments.....0.81

Run-2 penetration-6.03m; recovery-3.05m
Silt, black (2.5Y2/0); clayey; (fluid mud).....0.10

Sand, fine grained; micaceous; scattered shell fragments.....0.25

Sand, very dark gray (5Y 3/1), fine to very fine grained; micaceous scattered shell fragments; interlayered with silty clay; 1cm shell layer in this interval at 0.92m.....0.95

Silt, clayey.....0.15

Sand, fine grained; micaceous; scattered shell fragments.....0.10

Sand, fine grained; clayey silt; interlayered; micaceous; scattered shell fragments.....0.23

Shell fragments (10cm long).....0.04

Sand, dark gray (5Y 4/1), fine grained; micaceous; very few mud pods; shell hash.....0.48

Sand, fine to very fine; micaceous; interlayered with silty clay and clayey silt; slightly mottled.....1.14

CORE C4

Sand, very dark gray (5Y 3/1), medium to fine grained; micaceous; shelly; shell fragments.....0.60

Sand, medium to fine grained; shelly; interlayered with silty clay

pieces of wood this interval at 0.28m.....0.35

Clay, silty; with sand laminations (shelly and medium sand, 1cm thick)..0.61

Clay, silty.....0.32

Sand, fine to medium grained; micaceous; few shell fragments; grading to medium grained sand.....0.32

Sand, medium grained; micaceous; piece of wood 6cm long this interval at 0.77m.....1.14

Sand, fine grained; micaceous; few shell fragments.....0.28

CORE C5

Shells and shell hash; with quartzose sand, fine grained; (bivalves)....0.42

Sand, fine grained; micaceous; with laminations of shell hash and clayey silt (less than 1cm thickness); scattered shell hash.....0.78

Sand, very dark gray (5Y 3/1), very fine grained; muddy; grading into very fine sandy mud.....0.31

Sand, very dark gray (5Y 3/1), fine to very fine grained; muddy; micaceous; with pods of very fine sandy clayey silt.....1.55

Sand, very dark gray (5Y 3/1), fine to very fine grained; muddy; micaceous; with pods of very fine clayey silt; some scattered shell hash; shelly layer this interval at 0.34-0.39m.....1.55

Sand, fine to very fine grained; muddy; shelly.....0.39

Sand, fine to very fine grained; muddy; micaceous; with pods of fine sandy clayey silt.....0.95

Sand, fine to very fine grained; micaceous; small amount of silt.....0.15

CORE C6

Sand, fine grained; micaceous; scattered shell fragments.....0.10

Sand, fine grained; muddy; shelly.....0.10

Sand, fine grained; micaceous; scattered shell fragments.....0.10

Sand, very dark gray (5Y 3/1), fine to very fine grained; pods of silty clay up to 15cm thick; scattered shell fragments, 1cm thick shell layer in this interval at 0.03m.....1.25

Sand, very dark gray (5Y 3/1), fine to very fine grained; alternating layers with scattered shell fragments and silty clay; lamination thickness ranges from less than 1cm to 10cm; micaceous.....1.54

Clay, very dark gray (2.5Y 3/0); silty; some very fine sand; massive....0.47

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; shell fragments (including gastropod, Ensis, up to 2cm) almost a shell hash; silt and clay layer this interval at 0.14-0.20m.....0.28

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; massive.1.01

CORE C7

Sand, black (2.5Y 2/0), fine to very fine grained; massive; small mud pods; abundant small shell fragments (a few mm); sandy shell layer (Ensis, oyster shell, to 4cm) this interval at 0.25-0.34m.....0.34

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; scattered shell fragments (a few mm).....0.51

Shell layer - bivalves (1cm) and fragments up to 3cm.....0.04

Sand, dark gray (5Y 4/1), fine to very fine grained; scattered shell fragments; increase in mud content at bottom (slightly muddy sand).0.65

Sand, dark gray (5Y 4/1), fine to very fine grained; shell fragments (bivalve, to 4cm).....0.26

Sand, medium to coarse grained; quartzose; abundant shell fragments (up to 10cm clam shell, also gastropods).....0.25

Sand, olive gray (5Y 5/2), medium to coarse grained; shell fragments rare (a few mm).....0.26

Clay, dark gray (5Y 4/1), silty; plastic.....0.11

Mud, medium sandy; shell fragments rare.....0.20

Sand, gray (5Y 5/1), medium to coarse grained; shell hash; and fragments up to 3cm.....0.43

Clay, very dark gray (5Y 3/1), silty; with shelly medium sand pods

or lenses (up to 3cm thick); plastic mud.....0.68

CORE C8 RUN-1, RUN-2, RUN-3

Run-1
Sand, olive gray (5Y 4/2), fine to medium grained; abundant shell fragments (1cm bivalves and smaller fragments); grades into below..0.26

Sand, very dark gray (5Y 3/1), fine grained; micaceous; scattered shell fragments.....0.36

Shell hash, (1cm bivalve and fragments to 4cm); with sand, coarse grained.....0.10

Sand, olive (5Y 4/4), fine grained; some fine parallel laminations; scattered shell fragments; micaceous.....0.32

Run-2 jetted-2.07m; penetration-3.08m; recovery-1.46m
Sample 8-2 continues into core 8 Run-2
Sand, olive (5Y 4/4), fine grained; some parallel laminations; micaceous; scattered shell fragments, (1cm bivalves and smaller fragments).....1.45

Run-3 jetted-3.05m; penetration-6.04m; recovery-2.90m
Clay, olive gray (5Y 4/2), plastic; with lenses of fine grained sand; up to 2cm thick.....0.42

Sand, dark gray (5Y 4/1), fine grained; abundant shell in top half of layer (1cm bivalves and smaller fragments; micaceous.....0.25

Mud, dark gray (5Y 4/1), plastic; sandy; shell fragments.....0.13

Sand, olive gray (5Y 4/2), fine grained; micaceous; scattered shell fragments; and mud lenses this interval at 0.00-0.03m and 0.05-0.07m.....0.73

Sand, olive gray (5Y 4/2), fine grained; micaceous; scattered shell fragments.....0.65

Mud and fine grained sand pods; gradual color change.....0.15

Sand, very dark gray (5Y 3/1), fine grained; with mud lenses to 2cm thick; micaceous; scattered shell fragments.....0.44

Shell hash, mostly bivalves of <1cm.....0.07

Sand, very fine grained; clayey; silty.....0.08

Clay, very dark gray (5Y 3/1); silty; highly plastic;
with 2cm thick fine sand lamination.....0.15

