

**Physical and Environmental Assessment of Sand Resources
Sabine and Heald Banks
Second Phase 1994-1995**

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CONTENTS

SUMMARY	1
INTRODUCTION	2
Regional Overview	2
Objectives of the Study	2
ADDITIONAL INVESTIGATION OF SABINE AND HEALD BANKS	4
Sources of Data	4
Vibracores	4
Sediment Textures	5
Data Management	6
SAND RESOURCE ASSESSMENT OF SABINE AND HEALD BANKS	6
Bank Morphologies	6
Scour Depths	7
Primary Bank Lithofacies	7
Overview of Sand Quality	9
Overview of Sand Quantity	10
Sediments of Sabine Bank	10
Sand Quality	10
Sand Quantity	22
Sediments of Heald Bank	22
Sand Quality	22
Sand Quantity	22
WAVE REFRACTION ANALYSIS, SABINE AND HEALD BANKS	22
Model Parameters and Input	23
Results of Wave Refraction Analysis	38
Implications of Results	39
POTENTIAL WEATHER-RELATED DREDGING RESTRICTIONS	40
Wind and Wave Analysis	41
Waves	44
Winds	47
First Quarter 1995 Weather Conditions	54
ESTIMATED COSTS OF DREDGING	54
Galveston Beach Nourishment Project	56
Planned Ship Shoal Project	58
Proposed South Padre Island Project	58

CONCLUSIONS AND RECOMMENDATIONS	59
REFERENCES	60
APPENDIX A. LOCATIONS OF CORES	63
APPENDIX B. CORE DESCRIPTIONS SABINE BANK.....	67
APPENDIX C. CORE DESCRIPTIONS HEALD BANK	107
APPENDIX D. SEDIMENT TEXTURES	203
Gravel, Sand, Mud	205
Hydrometer Analyses.....	207
Sieve Analyses	209
Cumulative Curves (Sieve Analyses)	212
APPENDIX E. LITHOLOGIC PROFILES OF VIBRACORES	223

Figures

1. Locations of vibracores collected from Sabine Bank and Heald Bank.....	3
2. Relationship between water depth and depth of storm wave scour in sediments of Sabine Bank.	8
3. Locations of stratigraphic cross sections illustrating lithofacies associated with Sabine and Heald Banks.	12
4. Stratigraphic dip section across eastern end of Sabine Bank.....	13
5. Stratigraphic dip section across middle of Sabine Bank.....	14
6. Stratigraphic dip section across middle of Sabine Bank.....	15
7. Stratigraphic dip section across middle of Sabine Bank.....	16
8. Stratigraphic strike section along middle of Sabine Bank, eastern, central, and western sections.....	17
9. Stratigraphic dip section along middle of Heald Bank.	20
10. Stratigraphic strike section along middle of Heald Bank.	21
11. Bathymetry and wave heights for case 1 wave conditions	25
12. Bathymetry and wave heights for case 2 wave conditions	26
13. Bathymetry and wave heights for case 3 wave conditions	27
14. Bathymetry and wave heights for case 4 wave conditions	28
15. Bathymetry and wave heights for case 5 wave conditions	29
16. Bathymetry and wave heights for case 6 wave conditions	30
17. Bathymetry and wave heights for case 7 wave conditions	31
18. Bathymetry and wave heights for case 8 wave conditions	32
19. Bathymetry and wave heights for case 9 wave conditions	33

20. Wave-height difference map for excavated and nonexcavated conditions for modal wave conditions of case 3	34
21. Wave heights along the landward 4-m isobath	35
22. Wave-height difference map for excavated and nonexcavated conditions for storm wave conditions of case 9	36
23. Wave heights along the landward 4-m isobath	37
24. Map showing locations of wind and wave recording and hindcast stations in the vicinity of Heald and Sabine Banks	43
25. Wave rose diagram and percent occurrence of wave height and period for WIS hindcast station 12	45
26. Cumulative percent occurrence for significant wave heights at buoy mooring 42035 and WIS hindcast station number 12	49
27. Wind rose diagram and wind speed summary for WIS hindcast station number 12	50
28. Wind rose diagram and wind speed summary for buoy mooring #42035.	51
29. Wind rose diagram and wind speed summary for CMAN station SRST2 at Sea Rim State Park	52
30. Wind rose diagram and wind speed summary for the Houston Intercontinental Airport ...	53

Tables

1. Thickness of sand facies in each vibracore from Heald Bank and Sabine Bank	11
2. Wave parameters used in model runs displayed in figures 1 through 9	24
3. Selected sources of wind and wave data in the Sabine and Heald Banks area	42
4. Cumulative percent of significant wave heights for WIS station 12.	46
5. Cumulative percent of significant wave heights for NOAA buoy #42035.	48
6. Cumulative percent of inshore significant wave heights inferred from NOAA buoy #42035.	55
7. Completed, proposed, and potential beach fill projects utilizing sand deposits from the Gulf of Mexico.	57

SUMMARY

Sand deposits on the continental shelf of the western Gulf of Mexico are potential sources of fill material to nourish recreational beaches in Texas. Demand for beach nourishment sand is increasing as the combined effects of relative sea-level rise and reduced sediment supply cause rapid erosion and accelerated loss of recreational beaches. Particularly promising for leasing and commercialization in the near term are offshore deposits of sand that form shoals on the inner continental shelf. Preliminary geological and engineering analyses indicate that these sand deposits are suitable for beach replenishment because sediment textures of the shoals are generally compatible with those of native beach sand. Also, offshore sand extraction may be economically feasible if onshore or nearshore sources of beach-quality sand are volumetrically limited.

In Texas, Sabine and Heald Banks are two offshore sand deposits that have the greatest economic potential for near-term exploitation because they are (1) suitable for beach replenishment, (2) the largest sand deposits located offshore of some of the most rapidly eroding developed shores, (3) relatively close to potential markets in both southeastern Texas and western Louisiana, and (4) relatively close to major ports that can support offshore mining activities.

A prior geological investigation demonstrated that large volumes of sand-rich sediments are associated with Sabine Bank and Heald Bank (Morton and Gibeau, 1993). The total volume of sandy sediments, estimated at more than 1.8 billion m³, constitutes a large hard-mineral resource. Most of that material would be suitable for beach replenishment and other construction activities that can use well-sorted fine sand with some shell and some sediments finer than sand. The previous study also showed that the offshore sand deposits are located in water depths ranging from 4.5 m to about 16 m and the greatest thicknesses of beach-quality sand generally coincide with the shallowest water depths.

The second phase of this study was directed principally toward assessing the quality and volume of Sabine and Heald Bank sediments. To accomplish this, the banks were cored, sediment textures and mineralogy were determined, and sand volumes were estimated using bathymetry and lithologic information. Geographic locations and attributes of all the pertinent offshore data sources were incorporated into ARC/INFO, a widely used Geographic Information System (GIS). An additional task of the second phase evaluated the potential environmental impact of mining the sand deposits by examining the potential changes in wave refraction patterns if large volumes of sand were removed from Sabine and Heald Banks. Another task analyzed the wave heights and wind patterns near the Banks to estimate the maximum number of working days for shallow-draft dredges working in the Gulf, and we also conducted a preliminary investigation of dredging costs based on experience with the 1995 Galveston Beach replenishment project and two other beach nourishment projects planned for the western Gulf of Mexico.

INTRODUCTION

Regional Overview

Potentially economic concentrations of sand and shell have been identified in the western Gulf of Mexico during decades of exploration and research on the continental shelf. On the Texas portion of the continental shelf, significant sand accumulations at or near the seafloor occur as shore-aligned sand bodies and patchy accumulations of transgressive sands that were deposited during the most recent rise in sea level (Paine et al., 1988). Fluvial sand and gravel occur within late Wisconsin stream courses that extend across the continental shelf, but these valley-fill deposits are typically covered by tens of meters of overburden and are not exploitable considering the current economic constraints.

There are potential markets for offshore sand along the western Gulf of Mexico. Sand contained in submerged shoreline and nearshore deposits has the greatest near-term economic potential because it can be used for beach replenishment projects. Beach replenishment can be justified where large recreational, residential, and industrial investments would be damaged or destroyed by continued coastal erosion and storm impacts.

Long-term erosion of beaches and heavy beach use near population centers in the western Gulf make beach replenishment an attractive alternative to other methods of shoreline stabilization. The City of Galveston recently (spring 1995) completed a beach nourishment project using offshore sand dredged from a borrow area on the adjacent shoreface. The Town of South Padre Island is also planning for a beach nourishment project in the near future, and a feasibility plan and environmental impact statement are being prepared for mining Ship Shoal in coastal Louisiana. The history of coastal development in Texas and widespread beach erosion suggest that other beach communities such as North Padre Island and Freeport will likely need beach nourishment in the near future.

Objectives of the Study

The assessment study of Sabine and Heald Banks (Figure 1) accomplished several objectives. First, it provided information that could stimulate interest in offshore sand resources, thus bringing closer the time when leasing and commercial utilization in the western Gulf of Mexico are a reality. Second, the study quantified the sediment textures of Heald Bank, which contains the largest sand deposits that are closest to Galveston Island, a primary site for future beach replenishment. Third, the study characterized the wave conditions that offshore mining equipment might encounter.

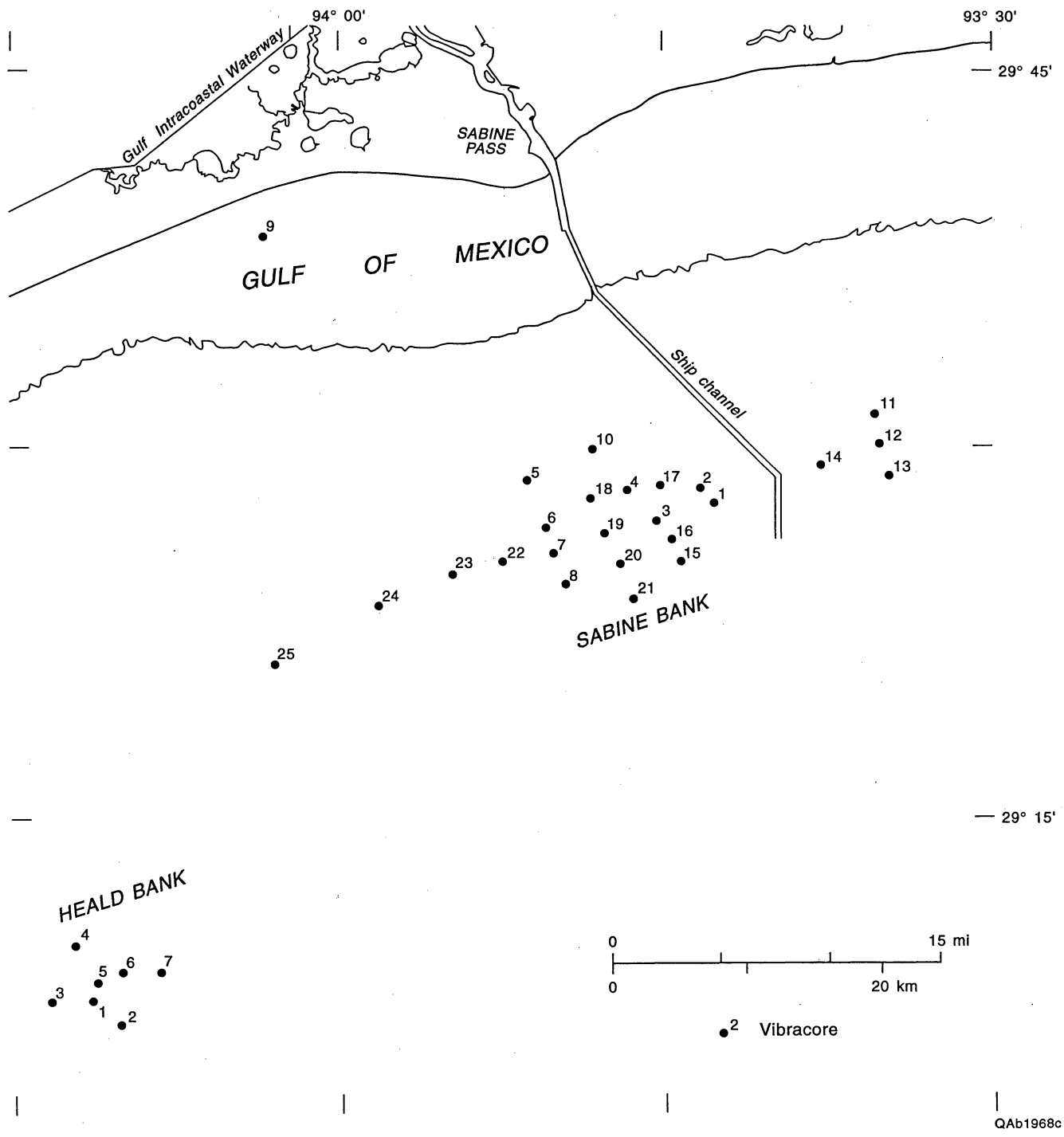


Figure 1. Locations of vibracores collected from Sabine Bank and Heald Bank.

Fourth, the study examined if sand extraction will significantly alter wave propagation and thus possibly accelerate erosion of beaches along the southeastern Texas coast. Finally, the study provided a preliminary cost analysis of mining sand from Heald and Sabine Banks.

One of the primary objectives was to determine the suitability of offshore sand for replenishment of beaches along the southeastern Texas coast. To reach this objective, the following physical attributes were determined for Sabine and Heald Banks: (1) the three-dimensional geometry of the deposits and their approximate volumes; (2) the textural characteristics of the deposits, including composition, grain size, sorting, and lateral and vertical variations; and (3) the degree to which the compositional and textural characteristics of the banks match characteristics of nearby beaches. The detailed sedimentological data provided a basis for calculating sand volume, determining its suitability for beach replenishment, and providing a basis for evaluating the costs of extracting sand from these deposits.

The second phase of the study was designed and organized to (1) obtain vibracores on Heald Bank and to quantify textures of sediments associated with that poorly defined sand deposit, (2) acquire meteorological and oceanographic data near the proposed mining sites as they relate to the physical climate of mining activities and the potential problems that might be encountered because of bad weather, high waves, or strong currents, (3) determine if sand extraction at Sabine and Heald Banks might alter wave refraction patterns and possibly exacerbate erosion of nearby beaches, and (4) estimate the cost of mining and transporting the sand to nearby beaches.

ADDITIONAL INVESTIGATION OF SABINE AND HEALD BANKS

Sources of Data

Vibracores

In addition to the eight vibracores collected during the first phase of study, 24 vibracores (Figure 1) were collected to determine the quality and suitability of the bank deposits for beach replenishment or other construction uses. Coring sites were selected by analyzing and integrating the bathymetric, seismic, and lithologic data that were available from the first phase of the project. Core site criteria included anticipated thicknesses of the sand deposits, seismic characteristics of the sand bodies and underlying reflections, water depth, potential variable mining characteristics (presence or absence of hardgrounds), and any limitations imposed by the vibracoring equipment.

Vibracores were collected using standard aluminum irrigation tubes, which are 6 m long and 7.6 cm in diameter. Each tube is fitted with a brass core catcher and is attached to a pneumatic vibrator head that is part of a rigid steel frame. The frame is lowered by cable to the seafloor where

it rests on four pads. Compressed air rapidly vibrates the head, which drives the core tube into the unconsolidated sediments. A track on the frame guides the vibrator head and keeps the core tube vertical as it penetrates the sediments and is recovered. After the core is retrieved, it is sealed and marked for later processing. Geographic coordinates of the vibracores (Appendix A) were provided by a dual-channel GPS navigation receiver.

Considering both phases of the investigation, a total of 25 vibracores were collected from Sabine Bank and 7 vibracores were taken from Heald Bank (Figure 1). Penetration depths of the vibracores were controlled primarily by sediment composition. Soft mud with only a few scattered and broken shells allowed complete penetration of an entire 6 m core tube. In contrast, well-sorted sand or shelly sand was the most difficult sediment to penetrate. Core tubes encountering these sediments penetrated less than 2 m below the seafloor.

The vibracores were transported to the Core Research Center of the Bureau of Economic Geology in Austin, Texas, where they were inventoried, split into equal halves, trimmed with an osmotic knife, and physically described using standard core description sheets (Appendices B and C). Information recorded on the sheets included core depth, sediment color, sediment type, nature of contacts, textural trends, sedimentary structures, and presence of accessories (organic material, shells). The cores were then photographed (large format color prints and 35 mm slides) and sampled for textural and compositional analyses. The photographed half and sampled half of the core were wrapped in plastic and placed in separate core boxes and are stored in a climate-controlled room. The archived core half serves as a permanent record of the sediment types encountered and the types of material sampled.

Sediment Textures

To assess textural characteristics of the sand deposits and their compatibility with native beach sediments, 120 sediment samples from 32 vibracores were analyzed for gravel, sand, silt, and clay content. Because shell dominates the gravel fraction, the two classifications (size and composition) are used interchangeably in the discussion.

Textural analyses of the cores collected in 1994 were conducted at the Soils and Physical Geography Laboratory at the University of Wisconsin, Milwaukee. A set of standard sieves were used to analyze the sand and gravel fractions, and hydrometer techniques were used to analyze the clay and silt fractions. Numerical and graphical results of the textural analyses are presented in Appendix D.

Data Management

Data generated in conjunction with the sand assessment project are being manipulated and stored in a geographic information system (ARC/INFO) so that archiving and future retrieval will be facilitated. Most Federal and State agencies use a GIS to store locational information and to create maps that superimpose several layers of information. The GIS component of this study anticipates the need for a digital data base so that information can be readily transferred to other users.

Major components of the sand assessment GIS include a digital base map with shoreline features and bathymetry, locations of seismic lines and shotpoints, values for the thickness between the seafloor and ravinement surface, locations of pipelines and platforms, and locations of subsurface lithologic information including foundation borings, cores, and rotary borings, which were compiled from several sources (unpublished data; Nelson and Bray, 1970; Thomas, 1990; this study). Maps showing the locations of seismic profiles, offshore petroleum facilities, and other subsurface data for the Sabine Bank Heald Bank area were presented by Morton and Gibeaut (1993).

SAND RESOURCE ASSESSMENT OF SABINE AND HEALD BANKS

Bank Morphologies

Sabine Bank is delineated by the 10 m isobath. The Bank extends 50 km in a northeast-southwest orientation and is about 7.5 km wide (Figure 1). A few small shoals detached from Sabine Bank exist to the east but are not considered in this study. The shallowest portions of Sabine Bank are on the eastern end between the spoil areas and west of the ship channel. This shoal area is marked by the Sabine Bank lighthouse. Depths are as shallow as 4.5 m but deepen to more than 9 m to the southwest.

The bathymetric map (Morton and Gibeaut, 1993) shows that the 10 m and 8 m isobaths are smooth on the landward side of Sabine Bank relative to the seaward side, and on the eastern part of the bank, the landward side is steeper than the seaward side. On the seaward side, however, the 10 m and especially the 8 m isobaths display a digitate configuration oriented southeast-northwest, which is normal to the alignment of the long axis of the Bank. The 6 m isobath outlines small shoals, which are aligned normal to the axis of the Bank, on top of the eastern half of the Bank.

On the Louisiana inner shelf, near the filled former incised valley of the Calcasieu River, the eastern extension of Sabine Bank trends almost 90° to the main axis of sand body. This abrupt

change in orientation is easy to explain in terms of former shoreline deposits when sea level was lower, but it is difficult to explain using only alongshelf currents and a depositional model that requires complete subtidal deposition.

Heald Bank (Figure 1) is 27 km southwest of Sabine Bank and 55 km southeast of the Entrance to Galveston Harbor. Heald Bank is not as well defined as Sabine Bank and has a relatively small area that is shallower than 10 m. The 14-m isobath encloses a much larger area extending 30 km to the southwest from the eastern shallow areas. The 10 m isobath encloses two irregularly shaped areas with no particular orientation.

Scour Depths

To understand sand bank evolution and the history of the bank deposits, it is necessary to distinguish between sedimentary features that are related to modern processes and bank reworking as compared to paleo sedimentary features that originated when the banks first formed. Many of the cores from Sabine and Heald Banks exhibit upward-fining textures in the upper few meters (Appendices B, C, and D). The upward-fining patterns are characterized by distinct erosional bases overlain by gravel-size clasts of whole and broken shell that grade into shelly sand and sand with only minor amounts of finely broken shell. These cyclical textural patterns are interpreted as shelf storm deposits and the products of modern shelf processes.

The depth to the base of scour depends partly on water depth (Figure 2) and partly on lithology of the underlying sediments. Position on the bank surface (crest or margins) is less important than water depth in controlling scour depth. Wave and current scour greater than 1.5 m is observed where the upper part of the bank is composed of sand, and water depths are less than 10 m. These relatively shallow water depths also coincide with the bank crest. Where water depths exceed 11 m and the sediments are muddy, scour is minimized and essentially no storm deposits are preserved.

Primary Bank Lithofacies

Our initial study (Morton and Gibeaut, 1993) identified six lithofacies that characterize sediments within and around Sabine and Heald Banks (Appendices B and C). The lithofacies, which were identified from detailed descriptions of the vibracores, are fine sand (A), shelly sand and gravel (B), slightly muddy sand (C), muddy sand (D), sandy mud (E), and organic clay (F). Each lithofacies exhibits different sediment compositions, sediment textures, and preserved fauna. Also each lithofacies occupies a predictable stratigraphic position within the vertical succession of lithofacies. The superposition of lithofacies describes an overall upward-coarsening facies

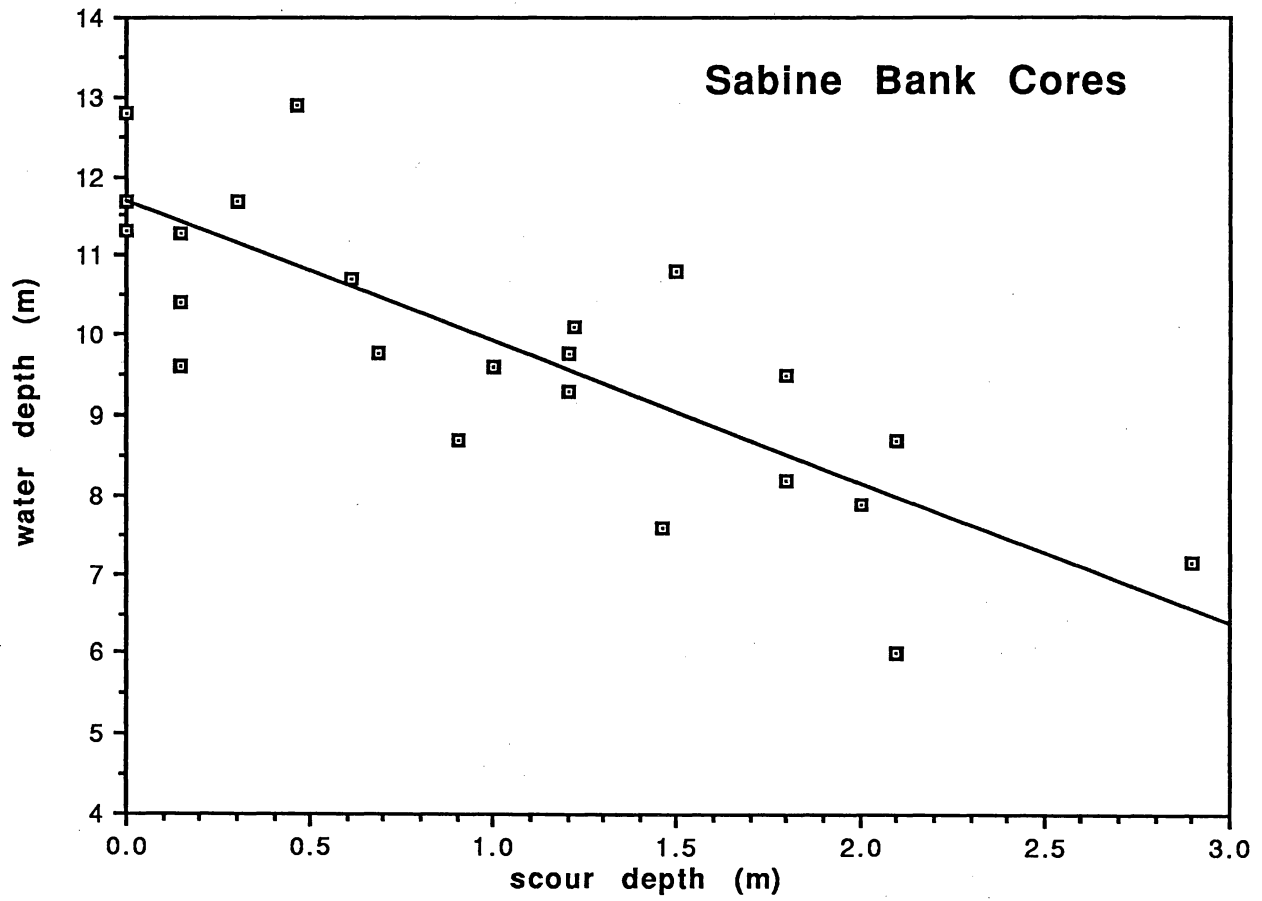


Figure 2. Relationship between water depth and depth of storm wave scour in sediments of Sabine Bank.

architecture with progressively more sand and less mud from bottom to top. The attributes of each lithofacies are described in detail by Morton and Gibeaut (1993).

Overview of Sand Quality

Sand quality of the banks was evaluated using two methods that differed in detail and scale of the analysis. The large-scale method considered the relationship between sedimentary facies of the banks determined from the core descriptions and sediment textures derived from the grain-size analyses. Quantitative textural analyses (Appendix D) were performed on 120 samples taken from the 32 vibracores obtained for this study. There is good correspondence between the textural data and the qualitative facies descriptions (Morton and Gibeaut, 1993). This agreement provided a mechanism for extrapolating the textural data to sections of the cores that lacked textural analyses. However, qualitative (visual) estimates of shell content based on core descriptions do not agree closely with quantitative measurements from sieve analyses. In fact, the visual estimates of shell content are consistently higher than the actual measurements. This discrepancy did not interfere with evaluations of sand quality. The second method of evaluating sand quality relied just on textural analyses from the upper 2 m of core. This small-scale, more detailed evaluation of sand quality considered the depth of dredging that would likely occur on the banks in order to optimize sand content in the dredged material.

The fine sand, shelly sand and gravel, and slightly muddy sand facies (facies A, B, and C) generally contain less than 15% mud and range in mean grain size from 0.75 ϕ to 2.98 ϕ (0.13 mm to 0.59 mm). The fine sand and slightly muddy sand facies are moderately well to poorly sorted, whereas the shelly sand and gravel is poorly to very poorly sorted. These are the coarsest facies in the Sabine Bank area, and mean grain size within and between these facies is primarily a function of the relative amounts of coarse shell material and mud.

The muddy sand and sandy mud facies (facies D and E) contain considerably more mud than overlying facies. The muddy sand averages 23% mud and ranges from 14 to 34% mud, whereas the sandy mud facies averages 48% mud and ranges from 24 to 71% mud. The mud fraction in both facies is dominated by clay-size material. The average mean grain sizes of the muddy sand and sandy mud are 4.29 ϕ (0.05 mm) and 5.70 ϕ (0.02 mm), respectively. Both facies are very poorly sorted partly because the sediments are highly bioturbated.

The finest grained facies is the organic clay (facies F), which occurs at the bottom of the sedimentary sequence. Four samples from different cores (3 Sabine Bank, 1 Heald Bank) analyzed for this facies yielded very similar textural values with 91 to 95% mud.

The available compositional and textural data indicate that the sand deposits associated with Sabine Bank and Heald Bank are compatible with the beach sediments of the southeastern Texas

coast (Morton et al., 1995). Beach replenishment using the fine sand, shelly sand, slightly muddy sand, and muddy sand facies (facies A, B, C, and D) would require only moderate overfill ratios. The sandy mud and organic clay facies (facies E and F), however, are not appropriate for beach replenishment.

Overview of Sand Quantity

Revised estimates of sand volume in Sabine and Heald Banks used the three-dimensional geometry of the sand deposits as determined by nearsurface lithology and bathymetry. Nearsurface lithology, provided primarily by the vibracores, delineated the lateral extent of sand as well as the thickness of sand and any overburden (Table 1). Bathymetry also was used to help define the lateral extent of sand in those areas where core control was not available.

Both Sabine and Heald Banks are lenticular sand bodies that cover large areas (Figures 3-10). Revised estimates of sand volume based on all vibracores indicate that together the banks contain about 1.8 billion m³ of sand, shelly sand, and muddy sand. Within the overall trends of sand deposits are elongate lenses where sand and muddy sand deposits more than 3 m thick are concentrated (Table 1). These elongate lenses would be the optimum sites for sand extraction because sand concentrations are relatively high. The distribution of sand associated with Heald Bank is not well defined, and it does not coincide just with the bathymetric highs but extends far beyond the small irregular shoals defined by the 10-m isobath (Morton and Gibeaut, 1993).

Sediments of Sabine Bank

Sand Quality

Most of the vibracores collected for this study, and consequently most of the textural analyses, are from Sabine Bank (Figure 1, Appendix D). Examination of sediment textures in the upper 2 m of core from Sabine Bank shows that sediments generally are composed of more than 91% sand. Shallow shelf sediments containing low concentrations of sand (high concentrations of mud) are located in relatively deep water and around the margins of the banks at sites such as vibracore locations 5, 10, 11, 13, and 15 (Figure 1).

Locally high concentrations of shell found in vibracores 2, 7, 12, 14, 16, 20, 21, and 25 range from 26 to 71% of the sediment sample. These sites of high shell concentration also generally coincide with physical settings that are subjected to relatively high wave energy such as the crest or seaward flank of Sabine Bank. The shelly sand facies in Sabine Bank probably consists of lenses representing less than 12 percent of the total sand facies (Table 1); therefore, locally high shell concentrations should not limit the use of the sand resource for beach nourishment.

Table 1. Thickness of sand facies in each vibracore from Heald Bank (HB) and Sabine Bank (SB).

Core	Sand (m)	Shelly Sand (m)	Muddy Sand (m)	Total (m)
SBV - 1	1.6	0.3	0.8	2.7
SBV - 2	1.3	1.4	0.0	2.7
SBV - 3	1.6	0.2	0.3	2.1
SBV - 4	1.7	0.2	1.6	3.5
SBV - 5	0.0	0.0	2.9	2.9
SBV - 6	1.7	0.3	2.6	4.6
SBV - 7	0.7	0.3	3.4	4.4
SBV - 8	0.9	0.2	3.4	4.5
SBV - 9	0.0	0.0	0.0	0.0
SBV - 10	0.0	0.0	2.1	2.1
SBV - 11	0.3	0.0	1.4	1.7
SBV - 12	2.8	0.8	1.2	4.8
SBV - 13	0.3	0.0	3.2	3.5
SBV - 14	1.1	0.0	1.5	2.6
SBV - 15	0.3	0.0	0.8	1.1
SBV - 16	0.4	0.8	1.5	2.7
SBV - 17	3.4	1.1	0.0	4.5
SBV - 18	3.0	0.0	2.6	5.6
SBV - 19	1.3	0.0	1.1	2.4
SBV - 20	1.4	0.2	0.0	1.6
SBV - 21	0.0	0.4	0.3	0.7
SBV - 22	1.3	0.1	3.5	4.9
SBV - 23	0.5	0.5	4.8	5.8
SBV - 24	0.0	0.5	2.4	2.9
SBV - 25	0.6	0.3	4.1	5.0
HBV - 1	1.5	1.3	0.0	2.8
HBV - 2	1.5	0.1	0.6	2.2
HBV - 3	2.2	0.0	1.8	4.0
HBV - 4	0.8	0.0	0.9	1.7
HBV - 5	4.3	1.8	0.0	6.1
HBV - 6	3.1	0.2	0.0	3.3
HBV - 7	1.5	0.3	0.6	2.4

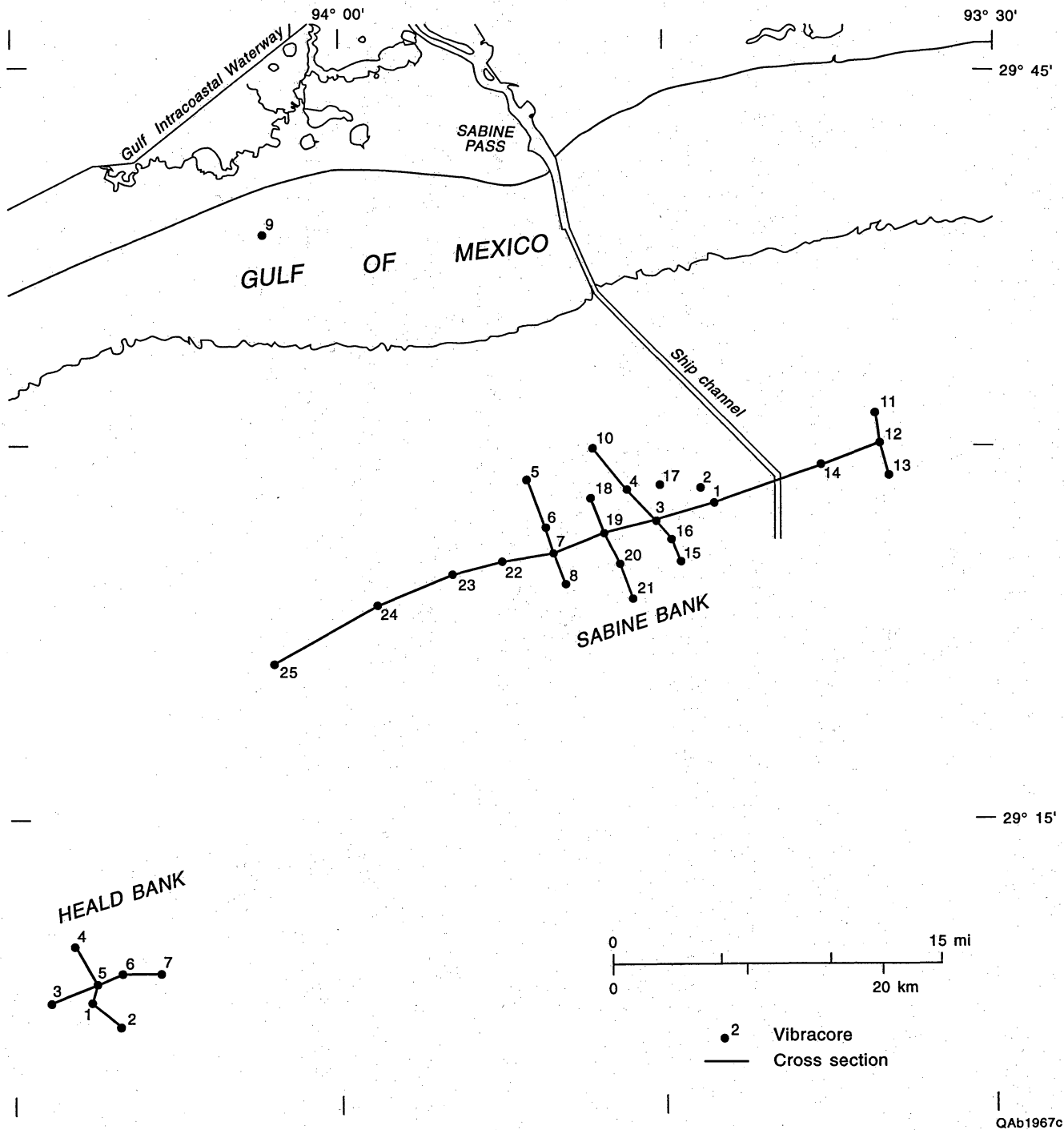


Figure 3. Locations of stratigraphic cross sections illustrating lithofacies associated with Sabine and Heald Banks.

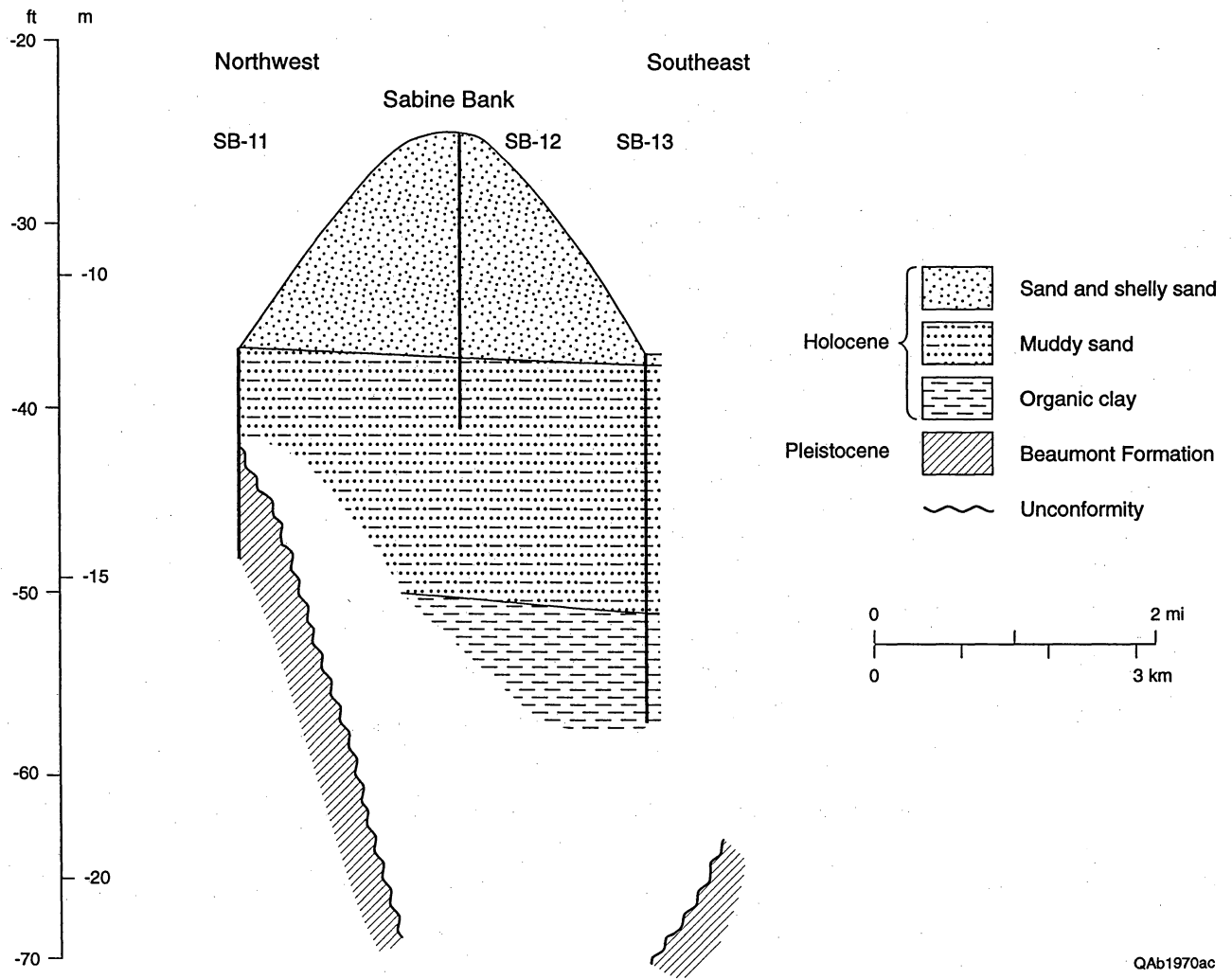


Figure 4. Stratigraphic dip section across eastern end of Sabine Bank.

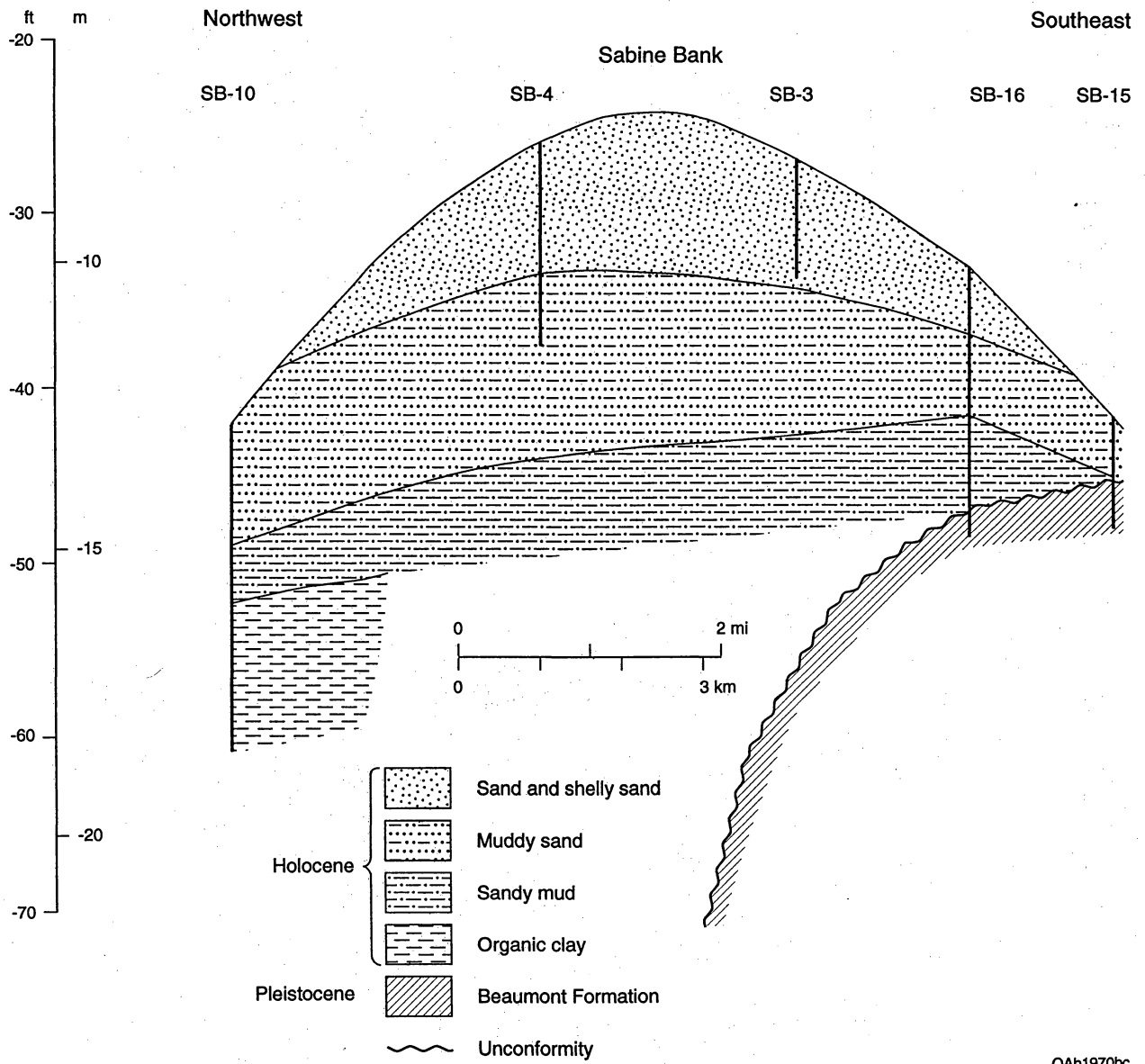


Figure 5. Stratigraphic dip section across middle of Sabine Bank.

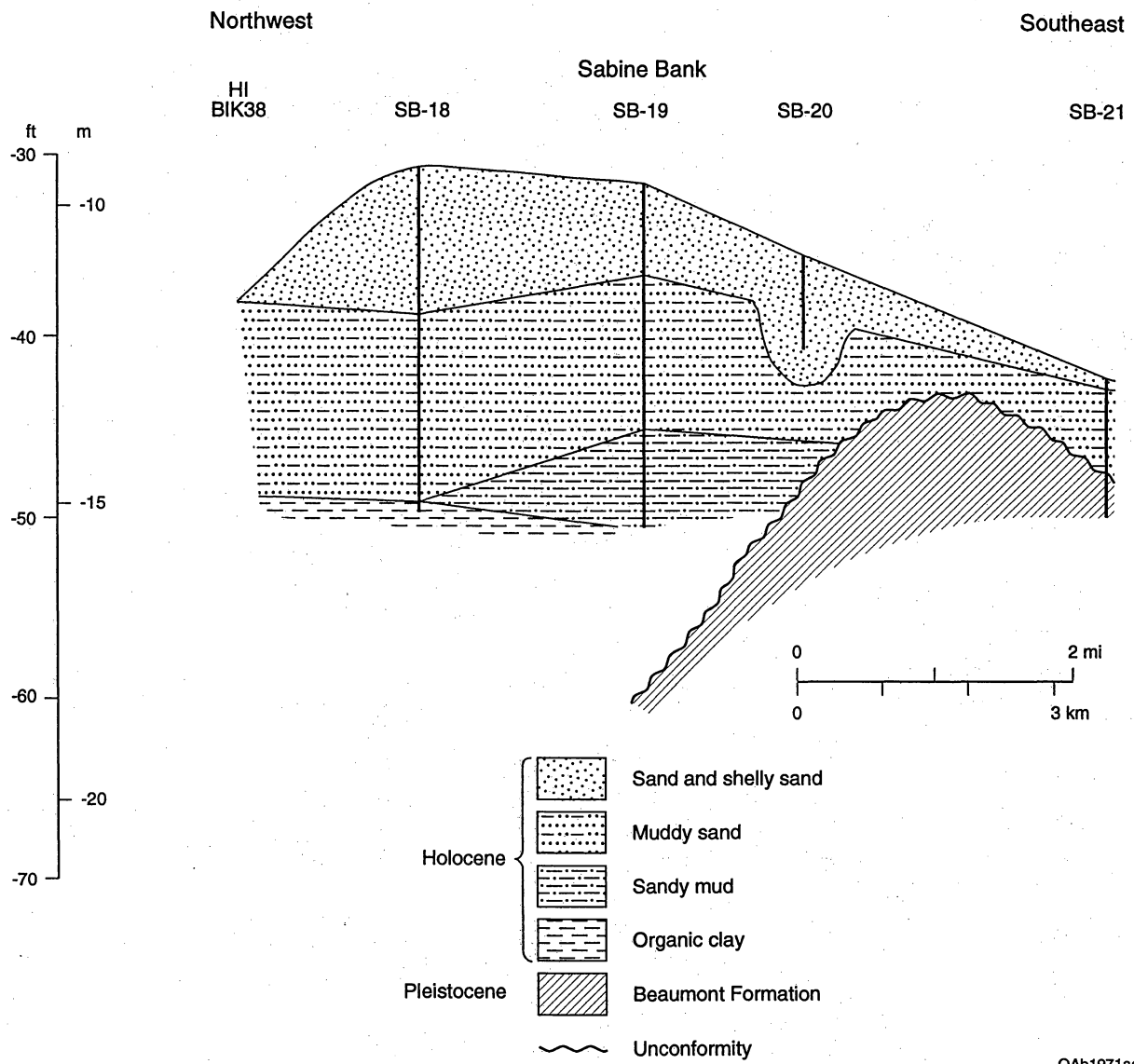


Figure 6. Stratigraphic dip section across middle of Sabine Bank.

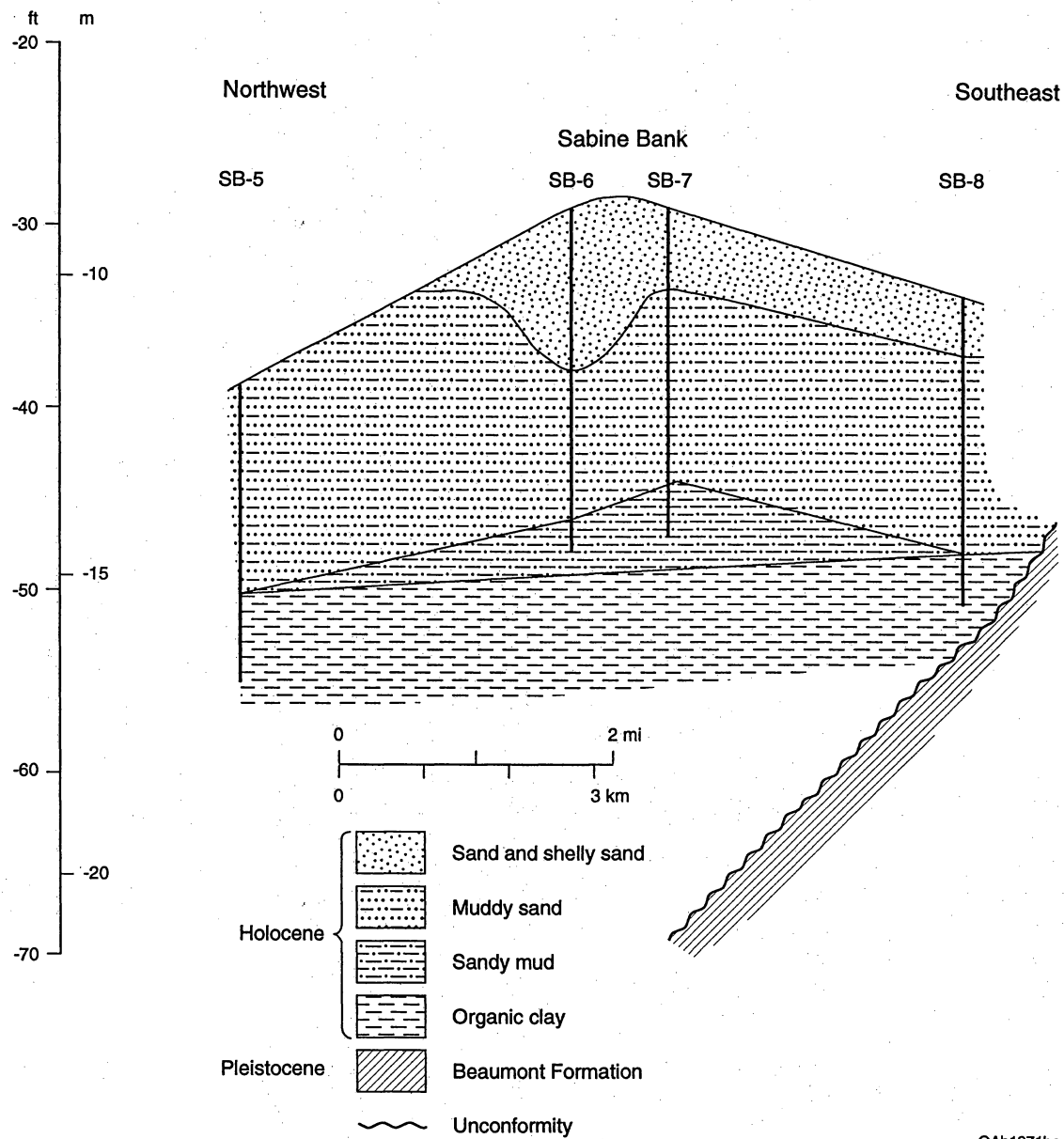
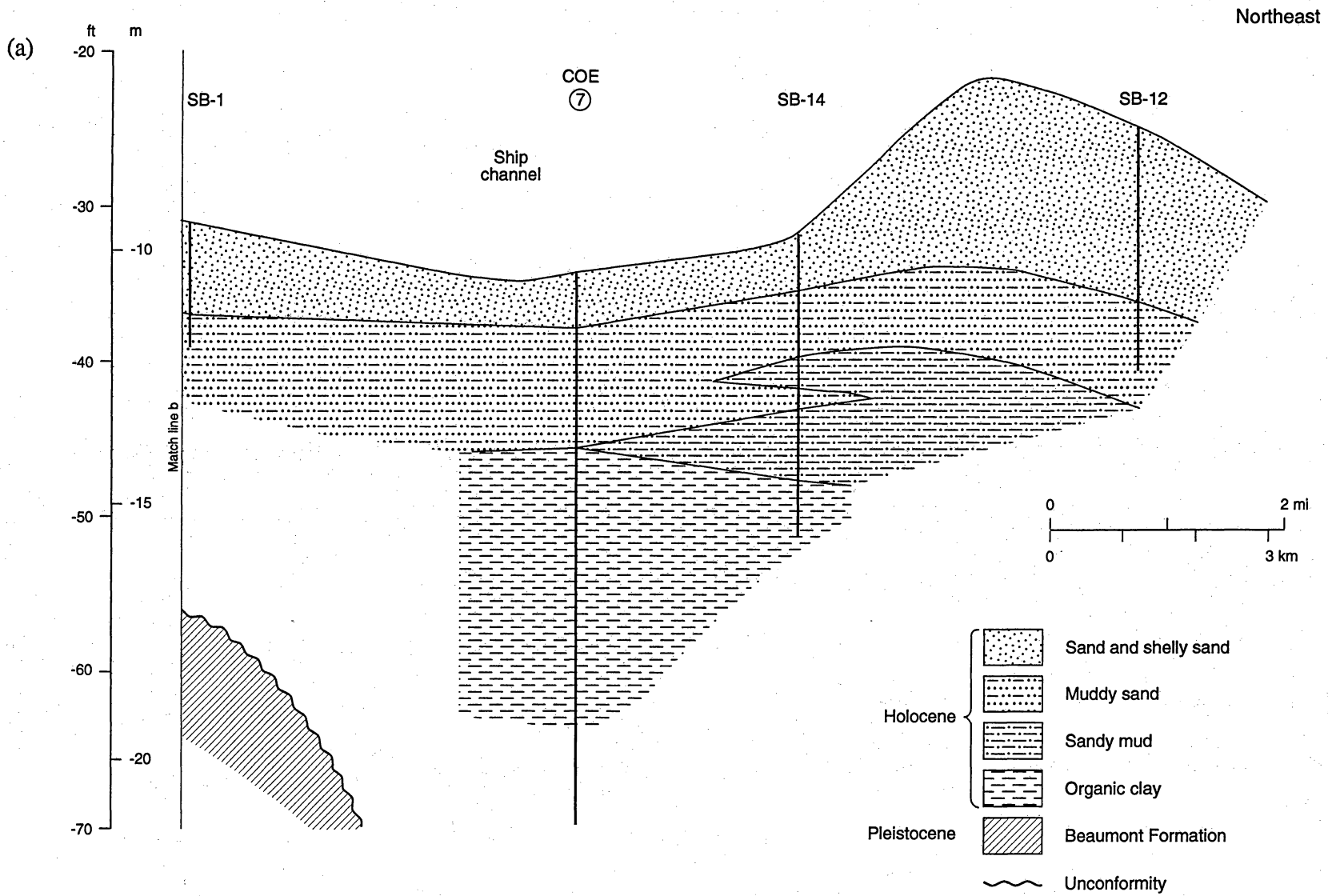


Figure 7. Stratigraphic dip section across middle of Sabine Bank.



QAb1972cc

Figure 8. Stratigraphic strike section along middle of Sabine Bank, (a) eastern, (b) central, and (c) western sections.

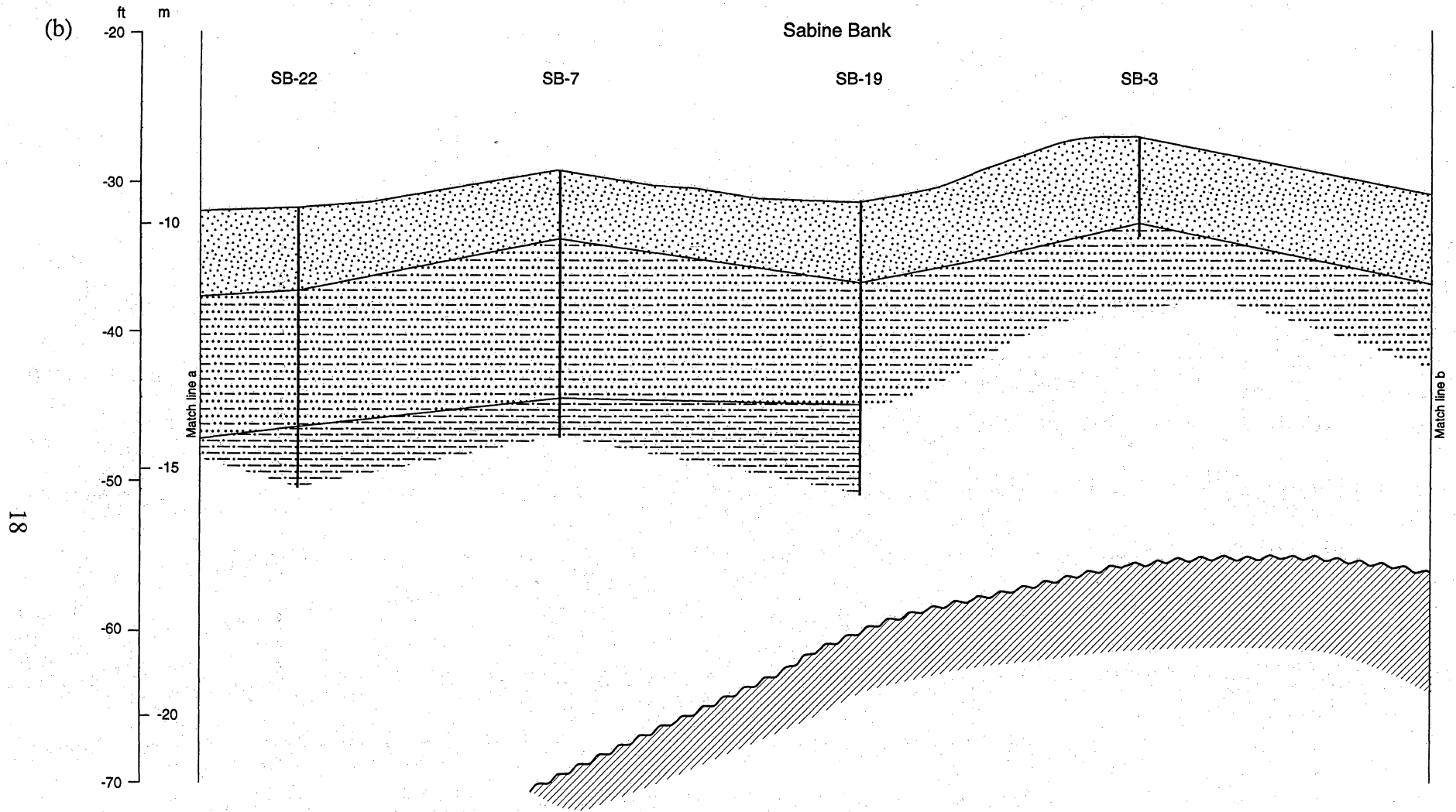


Figure 8. (cont.)

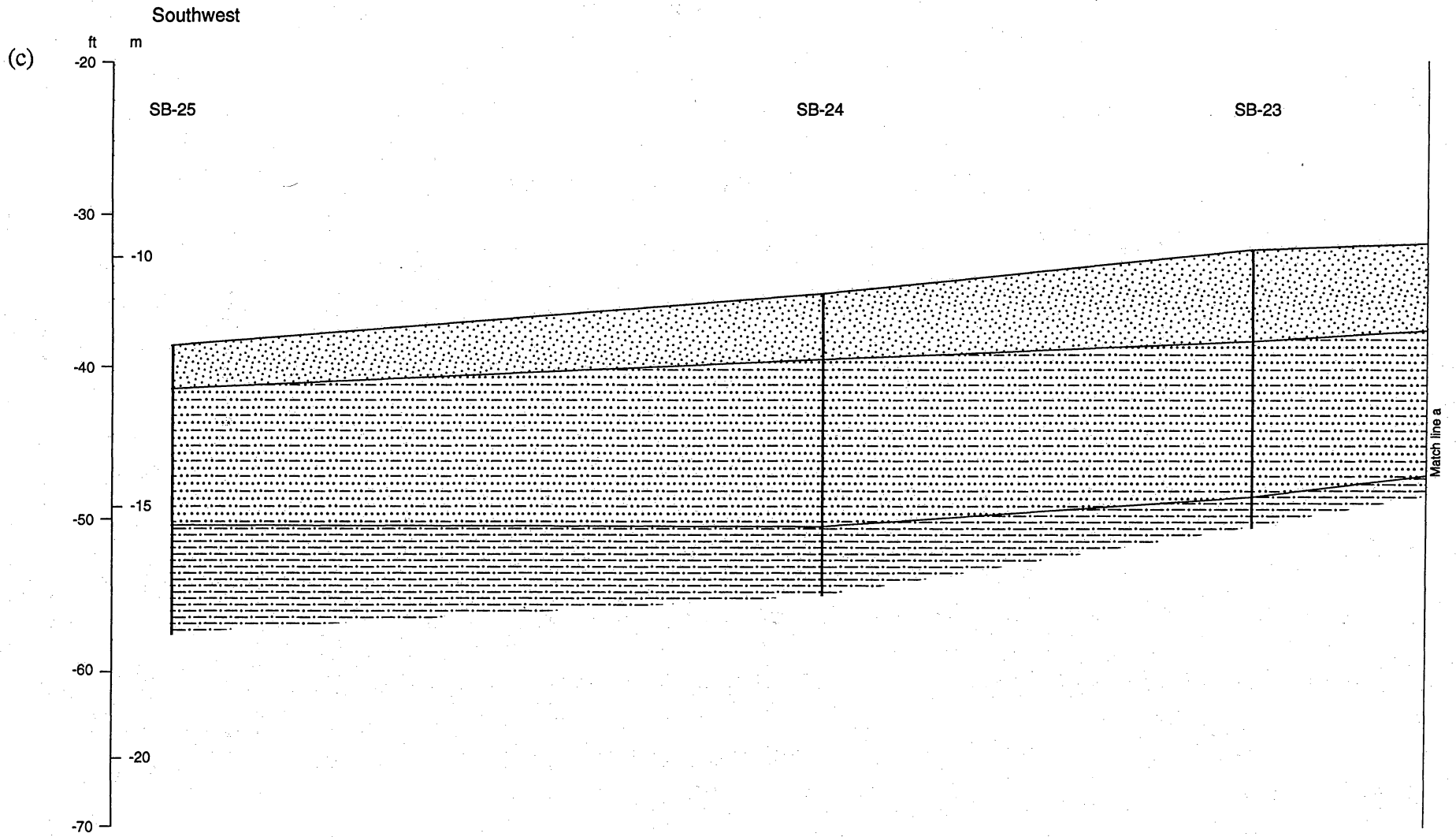


Figure 8. (cont.)

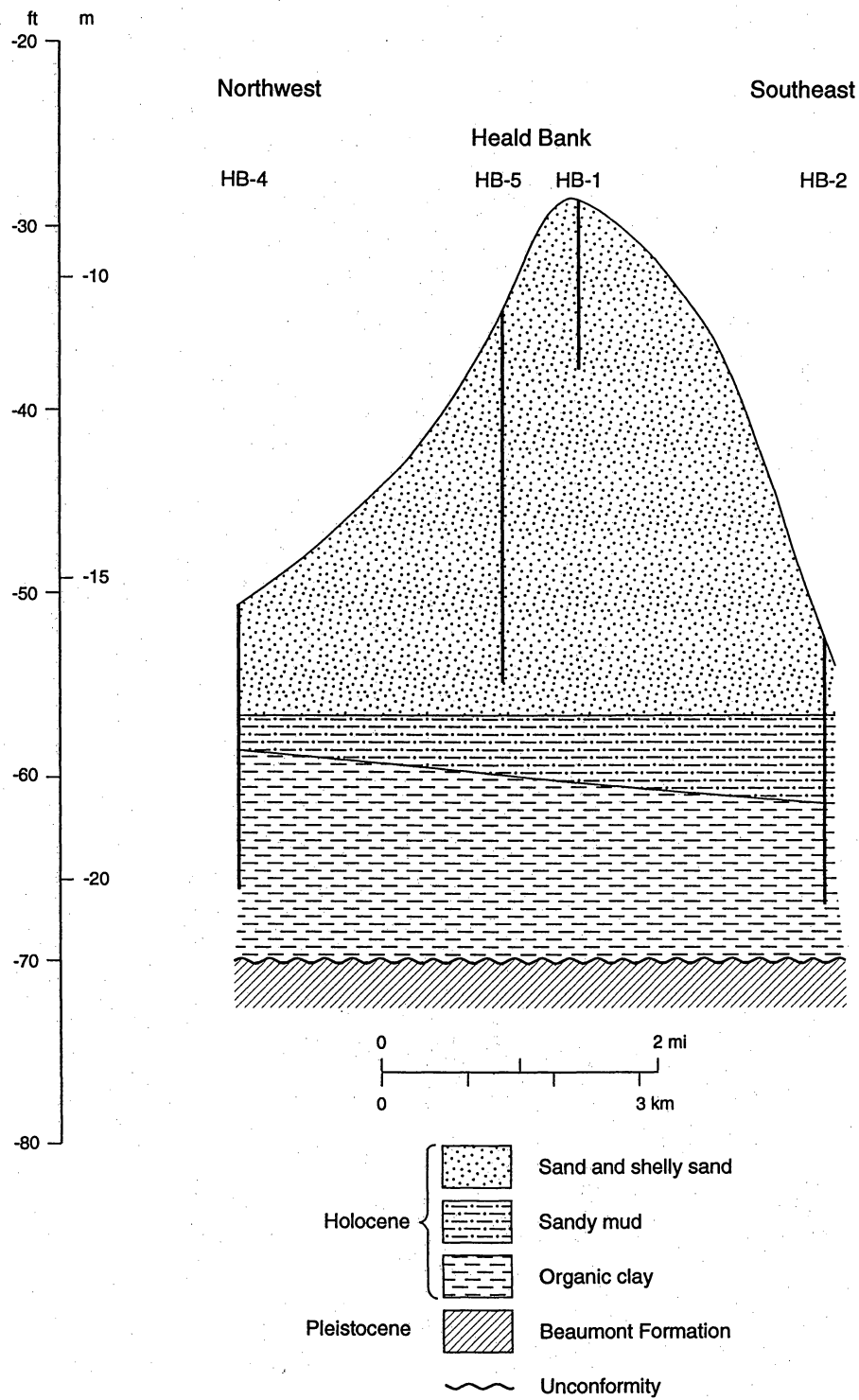


Figure 9. Stratigraphic dip section along middle of Heald Bank.

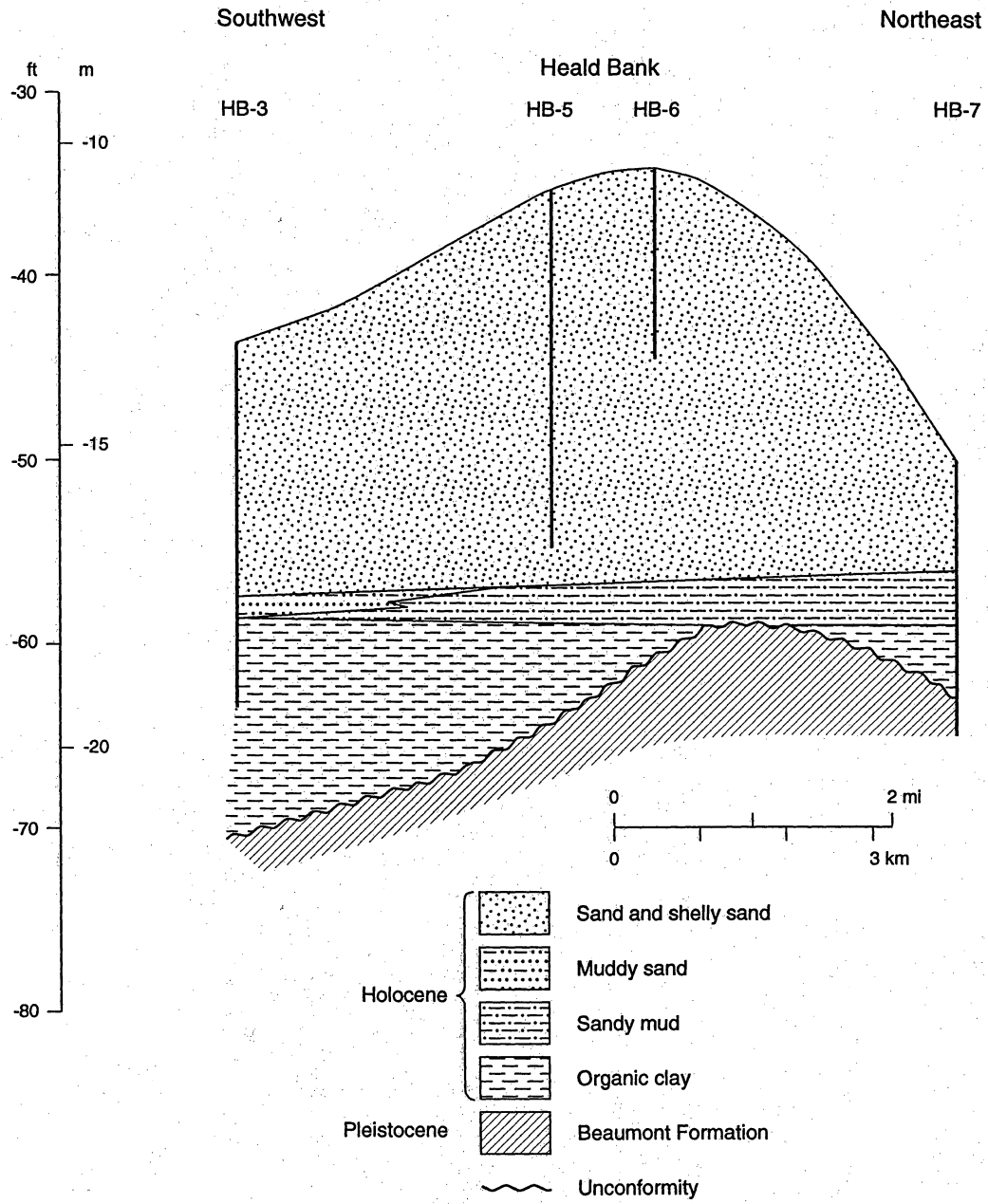


Figure 10. Stratigraphic strike section along middle of Heald Bank.

Sand Quantity

The total volume of sand, shelly sand, and muddy sand estimated for Sabine Bank in Texas is about 1.2 billion m³. This estimate is based on an average sand-body length of 50 km, an average sand-body width of 7.5 km, and an average sand thickness of 3.3 m. Of this total sand facies that makes up Sabine Bank, about 562 million m³ is sand and shelly sand with an average thickness of about 1.5 m (Table 1).

Sediments of Heald Bank

Sand Quality

Textural analyses of sediment samples from Heald Bank (Appendix D) indicate uniformly good sand quality. Nearly all samples from the upper 2 m of the Bank contain more than 95% sand. Most sediment samples contain less than 5% shell, and only one sample contained 11% shell. When the thicknesses of sand facies (Table 1) are used to estimate shell concentrations in the Bank deposits, the shelly sand facies represents from 0 to 46% of the total sand facies in Heald Bank sediments. However, most of the vibracores from Heald Bank contain less than 12% shelly sand facies compared to the total sand facies. Considering that the shell material is generally dispersed in Heald Bank and not in thick concentrations (Appendix E), the shell content should not limit the use of the sand resource for beach nourishment.

Sand Quantity

The total volume of sand, shelly sand, and muddy sand estimated for Heald Bank is approximately 585 million m³. This estimate is based on an average sand-body length of 13.5 km, an average sand-body width of 13.5 km, and an average sand thickness of 3.2 m. Of this total sand facies that makes up Heald Bank, more than 458 million m³ is sand and shelly sand with an average thickness of about 2.5 m (Table 1).

WAVE REFRACTION ANALYSIS, SABINE AND HEALD BANKS

A preliminary analysis was conducted of potential wave transformation that might occur if large volumes of sand were dredged from the crest of Sabine and Heald Banks. Results of these analyses were compared with extant wave conditions to determine if wave energy would be

significantly altered as a result of sand mining. Nine cases of wave refraction were considered (Table 2). Each case evaluated the differences in wave height between existing water depths and altered water depths over Sabine Bank. The first seven cases analyzed average conditions for waves propagating from easterly to southwesterly directions, the eighth case analyzed average conditions for all onshore waves, and the ninth case was a special case that considered storm waves generated by Hurricane Alicia.

Model Parameters and Input

The wave refraction analysis was designed to address environmental concerns regarding possible increased erosion of beaches adjacent to the proposed mining sites. To accomplish this, the Regional Coastal Processes Wave (RCPWAVE) Propagation Model (Ebersole et al., 1986) was applied to the region offshore of the southeastern Texas coast (Figures 11-23). This is the same model that was used by Byrnes and Patnaik (1991) to investigate potential wave transformation over Ship Shoal. The Waterways Experiment Station of the U.S. Army Corps of Engineers developed RCPWAVE to predict natural and human-induced coastal change across an extensive length of shoreline. RCPWAVE can predict linear, plane wave propagation over a coastal region with varying bathymetry. The model does not include nonlinear effects, and wave input is monochromatic. RCPWAVE was modified to run on a SUN 1000 workstation. It was also modified to provide output suitable for input into the CPS-3 mapping and contouring program (Schlumberger GeoQuest 1994) for graphical display of the results.

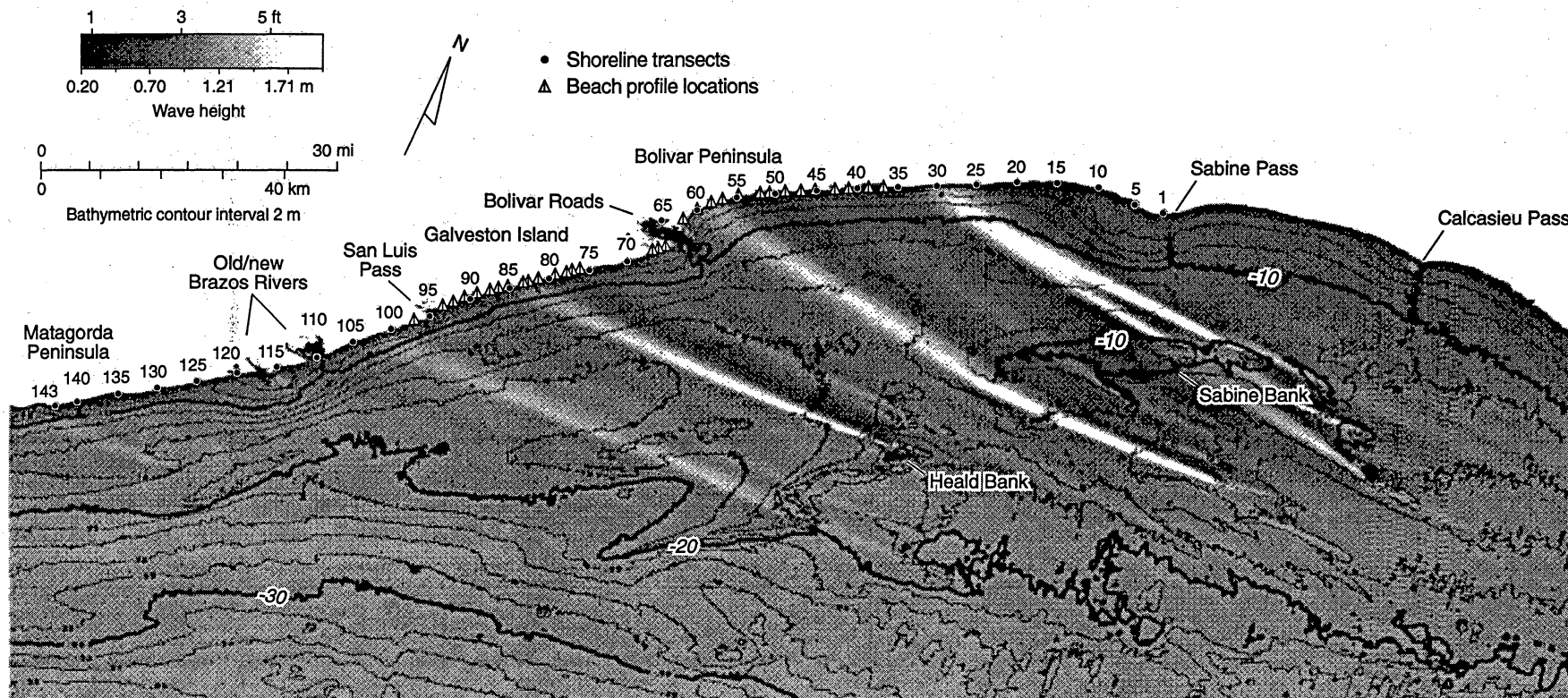
RCPWAVE is well suited to measure the effects that mining Sabine and Heald Banks may have on wave patterns. Because these banks are up to 50 km offshore, a large area must be considered in the wave model. This analysis includes the southeastern Texas coast between the Calcasieu River (Louisiana) on the east and Matagorda Peninsula on the west. Using CPS-3 mapping software, we developed a rectilinear bathymetric grid covering this area that is 300 km in the alongshore direction and 100 km in the offshore direction out to depths of 30 m. The grid is not smoothed, and cells measure 500 m alongshore and 125 m normal to shore forming a grid with 600 by 800 cells.

Two types of data are required for the wave transformation analysis: wave climate and bathymetry. Digital bathymetric data used to construct the grid were obtained from the National Geophysical Data Center through the U.S. Geological Survey in St. Petersburg, Florida. Bathymetry data were compiled from a combination of surveys dating from the 1930's to the 1970's. Care was taken to use the latest data available from the National Oceanographic and Atmospheric Administration for a particular area.

Table 2. Wave parameters used in model runs displayed in figures 1 through 9. Hs= significant wave height, WIS= Wave Information Study. Frequency is percent occurrence of all waves approaching from 78.75 to 236.25 degrees.

Case	Height (m)	Period (s)	True direction	Frequency	Comments
1	1.2	5.4	90.0	12.1%	Mean Hs and mean period for wave directions in a 22.5 degree arc centered around 90 degrees; WIS station #12
2	1.1	5.6	112.5	17.4%	Mean Hs and mean period for wave directions in a 22.5 degree arc centered around 112.5 degrees; WIS station #12
3	1.2	6.1	135.0	35.5%	Mean Hs and mean period for wave directions in a 22.5 degree arc centered around 135 degrees; WIS station #12
4	1.4	6.1	157.5	23.5%	Mean Hs and mean period for wave directions in a 22.5 degree arc centered around 157.5 degrees; WIS station #12
5	1.2	5.7	180.0	8.1%	Mean Hs and mean period for wave directions in a 22.5 degree arc centered around 180.0 degrees; WIS station #12
6	1.1	5.3	202.5	2.4%	Mean Hs and mean period for wave directions in a 22.5 degree arc centered around 202.5 degrees; WIS station #12
7	1.0	5.1	225.0	1.1%	Mean Hs and mean period for wave directions in a 22.5 degree arc centered around 225 degrees; WIS station #12
8	1.2	5.8	131.0	N/A	Mean Hs and mean period for wave directions between 33.75 and 259.75 degrees true; WIS station #12
9	2.0	8.5	135.0	N/A	Estimated Hurricane Alicia conditions from CERC-84-6 Tech. Rpt. Data from Shell Oil platform (Vermillion 22, 25 ft deep). Hs and period are measured but directions are absent other than statement of predominantly southeast waves, therefore used southeast compass direction for model.

