PRELIMINARY ASSESSMENT OF OFFSHORE SAND RESOURCES, SOUTH PADRE ISLAND, TEXAS

Prepared for Shiner, Moseley and Associates
and the
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by

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INTRODUCTION

The purpose of this report is to provide a preliminary qualitative assessment of potential offshore sand resources that might be suitable for replenishment of beaches along South Padre Island, Texas. The investigation involved a literature search and compilation of published and unpublished data to determine if deposits of beach quality sand might be located on the shoreface and inner continental shelf near the Town of South Padre Island.

The location of the study area and potential offshore sites of beach quality sand are presented in figure 1. It should be emphasized that this reconnaissance study does not provide the level of information needed to actually conduct offshore mining operations. Additional work involving sediment cores and high-resolution seismic surveys would be necessary to determine the quantity and quality of sand resources offshore of South Padre Island.

SOURCES OF INFORMATION

Published Reports - Geologic framework and resource studies previously conducted by the Bureau of Economic Geology (Garner, 1967; Morton, 1977; Morton and McGowen, 1980;White et al., 1986; Morton and Price, 1987; Paine et al., 1988) and supplemental unpublished reports (see following paragraph) were the primary sources of information used to prepare a preliminary assessment of sand resources offshore of South Padre Island.

Unpublished Reports - A total of 10 geotechnical reports containing descriptions of foundation borings were obtained from the Texas Highway Department, U.S. Army Corps of Engineers, and engineering companies who conducted geotechnical tests for bridges and large buildings on South Padre Island and production platforms in the Gulf of Mexico. The boring logs contain descriptions of sediment types and depths that can be used to construct cross sections depicting geological conditions about 50 to 100 ft below the land surface. Some of the geotechnical reports also provide sediment textural data (grain-size) in the form of percent material passing the 200 mesh screen. The reported value of material passing the 200 mesh screen represents the percent mud (silt and clay) in the sample, whereas the difference in the reported value and 100 is the percent sand in the sample. The average grain size and percent sand are used to evaluate the quality of potential beach fill material.

QUALITATIVE OFFSHORE SAND ASSESSMENT

Surface Sediments

A preliminary report of offshore sand resources in Texas (Paine et al., 1988) identified a band of shore parallel sand deposits that blanket the nearshore zone of South Padre Island. The band of sand extends from the beach to about two miles offshore (fig. 2). Within a mile of the beach and at water depths of 30 ft or less, bottom sediments contain about 90 percent sand (figs. 2 and 3).

The thickness and volume of these nearshore sand deposits is uncertain because core samples that would provide that information have not been taken. However, the geological setting of South Padre Island suggests that the thickest deposits of nearshore sand probably are located adjacent to and just north of the north jetty at Brazos Santiago Pass (fig. 1).

The arcuate accumulation of sandy sediments and associated shoals (bars) near the entrance to a tidal inlet are known as the ebb tidal delta. Before artificial channel deepening and construction of the jetties at Brazos Santiago Pass, the sand-rich ebb tidal delta deposits were about 15 ft thick and they extended from -10 to -25 ft below sea level (fig. 4). Comparison of bathymetric surveys in 1917 and 1974 indicates that more than 3 million cubic yards of sediment accumulated on the beach and shoreface north of the north jetty after the jetties were constructed (fig. 5). This accumulation of sandy sediments caused rapid beach accretion (Morton and Pieper, 1975). Sandy sediments have continued to accumulate at the same general location as the ebb tidal delta, and the adjacent sand beach has continued to accrete (Paine and Morton, 1989; Morton, 1993). Although not shown on figure 1, a large volume of tidal delta sand should also be present on the south side of Brazos Santiago Pass in about the same position as the deposits on the north side of the inlet.

The nearshore sand deposits parallel to the beach and north of the north jetty at Brazos Santiago Pass have a mean grain size of 0.10 mm, which is very fine sand (White et al., 1986). This grain size is slightly smaller than the average grain size of beach sediments from South Padre Island, which is 0.18 mm or fine sand (Garner, 1967).

Shallow Subsurface Sediments

Detailed descriptions of foundation borings were used to construct four geological cross sections. The cross sections illustrate the thickness and inferred continuity of

sediments and their arrangement as strata, or lithologic units, that can be correlated from boring to boring. The cross sections are oriented both perpendicular and parallel to South Padre Island so that the areal distribution of the lithologic units can be evaluated.