Sand, very dark gray (5Y 3/1), very fine; micaceous.....0.72

Run-2 jetted-2.62m; penetration-4.82m; recovery-2.44m
NOTE: TOP OF CORE TOTALLY DISTURBED
Sand, dark gray (5Y4/1), fine grained; micaceous.....0.10

Clay, dark gray (5Y 4/1); silty; plastic.....0.15

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous.....0.53

Clay, silty (layer).....0.03

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous.....0.45

Sand, dark gray (5Y 4/1), fine grained; micaceous; shell
fragments up to 5cm.....0.34

Sand, shelly; with bivalves and gastropods.....0.09

Sand, dark gray (5Y 4/1), fine grained; micaceous; fine sand with
shell fragments this interval at 0.49-0.54m.....0.80

CORE C13 RUN-1, RUN-2, RUN-3

Run-1
Sand, dark gray (5Y 4/1), medium to fine grained; scattered shell
fragments up to 5cm.....0.60

Shell with medium grained sand; shell fragments up to 5cm long.....0.27

Sand, fine grained; micaceous; shell fragments up to 5cm long.....0.15

Sand, fine grained; shelly; shell fragments up to 2cm mostly bivalves
and gastropods.....0.21

Sand, dark gray (5Y 4/1), fine grained; micaceous; silty clay layer
this interval at 0.33-0,36m.....1.00

Run-2 jetted-2.29m; penetration-5.00m; 1.98m
Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; fine
silty clay laminations this interval at 1.16-1.19m.....1.92

Run-3 jetted-4.21m; penetration-6.04m; 1.74m
Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous.....1.71

CORE C14 RUN-1, RUN-2, RUN-3

Run-1
Sand, fine grained; micaceous; shell fragments (to 1cm).....0.13

Sand, coarse grained; shell fragments (gastropods to 2cm, etc.).....0.03

Sand, dark gray (5Y 4/1), fine grained; micaceous; shell fragments rare; color change to olive gray (5Y 4/2) this interval at 0.79m...0.91

Sand, fine grained; micaceous; abundant shell fragments.....0.06

Shell hash with matrix of micaceous fine grained sand; (bivalves 1-2cm).0.04

Sand, fine grained; micaceous; shell fragments rare; shell fragments becoming more abundant toward bottom.....0.24

Clay, olive gray (5Y 4/2); silty.....0.02

Clay, olive gray (5Y 4/2); silty; layers of fine grained sand (1-2cm thick); sand layer this interval at 0.07-0.10m.....0.32

Sand, dark grayish brown (2.5Y 4/2), fine grained; micaceous.....0.19

Clay, silty; sand laminations (up to 1cm thick).....0.09

Sand, olive (5Y 4/3), fine to very fine grained; micaceous; no shell fragments.....0.48

Clay, silty; with fine grained sand laminations (up to 1cm).....0.17

Sand, fine to very fine grained; micaceous.....0.06

Run-2 jetted-2.41m; penetration-4.18m; recovery-2.20m
Sand, dark gray (5Y 4/1), fine grained; micaceous.....0.15

Shell layer (fragments of up to a few mm).....0.01

Clay, silty.....0.04

Sand, fine grained; micaceous.....0.05

Clay, silty; pockets of micaceous fine grained sand.....0.25

Sand, dark grayish brown (2.5Y 4/2), fine grained; micaceous; silty clay laminations this interval at 0.20-0.25m; shell fragments (1mm or less) and silty clay laminations at 1.10-1.2; mud ball at 1.41-1.44m.....1.70

Run-3 jetted-4.42m; penetration-6.04m; recovery-1.83m
Sand, fine grained; micaceous; shell fragments rare; sediments disturbed by water in core liner.....0.33

Clay, gray (5Y 5/1), silty; sand laminations (up to 1cm thick).....0.21

Sand, olive gray (5Y 4/2), fine grained; shell fragments rare this interval at 0.96-1.01m.....1.31

Core C15 RUN-1, RUN-2

Run-1
Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; top 12cm has scattered shell fragments (up to 1cm).....0.80

Clay, silty; with fine sand laminations (0.5 cm thick).....0.20

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; color changes to olive gray (5Y 4/2) this interval at 0.30m.....0.88

Run-2 jetted-1.83m; penetration-6.04m; recovery-2.14m
Sand, olive gray (5Y 4/2), fine grained; micaceous; (no shell); silty clay laminations this interval at 1.01-1.03m and 1.33-1.36m; color changes to olive brown (2.5Y 4/4) this interval at 1.00m.....2.10

CORE C16 RUN-1, RUN-2

Run-1
Sand, very dark gray (2.5Y 3/0), fine grained; micaceous; rare shell fragments (abundant only from 0.15-0.20m); color changes to dark gray (5Y 4/1) this interval at 0.94m EXCEPT for silty clay lamination this interval at 1.21-1.22m with color of very dark gray (2.5Y 3/0).....1.69

Run-2 jetted-1.98m; penetration-3.36m; recovery-0.92
Sand, dark gray (2.5Y 4/0), fine to very fine grained; micaceous; few scattered shell fragments (1mm); silty clay laminations this interval at 0.22-0.23m and 0.30-0.33m; color changes to dark grayish borwn (2.5Y 4/2) this interval at 0.30m.....0.96

CORE C17 RUN-1, RUN-2, RUN-3, RUN-4

Run-1
Sand, dark gray (2.5Y 4/0), fine to very fine grained; micaceous; shell fragments (1mm) rare; silty clay lamination this interval at 1.28m.....1.64

Dark gray (2.5Y 4/0); silty clay and micaceous fine grained sand, alternating layers; (layers up to 7cm thick); scattered shell fragments in sand; color changes to dark gray (5Y 4/1) this interval at 0.19m.....0.36

Sand, dark gray (5Y 4/1), fine grained; micaceous; scattered shell fragments 1mm (mostly below .35); silty clay laminations with shell fragments (a few mm) this interval at 0.72-0.73m and 0.75-0.76m....0.85

Run-2 jetted-2.29m; penetration-3.66m; recovery-0.76m
Clay, dark gray (2.5Y 4/0), silty; laminations of micaceous, silty, fine grained sand; (up to 3cm thick); widely scattered shell fragments a few mm; color changes to very dark gray (5Y 3/1) in this interval at 0.10m.....0.36