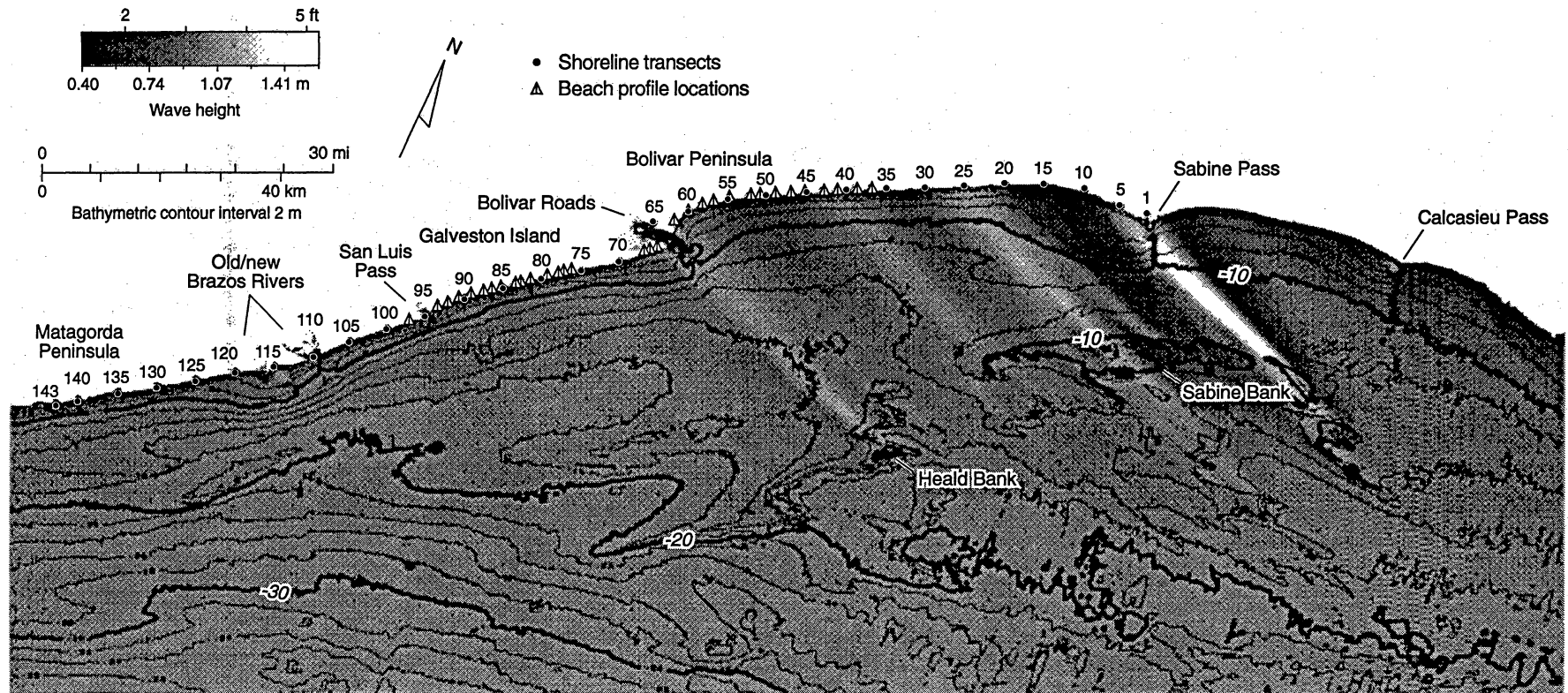
Case 1



QAb1782c

Figure 11. Bathymetry and wave heights for case 1 wave conditions: height= 1.2 m; period= 5.4 s; direction= 90°.

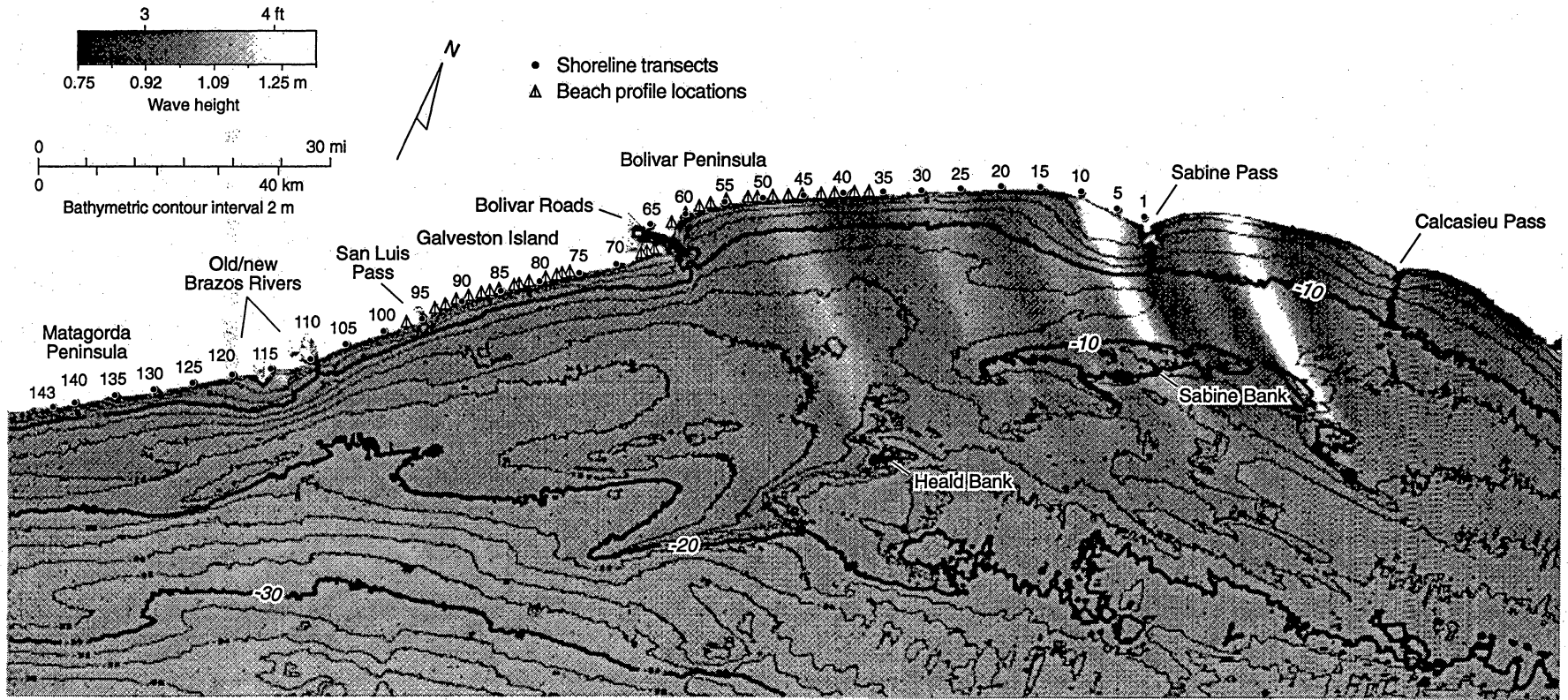
Case 2



QAb1783c

Figure 12. Bathymetry and wave heights for case 2 wave conditions: height= 1.1 m; period= 5.6 s; direction= 112.5°.

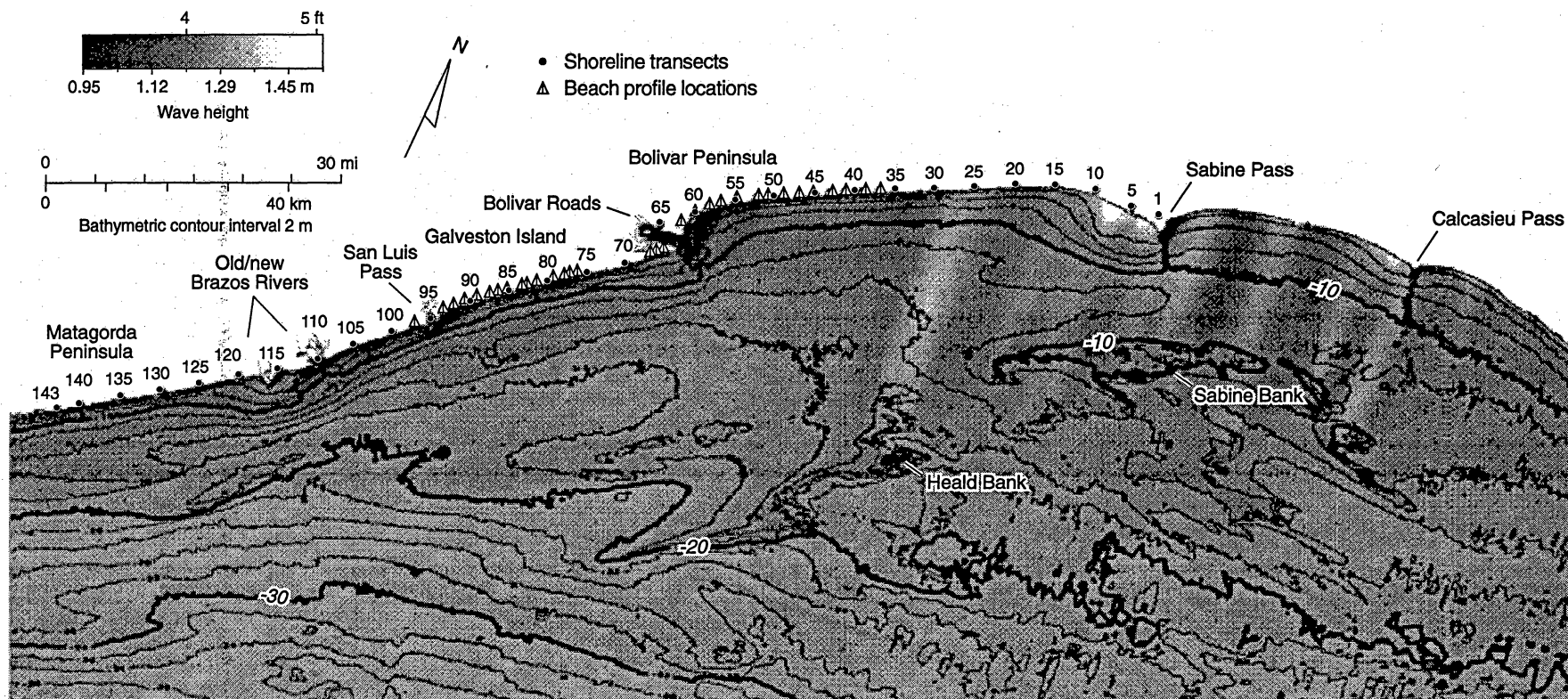
Case 3



QAb1784c

Figure 13. Bathymetry and wave heights for case 3 wave conditions: height= 1.2 m; period= 6.1 s; direction= 135°.

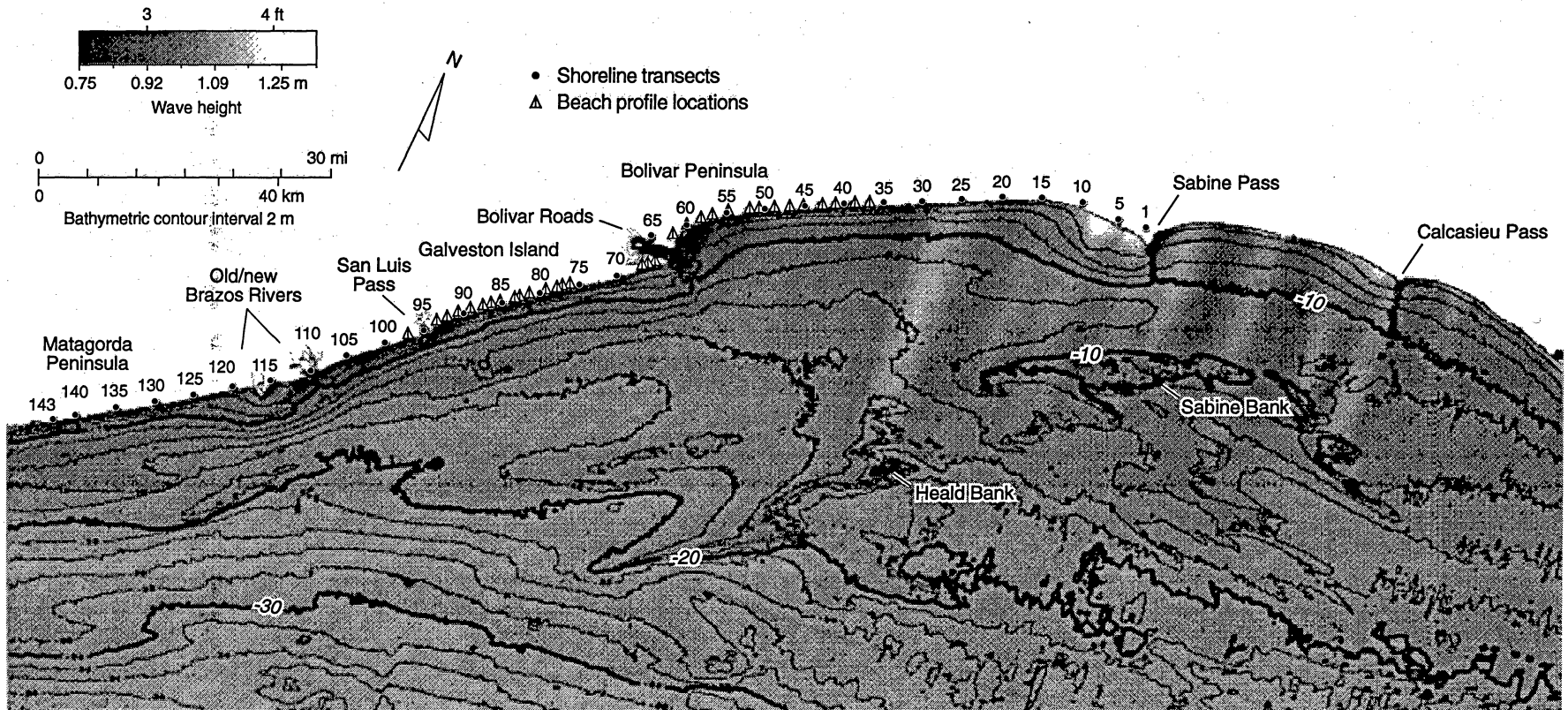
Case 4



QAb1802c

Figure 14. Bathymetry and wave heights for case 4 wave conditions: height= 1.4 m; period= 6.1 s; direction= 157.5°.

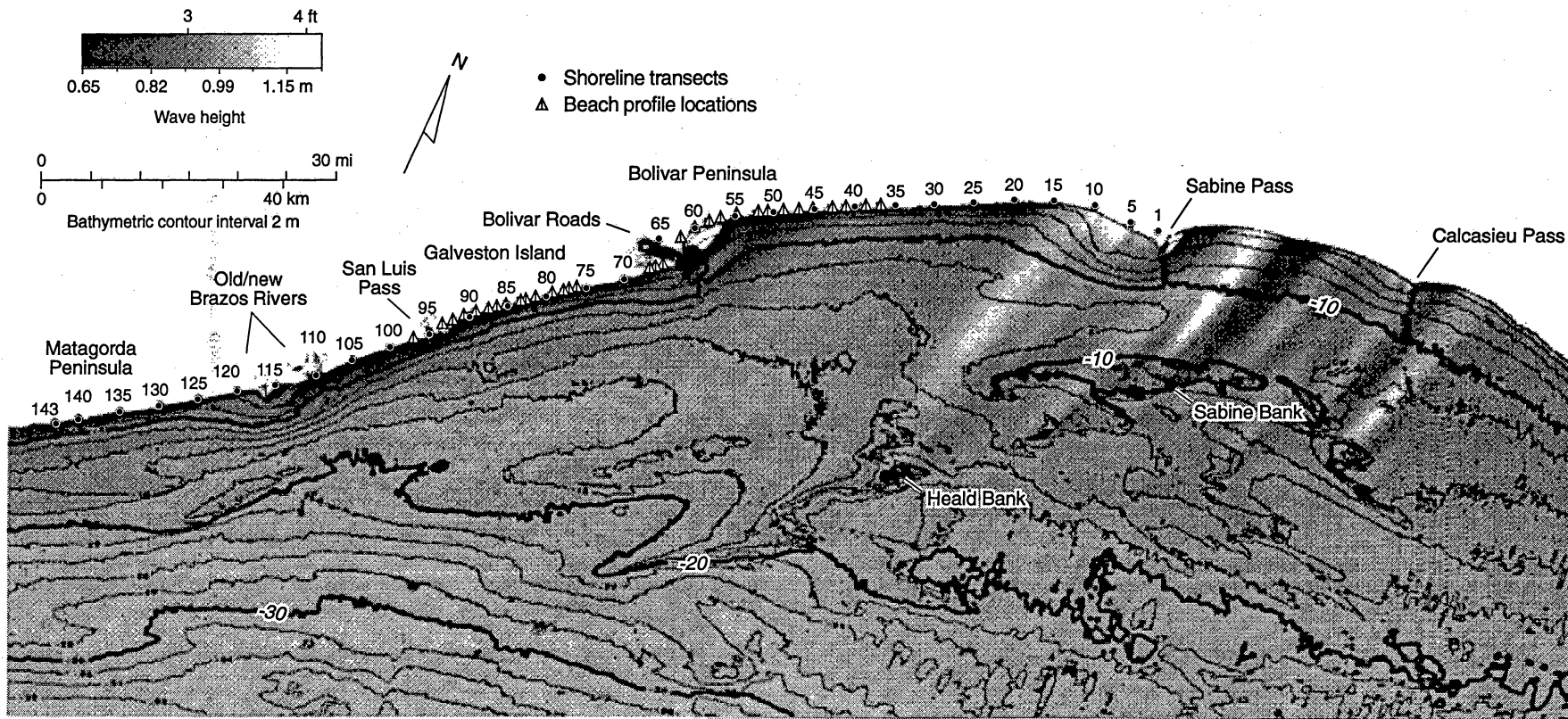
Case 5



QAb1803c

Figure 15. Bathymetry and wave heights for case 5 wave conditions: height= 1.2 m; period= 5.7 s; direction= 180°.

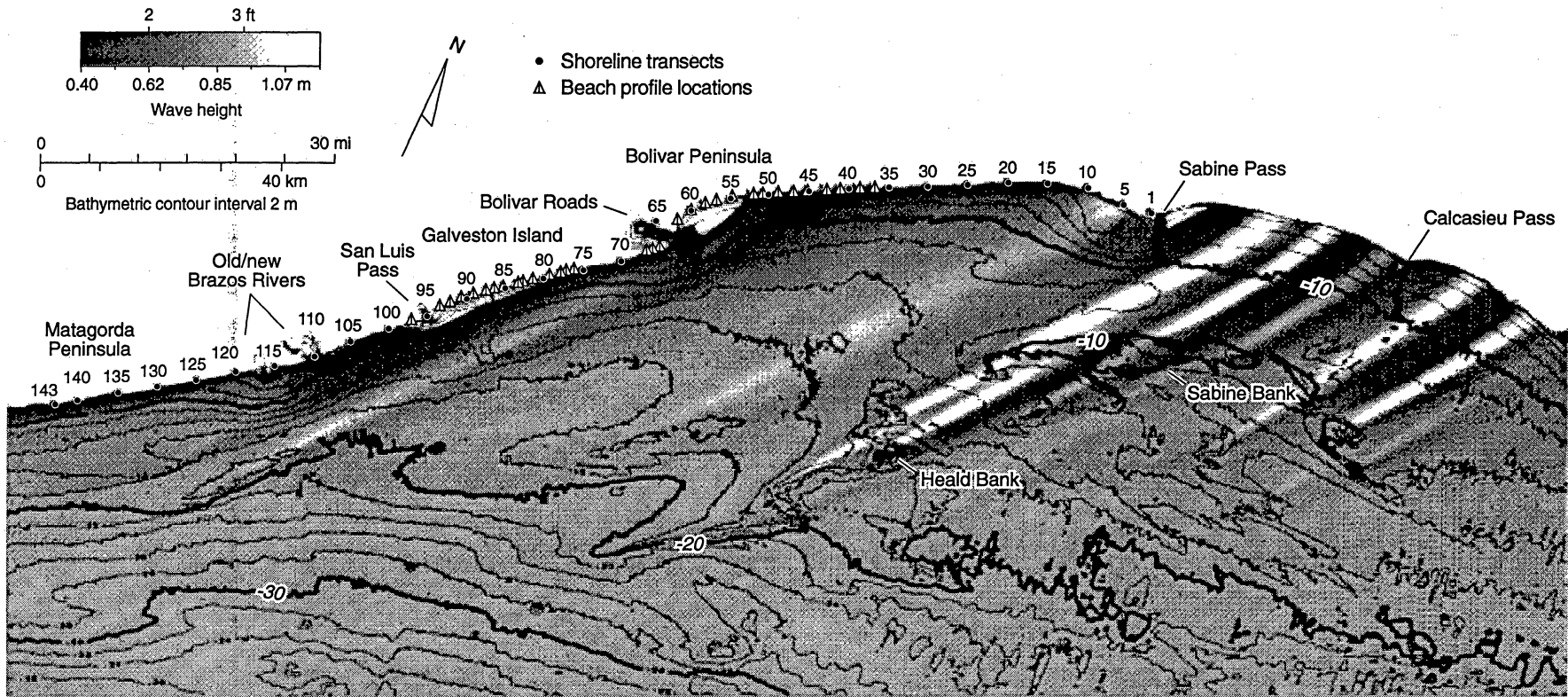
Case 6



QAb1804c

Figure 16. Bathymetry and wave heights for case 6 wave conditions: height= 1.1 m; period= 5.3 s; direction= 202.5°.

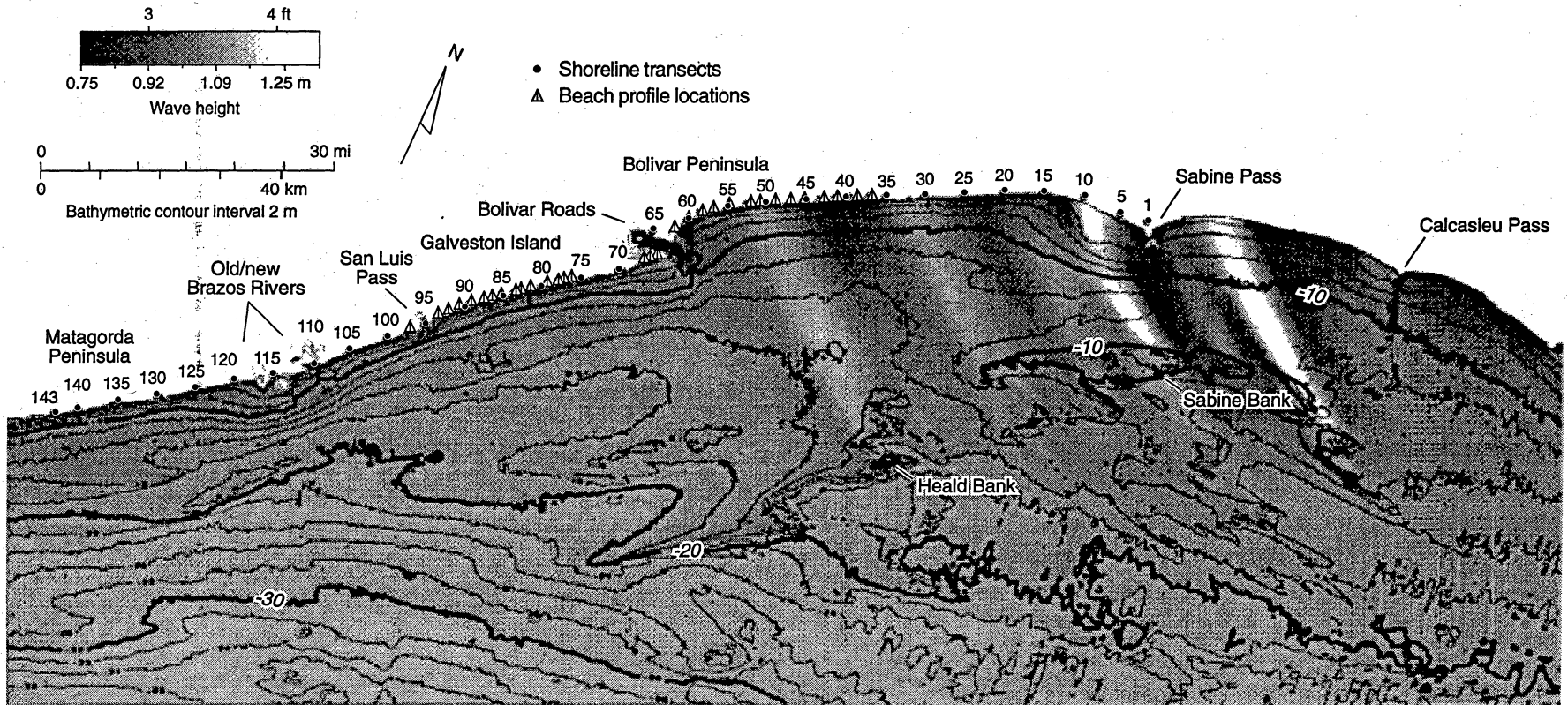
Case 7



QAb1805c

Figure 17. Bathymetry and wave heights for case 7 wave conditions: height= 1.0 m; period= 5.1 s; direction= 225°.

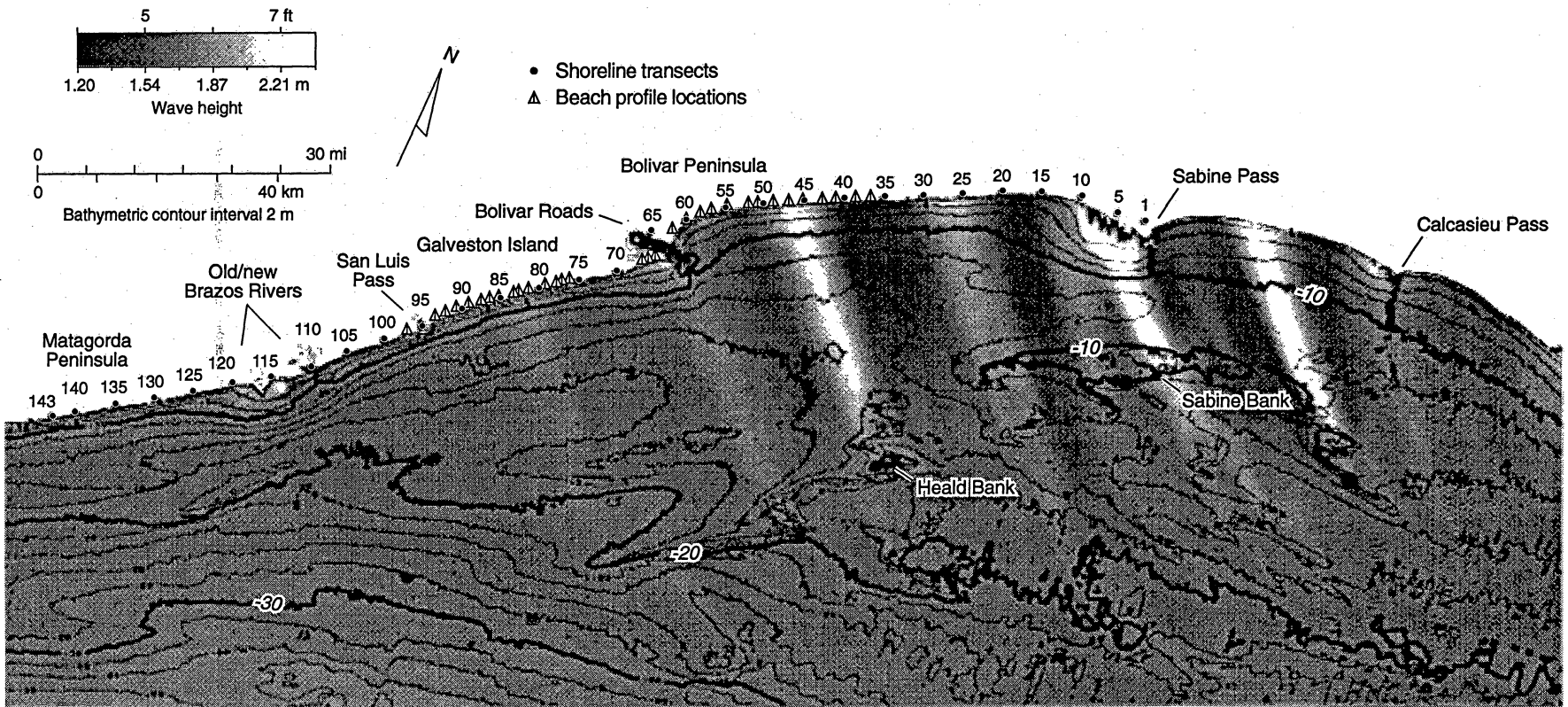
Case 8



QAb1806c

Figure 18. Bathymetry and wave heights for case 8 wave conditions: height= 1.2 m; period= 5.8 s; direction= 131°.

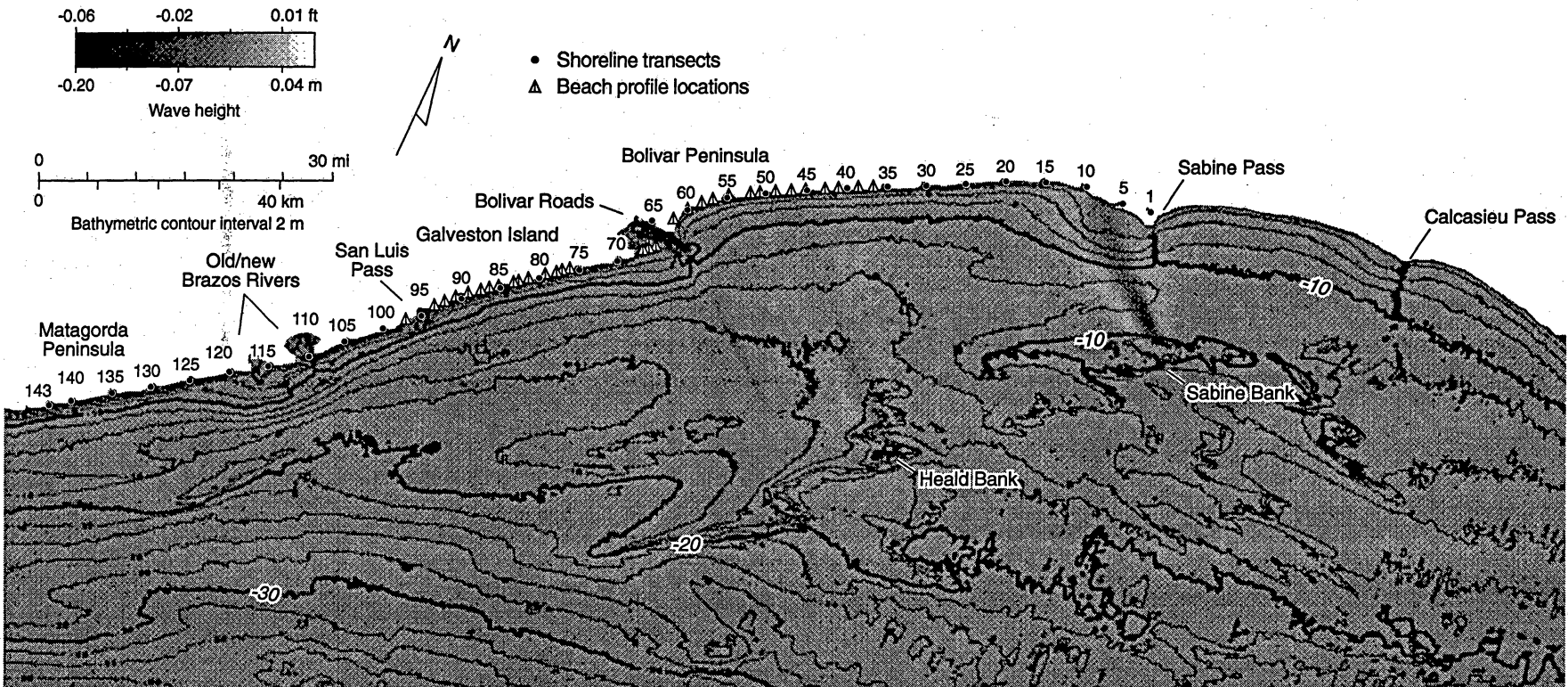
Case 9



QAb1807c

Figure 19. Bathymetry and wave heights for case 9 wave conditions: height= 2.0 m; period= 8.5 s; direction= 135°.

Case 10 – Case 3



34

QAb1996c

Figure 20. Wave-height difference map for excavated and nonexcavated conditions for modal wave conditions of case 3: height= 1.2 m; period= 6.1 s; direction= 135°. Lighter shades indicate where higher wave heights are predicted for excavated condition relative to nonexcavated condition. Darker shades indicate the opposite.

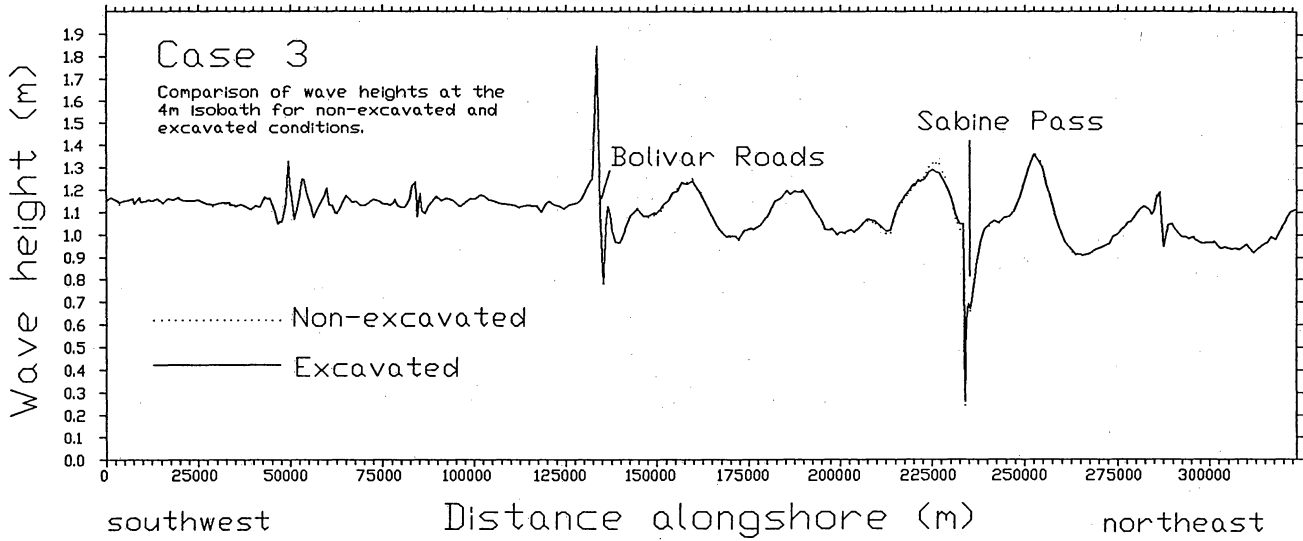
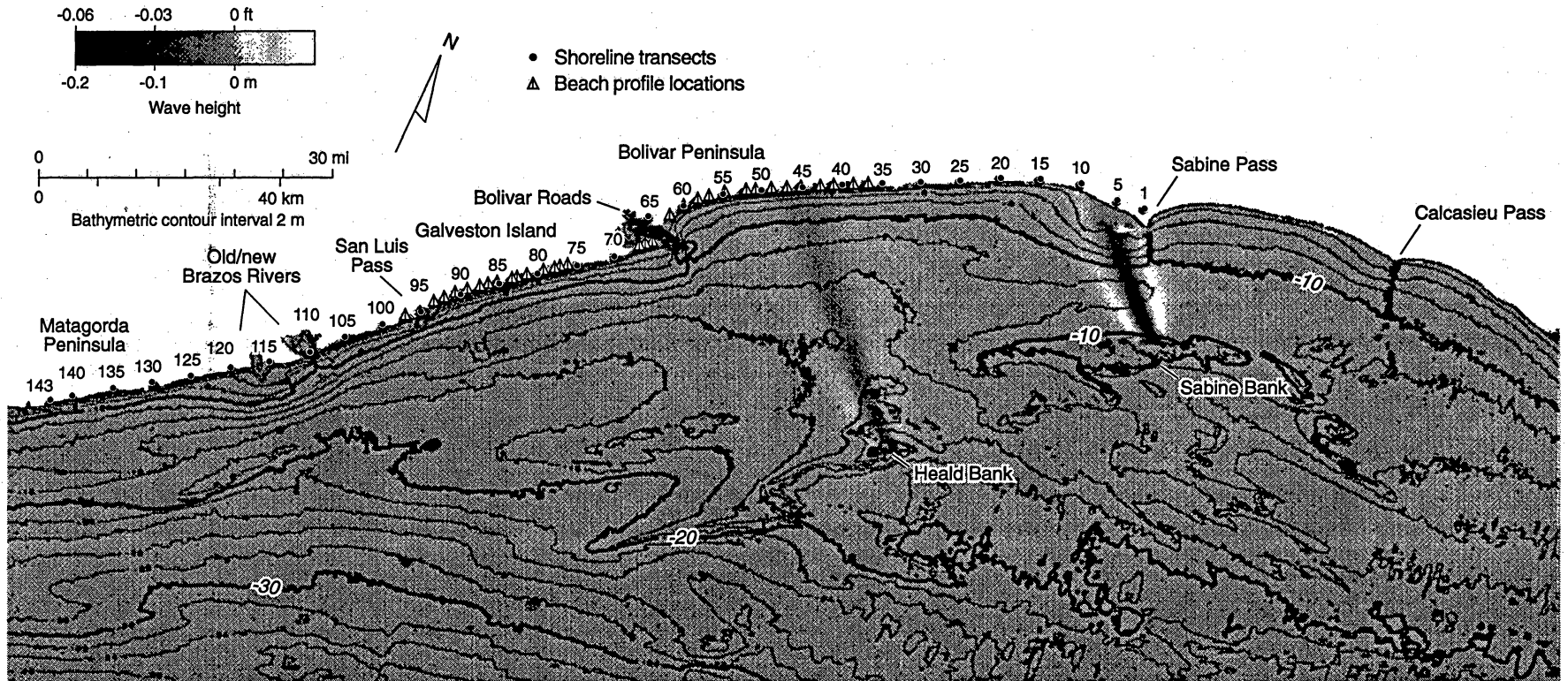


Figure 21. Wave heights along the landward 4-m isobath. Comparison of excavated and nonexcavated conditions for wave conditions of case 3: height= 1.2 m; period= 6.1 s; direction= 135°.

Case 11 – Case 9



QAb1995c

Figure 22. Wave-height difference map for excavated and nonexcavated conditions for storm wave conditions of case 9. Lighter shades indicate where higher wave heights are predicted for excavated condition relative to nonexcavated condition. Darker shades indicate the opposite.

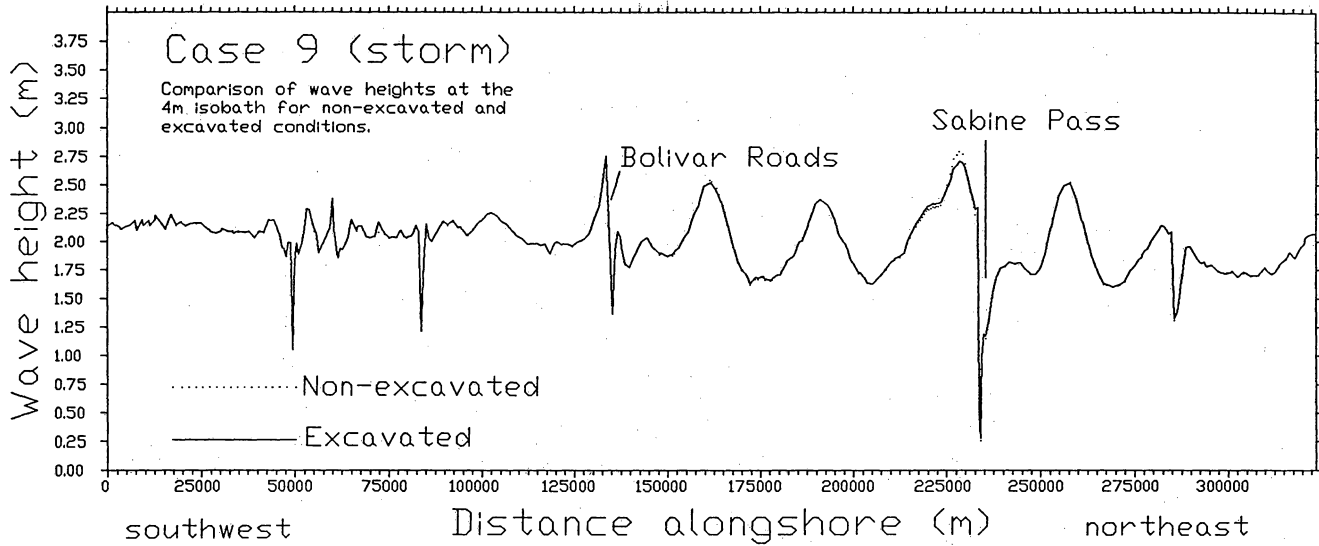


Figure 23. Wave heights along the landward 4-m isobath. Comparison of excavated and nonexcavated conditions for storm wave conditions of case 9: height= 2.0 m; period= 8.5 s; direction= 135°.

To measure the effects of mining sand, we used a dredging scenario that would result in the maximum effects on wave propagation. Excavated conditions were simulated by subtracting two rectangular solids from the bathymetric grid, thereby increasing water depths. Each solid measured 4,000 m in the alongshore direction, 1,000 m in the shore normal direction, and 2.5 m deep. The hypothetical sand volume was removed from the shallowest portions of Sabine and Heald Banks to simulate dredging of 10 million m³ from each bank. The model was run with excavated and non-excavated conditions for comparison.

Wave parameters are from the Coastal Engineering Research Center's Wave Information Study for the Gulf of Mexico (Hubertz and Brooks, 1989). This data set is a hindcast of wave conditions for coastal and offshore locations for the period from 1956 to 1975. Tropical storm and hurricane conditions are excluded from the hindcast. Data from station number 12, located 70 km offshore of Bolivar Peninsula and in 20 m water, was used in this study. Station 12 is about 20 km seaward of Heald and Sabine Banks. The Wave Information Study provides 20 years of hindcast wave conditions computed every three hours and compiled in percent occurrence tables for specified directions of wave propagation. For wave cases one through seven in this study, the mean significant wave height (Hs) and period were used for each onshore wave direction interval spanning an arc of 22.5° (Table 2). Case eight uses a mean Hs, period, and direction for all onshore directions, and case nine estimates Hurricane Alicia conditions in 1983 based on data presented in Garcia and Flor (1984).

Results of Wave Refraction Analysis

The influence of offshore shoals on wave refraction is readily apparent when contour maps of wave height are viewed (Figures 11-19). Minimum water depths are 6 to 10 m over Heald and Sabine Banks and related smaller shoals. Waves focus landward of the shoals causing zones of relatively high and low wave heights along the shoreline (Figures 11-19). These zones of constructive and destructive interference shift along the coast as wave directions change. For the more common wave directions (Figures 12-16 and 18-19), the variance in alongshore wave heights caused by the shoals only occurs east of Bolivar Roads. West of Bolivar Roads (Galveston Island, Follets Island, and Matagorda Peninsula), wave heights are relatively constant except for local variations caused by ebb-tidal deltas at Bolivar Roads and San Luis Pass and at the Brazos River delta.

Cases 3 and 9 both have a wave direction of 135° but case 9 represents high long-period waves associated with storm conditions (Figures 13 and 19). The variance in alongshore wave height along Bolivar Peninsula is about 1.0 m for hurricane conditions or 50% of the initial wave height of 2 m. Wave heights for case 3, on the other hand, range about 0.3 m, or 25% of the

initial wave height of 1.2 m. Wave-height zones are also shifted about 4 km to the east for long-period hurricane conditions compared with nonstorm conditions.

Cases 3 and 9 were run with the bathymetric grid reflecting post-extraction conditions as described above. For each case, a wave-height difference map was created by subtracting wave heights computed for the excavated condition from the wave heights computed for the non-excavated condition. Figure 20 shows the wave-height difference grid for the modal wave condition of case 3. The simulated dredging caused wave heights to change less than 3 cm landward of the Heald Bank dredge site and less than 10 cm landward of the Sabine Bank site in the direction of initial wave propagation. Wave heights are lower in the landward "shadow" of the excavated sites, but higher on each end. Wave heights along the landward 4-m isobath were also plotted, and excavated versus nonexcavated scenarios compared (Figure 21). For case 3, the only measurable change at the 4-m isobath is produced by dredging Sabine Bank, which predicts lowering of wave heights by 5 cm just southwest of Sabine Pass.

The storm condition of case 9 was also run with and without excavated bathymetry; Figure 22 is the wave-height difference map for the two scenarios. Changes in wave heights caused by dredging are less than 10 cm at Heald Bank and less than 20 cm at Sabine Bank. The pattern of change in the lee of each bank is the same as described for case 3. For case 9, the greatest predicted change at the 4-m isobath is produced by dredging Sabine Bank. The model predicts lowering of wave heights by 10 cm just west of Sabine Pass (Figure 23). Similarly, the model predicts that dredging Heald Bank will cause a lowering of wave heights by less than 5 cm northeast of Bolivar roads.

Implications of Results

As waves propagate across the shallowest portions of Sabine and Heald Banks, they converge and wave heights increase landward of shoals. This wave-focusing effect of the offshore shoals causes variation in the distribution of wave heights arriving at the shoreline east of Bolivar Roads. These offshore shoals, therefore, are expected to have a significant effect on shoreline change. West of Bolivar Roads, variation of alongshore wave heights is caused by the more local effects of wave refraction around tidal inlets and river deltas, which would not be influenced by dredging at Heald or Sabine Banks.

Dredging the crests of Heald and Sabine Banks probably would decrease their wave-focusing effect only slightly. The wave propagation model predicts that during average wave conditions, wave heights will be lowered by less than 10 cm in the lee of the banks and by less than 5 cm at the 4-m isobath. During storm conditions, lowering of wave heights probably would be less than 20 cm in the lee of Sabine Bank and less than 10 cm at the 4-m isobath. The borrow scenario used

in this analysis is for a volume of sand that is approximately 10 times the amount used in a typical beach nourishment project. If Sabine and Heald Banks become offshore mining sites, it is conceivable that this volume could be dredged over several years because of the initial needs of several projects and continued maintenance nourishment. Based on the wave refraction analysis, the effects of dredging Heald Bank on wave propagation and coastal sedimentation are negligible. The effect of dredging Sabine Bank is greater, but also small, and is not expected to alter sedimentation patterns away from the dredge site.

POTENTIAL WEATHER-RELATED DREDGING RESTRICTIONS

Successful offshore mining operations depend on understanding the physical processes in the Gulf of Mexico near the Banks and the potential influence of those processes on sand extraction operations. The preliminary work by Morton and Gibeaut (1993) only reported average conditions for waves and tides. Those statistical averages provide some limited information about wave heights and periods, but they are inadequate with regard to planning a sand extraction operation. More important than averages are the distributions of wave heights, wave periods, wave directions, current speeds, and current directions as well as the seasonality of all these processes. An analysis of inner shelf processes was conducted to determine if dredging equipment would be able to operate uninterrupted throughout the year or if mining operations would be suspended during certain months when wave energy is greatest. This analysis indicates how the mining operations might be effected by weather patterns and meteorological factors (wind, barometric pressure, rain, and fog) and how the offshore physical oceanographic conditions are linked to the meteorological forces. Another possible application of the physical processes analysis has to do with predicting the direction and distance that suspended sediment will be transported away from the mining site. Movement and dispersion of the suspended sediment plume will depend on the sea state and shelf currents at the time of dredging.

The results of this task provide a better understanding of offshore mining conditions and the annual cycle of environmental energy that would be encountered in the western Gulf of Mexico. It also provides a basis for determining the annual durations of mining, which are needed for the economic analysis.

The physical processes task was accomplished by examining historical records of tides, waves, and weather patterns. A primary objective of this task is developing a summary of seasonal characteristics of the critical offshore parameters including wind directions, wind speeds, wave directions, wave heights, and identifying unusual circumstances (water spouts, hurricanes) that might disrupt mining activities. Because offshore weather data are sparse or difficult to obtain

(proprietary data), we used available National Weather Service records either from nearby coastal sites such as Port Arthur and Galveston or offshore monitoring buoys.

Oceanographic records for coastal tide gauges and wave gauges or hindcast wave data were ordered from the National Ocean Survey and the Corps of Engineers and examined. Principal investigators for the MMS-funded Louisiana-Texas Shelf Circulation program (LATEX) were contacted to see if any of their monitoring stations and data sets would be suitable for our analysis of oceanographic conditions near Sabine and Heald Banks. Each data set was analyzed independently using time-series methods that reveal trends in the data such as seasonal variability and yearly maximums. The data sets were also examined to see if they cover the same time periods. Because the data sets coincide temporally, additional statistical analyses were performed to investigate the relationships among the measured variables. The results of this work could be used to determine the optimal periods of mining and the duration of uninterrupted mining activities. This type of mining restriction analysis is needed before an economic analysis of the operation can be conducted.

A practical approach to understanding offshore mining conditions was also included in this task. We contacted marine operators working in the Gulf of Mexico to determine what conditions currently alter or interrupt offshore activities such as dredging, laying pipelines, or towing barges. We also discussed with dredging companies the potential mining problems associated with changing weather while working in the Gulf of Mexico.

Wind and Wave Analysis

Wind and wave data from several sources in the vicinity of Heald and Sabine Banks (Table 3) were analyzed to describe the likely sea conditions that a dredging operation would encounter. Both measured and hindcast data are presented. The hindcast data are from the Wave Information Study (WIS) conducted by the U.S. Army Corps of Engineers (Hubertz and Brooks, 1989). For the hindcast, a wind field is computed from an atmospheric pressure field and merged with observed wind data (Resio et al., 1982). A discrete spectral model then uses the merged wind field to determine the generation of waves (Resio, 1982). The results of the hindcast are time series of directional wind and wave data for discrete locations, including a location near Heald Bank presented in this study (Figure 24).

Measured wind and wave data are available from moored buoys and coastal stations operated by the National Data Buoy Center (NDBC) of the National Oceanographic and Atmospheric Administration (NOAA). Coastal stations are referred to as Coastal-Marine Automated Network (CMAN) stations. A CMAN station west of Sabine Pass at Sea Rim State Park provided directional wind data for this report (Figure 24). A moored sea buoy offshore of Galveston Island

Table 3. Selected sources of wind and wave data in the Sabine and Heald Banks area.

Identification	Description	Latitude/Longitude	Data	Period
42035	moored buoy, National Data Buoy Center (NDBC)	29 14' 47"N/ 94 24' 35"W 30 km ESE of Bolivar Roads, 25 km NW of Heald Bank	hourly directional winds and nondirectional waves	5/93 to present
SRST2	Coastal-Marine Automated Network (CMAN) station, NDBC	29 40' 12"N/ 94 03' 00"W Sea Rim State Park on coast 20 km W of Sabine Pass, 35 km landward of Sabine Bank	hourly directional winds	1985 to present
41-4300 or 996830	National Weather Service first order weather station	29 58'N/ 95 21'W Houston Intercontinental Airport, 100 km inland	less than hourly directional wind	before 1983 to present
WIS-11	Wave Information Study (WIS) hindcast data, U.S. Army Corps of Engineers	29 00' 00"N/ 94 30' 00"W 35 km SW of Heald Bank	3 hourly directional winds and waves	1956 to 1975
WIS-12	Wave Information Study (WIS) hindcast data, U.S. Army Corps of Engineers	29 00' 00"N/ 94 00' 00"W 20 km SE and seaward of Heald Bank	3 hourly directional winds and waves	1956 to 1975
WIS-13	Wave Information Study (WIS) hindcast data, U.S. Army Corps of Engineers	29 30' 00"N/ 93 30' 00"W 25 km E of Sabine Bank	3 hourly directional winds and waves	1956 to 1975

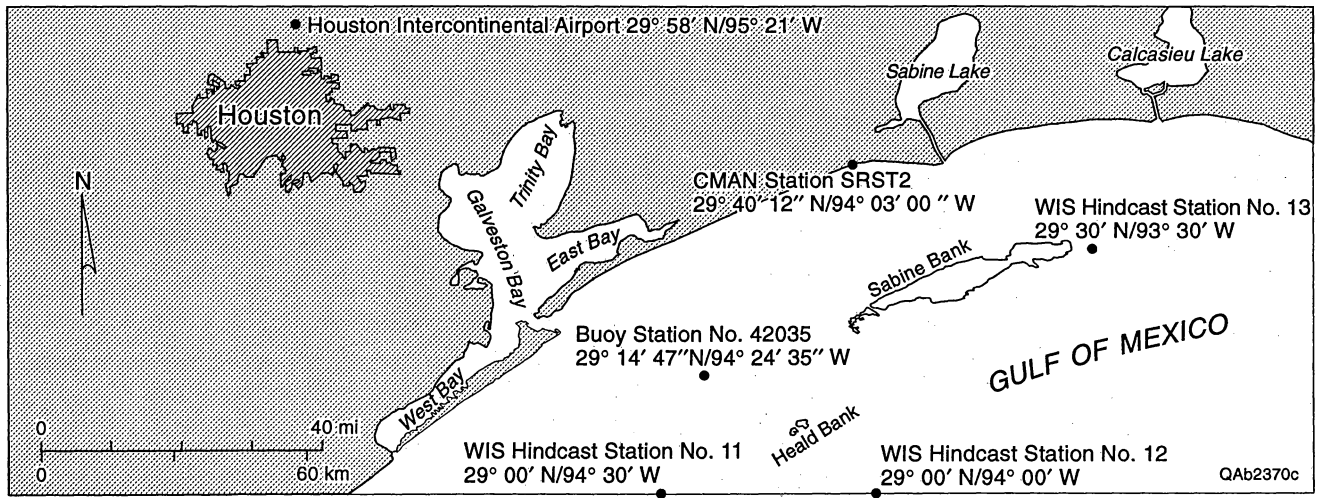


Figure 24. Map showing locations of wind and wave recording and hindcast stations in the vicinity of Heald and Sabine Banks.

provided directional wind and nondirectional wave data. In addition, wind data from the National Weather Service's station at the Houston Intercontinental Airport provided directional wind data (Figure 24).

Waves

The longest time series of wave data in the area is the hindcast data. These directional data are computed at three hourly intervals for the 20-year period from 1956 to 1975. Tropical cyclones are excluded from the hindcast. Figure 25 is a reproduction of the summary percent occurrence table and wave rose diagram for WIS station 12 as they appear in the WIS report number 18 (Hubertz and Brooks, 1989). Station 12 is located 20 km southeast and seaward of Heald Bank in 20-m water depth.

Hindcast data indicate that nearly half of the time waves come from the southeast and that the most common significant wave height (H_s , average height of the upper one-third highest waves) is between 1.00 m and 1.49 m, which occurs 45% of the time. The most common peak wave period (T_p) is between 5.4 and 6.5 s which occurs 28% of the time. The overall mean H_s is 1.2 m and the mean T_p is 5.8 s. The monthly mean H_s as computed over the 20-year period varies from 0.9 m in July and August to 1.4 m in December, January, February, March, and April.

Table 4 is a cumulative percent table of H_s and may be used to approximate weather delays for dredging operations caused by high waves. This table indicates the fraction of time that waves were equal to or less than a particular H_s for all wave directions. When considering all the data for the 20-year period, waves with heights of 1.5 m or less occurred 80% of the time. Table 4 also presents cumulative data for each month. January is the stormiest month with wave heights of 1.5 m or less occurring 66% of the time, whereas July and August are the calmest months with wave heights of 1.5 m or less occurring 98% of the time. The H_s of 1.5 m is used in this discussion because most dredging operations are delayed or hindered when waves exceed this height. Table 4, however, may be used to approximate dredging delays for a variety of wave heights. It is important to note that H_s is spectral, and for conditions when there is a large variation in wave height, some waves may be considerably higher than the stated H_s . In addition, the wave refraction analysis in this report shows that waves tend to be higher on and in the lee of the crests of the banks. And finally, the hindcast data exclude tropical storms and hurricanes, and even though August, September, and October are relatively low- H_s months, the chances for a major storm are greater than at other times of the year.

Two years of nondirectional wave data from May 1993 through April 1995 were collected by NDBC buoy mooring number 42035 located in 15-m water depth 25 km northwest of Heald Bank and 45 km northwest and landward of WIS station number 12. These data are hourly and nearly

STATION 12 29.00N 94.00W FOR ALL DIRECTIONS
PERCENT OCCURRENCE(X1000) OF HEIGHT AND PERIOD FOR ALL DIRECTIONS

HEIGHT(METERS)	PERIOD(SECONDS)										TOTAL
	<4.2	4.2-5.3	5.4-6.5	6.6-7.4	7.5-8.7	8.8-9.5	9.6-10.5	10.6-11.8	11.9-13.3	13.4-LONGER	
0.0-0.4	330	629	573	807	191	11	11	..	..	..	1535
0.5-0.9	3875	17782	4723	8097	936	49	17	..	..	..	27380
1.0-1.4	41	1140	2776	2161	2166	41	13	3	..	..	45300
1.5-1.9	..	198	799	136	210	63	..	..	..	..	19202
2.0-2.4	..	11	61	50	78	210	3	..	..	..	5071
2.5-2.9	..	..	13	13	29	167	8	..	..	..	1146
3.0-3.4	..	..	..	..	..	..	..	..	..	..	281
3.5-3.9	..	..	..	..	..	..	..	..	..	..	49
4.0-4.4	..	..	..	..	..	..	..	..	..	..	13
4.5-4.9	..	..	..	..	..	..	..	..	..	..	1
5.0-5.4	..	..	..	..	..	..	..	..	..	..	0
TOTAL	4246	29995	41695	17498	5817	549	150	27	1	0	58440

MEAN HS(M) = 1.2 LARGEST HS(M) = 4.6 MEAN TP(SEC) = 5.8 TOTAL CASES = 58440.

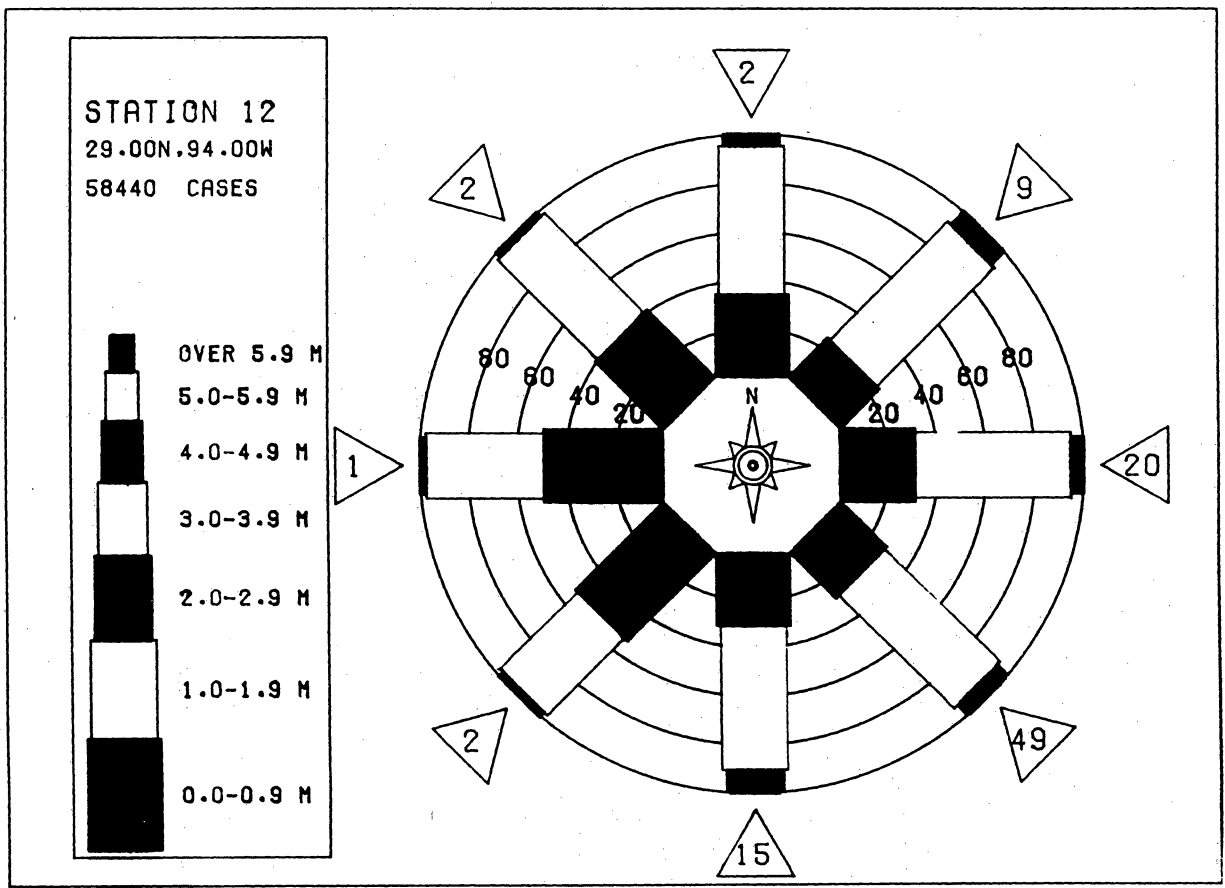


Figure 25. Wave rose diagram and percent occurrence of wave height and period for WIS hindcast station 12, from Hubertz and Brooks (1989).

Table 4. Cumulative percent of significant wave heights for WIS station 12 (20 years hindcast data: 1956 to 1975).
Percent values are percent of time with significant wave heights (Hs) less than or equal to the height given in column one.

Hs (m)	All Data cum. %	Jan cum. %	Feb cum. %	Mar cum. %	Apr cum. %	May cum. %	Jun cum. %	Jul cum. %	Aug cum. %	Sep cum. %	Oct cum. %	Nov cum. %	Dec cum. %
0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.3	0.1	0.1	0.0	0.0	0.0	0.8	0.1	0.0	0.1	0.0	0.0	0.0	0.1
0.4	1.5	0.3	0.4	0.4	0.5	2.8	3.5	4.7	3.1	1.1	0.8	0.5	0.4
0.5	4.4	1.2	1.0	0.9	1.5	5.6	8.5	14.1	9.8	4.6	2.6	1.5	1.1
0.6	7.9	2.6	2.5	2.0	2.5	9.7	14.2	23.0	17.4	9.6	5.2	3.3	2.2
0.7	12.4	4.6	5.0	4.4	4.5	14.2	20.5	32.7	27.8	15.5	8.7	5.5	4.2
0.8	18.8	8.1	8.9	8.2	8.0	20.4	29.3	44.7	39.6	24.6	15.4	9.3	7.8
0.9	28.9	13.5	15.6	14.8	13.9	29.7	43.2	63.4	56.6	37.9	26.7	16.1	14.5
1.0	40.1	22.0	23.2	23.5	21.3	39.9	56.2	78.2	71.9	51.5	41.2	26.3	24.1
1.1	50.6	31.5	32.4	33.6	30.5	50.5	67.5	87.4	82.8	63.6	54.6	37.1	34.6
1.2	59.6	41.1	42.7	44.0	39.6	59.3	76.0	92.4	90.1	73.0	64.4	46.5	44.3
1.3	67.4	49.9	52.0	54.0	49.5	67.6	82.2	95.8	94.0	80.1	72.7	55.8	53.8
1.4	74.2	58.3	60.9	63.4	59.0	74.8	86.7	97.7	96.2	85.9	79.8	64.2	62.8
1.5	79.7	66.1	69.1	71.0	67.5	80.1	89.5	98.4	97.8	89.5	85.4	71.4	70.1
1.6	84.8	73.4	76.4	77.7	75.4	85.7	92.6	99.1	98.9	92.2	90.0	79.3	76.6
1.7	88.3	79.1	81.5	82.3	81.1	89.3	94.3	99.5	99.3	94.2	92.8	84.4	81.6
1.8	91.5	84.1	86.3	86.8	86.0	92.5	95.9	99.8	99.6	95.9	95.3	89.3	85.9
1.9	93.4	87.6	89.8	89.7	88.4	94.2	96.7	99.9	99.7	97.0	96.7	92.3	89.0
2.0	95.2	90.9	92.5	92.4	90.8	96.1	97.3	99.9	99.8	97.9	98.0	94.8	91.9
2.1	96.6	93.8	94.8	94.4	93.1	97.4	97.9	100.0	99.9	98.5	98.8	96.3	94.2
2.2	97.3	95.2	95.9	95.5	94.3	98.1	98.3	100.0	100.0	98.9	99.2	97.1	95.2
2.3	98.0	96.9	97.2	96.5	95.5	98.7	98.7	100.0	100.0	99.0	99.4	98.0	96.4
2.4	98.5	97.9	98.1	97.3	96.3	99.0	98.8	100.0	100.0	99.2	99.6	98.8	97.2
2.5	98.9	98.6	98.6	98.1	97.0	99.3	99.1	100.0	100.0	99.3	99.8	99.2	97.9
2.6	99.1	99.0	98.9	98.5	97.5	99.5	99.3	100.0	100.0	99.4	99.9	99.4	98.4
2.7	99.4	99.3	99.2	98.8	98.1	99.7	99.6	100.0	100.0	99.5	99.9	99.6	98.8
2.8	99.5	99.4	99.4	99.1	98.5	99.7	99.8	100.0	100.0	99.5	100.0	99.7	99.1
2.9	99.7	99.6	99.6	99.4	98.8	99.8	99.9	100.0	100.0	99.5	100.0	99.9	99.4
3.0	99.7	99.7	99.7	99.4	99.2	99.9	100.0	100.0	100.0	99.5	100.0	99.9	99.6

continuous over the 2 years. The average H_s measured for the 2 years was 0.91 m, and the average period was 5.6 s. Table 5 is a cumulative percent table of H_s in the same format as Table 4 discussed above. When considering all the data for the 2-year period, waves with heights of 1.5 m or less occurred 92% of the time. January was the stormiest month with wave heights of 1.5 m or less occurring 85% of the time, whereas July and August are the calmest months with wave heights of 1.5 m or less occurring nearly 100% of the time.

Figure 26 is a plot of the cumulative wave heights computed from buoy and hindcast data. The buoy data measured the H_s lower than the hindcast data, and there are three possible causes for this: (1) average wave heights were lower from 1993 to 1995 than from 1956 to 1975; (2) the hindcast routine is biased toward higher wave heights; and (3) waves at the hindcast location tend to be higher than those at the buoy location. The WIS hindcast station number 11 is 48 km to the west of station 12 and has an average H_s of 1.1 m, which is 0.1 m lower than at station 12. WIS station 11 is closer to shore than station 12 and 20 km closer to the buoy than station 12. The buoy location is also closer to shore than station 12. Spatial variability, therefore, can explain part but probably not all of the difference in H_s . Average wave periods between the two data sets agree well.

Winds

Wind rose diagrams and tables of wind speed summaries are presented in Figures 27 through 30. Winds hindcast at WIS station 12 (Figure 27) and measured at NDBC buoy mooring 42035 (Figure 28) show the prevailing winds to be from the southeast. The hindcast shows winds with speeds greater than 10 kts occurring 80% of the time, but for the 2 years of buoy data, winds exceeded 10 kts only 51% of the time. The same possible reasons for the discrepancies in wave height between the hindcast and buoy data sets discussed above apply to wind speed. Six years of hourly data from the coastal CMAN station at Sea Rim State Park (Figure 29) show a more southerly component to the winds and calmer conditions than at the offshore sites. At the coast, wind speeds exceeded 10 kts only 37% of the time. Houston Intercontinental Airport is 100 km from the coast, and wind speeds for the same 6-year period (1985 to 1991) as the CMAN time series are lower with speeds exceeding 10 kts only 15% of the time (Figure 30). The directional distribution of winds at the Houston airport is also more even than at the coastal and offshore sites.

Winds out of the northwest, north, and northeast occur less frequently than from other directions, but they tend to be strong. These strong northerly winds are associated with the passage of winter cold fronts. Because northerly winds generally blow offshore, they do not generate large waves nearshore, and thus their potential effect on dredging operations is not represented in the wave data. Based on the hindcast and buoy data, northerly winds that exceed

Table 5. Cumulative percent of significant wave heights for NOAA buoy #42035 (May 1993 through April 1995).
Percent values are percent of time with significant wave heights (Hs) less than or equal to the height given in column one.

Hs (m)	All Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	cum. %	cum. %	cum. %	cum. %	cum. %	cum. %	cum. %	cum. %	cum. %	cum. %	cum. %	cum. %	cum. %
0.1	0.3	2.3	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.3
0.2	2.8	6.0	3.8	5.4	0.0	1.0	1.3	0.0	2.5	6.7	1.9	1.3	2.7
0.3	7.3	8.9	10.9	9.6	2.9	4.1	5.7	0.9	7.5	20.1	5.2	2.6	8.0
0.4	14.7	14.5	18.8	19.8	7.9	14.8	10.5	5.2	21.2	31.7	13.5	4.3	13.7
0.5	22.1	21.2	25.8	24.9	14.7	24.0	14.7	11.5	38.3	40.4	21.8	8.7	20.5
0.6	31.4	26.2	33.7	32.9	24.6	34.7	22.9	23.9	56.5	47.6	30.2	19.5	29.0
0.7	40.8	31.9	40.6	41.7	33.5	49.4	29.8	38.1	68.8	56.6	39.0	30.2	37.7
0.8	50.1	38.5	51.5	48.7	42.7	60.5	39.2	51.5	74.4	66.5	51.2	37.4	46.8
0.9	59.0	46.0	62.9	57.0	51.0	68.4	49.0	63.4	80.8	76.9	58.8	44.9	56.9
1.0	67.5	53.9	73.7	63.9	64.4	76.1	56.7	73.5	86.9	83.3	65.4	54.3	66.4
1.1	75.1	60.9	82.2	71.0	74.1	82.2	68.0	81.2	92.3	87.1	71.7	63.1	75.5
1.2	81.6	68.1	88.9	77.1	79.6	88.9	76.3	88.9	96.3	89.6	76.6	72.2	83.9
1.3	86.1	75.0	92.6	81.2	83.9	93.2	82.8	93.1	98.6	92.8	80.0	78.0	88.8
1.4	89.6	80.5	94.9	85.7	88.5	95.0	86.7	95.9	99.2	95.1	84.1	82.8	92.5
1.5	92.5	84.7	96.2	89.5	91.6	97.1	90.4	96.9	99.7	96.2	89.3	87.4	95.3
1.6	94.6	87.6	97.8	92.7	93.9	97.9	93.1	98.6	100.0	96.8	92.4	91.1	96.7
1.7	96.1	90.2	99.2	94.4	95.6	98.6	95.1	99.9	100.0	97.1	94.9	93.4	97.4
1.8	97.1	92.9	99.5	95.9	96.7	98.9	96.5	100.0	100.0	97.5	96.2	95.4	97.6
1.9	98.0	94.9	99.9	97.4	98.2	99.4	97.1	100.0	100.0	97.7	97.8	96.8	98.0
2.0	98.6	96.8	99.9	98.7	98.6	99.7	97.5	100.0	100.0	97.8	98.6	97.7	98.4
2.1	98.9	98.0	99.9	99.0	99.4	99.9	97.8	100.0	100.0	98.0	98.9	98.3	98.4
2.2	99.3	98.6	100.0	99.5	99.7	100.0	98.3	100.0	100.0	98.3	99.4	99.1	98.9
2.3	99.5	98.9	100.0	99.7	99.8	100.0	98.4	100.0	100.0	98.7	99.7	99.5	99.4
2.4	99.6	99.1	100.0	99.9	99.9	100.0	98.5	100.0	100.0	99.1	99.8	99.7	99.5
2.5	99.8	99.4	100.0	100.0	99.9	100.0	98.7	100.0	100.0	99.4	100.0	99.9	99.9
2.6	99.9	99.7	100.0	100.0	99.9	100.0	99.1	100.0	100.0	99.5	100.0	100.0	100.0
2.7	99.9	99.9	100.0	100.0	100.0	100.0	99.2	100.0	100.0	99.6	100.0	100.0	100.0
2.8	99.9	100.0	100.0	100.0	100.0	100.0	99.2	100.0	100.0	99.8	100.0	100.0	100.0
2.9	99.9	100.0	100.0	100.0	100.0	100.0	99.4	100.0	100.0	99.9	100.0	100.0	100.0
3.0	100.0	100.0	100.0	100.0	100.0	100.0	99.5	100.0	100.0	100.0	100.0	100.0	100.0

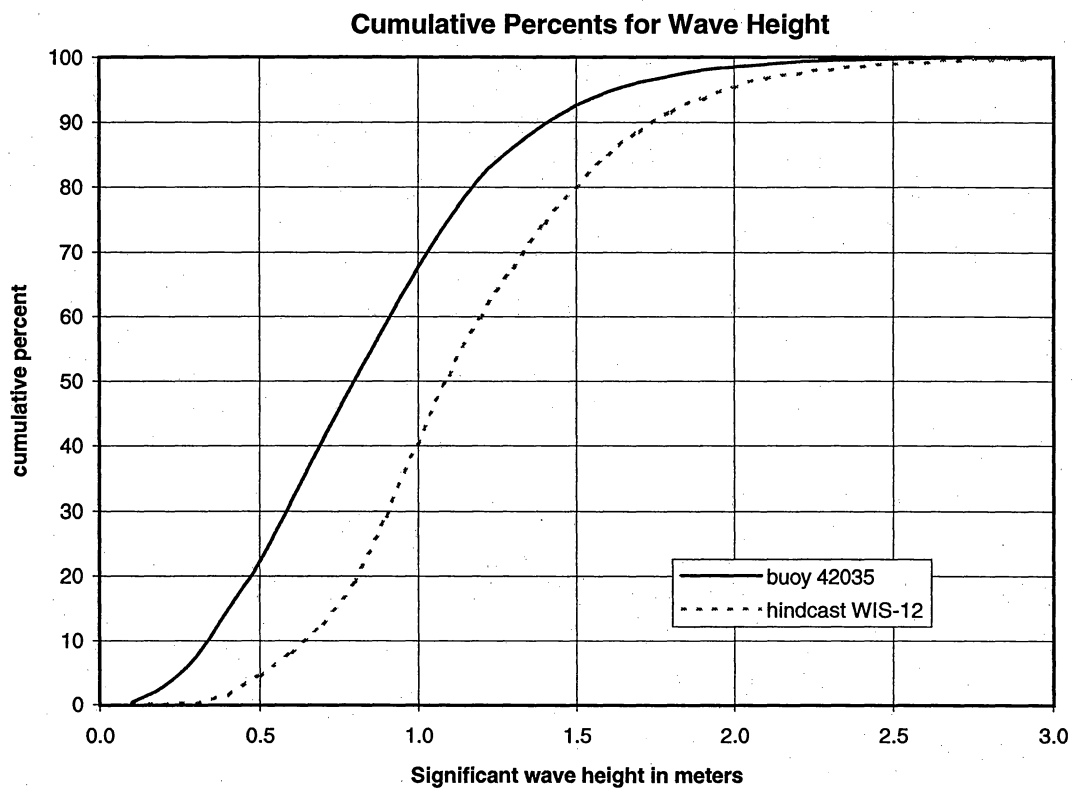


Figure 26. Cumulative percent occurrence for significant wave heights at buoy mooring 42035 and WIS hindcast station number 12. Buoy data cover the 2-year period from May 1993 through April 1995. Hindcast data cover the 20-year period from 1956 to 1975.

WIS Hindcast Station 12
Winds from January 1956 through December 1975

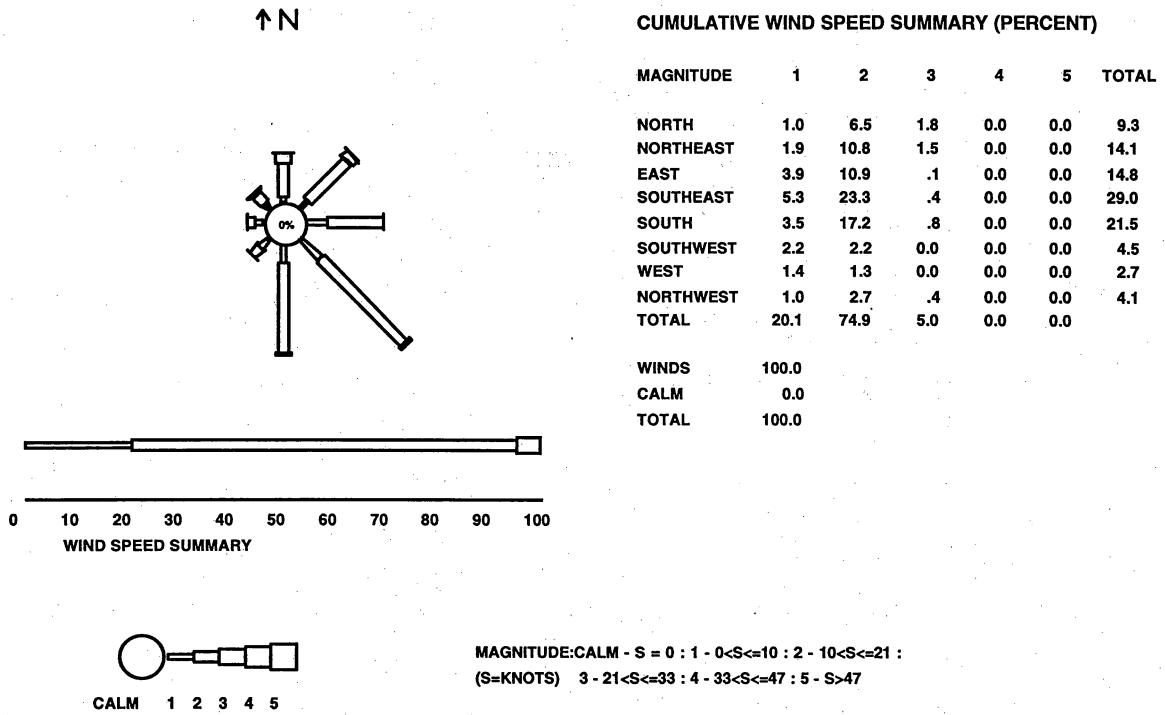


Figure 27. Wind rose diagram and wind speed summary for WIS hindcast station number 12.

Buoy #42035
Winds from May 1993 through April 1995

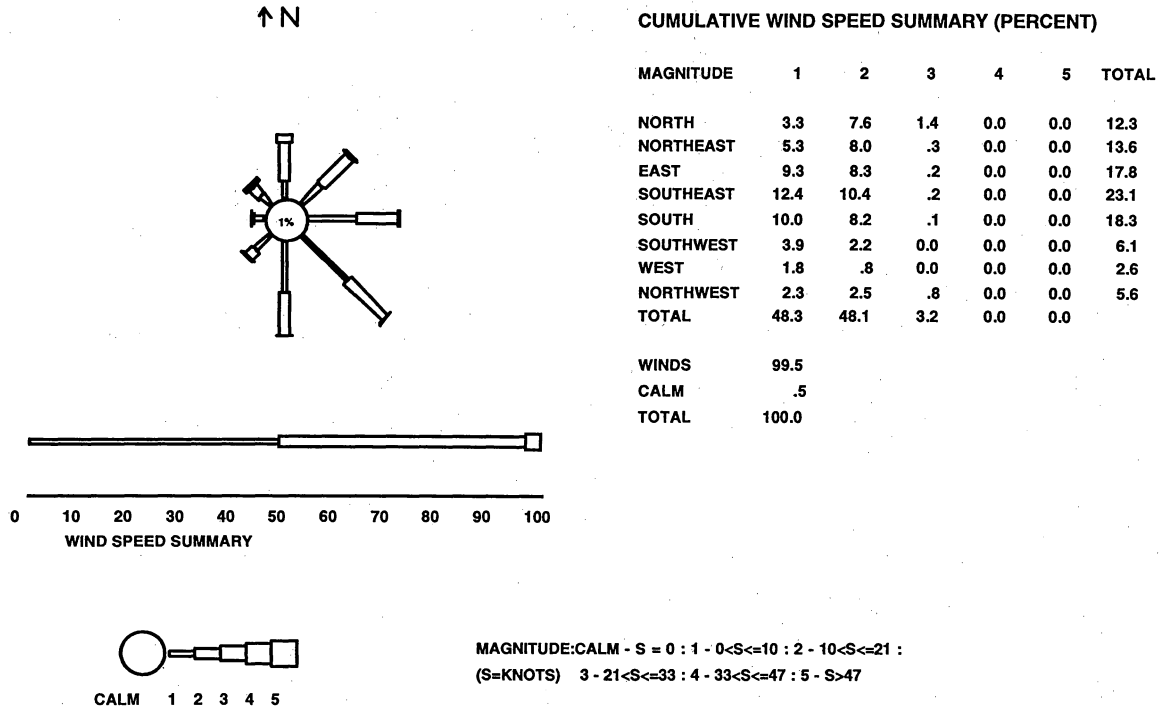


Figure 28. Wind rose diagram and wind speed summary for buoy mooring number 42035.