Although each cross section exhibits differences in detail, the cross section segments that include South Padre Island all show a consistent vertical pattern of lithologic units. The strata consist of two layers of sand separated by a layer composed predominantly of mud with some minor lenses of sand (figs. 6 and 7).

Barrier Island Sand - The uppermost sand unit, which is exposed at the surface, represents the barrier island and tidal inlet deposits of South Padre Island. The barrier island sand is about 10 to 15 ft thick, not counting the height of the dunes, and extends down to a depth of about -10 ft below sea level. The sand dunes and other sand features of South Padre Island were derived from the beach and therefore the sand would be ideal beach replenishment material. However, mining barrier sand in Texas is generally prohibited by a State regulation; therefore, the barrier sand is not considered a potential source of beach fill material.

Rio Grande Delta Mud - The intermediate layer of sediments composed predominantly of mud containing some lenses of sand was deposited by the Holocene Rio Grande delta several thousand years ago. The muddy sediments are found at depths ranging from -10 to -50 below sea level (figs. 6 and 7). The sand bodies (former river channels) within the mud deposits are discontinuous and prediction of their location is difficult because their thickness and width are highly variable. Basal channel fill deposits of sand would be at least as coarse as beach sand, but the channel fill would likely also contain a substantial amount of interlaminated mud. The lack of sand body continuity and the potential inclusion of mud suggest that the delta sediments do not contain large volumes of beach quality sand that could be mined at reasonable depths and nearshore locations.

Marine Sand - Beneath the muddy delta deposits is a layer of sand that occurs at a depth of about -50 to -60 ft below sea level. In figure 6 it is referred to as transgressive marine sand and in figure 7 it is referred to as distributary channel and delta front sand. Lithologic descriptions indicate that this sand layer was deposited in the Gulf of Mexico on the continental shelf by an older (late Pleistocene) Rio Grande delta and then the sand was reworked by marine processes as sea level rose several thousand years ago. The sand layer is about 25 to 30 ft thick and appears to be relatively continuous beneath the island (fig. 7); it extends landward toward Port Isabel (fig. 6), and seaward at least offshore of Port Mansfield (fig. 7). The cross sections indicate that the marine sand could be present over a wide area offshore of South Padre Island (fig. 1).

If the marine sand unit extends offshore from the Town of South Padre Island, it should be present in water depths of 50 to 60 ft (fig 7). These water depths are located approximately 2.5 miles offshore from the beach (fig. 1).

RESULTS

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 indicate 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 20 ft thick occur in water depths ranging from 15 to 60 ft. These sand deposits occur at the seafloor and there appears to be very little, if any, mud covering the sand deposits (overburden). These data provide sufficient information so that a preliminary economic analysis of offshore sand extraction can be conducted and compared with the economic analysis of using dredged material from Brazos Santiago Pass as the source of sand for the beach replenishment project.

Two potential offshore sand deposits were identified on the basis of this preliminary qualitative sand resource evaluation (fig. 1). 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 15 to 25 ft. These sand deposits would be a primary target for beach replenishment sand since 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 cubic yards).

A secondary target for sand exploration would be the marine sand sheet that is projected offshore using the available foundation borings. This sand deposit potentially contains a large volume of sediment with a grain-size distribution compatible with the native beach sand. The marine sand is farther offshore and in deeper water than the ebb-tidal delta, and therefore costs associated with extraction would probably be higher.

RECOMMENDATIONS

The following recommendations are made considering the results of the preliminary assessment of sand resources offshore of South Padre Island.

- Conduct a preliminary economic analysis of each offshore site considering, among other factors, the water depths, potential quantity of sand, pumping distances, and availability of shallow-draft open-water dredging equipment.
- If either economic analysis is favorable, prepare a plan and cost estimate for exploratory field tests to determine the quality and quantity of offshore sand near the beach replenishment site.