Sand, fine grained; micaceous; (no shell); layer of abundant shell fragments (bivalves, a few mm) this interval at 0.34-0.39m.....0.53

Run-3 jetted-3.29m; penetration-4.06m; recovery-1.07m
Clay, dark gray (5Y 4/1), silty; laminations of silty fine grained sand (to 1 cm thick).....0.21

Sand, very dark gray (5Y 3/1), fine grained; micaceous.....0.23

Clay, silty; fine grained sand lamination this interval at 0.04-0.05m...0.20

Sand, dark gray (5Y 4/1), fine grained; micaceous; few scattered shell fragments (about a mm).....0.36

Run-4 jetted-4.03m; penetration-6.04m; recovery-1.52m
Sand, very dark gray (5Y 3/1), fine to very fine grained; micaceous; scattered shell fragments (to 1cm); in this interval: silty clay layer at 0.45-0.50m; widely scattered shells between 0.42-0.90m (1mm); silty clay layer with shell fragments at 0.91-0.96m; abundant shell fragments (bivalves, a few mm) silty sand at 1.04-1.06m; abundant shell fragments silty clay with sand at 1.28-1.32m.....1.50

CORE C18 RUN-1, RUN-2

Run-1
Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; abundant to widely scattered shell fragments (<1mm- 1.5cm); shell fragments up to 4cm this interval at 2.00-2.09m.....2.09

Run-2 jetted-1.98m; penetration-2.59m; recovery-0.55
Sand, dark gray (5Y 4/1), fine grained; miccaceous; scattered shell fragments (mostly 1-2mm, also a bivalve of 2cm).....????

CORE C19 RUN-1, RUN-2, RUN-3

Run-1
Sand, dark gray (2.5Y 4/0), fine to very fine grained; lightly scattered shell fragments, 1-2mm; grades into silty fine sand.....1.80

Sand, fine to coarse grained; silty; and gravel; micaceous; shell fragments up to 3cm.....0.10

Run-2 jetted-1.83m; penetration-4.88m; recovery-1.62m
Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; scattered shell fragments up to 6cm; shell fragments up to 1cm common this interval at 0.98-1.09m.....1.09

Sand, light gray (5Y 6/1), medium with some fine grained; shell fragments up to 6cm (bivalve); this interval at 0.00-0.06m; pod of fine to medium sand, slightly silty this interval at 0.39-0.43m....0.46

Run-3 jetted-3.38m; penetration-5.89m; recovery-2.10m
Sand, medium with fine grained; widely scattered gravel and shell fragments; gravel up to 5cm; shell fragments up to 4cm; scattered pods of mud (1cm size); cobble this interval at 1.85m.....1.70

Sand, fine grained; pod of silty fine sand this interval at 0.03-0.07m..0.38

CORE C20 RUN-1, RUN-2

Run-1
Sand, dark olive gray (5Y 3/2), coarse with some fine grained; scattered shell fragments up to 3cm.....0.27

Cobble; sandy siltstone, in fine to medium sand; rounded gravel; shell fragments.....0.18

Sand, dark gray (5Y 4/1), fine grained; shelly; pods of silty sand and gravelly shell hash, shell up to 1-2mm.....0.37

Shell fragments in silty clay matrix with fine to medium sand and gravel; shell fragments up to 3cm.....0.10

Clay, silty; lenses of fine to medium grained sand; also gravel; lenses less than 1cm thick; some mica.....0.30

Clay, dark gray (5Y 4/1), slightly silty; lenses of medium to fine grained sand; micaceous; lenses <1cm; thin parting of clayey silt <1mm, black this interval at 0.43m and 0.72m.....1.27

Sand, fine grained; micaceous; with silty clay layers up to .5cm thick..0.09

Run-2 penetration-6.04m; recovery-5.09m
Sand, dark grayish brown (2.5Y 4/2), coarse to medium grained; shell fragments (up to 6cm) and rounded gravel (up to 2cm) increasing in abundance downward.....0.50

Cobble showing alternating layers of sandstone and siltstone; pebbles and shells commom.....0.06

Sand, dark gray (5Y 4/1), fine grained; abundant shell fragments (up to 2mm) and some rounded gravel (<1cm); shelly layer this layer at 0.83-0.84m.....0.44

Shell hash, sandy; fragments up to 3cm, some gravel; silty clay pods....0.08

Sand, fine grained; some silt.....0.03

Clay, dark gray (5Y 4/1), silty; micaceous; fine sand laminations (up to 1mm); crossbed of silty fine sand and gravel <3cm thick this interval at 0.26m.....0.39

Clay, dark gray (5Y 4/1), micaceous and silty, alternating with beds of micaceous silty fine grained sand; layering ranges from <1mm to 1cm for sandy layers and <1mm to 5cm for clayey layers; sporadic pods of silty medium and fine grained; sandy layers begin to range in thickness from <1mm to 8cm; this interval at 2.1 to 2.55m.....3.16

CORE C21

Sand, olive gray (5Y 5/2), coarse grained; few scattered shell fragments.....0.40

Sand, olive gray (5Y 5/2), course grained; and gravel; abundant biodetritus, bivalves up to 10cm (quratz shelly sand).....0.46

Clay, gray (5Y 4/1), silty; plastic; with coarse sand pockets

this interval between 0.04-0.09m.....1.34

CORE C22

Sand, olive gray (5Y 4/2), coarse grained; lot of shell fragments up to 6cm long).....0.40

Sand, olive gray (5Y 4/2), coarse to medium grained; scattered shell frgaments.....0.45

Sand, olive gray (5Y 4/2), medium grained; shell fragments.....0.65

Sand, medium grained.....0.15

Sand, olive gray (5Y 4/2), coarse grained; shell fragments up to 4cm long.....0.06

Sand, medium grained.....0.09

Sand, coarse grained; shell fragments up to 4cm long.....0.03

Sand, medium grained.....0.07

Sand, medium grained; abundant shell fragments.....0.15

Sand, gray (5Y 4/1), medium grained.....0.40

Sand, medium grained; abundant shell fragments.....0.05

Sand, medium grained; big oyster shell this interval at 0.30m.....0.40

Sand, medium to fine grained; scattered shell fragments.....0.15

Sand, very dark gray (5Y 3/1), fine grained; scattered shell fragments; small silty clay pod this interval at 0.87m.....1.09

Sand, coarse grained.....0.04

Sand, very dark gray (5Y 3/1), fine to medium grained; small amounts of silt; scattered shell fragments.....0.08