**Sea Rim State Park, CMAN Station SRST2
Winds from January 1985 through December 1991**

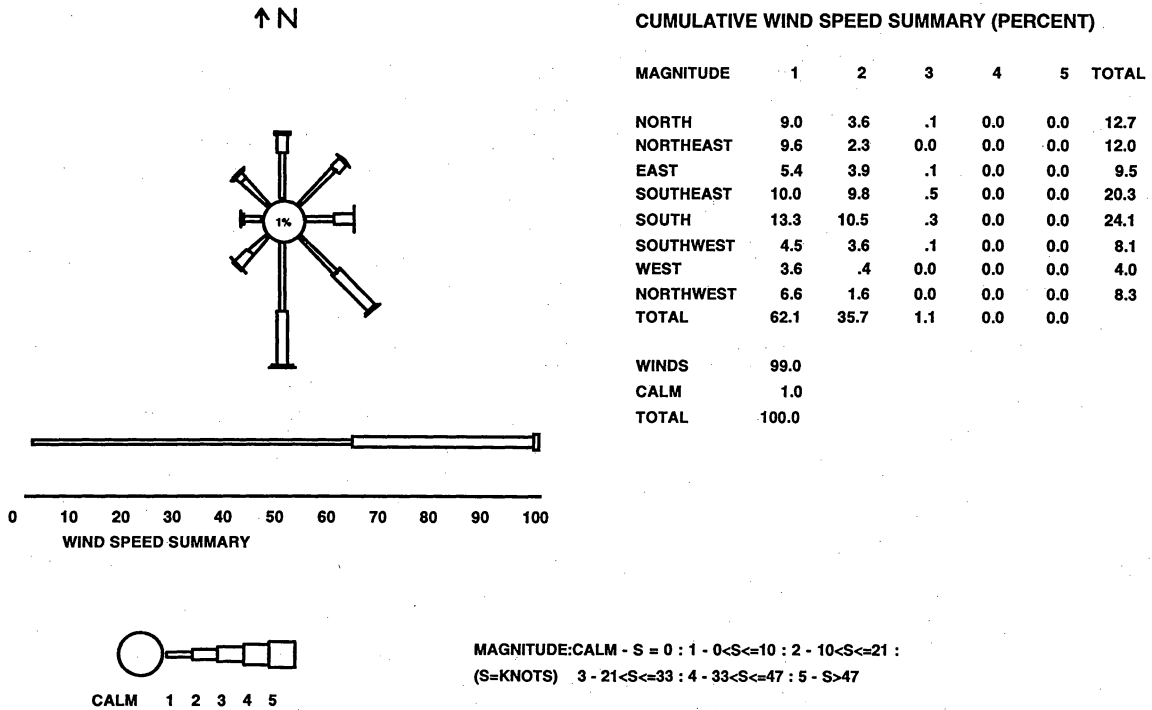


Figure 29. Wind rose diagram and wind speed summary for CMAN station SRST2 at Sea Rim State Park.

Houston Intercontinental Airport Winds from January 1985 through December 1991

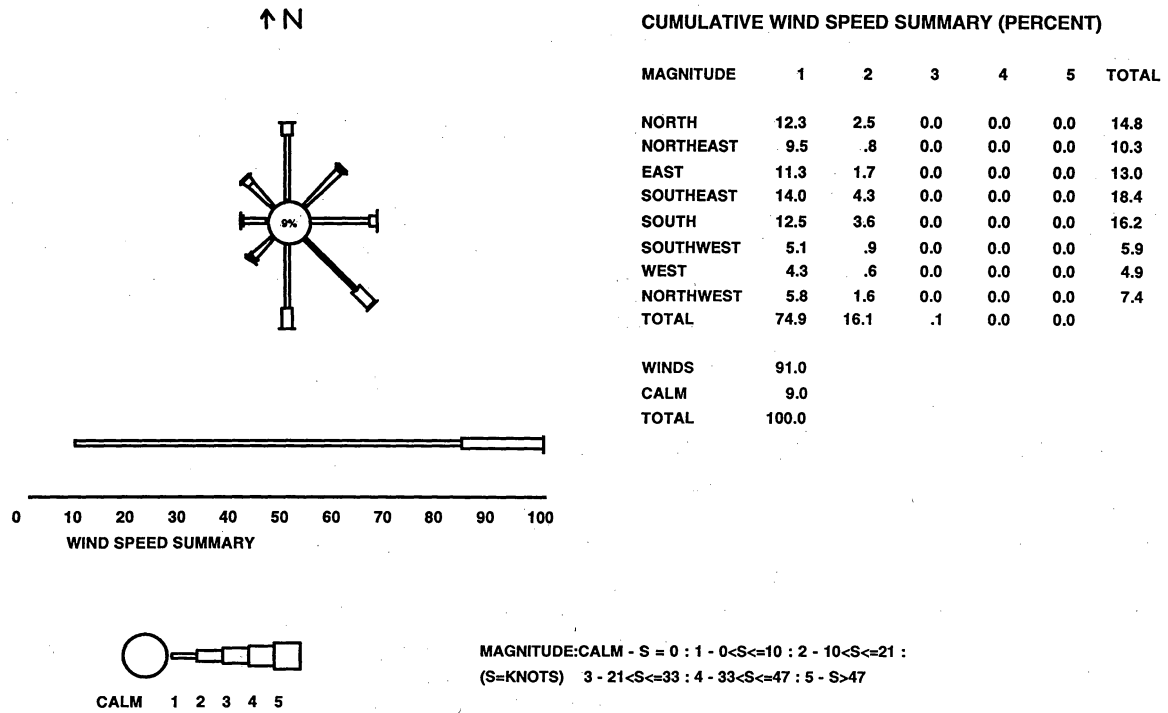


Figure 30. Wind rose diagram and wind speed summary for the Houston Intercontinental Airport.

10 kts occur about 23% of the time, and northerly winds that exceed 20 kts occur about 3% of the time in the vicinity of Sabine and Heald Banks. Strong northerly winds occur less frequently near the shoreline as shown by the CMAN data from Sea Rim State Park.

First Quarter 1995 Weather Conditions

Approximately 535,500 m³ of sand were dredged from a site 1.5 km offshore of East Beach on the eastern end of Galveston Island Texas from January through April 1995. Table 6 presents cumulative Hs data for this time period recorded by NDBC buoy mooring 42035. The buoy wave data are nondirectional; however, the wave periods, which averaged 5.6 s during this time, indicate that the waves were locally generated and that wind direction recorded by the buoy may be used to infer wave direction. Onshore-directed waves had an average Hs of 0.96 m and average period of 5.8 s for the 4-month period. Because the dredge site was nearshore, the cumulative wave-height data in Table 6 were computed by assigning a wave height of 0.0 m during times of offshore directed winds. Table 6 shows that about 95% of the time waves were either directed offshore or were equal to or less than 1.5 m high.

The buoy position is 30 km east-southeast of the dredge site in 15 m of water, and the borrow site is in 6 m of water. Qualitative inspection of wave refraction maps presented in this report indicates that, for the common wave directions, wave heights are expected to be 0.2 to 0.3 m higher at the dredge site than at the buoy site. Therefore, the Hs values should be conservatively revised up by 0.3 m. After this revision, we estimate that the Hs at the borrow site was less than or equal to 1.5 m about 85% of the time during the dredging operation.

ESTIMATED COSTS OF DREDGING

Before leasing of offshore sand resources in the western Gulf commences, an economic analysis of offshore mining will need to be conducted. An economic analysis of offshore sand extraction has not been conducted for the Sabine-Heald Bank trend for several reasons. First, the physical and environmental issues regarding quality of the sand resource and possible environmental impacts need to be resolved before an economic analysis is conducted. Second, economic analyses are ephemeral because of the transient nature of supply and demand as well as externalities that determine economic climate. An economic analysis would need to be conducted before the near-term leasing phase is achieved but after specific mining objectives have been determined. A third reason why an economic analysis of Sabine and Heald Banks has been postponed is that an economic analysis of mining sand in the Gulf of Mexico at Ship Shoal was favorable (Kelly and Crawford, 1991). Furthermore, mining of sand off the Atlantic coast and

Table 6. Cumulative percent of inshore significant wave heights (Hs) inferred from NOAA buoy #42035. Period is January 1995 through April 1995. Percent values are percent of time with Hs less than or equal to the height given in column one. During times of offshore winds, Hs was assigned to 0 to infer inshore conditions.

Hs (m)	cum. %
0.1	38.2
0.2	40.4
0.3	42.1
0.4	46.0
0.5	50.6
0.6	53.7
0.7	57.3
0.8	62.1
0.9	68.1
1.0	74.5
1.1	80.7
1.2	84.9
1.3	88.4
1.4	92.0
1.5	94.6

Hs (m)	cum. %
1.6	96.1
1.7	97.1
1.8	97.8
1.9	98.8
2.0	99.2
2.1	99.5
2.2	99.6
2.3	99.8
2.4	99.8
2.5	99.9
2.6	99.9
2.7	100.0
2.8	100.0
2.9	100.0
3.0	100.0

along the west coast of Florida for beach replenishment is currently economical, and the economics of offshore sand mining in the Gulf of Mexico should improve as demand increases. In the first quarter of 1995, sand for beach replenishment at Galveston, Texas, was mined from the Gulf of Mexico.

A preliminary summary of costs associated with extracting and delivering offshore sand for beach replenishment was prepared for areas where erosion is critical, such as at Galveston and along the southeastern Texas coast (Jefferson County). This aspect of the economic analysis focused on the estimated costs of mining sand resources associated with Sabine and Heald Banks. This information is needed to assess the potential of near-term leasing of hard minerals in the Federal waters of offshore Texas. The cost analysis considered parameters used in simulation models, but did not involve actual model runs.

Local geological and engineering data (water depths, sand thickness, areal extent, percent sand, haul distances, dredge methods, fill requirements) were compiled from prior work and the results presented by Byrnes and Groat (1991), Morton and Gibeaut (1993), Morton (1994), Kraus et al. (1995), and Morton et al. (1995). The results of this task provide a basis for comparing the relative economic differences between mining sites and extraction technologies even if the cost estimates are not highly accurate.

Galveston Beach Nourishment Project

The first large-scale nourishment of a Gulf beach in Texas was completed during the spring of 1995 on a 6.4-km stretch of Galveston Island extending from 10th Street to 61st Street. The project, which was funded by the City of Galveston, was designed to restore the recreational beach along the seawall where the density of commercial development is highest.

Sand for the nourishment project came from the shoreface off East Beach, which is immediately east of the beach fill area. The mining site was 1.5 to 2.0 km offshore and in 5 to 6 m of water (Table 7). Significant wave heights at the borrow site are about 1.2 m. Textural analyses from the borrow area indicate that the mined sediments were 95% sand and the average grain size was fine to very fine sand, which is slightly finer than the native beach sand (Morton et al., 1995).

A hydraulic cutterhead dredge excavated 535,500 m³ in four months, and the most significant mining delays were due to inclement weather. In December 1994, the dredge was only able to operate 40% of the time because high waves in the Gulf either caused or threatened separation of the pipeline connections. During rough weather, the dredge left the borrow site and moved to protected water in Galveston Bay.

Large-diameter (1 m) pipes and pumps were used to transport the sand onshore from the dredge. Additional pipe was laid along the beach, and pumps were added to transfer the sand in a

Table 7. Completed, proposed, and potential beach fill projects utilizing sand deposits from the Gulf of Mexico.

Parameter	Galveston ^a	South Padre Island ^b	Ship Shoal ^c	Sabine Bank ^d	Heald Bank ^d
Sand Source	Shoreface	Channel Maintenance	Offshore Shoal	Offshore Shoal	Offshore Shoal
Offshore Distance	2 km	3 km	15-30 km	30-35 km	50-60 km
Water Depths	5-6 m	12 m	3-7 m	8-12 m	10-16 m
Signif. Wave Height	1.2 m	<1 m (between jetties)	1.4 m	1.2 m	1.2 m
Areal Extent of Sand	3.4 km ²	1 km ² (along channel)	250 km ²	450 km ²	100 km ²
Percent Sand	95%	75-90%	75-90%	85-100%	80-100%
Fill Requirement	535,500 m ³	417,000 m ³	764,000 m ³	1,000,000 m ³	1,000,000 m ³
Pumping Distances	3-17 km	9-11 km	2-15 km	3-15 km	3-15 km
Dredge Method	Cutterhead	Pipeline	Hopper	Hopper	Hopper
Est. Dredging Costs	\$7.65/m ³	\$3.62/m ³	\$8.14-16.35/m ³	\$10-18/m ³	\$10-18/m ³

a Source Morton et al. (1995)

b Source Kraus et al. (1995) and Galveston District, Corps of Engineers

c Source Byrnes and Groat (1991)

d Source This Report

slurry to the diffuser where the sand was deposited from the slurry. Pumping distances ranged from 3 to 17 km depending on proximity of the beach fill to the borrow site. According to the consulting engineering firm on the project, dredging and pumping the sand cost \$7.65/m³. Mobilization and demobilization costs added another \$1,000,000 to the cost of the project.

Comparing the costs of dredging at Galveston with those expected at Sabine and Heald Banks indicates that costs are lower at the Galveston site despite greater water depths, similar sand quality, and similar wave climate. This is primarily because the Galveston project involved a single-step pumping operation rather than a more expensive hopper dredge or two-step sand transfer operation, which is required at Sabine or Heald Banks to overcome the long offshore distances.

Proposed Ship Shoal Project

A major barrier island restoration project has been proposed for southwestern Louisiana that would excavate sand from Ship Shoal and place it on Isle Dernieres (Byrnes and Groat, 1991). The purpose of the project is to partly mitigate rapid coastal land loss in Louisiana and to provide protection for the wetland resources located on the adjacent delta plain and associated estuaries. A Feasibility Study and an Environmental Impact Statement (EIS) are currently (1995) being prepared to ensure that the project would be cost effective and to assure that it would not cause environmental degradation.

Ship Shoal is a large sand deposit located approximately 15 km offshore of the Isle Dernieres in 3 to 7 m of water (Table 7). Significant wave heights vary around the shoal because variable water depths influence wave heights. Seaward of the shoal, significant wave heights in the Gulf of Mexico are about 1.4 m, whereas wave heights are lower where the shoal provides a sheltering effect. The shoal contains an estimated 1.2 billion m³ of sand-rich sediment that would be suitable for barrier restoration and beach nourishment.

In 1991, the estimated costs of dredging sand from Ship Shoal for replenishment of nearby barriers ranged from \$8.14 to \$16.35 (Byrnes and Groat, 1991). It is expected that mining sand at Heald and Sabine Banks using similar techniques and for similar purposes would be slightly more expensive because offshore distances and water depths are greater. Other factors such as nearshore sand quality, wave climate, and weather conditions are similar in Texas and Louisiana.

Proposed South Padre Island Project

South Padre Island is another Texas barrier resort community that depends on beach-related tourism to sustain its economy. In the developed area about 10 km north of Brazos Santiago Pass,

the beaches are eroding and there is a need for a major beach replenishment project that would widen the beach and rebuild the dunes (Kraus et al., 1995). Current plans call for dredging approximately 417 million m³ of sand from between the jetties at Brazos Santiago Pass by the Corps of Engineers for maintenance of the navigation channel to Brownsville. Estimated costs for this project are relatively low (Table 3) because the pumping distances are relatively short, the dredging site is protected from open Gulf waves, and a pipeline dredge can be used.

Morton (1994) identified two potential sand deposits offshore of South Padre Island. The most likely nearshore source of beach-quality sand is the former ebb-tidal delta and post-jetty sand deposits that occur at water depths of 5 to 8 m. If other sand sources were not available, these offshore deposits would be a primary target for beach replenishment sand because the material is close to the proposed beach replenishment area, the material is compatible with the existing beach sediments, and there appears to be a large volume of sand-rich sediment trapped by the north jetty (more than 3 million m³).

Comparison of grain size analyses of surface sediments of the inner continental shelf reported by White et al. (1986) with grain size analyses of beach sediments from South Padre Island indicates that beach-quality material is present in the nearshore zone offshore of South Padre Island. The water depths and distances offshore to the most probable sand deposits are well within the range of available dredging equipment. Descriptions of borings taken along South Padre Island indicate that sand layers about 6 m thick occur in water depths ranging from 5 to 18 m. These sand deposits occur at the seafloor, and there appears to be very little, if any, mud covering the sand deposits (overburden).

Mining sand offshore at South Padre Island is not economically competitive with sand periodically available from maintenance dredging of the ship channel. Pumping the sand onto the beach solves two problems; it mitigates the beach erosion and eliminates or greatly reduces the need for offshore disposal of dredged material.

CONCLUSIONS AND RECOMMENDATIONS

The present and prior geological investigations of the inner continental shelf of the southeastern Texas offshore area have demonstrated that a large volume of sand-rich sediments are associated with Sabine and Heald Banks. The total volume of sandy sediments, estimated at more than 1.8 billion m³, constitutes a large hard-mineral resource suitable for uses such as beach replenishment and other construction activities. Compared to Sabine Bank, Heald Bank is in deeper water, contains less shell material, and is closer to potential markets such as Galveston Island where projects requiring beach-quality sand are currently being conducted or planned.

The sand deposits are located in water depths ranging from 4.5 m to about 17 m, and the greatest thickness of beach-quality sand coincides with the shallowest water depths on Sabine Bank. Several petroleum pipelines, production platforms, and a lighthouse are located within the trend of high-quality sand deposits, but they would not necessarily prevent mining of sand from either of the banks. Offshore mining of the sand resource would require equipment designed for open-water dredging (moderate wave climate). Also it is anticipated that dredging and sand transportation would be separate operations because of the distances between the sand deposits and their potential market. Based on current offshore mining technology, costs of operation, and mining efficiencies, it appears that a hydraulic sidecast dredge or bucket dredge would be appropriate for sand extraction, and a system of tugs and scowls would be needed to move the sand between the Banks and beach fill sites. Alternatively, a hopper dredge with pumpout capability or a combination of hopper dredge and cutterhead dredge could be employed to convey the sand from the mining site to the beach.

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APPENDIX A. LOCATIONS OF CORES

Latitude and Longitude of Sabine Bank and Heald Bank Vibracores

<u>Core I.D.</u>	<u>Latitude (degrees min.)</u>	<u>Longitude (degrees min.)</u>
Sabine Bank		
SBV - 1	29 27.726	93 42.867
SBV - 2	29 28.327	93 43.511
SBV - 3	29 27.059	93 45.498
SBV - 4	29 28.379	93 46.889
SBV - 5	29 28.618	93 51.448
SBV - 6	29 26.772	93 50.641
SBV - 7	29 25.790	93 50.241
SBV - 8	29 24.589	93 49.818
SBV - 9	29 38.090	94 03.449
SBV - 10	29 29.722	93 48.413
SBV - 11	29 31.177	93 35.648
SBV - 12	29 30.007	93 35.307
SBV - 13	29 28.729	93 34.872
SBV - 14	29 29.283	93 38.052
SBV - 15	29 25.341	93 44.381
SBV - 16	29 26.139	93 44.899
SBV - 17	29 28.318	93 45.257
SBV - 18	29 27.692	93 48.413
SBV - 19	29 26.411	93 47.782
SBV - 20	29 25.035	93 41.144
SBV - 21	29 23.800	93 46.506
SBV - 22	29 25.163	93 52.618
SBV - 23	29 24.610	93 54.689
SBV - 24	29 23.378	93 58.237
SBV - 25	29 20.895	94 03.237
Heald Bank		
HBV - 1	29 07.646	94 11.265
HBV - 2	29 06.357	94 10.097
HBV - 3	29 07.373	94 13.163
HBV - 4	29 08.993	94 11.565
HBV - 5	29 08.131	94 11.005
HBV - 6	29 08.630	94 09.949
HBV - 7	29 08.672	94 08.193

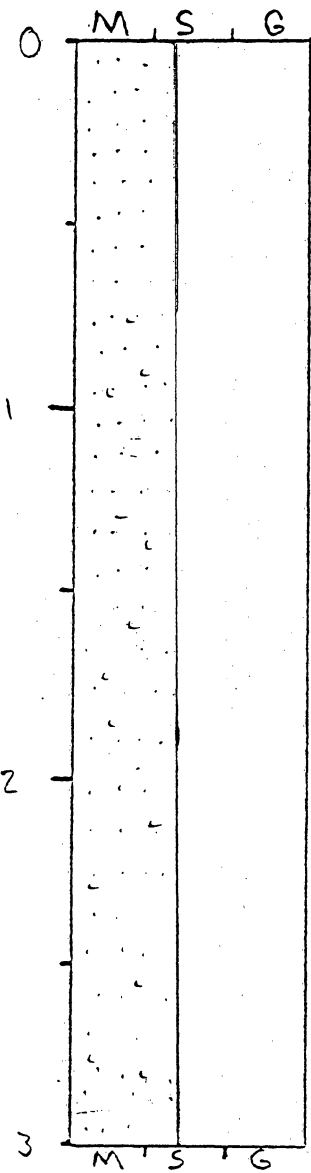
APPENDIX B. CORE DESCRIPTIONS SABINE BANK

CORE LOG

CORE # HBV-1(A) TYPE Vibracore LOCATION Heald Bank
 LATITUDE 29° 07.646' LONGITUDE 94° 11.265' SURFACE ELEVATION -28.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 9' 2" % COMPACTION ?

OBTAINED BY Gibeault / RV Kit Jones DATE 10-12-94
 DESCRIBED BY White DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Fine quartz sand (99%)
 Very well sorted
 sub rounded to rounded

Light olive gray
 to yellowish gray

scattered ^{& smaller} (granule size) shell
 fragments (< 2%)
 more apparent below
 0.6'

1.1 - 1.4' gray in center of
 core

1.4 - 1.6 back to yellowish gray fine sand
 to light olive gray

1.6 - 2.8

fine sand - medium dark gray
 with hint of light olive gray
 light olive gray along margins
 next to core

scattered granule size & smaller
 shell fragments

fine, well to very well sorted, sand

light olive gray fine sand

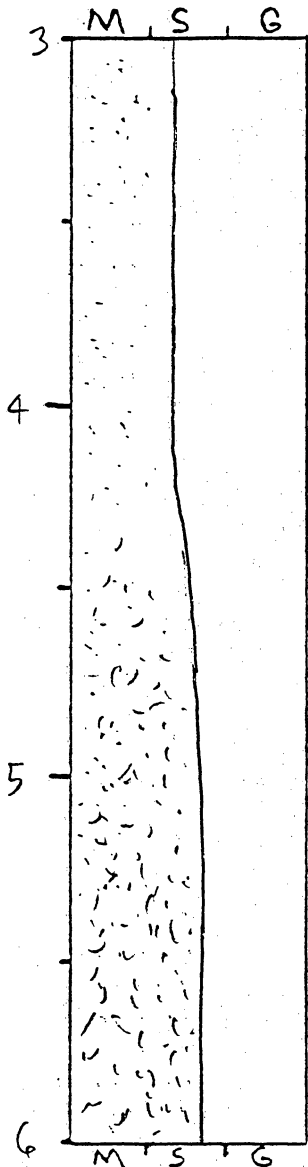
General Comments:

CORE LOG

CORE # HBV-1(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Fine, very well sorted rounded to sub rounded, sand
 99% quartz sand

Light olive gray

Fine sand with increasing shell flakes (coarse to very coarse sand) below 3.5' ≈ 5% shell

gradational increase in shell flakes increasing to ≈ 30% below 4.4'

Fining upward

Fine sand mixed with coarse to very coarse sand-size shell fragments (granule size) ≈ 50% shell frag. below 4.7' shell increasing with depth

Light olive gray fine sand mixed with light & darker gray shell fragments speckled appearance

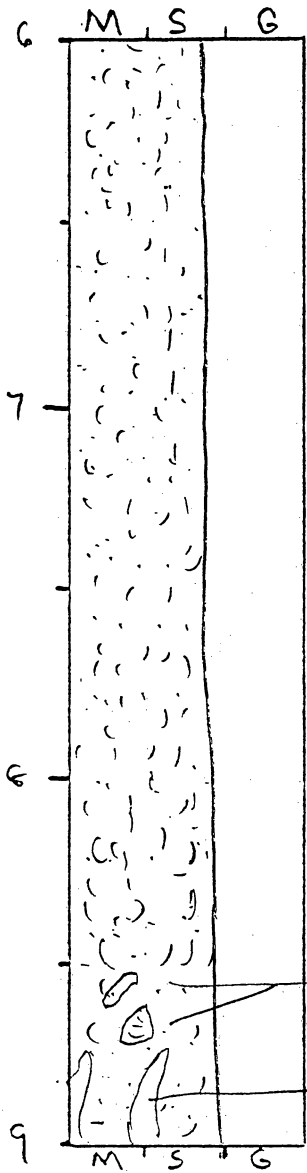
General Comments:

CORE LOG

CORE # HBV-1(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



shelly sand or
 sandy shell
 ≈ 50% shell fragments
 granule to pebble size
 mixed with fine sand

Light olive
 gray sand
 peppered with
 darker & lighter
 shell fragments

fining upward
 shells becoming more abundant
 than sand at depth

shell fragments
 becoming coarser

Sandy shell

shell fragments 2-3 cm long

core catcher

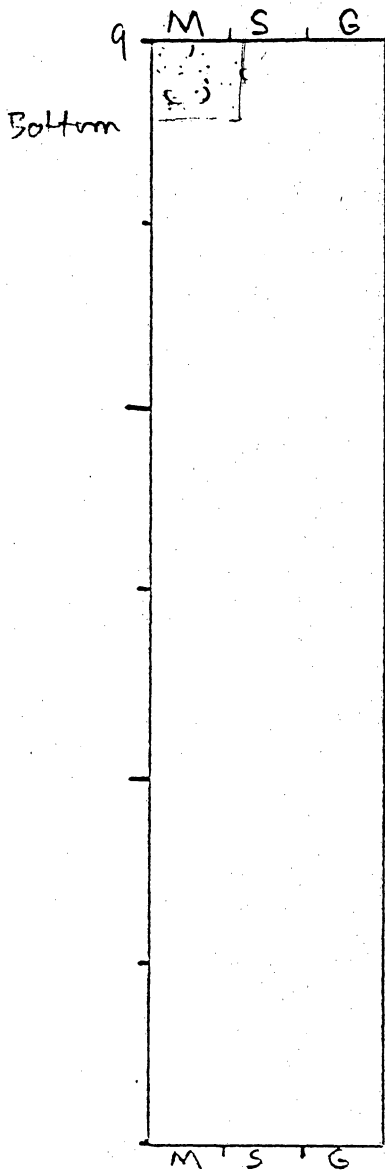
General Comments:

CORE LOG

CORE # HBV-1 (D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Predominantly
 fine quartz sand (95%)
 scattered shells

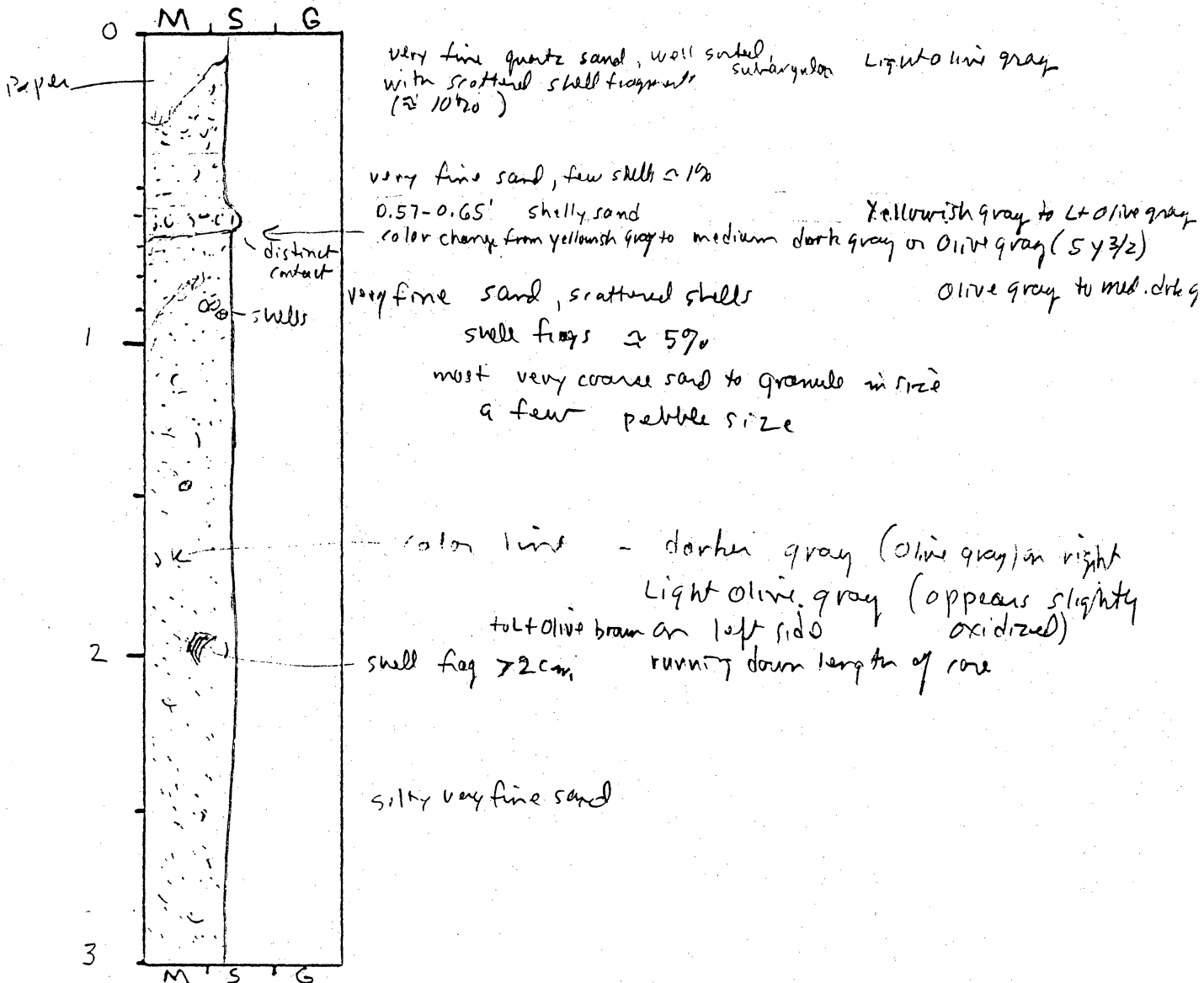
yellowish gray

General Comments:

CORE LOG

CORE # HBV-2(A) TYPE Vibracore LOCATION Heald Bank
 LATITUDE 29° 06.357' LONGITUDE 92° 10.097' SURFACE ELEVATION -52.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 14' 7" % COMPACTION ?
 OBTAINED BY Gibeaut / RV Kit Jones 14.6'
 DESCRIBED BY White DATE 10-12-94
 DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



General Comments:

CORE LOG

CORE # HBV-2(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

<p>3</p> <p>M S G</p> <p>4</p> <p>5</p> <p>6</p> <p>M S G</p>	<p>Silty, very fine sand scattered shell frag. local small shell pellets</p> <p>muddy sand (muddier sediment becomes apparent at about 4.2')</p> <p>"interbedded" with silty very fine sand</p> <p>some-what mottled with medium dark gray mud & sand Indistinct mud layers scattered shell fragments</p> <p>muddy very fine sand or sandy mud shells more abundant 5.3-5.7' 7-10% shell fragments (granule to very coarse) shells decrease below 5.7' < 1% possible organic traces (specks)</p>	<p>mod. drk gray to olive gray</p> <p>mod. dark gray</p> <p>color along margin of left side light olive brown indicating slight oxidation</p> <p>mostly granule to very coarse sand size (med. drk gray color)</p>
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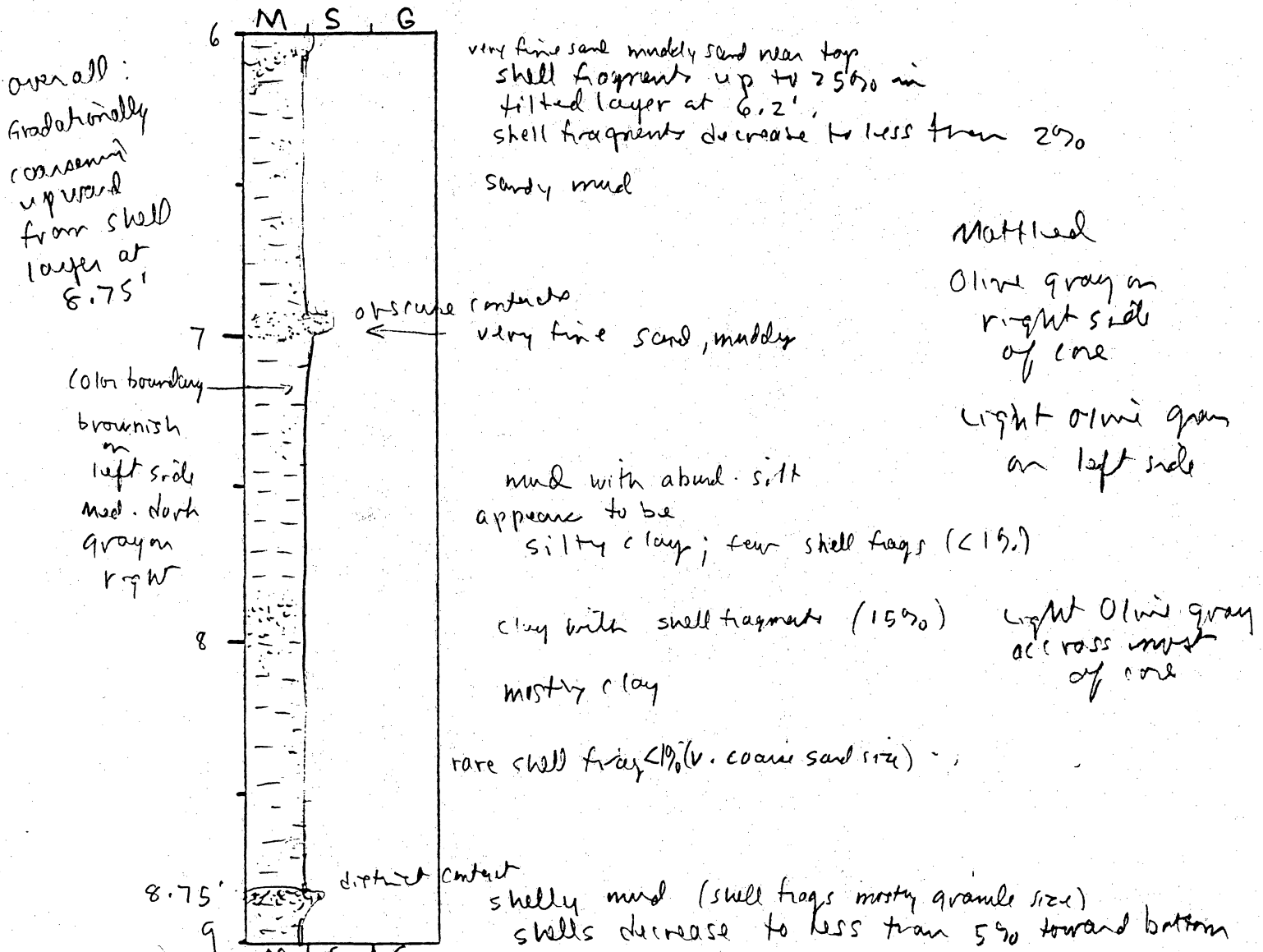
General Comments:

CORE LOG

CORE # HBV-2(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



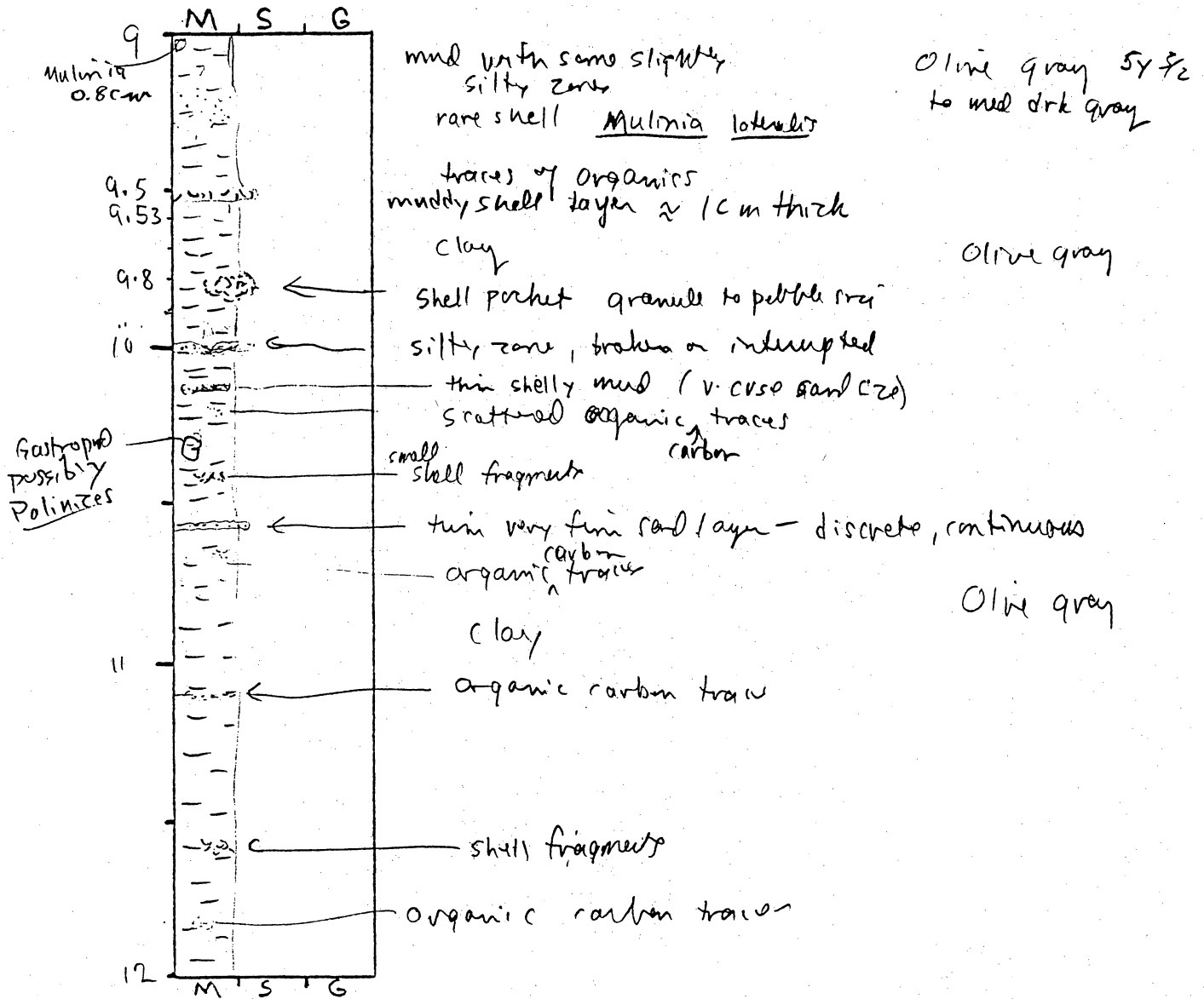
General Comments:

CORE LOG

CORE # HBV-2(D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



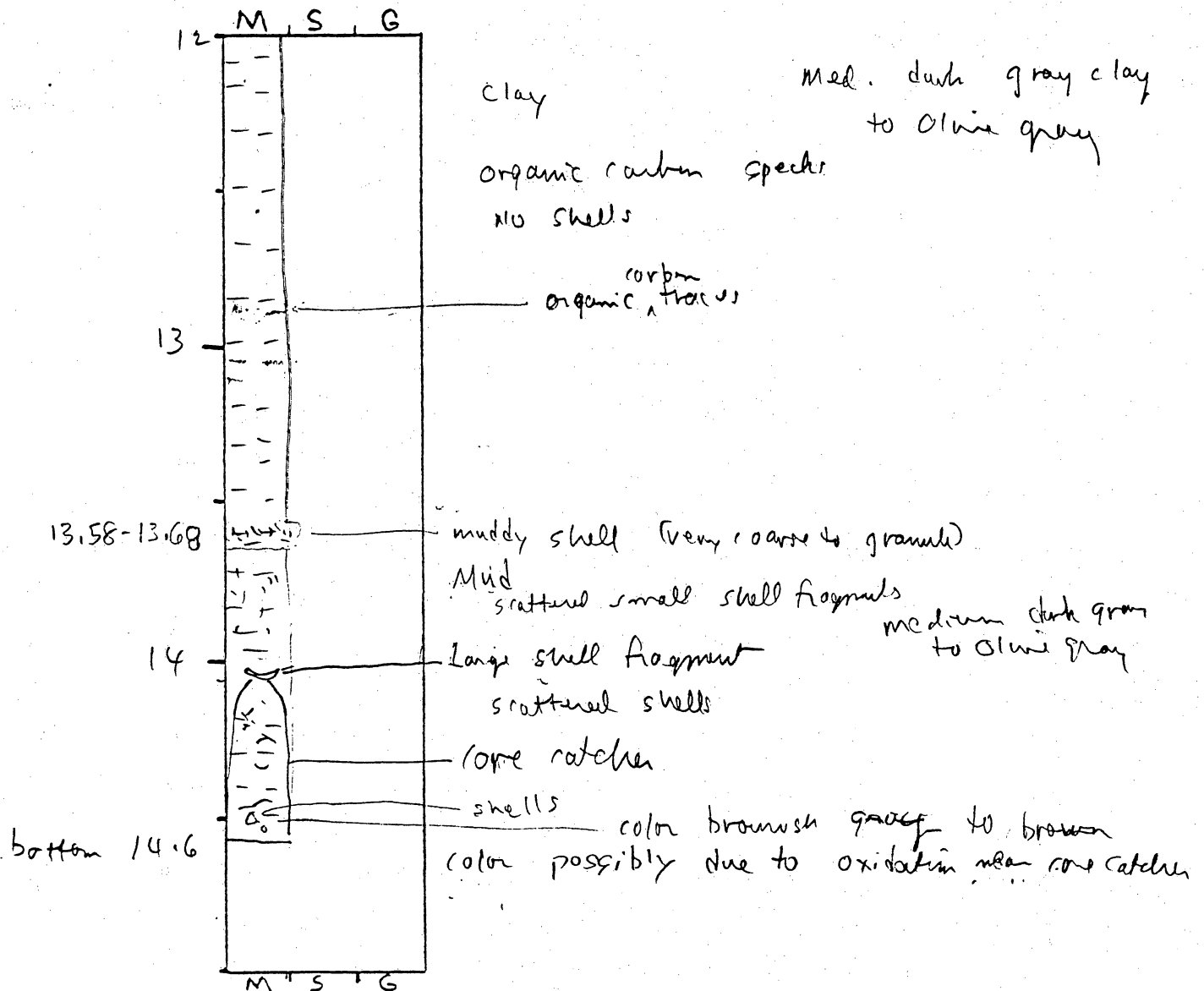
General Comments:

CORE LOG

CORE # HBV-2(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



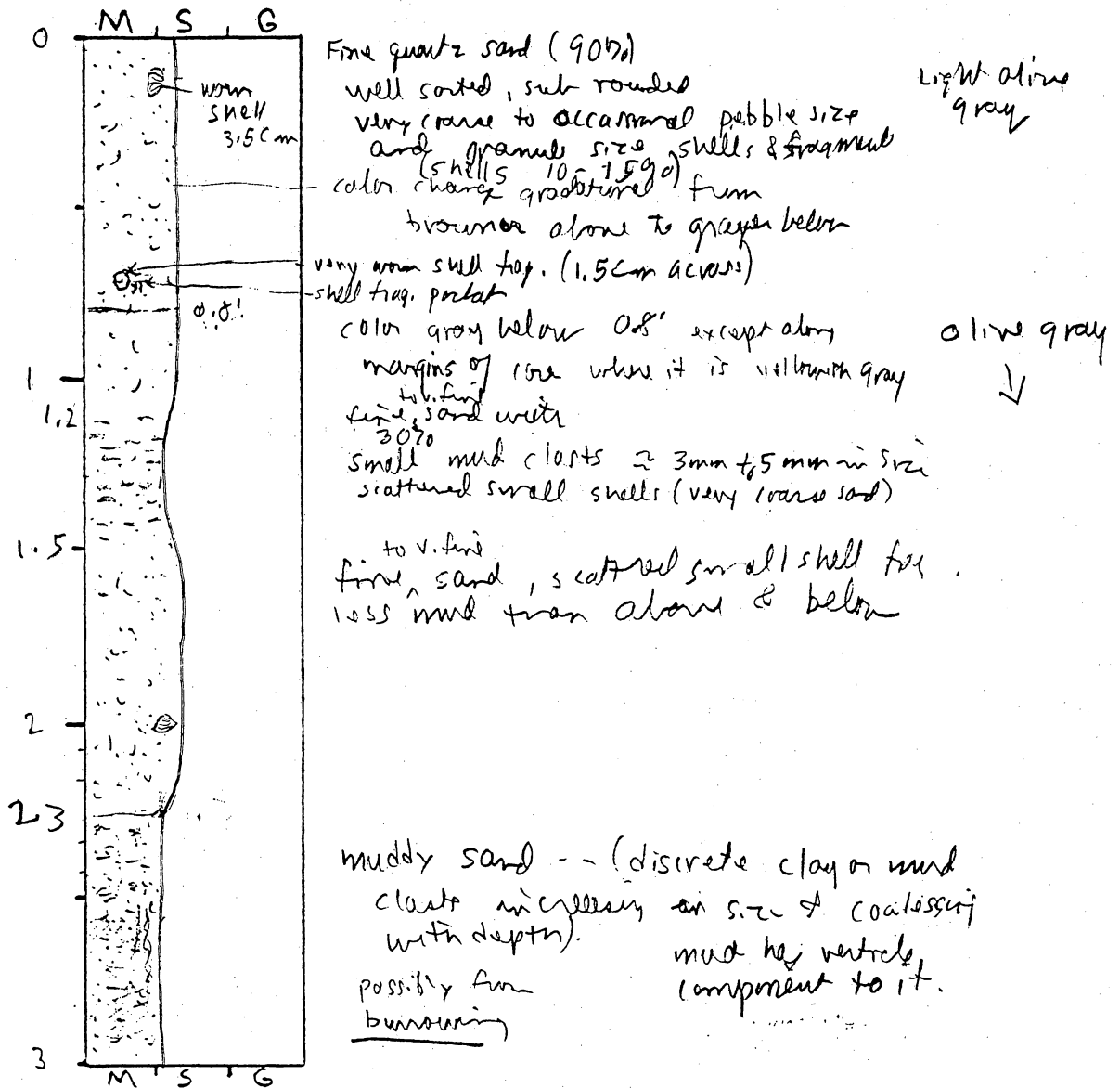
General Comments:

CORE LOG

CORE # HBV-3(A) TYPE Vibra core LOCATION Hould Bank
 LATITUDE 29° 07.373 LONGITUDE 94° 13.163 SURFACE ELEVATION -43.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 20' % COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-12-94
 DESCRIBED BY White DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



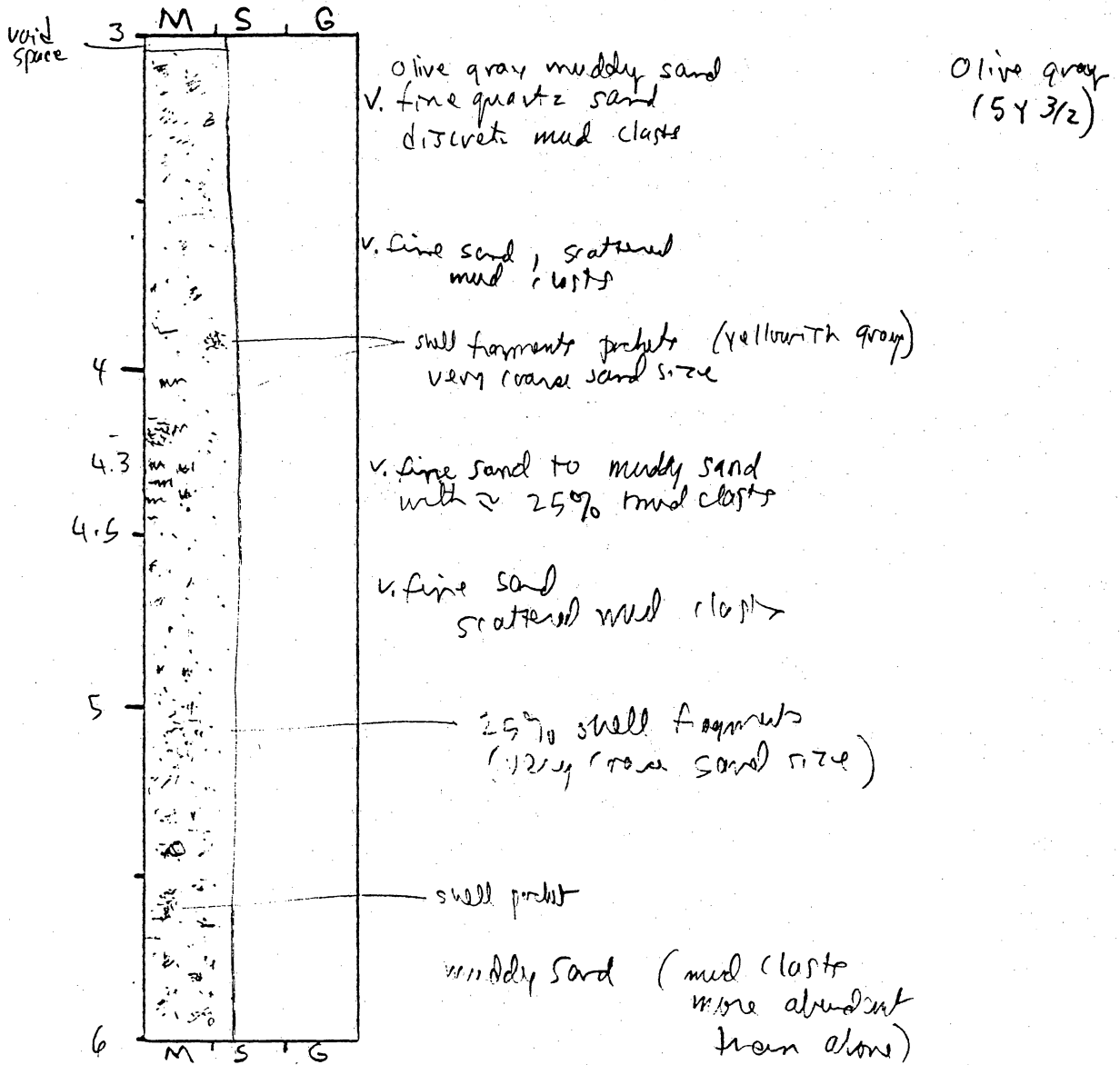
General Comments:

CORE LOG

CORE # HBV-3(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



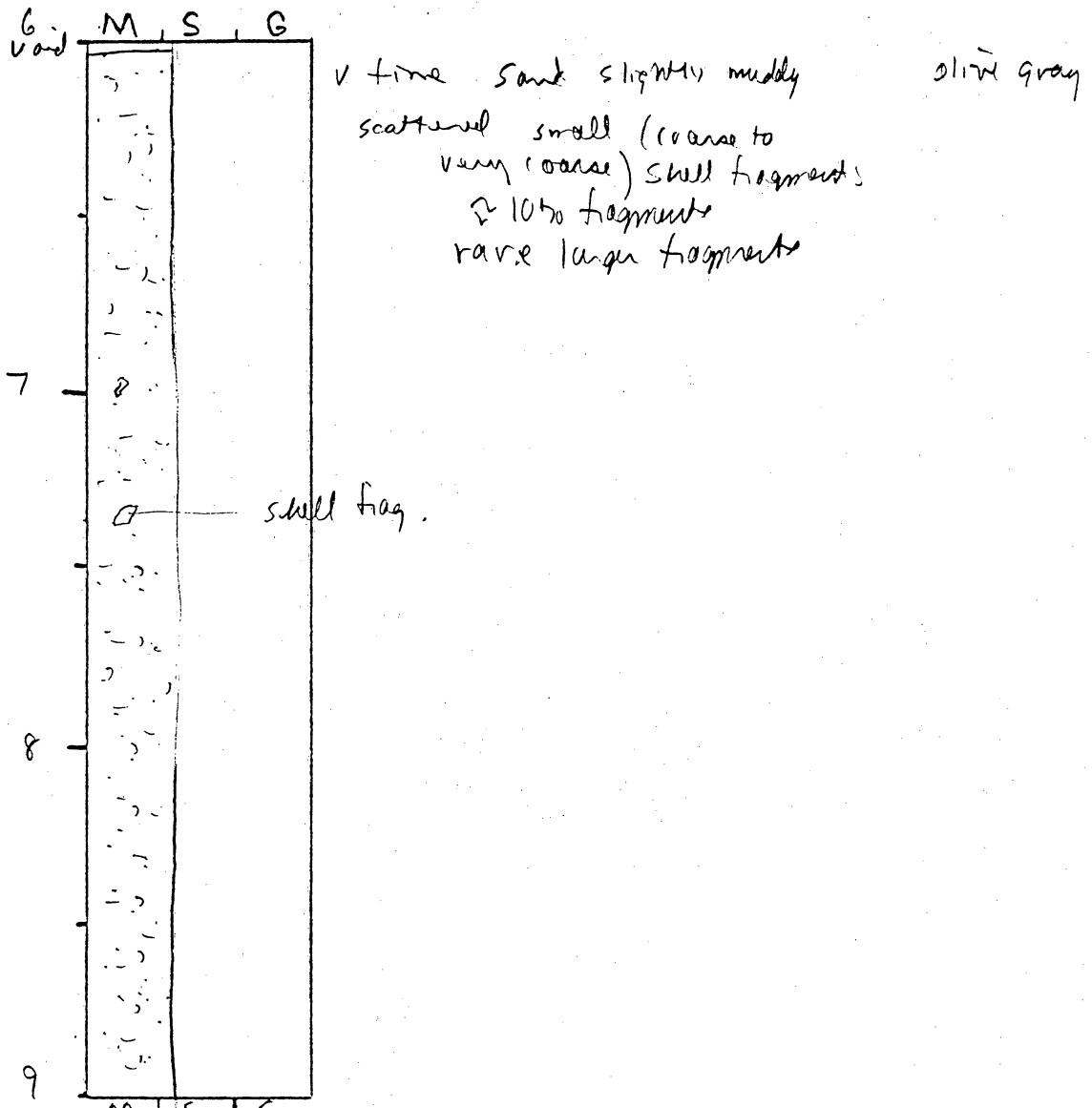
General Comments:

CORE LOG

CORE # HBV-3 (C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



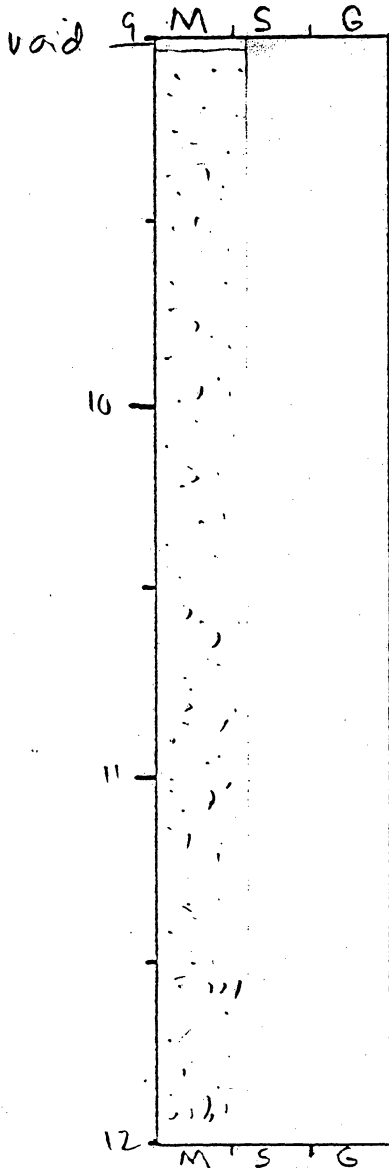
General Comments:

CORE LOG

CORE # HBV-31D TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



slightly muddy v. fine sand
 Scattered small shells fragments
 (< 5%)

Olive gray
 with
 light olive gray to
 light olive brown
 mottling thin left
 side of core
 (and right side
 near bottom).

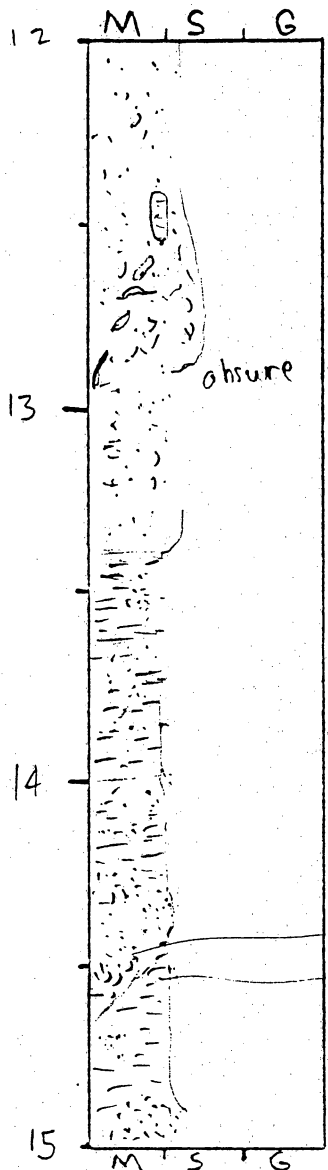
shell fragments increase in
 abundance and size below
 ~ 10.5' (approx) ~ 10%
 locally concentrated ~ 20%

General Comments:

CORE LOG

CORE # 45V-3 (E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



v. fine sand
 slightly muddy
 scattered shells
 10%

olive
 gray
 (5Y 3/2)

Increase in shells (some found 72u)
 > 25% shelly sand

13
 obscure contact

v. fine sand
 increase in mud with depth
 scattered shells
 muddy sand to sandy mud

(Mottling & irregular
 contacts possibly due
 to burrowing)

14

13.7' - 14'
 mud becomes dominant
 (sandy mud)

muddy sand

15

shell pocket muddy shelly sand
 dipping contact

mud dominant (sandy mud)

sand dominant scattered shells

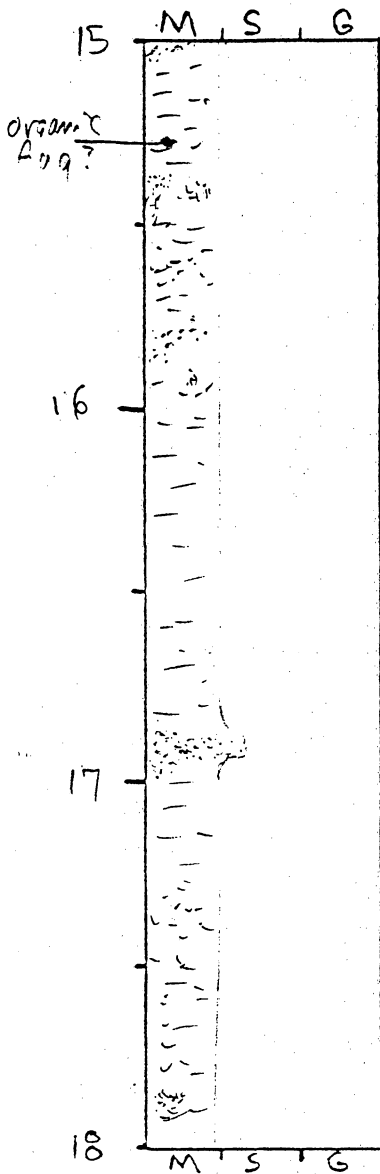
General Comments:

CORE LOG

CORE # HBV-3(F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



mottled clay
with pockets
of shell frag.
& sand

mottled
down length
of core
from light
olive gray to
olive gray

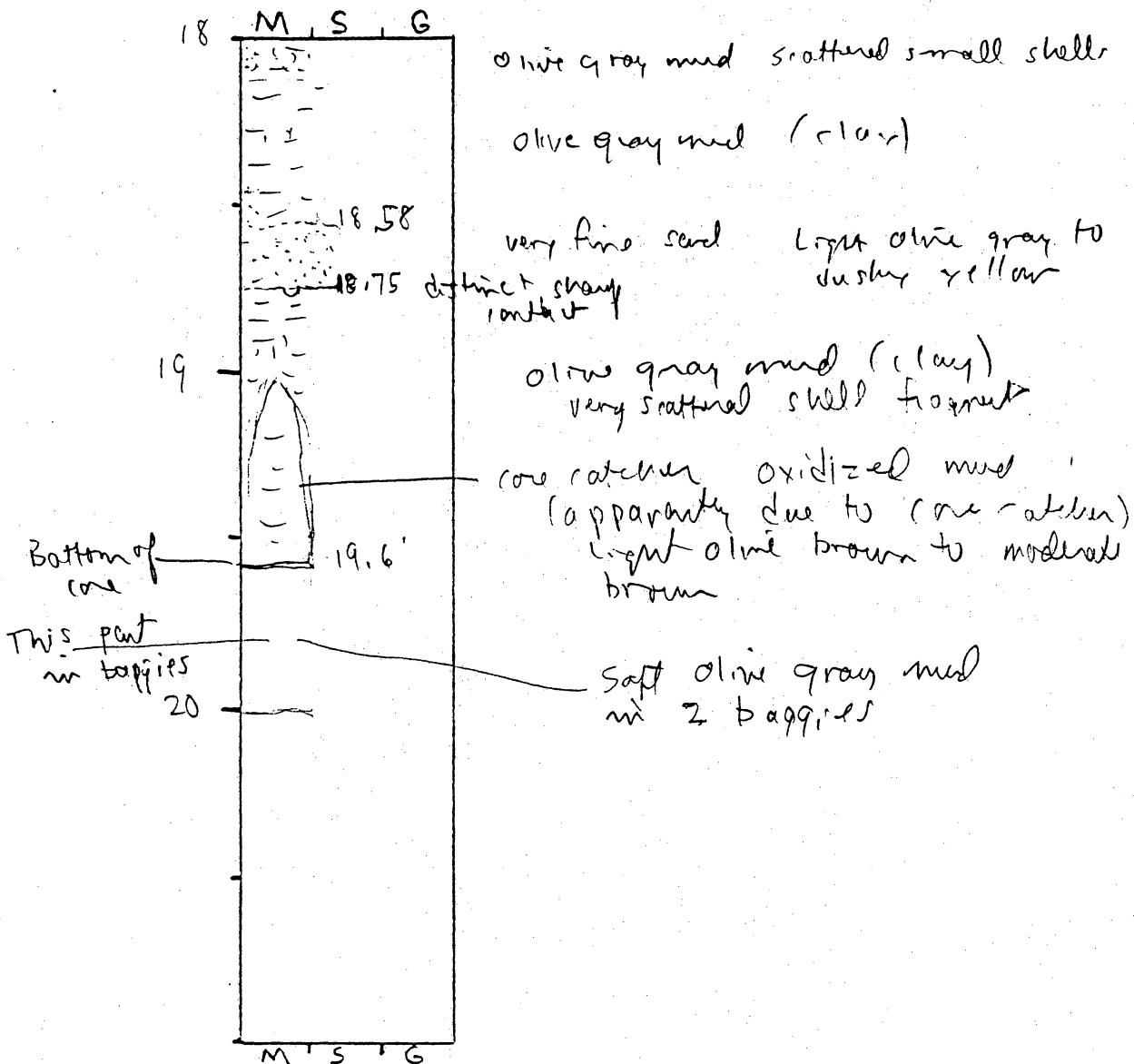
sand (very fine) straggles

General Comments:

CORE LOG

CORE # HBV-3(G) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



General Comments:

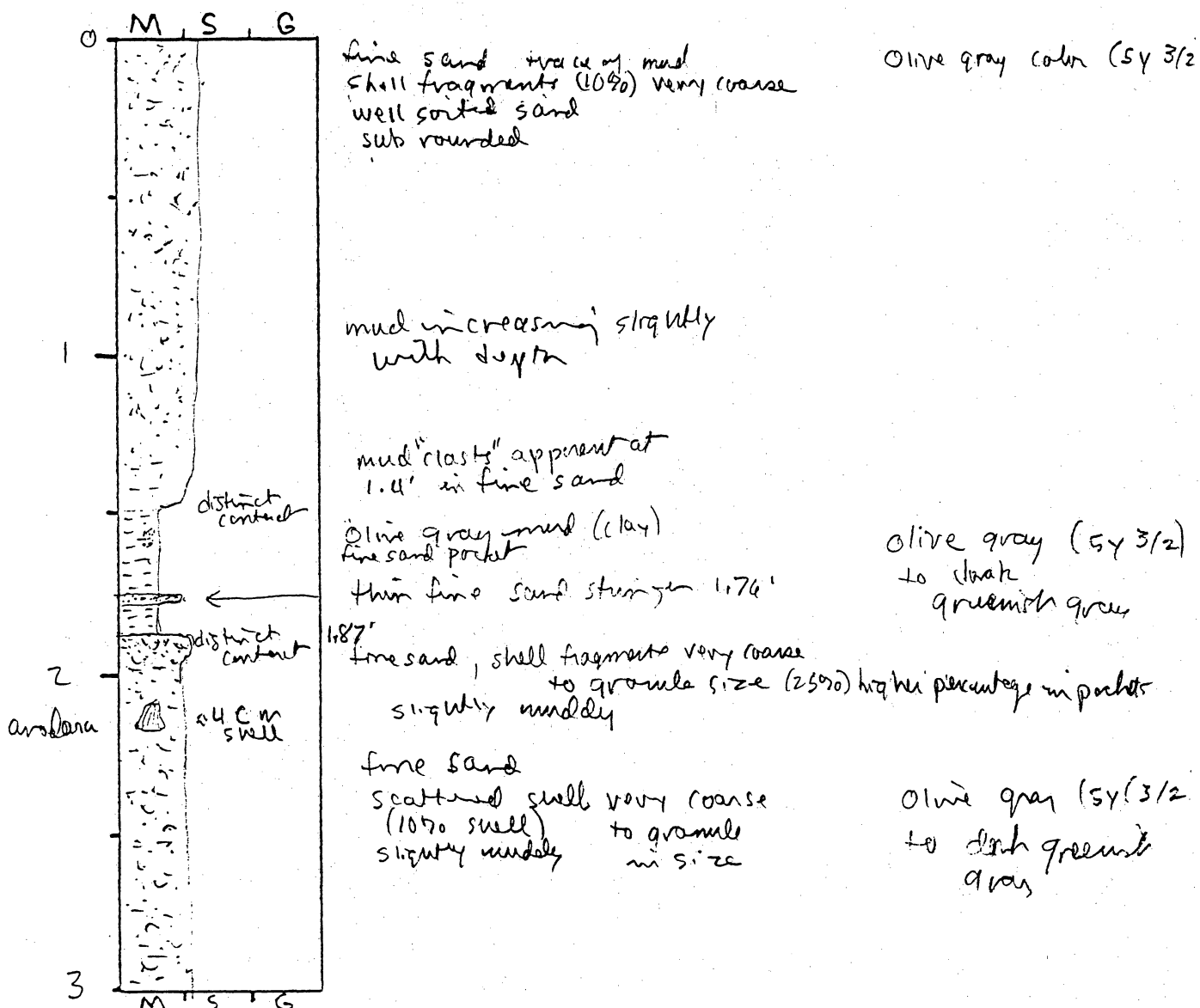
Photographed 1-25-95

CORE LOG

CORE # HBV-4(A) TYPE Vibracore LOCATION Heald Bank
 LATITUDE 29° 08.993 LONGITUDE 94° 11.565 SURFACE ELEVATION -50.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 15' 8 1/2" % COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-12-94
 DESCRIBED BY White DATE 15.7'

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



General Comments:

CORE LOG

CORE # HBV-4(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
3		slightly muddy fine sand with scattered (10%) shell fragments up to granule in size and slightly larger		dark greenish gray to olive gray (5Y 3/2)
4		fine sand; mud becoming more apparent between 4.4' scattered shells up to small pebble in size 15% shell		dark greenish gray to olive gray (5Y 3/2)
5		mud increasing with depth muddy sand obscure mud "clasts" most abundant mud between 5.25' - 5.42'		
6		concentration of shell material in fine sand ~ 40% fine sand, slightly muddy scattered shell fragments.		

General Comments:

CORE LOG

CORE # HBV-4(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

6		fine sand, slightly muddy, scattered shell distinct contact at 6.25' but irregular surface, possibly from rain or burrowing.	olive gray (5Y 3/2) to dark greenish gray
7		clay few shell fragments local shell patches	
		shelly muddy sand sturgeon	
8		fine sand scattered shells (up to small muddy pebble in size)	(5Y 3/2) olive gray to dark greenish gray
		shell sturgeon at 8.25'-8.30' gravel size	
		clay or mud, slightly sandy shell patches, gravel size	
9			

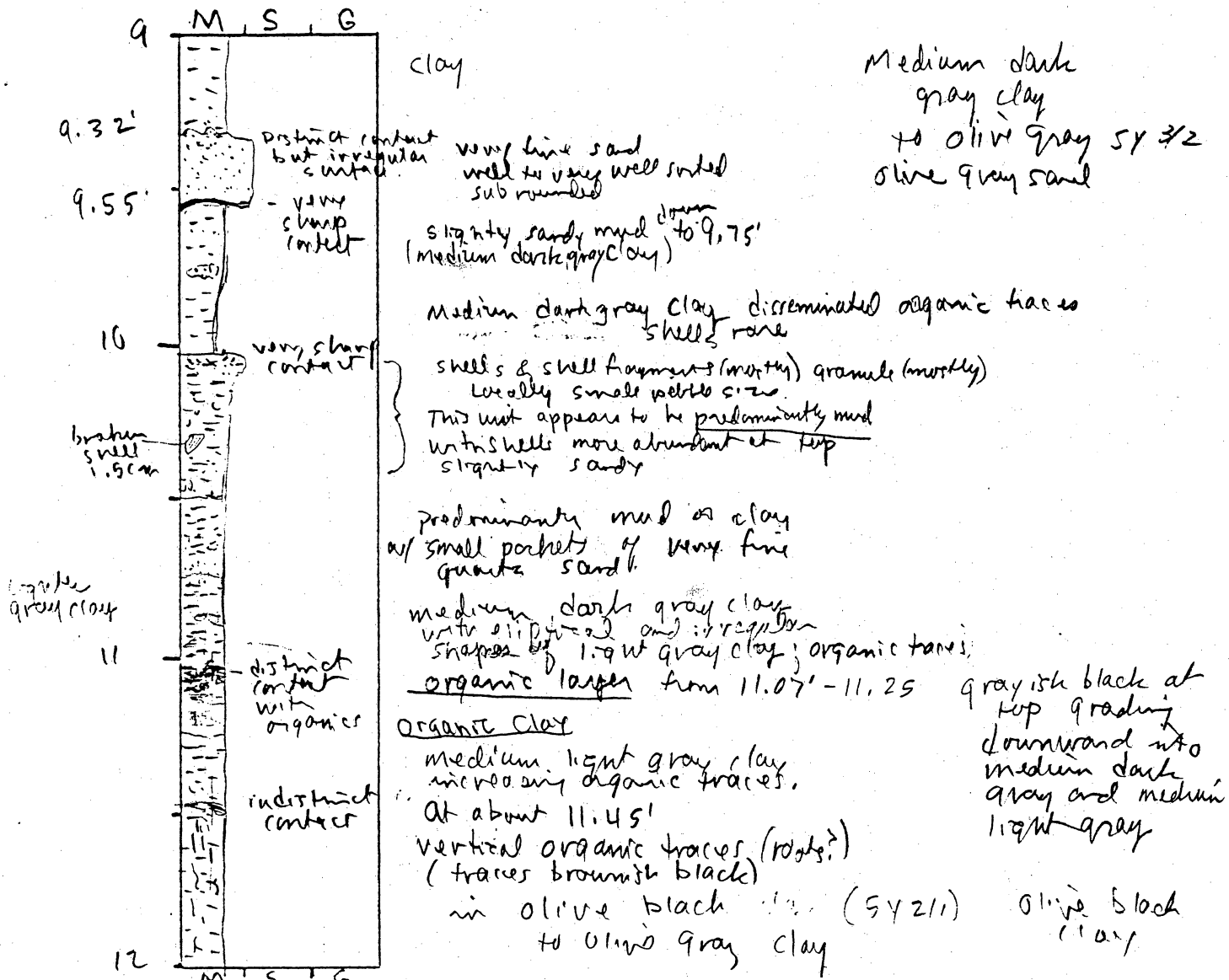
General Comments:

CORE LOG

CORE # HBV-4 (D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

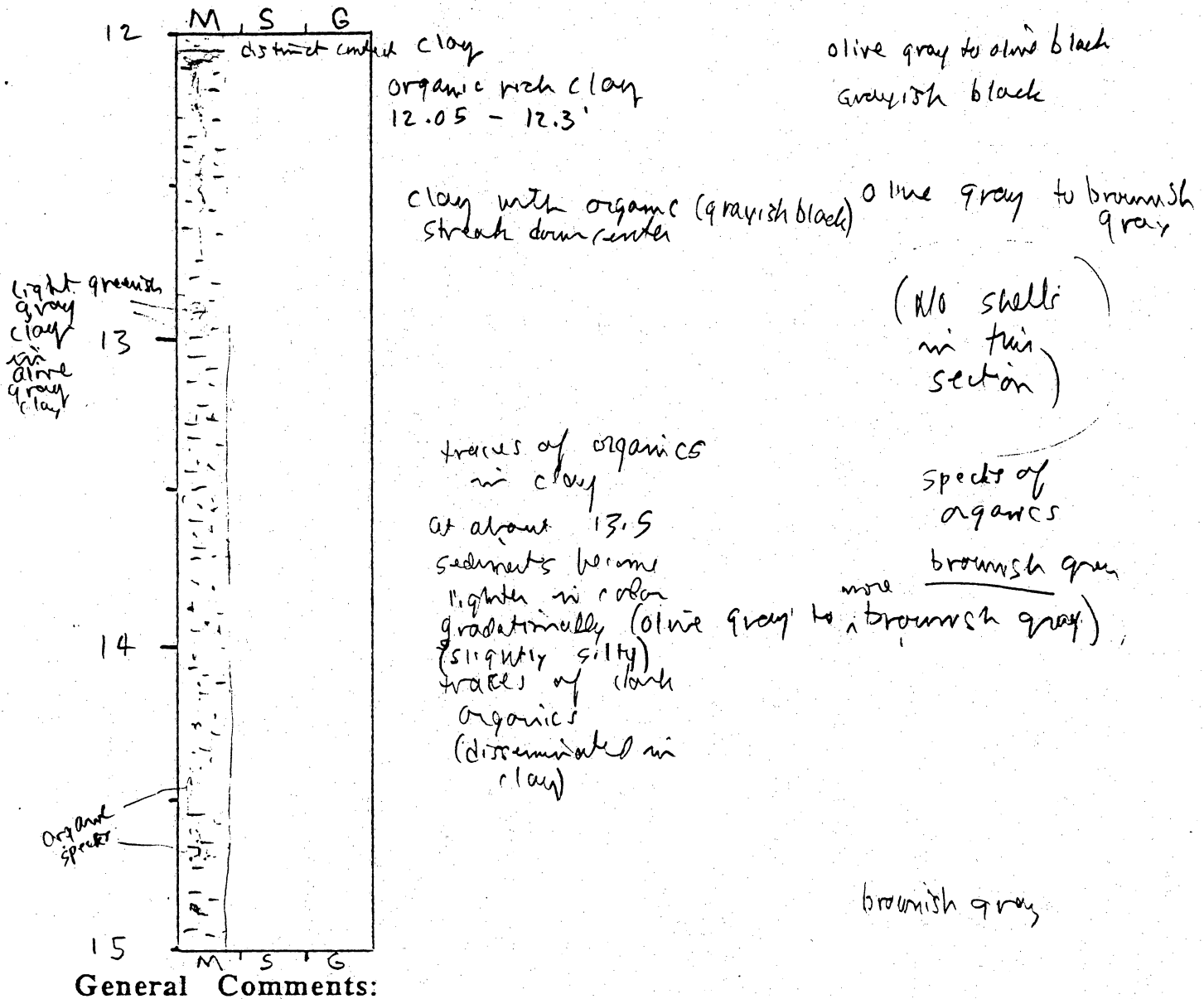


General Comments:

CORE LOG

CORE # HBV-4(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

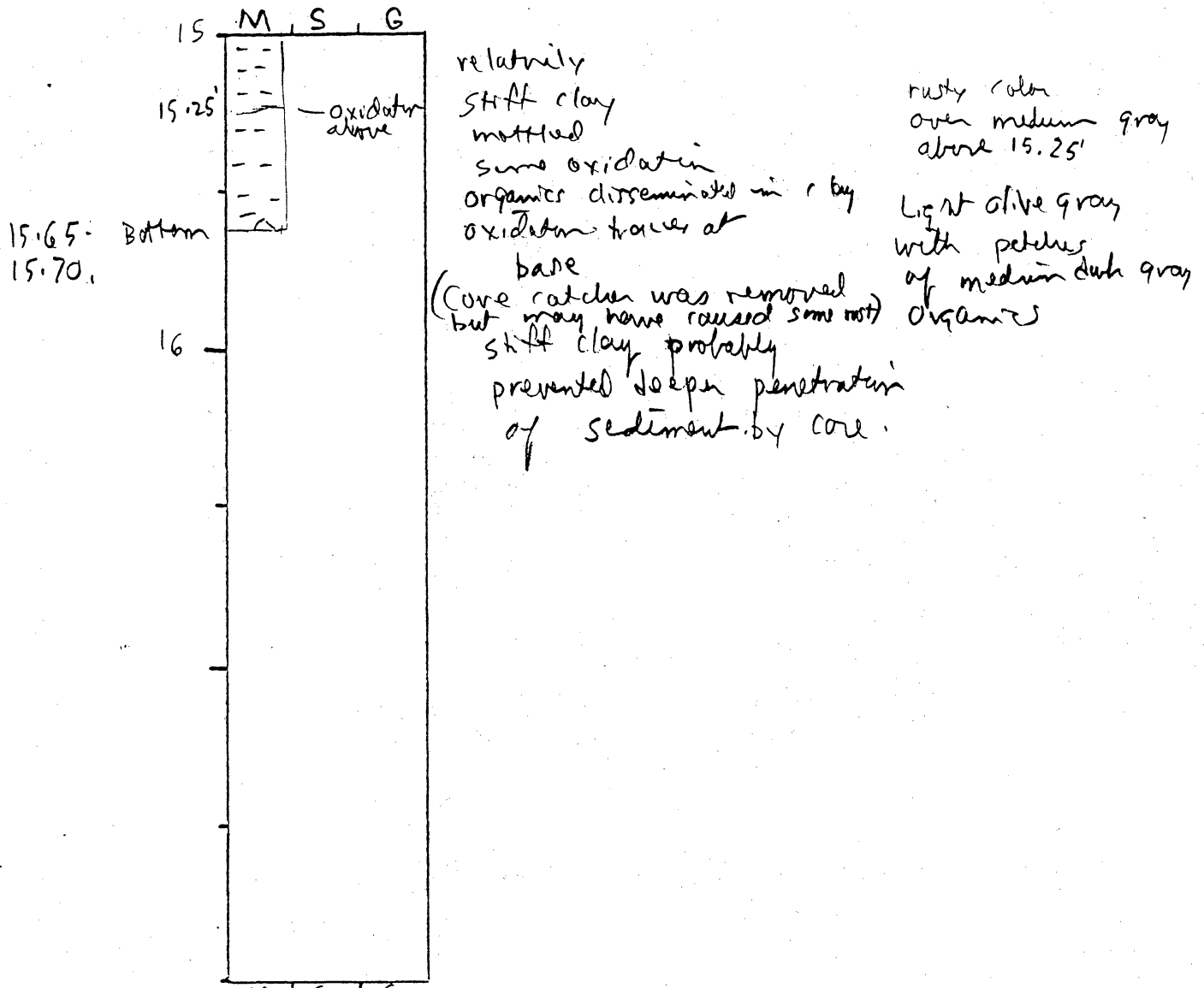
DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



CORE LOG

CORE # HBV-4(F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



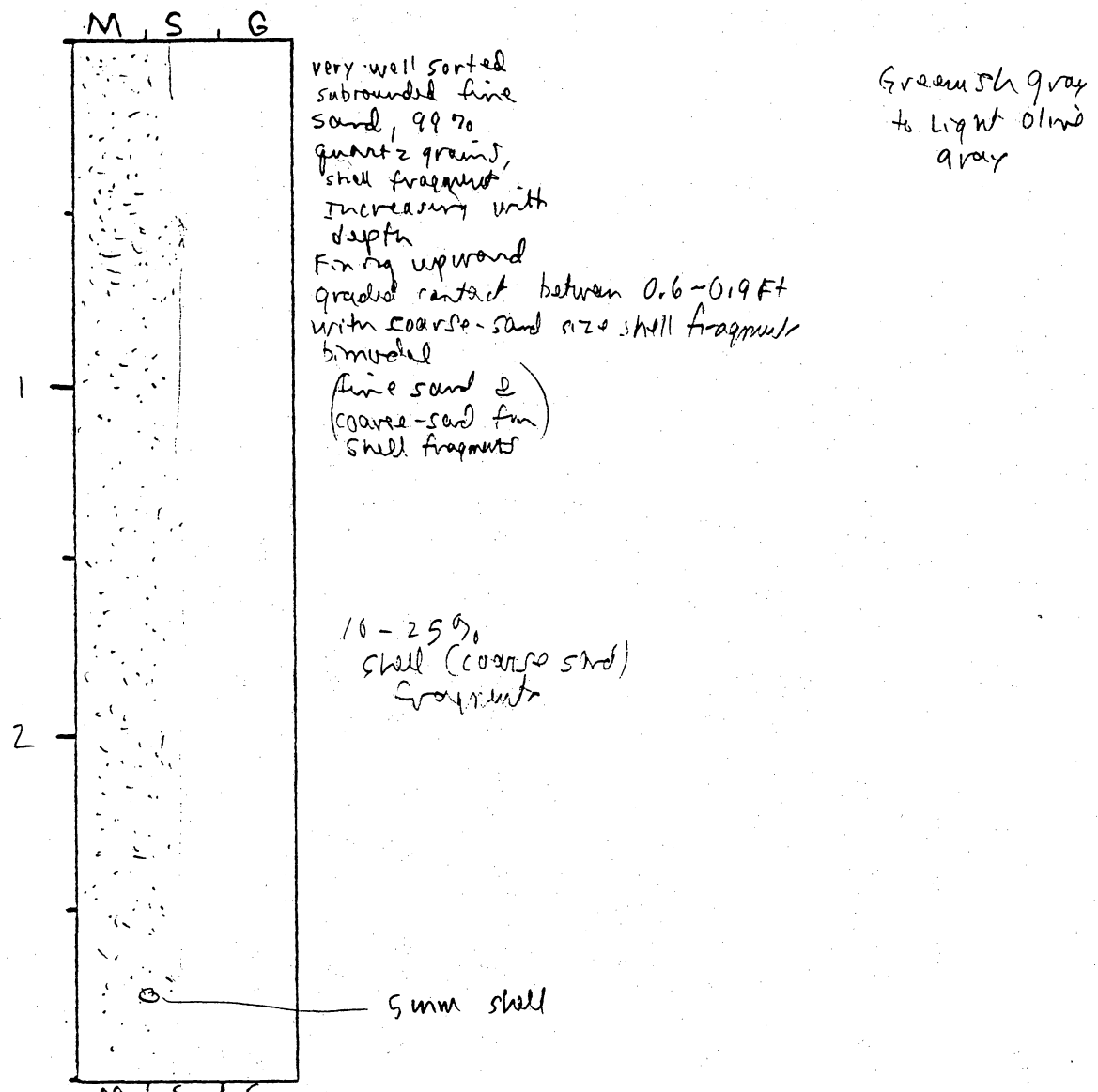
General Comments:

CORE LOG

CORE # HBV-5 (A) TYPE Vibracore LOCATION Heald Bank
 LATITUDE 29° 08.13' LONGITUDE 74° 11.025' SURFACE ELEVATION -35'
 DEPTH PENETRATED ? LENGTH RECOVERED 19'10" % COMPACTION ?