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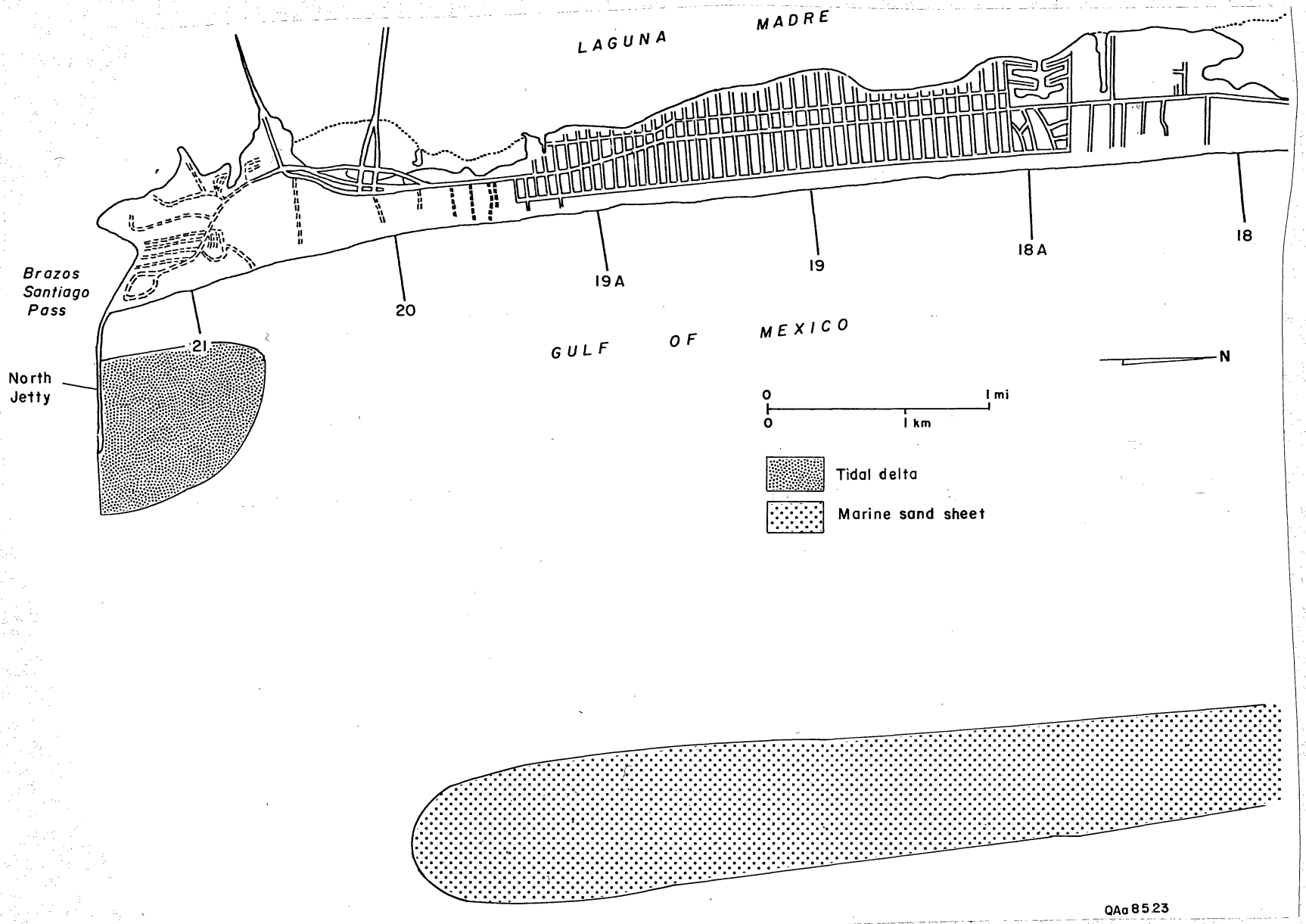

Figure 1. Index map of South Padre Island showing shoreline monitoring transects and locations of probable sand deposits.

