HYDROCHEMICAL CHARACTERIZATION OF SALINE AQUIFERS OF THE TEXAS GULF COAST USED FOR DISPOSAL OF INDUSTRIAL WASTE

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EXECUTIVE SUMMARY

Disposal of toxic chemical wastes into geologic formations in the deep subsurface and the number of disposal wells used has increased sharply during the last 30 years. In Texas, permits for more than 200 waste disposal wells, which accept approximately 16 percent of the chemical wastes generated in the United States, were issued by the Texas Department of Water Resources during this period (Knape, 1984). Most injection operations use porous, saline sandstone aquifers along the Texas Gulf Coast, namely Frio, Yegua, Catahoula, Oakville, Wilcox, and undifferentiated Miocene sandstones. Injection occurs within a depth range of 2,000 to 8,500 feet below land surface, where these units constitute salt-water aquifers, with most injection zones within a range of 4,000 to 7,000 feet. Between 1961 and 1981 an estimated total of 66 billion gallons of industrial waste was injected into these zones. Yearly total injection during the late 1970's and early 1980's averaged approximately 6 billion gallons (Knape, 1984). Simultaneously, fresh ground water is recovered from shallower, updip sections of these aquifers. Therefore, integrity of disposal zones is of importance both on a statewide and on a nationwide level.

Waste injected into subsurface formations may react with formation fluid or formation material, depending on the chemical and physical nature of the phases involved. Aquifer material may dissolve or mineral matter may precipitate, thus changing original compositions of disposal zones. It is desirable to predict these changes to assure successful operation of injection practices. To satisfactorily evaluate suitability of deep-well injection into Gulf Coast formations, hydrochemical and hydrogeological parameters of these aquifers are currently under study by the

Bureau of Economic Geology, The University of Texas at Austin. This report represents the first stage of the characterization of saline aquifers in the Gulf Coast that are used for industrial waste disposal and summarizes geochemical parameters of disposal zones.

Approximately 1,300 chemical analyses from major disposal units along the Texas Gulf Coast were selected from existing literature for characterization of chemical parameters of formation waters. Most of the brines are of the NaCl type. Some Frio, Vicksburg, and Wilcox waters in South Texas are extremely rich in calcium, having concentrations of up to 40,000 mg/L, and represent a second water type (NaCaCl brine). Salinities vary laterally and vertically, ranging from less than 10,000 mg/L to greater than 250,000 mg/L. Most waters have salinities in the range of 30,000 to 80,000 mg/L. Dissolution of salt from salt domes accounts in part for high salinities in brines along the upper Gulf Coast. In contrast, mixing between fresh water and brine may cause some of the low-saline waters at depths between 4,000 and 9,000 ft below land surface along the lower Gulf Coast. Magnesium and sulfate concentrations in Gulf Coast brines generally are very low. High contents of organic acids probably account for the extremely high alkalinities, which are reported in concentrations of up to several thousands of mg/L. Bicarbonate seems not to be the major contributing component of alkalinity in Gulf Coast brines. Acidity or pH values of Gulf Coast brines reported in the literature probably overestimate in situ pH values by 1 to 3 units. The most likely range of pH values is between 4.0 and 6.0.

Because of uncertainties in pH, bicarbonate concentrations, and temperatures, estimates of mineral stabilities with chemical equilibria programs such as SOLMNEQ, PHREEQE, or WATEQ were not made. Low sulfate concentrations, the presence of organic acids, degradation of organic acids by anaerobic bacteria, upward flow of reducing ground water in areas of shallow mineralization trends in South Texas, and calculations of redox potentials of deep-basin brines indicate reducing conditions in the deep subsurface along the Gulf Coast.

Mineralogy and rock chemistry of major Tertiary units along the Gulf Coast are surprisingly uniform, although percentages of chemical constituents vary through a wide range within individual units. Quartz is the major component of sandstones, having percentages of up to 95 percent of total rock constituents. Feldspar and rock fragments generally are between 5 to 50 percent of total rock. In general, calcite and smectite percentages decrease with depth, whereas illite and shale contents increase with depth.

INTRODUCTION

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Waste injected into subsurface formations may react with formation fluid or formation material, depending on the chemical and physical nature of the phases involved. Aquifer material may dissolve or mineral matter may precipitate, thus changing original compositions of disposal zones. It is desirable to predict these changes to assure successful operation of injection practices. To satisfactorily evaluate suitability of deep-well injection into Gulf Coast formations, hydrochemical and hydrogeological parameters of these aquifers are currently under study by the

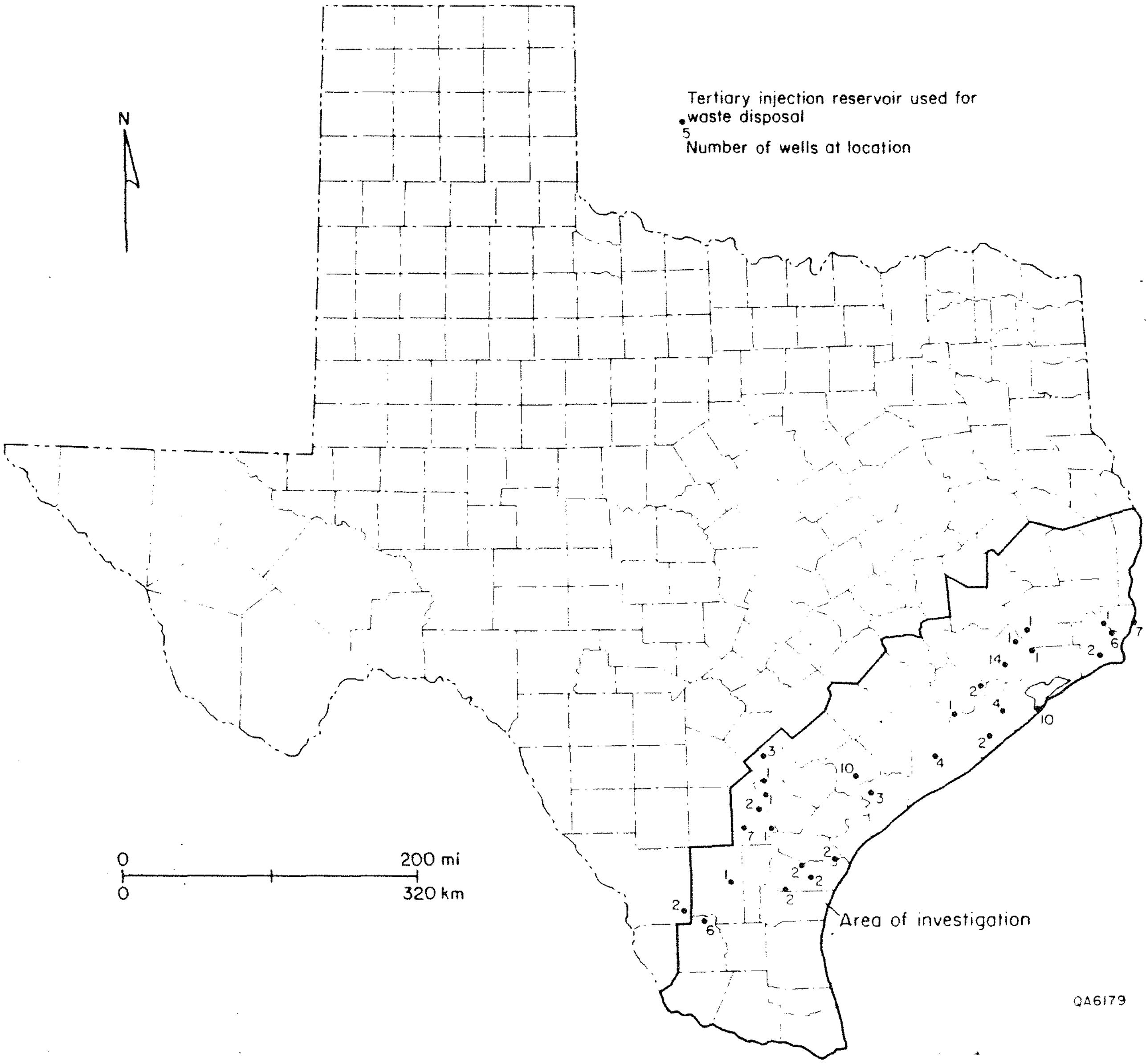


Figure 1. Location map of area of investigation and of industrial waste disposal wells along the Texas Gulf Coast, as of 1983 (after Knape, 1984).

Bureau of Economic Geology, The University of Texas at Austin. This report represents the first stage of the characterization of saline aquifers in the Gulf Coast that are used for industrial waste disposal and summarizes geochemical parameters of disposal zones.

Deep-well Injection Along the Texas Gulf Coast

Toxic chemical wastes are currently being injected into deep, saline sections of aquifers belonging to the following Tertiary units: Oakville, Catahoula, and Frio Formations, undifferentiated Miocene Series, Yegua Formation, and Wilcox Group (table 1). Injection into Frio and younger units dominates along the middle and upper Gulf Coast, whereas Yegua and Wilcox sandstones are utilized in South Texas (fig. 2). Most injection operations use Miocene, Frio, Yegua, and Catahoula aquifers (table 2). Depths of disposal zones range from 2,000 to 8,250 ft below land surface, but normally occur below 3,000 ft in a range of mean depths from 3,850 to 6,700 ft. Between 1961 and 1981 an estimated total of 66 billion gallons of industrial waste was injected into these zones (fig. 3). Yearly total injection during the late 1970's and early 1980's averaged approximately 6 billion gallons (Knape, 1984).

A wide variety of manufacturing processes is responsible for the accumulation of chemical waste, such as production of plastics, detergents, paints, solvents, preservatives, synthetic fabrics, pesticides, and drugs (Klemt, in press). Some of the by-products of these processes are highly toxic and non-biodegradable, whereas others are less toxic and biodegradable.

Geologic and Hydrogeologic Setting of Gulf of Mexico Sedimentary Basin

Unconsolidated Tertiary sandstones in the Oakville, Catahoula, undifferentiated Miocene, Frio, Yegua, and Wilcox aquifers are the sedimentary units used as

Table 1. Stratigraphic units of part of the Coastal Plain of Texas (from Baker, 1979).

Era	System	Series	Group	Stratigraphic Units	Stratigraphic Units (Member / Subsurface)
CENOZOIC	Quaternary	Holocene		Alluvium	
		Pleistocene		Beaumont Clay	
				Montgomery Formation	
				Bentley Formation	
				Willis Sand	
	Tertiary	Pliocene		Goliad Sand	
		Miocene		Fleming Formation	
				Oakville Sandstone	
				Surface: Catahoula Tuff or Sandstone	Subsurface: Upper part of Catahoula Tuff or Sandstone
					Anahuac Formation
					"Frio" Formation
		Oligocene(?)		Surface: Frio Clay	Subsurface: Vicksburg Group equivalent
		Eocene	Jackson Group	Whitsett Formation	Fashing Clay Member
					Calliham Sandstone Member or Tordilla Sandstone Member
					Dubose Member
					Deweesville Sandstone Member
					Conquista Clay Member
					Dilworth Sandstone Member
				Manning Clay	
				Wellborn Sandstone	
				Caddell Formation	
			Claiborne Group	Yegua Formation	
				Cook Mountain Formation	
				Sparta Sand	
				Weches Formation	
				Queen City Sand	
				Reklaw Formation	
				Carrizo Sand	
			Wilcox Group		
		Paleocene	Midway Group		

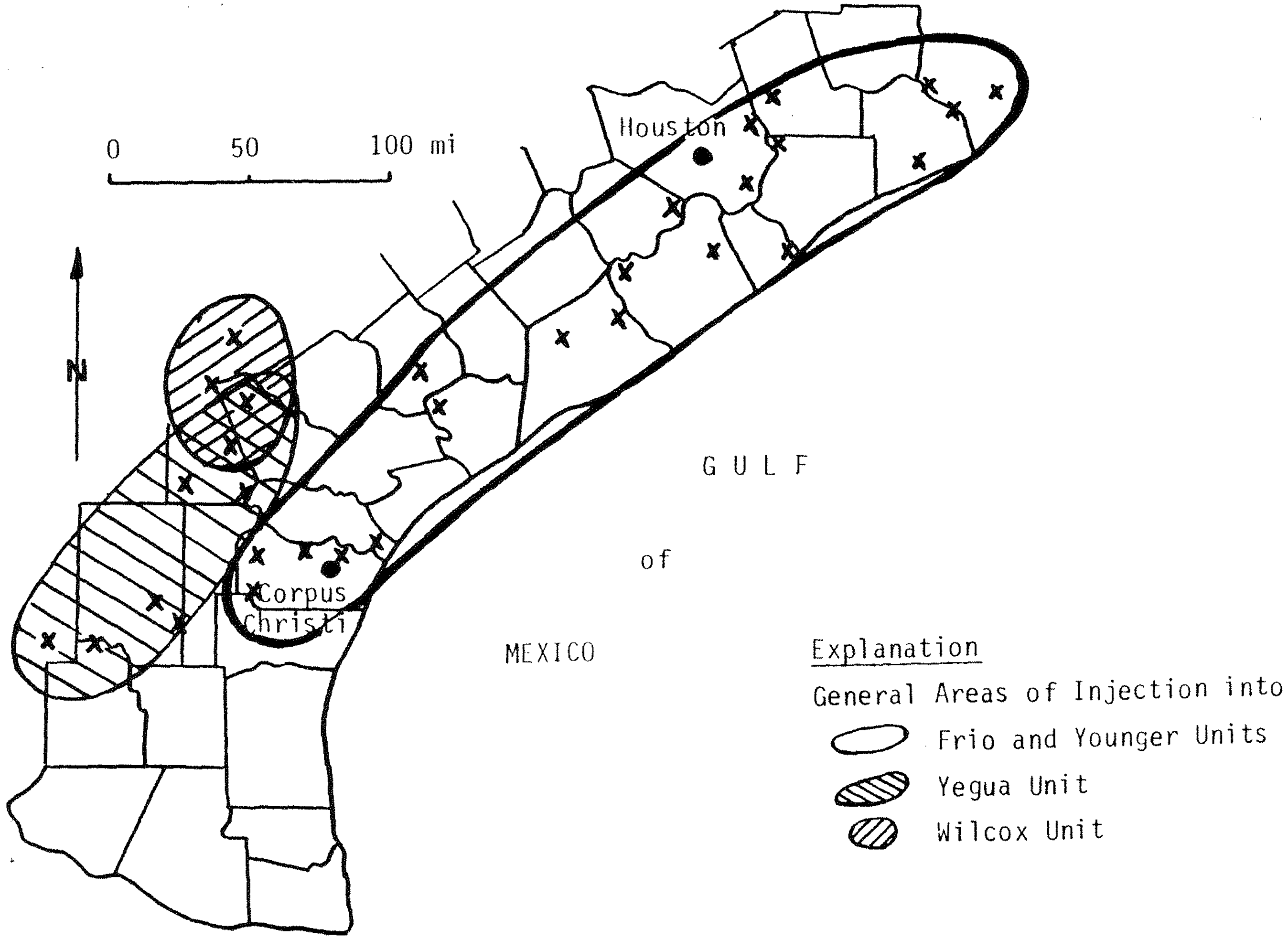


Figure 2. Areal distribution of major disposal zones.

Table 2: Disposal units and depth of injection zones in reservoirs along the Texas Gulf Coast (modified from Knape, 1984).

Aquifer	No. of wells	Depth (ft)	Mean depth (ft)
Undifferent. Miocene	41	2,000 - 7,550	5,100
Frio	23	6,900 - 8,250	6,700
Yegua	20	2,900 - 6,600	4,200
Catahoula	14	3,000 - 7,400	4,450
Oakville	7	3,000 - 4,800	3,850
Wilcox	4	5,600 - 7,600	6,500

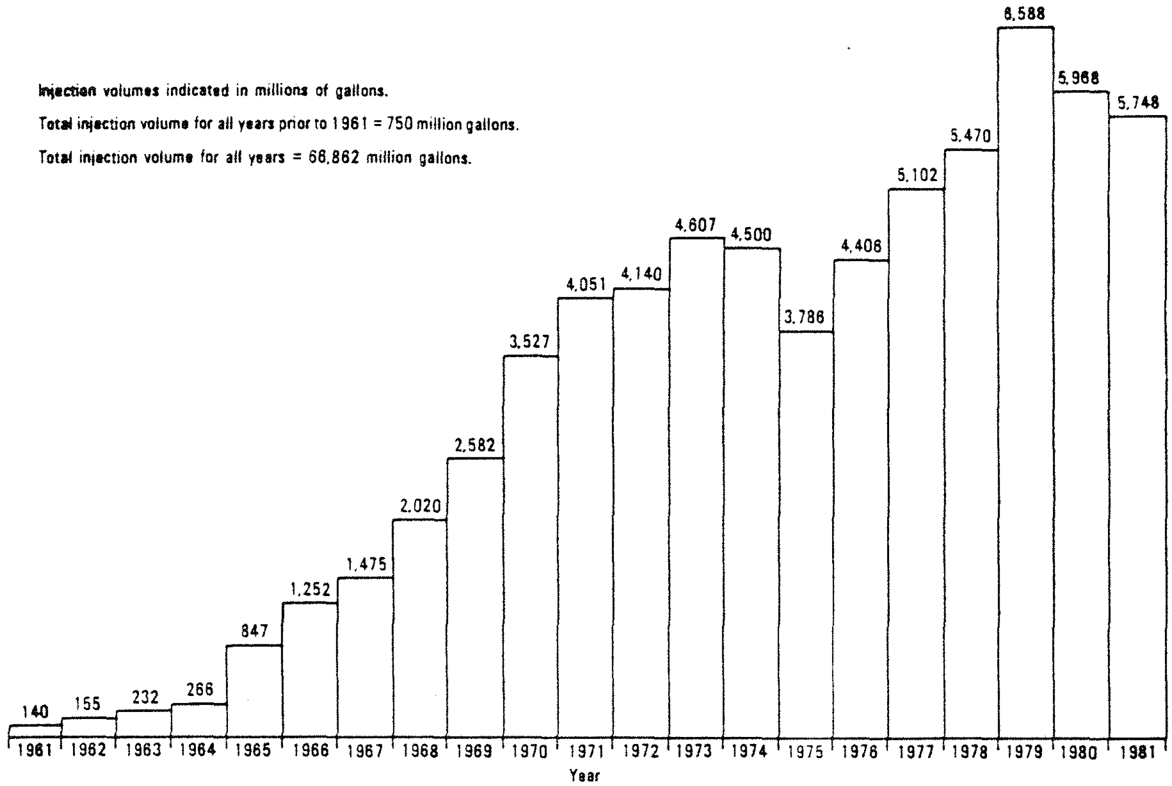


Figure 3. Yearly total injection volumes of industrial waste in Texas (from Knape, 1984).

disposal reservoirs (tables 1 and 2). They constitute part of a larger sedimentary wedge of sands and shales, referred to as the Gulf of Mexico sedimentary basin, that have been deposited continuously for the last 70 million years. Each sandstone unit extends from outcrop (where these sandstones constitute fresh-water aquifers) to depths greater than 10,000 ft off the Texas coast (fig. 4). Some sandstones are continuous and may have good hydrologic continuity from outcrop to great depth, whereas other sandstones are discontinuous because of lithologic changes or fault barriers and thus have poor hydrologic continuity. The downdip part of these sandstones contains numerous oil and gas fields as well as the zones used for deep-well injection.

Ground waters in the Gulf of Mexico aquifers are considered to have two origins: meteoric ground waters, which are recharged by precipitation into shallow aquifers, and formation waters, which were incorporated into the strata when the sediments were originally deposited (Kreitler, 1979). Three hydrologic regimes occur for these two types of ground water in this large sedimentary basin (fig. 5). (1) A fresh meteoric section forms the uppermost ground-water regime. Within this regime, surface waters infiltrate permeable strata and ground-water flow is directed toward the basin center. Depths to the lower boundary of this system vary from 0 to several thousand feet below land surface. (2) The underlying hydrostatic section is characterized by expulsion of water from sediments due to compaction. Hydraulic connection between the hydrostatic and the meteoric sections prevents excessive pressure build-ups within the hydrostatic zone. (3) In the underlying section, restricted drainage conditions at greater depths hold fluids that would otherwise escape due to overburden pressures. This causes abnormally high fluid pressures within the zone, which is also known as the overpressured or geopressured zone. The waters within the saline hydrostatic zone generally have been assumed to be

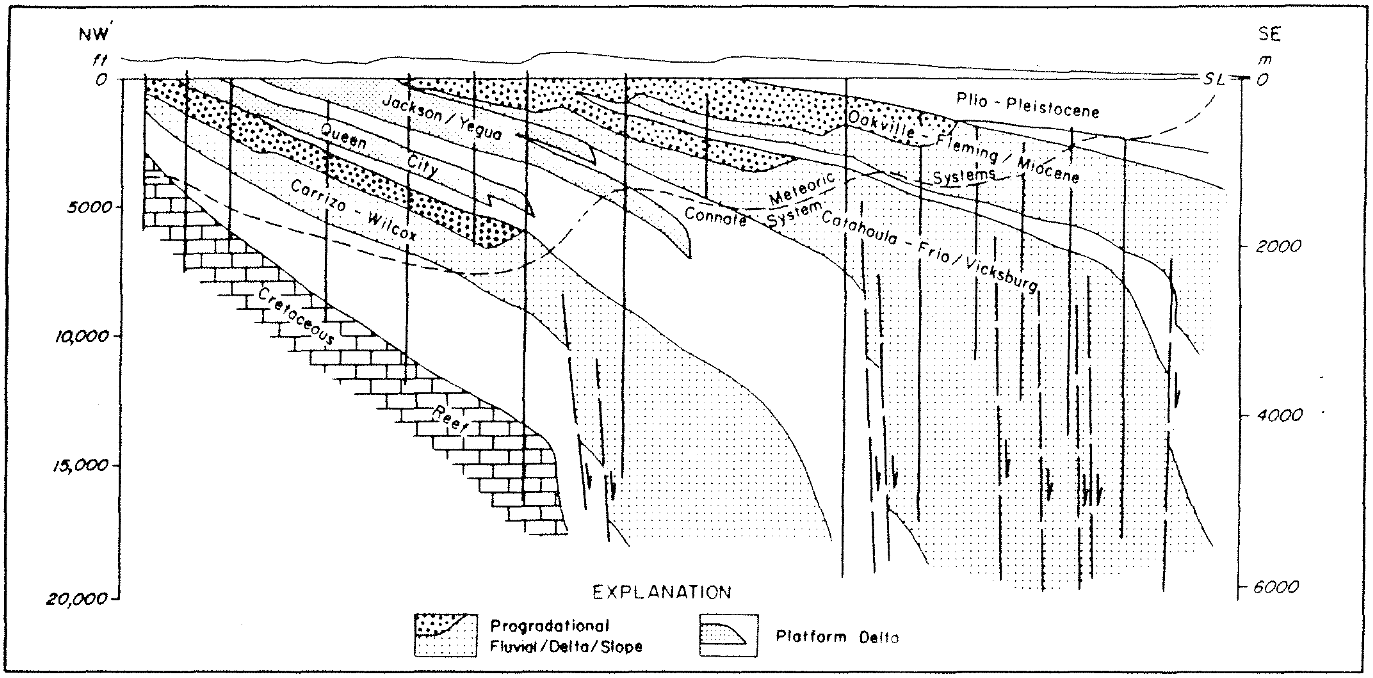


Figure 4. Generalized stratigraphic cross section, Gulf of Mexico (from Galloway and others, 1982).

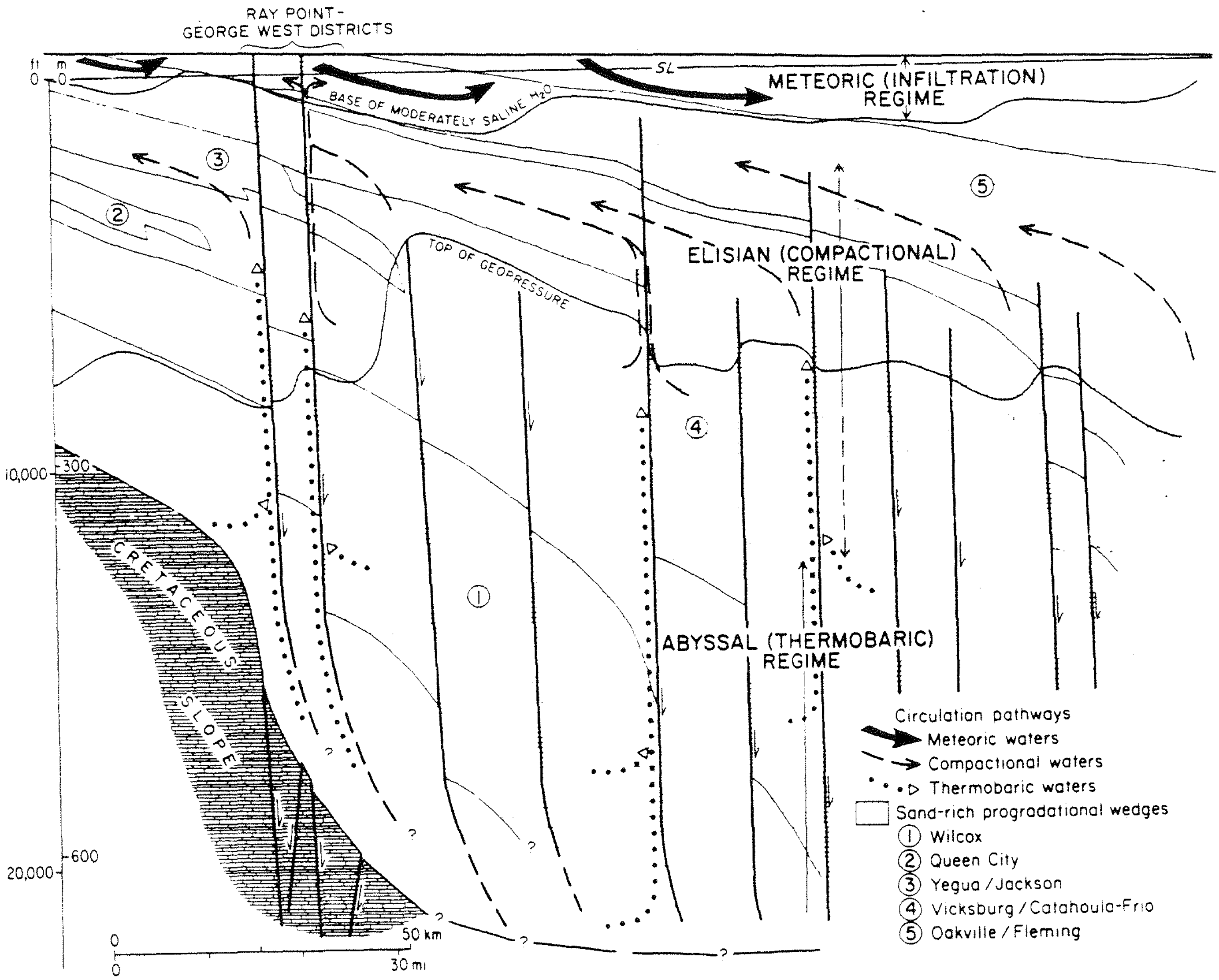


Figure 5. Ground-water regimes and circulation pathway within the Tertiary basin fill of the northwestern Gulf Coast Basin (modified from Galloway, 1982).

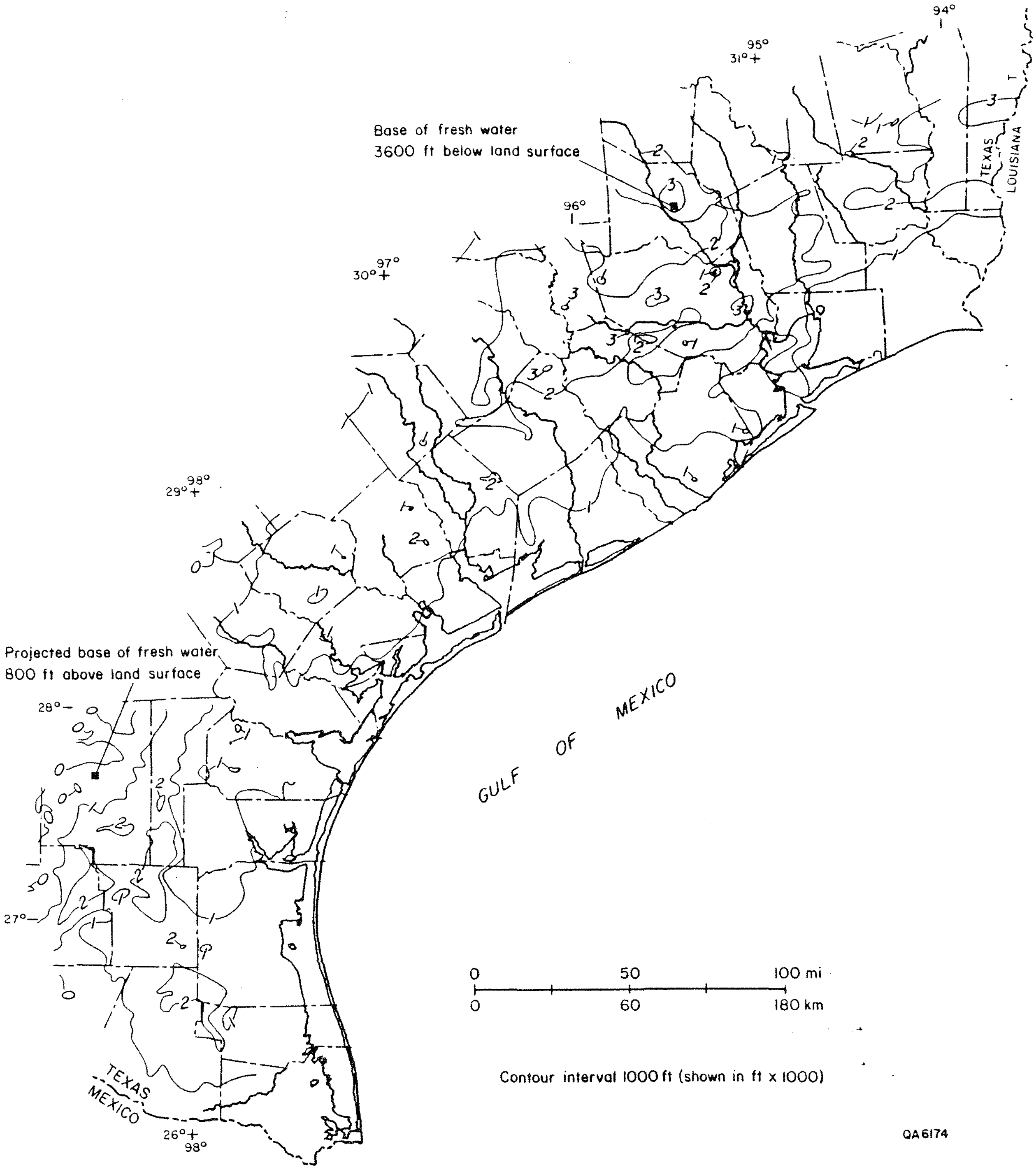


Figure 6. Base of fresh to slightly saline water along the Texas Gulf Coast (after Wood and others, 1963).

original formation waters or at least several million years old and hydrologically static. However, there is little hydrologic documentation of these assumptions.

Hydrochemical and isotopic data suggest that the hydrodynamics of this saline aquifer system are more complex than is generally assumed for both the deep, saline formation waters and the shallow, meteoric waters. The Gulf Coast sedimentary basin is considered to be a compacting basin. Because of compaction of thick shales by the weight of the overburden, original saline formation waters slowly migrate up and out of the basin. This process is observed through the discharge of saline waters into both shallow and fresh-water aquifers in sandstone and limestone (Galloway, 1982; Senger and Kreitler, 1984).

There are indications that meteoric, fresh ground waters have penetrated deep into the saline sections of the Gulf Coast Basin. However, the depth of this penetration is not well known. Bachman (1979) reported the average depth of fresh water along the Gulf Coast at 2,000 ft below land surface. A contour map that illustrates the depths to the base of fresh to slightly saline water for the Gulf Coast region indicates penetration of fresh water to depths exceeding 3,500 ft below land surface in Montgomery County (fig. 6). In contrast, artesian conditions of saline aquifers underlying Duval County cause the base to be at land surface. Mixing between fresh, meteoric ground water and brine results in saline ground water and thus the depth of fresh water does not necessarily depict the depth to which meteoric water has penetrated. Carothers and Kharaka (1978) reported low contents of organic acids in Gulf Coast brines at temperatures less than 80°C, which corresponds to depths less than approximately 6,000 ft below land surface. Detailed analyses of organic components led them to the conclusion that only mixing between meteoric water low in organics and deep-basinal brine rich in organics can explain the observed composition. Recent investigations of the isotopic composition of saline waters in parts of the Gulf Coast sedimentary basin indicate an intrusion of meteoric ground waters to even greater depths. Fisher (1982) and Lundegard (1985) identified extensive penetration of isotopically depleted water (which can be interpreted to be meteoric in origin) to depths of up to 10,000 ft below land surface within the Wilcox Group beneath the Texas Gulf Coast. The Wilcox is the oldest of the formations used for waste injection and lies beneath these formations. Implicit with this recharge is discharge, but where the deep Wilcox waters discharge is not known. Interaction of ground waters with different origin (meteoric versus deep-basinal) seems to be very complex along the Gulf Coast and cannot be defined by a stratigraphic datum or a certain depth range.

The same seems to be valid for the underlying regime, the geopressured zone. Depth to this zone varies along the Gulf Coast. Kharaka and others (1977) reported depths of 10,100 ft in the Houston area and 9,500 ft in the Corpus Christi area. A relationship between the depth to this zone and lithology was found by Fisher (1982). In areas where the Wilcox is dominated by shale, top of the geopressured zone ranges between 8,000 and 10,000 ft, whereas where the Wilcox is dominated by sandstone, top of the geopressured zone ranges between 11,000 and 13,000 ft.

Along the boundary between hydropressured and geopressured zones, Jones (1968) observed an upwarping of isotherms, which may indicate upward flow of deep-basinal ground water. Release of ground water from the geopressured zone upward into shallower, regional aquifer systems was suggested by numerous investigators. Fisher (1982) described the Wilcox (1) as an open flow system that has received fluid from deeper, older, basinward strata in which (2) basinal brine and meteoric waters have mixed and (3) in which fluid flow is up and out of the basin. Upward flow of deep-basinal brine is also suggested for the Frio and Miocene aquifers. Light and others (1985) investigated thermal maturities of Frio and Miocene hydrocarbons from deep reservoirs underlying Brazoria County. Higher thermal maturities of hydrocarbons when compared to thermal maturities of surrounding reservoir rocks indicate a deeper source of the hydrocarbons and thus an upward direction of fluid movement. The same is indicated by silica geothermometers, which allow determination of temperature regimes a water or rock was subjected to based on stability requirements of suites of mineral components. Silica geothermometers for Frio brines in the area suggest a deeper and hotter source of the brine than the present day position would indicate (Kharaka and others, 1977). Workman and Hanor (1985) gave an estimate of the distance of fluid movement by proposing vertical upward flow of brine of at least 6,000 ft. This estimate is based on studies of organic acids in deep-basin brines from the Louisiana Gulf Coast, which are used as tracers originating within certain temperature (depth) regimes. The direction of fluid movement in Gulf Coast sediments was modeled by Magara (1976), using a compaction model of a sequence of sand and shale units at the top and a thick shale unit at the bottom. This model suggests upward flow in the deep section and horizontal flow (updip flow within high-permeable sandstone units) in the shallow system. Therefore, numerical modeling supports geochemical studies in the Gulf Coast area.

It was shown in figure 6 that saline water may be close to or at land surface in some places along the Gulf Coast. The same is suggested by Galloway and others (1982) and Goldhaber and others (1983), who investigated uranium deposits in South Texas. Upward movement of deep-basin brines along faults and mixing between reducing brine and oxidizing meteoric water is the driving mechanism for these mineralization trends within the shallow subsurface. A connection between shallow sediments and deep reservoirs of gas also was suggested by Stahl and others (1981). Carbon isotopes in shallow-subsurface (4 ft deep) methane gas and in deep reservoirs (10,000 ft) along the Gulf Coast proved to be remarkably similar, which may indicate migration of natural gas from deep reservoirs to land surface.

Previous studies indicate upward flow of deep-basinal brine and downward flow of meteoric water. These ground waters mix with or flush formation waters of different stratigraphic units at various depths and locations. Factors that control this fluid movement are (1) pressures, (2) sand-body geometry, thickness, and continuity, and (3) sand-to-shale ratios. It should be noted that no reference is made to rates of flow. Flow rates are not known. The ground-water movement results from geologic processes (for example, compaction) and, therefore, flow rates should be put in the context of geologic time, that is, millions of years. Upward flow of deep-basinal brine, downward flow of meteoric water, and the possible presence of original formation water suggest that different water facies should occur within Gulf Coast aquifers. These facies may be the pure end members or mixing products among them. As those waters migrate through aquifers they interact with the rock matrix, thus changing the composition of water and host rock. Therefore, mapping of hydrochemical facies and determination of chemical characteristics of ground water may allow interpretations regarding sources and evolution of a specific water type.

Methodology

This report is based on a review of existing literature and of published chemical data. Most of the chemical analyses of formation waters were supplied to investigators by oil field operators and thus bear several limitations: (1) Most analyses are restricted to the major chemical constituents calcium, magnesium, sodium, bicarbonate, sulfate, and chloride; bicarbonate and sulfate concentrations frequently are omitted. (2) Sodium (and potassium) concentrations in many analyses were calculated rather than measured, preventing quality control of performed analyses. (3) Different sampling, treatment, and storage techniques were applied to the samples, introducing unknown handling errors. (4) Background information on the source of water samples is often limited.

Chemical analyses of formation water were compiled from the following sources:

(1) Taylor, 1975

Taylor lists 4,269 water samples, which were provided by oil field operators from wells in 66 counties along the Texas Gulf Coast. Most of the wells listed are located outside the area of interest to this study. Nevertheless, this reference constitutes the major source of chemical data.

(2) USGS, Water-quality data tape

The USGS District Office at Austin provided a data tape of chemical analyses of ground waters from the Texas Gulf Coast. A total of 200 analyses were selected from this tape, most of which pertain to the Frio and Wilcox aquifers.

(3) Texas Natural Resources Information System

Water-quality data available from TNRIS nearly exclusively represent fresh ground water from shallow aquifers and thus were not used in this study.

(4) Core Laboratories, Inc., 1972

Thousands of chemical analyses of saline formation waters in Texas were compiled by Core Laboratories, Inc. Although an overlap in data coverage between this and other sources existed, approximately 200 chemical analyses could be selected from this reference.

(5) Waste-disposal-well files, TDWR

Chemical analyses of formation waters are included in most application and completion reports of waste disposal wells. However, previously published analyses rather than new water analyses are submitted to TDWR in most reports. Therefore, only 35 analyses were obtained from these files.

(6) Jessen and Rolshausen, 1944

The first published study of the chemical composition of Frio formation water, this report lists 116 water analyses from depths ranging from 1,300 to 11,400 ft below land surface.

(7) Morton and others, 1981

As part of research on geopressured-geothermal energy resources, Morton and others sampled 80 waters from oil and gas fields along the Texas Gulf Coast. Samples were obtained from depths below 7,000 ft, most of them from the geopressured zone below 9,000 ft.

(8) Morton, analyses on file at BEG

During the research project mentioned above, Morton and others compiled chemical analyses from oil and gas fields. More than 500 analyses of Frio and Vicksburg formation waters were provided by oil field operators during this compilation.

(9) Fisher, 1982

In a study of the diagenetic history of Wilcox sandstones and associated formation waters of south-central Texas, Fisher presented 37 water samples, which he considered representative of Wilcox formation water.

(10) Lundegard, 1985

Frio and Wilcox formation waters were investigated by Lundegard in a study concerning burial diagenesis of Gulf Coast sediments. Twenty-two analyses of Frio brines and 16 analyses of Wilcox brines were selected from that study.

(11) Jones, 1968

Within a comprehensive study of hydrologic regimes in the northern Gulf of Mexico Basin, Jones reported chemical analyses of Tertiary formation waters from the

Louisiana and Texas Gulf Coast. Vicksburg formation samples from South Texas were obtained from this investigation.

After compilation of all available data, the created data base was reduced by elimination of incomplete analyses and those analyses that showed an error of greater than 5 percent in cation/anion balance. According to comments for many analyses, sodium concentrations were calculated and not analyzed. These samples cannot be checked for accuracy but nevertheless were kept in the data base.

Reported salinities of samples from some wells are extremely low when compared to values from nearby wells at comparable depths. Kharaka and others (1977) and Morton and others (1981) showed that dilution of water samples by condensed water vapor produced with natural gas is responsible for these low salinities. Therefore, these analyses are not representative of formation water at that depth. To minimize possible errors by diluted samples, water samples from gas wells producing less than 10 bbl of water per million ft^3 of gas were considered nonrepresentative by Kharaka and others (1977) and by Morton and others (1981). Background information of data compiled during the present study did not allow this kind of data control. Instead, comparison of values on a geographical basis was done to eliminate samples with salinities suspiciously low (less than 10,000 mg/L). This seemed appropriate considering the objective of the study, which calls for a regional rather than a local characterization of chemical parameters.

The final data base of formation water for the seven aquifer units for which a sufficient number of chemical analyses was obtained is listed on table 3. Of the total 1,295 analyses considered representative of formation water, more than half originated from the Frio Formation (appendix A). Only a very limited data base was obtained for the Oakville (17), Catahoula (30), and undifferentiated Miocene (37) aquifer units. Nevertheless, these strata are considered in this study because

Table 3: Number of selected chemical analyses per aquifer unit.

Aquifer unit	Number of analyses
Oakville	17
Catahoula	30
Undiff. Miocene	37
Frio	753
Vicksburg	121
Yegua	100
Wilcox	237
Total	1,295

available data cover at least part of the Gulf Coast fairly well (figs. 7 through 9). Good areal coverage was obtained for the Frio (753), Wilcox (237), Vicksburg (121), and Yegua (100) aquifers (figs. 10 through 13). The Vicksburg Formation, although not a disposal zone for industrial waste, was included because of its stratigraphic position (table 1), underlying one of the major disposal units (Frio).

Two graphical methods are used to illustrate characteristics of ground water. The percentages of major cations and anions are presented in Piper diagrams (Piper, 1944). This allows determination of major hydrochemical facies by illustrating the dominant cation and anion. Two chemically different waters plot at different percentages in the cation and anion fields, regardless of concentration ranges. Mixtures of these waters plot on a line that connects these end members.

The concentrations and ratios of individual chemical constituents are illustrated in plots of Na/Cl, Ca/Cl, Mg/Cl, HCO_3/Cl, SO_4/Cl, and pH/Cl. Two groups of unrelated waters cluster in different parts of the plot, whereas related samples approach a line connecting end members of hydrochemical facies.

WATER CHEMISTRY

Ranges of chemical components were plotted in histograms and are included in appendix B. Most chemical analyses available from published literature list only major chemical constituents, i.e., calcium, magnesium, sodium, bicarbonate, sulfate, and chloride. Commonly, sodium concentration was calculated as the difference between total anions and the major cations calcium and magnesium. This kind of analysis does not permit quality control of the performed analysis and assumes that potassium concentrations are of minor importance. Discussion of chemical constituents is restricted to major cations and anions.

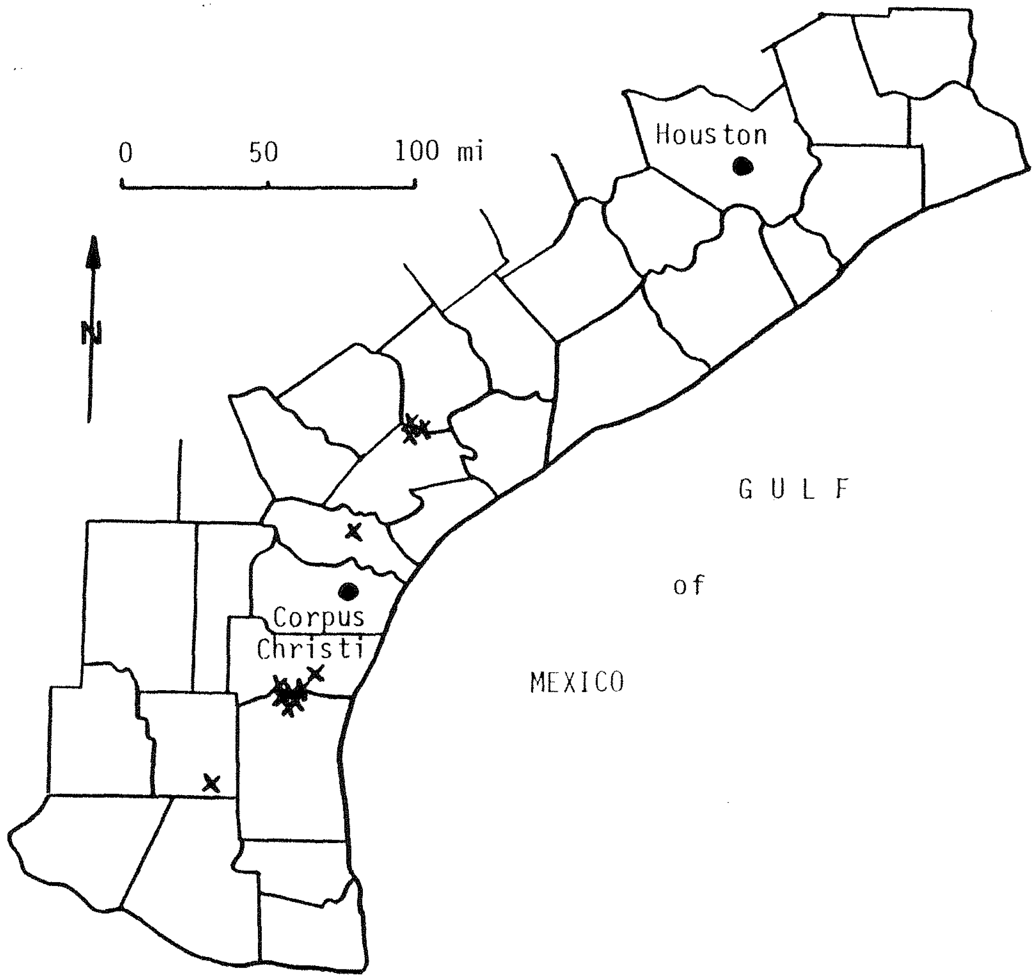


Figure 7. Geographic distribution of selected analyses from the Oakville aquifer.

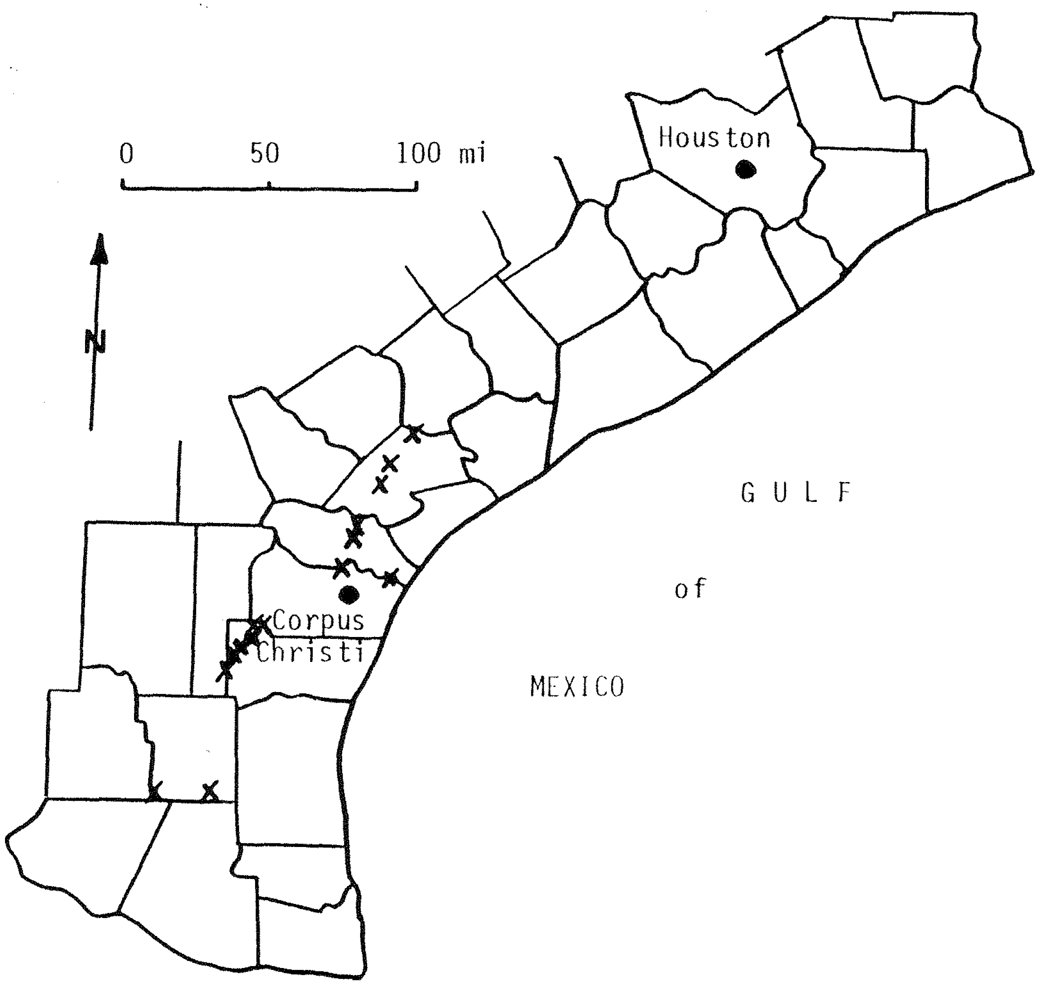


Figure 8. Geographic distribution of selected analyses from the Catahoula aquifer.

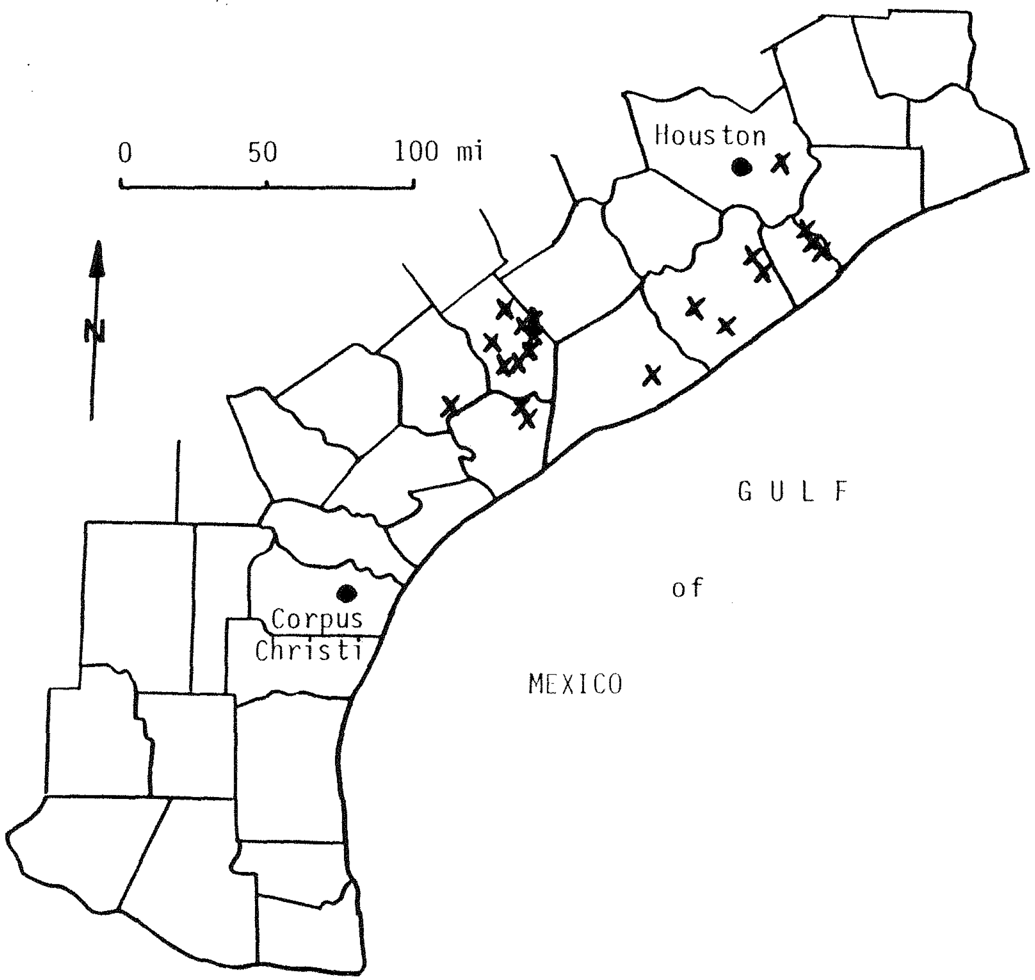


Figure 9. Geographic distribution of selected analyses from aquifers in undifferentiated Miocene sandstones.

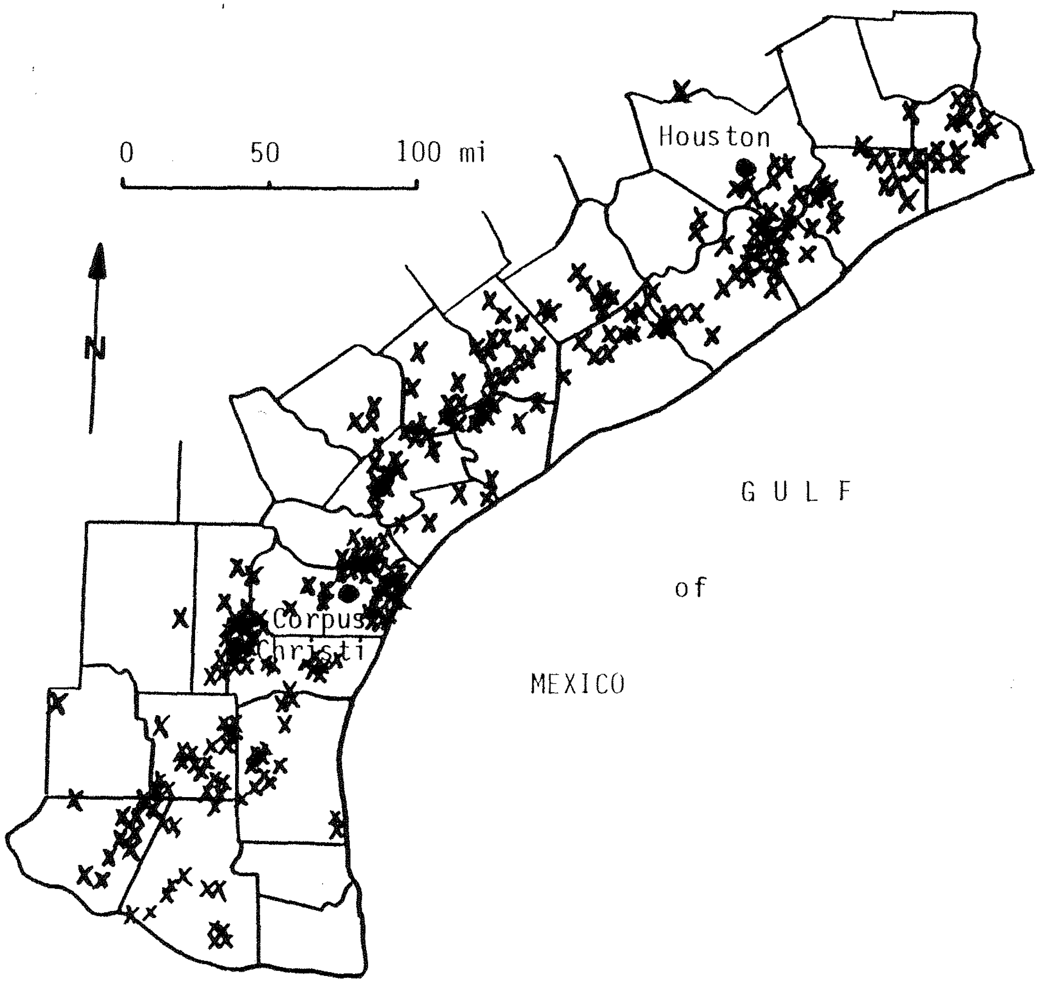


Figure 10. Geographic distribution of selected analyses from the Frio aquifer.

