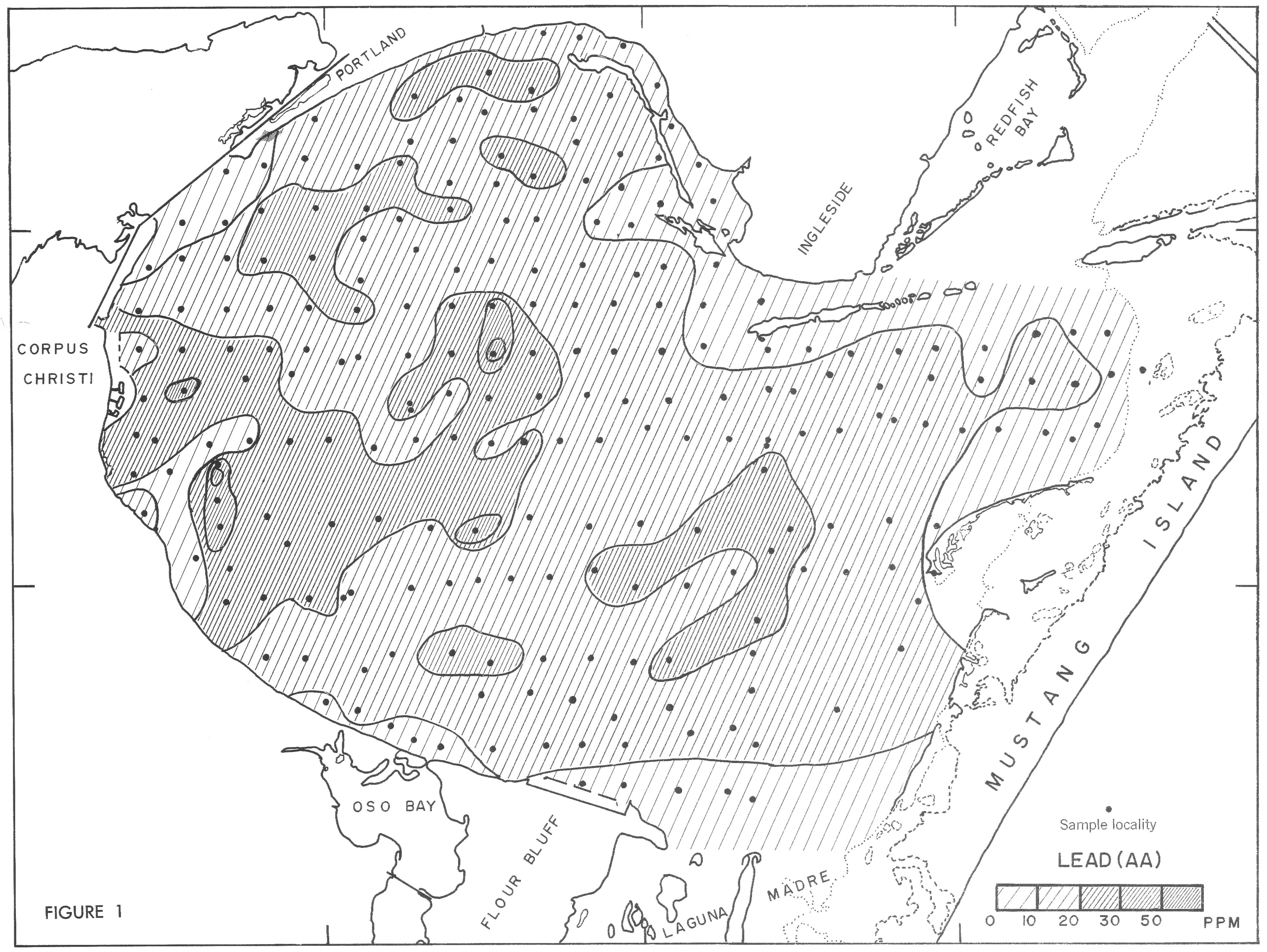

FIGURE 1

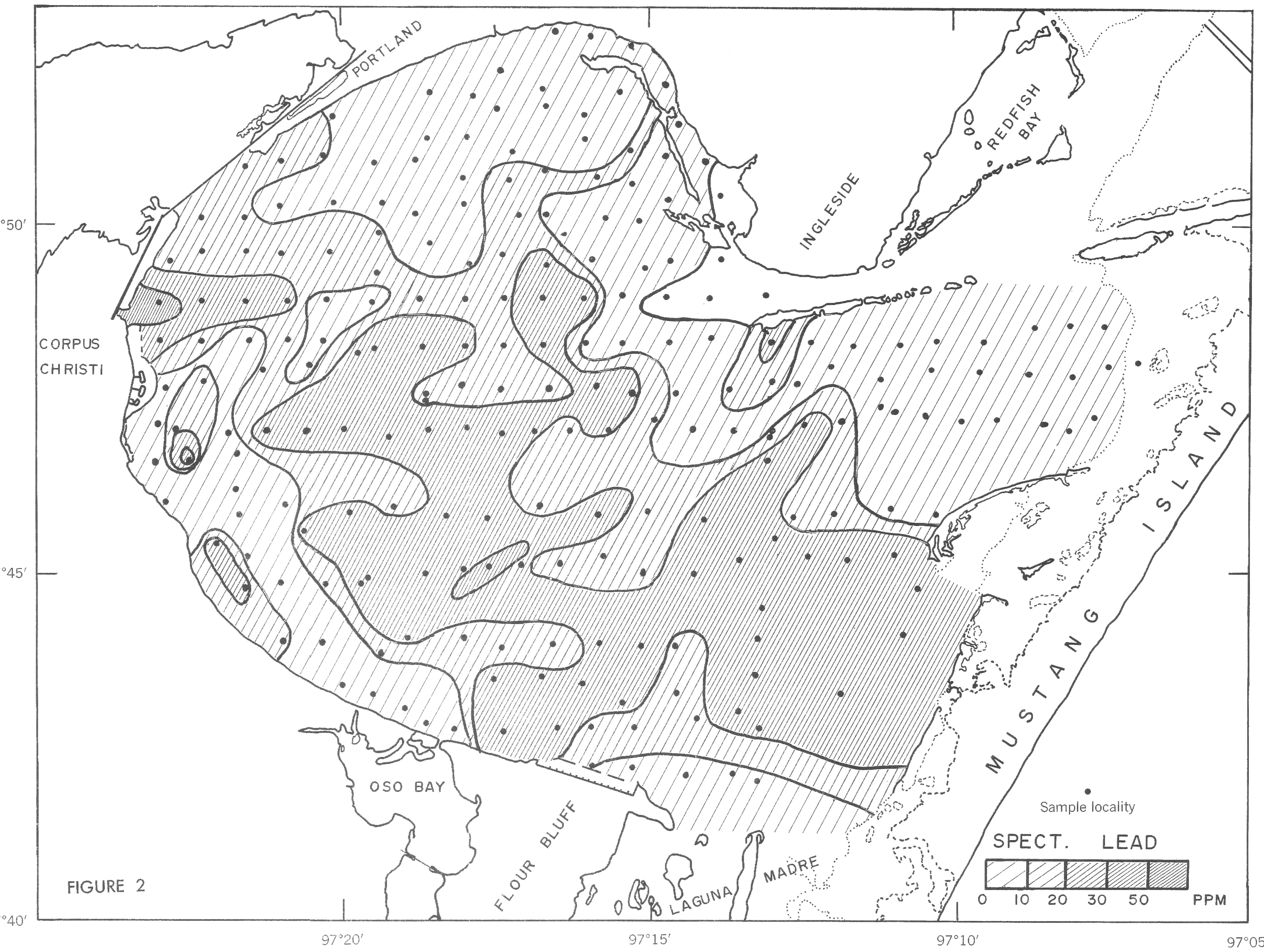

FIGURE 2

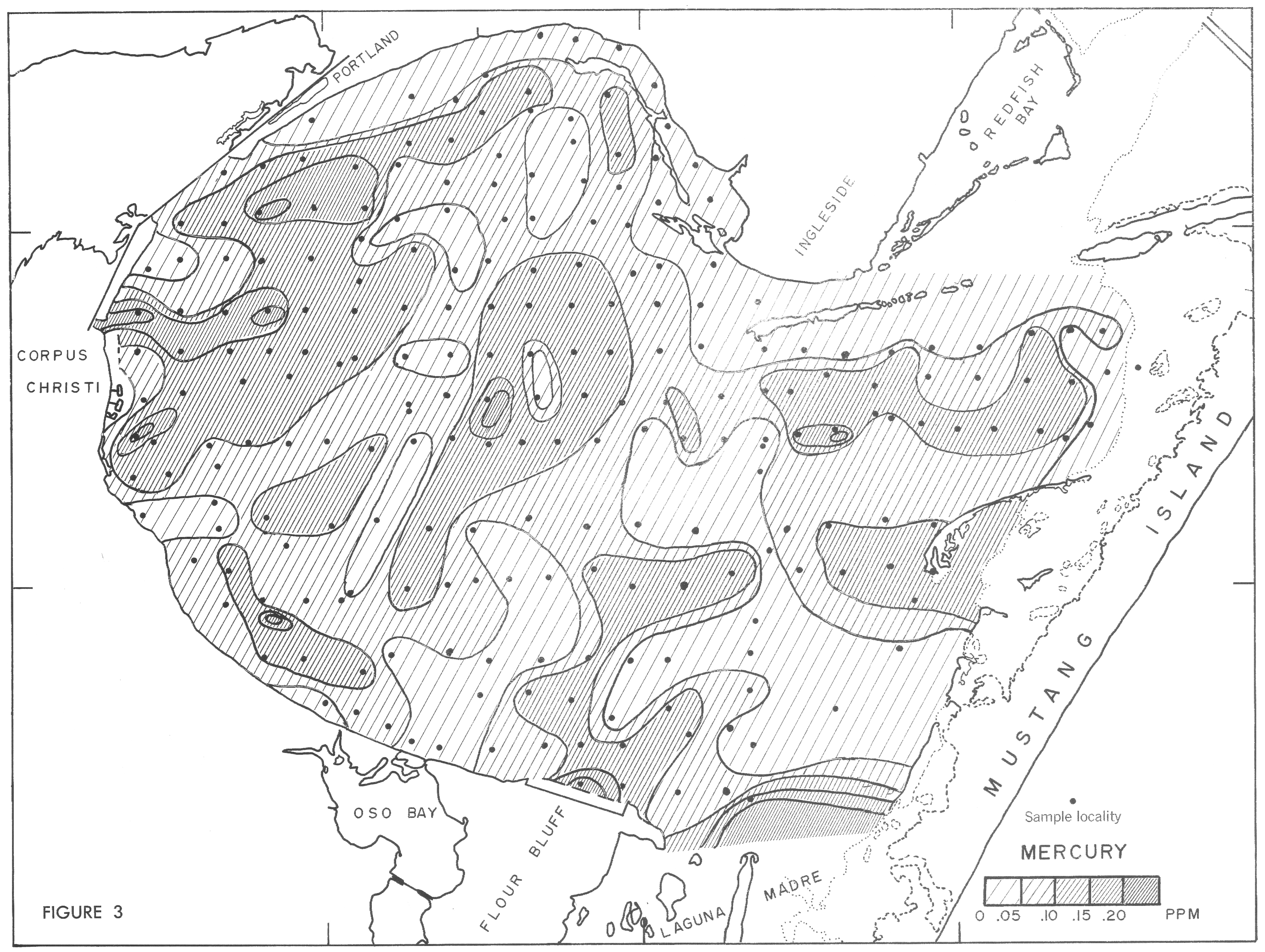

FIGURE 3

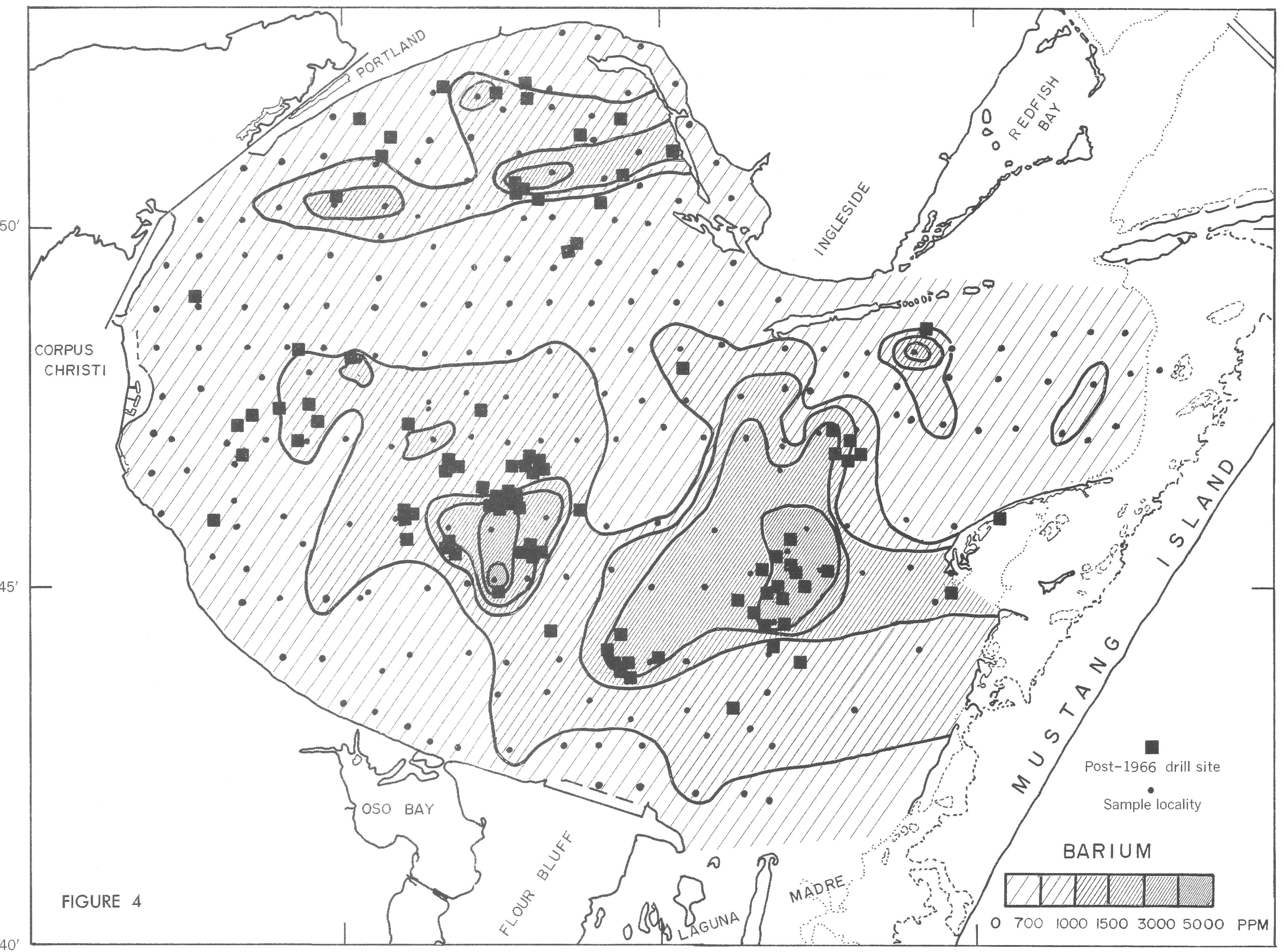

FIGURE 4

INTRODUCTION

Over the past few years much has been written and spoken concerning the increasing rate of man-derived pollution in the coastal zone. With more and more environmental stress being placed on this zone, answers are being demanded on how to cope with the degradation problems and manage this critical region to the greatest benefit of the environment. For most regions there is a total lack of data on which sound judgments can be made; where data are available, they are incomplete or questionable. The lack of sufficient data is extremely acute for determining the distribution and abundance of metals in the sediment and water in the coastal zone. In order to define the distribution of these potentially hazardous elements, information is needed on the temporal and spatial distribution of all elements in water, sediment, and biota of the coastal zone. This report gives the results of a survey of elements in the surface-bottom sediments (to a depth of 5 cm) of two estuarine systems of south Texas.