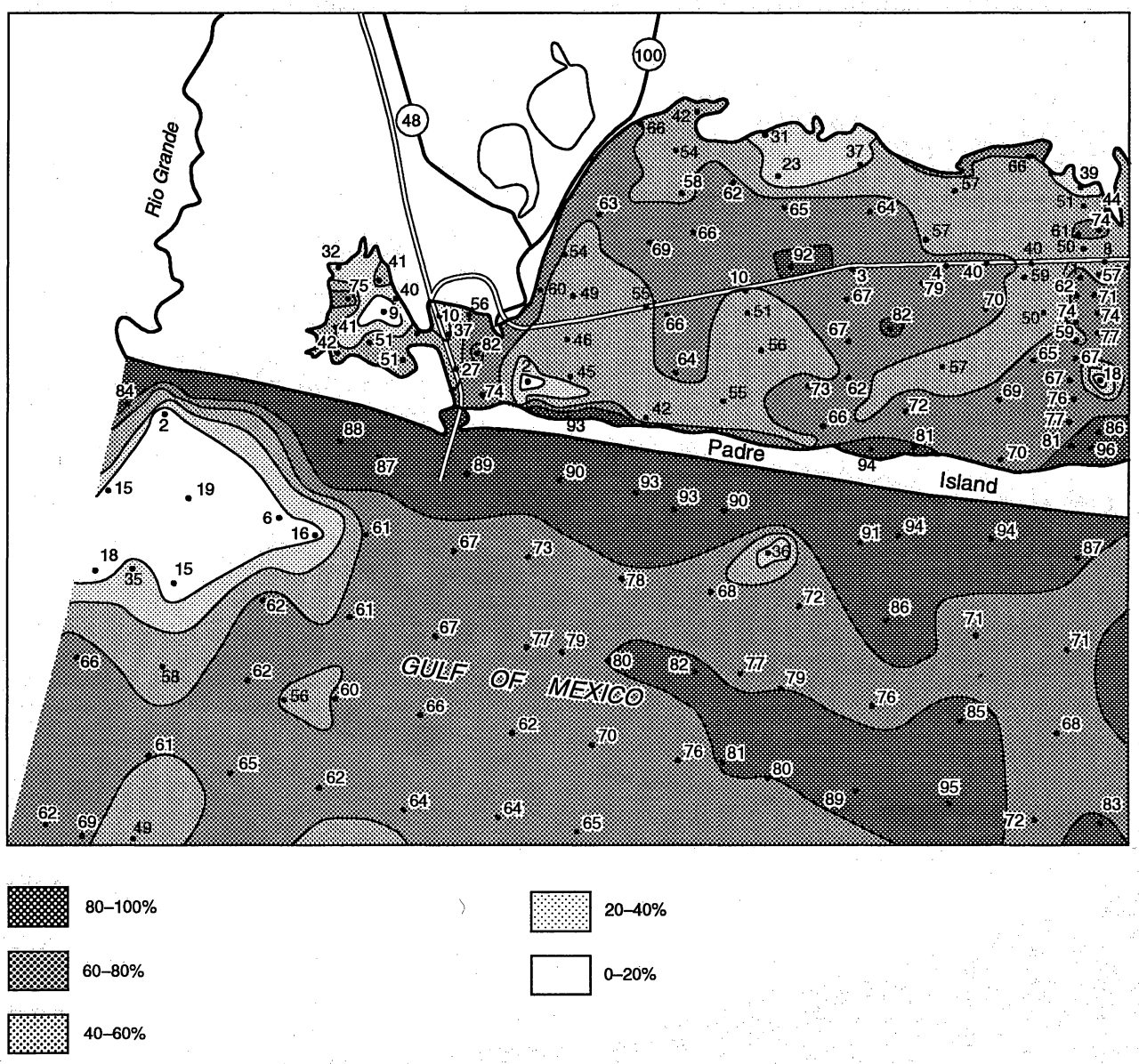

Figure 2. Map of percent sand in sediments offshore of South Padre Island as reported by White et al., 1986.