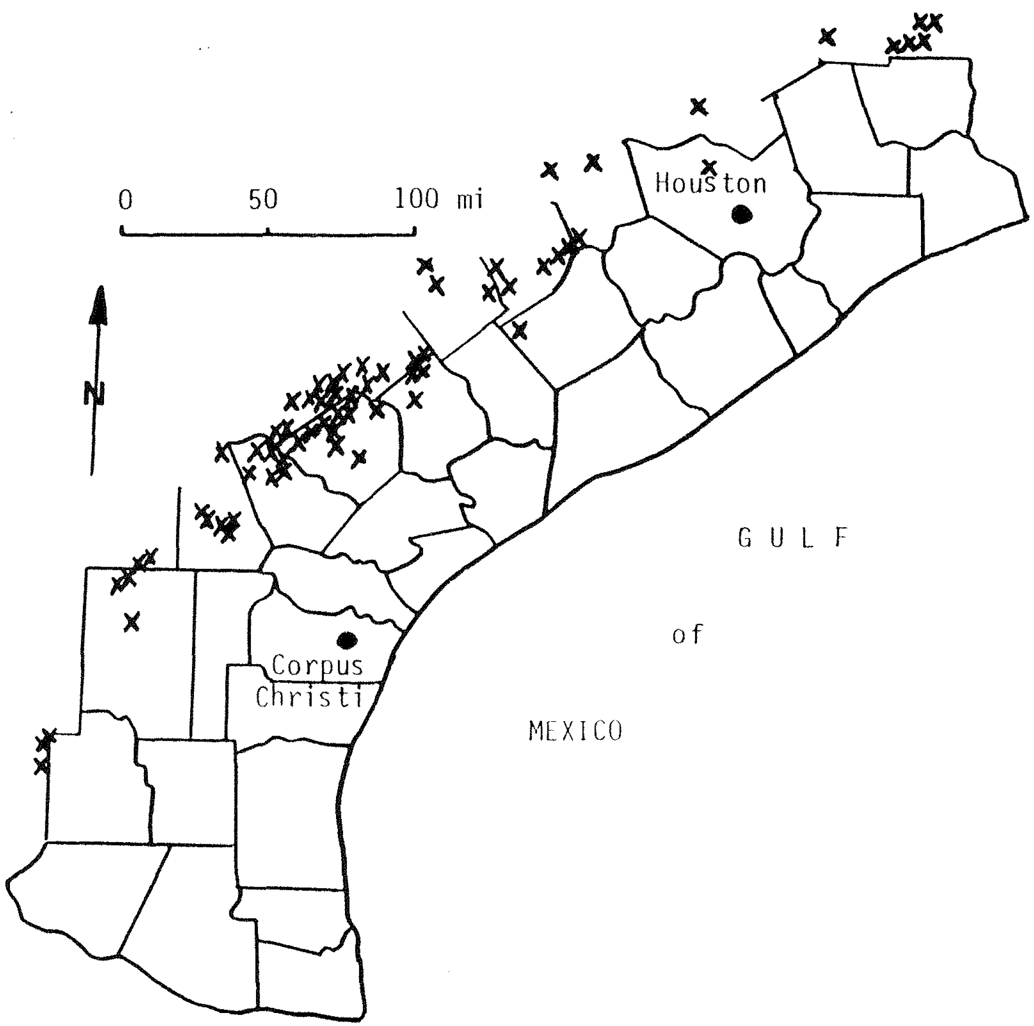


Figure 11. Geographic distribution of selected analyses from the Wilcox aquifer.

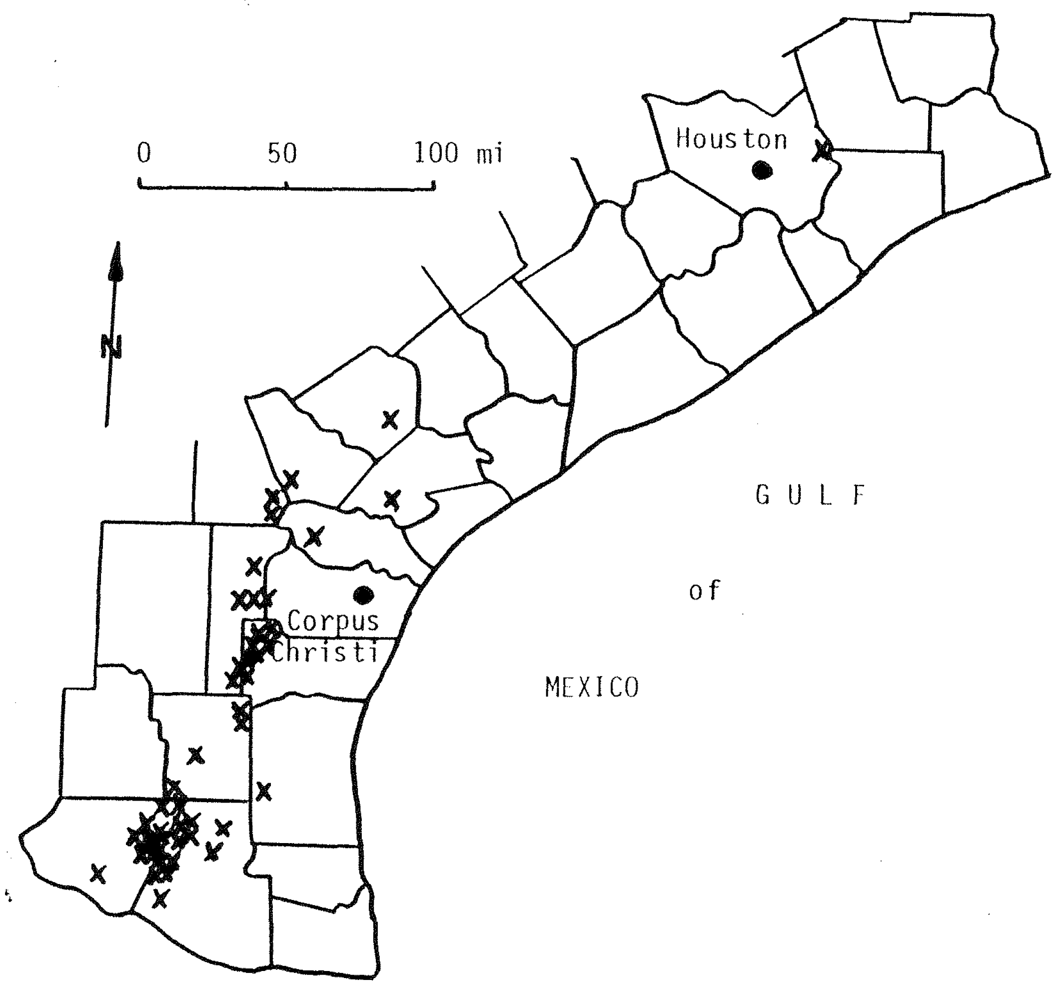


Figure 12. Geographic distribution of selected analyses from the Vicksburg aquifer.

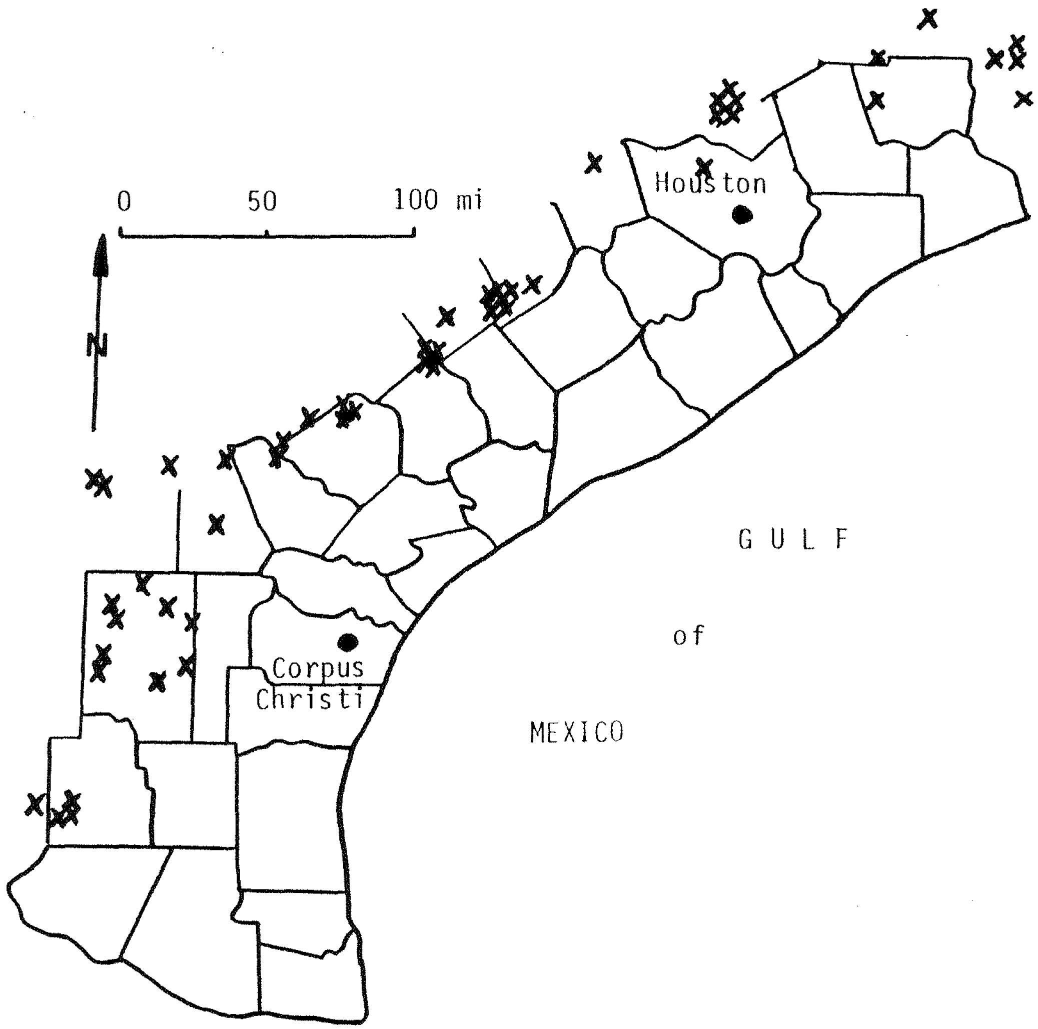


Figure 13. Geographic distribution of selected analyses from the Yegua aquifer.

Piper Diagrams

Major chemical facies of ground water commonly are presented by plotting major cation and major anion percentages in the form of Piper diagrams (Piper, 1944). Saline formation waters of the Texas Gulf Coast are predominantly of the NaCl type; for example, sodium and chloride constitute the major cation and anion, respectively (figs. 14 through 16). The distribution of major cations and major anions seems to indicate three major facies: (1) NaCl water in Oakville, Catahoula, and Miocene units (fig. 14), (2) NaCaCl water in Frio and Vicksburg units (fig. 15), and (3) $Na(HCO_3)Cl$ waters in Yegua and Wilcox units (fig. 16).

Catahoula, Oakville, and undifferentiated Miocene formation waters plot very similarly, with sodium percentages greater than approximately 75 percent of total cations. Calcium percentages range from 2.5 to 25 percent, whereas magnesium percentages range from only 1 to 10 percent. Bicarbonate percentages are essentially zero. Sulfate concentrations generally are very low in Oakville and Miocene waters but constitute up to 75 percent of total anions in some Catahoula waters. High sulfate percentages in some Catahoula formation waters occur typically in low-Cl waters and are not representative of saline formation water in the area.

High calcium percentages generate similar Piper diagrams of Frio and Vicksburg formation water (fig. 15). Sodium percentages range from 100 to 25 percent, with a corresponding increase in calcium from 0 to 75 percent. Magnesium typically falls in a range of 0 to 10 percent.

High bicarbonate percentages characterize Yegua and Wilcox waters (fig. 16). Cation percentages are similar to those in waters from the Oakville, Miocene, and Catahoula units, with sodium falling in a range of 75 to 100 percent. High bicarbonate values may actually represent high values of alkalinity, as will be discussed later.

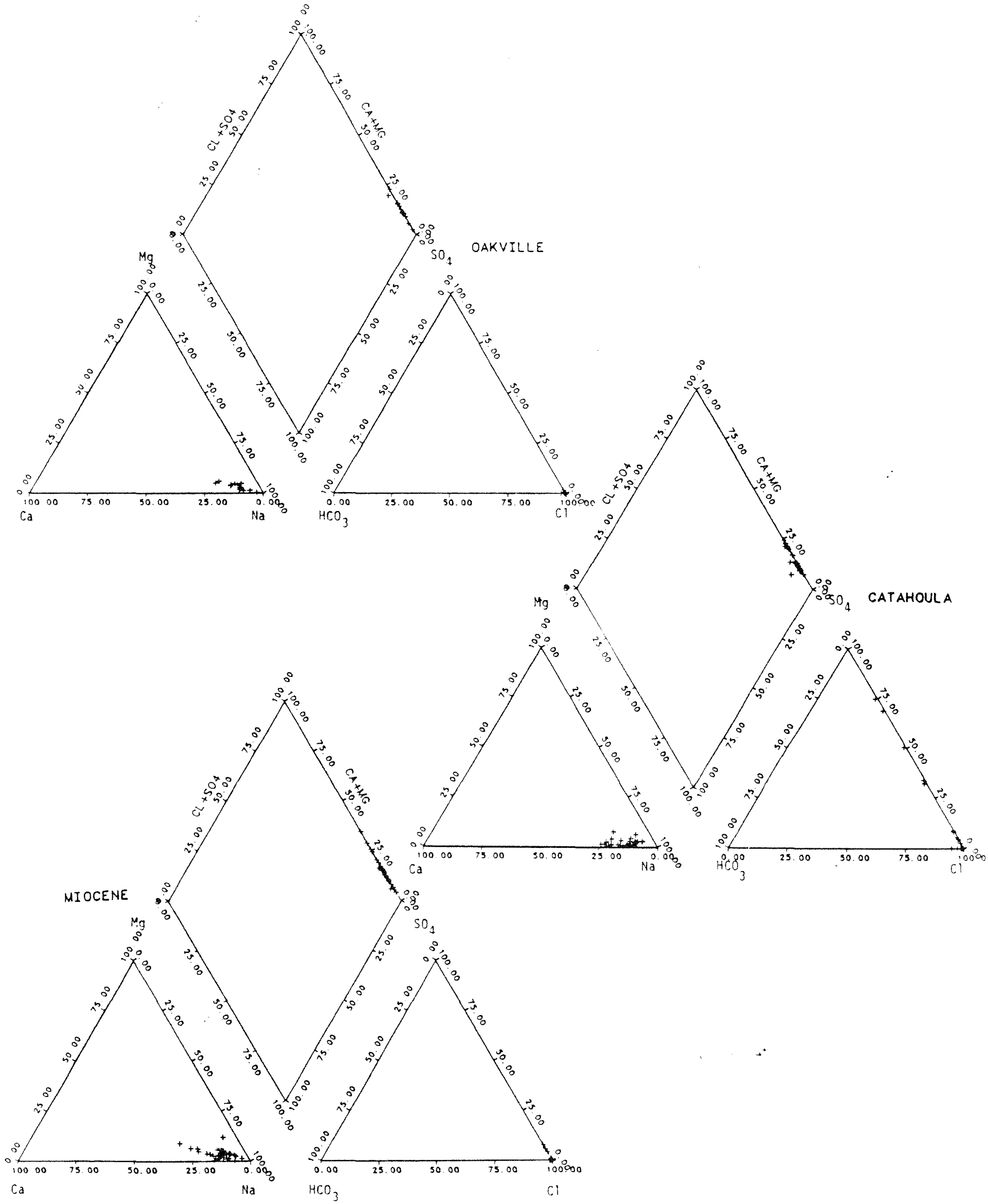


Figure 14. Piper diagrams of Oakville, Catahoula, and Miocene formation waters.

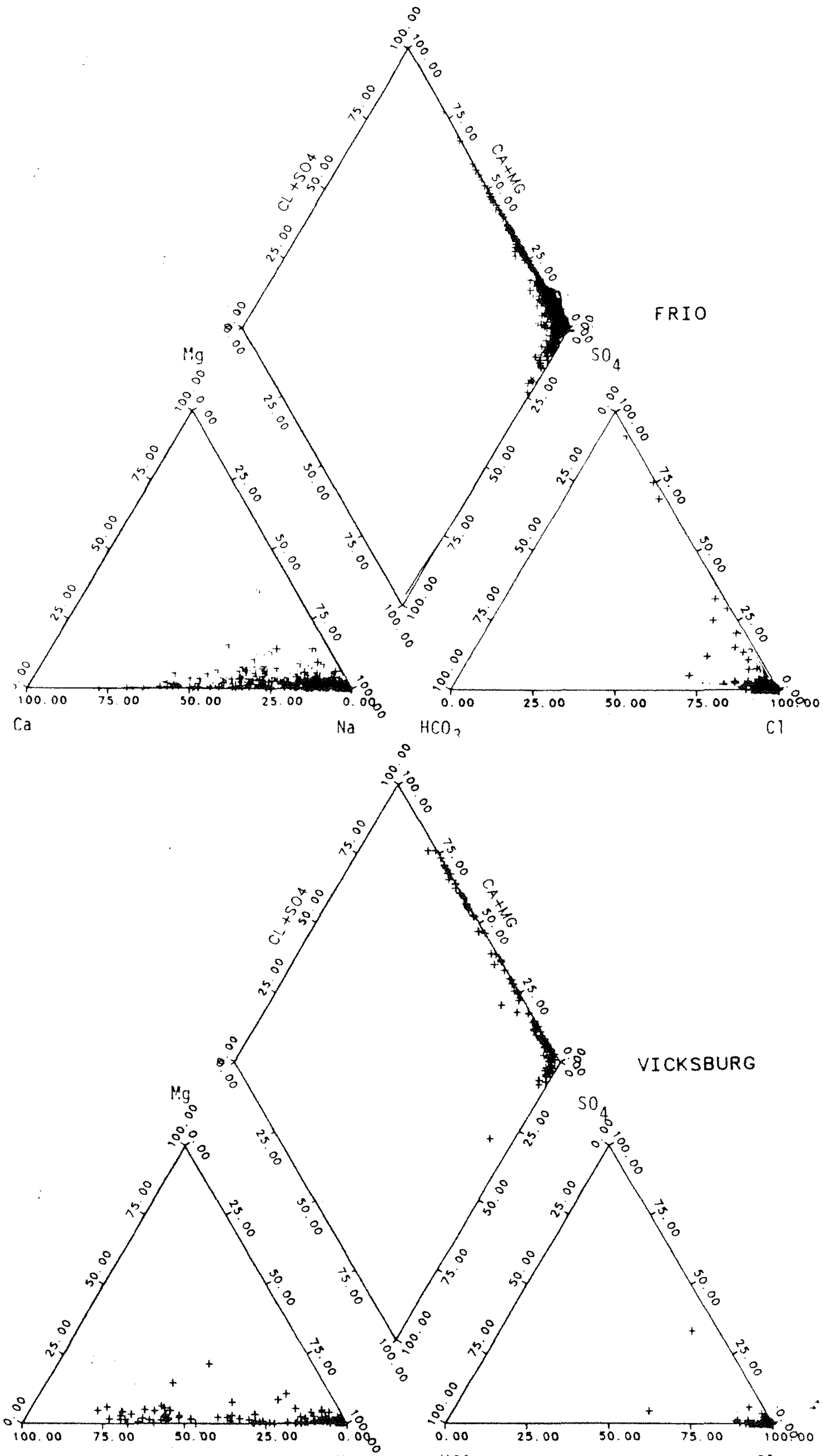
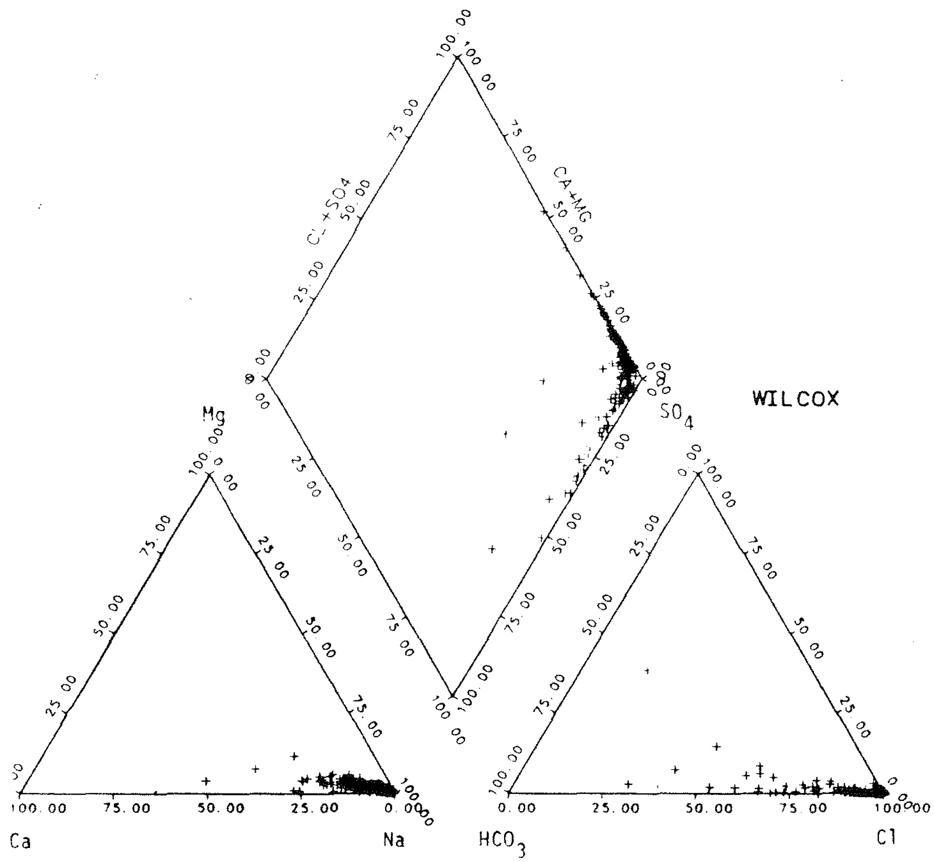


Figure 15. Piper diagrams of Frio and Vicksburg formation waters.



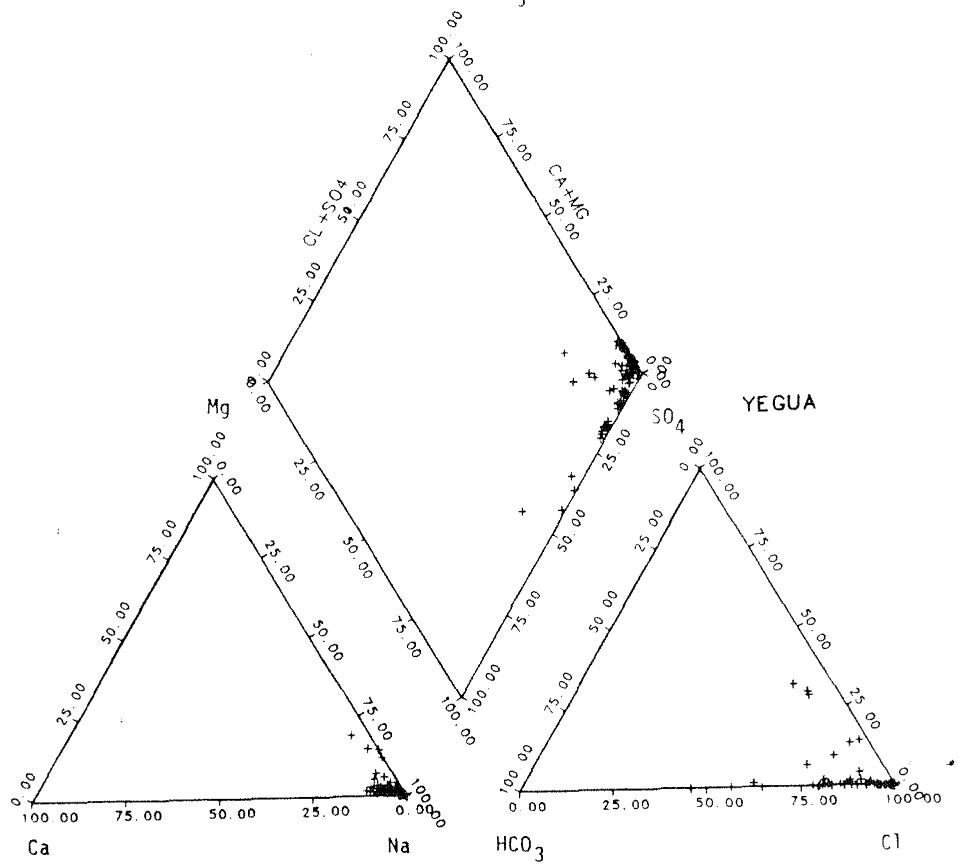


Figure 16. Piper diagrams of Yegua and Wilcox formation waters.

Chloride

Chloride concentrations of formation water in Gulf Coast aquifers vary widely (table 4). Highest concentrations (in excess of 150,000 mg/L) were measured in Frio, Vicksburg, and Wilcox units, whereas Catahoula, Oakville, and Yegua brines do not exceed 80,000 mg/L. Surprisingly, mean chloride concentrations do not vary much between the units (23,500 to 33,400 mg/L) except for Miocene brines (50,000 mg/L). A change in chlorinity through time was observed by Jones (1968) who attributed the great diversity of salinities to different sampling techniques. A change of up to 42 percent in salinity of Gulf Coast oil field brines, for a period of 20 years, was reported by Fowler (1970), who concluded that the history of the reservoir and of fluid production plays a major role in salinity data. Therefore, some of the scatter in plots of chemical constituents might be attributable to sampling differences and to undetermined factors of reservoir history.

Miocene, Yegua, Oakville, and to a smaller degree Catahoula formation waters show a trend toward increasing chloride concentrations with depth (figs. 17 and 18). Typically, this trend prevails at depths above 6,000 to 7,000 ft. Below these depths, high scatter characterizes chloride-depth plots (figs. 17 and 18). No trends are apparent in Frio, Vicksburg, and Wilcox waters. Chloride concentrations in Yegua samples seem to follow two salinization trends, one high in chloride and the other low in chloride. In both, straight line relationships indicate mixing between saline ground water and relatively fresh water.

At depths of 4,000 to 9,000 ft below land surface, some Frio samples in the Corpus Christi area show low chloride concentrations (fig. 19). This is not true of the same unit in the Houston area, where chloride concentrations are high at this depth interval. Typically, chloride concentrations seem to be higher along the upper Gulf Coast than along the lower Gulf Coast. This is shown on a distribution map

Table 4: Ranges and means of chemical concentrations in 7 brine aquifers, Gulf Coast of Texas (analyses in mg/L, except pH).

	Range	Oakville	Catahoula	Frio	Miocene
pH	min.-max.	6.0-9.6	6.2-7.7	4.0-11.8	5.7-8.7
	mean	7.2	6.9	7.2	7.0
Ca	min.-max.	160-6,200	440-6,500	up to 36,000	1,100-4,600
	mean	1,800	2,100	2,650	2,900
Mg	min.-max.	up to 1,070	up to 900	up to 9,450	50-2,000
	mean	365	270	250	535
Na	min.-max.	4,600-31,000	3,400-33,500	1,200-70,000	7,000-87,000
	mean	17,900	17,900	18,400	28,000
Cl	min.-max.	7,800-61,800	up to 65,700	400-152,000	14,700-87,000
	mean	31,700	30,700	33,400	50,000
no. of analyses		17	30	753	37

		Vicksburg	Yegua	Wilcox
pH	min.-max.	5.1-10.9	4.6-9.3	2.8-8.9
	range	7.0	7.4	7.0
Ca	min.-max.	40-42,500	up to 2,965	up to 16,500
	range	4,250	521	1,482
Mg	min.-max.	up to 8,200	up to 680	up to 3,100
	range	300	150	240
Na	min.-max.	1,000-60,800	1,450-48,000	180-85,000
	range	12,000	15,000	16,500
Cl	min.-max.	4,500-163,000	1,100-80,000	300-170,000
	range	27,000	23,500	28,400
no. of analyses		121	100	237

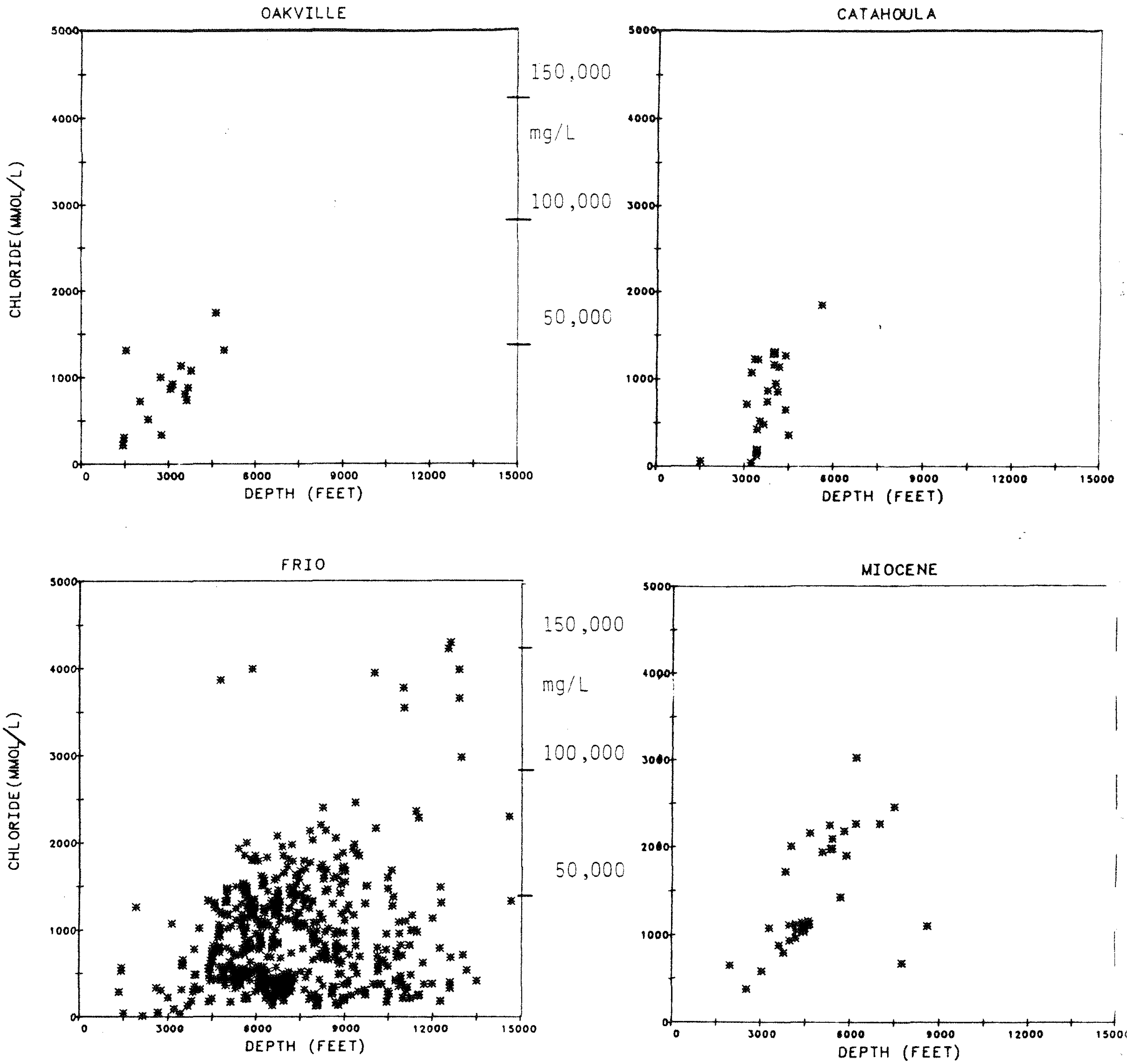


Figure 17. Chloride-depth plot for Oakville, Catahoula, Frio, and Miocene formation waters.

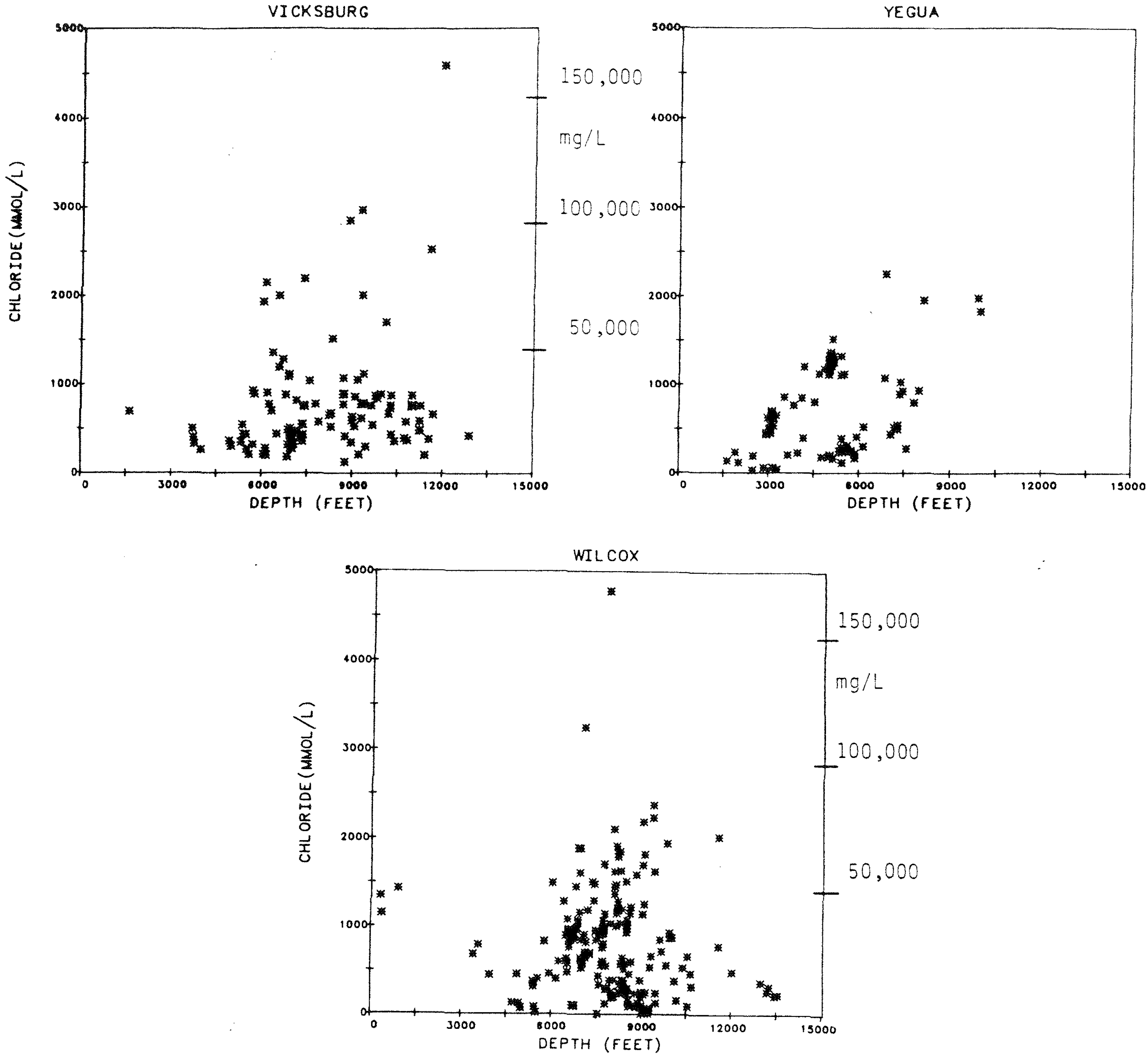
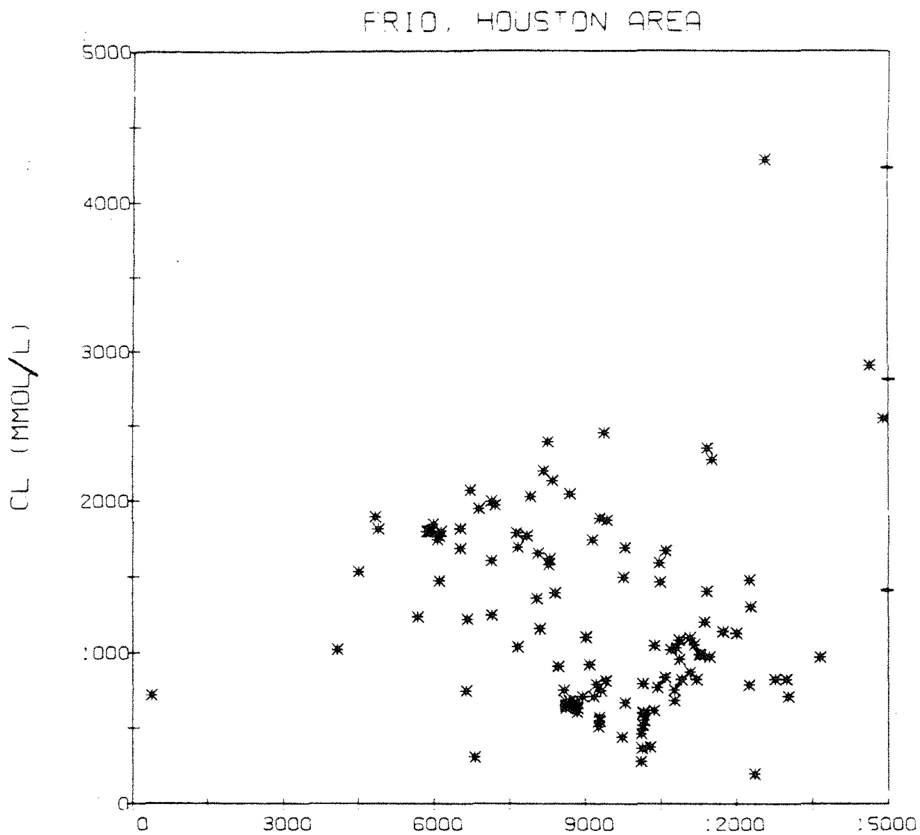


Figure 18. Chloride-depth plot for Vicksburg, Yegua, and Wilcox formation waters.



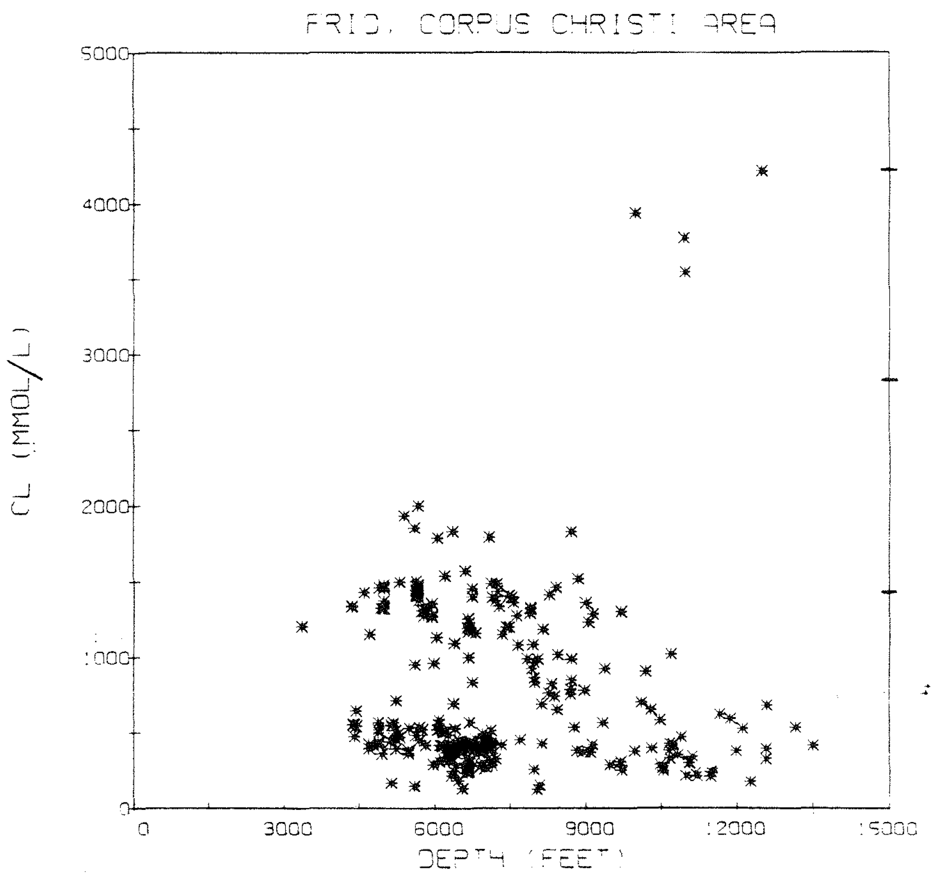


Figure 19. Chloride-depth plot of Frio formation water in Corpus Christi and Houston areas. Note relatively low chloride concentrations in Corpus Christi area at depths between 4,500 and 9,000 ft below land surface.

of concentrations of total dissolved solids, which is similar to a chloride map in relative concentrations (fig. 20). Morton and others (1983) explained high-chloride waters along the upper coast to result from dissolution of salt from salt domes, which are abundant in the subsurface along the upper coast. Salt domes are absent along the lower Gulf Coast.

Bromide concentrations and especially Br/Cl ratios can be used to differentiate salt-dissolution brine from oil field (deep-basin) brines (Whittemore and Pollock, 1979; Whittemore and others, 1981; Richter and Kreitler, in press). Bromide concentrations in brines are governed by the interaction of water with evaporite rocks or by the composition of the original formation fluid or by both. During the evaporation of seawater and precipitation of halite salt some bromide is incorporated into the halite crystal, according to a distribution coefficient of about 0.035 at 25°C (Holser, 1979). Therefore, bromide concentrations and Br/Cl ratios are lower than those of seawater in halite but greater than those of seawater in evaporated brine. Dissolution of this halite, which has a low Br/Cl ratio, by contact with ground water will increase the chloride concentration in the resulting water to a greater extent than it will increase the bromide concentration in the water and thus will cause a decrease in the Br/Cl ratio in the resulting salt water. Halite-dissolution brines typically have Br/Cl weight ratios of less than 0.0025 (Whittemore and others, 1981; Richter and Kreitler, in press). In contrast, connate formation waters have Br/Cl weight ratios similar to or greater than those of seawater, that is greater than 0.0033. Ratios of Br/Cl greater than 0.004 are typical for oil field brines, as reported by Whittemore and others (1981) for oil field brines in Kansas and by Richter and Kreitler (in press) for deep-basin brines underlying the Rolling Plains of North-Central Texas. Morton and others (1983) mapped three ranges of

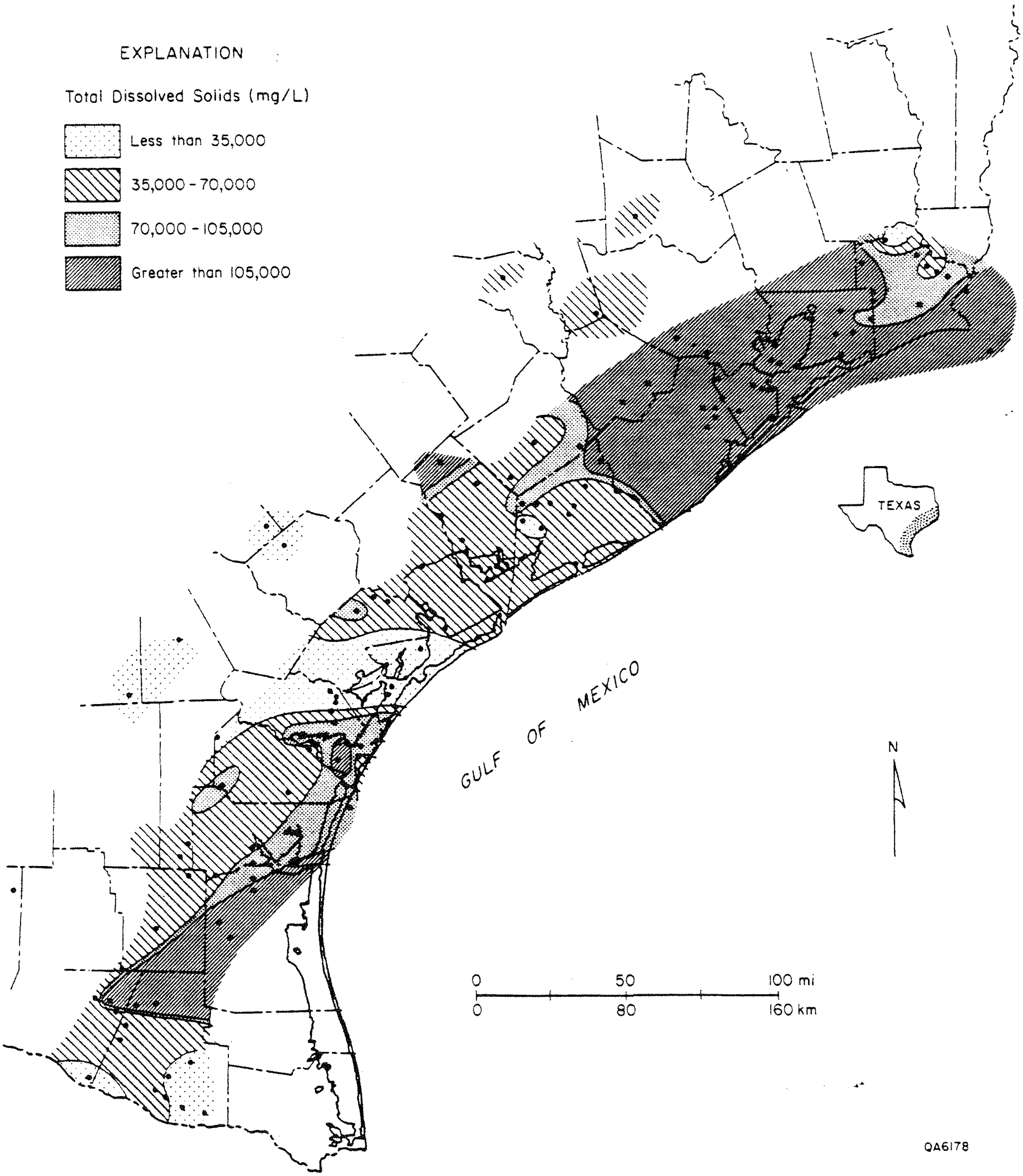


Figure 20. Total dissolved solids concentrations in geopressured brines along the Texas Gulf Coast (after Morton and others, 1983).

Br/Cl ratios in geopressured Gulf Coast brines: (1) Br/Cl ratios greater than 0.005 were measured in brines from the lower and middle Gulf Coast, (2) Br/Cl ratios less than 0.005 were reported in brines from the upper Gulf Coast, and (3) Br/Cl ratios in excess of 0.01 were measured in some brine samples from the lower and middle Gulf Coast (fig. 21). Low Br/Cl ratios in brines from the upper Gulf Coast (Group 2) suggest salt dissolution as an additional source of chloride. High Br/Cl ratios in brines from the lower and middle Gulf Coast (Groups 1 and 3) indicate typical deep-basinal fluids and absence of halite dissolution. Mixing of deep-basinal waters with meteoric water does not change the Br/Cl ratio. Therefore, mixing of brine (having high Br/Cl ratios) with fresh ground water could account for the low-chloride waters in shallow units in the Corpus Christi area (fig. 19). This dilution effect does not occur in the Houston area where chloride concentrations are high at shallow depths (fig. 19). Dissolution of halite most likely accounts for the high-Cl and low-Br/Cl waters in the Houston area.

Sodium

Plots of sodium versus depth (figs. 22 and 23) show trends and scatter similar to those in chloride-depth plots. Oakville, Catahoula, Miocene, and Yegua waters show an increase in sodium concentrations with depth, whereas much scatter characterizes plots of Frio, Vicksburg, and Wilcox ground water. An excellent correlation exists between the two major components of Gulf Coast brines, sodium and chloride (figs. 24 and 25). Deviations from the major NaCl trend occur mainly in Frio and Vicksburg and to a smaller extent in Wilcox samples. These deviations are caused predominantly by brines high in calcium concentrations or by samples of relatively low salinity. The areal distribution of waters high or low in sodium resembles that of total dissolved solids (fig. 26). Dissolution of halite and possibly

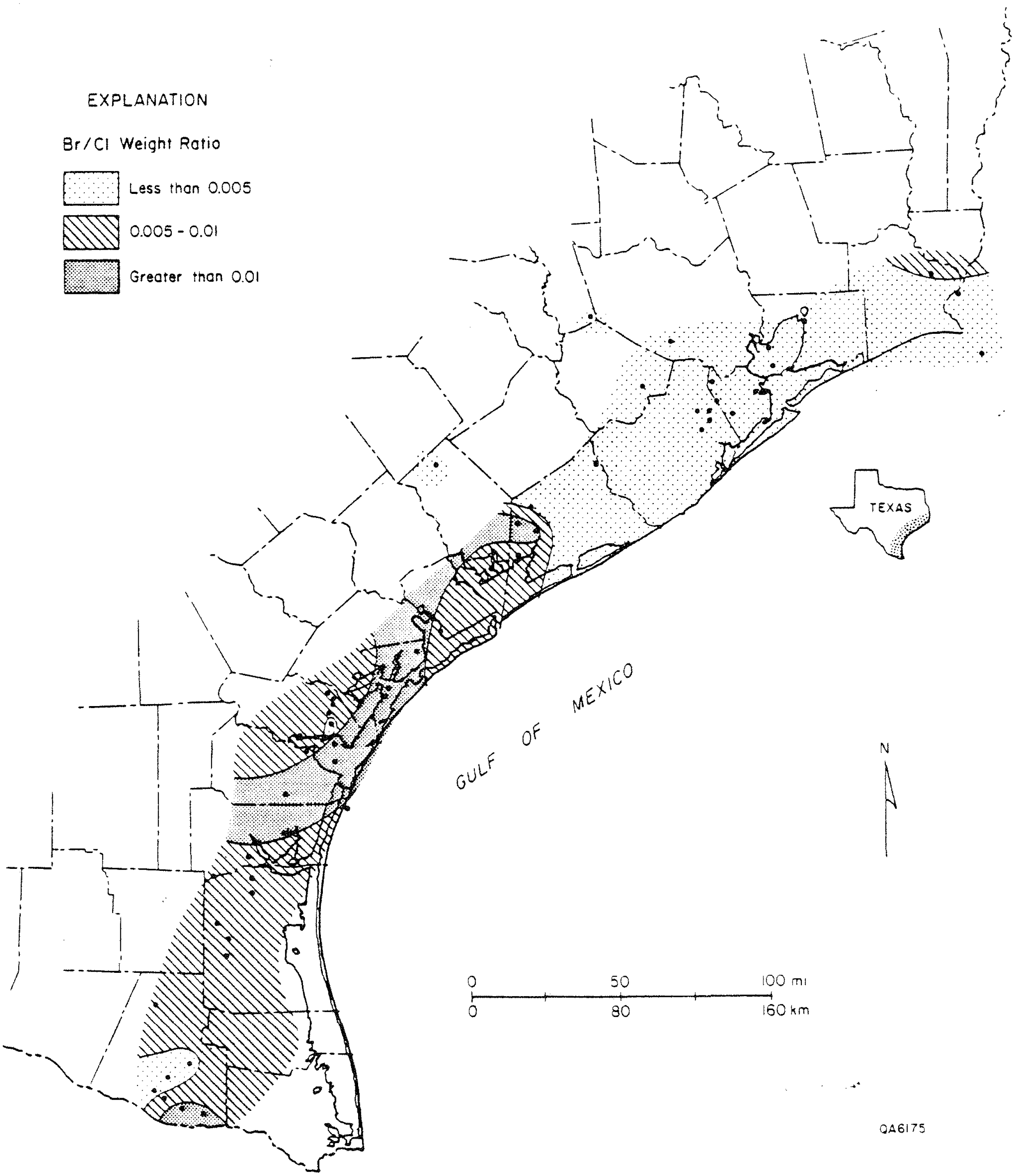


Figure 21. Bromide/chloride ratios in geopressured Tertiary brines along the Texas Gulf Coast (after Morton and others, 1983).

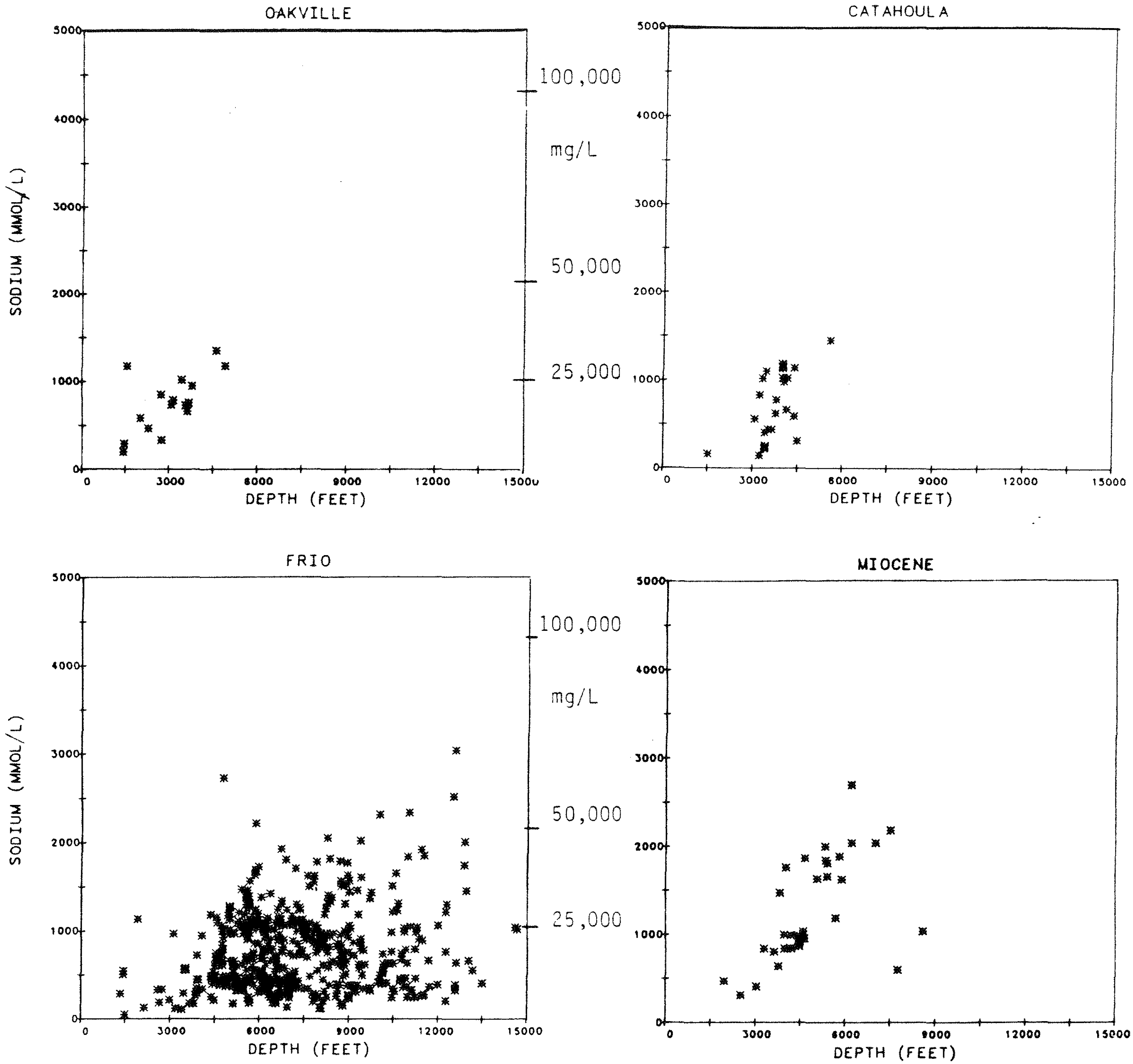


Figure 22. Sodium-depth plot for Oakville, Catahoula, Frio, and Miocene formation waters.

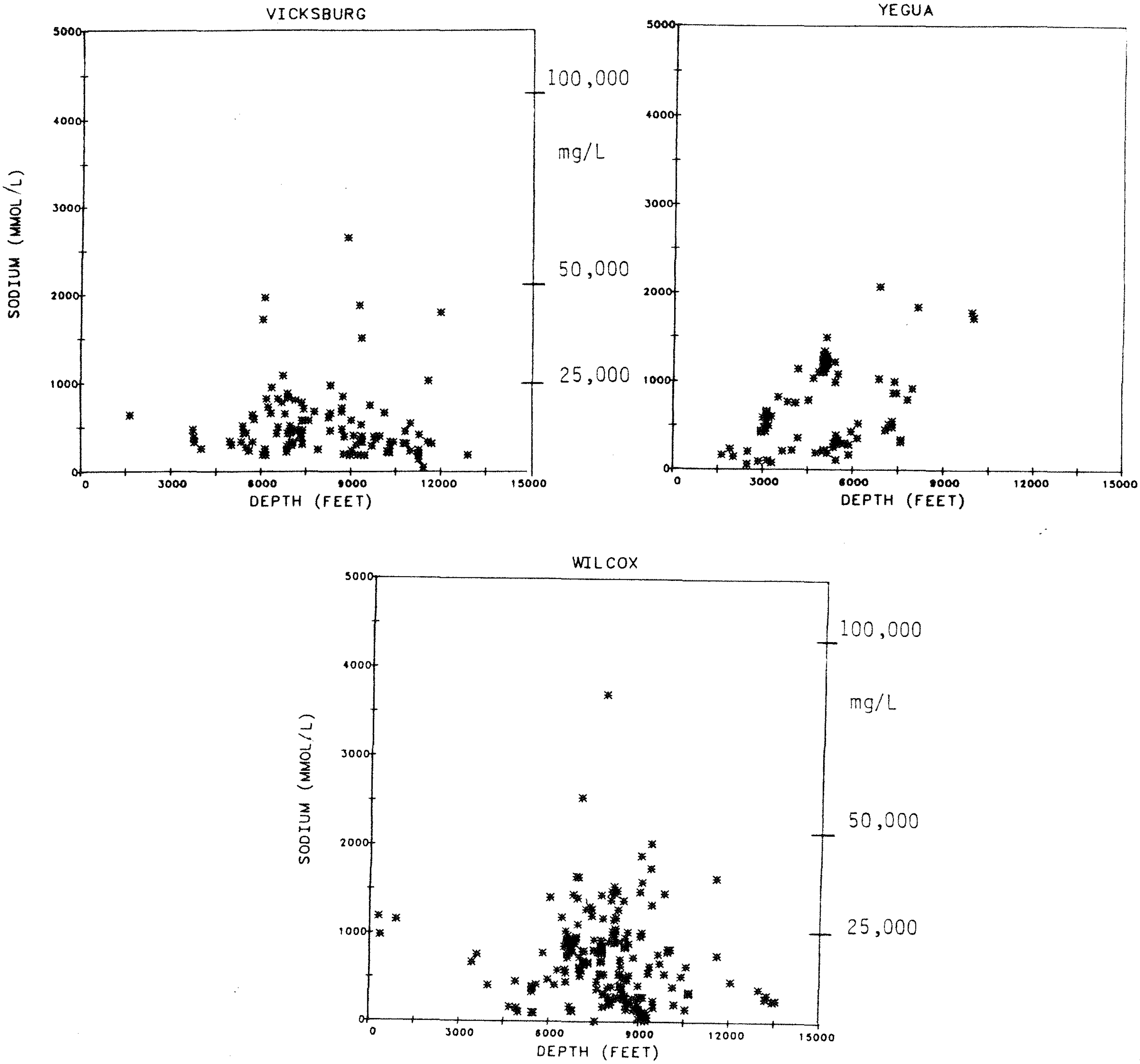


Figure 23. Sodium-depth plot for Vicksburg, Yegua, and Wilcox formation waters.