OBTAINED BY G. Beant - R/V Kit Jones DATE 10-12-94
 DESCRIBED BY White DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



General Comments:

CORE LOG

CORE # HBV-5 (5) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
3		<p>Fine, predominantly quartz sand (subrounded) with scattered (very well sorted) shell & shell fragments</p> <p>Increase in shell with depth Obscure contact at ~ 3.8' (graded) fine well-sorted sand & increasing shell fragments very coarse</p>		Light olive gray
4				
5		<p>fine quartz sand with coarse sand sized shell fragments and scattered gravel sized shell increasing to depth of 5.75'</p>		
6		<p>5.75' obscure contact with decrease in shell below fine sand with scattered shell</p>		

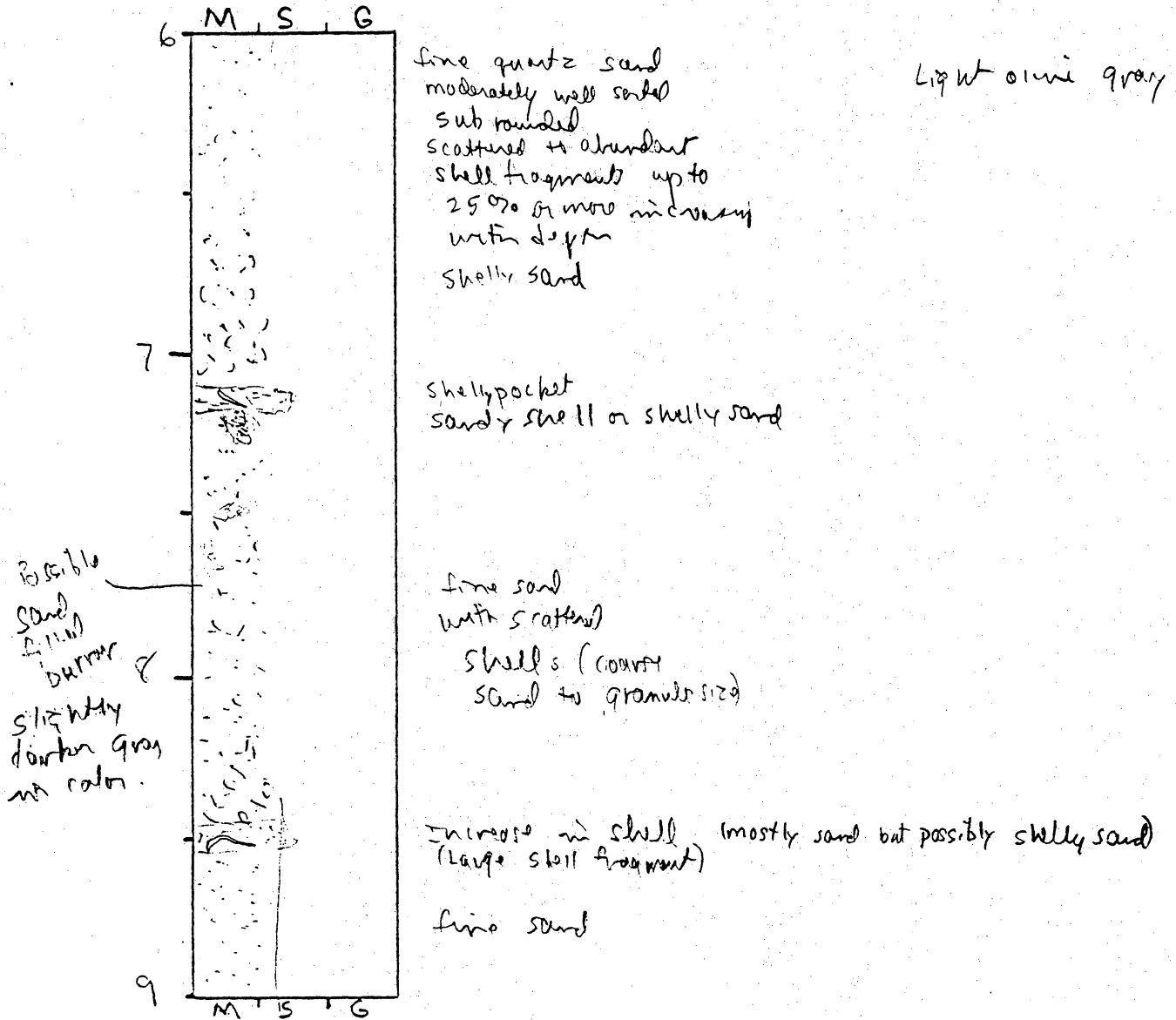
General Comments:

CORE LOG

CORE # HBV-5(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



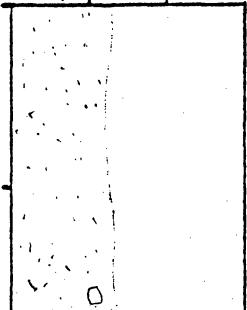
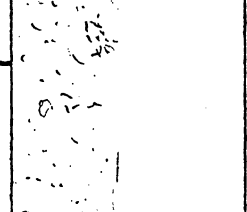
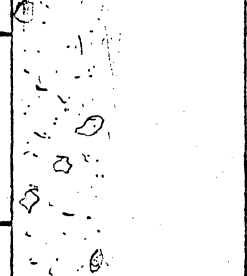
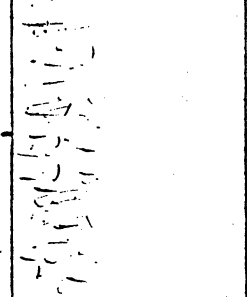
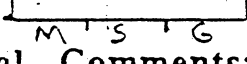
General Comments:

CORE LOG

CORE # HBV-5(D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
9		fine quartz sand well sorted, subrounded		Light olive gray
10		Shell hash pockets and occasional large fragment (> 1 cm)		
11		Scattered gravel-size shell fragments in fine quartz sand		
11.5		Traces of mud below 11.3' (granular contact) still predominantly fine sand but mud products darkly colored gray; scattered		Dark greenish gray
12		coarse-sand shell fragments.		

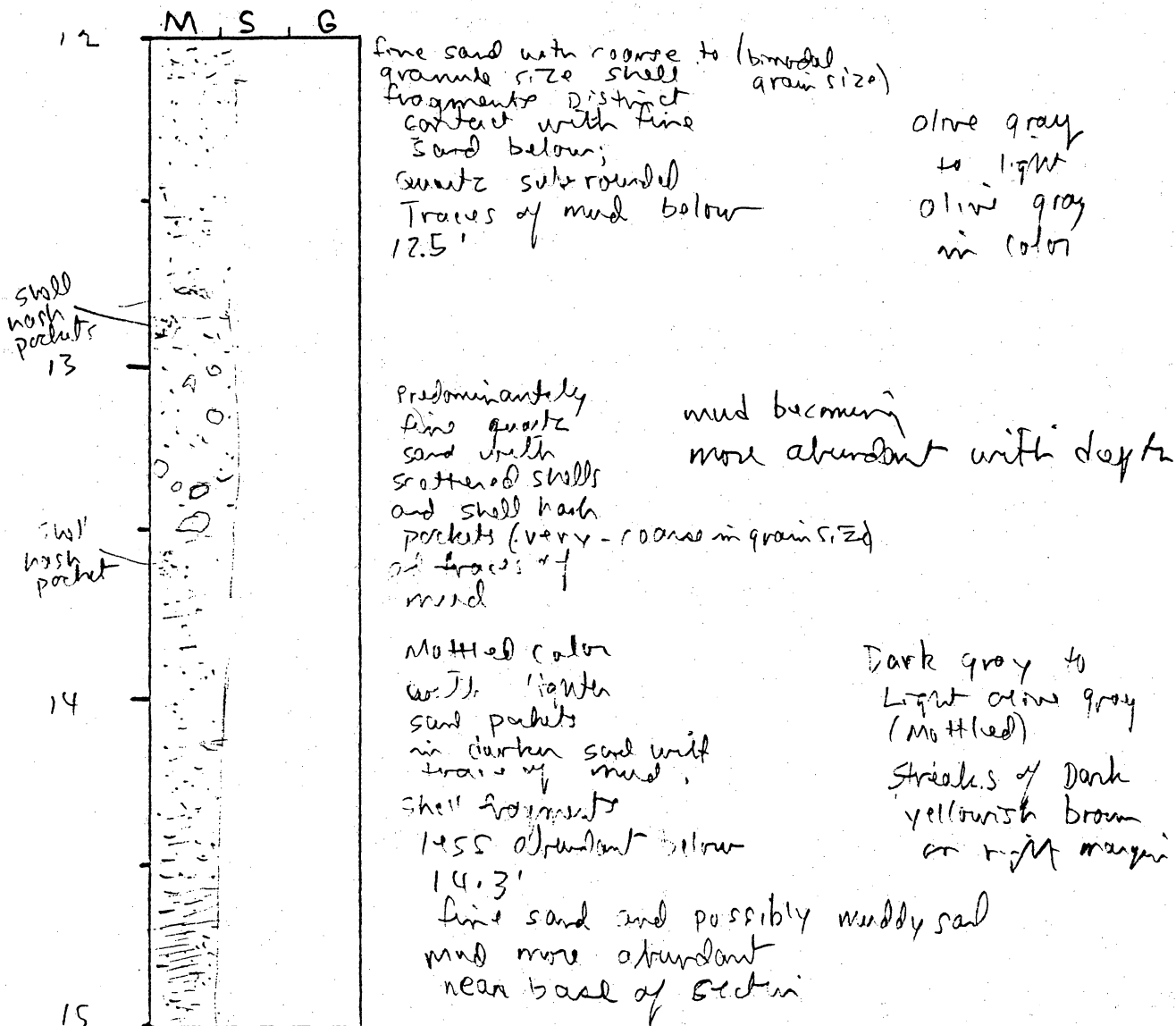
General Comments:

CORE LOG

CORE # HBV-5 (E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



General Comments:

CORE LOG

CORE # 4BV-5 (F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
15		fine quartz sand well sorted Traces of mud more apparent below 15.4'		olive gray becoming dark greenish gray to dark gray below 15.4'
16		fine quartz sand scattered shell fragments & occasional small (1-2 mm) shell hash pockets and more concentrated sand pockets slightly muddy		Dark greenish gray to Dark gray
17				
18				

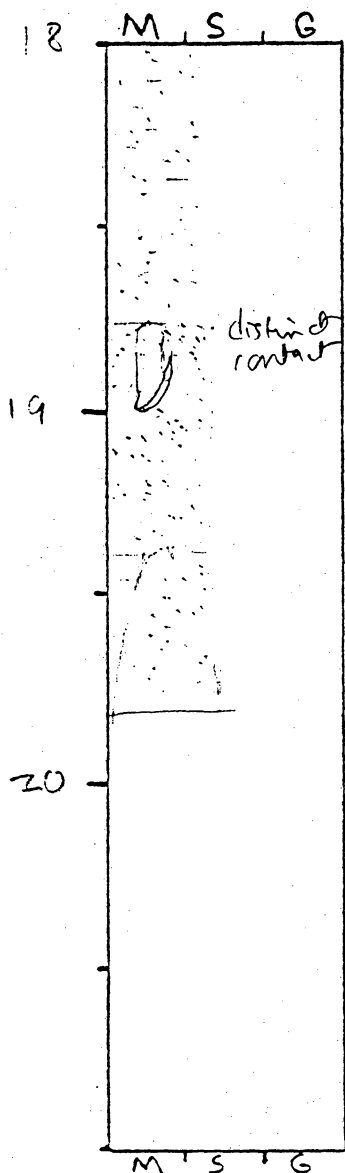
General Comments:

CORE LOG

CORE # HBV-5(G) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



fine sand (quantity)
 slightly muddy

Dark gray color

19 distinct contact

large gastropod
 8-9 cm long

Gastropod cut in
 hole by saw
 (chamber shown)

color change
 below gastropod;
 fine sand with scattered shell frags.
 color change
 oxidation
 (possibly due to core catcher)

Olive gray
 moderate yellowish brown
 (ore catcher) (rusty)

19.8' Bottom

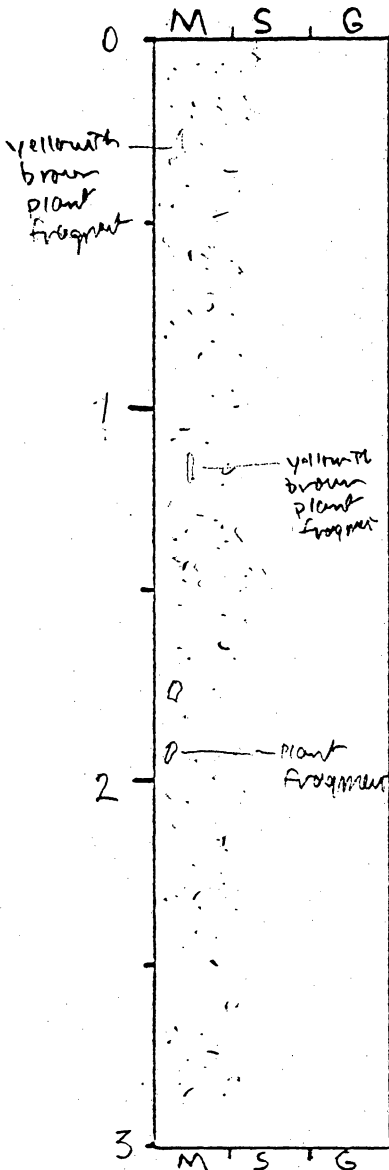
General Comments:

CORE LOG

CORE # HBV-6(A) TYPE Vibro core LOCATION Head Bank
 LATITUDE 29° 08.630' LONGITUDE 84° 09.949' SURFACE ELEVATION -34'
 DEPTH PENETRATED ? LENGTH RECOVERED 10.6 % COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-12-94
 DESCRIBED BY White DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



fine sand (quartz)
 with scattered shell
 fragment, possibly 20% shell
 Locally, plant fragments
 granules & very coarse sand size

Light olive grey color

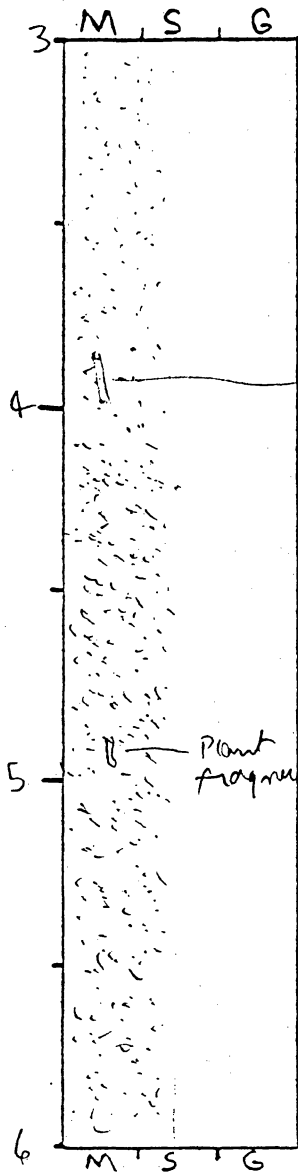
General Comments:

CORE LOG

CORE # HBV-6 (B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



fine sand (quartz)
 scattered shell fragments
 granule to coarse grained.
 quartz well sorted
 sub-rounded

Light olive gray
 in color
 with dark specks (shells)
 and some heavier frags

Bryozoa plate fragment

fine sand
 Coarsening becomes more
 apparent below 4.3' but
 is
 Gradational.
 Coarsening downward
 as shell material
 becomes more abundant
 ≈ 25%

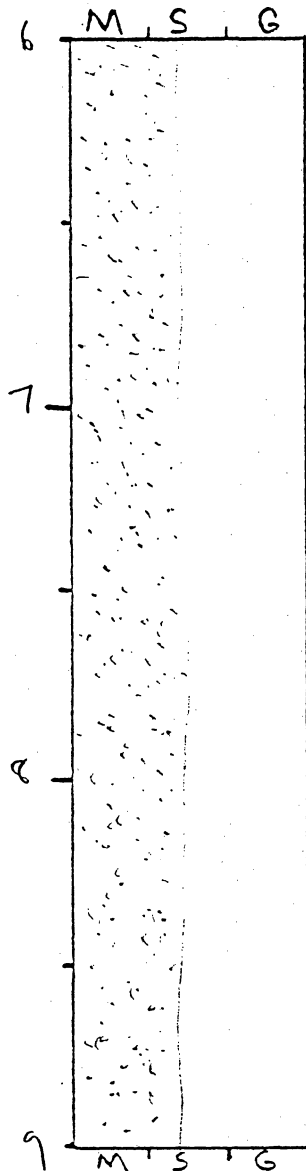
General Comments:

CORE LOG

CORE # H BV-6 (C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



fine quartz sand
 with shell fragments
 coarse to granule in
 size
 quartz well sorted, sub rounded
 Appears to be slight
 coarsening with
 depth as
 shell fragments
 compose \approx 25%
 of sediment
 occasional shell
 fragment up to
 6 mm in length

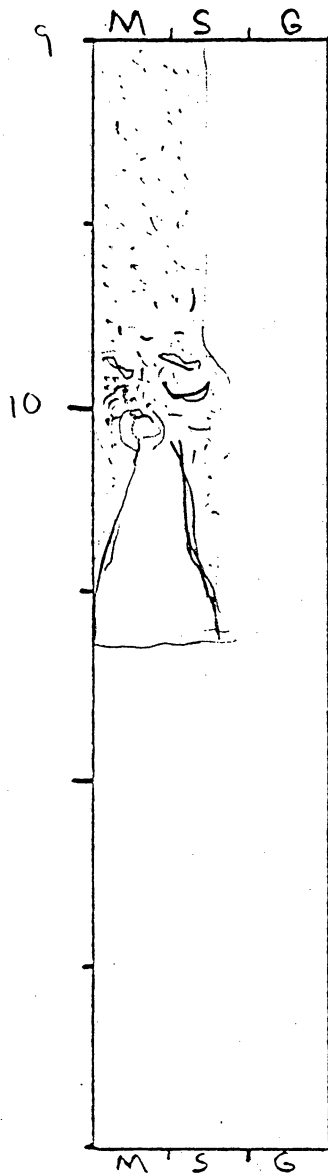
light olive gray
 with black
 speckles
 from shell
 fragments &
 heavy mineral

General Comments:

CORE LOG

CORE # HBV-6 (D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



fine sand (quartz)
 coarse to granule
 shell fragments ~ 25%
 qtz sand sub-rounded
 well sorted

Light olive gray
 with darker speckles
 of shell fragments

shelly sand
 to sandy shell
 most granule
 size or finer
 but some gravel size
 shells

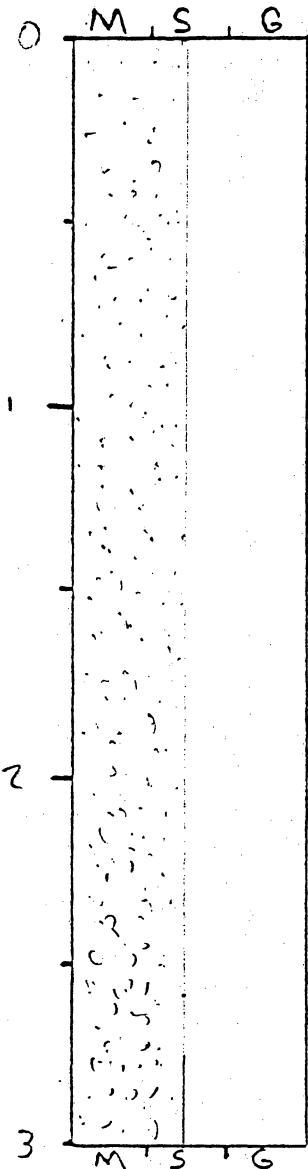
General Comments:

CORE LOG

CORE # HBV-7(A) TYPE Vibracore LOCATION Heald Bank
 LATITUDE 29° 08.672 LONGITUDE 94° 08.193 SURFACE ELEVATION -50'
 DEPTH PENETRATED ? LENGTH RECOVERED 15' % COMPACTION ?

OBTAINED BY Gibeaut - RN Kit Jones DATE 10-12-94
 DESCRIBED BY White DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Lt olive gray to light olive brown
 Fine sand with scattered shell fragments
 very coarse to granule in size becoming
 coarser toward bottom of core

traces of clay in
 upper part of core

Lt olive gray
 to
 Lt olive brown
 in color.

becomes coarser at depth
 (increases in very coarse to
 granule size shell frags.)

Gradational

shell ≈ 2590 near bottom

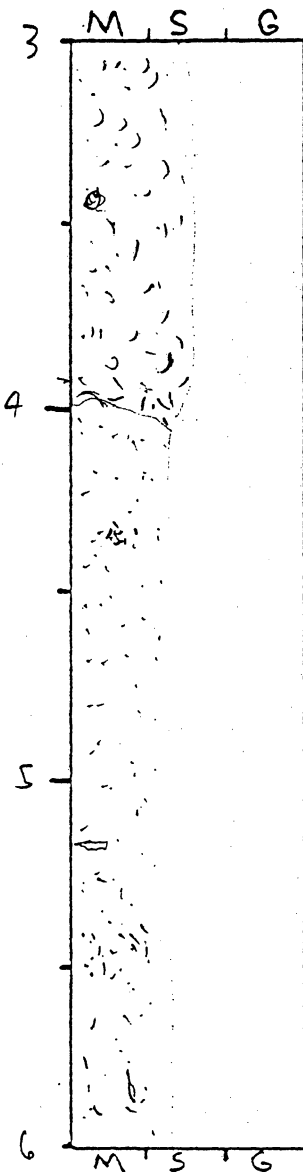
General Comments:

CORE LOG

CORE # NBV-7(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Lt Olive gray shelly fine sand to medium & coarse (fine shell fragments)

Shell fragments & whole shells (7mm long)

sediments become grayer
 < 10% shell fragments except for local pebbles
 v. fine sand with scattered shells

Lt Olive gray
 to
 Olive gray

Increase in shells locally 10-15%

General Comments:

CORE LOG

CORE # H3V-7(c) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
6		v. fine muddy sand at top. sandy clay or mud (few shells) lt olive green muddy sand		muddy. lt olive green but some mottling (possibly burrow) on right side olive gray
7.		color change from lt olive gray (brownish) to olive gray - dark gray muddy sand		
		increase in mud in this area muddy sand or sandy mud mud sand & shell very shelly		
8		fine sand, slightly muddy scattered shells		
9		2 large shells (2.5cm long) in fine sand		

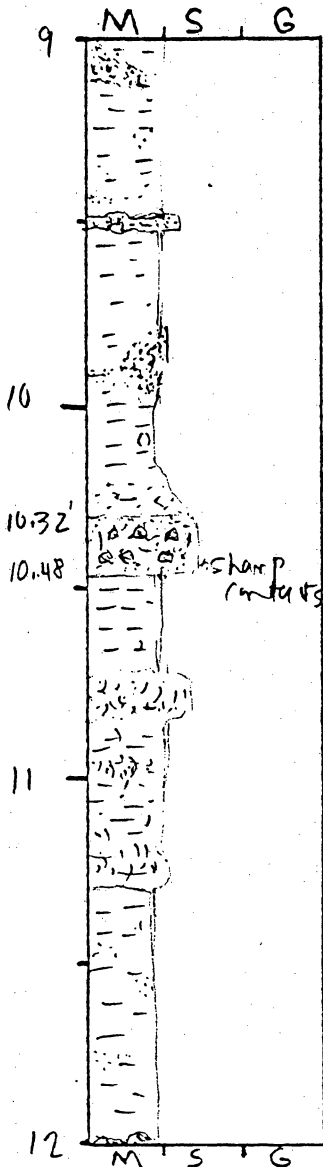
General Comments:

CORE LOG

CORE # 148V-7 (D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Olive gray mud with pockets of very fine sand (olive gray)
 Some burrowing
 54 3/2
 thin sand layer

Sand pocket in mud
 Some light olive gray mottling (brownish)

10 muddy sand zone above shell zone
 10.32 shelly sand or sandy shell, shell fragments & whole shells up to 1 cm. w
 10.48 sharp contacts
 mud (rare shells)

Sandy shelly mud or muddy shell (fragments & whole shells 1 cm wide)

11 mixture of mud, sand & scattered shells
 shelly mud or muddy shell, some sand

Mostly olive gray mud, some sand pockets
 few shells

small pockets of brown sand in bottom, small whole shells

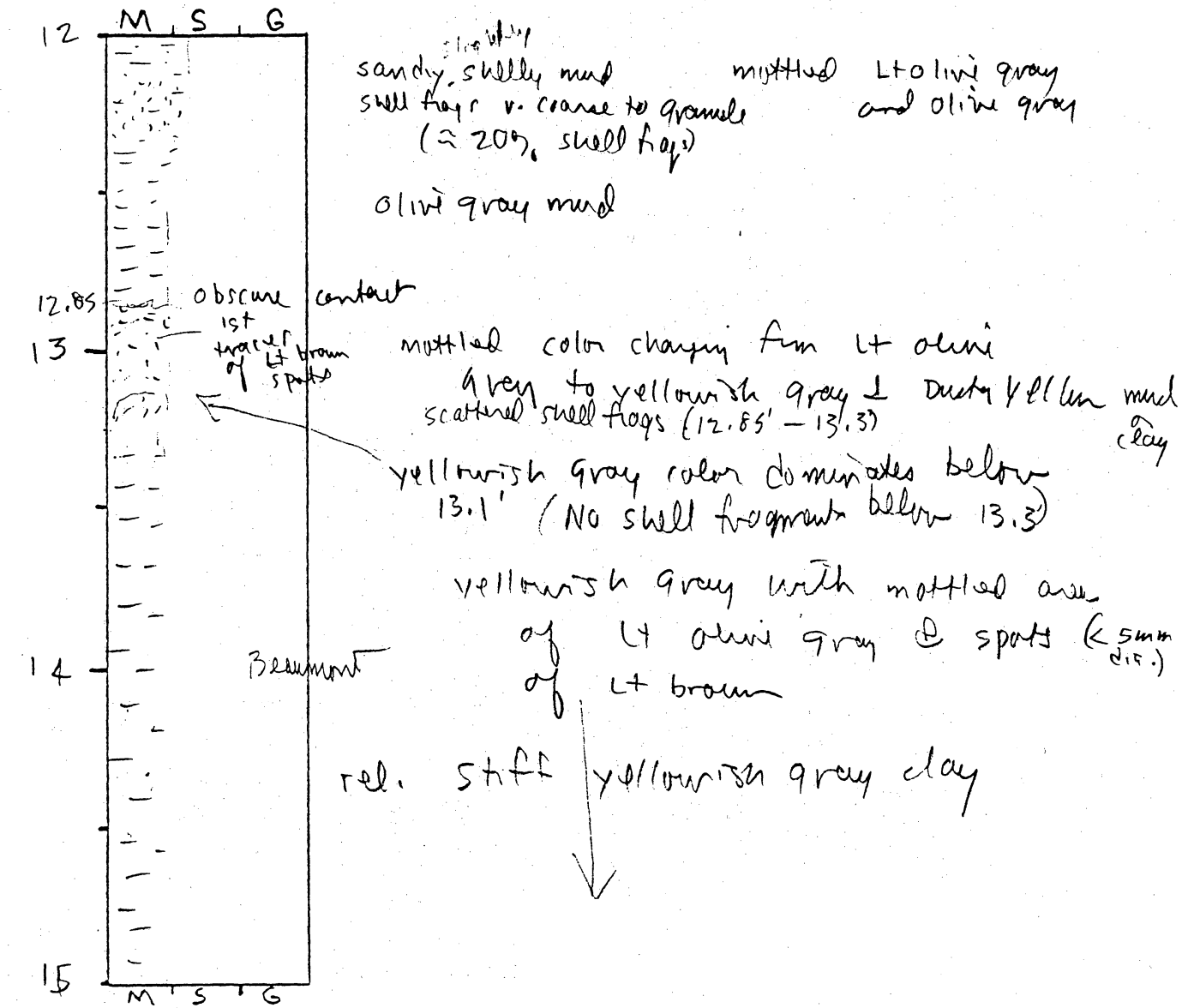
General Comments:

CORE LOG

CORE # HBV-7(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



General Comments:

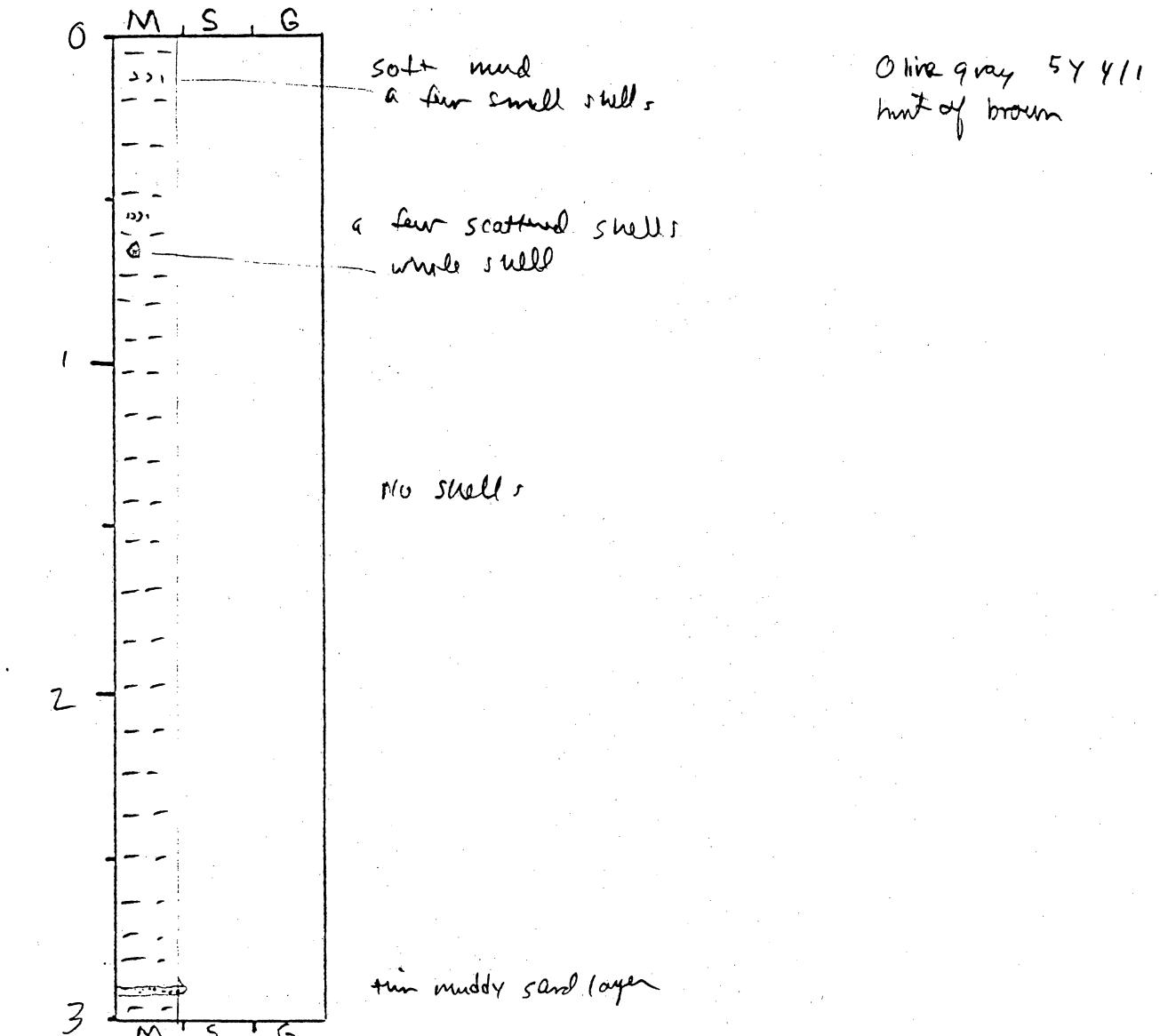
APPENDIX C. CORE DESCRIPTIONS HEALD BANK

CORE LOG

CORE # SBV-9 (A) TYPE Vibracore LOCATION Sabin's Bank
 LATITUDE 20° 38.090' LONGITUDE 94° 03.449' SURFACE ELEVATION 18'
 DEPTH PENETRATED ? LENGTH RECOVERED 7' 2" % COMPACTION 2
7.2'

OBTAINED BY Gibeault, R/V Kit Jones DATE 10-10-94
 DESCRIBED BY WWT DATE 2-3-95

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
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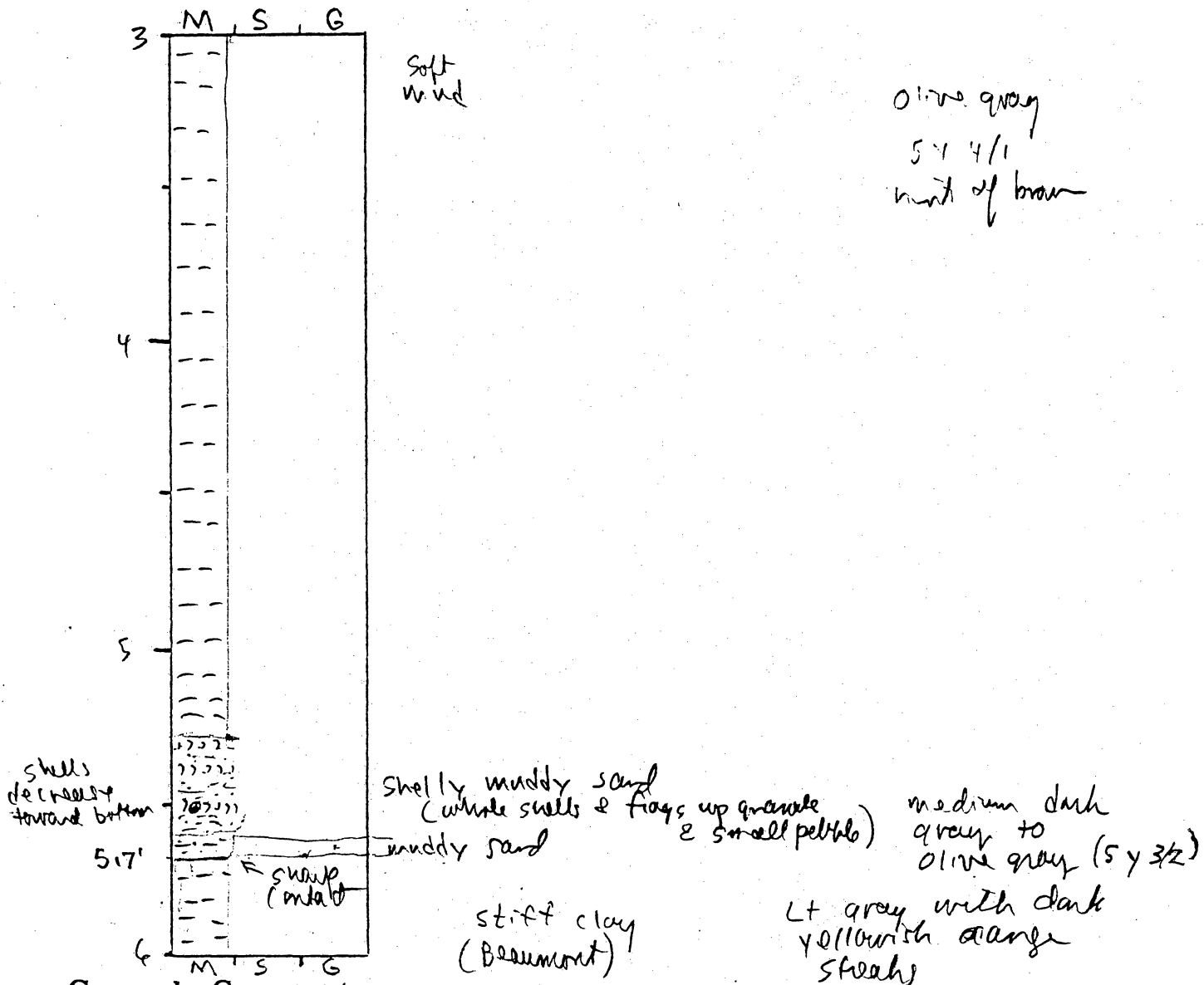


General Comments:

CORE LOG

CORE # SBV-9 (B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



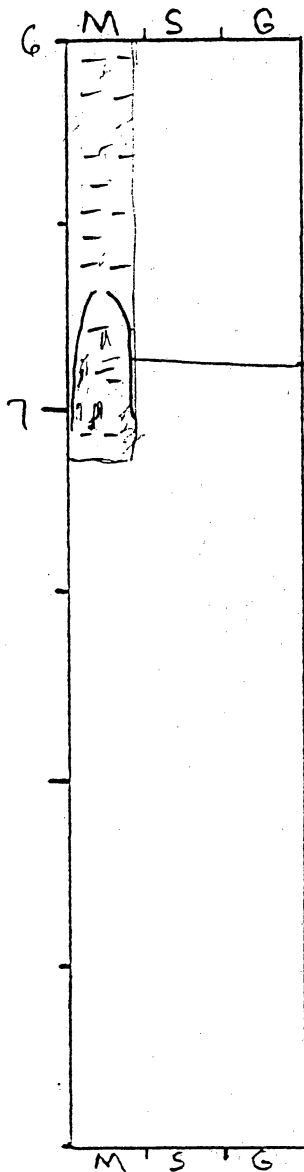
General Comments:

CORE LOG

CORE # SBV-9(c) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



stiff clay (mottled)
 (Beaumont)
 No shells

light gray to pale olive with dark yellowish orange streaks (vertical)

Core catcher

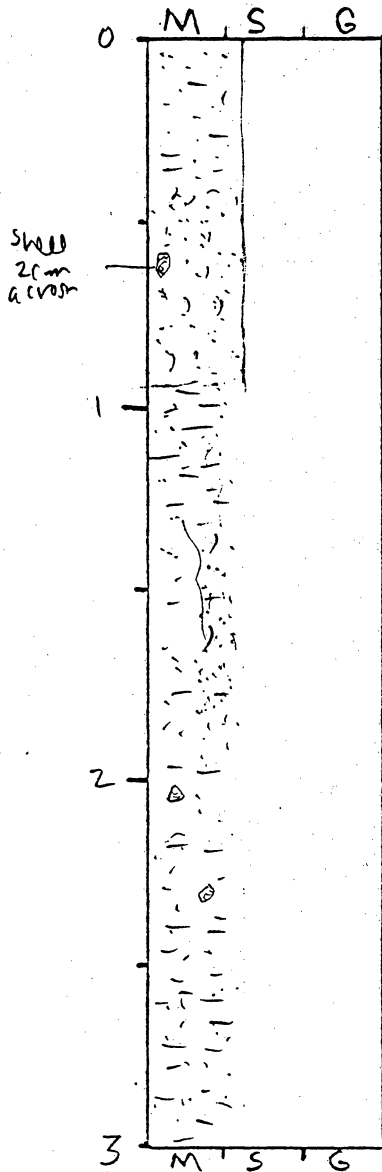
mottled Lt gray, ^{dark} yellowish orange, and small streaks of dark gray

General Comments:

CORE LOG

CORE # SBV-10(A) TYPE Vibrocne LOCATION Sabine Bank
 LATITUDE 29° 29.72' LONGITUDE 93° 48.43' SURFACE ELEVATION -42'
 DEPTH PENETRATED 7' LENGTH RECOVERED 18.5' % COMPACTION 2%
 OBTAINED BY G. Brouet & R/V Kit Jones DATE 10/11/94
 DESCRIBED BY V. Witz DATE 2/3/95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand (v. fine qtz sd) Dark yellowish Brown
 scattered shell frags & whole shells
 granules & pebbles in size
 shells more concentrated (to 10%) from 0.4' - 0.9' (higher conc. of sd also)
 appear to be heavily burrowed
 based on sand & mud relationships

(muddy sand)
 muddier and more olive gray in color
 from 0.9' - 1.4
burrows

Dark yellowish brown
 to
 olive gray

muddy sand but mud appear
 to be increasing at depth
 color becoming more
 olive gray toward
 bottom (less
 brownish)

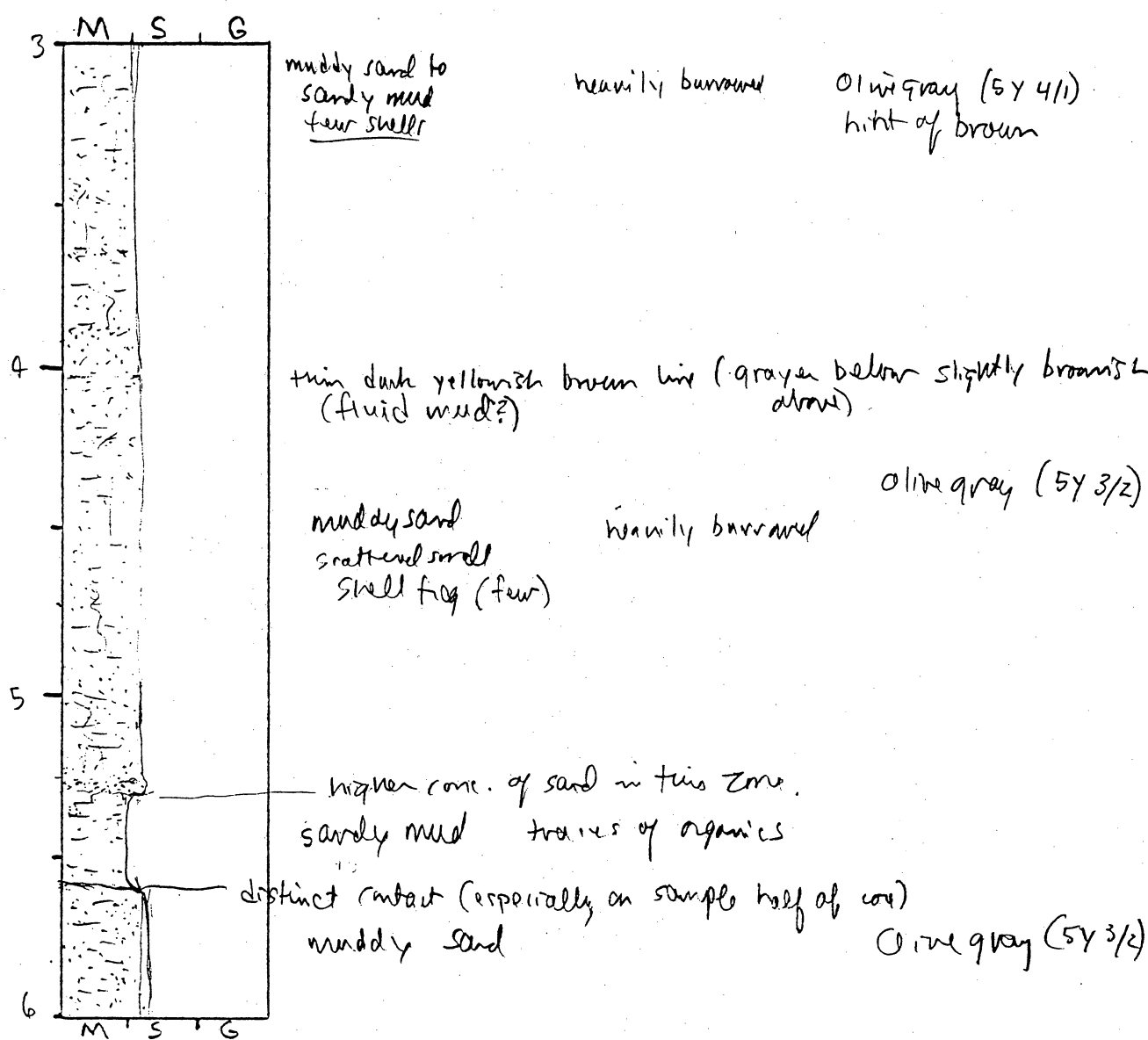
General Comments:

CORE LOG

CORE # SBV-10(13) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



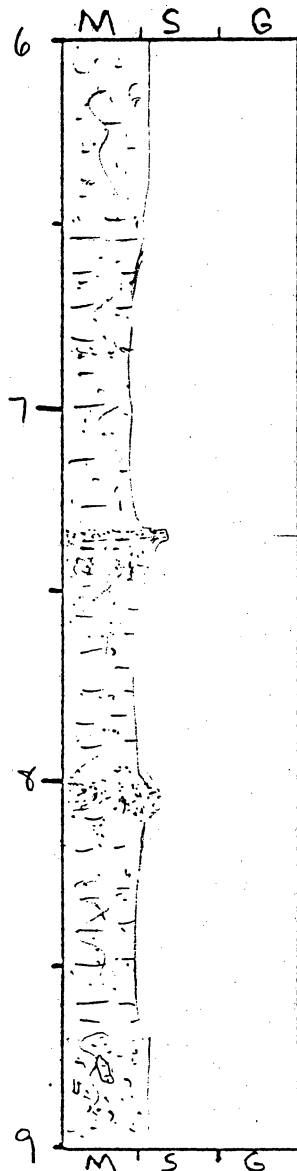
General Comments:

CORE LOG

CORE # SBV-10(9) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand
 v. few shells
 burrowed

sandy mud
 small sand pockets

sand (slightly muddy)
 burrowed

Sandy mud
 v. few shells

sand (slightly muddy) a few small shells

Sandy mud
 (small sand pockets) (v. few shells)

muddy shelly sand (burrowed)
 (a couple of shell frag gravel size)

olive gray (5Y 7/2)

olive gray (5Y 3/2)

General Comments:

CORE LOG

CORE # SBV-100D TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

9	M, S, G	muddy sand (v. fine sand) slightly shelly < 10% sand filled burrow discrete mud & sand zone	burrowed	olive gray
10	distinct contact	slightly sandy mud sandy pockets; v.s scattered shells in sand		
	distinct contact	muddy shelly sand (shell frags granules)		
11		organic mud or clay traces of sand or silt (olive gray clay or mud with organic traces)		
		mud (traces of silt & sand in pockets) scattered small shell frags (v. coarse to granule)		
		slightly more sand (sandy mud) (scattered ^{small} shell frags)		
12	M, S, G	mud organic traces		olive gray

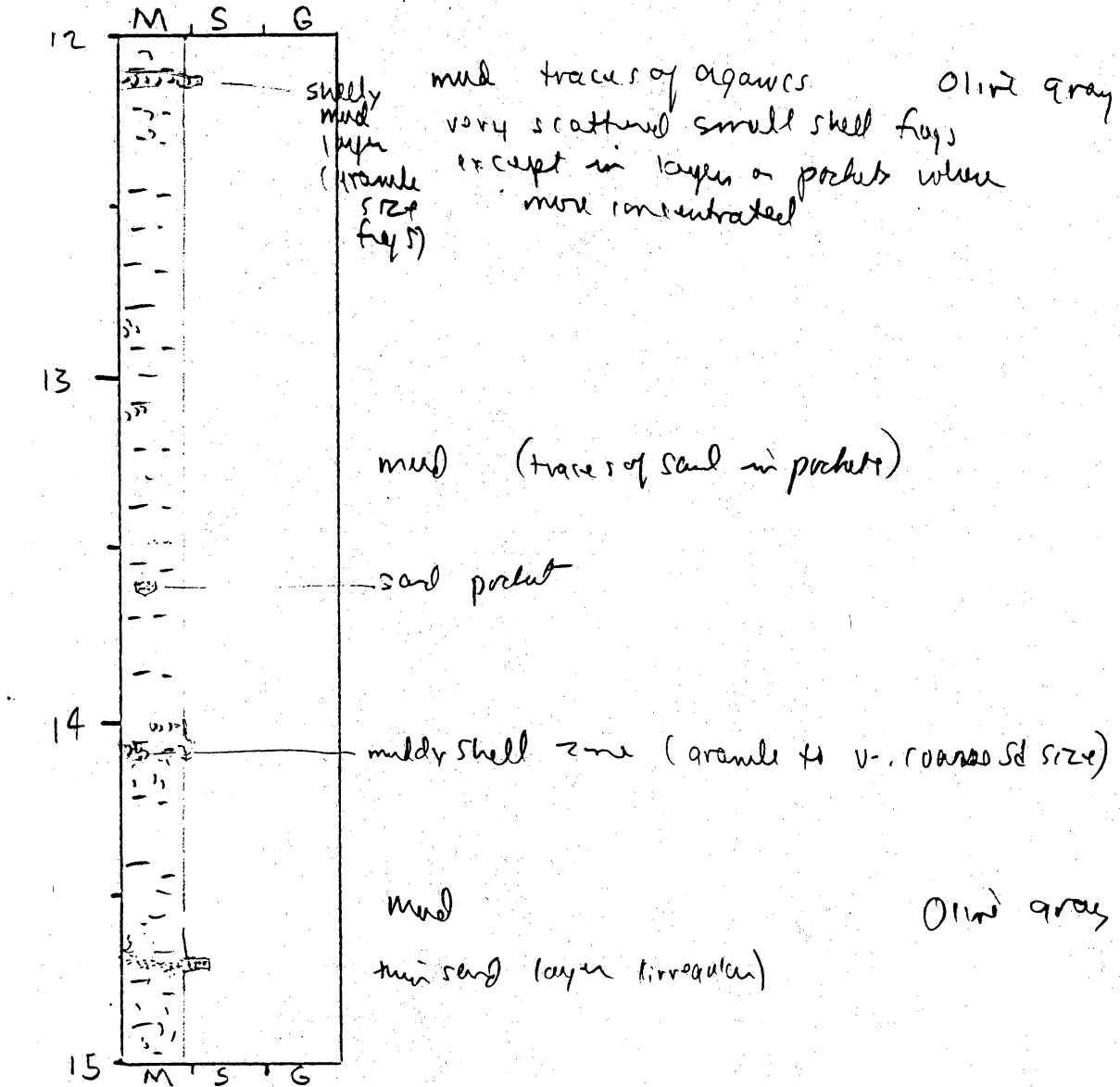
General Comments:

CORE LOG

CORE # SBV-10(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



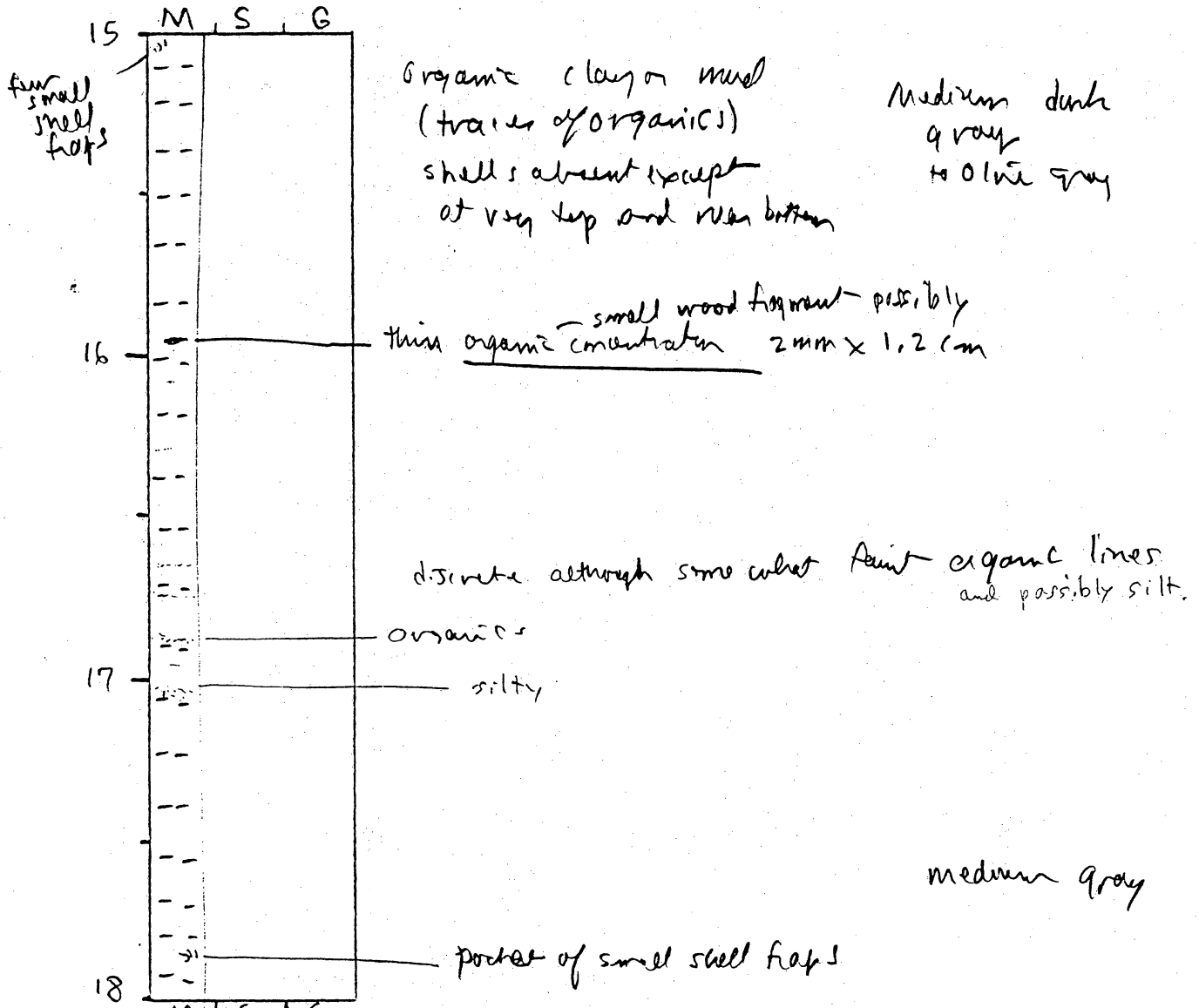
General Comments:

CORE LOG

CORE # SBV-10 (F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



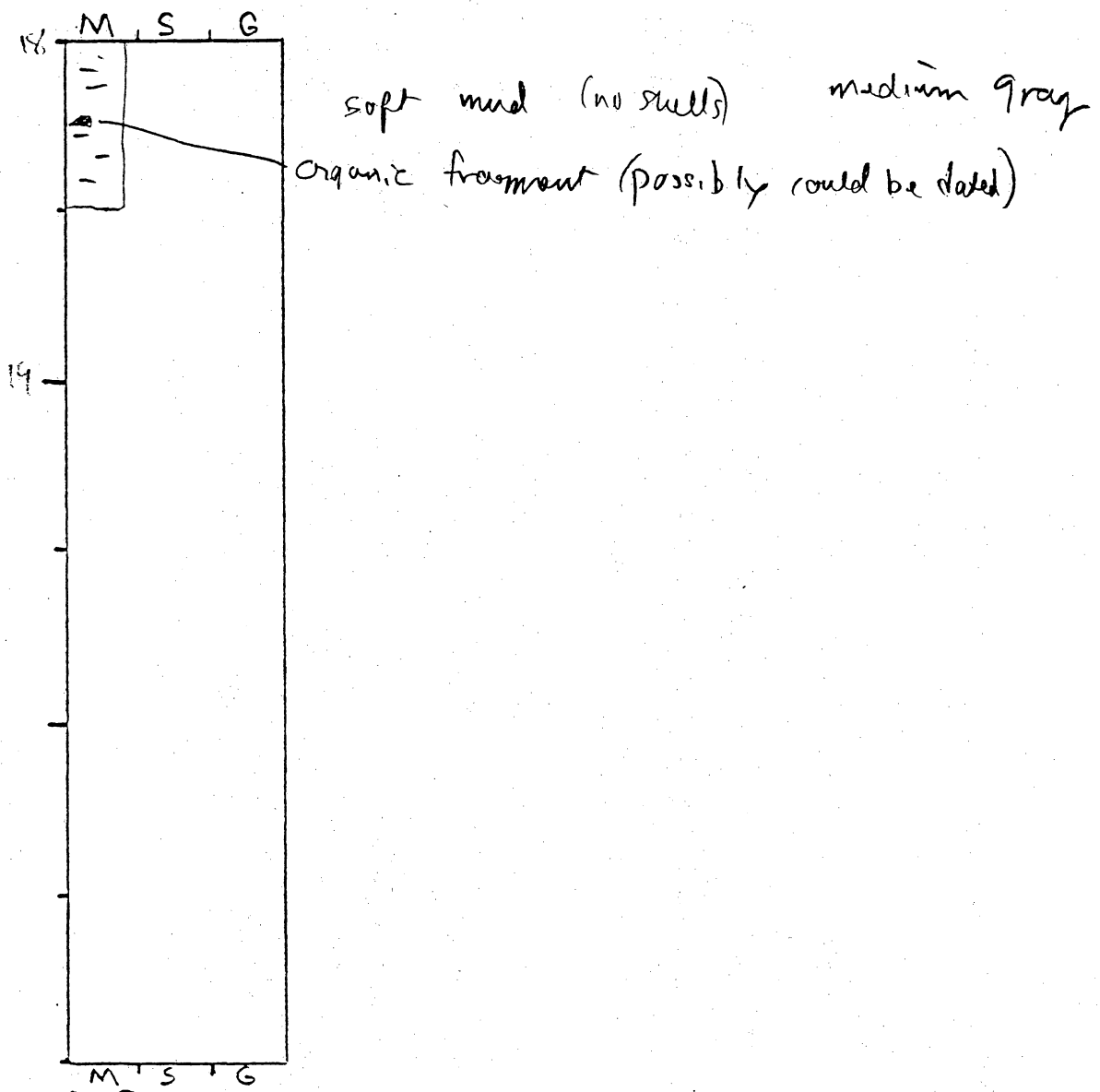
General Comments:

CORE LOG

CORE # SBV-10(G) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



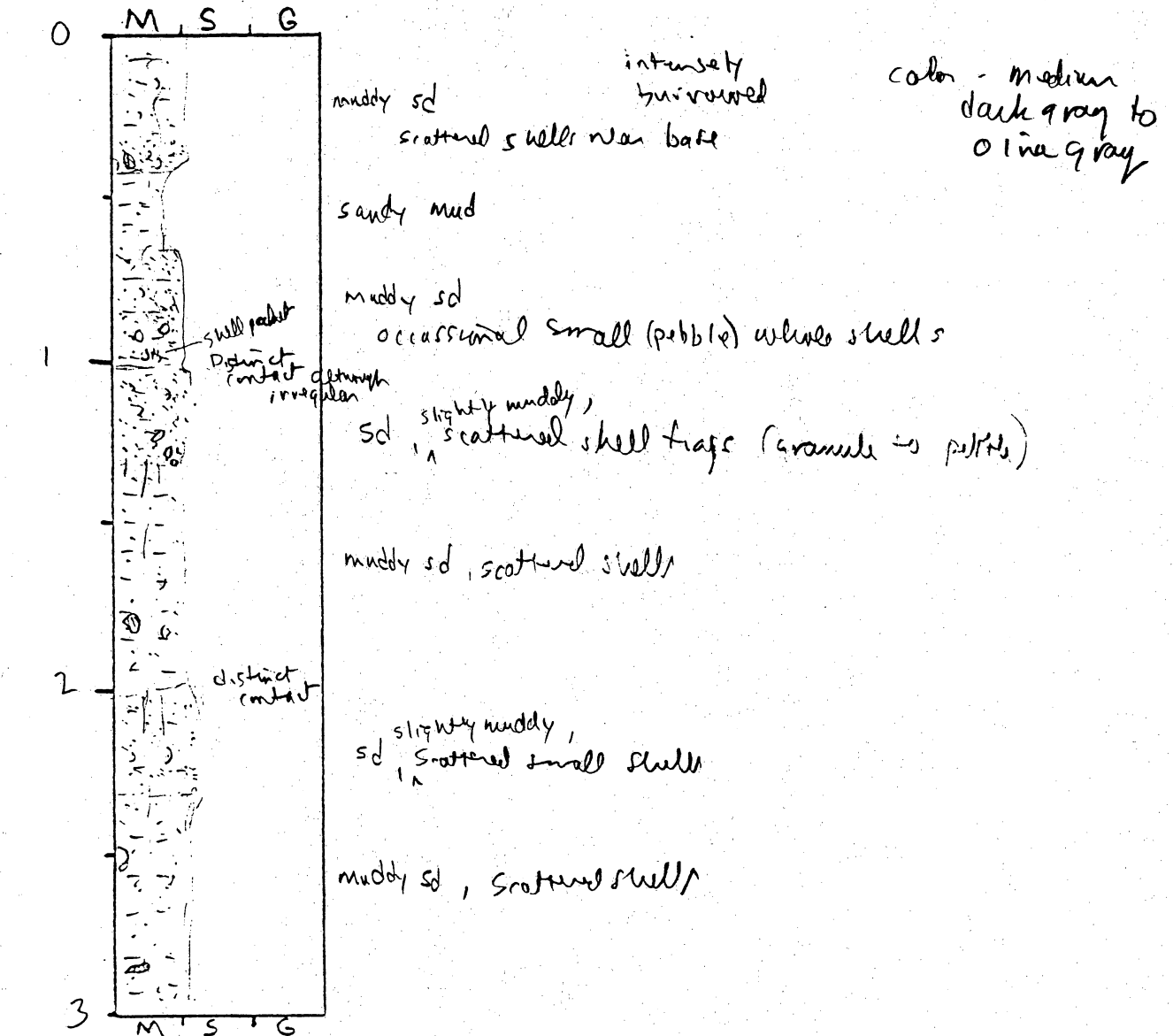
General Comments:

CORE LOG

CORE # SBV-11(A) TYPE Vibracore LOCATION Sabine Bank
 LATITUDE 29° 31.177' LONGITUDE 93° 25.649' SURFACE ELEVATION -37'
 DEPTH PENETRATED ? LENGTH RECOVERED 11 3/4" COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-13-94
 DESCRIBED BY White DATE 3-6-95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



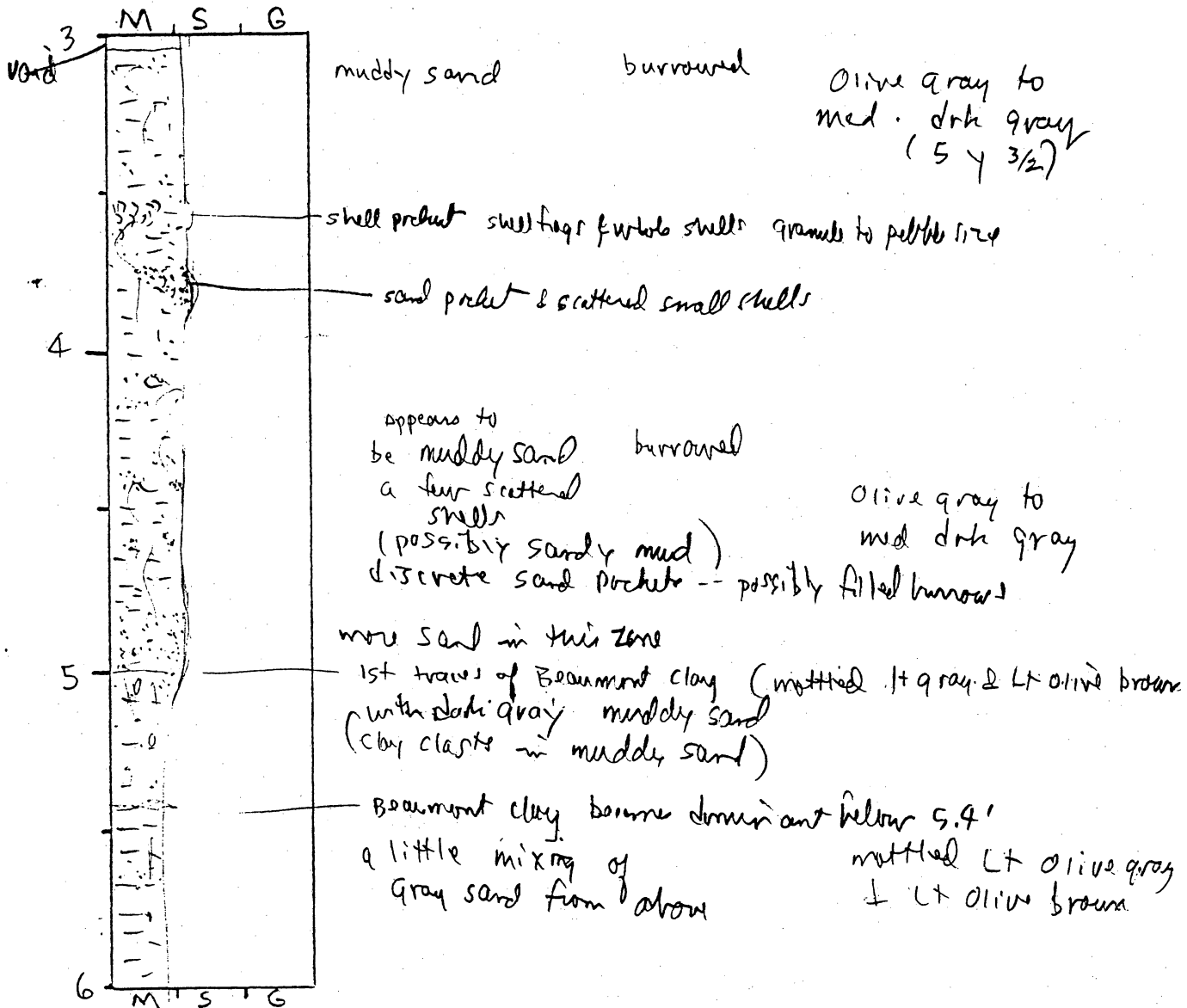
General Comments:

CORE LOG

CORE # SBV-11(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



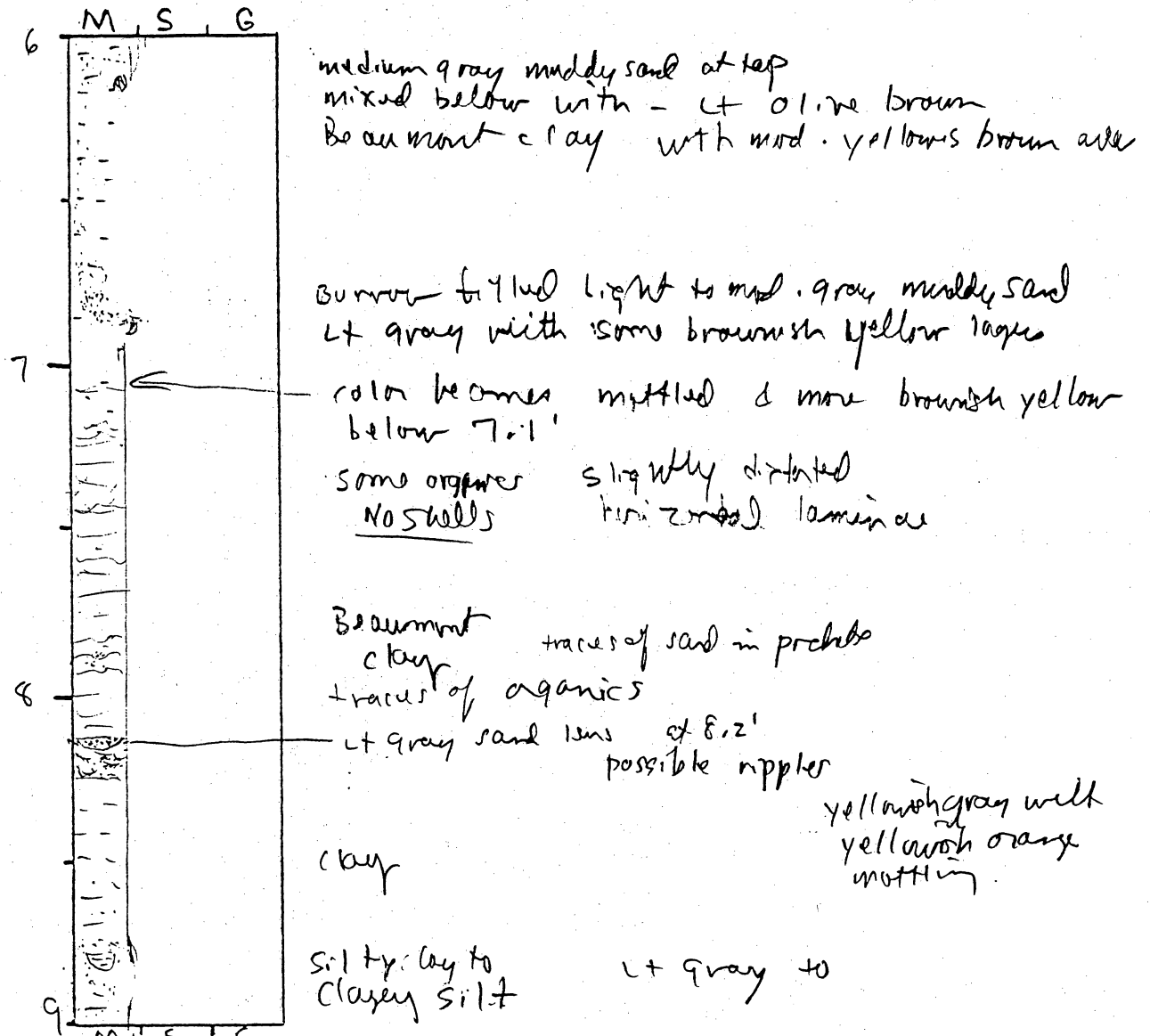
General Comments:

CORE LOG

CORE # SBV-11 (C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



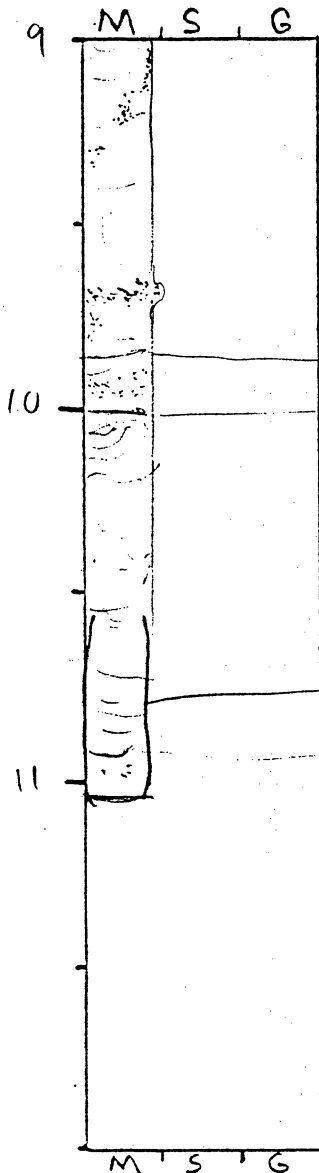
General Comments:

CORE LOG

CORE # SBV 11 (D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Beaumont clay
 occasional thin v. fine sand or silt layers &
 Organic layers

organic
 slightly disturbed laminae
 thin dark brown organic layer

cone ratchet
 organic

mottled colours
 from lt ^{olive} gray to
 dk yellowish
 orange
 and grayish orange

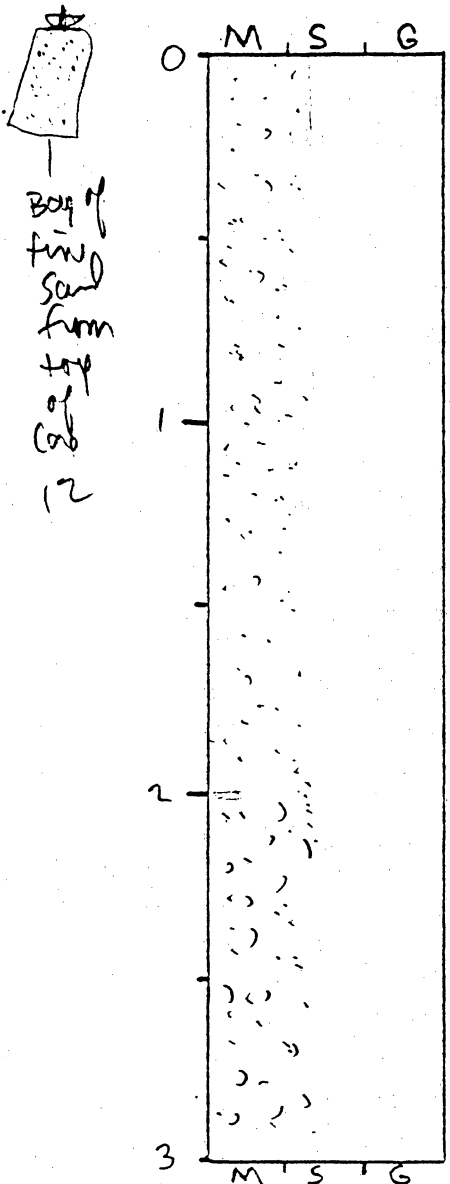
General Comments:

CORE LOG

CORE # SBV-12(A) TYPE Vibracore LOCATION Sabine Bank
 LATITUDE 29° 30.007' LONGITUDE 93° 35.307' SURFACE ELEVATION -25'
 DEPTH PENETRATED ? LENGTH RECOVERED 16' 9" % COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-13-94
 DESCRIBED BY White DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Fine quartz sand, subrounded, well sorted
 .5-10% shell frags - coarse sand size
 Lt olive gray (SY 5/2)
 to olive gray
 hint of brown