Sand, olive gray (5Y 4/2), medium to coarse grained; gravel (quartz) up to 2cm.....0.10

Sand, olive gray (5Y 4/2), medium to coarse grained.....0.69

Sand, olive gray (5Y 4/2), medium to fine grained; scattered shell

fragments; scattered gravel (quartz and rock)up to 2cm.....0.40

CORE C23

Clay, very dark gray (2.5Y 3/0), silty; smelly; small silty sand pocket this interval at 0.17-0.19m; shelly layer this interval at 0.96m..1.55

Sand, silty; washed in???.....0.06

Clay, black (5Y 2.5/1), silty.....0.31

Sand, dark gray (2.5Y 4/0), silty; laminations of coarse to medium sand up to 2cm thick; very micaceous; no shell fragments.....0.78

Sand, very fine grained; micaceous.....0.36

Sand, dark gray (5Y 4/1), very fine grained; micaceous.....0.70

Sand, coarse grained.....0.05

Sand, very fine grained; micaceous; silty clay this interval at 0.00-0.02m.....0.10

Sand, gray (5Y 5/1), coarse grained; grading into below.....0.55

Sand, medium grained.....0.16

Sand, dark gray (5Y 4/1), medium to coarse grained.....0.59

Sand, coarse grained; gravel and pebbles up to 2cm.....0.20

Sand, medium to coarse grained.....0.55

Sand, fine to very fine grained; micaceous; shelly layer with fine sand shell (biodetritus) to 5cm long, this interval at 0.07-0.15m.....0.21

CORE C24

Sand, dark gray (5Y 4/1), coarse to medium grained.....0.91

Sand, dark gray (5Y 4/1), coarse grained; and gravel; scattered shell fragments up to 8cm.....0.30

Sand, dark gray (5Y 4/1), medium to fine grained; higher concentration of finer grained material at bottom; some well-preserved bivalves

3-4cm long this interval at 0.35m.....0.40

Sand, coarse to medium grained; scattered shell fragments.....0.13

Sand, dark gray (2.5Y 4/1), medium to fine grained; scattered shell fragments.....1.16

Clay, silty; interlaminated with mediuum to fine sand up to 1cm thick...0.06

Sand, fine grained; shell fragments up to 7cm long.....0.20

CORE C25

Clay, dark gray (5Y 4/1), silty; very silty medium grained sand pods in this interval at: 0.03-0.12m (with scattered shell fragments), and 0.16-0.22m, and 0.50-0.52m (with shell fragments up to 2cm), and 0.70-1.03m, and 1.19-1.21m (with scattered shell fragments), and 1.31-1.33m (with medium to fine sand).....1.35

Sand, gray (5Y 5/1), coarse grained; shell fragments; becomes silty towards bottom; silty clay pod this interval at 0.20m.....0.50

Sand, dark gray (5Y 4/1), fine grained; silty.....0.10

Sand, gray (5Y 5/1), medium grained; grading into below.....0.15

Sand, coarse grained.....0.45

Clay, silty.....0.04

Sand, coarse grained; cobble (5cm).....0.06

Clay, dark gray (5Y 4/1), silty; and fine to very fine sand laminations up to 3cm thick.....0.65

Sand, dark gray (5Y 4/1), very coarse grained; and gravel; large shell fragments up to 8cm; silty clay lens this interval at 0.44-0.45m...0.45

Sand, gray (5Y 5/1), coarse to medium.....0.53

CORE C26

Sand, olive gray (5Y 5/2), fine to very fine grained; micaceous; fine grained sand with shell hash; fragments up to 1cm this interval at 1.10-1.14m and at 1.26-1.28m; silty fine grained

sand laminations 1cm thick at 1.20-1.25m; silty clay layer at 1.60-1.64m; color changes to dark gray (5Y 4/1) at 1.24m.....1.71

Sand, fine to very fine grained; micaceous; some scattered shell fragments; shell fragments up to 8cm long this interval at 0.20-0.25m concentration of shell fragments at 0.33-0.36m.....0.69

Sand, medium grained; shell fragments up to 2cm and clay balls 2cm dia..0.13

Sand, fine grained; silty; silty clay pod this interval at 0.16-0.32m; silty clay layers at 0.72-0.75m and 0.84-0.87m.....0.90

Clay, very dark gray (5Y 3/1), silty; laminations of silty fine grained sand; sand laminations up to 1cm thick; color changes to dark gray (5Y 4/1) this interval at 0.16m.....0.63

Sand, fine grained; silty; with silty clay laminations; clay laminations vary between 1cm and 10cm thick; concentration of bivalve shells up to 1cm long fine sand matrix this interval at 0.04-0.13m; shell fragments up to 4cm long at 0.54-0.56m; crossbedded (?) clay layer at 0.56-0.62m; concentration of bivalve and gastropod shells up to 1.5cm, in fine sand matrix at 0.62-0.69m.....1.02

CORE C27

Sand, dark gray (5Y 4/1), coarse to very coarse grained; scattered shell fragments.....0.12

Sand, dark gray (5Y 4/1), fine grained; micaceous; silty clay lamination this interval at 0.11m.....0.13

Sand, coarse to medium grained; sandy shell hash (shell fragments up to 3cm long) this interval at 0.07-0.13m.....0.20

Sand, very fine grained; micaceous; scattered shell fragments.....0.08

Clay, dark gray (2.5Y 4/1), silty; shelly medium to coarse sand this interval at 0.08-0.11m; silty sand pods at 0.12-0.17m and 0.0.43-0.45m.....1.20

Clay, dark gray (2.5Y 4/1), silty; small well compacted sand pod this interval at 0.03-0.05m.....2.95

Silt, sandy; various amounts of fine sand.....0.32

Gravel to coarse sand; gravel up to 7cm (quartz); small mud pod this interval at 0.10-0.15m.....0.30

CORE C28

Sand, medium to fine grained; colors as follows: light olive gray (5Y 6/2) up to 0.28m, dark gray (5Y 4/1) up to 1.30m, light olive gray (5Y 6/2)up to 1.59; shell fragment 2cm long this interval at 0.44m; exhibits planer bedding at 0.50-0.60m; silty clay layer thins fron 3cm to <0.05cm at 1.99-2.02m.....2.12

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; scattered shell fragments <0.05cm; concentration of shell fragments some medium sand this interval at 1.62-1.72m; grading into below.....2.08