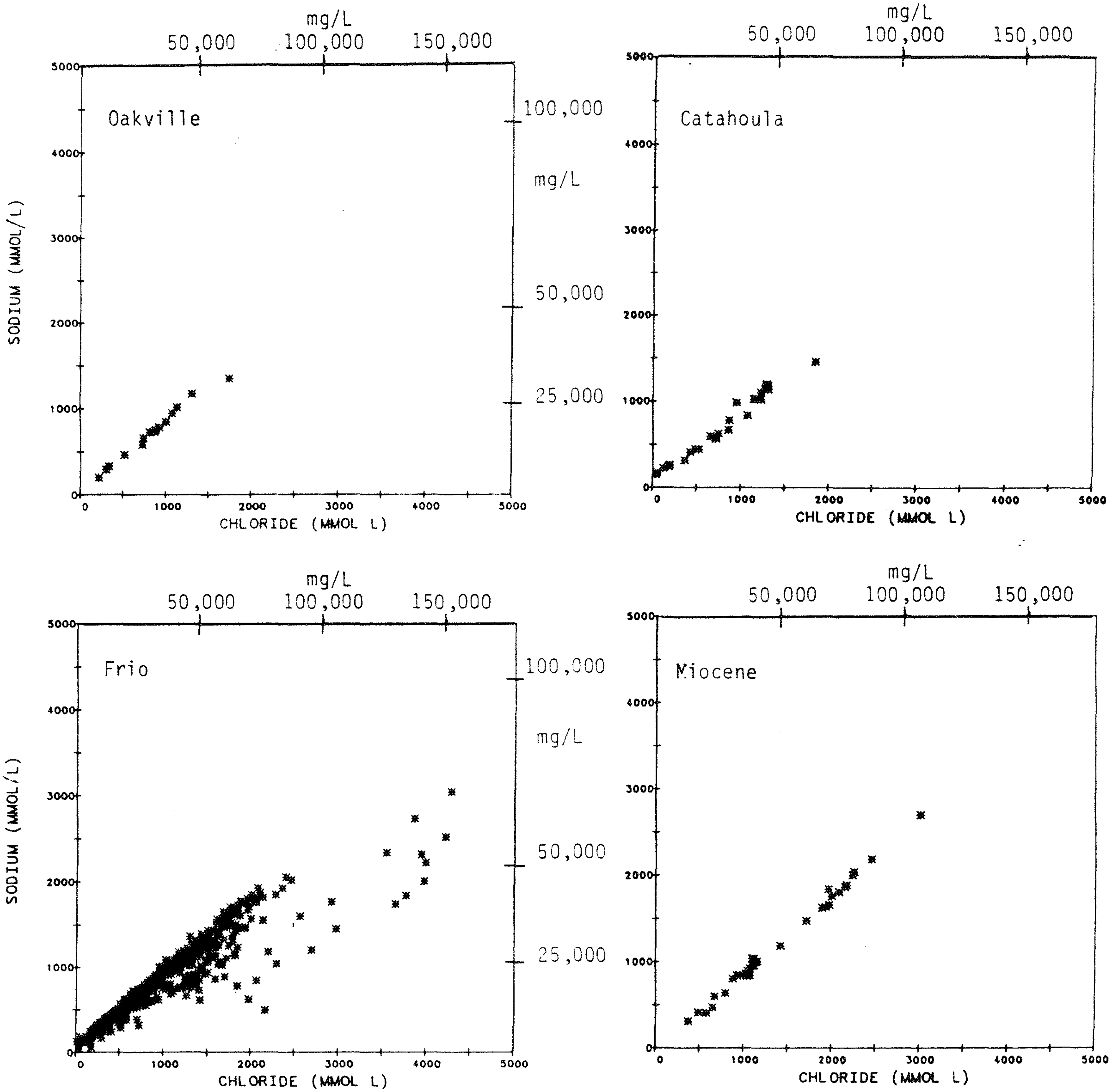


Figure 24. Sodium-chloride plot for Oakville, Catahoula, Frio, and Miocene formation waters.

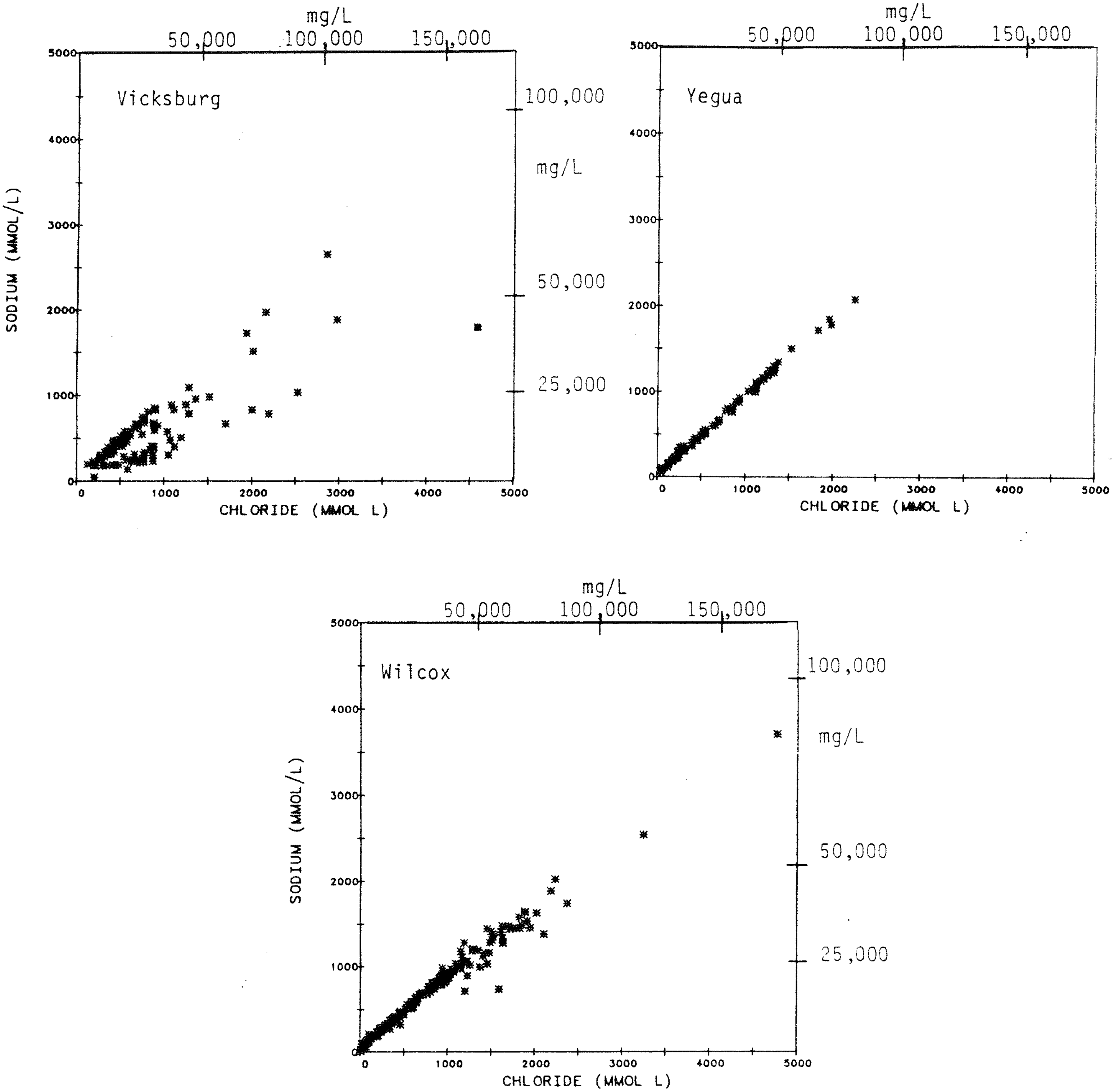


Figure 25. Sodium-chloride plot for Vicksburg, Yegua, and Wilcox formation waters.

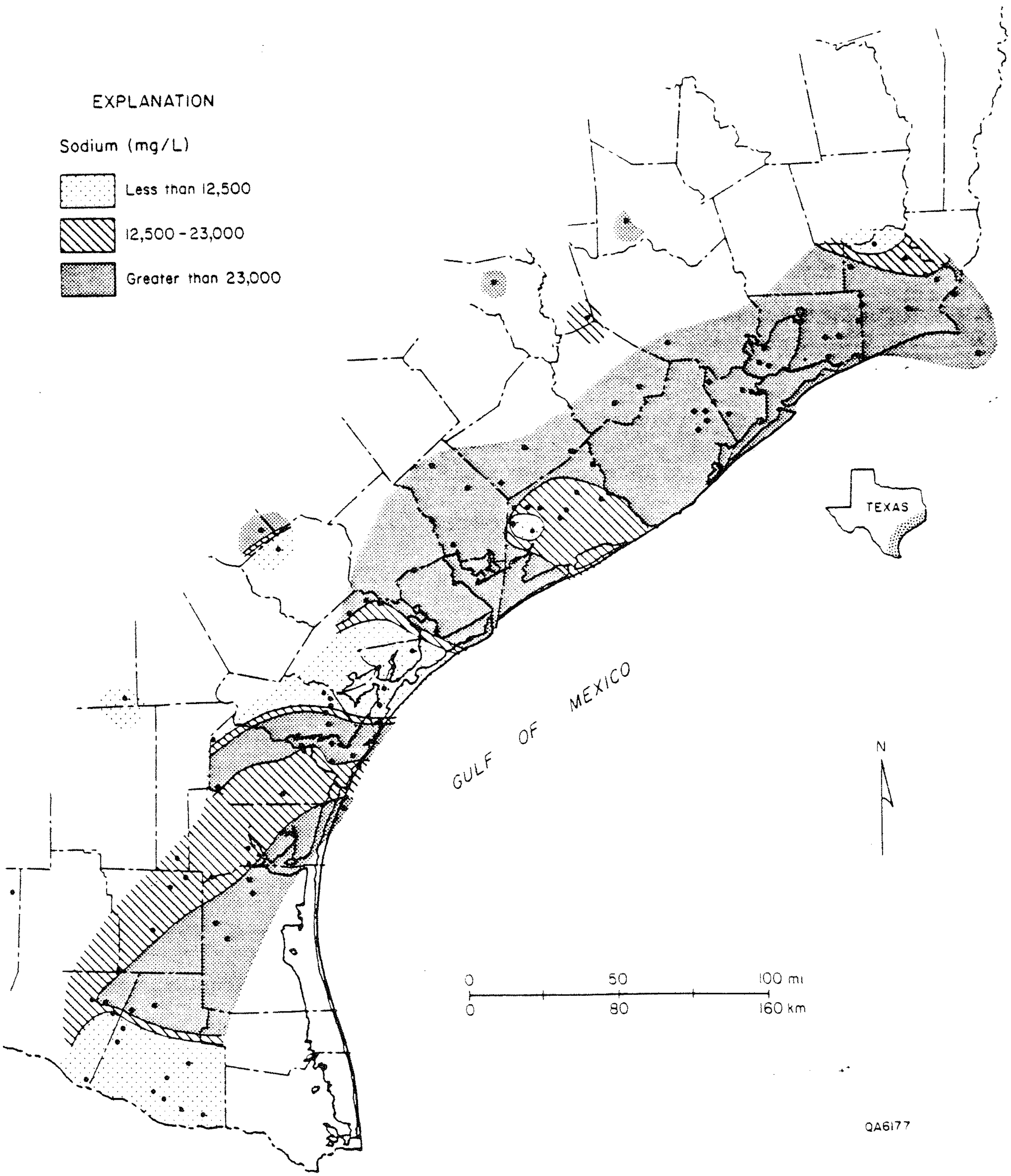


Figure 26. Sodium concentrations in geopressured Tertiary brines along the Texas Gulf Coast (after Morton and others, 1983).

diagenesis of clay minerals are major sources of sodium in deep-basin brines. In contrast, albitization is considered a major sink of sodium.

Calcium

Calcium concentrations typically exhibit much scatter and no apparent correlation with depth of producing intervals (figs. 27 and 28). Oakville, Catahoula, Miocene, and Yegua brines generally are relatively low in calcium, with concentrations of less than 6,500 mg/L. Calcium concentrations in Frio, Vicksburg, and Wilcox brines frequently are very high, with maximum concentrations of up to 42,500 mg/L (table 4). Calcium content increases with chloride in all seven units but is most pronounced in Frio and Vicksburg brines (figs. 29 and 30). The slight increase in calcium with chloride probably is related to dissolution of calcite in shales, cation exchange, or diagenesis of clay minerals within the aquifers. Extremely high concentrations in some Frio, Vicksburg, and Wilcox brines indicate an additional mechanism of calcium enrichment. Calcium-chloride plots of Frio and Vicksburg samples show a trend from low calcium concentrations at low chloride contents to high calcium concentrations at high chloride contents. This suggests mixing between a calcium-rich brine and a ground water relatively low in chloride and calcium or a NaCl brine reacting with a Ca-rich mineral such as anorthite (albitization). Upward flow of hot, deep-basinal CaCl brines along faults and mixing of this brine with NaCl pore water is one possible explanation for calcium-rich brines in the Frio of South Texas (fig. 31; Morton and others, 1983). Land and Prezbindowski (1981) suggest that albitization is an important reaction causing Ca-rich brines in the Texas Gulf Coast.

Magnesium

Magnesium concentrations in Gulf Coast aquifers typically are low, with mean concentrations ranging from 150 to 535 mg/L (table 4). Very similar to calcium,

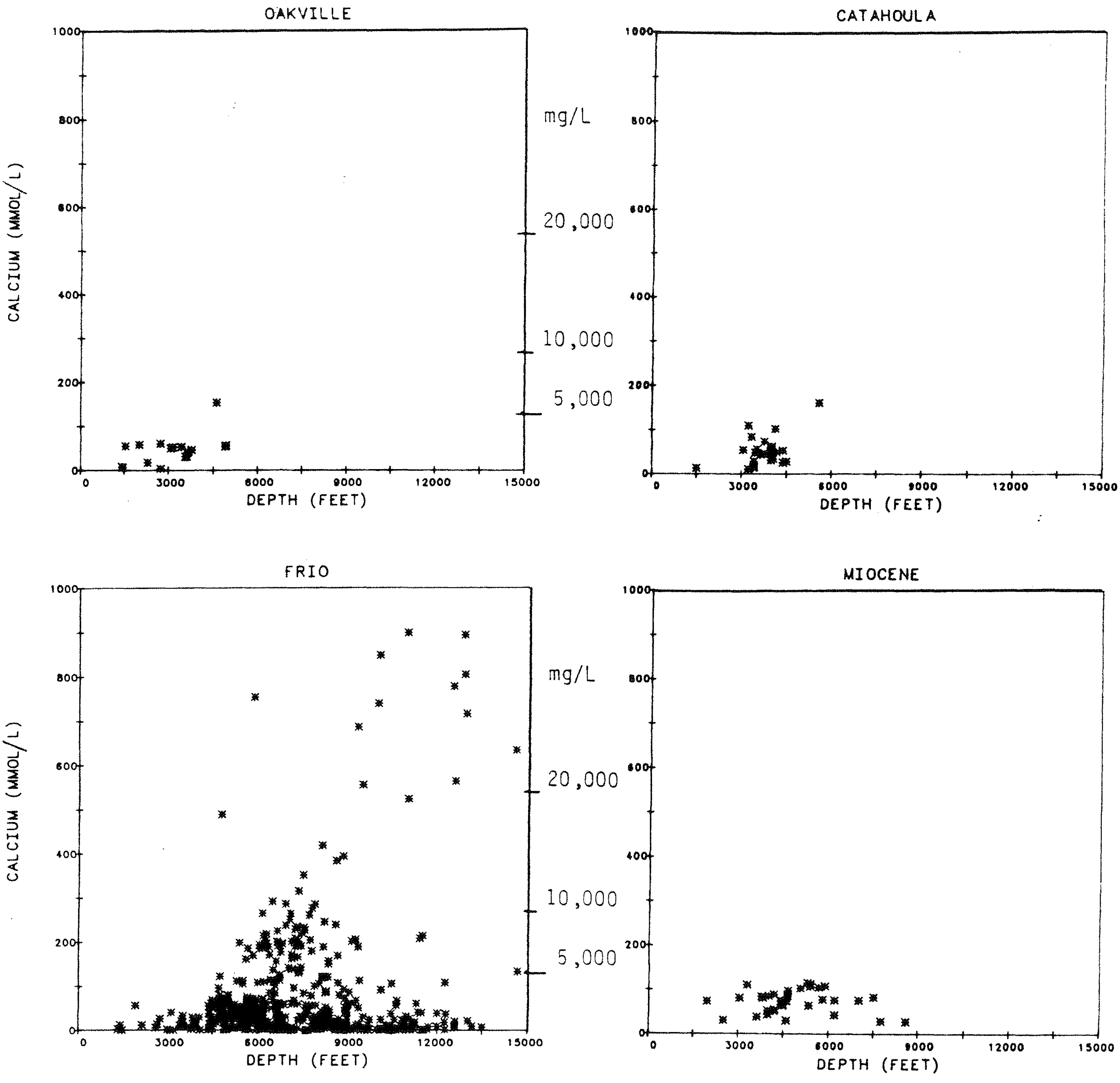


Figure 27. Calcium-depth plots for Oakville, Catahoula, Frio, and Miocene formation waters.

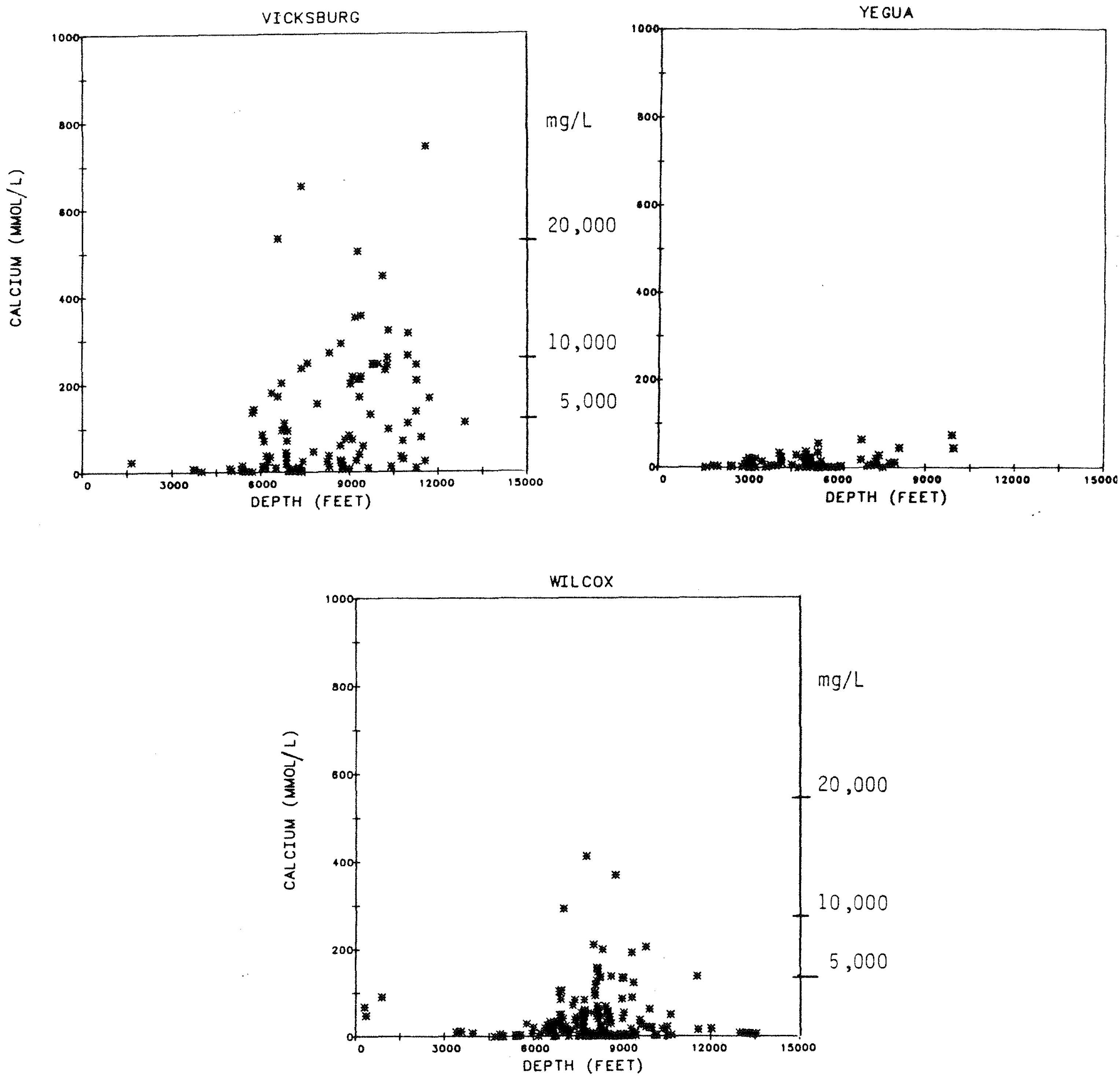


Figure 28. Calcium-depth plots for Vicksburg, Yegua, and Wilcox formation waters.

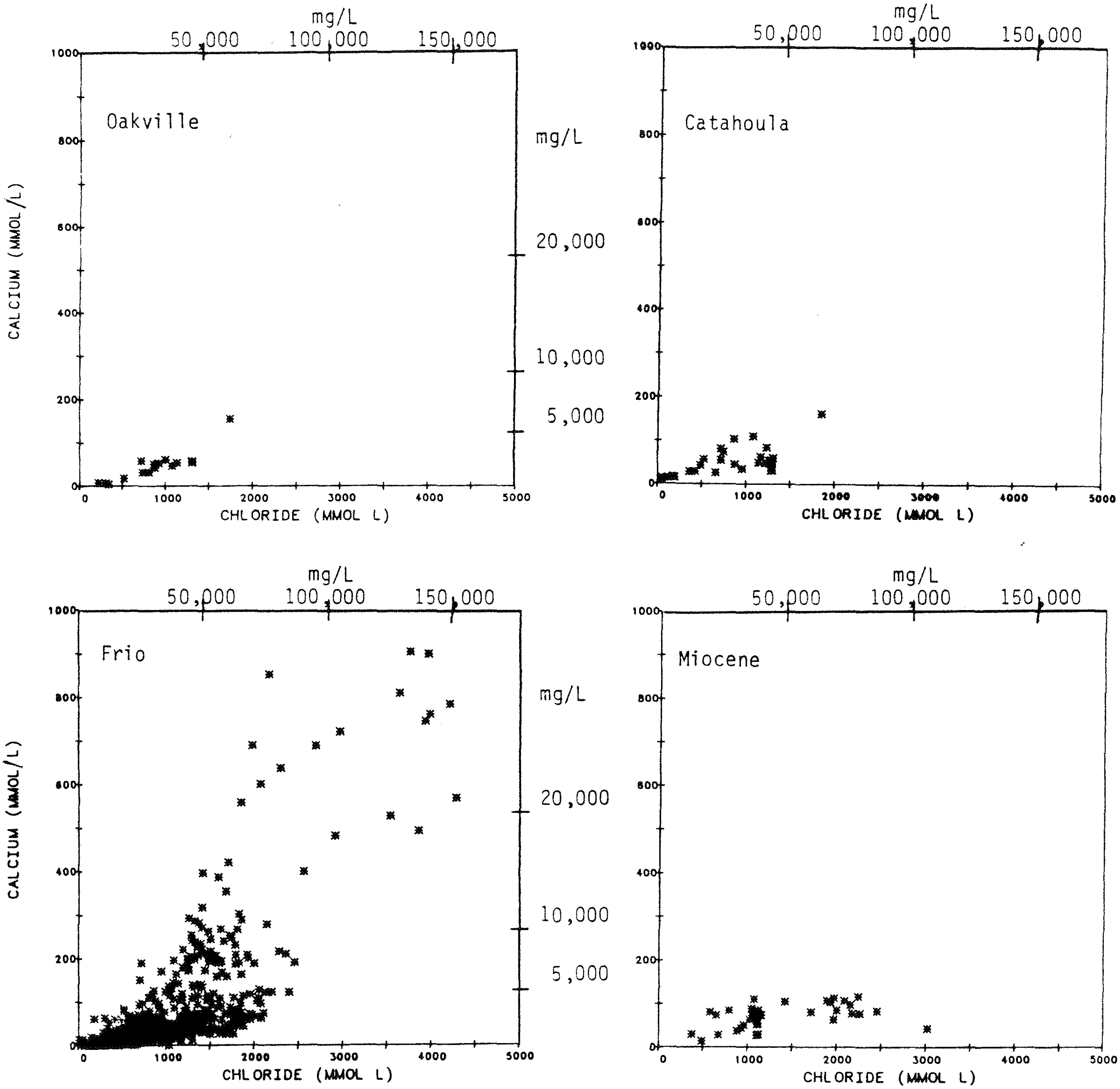


Figure 29. Calcium-chloride plots for Oakville, Catahoula, Frio, and Miocene formation waters.

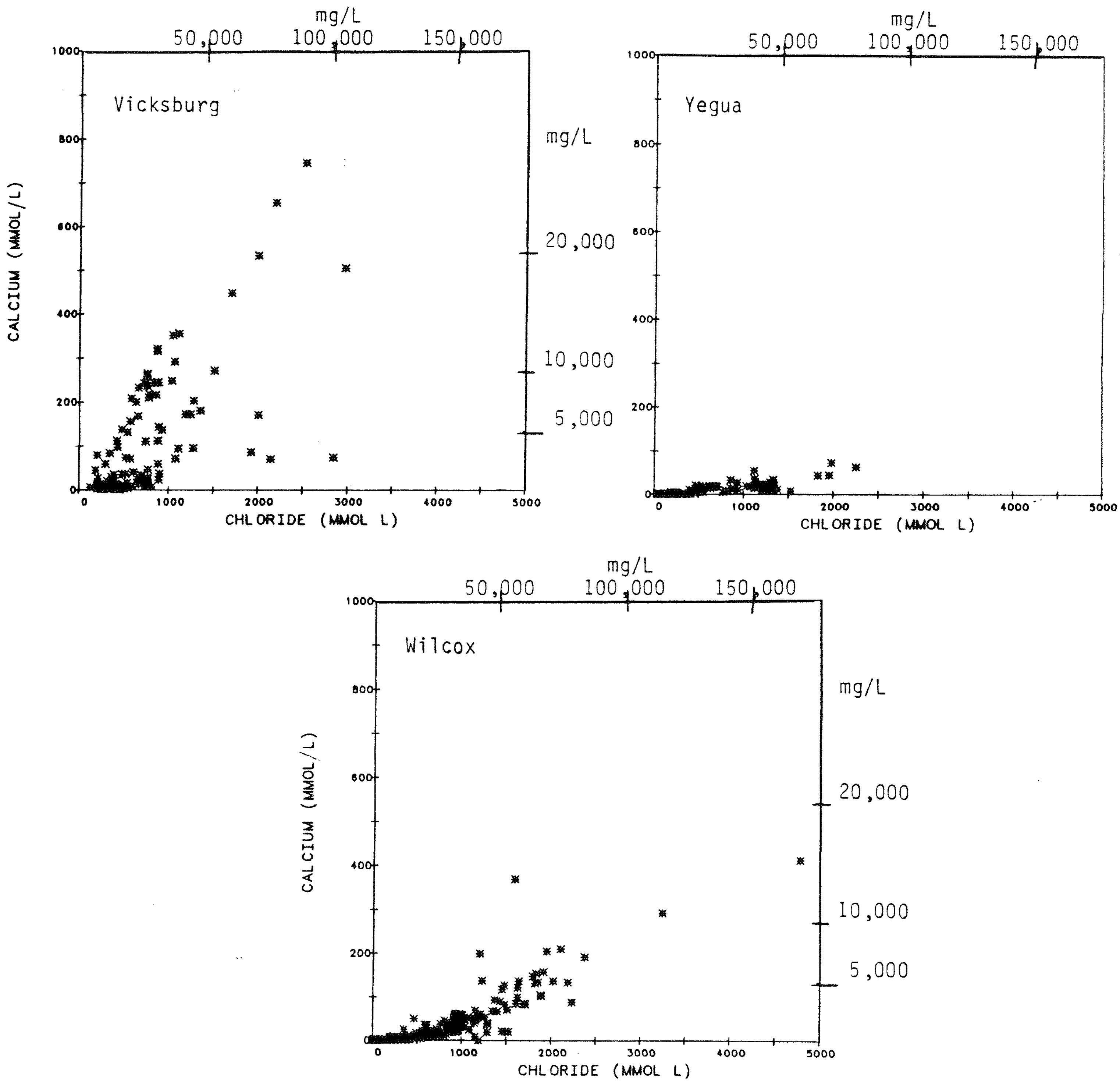


Figure 30. Calcium-chloride plots for Vicksburg, Yegua, and Wilcox formation waters.

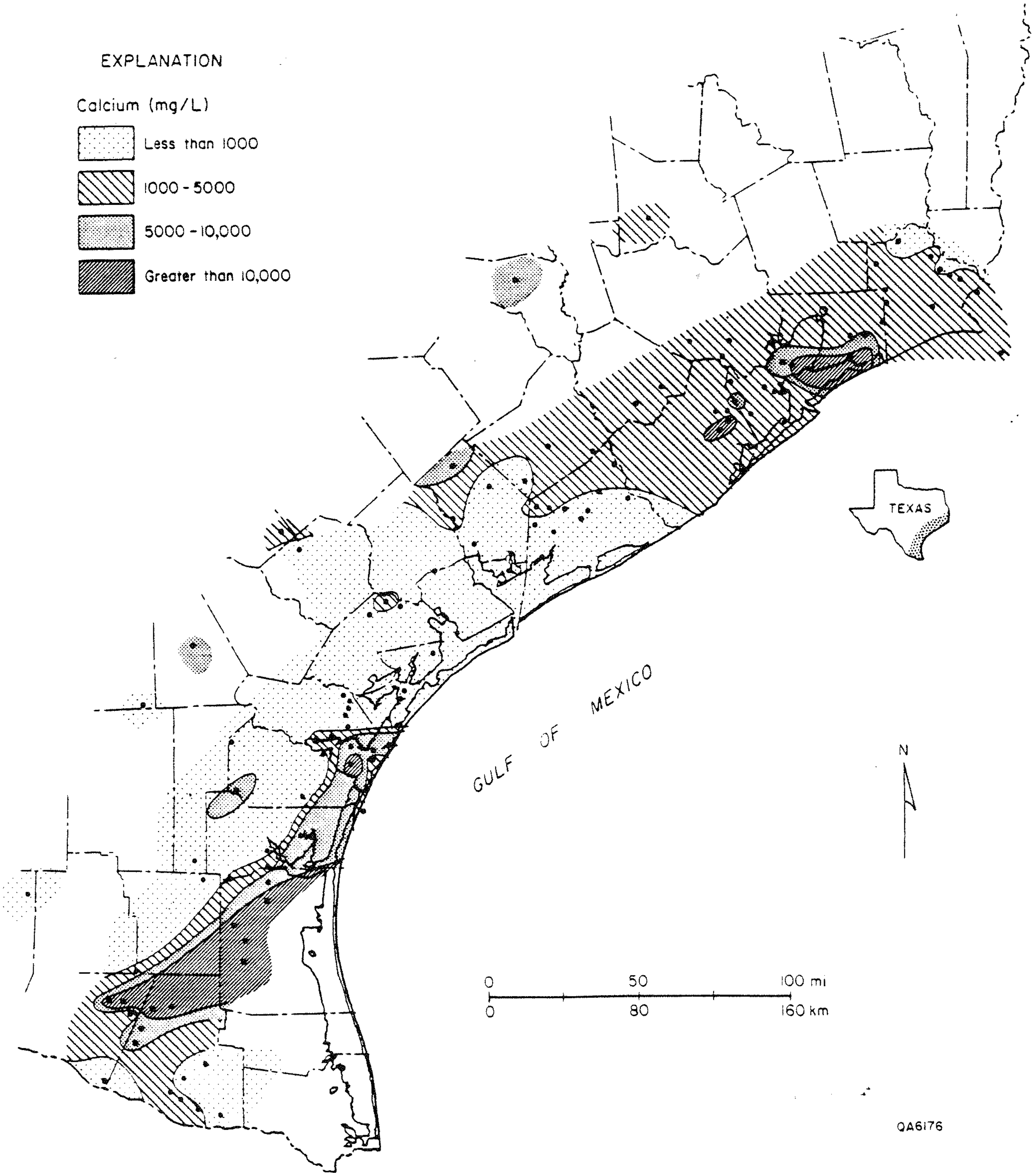


Figure 31. Calcium concentrations in geopressured Tertiary brines along the Texas Gulf Coast (after Morton and others, 1983).

magnesium concentrations increase slightly with chloride (figs. 32 and 33) and do not show any correlation with depth (figs. 34 and 35). Also, high magnesium concentrations found in some Vicksburg, Frio, and Wilcox brines are associated with high calcium concentrations. Therefore, magnesium and calcium seem to have similar sources and sinks in Gulf Coast aquifers.

Sulfate

Sulfate concentrations in deep Gulf Coast aquifers are mostly very low (table 4) because of the general reducing environment of these formations. High sulfate concentrations are reported in some Catahoula and Frio waters, at depths between 3,000 and 7,000 ft (figs. 36 and 37). Typically, these waters are low in chloride concentrations and thus may represent mixing of formation water and meteoric, fresh ground water (figs. 38 and 39). Carothers and Kharaka (1978) propose the presence of aerobic bacteria at depth down to approximately 6,000 ft. Aerobic environments could explain high sulfate concentrations at those extreme depths. However, this seems to be atypical, because most sulfate concentrations are low.

Alkalinity - Bicarbonate and Organic Acids

Alkalinity measurements of ground water are often expressed as bicarbonate (HCO_3) concentrations. Carothers and Kharaka (1978), however, showed that up to 100 percent of titrated alkalinity in California brines can be attributed to the presence of organic acids rather than to bicarbonate (fig. 40). They also reported concentrations of up to 1,530 mg/L organic acid in Gulf Coast brines (Carothers and Kharaka, 1978). Concentrations of volatile fatty acids of up to 166 mg/L (up to 35 percent of total titration alkalinity) from Tertiary formations of the Louisiana Gulf Coast were reported by Workman and Hanor (1985). This suggests that bicarbonate concentrations reported for Gulf Coast brines (in the absence of organic acid determination) may be questionable and in general too high. This is of major

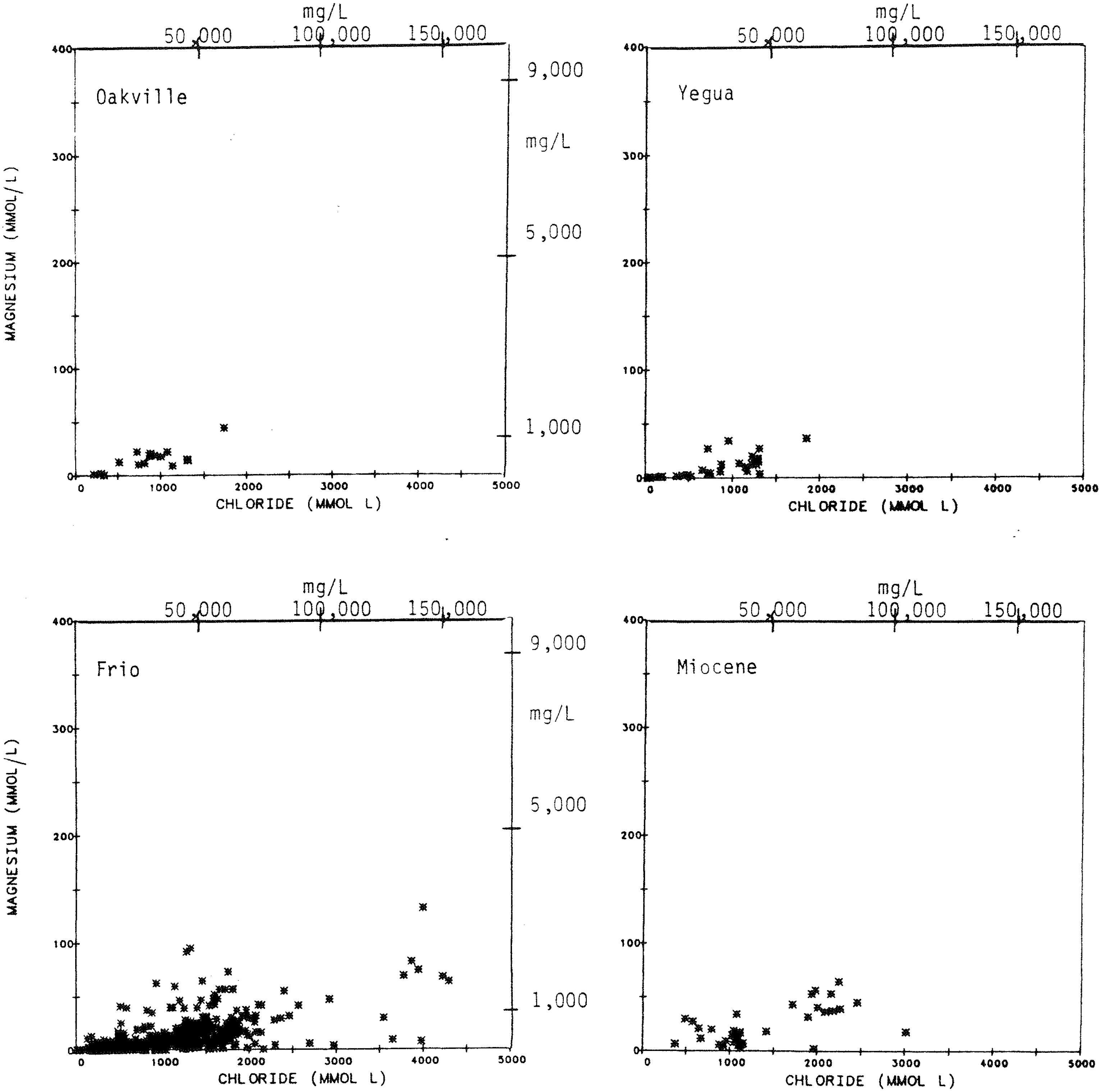


Figure 32. Magnesium-chloride plots of Oakville, Catahoula, Frio, and Miocene formation waters.

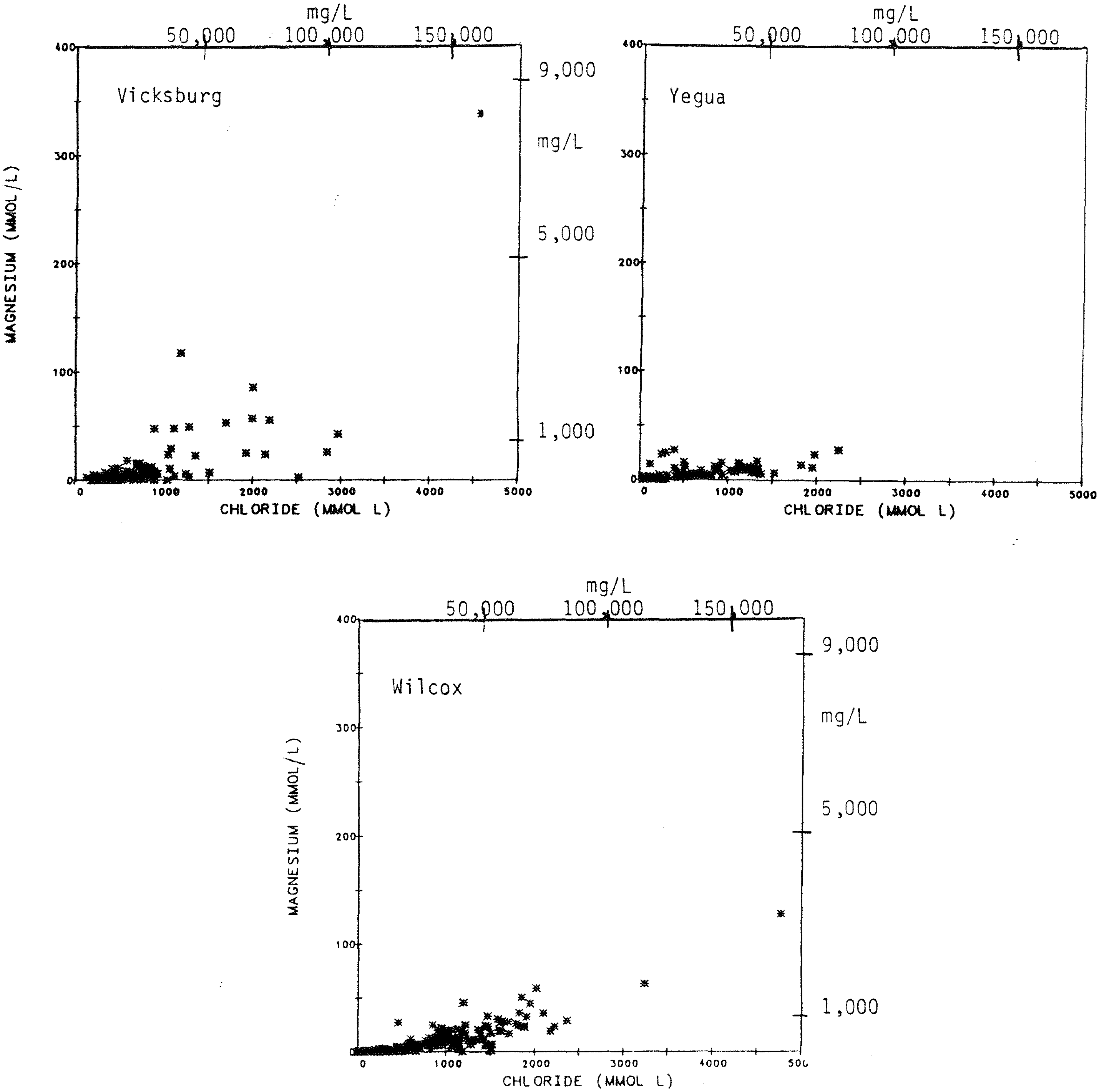


Figure 33. Magnesium-chloride plots of Vicksburg, Yegua, and Wilcox formation waters.

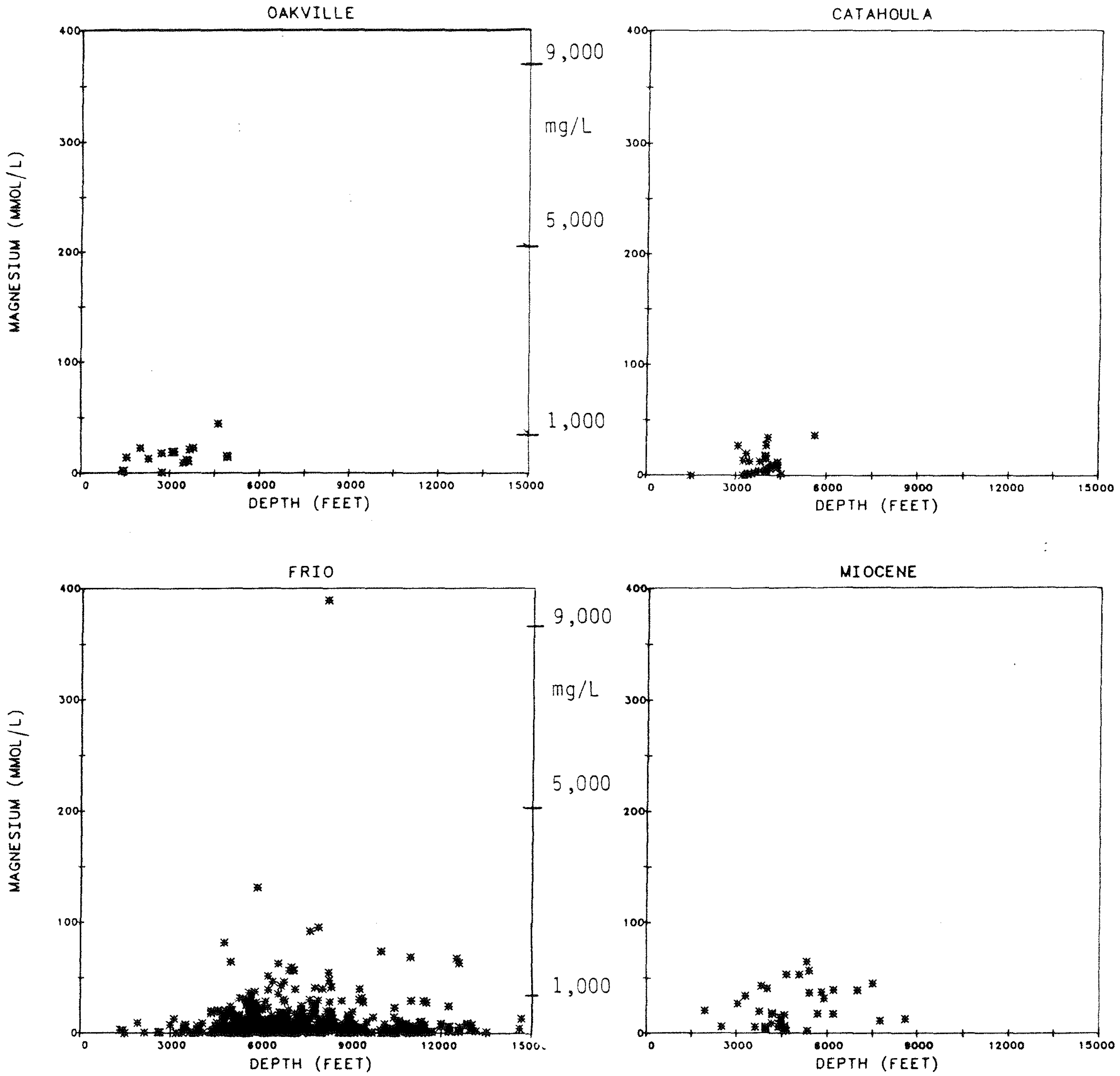


Figure 34. Magnesium-depth plots of Oakville, Yegua, Frio, and Miocene formation waters.

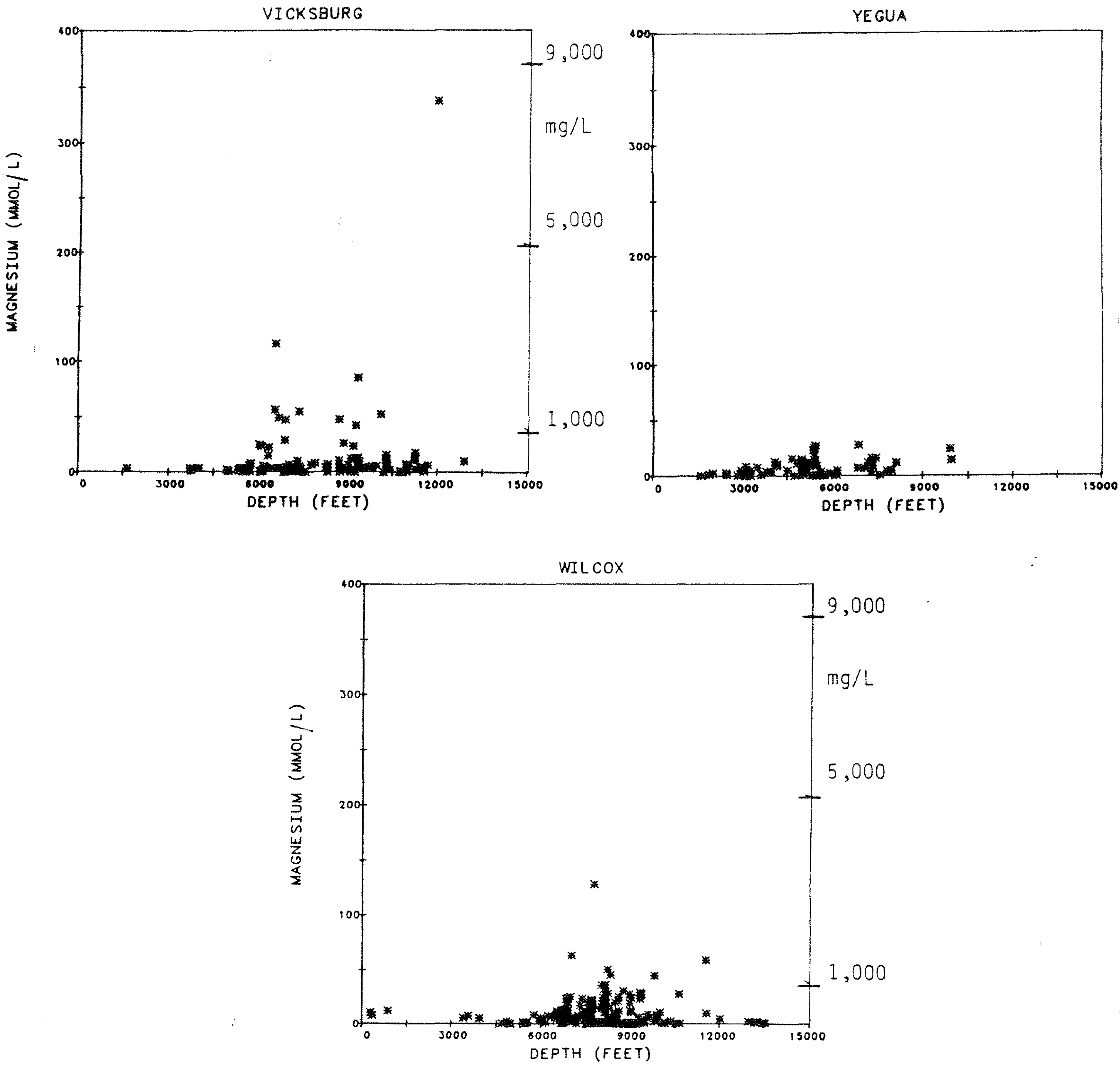


Figure 35. Magnesium-depth plots for Vicksburg, Yegua, and Wilcox formation waters.

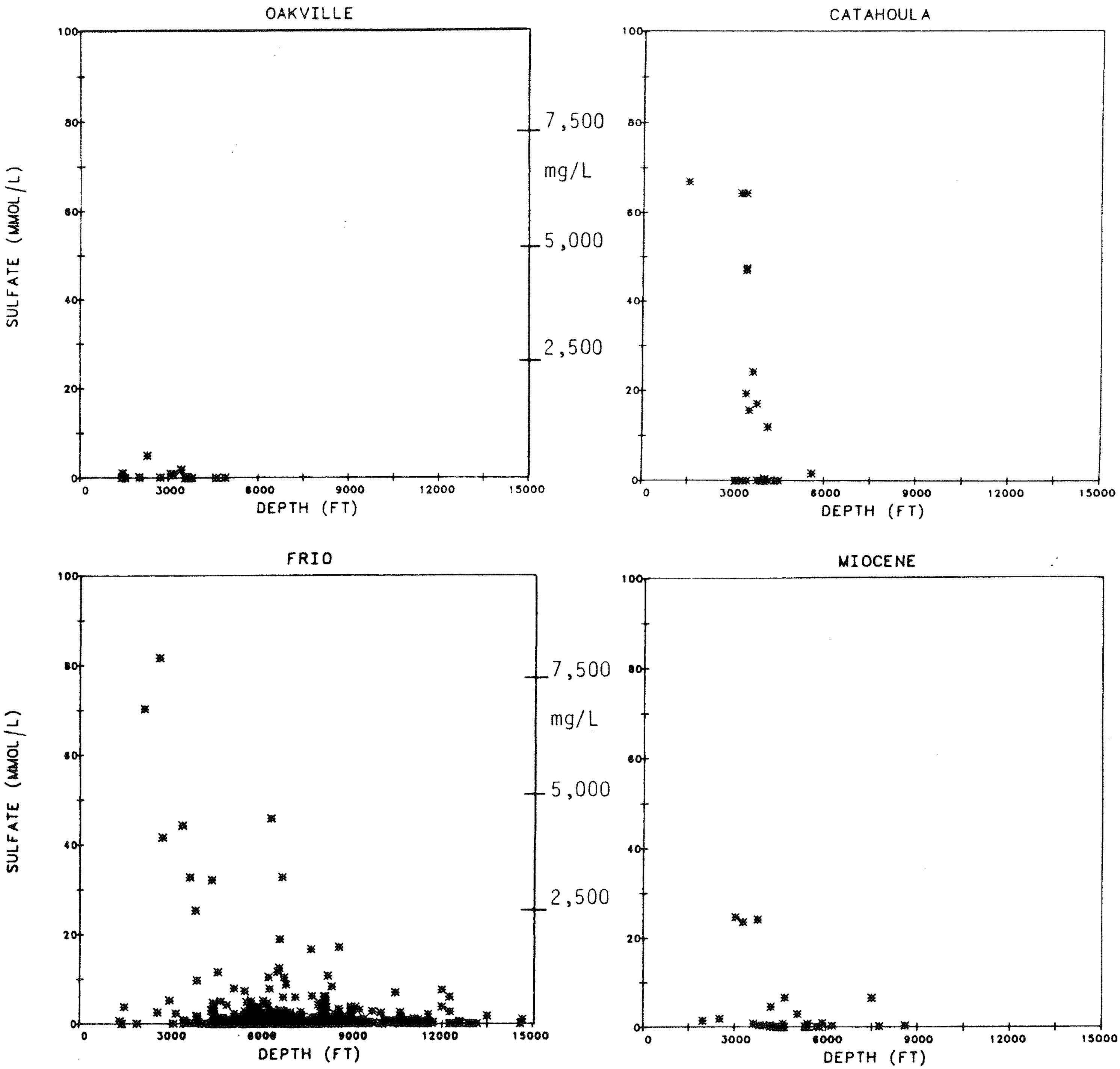


Figure 36. Sulfate-depth plots for Oakville, Catahoula, Frio, and Miocene formation waters.

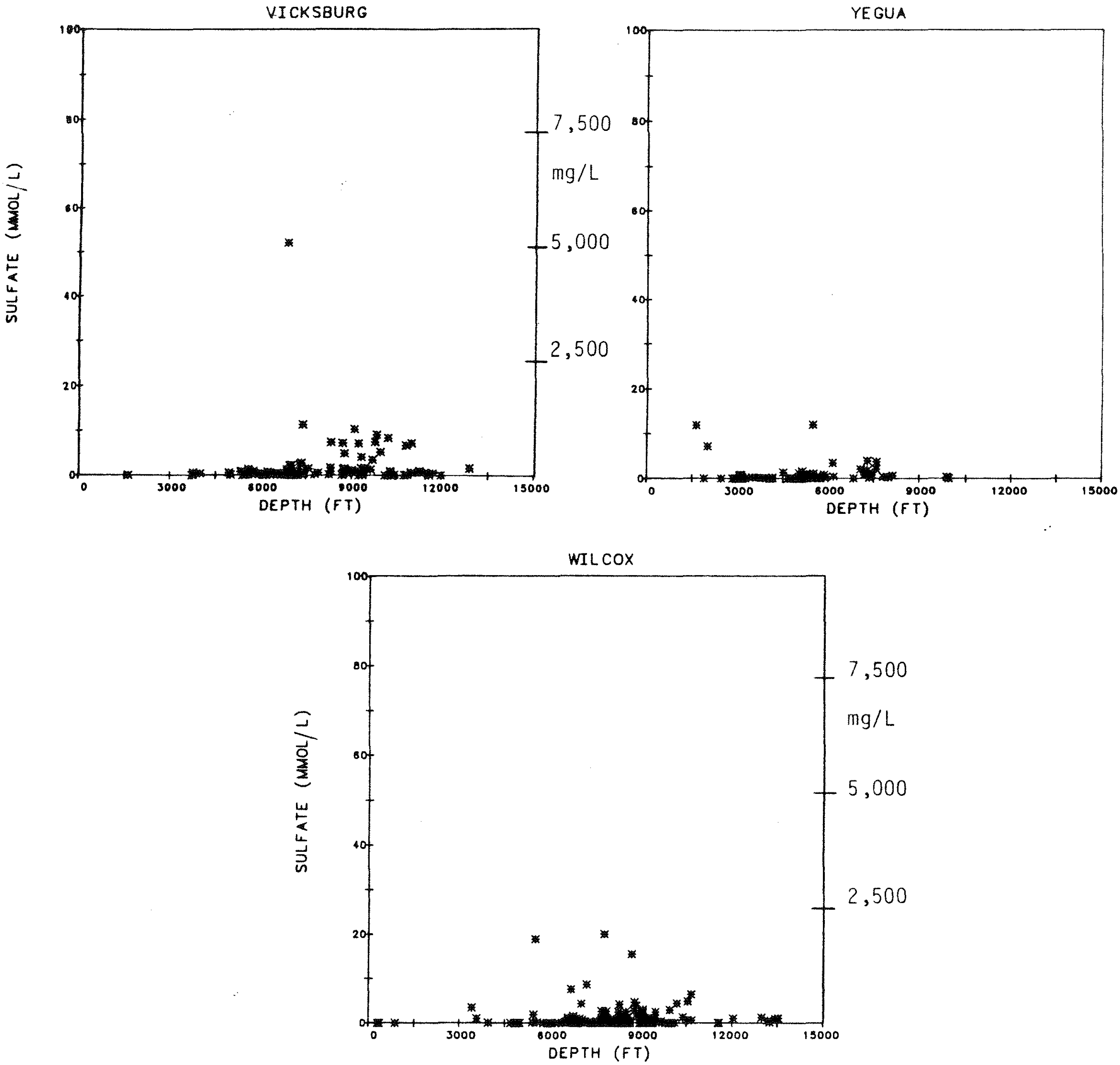


Figure 37. Sulfate-depth plots for Vicksburg, Yegua, and Wilcox formation waters.