Corpus Christi Bay, averaging 4 m deep, is the deepest bay along the Texas coast. The bay is nearly equidimensional, with an area of approximately 300 km^2. In the central part of the bay, the sediments are fine silts and clays; on the shallow shelves rimming the bay, the sediments are fine sand. A ship channel 15 m deep and 123 m wide nearly bisects the bay and terminates in a narrow, 13-km long, landlocked harbor, along which the major petrochemical and other industries are located. Spreading from the harbor area along the shoreline of the bay are the urbanized centers of the cities of Corpus Christi, Portland, and Ingleside. Along with the urban development along the shores of the bay, the central part of the bay has been the site of oil exploration and drilling since 1948.

Baffin Bay, a shallow (2 m deep) Y-shaped bay, is separated from the Gulf of Mexico by a barrier island (Padre Island); the only communication with the gulf is through Laguna Madre. With the exception of the small fishing communities of Riviera and Loyola Beach, the bay lacks significant urban development. The only commercial development is in the form of oil and gas production within the bay and has been restricted to the junction of the three major arms of the bay. Comparison of elemental differences in the sediments of these two bay systems may demonstrate the effects of urbanization, if any.

METHOD

Two hundred eighty-eight sediment samples were taken in Corpus Christi Bay and 78 sediment samples from Baffin Bay were analyzed for 30 elements by semiquantitative methods (Grimes and Marranzino, 1968). These samples were taken by a Van-Veen sampler and represent a composite sample of the upper 10 cm of the sediment column in the bays. Samples were air dried and ground in a ceramic ball mill. The collection and handling of the samples were conducted so as to minimize potential laboratory contamination. This method yields precision that is generally within ±50 percent variability; repeat values range from ½ to 3/2 times the first reported value (Peterson and others, 1972).

Mercury was determined in the samples from Corpus Christi Bay by flameless-vapor atomic-absorption techniques (Vaughn, 1967). Acid-soluble lead, zinc, and cadmium were determined for the Corpus Christi Bay samples by standard atomic-absorption techniques (J. Negri, U.S. Geological Survey, written commun., 1973). The total organic carbon content was determined by ignition method for the Baffin sediments and by a titration method for the samples from Corpus Christi Bay (Gross, 1971). Size analyses were by the standard settling techniques as outlined by Galehouse (1971).

DISCUSSION

The results of the semiquantitative analyses are in table 1 which lists the analytical resolution (the lower limit of determination), the geometric mean, range, and mode for the elements in Corpus Christi Bay and Baffin Bay sediments. Where the ratio of the modal value of an element to that of the value for the analytical resolution approaches one, the reliability of the element for comparative purposes is low (Peterson and others, 1972). Only 12 elements (B, Ba, Ca, Cr, Fe, Mg, Mn, Ni, Pb, Ti, V, Zr) have modal values greater than three times the analytical resolution and are considered to be useful. Of these 12 elements, only the concentrations of boron, calcium, nickel, lead, vanadium, and zirconium differ significantly between the two bays. In sediments of Corpus Christi Bay, boron, calcium, lead, and vanadium are higher; nickel and zirconium are higher in Baffin Bay. Boron and lead are apparently anthropogenic, for example, boron is a component of detergents; lead is an element associated with urbanization and industrialization especially from gasoline combustion. Calcium, on the other hand, not considered a pollutant, is high in Corpus Christi Bay due to the abundance of shell material within the sediment, particularly in the regions of soil deposition along the dredged channels. In Baffin Bay, the zirconium is derived from the zirconium-rich sediment surrounding the bay. The higher nickel content in Baffin Bay appears to be associated with the high organic content in the sediments of the bay, as shown by the high statistical correlation of nickel and organic content (table 3). The significance of the higher lanthanium content of Baffin Bay is not known, but the weak correlation, however, with barium suggests a similar origin.