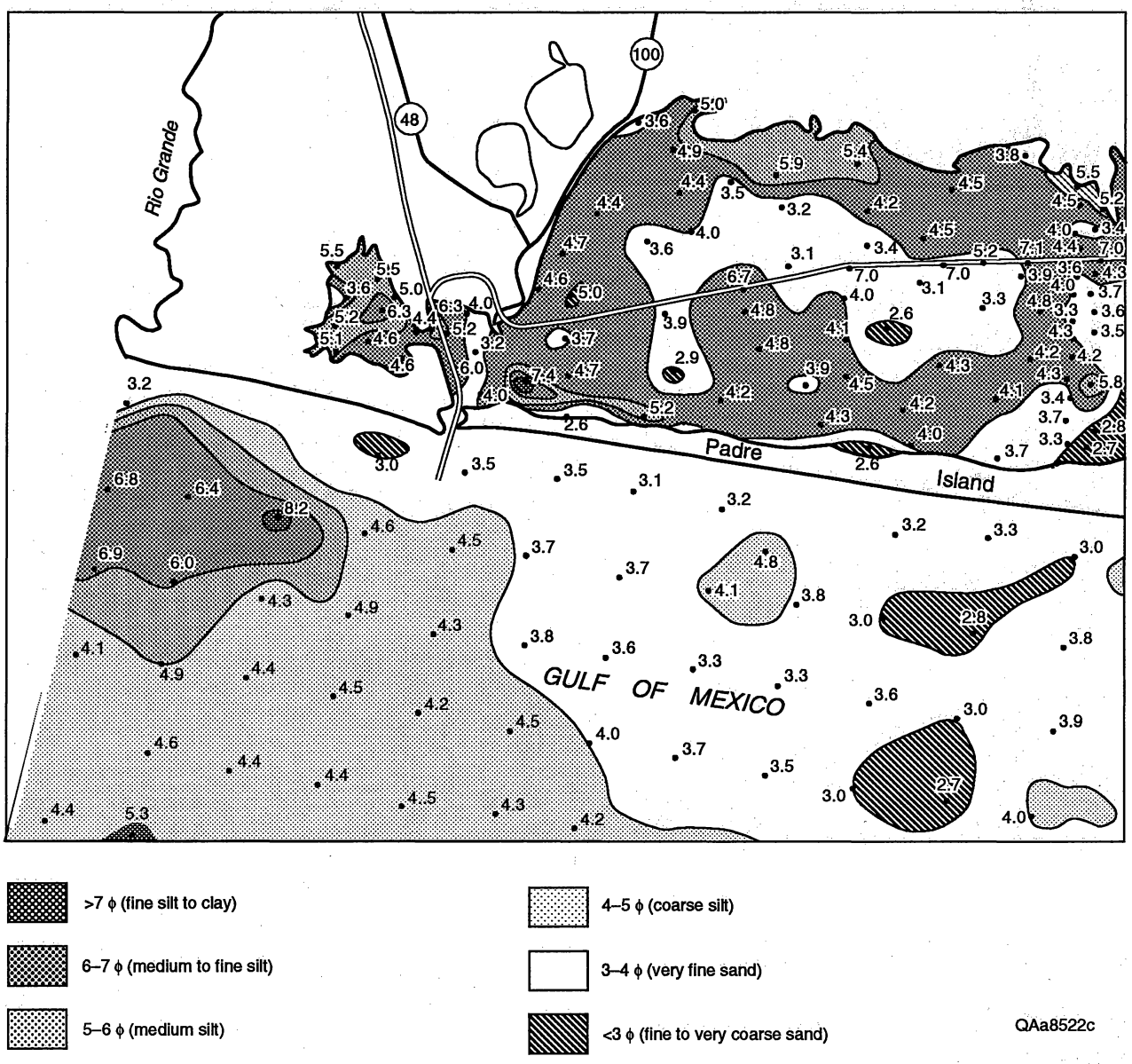

Figure 3. Map of average grain size of sediments offshore of South Padre Island as reported by White et al., 1986.