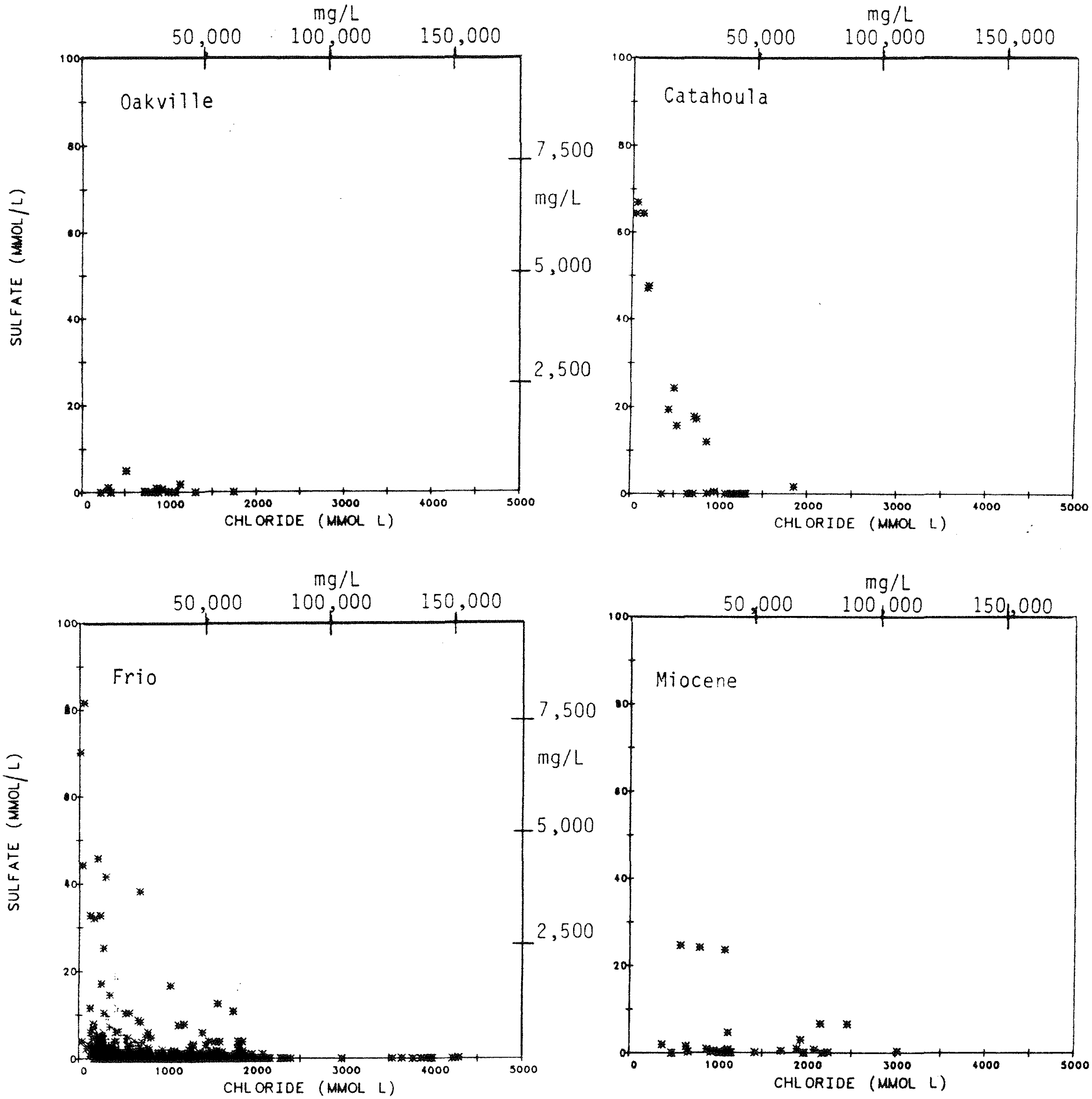


Figure 38. Sulfate-chloride plots for Oakville, Catahoula, Frio, and Miocene formation waters.

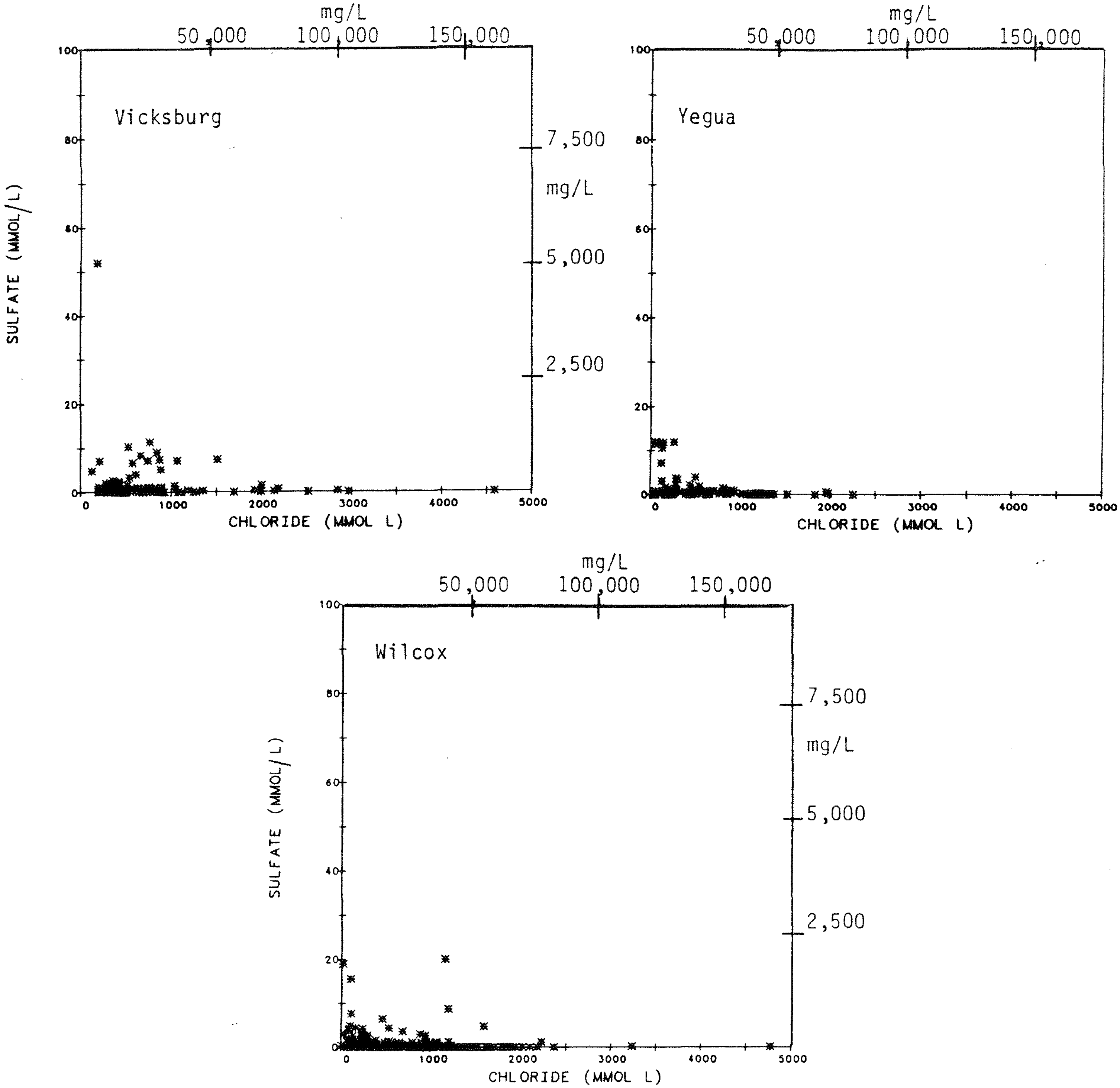


Figure 39. Sulfate-chloride plots for Vicksburg, Yegua, and Wilcox formation waters.

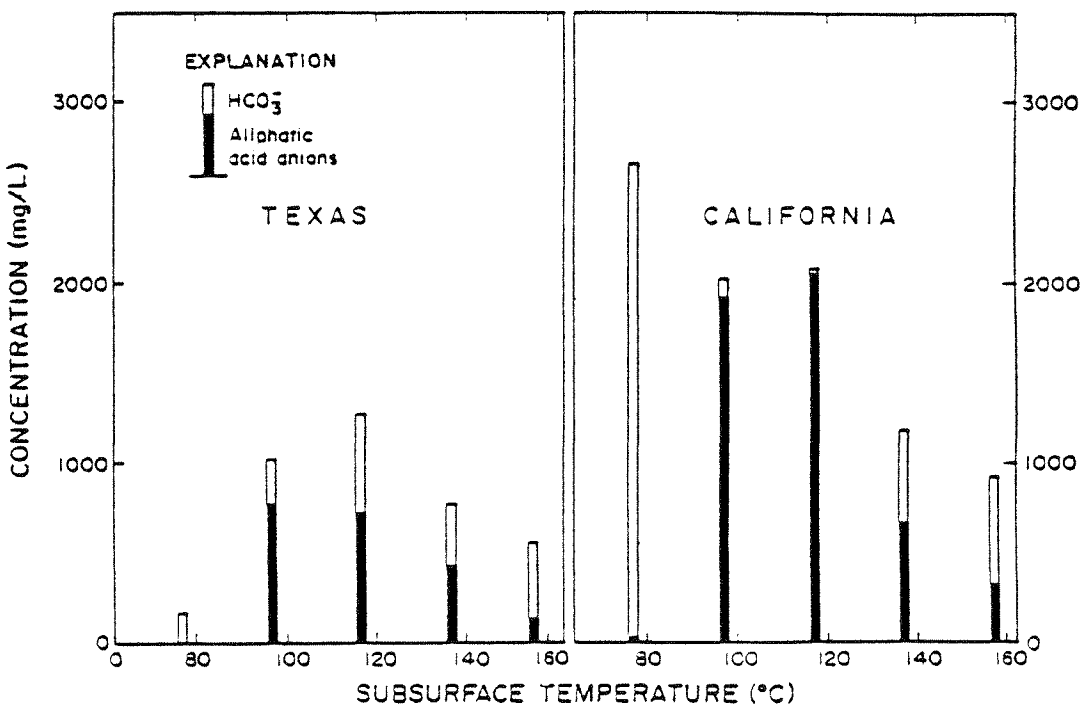


Figure 40. Average concentrations of aliphatic acid anions and bicarbonate in oil field waters from Texas and California (from Carothers and Kharaka, 1978).

importance in estimating stabilities of carbonate minerals because bicarbonate activities are used in calculation of saturation states.

Alkalinity concentrations are relatively low and do not correlate with depth in Oakville, Catahoula, and Miocene waters (figs. 41 and 42). In contrast, concentrations of several thousands of mg/L were measured in Frio, Vicksburg, Yegua, and Wilcox brines. High alkalinities typically are found in a depth range of approximately 5,000 to 10,000 ft below land surface. These depths are not covered by samples from the three youngest units, therefore, it is possible that high alkalinities also occur in these units at greater depths. Considering that highest alkalinities appear below 5,000 ft, it is surprising to see consistent trends of decreasing alkalinity with increase in chlorinity (figs. 43 and 44). Typically, alkalinity concentrations are less than approximately 2,000 mg/L at chloride concentrations of more than 20,000 mg/L. Recharge of fresh water and mixing between bicarbonate-rich fresh water and low-bicarbonate brine could explain the alkalinity-chloride plot. However, alkalinity-depth plots suggest a deep rather than a shallow source of alkalinity.

As mentioned above, organic acids may contribute significantly to high alkalinities in Frio, Yegua, and Wilcox brines. Workman and Hanor (1985) proposed preferential production of volatile fatty acids in the deep subsurface at temperatures exceeding 80^{o} to 100^{o}C (175^{o} to 210^{o}F). A temperature boundary of 80^{o}C between brines low in aliphatic acid anions at lower temperatures and brines rich in aliphatic acid anions at higher temperatures was also given by Carothers and Kharaka (1978). Below this temperature two processes may cause the low concentrations of organic acids in samples obtained by Carothers and Kharaka (1978): (1) microbiologic degradation by the action of aerobic <u>and</u> anaerobic bacteria and (2) dilution by percolating meteoric water. Bacterial degradation is indicated by

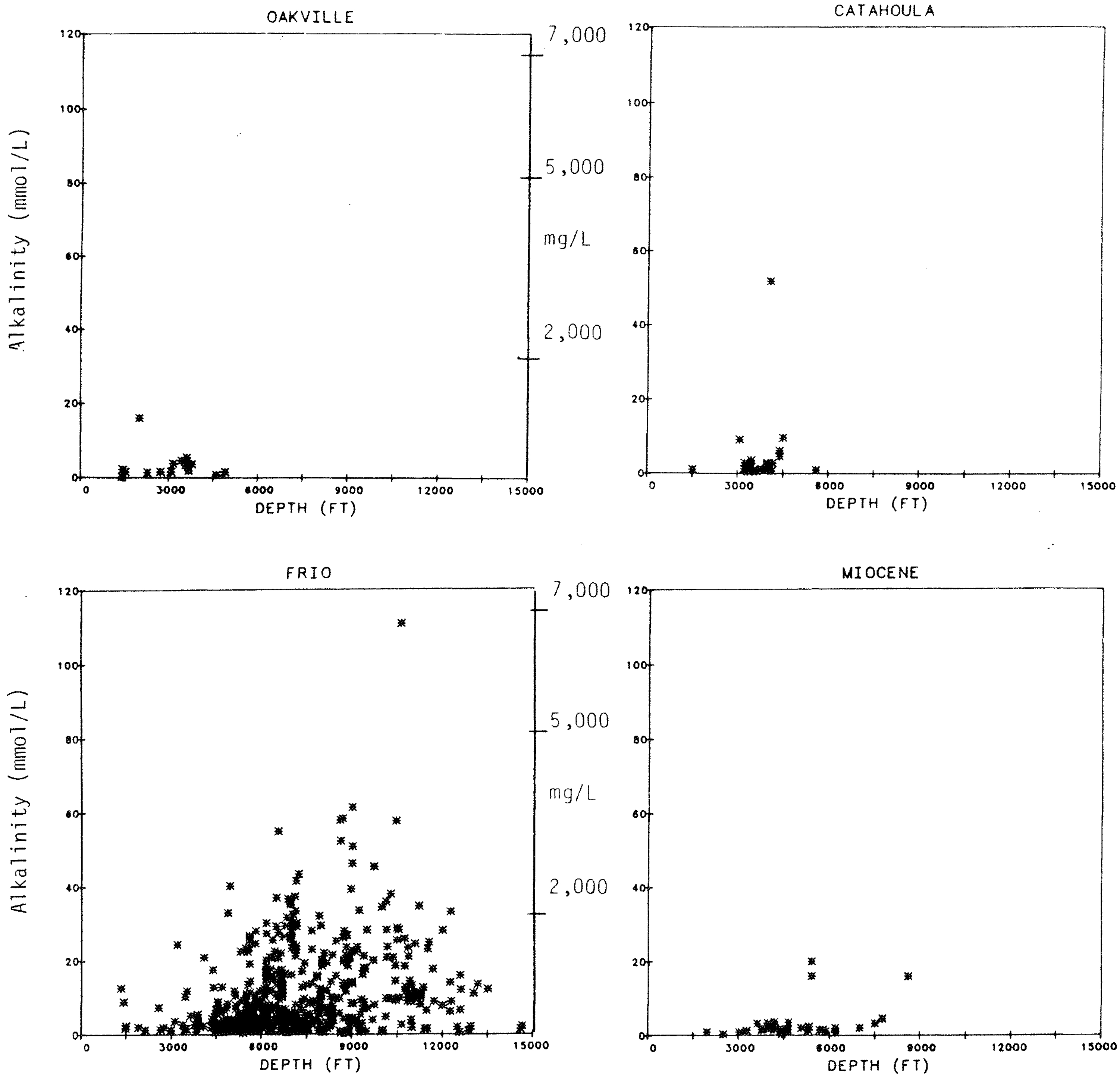


Figure 41. Alkalinity-depth plots for Oakville, Catahoula, Frio, and Miocene formation waters.

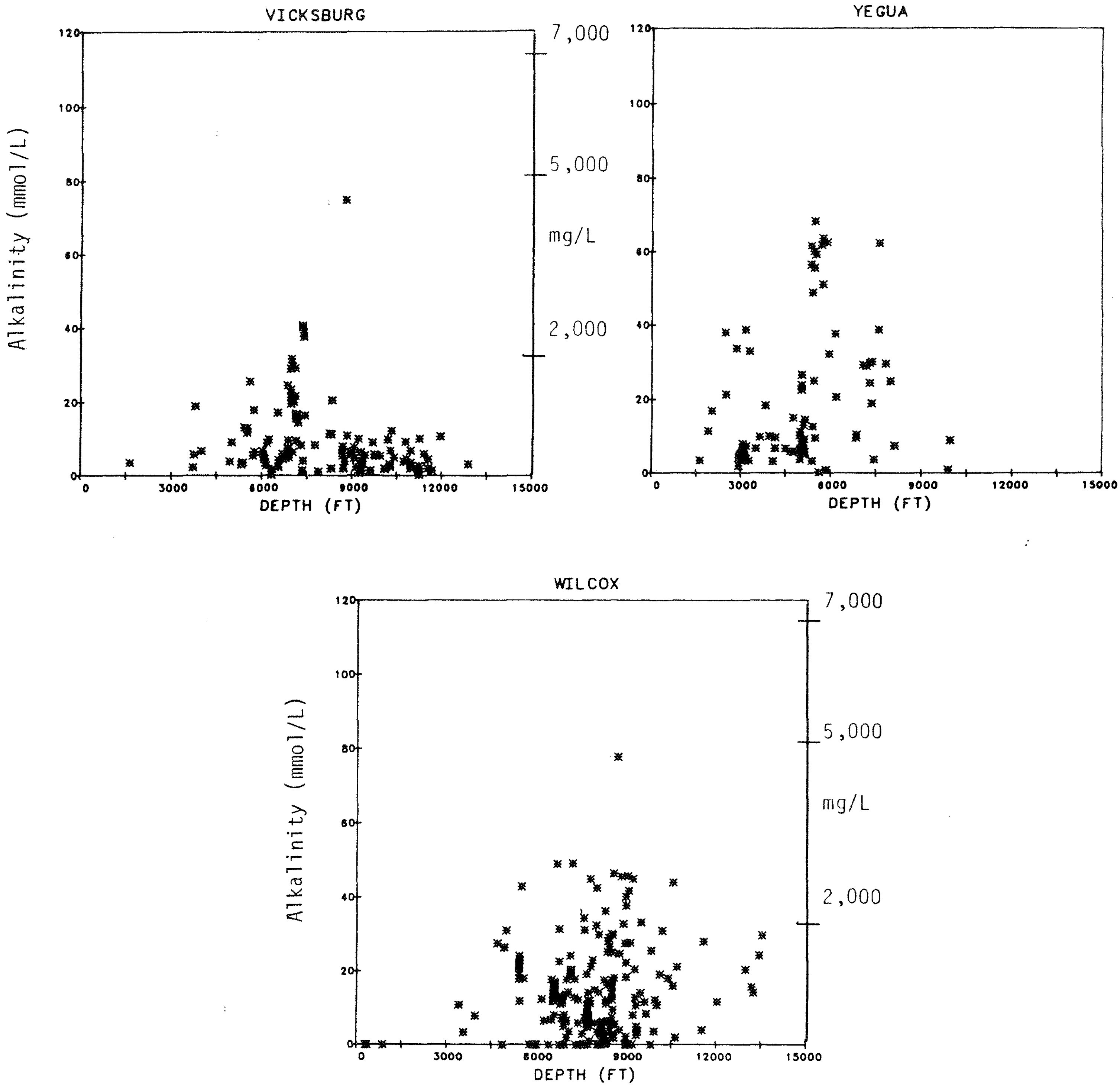


Figure 42. Alkalinity-depth plots for Vicksburg, Yegua, and Wilcox formation waters.

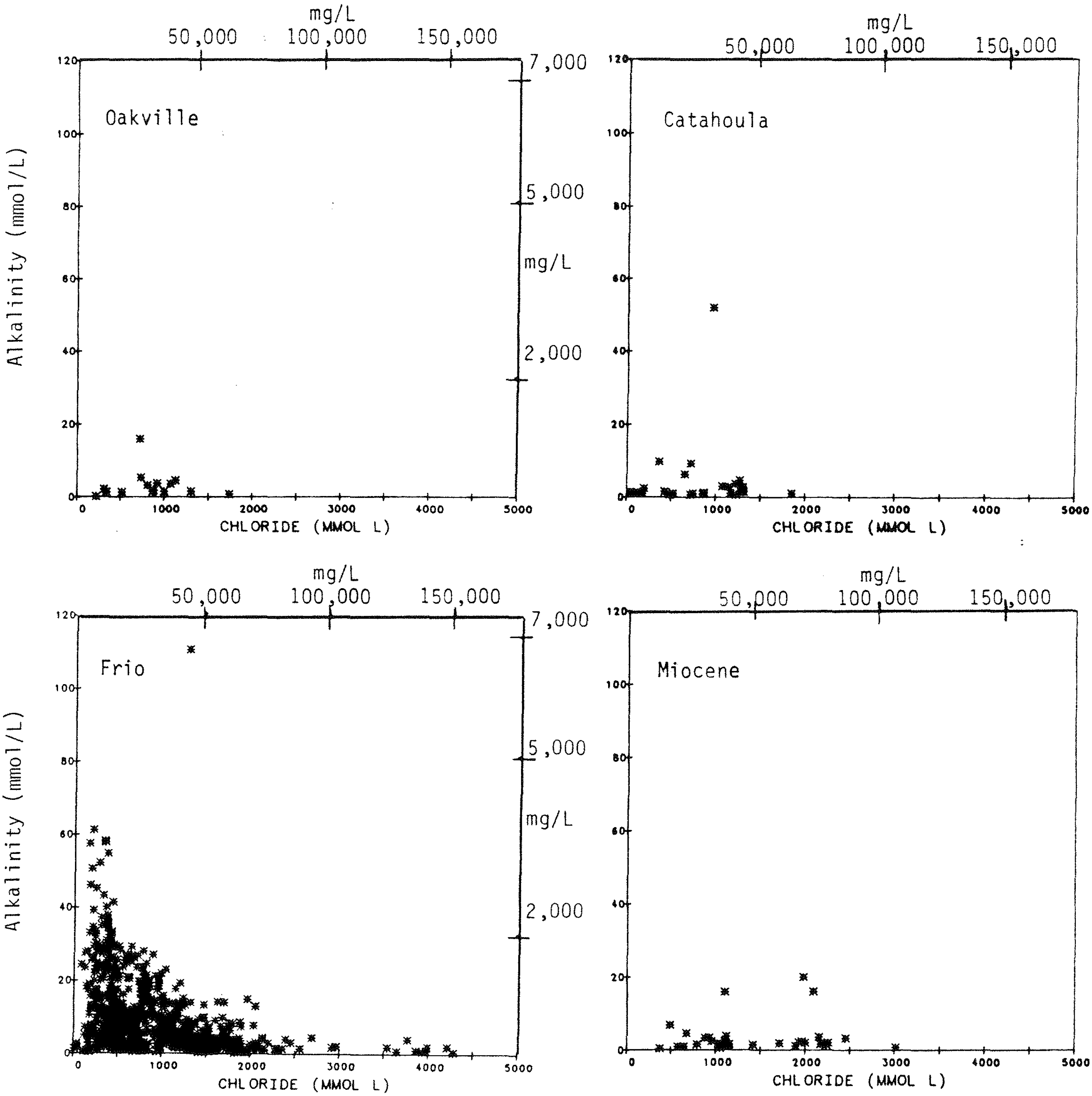


Figure 43. Alkalinity-chloride plots for Oakville, Catahoula, Frio, and Miocene formation waters.

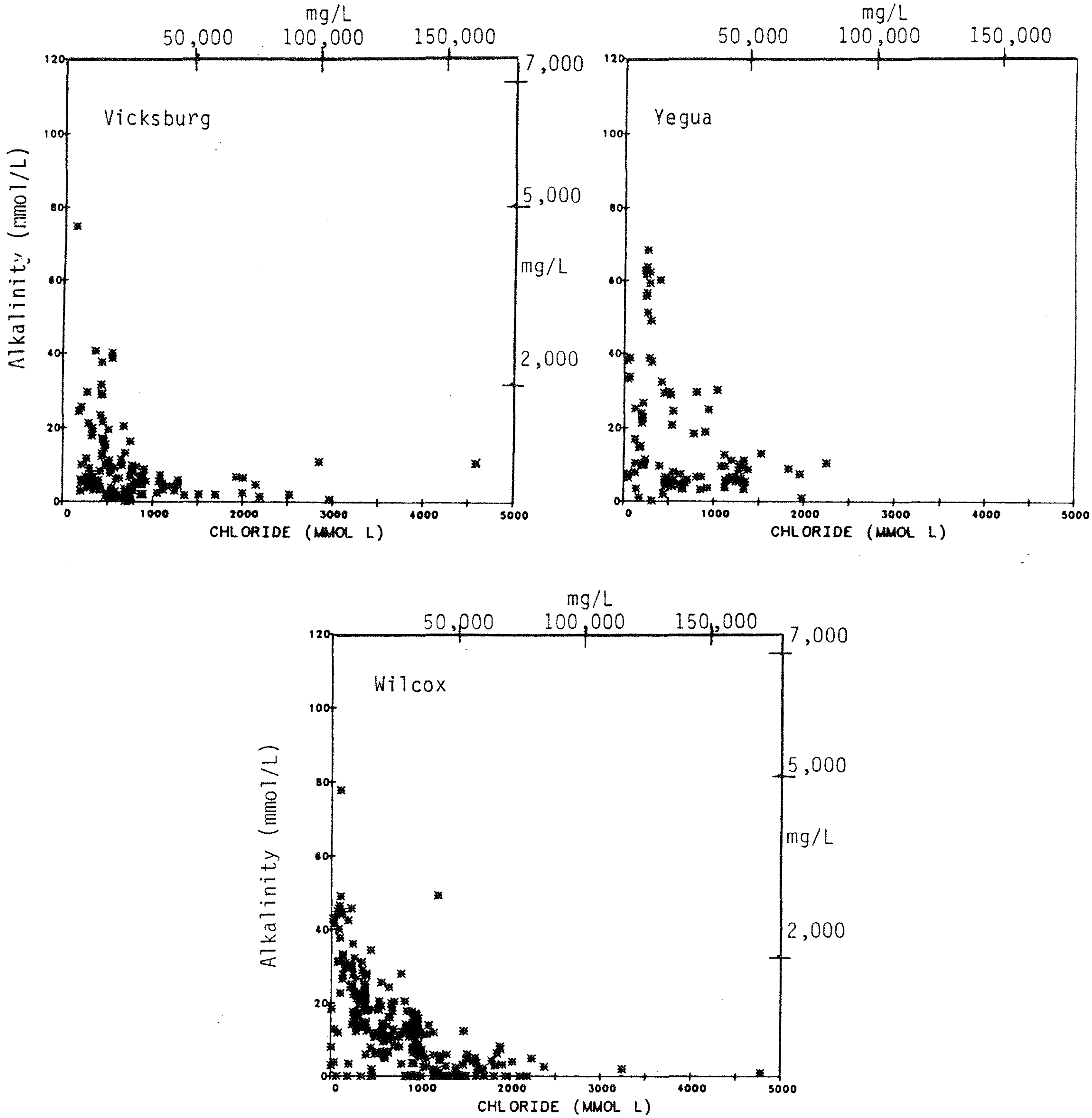


Figure 44. Alkalinity-chloride plots for Vicksburg, Yegua, and Wilcox formation waters.

preferential loss of certain organic constituents over others. However, dilution by meteoric water is needed because only the action of aerobic and anaerobic bacteria, which cannot exist within the same environment, can explain the type of degradation observed (Carothers and Kharaka, 1978). Thermal decarboxylation and oxidation of organic acids are additional possible processes of degradation of organic acids (Workman and Hanor, 1985). Possible degradation products include methane and bicarbonate.

Given an average geothermal gradient of approximately 1.6^{o}F/100 ft for the Gulf Coast, temperatures in excess of 80^{o}C translate to depths of greater than approximately 6,000 ft below land surface in Gulf Coast aquifers. This suggests that production of organic acids occurs preferentially at depths below 6,000 ft, whereas degradation should prevail above this depth. This could explain alkalinity-depth relationships observed in Frio, Vicksburg, Yegua, and Wilcox brines (figs. 41 and 42), assuming that organic acids contribute significantly to reported total alkalinities. Mixing with fresh water low in organics could also explain the alkalinity-depth relationship. However, neither bacterial degradation nor mixing with fresh water explains the alkalinity-chloride relationship (figs. 43 and 44).

pH

An important parameter in characterizing chemical environments and in estimating saturation states is the pH of formation water. Reported values of pH in Gulf Coast brines, measured at wellhead or in laboratories, range from 3 to 12 pH units, with a range of mean values from 6.9 to 7.4 (table 4). A correlation with depth and chloride is indicated for some aquifers but generally is very poor (figs. 45 through 48).

There are numerous observations that reported pH values overestimate true in situ pH values of formation water by 1 to 3 pH units. Kharaka and others (1980) computed pH values for geopressured Gulf Coast brines, ranging from 4.0 to 5.5.

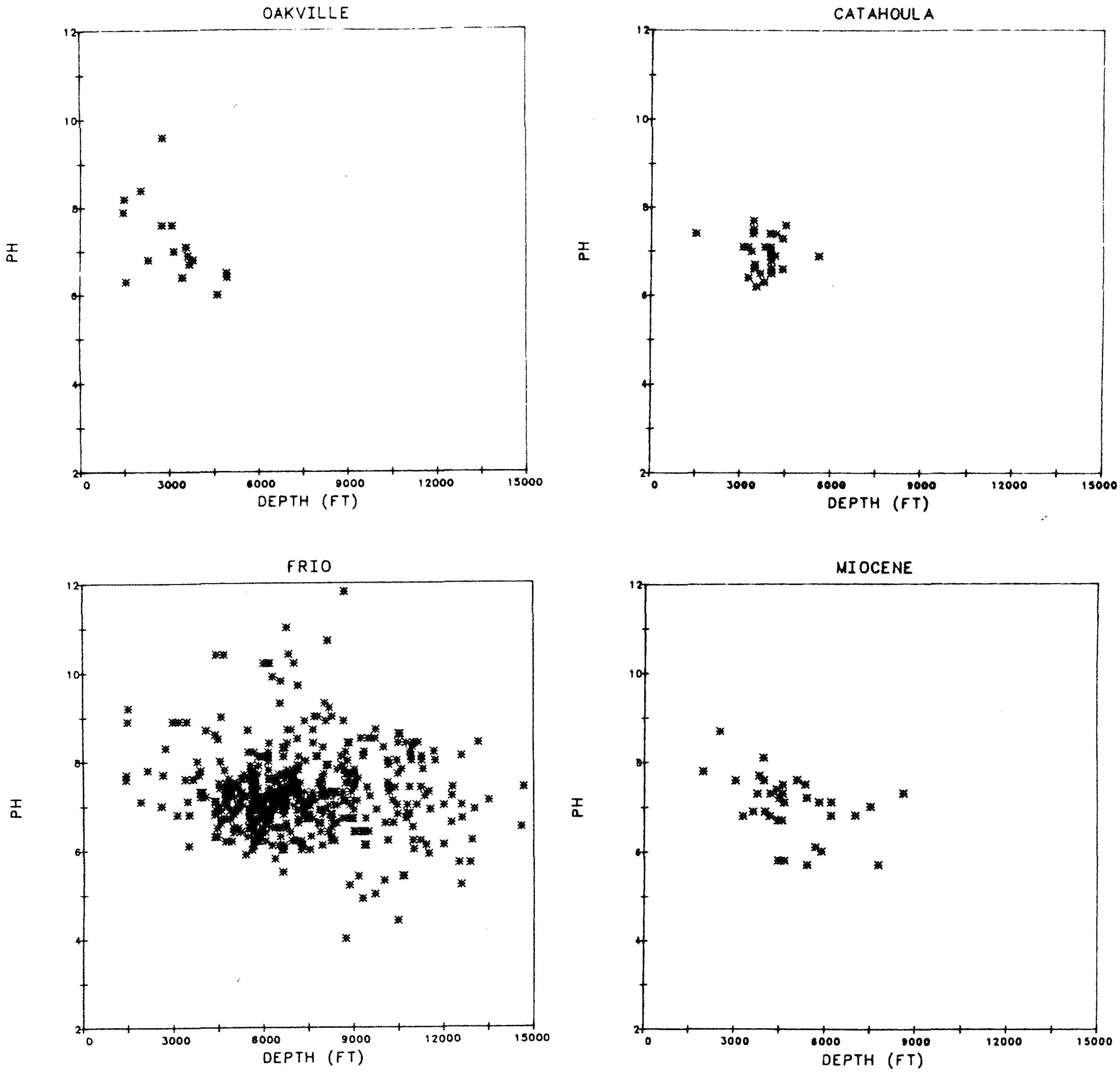


Figure 45. Plots of pH versus depth for Oakville, Catahoula, Frio, and Miocene formation waters.

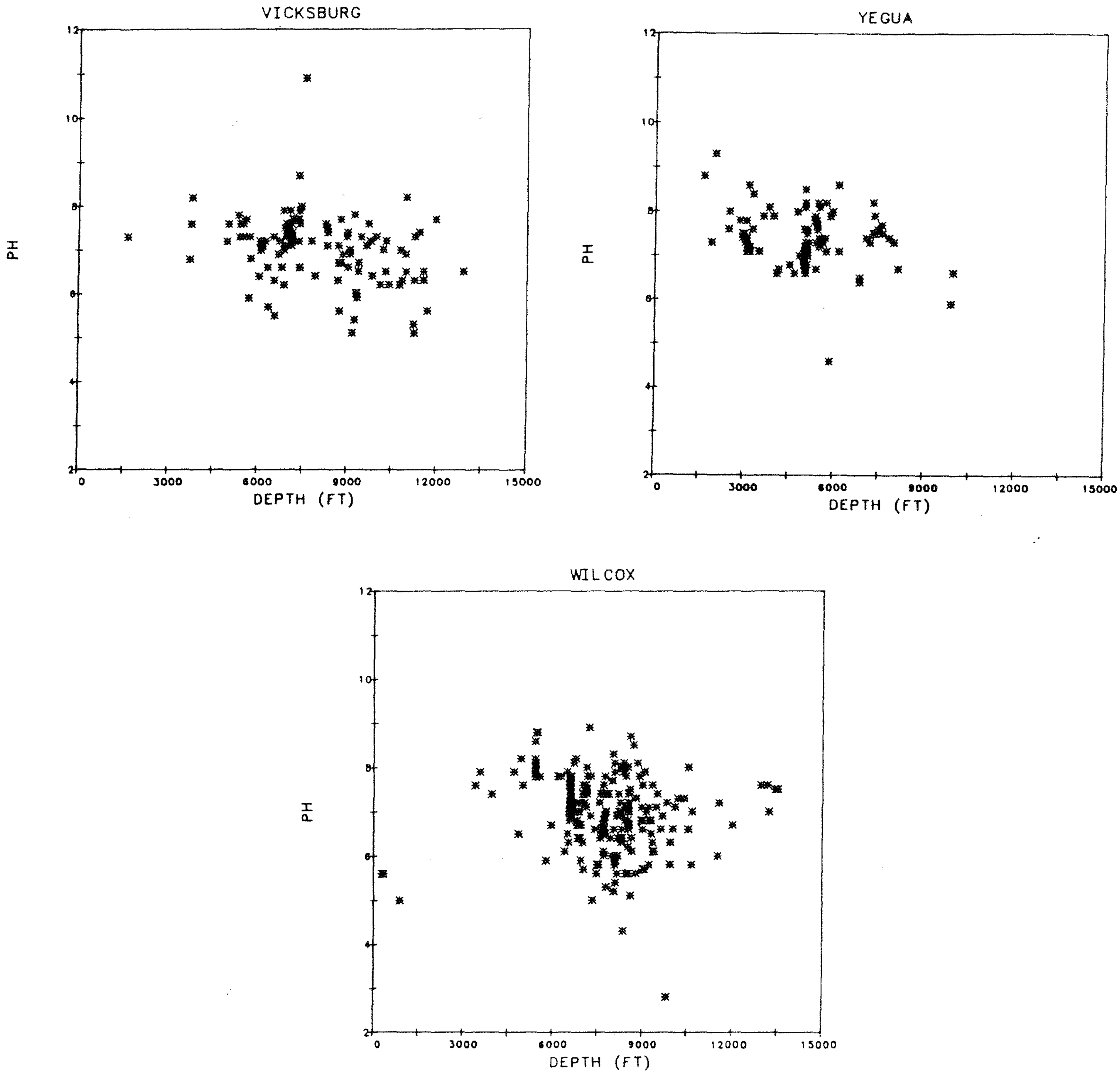


Figure 46. Plots of pH versus depth for Vicksburg, Yegua, and Wilcox formation waters.

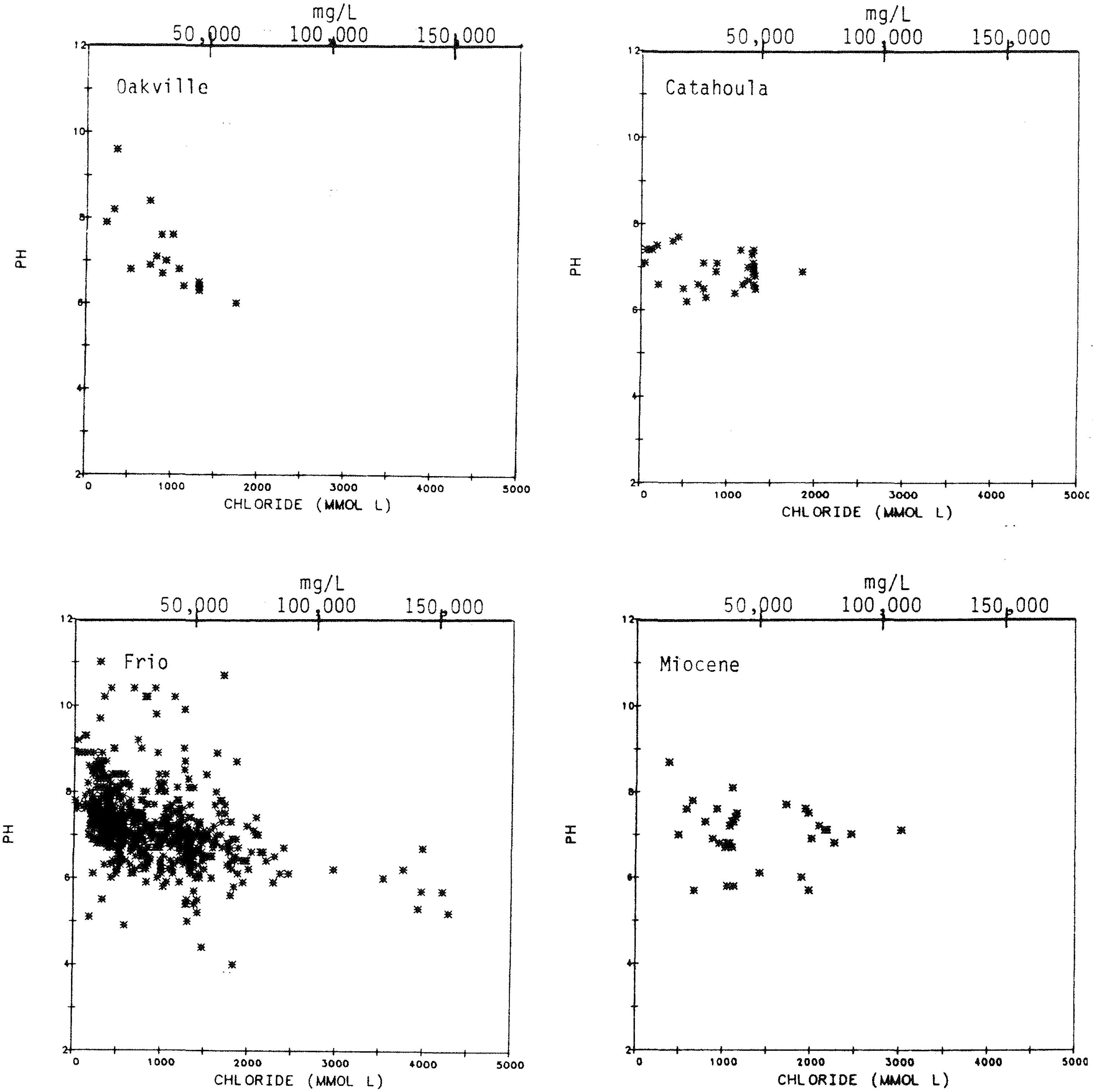


Figure 47. Plots of pH versus chloride for Oakville, Catahoula, Frio, and Miocene formation waters.

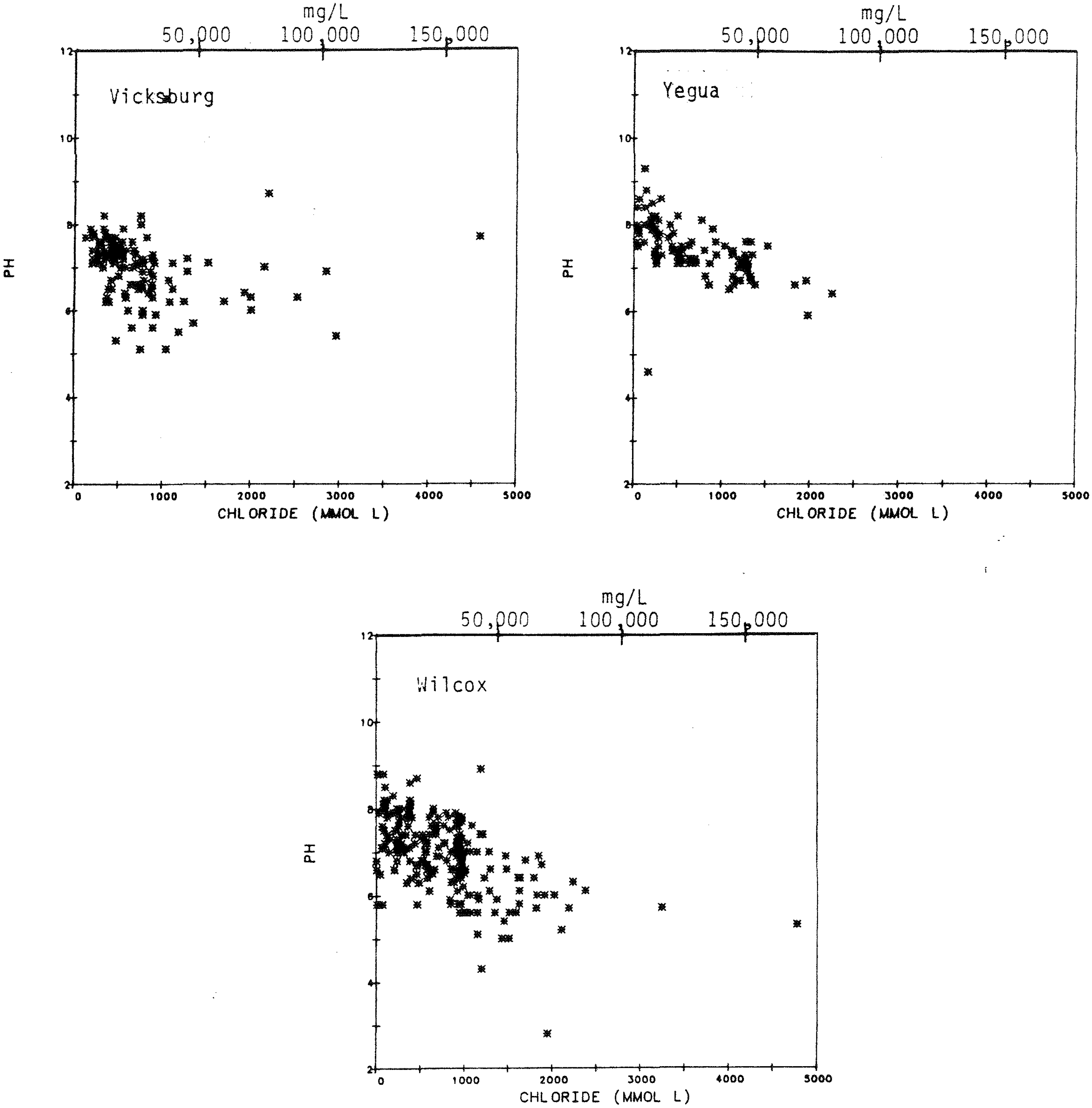


Figure 48. Plots of pH versus chloride for Vicksburg, Yegua, and Wilcox formation waters.

In contrast, values measured at the wellhead were up to 2.5 pH units higher (Kharaka and others, 1980). Franks and Forester (1985) calculated a pH range from 4.6 to 6.7 for Gulf Coast brines assuming SiO_2 saturation, with a mean range of 5.3 to 6.0. In-line pH measurements of formation water from a well at the Louisiana Gulf Coast recorded a pH range from 4.1 to 5.4. In contrast, laboratory measurements of pH from the same samples ranged from 6.2 to 6.6 (Hankins and others, 1978). Outgassing of CO_2 and/or other gases during and after collection is probably responsible for the elevated pH values reported for Gulf Coast brines. It can be assumed that typical in situ pH values of Gulf Coast formation water range from 4.0 to 6.0.

Temperature

Chemical reactions within and between fluids and between aquifer minerals and fluids are dependent on temperature. Such an example was mentioned above regarding production and degradation of organic acids. Precipitation reactions, dissolution reactions, and diagenesis of mineral matter are other temperature-dependent processes in aquifer systems. For example, smectite converts to illite at an increased rate in the approximate critical range of subsurface temperatures from 200^{o} to $220^{o}F$ (Burst, 1969), which alters cation exchange capacities of the clays.

Temperature gradients, expressed as temperature units per depth unit, can be calculated from log-derived or from measured temperature values. Both methods contain some degree of uncertainty but measured temperatures should be preferred over log-derived temperatures. This was shown by Berg and Habeck (1982) and by Morton and others (1983), who observed that calculated values of temperature underestimate measured values of temperature in Gulf Coast formation waters by as much as $50^{o}F$ (fig. 49).

Temperature gradients reported for aquifers along the Texas Gulf Coast vary significantly vertically, laterally, and from investigator to investigator. Within the

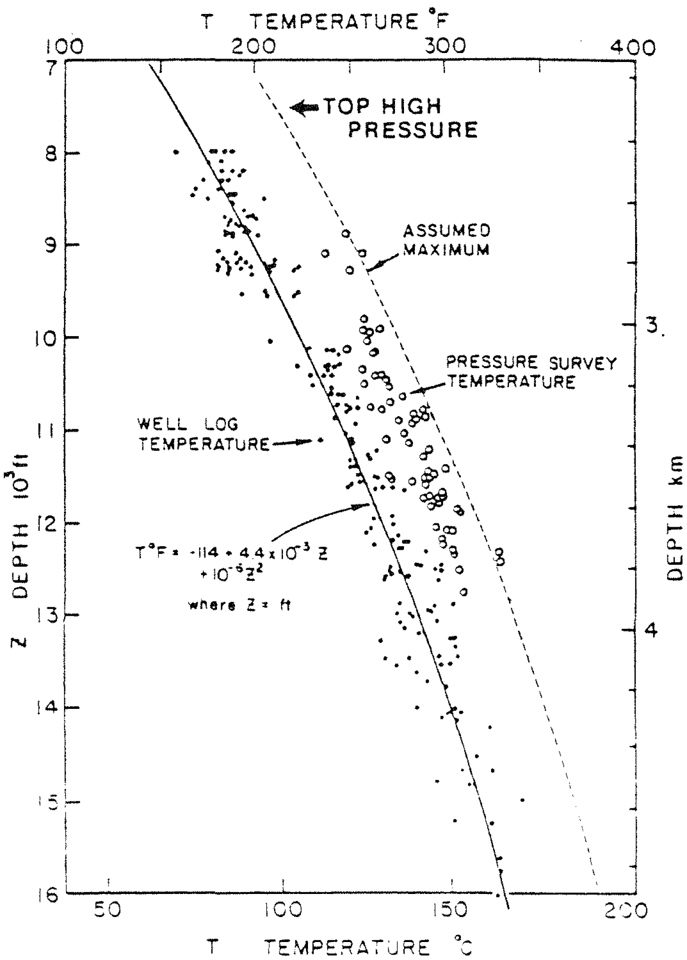


Figure 49. Temperatures derived from well logs versus temperatures derived from bottom-hole pressure surveys, Vicksburg Formation, McAllen Ranch field (from Berg and Habeck, 1982).

hydropressured zone, temperature gradients along the Gulf Coast range typically between 1.4° and 1.8°F/100 ft (Moses, 1961; Jones, 1968; Kharaka and others, 1977; Ewing and others, 1984). Gradients calculated from temperature values compiled during the present study fall within this range (fig. 50). Temperature gradients increase landward from the Gulf of Mexico with isotherms roughly parallel to the coast line (fig. 51). Temperatures at depths encountered during waste injection range from approximately 50° to 110°C (120° to 230°F) (fig. 52).

Redox Potentials

There is a tendency in ground-water systems to change from oxidizing conditions in recharge areas to reducing conditions at depths isolated from the earth's atmosphere. Hydrochemical and biochemical reactions consume most of the available free oxygen within the shallow subsurface. After all the free oxygen is consumed within an aerobic environment, anaerobic bacteria take over by utilizing and oxidizing organic matter. During this process inorganic constituents, such as sulfate, will be reduced. This is the case in Wilcox formation water in East Texas, where sulfate reduction and then organic fermentation reactions were observed (Kreitler and others, 1981).

The oxidizing or reducing condition of an environment is often expressed in terms of electron transfer potentials, in units of volts (Eh) and has been measured as redox pairs (for example, NO_3-NH_3) or with platinum electrodes. Even though there are inherent problems with trying to measure or calculate the oxidation-reduction state (see, for example, Lindberg and Runnells, 1984), redox values can be used qualitatively to identify reducing (or oxidizing) environments. Kreitler and others (1981) observed a continual decrease in Eh values (measured with platinum electrodes) from outcrop in downdip sections of the Wilcox aquifer. Positive Eh values indicate oxidizing conditions, whereas negative Eh values are equivalent with

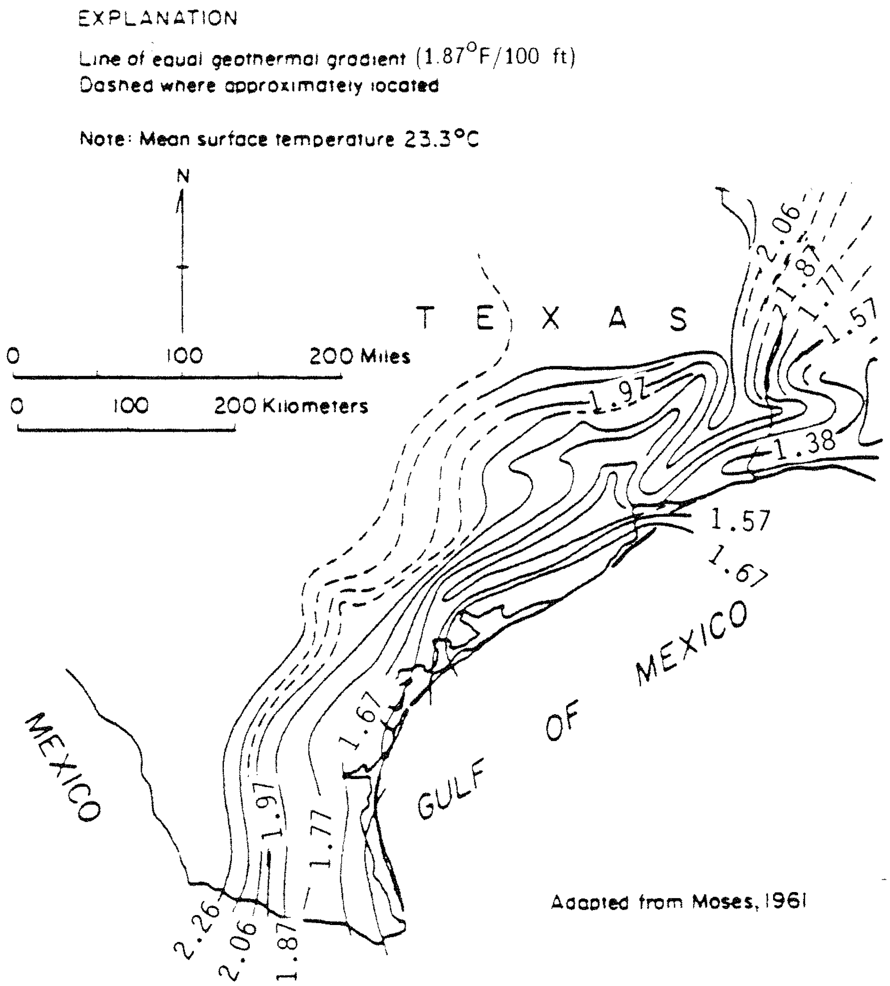


Figure 50. Temperature gradients in the hydropressured zone (adapted from Moses, 1961, by Jones, 1975).

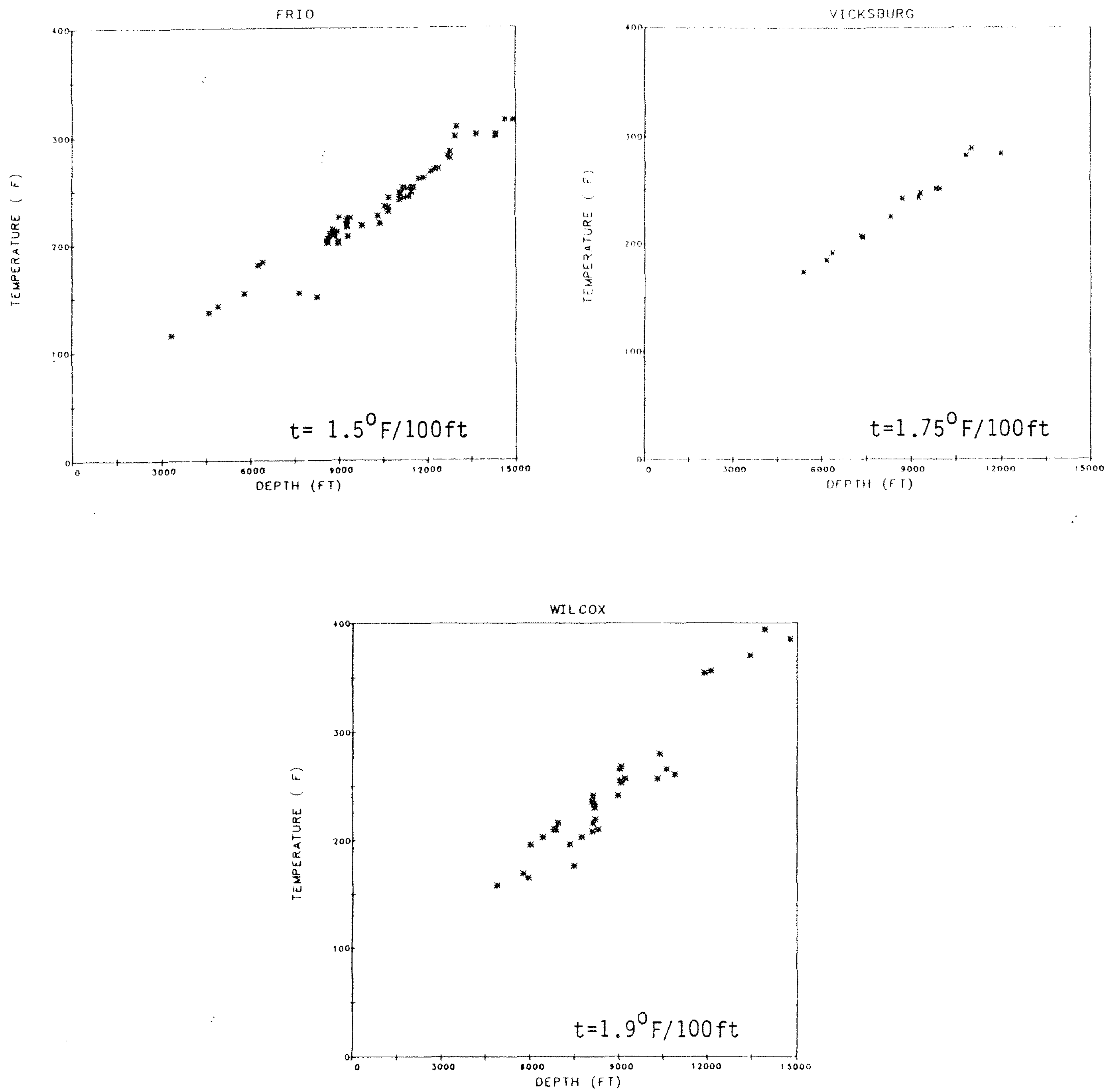


Figure 51. Temperature-depth plots for Frio, Vicksburg, and Wilcox formation waters.