Sand, medium to coarse grained.....0.15

Sand, dark gray (5Y 4/1), fine to medium grained with interlaminations silty clay; silty clay 3mm-1cm thick; sand 1-3cm thick.....0.67

Sand, dark gray (5Y 4/1), medium grained; scattered shell fragments up to 1cm.....0.26

Sand, dark gray (5Y 4/1), fine to very fine grained; silty; widely scattered shell fragments; becomes slightly coarser this interval at 5.75m.....1.00

CORE C29

Sand, olive gray (5Y 5/2), medium to fine grained; some silt; scattered shell fragments up to 2mm; concentration of fragments this interval at 0.98-1.02m; and at 0.95-1.45m (these up to 3cm); color changes to dark gray (5Y 4/1) at 1.50m.....2.33

Clay, dark gray (5Y 4/1), silty; well compacted; mud pods of less compaction this interval at 0.18m and 0.32m and 0.57m; fine grained sand pod at 2.27m (2mm thick).....2.89

CORE C30

Clay, dark gray (5Y 4/1), silty; scattered shell fragments <1mm; fine sandy silt layer 3cm thick at a 45 degree angle this interval at 0.20m.....0.34

Sand, fine grained; silty; shell fragments up to 3cm; peice of wood 2cm long this interval at 0.08m.....0.44

Clay, dark gray (5Y 4/1), silty with interlayers and silty fine sand; with scattered shell fragments up to 1mm; clay layers 4-5cm; sand layers 15-20cm.....0.56

Clay, dark gray (5Y 4/1), silty.....0.14

Sand, fine grained; silty; scattered shell fragments to 1mm.....0.29

Clay, dark gray (5Y 4/1), silty; widely scattered shell fragments <1mm well compacted; shell fragment 2cm long this interval at 0.74m.....1.69

Clay, dark gray (5Y 4/1), silty; shell fragments absent; air pockets in center of core this interval at 0.13-0.17m and 0.46-0.64m.....1.64

CORE C31 RUN-1, RUN-2

Run-1
Sand, pale yellow (5Y 7/4), medium grained; scattered shell fragments up to 1mm; clam shell 3cm this interval at 0.31m; color changes very dark gray (5Y 3/1) at 0.15-1.20m (bioturbation), pale yellow (5Y 7/4) at 1.20-1.40m, dark gray (5Y 4/1) at 1.45-2.00m (bioturbation); medium to coarse grained sand with higher concentration of shell fragments at 2.40-2.54m, and at 2.87-2.92m.....3.05

Run-2 penetration-3.11m; recovery-2.99m
Sand, dark gray (5Y 4/1), fine grained; some silt; shell fragments up to 2mm; plastic plug this interval at 0.35-0.45m.....0.45

Sand, dark gray (5Y 4/1), fine grained; silty; scattered shell fragments <1mm; very moist to wet (high water content).....1.51

Silt, sandy, fine grained; scattered shell fragments <1mm.....0.27

Sand, coarse grained; silty; shell fragments <2mm; upper contact at 45 degree angle.....0.16

Silt, sandy, fine grained; shell fragments <1mm.....0.06

Sand, coarse grained; silty; upper contact at 45 degree angle.....0.09

Sand, dark gray (5Y 4/1), fine grained; silty; scattered shell fragments up to 4cm.....0.26

CORE C32

Sand, dark gray (5Y 4/1), fine grained; silty; scattered shell fragments up to 2mm; large shell fragment (3cm long) this interval at 0.70m; becomes coarser at 0.85-1.05m.....1.17

Silt; fine grained sandy; scattered shell frgaments <1mm.....0.11

Sand, dark gray (5Y 4/1), coarse grained; silty; grading into fine grained sand this interval at 0.04m; scattered shell fragments up to 3mm.....0.28

Sand, fine grained; scattered shell fragments.....0.49

Clay, silty.....0.05

Sand, fine grained; scattered shell fragments.....0.14

Clay, dark gray (5Y 4/1); several <1mm silty sand laminations; silty fine grained sand layer this interval at 0.17-0.18m; concentration of shell at bottom contact.....0.25

Sand, dark grayish brown (2.5Y 4/2), fine grained; micaceous; silty; silty clay lamination (1mm thick) this interval at 0.14m; horizontal bedding visible; color changes to light olive brown (2.5Y 5/4) at 0.11m.....0.16

Clay, light olive brown (2.5Y 5/4), silty; becomes coarser from 0.30m and down; color changes several times in this interval to gray (5Y 5/1) at 0.04m; and dark gray (5Y 4/1) at 0.05m; and dark grayish brown (2.5Y 4/2) at 0.30m.....0.45

Sand, dark gray (5Y 4/1), very fine grained; silty ; micaceous; color changes several times this interval: from 0.13 to bottom alternating colors of olive gray (5Y 4/2) and yellowish brown (10YR 5/8) with fine material related to darker color and coarser material related to lighter colors.....0.40

Sand, laminations of silty fine grained and medium grained; laminations range from 1mm to 0.5cm thick.....0.15

Sand, medium to coarse grained; and gravel; (rounded).....0.06

Sand, fine grained; micaceous; mud lens <1mm this interval at 0.04m ....0.04

Sand, medium to coarse grained; and gravel.....0.03

Sand, medium grained.....0.08

Sand, medium grained; and gravel.....0.04

Clay; with fine grained sand lenses.....0.08

Sand, olive gray (5Y 4/2), fine grained; some silt; micaceous.....0.54

Sand, dark gray (2.5Y 4/0), fine grained; some silt; micaceous; begin to have shell fragments increasing concentration with depth.....0.20

Shell hash; some fine grained sand; mostly bivalves up to 1cm with trace gravel.....0.26

Sand, dark gray (2.5Y 4/0), very fine grained; silty; micaceous; widely scattered shell fragments; shelly layer this interval at 0.10-0.12m.....0.57

CORE C33

Sand, black (2.5Y 6/0), fine grained; silty; widely scattered shell fragments; interlayers of silty clay ranging from 0.5-6.0cm thick this interval from 0.0-0.95m;silty clay layers at 0.32-0.38m, and 0.45-0.48m (with .5cm layer of coarse sand below), and 0.64-0.67m; silty fine to medium sand layer at 0.50-0.57m; medium sand with shell fragments up to 4cm some silt at 0.68-0.73m; color changes to dark gray (2.5Y 4/0) at 0.48m.....1.54