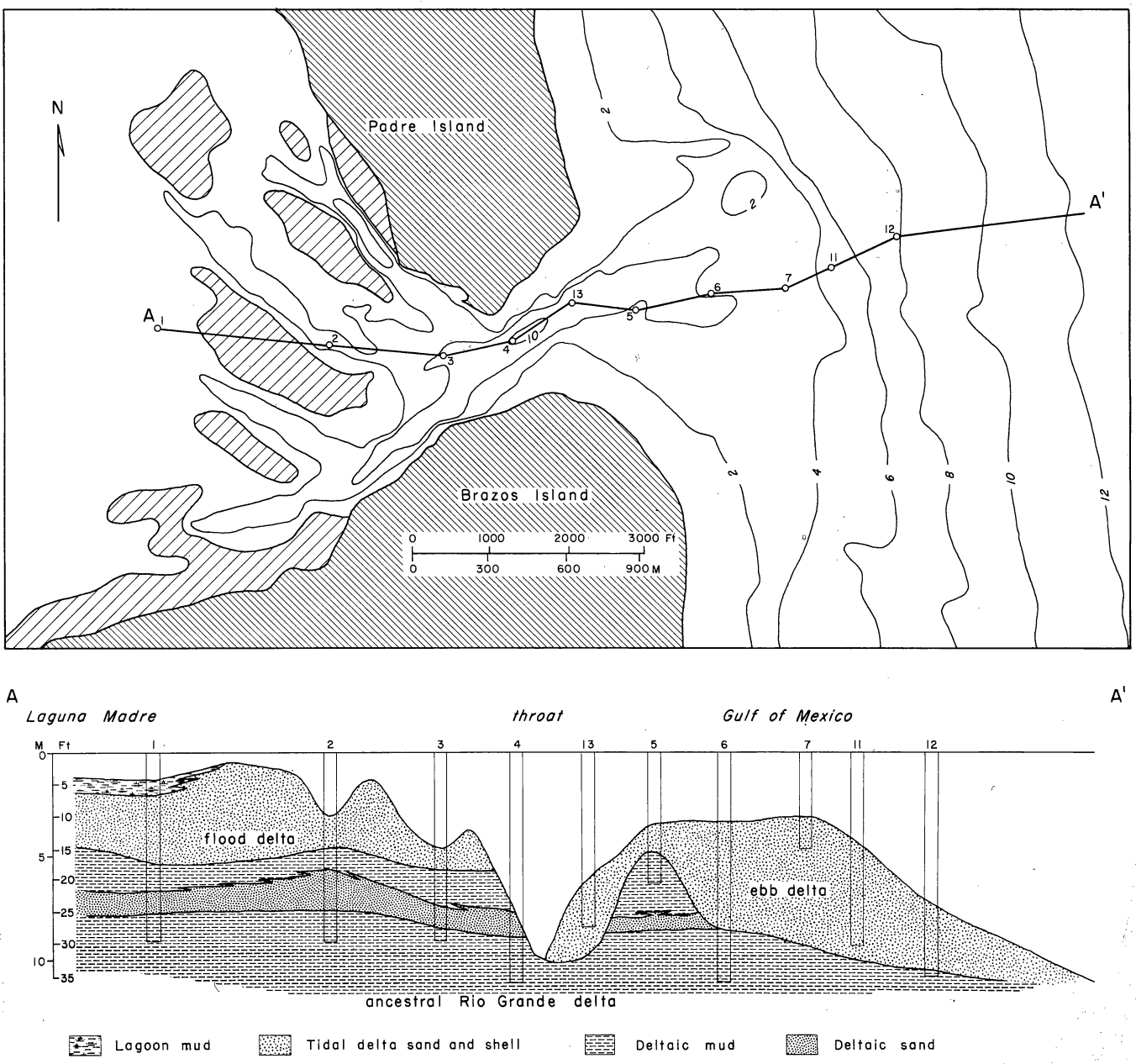

Figure 4. Location and thickness of tidal inlet and tidal delta deposits at Brazos Santiago Pass. The diagram depicts natural conditions in 1919 before the channel was enlarged and jetties were constructed. From Morton and McGowen, 1980.