Figures 1 and 2 show the distribution of acid-leached lead (determined by atomic-absorption methods--AA) and spectrographically determined lead. The acid-leached lead is that lead entering the bay in the form of various pollutants along with minor amounts of soluble lead from natural sources. The spectrographically determined lead is a measure of the total lead. The salient feature of these maps is the concentration of lead near the harbor which tails off to the south and east. Lead is also found to be high in samples taken near storm drains from the City of Corpus Christi, pointing to automotive-derived atmospheric lead washed from the city during heavy rains. The pattern of spectrographically determined lead also reveals a high concentration near the harbor entrance, as well as a high correlation with the distribution of fine, unctuous mud in the bay. The distribution of mercury also gives an indication of input to the bay from the harbor, where high amounts have been measured (fig. 3). However, the pattern of mercury in the sediments of the rest of the bay reveals no clear source(s). One of the most interesting distribution patterns is that of barium (fig. 4). A plot of drill sites for wells which have been drilled since 1966 overlayed on the barium distribution shows that a strong correlation exists between the density of drill sites and barium concentration in the mud. Sites which fall outside the areas of high concentration are either the oldest or are in the area of greatest sedimentation. The remaining elements in Corpus Christi Bay, with the exception of zinc and cadmium which are anomalously high near the harbor, grading to background levels near Ingleside (Holmes and others, 1974), show no discernible pattern. The average values for zinc and cadmium are given in table 4.

In Baffin Bay, the distribution of all elements measured with the exception of the calcium and strontium "couple" is similar (figs. 5, 6). Iron, which has a strong to moderate correlation with the transition metals is shown to represent the distribution pattern of these elements. Strontium along with calcium, shows a strong negative correlation with the other elements and is representative of the calcium-strontium pair. Iron and its associated elements have highest concentrations in the center of the basin. Strontium (and calcium) is directly related to the distribution of beach rock and other carbonate deposits formed within the bay.

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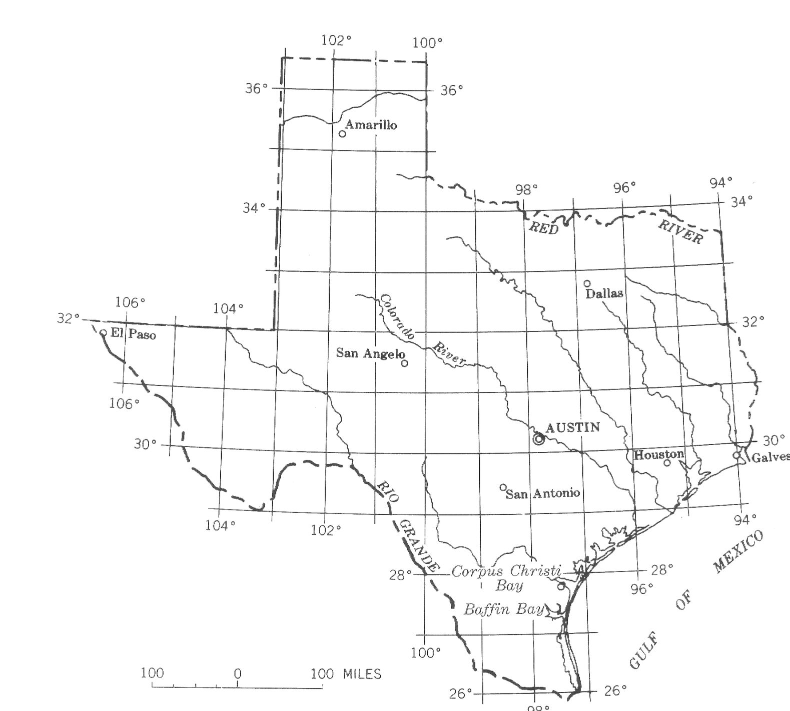
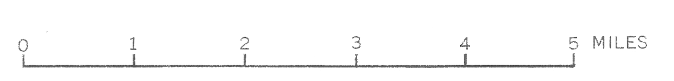


Index map

Base from U.S. Coast & Geodetic Survey Chart 523 (1967)



MAPS SHOWING DISTRIBUTION OF SELECTED ELEMENTS IN SURFACE-BOTTOM SEDIMENT OF CORPUS CHRISTI AND BAFFIN BAYS, TEXAS

By

Charles W. Holmes

1974