Sand, fine grained; silty.....0.34

Clay, silty.....0.03

Sand, fine grained; silty.....0.04

Clay, silty; with several fine grained sand lenses.....0.05

Sand, dark olive gray (5Y 3/2), coarse grained; and gravel; abundant shell fragments up to 5cm long; pod of mud this interval at 0.06m..0.31

Sand, dark gray (2.5Y 4/0), fine grained; very silty; mud pods; scattered shell fragments.....0.53

Silt, clayey; interlayered with silty clay, layers range 1-2cm; shell absent.....0.13

Clay, very dark gray (2.5Y 3/0), silty; grading into below.....0.15

Sand, dark gray (5Y 4/1), fine grained; silty; becomes less silty with depth; pod of mud this interval at 0.91m.....1.34

Sand, dark gray (5Y 4/1), fine grained; gravelly.....0.17

Gravel, black (2.5Y 2/0); with silty fine sand; scattered shell fragments.....0.32

Silt, clayey; more clayey at top; some gravel at bottom.....0.16

Gravel; with silty fine sand; scattered shell fragments; gravelly silt layer this interval at 0.14-0.15m; higher concentration of shell fragments with some medium sand toward bottom.....0.26

Silt, black (2.5Y 2/0), clayey.....0.06

Gravel and shell fragments; with silty fine grained sand and some medium grained sand.....0.25

Clay, silty; interlayered with clayey silt; with gravel; shows horizontal bedding.....0.07

Gravel and scattered shell fragments; with medium to coarse sand and silt.....0.17

Sand, gray (5Y 5/1), interbedding of silty fine and medium grained; mud pod with medium sand this interval at ????; clay ball this interval at 0.09m.....0.10

Sand, gray (5Y 5/1), medium to fine grained; and gravel; trace clay; abundant shell fragments.....0.17

CORE C34

Sand, olive gray (5Y 5/2), medium grained; trace of coarse and fine grained sand; widely scattered shell fragments.....2.20

Sand, fine to medium grained; widely scattered shell fragments; mud lamination up to 2mm thick this interval at 0.15m; higher percent of medium sand at 0.20-0.27m.....0.27

Sand, dark gray (5Y 4/1), fine to very fine grained; widely scattered shell fragments; layer of abundant shell fragments 2cm thick this interval at 0.43m.....1.05

Sand, medium grained; shell fragments.....0.02

Sand, dark gray (5Y 4/1), very fine grained; silty; with layers of medium grained sand and shell fragments this interval at 0.13-0.14m, and 0.23-0.26m; pod of coarse sand at 0.33-0.38m;

0.5 cm thick layer of silty clay at 0.39m.....0.39

Sand, olive gray (5Y 5/2), coarse grained; shell fragments; several mud pods.....0.17

Sand, fine grained; and shell fragments.....0.06

Sand, olive gray (5Y 5/2), coarse grained; abundant shell fragments.....0.11

Sand, dark gray (f5Y 4/1) very fine grained; silty.....0.52

CORE C35

Sand, medium grained; in mud matrix; shell fragments up to 4cm.....0.08

Clay, very dark gray (5Y 3/1); pods and discontinuous laminations of fine sand common; pods toward surface contain medium sand and mud; scattered fragments of wood this interval at: 1.15-1.20m, and 1.35-1.56m, and 1.80-1.95m; color changes to dark gray (5Y 4/1) at 0.80m; abundant fine grained sand laminations at 4.15-4.60m; sand laminations increase in thickness and interlayers of clay becomes more silty and thinner at 5.25-5.42m.....5.42

Sand, gray (5Y 5/1), medium to fine grained; grading to very fine sand at bottom; interlayered mud and fine grained sand this interval at 0.35-0.38m, and 0.42-0.46m; trace of gravel at bottom contact this interval at 0.48m.....0.48

Clayey silt matrix; pods of greener more compacted clay; scattered shell fragments; colors: clay, dark greenish gray (5GY4/1); silt, dark gray (5Y 4/1).....0.12

CORE C36 RUN-1, RUN-2, RUN-3, RUN-4

Run-1
Sand, olive (5Y 5/3), medium to coarse grained; abundant shell fragments up to 5cm; abundant fine to medium sand, coarse sand commom this interval at 0.72m.....1.25

Run-2 jetted-1.13m; penetration-2.41m; recovery-1.37m
Sand, pale olive (5Y 6/3), medium grained; scattered shell fragments; plastic plug this interval at 0.22-0.32m; color changes to olive gray (5Y 5/2) this interval at 0.15m; silty clay pod with color of dark gray (5Y 4/1) this interval at 1.02m; grades into below.....1.15

Sand, fine to medium; scattered shell fragments.....0.23

Run-3 jetted-2.35m; penetration-3.08m; recovery-1.07m
NOTE: top 0.4m of tube empty; measurements not exact-core disturbed
Sand, olive (5Y 5/3), medium grained; abundant shell fragments; color changes to gray (5Y 5/1) this interval at 0.55m.....1.03

Sand, dark gray (5Y 4/1), fine grained; abundant shell fragments.....0.33

Run-4 jetted-2.99m; penetration-3.96m; recovery-1.01
Sand, gray (5Y 5/1), fine to medium grained; abundant shell fragments; darker colored parting this interval at 0.33m; plastic plug this interval at 0.77-0.87m.....1.00

CORE C37

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; scattered shell fragments; concentration of shell fragments mostly Ensis this interval at 0.12-0.14m; laminations of silty clay up to 2cm thick at 0.53-0.65m and 1.29-1.30m grading into below.....2.00

Sand, dark gray (5Y 4/1), medium to fine grained; shelly layer in sand matrix, fragments up to 3cm this interval at 0.45-0.53m; shell layer in sand matrix, gastropods and bivalves up to 8cm at 0.75-0.80m.....0.82

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; silty sand layer this interval at 0.31-0.33m; silty clay layers at 0.46 and 0.56 (1cm).....2.14

CORE C38

Sand, very dark gray (5Y 3/1), fine to very fine grained; micaceous; Ensis shell fragment 4cm long this interva; at 0.81-0.84m.....1.03

Sand, dark olive gray (5Y 3/2), coarse grained; some gravel.....0.08

Sand, medium grained; silty.....0.03

Sand, medium to coarse grained; shell fragments up to 4cm.....0.06

Sand, very dark gray (5Y 3/1), medium to fine grained; silty clay this interval at 0.00-0.01m.....0.22