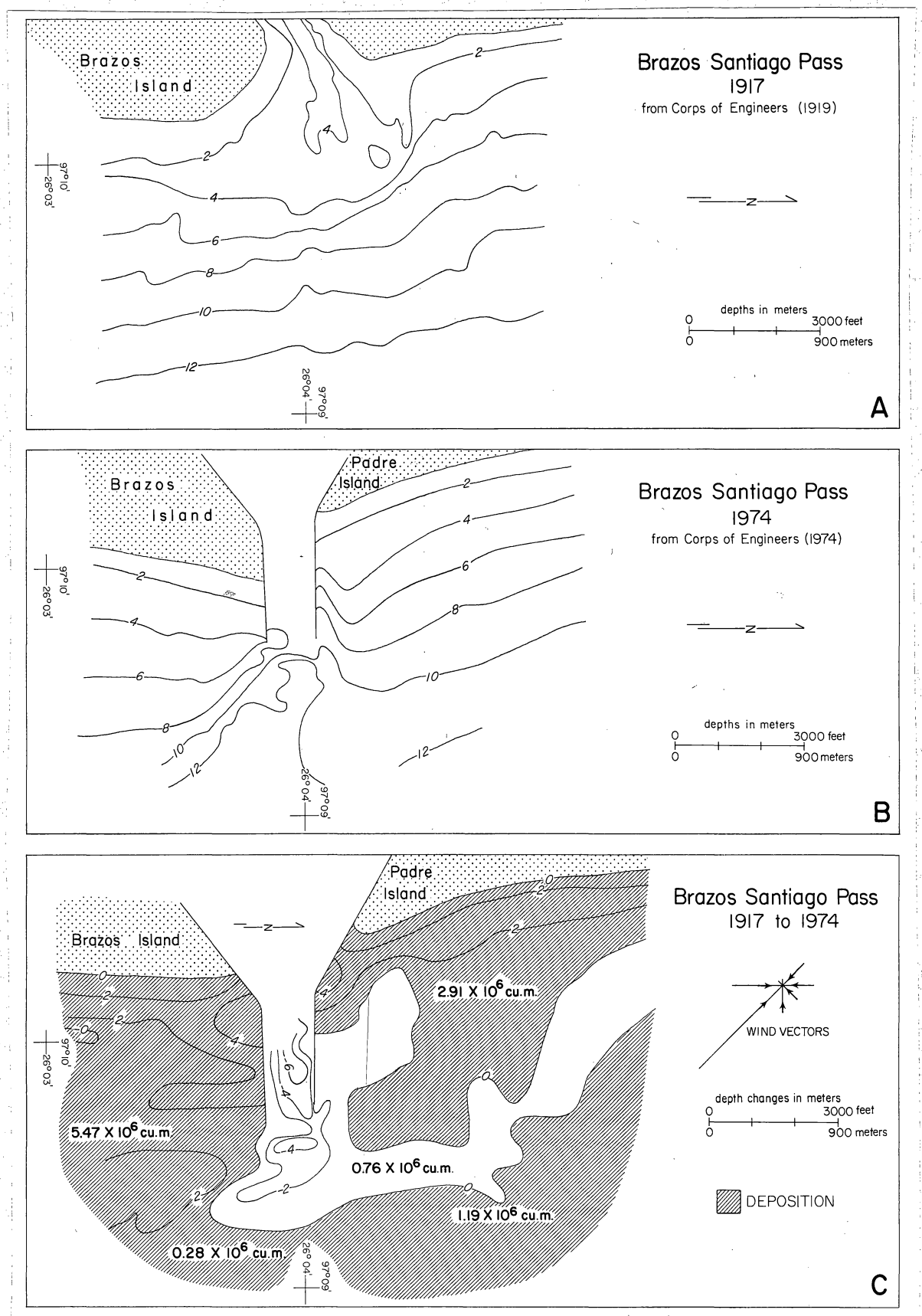

Figure 5. Changes in nearshore bathymetry and sediment volume related to construction of the jetties at Brazos Santiago Pass. From Morton, 1977.

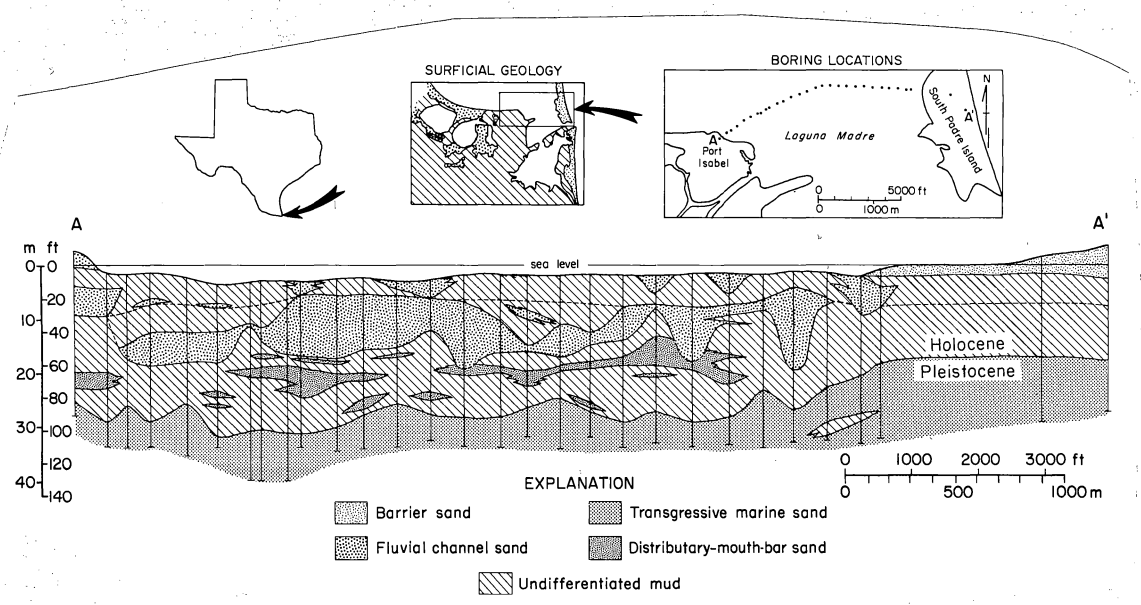

Figure 6. Detailed geologic cross section across Laguna Madre parallel to the Queen Isabella Causeway. From Morton and Price, 1987.