Fining upward sequence

Fine quartz sand with increasing amounts of shell fragments, also coarsening of shell fragments -- granules in fragments approaching 250% size below ~ 2'

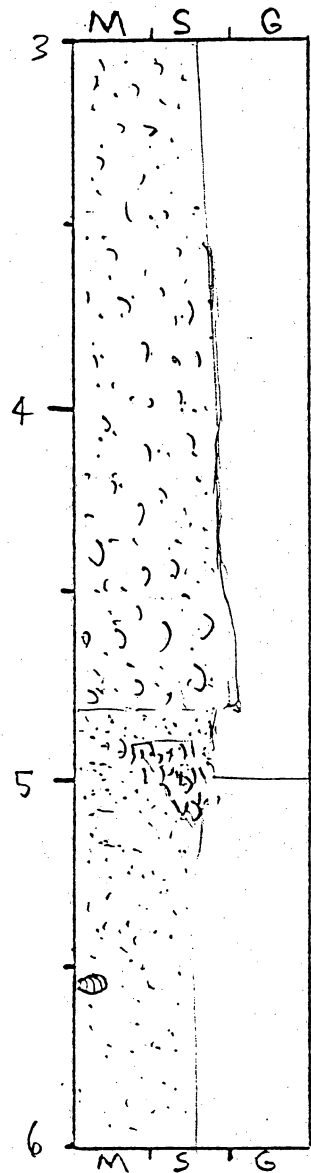
General Comments:

CORE LOG

CORE # SBV 12 (B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



shelly sand
 Lt Olive gray (5Y 5/2)
 to Olive gray (5Y 4/1)
 gradual increase in shell frags.
 quantity & size with depth
 Fining upward
 sandy shell
 coarsening of shells
 pebble size
 some whole shells
 shell pocket
 Fine sand, scattered small shell frags.
 Olive gray sd
 (5Y 5/2)

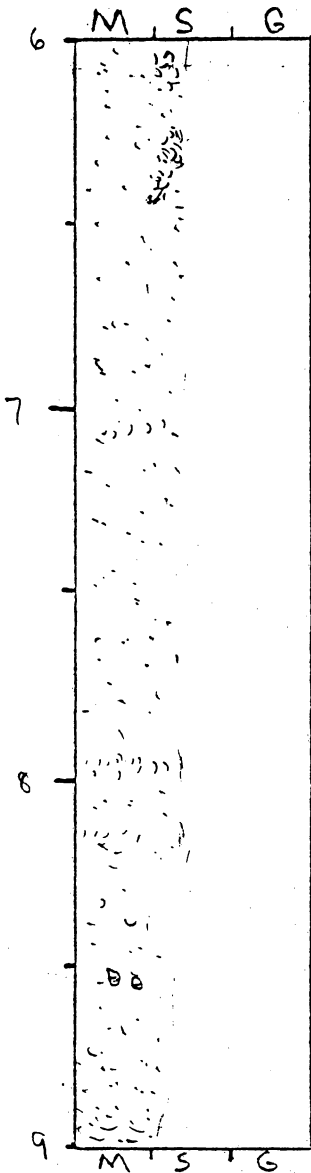
General Comments:

CORE LOG

CORE # SBV-12(c) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Fine quartz sand, sub rounded
 well sorted except for local shell frags,
 very coarse to granule shell frags

Olive gray
 5Y 4/1 to
 5Y 5/2

Fine quartz sand

local remains of shell frags mostly very coarse sand size
 < 10% shell frags

slightly muddy sand

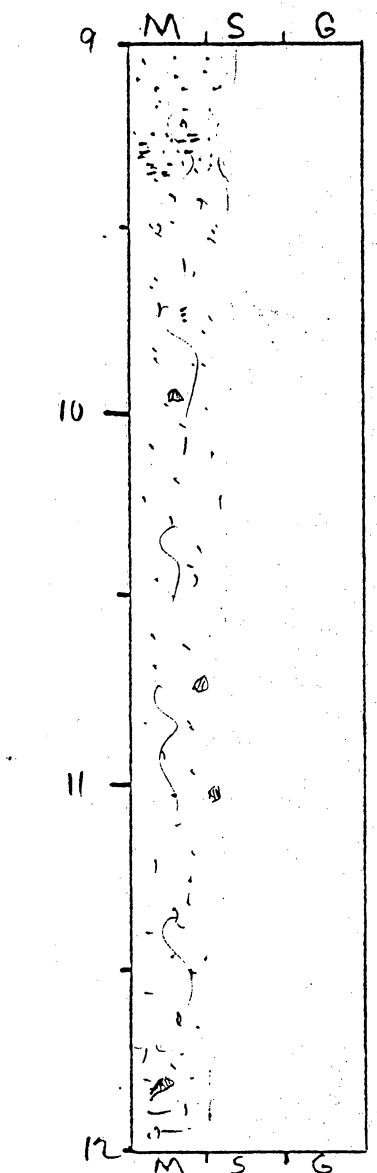
Olive gray
 5Y 3/2

General Comments:

CORE LOG

CORE # SBV-12(D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Fine to v. fine quartz sand
 muddy very fine sand (Burrowed)
 discrete mud & sand

Olive gray
 (5Y 3/2)
 becoming darker gray than above section

slightly muddy sand
 Scattered shell fragments (small)
 very coarse to granule size
 mud clasts?

occasional whole (small) shell

Burrowed

v. fine sand, slightly muddy
 mud clasts?

mud seems to increase near bottom
 muddy sand

Olive gray
 (5Y 3/2)

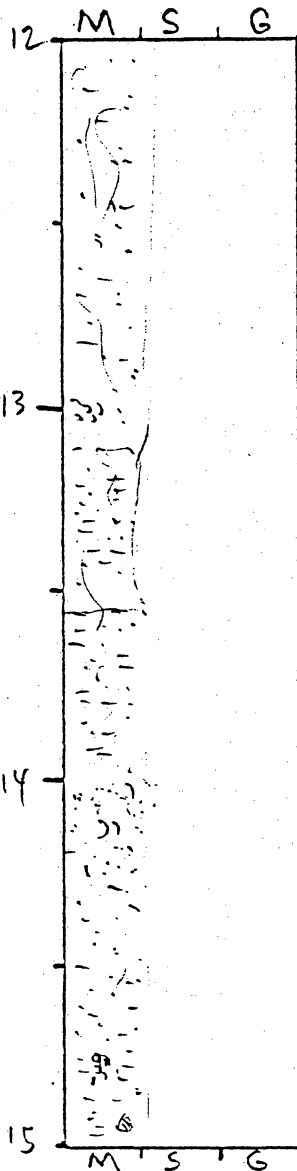
General Comments:

CORE LOG

CORE # SAV-12(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand indentedly Burrowed olive gray (5Y 3/2)
 a few scattered shell frags ± 1 or 2%
 becoming darker gray than above section
 discrete sand and mud (clay) zones. Indentedly Burrowed
 slightly muddier from 13.1 - 13.6
 Lt Olive gray (brownish) sd layer a few larger shells (pebble size)
 muddy sand occasional shell pebbles
 Olive gray (5Y 3/2)

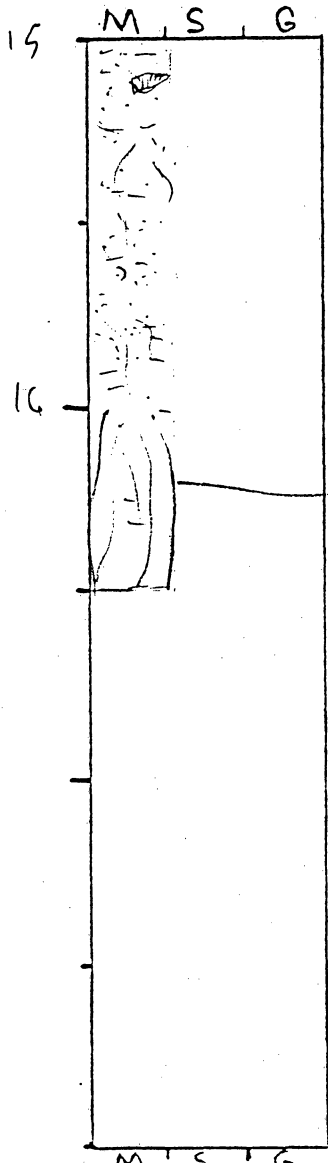
General Comments:

CORE LOG

CORE # SBV-12 F TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand to sandy mud
 whole shell \approx 2 cm long
 < 1% shell frags

discrete sand
 pockets &
 clay zone

Intensely
 burrowed

Olive gray
 (5 y 3/2)
 darker than
 above

row catches

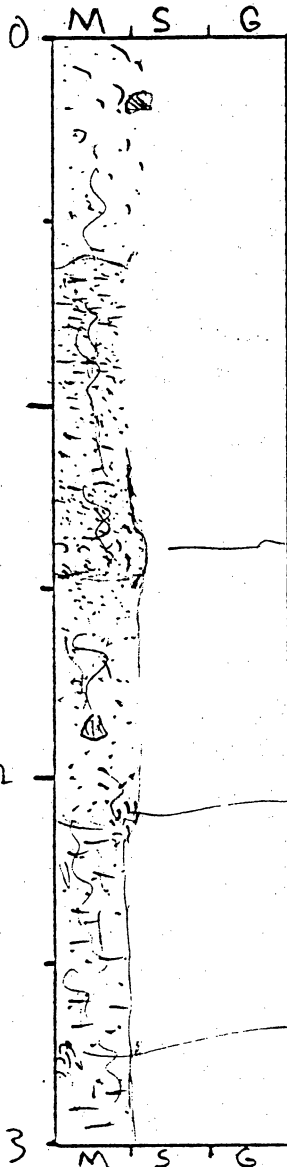
General Comments:

CORE LOG

CORE # SBY-13 (A) TYPE Vibro core LOCATION Sabine Bank
 LATITUDE 29° 28.724 LONGITUDE 93° 34.872 SURFACE ELEVATION -37'
 DEPTH PENETRATED ? LENGTH RECOVERED 19' 4 1/2" COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-13-94
 DESCRIBED BY White DATE 2-7-95

DEPTH
 (ft, m) **SKETCH** **LITHOLOGY** **STRUCTURE** **REMARKS**



shelly fine sand, fragmented whole
 up to pebble size
 longer shell fragments near top, decrease below

Olive gray (5Y 3/2 to 5Y 4/1)

muddy sand to sandy mud
 intensely burrowed

muddy, shelly sand

sand, scattered shell frags, slightly muddy

shell pocket
 becomes muddier
 intensely burrowed

muddy sand
 shell pocket

Olive gray (5Y 3/2)

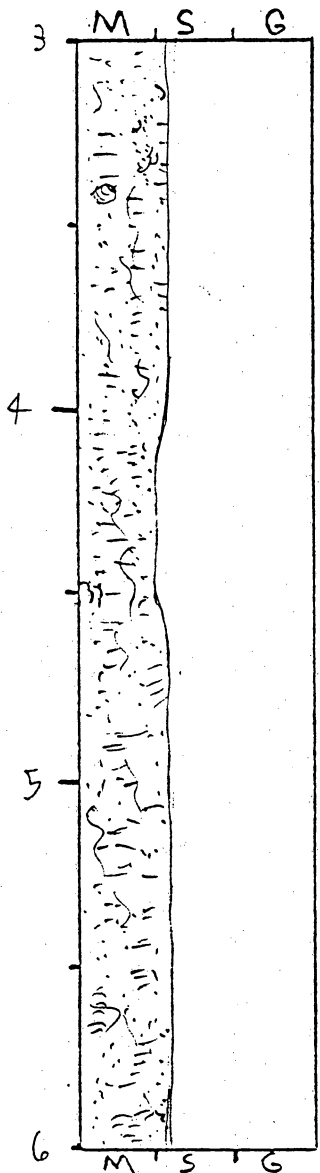
General Comments:

CORE LOG

CORE # SPV-13(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand
 very scattered shells
 < 1%
 Intensely Burrowed
 muddier muddy sand to sandy mud
 Intensely Burrowed
 muddy sand
 discrete mud & sand areas
 Intensely Burrowed

Olive gray
 (SY 3/2)

Olive gray
 (SY 3/2)

General Comments:

CORE LOG

CORE # SBV-13(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

<p>6</p> <p>M S G</p>	<p>muddy sand to sandy mud mud became more abundant in this section, still lots of fine sand a few scattered shells discrete sand and mud areas</p> <p>discrete mud & sand zone</p> <p>thin sand layer (light olive gray to olive gray)</p> <p>sandy mud</p> <p>muddy sand to sandy mud very scattered shell frags < 1%</p>	<p>olive gray 5 y 3/2</p> <p>Intensely Burrowed</p> <p>Intensely Burrowed</p> <p>olive gray (5 y 3/2)</p>
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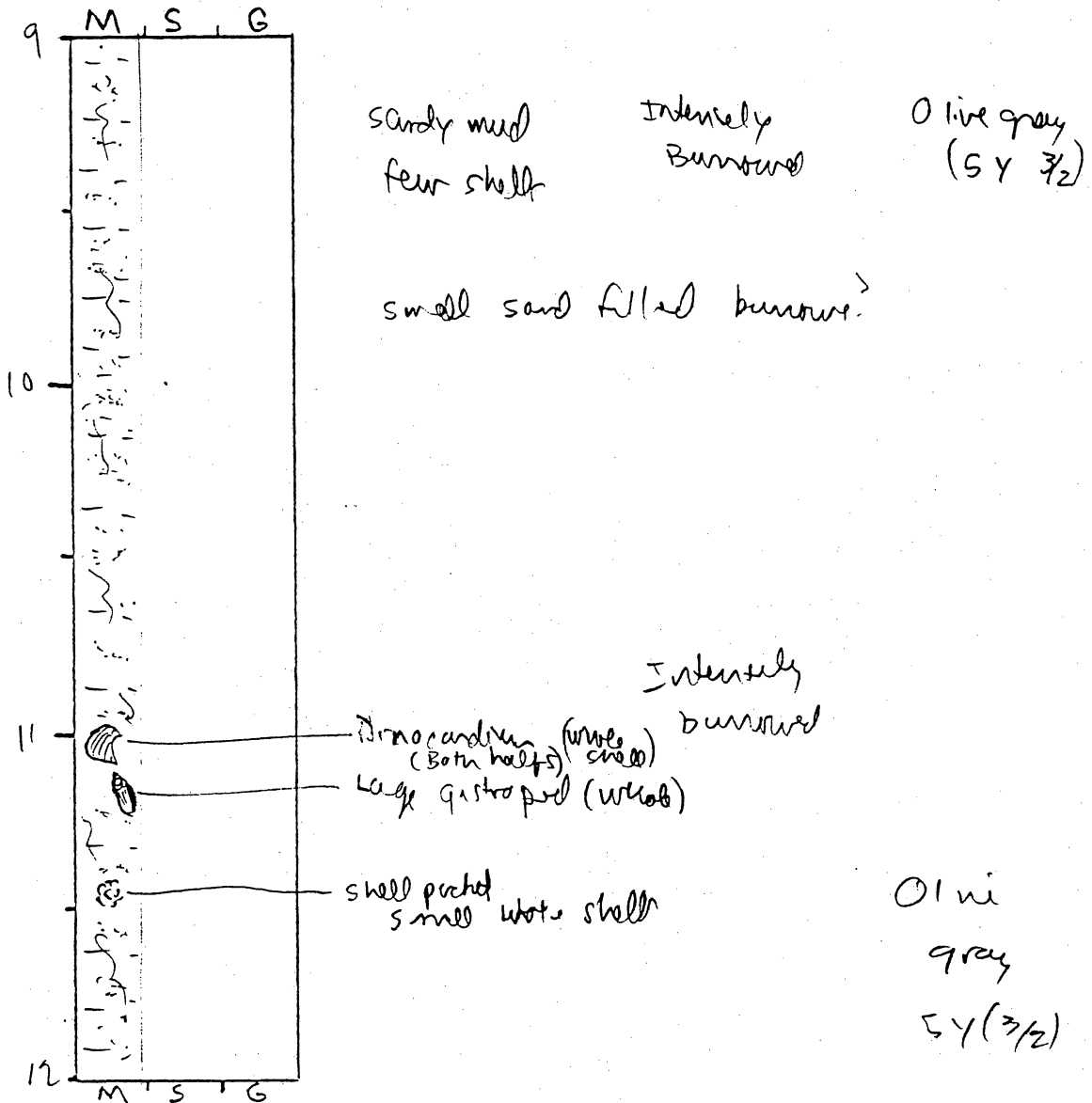
General Comments:

CORE LOG

CORE # SBV-13(D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

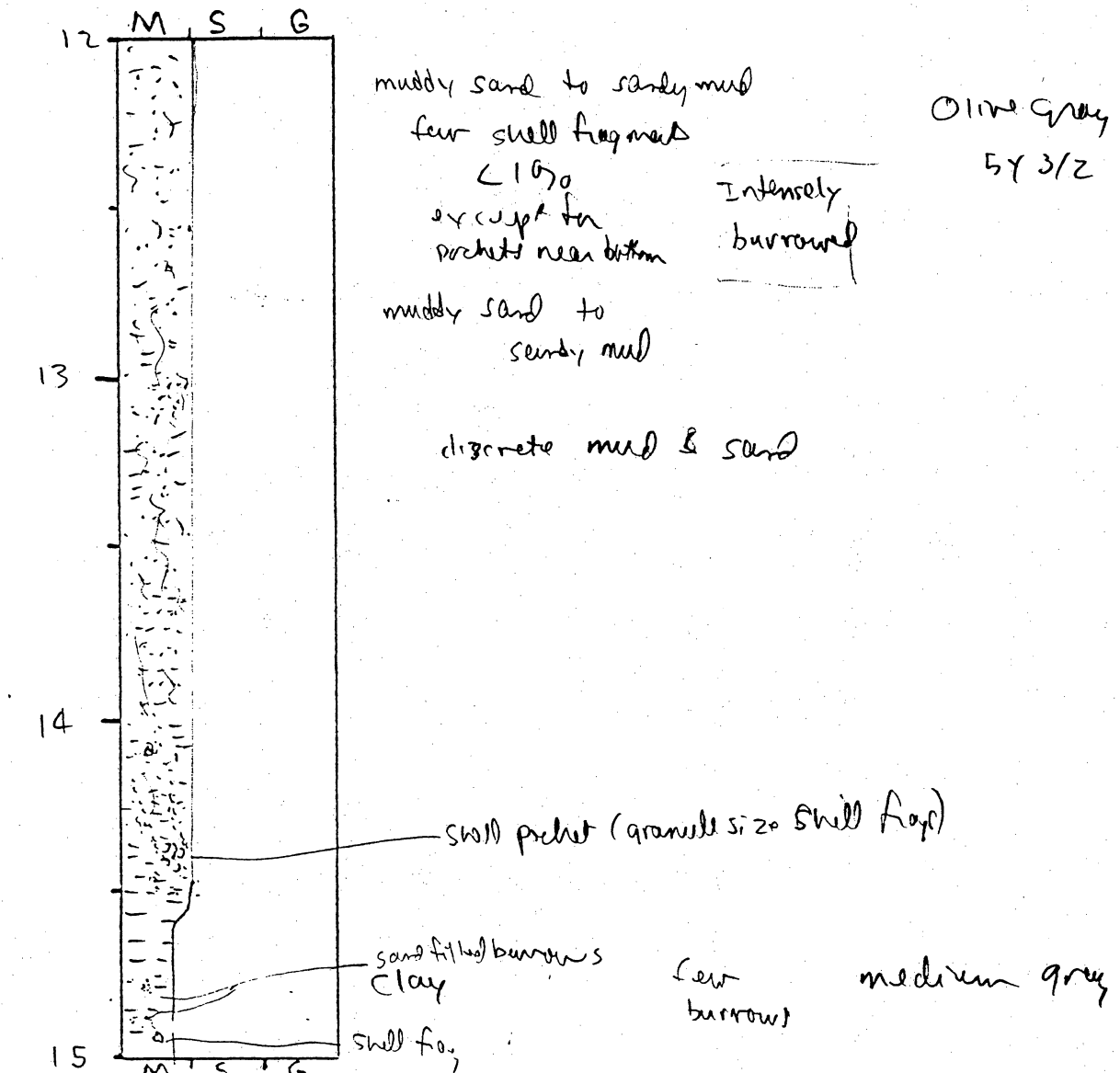


General Comments:

CORE LOG

CORE # SBV-13(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



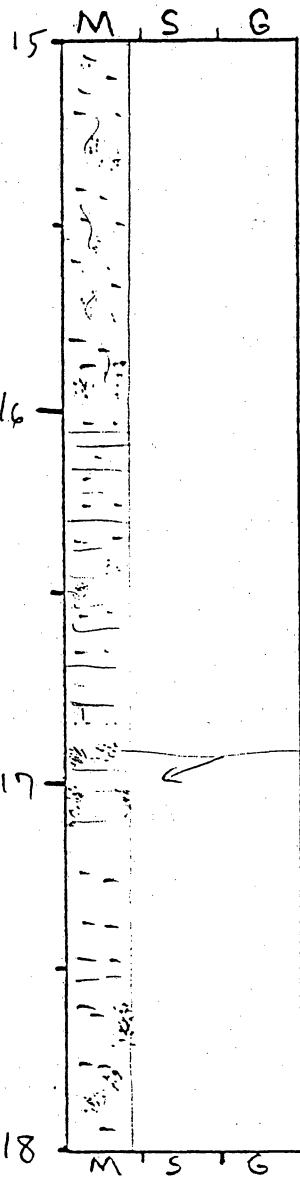
General Comments:

CORE LOG

CORE # SBV-13(F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



mud or silty clay
 burrowed
 silt and fine sand
 pockets (burrows)
 medium dark gray
 to olive gray
 medium gray
 below 15.6'

silty clay
 fine horizontal silty
 laminae
 v. few shells - mostly restricted to
 sand pockets
 sand pockets

Some burrows
 medium gray to
 olive gray
 (5 Y 3/2)

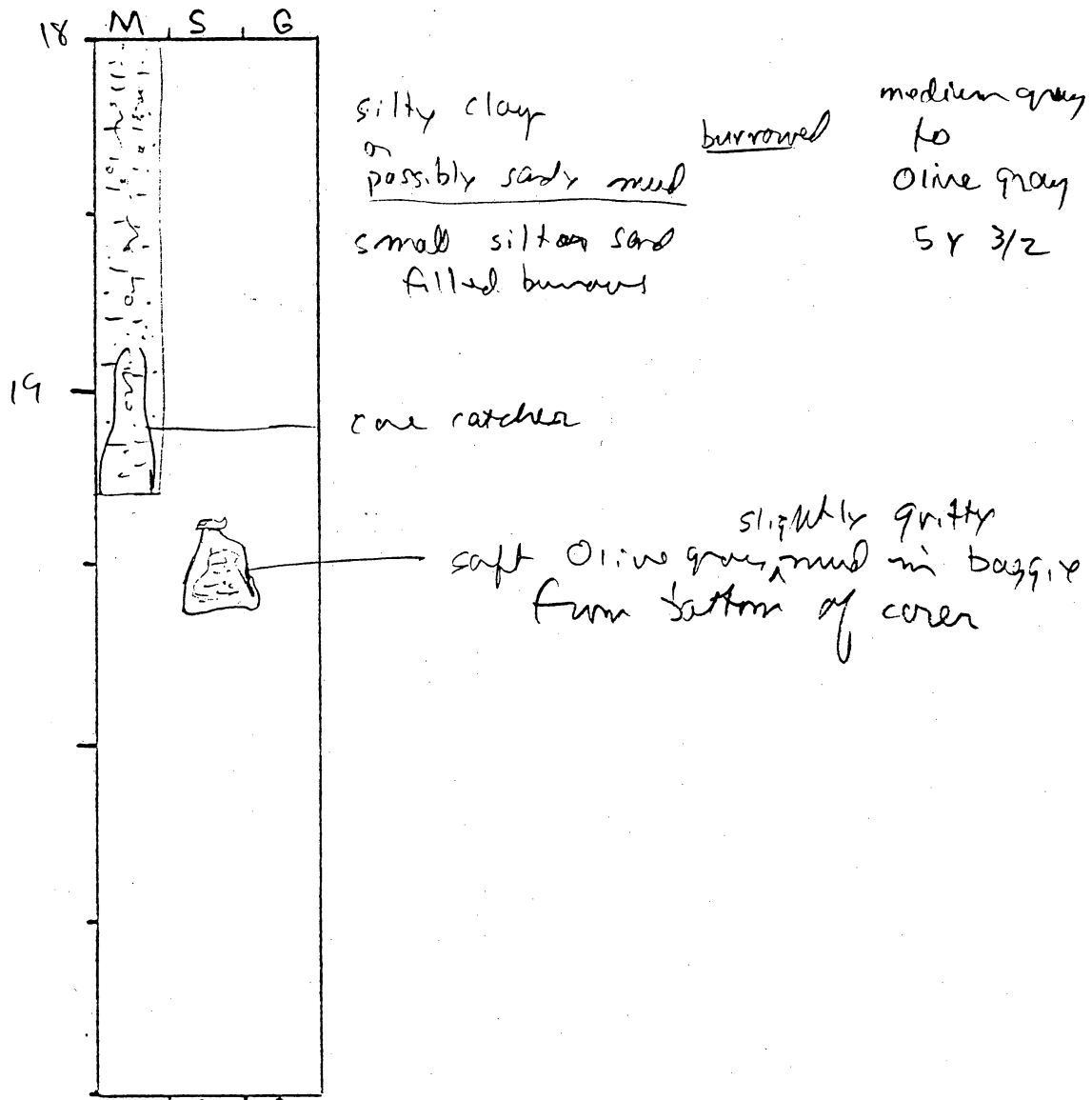
General Comments:

CORE LOG

CORE # SBA-3(G) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH
 (ft, m) **SKETCH** **LITHOLOGY** **STRUCTURE** **REMARKS**



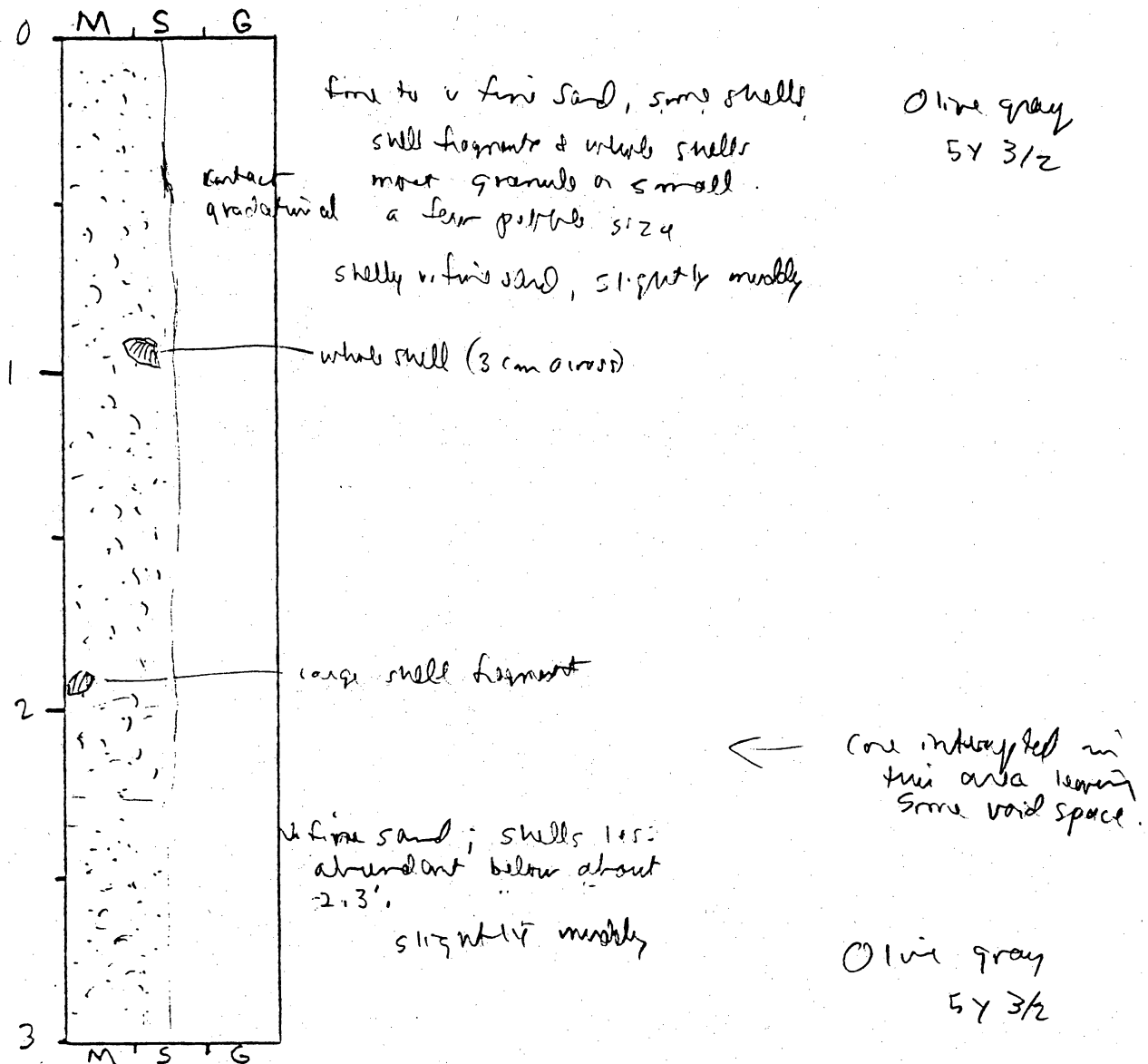
General Comments:

CORE LOG

CORE # SBV-14(A) TYPE Vibrocore LOCATION Sabine Bank
 LATITUDE 29° 24.283 LONGITUDE 93° 38.052 SURFACE ELEVATION -32'
 DEPTH PENETRATED ? LENGTH RECOVERED 19' 9 1/4" % COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 11-13-94
 DESCRIBED BY White DATE 2-7-95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



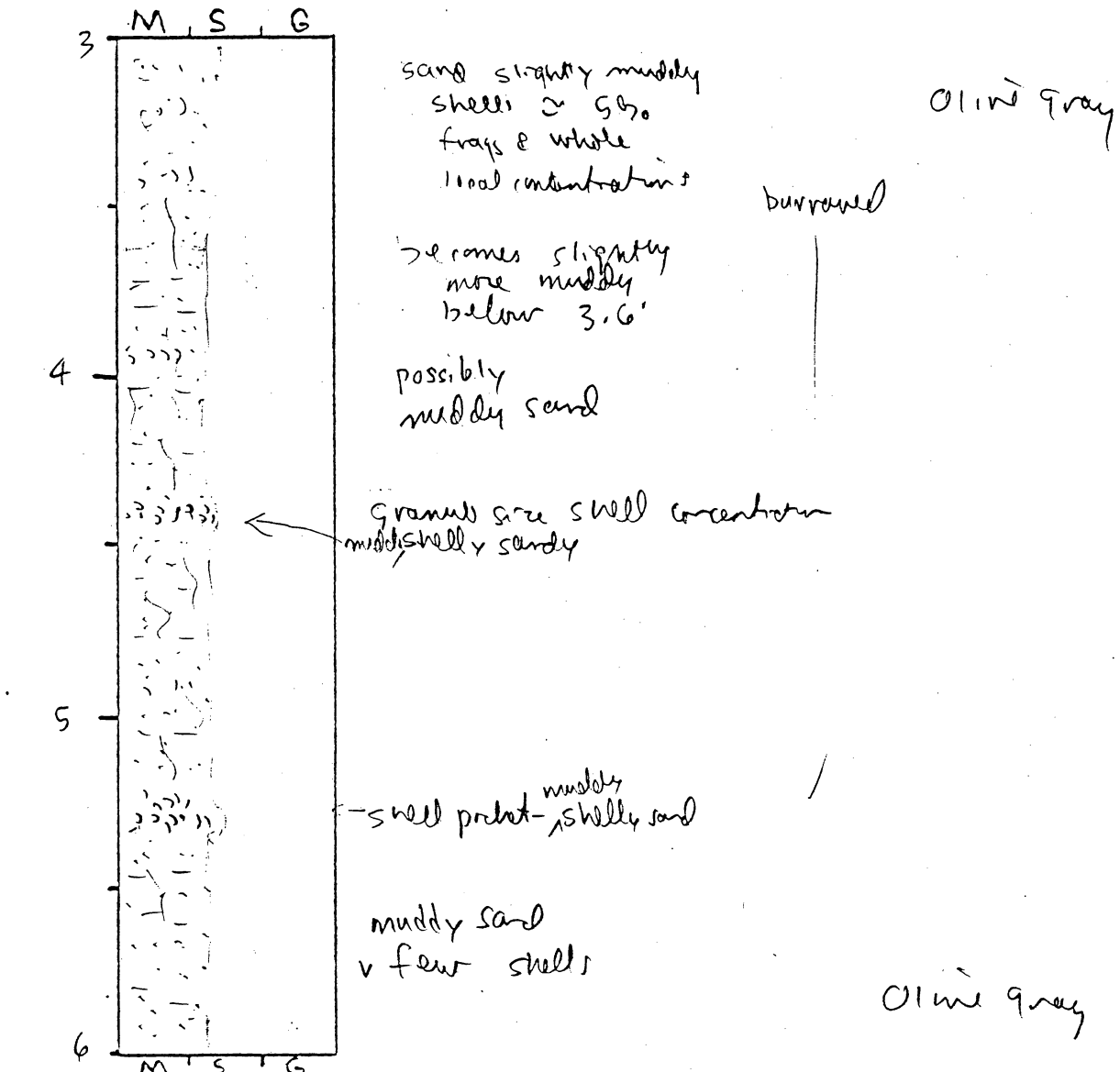
General Comments:

CORE LOG

CORE # SBV-14(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



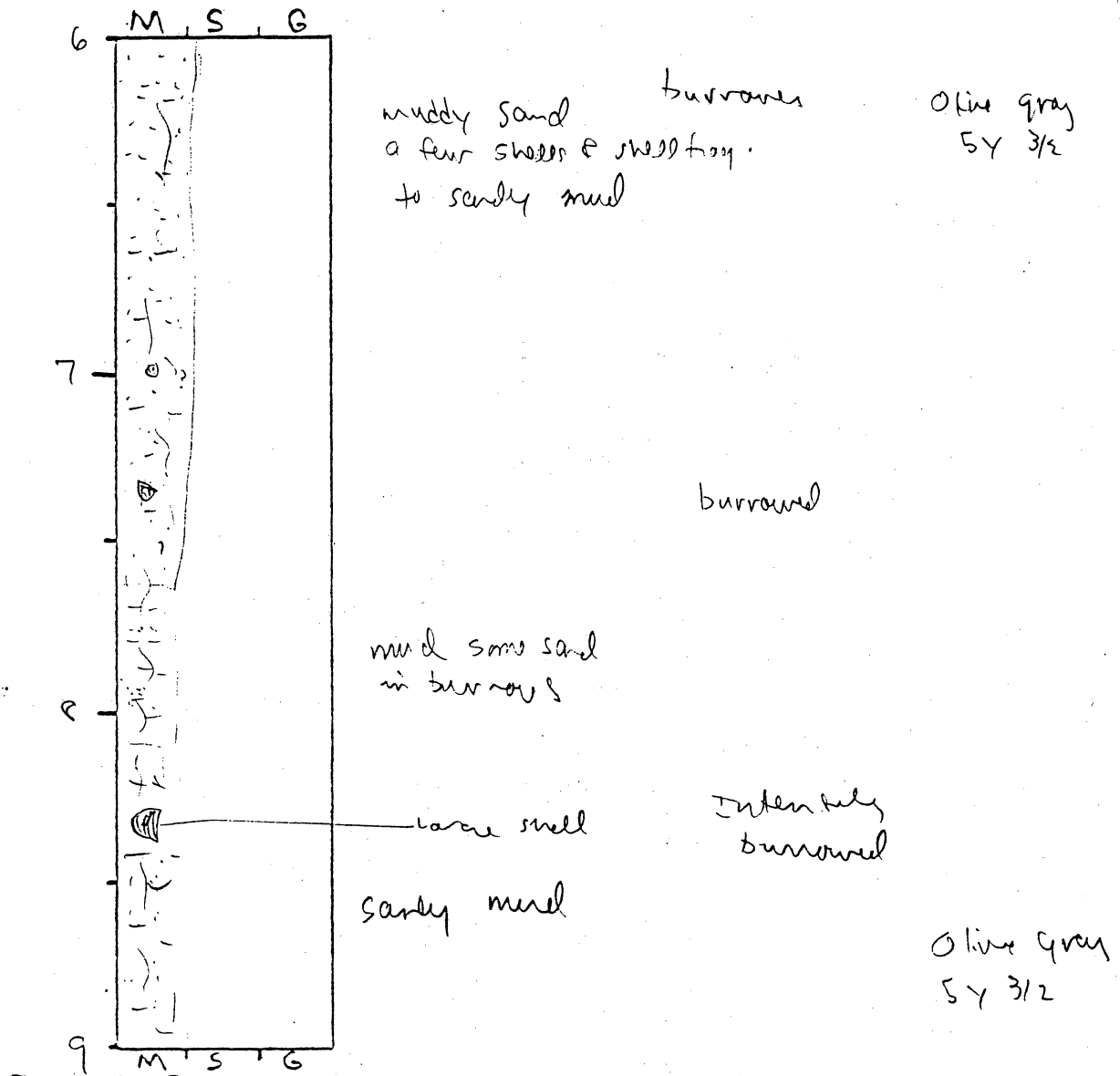
General Comments:

CORE LOG

CORE # SBV-14(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



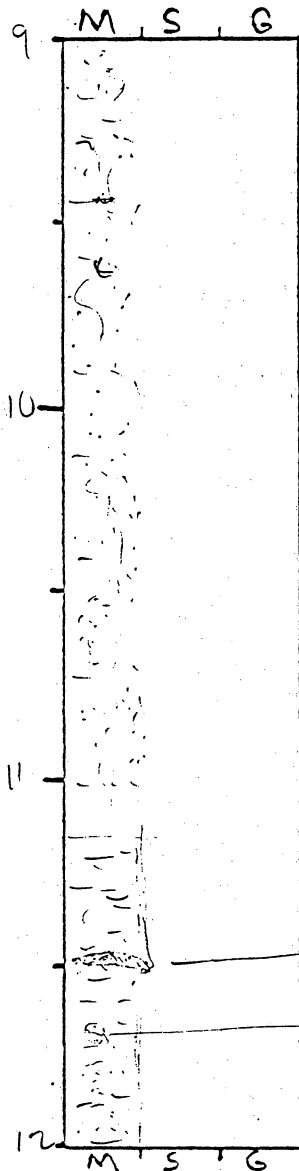
General Comments:

CORE LOG

CORE # SBV-14(D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



sandy mud Intensely Burrowed
 a few shells (very scattered < 1%)

Olive grey
 (5Y 3/2)

(slightly more sand from 10-11.2')

sandy mud

discrete sand & mud areas

sandy mud
 sandy unit not well defined
 sand filled burrows

Olive grey
 (5Y 3/2)

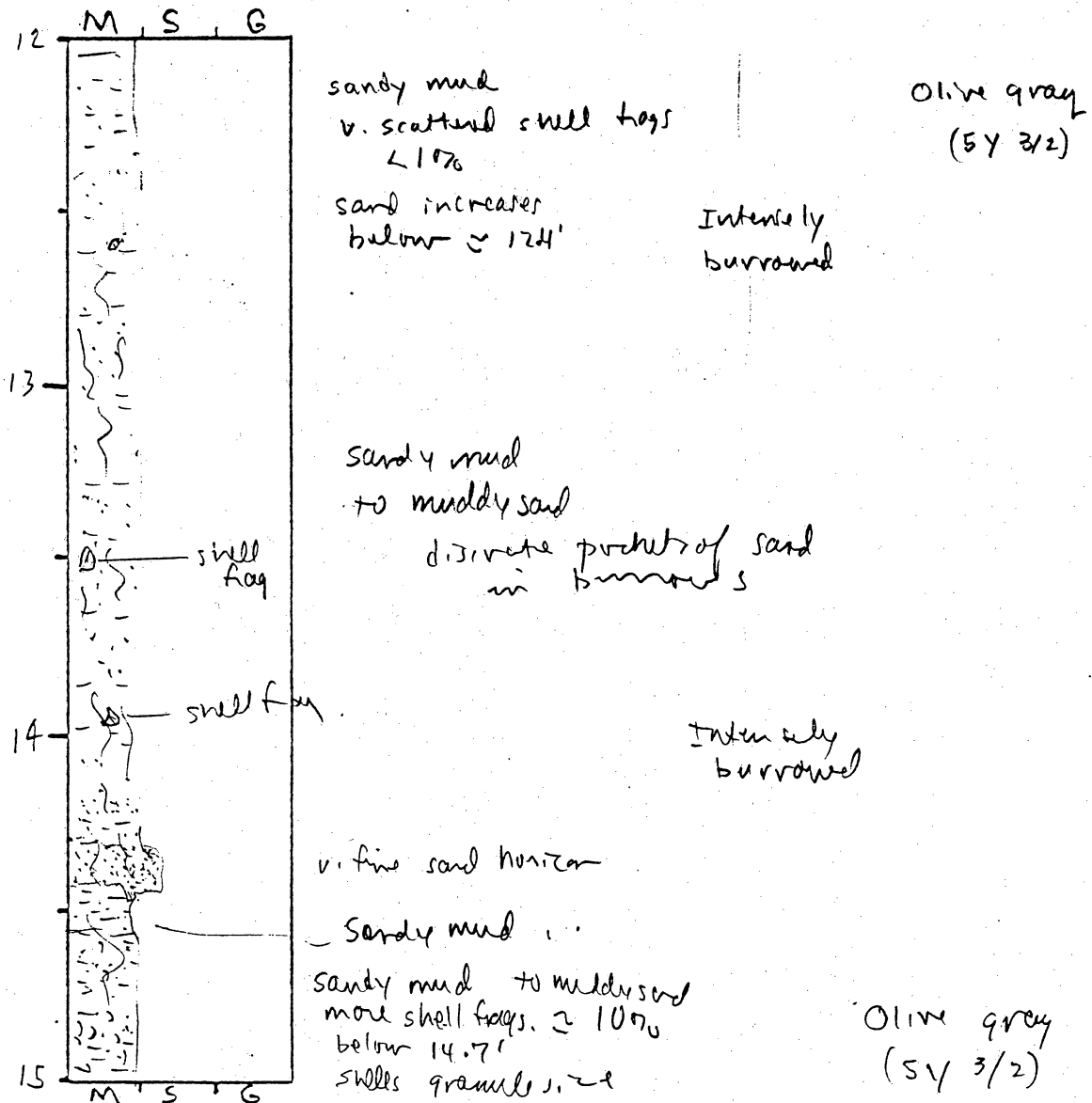
General Comments:

CORE LOG

CORE # SBV-14(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



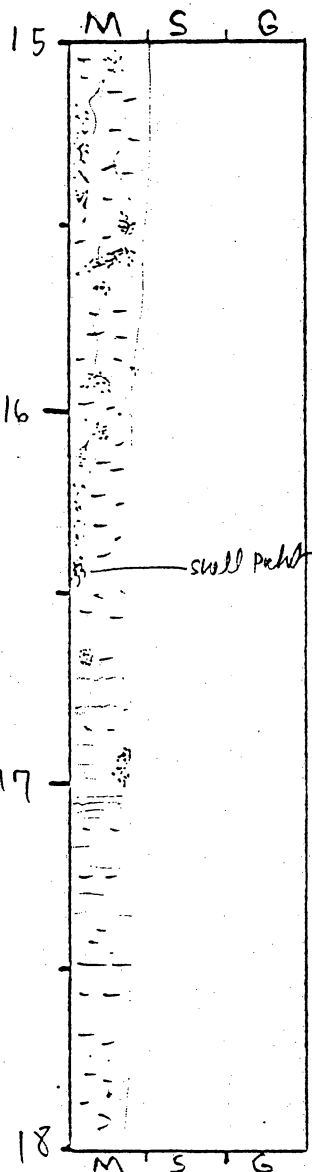
General Comments:

CORE LOG

CORE # SBV-14F TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



sandy mud (sand filled burrows)

olive gray (5Y 3/2) to medium gray

discrete sand filled burrows a few v. coarse shell frags in sandy areas

occasional burrows

clay

few burrows

medium gray

thin silty horizontal laminae in clay

no burrows

clay

some organic specks

medium gray

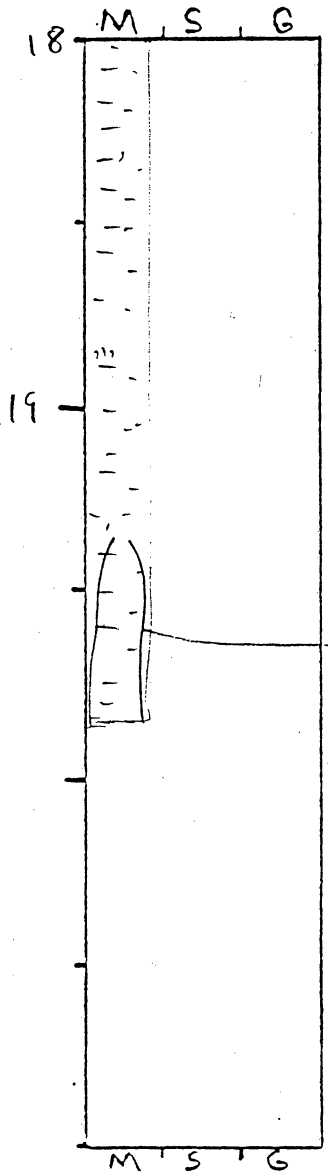
General Comments:

CORE LOG

CORE # SBV-14 (G) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Clay some organic specks
 very scattered shell frags
 v coarse sand size

medium
 gray
 to olive gray

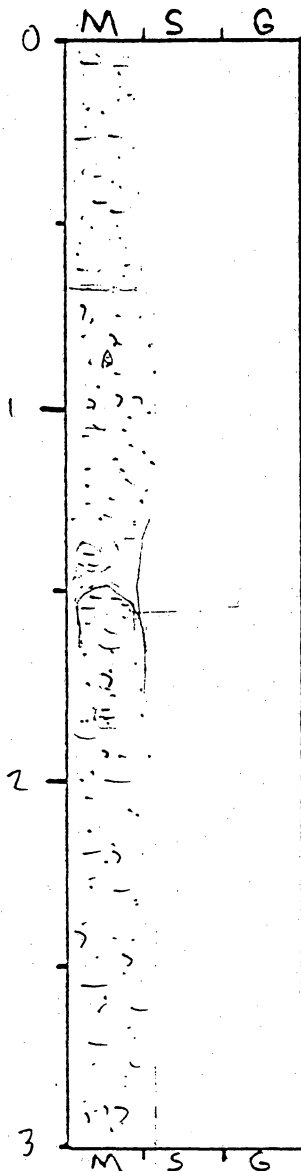
General Comments:

CORE LOG

CORE # SBV-15(A) TYPE Vibroc core LOCATION Sabine Bank
 LATITUDE 29° 25.34' LONGITUDE 93° 44.38' SURFACE ELEVATION -42'
 DEPTH PENETRATED ? LENGTH RECOVERED 5' 10 3/4" COMPACTION ?

OBTAINED BY G. beaut - R/V Kit Jones DATE 10-15-94
 DESCRIBED BY White DATE 2-8-95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand
 scattered shells < 5%

medium dk gray
 to olive gray
 (5Y 7/2)

sand, scattered shells ≈ 5%
 up to granule size
 slightly muddy

clasts of Beaumont clay

mottled
 Lt olive gray & Lt olive brn
 in medium gray sand

clayey sand
 v. scattered shell frags

mottled
 Greenish gray (5GY 6)
 to
 medium gray

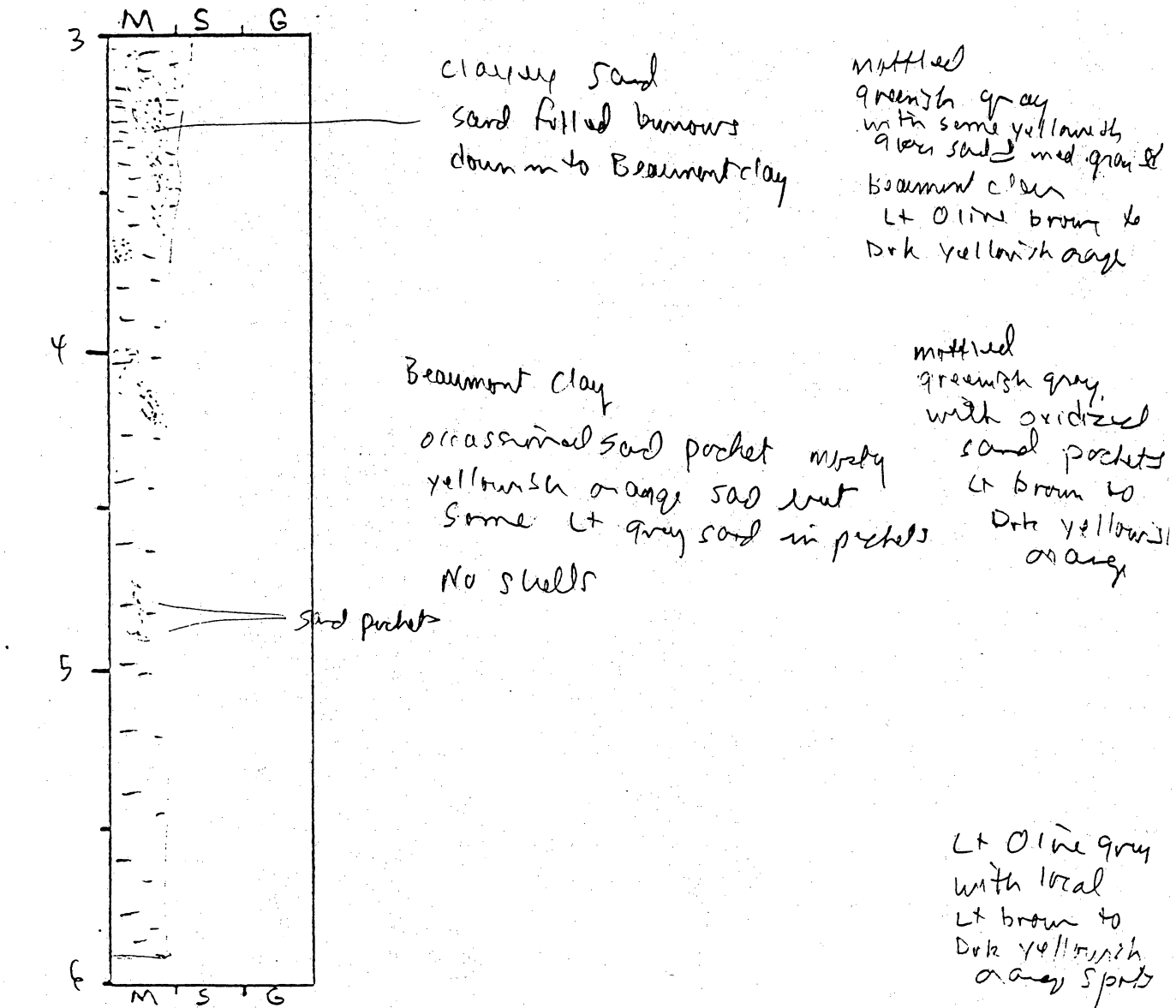
General Comments:

CORE LOG

CORE # SBV-15(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



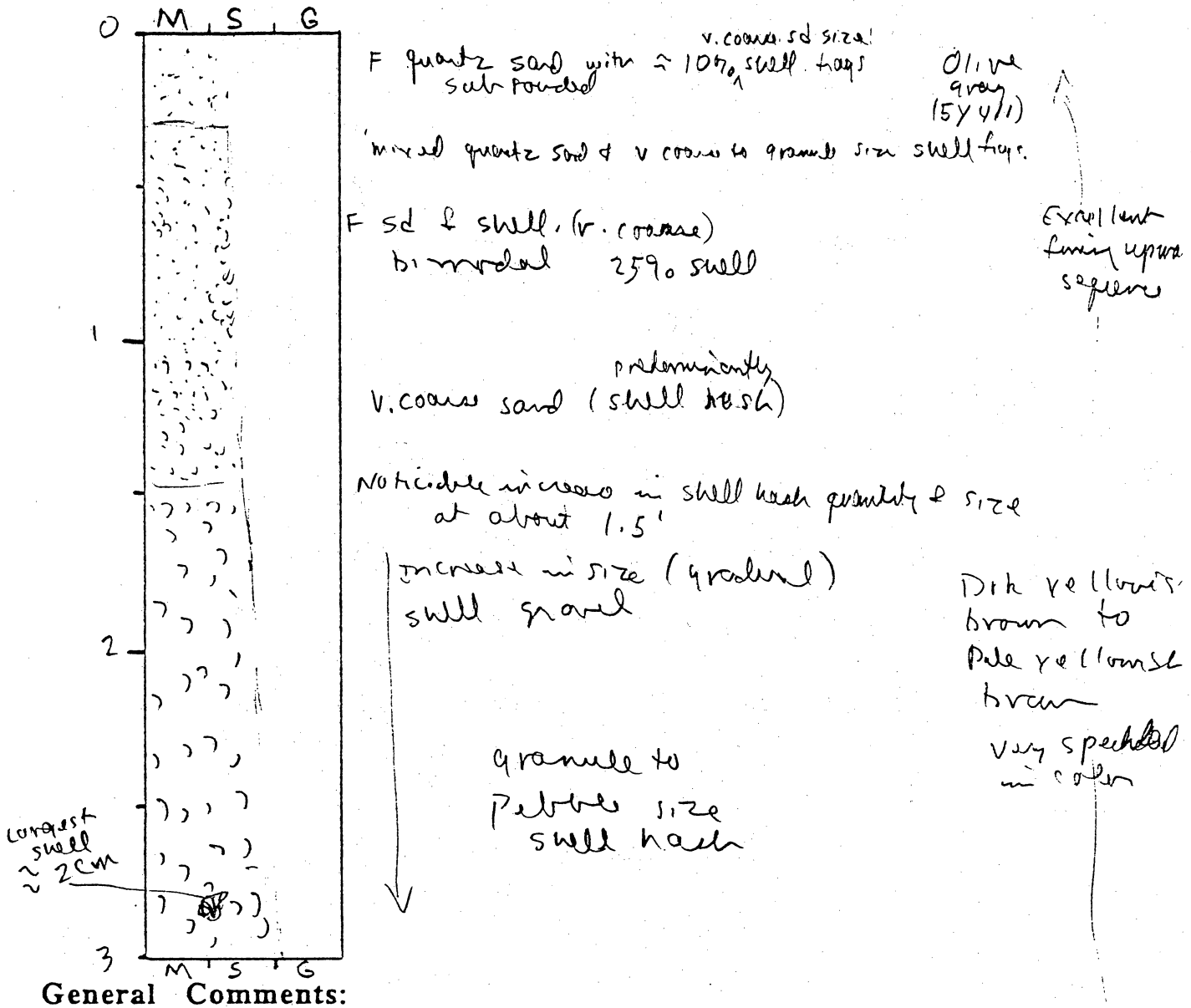
General Comments:

CORE LOG

CORE # SBV-16(A) TYPE Vibrocore LOCATION Sabine Bank
 LATITUDE 29° 26.13' LONGITUDE 93° 44.89' SURFACE ELEVATION -33'
 DEPTH PENETRATED ? LENGTH RECOVERED 15' 3 3/4" COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-13-74
 DESCRIBED BY White DATE 2-8-95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

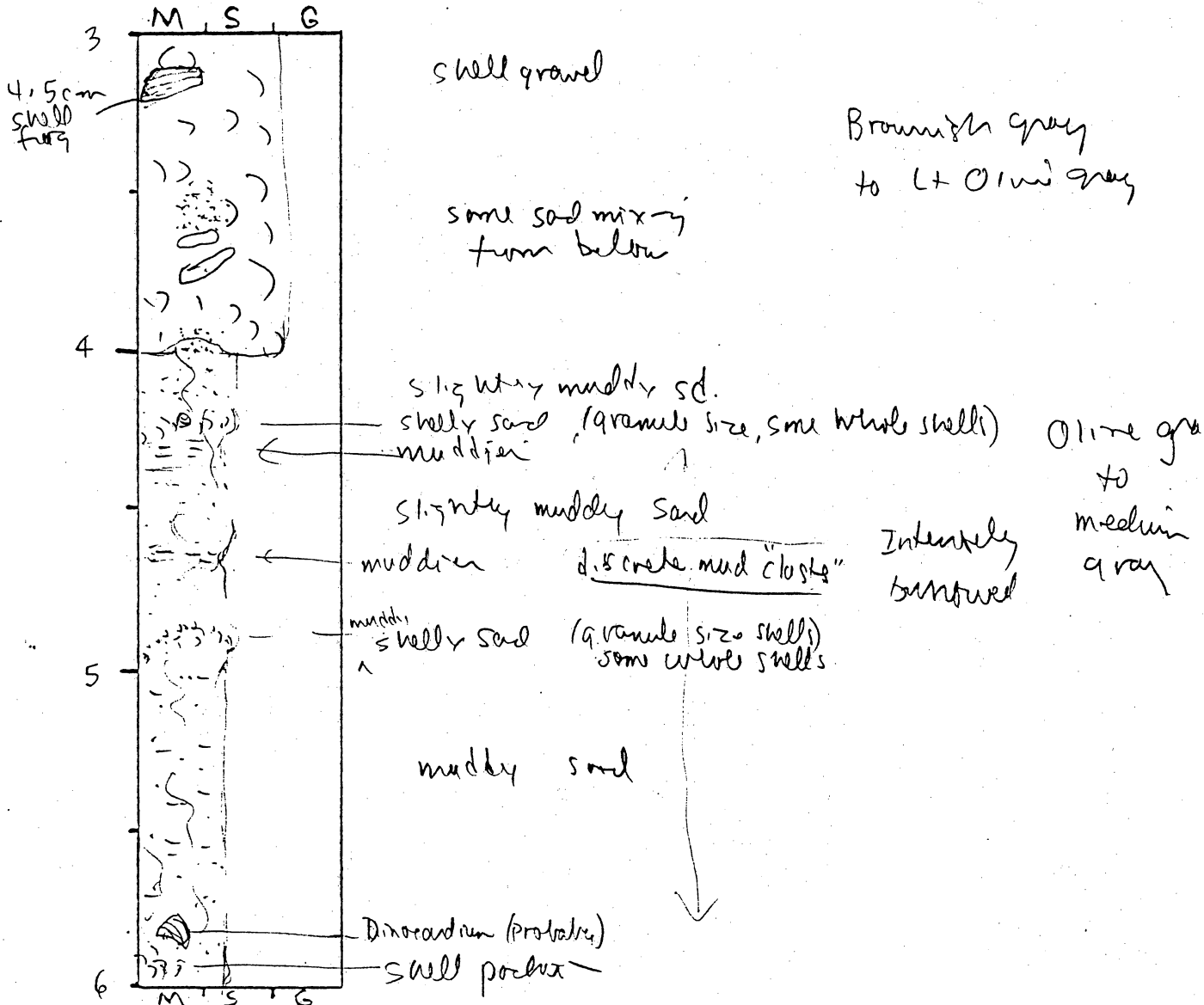


CORE LOG

CORE # SB11-16 (B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



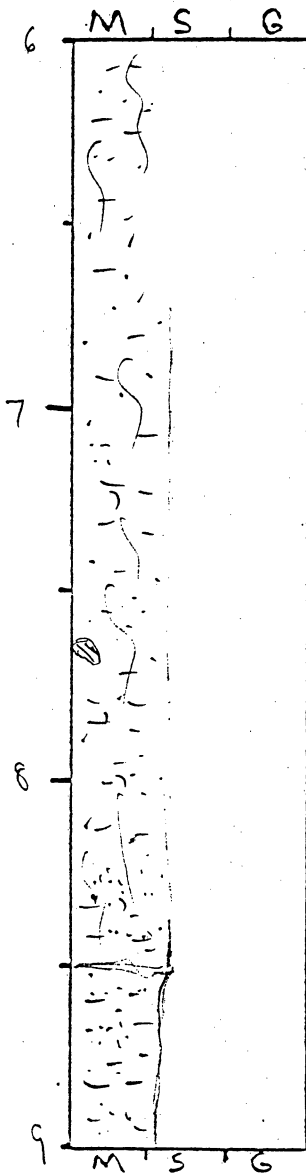
General Comments:

CORE LOG

CORE # SBV-16(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand (more mud than (intensely burrowed) in previous section)

v. scattered small shells
 occasional larger frags
 (< 2%)

Olive gray

muddy sand

discrete mud clasts? in sand

sandy mud

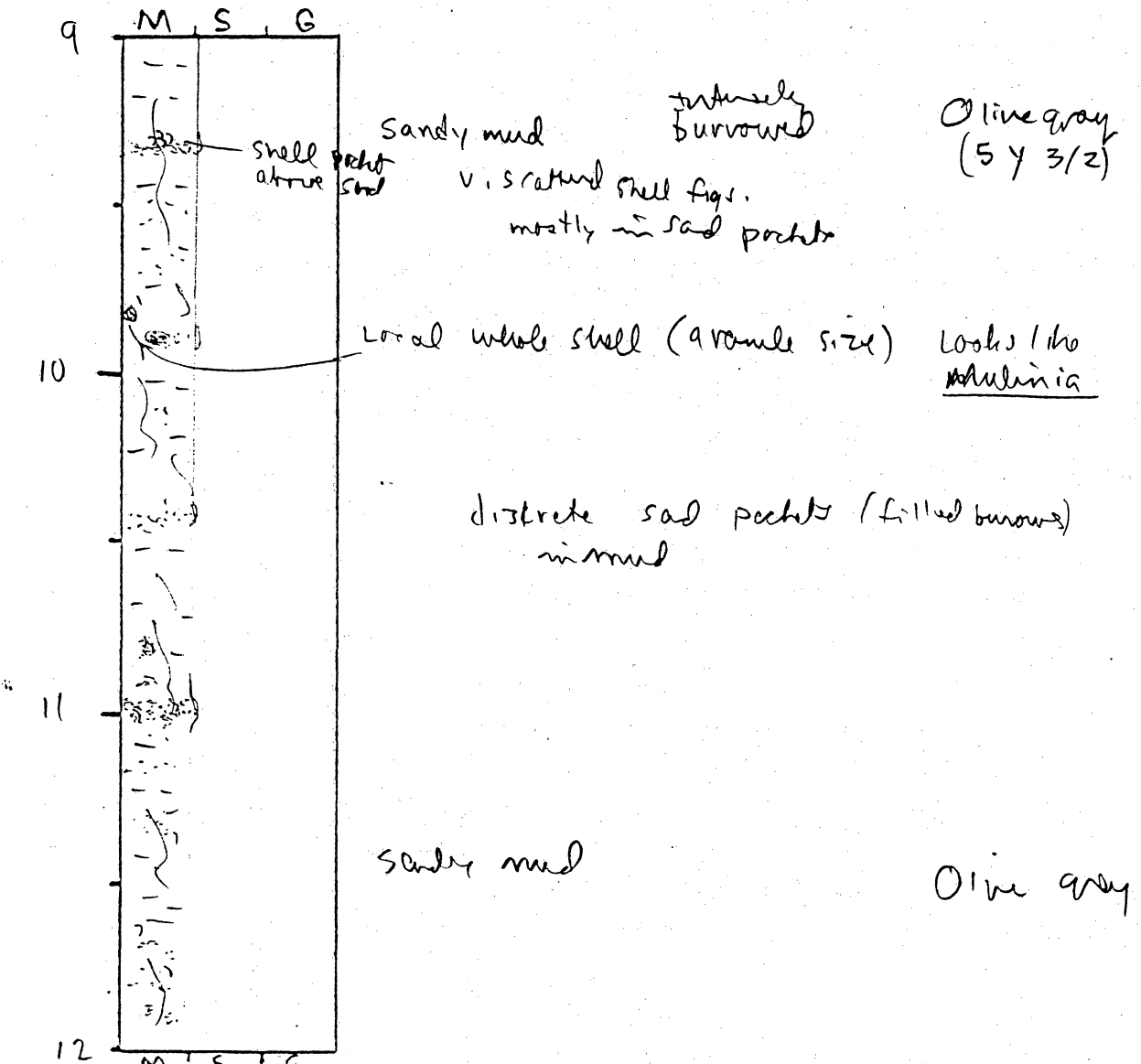
General Comments:

CORE LOG

CORE # SBV-16(D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

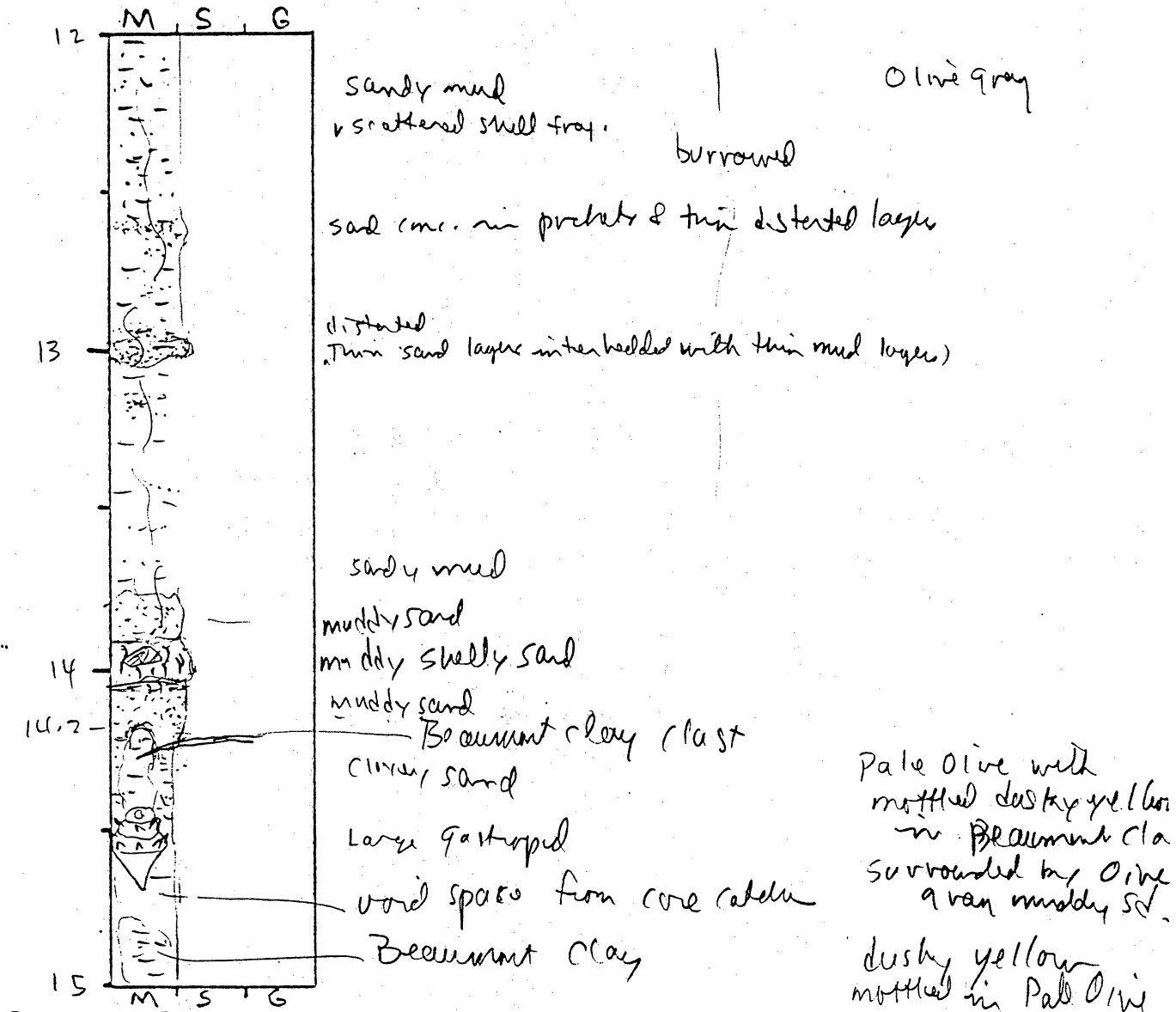


General Comments:

CORE LOG

CORE # SBV-16(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



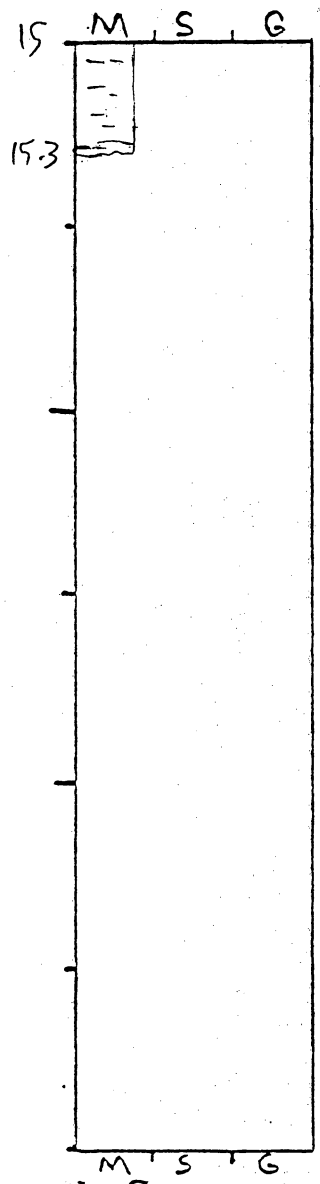
General Comments:

CORE LOG

CORE # SBU-16 (F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Beaumont clay

Pale Olive mottled with dusky yellow to Lt Olive brown.

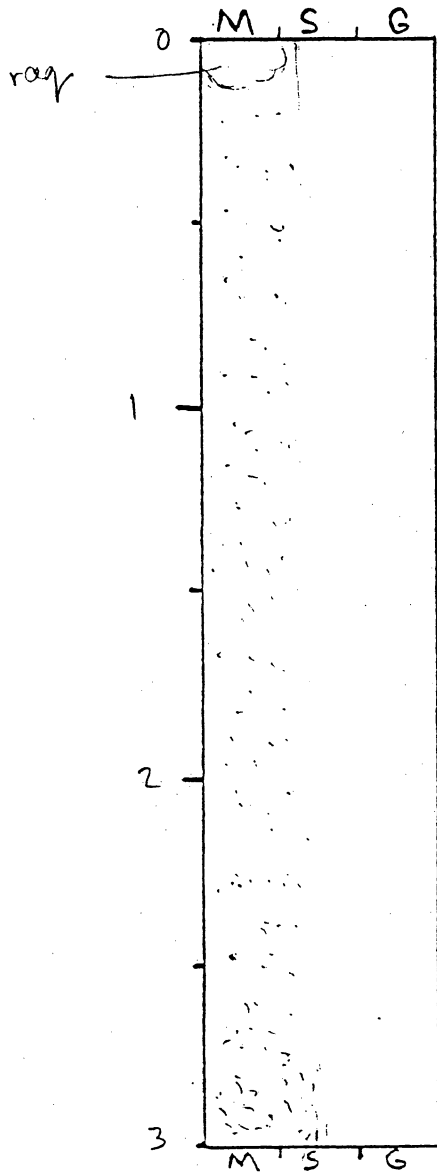
General Comments:

CORE LOG

CORE # SBV-17(A) TYPE Vibracore LOCATION Sabine Bank
 LATITUDE 29° 28.318 LONGITUDE 93° 45.257 SURFACE ELEVATION -23.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 14' 7/4" COMPACTION ?

OBTAINED BY Gibeault - R/V Kit Jones DATE
 DESCRIBED BY White DATE 2-8-95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Fine quartz sand with
 v. coarse sand size
 shell frags. \approx 10-20%
 quartz sub-rounded, well sorted

Light Olive gray
 SY 5/2

part of fining upward sequence

increase in
 shell frags near base to \approx 20% - 25%
 v. coarse sd grain size
 bimodal with fine qtz sand

lt Olive Gray
 SY 5/2

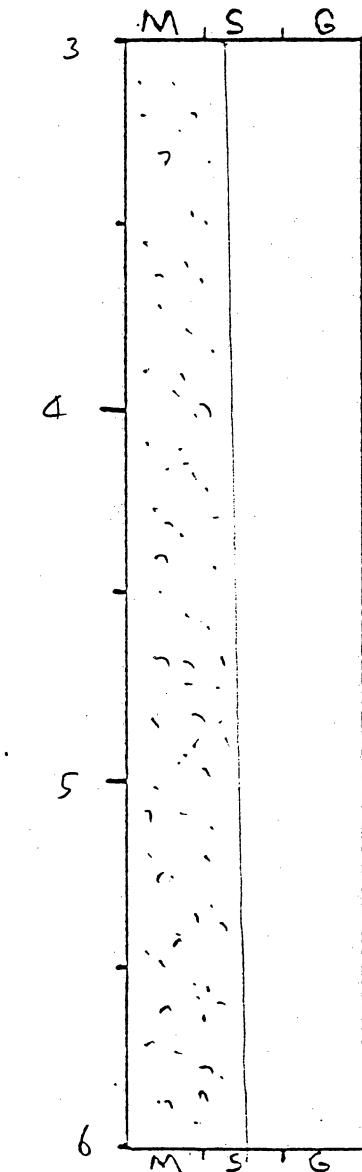
General Comments:

CORE LOG

CORE # SBV-17(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



(quant)
 Fine to v. coarse sand (shell)
 shell fragments increase
 in quantity with depth
 mostly v. coarse sand to
 granule in size
 occasional pebble size shell
 frag.

Light olive gray
 SY 5/2

Part of fining upward sequence

Fine (quartz) to v. coarse sd
 & granule in size (shell)
 ≈ 30% shells

Light olive gray
 SY 5/2

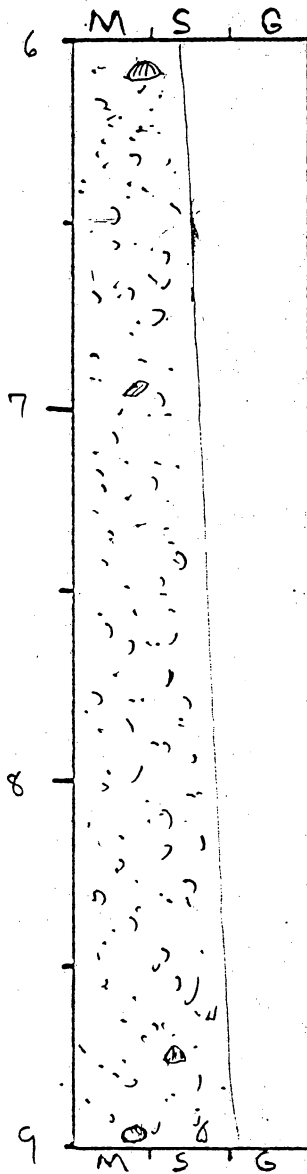
General Comments:

CORE LOG

CORE # SBV-17(c) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Fine quartz sand & shell frags
 V coarse to granule in size
 local pebble size shells
 Bimodal grain size

lt Olive gray

part of
 Fining upward
 sequence

shell fragments become more abundant
 @ slight layer with depth

shelly sand

~ 40% shell fragments

lt Olive gray

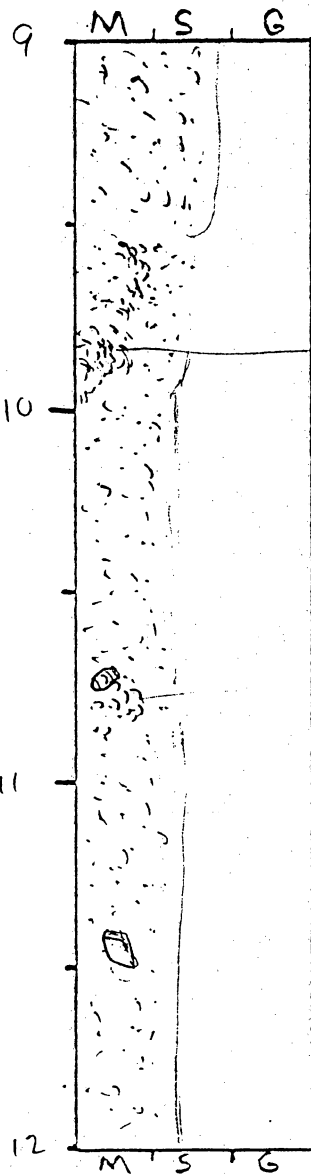
General Comments:

CORE LOG

CORE # SBV-17 (D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



shelly sand
 ≈ 50% shell

lt olive gray to
 olive gray

sand with
 40% shell

Sandy shell pocket

Fine sand with ≈ 25% v. coarse to
 granule shell frags

lt olive gray

shell pocket

fine quartz sand with
 20-25% shells
 v. coarse ^{sd} to granule size

lt olive gray

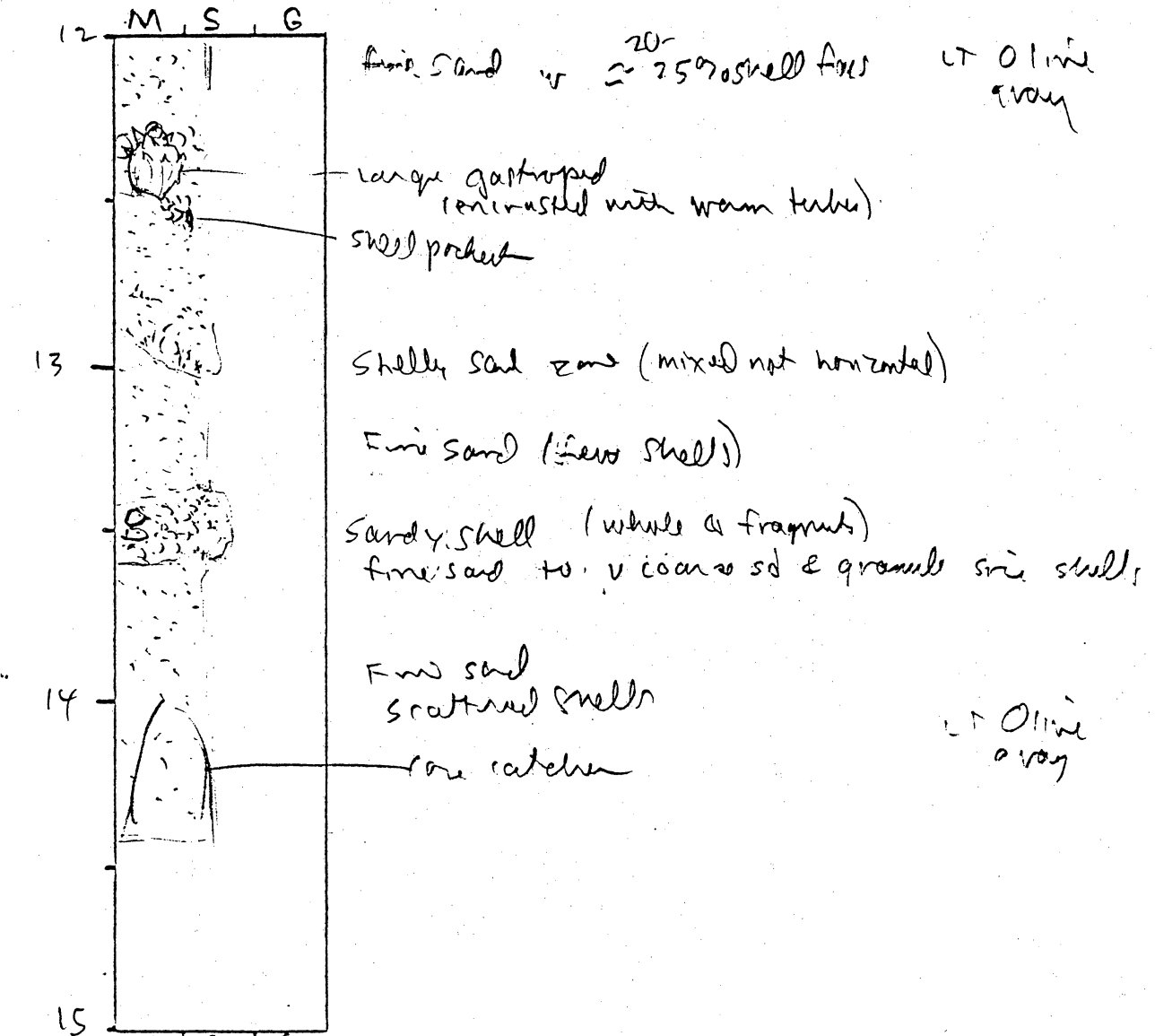
General Comments:

CORE LOG

CORE # SBV-17(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



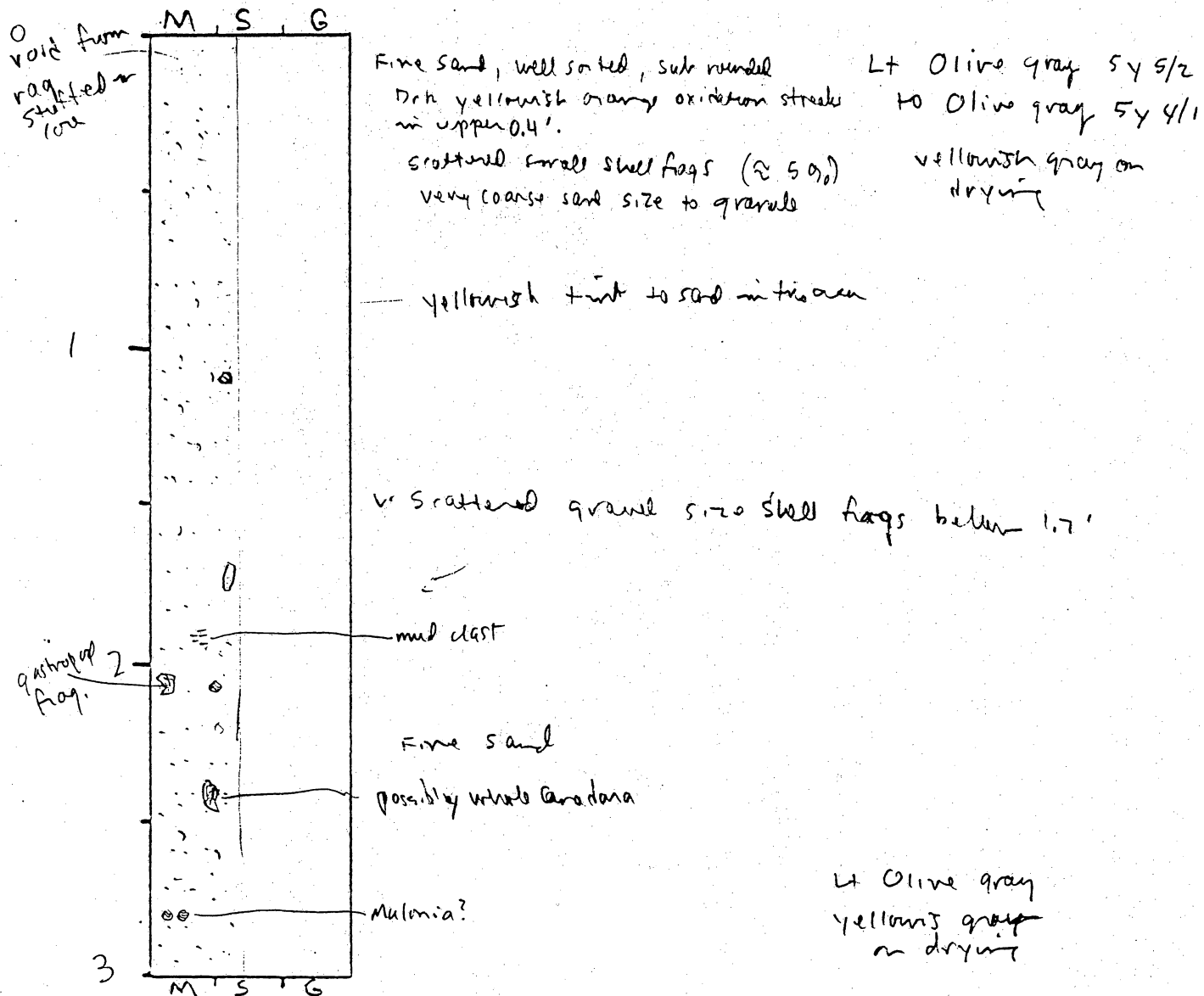
General Comments:

CORE LOG

CORE # SBV-18 (A) TYPE Vibrocore LOCATION Salina Bank
 LATITUDE 29° 27.642' LONGITUDE 92° 48.413' SURFACE ELEVATION -30.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 19' 4 1/2' COMPACTION ?