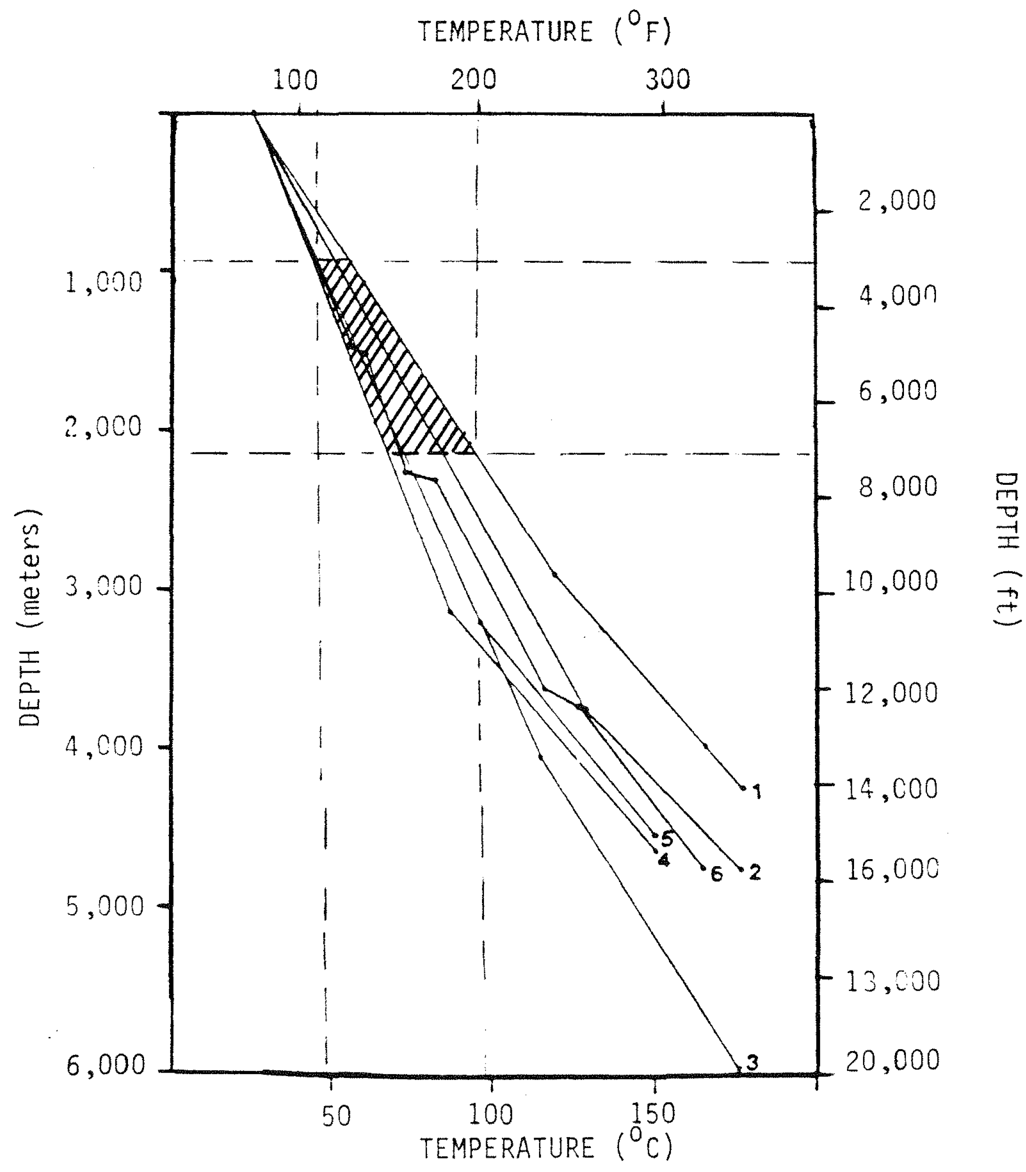


Figure 52. Temperature-depth relationships along the Texas and Louisiana Gulf Coast and most-likely temperatures encountered during waste injection (modified from Bodner and others, 1985; data from Lewis and Rose, 1970, Schmidt, 1973, Sharp, 1976, and Kharaka and others, 1980).

reducing conditions. There are additional indications for reducing conditions in the Gulf Coast subsurface. (1) Low sulfate concentrations, which prevail in all Gulf Coast aquifers, suggest reduction of sulfate by sulfate-reducing bacteria. (2) Preferential degradation of organic acids at depths above approximately 6,000 ft requires the action of anaerobic bacteria. However, penetration of fresh water and of aerobic bacteria is also required to explain some of the fractionation reactions involving organic acids (Carothers and Kharaka, 1978). (3) Mineralization trends in the shallow subsurface of South Texas result from the mixing between oxidizing, meteoric ground water and ascending, reducing deep-basinal brines (Galloway and others, 1982). Kharaka and others (1980) calculated Eh values for two deep-basin brines (12,000 to 13,000 ft deep) from the Texas and Louisiana Gulf Coast. Using redox reactions involving iron, they calculated Eh values ranging from -140 to -220 mV for one sample and from -160 to -230 mV for the other sample. This indicates highly reducing conditions for formations in the deep subsurface along the Gulf Coast. The chemical composition of the two samples and physical characteristics of the zones from which the samples were obtained were very different (for instance, a difference in total dissolved solids of 200,000 mg/L), which is a remarkable contrast to the similarity in redox potentials. This may indicate that redox potentials are uniform along the Gulf Coast. However, mixing between meteoric ground water and deep-basin brine at shallow depths, as suggested by previous studies, certainly changes redox conditions. Nevertheless, reducing conditions should prevail within zones of interest for waste injection. This could lead to anaerobic degradation of some organic wastes. However, many of the wastes that are being injected into Gulf Coast aquifers are refractory organics.

Solubilities

Uncertainties in reported pH and bicarbonate values and the often incomplete nature of chemical analyses make calculation of saturation states questionable. Kaiser and Richmann (1981), for example, studied the effect of pH on stability calculations of kaolinite and chlorite. Given a computed pH value of 4, kaolinite was the stable mineral phase (as observed in core samples) in two formation waters from Brazoria County, whereas using the measured values of 6.2 and 6.5 of these waters, chlorite was the stable phase (fig. 53; Kaiser and Richmann, 1981). Studies of the isotopic geochemistry of Frio brines in Brazoria County indicate that no isotopic equilibrium exists between water and rock in the hydropressured zone (Milliken and others, 1981).

CHEMISTRY OF AQUIFER MATERIAL

Information on mineral and rock chemistry of Tertiary strata along the Texas Gulf Coast can be found mainly in studies of diagenesis and sandstone reservoir qualities. For reasons of simplicity, data derived from those reports are listed below according to major investigations rather than according to formation. The following discussions are adapted closely from the respective references.

Loucks and others (1979)

Regional controls on diagenesis and reservoir quality of lower Tertiary sandstones were studied in detail by Loucks and others. To delineate regional trends they divided the Texas Gulf Coast into six geographic areas (fig. 54).

Sandstones in the Wilcox Group consist of 45 to 90 percent quartz, 10 to 40 percent feldspar, and 5 to 30 percent rock fragments (fig. 55). Quartz content increases from upper to lower Gulf Coast, whereas the percentage of rock fragments decreases in the same direction (fig. 55). Major components of rock fragments are

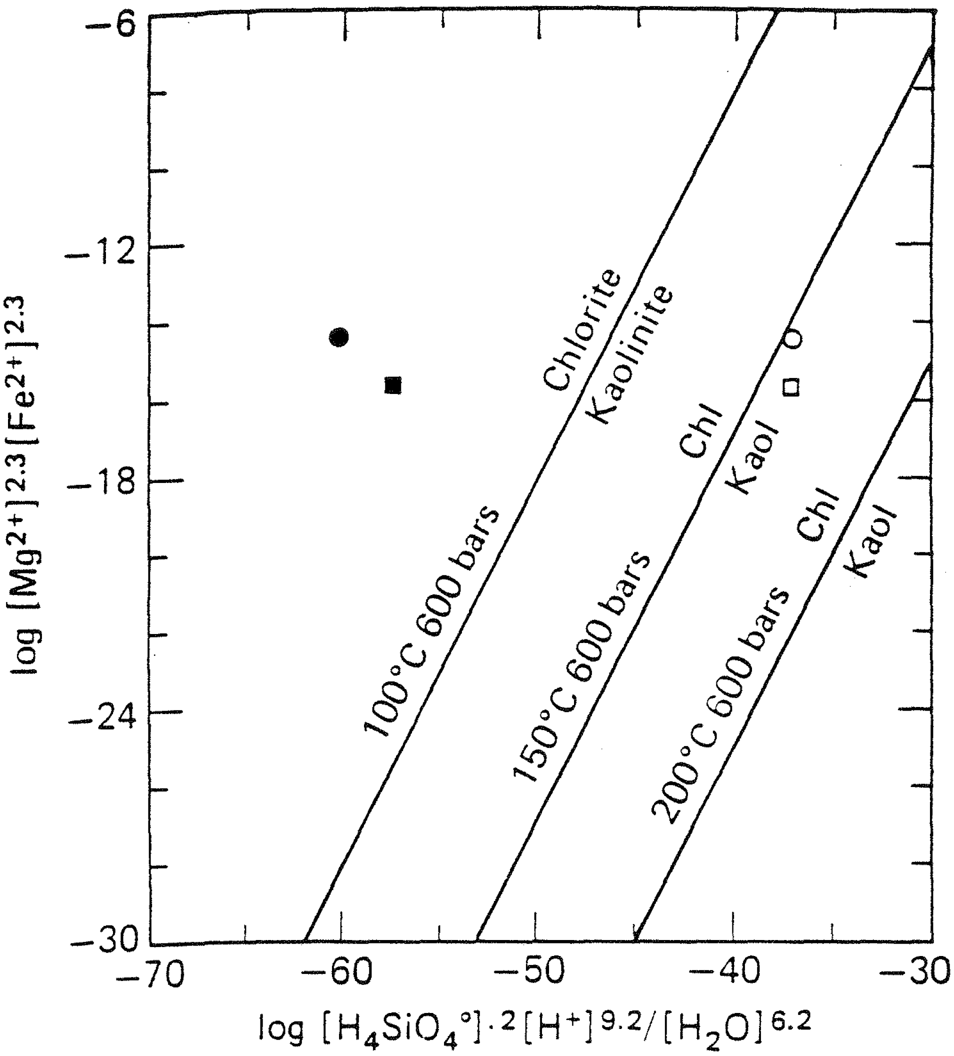


Figure 53. Stability diagram for kaolinite and chlorite for formation water from Pleasant Bayou geopressured-geothermal test well (from Kaiser and Richman, 1981, modified by Kharaka and others, 1985).

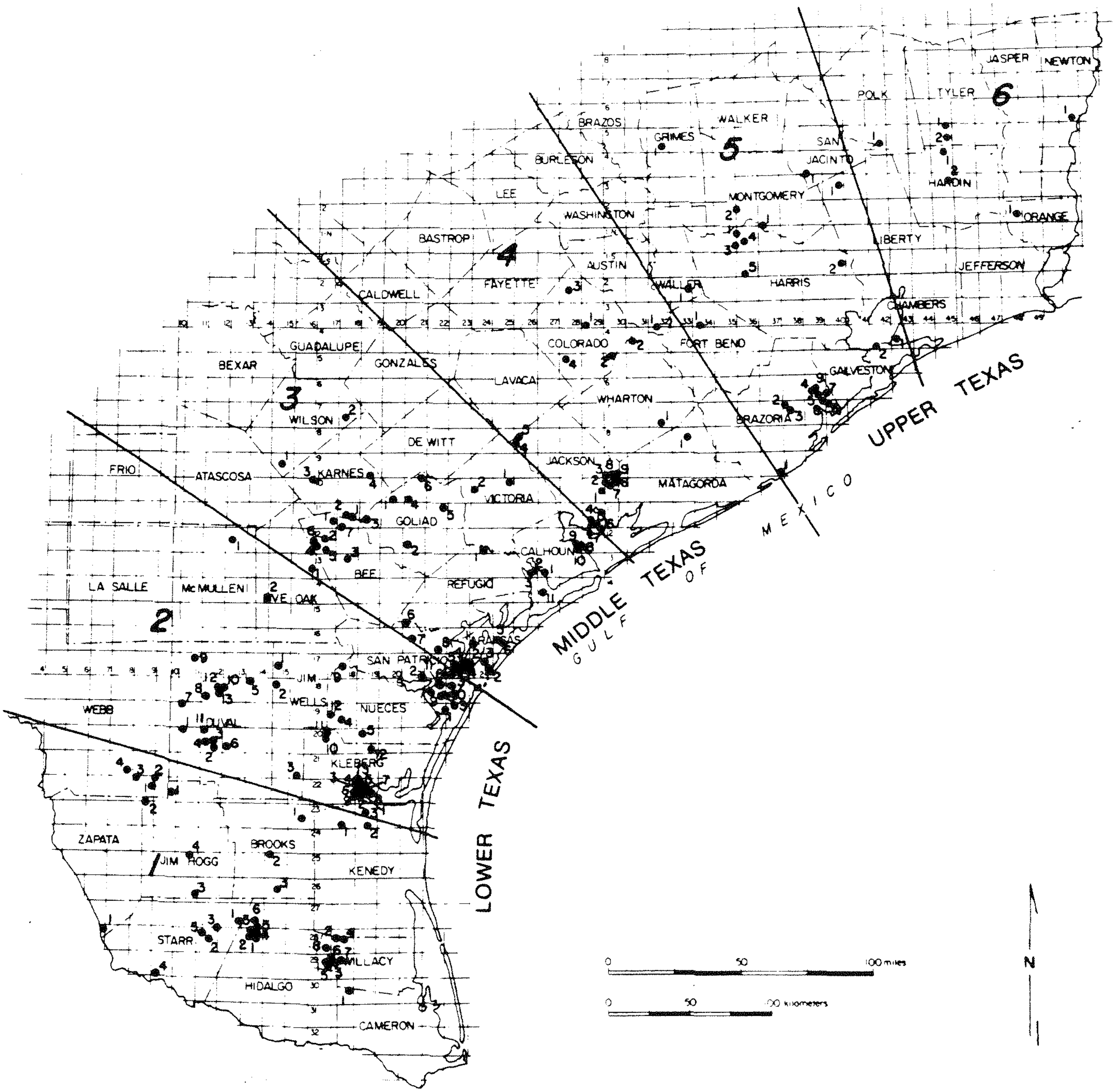


Figure 54. Subdivisions of Texas Gulf Coast for which data are plotted individually in figures 45 through 50 (from Loucks and others, 1979).

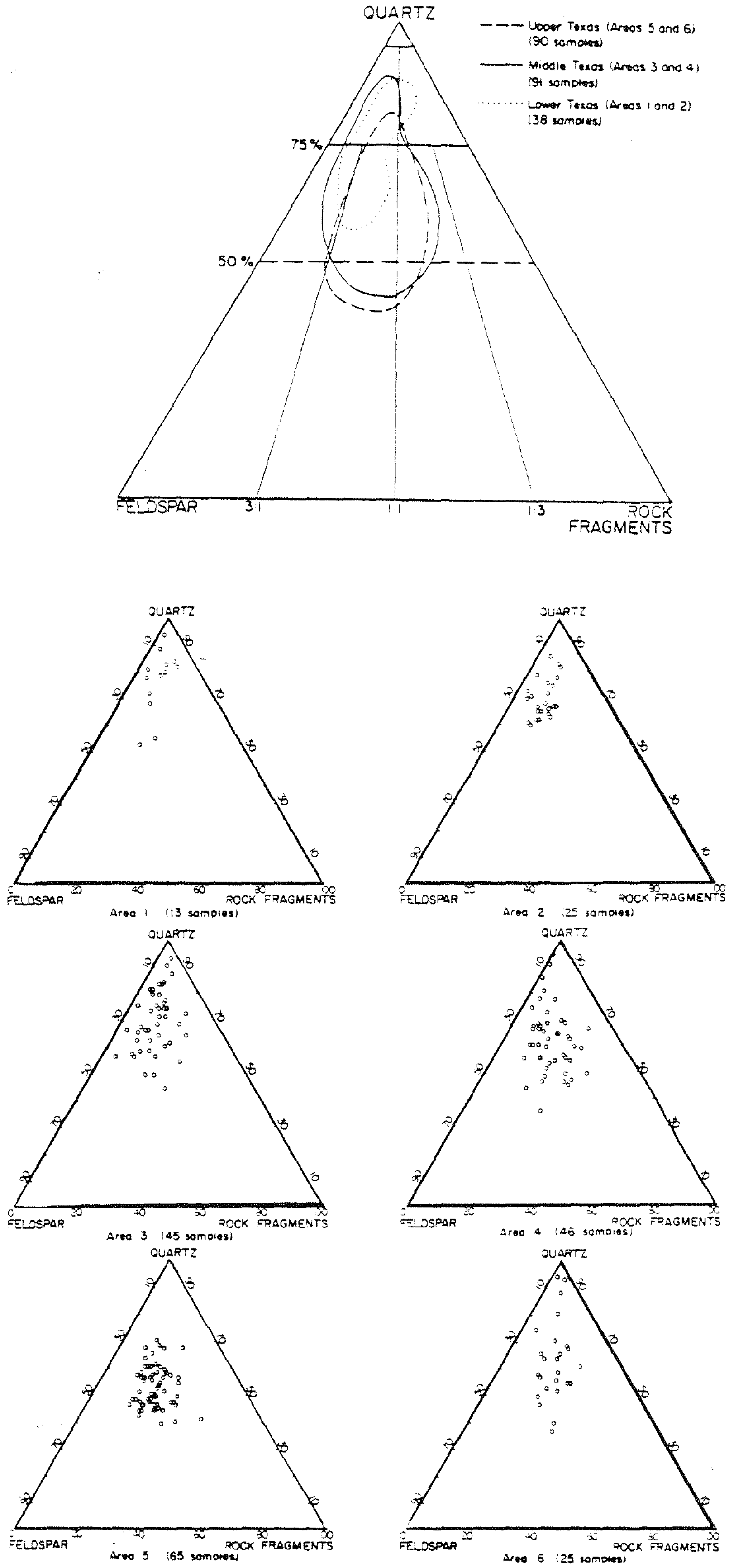


Figure 55. Composition of Wilcox sandstones (for individual areas see fig. 54; from Loucks and others, 1979).

metamorphic and volcanic rocks (fig. 56). Slates, quartzites, and muscovite schists make up metamorphic rock fragments. Volcanic rocks are rhyolitic in composition but mostly are highly altered and typically silicified.

Yegua sandstones generally contain less quartz than Wilcox sandstones. Quartz percentages range from 20 to 75 percent feldspar from 20 to 70 percent, and rock fragments from 10 to 50 percent (fig. 57). In contrast to Wilcox sandstones quartz percentages in Yegua sandstones increase from lower to upper Gulf Coast (fig. 56). Volcanic and metamorphic rock fragments (fig. 56) are similar in composition to Wilcox rock fragments. Carbonate rock fragments, which are common in lower Gulf Coast sandstones, are composed of micrite.

The composition of Frio sandstones varies considerably from lower to upper Gulf Coast and shows a trend similar to that of Yegua sandstones (fig. 58). Quartz percentage increases from 20 to 60 percent at the lower coast to 50 to 85 percent at the upper coast. This corresponds to a decrease in rock fragments from 10 to 50 percent at the lower coast to 5 to 20 percent at the upper coast. Feldspar decreases from 20 to 50 percent to 10 to 30 percent in the same direction. Sandstones along the lower coast are rich in volcanic and, to a smaller degree, carbonate rock fragments (fig. 56). Carbonate fragments decrease and metamorphic rock fragments increase toward the middle coast. Volcanic fragments dominate again in upper Gulf Coast sandstones (fig. 56). These fragments are dominantly rhyolites and trachytes (Lindquist, 1977) and are silicified or altered to chlorite. Carbonate fragments along the lower coast are caliche clasts.

In a subsiding basin, such as the Gulf Coast sedimentary basin, sediments are subject to changes in temperature and pressure with burial. This causes diagenetic changes, such as leaching of mineral phases, overgrowths and cementation, mineral replacements, and compaction. Along the Gulf Coast, diagenetic events that affected

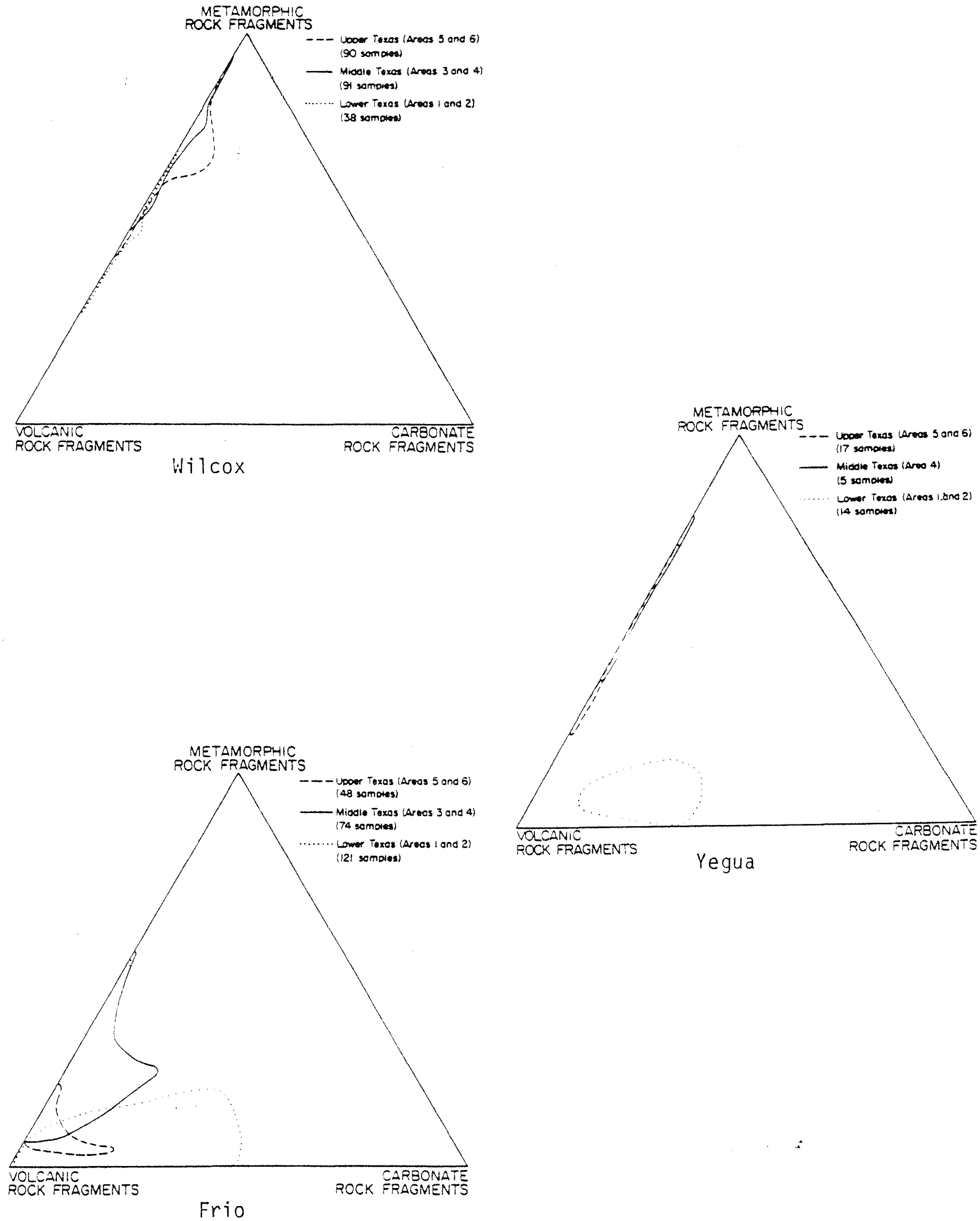


Figure 56. Composition of Wilcox, Yegua, and Frio rock fragments (from Loucks and others, 1979).

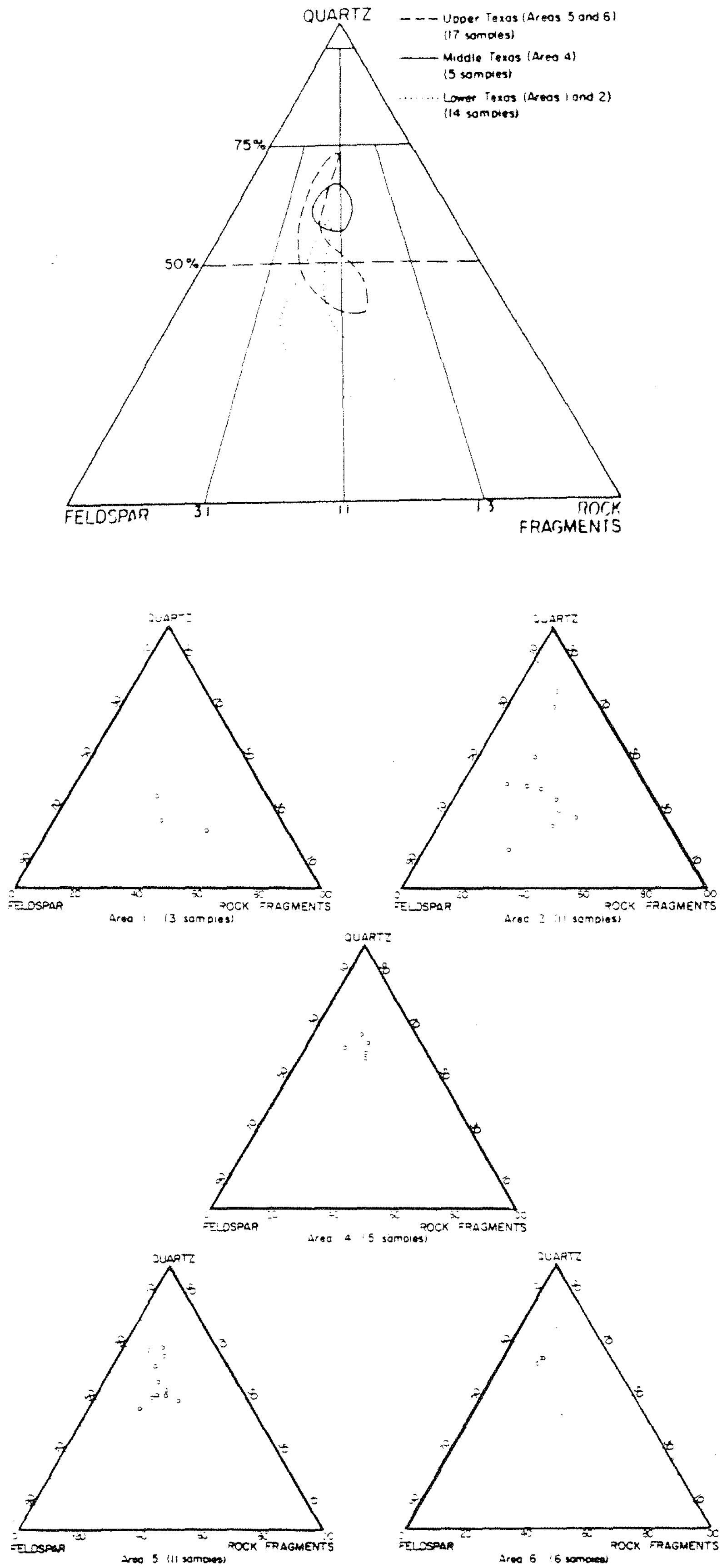


Figure 57. Composition of Yegua sandstones (for area designation see fig. 54, from Loucks and others, 1979).

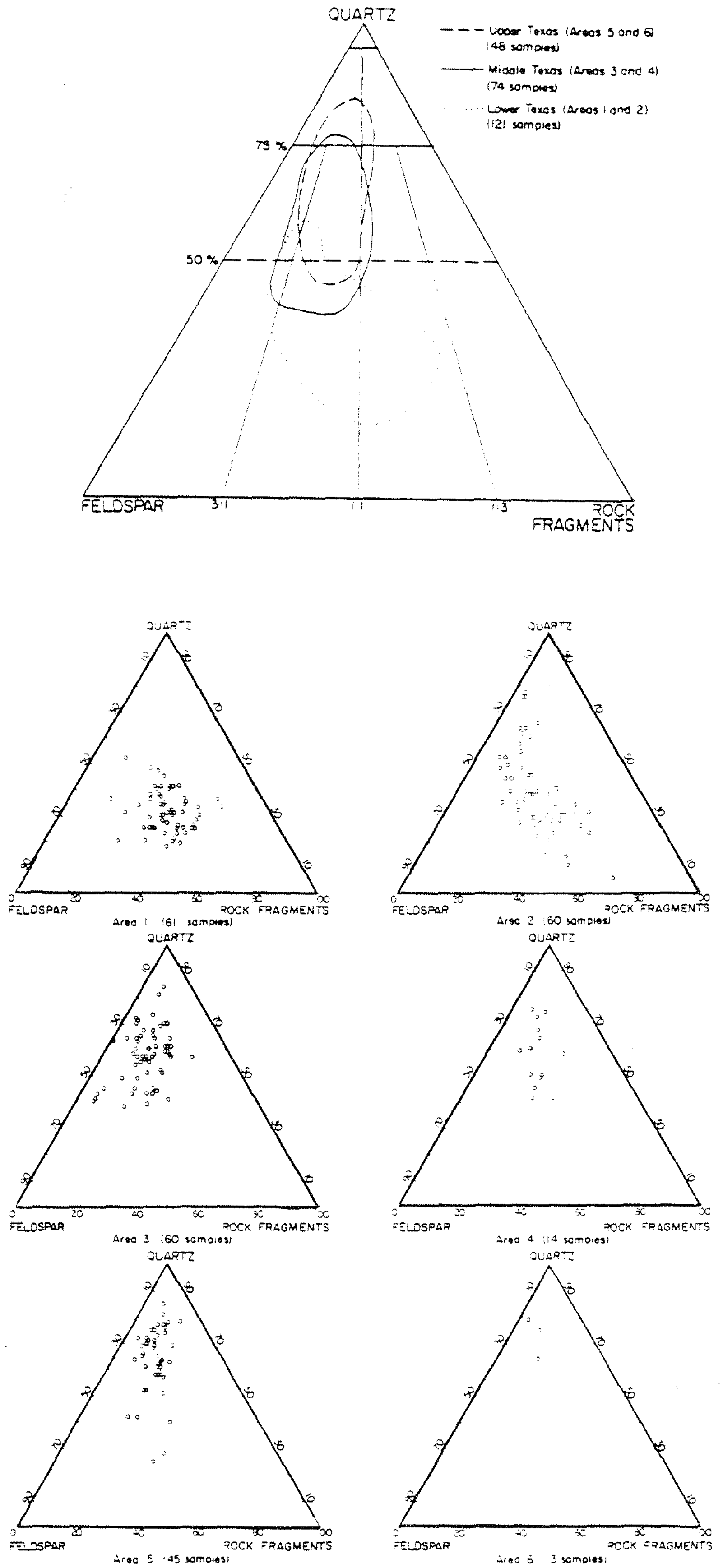


Figure 58. Composition of Frio sandstones (for area designation see fig. 44; from Loucks and others, 1979).

sediments affected different stratigraphic units in more or less the same manner (fig. 59). Minor differences exist in the depth ranges at which diagenetic events were active. This suggests that diagenetic changes affected formation waters of different aquifers in a similar manner and therefore differences in chemical compositions may result from mixing of different water types rather than exclusively from diagenetic events.

Hower and others, 1976

Detailed analyses of clay minerals and major nonclay minerals from a well along the Texas Gulf Coast were presented by Hower and others (1976). The stratigraphic interval covered by this investigation includes Oligocene and Miocene sediments within a depth range of 4,000 to 18,000 ft. Most striking is the disappearance of calcite and K-feldspar and the increase in clay with depth (table 5). The latter is of major importance because the abundance, type, and distribution of clay minerals are significant with respect to fluid flow and chemical reactions. Typically, shallow clay minerals along the Gulf Coast are dominated by smectite. With increasing depths smectite percentages generally decrease and illite percentages increase. In South Texas, approximately 80 percent of the smectite is converted to illite in mixed-layer clays at a depth of 9,000 ft (Loucks and others, 1981). This change in clay type with depth causes a decrease in cation-exchange capacity in the shale (table 6). However, the decrease in cation-exchange capacity of the individual clay mineral may be offset by the general increase in clay content of Gulf Coast sediments with depth.

Freed, 1979

As part of the research done at the geothermal-geopressure test well in Brazoria County, Freed examined 33 shale samples, ranging in depths from 2,185 to 15,592 ft. Hydropressured conditions in this well exist to a depth of approximately

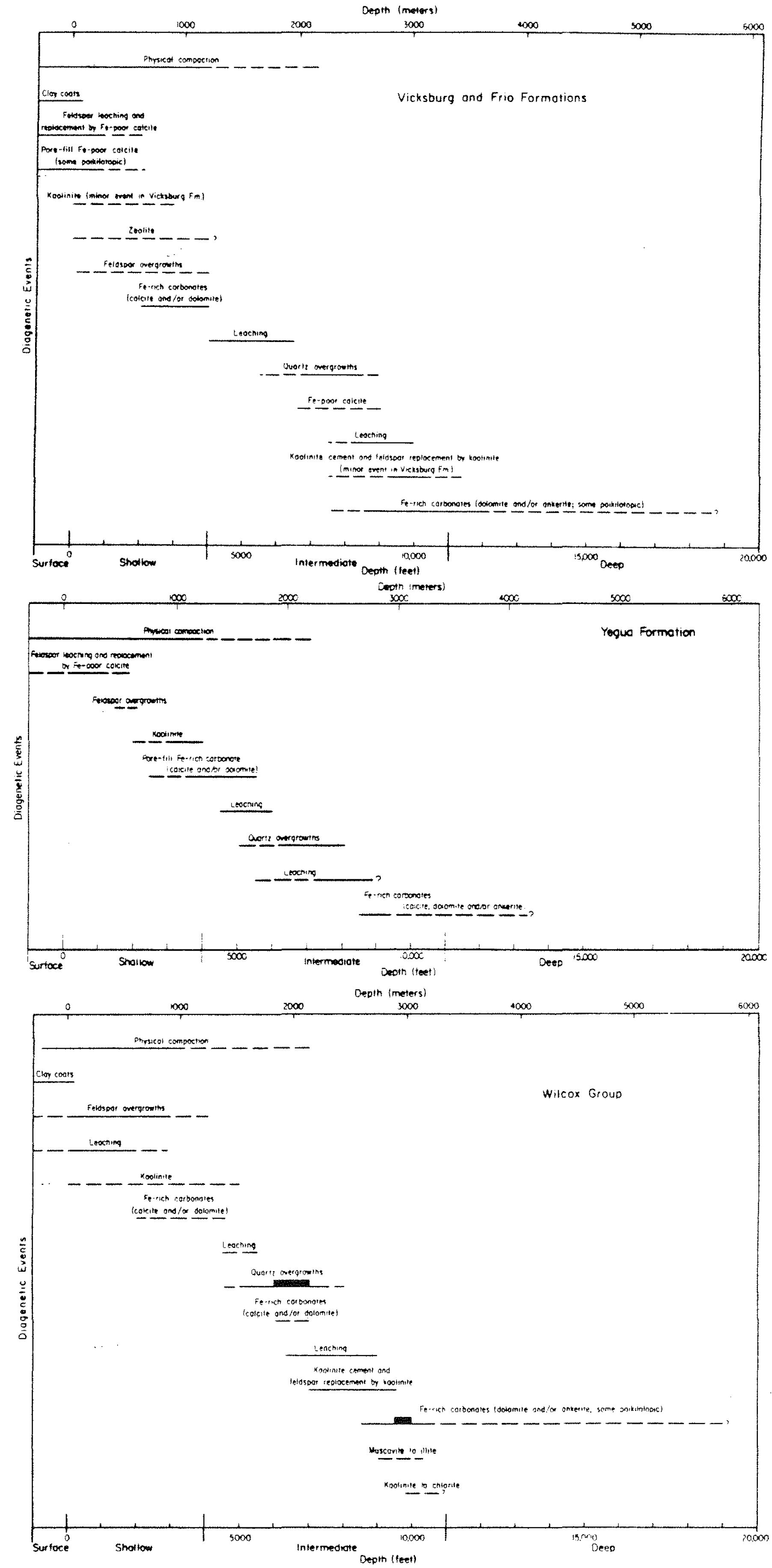


Figure 59. Diagenetic events for Wilcox, Yegua, and Frio sandstones (from Loucks and others, 1979).

Table 5. Percentages of clay and major non-clay minerals and estimates of clay-mineral abundances in Oligocene-Miocene sediments (from Hower and others, 1976).

TOTAL CLAY MINERALS AND SEMIQUANTITATIVE ESTIMATE OF CLAY-MINERAL ABUNDANCES

Size fraction		Depth (m) 1,250	1,500	1,750	1,850	2,150	2,450	2,600	2,750	2,900	3,100	3,200	3,400	3,500	3,700	4,000	4,300	4,600	4,900	5,200	5,500
>10 μm	Total clay	16	15	..	15	15	16	19	17	18	18	..	19	21	21	24	24	23	25	28	27
	I/S	6	5	..	5	5	6	9	7	8	8	..	13	17	11	18	12	11	14	13	16
	Chlorite	0	0	..	0	0	0	0	0	0	0	..	6	4	11	6	12	12	11	15	11
	Kaolin	0	0	..	0	0	0	0	0	0	0	..	0	0	0	0	0	0	0	0	0
	Mica	10	10	..	10	10	11	10	10	11	10	..	tr.	0	tr.	tr.	0	0	0	tr.	0
2 to 10 μm	Total clay	14	..	..	16	16	15	..	..	..	18	..	21	23	20	25	24	25	27	24	23
	I/S	5	..	..	7	7	6	..	..	..	8	..	8	10	11	10	9	12	11	12	12
	Chlorite	0	..	..	0	0	0	..	..	..	tr.	..	4	..	3	9	9	7	10	6	6
	Kaolin	3	..	..	3	tr.	2	..	..	..	2	..	5	..	3	3	3	5	3	4	4
	Mica	6	..	..	6	8	7	..	..	..	8	..	4	2	3	3	3	tr.	3	2	..
0.5 to 2 μm	Total clay	..	..	..	57	51	69	62	..	..	67	69	73	..	74	71	75	72	81	76	75
	I/S	..	..	..	34	29	41	32	..	..	37	38	41	..	39	41	41	37	42	38	40
	Chlorite	..	..	..	0	0	10	..	..	..	20	..	16	..	..	9	8	12	11	14	11
	Kaolin	..	..	..	22	21	18	..	..	..	10	..	16	..	..	21	27	23	29	25	24
0.1 to 0.5 μm	Total clay	..	..	..	93	91	92	..	92	..	91	..	90	..	88	89	88	88	87	87	86
	I/S	..	..	..	67	60	62	..	58	..	61	..	61	..	73	81	75	74	78	75	76
	Chlorite	..	..	..	0	0	12	..	..	..	8	..	5	..	6	3	5	5	4	6	4
	Kaolin	..	..	..	26	31	19	..	..	..	23	..	25	..	9	4	8	9	4	6	6
<0.1 μm	Total clay	<0.1 μm is 100% clay minerals																			
	I/S	..	..	..	93	92	88	..	..	..	92	..	92	..	94	98	96	94	97	96	95
	Kaolin	..	..	..	7	8	12	..	..	..	8	..	8	..	6	2	4	6	3	4	5

SEMIQUANTITATIVE ESTIMATES OF NONCLAY MINERALS

Size fraction		Depth (m) 1,250	1,500	1,750	1,850	2,150	2,450	2,600	2,750	2,900	3,100	3,200	3,400	3,500	3,700	4,000	4,300	4,600	4,900	5,200	5,500
>10 μm	Calcite	31	12	..	19	15	3	14	14	11	14	..	9	5	2	1	2	2	1	0	1
	Quartz	..	44	..	44	37	51	..	45	58	57	..	64	63	58	54	47	54	56	56	52
	K feldspar	17	14	..	14	16	22	..	17	10	4	1	2	0	0	0	0	0	0	0	0
	Plagioclase	..	15	..	8	17	8	..	7	3	8	..	8	10	19	21	27	21	19	16	20
2 to 10 μm	Calcite	..	9	..	20	29	12	..	..	..	17	..	9	tr.	0	0	0	0	0	0	0
	Quartz	..	..	..	32	42	60	..	..	..	51	..	70	..	..	45	59	60	60	69	65
	K feldspar	10	..	..	7	10	15	..	..	..	5	0	..	..	..	0	0	0	0	0	0
	Plagioclase	..	..	..	33	10	5	..	..	..	8	..	7	..	..	37	27	..	20	14	19
0.5 to 2 μm	Calcite	..	19	31	20	30	3	20	..	..	9	tr.	0	0	0	0	0	0	0	0	0
	Quartz	..	..	..	24	19	29	..	..	..	25	..	28	..	26	..	22	22	16	26	24
0.1 to 0.5 μm	Quartz	..	..	..	7	9	8	..	8	..	9	..	10	..	12	11	12	12	13	13	14

Note: Calcite was not detected in any <0.5 μm fraction. Feldspar was not detected in any <2 μm fraction.

Table 6: Cation-exchange capacity of clay minerals (in milliequivalents per 100 grams) (from Grim, 1962).

Kaolinite	3-15
Montmorillonite	80-150
Illite	10-40
Chlorite	10-40

8,500 ft. Bulk mineralogy and clay mineralogy, expressed as weight percent of major components, are presented in tables 7 and 8, respectively. Remarkably little change occurs within this section represented by 13,000 ft of core, except a decrease in calcite percentage.

Boles, 1978

Boles studied active ankerite cementation in the Wilcox of southwest Texas. Calcite cementation was documented above a depth of 7,600 ft, whereas ankerite cementation was detected at depths below this datum. Within the discussion of Wilcox petrology Boles (1978, p.14) gives the following description of Wilcox sandstones and shales:

> most clean sandstones consist of >80% quartz (detrital and authigenic), and about 5% detrital alkalic feldspar, several % sedimentary and quartzose rock fragments, several % detrital mica (predominantly muscovite), accessory amounts of pyrite, magnetite, zircon, tourmaline, and sometimes epidote. Authigenic carbonate and clay minerals make up the remainder of the mode. Clay minerals include mixed-layer illite-smectites and discrete chlorite, kaolinite, and illite. Calcite and ankerite are the main authigenic carbonates in Wilcox sandstones. Subordinate ferrous dolomite and very minor siderite is also present. Shales generally have higher proportions of total clay, illite/smectite, discrete mica, and lower proportions of chlorite, than associated sandstones. Siderite, in minor amounts, occurs more frequently in shales than in sandstones.

Table 7. Estimates of bulk mineralogy, expressed as weight percent, of 33 shale samples from Pleasant Bayou No. 1 geothermal test well, Brazoria County, Texas (from Freed, 1979).

Depth (ft)	TC	C	Q	KF	Pl	D	S	Py	B
2185	70	10	14	2	2	1			
2335	67	13	15	2	4				
3860	56	19	15	2	4	4			
4347	68	13	12	3	3	1			
5630	68	20	8	2	2				
6020	62	27	7	2	2				
6703	62	28	5	1	2	2			
7110	66	19	7	2	2			4	
7400	64	20	11	2	3				
7800	64	6	13	3	7		2	6	
8100	66	8	14	3	4		1	4	
8330	68	7	15	2	3			4	
8400	65	5	15	3	7			4	
8690	63	5	13	1	1		1	4	12
9020	62	9	14	2	2		1	4	4
9320	64	5	13	1	5		2	6	4
9380	66	5	15	2	4		2	6	
9590	71	5	15	1	3		1	4	
9890	62	4	15	1	5		1	6	7
10232	68	5	13	3	8				4
10430	68	2	16	4	5				4
10700	66	3	14	3	5			4	6
11000	70	3	15	4	8				
11210	67	3	16	4	5				4
11540	66	2	16	3	3			4	6
11750	81		5	4	4			6	
11930	72	1	15	3	4			4	
12320	70	3	14	3	5			4	
12630	70		17	3	5			6	
13130	65	3	16	5	5			4	
13610	70	2	18	2	4			4	
14078	78		14	2	3			4	
15592	81		11	3	4				

TC - Total Clay
C - Calcite
Q - Quartz
KF - Potassium Feldspar
Pl - Plagioclase
D - Dolomite
S - Siderite
Py - Pyrite
B - Barite

Table 8. Estimates of clay mineralogy, expressed as weight percent, of 33 shale samples from Pleasant Bayou No. 1 geothermal test well, Brazoria County, Texas (from Freed, 1979).

Depth (ft)	K	I	I/M	C
2185	36	36	29	
2335	26	28	46	
3860	22	32	46	
4347	28	39	32	
5630	24	36	36	5
6020	16	24	59	
6703	21	16	64	
7110	20	22	58	
7400	24	46	23	7
7800	33	17	50	
8100	20		80	
8330	34	17	48	
8400	18	23	58	
8690	20	23	57	
9020	40	32	26	2
9320	41	24	34	
9380	27	18	55	
9590	33	29	37	
9890	26	17	57	
10232	13		87	
10430	22		78	
10700	33	29	38	
11000	11		89	
11210	36		64	
11540	47		53	
11750	13		87	
11930	28		72	
12320	32	21	47	
12630	35		65	
13130	21	15	64	
13610	37		63	
14078	34	12	53	
15592	17		83	

K Kaolinite

I Illite

I/M Illite-Montmorillonite

C Chlorite

Galloway, 1977

The composition of sands and clays in outcrop areas of the Catahoula Formation was studied by Galloway and others. Diagrams of sand composition show more or less equal percentages of feldspar, quartz, and rock fragments (fig. 60). Major differences between the lower and upper coasts are (1) dominance of plagioclase feldspar in the south in contrast to equal parts of orthoclase and plagioclase in the north, (2) an overall abundance of rock fragments, dominated by volcanic components, in the south, and (3) a gradation from a mixed calcium-sodium-smectite suite in the lower (and middle) Gulf Coast to a mixed smectite-kaolinite suite in the upper Gulf Coast. With increasing depth, smectite and kaolinite percentages decrease and illite percentages increase (Perry and Hower, 1970), lowering the cation-exchange capacity of the shale (table 6).

Waste-disposal-well files, TDWR

Core descriptions and core analyses are included in some completion reports of waste disposal wells, available at Texas Department of Water Resources (table 9). Among Frio, Yegua, and Miocene cores, Frio samples generally are highest in quartz content but lowest in calcite and mixed-layer clays. Yegua samples are low in quartz but enriched in illite, kaolinite, and chlorite relative to Frio and Miocene samples. This suggests that cation-exchange capacities are highest in Yegua shales.

WASTEWATER CHEMISTRY

The suitability of waste for deep-well injection depends on the properties of the injection zone and on the physical and chemical characteristics of the waste. Characteristics of the waste include temperature, concentration of suspended solids, gas content, concentration of dissolved chemical constituents, and pH. These parameters change from injection plant to injection plant, from waste stream to waste stream, and occasionally with time. Chemical constituents of waste streams

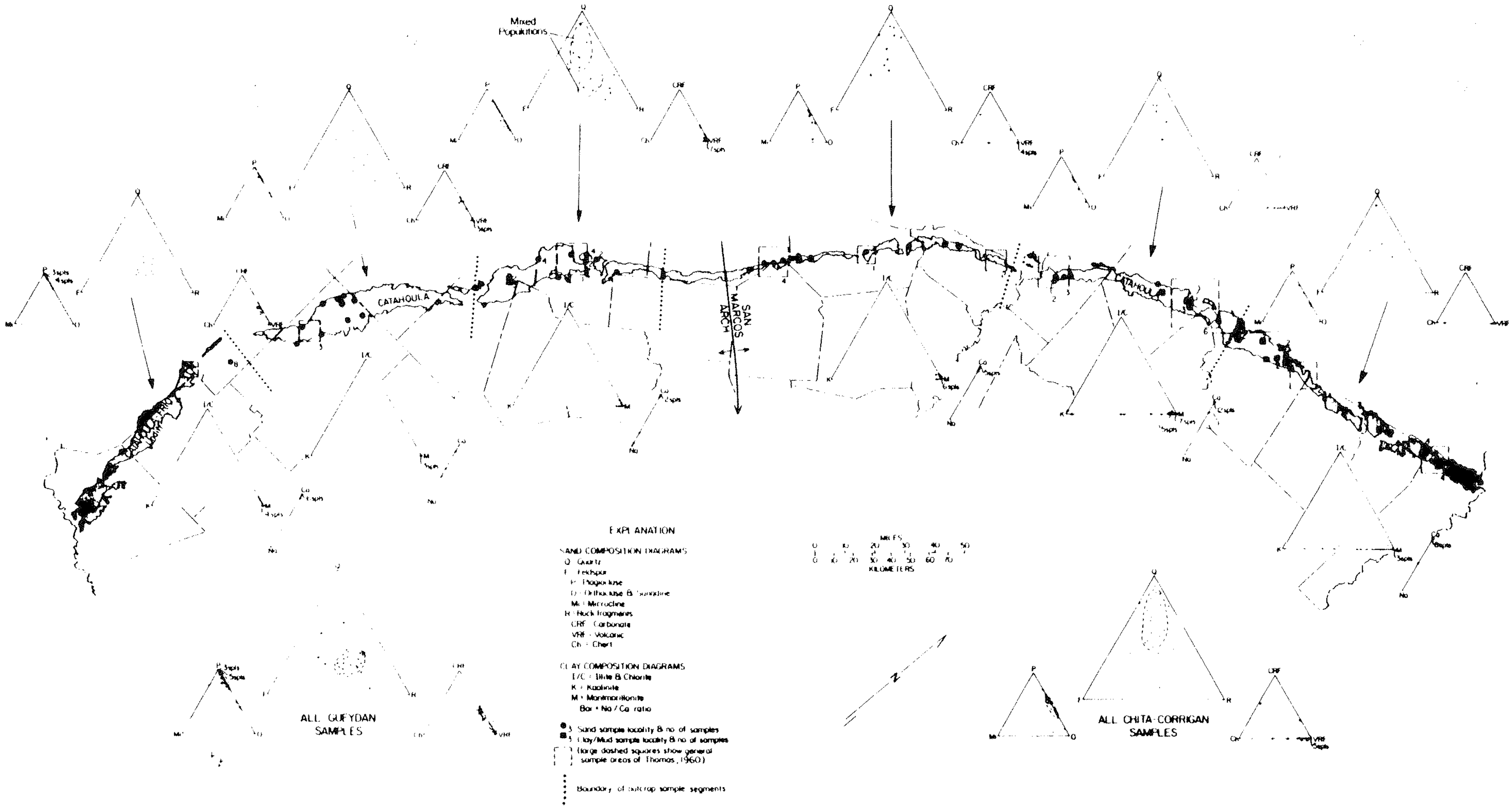


Figure 60. Summary of petrofacies of sandstones and clays, Catahoula Formation outcrop area (from Galloway, 1977).

Table 9: Chemical composition of rock samples from disposal zones (from waste-disposal-well files, Texas Department of Water Resources).

Mineral	Frio	Yegua	Miocene
Quartz	34-81%	20-30%	30-50%
Feldspar	9-15%	10-20%	0-20%
Calcite	trace-2%	1-15%	15-45%
Illite	0-3%	5-15%	- 1%
Kaolinite	0-8%	10-15%	0-2%
Chlorite	0-2%	10-25%	0-1%
Montmorillonite	0-32%	5-20%	5-10%
mixed-layer clay	trace-4%	5-15%	0-15%
number of cores	5	3	2

are as diverse as the manufacturing processes from which they originate. The source of the waste is the production of plastics, detergents, synthetic fabrics, pesticides, drugs, paints, solvents, preservatives, and others (Klemt, in press). Most waste streams contain hazardous material that may or may not be biodegradable. Wastewater analyses listed in waste disposal well files at the Texas Department of Water Resources often include only hypothetical and estimated chemical compositions of injection streams, presented in concentration ranges (table 10).

PRESSURE-DEPTH RELATIONSHIP

A total of 627 pressure data from oil fields reported by the Railroad Commission of Texas (1978) was used to construct a preliminary pressure-depth plot (fig. 61). Pressure data were selected from a set that were listed as original reservoir pressures in oil fields along the Texas Gulf Coast. Enhanced recovery operations are being undertaken in these fields at present. A pressure gradient of 0.43 psi/ft represents hydrostatic conditions in a fresh-water system. Depending on the salinity of formation water, pressure gradients representing hydrostatic conditions in salt-water systems vary between 0.43 and 0.50 psi/ft. Therefore, hydrostatic conditions are suggested from the slope of the data compiled during this study, ranging from 0.43 to 0.46 psi/ft (fig. 61). However, the listed pressure data most likely underestimate original pressure data owing to production of fluids and gas from those reservoirs.

Ewing and others (1984) distinguished four pressure zones at Pleasant Bayou, Brazoria County. (1) A zone of hydropressure above a depth of approximately 8,400 ft, underlain by (2) a zone of highly geopressured shale but normally pressured sandstone, followed by (3) a zone of highly geopressured shale and moderately geopressured sandstones, underlain by (4) a zone of highly geopressured shale and

Table 10: Chemical composition of selected waste streams from Gulf Coast injection operations (from waste-disposal-well files, Texas Department of Water Resources). (All analyses in mg/L, except pH and when noted otherwise.)

Disposal well	224	189	145
Total residue	30,000-540,000	10,000-90,000	120,000-200,000
pH	up to 8.5	6.0-9.5	9.6-12.8
Chloride	100-35,000	3,000-96,000	70,000-120,000
Sodium	....	4,500-40,000	....
Calcium	....	200-500	10-20
Sulfate	25,000-455,000	2,000-4,000	5
Alkalinity(HCO_3)	....	(2,000-5,000)	....
Ammonia-N	up to 85,000	....	....
Total N	....	....	....
Cyanide	....	....	200
Arsenic	....	0-100	....
Organics	....	....	....
COD	25,000-55,000	....	1,000-12,000
BOD	....	....	....
Temperature	194°F	....	....

Table 10 (cont.)

Disposal well	173	105-106	91	122
Total residue	135,000-172,000	up to 200,000	286,000	32,000
pH	8-11	1.3-12.8	5.8-7.6	6.2-7.5
Chloride	62,000-96,000	32,000-112,000	3,500	6,700
Sodium	39,000-59,000	....	6,000	4,000
Calcium	1-3	....	....	200
Sulfate	....	....	200,000	1,350
Alkalinity(HCO_3)	(1,400-7,400)	....	15,000	....
Ammonia-N	....	....	61,000	....
Total-N	....	....	70,000	....
Cyanide	....	up to 134	....	....
Arsenic	....	....	....	....
Organics	1-5.5 wt%	....	....	....
COD	18-51	9,000-18,000	33,000	2,300
BOD	....	....	10,000	1,000
Temperature	....	....	160°F	....

Table 10 (cont.)

Disposal well	148	89	222/223	1
Total residue	up to 150,000	7,000-23,000	....	33,000
pH	2-12	7.7-9.4	3.0	12.0
Chloride	....	....	....	100
Sodium	....	....	....	....
Calcium	....	....	....	....
Sulfate	....	....	....	1,500
Alkalinity(HCO_3)	....	(0-24)	....	....
Ammonia-N	....	....	1,108	....
Total-N	....	....	....	....
Cyanide	....	50-180	32	....
Organics	....	......	....	....
COD	16,000-300,000	1,400-2,000	4,400	20,000
BOD	....	400-580	....	14,000
Temperature	....	84-90°F	....	....

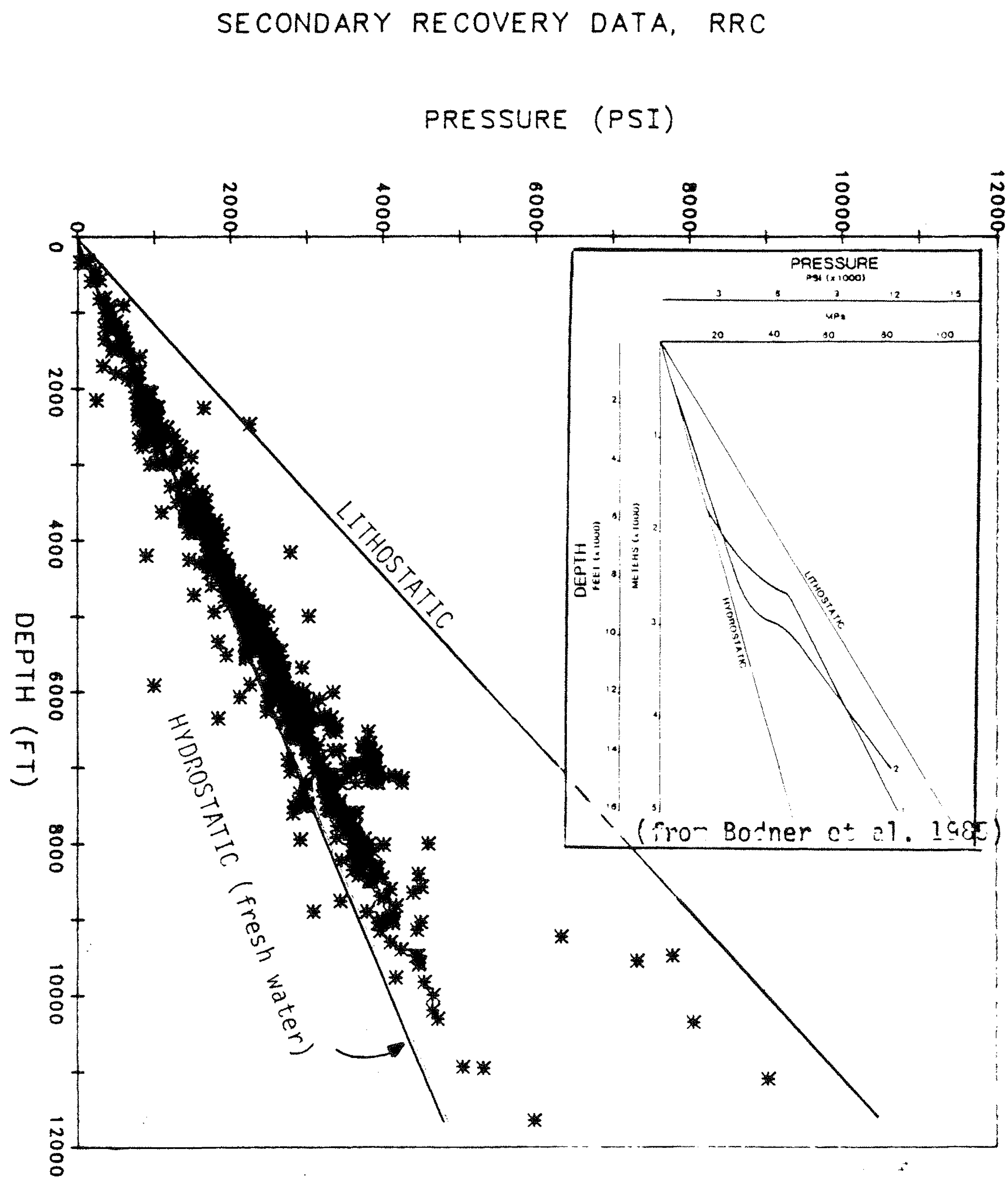


Figure 61. Pressure-depth plot of formation water, Texas Gulf Coast (data from Railroad Commission of Texas, 1978). Data follow hydrostatic conditions of fresh water and fall within the range of pressures reported by Dickinson (1953) and Jones (1968) (inset plot from Bodner and others, 1985).

highly geopressured sandstone. Of most importance to waste injection are zones 1 and 2. Zone 1 contains potential disposal reservoirs for chemical waste. Sandstones in zone 2 must be in hydraulic connection with this zone (for instance, across faults) to maintain hydrostatic pressure and thus supply formation water to zone 1.

