UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Open-File Report 79-579

RESULTS OF LABORATORY TESTS ON SURFICIAL SEDIMENTS FROM THE UPPER CONTINENTAL SLOPE NORTHERN GULF OF MEXICO

by

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1979

1. Corpus Christi, TX

Foreword

In order to evaluate potential geologic hazards and sediment engineering properties of the upper Continental Slope, northern Gulf of Mexico, the U.S. Geological Survey conducted an extensive investigation of the region. This report presents, without interpretation, the results of laboratory analyses on piston cores taken as a part of that study.

The piston coring stations were within 15 general areas (Fig. 1) that were selected on the basis of previous seismic profiling work. Sampling operations were carried out aboard the R/V FAY in the spring of 1976. The 34 cores collected averaged 8 m in length.

Users of these data should be aware that, despite precautions, a certain amount of core disturbance is unavoidable; and the effect of this disturbance on the data, particularly the shear strength values, is unknown.

All laboratory analyses were performed by personnel of the Office of Marine Geology, U.S. Geological Survey, Corpus Christi, Texas.

A companion report, which presents the data from the high resolution seismic profiling, is also available for general distribution.

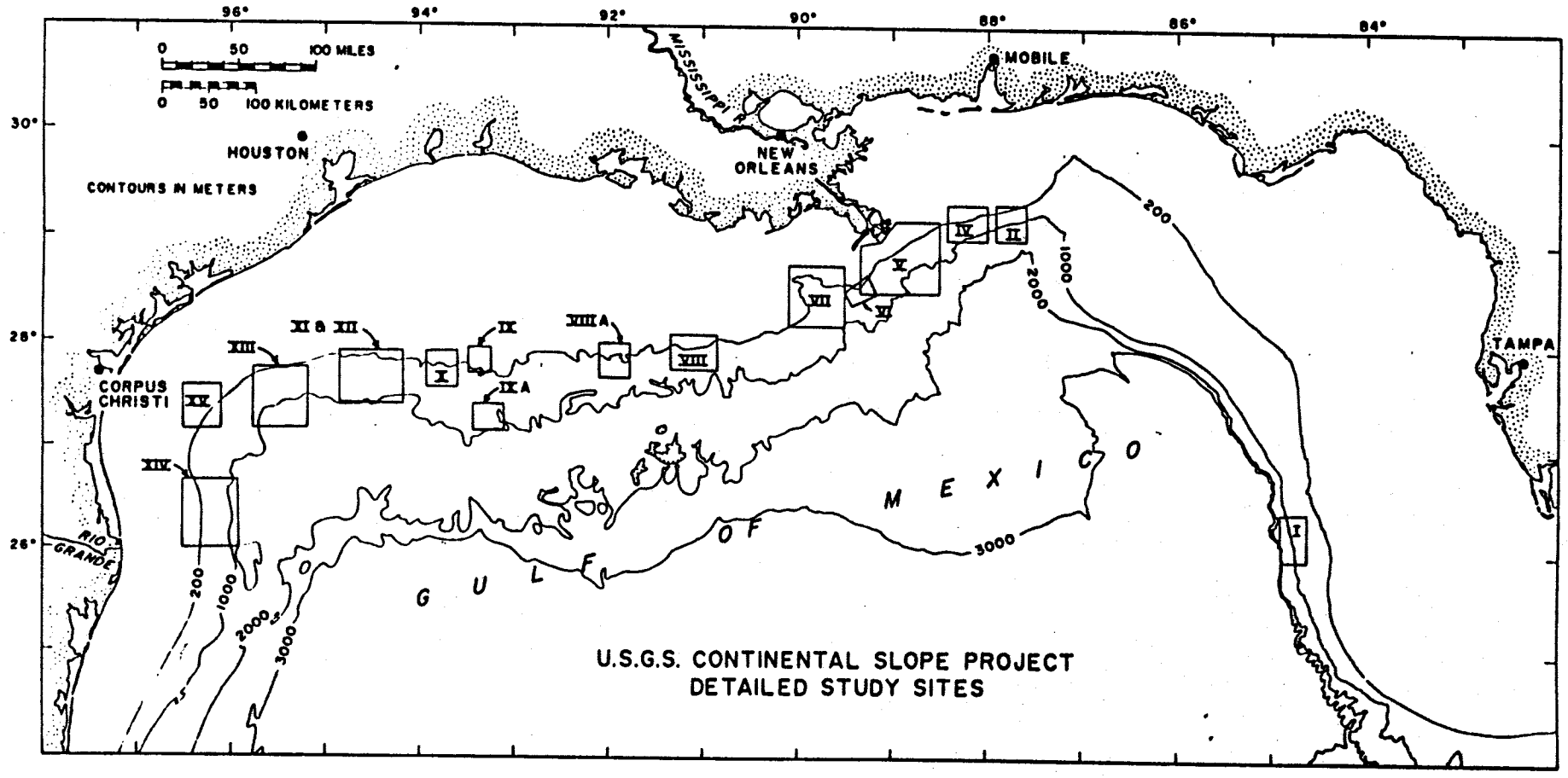

Fig. 1. Location of General Study Sites

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Introduction

The purpose of this report is to present the results of geotechnical, textural, and chemical tests performed on samples from the upper Continental Slope, northern Gulf of Mexico.

The samples were collected by a piston corer up to 12 m (40 ft.) in length with a head weight of 908 kg (one ton). The inside diameter of the C. A. B. liner was 89 mm (3.5 inches). Upon retrieval, the cores were cut in 1.5 m sections, examined for evidence of disturbance, then, if in acceptable condition, were sealed and placed in their in situ vertical position in a refrigerated van. Once ashore, the sections were opened, sealed with wax, recapped and stored as before.

The cores were split lengthwise for analysis. One half of the core was X-rayed and the radiograph was carefully examined as a further check for disturbance. This half was then archived. The other half of the core was used for the laboratory work.

Laboratory Tests

Shear strength ("undisturbed")