OBTAINED BY Sibbott - R/V Kit Jones DATE 10-14-94
 DESCRIBED BY Vik, Jr DATE 2-9-95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



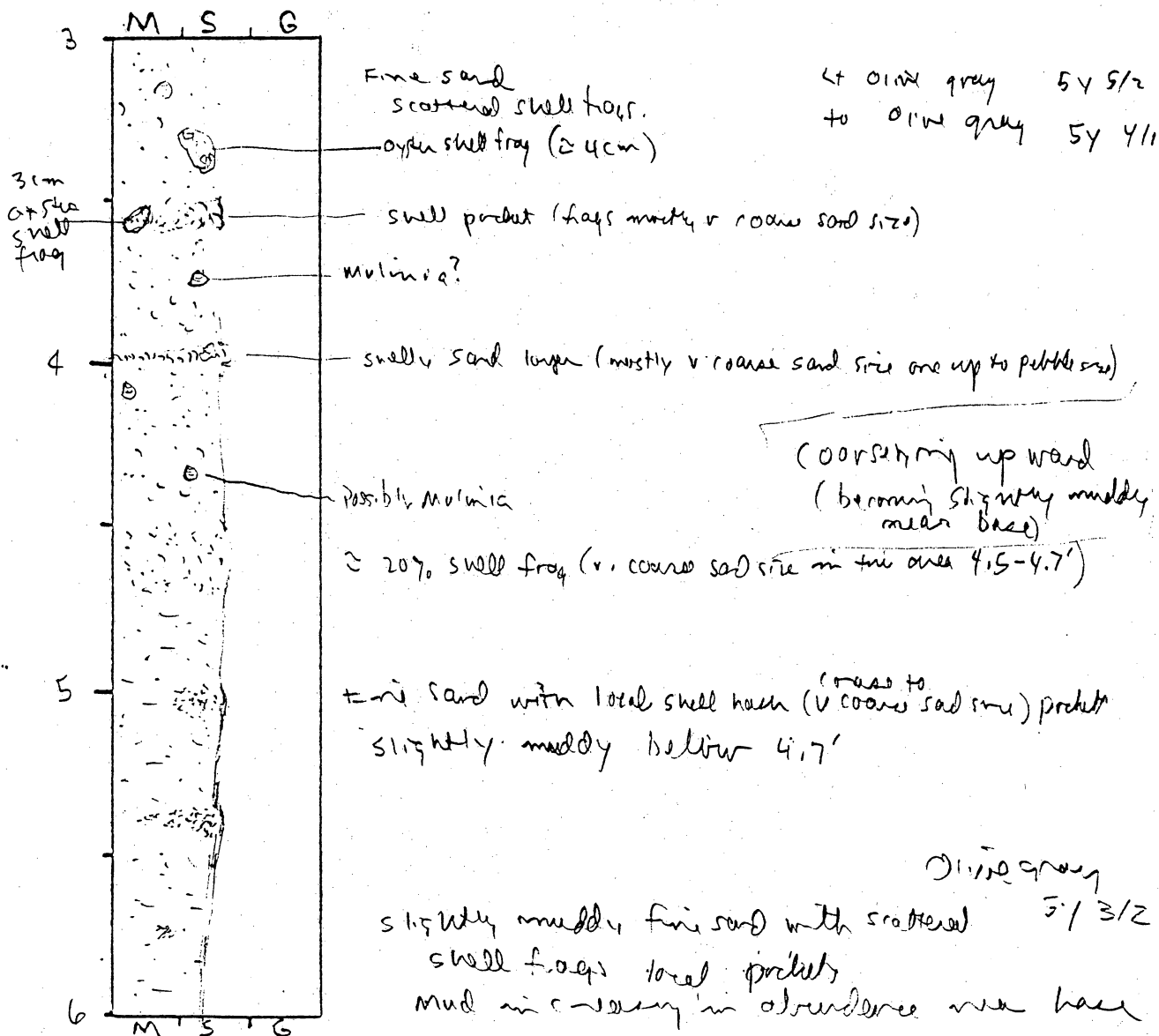
General Comments:

CORE LOG

CORE # SBV-R (B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



General Comments:

CORE LOG

CORE # SBV-8(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
6		Fine sand, a few shells V. slightly muddy		Olive green 54 3/2 to 54 4/1
7		Increase in shells 10-20% sand mud increasing below 6.81		mud increase with depth
8		slightly muddy sand scattered shell frags	barren	
9		very granular contact muddy sand, scattered shell frags, and pockets of v coarse sand size shell frags discrete mud & sand zone local gravel size shell shell ~ 10 %	Intensely burrowed	Olive grey 54 3/2 (darker than near top)

General Comments:

CORE LOG

CORE # SBV-18(D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
9		muddy sand sand in pockets and irregular layers include coarse sand size shell hash locally	Intensely burrowed	(5y 3/2) Olive gray to dark gray
10		sandy mud muddy sand	Mud increases with depth	Color change in this core to darker gray
11		sandy mud to muddy sand scattered small shell frags associated with sand pockets	Intensely Burrowed	Overall mud appears to become more abundant than sand below 10.2'
12		muddy sand to sandy mud		Dark gray to olive gray 5y 3/4

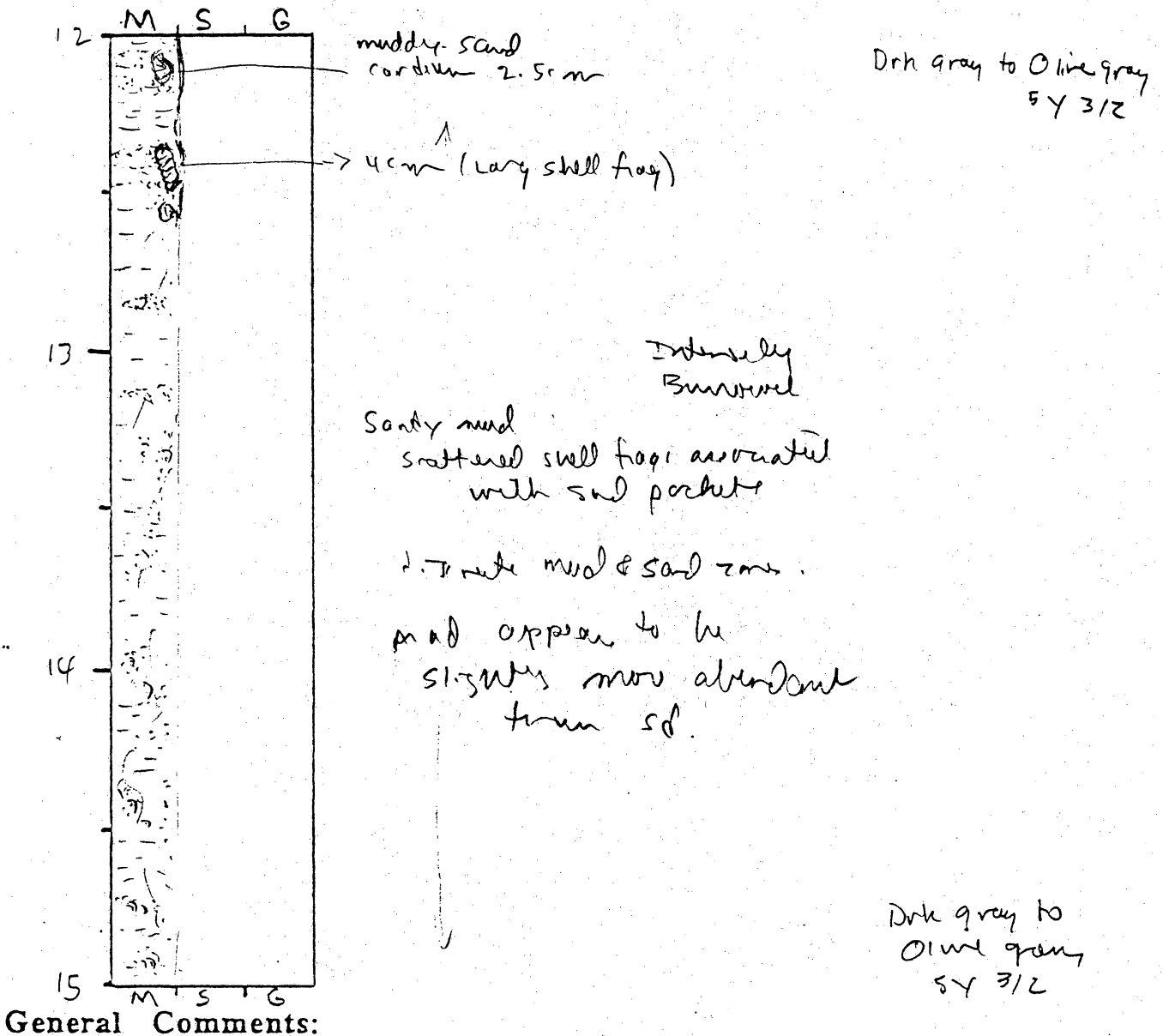
General Comments:

CORE LOG

CORE # SBV-18 (E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



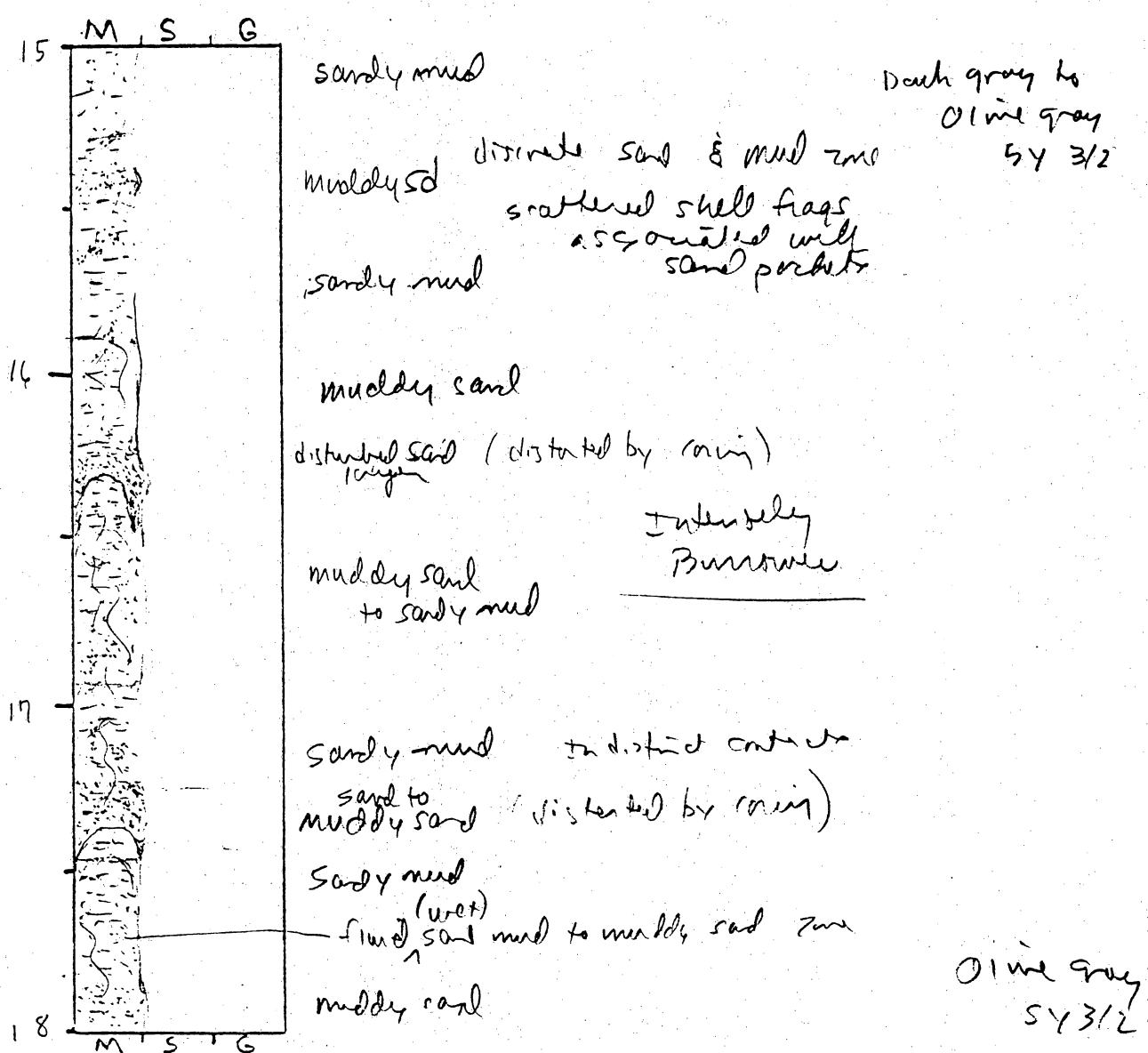
General Comments:

CORE LOG

CORE # SBV-18 F TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

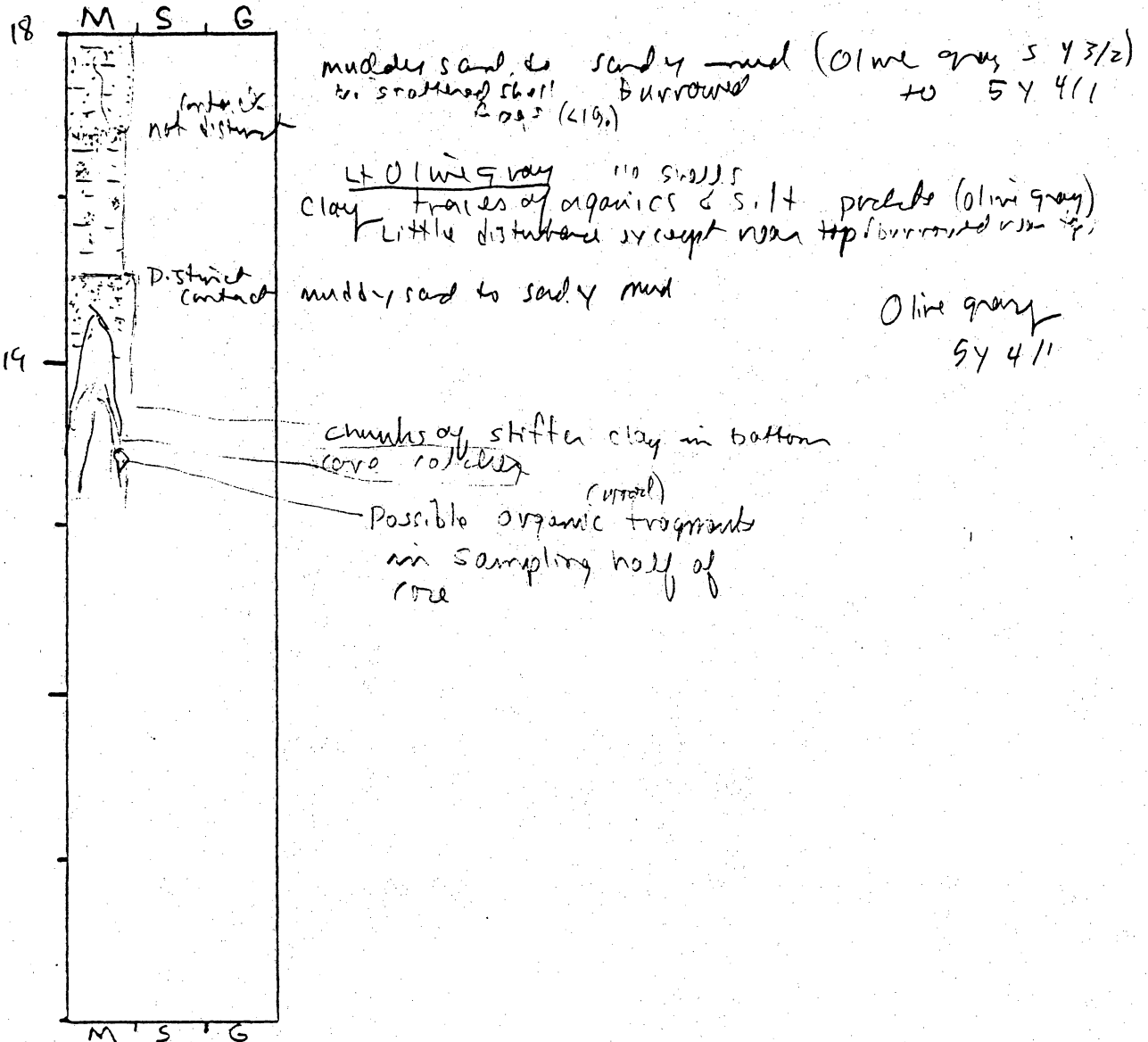


General Comments:

CORE LOG

CORE # SBV-18(G) TYPE Vibracore LOCATION Sabine Bank
 LATITUDE 29° 27.642 LONGITUDE 92° 48.413 SURFACE ELEVATION -39.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 19' 4 1/2" % COMPACTION ?
 OBTAINED BY Gibeaut - R/V Kit Jones 19.4' DATE 10-14-94
 DESCRIBED BY White DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



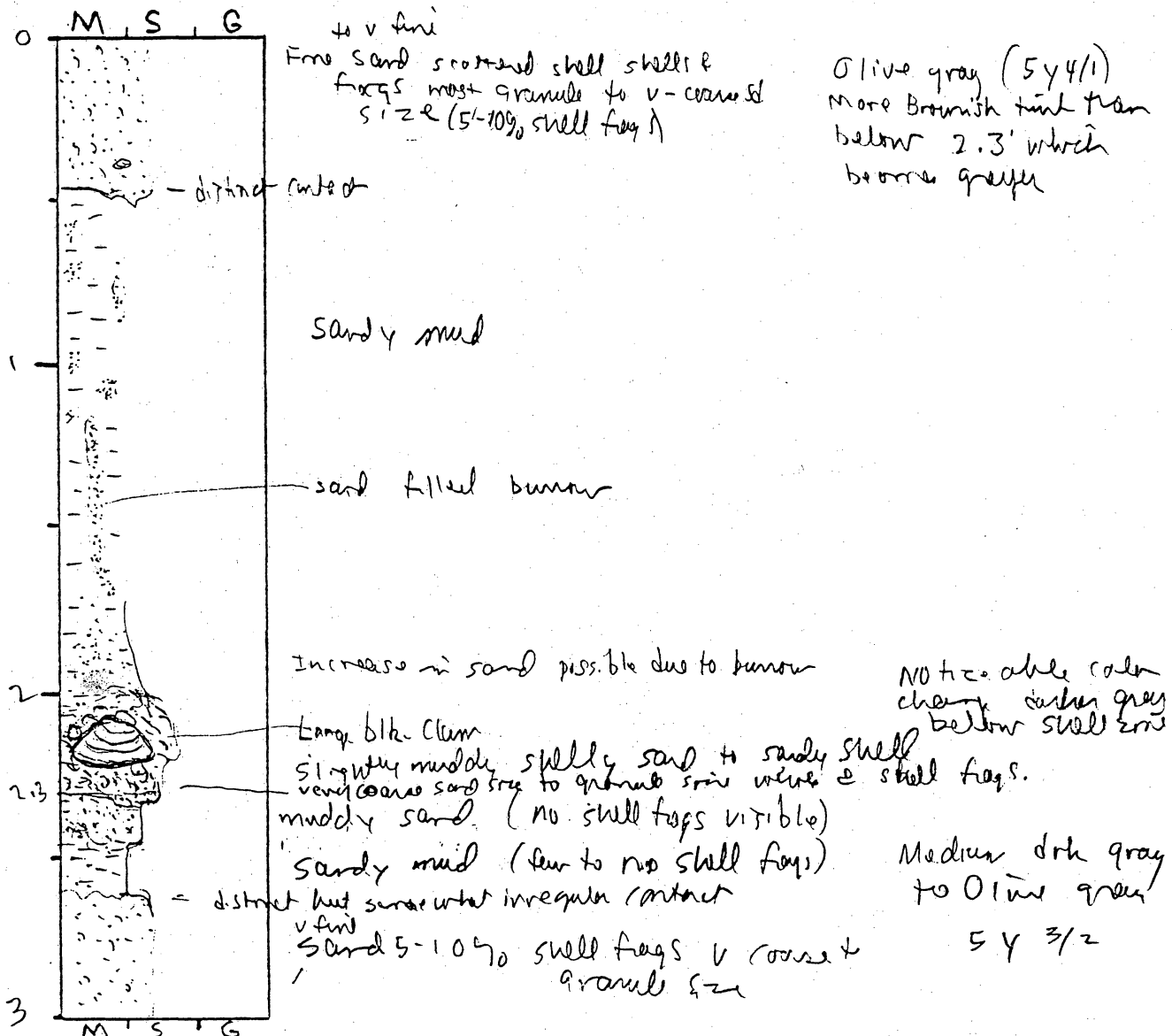
General Comments:

CORE LOG

CORE # SBV-19(A) TYPE Vibracore LOCATION Sabine Bank
 LATITUDE 29° 26.41' LONGITUDE 93° 47.782 SURFACE ELEVATION -31.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 19' 4 1/2" % COMPACTION ?

OBTAINED BY Gibson - Riv Kit Jones DATE 10-14-94
 DESCRIBED BY White DATE 2-9-95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



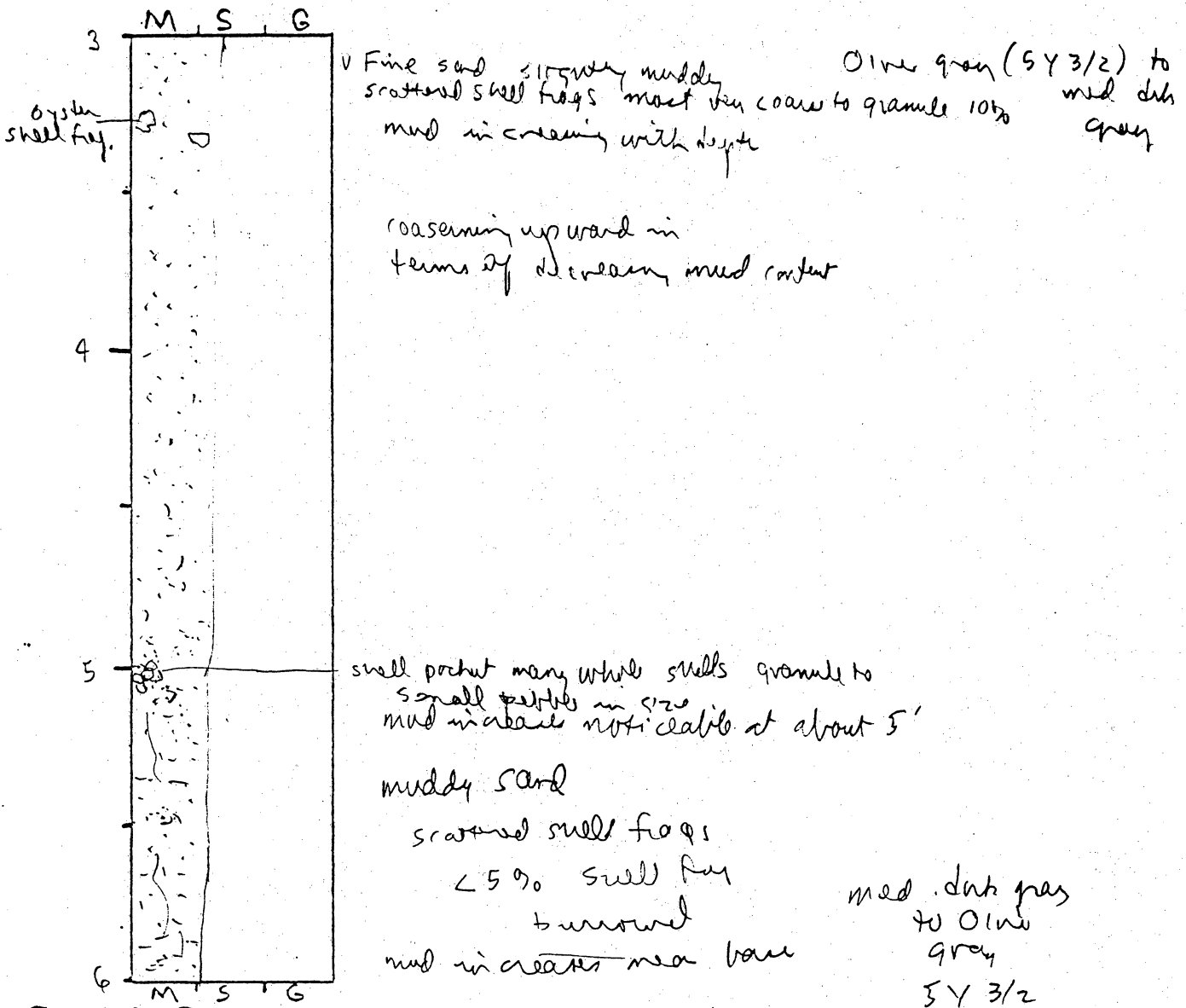
General Comments:

CORE LOG

CORE # SBV-19(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



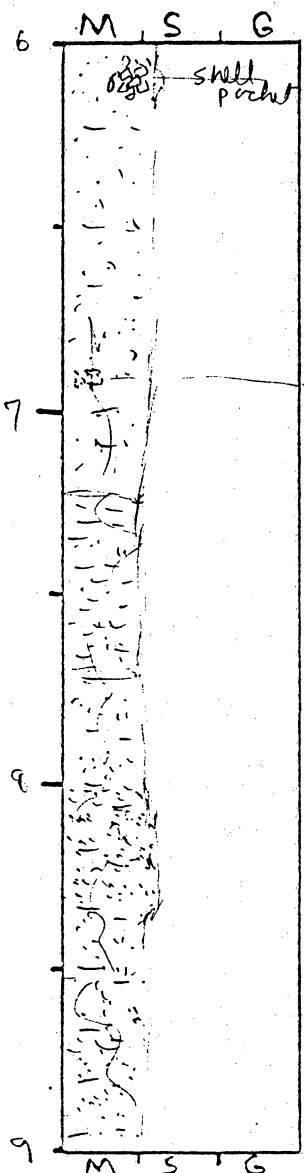
General Comments:

CORE LOG

CORE # SBV-19 (c) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand
 ↓ scattered shell frags -- < 5%
 except in shell pocket

olive green
 5Y 3/2
 to mud
 dark gray

shell frag pocket (v coarse sand size)

mud increase noticeable below 7.3'

wetter zone 7.3 - 7.8' intensely burrowed

sandy mud to muddy sand

discrete pockets of sand & mud

< 1% shell frags

sand increase slightly below 8'
 muddy sand

muddy sand to sandy mud

intensely burrowed
 olive green
 5Y 3/2
 to mud
 dark gray

General Comments:

CORE LOG

CORE # SBV-19 (D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
9		muddy sand to sandy mud ≈ 1 to shell frag sandy mud to muddy sand	Intensely burrowed	(SY 3/2) 01 m gray to med dk gray Intensely burrowed with almost equal portions of mud & sand difficult call about where sand is most abundant & mud is most abundant
10		discrete sand & mud units shell pocket muddy sand to sandy mud sandy mud to muddy sand	channel by organism	
11		muddy sand to sandy mud		
12		sandy mud		

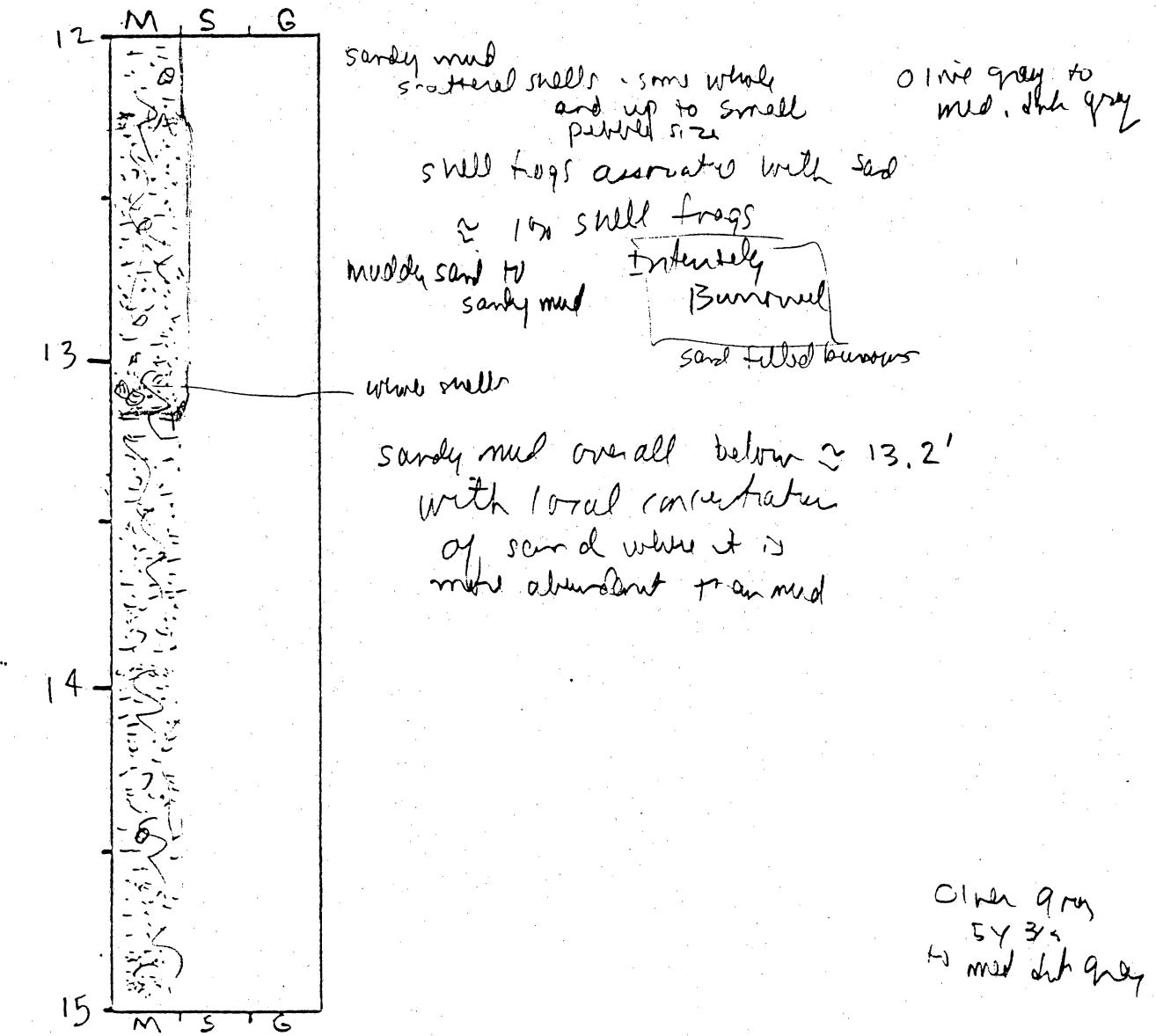
General Comments:

CORE LOG

CORE # SBV-19 (E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

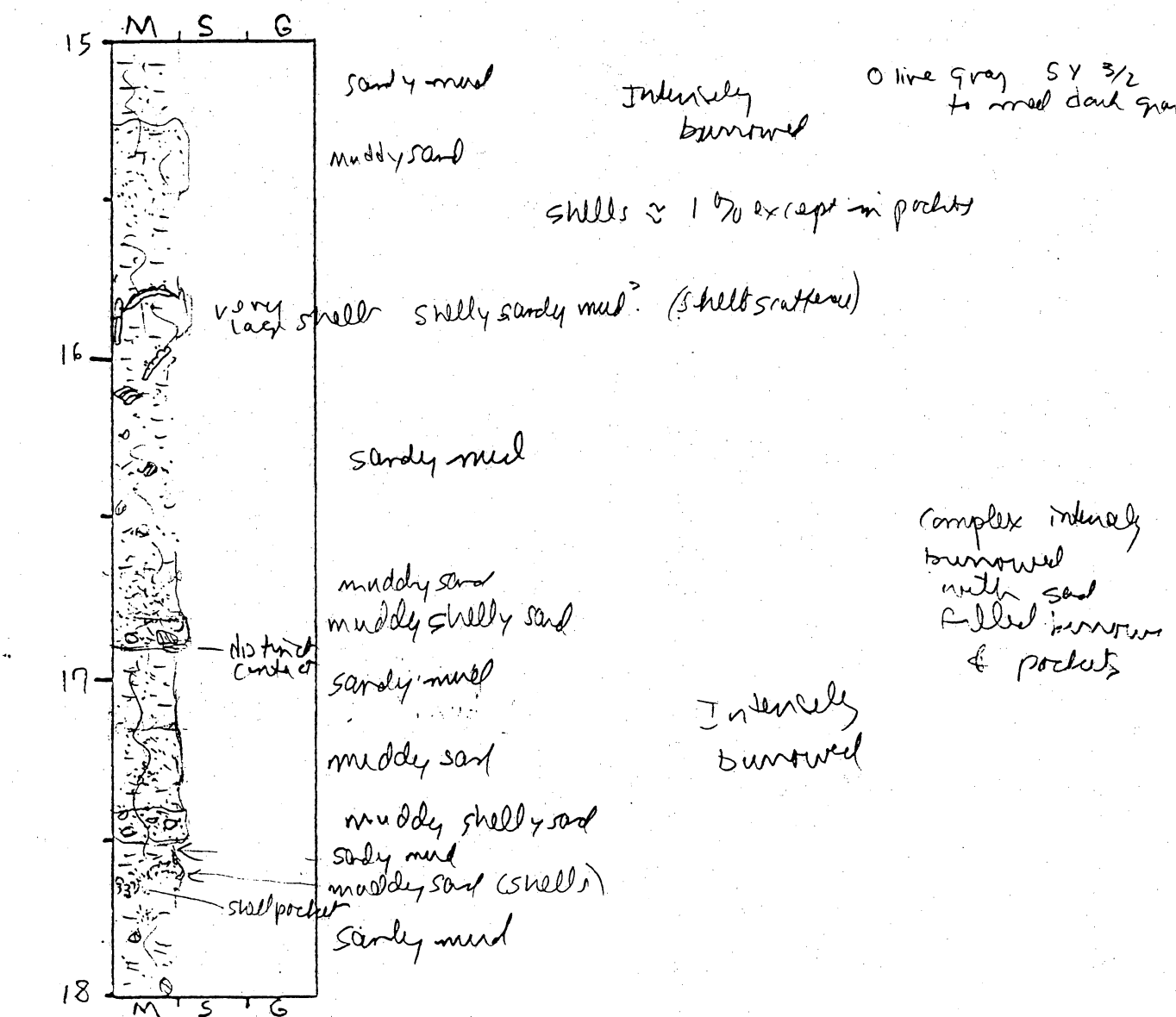


General Comments:

CORE LOG

CORE # SBV-19 (F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



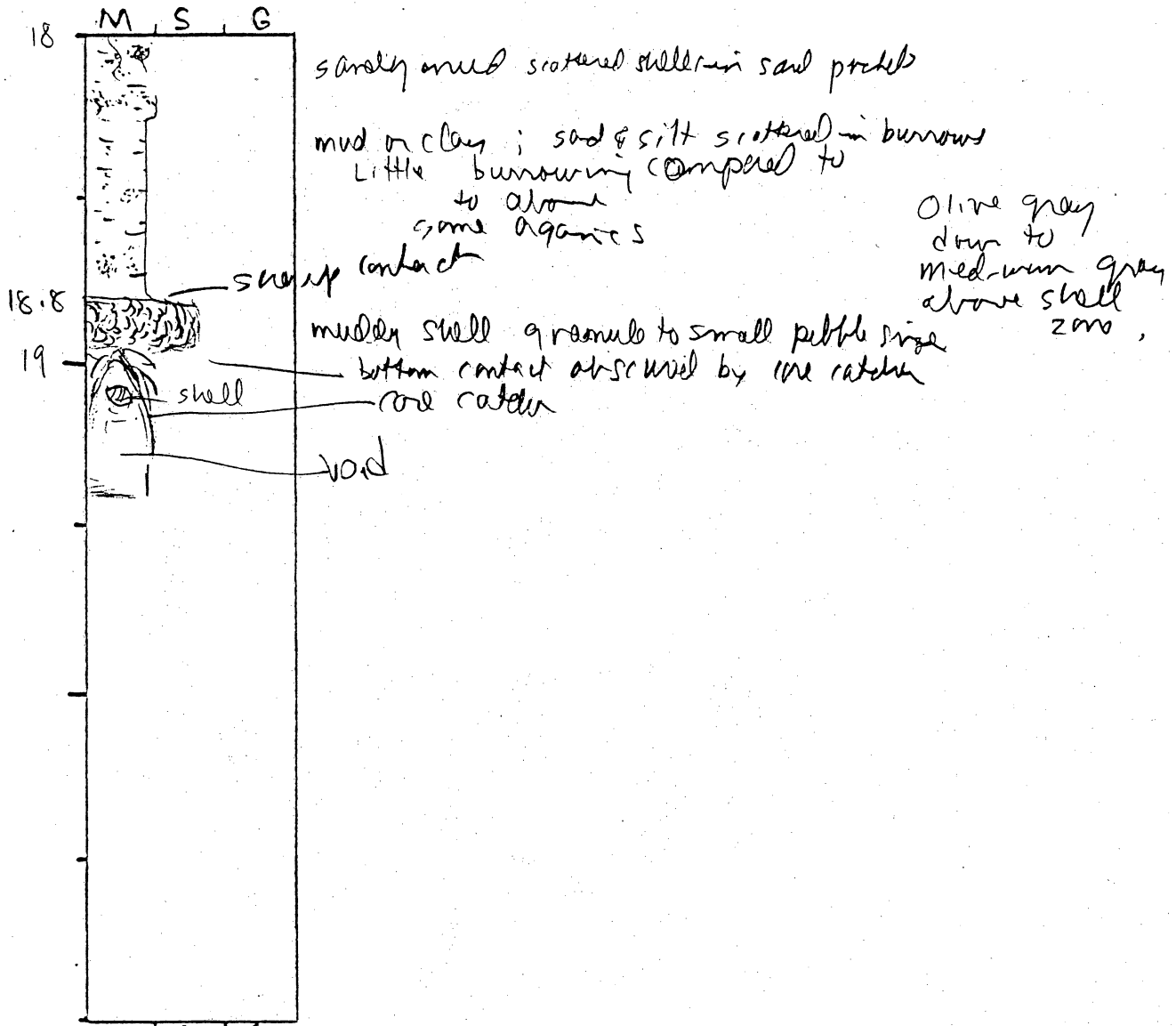
General Comments:

CORE LOG

CORE # SBV-19(G) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



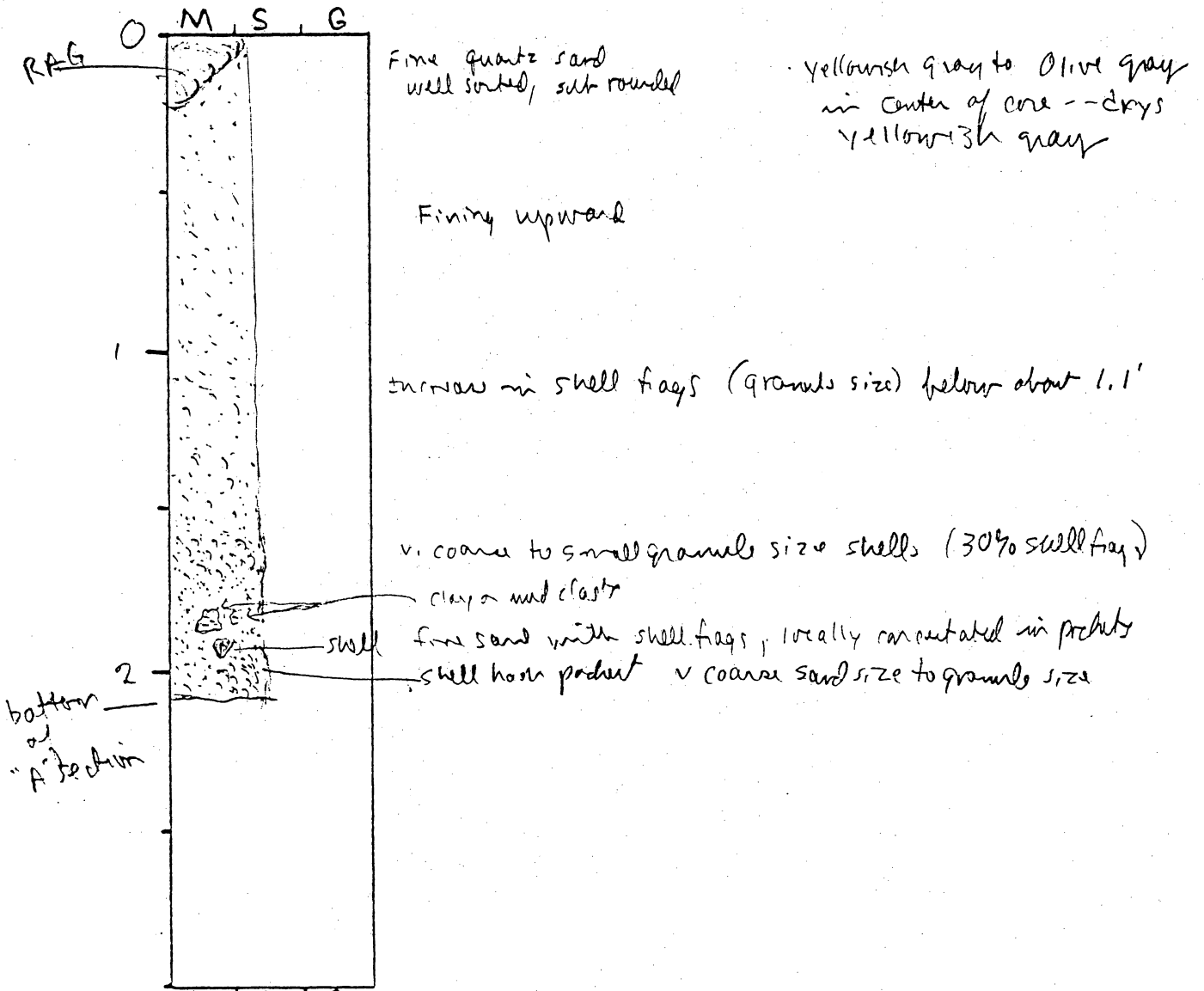
General Comments:

CORE LOG

CORE # SBV-201A TYPE Vibracore LOCATION Sabine Bank
 LATITUDE 29° 25.035 LONGITUDE 93° 47.144 SURFACE ELEVATION -35.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 5' 2" % COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 11-14-94
 DESCRIBED BY White DATE 7-22-95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

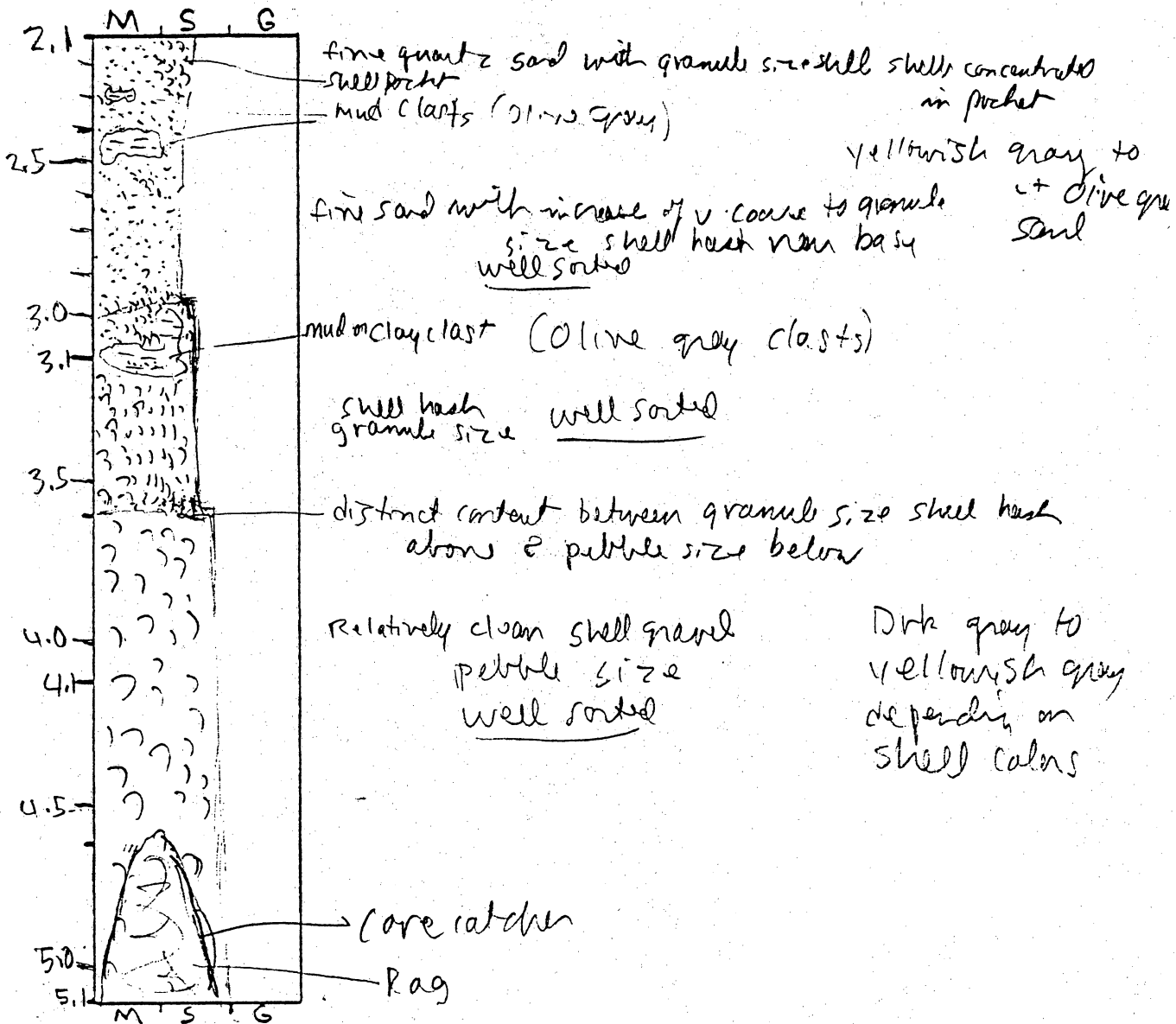


General Comments:

CORE LOG

CORE # SBV-20 (B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



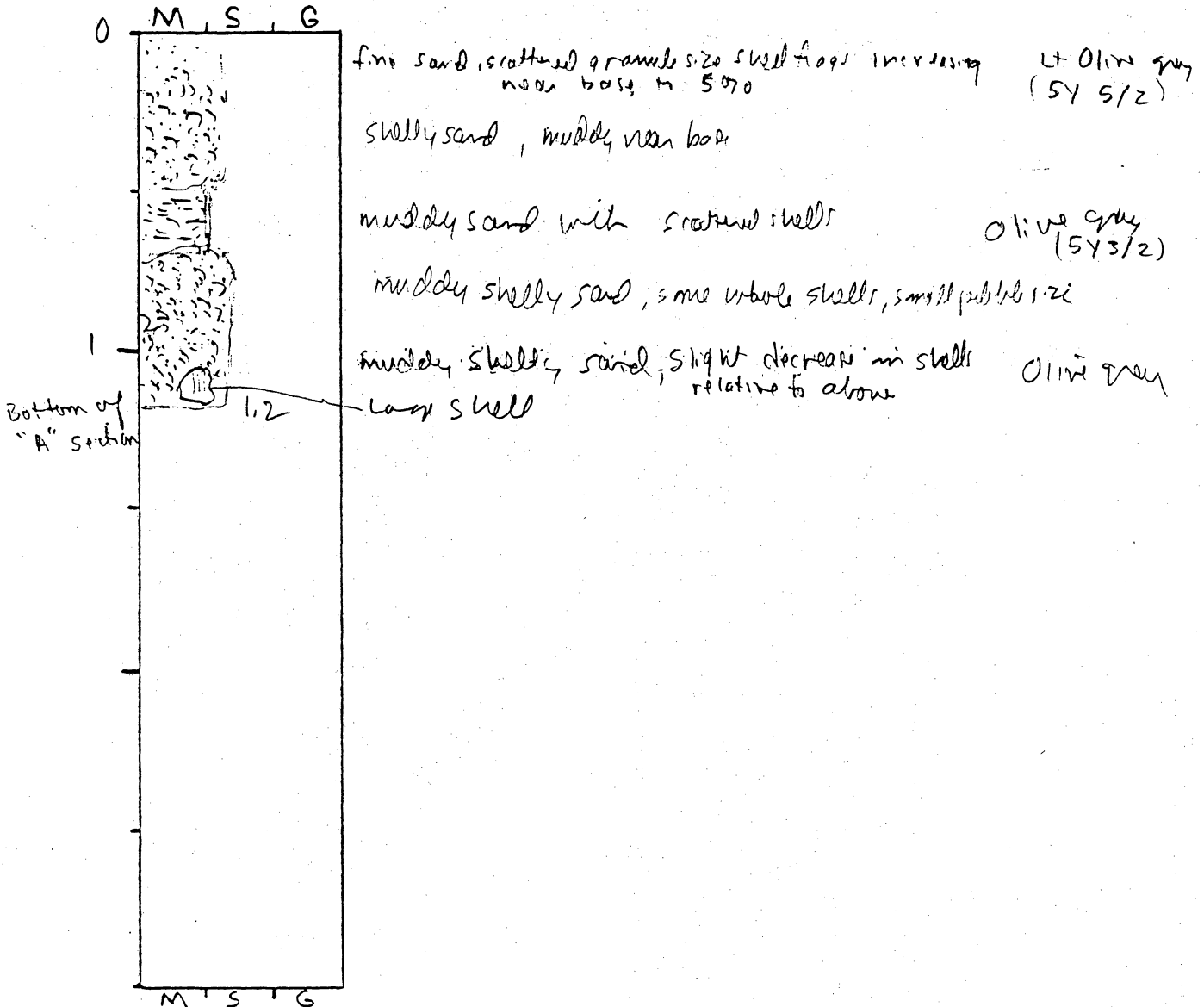
General Comments:

CORE LOG

CORE # SBV-21(A) TYPE Vibracore LOCATION Sabine Bank
 LATITUDE 29° 23.80' LONGITUDE 93° 46.50' SURFACE ELEVATION -42.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 7' 2 1/2" % COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-12-94
 DESCRIBED BY White DATE 2-22-95

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
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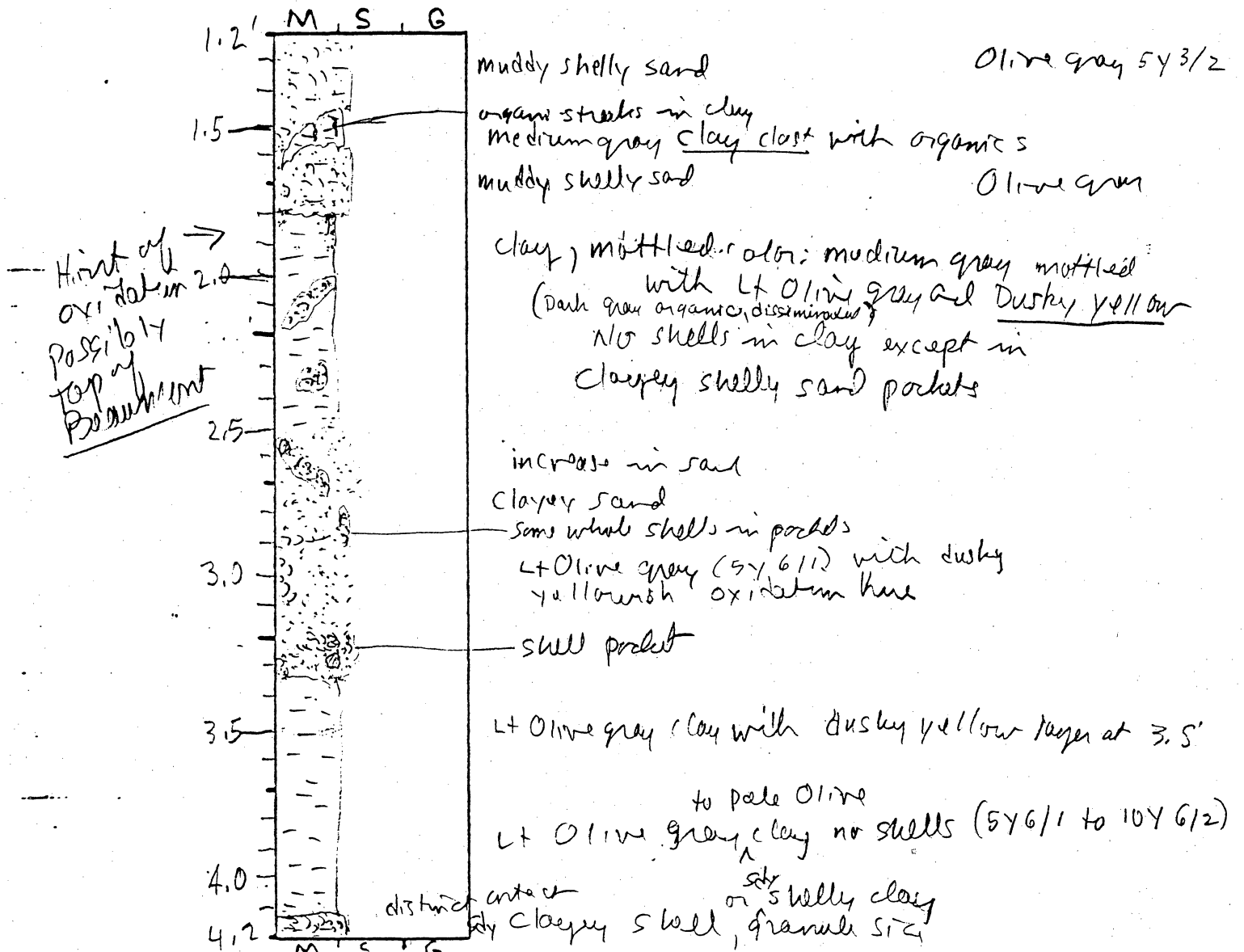


General Comments:

CORE LOG

CORE # SBV-2(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

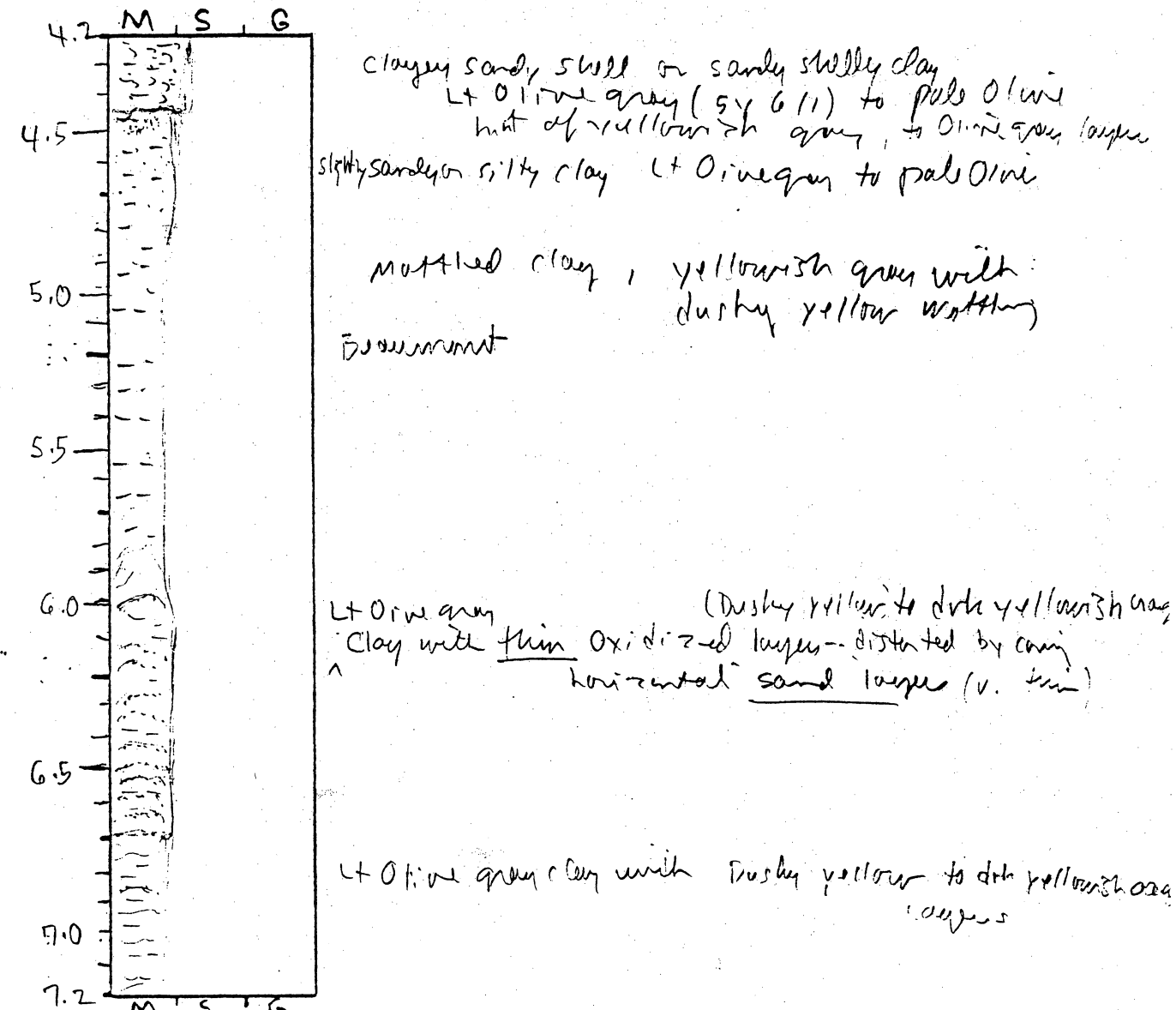


General Comments:

CORE LOG

CORE # SBV-21(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH
 (ft, m) **SKETCH** **LITHOLOGY** **STRUCTURE** **REMARKS**



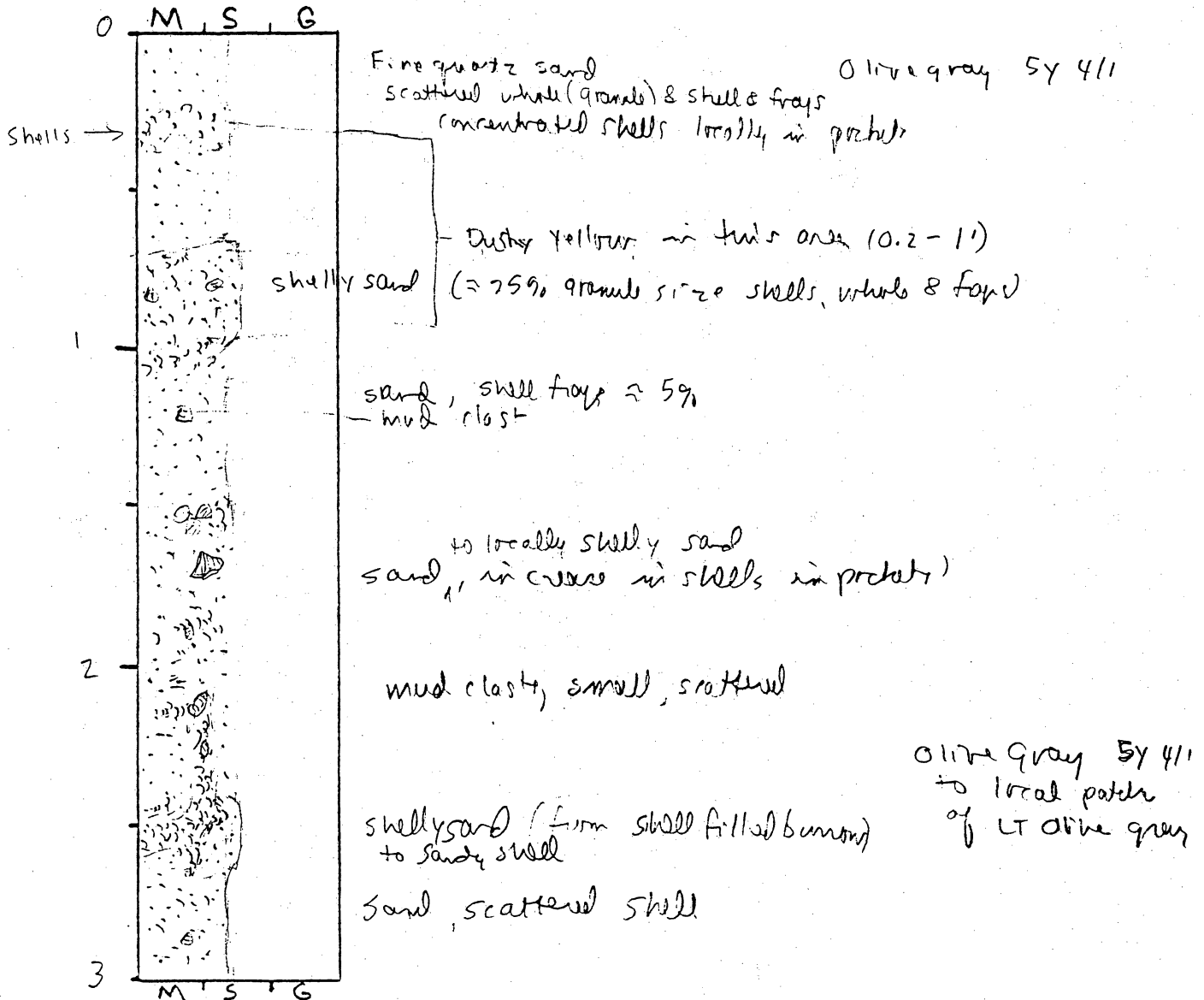
General Comments:

CORE LOG

CORE # SBV-22 (A) TYPE Vibrocore LOCATION Sabine Bank
 LATITUDE 29° 25.163 LONGITUDE 92° 52.618 SURFACE ELEVATION -31.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 19' 3 1/2" % COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-14-94
 DESCRIBED BY White DATE 2-17-95

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



General Comments:

CORE LOG

CORE # SBV-22 (B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
3		Fine quartz sand, slightly muddy, ~ 10% shell frags, small, sandy shell, small granules size shell hash		Olive gray 5 Y 3/2
4		sand, slightly muddy, scattered shell frags (< 5%) mud apparently increase with depth		
5		sandy slightly muddy scattered shell frags ~ 5%		
6		muddy sand, scattered shell frags mud clasts		

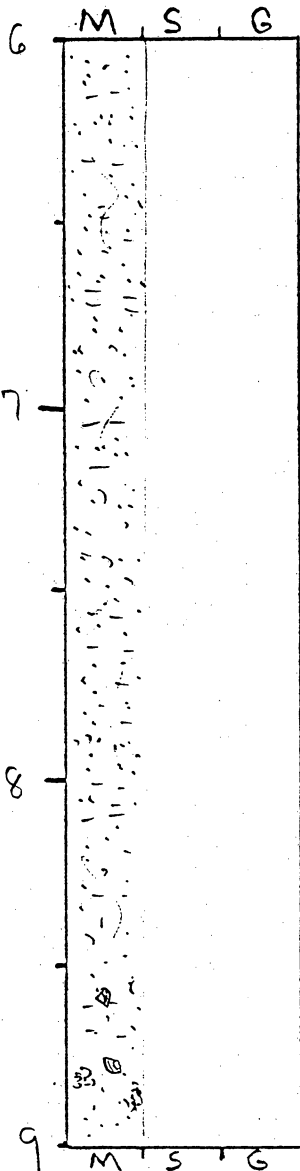
General Comments:

CORE LOG

CORE # SBV-22(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand
 mud clasts
 scattered shells, vitals & faq
 5% locally 10% mostly gravel in size
 Burrowed
 Olive gray
 SY 3/2

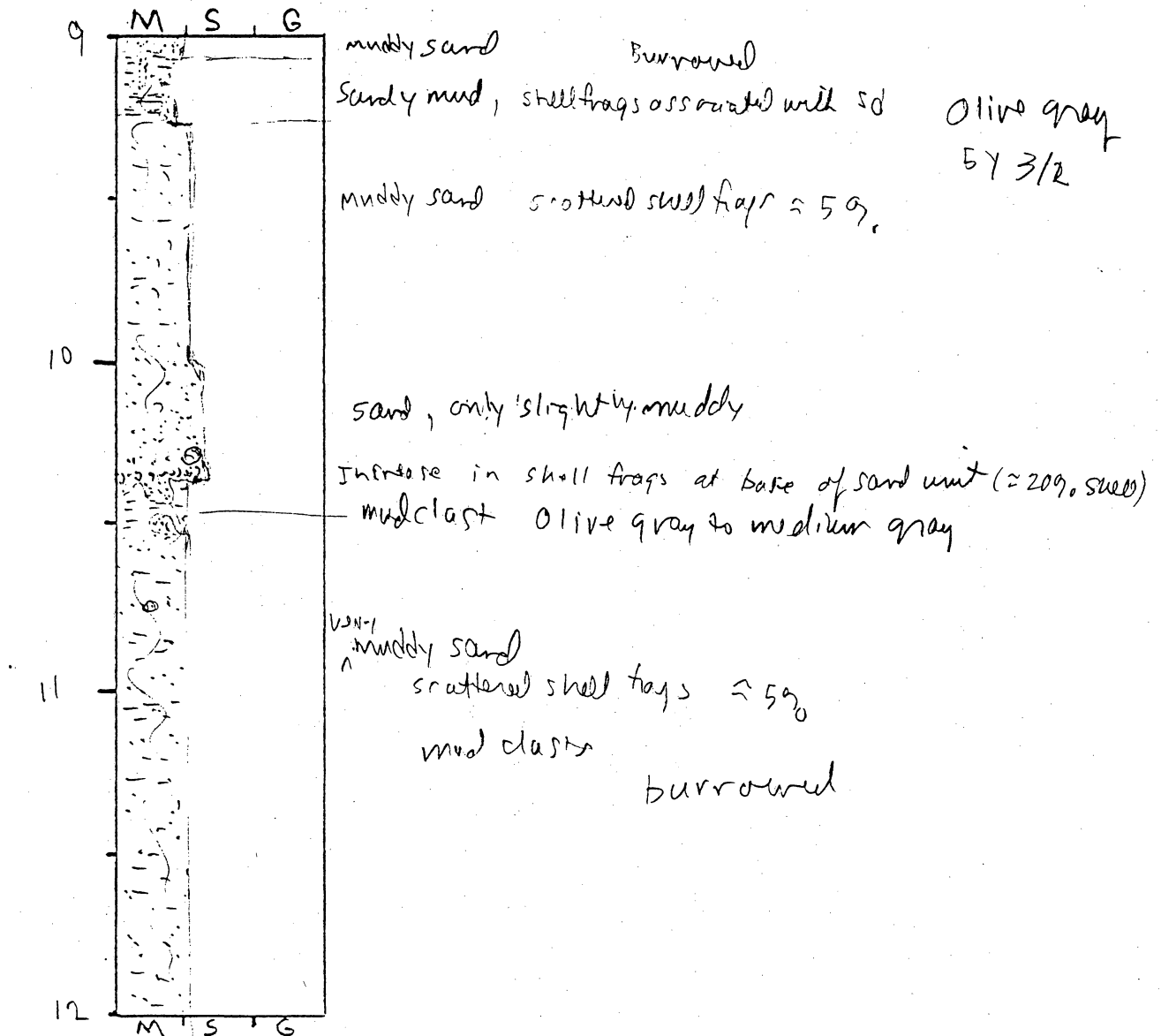
General Comments:

CORE LOG

CORE # SBV-22 (D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



General Comments:

CORE LOG

CORE # SBV-22(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

12	M, S, G	v muddy sand		
		sandy mud	Intensely burrowed	Olive gray
12.4		sand, with thin shell hash lens (proker)		5 Y 3/2
12.6	distinct	but burrowed out		
		Sandy mud to ^{very} muddy sand		
13		scattered small shell fragments associated with sand	Intensely Burrowed	
		Muddy sand to sandy mud		
14				
15	M, S, G	Sandy mud to muddy sand		

General Comments:

CORE LOG

CORE # SBV-22(F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

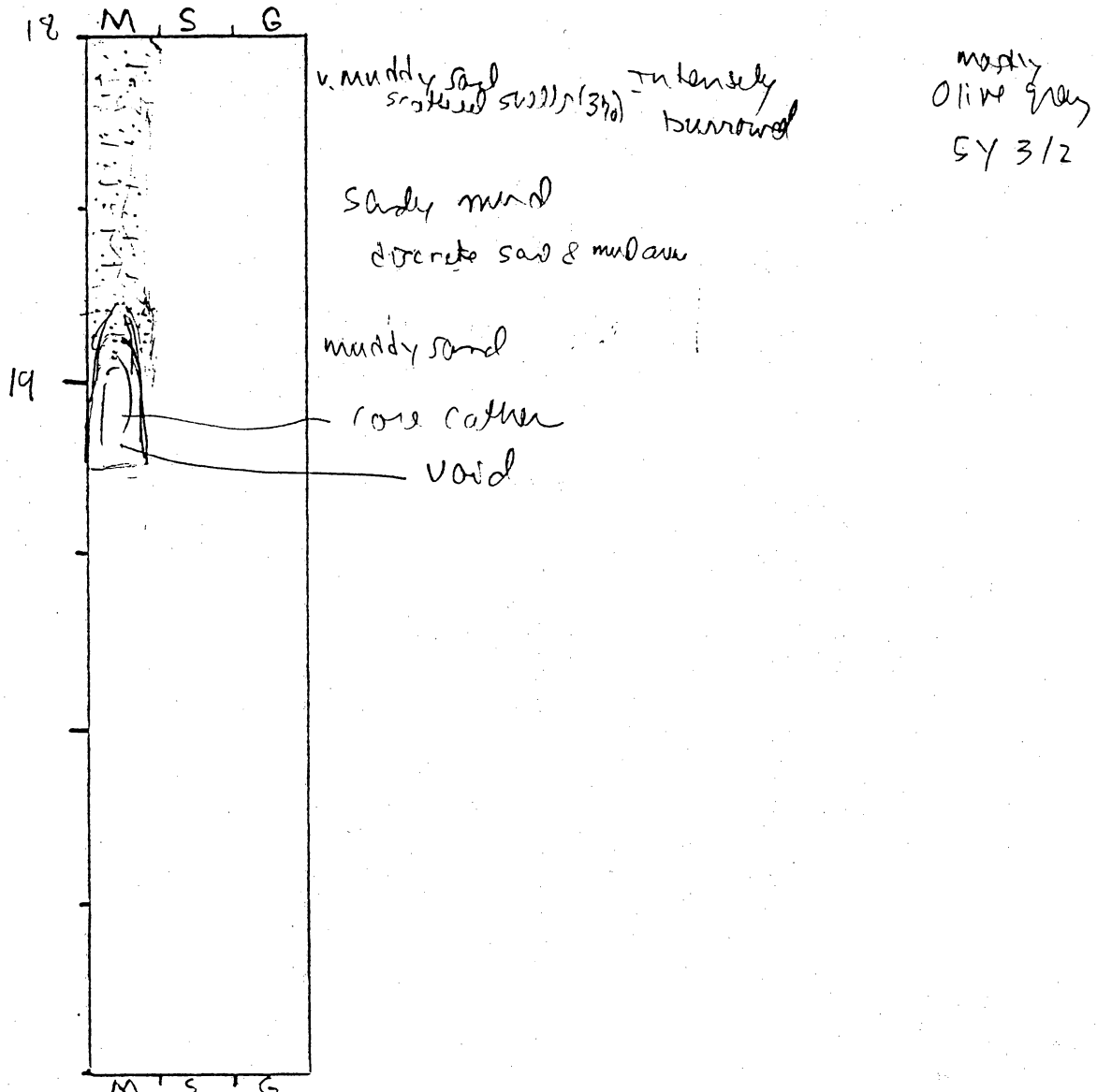
15	M S G	sandy mud to muddy sand muddy sand		Olive gray 54 3/2 to Olive gray 54 4/9
		shell pocket		Intensely burrowed
		sandy mud sand, slightly muddy		
16		sandy mud muddy sand sandy mud muddy sand sandy mud	Discrete m. nod. of sand zone	
17		2 large shells		
		sandy mud sand slightly muddy sandy mud		
18	M S G			

General Comments:

CORE LOG

CORE # BBV-22G TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



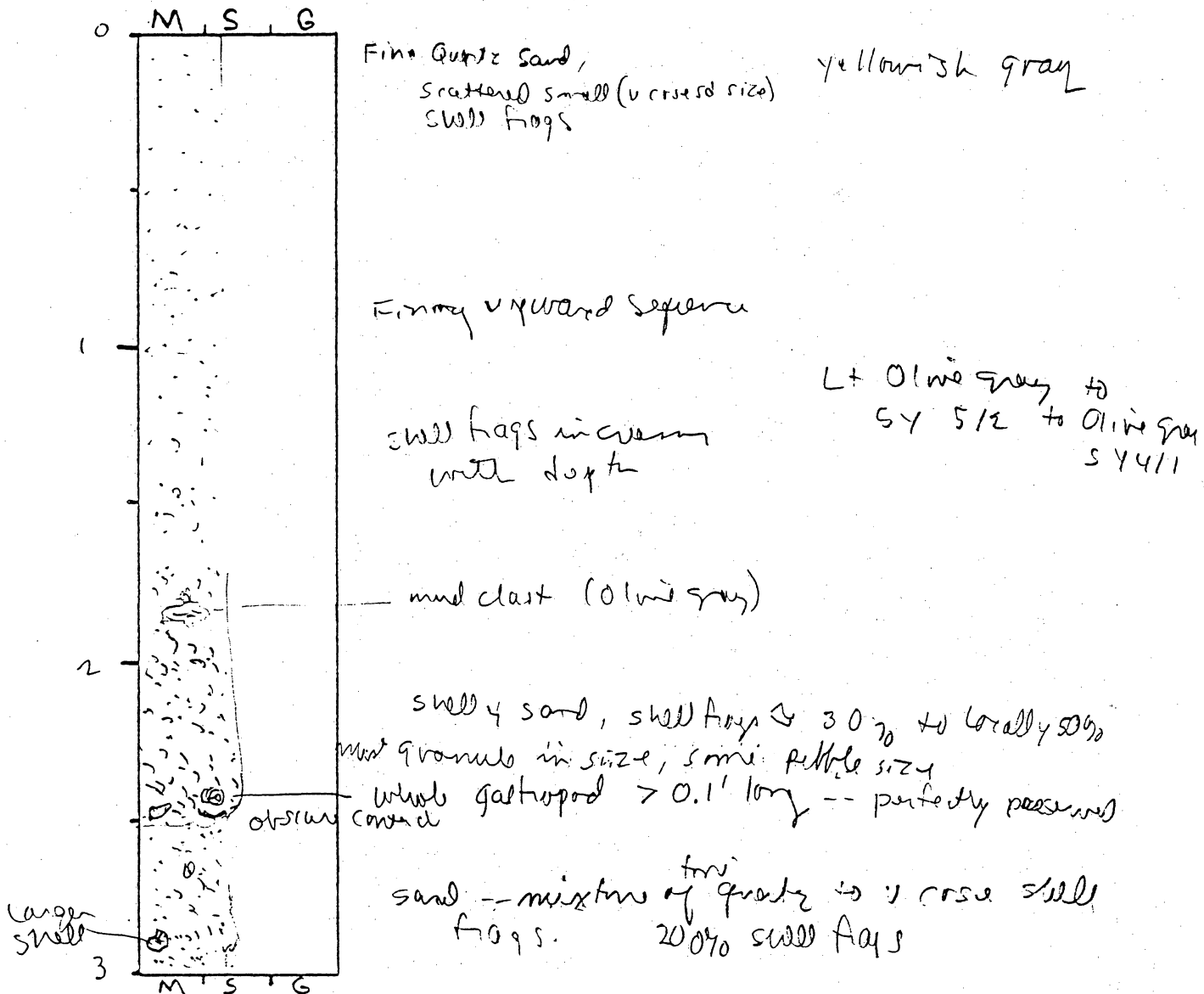
General Comments:

CORE LOG

CORE # SBV-23(A) TYPE Vibracore LOCATION Sabine Bank
 LATITUDE 29° 24.610 LONGITUDE 92° 54.121 SURFACE ELEVATION -32'
 DEPTH PENETRATED ? LENGTH RECOVERED 12' 11 1/2" % COMPACTION ?