SUMMARY

The amount of industrial waste injected into Tertiary sediments along the Texas Gulf Coast accounts for approximately 15 percent of the industrial waste generated in the United States. Most injection operations use Frio, Yegua, Catahoula, Oakville, Wilcox, and undifferentiated Miocene sandstones. Injection occurs within a depth range of 2,000 to 8,500 ft below land surface, where these units constitute salt-water aquifers, with most injection zones within a range of 4,000 to 7,000 ft.

Approximately 1,300 chemical analyses from major disposal units along the Texas Gulf Coast were selected from existing literature for characterization of chemical parameters of formation waters. Most of the brines are of the NaCl type. Some Frio, Vicksburg, and Wilcox waters in South Texas are extremely rich in calcium, having concentrations of up to 40,000 mg/L, and represent a second water type (NaCaCl brine). Salinities vary laterally and vertically, ranging from less than 10,000 mg/L to greater than 250,000 mg/L. Most waters have salinities in the range of 30,000 to 80,000 mg/L. Dissolution of salt from salt domes accounts in part for high salinities in brines along the upper Gulf Coast. In contrast, mixing between fresh water and brine may cause some of the low-saline waters at depths between 4,000 and 9,000 ft below land surface along the lower Gulf Coast. Magnesium and sulfate concentrations in Gulf Coast brines generally are very low. High contents of organic acids probably account for the extremely high alkalinities,

which are reported in concentrations of up to several thousands of mg/L. Bicarbonate seems not to be the major contributing component of alkalinity in Gulf Coast brines. Acidity or pH values of Gulf Coast brines reported in the literature probably overestimate in situ pH values by 1 to 3 units. The most likely range of pH values is between 4.0 and 6.0.

Because of uncertainties in pH, bicarbonate concentrations, and temperatures (temperature gradient of 1.4^{o} to 1.8^{o}F/100 ft), estimates of mineral stabilities with chemical equilibria programs such as SOLMNEQ, PHREEQE, or WATEQ were not made. Low sulfate concentrations, the presence of organic acids, degradation of organic acids by anaerobic bacteria, upward flow of reducing ground water in areas of shallow mineralization trends in South Texas, and calculations of redox potentials of deep-basin brines indicate reducing conditions in the deep subsurface along the Gulf Coast.

Mineralogy and rock chemistry of major Tertiary units along the Gulf Coast are surprisingly uniform, although percentages of chemical constituents vary through a wide range within individual units. Quartz is the major component of sandstones, having percentages of up to 95 percent of total rock constituents. Feldspar and rock fragments generally are between 5 to 50 percent of total rock. In general, calcite and smectite percentages decrease with depth, whereas illite and shale contents increase with depth.

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APPENDIX A:

Chemical analyses of Oakville, Catahoula, undifferentiated Miocene, Frio, Vicksburg, Yegua, and Wilcox formation waters.

---------------CHEMICAL ANALYSES OF OAKVILLE FORMATION WATER------------------
(FOR SOURCES OF ANALYSES SEE FOOTNOTE AT END OF TABLE)

LAT	LONG	DATE (Y-M-D)	PH	CA	MG	NA	HCO3	SO4	CL	TDS	DEPTH (FT)
				<-------	-------	-------	MG/L	-------	-------	------->	
KENEDY COUNTY											
3*27.373	97.713	631011	6.7	1697.	516.	17390.	117.	3.	31299.	51029.	3669
2*27.255	97.741	490726	6.9	1287.	256.	15168.	328.	12.	26250.	43303.	3617
2*27.252	97.729	510727	8.2	295.	56.	6736.	134.	104.	10900.	18249.	1455
2*27.253	97.729	510727	8.4	2351.	545.	13395.	975.	20.	25700.	43118.	2021
2*27.252	97.729	510728	7.6	2450.	436.	19471.	98.	16.	35600.	58077.	2735
SAN PATRICIO COUNTY											
2*28.029	97.375	640901	6.4	2283.	344.	26889.	99.	3.	46500.	76118.	4934
2*28.033	97.378	640901	6.3	2243.	344.	26936.	99.	3.	46500.	76125.	1550
2*28.035	97.380	640901	6.5	2182.	368.	26894.	99.	3.	46400.	75496.	4914
2*28.033	97.377	371001	7.9	335.	36.	4615.	12.	1.	7800.	12804.	1426
REFUGIO COUNTY											
2*28.530	97.045	321129	7.0	2144.	466.	18052.	232.	67.	32800.	53761.	3148
2*28.530	97.045	321215	7.1	1287.	287.	16734.	201.	1.	28800.	47309.	3555
2*28.530	97.045	321216	6.8	1887.	545.	21732.	223.	1.	38200.	62587.	3787
2*28.530	97.045	321129	7.6	2044.	458.	16845.	98.	90.	30800.	50335.	3083
3*28.531	97.060	320330	6.8	730.	310.	10707.	85.	480.	18300.	30612.	2291
3*28.531	97.061	320503	6.4	2165.	227.	23342.	281.	180.	40200.	66374.	3436
BROOKS COUNTY											
2*26.841	98.110	490106	9.6	167.	15.	7643.	92.	1.	12075.	19998.	2745
KLEBERG COUNTY											
2*27.373	97.571	641221	6.0	6172.	1077.	30923.	49.	1.	61800.	100000.	4610

....
2* FROM TAYLOR, 1975
3* FROM U.S.G.S. DATA TAPE
N.R. NOT REPORTED

-------------CHEMICAL ANALYSES OF CATAHOULA FORMATION WATER------------------
(FOR SOURCES OF ANALYSES SEE FOOTNOTE AT END OF TABLE)

LAT	LONG	DATE (Y-M-D)	PH	CA	MG	NA	HCO3	SO4	CL	TDS	DEPTH (FT)
				<---	---	---	MG/L	---	---	--->	
NUECES COUNTY											
2*27.837	97.176	600930	6.9	6496.	896.	33560.	65.	160.	65696.	106900.	5600
1* N.R.	N.R.	N.R.	7.1	1833.	311.	17950.	80.	8.	31000.	51182.	3800
1* N.R.	N.R.	N.R.	N.R.	1400.	840.	22700.	3170.	50.	34000.	68262.	4060
SAN PATRICIO COUNTY											
2*28.026	97.376	561106	6.9	1795.	435.	26814.	100.	6.	45743.	74907.	3985
2*28.026	97.363	640901	6.6	2182.	368.	26643.	124.	1.	46000.	75318.	4013
2*28.028	97.378	590115	7.4	2066.	419.	26626.	148.	1.	45900.	75159.	3978
2*28.025	97.375	561106	7.1	1248.	440.	27442.	102.	4.	45743.	74986.	3987
2*28.028	97.367	510424	6.5	2490.	91.	27267.	92.	1.	46700.	76630.	4011
2*28.031	97.366	510417	6.6	2530.	151.	23717.	69.	1.	41500.	67966.	4008
2*28.028	97.374	561106	7.0	1285.	428.	27626.	91.	6.	46040.	75489.	3990
2*27.880	97.436	590822	7.0	3377.	490.	23518.	37.	1.	43654.	71085.	3342
2*27.882	97.429	650415	6.8	2427.	666.	26209.	175.	1.	46560.	76093.	4006
REFUGIO COUNTY											
2*28.379	97.172	350626	7.3	2143.	299.	26359.	287.	1.	45200.	74288.	4394
2*28.273	97.242	540105	6.7	1943.	308.	25454.	227.	6.	43500.	71438.	3461
2*28.530	97.057	320522	6.6	1043.	184.	13712.	384.	1.	23300.	38623.	4391
2*28.531	97.060	320510	7.4	1979.	251.	23654.	177.	1.	40600.	66661.	4172
BROOKS COUNTY											
2*26.799	98.412	541106	7.4	557.	1.	3832.	74.	6430.	2105.	12999.	1506
1* N.R.	N.R.	N.R.	7.6	1138.	36.	7218.	595.	1.	12907.	21901.	4500
2*26.842	98.113	480724	7.1	2182.	662.	12972.	564.	1.	25500.	41880.	3074
2*26.841	98.110	490110	6.4	4403.	328.	19232.	184.	1.	38350.	62497.	3243
KLEBERG COUNTY											
2*27.579	97.907	630729	6.6	636.	30.	5994.	151.	4570.	7000.	18381.	3434
2*27.582	97.902	640123	6.9	4122.	147.	15376.	49.	1150.	30600.	51444.	4140
2*27.573	97.902	630718	6.5	3262.	123.	13367.	41.	1700.	25500.	43993.	N.R.
2*27.517	97.963	620415	6.5	1721.	71.	10195.	41.	2330.	17250.	31608.	3640
2*27.486	97.993	641116	7.5	669.	21.	5527.	62.	4520.	6400.	17199.	3417
2*27.480	98.000	640519	7.4	590.	20.	5124.	74.	6180.	4400.	16388.	3403
2*27.425	98.039	600617	7.7	1159.	52.	9378.	96.	1860.	15250.	27795.	3414
2*27.400	98.032	600915	6.2	2263.	38.	10190.	68.	1510.	18700.	32769.	3520
2*27.606	97.879	610115	6.3	2953.	104.	14391.	65.	1650.	26500.	45663.	3770
2*27.590	97.905	160424	7.1	447.	13.	3416.	85.	6180.	1485.	11626.	3230

1* FROM CORE LABORATORIES, INC., 1972
2* FROM TAYLOR, 1975
N.R. NOT REPORTED

CHEMICAL ANALYSES OF MIOCENE FORMATION WATER

(FOR SOURCES OF ANALYSES SEE FOOTNOTE AT END OF TABLE)

LAT	LONG	DATE (Y-M-D)	PH	CA	MG	NA	HCO3	SO4	CL	TDS	DEPTH (FT)
				<----	----	----	MG/L	----	----	---->	
BRAZORIA COUNTY											
3*29.086	95.557	590114	7.6	4132.	1288.	37376.	129.	284.	68500.	111709.	5066
3*29.086	95.558	590115	7.7	3232.	1047.	33729.	117.	46.	60750.	98921.	3821
7*29.256	95.212	N.R.	N.R.	4610.	1570.	45800.	87.	19.	79500.	149100.	5309
7*29.004	95.400	690710	7.1	1700.	430.	61800.	48.	31.	107000.	182000.	6200
7*29.317	95.250	N.R.	7.1	3897.	1292.	42713.	219.	637.	76385.	124402.	4651
CALHOUN COUNTY											
3*28.605	96.509	520727	6.8	4425.	825.	19187.	89.	2261.	38112.	64899.	3289
3*28.605	96.509	520731	7.3	3373.	484.	14622.	98.	2319.	28167.	49063.	3760
3*28.617	96.491	450526	6.1	4200.	437.	27144.	91.	12.	50400.	99000.	5679
GALVESTON COUNTY											
7*29.352	94.886	680103	6.9	3400.	986.	40330.	126.	N.R.	71000.	116832.	4018
7*29.433	94.967	691216	6.8	3040.	952.	46689.	127.	N.R.	80100.	130908.	6195
7*29.350	94.884	N.R.	7.0	3300.	1100.	50000.	200.	630.	87000.	141500.	7500
7*29.353	94.886	741106	7.1	3100.	910.	43200.	102.	1.	77100.	124000.	5800
7*29.375	94.923	N.R.	6.8	3040.	952.	46689.	127.	N.R.	80100.	133300.	7000
HARRIS COUNTY											
7*29.754	95.104	721022	5.7	4520.	1368.	37950.	1220.	9.	70000.	115108.	5400
7*29.754	95.104	N.R.	7.2	4280.	888.	41377.	980.	78.	74000.	120721.	5400
7*29.754	95.104	N.R.	7.0	587.	722.	9450.	415.	1.	17300.	28703.	N.R.
JACKSON COUNTY											
3*28.807	96.589	440503	7.6	3232.	661.	9292.	61.	2369.	20560.	38400.	3035
3*28.812	96.594	440210	6.7	2540.	346.	19837.	110.	10.	36400.	60300.	4451
3*28.824	96.518	450709	7.4	2960.	150.	22600.	78.	3.	40400.	64350.	4399
3*28.824	96.518	450712	7.5	2950.	170.	22900.	100.	6.	41000.	64400.	4601
3*28.829	96.513	440918	7.2	2625.	349.	21068.	61.	8.	38000.	67000.	4488
3*28.895	96.451	450727	6.7	2940.	135.	21800.	98.	3.	39000.	64720.	4575
3*28.909	96.432	440214	7.3	1187.	405.	23677.	61.	78.	39700.	66400.	4593
3*28.909	96.661	441018	6.8	2045.	224.	19421.	146.	46.	34000.	59500.	4173
3*28.949	96.443	450814	5.8	3410.	56.	21800.	98.	2.	39800.	62520.	4641
3*28.982	96.439	440604	5.8	2960.	193.	20444.	30.	2.	37200.	65000.	4444
3*28.982	96.444	440619	7.8	2950.	506.	10708.	61.	146.	23000.	40000.	1965
3*29.020	96.467	450628	6.8	3550.	455.	19150.	100.	9.	37000.	58400.	4196
3*29.063	96.590	440701	6.9	1520.	142.	18395.	201.	82.	31200.	53500.	3620
JEFFERSON COUNTY											
1* N.R.	N.R.	N.R.	7.3	1107.	321.	23724.	972.	31.	38899.	65054.	8600
KLEBERG COUNTY											
1* N.R.	N.R.	N.R.	6.0	4314.	768.	37171.	70.	88.	67108.	109545.	5884
1* N.R.	N.R.	N.R.	5.7	1138.	279.	13658.	281.	20.	23758.	39178.	7755
MATAGORDA COUNTY											
3*28.765	95.806	450811	7.5	2560.	52.	42200.	145.	1.	69700.	113260.	5336
NUECES COUNTY											
1* N.R.	N.R.	N.R.	7.3	2200.	427.	22648.	231.	442.	39554.	65000.	4200
VICTORIA COUNTY											
3*28.625	96.875	440601	8.7	1198.	155.	7107.	24.	184.	13290.	23252.	2512
3*28.628	96.869	690626	7.6	1752.	107.	19225.	209.	22.	32915.	54203.	3972
3*28.628	96.870	690702	8.1	2098.	150.	22790.	150.	36.	39177.	64401.	3961

1* FROM CORE LABORATORIES, INC., 1972

3* FROM U.S.G.S. DATA TAPE

7* FROM DISPOSAL-WELL FILES, TEXAS DEPARTMENT OF WATER RESOURCES

N.R. NOT REPORTED

---------------CHEMICAL ANALYSES OF FRIO FORMATION WATER-------------------
(FOR SOURCES OF ANALYSES SEE FOOTNOTE AT END OF TABLE)

LAT	LONG	DATE (Y-M-D)	PH	CA	MG	NA	HCO3	SO4	CL	TDS	DEPTH (FT)
				<------	------	------	MG/L	------	------	------>	
WILLACY COUNTY											
1* N.R.	N.R.	N.R.	7.8	970.	163.	16610.	336.	169.	27500.	45757.	3900
JIM WELLS COUNTY											
2*27.867	98.003	440127	8.5	133.	15.	4828.	409.	263.	7300.	12984.	4480
2*27.681	97.953	471215	8.0	10643.	698.	23687.	153.	1.	57400.	92581.	6141
2*27.676	97.947	481229	8.7	45.	19.	7713.	1274.	1.	11150.	20387.	4094
2*27.379	98.078	521017	6.9	1016.	220.	11100.	718.	1.	19200.	32267.	5933
2*27.375	98.086	520718	6.8	907.	166.	10790.	724.	1.	18300.	30910.	6055
3*27.367	98.128	561116	6.9	615.	617.	10370.	460.	16.	18600.	30709.	5556
3*27.370	98.109	561116	7.3	542.	129.	8542.	968.	15.	13930.	24139.	6123
3*27.372	98.124	561116	7.3	1294.	404.	10620.	187.	31.	19720.	32259.	5288
3*27.376	98.124	561118	7.0	606.	326.	3004.	296.	5.	6508.	10820.	6942
3*27.379	98.124	561116	7.6	450.	76.	7194.	149.	7.	12040.	19920.	6137
1*27.714	98.063	561116	7.7	275.	80.	8105.	194.	74.	13040.	21769.	5343
3* N.R.	N.R.	N.R.	7.2	268.	N.R.	7359.	347.	95.	11562.	19631.	5300
GOLIAD COUNTY											
3*28.561	97.372	641015	6.8	740.	122.	12757.	720.	30.	20900.	35269.	3522
3*28.561	97.373	641015	7.1	860.	134.	12938.	625.	6.	21500.	36063.	3470
3*28.561	97.373	641015	8.9	40.	5.	2754.	1490.	220.	3190.	7795.	3199
3*28.571	97.286	650131	7.7	100.	12.	5367.	1560.	136.	7480.	14655.	5597
3*28.571	97.286	650131	7.8	96.	18.	5439.	1600.	120.	7590.	14863.	5597
3*28.571	97.286	650202	7.5	376.	146.	13969.	720.	24.	22200.	37435.	5093
3*28.621	97.288	650502	7.4	580.	159.	15225.	537.	82.	24600.	41183.	4532
3*28.621	97.288	650505	7.5	700.	172.	16143.	395.	15.	26400.	43825.	4521
DUVAL COUNTY											
2*27.637	98.298	490320	8.9	90.	182.	4958.	77.	500.	7840.	13722.	2996
2*27.637	98.298	490325	8.0	112.	6.	4022.	171.	12.	6290.	10636.	3791
2*27.637	98.299	490501	8.9	359.	90.	6684.	91.	80.	11050.	18341.	3454
1* N.R.	N.R.	N.R.	7.0	252.	16.	7617.	447.	246.	11899.	20378.	2603
ARANSAS COUNTY											
4*28.100	96.983	810929	8.0	460.	50.	10500.	490.	7.	17150.	28400.	11250
4*28.083	97.133	761223	7.3	6320.	482.	30544.	409.	1.	59720.	98081.	8362
4*27.783	97.450	810929	8.3	315.	17.	8400.	580.	17.	13050.	22400.	10960
4*27.784	97.450	810929	8.0	330.	29.	8400.	540.	49.	13400.	22900.	11712
4*28.233	96.667	790301	7.2	105.	4.	5257.	760.	50.	7890.	14241.	N.R.
4*28.233	96.833	810914	8.5	30.	5.	7050.	2040.	86.	8700.	16600.	9248
REFUGIO COUNTY											
1* N.R.	N.R.	N.R.	7.1	2280.	224.	26100.	127.	2.	44900.	73777.	1920
1* N.R.	N.R.	N.R.	6.9	4250.	302.	24350.	95.	3.	46000.	75000.	5500
5*28.534	97.100	N.R.	N.R.	2022.	253.	24812.	122.	1.	42500.	69709.	N.R.

Refugio County (continued)

5*28.534	97.101	N.R.	N.R.	1454.	218.	25217.	211.	1.	42000.	N.R.	N.R.
4*28.450	96.967	801027	7.2	560.	112.	19500.	753.	3.	31580.	52731.	7926
2*28.530	97.045	330120	8.0	1084.	232.	17173.	122.	1.	29000.	47611.	4541
2*28.530	97.045	330120	7.0	2210.	378.	25510.	244.	1.	44200.	72542.	5309
2*28.493	96.998	400210	7.2	2620.	175.	23284.	256.	1.	40900.	67235.	5898
2*28.374	97.171	480414	6.9	1126.	300.	25473.	673.	1.	41800.	69372.	5508
2*28.374	97.171	480421	6.9	1126.	300.	22266.	417.	1.	37000.	61109.	5158
2*28.392	97.260	550209	7.6	2020.	212.	21800.	292.	1.	37700.	62031.	6212
2*28.420	97.260	550405	6.8	1980.	174.	22700.	206.	1.	38900.	64023.	6192
2*28.348	97.146	340901	N.R.	1034.	115.	25900.	256.	1.	42000.	69305.	5015
2*28.291	97.217	510613	7.1	2540.	97.	25775.	121.	5.	44500.	73038.	5876
2*28.268	97.232	540204	7.2	2657.	180.	23293.	138.	19.	41100.	67387.	5919
2*28.271	97.230	610825	6.5	2380.	255.	25679.	174.	3.	44500.	72991.	5942
2*28.278	97.228	531218	7.2	1097.	218.	24206.	555.	31.	39600.	65707.	5316
2*28.291	97.230	531213	7.9	189.	24.	9051.	3529.	97.	12250.	25140.	8602
2*28.291	97.230	531221	7.8	143.	24.	8916.	3554.	110.	11950.	24702.	8682
2*28.268	97.237	540110	6.7	2457.	244.	24632.	151.	6.	43000.	70490.	5879
2*28.266	97.237	611002	6.3	2426.	255.	25474.	117.	3.	44300.	72575.	5858
2*28.266	97.237	611002	6.7	2216.	269.	25608.	247.	3.	44100.	72443.	5702
2*28.273	97.243	531222	6.7	2657.	205.	25306.	120.	6.	44300.	72594.	5882
2*28.244	97.263	531214	7.9	491.	47.	12673.	825.	460.	19750.	34246.	5550
2*28.204	97.266	531213	7.0	1183.	141.	18736.	725.	13.	31000.	51798.	8148
2*28.203	97.264	540117	6.6	2171.	467.	26629.	542.	6.	46000.	75815.	4560
2*28.199	97.258	531215	6.9	2500.	480.	25191.	378.	1.	44500.	73049.	4583
2*28.197	97.259	531215	6.7	2409.	508.	26462.	176.	1.	46500.	76055.	4581
2*28.530	97.057	320610	7.4	2345.	410.	24402.	116.	1.	42900.	70173.	4738
2*28.531	97.060	320601	7.2	1737.	360.	19311.	165.	1.	33800.	55793.	4732
2*28.531	97.060	320606	7.6	2436.	505.	23537.	122.	1.	42000.	68600.	4830
2*28.531	97.061	320615	7.2	2244.	460.	23383.	122.	1.	41300.	67509.	5018

SAN PATRICIO COUNTY

1* N.R.	N.R.	N.R.	6.9	3200.	382.	29061.	87.	1.	51600.	84331.	5000
1* N.R.	N.R.	N.R.	6.9	2782.	437.	25000.	117.	4.	46453.	76800.	5800
1*27.900	97.367	N.R.	N.R.	2925.	580.	29282.	148.	1.	51783.	N.R.	N.R.
4*27.900	97.417	N.R.	6.7	134.	22.	9000.	939.	46.	13400.	24600.	N.R.
4*27.901	97.417	N.R.	6.8	89.	15.	6500.	1040.	110.	9270.	17900.	N.R.
4*27.901	97.418	N.R.	6.8	101.	18.	7500.	932.	59.	10700.	20300.	N.R.
4*27.901	97.418	N.R.	6.9	54.	9.	5375.	775.	75.	7400.	14700.	N.R.
4*27.901	97.418	N.R.	6.9	47.	9.	6250.	1213.	67.	8200.	16600.	N.R.
4*28.000	97.217	N.R.	7.4	42.	9.	6500.	858.	54.	8700.	17500.	N.R.
4*27.967	97.333	N.R.	6.4	370.	56.	11750.	575.	26.	18700.	32400.	N.R.
4*27.967	97.334	N.R.	6.4	330.	48.	13250.	200.	42.	21000.	36300.	N.R.
4*27.900	97.417	N.R.	6.8	2500.	455.	29500.	270.	13.	51700.	85400.	N.R.
4*27.900	97.417	N.R.	6.6	3040.	475.	22750.	97.	67.	42800.	69800.	N.R.
4*27.901	97.417	N.R.	7.0	2500.	590.	28500.	189.	15.	50600.	83300.	N.R.
4*27.901	97.418	N.R.	6.8	2880.	340.	25250.	113.	50.	45100.	74600.	N.R.
4*27.901	97.418	N.R.	6.8	200.	31.	9250.	278.	22.	14000.	24800.	N.R.
4*28.017	97.250	810827	8.4	42.	9.	5650.	800.	66.	7600.	15900.	10983
4*28.017	97.250	810827	8.6	45.	8.	7170.	1720.	64.	9400.	18600.	10535
4*27.983	97.300	810827	5.0	484.	29.	31300.	237.	270.	46100.	77800.	9695
4*27.984	97.300	810827	8.5	24.	12.	8100.	1220.	9.	10900.	19900.	9702
4*27.984	97.301	810707	8.4	282.	22.	7550.	687.	15.	12150.	20700.	11134
4*27.984	97.301	810707	8.4	398.	46.	12690.	820.	9.	19000.	32500.	13162
4*27.984	97.301	740701	7.0	392.	136.	8924.	1708.	365.	13500.	25015.	11994
4*27.985	97.301	790712	7.0	270.	31.	7500.	970.	60.	11600.	20465.	12582
4*27.867	97.300	810818	8.4	156.	23.	10500.	1120.	52.	15200.	27400.	10745
4*27.867	97.300	810818	8.7	48.	8.	7330.	2760.	37.	8900.	16900.	9724
4*27.867	97.301	810818	8.5	31.	8.	7860.	1720.	4.	10200.	19400.	9490
4*27.868	97.301	761222	7.2	64.	37.	4763.	2013.	260.	6300.	13485.	12263
4*27.868	97.301	760506	6.7	60.	37.	9895.	1574.	45.	14700.	26360.	10735
4*27.868	97.302	771221	7.0	88.	24.	7367.	1488.	109.	10700.	19805.	11080

Frio Formation - continued

San Patricio County (continued)

4*27.868	97.301	770526	6.4	3480.	464.	23541.	506.	10.	43600.	71625.	9051
4*27.869	97.302	771228	7.0	3760.	293.	29976.	37.	123.	53800.	88050.	8857
4*27.869	97.302	780520	4.0	3200.	N.R.	34592.	N.R.	1.	64800.	105595.	8726
4*27.869	97.303	780502	7.3	72.	5.	6010.	1403.	47.	8600.	16155.	11486
4*27.869	97.303	760504	6.9	70.	37.	6366.	1513.	204.	9100.	17325.	11537
4*27.870	97.303	790219	6.6	420.	98.	14469.	586.	56.	23100.	38790.	10306
4*27.870	97.303	761110	6.8	120.	32.	8259.	1427.	73.	12400.	22430.	10844
4*27.870	97.304	770330	7.4	100.	18.	5550.	2111.	104.	7500.	15390.	11220
4*27.871	97.304	N.R.	6.7	101.	21.	10000.	915.	40.	15100.	27500.	N.R.
4*27.986	97.303	800521	7.1	296.	24.	9340.	737.	172.	14710.	25480.	13500
4*25.967	97.233	810827	8.6	27.	9.	7900.	1750.	58.	10300.	21000.	10490
2*28.029	97.375	600319	6.2	2232.	452.	27010.	123.	1.	46900.	76718.	4934
2*27.884	97.429	550704	6.9	3170.	370.	29100.	239.	1.	51400.	84360.	5016
2*27.884	97.439	561112	6.7	1239.	586.	29790.	197.	6.	49730.	81550.	5647
2*27.882	97.437	530326	7.2	2360.	393.	29500.	200.	1.	50600.	83074.	5655
2*27.883	97.441	561106	7.0	1184.	599.	30294.	191.	6.	50450.	82727.	5636
2*27.884	97.441	561106	7.0	1156.	500.	30195.	230.	5.	50041.	82145.	5624
2*27.884	97.437	550414	7.6	3420.	247.	20800.	434.	60.	38700.	63728.	6384
2*27.884	97.438	551415	6.7	2870.	281.	25500.	575.	1.	45100.	74564.	5944
2*27.883	97.439	561112	7.0	1175.	737.	30742.	129.	6.	51576.	84379.	6740
2*27.883	97.439	650518	6.4	3184.	475.	29464.	136.	1.	52380.	85707.	4992
2*27.884	97.440	561113	7.0	1165.	464.	28544.	448.	6.	47175.	77803.	5867
2*27.883	97.441	561113	6.8	1175.	562.	26743.	230.	13.	44822.	73574.	5942
2*27.883	97.441	650518	7.0	2401.	571.	27405.	274.	1.	48015.	78741.	5942
2*28.029	97.378	600319	6.3	2232.	485.	27273.	123.	1.	47400.	77514.	4371
2*28.030	97.376	590115	7.1	2199.	435.	27276.	123.	1.	47200.	77233.	4357
2*28.035	97.384	640901	6.6	2202.	381.	26787.	111.	1.	46300.	75782.	5745
2*27.899	97.272	440205	8.9	760.	68.	2814.	49.	433.	5500.	9660.	8080
2*27.899	97.272	440205	7.3	1712.	95.	13931.	354.	287.	24400.	40779.	8140
2*27.899	97.273	440209	8.3	526.	12.	5550.	183.	300.	9100.	15645.	7980
2*27.899	97.273	440209	9.3	232.	18.	2751.	37.	280.	4420.	7792.	8040
2*27.899	97.273	440228	7.6	2404.	58.	7004.	214.	370.	14850.	24900.	9140
2*27.899	97.273	440306	5.4	8088.	201.	19918.	146.	1.	45600.	73953.	9140
2*27.906	97.268	440701	7.2	1190.	122.	17984.	988.	70.	29600.	49954.	6746
2*27.916	97.265	441227	7.2	608.	302.	24888.	470.	1.	40100.	66368.	6022
2*27.978	97.266	481115	7.3	1884.	170.	14645.	231.	80.	26250.	43260.	8391
2*27.978	97.266	490602	8.3	97.	77.	9392.	2097.	235.	13400.	25383.	9984
2*27.877	97.431	540701	7.0	2571.	588.	29918.	265.	7.	52300.	85649.	5647
2*27.880	97.429	491214	6.9	1732.	387.	28983.	495.	1.	48650.	80247.	5674
2*27.877	97.436	540701	7.0	2657.	503.	30084.	365.	7.	52400.	86016.	5674
2*27.884	97.427	500616	6.0	891.	N.R.	20872.	N.R.	198.	33645.	55737.	5607
2*27.884	97.427	560111	6.6	3060.	359.	29400.	134.	1.	51800.	84769.	5655
2*27.882	97.429	650421	6.5	2427.	586.	26566.	221.	1.	46851.	76726.	4992
2*27.882	97.433	650517	6.9	2767.	729.	30027.	143.	1.	53253.	73000.	5630
2*27.884	97.435	530326	7.0	2310.	399.	29800.	138.	1.	51200.	83865.	5624
2*27.884	97.435	560625	6.1	2870.	464.	32000.	97.	70.	50700.	86383.	5664
2*27.884	97.436	561106	6.8	1221.	1562.	29144.	127.	6.	51576.	83639.	5002
2*27.884	97.433	550516	6.5	2890.	503.	27500.	199.	1.	48600.	79993.	4995

NUECES COUNTY

4*27.867	97.350	N.R.	6.5	3700.	375.	26000.	162.	18.	48200.	80100.	N.R.
5*27.667	97.300	N.R.	N.R.	1026.	241.	25716.	805.	20.	41700.	N.R.	N.R.
5*27.667	97.733	N.R.	N.R.	2090.	493.	23237.	97.	1.	40892.	66809.	N.R.
5*27.833	97.917	N.R.	N.R.	6.	43.	3808.	1122.	109.	5274.	N.R.	N.R.
1* N.R.	N.R.	N.R.	N.R.	4480.	766.	27841.	73.	159.	53000.	86321.	5300
4*27.750	97.550	810818	8.4	166.	28.	14400.	1550.	28.	20600.	37900.	10482
4*27.750	97.550	810818	8.2	181.	30.	13300.	990.	18.	20000.	34200.	9346
4*27.751	97.551	810818	8.1	491.	45.	10600.	570.	46.	16700.	29900.	10898
4*27.751	97.551	810818	8.1	375.	26.	8860.	400.	5.	14000.	24500.	12586
4*27.751	97.551	810818	8.2	87.	38.	15200.	1070.	3.	22000.	38900.	11670
4*27.783	97.250	811307	6.02	1000.	715.	53600.	114.	8.	125600.	213000.	10993

Nueces County (continued)

4*27.767	97.183	700306	6.7	689.	117.	21988.	846.	75.	34959.	58674.	8726
4*27.767	97.184	700901	6.7	498.	125.	20893.	1292.	21.	32734.	55563.	9387
4*27.767	97.184	810319	5.8	2050.	74.	21036.	317.	12.	36125.	60183.	N.R.
4*27.768	97.184	780525	7.7	532.	105.	20344.	842.	1.	32117.	53950.	N.R.
4*27.850	97.450	760501	7.1	4200.	120.	21896.	354.	1.	41180.	67750.	N.R.
4*27.850	97.450	510427	N.R.	106.	58.	9075.	1545.	6.	13453.	24243.	N.R.
4*27.867	97.150	N.R.	6.8	83.	16.	8000.	740.	25.	11600.	21200.	N.R.
4*27.867	97.151	N.R.	6.3	1640.	15.	10500.	115.	47.	18900.	31800.	N.R.
4*27.784	97.250	740502	6.23	6020.	1664.	42138.	237.	1.	133680.	214524.	10969
4*27.784	97.251	740212	5.32	9640.	1791.	53051.	41.	1.	139700.	226262.	9996
4*27.784	97.251	761208	5.73	1190.	1640.	57732.	123.	1.	149460.	241606.	12496
2*27.753	97.538	561115	6.7	1331.	2233.	23640.	340.	9.	45130.	72700.	7616
2*27.753	97.537	561120	6.4	4727.	351.	21220.	352.	6.	41940.	68600.	8150
2*27.753	97.530	530804	7.1	207.	N.R.	8730.	1360.	44.	13000.	23411.	9100
2*27.755	97.528	530604	6.7	7450.	513.	31700.	92.	1.	63400.	103200.	6054
2*27.755	97.528	530618	6.6	5580.	181.	25400.	350.	1.	49400.	80908.	7139
2*27.816	97.199	620307	6.9	684.	80.	17396.	868.	244.	27666.	47060.	8986
2*27.818	97.197	620402	9.0	473.	N.R.	17295.	618.	136.	26950.	45554.	8276
2*27.799	97.155	571115	7.4	826.	289.	23450.	640.	15.	38100.	63320.	7976
2*27.799	97.149	571113	7.4	799.	315.	23590.	615.	44.	38360.	63730.	7954
2*27.799	97.156	530804	6.8	1220.	255.	26000.	814.	28.	42500.	70848.	7467
2*27.799	97.156	530804	6.9	907.	178.	22700.	935.	35.	35000.	61269.	7836
2*27.809	97.178	601111	7.7	464.	168.	18756.	1202.	8.	29522.	50120.	7995
2*27.837	97.176	600930	6.9	6496.	896.	33560.	65.	160.	65696.	106900.	5600
2*27.830	97.171	600930	7.2	534.	224.	19172.	1123.	16.	30492.	51561.	7986
2*27.815	97.161	530226	11.8	664.	N.R.	18200.	N.R.	1.	27900.	47537.	8702
2*27.816	97.154	621011	7.9	154.	61.	10190.	1175.	590.	15050.	27220.	8135
2*27.804	97.149	521123	7.3	534.	321.	20272.	579.	53.	32657.	54598.	7934
2*27.842	97.154	521126	7.5	288.	148.	17200.	1200.	144.	26700.	45687.	8714
2*27.842	97.154	521126	7.8	252.	148.	15100.	1540.	217.	23100.	40371.	8450
2*27.842	97.154	521126	7.2	294.	156.	18800.	1310.	10.	29200.	49798.	8339
2*27.842	97.155	521126	6.9	548.	146.	22300.	1340.	70.	35000.	59462.	8055
2*27.842	97.155	521126	6.8	480.	216.	21700.	1220.	1.	34200.	57854.	7980
2*27.842	97.155	521126	7.0	844.	231.	22300.	966.	98.	36000.	60491.	8447
2*27.845	97.155	520728	7.1	287.	88.	19400.	1220.	1.	30000.	51012.	8728
2*27.732	97.189	561122	6.8	872.	488.	24810.	777.	29.	40740.	67720.	7332
2*27.734	97.191	651111	6.7	1260.	300.	25634.	1176.	25.	42540.	71058.	7406
2*27.679	97.311	590415	7.3	1404.	419.	29947.	N.R.	567.	49600.	81945.	6735
2*27.661	97.288	361212	6.0	296.	71.	9483.	408.	20.	15100.	25370.	6655
2*27.666	97.291	370209	6.1	733.	183.	22000.	641.	1.	35400.	58950.	6660
2*27.664	97.286	360805	6.8	1150.	207.	25590.	763.	1.	41650.	69360.	6657
2*27.668	97.302	430226	7.4	2472.	159.	25340.	781.	23.	43500.	72280.	6660
2*27.798	97.629	400629	6.9	2148.	91.	19480.	140.	30.	34050.	55940.	5984
2*27.753	97.538	561115	6.9	1313.	2308.	24520.	342.	10.	46660.	75160.	7898
2*27.678	97.281	361201	7.1	498.	138.	12620.	756.	276.	20100.	34380.	6680
2*27.678	97.282	361215	7.2	1026.	241.	25710.	805.	1.	41700.	69480.	6679
2*27.678	97.280	370302	7.0	1364.	319.	25620.	756.	1.	42400.	70460.	6678
2*27.679	97.274	500104	6.0	6279.	452.	28600.	42.	1200.	55700.	92270.	6605
2*27.677	97.271	500104	7.1	1427.	181.	25770.	852.	1.	42350.	70580.	6628
2*27.674	97.282	361027	7.6	680.	104.	8202.	616.	267.	13600.	23470.	6680
2*27.650	97.282	430226	6.9	1880.	300.	24400.	610.	27.	41500.	68720.	6651
2*27.680	97.258	590410	6.9	1483.	451.	26580.	813.	9.	44500.	73840.	6646
2*27.747	97.525	611112	7.7	211.	14.	8723.	1352.	48.	13072.	23467.	8958
2*27.819	97.151	650526	6.7	835.	143.	14641.	731.	1.	24153.	40785.	12600
2*27.664	97.140	571119	7.2	1509.	307.	22850.	833.	145.	38230.	63920.	7653

HIDALGO COUNTY

4*26.167	98.067	790613	6.3	2128.	36.	5711.	293.	175.	12375.	20968.	8265
4*26.167	98.067	750826	6.9	328.	15.	6081.	315.	327.	9585.	16649.	N.R.
4*26.167	98.067	570115	N.R.	512.	58.	10459.	366.	1812.	15672.	28904.	6621
4*26.168	98.068	790907	6.9	733.	36.	7353.	182.	120.	12544.	21450.	N.R.

Hidalgo County (continued)

5*26.233	98.533	N.R.	N.R.	95.	48.	10321.	84.	83.	16062.	26693.	N.R.
5*26.234	98.534	N.R.	N.R.	173.	44.	6933.	367.	1.	10912.	18429.	N.R.
5*26.234	98.534	N.R.	N.R.	130.	47.	12048.	809.	4.	18470.	31508.	N.R.
5*26.267	98.417	N.R.	N.R.	1096.	162.	17028.	182.	10.	28555.	47033.	N.R.
5*26.267	98.417	N.R.	N.R.	1640.	270.	15251.	157.	3672.	24297.	45377.	N.R.
5*26.267	98.417	N.R.	N.R.	762.	126.	15548.	194.	1.	25578.	42208.	N.R.
5*26.268	98.418	N.R.	N.R.	925.	96.	11564.	73.	987.	18963.	32608.	N.R.
2*26.358	98.331	591103	6.1	2801.	168.	12263.	186.	24.	24319.	39901.	6498
2*26.358	98.332	630318	6.5	5497.	207.	23330.	292.	12.	46137.	75498.	6498
2*26.363	98.330	551208	7.6	2290.	170.	12500.	304.	131.	23100.	38511.	7935
2*26.778	98.097	490807	8.3	8018.	172.	20442.	290.	80.	46000.	75053.	6637
2*26.778	98.097	490811	11.0	799.	25.	6667.	N.R.	1000.	10300.	19348.	6776
2*26.778	98.098	490813	10.4	2387.	148.	13187.	32.	840.	24000.	40916.	6836
2*26.778	98.098	490823	7.3	9181.	387.	29817.	227.	20.	63300.	102900.	7238
2*26.778	98.098	490826	8.9	7706.	161.	28425.	138.	150.	57600.	94375.	7365
2*26.778	98.098	490906	6.61	1088.	387.	35652.	239.	1.	75700.	123100.	7809
2*26.664	98.299	650106	8.3	1070.	N.R.	7716.	122.	4000.	10767.	23700.	2749

STARR COUNTY

1* N.R.	N.R.	N.R.	N.R.	112.	66.	6631.	770.	61.	10123.	17763.	1341
1* N.R.	N.R.	N.R.	N.R.	1842.	82.	14249.	561.	130.	25049.	41913.	5421
5*26.700	98.500	N.R.	N.R.	1656.	73.	13802.	214.	18.	24244.	40000.	N.R.
5*26.767	98.467	N.R.	N.R.	2444.	58.	13819.	116.	53.	25896.	42386.	N.R.
5*26.417	98.667	N.R.	N.R.	344.	90.	11921.	842.	1.	18764.	31961.	N.R.
5*26.600	98.567	N.R.	N.R.	1268.	50.	7395.	110.	1400.	12696.	22919.	N.R.
5*26.600	98.567	N.R.	N.R.	933.	78.	10707.	78.	445.	17923.	30164.	N.R.
5*26.383	98.067	N.R.	N.R.	455.	90.	14583.	288.	37.	23356.	38809.	N.R.
5*26.384	98.067	N.R.	N.R.	360.	102.	13714.	433.	112.	21746.	36467.	N.R.
5*26.384	98.067	N.R.	N.R.	480.	131.	15606.	444.	78.	24980.	41719.	N.R.
5*26.700	98.500	N.R.	N.R.	923.	98.	11008.	1781.	25.	17839.	31674.	N.R.
5*26.601	98.567	N.R.	N.R.	801.	96.	14823.	212.	37.	24400.	40369.	N.R.
5*26.601	98.568	N.R.	N.R.	192.	46.	6882.	689.	362.	10418.	N.R.	N.R.
5*26.383	98.117	N.R.	N.R.	190.	55.	8300.	464.	1.	13023.	22033.	N.R.
5*26.701	98.567	N.R.	N.R.	690.	87.	10351.	1060.	91.	16750.	N.R.	N.R.
5*26.767	98.467	N.R.	N.R.	1096.	88.	12938.	1647.	1.	21189.	38958.	N.R.
5*26.433	98.267	N.R.	N.R.	480.	116.	14085.	350.	1.	22700.	37731.	N.R.
5*26.434	98.267	N.R.	N.R.	356.	78.	12189.	562.	1.	19326.	32811.	N.R.
5*26.767	98.467	N.R.	N.R.	1786.	76.	13536.	226.	49.	24084.	39757.	N.R.
5*26.768	98.468	N.R.	N.R.	4160.	274.	22074.	368.	1.	41983.	68859.	N.R.
2*26.610	98.534	560712	8.6	112.	N.R.	5710.	1070.	3080.	6040.	16078.	4390
2*26.610	98.534	560712	9.0	772.	N.R.	10045.	395.	1110.	15700.	28104.	4588
2*26.595	98.535	580422	6.2	7797.	221.	15717.	376.	1.	38497.	62668.	6050
2*26.606	98.531	581223	7.01	1701.	266.	15209.	435.	1.	44697.	72336.	6469
2*26.606	98.531	581229	8.1	1692.	109.	12534.	565.	44.	22278.	37222.	5809
2*26.581	98.505	580904	7.8	1996.	78.	15522.	785.	480.	26883.	45754.	4685
2*26.767	98.827	630519	9.2	37.	2.	1175.	150.	376.	1394.	3262.	1518
2*26.767	98.827	630519	8.9	42.	2.	1212.	110.	360.	1558.	3365.	1496
2*26.781	98.409	400131	7.5	1986.	28.	10911.	116.	103.	20250.	33376.	4752
2*26.777	98.422	560717	7.0	1513.	1.	12842.	641.	48.	22100.	37144.	5130
2*26.780	98.418	560717	7.0	4432.	230.	25158.	268.	18.	47200.	77306.	6516
2*26.773	98.388	541202	7.8	509.	12.	2930.	82.	6750.	420.	10703.	2152
2*26.773	98.389	541203	7.7	589.	20.	4288.	88.	7840.	1870.	14695.	2657
2*26.773	98.389	541204	7.7	1177.	6.	6298.	50.	2430.	10000.	19961.	3842
2*26.766	98.430	560717	6.7	2594.	33.	13979.	61.	58.	26200.	42925.	4759
2*26.691	98.370	600109	6.9	2500.	210.	17336.	656.	64.	31341.	52108.	5800
2*26.571	98.505	561120	7.0	2359.	280.	18208.	400.	40.	32810.	54097.	4773
2*26.578	98.512	561120	7.3	2745.	178.	9936.	442.	17.	20410.	33728.	4854
2*26.519	98.627	421017	7.3	704.	67.	10140.	128.	30.	17000.	28069.	3963
2*26.519	98.627	421127	7.3	404.	41.	7973.	268.	930.	12300.	21916.	3895
2*26.523	98.627	421119	7.6	334.	10.	4142.	311.	3140.	4500.	12446.	3655
2*26.523	98.627	421121	7.2	658.	34.	10415.	226.	151.	17100.	28584.	3907

Frio Formation - continued

Starr County (continued)

2*26.516	98.627	421018	7.3	300.	61.	6651.	183.	93.	10800.	18088.	3912
2*26.429	98.763	630903	7.7	526.	64.	12559.	538.	1.	20176.	33868.	1437
2*26.428	98.769	630903	7.6	500.	64.	11651.	543.	1.	18724.	31488.	1425

BROOKS COUNTY

5*26.833	98.400	N.R.	N.R.	2460.	60.	13502.	66.	32.	25286.	41406.	N.R.
5*26.967	98.250	N.R.	N.R.	3032.	170.	18941.	610.	12.	34700.	57465.	N.R.
2*26.824	98.394	550922	6.5	2173.	3.	16507.	1257.	16.	28600.	48556.	6551
2*26.825	98.398	540518	7.3	3200.	90.	14777.	69.	13.	28700.	46849.	4719
2*26.823	98.403	570920	7.5	2599.	7.	11480.	85.	138.	22200.	36509.	4508
2*26.813	98.402	540518	7.1	2914.	148.	14144.	44.	13.	27400.	44663.	4728
2*26.807	98.404	540518	7.0	2800.	151.	13884.	44.	20.	26800.	43699.	4494
2*26.795	98.399	541105	7.6	444.	3.	2476.	165.	4250.	1300.	8718.	3400
2*26.788	96.400	560717	6.6	1946.	33.	15851.	1025.	26.	27400.	46281.	6110
2*26.788	98.403	560717	7.2	595.	N.R.	4162.	451.	22.	7200.	12430.	5669
2*26.784	98.403	560717	6.6	4567.	214.	25888.	220.	14.	48550.	79453.	6729
2*26.939	98.181	460114	7.2	7688.	1034.	25924.	262.	32.	56500.	91440.	6668
2*26.939	98.168	460322	6.4	6827.	681.	19788.	104.	120.	44500.	72020.	5838
2*26.939	98.168	460329	6.9	7751.	559.	24852.	232.	18.	53600.	87012.	6240
2*26.932	98.169	450730	7.6	4571.	331.	18294.	470.	124.	36950.	60740.	6445
2*26.849	98.080	600305	6.8	9833.	291.	28801.	160.	1030.	61900.	102000.	8219
2*26.842	98.113	480827	10.2	5678.	1445.	17042.	231.	50.	40250.	64846.	7010
2*26.841	98.108	490122	10.4	912.	73.	9145.	N.R.	450.	14600.	25780.	4429
2*26.841	98.109	490122	10.4	3853.	36.	16942.	N.R.	130.	32400.	53700.	4688
2*26.841	98.109	490206	8.4	8619.	273.	24261.	259.	1.	53350.	86797.	6174
2*26.829	98.102	490606	8.71	1466.	516.	28399.	37.	38.	65600.	106100.	6914
2*27.067	98.018	460626	7.1	3881.	121.	12358.	317.	180.	26000.	42857.	7198
2*27.068	98.026	451114	7.0	2619.	299.	10302.	487.	1000.	20400.	35107.	6259
2*27.068	98.026	451203	7.1	5228.	320.	17900.	407.	10.	37650.	61545.	7352
2*27.068	98.026	451223	7.2	4266.	973.	18377.	418.	180.	38400.	62614.	8043
2*27.068	98.026	460225	7.0	2410.	438.	7961.	531.	180.	17400.	28920.	7332
2*27.068	98.027	460307	7.3	7831.	948.	17847.	232.	110.	44000.	70968.	6240
2*27.060	98.026	450924	7.9	121.	268.	2848.	438.	578.	4695.	8940.	8087
2*27.060	98.026	450924	8.1	289.	97.	5959.	590.	1645.	9160.	17740.	8582
2*27.060	98.026	450924	7.9	404.	61.	4744.	420.	480.	7650.	13759.	8142
2*27.023	98.119	480926	6.73	0258.	3190.	50891.	121.	1.	141500.	226000.	5854
2*27.137	98.379	300916	N.R.1	9600.	1986.	62633.	61.	4.	137000.	221300.	4775
2*27.003	98.276	451130	6.3	4563.	340.	13750.	639.	20.	30000.	49312.	6555
2*26.999	98.276	460216	9.8	3414.	1520.	14861.	573.	90.	32800.	53258.	6578
2*26.988	98.280	450924	7.2	105.	128.	3962.	328.	80.	6425.	11028.	6573
2*26.984	98.282	451227	6.9	4067.	851.	13930.	342.	10.	31000.	50200.	6560
2*26.826	98.381	460608	6.7	2906.	243.	18242.	1061.	8.	33400.	55860.	6144
2*26.842	98.391	451021	7.4	1946.	289.	21134.	778.	51.	36400.	60589.	6176
2*26.842	98.388	451210	7.5	1875.	122.	15844.	1165.	80.	27400.	46486.	5599
2*26.842	98.388	451220	7.7	1934.	912.	15415.	1501.	20.	29000.	48782.	5791
2*26.841	98.384	451221	7.1	2480.	547.	16352.	883.	18.	30700.	50980.	5632
2*26.840	98.391	560717	6.8	2000.	1.	16188.	1366.	22.	27725.	47301.	5530
2*26.838	98.391	460222	N.R.	1606.	292.	17968.	903.	14.	30900.	51683.	6148
2*26.839	98.387	461012	7.0	2117.	135.	15560.	1437.	44.	27300.	46593.	5577
2*26.838	98.384	451122	7.4	2053.	71.	16735.	1708.	130.	27700.	48397.	5804
2*26.834	98.391	560717	7.0	1946.	66.	14882.	1635.	20.	25650.	44199.	5593
2*26.829	98.384	560717	6.7	2594.	1.	18183.	268.	20.	32500.	53565.	6125
2*26.829	98.391	460719	6.7	1861.	109.	17532.	1122.	40.	30000.	50664.	6144
2*26.829	98.397	560416	6.5	2675.	17.	15191.	122.	100.	28100.	46205.	4986
2*26.829	98.411	560717	6.2	4919.	17.	17175.	55.	8.	35250.	57424.	4734
2*26.826	98.397	560717	6.3	676.	1.	9492.	1427.	26.	15000.	26621.	5470
2*26.826	98.397	550927	6.5	2123.	62.	15157.	171.	60.	27200.	44773.	5144
2*26.824	98.394	550922	6.5	2173.	3.	16061.	1251.	36.	27900.	47424.	6551
2*27.143	98.044	460423	6.8	3373.	255.	7741.	287.	20.	18500.	30176.	7524
2*27.139	98.036	460815	7.1	1673.	121.	16067.	537.	16.	27800.	46214.	7591
2*27.076	98.014	480503	8.7	7904.	696.	18692.	331.	28.	44600.	72335.	6794

Frio Formation - continued

Brooks County (continued)

2*27.076	98.014	480525	9.9	7904.	127.	19784.	92.	190.	44400.	72702.	6292
2*27.076	98.014	480527	8.1	8052.	190.	20572.	379.	68.	46300.	75585.	6652
2*27.076	98.014	480603	7.7	7825.	443.	20628.	355.	20.	46800.	76071.	6818
2*27.076	98.015	480603	6.5	6876.	443.	20320.	490.	106.	44400.	72719.	7120
2*27.076	98.015	480609	8.0	5434.	411.	16806.	588.	60.	36400.	59699.	7389
2*27.076	98.015	480615	8.1	8200.	570.	20932.	526.	24.	48200.	78452.	7751
2*27.076	98.016	480624	9.0	7212.	506.	19611.	239.	120.	44200.	71990.	7801
2*27.076	98.016	480714	6.9	6547.	963.	16314.	367.	1.	39400.	63591.	7123
2*27.075	98.031	480409	7.8	7114.	1125.	17218.	318.	100.	42200.	68099.	6764
2*27.067	98.018	460430	7.0	9016.	377.	20471.	159.	12.	48600.	78635.	6650
2*27.067	98.018	460502	6.5	5040.	328.	13463.	165.	120.	30500.	49616.	6740
2*27.067	98.018	460515	7.1	5743.	304.	17644.	317.	40.	38100.	62148.	7422

KENEDY COUNTY

3*26.794	97.955	500104	7.3	1638.	97.	13430.	362.	8.	23699.	39229.	8304
3*26.880	97.843	541021	7.2	9600.	88.	18880.	353.	320.	45999.	75239.	8588
3*26.894	97.851	540520	7.3	8771.	63.	17570.	107.	752.	42249.	69509.	6291
3*26.899	97.172	621202	6.3	5287.	114.	26119.	233.	3.	49899.	81659.	17580
3*26.961	97.755	540907	8.9	6800.	3.	14060.	25.	128.	33499.	54659.	8663
3*27.250	97.718	631011	6.5	8163.	172.	26369.	111.	175.	55499.	90489.	6260
2*27.247	97.746	480221	6.9	7554.	1250.	25819.	61.	370.	56600.	91654.	6234
2*27.247	97.746	480225	7.3	6859.	1125.	23226.	147.	300.	51000.	82657.	6390
2*27.247	97.746	480304	7.5	9534.	1375.	24509.	245.	32.	58600.	94295.	6928
2*27.247	97.747	480307	7.51	0078.	1375.	25442.	270.	20.	61000.	98185.	7058
2*27.247	97.747	480308	6.91	0621.	1375.	26867.	233.	1.	64200.	103300.	7089
2*27.247	97.747	480318	7.11	0433.	625.	20852.	220.	1.	52400.	84530.	7712
2*27.247	97.747	480319	8.1	3162.	1000.	6535.	196.	122.	18400.	29427.	7785
2*27.004	97.869	491110	10.71	6762.	39.	20284.	N.R.	48.	60200.	97510.	8140
2*26.996	97.875	480625	10.2	4365.	542.	12563.	N.R.	200.	28400.	46205.	5991
2*26.996	97.875	480701	10.2	4412.	152.	13875.	N.R.	460.	29150.	48186.	6204
2*26.996	97.875	480730	7.31	2648.	602.	16673.	208.	28.	49800.	79959.	7343
2*26.996	97.875	481213	6.2	6046.	455.	8815.	300.	800.	24900.	41316.	8351
2*26.996	97.876	481217	9.2	7577.	485.	7240.	98.	355.	25550.	41450.	8188
4*27.383	97.550	810914	6.9	8100.	95.	25600.	84.	25.	53850.	91200.	7340
4*26.667	97.450	810713	6.71	5400.	26.	19750.	59.	5.	56300.	96300.	8608
4*26.667	97.451	810713	5.1	2440.	8.	1370.	26.	1.	6530.	10600.	15828
4*26.668	97.451	81	N.R.3	2240.	220.	39900.	47.	12.	129400.	245600.	12870
4*26.668	97.451	810720	6.63	4000.	12.	11300.	70.	2.	76650.	125200.	10040
4*26.668	97.451	810720	5.73	5800.	177.	46000.	53.	7.	141000.	252000.	12870
4*26.668	97.452	810827	6.42	7500.	46.	14200.	43.	1.	70000.	111400.	9316
4*26.669	97.452	810827	6.42	2260.	117.	17870.	48.	2.	65400.	102600.	9484
4*27.001	97.884	810914	5.21	5800.	70.	13900.	21.	10.	50150.	81800.	8836
4*27.000	97.883	810827	7.01	4100.	74.	23400.	120.	10.	59300.	94600.	7496
4*27.000	97.884	810827	6.22	8700.	98.	33300.	127.	2.	105300.	171000.	12946
4*27.267	97.733	810707	7.0	6675.	287.	29000.	51.	5.	57800.	97700.	7328
4*27.267	97.734	810707	6.8	7670.	112.	25950.	143.	3.	55900.	95900.	7443
4*27.267	97.734	810707	7.4	5350.	319.	23350.	135.	100.	47150.	79100.	14667
4*27.267	97.734	810720	6.52	5400.	111.	23850.	89.	3.	81400.	146200.	14599
4*27.233	98.933	801202	6.4	2045.	65.	19800.	411.	1.	35000.	57685.	9370
6*27.000	97.883	N.R.	N.R.	9721.	153.	21500.	216.	N.R.	53300.	N.R.	N.R.
6*27.000	97.884	N.R.	N.R.1	2036.	134.	26200.	14.	N.R.	64600.	N.R.	N.R.
6*27.150	97.733	N.R.	N.R.2	3970.	139.	19300.	147.	N.R.	73200.	N.R.	N.R.
6*27.000	97.884	N.R.	N.R.	2540.	25.	3800.	227.	N.R.	10700.	N.R.	N.R.
6*27.000	97.884	N.R.	N.R.2	7438.	138.	27700.	271.	N.R.	95500.	N.R.	N.R.