Undrained cohesive shear strength was measured by means of a four-bladed, 12.7-mm-square laboratory vane which was inserted normal to the laminae and buried at least 20 mm into the sample. The rotation was 0.0262 rad/s (90°/min). Measurements were made at 0.5 m intervals and at lithologic changes. A total of 544 measurements were made. Precision of measurements: $\pm$0.3kPa.

Remolded Shear Strength

After shear strength had been measured in the "natural" state, the sample was placed in a plastic bag and kneaded vigorously and thoroughly. After remolding was complete, a shear strength measurement was made. Depth of insertion and rotation rate were the same as for the "undisturbed" case. Determinations were made at 0.5 m intervals and at lithologic changes. A total of 535 measurements were made. Precision of measurements: $\pm$0.3KPa.

Water Content

Water content was determined according to the specifications of ASTM D2216-71. Results were corrected for salt content (assumed 35 0/00). The interval of testing was 0.5 m and at lithologic changes. 554 measurements were made. Precision of measurements: $\pm$3% of given value.

Grain Specific Gravity

Values of specific gravity were determined by an air-comparison pycnometer with helium purge. A dried sample is pulverized, further dried in an oven at 110°C, placed in a dessicator to cool, then weighed. It is then placed in the pycnometer and the volume measured. Grain specific gravity was measured at 0.5 m intervals and at lithologic changes. A total of 556 measurements were made. Precision of measurement: $\pm$0.7% of given value.

Liquid Limit

Liquid limit was determined according to the procedure outlined in ASTM D423-66 with three modifications. First, the samples were not passed through a no. 40 sieve prior to analysis. Second, the samples were tested on the basis of decreasing water content. Third, the samples were not dried prior to testing. The three trial method was used for all tests. The results were corrected for salt content (assumed salinity: 35 0/00). Tests were performed at 1 m intervals and at lithologic changes. A total of 359 tests were made. Precision of measurement: $\pm$3% absolute.

Plastic Limit

Plastic limit was determined by following the basic procedure outlined in ASTM D424-59. However, the material was passed through a no. 40 sieve or air-dried prior to testing. The results were corrected for salt content (assumed salinity: 35 0/00). Measurements were made at 1 m intervals and at lithologic changes. A total of 286 tests were performed. Precision of measurement: $\pm$2% absolute.