OBTAINED BY Gibeaut - Riv Kit Jones DATE 10-14-94
 DESCRIBED BY JJW DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



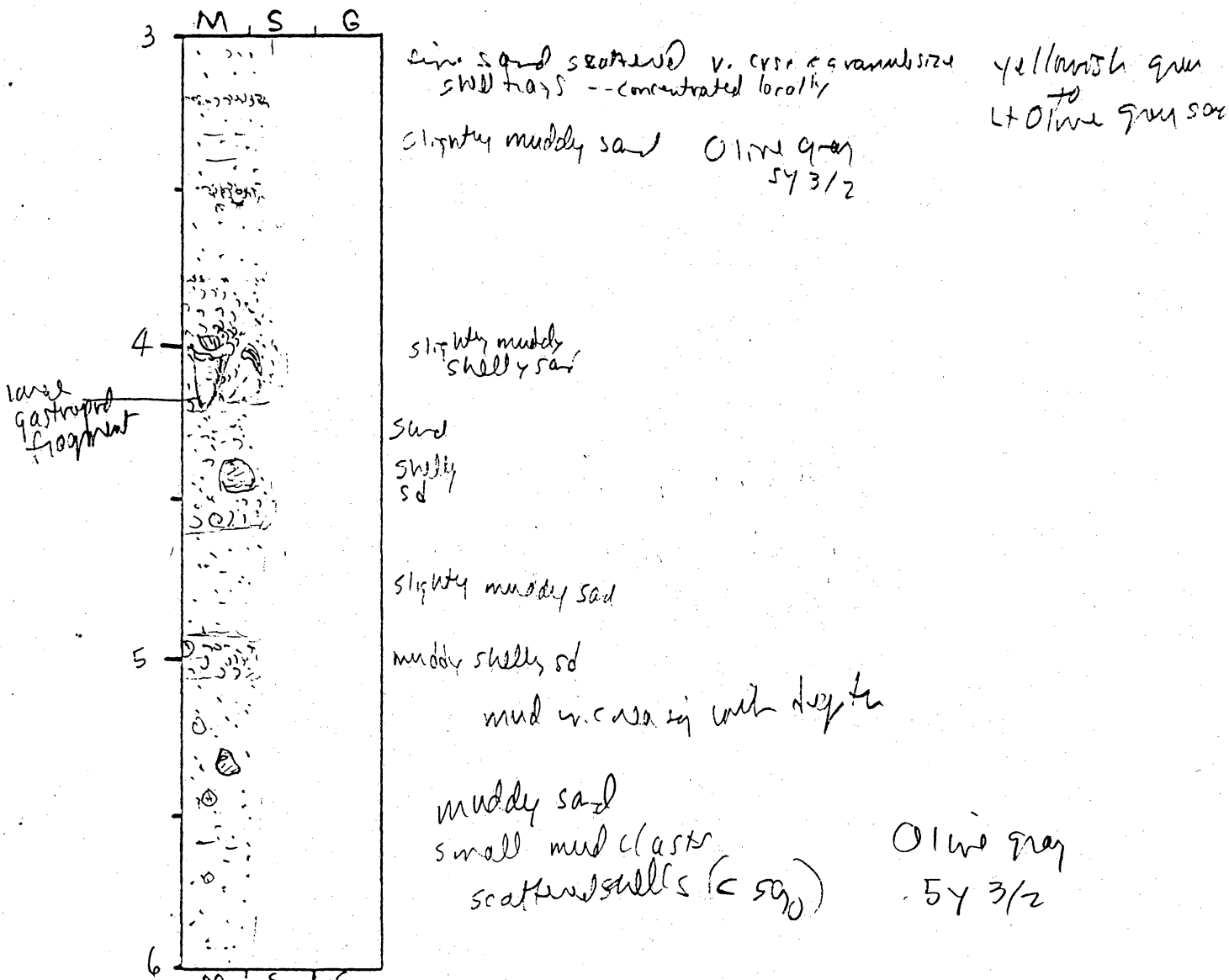
General Comments:

CORE LOG

CORE # SBV-23 (B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



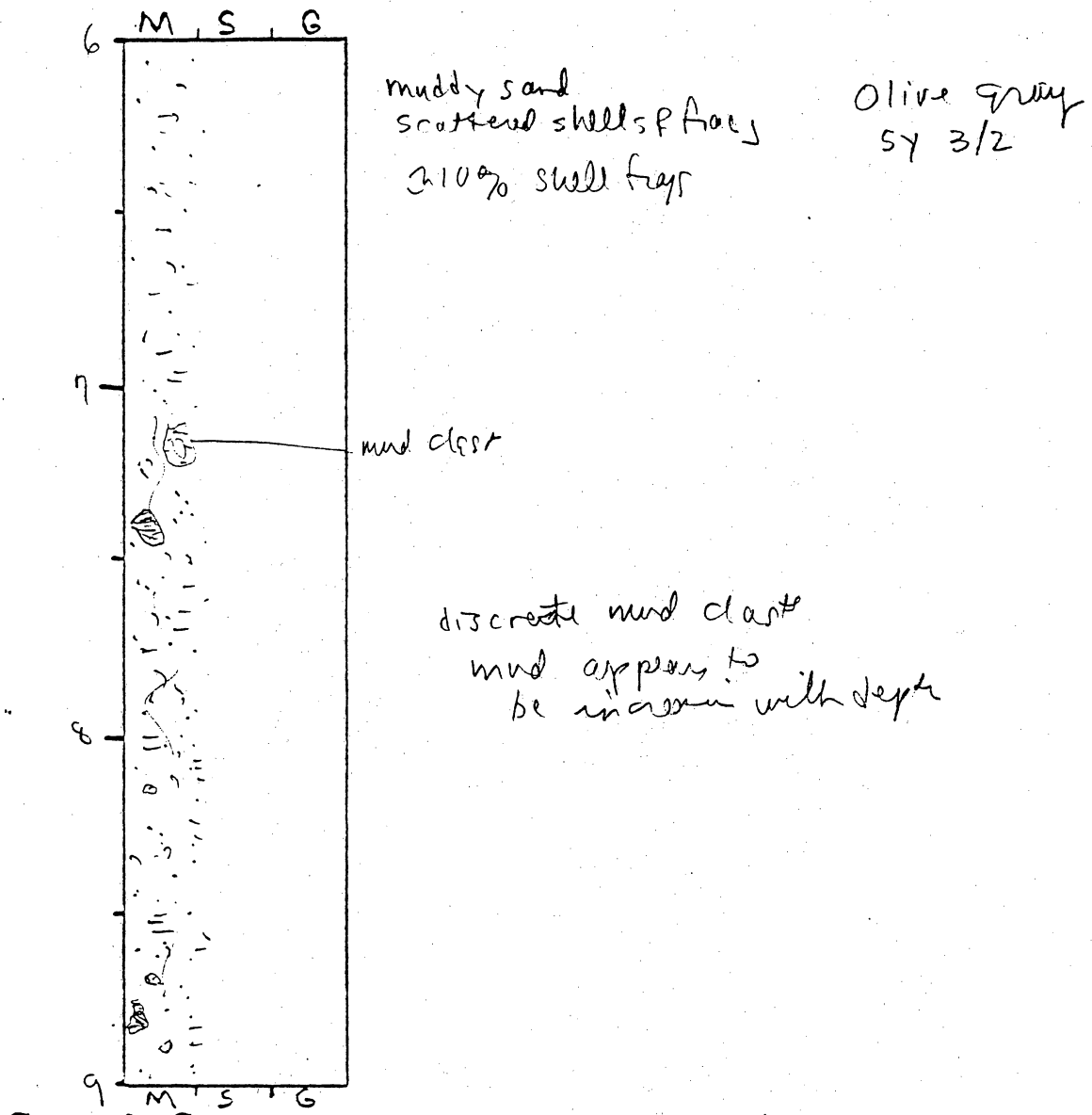
General Comments:

CORE LOG

CORE # SRV-23(c) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



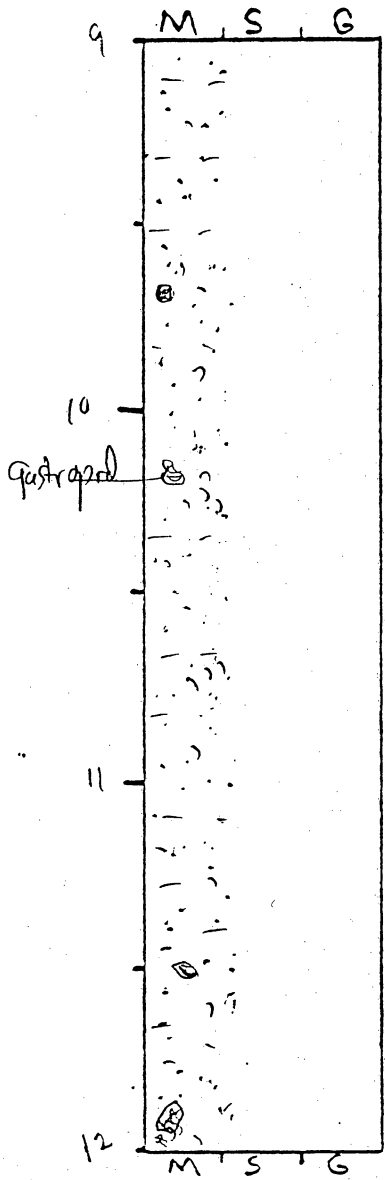
General Comments:

CORE LOG

CORE # SBV-23(D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand
 scattered small shells & forams
 granules to small pebbles
 ≈ 10%

Olive gray
 5Y 3/2

probably burrowed

discrete clay clasts

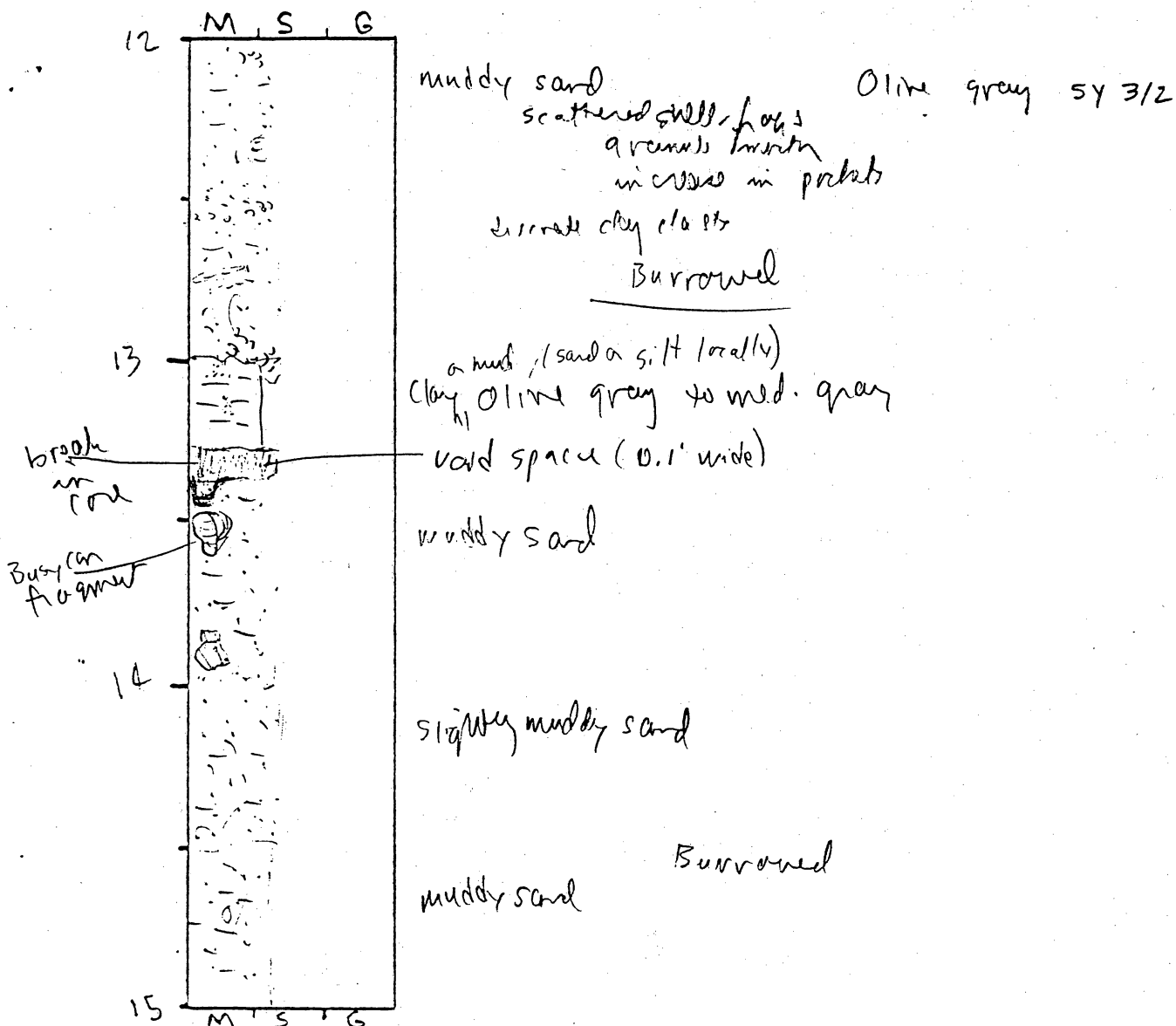
General Comments:

CORE LOG

CORE # SBV-23(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

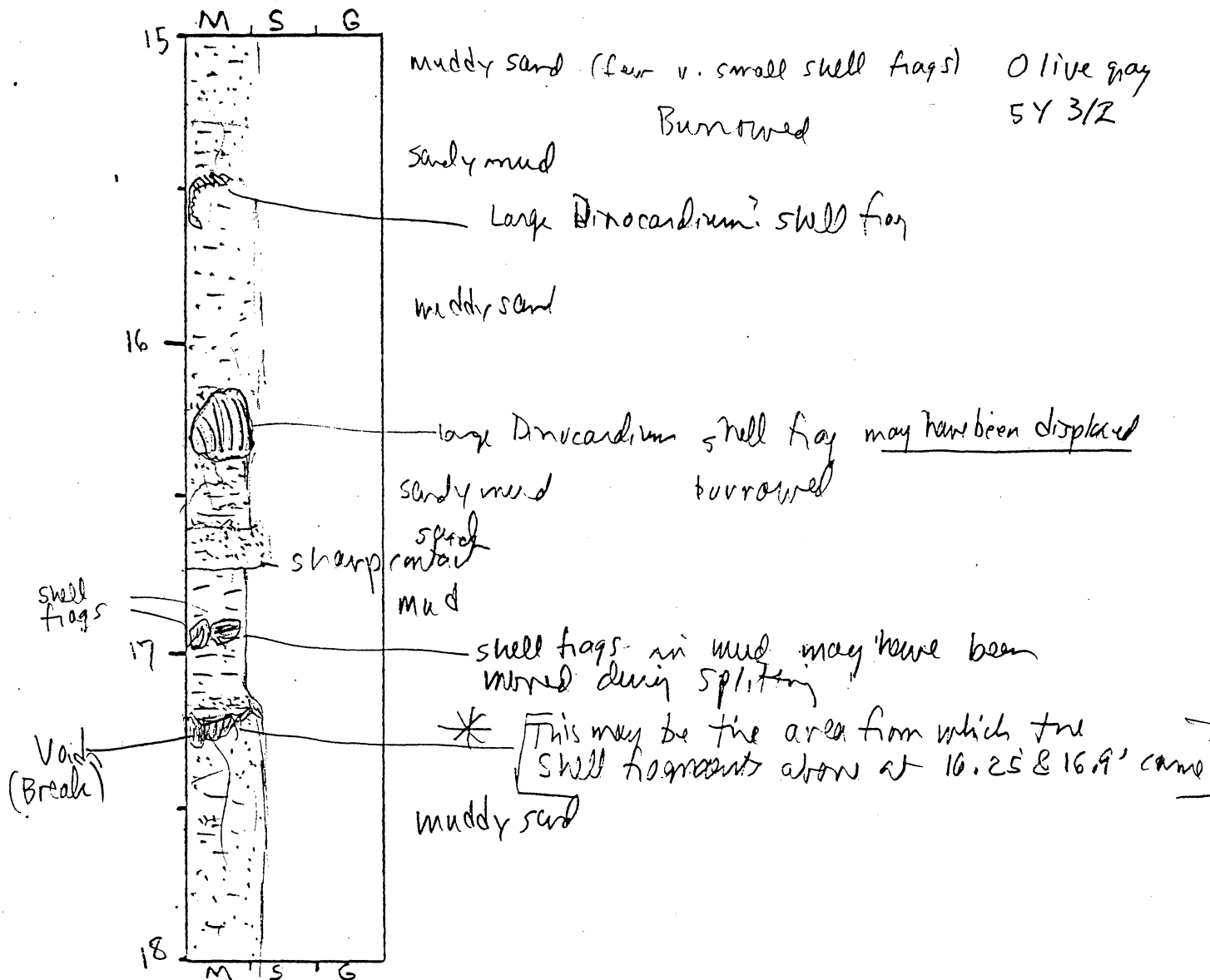


General Comments:

CORE LOG

CORE # SBV-73(F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



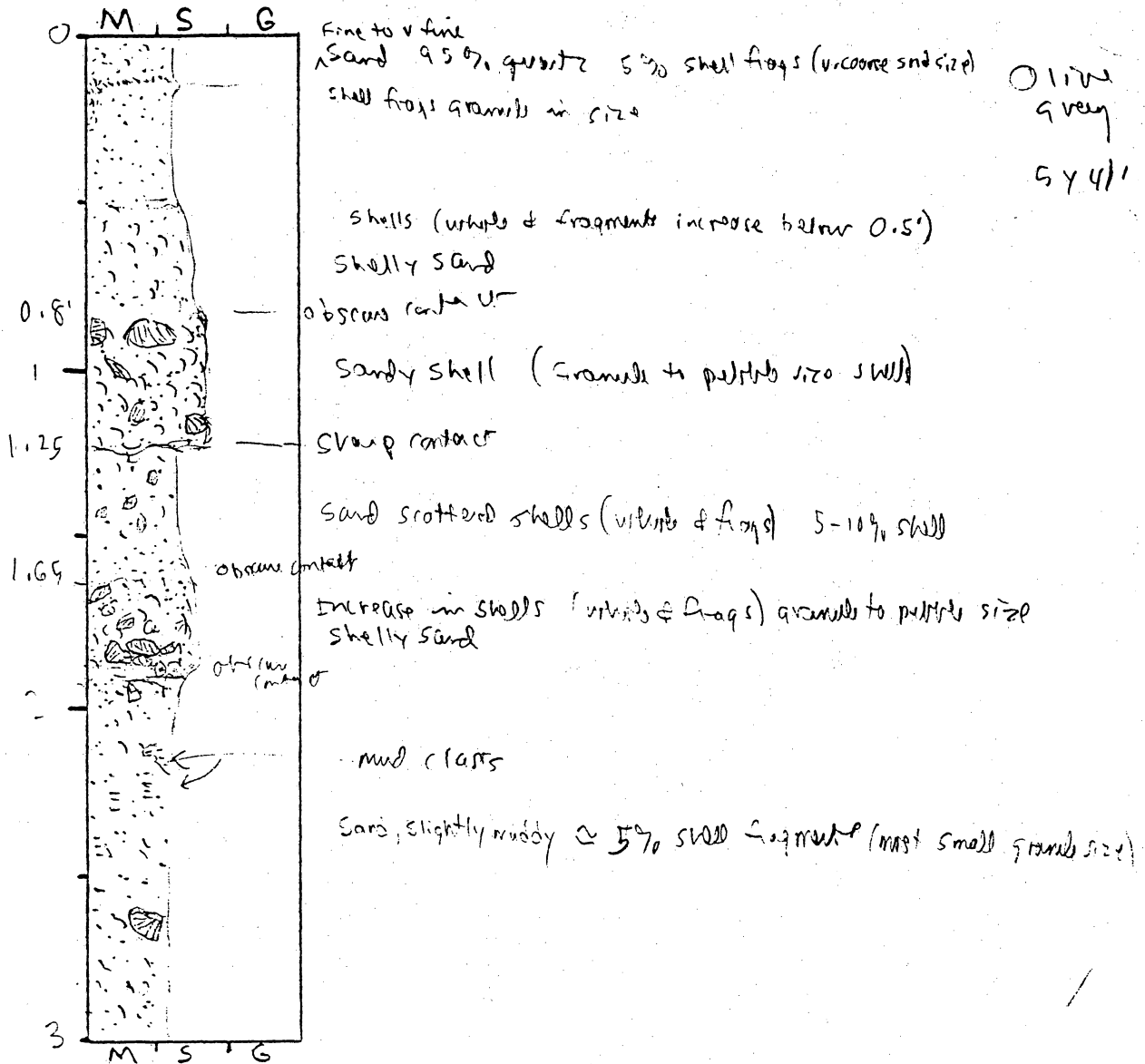
General Comments:

CORE LOG

CORE # SBY-24(A) TYPE Vibro Core LOCATION Sabine Bank
 LATITUDE 29° 22.378' LONGITUDE 92° 58.237' SURFACE ELEVATION -35'
 DEPTH PENETRATED ? LENGTH RECOVERED 20' % COMPACTION ?

OBTAINED BY Gibeault - Riv Kit Jones DATE 10-14-94
 DESCRIBED BY White DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



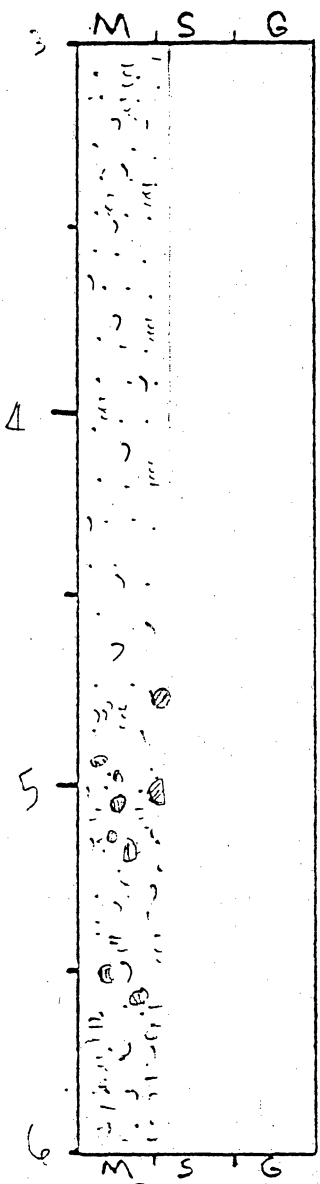
General Comments:

CORE LOG

CORE # SBY-24(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



sand, slightly muddy (small mud clasts) scattered olive gray 54 4/16 to 54.
 scattered shell, white & frags, mostly granule size
 ≈ 10% shell fragments

appear to be slight increase of mud with depth.

Much of this section could probably be called Muddy Sand
 scattered mud clasts

shells more abundant in this section ≈ 20%

mud more abundant than above

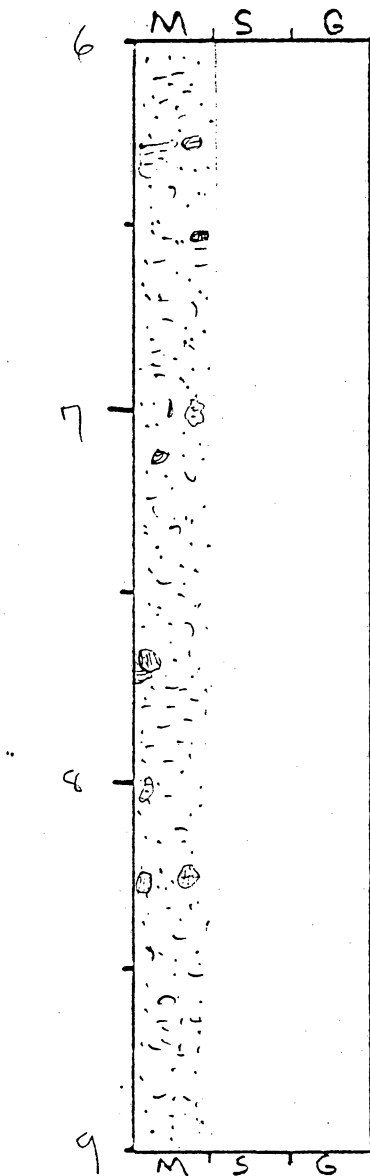
General Comments:

CORE LOG

CORE # SBY-2A(C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



muddy sand (mud clasts larger than in above section) 0.1 m gray
SY 3/2
 scattered shell fragments and whole shells, granules to small pebbles in size $\approx 10-15\%$

discrete mud clasts

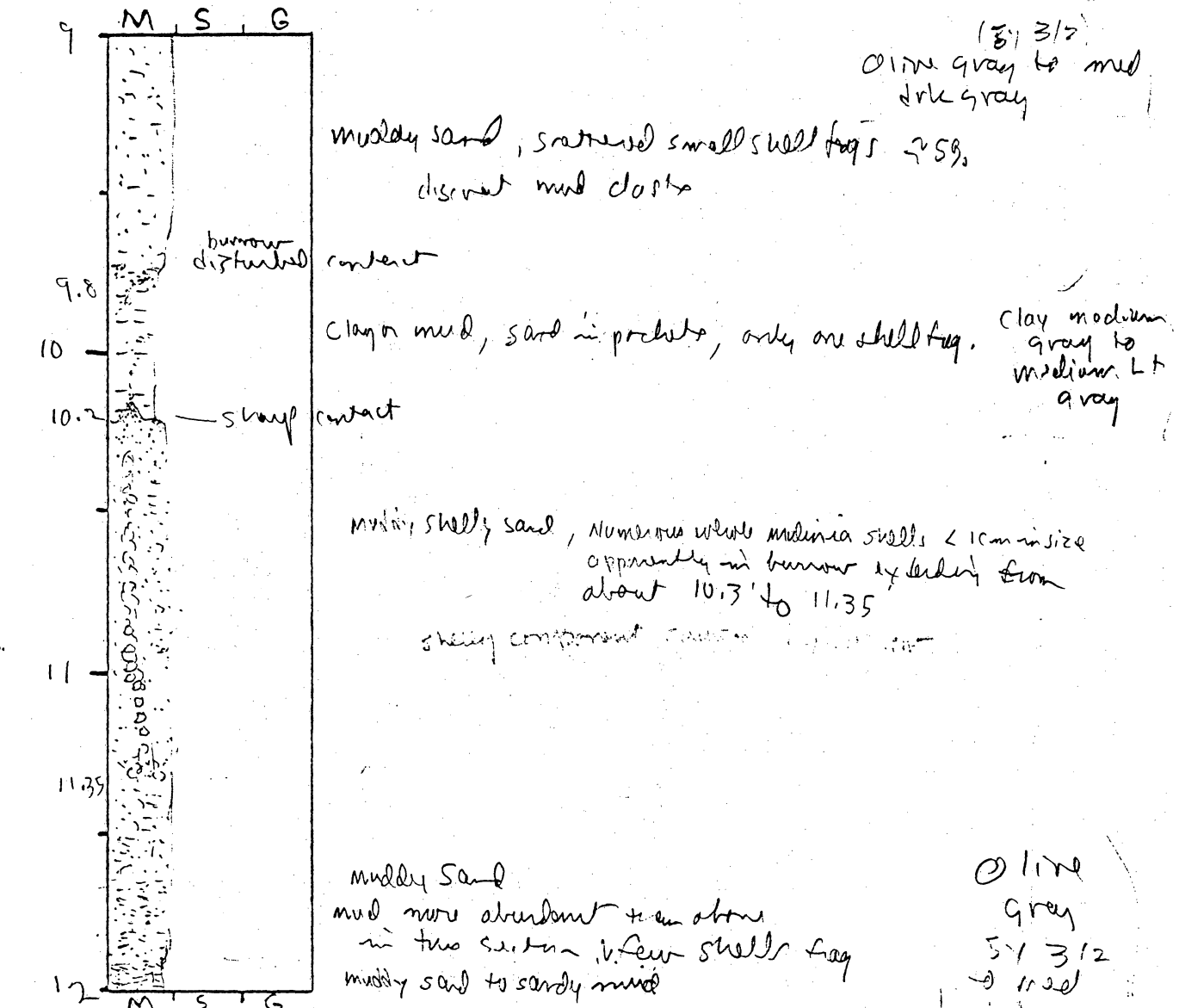
General Comments:

CORE LOG

CORE # SBV-24(D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



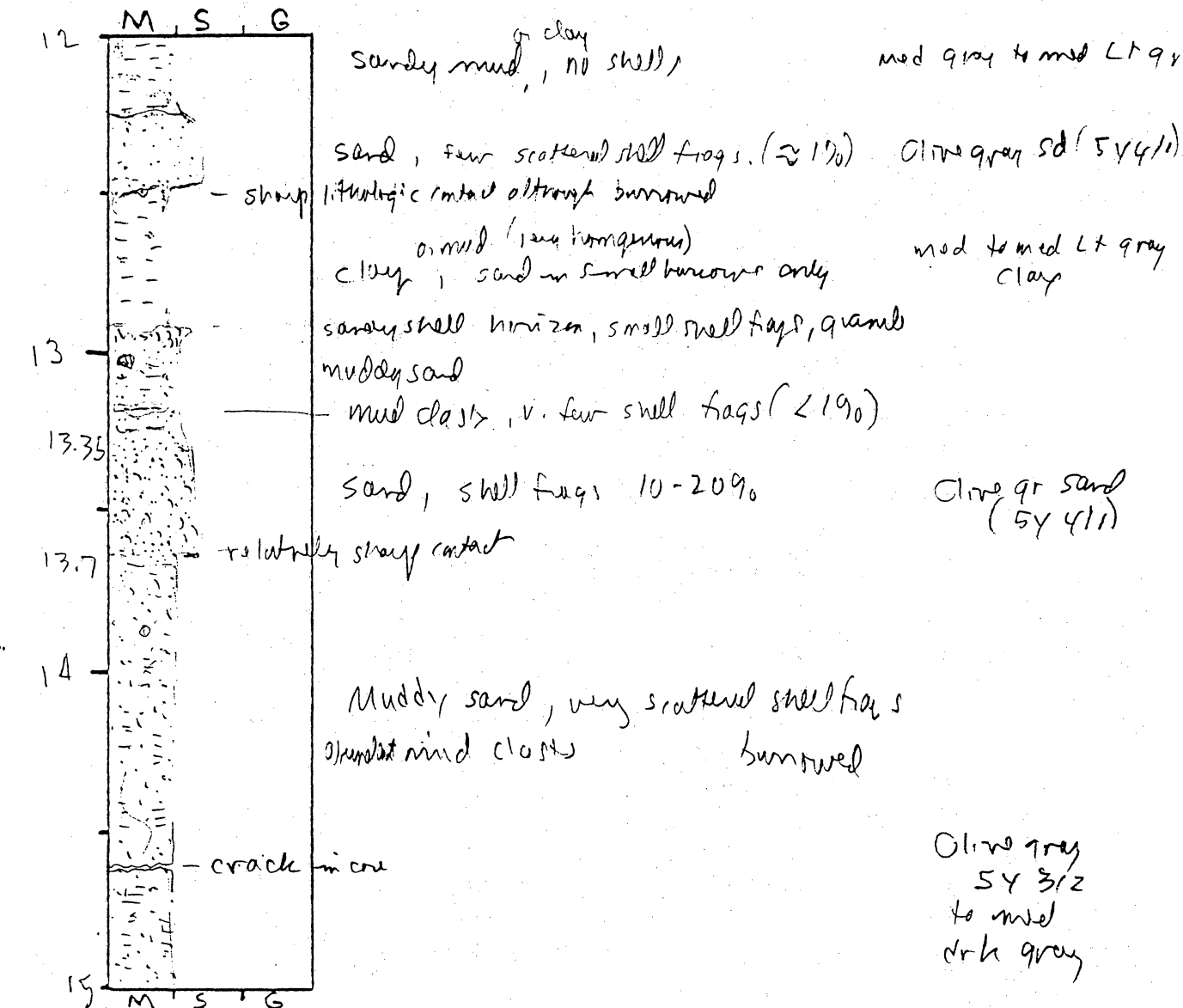
General Comments:

CORE LOG

CORE # SBV-24(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

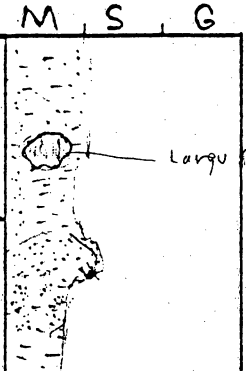
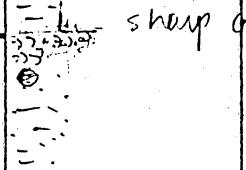
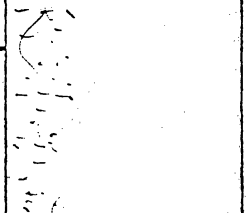
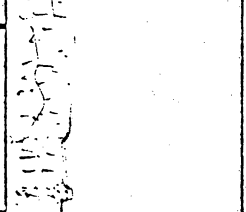
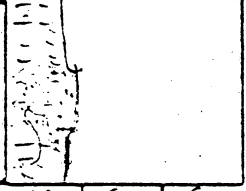


General Comments:

CORE LOG

CORE # SBV-24F TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

15		v muddy sand Large shell frag (4cm across) Sandy mud sand (disturbed margin by (rain)) sandy mud (mud becomes more pure near base)	burrowed	(color muddy) Olive gray 54411
16		sharp contact muddy, shelly sand or muddy sandy shell		
17		but sandy mud in places Primarily muddy sand & scattered shell frags mud very abundant in places	intensely burrowed	
17.35		sandy mud muddy sand Sandy mud (no shell frags)		
18		muddy sand sandy mud (no shell frags) to mud at base		

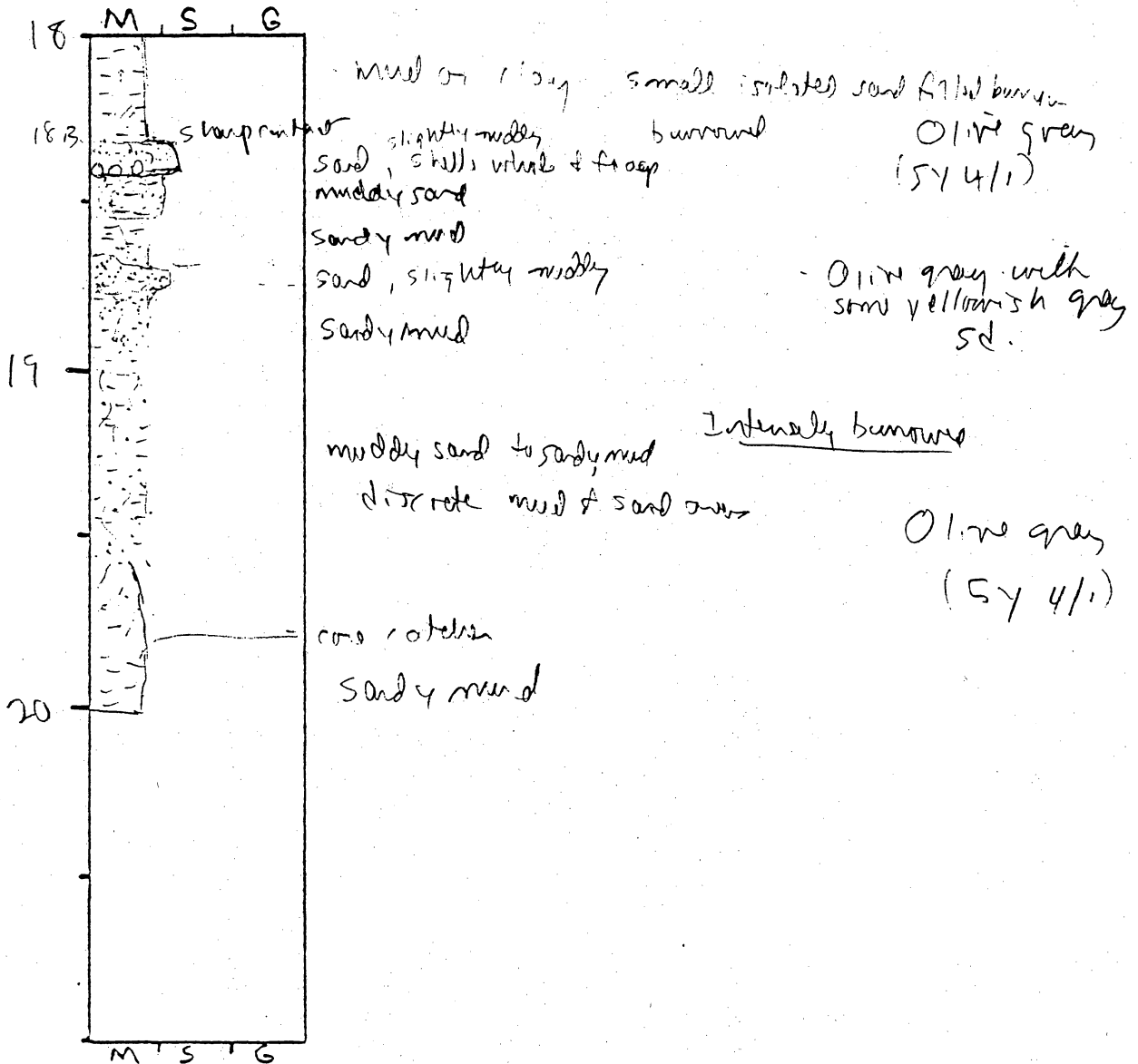
General Comments:

CORE LOG

CORE # SBV-24(G) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



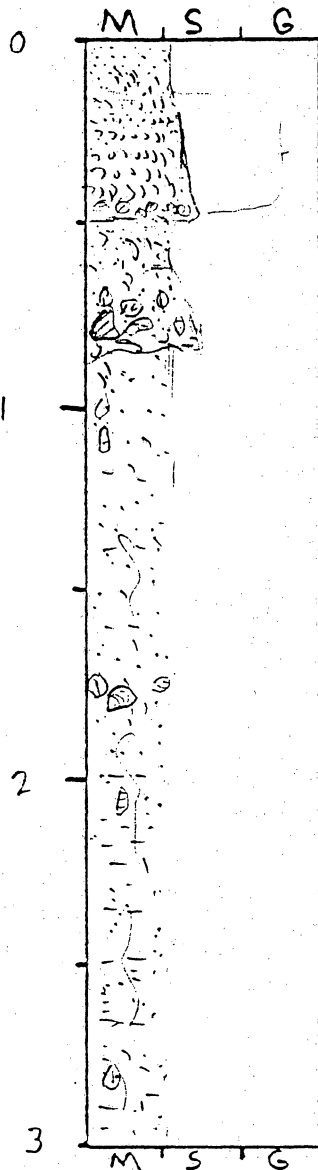
General Comments:

CORE LOG

CORE # SBV-25A TYPE Vibrocore LOCATION Sabine Bank
 LATITUDE 29° 20.245 LONGITUDE 90° 03.237 SURFACE ELEVATION -38.5'
 DEPTH PENETRATED ? LENGTH RECOVERED 18' 11 3/4' % COMPACTION ?

OBTAINED BY Gibeaut - R/V Kit Jones DATE 10-14-94
 DESCRIBED BY White DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



Fine quartz sand grading down into coarse shell hash
 Olive gray sand (5Y 4/1)
 Dark gray, include whole shells
 Shell hash; fining upward; granule to v. coarse sand size

shelly sand Lt Olive gray (5Y 4/1)

sandy shell

Olive gray (5Y 4/1)

muddy sand, scattered small shell frags
 occasional whole shell
mud increasing with depth

Burrowed

discrete small mud clasts
 2-3 ft.

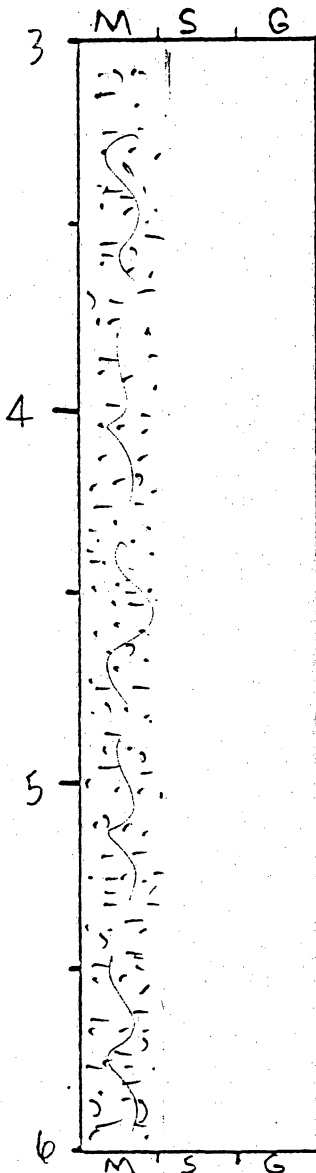
Olive gray
 (5Y 3/2)

General Comments:

CORE LOG

CORE # SPV-25(B) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
------------------	--------	-----------	-----------	---------



muddy sand
 scattered shells
 granules in size (5-10%)
 muddier than previous section (above)

intensely
 burrowed

olive grey
 (5Y 3/2)

Discrete clay or mud

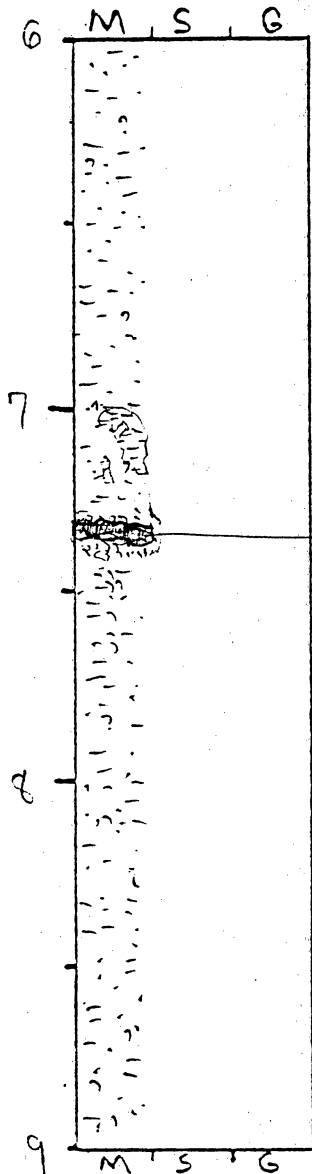
General Comments:

CORE LOG

CORE # SBV-25 (C) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



V. muddy sand
 scattered small shell frags
 < 5%
 Discrete mud clast

Intensely
 burrowed

Olive grey
 (SY 3/2)

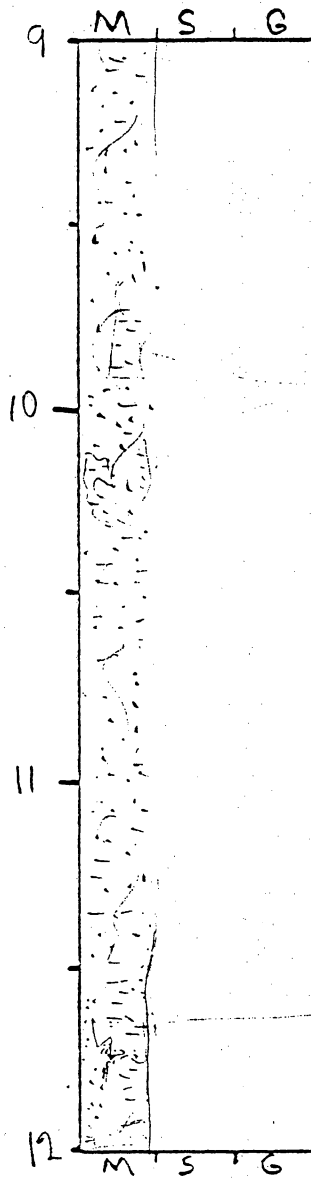
break in core (void)
 shelly muddy sand

General Comments:

CORE LOG

CORE # SPY-25 (D) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



V. muddy sand
 + locally sandy mud
 scattered small shell frags < 5%

intensely burrowed

olive gray (5Y 3/2)

discrete mud clast

med clay approaching sandy mud in composition

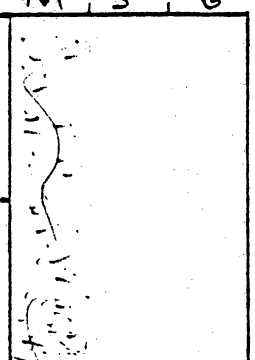
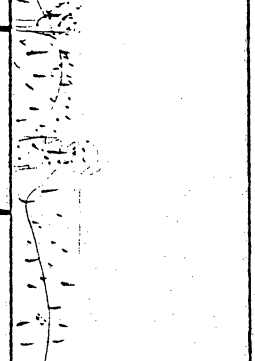
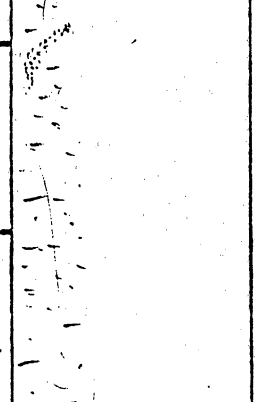
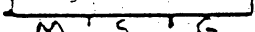
General Comments:

CORE LOG

CORE # SBV-25(E) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS

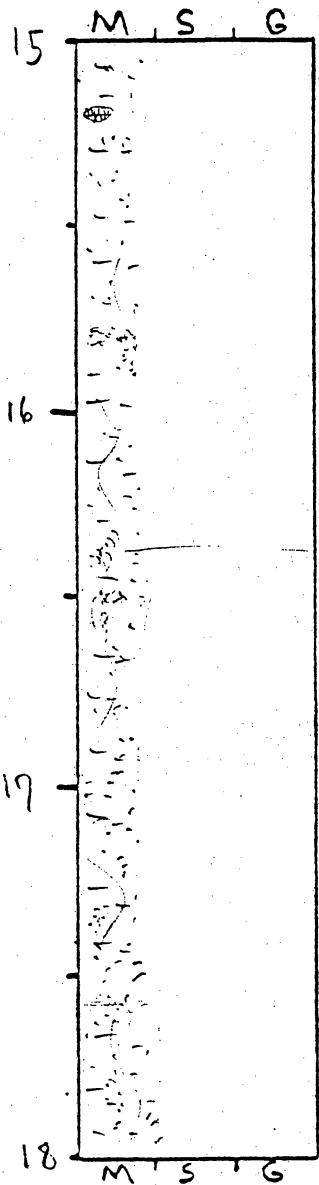
DEPTH (ft, m)	SKETCH	LITHOLOGY	STRUCTURE	REMARKS
12		v muddy sand	Intensely surrowed	Olive gray (SY 3/2)
13		sand mud muddy sand sandy mud	discrete mud & sand	
14		v muddy sand to sandy mud		Olive gray (SY 3/2)
15				

General Comments:

CORE LOG

CORE # SBV-25(F) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____
 OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH (ft, m) SKETCH LITHOLOGY STRUCTURE REMARKS



v muddy sand to sandy mud
 intensely burrowed
 scattered shell fragments < 1% except for local pockets
 01 wt gray (5 y 3/2)
 shell pocket (small shell frags) 10 to 15% (rare to granule)
 intensely burrowed
 sandy mud (mud appears dominant in this area)
 muddy sand

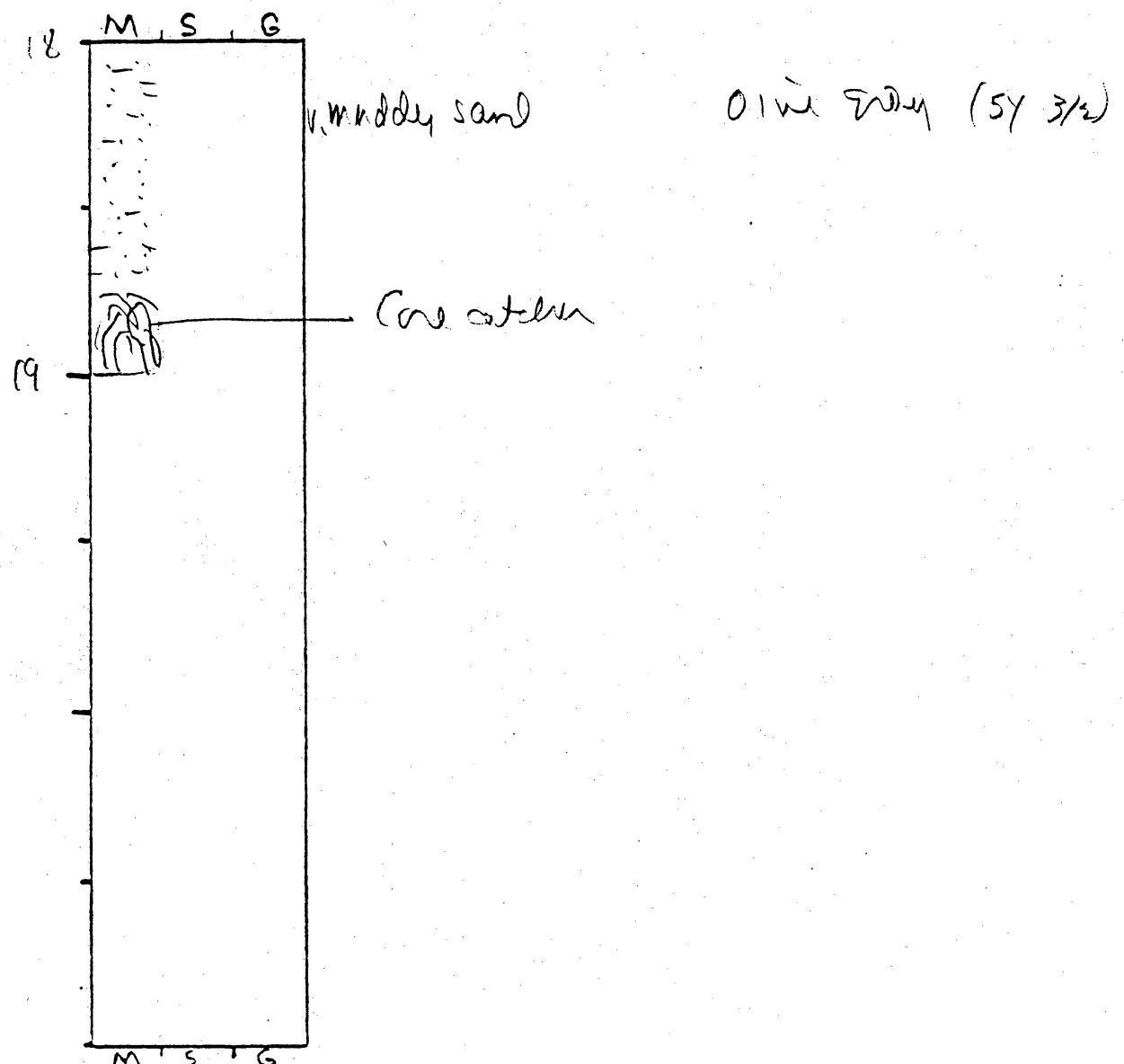
General Comments:

CORE LOG

CORE # SBV-75(G) TYPE _____ LOCATION _____
 LATITUDE _____ LONGITUDE _____ SURFACE ELEVATION _____
 DEPTH PENETRATED _____ LENGTH RECOVERED _____ % COMPACTION _____

OBTAINED BY _____ DATE _____
 DESCRIBED BY _____ DATE _____

DEPTH
 (ft, m) **SKETCH** **LITHOLOGY** **STRUCTURE** **REMARKS**



General Comments:

APPENDIX D. SEDIMENT TEXTURES

Gravel, Sand, Mud

Hydrometer Analyses

Sieve Analyses

Cumulative Curves (Sieve Analyses)

**Gravel, Sand, Mud Analyses
Heald Bank and Sabine Bank samples**

Sample ID	Gravel %	Sand %	Mud %
HBV-1-1.5	0.6	99.3	0.1
HBV-1-5.5	20.3	79.5	0.2
HBV-1-8.0	38.6	61.1	0.3
HBV-2-1.5	0.0	81.4	19.0
HBV-2-4.5	0.0	34.2	66.0
HBV-2-7.5	0.0	12.4	87.0
HBV-2-10.2	0.0	6.3	94.0
HBV-3-1.8	6.1	91.5	2.4
HBV-3-2.6	0.0	71.5	28.0
HBV-3-4.5	0.0	73.8	26.0
HBV-3-6.5	0.0	76.8	23.0
HBV-3-12.75	0.0	73.7	26.0
HBV-4-1.0	1.1	94.1	4.8
HBV-4-5.0	9.2	79.6	11.2
HBV-4-6.5	0.0	18.4	82.0
HBV-5-2.0	2.6	97.2	0.2
HBV-5-5.75	9.7	90.0	0.3
HBV-5-14.75	5.0	89.9	5.1
HBV-5-19.1	3.4	91.0	5.6
HBV-6-1.0	3.2	96.4	0.4
HBV-6-4.5	6.1	93.6	0.3
HBV-6-9.8	19.4	80.3	0.3
HBV-7-2.5	20.5	79.3	0.2
HBV-7-6.25	0.0	24.4	76.0
HBV-7-9.3	0.0	14.6	86.0
SBV-10-0.7	0.0	67.6	16.0
SBV-10-3.2	0.0	54.2	46.0
SBV-10-7.0	0.0	24.7	76.0
SBV-10-11.2	0.0	6.1	94.0
SBV-11-0.25	0.0	67.3	32.0
SBV-11-4.5	0.0	44.1	56.0
SBV-12-1.0	2.4	97.5	0.1
SBV-12-4.5	36.7	63.2	0.1
SBV-12-7.0	1.7	97.7	0.6
SBV-12-11.0	0.0	76.1	24.0
SBV-13-0.4	16.1	79.8	4.1
SBV-13-0.75	0.0	66.2	34.0
SBV-13-5.5	0.0	60.1	40.0
SBV-13-14	0.0	68.4	32.0
SBV-14-1.5	24.5	72.8	2.7
SBV-14-4.2	8.5	75.9	15.6
SBV-14-8.6	0.0	44.5	56.0
SBV-15-0.5	0.0	67.7	33.0

SBV-15-0.95	0.0	67.7	33.0
SBV-16-0.2	3.3	95.4	1.3
SBV-16-2.5	69.2	30.4	0.4
SBV-16-4.5	0.0	78.4	21.0
SBV-17-1.0	4.9	94.9	0.2
SBV-17-5.8	15.4	84.4	0.2
SBV-17-9.2	21.5	78.3	0.2
SBV-17-14.0	5.7	94.1	0.2
SBV-18-0.5	4.2	95.4	0.4
SBV-18-5.7	12.5	82.5	5.0
SBV-18-8.25	18.5	74.9	6.6
SBV-19-0.8	0.0	20.0	80.0
SBV-19-2.8	7.1	88.2	4.7
SBV-19-5.5	0.0	67.7	33.0
SBV-19-8.5	0.0	52.6	48.0
SBV-20-0.5	0.2	99.5	0.3
SBV-20-2.7	0.6	99.3	0.1
SBV-20-4.1	84.0	15.7	0.3
SBV-21-1.0	26.9	64.3	8.8
SBV-22-2.0	10.6	88.0	1.4
SBV-22-5.75	5.2	89.8	5.0
SBV-22-10.95	9.6	69.2	21.2
SBV-22-13.5	3.0	71.8	25.5
SBV-23-0.5	1.9	93.0	5.1
SBV-23-5.5	5.3	88.0	6.7
SBV-23-12.4	6.9	73.4	19.7
SBV-23-17.8	0.0	49.0	51.0
SBV-24-2.2	3.0	91.5	5.5
SBV-24-5.6	5.3	82.7	12.0
SBV-24-7.0	6.5	80.6	12.9
SBV-24-16.5	0.0	40.9	59.0
SBV-25-0.4	56.4	42.9	0.7
SBV-25-1.5	7.8	86.6	5.6
SBV-25-11.2	3.7	63.5	32.8

Hydrometer Analyses
Heald Bank and Sabine Bank samples

Lab #	Sample ID	Sand %	Silt %	Clay %
1	HBV-1-1.5	sieve		
2	HBV-1-5.5	sieve		
3	HBV-1-8.0	sieve		
4	HBV-2-1.5	81	8	11
5	HBV-2-4.5	34	40	26
6	HBV-2-7.5	12	60	27
7	HBV-2-10.2	6	28	66
8	HBV-3-1.8	sieve		
9	HBV-3-2.6	72	7	21
10	HBV-3-4.5	74	6	20
11	HBV-3-6.5	77	6	17
12	HBV-3-12.75	74	9	17
13	HBV-4-1.0	sieve		
14	HBV-4-5.0	sieve		
15	HBV-4-6.5	18	32	50
16	HBV-5-2.0	sieve		
17	HBV-5-5.75	sieve		
18	HBV-5-14.75	sieve		
19	HBV-5-19.1	sieve		
20	HBV-6-1.0	sieve		
21	HBV-6-4.5	sieve		
22	HBV-6-9.8	sieve		
23	HBV-7-2.5	sieve		
24	HBV-7-6.25	24	36	40
25	HBV-7-9.3	15	44	42
26	SBV-12-1.0	sieve		
27	SBV-12-4.5	sieve		
28	SBV-12-7.0	sieve		
29	SBV-12-11.0	76	12	12
30	SBV-11-0.25	67	16	16
31	SBV-11-4.5	44	29	27
32	SBV-10-0.7	68	16	16
33	SBV-10-3.2	54	26	20
34	SBV-10-7.0	25	42	34
35	SBV-10-11.2	6	28	66
36	SBV-13-0.4	sieve		

37	SBV-13-0.75	66	17	17
38	SBV-13-5.5	60	21	19
39	SBV-13-14	68	16	16
40	SBV-14-1.5	sieve		
41	SBV-14-4.2	sieve		
42	SBV-14-8.6	44	36	20
43	SBV-15-0.5	68	16	17
44	SBV-15-0.95	68	16	17
45	SBV-16-0.2	sieve		
46	SBV-16-2.5	sieve		
47	SBV-16-4.5	78	9	12
48	SBV-17-1.0	sieve		
49	SBV-17-5.8	sieve		
50	SBV-17-9.2	sieve		
51	SBV-17-14.0	sieve		
52	SBV-18-0.5	sieve		
53	SBV-18-5.7	sieve		
54	SBV-18-8.25	sieve		
55	SBV-19-0.8	20	42	38
56	SBV-19-2.8	sieve		
57	SBV-19-5.5	68	20	13
58	SBV-19-8.5	53	29	19
59	SBV-20-0.5	sieve		
60	SBV-20-2.7	sieve		
61	SBV-20-4.1	sieve		
62	SBV-21-1.0	sieve		
63	SBV-22-2.0	sieve		
64	SBV-22-5.75	sieve		
65	SBV-22-10.95	sieve		
66	SBV-22-13.5	sieve		
67	SBV-23-0.5	sieve		
68	SBV-23-5.5	sieve		
69	SBV-23-12.4	sieve		
70	SBV-23-17.8	49	34	17
71	SBV-24-2.2	sieve		
72	SBV-24-5.6	sieve		
73	SBV-24-7.0	sieve		
74	SBV-24-16.5	41	40	19
75	SBV-25-0.4	sieve		
76	SBV-25-1.5	sieve		
77	SBV-25-11.2	sieve		

Sieve Analyses

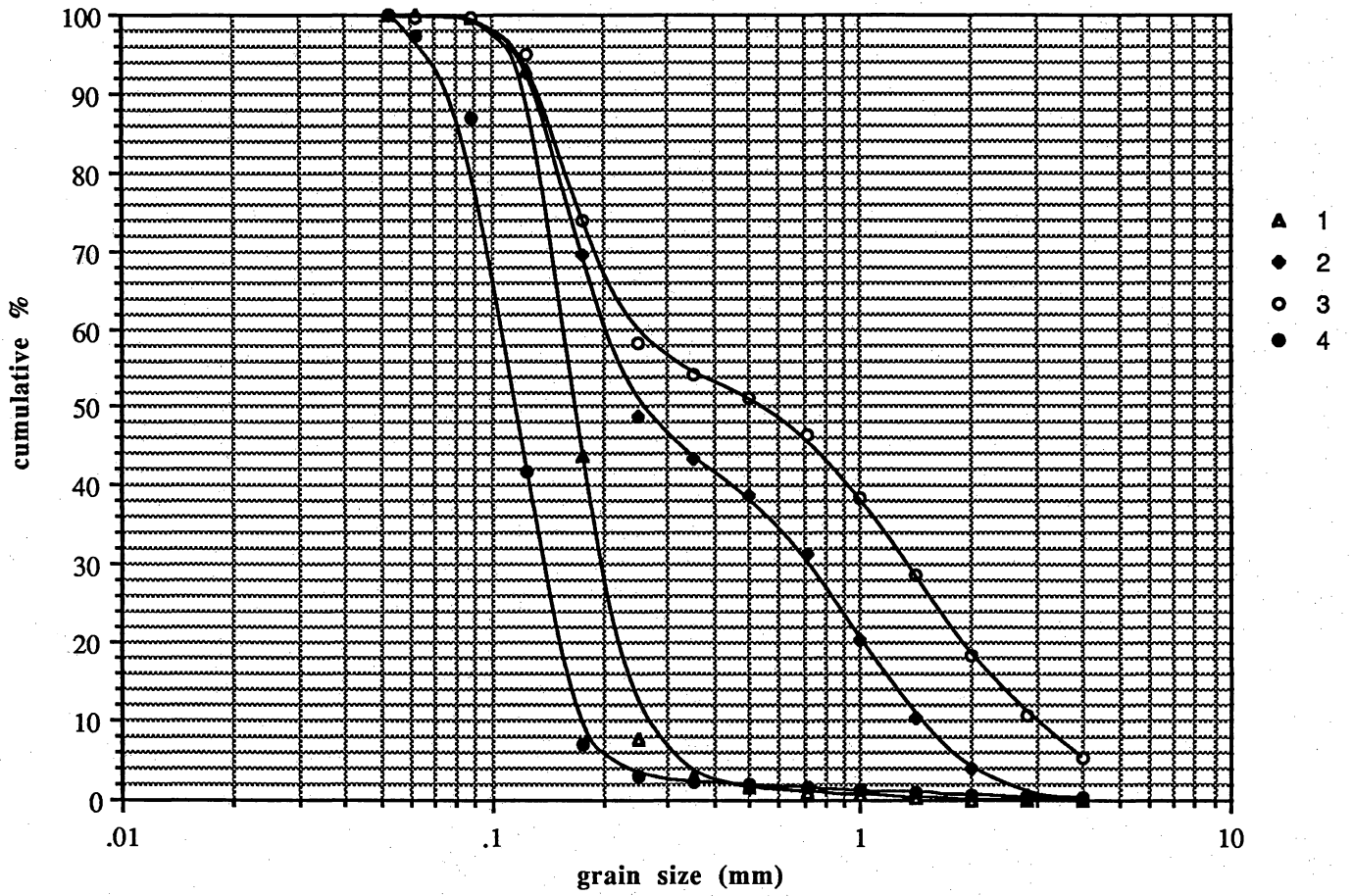
Heald Bank and Sabine Bank samples

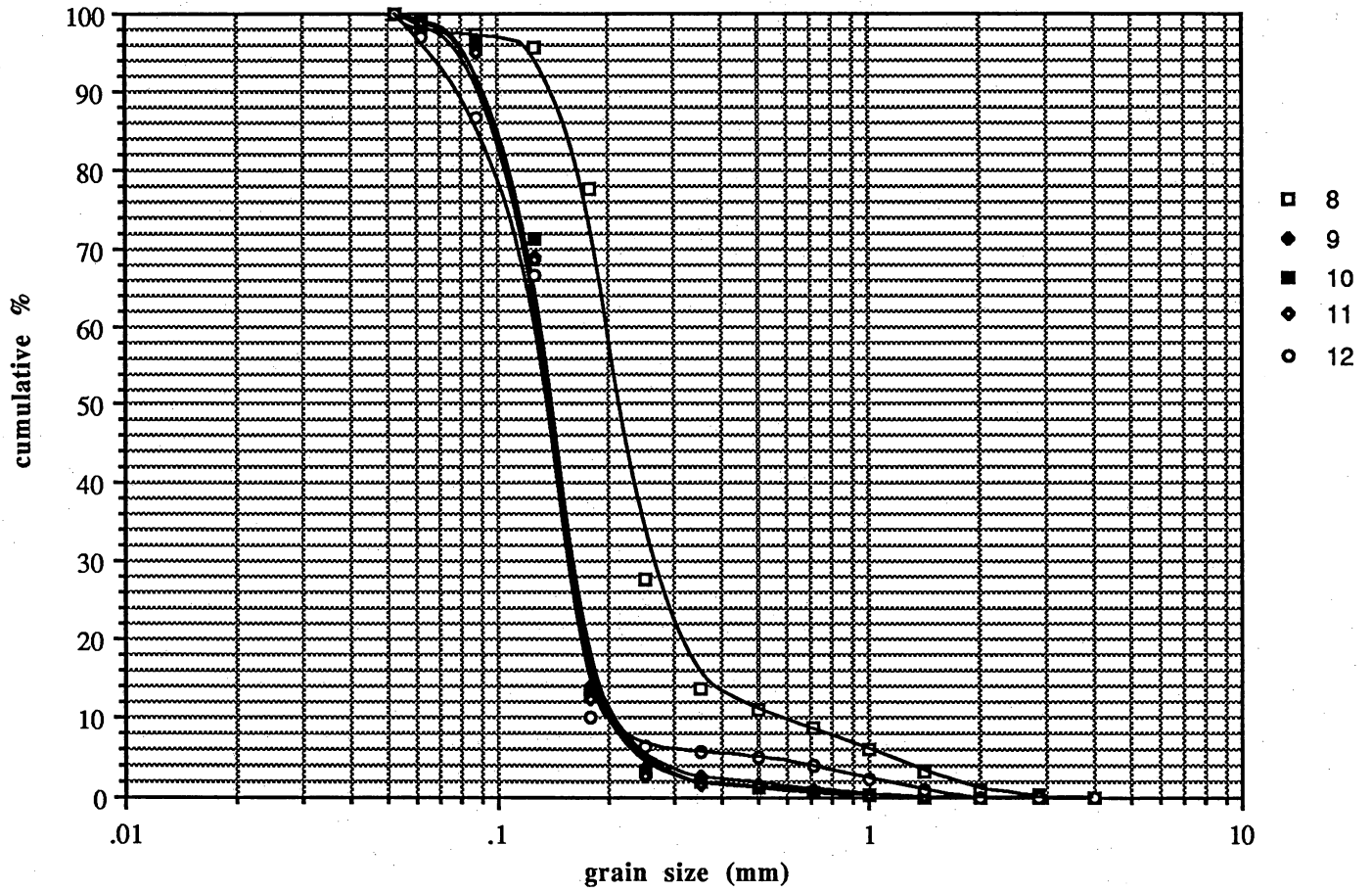
cumulative %'s

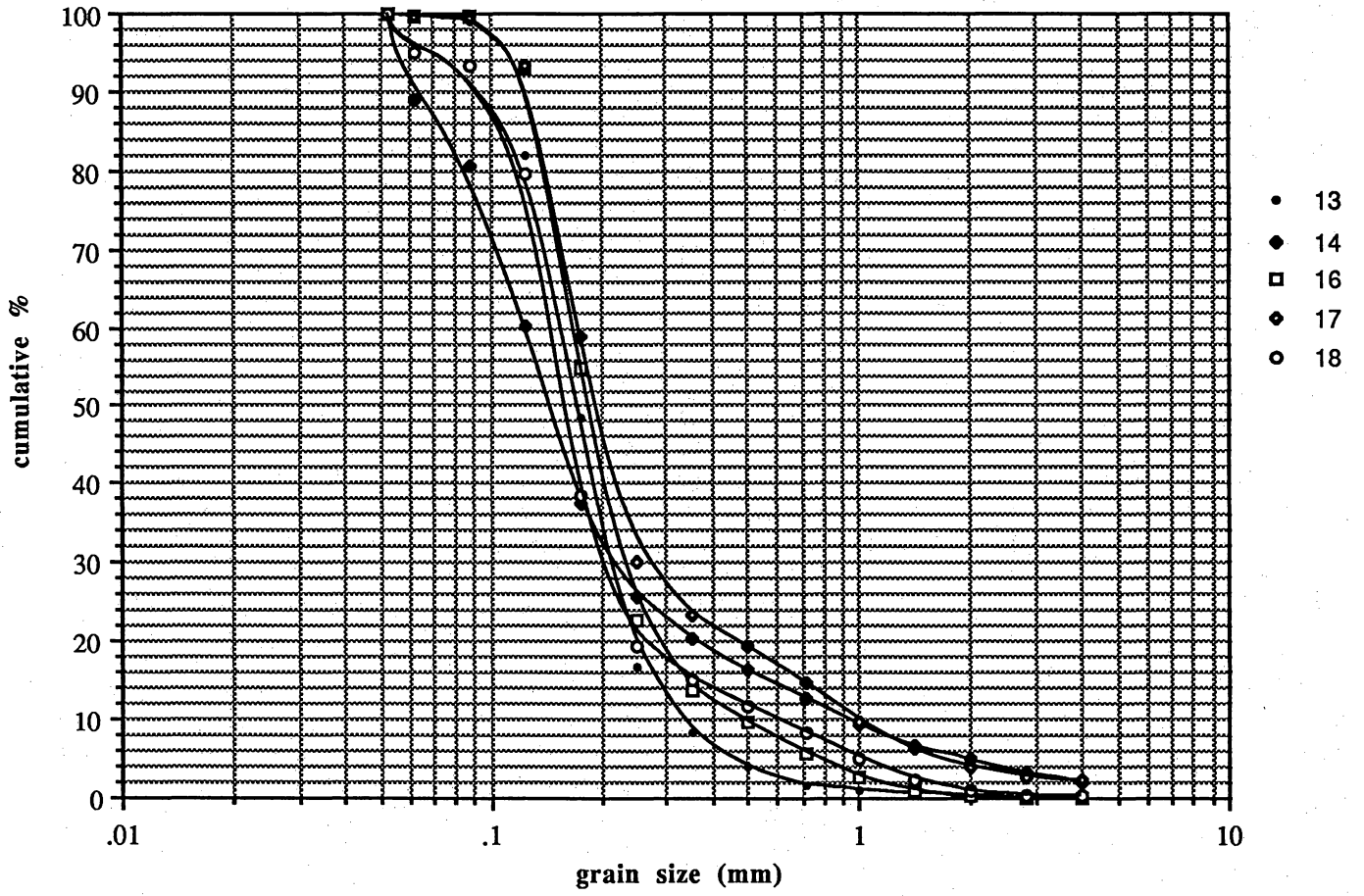
Lab #	Sample ID	-2.0ø	-1.5ø	-1.0ø	-0.5ø	0ø	0.5ø	1.0ø	1.5ø	2.0ø	2.5ø	3ø	3.5ø	4.0ø	pan
		%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	HBV-1-1.5	0.0	0.0	0.1	0.4	0.6	1.0	1.7	2.9	7.7	43.9	93.0	99.7	99.9	100.0
2	HBV-1-5.5	0.0	0.8	4.0	10.5	20.3	31.3	38.9	43.4	48.7	69.4	94.9	99.5	99.8	100.0
3	HBV-1-8.0	5.2	10.7	18.5	28.7	38.6	46.4	51.2	54.3	58.3	73.8	95.1	99.5	99.7	100.0
4	HBV-2-1.5	0.3	0.4	0.7	0.9	1.2	1.6	2.0	2.3	2.9	7.0	41.9	87.0	97.4	100.0
5	HBV-2-4.5	hydrometer													
6	HBV-2-7.5	hydrometer													
7	HBV-2-10.2	hydrometer													
8	HBV-3-1.8	0.0	0.2	1.1	3.2	6.1	8.6	11.0	13.7	27.7	77.5	95.8	97.2	97.6	100.0
9	HBV-3-2.6	0.0	0.0	0.0	0.1	0.5	1.0	1.8	2.6	3.8	14.1	68.8	96.8	99.2	100.0
10	HBV-3-4.5	0.0	0.0	0.0	0.1	0.3	0.8	1.4	1.9	3.2	13.5	71.3	96.1	99.1	100.0
11	HBV-3-6.5	0.0	0.0	0.0	0.1	0.2	0.6	1.2	1.7	2.8	12.3	68.7	95.1	98.6	100.0
12	HBV-3-12.75	0.0	0.0	0.0	0.9	2.4	3.9	5.0	5.7	6.3	10.1	66.6	86.7	97.1	100.0
13	HBV-4-1.0	0.0	0.1	0.5	0.7	1.1	1.8	4.0	8.3	16.6	48.4	81.8	93.0	95.2	100.0
14	HBV-4-5.0	2.0	3.2	4.9	6.7	9.2	12.8	16.4	20.4	25.6	37.4	60.2	80.5	88.8	100.0
15	HBV-4-6.5	hydrometer													
16	HBV-5-2.0	0.0	0.1	0.2	1.0	2.6	5.8	9.8	13.8	22.6	55.0	93.1	99.5	99.8	100.0
17	HBV-5-5.75	2.3	2.8	4.0	6.2	9.7	14.8	19.5	23.4	30.1	58.7	93.2	99.3	99.7	100.0
18	HBV-5-14.75	0.3	0.5	1.0	2.4	5.0	8.5	11.8	15.2	19.3	38.4	79.5	93.3	94.9	100.0
19	HBV-5-19.1	0.0	0.0	0.2	1.2	3.4	6.5	9.4	12.5	16.4	28.5	69.9	91.0	94.4	100.0
20	HBV-6-1.0	0.0	0.1	0.4	1.2	3.2	6.9	11.0	15.2	24.9	64.2	95.3	99.3	99.6	100.0
21	HBV-6-4.5	0.0	0.1	0.6	2.3	6.1	12.3	18.4	23.7	33.8	70.3	96.0	99.4	99.7	100.0
22	HBV-6-9.8	8.6	9.6	11.2	14.3	19.4	25.9	31.9	36.5	45.3	76.4	97.2	99.5	99.7	100.0
23	HBV-7-2.5	1.3	2.4	4.8	10.6	20.5	34.1	47.8	54.7	68.2	84.8	97.2	99.7	99.8	100.0