KLEBERG COUNTY

5*27.433	98.033	N.R.	N.R.	738.	35.	8257.	128.	111.	14000.	23269.	N.R.
5*27.434	98.034	N.R.	N.R.	1500.	10.	10634.	384.	54.	19000.	31672.	N.R.
5*27.600	97.917	N.R.	N.R.	195.	18.	5800.	1068.	1.	8750.	N.R.	N.R.
5*27.600	97.917	N.R.	N.R.	8168.	234.	25551.	201.	1.	54500.	88654.	N.R.

Frio Formation - continued

Kleberg County (continued)

5*27.483	97.467	N.R.	N.R.	2400.	24.	13756.	201.	160.	25300.	41841.	N.R.
1* N.R.	N.R.	N.R.	6.6	1345.	324.	31675.	600.	5.	51772.	66058.	8419
2*27.502	98.023	620415	7.2	754.	17.	11178.	397.	11.	18400.	30757.	5757
2*27.502	98.029	631107	6.9	1536.	25.	11175.	253.	268.	19700.	32957.	4398
2*27.610	97.884	440315	8.1	248.	67.	6028.	1061.	300.	9100.	16804.	6663
2*27.603	97.883	540819	7.7	126.	7.	6301.	958.	18.	9400.	16810.	6655
2*27.603	97.884	610215	7.2	164.	7.	6456.	644.	1.	9900.	17172.	6655
2*27.599	97.883	430312	7.6	195.	18.	5809.	1068.	1.	8750.	15840.	6669
2*27.596	97.896	421211	7.6	210.	31.	4282.	647.	262.	6500.	11932.	6464
2*27.594	97.883	490215	8.1	118.	38.	6457.	943.	50.	9700.	17306.	6659
2*27.593	97.887	471006	9.3	16.	34.	4313.	1683.	1110.	4685.	12094.	6552
2*27.593	97.888	471023	5.5	1567.	250.	5520.	641.	80.	11600.	19658.	6624
2*27.586	97.947	460907	7.2	445.	194.	5661.	915.	28.	9550.	16793.	6399
2*27.582	97.948	490215	7.5	284.	61.	5700.	967.	156.	8800.	15968.	6374
2*27.554	98.056	480410	8.1	79.	45.	6865.	514.	305.	10300.	18144.	5967
2*27.530	98.011	631028	7.2	436.	15.	9298.	618.	12.	14800.	25179.	6100
2*27.528	98.008	491214	10.2	139.	16.	8470.	1666.	173.	11800.	22264.	6154
2*27.528	98.012	631028	6.7	1386.	7.	10114.	223.	85.	17900.	29715.	6213
2*27.513	98.029	460831	6.7	1344.	145.	8573.	85.	400.	15700.	26247.	4880
2*27.513	98.029	460904	7.0	1265.	230.	8391.	183.	220.	15600.	25889.	5127
2*27.513	98.029	461006	7.4	165.	79.	9476.	3346.	1.	13200.	26266.	6551
2*27.506	98.005	631028	7.8	70.	15.	9774.	1779.	22.	14200.	25860.	7146
2*27.503	98.000	631107	7.3	152.	22.	9347.	1372.	15.	13950.	24858.	6427
2*27.484	98.000	461208	7.1	769.	123.	11906.	677.	8.	19700.	33183.	6073
2*27.484	98.000	461211	7.3	454.	110.	10703.	907.	28.	17100.	29302.	6263
2*27.484	98.000	461227	7.4	116.	74.	11102.	1787.	20.	16500.	29599.	7055
2*27.509	98.001	470217	7.3	103.	20.	10329.	2034.	1.	15000.	27486.	7120
2*27.480	97.996	470427	6.8	194.	22.	9938.	1036.	263.	14950.	26403.	7322
2*27.499	98.004	631115	7.5	703.	25.	11273.	513.	29.	18400.	30943.	4877
2*27.501	98.026	621415	7.1	544.	31.	10500.	781.	11.	16800.	28667.	4408
2*27.501	98.026	631107	6.8	1556.	25.	11100.	266.	286.	19600.	32833.	4369
2*27.499	98.029	620415	6.3	2442.	31.	12174.	157.	370.	22850.	38024.	4442
2*27.499	98.029	631107	6.5	1192.	43.	11159.	297.	125.	19200.	32016.	4442
2*27.488	98.029	480425	8.1	445.	250.	11059.	1231.	40.	17800.	30861.	6135
2*27.491	98.009	460813	7.0	213.	49.	4001.	232.	760.	6000.	11255.	5126
2*27.491	98.009	460831	7.6	803.	145.	7951.	586.	270.	13600.	23355.	5473
2*27.491	98.009	460831	7.6	285.	158.	9280.	988.	20.	14700.	25431.	6179
2*27.491	98.009	461002	7.7	122.	44.	10416.	1587.	1.	15500.	27669.	6984
2*27.484	98.012	631107	7.4	115.	15.	10288.	1396.	19.	15300.	27133.	7109
2*27.483	98.007	631028	7.9	93.	21.	10649.	1459.	19.	15800.	18041.	7133
2*27.481	98.057	631107	6.9	736.	49.	15129.	420.	7.	24550.	40891.	6375
2*27.479	98.055	631107	6.9	800.	54.	12543.	407.	1.	20700.	34505.	6082
2*27.479	98.051	640519	6.4	784.	39.	11055.	445.	14.	18300.	30637.	6045
2*27.477	98.017	631028	6.4	877.	25.	9364.	482.	1.	15800.	26594.	5693
2*27.469	98.025	480405	8.1	321.	63.	7163.	759.	495.	11000.	19801.	6084
2*27.471	98.019	631107	6.6	719.	20.	11238.	383.	9.	18450.	30819.	6073
2*27.473	98.004	480827	7.1	119.	181.	10339.	2530.	1.	15500.	28195.	7137
2*27.466	98.021	480623	7.2	150.	101.	10284.	1421.	12.	15600.	27568.	6985
2*27.458	98.008	491112	7.8	261.	13.	12079.	1293.	24.	18375.	32045.	7113
2*27.459	98.024	480314	7.3	439.	75.	9873.	1041.	40.	15600.	27068.	6520
2*27.451	98.041	461031	7.7	159.	44.	8864.	1884.	130.	12900.	23981.	6969
2*27.440	98.024	570404	8.4	759.	39.	10131.	1012.	30.	16400.	28443.	6788
2*27.447	98.049	470101	7.4	694.	109.	10347.	691.	24.	17100.	28965.	5619
2*27.444	98.049	461128	7.3	116.	69.	9312.	1787.	140.	13600.	25024.	6768
2*27.440	98.049	461018	7.5	100.	59.	10109.	1932.	38.	14800.	27038.	6822
2*27.440	98.049	580205	7.1	416.	32.	9323.	721.	3.	14800.	25295.	6340
2*27.440	98.049	600617	6.1	850.	26.	10176.	411.	3.	17050.	28516.	6278
2*27.440	98.049	601228	7.2	260.	19.	9934.	1274.	11.	15100.	26598.	6278
2*27.449	98.057	570807	7.2	747.	29.	10672.	256.	46.	17700.	29450.	4890
2*27.449	98.057	620629	7.1	402.	28.	9885.	685.	76.	15600.	26676.	6699
2*27.449	98.058	631010	6.9	695.	44.	9327.	1607.	32.	14800.	26505.	6699
2*27.449	98.058	640123	8.3	263.	17.	7542.	803.	63.	11600.	20325.	6699

Kleberg County (continued)

2*27.423	98.053	490520	6.2	573.	97.	9418.	1840.	105.	14650.	26683.	6150
2*27.415	98.049	470613	7.5	158.	18.	6785.	1801.	40.	9725.	18527.	7016
2*27.415	98.053	420708	7.3	844.	29.	8764.	110.	63.	15000.	24810.	4695
2*27.409	98.057	480623	7.3	1404.	177.	9561.	331.	100.	17500.	29073.	5268
2*27.409	98.057	480623	7.8	474.	177.	8764.	919.	70.	14300.	24704.	6147
2*27.409	98.057	480827	7.5	115.	193.	9537.	1800.	40.	14400.	26058.	7098
2*27.404	98.057	421102	7.6	1526.	34.	9042.	1372.	101.	16600.	28675.	5302
2*27.404	98.057	421125	7.3	1590.	10.	10634.	384.	54.	19000.	31672.	5699
2*27.400	98.048	590315	7.4	334.	48.	6108.	173.	1.	10060.	16724.	6921
2*27.568	97.926	490731	7.6	140.	44.	9230.	1734.	52.	13575.	24775.	6975
2*27.557	97.927	631015	6.8	873.	15.	10579.	371.	7.	17700.	29545.	6174
2*27.576	97.911	470218	7.4	108.	10.	5844.	1343.	12.	8450.	15767.	6638
2*27.574	97.895	610424	6.5	1938.	38.	9924.	411.	39.	18600.	30950.	6400
2*27.574	97.896	610505	7.1	444.	19.	6626.	425.	3140.	8500.	19154.	6699
2*27.573	97.902	620410	6.9	707.	14.	6221.	76.	4400.	7600.	19018.	6328
2*27.573	97.927	620503	7.2	226.	18.	9884.	1041.	5.	15100.	26274.	6526
2*27.569	97.913	490731	7.6	614.	24.	8116.	678.	24.	13725.	22731.	6183
2*27.558	97.918	631013	7.4	198.	15.	9645.	982.	12.	14700.	25552.	6988
2*27.539	97.988	480520	7.7	154.	35.	9223.	2254.	1.	13300.	24966.	6491
2*27.539	97.988	480827	7.3	117.	205.	8578.	2141.	1.	12800.	23841.	6957
2*27.533	97.990	631028	6.4	1495.	12.	10134.	173.	42.	18200.	30056.	5218
2*27.531	97.980	460117	7.6	1394.	11.	7527.	232.	120.	13900.	23184.	5229
2*27.531	97.980	470225	7.5	103.	12.	6647.	1676.	260.	9310.	18008.	6988
2*27.531	97.980	470227	7.1	228.	14.	7846.	1261.	32.	11800.	21181.	6343
2*27.531	97.981	470227	7.5	103.	14.	5467.	1826.	1.	14700.	22110.	7008
2*27.531	97.981	470228	7.3	87.	14.	9543.	1977.	1.	13775.	25396.	7031
2*27.528	97.976	470411	7.1	323.	29.	7420.	954.	8.	11550.	20284.	6298
2*27.528	97.984	490207	7.5	77.	5.	9093.	2456.	77.	12700.	24408.	4958
2*27.528	97.984	490207	9.7	1.	1.	7741.	1396.	572.	10200.	19910.	7141
2*27.528	97.996	461027	7.7	82.	25.	9210.	2237.	43.	13100.	24697.	6873
2*27.528	97.996	461029	7.8	83.	64.	7754.	2138.	215.	10900.	21154.	6957
2*27.528	97.997	461102	7.9	65.	3.	7825.	2272.	40.	10850.	21055.	7106
2*27.528	97.997	461104	7.5	79.	24.	8437.	2643.	28.	11675.	22886.	7216
2*27.526	97.986	631028	6.2	1228.	20.	10093.	346.	21.	17600.	29308.	6942
2*27.524	97.984	480117	7.5	68.	18.	9532.	2168.	32.	13600.	25418.	6942
2*27.513	97.994	470510	7.0	291.	17.	9346.	1080.	16.	14350.	25100.	6285
2*27.511	97.990	631028	8.1	61.	13.	8973.	1842.	32.	12900.	23821.	7155
2*27.508	97.990	631028	7.5	156.	16.	9061.	1557.	3.	13400.	24193.	6359
2*27.506	97.992	461217	8.7	876.	172.	7514.	459.	700.	12800.	22580.	5478
2*27.506	97.992	470101	7.3	184.	48.	10607.	1784.	1.	15800.	28423.	6473
2*27.506	97.992	470101	7.9	754.	121.	8727.	540.	200.	14700.	25042.	5817
2*27.506	97.993	470101	8.2	1517.	84.	10576.	641.	120.	18800.	31738.	5491
2*27.508	97.993	470101	7.3	120.	121.	11509.	1571.	20.	17400.	30741.	6948
2*27.506	97.993	470101	7.3	104.	109.	10110.	2010.	50.	14900.	33155.	4881
2*27.504	97.994	631028	6.9	1788.	43.	11002.	62.	60.	20200.	33155.	4881
2*27.504	97.990	631028	7.1	1818.	37.	10919.	74.	60.	20100.	33008.	5180
2*27.441	97.569	631028	6.2	7678.	196.	25028.	87.	110.	52700.	85799.	7235
2*27.441	97.569	631028	6.2	7476.	712.	35961.	87.	6.	70800.	115000.	5668
2*27.441	97.573	591116	5.71	1241.	307.	18036.	55.	6.	48650.	78295.	N.R.
2*27.441	97.573	591116	5.51	0099.	258.	17530.	49.	10.	45700.	73646.	N.R.
2*27.441	97.574	591116	5.51	0789.	355.	19337.	49.	7.	50000.	80537.	N.R.
2*27.441	97.574	631028	6.0	8365.	270.	22856.	49.	115.	50800.	82455.	7243
2*27.441	97.574	631028	6.41	1436.	73.	17187.	62.	6.	47000.	75764.	7893
2*27.465	97.578	631028	5.9	7961.	761.	33800.	25.	11.	68500.	111100.	5394
2*27.452	97.579	631028	6.3	9092.	73.	20595.	68.	3.	48100.	77931.	7568
2*27.452	97.587	631028	6.1	9456.	98.	19610.	62.	3.	47300.	76529.	7284
2*27.452	97.595	631028	6.0	9335.	49.	21203.	62.	3.	49400.	80088.	7529
2*27.448	97.583	631028	5.8	7557.	393.	32638.	43.	15.	64900.	105500.	6356
2*27.448	97.589	631028	6.2	8082.	245.	24437.	62.	60.	52700.	85586.	7117
2*27.445	97.592	631028	6.7	8809.	73.	22103.	105.	7.	49900.	80997.	7473
2*27.436	97.587	591116	5.6	8283.	614.	30537.	49.	27.	63500.	103000.	N.R.
2*27.436	97.587	631028	6.2	8122.	147.	24725.	93.	76.	52900.	86063.	7117

Frio Formation - continued

Kleberg County (continued)

2*27.396	97.564	540527	7.5	3686.	10.	11917.	290.	62.	24750.	40715.	10118
2*27.451	98.032	461209	7.3	155.	93.	11032.	1474.	24.	16700.	29478.	7029
2*27.451	98.033	461224	7.2	399.	172.	9661.	845.	40.	15600.	26717.	6486
2*27.478	97.794	400215	7.3	2400.	24.	13756.	201.	160.	25300.	41841.	5243
2*27.499	97.984	490616	9.0	20.	26.	10994.	555.	597.	16000.	28192.	7693
2*27.495	97.992	640519	7.3	453.	29.	10444.	816.	47.	16500.	28289.	N.R.
2*27.484	98.000	461025	7.4	1625.	172.	10578.	483.	52.	19400.	32314.	5151

WHARTON COUNTY

2*29.149	96.049	400124	6.9	2124.	607.	29890.	390.	0	51420.	84621.	5546
2*29.151	96.052	400124	6.5	1470.	638.	32490.	425.	0	54340.	89613.	5548
1* N.R.	N.R.	N.R.	6.5	1744.	620.	31900.	378.	1.	53600.	91518.	5550
5*29.167	96.083	N.R.	N.R.	2352.	376.	30583.	817.	1.	52000.	N.R.	N.R.
5*29.083	96.367	N.R.	N.R.	870.	109.	19957.	390.	1.	32400.	N.R.	N.R.
5*29.250	96.200	N.R.	N.R.	2660.	220.	23100.	290.	1.	41000.	N.R.	N.R.

LIBERTY COUNTY

1* N.R.	N.R.	N.R.	7.2	1259.	253.	14102.	433.	3.	24485.	40581.	8136
1* N.R.	N.R.	N.R.	7.2	1242.	253.	14145.	431.	4.	24521.	40638.	9522

FORT BEND COUNTY

5*29.467	95.250	N.R.	N.R.	5100.	628.	40307.	193.	8.	73000.	119236.	N.R.
5*29.467	95.250	N.R.	N.R.	3480.	484.	34856.	169.	3.	61300.	100292.	N.R.
5*29.467	95.251	N.R.	N.R.	3880.	472.	37145.	181.	6.	65500.	107184.	N.R.
5*29.550	95.050	N.R.	N.R.	2781.	508.	30980.	311.	1.	54000.	88580.	N.R.
5*29.467	95.567	N.R.	N.R.	2040.	322.	37937.	195.	1.	63000.	103494.	N.R.
5*29.467	95.567	N.R.	N.R.	2280.	1160.	32700.	122.	1.	57784.	94046.	N.R.

JEFFERSON COUNTY

5*29.967	94.133	N.R.	N.R.	426.	79.	11903.	537.	62.	19000.	N.R.	N.R.
5*29.967	94.134	N.R.	N.R.	816.	136.	16290.	287.	1.	26800.	44335.	N.R.
5*29.967	94.134	N.R.	N.R.	348.	152.	11869.	659.	80.	18900.	32008.	N.R.
5*30.067	94.133	N.R.	N.R.	2756.	606.	35540.	79.	1.	61400.	100381.	N.R.
5*30.067	94.134	N.R.	N.R.	1475.	192.	17670.	43.	1.	30400.	N.R.	N.R.
5*30.067	94.134	N.R.	N.R.	1568.	238.	20290.	98.	1.	34700.	56894.	N.R.
5*30.017	94.400	N.R.	N.R.	2835.	764.	40100.	27.	11.	69100.	112837.	N.R.
5*30.017	94.400	N.R.	N.R.	2970.	611.	38232.	221.	103.	65794.	107931.	N.R.
5*29.800	94.283	N.R.	N.R.	4655.	906.	38383.	908.	96.	69502.	114450.	N.R.
5*29.800	94.284	N.R.	N.R.	2658.	211.	30692.	605.	79.	52268.	86513.	N.R.
4*29.600	94.417	811008	8.0	480.	100.	22600.	1130.	14.	33800.	57200.	10434
4*28.000	97.250	810818	8.0	190.	31.	10500.	880.	75.	15500.	27900.	10914
4*29.950	94.000	650326	5.4	2248.	272.	28200.	6751.	250.	45200.	83131.	10616
4*29.950	94.000	650326	5.4	2685.	216.	30080.	158.	134.	48800.	82258.	10650
4*29.917	94.000	610201	7.8	2455.	233.	23860.	660.	48.	41400.	68790.	11286
4*29.917	94.000	610201	6.5	1288.	160.	14496.	530.	19.	25115.	41878.	10956
4*29.800	94.167	740215	7.0	891.	157.	25500.	1080.	35.	40700.	68377.	N.R.
4*29.800	94.167	790309	7.0	3800.	779.	41800.	80.	15.	73500.	120067.	N.R.
4*29.801	94.167	790309	7.0	2930.	1020.	43000.	89.	1.	74500.	121611.	N.R.

CHAMBERS COUNTY

4*29.633	94.900	750929	6.9	1764.	420.	38472.	244.	373.	63900.	105789.	5890
4*29.634	94.900	740412	6.4	2095.	613.	38878.	195.	186.	63900.	106498.	5858
4*29.634	94.901	761119	6.2	1849.	458.	37482.	231.	230.	63900.	104776.	5836
4*29.634	94.901	740412	6.5	2050.	511.	39672.	207.	360.	65675.	109142.	5964
4*29.667	94.500	790906	6.6	4830.	1010.	41700.	269.	2.	75700.	123655.	8335
4*29.667	94.500	800623	6.5	3420.	1160.	30100.	162.	N.R.	56000.	91072.	8264
4*29.667	94.501	790906	6.7	4840.	1330.	47100.	245.	2.	84900.	138553.	8246

Frio Formation - continued

Chambers County (continued)

4*29.533	94.833	730501	7.1	392.	29.	17991.	898.	20.	28045.	47728.	N.R.
4*29.800	94.400	670508	6.3	2914.	1770.	33900.	222.	15.	62150.	100355.	N.R.
4*29.800	94.400	680416	7.3	2320.	732.	37240.	500.	3.	63480.	104406.	7612
4*29.801	94.401	700218	6.6	2240.	561.	37197.	383.	6.	62770.	103223.	7826
4*29.534	94.834	800202	6.2	1020.	197.	16900.	590.	36.	28200.	46992.	10126
4*29.534	94.834	800510	6.9	1010.	343.	32900.	485.	N.R.	53200.	87982.	9742
4*29.534	94.834	801022	6.8	1500.	343.	34600.	554.	N.R.	56600.	93652.	10450
4*29.534	94.834	801021	7.4	687.	218.	23700.	546.	N.R.	38600.	64000.	10846
4*29.535	94.835	801016	6.4	4870.	9450.	27200.	179.	N.R.	78000.	119819.	8170
4*29.535	94.835	801022	6.1	7590.	766.	46300.	185.	N.R.	87100.	142203.	9347
4*29.767	94.383	781215	4.4	4230.	550.	27900.	N.R.	N.R.	52100.	84800.	10469
4*29.767	94.384	N.R.	7.1	2190.	953.	27700.	237.	13.	49400.	80576.	N.R.
5*29.783	94.583	N.R.	N.R.	2608.	312.	42472.	159.	1.	71000.	116551.	N.R.
5*29.784	94.584	N.R.	N.R.	4310.	517.	31116.	146.	50.	57000.	N.R.	N.R.
5*29.533	94.817	N.R.	N.R.	1286.	220.	37368.	854.	1.	60100.	N.R.	N.R.
5*29.633	94.917	N.R.	N.R.	4350.	450.	34965.	98.	101.	62800.	102764.	N.R.
5*29.634	94.917	N.R.	N.R.	4130.	347.	28786.	232.	378.	52300.	86173.	N.R.
5*29.850	94.667	N.R.	N.R.	1725.	483.	25267.	171.	103.	43261.	71010.	N.R.
1* N.R.	N.R.	N.R.	6.7	2438.	233.	25455.	133.	16.	44167.	72442.	7140
1* N.R.	N.R.	N.R.	6.8	3553.	683.	32245.	866.	70.	57440.	94931.	8290
1* N.R.	N.R.	N.R.	6.4	986.	145.	24334.	832.	27.	39192.	65780.	9000
1* N.R.	N.R.	N.R.	6.1	4524.	667.	36827.	525.	10.	66566.	109730.	9400

HARRIS COUNTY

7*29.750	95.100	680606	6.4	2320.	437.	41415.	61.	N.R.	69255.	113375.	6875
7*25.967	95.050	760611	7.4	2476.	403.	44214.	111.	98.	73609.	120924.	6700
7*29.751	95.101	780713	7.2	2740.	340.	39200.	115.	5.	70000.	N.R.	7200
7*29.752	95.102	N.R.	N.R.	1850.	440.	34500.	150.	11.	60140.	124900.	7650
7*29.727	95.125	N.R.	8.4	10.	5.	25000.	1400.	1600.	36800.	65000.	7650
5*29.667	95.333	N.R.	N.R.	4740.	1007.	27931.	140.	1.	54400.	88218.	N.R.
5*29.667	95.334	N.R.	N.R.	2552.	402.	40600.	170.	1.	67300.	111024.	N.R.
5*30.117	95.633	N.R.	N.R.	1540.	122.	14610.	189.	1.	25500.	41961.	N.R.
5*29.617	95.267	N.R.	N.R.	1849.	303.	39120.	116.	1.	64400.	105788.	N.R.
5*29.550	95.167	N.R.	N.R.	3050.	397.	35997.	220.	1.	62000.	101664.	N.R.
5*29.617	95.017	N.R.	N.R.	2744.	337.	37720.	122.	1.	64000.	104923.	N.R.
4*29.417	95.167	81	6.1	8350.	710.	44000.	88.	2.	83600.	139000.	11408
4*29.417	95.167	81	5.9	8580.	670.	42400.	94.	3.	80900.	133000.	11499

GALVESTON COUNTY

1* N.R.	N.R.	N.R.	6.6	4020.	719.	40800.	471.	6.	72000.	118185.	7900
4*29.301	95.134	N.R.	7.0	290.	60.	16500.	397.	39.	23200.	42100.	N.R.
4*29.302	95.135	460901	N.R.	425.	98.	15165.	1596.	58.	24181.	41405.	8680
4*29.302	95.136	530611	N.R.	302.	81.	15124.	1635.	46.	23151.	40339.	8770
4*29.303	95.136	461929	N.R.	292.	72.	16467.	1437.	78.	25234.	43580.	9163
4*29.303	95.136	060145	N.R.	827.	138.	18043.	655.	39.	29289.	48991.	10905
4*29.303	95.136	561218	N.R.	1600.	185.	20400.	394.	38.	34625.	57322.	11461
4*29.303	95.137	530611	N.R.	302.	81.	15124.	1635.	46.	23151.	40339.	8770
4*29.304	95.137	461020	N.R.	292.	72.	16467.	1437.	78.	25234.	43580.	9163
4*29.304	95.137	060145	N.R.	827.	138.	18043.	655.	39.	29289.	48991.	10905
4*29.304	95.138	460501	N.R.	441.	101.	13843.	1630.	24.	21459.	37498.	8832
4*29.305	95.138	561218	N.R.	582.	101.	18306.	1093.	24.	28934.	49091.	9386
4*29.305	95.138	520416	N.R.	1104.	168.	23994.	649.	34.	39102.	65147.	11068
4*29.305	95.139	680411	N.R.	4319.	595.	27820.	369.	1.	52600.	86685.	12248
4*29.333	95.100	810818	7.4	1490.	151.	29800.	536.	18.	46300.	79900.	12280
4*29.334	95.100	810818	8.1	783.	95.	22700.	628.	7.	35200.	58900.	11254
4*29.334	95.101	810818	8.0	606.	88.	24900.	848.	6.	36700.	62500.	N.R.
4*29.500	95.050	680415	7.1	4320.	708.	41030.	793.	1.	72700.	119339.	8675
4*29.334	95.101	670504	6.9	880.	183.	15200.	673.	13.	25180.	42223.	13022
4*29.334	95.101	670313	6.2	660.	134.	18170.	630.	7.	29260.	49034.	11210
5*29.467	95.100	N.R.	N.R.	2374.	486.	39996.	453.	40.	67012.	110361.	N.R.

Frio Formation - continued

Galveston County (continued)

5*29.467	95.100	N.R.	N.R.	1686.	400.	37432.	450.	25.	61921.	N.R.	N.R.
5*29.450	94.950	N.R.	N.R.	512.	235.	20435.	616.	1.	32750.	54548.	N.R.
5*29.450	94.950	N.R.	N.R.	2852.	496.	27106.	488.	1.	48100.	79042.	N.R.
5*29.451	94.951	N.R.	N.R.	746.	68.	16542.	561.	1.	26700.	44617.	N.R.
5*29.451	94.951	N.R.	N.R.	2910.	380.	34170.	458.	1.	58750.	96668.	N.R.
5*29.451	94.951	N.R.	N.R.	2288.	265.	23783.	561.	1.	41000.	67897.	N.R.
5*29.451	94.951	N.R.	N.R.	1880.	41.	19056.	885.	25.	32300.	54187.	N.R.
5*29.333	95.100	N.R.	N.R.	418.	81.	17120.	1089.	103.	26684.	45495.	N.R.
5*29.334	95.100	N.R.	N.R.	629.	163.	23446.	854.	52.	37233.	62367.	N.R.
4*29.367	95.133	N.R.	6.7	380.	70.	15250.	414.	31.	23400.	41300.	N.R.
4*29.367	95.134	N.R.	6.9	400.	75.	16000.	312.	32.	23800.	42500.	N.R.
4*29.350	94.967	N.R.	6.9	470.	85.	17000.	643.	34.	25200.	44600.	N.R.
4*29.333	95.100	N.R.	6.4	700.	90.	19500.	787.	11.	31000.	53100.	N.R.
4*29.334	95.100	N.R.	5.9	1230.	170.	18250.	506.	8.	29300.	50400.	N.R.

BRAZORIA COUNTY

6*29.217	95.150	N.R.	N.R.	15912.	1000.	36700.	88.	N.R.	90800.	N.R.	N.R.
6*29.217	95.150	N.R.	N.R.	19176.	1137.	40500.	113.	N.R.	103500.	N.R.	N.R.
6*29.217	95.151	N.R.	N.R.	61.	9.	5200.	743.	N.R.	7000.	N.R.	N.R.
4*29.400	95.283	810818	7.8	1010.	180.	37900.	600.	12.	59500.	98500.	10574
4*28.017	97.250	810827	8.4	42.	9.	5650.	800.	66.	7600.	15900.	10983
4*28.017	97.250	810827	8.6	45.	8.	7170.	1720.	64.	9400.	18600.	10535
4*29.267	95.300	810818	5.22	2600.	1535.	69700.	30.	16.	152000.	235000.	12568
4*29.267	95.300	810818	7.6	1540.	185.	27600.	220.	21.	43800.	74300.	N.R.
4*29.367	95.250	810818	8.2	330.	60.	22700.	1280.	21.	34000.	56600.	10864
4*29.317	95.200	N.R.	7.0	380.	70.	16250.	361.	43.	24000.	42800.	N.R.
4*29.317	95.200	N.R.	7.1	280.	60.	15250.	427.	43.	22500.	40200.	N.R.
4*29.317	95.201	N.R.	7.0	180.	40.	15750.	525.	42.	22400.	40000.	N.R.
4*29.318	95.201	N.R.	7.0	290.	60.	16500.	397.	39.	23200.	42100.	N.R.
4*29.318	95.201	N.R.	6.9	130.	30.	16500.	582.	25.	23800.	42000.	N.R.
4*29.318	95.201	N.R.	5.9	2000.	220.	26500.	333.	3.	42700.	73300.	N.R.
4*29.318	95.202	N.R.	7.0	710.	90.	25000.	269.	11.	36300.	63700.	N.R.
4*29.319	95.202	N.R.	5.9	1700.	200.	22000.	262.	5.	37500.	63000.	N.R.
4*29.319	95.202	N.R.	7.0	130.	25.	13000.	562.	57.	18100.	33400.	N.R.
4*29.319	95.202	N.R.	6.7	160.	35.	14000.	632.	59.	19600.	35800.	N.R.
4*29.319	95.203	N.R.	6.3	610.	95.	23250.	302.	11.	35200.	60700.	N.R.
4*29.320	95.203	N.R.	6.3	2000.	235.	24000.	317.	1.	40500.	68600.	N.R.
4*29.320	95.203	N.R.	7.4	140.	30.	14000.	596.	17.	20400.	36600.	N.R.
4*29.320	95.204	N.R.	7.2	170.	30.	12500.	484.	59.	19600.	34300.	N.R.
4*29.283	95.133	N.R.	6.8	1800.	170.	20500.	356.	16.	34500.	58000.	N.R.
4*29.284	95.134	N.R.	6.7	1600.	185.	17750.	400.	6.	29300.	50200.	N.R.
5*29.067	95.667	N.R.	N.R.	333.	21.	10750.	1348.	1.	16450.	N.R.	N.R.
5*29.067	95.667	N.R.	N.R.	98.	21.	10779.	1815.	60.	15769.	28542.	N.R.
5*29.067	95.667	N.R.	N.R.	137.	64.	14155.	1507.	151.	21276.	N.R.	N.R.
5*29.068	95.668	N.R.	N.R.	24.	17.	7180.	1808.	256.	9928.	19213.	N.R.
5*29.317	95.167	N.R.	N.R.	2244.	360.	29170.	580.	37.	49951.	82342.	N.R.
5*29.267	95.333	N.R.	N.R.	638.	112.	16625.	976.	75.	26500.	44926.	N.R.
5*29.267	95.334	N.R.	N.R.	1104.	29.	27400.	921.	1.	43800.	N.R.	N.R.
5*29.200	95.417	N.R.	N.R.	1688.	68.	17581.	854.	1.	29800.	49991.	N.R.
5*29.500	95.250	N.R.	N.R.	1804.	322.	38852.	183.	1.	64000.	105161.	N.R.
5*29.167	95.800	N.R.	N.R.	253.	72.	6890.	665.	1.	10900.	N.R.	N.R.
5*29.400	95.417	N.R.	N.R.	1808.	338.	36262.	244.	69.	59927.	N.R.	N.R.
5*29.400	95.417	N.R.	N.R.	2005.	368.	38899.	104.	37.	64537.	105950.	N.R.
3*29.020	95.746	670613	6.8	384.	78.	15467.	781.	16.	24300.	41026.	0776
3*29.025	95.767	670614	7.0	344.	64.	17520.	878.	14.	27300.	46120.	0433
3*29.044	95.676	670620	7.0	432.	68.	17046.	695.	72.	26800.	45113.	10766
3*29.044	95.686	410415	7.9	184.	31.	12370.	1720.	69.	18450.	32849.	10140
3*29.056	95.683	410415	8.0	90.	18.	9145.	2180.	68.	13000.	24512.	10122
3*29.058	95.694	670615	7.4	144.	39.	14258.	1270.	32.	21600.	37343.	10142
3*29.060	95.734	670620	7.1	120.	44.	9361.	2310.	50.	13400.	25285.	10280
3*29.063	96.590	440703	7.2	1180.	223.	21822.	140.	4.	36200.	60000.	4066

Frio Formation - continued

Brazoria County (continued)

3*29.064	95.729	670612	7.4	160.	49.	14480.	1270.	32.	22000.	37991.	10354
3*29.064	95.740	670620	7.3	96.	39.	13152.	1440.	46.	19700.	34473.	10170
3*29.086	95.557	590108	6.6	731.	148.	17553.	850.	578.	27900.	47760.	12244
3*29.086	95.558	590110	6.1	1547.	206.	24338.	468.	730.	40100.	67389.	11992

MATAGORDA COUNTY

3*28.972	95.483	500705	7.2	1660.	259.	20881.	769.	2.	35460.	N.R.	11348
5*28.967	95.917	N.R.	N.R.	4350.	450.	34965.	98.	101.	62800.	102764.	N.R.
5*28.900	96.050	N.R.	N.R.	896.	174.	19780.	1647.	50.	31636.	54183.	N.R.
5*28.967	96.033	N.R.	N.R.	244.	59.	16968.	1198.	51.	26053.	44573.	N.R.
5*28.967	96.034	N.R.	N.R.	64.	28.	4616.	1159.	112.	6560.	N.R.	N.R.
5*28.967	96.034	N.R.	N.R.	52.	51.	6424.	1824.	66.	9042.	N.R.	N.R.
6*29.083	95.867	N.R.	N.R.	874.	153.	27000.	230.	N.R.	45700.	N.R.	N.R.
6*29.083	95.867	N.R.	N.R.	1583.	289.	34200.	156.	N.R.	61000.	N.R.	N.R.
6*29.083	95.867	N.R.	N.R.	1750.	285.	33700.	338.	N.R.	60000.	N.R.	N.R.
6*28.767	96.283	N.R.	N.R.	85.	14.	9100.	629.	N.R.	12600.	N.R.	N.R.
4*28.883	96.100	651104	7.5	29.	90.	15431.	1785.	35.	23000.	40435.	N.R.
4*28.950	95.167	020180	7.7	25.	4.	5540.	3510.	670.	6060.	15813.1	0458
4*29.068	95.901	081881	7.7	1620.	286.	37400.	230.	15.	61000.	100000.	8945
4*29.068	95.902	081881	7.8	1660.	277.	36000.	242.	6.	59100.	98800.	9000
4*29.069	95.902	081881	7.7	1070.	225.	35900.	257.	7.	56900.	93700.	8712
4*28.983	95.917	111380	7.7	118.	26.	15040.	1251.	11.	22480.	39048.	8899
4*28.950	96.167	040876	7.3	1230.	356.	30900.	171.	6.	50800.	83540.	8331
4*28.951	96.167	061476	7.0	671.	153.	21500.	469.	18.	34500.	57341.	8352
4*29.067	95.900	112978	6.8	2006.	648.	27061.	854.	N.R.	46718.	78600.	N.R.
4*29.067	95.900	082179	6.8	1040.	187.	39146.	511.	45.	62481.	103600.	N.R.
4*29.067	95.901	100379	6.7	2890.	401.	35000.	279.	N.R.	60200.	98836.	8902
4*29.068	95.901	100777	7.1	2380.	23.	33000.	263.	360.	54800.	90938.	8992
4*29.068	95.901	100379	6.7	1710.	349.	40600.	260.	78.	66600.	109673.	8928

JACKSON COUNTY

6*28.783	96.567	N.R.	N.R.	987.	193.	23200.	245.	N.R.	41100.	N.R.	N.R.
6*28.783	96.567	N.R.	N.R.	956.	187.	24500.	240.	N.R.	42400.	N.R.	N.R.
6*28.783	96.567	N.R.	N.R.	1023.	178.	23700.	215.	N.R.	42400.	N.R.	N.R.
4*29.133	96.667	081881	6.4	8260.	730.	33500.	59.	4.	68100.	114000.	9268
5*29.017	96.500	N.R.	N.R.	652.	123.	23319.	442.	1.	37250.	61786.	N.R.
5*29.033	96.500	N.R.	N.R.	934.	232.	23290.	488.	15.	38000.	62959.	N.R.
5*28.917	96.417	N.R.	N.R.	1314.	307.	23616.	305.	1.	39500.	65042.	N.R.
5*28.883	96.500	N.R.	N.R.	1680.	119.	21598.	183.	1.	38000.	N.R.	N.R.
5*28.833	96.500	N.R.	N.R.	900.	170.	25643.	293.	12.	41500.	68518.	N.R.
5*28.917	96.733	N.R.	N.R.	1832.	93.	21271.	262.	1.	36200.	59658.	N.R.
5*28.917	96.734	N.R.	N.R.	1052.	68.	18229.	344.	6.	30000.	49699.	N.R.
3*28.766	96.637	651023	7.3	1200.	275.	21590.	189.	6.	36680.	60000.	5602
3*28.766	96.645	640721	6.5	1200.	319.	9547.	74.	7.	17731.	28884.	5593
3*28.766	96.645	640802	6.2	1049.	376.	9602.	48.	5.	17731.	28821.	5757
3*28.768	96.638	640809	6.5	1096.	271.	21849.	184.	6.	36314.	59723.	5593
3*28.768	96.638	651023	6.9	1080.	250.	20780.	209.	6.	35260.	57669.	5593
3*28.768	96.646	651023	6.3	2890.	464.	13660.	64.	4.	27830.	45030.	5760
3*28.886	96.479	440729	7.7	710.	153.	24334.	415.	123.	38800.	67500.	6798
3*28.886	96.479	440802	8.2	850.	158.	22425.	329.	41.	36200.	63500.	5678
3*28.909	96.661	441021	7.4	1100.	203.	22954.	244.	129.	37600.	53000.	4740
3*28.951	96.610	450306	7.4	1060.	21.	22236.	201.	4.	36000.	62500.	5005

CALHOUN COUNTY

4*28.200	96.533	081881	8.7	34.	16.	7900.	1710.	44.	10800.	19200.	7639
4*28.200	96.534	081881	8.4	185.	52.	23000.	1130.	15.	34100.	57300.	8848
4*28.201	96.534	081881	8.1	450.	111.	27200.	574.	24.	41500.	70100.	9309
4*28.283	96.667	092981	7.5	2100.	170.	22600.	120.	5.	42050.	59800.	8892
4*28.284	96.667	092981	8.0	740.	105.	17100.	710.	23.	27800.	49100.	8790

Frio Formation - continued

Calhoun County (continued)

4*28.284	96.667	092981	8.4	185.	31.	11200.	1300.	45.	17050.	31000.	8802
5*28.633	96.817	N.R.	N.R.	984.	225.	24154.	311.	1.	39500.	65174.	N.R.
7*28.567	96.837	012381	6.2	1320.	163.	22379.	138.	105.	39671.	63847.	8250
1* N.R.	N.R.	N.R.	6.5	4515.	730.	27406.	74.	1.	52400.	85126.	5500
3*28.569	96.521	680201	8.2	80.	60.	4120.	1705.	135.	5580.	11680.	8727
3*28.573	96.525	580222	7.7	30.	8.	3505.	1438.	62.	4630.	9705.	8804
3*28.580	96.731	491124	7.5	59.	39.	6245.	3739.	245.	7500.	17827.	9002
3*28.580	96.730	491124	7.5	62.	39.	5872.	2392.	330.	7650.	16345.	8970
3*28.582	96.728	500105	7.7	22.	19.	5296.	2814.	150.	6520.	14821.	8999
3*28.582	96.729	500105	7.4	22.	19.	5675.	3092.	170.	6930.	15908.	9011
3*28.591	96.731	451008	7.7	172.	73.	5573.	311.	350.	8680.	15159.	5649
3*28.591	96.731	451008	7.6	154.	36.	5054.	476.	500.	7380.	13600.	5697
3*28.591	96.731	451021	7.5	1911.	304.	23804.	115.	102.	40200.	66436.	5720
3*28.608	96.857	431213	7.2	1275.	160.	22380.	207.	23.	37100.	61145.	5470
3*28.615	96.880	591020	7.0	911.	238.	22930.	173.	6.	37600.	61858.	7536
3*28.615	96.881	640901	7.2	921.	192.	23581.	321.	6.	38400.	63421.	7536
3*28.616	96.869	640901	6.7	962.	167.	24146.	272.	6.	39300.	64853.	5499
3*28.624	96.662	551030	6.1	212.	26.	5743.	1793.	452.	7940.	16166.	7951
3*28.624	96.662	551102	7.5	126.	21.	6304.	1952.	406.	8580.	17389.	7902
3*28.626	96.706	490215	7.3	72.	164.	7396.	3185.	260.	9975.	21052.	8619
3*28.626	96.707	490215	7.4	206.	109.	11353.	1074.	112.	17500.	30354.	9434
3*28.631	96.690	480812	4.9	2728.	963.	8720.	328.	300.	20700.	33739.	9284
3*28.640	96.681	510415	7.3	127.	17.	11707.	1279.	135.	17500.	30765.	8890
3*28.643	96.684	500525	6.7	678.	109.	21312.	514.	24.	34100.	56737.	8971
3*28.666	96.407	580324	7.5	280.	55.	4460.	968.	136.	6935.	12909.	7810

VICTORIA COUNTY

3*28.630	96.871	670621	7.3	1305.	390.	21275.	210.	5.	36120.	59305.	4775
3*28.634	96.876	550715	6.8	1456.	194.	22703.	244.	115.	37942.	N.R.	6144
3*28.726	97.080	630131	6.8	1638.	313.	22294.	219.	5.	38100.	62569.	3126
3*28.748	96.834	650912	6.9	1980.	224.	23880.	103.	11.	40910.	67108.	5619
3*28.889	97.057	630622	6.1	1338.	188.	13320.	94.	48.	23360.	38348.	3515

1* FROM CORE LABORATORIES, INC., 1972
2* FROM TAYLOR, 1975
3* FROM U.S.G.S. DATA TAPE
4* FROM MORTON AND OTHERS, 1981, AND BEG ANALYSES
5* FROM JESSEN AND ROLSHAUSEN, 1944
6* FROM LUNDEGARD, 1985
7* FROM DISPOSAL-WELL FILES, TEXAS DEPARTMENT OF WATER RESOURCES
N.R. NOT REPORTED

-------------CHEMICAL ANALYSES OF VICKSBURG FORMATION WATER------------------
(FOR SOURCES OF ANALYSES SEE FOOTNOTE AT END OF TABLE)

LAT	LONG	DATE (Y-M-D)	PH	CA	MG	NA	HCO3	SO4	CL	TDS	DEPTH (FT)
				<------------------	------------------	------------------	MG/L	------------------	------------------	------------------>	
BROOKS COUNTY											
4*27.183	98.050	770624	6.2	500.	60.	7660.	299.	20.	12700.	21267.	10420
4*27.184	98.050	800102	7.4	298.	66.	13300.	369.	70.	21000.	35106.	8999
4*27.184	98.051	800721	7.1	373.	71.	17200.	90.	126.	26900.	45612.	9639
4*27.184	98.051	800228	7.3	401.	68.	9536.	610.	72.	17000.	28694.	11264
2*26.820	98.405	521206	7.7	455.	252.	8860.	501.	240.	14750.	25058.	7312
2*26.831	97.931	520415	6.3	29820.	61.	23626.	121.	6.	89500.	143100.	11561
2*26.988	98.280	450924	6.2	2859.	706.	20362.	438.	12.	38300.	62677.	6880
2*26.988	98.284	460716	7.4	240.	170.	7426.	390.	213.	12000.	20439.	7032
2*26.981	98.282	460106	7.1	3770.	1155.	19124.	302.	6.	39400.	63757.	6910
2*27.139	98.044	451212	6.3	2381.	1155.	15565.	378.	4.	31400.	50883.	8686
2*27.139	98.040	460517	7.2	1857.	158.	15583.	506.	20.	27500.	45624.	7780
2*27.139	98.040	460523	7.6	950.	97.	14024.	695.	16.	23200.	38982.	8255
2*27.139	98.041	460605	7.1	1089.	85.	16453.	488.	12.	27300.	45427.	8701
2*17.124	98.044	460322	7.1	803.	340.	14678.	805.	8.	24600.	41234.	N.R.
CHAMBERS COUNTY											
1* N.R.	N.R.	N.R.	6.4	3448.	607.	39447.	408.	42.	68418.	112370.	6040
HARRIS COUNTY											
2*29.855	94.989	661120	6.9	2960.	634.	60854.	659.	28.	101000.	166400.	8844
HIDALGO COUNTY											
9*26.483	98.383	N.R.	6.9	10602.	140.	5292.	217.	49.	27166.	43473.	10974
9*26.483	98.383	N.R.	6.5	12620.	183.	5299.	121.	70.	30908.	49010.	10974
9*26.450	98.450	N.R.	6.5	10438.	272.	5092.	188.	92.	26944.	43038.	10280
9*26.450	98.450	N.R.	6.3	8332.	435.	3176.	167.	66.	20767.	34945.	11254
9*26.451	98.451	N.R.	7.4	3151.	123.	1033.	360.	72.	7262.	12002.	11419
4*26.617	98.367	N.R.	7.7	42582.	8210.	41375.	644.	6.	162692.	255510.	11965
4*26.450	98.433	690916	7.6	5242.	99.	6586.	550.	328.	19200.	32000.	9700
4*26.450	98.434	690916	7.2	9789.	101.	9013.	354.	711.	30850.	50818.	9772
4*26.451	98.434	690916	6.4	9729.	126.	8391.	328.	867.	29756.	49197.	9823
4*26.451	98.434	690916	7.3	9798.	139.	9198.	329.	498.	31400.	51362.	9958
4*26.451	98.434	681125	6.7	11676.	255.	11036.	333.	692.	37800.	62000.	8700
4*26.467	98.433	610118	N.R.	12880.	188.	6887.	414.	67.	30920.	51364.	10300
2*26.621	98.316	601004	6.5	14244.	84.	9165.	196.	1.	39501.	63238.	9368
2*26.639	98.339	630905	6.2	6864.	143.	20464.	182.	9.	44126.	71978.	N.R.
2*26.655	98.308	621102	7.2	3892.	143.	7774.	740.	1.	15338.	27892.	10320
2*26.655	98.308	621105	6.7	8697.	239.	7728.	296.	41.	27810.	44861.	9380
2*26.478	98.441	590119	7.0	9290.	1.	5212.	596.	800.	23534.	39432.	10206
2*26.318	98.439	580904	7.4	3151.	123.	1033.	360.	72.	7262.	12002.	11419
2*26.496	98.422	580507	6.5	4484.	245.	4304.	190.	152.	15070.	24454.	12902
2*26.480	98.426	580119	5.3	5488.	272.	4299.	94.	61.	17040.	27266.	11242
2*26.480	98.427	580124	6.5	9721.	381.	4866.	149.	86.	25666.	40873.	10280
2*26.478	98.409	570927	5.6	6720.	164.	7217.	90.	56.	23430.	37720.	11693
2*26.478	98.409	571003	5.1	9766.	326.	5607.	13.	100.	26838.	42715.	11254
2*26.469	98.399	600303	6.9	10602.	140.	5292.	217.	49.	27166.	43473.	10974
2*26.650	98.131	620406	6.2	17880.	1275.	15280.	117.	1.	60207.	96773.	10106

Vicksburg Formation - continued

Hidalgo County (continued)

2*26.557	98.189	620619	7.7	226.	57.	4503.	4560.	464.	4530.	14342.	8760
2*26.557	98.189	641105	5.6	698.	1.	19545.	126.	120.	31573.	52311.	8730
2*26.672	98.296	640526	6.5	984.	16.	7718.	270.	30.	13555.	22641.	11554
2*26.661	98.294	650727	6.2	1409.	16.	7314.	233.	10.	13968.	23066.	10751
2*26.669	98.304	650115	6.3	1174.	1.	7233.	277.	17.	13095.	21965.	10838

JIM WELLS COUNTY

2*27.867	98.003	440127	7.2	368.	49.	7926.	238.	54.	12850.	21485.	4955
2*27.720	98.011	480318	7.3	103.	8.	6318.	711.	60.	9500.	16700.	5505
2*27.720	98.012	480318	7.3	61.	14.	7719.	1090.	40.	11400.	20324.	5726
2*27.705	97.986	490515	7.6	140.	84.	10055.	796.	1.	15550.	26625.	5413
2*27.708	97.985	490515	7.6	129.	84.	10006.	791.	12.	15450.	26472.	5509
2*27.369	98.105	530504	7.5	1410.	1.	9870.	586.	92.	17300.	29282.	6882
2*27.351	98.063	490520	7.5	119.	49.	10413.	1923.	210.	15150.	27864.	6981

LIBERTY COUNTY

1*	N.R.	N.R.	N.R.	7.0	2806.	573.	45177.	280.	21.	76150.	125063.	6100

LIVE OAK COUNTY

2*28.195	97.920	600422	6.8	340.	79.	11000.	140.	1.	17700.	29300.	3728
2*28.188	97.916	561226	7.6	270.	24.	8990.	355.	1.	14200.	23800.	3758
2*28.175	97.916	570128	8.2	220.	12.	7780.	1150.	57.	11700.	20900.	3782

REFUGIO COUNTY

2*28.204	97.266	511231	7.4	509.	88.	15247.	1248.	90.	23900.	41082.	8326

SAN PATRICIO COUNTY

2*28.026	97.670	420713	7.2	952.	106.	16783.	598.	75.	27500.	46014.	6240
2*28.026	97.670	420713	7.1	1484.	134.	18975.	537.	1.	32000.	53130.	6183

STARR COUNTY

4*26.650	98.533	670116	6.0	1605.	182.	12140.	78.	390.	21755.	36150.	9330
4*26.650	98.534	670209	6.0	6830.	2070.	34580.	390.	150.	71100.	115120.	9323
4*26.651	98.534	670628	5.4	20175.	1029.	43170.	36.	1.	105240.	169650.	9250
4*26.651	98.534	790412	5.7	7210.	552.	21900.	111.	27.	48000.	77882.	6355
4*26.533	98.483	591109	8.2	4450.	17.	12522.	414.	690.	26425.	44573.	10978
4*26.534	98.484	591111	7.0	2814.	21.	10438.	557.	639.	20347.	34816.	10800
4*26.600	98.600	650128	7.0	778.	75.	6575.	456.	115.	11380.	19379.	6868
4*26.600	98.600	570403	7.1	387.	26.	4220.	172.	26.	7200.	12085.	6160
4*26.601	98.601	591015	6.6	9476.	127.	7050.	246.	1088.	27063.	45050.	7380
4*26.601	98.601	590601	7.1	10837.	172.	22392.	122.	709.	53608.	87840.	8325
4*26.601	98.601	591007	8.7	26189.	1337.	17970.	85.	69.	77786.	123489.	7360
4*26.601	98.601	591223	7.3	630.	28.	11870.	226.	82.	19310.	32146.	5390
4*26.602	98.602	681210	7.2	515.	10.	4382.	314.	13.	7505.	12739.	6065
4*26.602	98.602	790126	7.6	169.	9.	6920.	554.	9.	10700.	18374.	5010
4*26.602	98.602	570403	7.1	533.	21.	5860.	219.	19.	9970.	16698.	6130
1*	N.R.	N.R.	N.R.	6.0	8428.	309.	7704.	196.	66.	27552.	44285.	9285
2*26.613	98.454	560927	6.6	1370.	368.	15200.	8.	45.	24800.	41792.	6324
2*26.573	98.462	580603	7.7	294.	27.	18590.	581.	58.	28879.	48429.	7148
2*26.605	98.535	561016	5.5	6900.	2830.	11628.	258.	50.	42150.	64428.	6567
2*26.597	98.533	580505	6.8	5737.	196.	13602.	399.	92.	31510.	51716.	5760
2*26.606	98.526	590915	7.9	1779.	1.	5144.	1489.	5000.	6511.	19923.	6855
2*26.606	98.526	591124	6.4	6250.	198.	5639.	69.	57.	20314.	32632.	7904
2*26.599	98.533	580505	5.9	5454.	147.	14786.	336.	12.	32880.	53932.	5715
2*26.580	98.536	580522	7.5	1475.	1.	10607.	684.	160.	18495.	31494.	8312
2*26.580	98.536	580522	10.9	9938.	1.	13224.	N.R.	148.	36716.	60934.	7584

Starr County (continued)

2*26.581	98.506	581228	5.9	8428.	309.	7704.	196.	66.	27552.	44285.	9333
2*26.777	98.414	551108	7.2	3802.	77.	24935.	268.	5.	45300.	74387.	6716
2*26.767	98.382	550330	6.0	1003.	71.	16276.	996.	42.	26500.	44888.	7423
2*26.581	98.506	590103	5.1	14072.	571.	6962.	147.	66.	37167.	58985.	9168
2*26.577	98.510	540712	6.6	8000.	153.	5430.	389.	107.	22500.	36489.	9020
2*26.572	98.505	541014	6.7	554.	80.	9000.	238.	144.	14700.	24748.	8776
2*26.578	98.512	561120	6.9	8124.	1199.	17994.	359.	6.	45379.	73063.	6696
2*26.566	98.515	651120	6.3	21343.	1376.	18963.	143.	9.	70913.	112700.	6565
2*26.568	98.521	590820	7.8	1055.	1.	4251.	603.	680.	7563.	14153.	9230
2*26.568	98.521	590917	7.3	3343.	71.	4167.	385.	99.	12249.	20314.	8972
2*26.566	98.529	590317	7.0	2940.	36.	9305.	468.	990.	18655.	32398.	9086
2*26.566	98.529	590917	6.9	8663.	298.	9342.	291.	81.	30422.	49176.	9086
2*26.558	98.518	590819	7.3	2361.	84.	4172.	341.	152.	10549.	17672.	9458
2*26.558	98.536	660525	6.6	4500.	92.	14990.	292.	19.	31170.	51069.	6796
2*26.429	98.773	630903	7.3	973.	80.	14719.	215.	1.	24530.	40522.	1643

1* FROM CORE LABORATORIES, INC, 1972
2* FROM TAYLOR, 1975
4* FROM MORTON AND OTHERS, 1981, AND MORTON, BEG FILES
9* FROM JONES, 1968
N.R. NOT REPORTED

CHEMICAL ANALYSES OF YEGUA FORMATION WATER

(FOR SOURCES OF ANALYSES SEE FOOTNOTE AT END OF TABLE)

AUSTIN COUNTY

LAT	LONG	DATE (Y-M-D)	PH	CA (MG/L)	MG (MG/L)	NA (MG/L)	HCO3 (MG/L)	SO4 (MG/L)	CL (MG/L)	TDS (MG/L)	DEPTH (FT)
2*29.991	96.134	300508	N.R.	473.	261.	8337.	591.	8.	14100.	23770.	4170

BEE COUNTY

LAT	LONG	DATE (Y-M-D)	PH	CA (MG/L)	MG (MG/L)	NA (MG/L)	HCO3 (MG/L)	SO4 (MG/L)	CL (MG/L)	TDS (MG/L)	DEPTH (FT)
3*28.638	97.825	560515	7.9	44.	23.	4895.	601.	23.	7320.	12906.	3645
3*28.679	97.802	520828	7.3	181.	23.	5448.	695.	4.	8384.	14668.	1898

COLORADO COUNTY

LAT	LONG	DATE (Y-M-D)	PH	CA (MG/L)	MG (MG/L)	NA (MG/L)	HCO3 (MG/L)	SO4 (MG/L)	CL (MG/L)	TDS (MG/L)	DEPTH (FT)
2*29.396	96.594	561028	7.3	92.	93.	7033.	13.	49.	11250.	18558.	5624
2*29.419	96.479	440905	8.6	42.	12.	8362.	2302.	330.	10824.	22424.	6147