Sand, very dark gray (5Y 3/1), medium grained.....0.11

Sand, very dark gray (5Y 3/1), fine to very fine grained; micaceous.....0.30

Clay, silty; some fine grained sand; micaceous.....0.15

Sand, coarse grained; silty; and gravel; shell fragments up to 7cm.....0.21

Clay, dark gray (5Y 4/1), slighty silty; high degree of compaction; small pods of coarse sand this interval at 1.64-1.74m; 0.5cm thick layer of shell fragments this interval at 3.20m..... 3.96

CORE C39

Sand, dark gray (5Y 4/1), very fine grained; massive; scattered shell fragments up to 4cm Ensis; dark band this interval at 0.10-0.12m...1.54

Sand, medium grained; and gravel; shell fragments.....0.05

Sand, fine to very fine grained; some medium sand; micaceous.....0.22

Sand, coarse to medium grained; trace of gravel.....0.03

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; scattered shell fragments; trace of subrounded gravel; concentration of gravel and shell fragments up to 4cm this interval at 0.46-0.56m; piece of wood 4cm long at 1.28m; concentration of bivalve shells at 2.05-2.08m; layer of silty fine sand at 2.79-2.84m; layer of silty clay at 2.89-2.95m; shell hash with fragments up to 3cm with coarse sand at 3.29-3.34m; interlaminations of silty clay and silty fine sand laminations up to 1cm thick at 3.42-3.46m.....3.59

CORE C40

Sand, dark gray (5Y 4/1), very fine grained; micaceous; massive; widely scattered shell fragments.....1.45

Sand, dark gray (5Y 4/1), very fine grained; micaceous; massive; scattered shell fragments up to 1cm; several pods of silty fine sand this interval at 0.55-0.70m; 1cm wide shell layer (clams 1cm at an angle) at 0.80m.....1.53

Sand, dark gray (5Y 4/1), very fine grained; micaceous; massive; widely

scattered shell fragments; 1cm thick lenses of silty fine sand common.....1.49

CORE C41

Sand, dark gray (5Y 4/1), fine to very fine grained; silty; micaceous; widely scattered shell fragments; in this interval: 1cm wide layer abundant shell fragments <1cm oriented at 45 degree angle at 0.30-0.35m; horizontal layer of abundant shell fragments 1cm at 0.42-0.44m; abundance of Ensis at 0.20m.....1.31

Sand, dark greenish gray (5GY 4/1), fine to very fine grained; micaceous; silty; widely scattered shell fragments up to 1cm; in this interval: decrease in sand and increase in clay content at 0.37m; silty clay with scattered occurances of very fine sand at 0.55m; scattered grains of coarse sand below 0.54m.....0.74

Clay; some silt; occasional larger grains.....0.17

Sand, gray (5Y 5/1), medium to coarse grained; and gravel, scattered shell fragments <1cm.....0.36

Sand, medium to coarse grained.....0.03

Sand, gray (5Y 5/1), fine to very fine grained; widely scattered shell fragments up to 1cm; gathering of shell fragments including 3cm Ensis this interval at 1.14m.....1.36

CORE C42

Sand, very dark gray (2.5Y 3/1), very fine grained; micaceous.....0.13

Sand, coarse grained; and gravel; shell fragments up to 1cm.....0.02

Sand, medium to fine grained.....0.05

Dark gray (2.5Y 4/1); interlaminations of medium to fine grained sand and silty clay laminations up to 2cm thick.....0.28

Sand, coarse grained; shelly; shell fragments up to 2cm.....0.09

Sand, dark gray (2.5Y 4/1), fine grained; micaceous; scattered shell fragments; silty sand layer this interval at 0.15m.....1.00

Sand, medium to fine grained; micaceous.....0.48

Sand, dark gray (5Y 4/1), medium to fine grained; micaceous; shell fragments up to 2cm.....0.25

Sand, dark gray (5Y 4/1), very fine grained; micaceous; variable amounts of silt and clay along core; in this interval: silty sand at 0.00-0.40m; clayey sand at 0.40-0.70m; silty sand at 0.70-0.81m....0.81

Sand, very fine grained; silty; clayey; variable amounts of silty clay along the core..no laminations pattern, looks loke disturbed lenses of sand, silt and clay; in this layer: silty clay layer at 0.05-0.07m; gastropod at 0.27m.....1.52

Clay, dark gray (5Y 4/1), silty; pods and stringers of silty fine sand; scattered shell fragments 1mm along clay sand boundary; in this interval: 3cm oval pebble at 0.92m; becoming more sandy at 1.17m...1.38

Sand, gray (5Y5/1), medium to fine grained; micaceous.....0.11

CORE C43

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; mud pod this interval at 0.78-0.80m; layer of coarse shelly sand, shell fragments up to 6cm at 1.24-1.30m.....1.77

Sand, fine grained; widely scattered shell fragments; shell fragments up to 3cm this interval at 1.48m.....1.48

Sand, fine grained; interlaminated with silty clay; laminations up to 2cm thick.....0.25

Sand, dark gray (2.5Y 4/1), very fine grained; micaceous; with silty sand and clay laminations up to 3cm long.....1.67

CORE C44

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; shelly layer 2cm thick this interval at 0.23m.....1.56

Sand, coarse grained; shelly; fragments up to 8cm.....0.09

Sand, dark gray (5Y 4/1), medium to fine grained; micaceous; abundant shell fragments;shell fragments up to 5cm throughout; shelly sand layers this interval at 0.13-0.17m and 1.48-1.52m and 1.73-1.79m; abundance of bivalve shells this interval at 1.87-2.05m.....2.35

Sand, coarse grained; interlaminated with silty clay; laminations up to 10cm thick; coarse sand - color gray (5Y 6/1); silty sand - color gray (2.5Y 5/1); piece of wood (sample taken) 6cm long this interval at 0.80m.....1.15

Sand, dark gray (5Y 4/1), medium to fine grained; widely scattered shell fragments.....0.09

CORE C45

Sand, fine to very fine grained; micaceous.....0.02

Sand, coarse to medium grained; scattered shell fragments up to 1mm.....0.08

Sand, fine to very fine grained; micaceous; scattered shell fragments...0.05

Sand, very dark gray (2.5Y 7/0), muddy; some shell fragments.....0.10

Clay, dark gray (5Y 4/1), silty; with laminations of shell hash and silty sand up to 2cm thick.....1.20