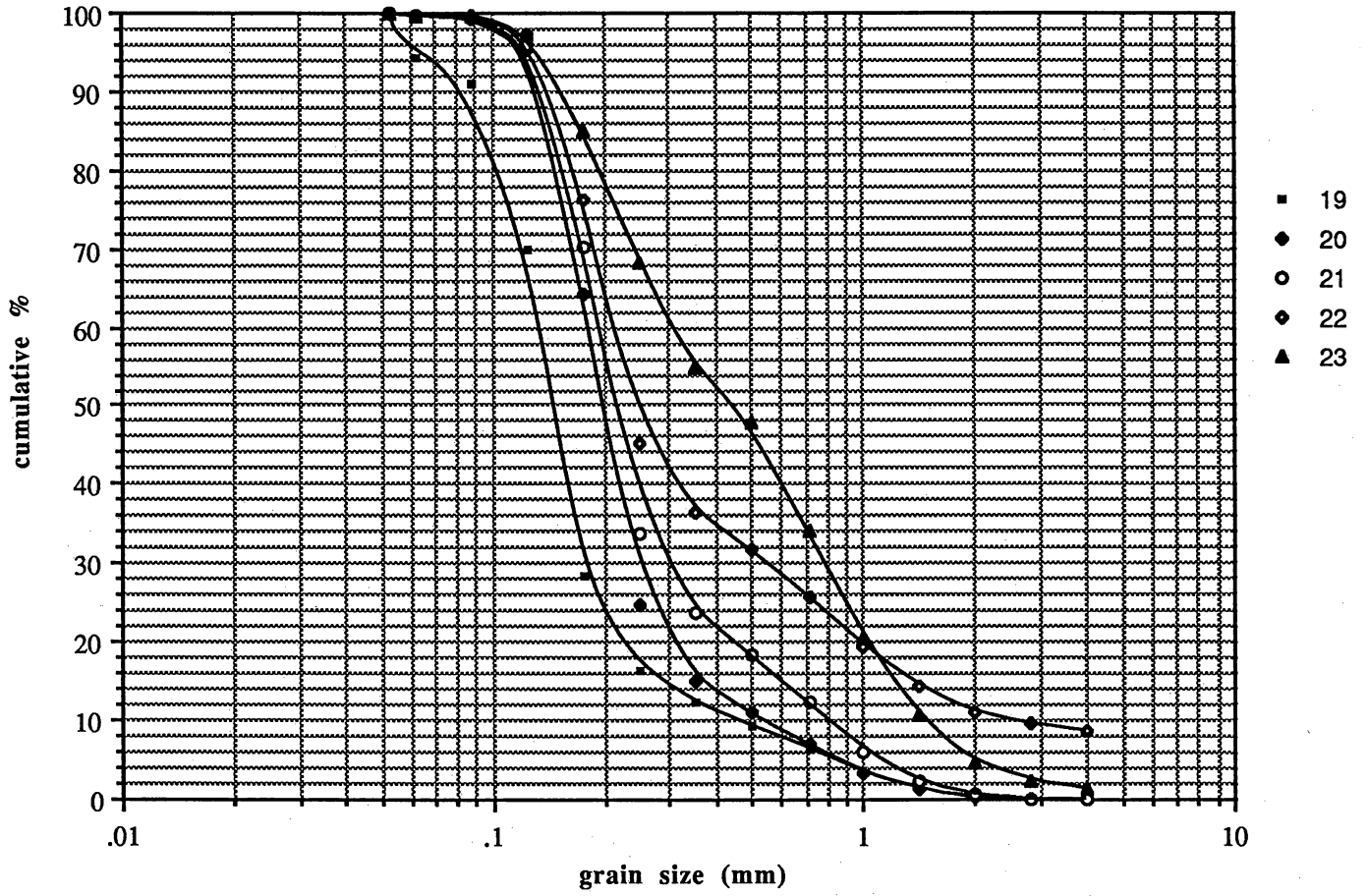
24	HBV-7-6.25	hydrometer													
25	HBV-7-9.3	hydrometer													
26	SBV-12-1.0	0.1	0.2	0.6	1.3	2.4	4.7	9.7	14.7	29.4	73.5	98.3	99.8	99.9	100.0
27	SBV-12-4.5	20.2	23.8	28.1	32.5	36.7	40.2	43.5	46.6	55.4	81.0	98.7	99.8	99.9	100.0
28	SBV-12-7.0	0.4	0.5	0.8	1.1	1.7	2.7	4.5	7.1	17.2	62.4	95.6	99.0	99.4	100.0
29	SBV-12-11.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	2.3	7.2	35.8	86.3	92.5	95.6	100.0
30	SBV-11-0.25	hydrometer													
31	SBV-11-4.5	hydrometer													
32	SBV-10-0.7	hydrometer													
33	SBV-10-3.2	hydrometer													
34	SBV-10-7.0	hydrometer													
35	SBV-10-11.2	hydrometer													
36	SBV-13-0.4	2.7	4.9	7.7	11.5	16.1	20.6	25.2	29.0	35.8	54.7	84.1	93.2	95.9	100.0
37	SBV-13-0.75	hydrometer													
38	SBV-13-5.5	hydrometer													
39	SBV-13-14	hydrometer													
40	SBV-14-1.5	8.5	12.2	16.0	20.5	24.5	28.0	31.5	35.1	42.0	59.4	89.0	95.6	97.3	100.0
41	SBV-14-4.2	0.3	0.4	1.3	4.3	8.5	12.8	16.6	19.9	25.9	42.2	67.2	76.7	84.4	100.0
42	SBV-14-8.6	hydrometer													
43	SBV-15-0.5	hydrometer													
44	SBV-15-0.95	hydrometer													
45	SBV-16-0.2	0.0	0.0	0.4	1.4	3.3	5.7	9.3	13.1	21.0	37.0	80.8	97.5	98.7	100.0
46	SBV-16-2.5	24.6	35.5	48.6	60.5	69.2	75.5	79.5	82.8	87.5	91.6	97.6	99.5	99.6	100.0
47	SBV-16-4.5	0.0	0.0	0.0	0.5	1.1	2.0	3.9	4.7	7.5	19.4	58.8	93.6	98.8	100.0
48	SBV-17-1.0	0.1	0.5	1.5	2.9	4.9	7.4	10.3	13.7	25.3	60.6	95.4	99.6	99.8	100.0
49	SBV-17-5.8	2.1	3.9	6.6	10.5	15.4	20.1	24.2	27.8	38.2	66.3	95.7	99.6	99.8	100.0
50	SBV-17-9.2	2.8	5.0	9.1	14.9	21.5	27.6	32.5	36.9	46.9	70.8	96.3	99.6	99.8	100.0
51	SBV-17-14.0	0.9	1.7	3.1	4.4	5.7	7.4	9.6	11.9	23.4	58.4	94.7	99.4	99.8	100.0
52	SBV-18-0.5	0.0	0.1	1.2	2.6	4.2	5.7	8.0	10.5	21.4	51.7	93.4	99.2	99.6	100.0
53	SBV-18-5.7	2.4	3.7	5.7	8.9	12.5	16.3	20.3	24.3	30.7	50.8	84.4	92.7	95.0	100.0
54	SBV-18-8.25	4.9	7.3	9.9	14.0	18.5	23.3	27.9	32.5	39.2	53.5	80.6	90.8	93.4	100.0
55	SBV-19-0.8	hydrometer													
56	SBV-19-2.8	0.4	0.8	1.9	4.2	7.1	10.3	13.8	17.8	24.5	41.5	78.3	92.8	95.3	100.0

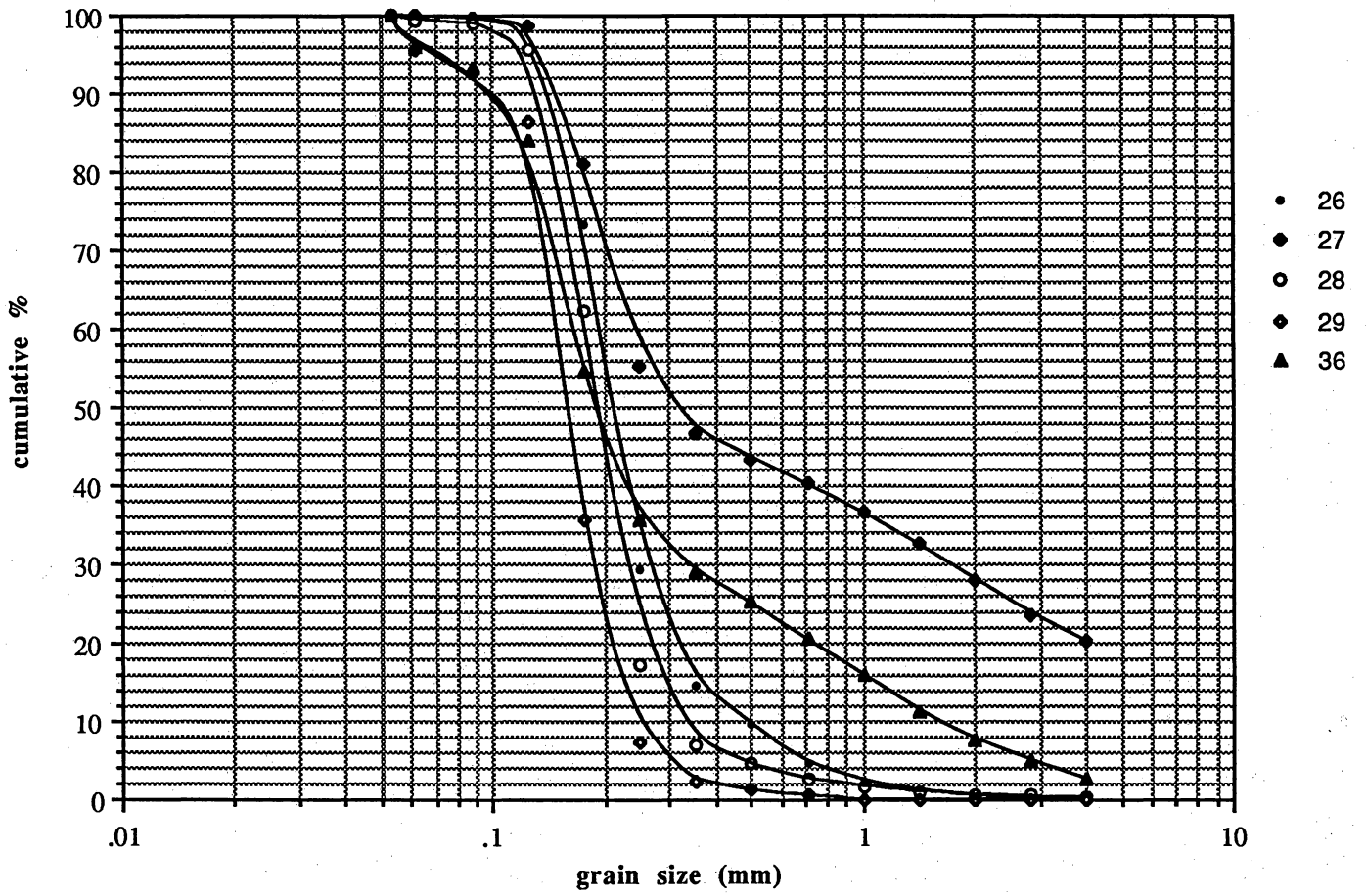
57	SBV-19-5.5	hydrometer													
58	SBV-19-8.5	hydrometer													
59	SBV-20-0.5	0.0	0.0	0.0	0.1	0.2	0.7	2.0	3.5	8.2	41.2	87.9	99.0	99.7	100.0
60	SBV-20-2.7	0.1	0.1	0.2	0.3	0.6	1.6	4.4	8.7	33.6	77.9	97.2	99.7	99.9	100.0
61	SBV-20-4.1	32.7	56.9	71.0	79.0	84.0	87.4	89.3	90.3	92.6	96.6	99.1	99.6	99.7	100.0
62	SBV-21-1.0	3.3	8.4	15.2	21.4	26.9	31.2	34.8	38.8	45.6	54.1	66.0	82.8	91.2	100.0
63	SBV-22-2.0	1.6	2.3	4.1	6.9	10.6	14.4	17.9	21.5	32.0	55.3	86.6	97.4	98.6	100.0
64	SBV-22-5.75	0.0	0.2	0.5	1.9	5.2	9.8	13.9	16.6	23.5	52.8	82.3	92.0	95.0	100.0
65	SBV-22-10.95	1.4	2.6	3.8	6.3	9.6	13.8	18.0	21.7	27.3	39.5	58.6	70.6	78.8	100.0
66	SBV-22-13.5	0.1	0.1	0.1	0.8	3.0	7.5	12.8	17.1	21.0	28.5	43.7	63.6	74.8	100.0
67	SBV-23-0.5	0.1	0.2	0.5	1.1	1.9	3.2	5.2	7.4	20.5	51.0	81.7	91.9	94.9	100.0
68	SBV-23-5.5	1.3	1.7	2.1	3.2	5.3	8.1	11.4	15.2	23.9	50.5	74.9	87.5	93.3	100.0
69	SBV-23-12.4	0.1	0.3	0.9	2.7	6.9	12.5	17.6	21.5	26.7	41.4	61.7	72.9	80.3	100.0
70	SBV-23-17.8	hydrometer													
71	SBV-24-2.2	0.4	0.4	0.8	1.5	3.0	5.6	8.8	12.1	17.8	41.2	80.3	91.8	94.5	100.0
72	SBV-24-5.6	0.4	0.6	1.2	2.5	5.3	9.4	13.4	16.7	21.2	35.7	65.8	80.7	88.0	100.0
73	SBV-24-7.0	0.0	0.9	1.4	3.1	6.5	11.1	15.2	18.4	22.8	37.0	65.1	80.7	87.1	100.0
74	SBV-24-16.5	hydrometer													
75	SBV-25-0.4	5.9	16.6	31.5	45.3	56.4	66.3	73.6	77.8	83.5	92.7	98.0	99.0	99.3	100.0
76	SBV-25-1.5	1.8	2.2	2.9	4.8	7.8	11.7	15.4	18.6	23.2	39.2	76.8	91.2	94.4	100.0
77	SBV-25-11.2	0.0	0.0	0.1	1.1	3.7	8.3	13.6	17.9	21.4	26.0	40.4	56.9	67.2	100.0

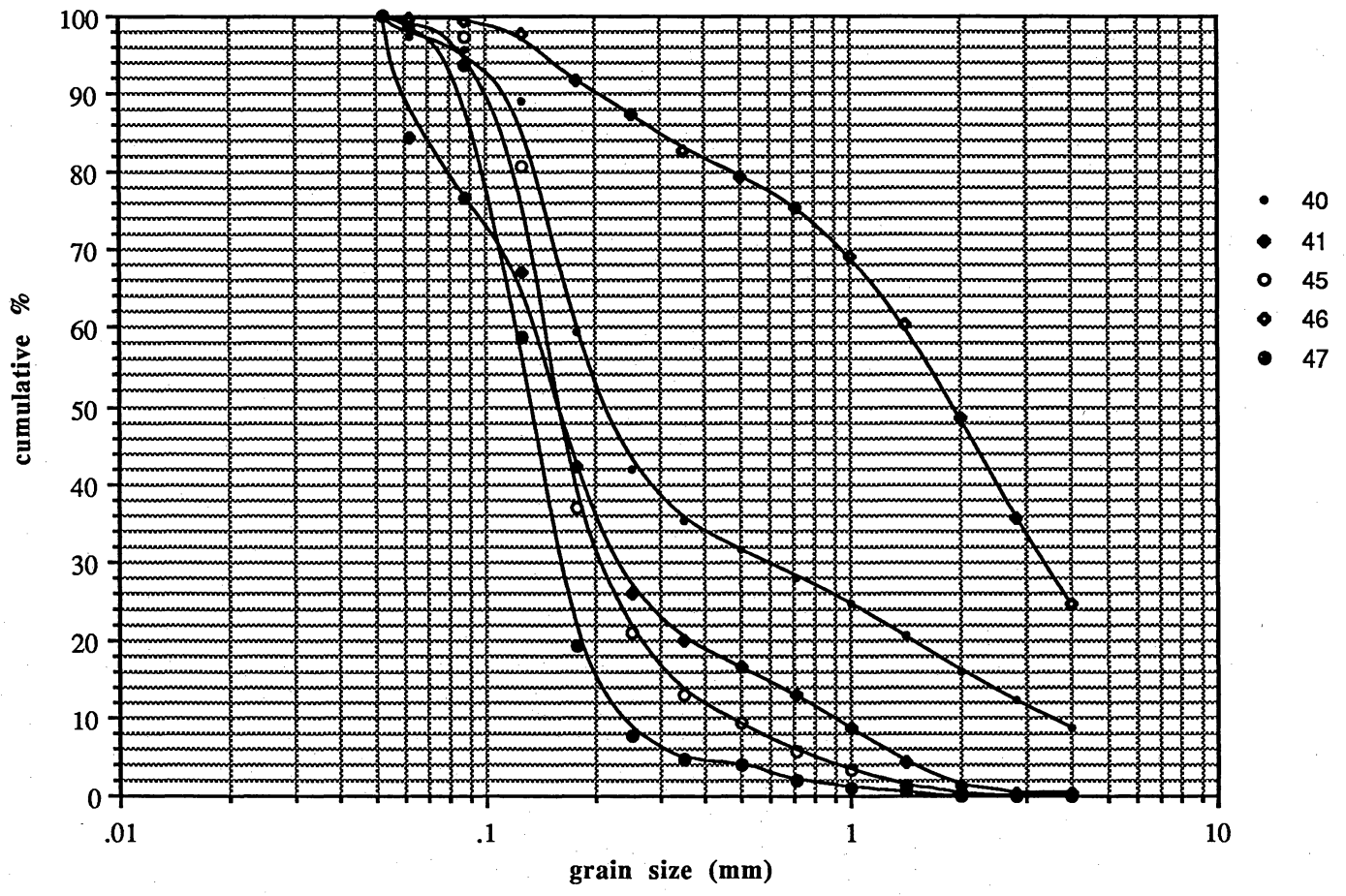


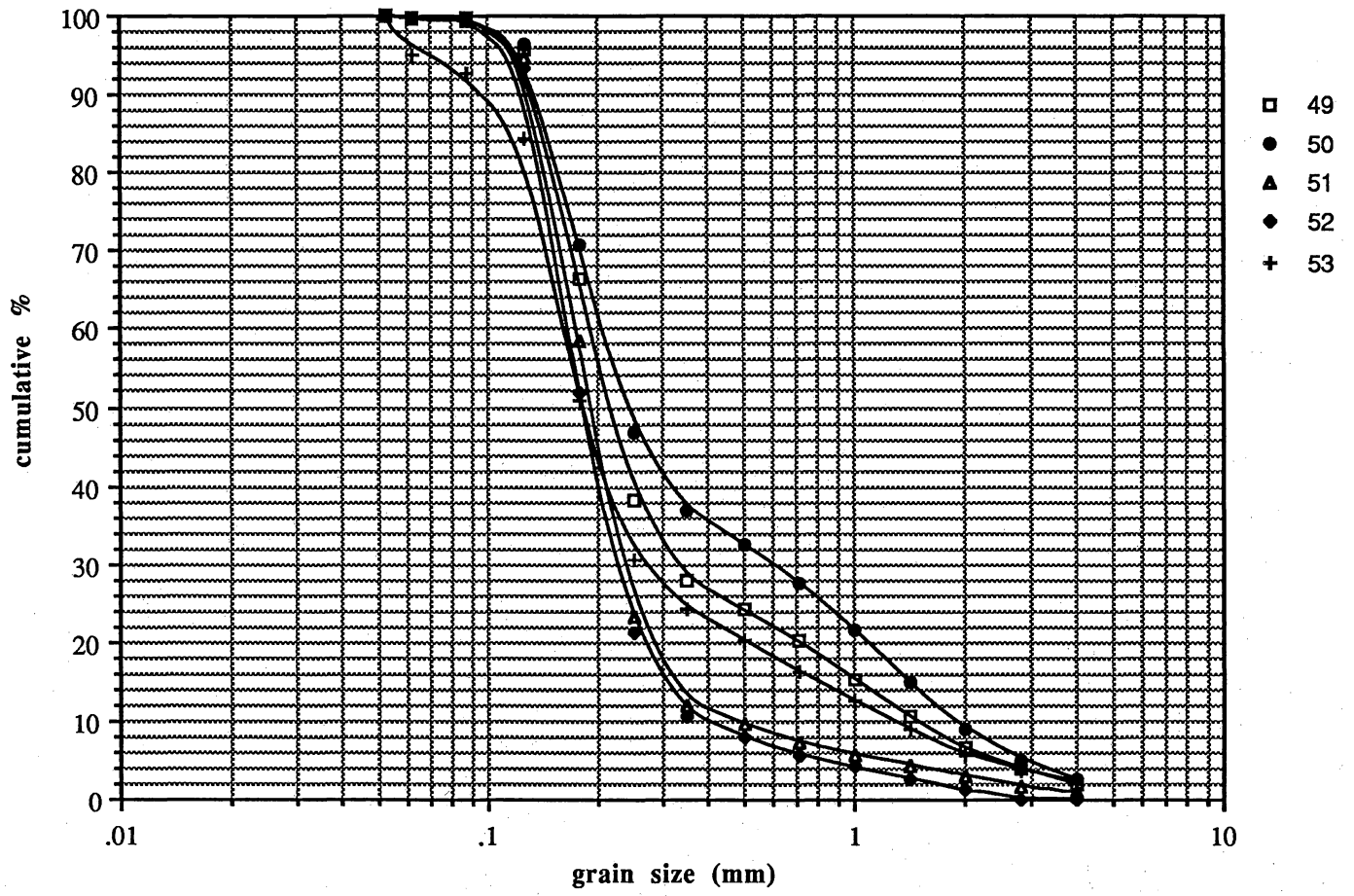


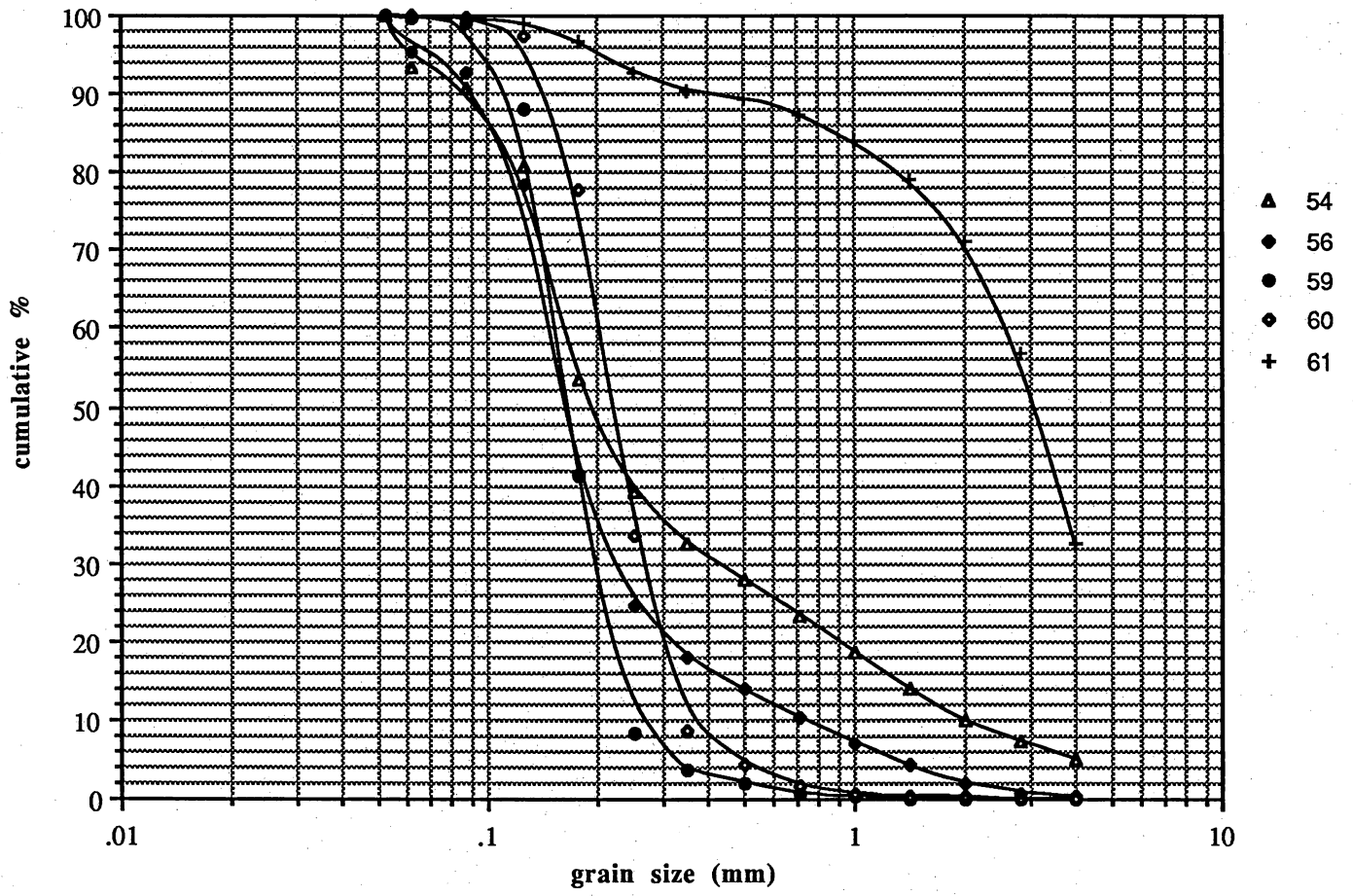


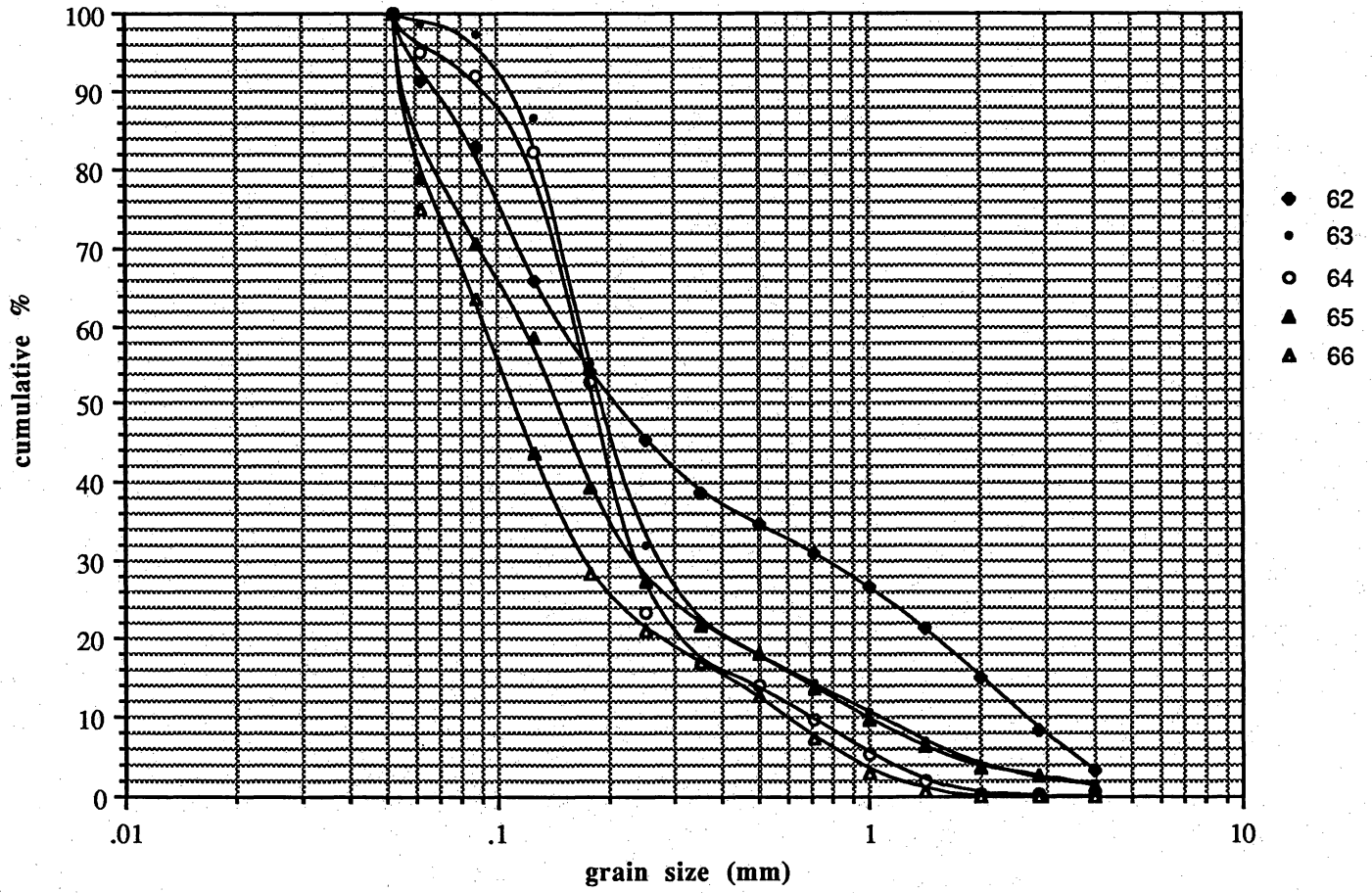


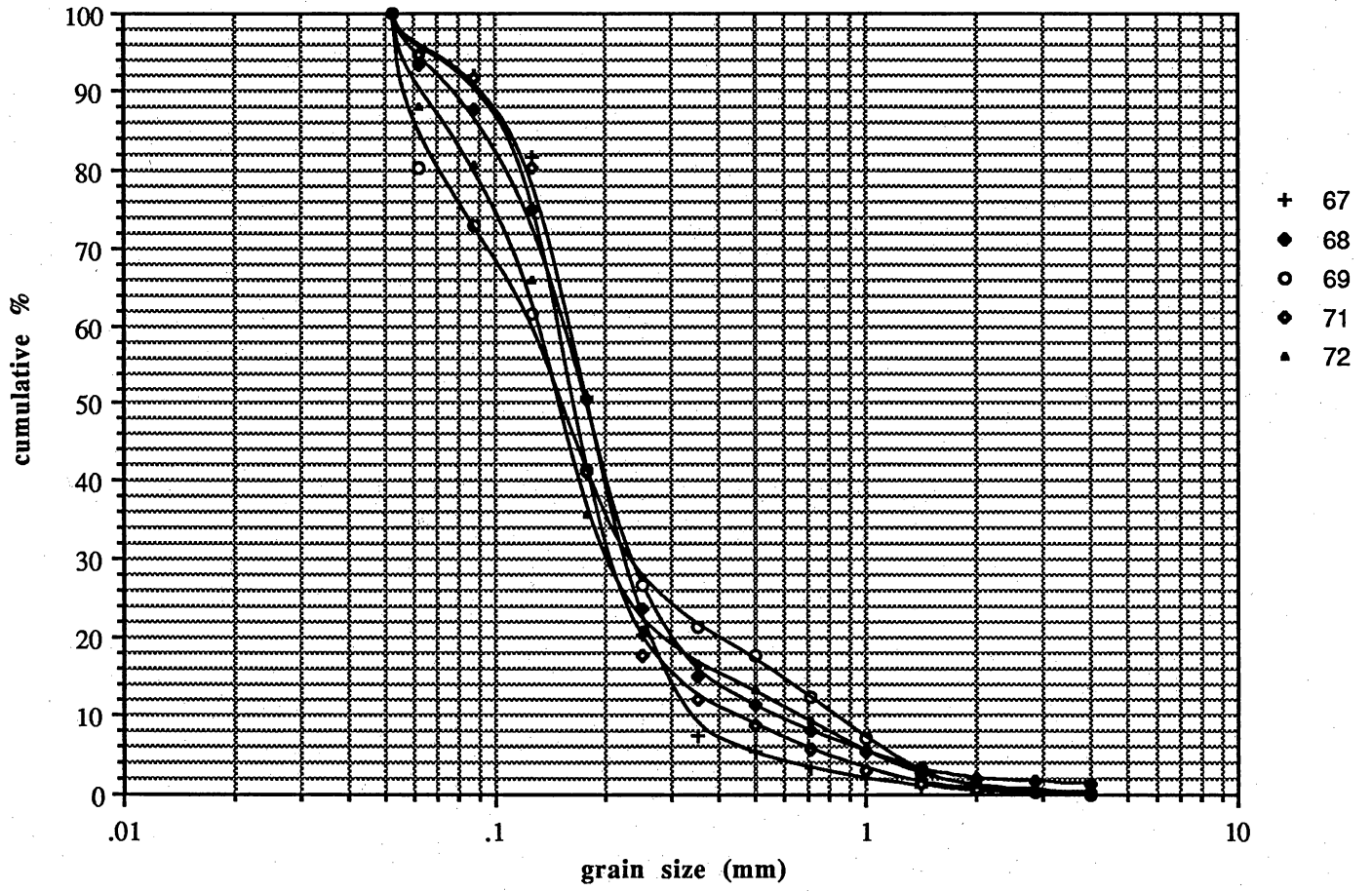


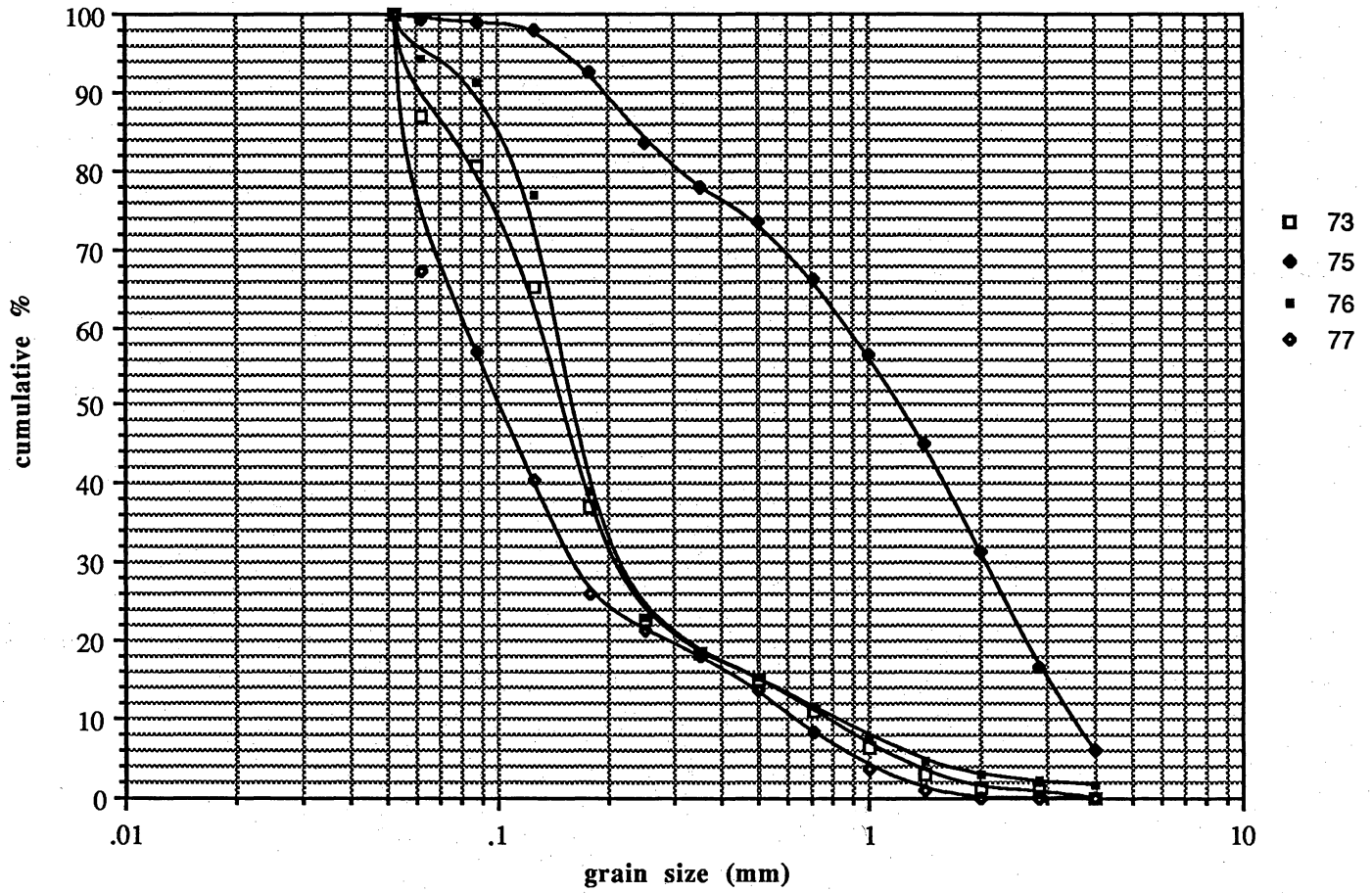




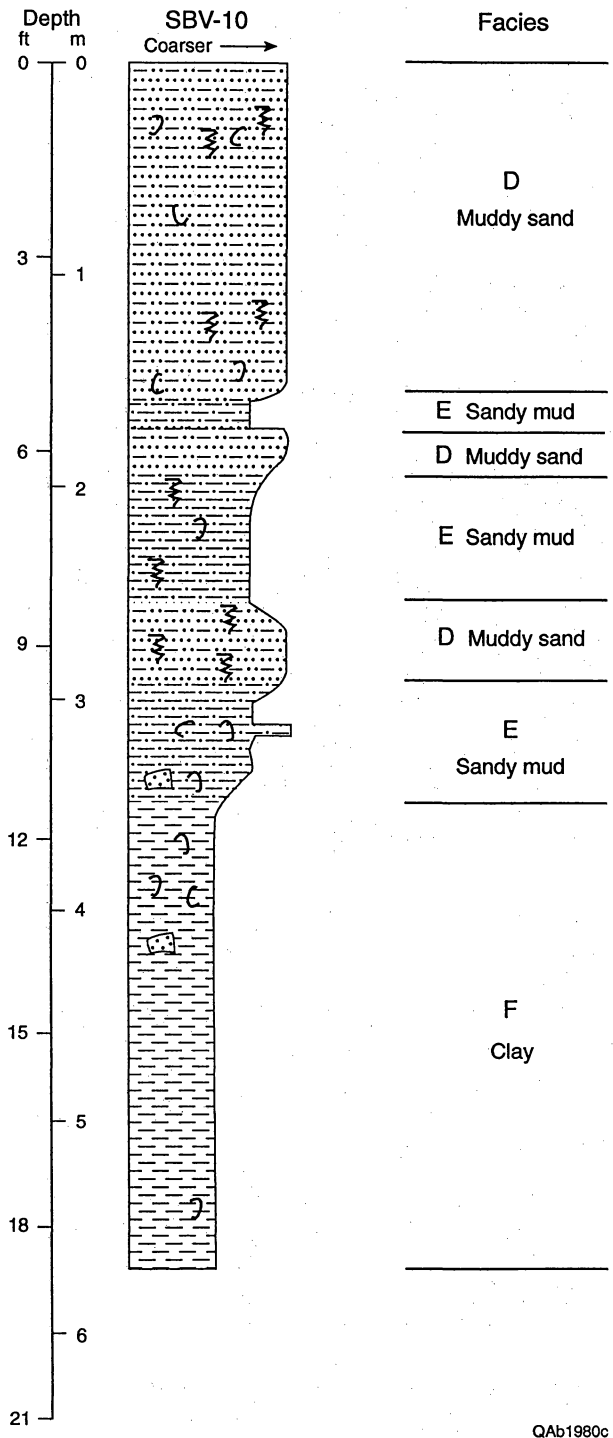


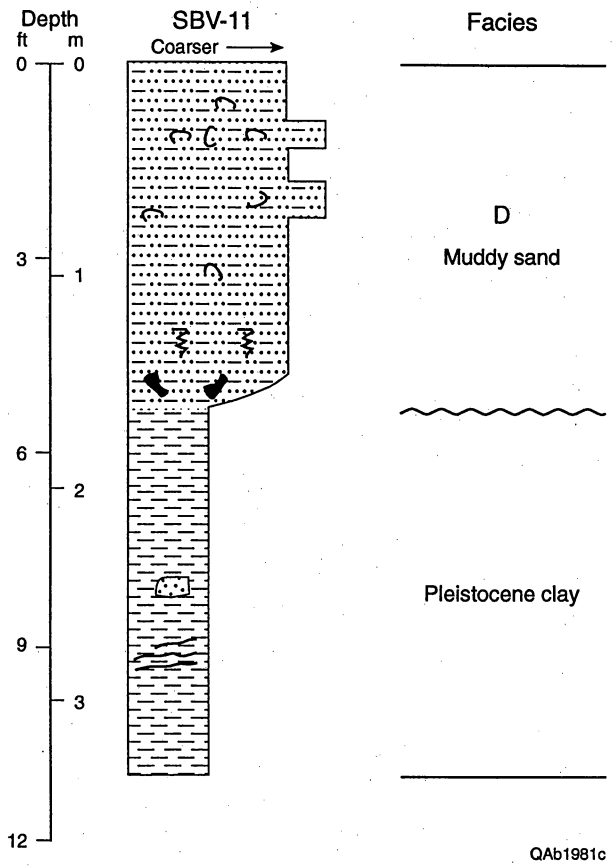


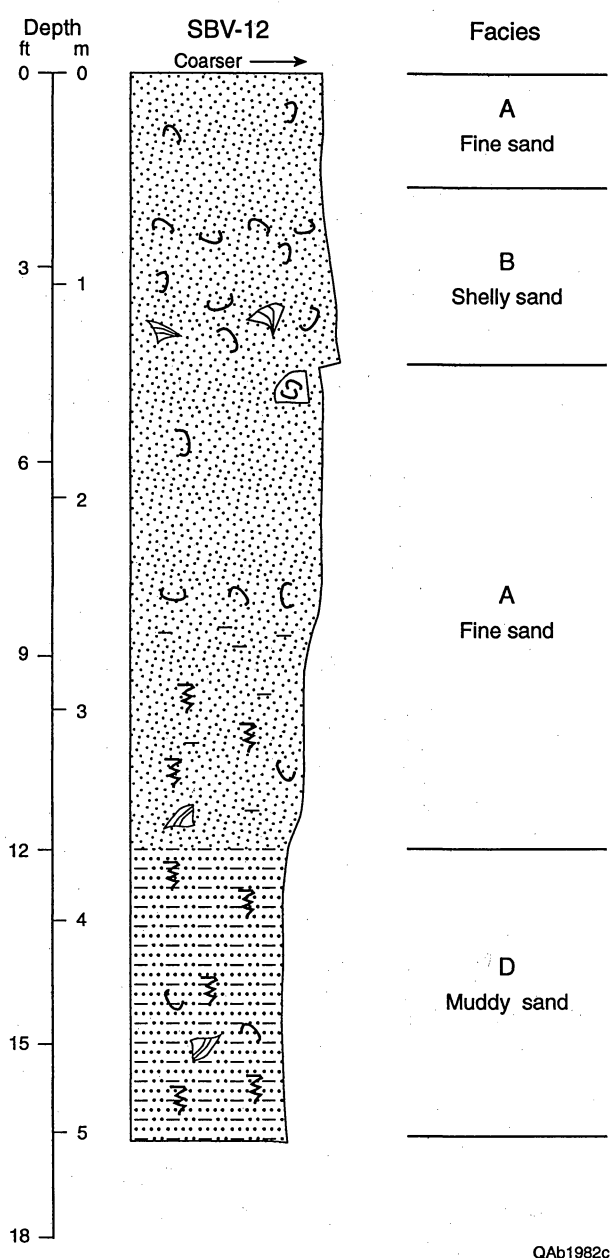




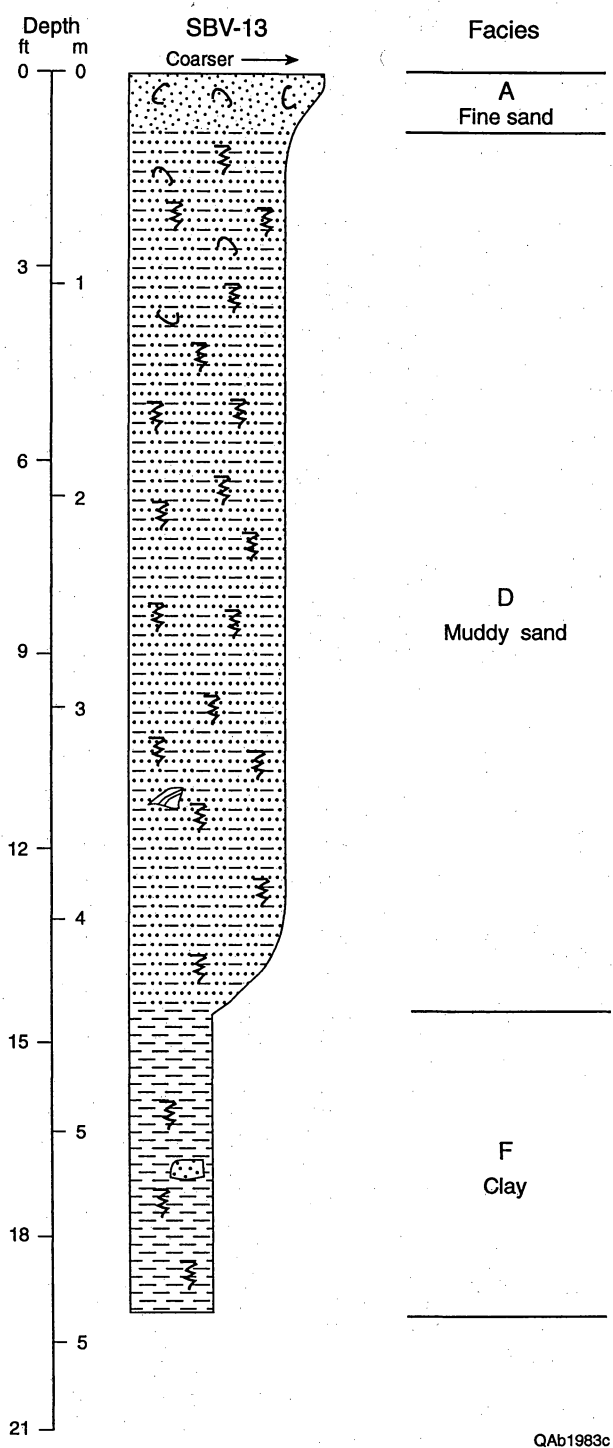
APPENDIX E. LITHOLOGIC PROFILES OF VIBRACORES

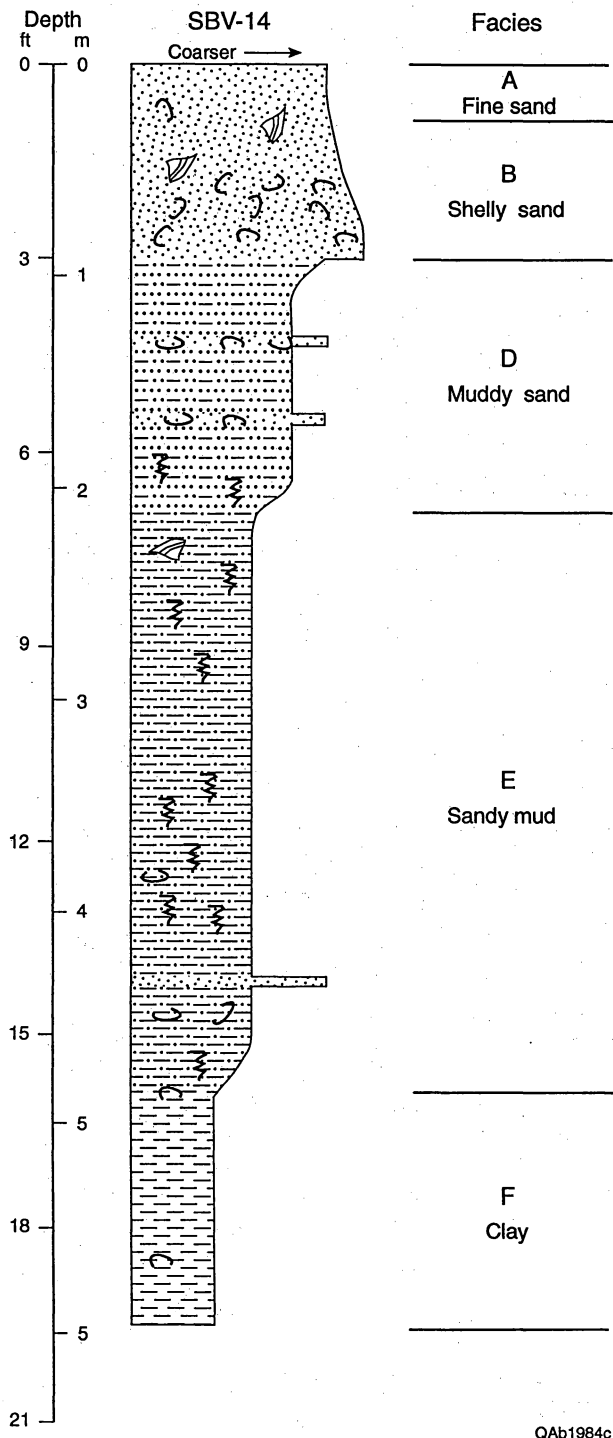


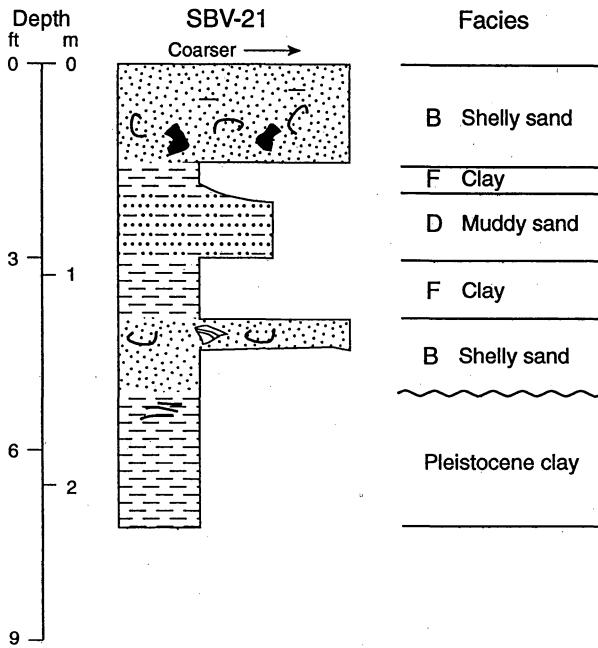
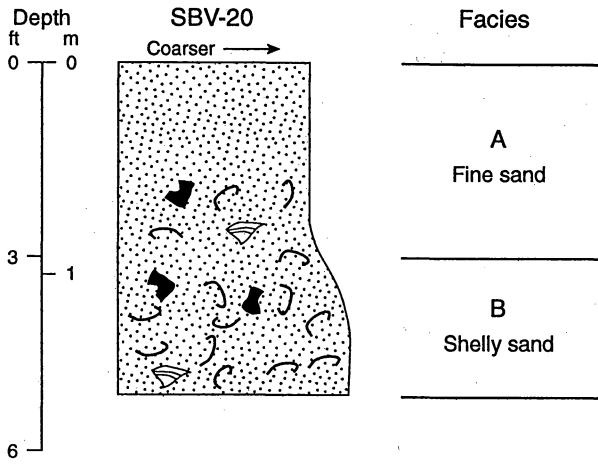
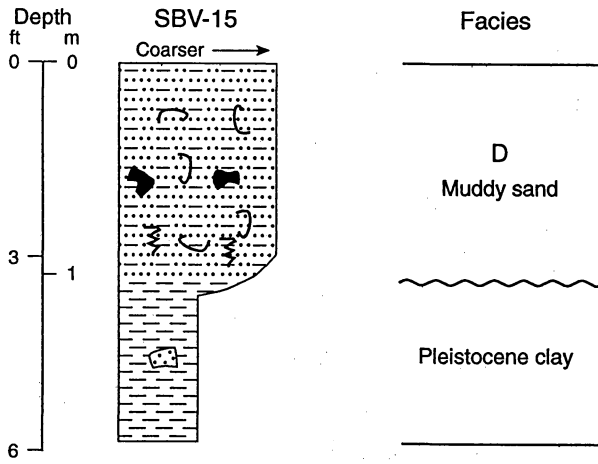


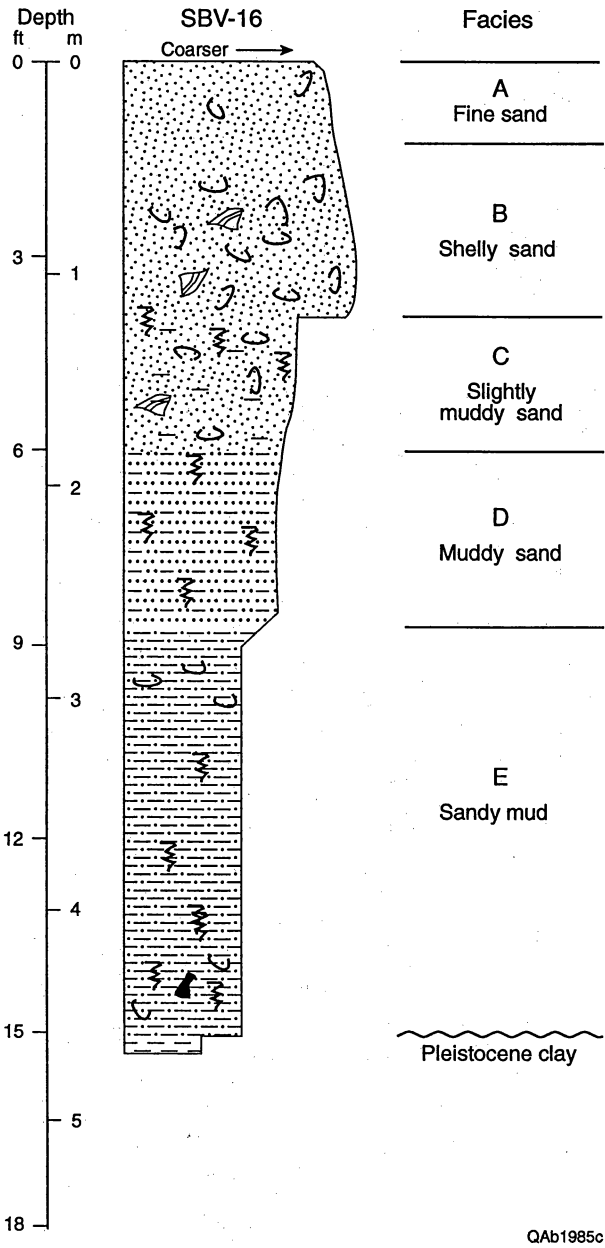


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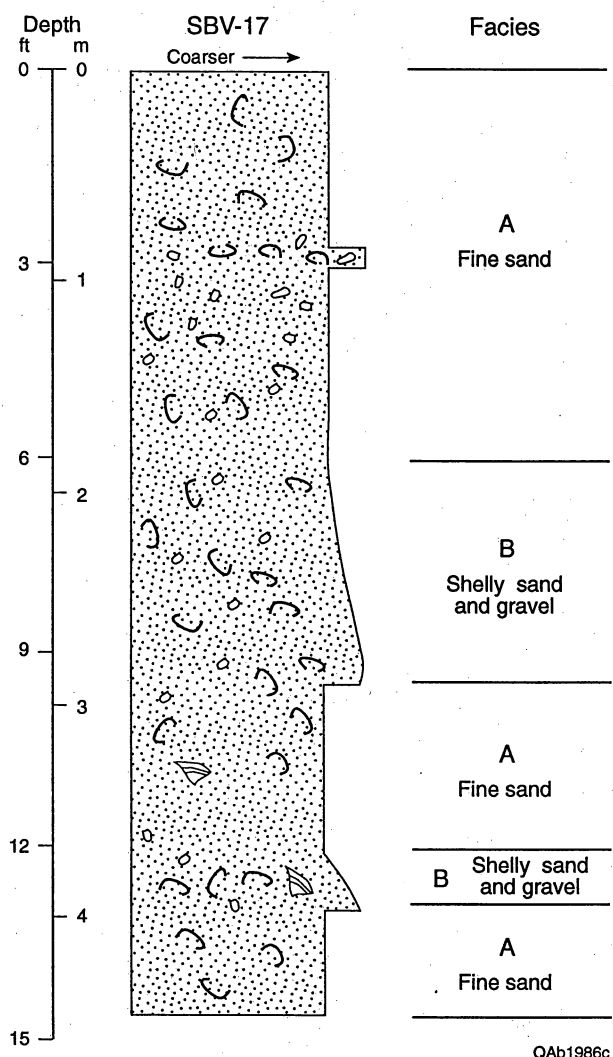


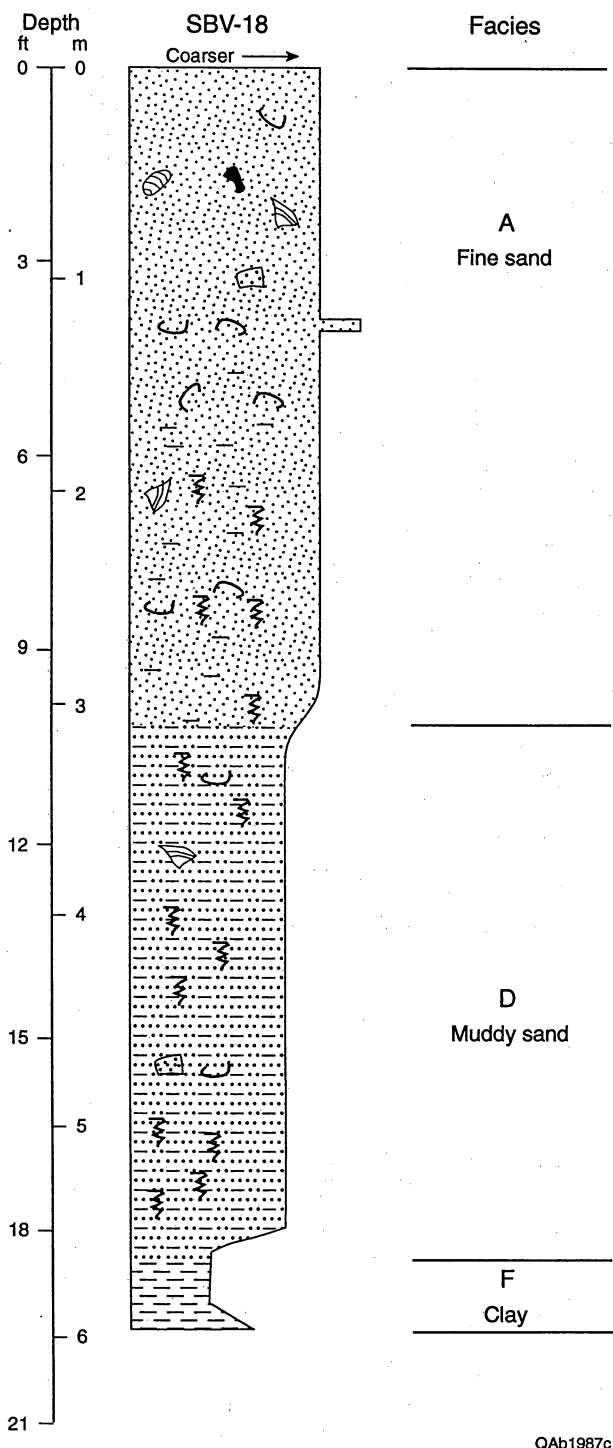


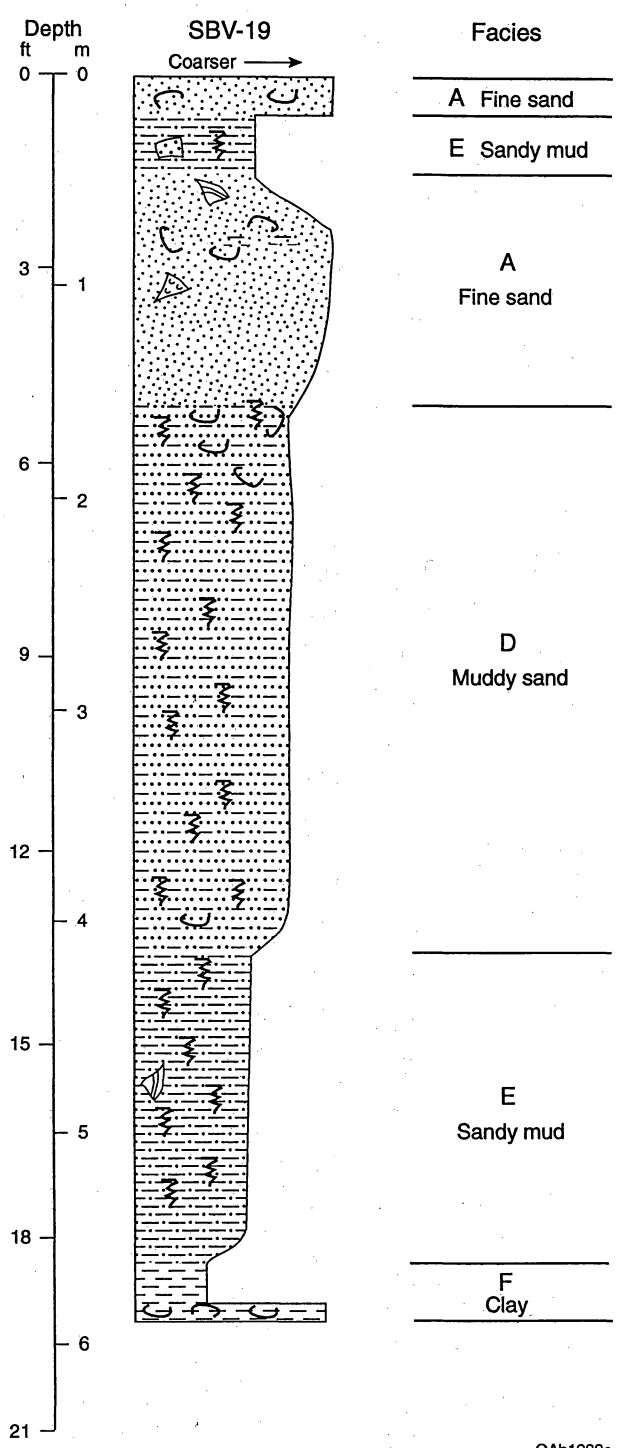




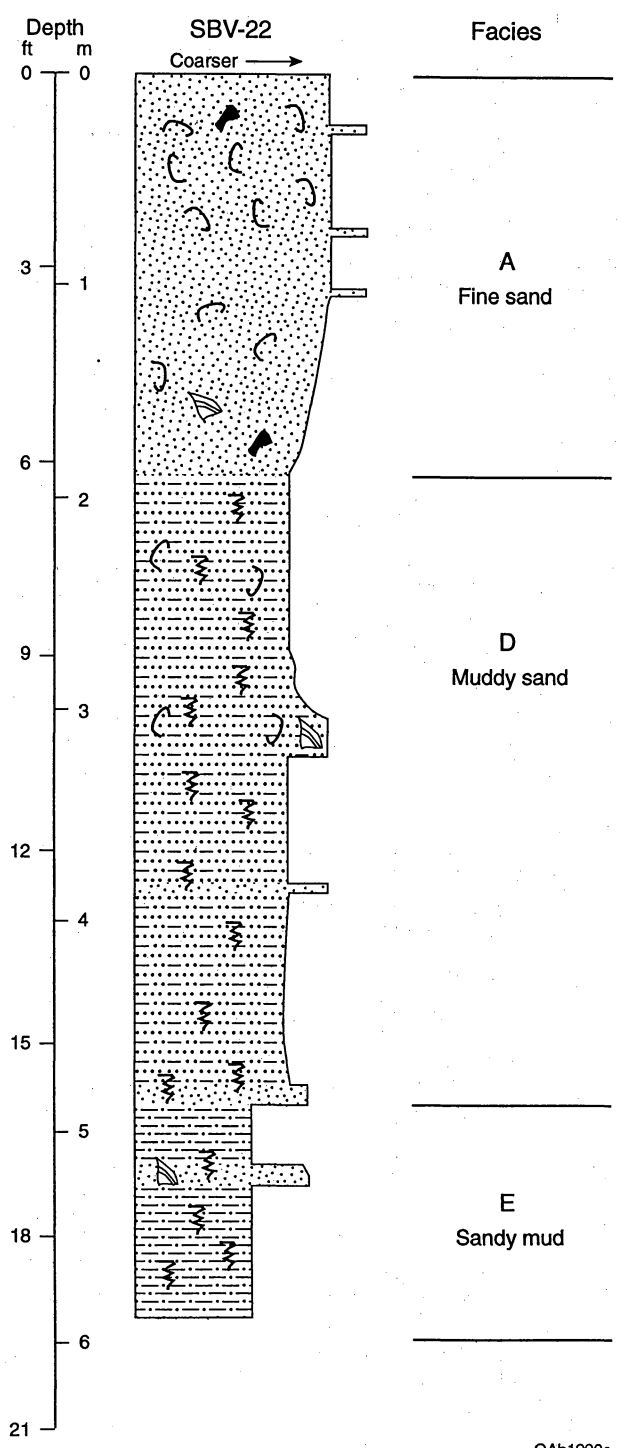
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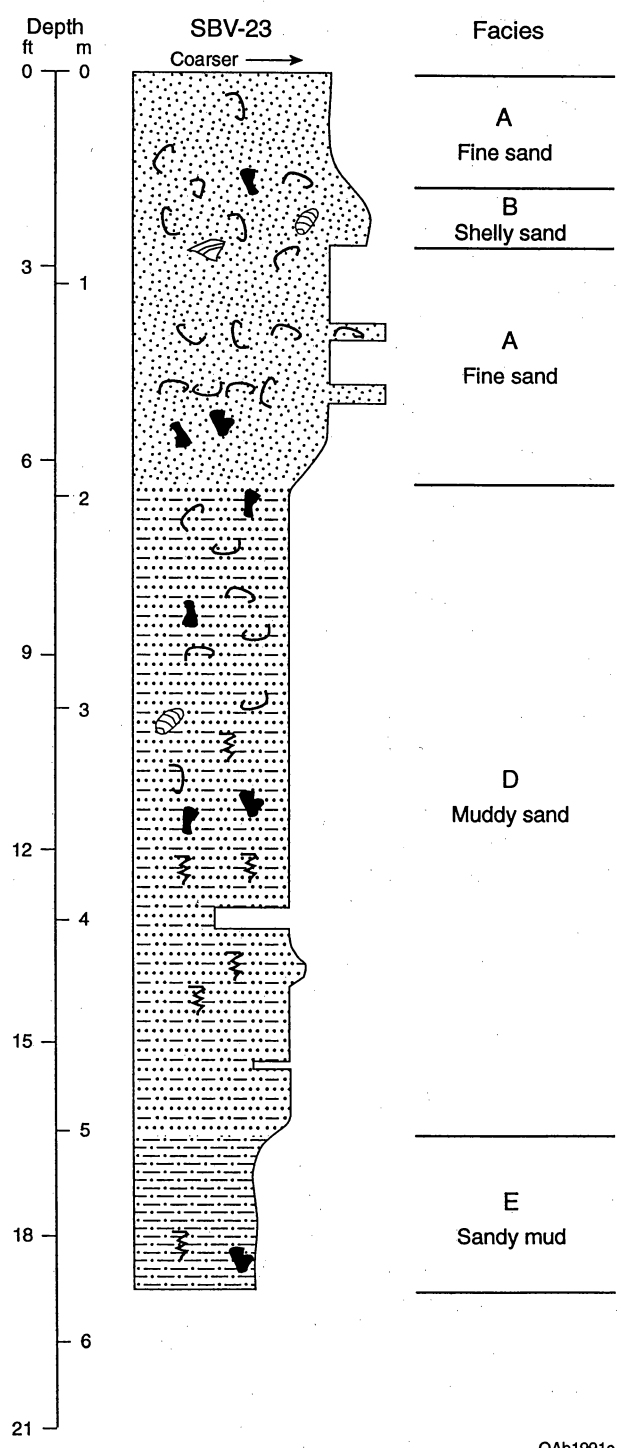


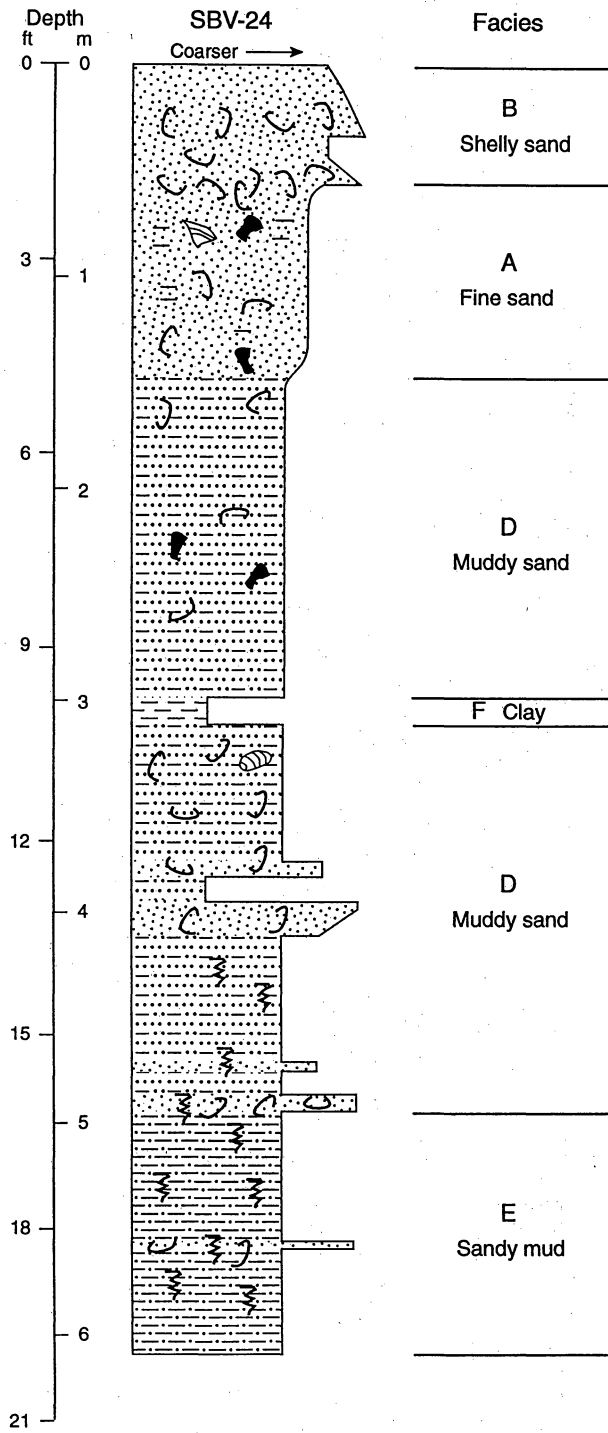


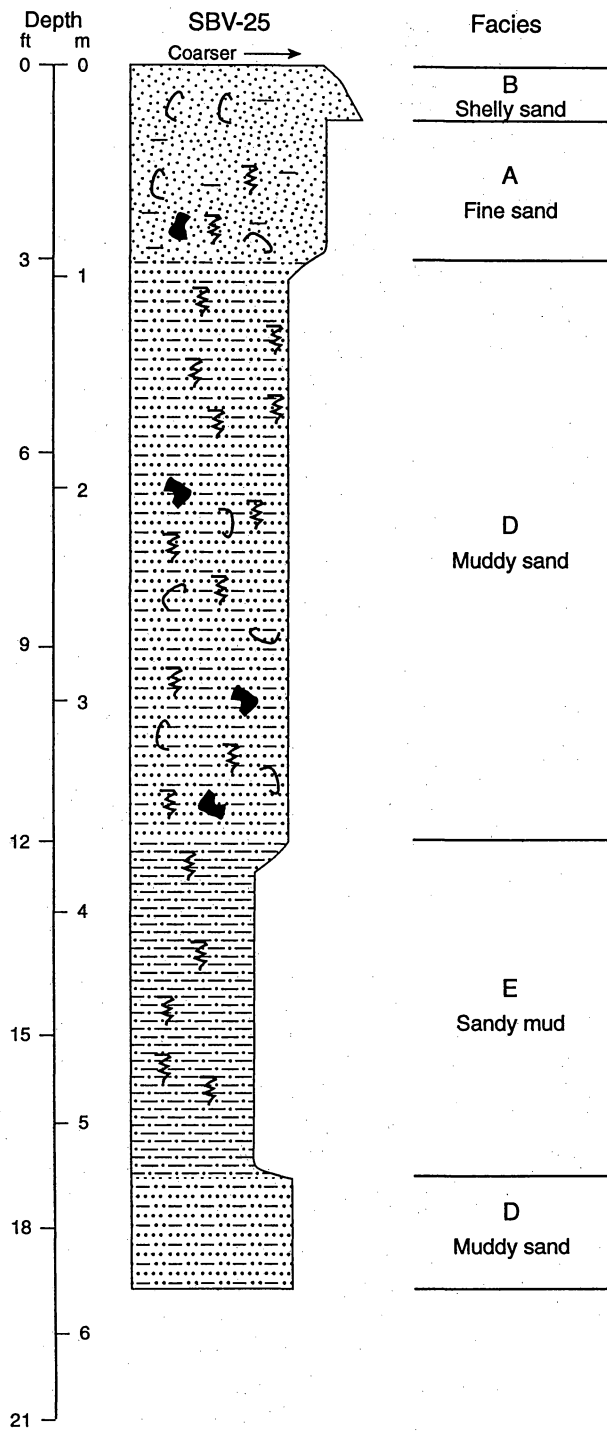


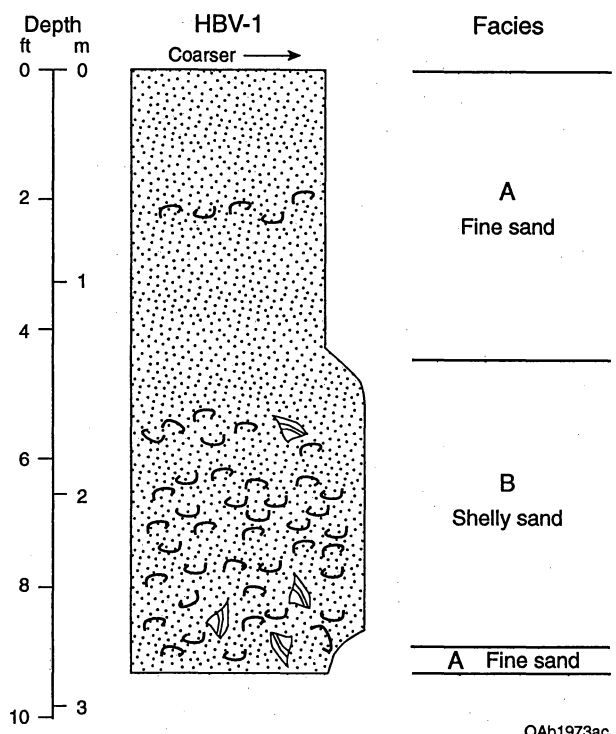
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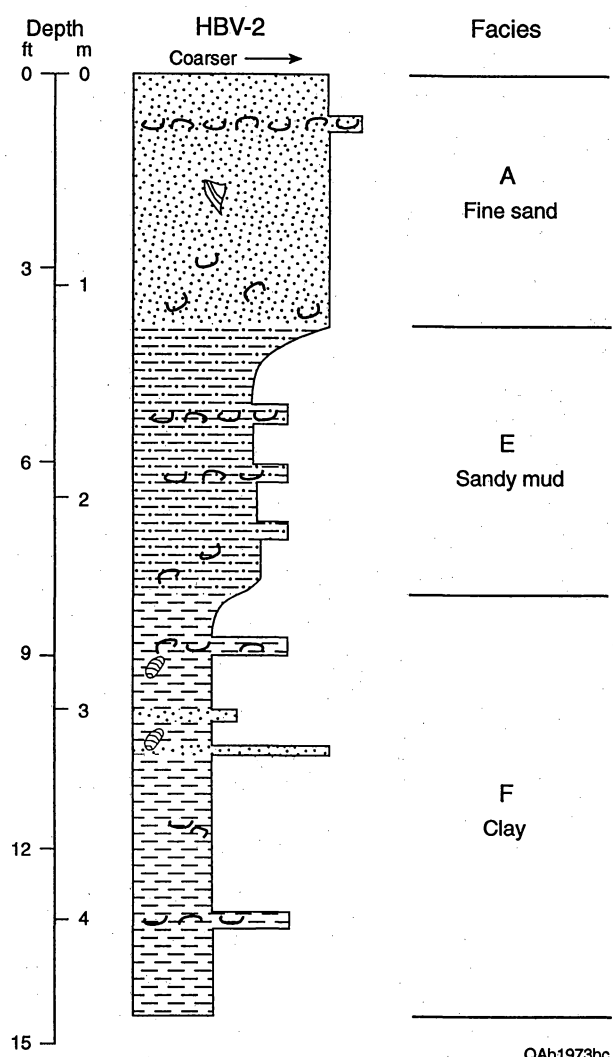


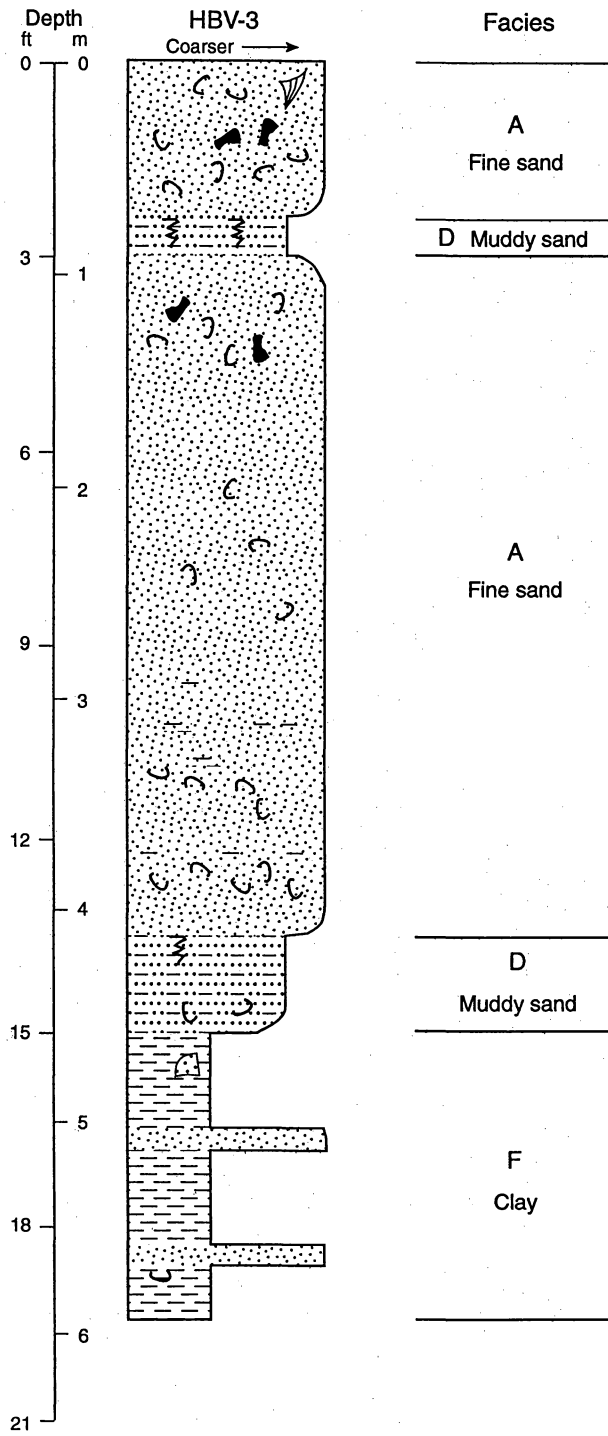




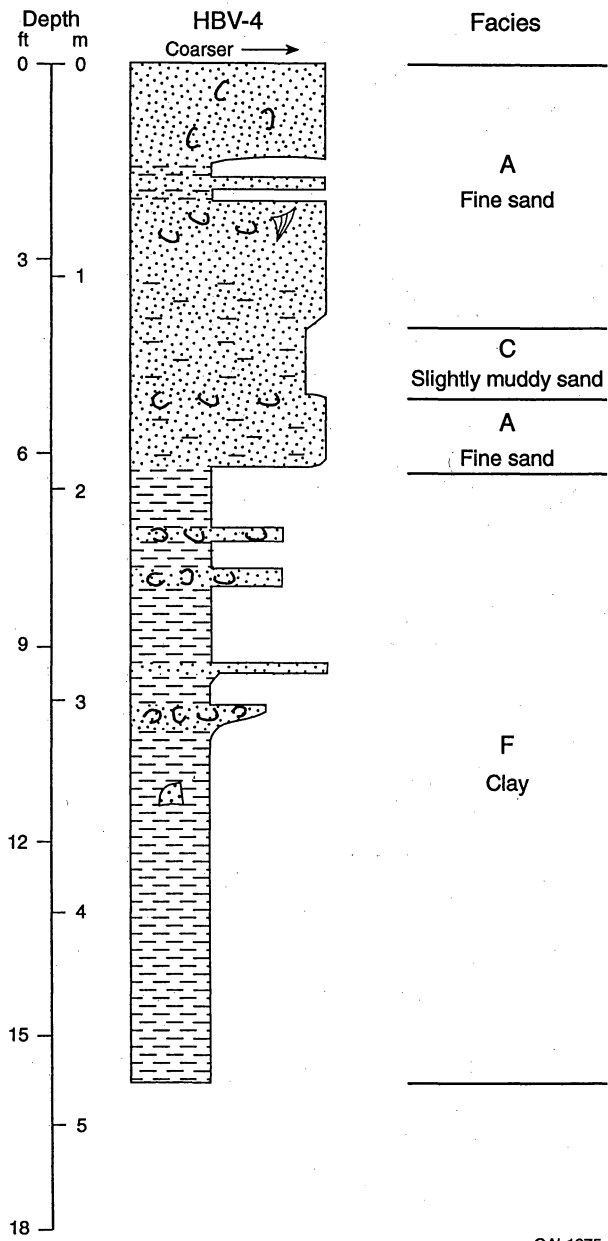


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