Texture

The subsamples used for textural analysis were wet-sieved to separate the coarse (greater than 62-micron sieve diameter particles) and fine fractions. The coarse fraction (sand) was then analyzed in

a settling tube (RSA). The fine fraction (silt and clay) was treated with a hydrogen peroxide solution to remove organic matter and then dispersed with a calgon (sodium metaphosphate) solution. It was then analyzed with a Coulter Counter.

The calculation of the various grain size parameters was done on a computer: the method of moments was used to determine mean, standard deviation, skewness and kurtosis; all other parameters (median, mode, sand %, silt %, clay %, sand-mud ratio, and silt-clay ratio) were determined by direct computation or graphically. Textural analysis was done at 2 m intervals and at lithologic changes. A total of 175 samples were analyzed.

Organic Carbon and Carbonate

Percent organic carbon and XCO_3 were determined on a LECO apparatus. The amount of carbonate material (chiefly $CaCO_3$) was determined by digestion and measuring the quantity of CO_2 generated. Similarly, total carbon was determined by combustion and measurement of CO_2, with organic carbon percentage being the difference between total and carbonate carbon. Tests were made at 1 m intervals and at lithologic changes. The total number of determinations of organic carbon % was 305, of calcium carbonate % was 308.

Derived Properties

From the basic set of geotechnical data the following properties were derived:

(1) Plasticity index (285 determinations)

$$I_p = [w_L - w_p]$$

Where w_L is liquid limit

w_p is plastic limit

(2) Liquidity Index (285 determinations)

$$I_L = \frac{w - w_p}{w_L - w_p}$$

where w is water content

w_L is liquid limit

w_p is plastic limit

(3) Void ratio (555 determinations)

$$e = \frac{(GS)\ (\gamma_w)\ (V)}{W_s} - 1$$

where GS is grain specific gravity

γ_w is unit weight of seawater

(taken as 1.027)

V is volume of sample

and where

$$W_s = \frac{\gamma_t}{\frac{w}{100} + 1}$$

with γ_t being bulk density

and w is water content

Assuming V is one, void ratio may be calculated from grain specific gravity, bulk density, and water content.

(4) Bulk density (unit wet weight) (555 determinations)

$$\gamma_t = \frac{wt._t + (GS)}{wt._s + [wt._w\ (GS)]}$$

where $wt._t$ is total weight of sample

GS is grain specific gravity

$wt._s$ is total weight of solids

$wt._w$ is weight of water

With the total weight being taken as one, $wt._s$ and $wt._w$ can be calculated from w, and thus w and GS are the only variables needed in the calculation. This calculation assumes 100% saturation.

(5) Sensitivity (528 determinations)

$$S_t = \frac{Su - u}{Su - R}$$

where Su - u is "undisturbed" shear strength

Su - R is remolded shear strength

TABLE I
DATA SUMMARY

Variable	N	Mean	Minimum	Maximum
GEOTECHNICAL				
Undisturbed Shear strength (KPa)	563	5.9	0.4	43.2
Remolded Shear strength (KPa)	544	1.8	0.2	19.2
Water content (%)	554	107	28	234
Grain Specific Gravity	556	2.69	2.60	2.74
Liquid Limit (%)	359	103	35	152
Plastic Limit (%)	286	32	16	44
Plasticity Index	285	71	17	119
Liquidity Index	285	1.04	0.32	2.32
Void Ratio	555	2.87	0.75	6.32
Bulk density (Unit wet weight)	555	1.50	1.26	2.02
Sensitivity	528	3.60	1.05	8.50
TEXTURAL				
Mean grain size (ϕ)	175	8.20	2.71	9.08
Std. Dev. (ϕ)	175	1.67	1.12	2.55
Skewness (ϕ)	175	-0.26	-0.81	+1.61
Kurtosis (ϕ)	175	+0.04	-1.35	+17.28
Median (ϕ)	175	8.39	2.55	9.44
Mode (ϕ)	175	9.00	2.21	10.03
Sand content (%)	175	3.87	0.00	94.17
Silt content (%)	175	35.46	4.64	64.70
Clay content (%)	175	60.67	1.19	82.94
Sand-mud ratio	175	0.16	0.00	16.14
Silt-clay ratio	175	0.72	0.18	4.44
CHEMICAL				
Organic Carbon (%)	305	0.93	0.21	3.73
$CaCO_3$ (%)	308	12.03	0.77	48.60