Clay, silty; laminations of muddy sand up to 3cm.....0.15

Sand, dark gray (5Y 4/1), medium grained; scattered shell fragments.....0.61

Sand, coarse grained; shell fragments up to 7cm, gastropod and bivalve..0.15

Sand, dark gray (5Y 4/1), medium to fine grained; scattered shell fragments; silty clay lense up to 2mm this interval at 0.59m.....1.14

Sand, coarse grained; abundant shell fragments up to 5cm, bivalves.....0.22

Sand, gray (5Y 5/1), medium grained; silty fine sand layer showing more compaction this interval at 0.30-0.38m.....0.49

CORE C46

Sand, dark gray (5Y 4/1), fine grained; micaceous; scattered shell fragments; in this interval: concentration of shell fragments at 0.30-0.40m; silty clay with very fine sand at 0.40-0.44m.....0.76

Sand, coarse grained; shelly; silty clay; shell fragments up to 4cm.....0.19

Clay, silty; scattered shell fragments.....0.10

Sand, silty; scattered shell fragments.....0.10

Sand, silty; with laminations of silty clay up to 2cm.....0.16

Sand, dark gray (5Y 4/1), medium grained; scattered shell fragments.....0.24

Sand, gray (5Y 5/1), medium grained; small amount of silt and clay; scattered shell fragments; shell hash this interval at 0.05-0.11m..0.34

Sand, gray (5Y 5/1), fine grained; interlaminated with silty clay; laminations range from 2-10cm; shell hash with fine sand this interval at 0.32-0.36m.....1.21

Clay, gray (5Y 5/1), silty; laminations of fine sand; laminations range from 1-5cm; in this interval: coarse sand layer at 0.36-0.42m; pod of coarse shelly sand at 1.38-1.42m; shell fragment 5cm at 1.60m.....1.68

Sand, coarse grained; shelly; fragments up to 4cm.....0.06

Sand, dark gray (5Y 4/1), medium grained; scattered shell fragments <1mm.....0.48

Sand, medium to fine grianed; with silty clay laminations up to 2cm.....0.16

Sand, coarse grained; abundant shell fragments; silty clay layer this interval at 0.03-0.05m.....0.28

Sand, medium to fine grained; scattered shell fragments about 1mm.....0.36

CORE C47

Sand, dark gray (5Y 4/1), fine to very fine grained; micaceous; silty clay lamination this interval at 0.40-0.43m.....0.56

Clay, dark gray (5Y 4/1), slightly silty; with laminations of coarse sand and fine sand; laminations range from 1-5cm; several large shell fragments up to 8cm this interval at 0.99m.....1.84

Sand, coarse grained; shelly; scattered shell fragments up to 5cm; silty clay layer this interval at 0.20-0.30m.....0.45

Sand, gray (5Y 5/1), medium to coarse grained; widely scattered shell fragments up to 1mm; trace of subangular gravel.....0.70

CORE C48 RUN-1, RUN-2, RUN-3

Run-1
Sand, light olive brown (2.5Y 4/4), medium to coarse grained; scattered shell fragments up to 2cm.....0.82
Sand, olive gray (5Y 4/2), fine to coarse grained; fewer scattered shell fragments than above.....1.06

Run-2 jetted-1.92m; penetration-4.39m; 3.99m
Sand, light olive gray (5Y 6/2), coarse to medium grained; with pods of darker colored coarse to medium sand; trace of shell fragments up to 2mm; in this interval: plastic plug at 0.47-0.57m; large shell fragment 5cm at 1.42m; layer of dark gray coarse to medium grained sand, olive gray (5Y 4/2) at 1.50-1.66m; and 1.70-2.02m....2.02

Sand, dark gray (5Y 4/1), coarse to medium grained; scattered shell fragments; pods of light brownish grey (2.5Y 6/2).....1.00

Sand, fine to medium grained.....0.13

Sand, dark gray (5Y 4/1), coarse to mediun grained; pods of light brownish gray (2.5Y 6/2); layer of medium to fine sand this interval at 0.25-0.27m; fine sandy silt at 0.71-0.74m.....0.80

Run-3 jetted-4.24m; penetration-6.04m; recovery-1.22m
Sand, olive gray (5Y 4/2), medium to fine grained; widely scattered shell fragments; in this interval: becoming coarse to medium grained at 1.40m; becomes very shelly, fragments up to 1.5cm grayish brown (2.5Y 5/2) at 1.60m.....1.91

Sand, dark gray (5Y 4/1), medium to fine grained; plastic plug this interval at 0.11-0.19m.....0.27

CORE C49

Sand, light olive gray (5Y 6/2), medium to coarse grained; widely scattered shell fragments.....0.50

Sand, olive gray (5Y 5/2), medium to coarse grained; widely scattered shell fragments; in this interval: a pod of color light olive gray (5Y 6/2) at 0.20-0.25m; larger percentage of coarse sand near bottom.....1.11

Sand, dark gray (5Y 4/1), coarse to medium grained; scattered shell fragments up to 1cm.....1.52

Silt, very clayey.....0.02

Sand, olive gray (5Y 5/2), fine to medium grained; scattered shell fragments; gets finer toward bottom; shell fragments to 2.5cm.....0.86

Sand layers, dark gray (5Y 4/1), fine grained and silty fine grained....0.13

Clay, silty; pods of medium to coarse shelly sand; shell fragments up to 3cm.....0.21

Clay, gray (5Y 5/1), silty; pods of silty fine shelly sand.....0.22

Clay, silty; and shelly medium to fine grained sand in patches; gravel in medium to fine grained sand ; shells up to 3cm.....0.56

Sand, fine to very fine grained; micaceous; widely scattered shell fragments up to 0.5cm.....0.61

CORE C50

Silt, dark gray (5Y 4/1); micaceous; with very fine sand and clay; pod of fine sand this interval at 0.42m; grading into below.....0.54

Clay, silty; micaceous.....0.30

Sand, very dark gray (5Y 3/1), patches of fine grained sand and clay mottled; more sandy and less silty toward bottom.....0.29

Clay, gray (5Y 5/1).....0.41

Clay, dark gray (2.5Y 4/1), silty; well compacted.....0.46

Clay.....1.07

Clay, dark gray (2.5Y 4/1), silty; well compacted; scattered shell fragments this interval at 0.18m and 0.53m.....1.53

Clay, silty; compacted; shell concentrations this interval at 0.54m and 0.70m.....1.11

Clay, very dark gray (5Y 3/1), silty; fine sandy.....0.06

Shell hash, dark gray (5Y 4/1), in clay matrix.....0.39