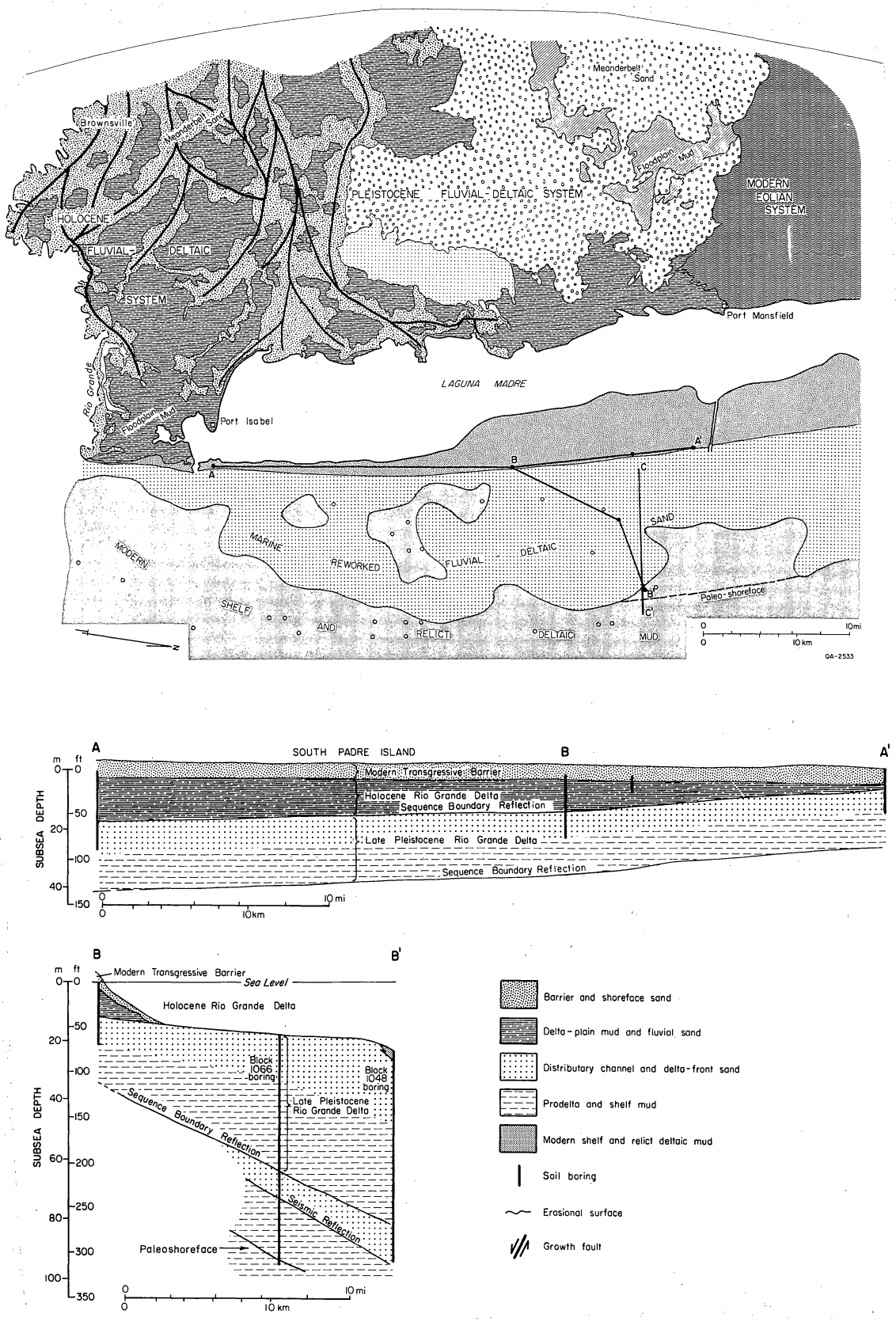

Figure 7. Regional geologic cross sections parallel and perpendicular to South Padre Island showing the inferred continuity of sand beds of the barrier island and the ancestral Rio Grande delta deposits. From Morton and Price, 1987.