DEWITT COUNTY

LAT	LONG	DATE (Y-M-D)	PH	CA (MG/L)	MG (MG/L)	NA (MG/L)	HCO3 (MG/L)	SO4 (MG/L)	CL (MG/L)	TDS (MG/L)	DEPTH (FT)
3*29.058	97.057	541208	7.8	113.	5.	7010.	3450.	79.	8970.	19670.	5358
3*29.076	97.041	510927	7.9	170.	566.	5999.	3761.	65.	8967.	19552.	5358
2*27.855	98.686	510311	8.0	198.	19.	4766.	1303.	1.	6950.	13284.	2488
2*27.654	98.769	501015	7.8	48.	12.	2148.	2060.	1.	2200.	6498.	2850
2*27.645	98.760	540612	8.4	9.	3.	1838.	2017.	13.	1532.	5536.	3290
2*27.660	98.738	570801	8.6	5.	4.	2460.	2370.	75.	2320.	7270.	3148
2*27.637	98.298	490426	8.2	304.	387.	11251.	1813.	380.	17770.	31835.	7300
2*27.637	98.298	490505	7.5	215.	90.	12800.	1493.	180.	19400.	34178.	7302
2*27.637	98.299	490506	7.3	221.	284.	11933.	1764.	85.	18550.	32837.	7196
2*27.637	98.299	490510	7.4	137.	168.	10503.	1789.	205.	15750.	28552.	7077
2*27.568	98.434	380102	7.3	2216.	221.	23010.	775.	1.	39600.	65822.	5409
2*28.019	98.521	540108	8.0	68.	58.	10100.	1970.	37.	14700.	26955.	5944
2*27.915	98.396	391229	8.1	220.	92.	17770.	1124.	20.	27400.	46626.	3821
2*27.833	98.261	491128	8.1	81.	6.	7809.	3614.	110.	10025.	21651.	5517
2*27.836	98.263	490839	7.1	95.	6.	6994.	3123.	20.	9150.	19388.	5750
2*27.836	98.263	490902	7.1	203.	116.	12187.	1259.	36.	18750.	32551.	6173
2*27.902	98.695	510307	7.6	62.	61.	1445.	2324.	1.	1150.	5054.	2470

GOLIAD COUNTY

LAT	LONG	DATE (Y-M-D)	PH	CA (MG/L)	MG (MG/L)	NA (MG/L)	HCO3 (MG/L)	SO4 (MG/L)	CL (MG/L)	TDS (MG/L)	DEPTH (FT)
3*28.811	97.477	500215	8.1	66.	16.	4930.	1458.	123.	6826.	13419.	5046
3*28.811	97.477	510531	8.5	44.	25.	5331.	1626.	7.	7411.	14451.	5046
3*28.811	97.477	521203	8.2	41.	14.	5196.	1383.	21.	7305.	13960.	5046
3*28.825	97.418	361129	N.R.	31.	44.	4402.	892.	164.	5921.	11802.	5147
3*28.830	97.438	560515	8.0	41.	7.	4502.	919.	16.	6480.	11965.	4760

HARRIS COUNTY

LAT	LONG	DATE (Y-M-D)	PH	CA (MG/L)	MG (MG/L)	NA (MG/L)	HCO3 (MG/L)	SO4 (MG/L)	CL (MG/L)	TDS (MG/L)	DEPTH (FT)
1* N.R.	N.R.	N.R.	7.4	606.	218.	25100.	586.	15.	40000.	66528.	5500
2*29.891	95.538	640721	6.5	744.	176.	23867.	586.	1.	38300.	63673.	6853
2*30.465	94.598	521208	6.4	2542.	681.	47857.	637.	1.	79909.	131600.	6860
2*30.288	94.608	640215	5.9	2960.	585.	41049.	56.	33.	70200.	114900.	9885

JASPER COUNTY

LAT	LONG	DATE (Y-M-D)	PH	CA (MG/L)	MG (MG/L)	NA (MG/L)	HCO3 (MG/L)	SO4 (MG/L)	CL (MG/L)	TDS (MG/L)	DEPTH (FT)
2*30.463	93.960	571217	7.7	42.	15.	7424.	2369.	208.	10000.	20085.	7586
2*30.465	93.948	571216	7.5	45.	12.	8045.	3797.	359.	10020.	22278.	7598

JIM WELLS COUNTY

LAT	LONG	DATE (Y-M-D)	PH	CA (MG/L)	MG (MG/L)	NA (MG/L)	HCO3 (MG/L)	SO4 (MG/L)	CL (MG/L)	TDS (MG/L)	DEPTH (FT)
2*26.915	98.911	501122	7.5	256.	46.	9800.	123.	1.	15600.	25861.	2935
2*26.924	98.903	510629	7.8	303.	73.	10078.	353.	1.	16100.	26907.	3075
2*26.918	98.904	400912	7.1	448.	85.	10916.	336.	1.	17700.	29485.	3087
2*26.944	98.894	640519	7.3	396.	64.	11013.	322.	1.	17700.	29496.	3026
2*26.937	98.889	431215	7.4	864.	76.	9980.	410.	78.	16500.	27908.	3084
2*26.937	98.889	431215	7.2	680.	78.	11546.	238.	33.	19100.	31675.	3180
2*26.943	98.887	510430	7.2	605.	68.	13631.	277.	80.	22400.	37261.	3119
2*26.946	98.886	510430	7.2	688.	87.	13993.	221.	20.	23250.	38259.	3114

Jim Wells County (continued)

2*26.959	98.894	580808	7.5	573.	123.	13731.	290.	1.	22400.	37118.	2984
2*26.961	98.884	510430	7.2	734.	85.	14882.	301.	60.	24300.	40362.	3113
2*26.957	98.884	420521	7.4	594.	70.	12032.	485.	62.	19500.	32743.	3074
2*26.953	98.885	510430	7.2	754.	212.	14890.	351.	60.	24700.	40967.	3117
2*26.949	98.885	510430	7.1	734.	95.	15414.	363.	80.	25100.	41786.	3134
2*26.961	98.899	640519	7.4	283.	59.	10222.	259.	1.	16300.	27124.	2938
2*26.973	98.879	421115	7.1	708.	79.	13784.	451.	1.	22500.	37522.	3193
2*26.977	98.879	421103	7.4	810.	55.	11742.	354.	19.	19500.	32480.	N.R.
2*26.983	98.879	430215	7.6	834.	128.	14004.	201.	1.	23350.	38517.	3277

KARNES COUNTY

3*28.794	97.659	520310	7.9	159.	96.	5115.	609.	12.	8160.	14209.	3971

LAVACA COUNTY

2*29.264	96.923	560830	6.8	288.	123.	18300.	407.	140.	28800.	39871.	4520
2*29.351	96.688	480812	7.8	3.	606.	6882.	2991.	89.	10580.	21153.	5412
2*29.344	96.674	510928	7.6	146.	338.	2563.	1531.	41.	4306.	8945.	5442
2*29.343	96.676	510630	7.7	15.	665.	9214.	3670.	1.	14036.	27609.	5443
2*29.358	96.670	530515	8.2	124.	1.	6670.	3400.	77.	8470.	18742.	5470
2*29.326	96.662	530323	7.4	79.	1.	6930.	3770.	1.	8660.	19497.	5701
2*29.330	96.632	530623	8.2	97.	1.	7080.	3890.	1.	8840.	19923.	5735
2*29.350	96.692	510221	4.6	24.	8.	3974.	55.	1.	6163.	10226.	5869
2*29.350	96.692	560810	7.9	42.	21.	6660.	3820.	84.	8110.	18738.	5869

LIBERTY COUNTY

1* N.R.	N.R.	N.R.	6.7	1796.	287.	42540.	454.	63.	69324.	114507.	8136
1* N.R.	N.R.	N.R.	6.6	1764.	335.	39570.	545.	2.	64892.	107275.	9950

LIVE OAK COUNTY

3*28.618	98.084	440412	9.3	100.	53.	3358.	1032.	687.	4260.	8500.	2011
2*28.618	98.084	440420	9.3	100.	53.	3350.	1032.	687.	4260.	9602.	2011
2*28.303	98.147	561002	7.1	580.	192.	19000.	410.	29.	30600.	50800.	3507

MCMULLEN COUNTY

3*28.472	98.763	630522	7.5	18.	6.	1810.	400.	1100.	1800.	4946.	N.R.
3*28.489	98.789	630522	8.0	12.	5.	1670.	464.	1130.	1500.	4790.	N.R.
3*28.498	98.792	630423	7.9	20.	7.	1820.	388.	1150.	1780.	5180.	N.R.
3*28.499	98.790	630423	7.9	20.	6.	1820.	388.	1150.	1780.	4979.	N.R.
3*28.570	98.394	590311	8.0	46.	11.	3570.	479.	1020.	4580.	9710.	N.R.
3*28.572	98.397	590311	8.4	20.	7.	3300.	634.	295.	4540.	8800.	N.R.

NEWTON COUNTY

2*30.519	93.842	560801	7.9	510.	218.	20227.	1152.	95.	31800.	54302.	7350
2*30.706	93.652	450715	6.7	1410.	430.	28200.	200.	2.	47200.	77442.	5400
2*30.466	93.797	550518	7.3	466.	113.	21345.	1519.	24.	33200.	56667.	7990
2*30.467	93.820	550518	7.4	394.	108.	18505.	1802.	37.	28500.	49346.	7822
2*30.462	93.826	550518	7.5	800.	215.	23152.	1840.	19.	36700.	62726.	7366
2*30.275	93.799	560801	7.6	1130.	387.	20144.	222.	86.	33000.	54969.	7447

TYLER COUNTY

2*30.657	94.322	541021	6.6	1189.	378.	24035.	353.	3.	40100.	66058.	4666
2*30.664	94.307	560219	7.0	963.	278.	25720.	354.	18.	42000.	69333.	4843

VICTORIA COUNTY

2*29.060	97.023	521022	7.2	123.	1.	7870.	4170.	1150.	9080.	22426.	5488

ZAPATA COUNTY

2*26.985	99.067	630920	8.8	11.	2.	3839.	207.	1140.	4935.	10185.	1630

1* FROM CORE LABORATORIES, INC., 1972
2* FROM TAYLOR, 1975
3* FROM U.S.G.S. DATA TAPE
N.R. NOT REPORTED

---------------CHEMICAL ANALYSES OF WILCOX FORMATION WATER------------------
(FOR SOURCES OF ANALYSES SEE FOOTNOTE AT END OF TABLE)

LAT	LONG	DATE (Y-M-D)	PH	CA	MG	NA	HCO3	SO4	CL	TDS	DEPTH (FT)
				<-----			MG/L			----->	
AUSTIN COUNTY											
2*30.014	96.129	401001	7.6	968.	146.	18282.	220.	25.	32300.	51941.	7100
2*29.995	96.124	401010	7.4	392.	85.	11928.	403.	414.	18800.	32022.	7012
2*29.995	96.124	401010	7.4	868.	49.	13869.	384.	101.	22800.	38071.	6972
2*29.995	96.124	401017	6.7	4208.	585.	37529.	494.	1.	66800.	109600.	6940
2*29.995	96.124	401024	6.7	4112.	561.	37782.	445.	1.	67000.	109900.	6862
2*29.995	96.125	401101	6.4	3408.	488.	32191.	305.	1.	57000.	93392.	6918
2*29.978	96.346	660207	6.1	7658.	709.	39955.	156.	1.	84090.	132600.	9342
2*29.978	96.347	660216	6.3	3556.	567.	46355.	296.	114.	79160.	130000.	9342
2*29.959	96.351	670407	6.8	3439.	674.	33851.	135.	1.	60185.	98284.	9000
2*29.959	96.351	670718	5.6	2793.	25.	31599.	264.	1.	53601.	88282.	8452
BEE COUNTY											
2*28.531	97.760	580505	6.6	880.	12.	14500.	978.	62.	23400.	39900.	10545
2*28.635	97.892	491127	7.1	983.	225.	19964.	999.	35.	32410.	54426.	6610
2*28.634	97.832	520310	6.9	600.	183.	15150.	1088.	42.	24290.	41353.	7270
3*28.531	97.760	580516	6.8	94.	2.	296.	486.	17.	330.	1230.	9230
3*28.531	97.778	580310	6.5	82.	10.	1170.	780.	17.	1510.	3560.	9286
3*28.531	97.778	580310	7.6	74.	13.	6300.	1360.	60.	9040.	16800.	8996
3*28.535	97.762	570930	7.3	88.	17.	6030.	1510.	266.	8420.	16300.	8777
3*28.544	97.768	570314	7.0	66.	24.	6240.	1690.	13.	8800.	16800.	9134
3*28.544	97.768	570316	7.9	80.	7.	6260.	2790.	242.	8000.	17400.	9056
3*28.544	97.769	570317	6.6	60.	7.	561.	1120.	40.	300.	2090.	9000
3*28.549	97.768	561011	6.8	170.	41.	9320.	1680.	148.	13700.	25100.	8952
3*28.549	97.768	561014	8.5	30.	4.	4840.	4740.	1490.	3600.	14800.	8686
3*28.631	97.831	510606	8.0	378.	142.	14721.	1479.	16.	22907.	39643.	7134
3*28.631	97.831	521208	7.5	369.	83.	15349.	1214.	33.	23829.	40877.	7134
3*28.632	97.827	560515	7.4	440.	107.	15353.	1147.	35.	24060.	41142.	7140
3*28.634	97.832	490605	7.8	564.	68.	18585.	1248.	26.	29113.	49610.	7154
3*28.634	97.832	520310	7.8	605.	107.	15534.	784.	26.	24857.	41913.	7270
3*28.634	97.832	560727	7.6	328.	100.	14190.	830.	17.	22200.	37700.	7000
3*28.635	97.829	501115	7.1	516.	108.	15962.	1241.	15.	25106.	42948.	7118
3*28.638	97.894	491127	7.1	893.	225.	19964.	999.	35.	32410.	54426.	6610
3*28.638	97.894	500629	7.2	972.	201.	20858.	1017.	12.	33864.	56924.	6610
3*28.638	97.894	501115	7.0	887.	216.	22545.	900.	14.	33342.	55904.	6610
3*28.638	97.894	510526	7.8	856.	275.	20046.	952.	14.	32659.	54802.	6610
3*28.638	97.895	511113	7.0	788.	162.	20785.	1025.	27.	33297.	56084.	6610
3*28.641	97.891	490614	7.3	867.	218.	19999.	760.	14.	32552.	54410.	6590
3*28.641	97.893	491127	7.2	1037.	239.	19827.	789.	26.	32623.	54541.	6590
3*28.641	97.892	500624	7.5	1026.	166.	18042.	860.	10.	29609.	49713.	6590
3*28.641	97.892	501115	7.4	972.	201.	20683.	856.	14.	33687.	56413.	6590
3*28.641	97.892	510522	7.8	896.	234.	20300.	932.	14.	33013.	55389.	6590
3*28.641	97.892	511113	7.7	948.	243.	21231.	848.	70.	34574.	57914.	6590
3*28.641	97.893	521119	7.6	915.	199.	20164.	760.	13.	32836.	54887.	6590
3*28.643	97.896	510415	7.9	1020.	142.	19702.	1083.	21.	31949.	53917.	6490
3*28.644	97.889	490614	7.2	943.	212.	20117.	784.	14.	32836.	54906.	6579
3*28.644	97.890	491206	7.3	1052.	255.	20288.	888.	48.	33332.	55863.	6579
3*28.644	97.890	500624	7.4	1088.	192.	20526.	900.	13.	33598.	56317.	6579
3*28.644	97.890	501115	7.3	999.	210.	21252.	963.	15.	34574.	58013.	6579
3*28.644	97.891	510522	7.7	970.	284.	20349.	1047.	16.	33297.	55963.	6579
3*28.644	97.891	511113	7.7	1349.	232.	20162.	917.	95.	33545.	56300.	6579
3*28.645	97.892	490629	6.9	943.	238.	19840.	791.	14.	32481.	54307.	6587
3*28.645	97.892	491206	7.3	1097.	232.	20145.	830.	4.	33191.	55499.	6587
3*28.645	97.892	500624	7.2	1023.	217.	20552.	867.	13.	33616.	56288.	6587
3*28.645	97.892	510526	7.6	834.	291.	20243.	755.	16.	33084.	55223.	6578
3*28.645	97.893	511113	7.2	878.	199.	20798.	734.	116.	33687.	56412.	6587
3*28.645	97.893	521119	6.8	927.	206.	20787.	715.	14.	33864.	56513.	6578
3*28.648	97.886	570627	6.8	1350.	322.	20300.	774.	20.	34200.	57000.	6826
3*28.656	97.872	490712	6.3	487.	115.	10362.	723.	13.	16950.	28814.	6546
3*28.656	97.872	510526	7.0	342.	171.	12765.	723.	15.	20354.	34370.	6546
3*28.656	97.872	560128	7.6	1010.	212.	23760.	846.	30.	38520.	64378.	6546
3*28.656	97.873	570719	6.7	1420.	247.	20400.	672.	10.	34400.	57200.	6807
3*28.660	97.874	490614	7.2	750.	165.	16677.	488.	6.	27233.	45319.	6599
3*28.663	97.877	560515	6.5	730.	155.	13671.	413.	28.	22560.	37557.	6513

COLORADO COUNTY

2*29.512	96.389	571002	6.1	4900.	668.	30500.	216.	1.	57600.	93900.	9391
2*29.574	96.293	570413	6.6	775.	268.	18909.	657.	1.	30968.	51690.	10020
2*29.407	96.574	570130	6.1	1170.	288.	12100.	338.	1.	21300.	35200.	8646
6*29.617	96.233	N.R.	N.R.	816.	171.	30900.	362.	1.	54000.	N.R.	N.R.
8*29.484	96.650	N.R.	N.R.	275.	38.	4100.	1.	1.	6880.	N.R.	8965
8*29.484	96.651	N.R.	5.8	26.	5.	1470.	1.	1.	2530.	N.R.	9205
8*29.617	96.217	N.R.	N.R.	858.	140.	33100.	1.	1.	51500.	N.R.	6780
8*29.617	96.217	N.R.	N.R.	857.	140.	32400.	1.	1.	53000.	N.R.	6004
8*29.617	96.217	N.R.	6.1	770.	167.	27300.	1.	1.	45500.	N.R.	6406
8*29.200	96.500	N.R.	5.7	5380.	467.	43200.	1.	1.	77500.	N.R.	9007
8*29.200	96.500	N.R.	5.7	5300.	586.	36300.	1.	1.	64500.	N.R.	9059

DEWITT COUNTY

1* N.R.	N.R.	N.R.	6.3	1600.	610.	16850.	1080.	12.	30000.	50180.	7000
1* N.R.	N.R.	N.R.	6.4	1600.	488.	18300.	18.	10.	32000.	52461.	7600
2*29.002	97.244	570617	5.1	1800.	516.	23459.	108.	1.	40800.	66683.	8602
2*29.024	97.361	601015	6.3	812.	151.	18873.	740.	280.	31200.	53076.	9950
6*28.883	97.633	N.R.	N.R.	1583.	207.	19000.	10.	1.	33900.	N.R.	N.R.
8*28.950	97.500	N.R.	5.9	1990.	307.	25400.	1.	1.	41200.	N.R.	6929
8*28.900	97.450	N.R.	5.6	2720.	255.	27300.	1.	1.	47700.	N.R.	0303
8*28.900	97.450	N.R.	5.0	3640.	291.	26600.	1.	1.	50700.	N.R.	0884
8*28.983	97.483	N.R.	5.6	1920.	185.	22500.	1.	1.	40700.	N.R.	0358
3*28.938	97.593	570826	7.6	688.	157.	14460.	646.	11.	23596.	39659.	9322
3*28.942	97.345	551122	6.6	2130.	332.	18039.	442.	5.	32269.	53217.	7627
3*29.034	97.076	551122	6.0	2800.	519.	22400.	346.	3.	40779.	66847.	8170
3*29.076	97.033	570324	6.4	5930.	635.	33219.	256.	1.	63500.	103541.	8180
3*29.076	97.033	630215	6.0	6176.	882.	33280.	178.	1.	64800.	105317.	8176
3*29.083	97.018	630215	6.0	6317.	796.	35229.	192.	1.	67800.	110335.	8140

DUVAL COUNTY

1* N.R.	N.R.	N.R.	7.4	325.	125.	9330.	476.	12.	15988.	26367.	3959
2*28.029	98.589	551003	6.9	1070.	151.	15242.	511.	50.	25500.	42523.	9670
2*28.011	98.610	560323	7.0	360.	52.	27031.	716.	1921.	40680.	70760.	7774
6*27.817	98.550	N.R.	N.R.	54.	23.	800.	234.	1.	1400.	N.R.	N.R.
6*27.817	98.550	N.R.	N.R.	526.	36.	13200.	593.	1.	22600.	N.R.	N.R.
6*27.817	98.550	N.R.	N.R.	430.	18.	10100.	373.	1.	17700.	N.R.	N.R.
6*27.818	98.551	N.R.	N.R.	502.	40.	7800.	358.	1.	14000.	N.R.	N.R.

GOLIAD COUNTY

1* N.R.	N.R.	N.R.	7.2	240.	97.	10400.	2100.	30.	15600.	28500.	7571
2*28.823	97.449	541213	6.2	2230.	258.	19656.	325.	27.	34800.	57296.	8520
2*28.853	97.444	480903	6.1	1958.	512.	18050.	395.	1.	32600.	53515.	7699
2*28.882	97.417	470719	6.6	768.	89.	12495.	866.	12.	20381.	34611.	7725
2*28.601	97.373	650406	7.5	156.	22.	5347.	1480.	88.	7660.	14753.	13445
8*28.850	97.567	N.R.	5.6	1750.	272.	18800.	1.	1.	33500.	N.R.	7478
8*28.767	97.567	N.R.	5.8	912.	145.	18600.	1.	1.	30000.	N.R.	7488
8*28.767	97.567	N.R.	5.8	912.	148.	21400.	1.	1.	34000.	N.R.	7484
3*28.601	97.376	650405	7.5	216.	27.	5612.	1810.	110.	7980.	15755.	13530
3*28.654	97.490	460813	7.0	149.	7.	7716.	1290.	57.	11390.	20609.	10677
3*28.681	97.665	500828	8.1	241.	8.	9153.	861.	62.	13914.	24327.	8074
3*28.702	97.651	600822	6.6	1519.	245.	27630.	356.	1.	45850.	75601.	7400
3*28.730	97.496	461010	7.5	36.	7.	3180.	2830.	38.	3314.	9405.	8572
3*28.771	97.499	460530	7.4	58.	7.	3856.	2734.	28.	4458.	11141.	7786
3*28.773	97.493	461104	6.4	831.	132.	12352.	672.	21.	20493.	34501.	8332
3*28.781	97.490	500710	8.0	177.	13.	6055.	1836.	243.	8439.	16763.	8500
3*28.781	97.490	500712	7.8	199.	22.	7039.	1625.	199.	10177.	19261.	8446
3*28.781	97.490	500715	8.0	107.	29.	6388.	2204.	399.	8546.	17673.	8285
3*28.781	97.491	500721	6.6	832.	150.	12338.	738.	9.	20496.	34563.	8301
3*28.794	97.431	451129	N.R.	14.	3.	3045.	2301.	30.	3369.	8761.	8990
3*28.794	97.431	451206	7.1	46.	5.	2621.	2739.	109.	2464.	7984.	9217

Goliad County (continued)

3*28.794	97.431	451207	7.9	15.	4.	1837.	2546.	290.	1176.	5868.	9067
3*28.794	97.432	451209	7.1	32.	5.	2810.	2448.	98.	2907.	8300.	8972
3*28.794	97.432	460104	7.0	48.	4.	4169.	1816.	133.	5370.	11540.	8555
3*28.795	97.503	560515	6.6	355.	27.	4399.	205.	41.	7340.	12367.	8035
3*28.796	97.557	551105	6.7	744.	136.	12230.	1165.	52.	19970.	34468.	7660
3*28.801	97.499	560911	6.4	246.	45.	8870.	907.	10.	13700.	23800.	7944
3*28.801	97.499	560913	7.4	114.	21.	7290.	1400.	254.	10500.	19600.	7860
3*28.801	97.499	560915	7.0	34.	6.	7080.	1290.	41.	10200.	18700.	7798
3*28.807	97.543	560515	5.8	56.	1.	191.	181.	28.	270.	727.	7539
3*28.819	97.274	571210	7.1	374.	89.	5360.	858.	114.	8600.	15400.	9468
3*28.823	97.449	500216	7.7	143.	24.	6542.	1972.	58.	9220.	17959.	7985
3*28.823	97.450	500301	6.7	1434.	192.	11629.	577.	24.	20672.	34529.	8556
3*28.823	97.450	500308	7.9	51.	43.	5186.	1821.	34.	7127.	14262.	8082
3*28.823	97.450	541129	6.6	2360.	481.	19899.	446.	12.	36000.	59198.	8521
3*28.823	97.451	550111	5.6	2160.	98.	21939.	156.	68.	37800.	62221.	8520
3*28.824	97.437	511226	8.3	53.	32.	5319.	2590.	98.	6808.	14900.	8006
3*28.824	97.437	511227	6.8	162.	45.	5813.	1529.	45.	8457.	16051.	8515
3*28.824	97.446	500517	7.8	41.	2.	3752.	2002.	144.	4592.	10533.	8885
3*28.824	97.446	500518	8.1	28.	2.	3085.	2780.	367.	2925.	9187.	8839
3*28.824	97.447	500714	7.4	274.	50.	6772.	982.	6.	10496.	18580.	8520
3*28.824	97.447	510531	8.0	246.	78.	6949.	1071.	14.	10744.	19102.	8520
3*28.824	97.447	520619	7.2	236.	46.	6641.	837.	100.	10230.	18090.	8520
3*28.824	97.448	521203	7.1	266.	53.	6478.	743.	30.	10159.	17729.	8520
3*28.840	97.464	560515	6.9	2320.	354.	18076.	473.	50.	32700.	53973.	7743
3*28.842	97.461	570110	6.8	1840.	328.	16000.	733.	6.	28400.	47300.	7733
3*28.842	97.461	560618	7.8	2430.	415.	18988.	320.	63.	34560.	56776.	7752
3*28.843	97.464	501106	6.5	2407.	410.	19619.	410.	5.	35460.	58309.	7752
3*28.843	97.464	510601	6.9	2401.	524.	18512.	460.	12.	34042.	55951.	7752
3*28.843	97.464	521203	6.9	2485.	433.	19051.	436.	36.	34751.	57192.	7752
3*28.846	97.457	520619	6.8	2226.	343.	19523.	539.	85.	34662.	57378.	7710
3*28.846	97.460	481125	6.0	2138.	320.	21348.	290.	111.	37765.	62276.	7712
3*28.846	97.460	510601	6.8	2208.	548.	18549.	506.	21.	33793.	55625.	7712
3*28.847	97.463	500330	4.3	7988.	1108.	16284.	20.	113.	42375.	67888.	8342
3*28.847	97.463	500412	7.4	1413.	177.	12126.	298.	19.	21524.	35557.	7709
3*28.847	97.464	520714	6.5	1850.	263.	19370.	594.	251.	33261.	55525.	7685
3*28.856	97.462	531219	7.6	1528.	262.	15522.	649.	13.	27050.	45024.	7691
3*28.857	97.720	660629	6.8	377.	72.	11425.	387.	12.	18262.	30535.	8408

HARDIN COUNTY

1* N.R.	N.R.	N.R.	7.0	1280.	220.	19315.	950.	22.	33180.	55332.	8500

HARRIS COUNTY

2*29.945	95.586	661214	7.0	230.	57.	7030.	859.	17.	11299.	18100.	13250

JASPER COUNTY

2*31.036	94.369	440815	7.6	425.	131.	15351.	659.	335.	24200.	41101.	3415

KARNES COUNTY

2*28.697	97.775	560515	7.0	1250.	302.	19003.	793.	94.	31860.	53302.	6753
2*28.857	97.720	660629	6.8	377.	72.	11425.	387.	12.	18262.	30535.	8405
8*28.983	98.017	N.R.	6.7	294.	61.	10900.	1.	1.	16400.	N.R.	5942
8*28.985	98.018	N.R.	6.5	229.	56.	10400.	1.	1.	16200.	N.R.	4867
3*28.694	97.775	481015	8.1	50.	4.	3905.	2989.	723.	3850.	11521.	6690
3*28.694	97.776	560515	7.0	1070.	293.	18039.	784.	57.	30060.	50303.	6760
3*28.694	97.776	480615	7.2	90.	27.	2747.	1383.	141.	3656.	8116.	6770
3*28.696	97.775	480921	6.4	1212.	260.	20392.	808.	40.	33900.	56656.	6846
3*28.697	97.775	480730	8.2	49.	14.	2869.	1919.	151.	3323.	8325.	6754
3*28.697	97.775	560515	7.0	1250.	302.	19003.	793.	94.	31860.	53302.	6753

Karnes County (continued)

3*28.701	97.819	581111	7.0	1970.	485.	21661.	690.	5.	37908.	62763.	6884
3*28.708	97.806	551118	7.2	1282.	254.	22244.	694.	2.	36878.	61354.	6896
3*28.716	97.780	551118	7.0	1223.	266.	21149.	713.	10.	35105.	58466.	6836
3*28.960	98.073	500625	7.8	324.	185.	13458.	397.	7.	21336.	36322.	6264
3*29.011	97.995	581107	8.2	32.	8.	3504.	1618.	9.	4537.	9756.	4923
3*29.013	97.994	551202	7.6	10.	4.	2376.	1898.	5.	2585.	6924.	4989

LAVACA COUNTY

8*29.417	96.950	N.R.	N.R.	3360.	407.	33000.	1.	1.	60600.	N.R.	7718
8*29.500	97.017	N.R.	N.R.	2150.	265.	23300.	1.	1.	44500.	N.R.	9069
8*29.500	97.017	N.R.	N.R.	1610.	297.	22300.	1.	1.	40500.	N.R.	9017
8*29.417	96.950	N.R.	5.0	2850.	414.	30100.	1.	1.	53500.	N.R.	7325
8*29.417	96.951	N.R.	5.8	4030.	454.	33900.	1.	1.	57500.	N.R.	8066
8*29.418	96.951	N.R.	5.9	1170.	206.	17900.	1.	1.	29500.	N.R.	5773
8*29.383	96.667	N.R.	6.3	1030.	17.	6100.	1.	1.	12200.	N.R.	8283

LIVE OAK COUNTY

2*28.278	98.053	600229	5.8	2490.	200.	18200.	220.	1.	33000.	54200.	9932
2*28.264	98.056	590514	7.3	690.	67.	11800.	1100.	123.	18900.	32700.	10390
2*28.288	98.036	580315	2.8	8200.	1090.	33400.	1.	1.	69000.	111600.	9815
2*28.311	98.179	540415	6.0	2143.	336.	20781.	353.	4.	36650.	60267.	7976
2*28.329	98.201	561011	7.2	410.	73.	13300.	877.	73.	20700.	35400.	7058
3*28.618	98.084	440426	8.8	76.	21.	2185.	2617.	1818.	620.	3700.	5494

MCMULLEN COUNTY

2*28.108	98.473	560729	8.9	24.	4.	29300.	3000.	830.	42100.	75900.	7200
2*28.075	98.520	560314	7.0	480.	31.	12379.	672.	98.	19560.	33220.	7819
3*28.604	98.503	530714	7.9	21.	8.	3748.	1685.	4.	4750.	10312.	4703
3*28.604	98.503	630812	7.8	42.	26.	9518.	754.	3.	14400.	24743.	6176
3*28.611	98.511	491129	7.9	124.	37.	8740.	1213.	17.	13085.	23216.	5425
3*28.613	98.506	490114	8.1	95.	32.	9001.	1398.	20.	13315.	23864.	5437
3*28.613	98.507	490115	7.8	129.	30.	9566.	1097.	22.	14414.	25261.	5563
3*28.613	98.508	490101	8.8	46.	1.	2306.	720.	183.	2979.	5510.	5443
3*28.613	98.508	490113	7.8	62.	19.	7665.	1205.	37.	11226.	20220.	5413
3*28.613	98.508	491129	7.8	160.	36.	8986.	1475.	22.	13368.	24047.	5413
3*28.613	98.509	501130	8.0	73.	35.	9025.	1316.	16.	13368.	23833.	5413
3*28.613	98.509	510530	8.2	111.	34.	9126.	1283.	28.	13599.	24181.	5413
3*28.613	98.509	511108	8.6	51.	36.	9113.	1089.	36.	13528.	23902.	5413

MONTGOMERY COUNTY

2*30.256	95.544	560304	7.2	620.	240.	17400.	1710.	1.	27600.	47570.	11580
2*30.256	95.544	560617	6.0	5490.	1430.	37400.	239.	1.	71600.	116400.	11540

NEWTON COUNTY

2*30.779	93.624	600813	7.1	120.	32.	9024.	1164.	9.	13550.	23899.	10105
2*30.706	93.652	460208	6.7	694.	116.	10506.	708.	100.	17300.	29424.	12030

POLK COUNTY

1* N.R.	N.R.	N.R.	5.3	16524.	3108.	84896.	60.	11.	169334.	274158.	7790
2*30.590	94.837	520118	5.7	11729.	1532.	58176.	121.	20.	115000.	186600.	7020

TYLER COUNTY

2*30.553	94.408	490406	8.1	109.	31.	9488.	1715.	42.	13883.	25268.	8382
2*30.550	94.404	610113	8.0	100.	40.	9080.	1540.	1.	13400.	24160.	8369
2*30.552	94.407	541001	8.7	170.	101.	10614.	1111.	36.	16260.	28308.	8588

Wilcox Formation - continued

Tyler County (continued)

2*30.548	94.416	550924	6.8	170.	22.	12600.	1248.	49.	19020.	33109.	9282
2*30.548	94.416	551021	7.9	430.	111.	14484.	984.	49.	22800.	38858.	8363
2*30.532	94.486	550913	6.6	1493.	222.	17636.	708.	7.	30100.	50166.	9610
2*30.558	94.348	560529	7.1	95.	16.	8500.	1769.	6.	12300.	22686.	8420
2*31.022	94.370	440214	7.9	464.	179.	17466.	207.	103.	28100.	46525.	3575
2*30.660	94.293	550510	7.2	872.	60.	12370.	1563.	10.	19900.	34775.	9824
2*30.661	94.299	510903	6.9	5378.	1226.	34145.	378.	10.	65600.	106700.	8244
2*30.662	94.329	530604	6.6	3348.	571.	29368.	745.	7.	52500.	86539.	7403

VICTORIA COUNTY

2*29.050	97.043	531111	6.4	5502.	688.	29260.	110.	1.	57880.	95281.	8275
6*29.067	97.033	N.R.	N.R.	2690.	426.	25700.	144.	1.	49500.	N.R.	N.R.
6*29.067	97.033	N.R.	N.R.	2050.	371.	24300.	258.	1.	43300.	N.R.	N.R.
8*29.067	97.033	N.R.	5.2	8420.	871.	31700.	1.	1.	74500.	N.R.	8046
8*29.067	97.034	N.R.	5.6	1820.	258.	20600.	1.	1.	35700.	N.R.	8156
8*29.067	97.034	N.R.	5.9	3760.	505.	22800.	1.	1.	48500.	N.R.	8092
8*29.068	97.034	N.R.	5.4	4710.	592.	23600.	1.	1.	51500.	N.R.	8092
3*28.862	97.066	650911	7.6	239.	33.	5970.	952.	57.	9130.	16381.	13190
3*28.862	97.067	650914	7.6	290.	61.	8480.	1245.	121.	12950.	23147.	12984
3*29.012	97.054	540721	6.4	5525.	609.	20400.	340.	38.	43365.	71192.	8629
3*29.022	97.088	690828	7.4	2447.	416.	24345.	276.	10.	42913.	70407.	8190
3*29.025	97.083	690919	7.0	1610.	270.	27211.	165.	2.	45495.	74753.	8204
3*29.029	97.078	690919	7.4	2335.	465.	23702.	95.	3.	41975.	68575.	8204
3*29.030	97.066	630130	7.0	1869.	370.	20860.	154.	11.	36730.	60540.	8300
3*29.031	97.076	690927	6.9	5110.	805.	26620.	190.	3.	52320.	85048.	8143
3*29.034	97.071	530508	7.2	178.	40.	5933.	1069.	240.	8784.	16244.	8247

ZAPATA COUNTY

2*27.263	98.957	600729	8.0	80.	18.	3310.	2680.	459.	3400.	9950.	10544
2*27.263	98.957	600731	7.3	107.	18.	4470.	1890.	420.	5700.	12600.	10180
2*27.263	98.957	600803	7.4	50.	24.	3700.	2030.	241.	4600.	10700.	9482
2*27.248	98.978	600419	5.8	2000.	669.	7340.	116.	612.	16300.	27000.	10648
6*27.133	99.000	N.R.	N.R.	326.	18.	10000.	648.	1.	17300.	N.R.	N.R.
6*27.133	99.000	N.R.	N.R.	141.	6.	7500.	814.	1.	12700.	N.R.	N.R.

1* FROM CORE LABORATORIES, INC., 1972
2* FROM TAYLOR, 1975
3* FROM U.S.G.S. DATA TAPE
6* FROM LUNDEGARD, 1985
8* FROM FISHER, 1982
N.R. NOT REPORTED

APPENDIX B:

Histograms of chemical parameters (mmol/L) and depth (ft)

of Oakville, Catahoula, Frio, Vicksburg, Yegua, Wilcox,

and undifferentiated Miocene formation waters.

Histograms of chemical parameters and depth. Oakville formation waters

```
CALCIUM'
 N=    17 MEAN=    46.552 MINMAX=     4.170   153.990 VAR= .11446314E+04
    CLASS        NO.
    10.00          3      ***
    20.00          1      *
    30.00          0
    40.00          2      **
    50.00          2      **
    60.00          7      *******
    70.00          1      *
    80.00          0
    90.00          0
   100.00          0
   110.00          0
   120.00          0
   130.00          0
   140.00          0
   150.00          0
   160.00          1      *


                          1 ASTERISK =    1 COUNTS.
MAGNESIUM'
 N=    17 MEAN=    15.216 MINMAX=      .620    44.300 VAR= .10414233E+03
    CLASS        NO.
    10.00          4      ****
    20.00          9      *********
    30.00          3      ***
    40.00          0
    50.00          1      *


                          1 ASTERISK =    1 COUNTS.
SODIUM
 N=    17 MEAN=   776.481 MINMAX=   200.740 1345.060 VAR= .11213114E+06
    CLASS        NO.
   100.00          0
   200.00          0
   300.00          2      **
   400.00          1      *
   500.00          1      *
   600.00          1      *
   700.00          1      *
   800.00          4      ****
   900.00          1      *
  1000.00          1      *
  1100.00          1      *
  1200.00          3      ***
  1300.00          0
  1400.00          1      *


                          1 ASTERISK =    1 COUNTS.
```

Histograms of chemical parameters and depth. Oakville formation waters (cont.)

```
HCO3
 N=    17 MEAN=     3.106 MINMAX=      .200    15.980 VAR= .12910424E+02
    CLASS       NO.
     1.00         2     **
     2.00         8     ********
     3.00         1     *
     4.00         3     ***
     5.00         1     *
     6.00         1     *
     7.00         0
     8.00         0
     9.00         0
    10.00         0
    11.00         0
    12.00         0
    13.00         0
    14.00         0
    15.00         0
    16.00         1     *


                        1 ASTERISK =    1 COUNTS.
SO4
 N=    17 MEAN=      .604 MINMAX=      .010     5.000 VAR= .15585118E+01
    CLASS       NO.
      .10         9     *********
     1.00         5     *****
     2.00         2     **
     3.00         0


                        1 ASTERISK =    1 COUNTS.
CHLORIDE
 N=    17 MEAN=   895.917 MINMAX=   220.030 1743.300 VAR= .16584438E+06
    CLASS       NO.
   200.00         0
   400.00         3     ***
   600.00         1     *
   800.00         2     **
  1000.00         4     ****
  1200.00         3     ***
  1400.00         3     ***
  1600.00         0
  1800.00         1     *
  2000.00         0


                        1 ASTERISK =    1 COUNTS.
APPROXIMATE DEPTH
 N=    17 MEAN= 3116.235 MINMAX= 1426.000 4934.000 VAR= .12690048E+07
    CLASS       NO.
  1000.00         0
  2000.00         3     ***
  3000.00         4     ****
  4000.00         7     *******
  5000.00         3     ***


                        1 ASTERISK =    1 COUNTS.
```

Histograms of chemical parameters and depth, Catahoula formation waters

```
CALCIUM
 N=    30 MEAN=    51.841 MINMAX=    11.150   162.080 VAR= .10653477E+04
     CLASS         NO.
     20.00           5      *****
     40.00           6      ******
     60.00          10      **********
     80.00           4      ****
    100.00           2      **
    120.00           2      **
    140.00           0
    160.00           0
    180.00           1      *
    200.00           0


                            1 ASTERISK =    1 COUNTS.
MAGNESIUM
 N=    30 MEAN=    11.275 MINMAX=      .040    36.860 VAR= .10678941E+03
     CLASS         NO.
     10.00          15      ***************
     20.00          10      **********
     30.00           3      ***
     40.00           2      **


                            1 ASTERISK =    1 COUNTS.
SODIUM
 N=    30 MEAN=   776.323 MINMAX=   148.500  1459.700 VAR= .15161766E+06
     CLASS         NO.
    200.00           2      **
    400.00           4      ****
    600.00           6      ******
    800.00           3      ***
   1000.00           2      **
   1200.00          11      ***********
   1400.00           1      *
   1600.00           1      *


                            1 ASTERISK =    1 COUNTS.
HCO3
 N=    29 MEAN=     2.433 MINMAX=      .610     9.750 VAR= .54614207E+01
     CLASS         NO.
      1.00           4      ****
      2.00          14      **************
      3.00           5      *****
      4.00           2      **
      5.00           1      *
      6.00           0
      7.00           1      *
      8.00           0
      9.00           0
     10.00           2      **


                            1 ASTERISK =    1 COUNTS.
```

Histograms of chemical parameters and depth, Catahoula formation waters (cont.)

```
S04
 N=    30 MEAN=   13.301 MINMAX=      .010    66.940 VAR= .47304534E+03
    CLASS        NO.
     1.00         18     ******************
    10.00          1     *
    20.00          5     *****
    30.00          1     *
    40.00          0
    50.00          2     **
    60.00          0
    70.00          3     ***

                         1 ASTERISK =    1 COUNTS.
CHLORIDE
 N=    30 MEAN=  867.923 MINMAX=    41.800 1853.200 VAR= .22591228E+06
    CLASS        NO.
   200.00          5     *****
   400.00          1     *
   600.00          3     ***
   800.00          4     ****
  1000.00          3     ***
  1200.00          3     ***
  1400.00         10     **********
  1600.00          0
  1800.00          0
  2000.00          1     *

                         1 ASTERISK =    1 COUNTS.

APPROXIMATE DEPTH
 N=    29 MEAN= 3756.241 MINMAX= 1506.000 5600.000 VAR= .44555226E+06
    CLASS        NO.
  2000.00          1     *
  3000.00          0
  4000.00         18     ******************
  5000.00          9     *********
  6000.00          1     *

                         1 ASTERISK =    1 COUNTS.
```

Histograms of chemical parameters and depth, Miocene formation waters

```
CALCIUM
 N=    35 MEAN=    71.909 MINMAX=    27.620   112.770 VAR= .61648513E+03
     CLASS        NO.
     20.00          0
     40.00          5     *****
     60.00          5     *****
     80.00         11     ***********
    100.00          8     ********
    120.00          6     ******

                          1 ASTERISK =    1 COUNTS.
MAGNESIUM
 N=    35 MEAN=    22.342 MINMAX=     2.140    56.270 VAR= .26738579E+03
     CLASS        NO.
     10.00         11     ***********
     20.00         10     **********
     30.00          2     **
     40.00          6     ******
     50.00          3     ***
     60.00          3     ***
     70.00          0

                          1 ASTERISK =    1 COUNTS.
SODIUM
 N=    35 MEAN= 1220.860 MINMAX=  309.100 2688.100 VAR= .32693530E+06
     CLASS        NO.
    200.00          0
    400.00          1     *
    600.00          3     ***
    800.00          1     *
   1000.00         14     **************
   1200.00          3     ***
   1400.00          0
   1600.00          1     *
   1800.00          5     *****
   2000.00          3     ***
   2200.00          3     ***
   2400.00          0
   2600.00          0
   2800.00          1     *
   3000.00          0

                          1 ASTERISK =    1 COUNTS.
```

Histograms of chemical parameters and depth, Miocene formation waters (cont.)

```
HC03
 N=    35 MEAN=     3.259 MINMAX=      .390    19.990 VAR= .20331794E+02
    CLASS        NO.
     1.00          7     *******
     2.00         12     ************
     3.00          7     *******
     4.00          5     *****
     5.00          1     *
     6.00          0
     7.00          0
     8.00          0
     9.00          0
    10.00          0
    11.00          0
    12.00          0
    13.00          0
    14.00          0
    15.00          0
    16.00          1     *
    17.00          1     *
    18.00          0
    19.00          0
    20.00          1     *

                         1 ASTERISK =   1 COUNTS.
S04
 N=    35 MEAN=     2.943 MINMAX=         0    24.660 VAR= .46137478E+02
    CLASS        NO.
      .10         14     **************
     1.00         12     ************
     2.00          2     **
     3.00          1     *
     4.00          0
     5.00          1     *
     6.00          0
     7.00          2     **
     8.00          0
     9.00          0
    10.00          0
    20.00          0
    25.00          3     ***

                         1 ASTERISK =   1 COUNTS.
```

Histograms of chemical parameters and depth. Miocene formation waters (cont.)

```
SO4
 N=    35 MEAN=     2.343 MINMAX=         0    24.660 VAR= .46137478E+02
    CLASS        NO.
      .10         14     **************
      .20          1     *
      .30          2     **
      .40          3     ***
      .50          2     **
      .60          0
      .70          0
      .80          0
      .90          3     ***
     1.00          1     *

                         1 ASTERISK =    1 COUNTS.
CHLORIDE
 N=    35 MEAN= 1410.614 MINMAX=  374.800 3018.300 VAR= .39982284E+06
    CLASS        NO.
   200.00          0
   400.00          1     *
   600.00          1     *
   800.00          3     ***
  1000.00          3     ***
  1200.00         13     *************
  1400.00          0
  1600.00          1     *
  1800.00          1     *
  2000.00          4     ****
  2200.00          4     ****
  2400.00          2     **
  2600.00          1     *
  2800.00          0
  3000.00          0
  3200.00          1     *

                         1 ASTERISK =    1 COUNTS.
APPROXIMATE DEPTH
 N=    35 MEAN= 4833.714 MINMAX= 1965.000 8600.000 VAR= .20324466E+07
    CLASS        NO.
  2000.00          1     *
  3000.00          1     *
  4000.00          7     *******
  5000.00         13     *************
  6000.00          7     *******
  7000.00          3     ***
  8000.00          2     **
  9000.00          1     *

                         1 ASTERISK =    1 COUNTS.
```

Histograms of chemical parameters and depth, Frio formation waters

```
CALCIUM
 N=   753 MEAN=    66.445 MINMAX=       .020   898.700 VAR= .13679033E+05
     CLASS        NO.
   200.00         692      **************************************************
   400.00          43      ****
   600.00           7      *
   800.00           7      *
  1000.00           4      *


                           1 ASTERISK =  14 COUNTS.
CALCIUM
 N=   753 MEAN=    66.445 MINMAX=       .020   898.700 VAR= .13679033E+05
     CLASS        NO.
    20.00         307      ********************************************
    40.00         129      *******************
    60.00         103      ***************
    80.00          71      ***********
   100.00          14      **
   120.00          25      ****
   140.00          12      **
   160.00           5      *
   180.00           9      **
   200.00          17      ***


                           1 ASTERISK =   7 COUNTS.
MAGNESIUM
 N=   753 MEAN=    10.353 MINMAX=       .010   388.730 VAR= .37041141E+03
     CLASS        NO.
    20.00         653      ***********************************************
    40.00          70      *****
    60.00          18      **
    80.00           7      *
   100.00           3      *
   120.00           0
   140.00           1      *
   160.00           0
   180.00           0
   200.00           0


                           1 ASTERISK =  14 COUNTS.
MAGNESIUM
 N=   753 MEAN=    10.353 MINMAX=       .010   388.730 VAR= .37041141E+03
     CLASS        NO.
     2.00         219      ********************************************
     4.00         107      **********************
     6.00          65      *************
     8.00          78      ****************
    10.00          46      **********
    12.00          36      ********
    14.00          34      *******
    16.00          23      *****
    18.00          17      ****
    20.00          28      ******


                           1 ASTERISK =   5 COUNTS.
```

Histograms of chemical parameters and depth, Frio formation waters (cont.)

```
SODIUM
 N=   753 MEAN=   800.545 MINMAX=     51.100 3031.700 VAR= .20427501E+06
    CLASS        NO.
  1000.00        508      ***********************************************
  2000.00        236      **********************
  3000.00          8      *
  4000.00          1      *


                          1 ASTERISK =  11 COUNTS.
SODIUM
 N=   753 MEAN=   800.545 MINMAX=     51.100 3031.700 VAR= .20427501E+06
    CLASS        NO.
   200.00         23      ********
   400.00        131      ********************************************
   600.00        145      *************************************************
   800.00        124      ******************************************
  1000.00         85      *****************************
  1200.00        115      ***************************************
  1400.00         53      ******************
  1600.00         29      **********
  1800.00         30      **********
  2000.00          9      ***


                          1 ASTERISK =   3 COUNTS.
HCO3
 N=   753 MEAN=    10.263 MINMAX=       .010   110.640 VAR= .11541709E+03
    CLASS        NO.
    10.00        480      ************************************************
    20.00        154      ****************
    30.00         85      *********
    40.00         21      ***
    50.00          5      *
    60.00          6      *
    70.00          1      *
    80.00          0
    90.00          0
   100.00          0
   110.00          0
   120.00          1      *


                          1 ASTERISK =  10 COUNTS.
HCO3
 N=   753 MEAN=    10.263 MINMAX=       .010   110.640 VAR= .11541709E+03
    CLASS        NO.
     2.00        132      ********************************************
     4.00        139      ***********************************************
     6.00         83      ****************************
     8.00         72      ************************
    10.00         54      ******************
    12.00         43      ***************
    14.00         45      ***************
    16.00         27      *********
    18.00         22      ********
    20.00         17      ******


                          1 ASTERISK =   3 COUNTS.
```

Histograms of chemical parameters and depth, Frio formation waters (cont.)

```
SO4
 N=   753 MEAN=     1.510 MINMAX=         0    81.620 VAR= .32788848E+02
    CLASS       NO.
     1.00       575      ************************************************
     2.00        80      *******
     3.00        29      ***
     4.00        21      **
     5.00        10      *
     6.00         5      *
     7.00         5      *
     8.00         4      *
     9.00         2      *
    10.00         1      *


                         1 ASTERISK =  12 COUNTS.
CHLORIDE
 N=   753 MEAN=   941.942 MINMAX=    11.850 4287.730 VAR= .39461493E+06
    CLASS       NO.
  1000.00       438      *************************************************
  2000.00       285      ********************************
  3000.00        21      ***
  4000.00         7      *
  5000.00         2      *


                         1 ASTERISK =   9 COUNTS.
CHLORIDE
 N=   753 MEAN=   941.942 MINMAX=    11.850 4287.730 VAR= .39461493E+06
    CLASS       NO.
   200.00        28      **********
   400.00       122      *****************************************
   600.00       128      *******************************************
   800.00        94      ********************************
  1000.00        66      **********************
  1200.00        87      *****************************
  1400.00        72      ************************
  1600.00        60      ********************
  1800.00        37      *************
  2000.00        29      **********
APPROXIMATE DEPTH
 N=   753 MEAN= 7094.479 MINMAX=         -017580.000 VAR= .60433670E+07
    CLASS       NO.
  2000.00        16      ****
  3000.00        11      ***
  4000.00        30      ********
  5000.00        76      *******************
  6000.00       127      ********************************
  7000.00       157      ****************************************
  8000.00        93      ************************
  9000.00        93      ************************
 10000.00        45      ************
 11000.00        53      **************
 12000.00        29      ********
 13000.00        15      ****
 14000.00         4      *
 15000.00         2      *
 16000.00         1      *
 17000.00         0
 18000.00         1      *
```

Histograms of chemical parameters and depth, Vicksburg formation waters

```
 PH
  N=   119 MEAN=     7.014 MINMAX=     5.100    10.900 VAR= .60615012E+00
      CLASS        NO.
       5.00          0
       6.00         13     *******
       7.00         38     *******************
       8.00         64     ********************************
       9.00          3     **
      10.00          0
      11.00          1     *

                           1 ASTERISK =    2 COUNTS.
 CALCIUM
  N=   121 MEAN=   106.392 MINMAX=     1.200   744.010 VAR= .13460973E+05
      CLASS        NO.
      10.00         37     *************************************
     100.00         42     ******************************************
     200.00         14     **************
     300.00         19     *******************
     400.00          4     ****
     500.00          1     *
     600.00          2     **
     700.00          1     *
     800.00          1     *
     900.00          0
    1000.00          0
    1100.00          0

                           1 ASTERISK =    1 COUNTS.
 MAGNESIUM
  N=   119 MEAN=    12.363 MINMAX=      .040   337.720 VAR= .12003273E+04
      CLASS        NO.
       2.00         36     ************************************
       4.00         29     *****************************
       6.00         14     **************
       8.00          8     ********
      10.00          3     ***
      20.00         13     *************
      40.00          6     ******
      60.00          7     *******
      80.00          0
     100.00          1     *
     150.00          1     *
     200.00          0
     250.00          0
     300.00          0
     350.00          1     *
     400.00          0
     450.00          0

                           1 ASTERISK =    1 COUNTS.
```

Histograms of chemical parameters and depth. Vicksburg formation waters (cont.)

MAGNESIUM

N= 119 MEAN= 12.363 MINMAX= .040 337.720 VAR= .12003273E+04

CLASS	NO.	
1.00	25	*************************
2.00	11	***********
3.00	14	**************
4.00	15	***************
5.00	4	****
6.00	10	**********
7.00	5	*****
8.00	3	***
9.00	2	**
10.00	1	*

1 ASTERISK = 1 COUNTS.

SODIUM

N= 121 MEAN= 523.282 MINMAX= 44.900 2646.900 VAR= .15430703E+06

CLASS	NO.	
200.00	11	***********
400.00	45	***
600.00	32	********************************
800.00	16	****************
1000.00	9	*********
1200.00	2	**
1400.00	0	
1600.00	1	*
1800.00	2	**
2000.00	2	**
2200.00	0	
2400.00	0	
2600.00	0	
2800.00	1	*

1 ASTERISK = 1 COUNTS.

HCO3

N= 121 MEAN= 10.001 MINMAX= 0 74.730 VAR= .11774593E+03

CLASS	NO.	
1.00	4	****
2.00	11	***********
3.00	8	********
4.00	14	**************
5.00	11	***********
6.00	11	***********
7.00	11	***********
8.00	4	****
9.00	3	***
10.00	9	*********
20.00	19	*******************
30.00	9	*********
40.00	4	****
50.00	2	**
60.00	0	
70.00	0	
80.00	1	*
90.00	0	
100.00	[illegible]	

1 ASTERISK = 1 COUNTS.

Histograms of chemical parameters and depth. Vicksburg formation waters (cont.)

```
S04
 N=  121 MEAN=     1.770 MINMAX=      .010    52.050 VAR= .26477321E+02
    CLASS        NO.
      .50         57     *****************************
     1.00         30     ***************
     2.00         13     *******
     3.00          6     ***
     4.00          1     *
     5.00          2     *
     6.00          1     *
     7.00          1     *
     8.00          5     ***
     9.00          1     *
    10.00          1     *
    11.00          1     *
    12.00          1     *
    50.00          0
    60.00          1     *


                         1 ASTERISK =    2 COUNTS.
CHLORIDE
 N=  121 MEAN=   763.570 MINMAX=   127.700  4589.300 VAR= .40211199E+06
    CLASS        NO.
   200.00          2     **
   400.00         26     **************************
   600.00         34     **********************************
   800.00         24     ************************
  1000.00         13     *************
  1200.00          7     *******
  1400.00          4     ****
  1600.00          1     *
  1800.00          1     *
  2000.00          1     *
  2200.00          4     ****
  2400.00          0
  2600.00          1     *
  2800.00          0
  3000.00          2     **
  4000.00          0
  5000.00          1     *


                         1 ASTERISK =    1 COUNTS.
APPROXIMATE DEPTH
 N=  119 MEAN= 8099.202 MINMAX= 1643.00012902.000 VAR= .43515610E+07
    CLASS        NO.
  2000.00          1     *
  3000.00          0
  4000.00          3     ***
  5000.00          1     *
  6000.00         10     **********
  7000.00         26     **************************
  8000.00         21     *********************
  9000.00         14     **************
 10000.00         18     ******************
 11000.00         14     **************
 12000.00         10     **********
 13000.00          1     *


                         1 ASTERISK =    1 COUNTS.
```

Histograms of chemical parameters and depth, Yegua formation waters

```
CALCIUM
 N=  100 MEAN=    12.586 MINMAX=       .070    73.850 VAR= .19522205E+03
    CLASS        NO.
     1.00         12      ************
    10.00         42      ******************************************
    20.00         23      ***********************
    30.00         15      ***************
    40.00          3      ***
    50.00          2      **
    60.00          1      *
    70.00          1      *
    80.00          1      *
    90.00          0
   100.00          0


                          1 ASTERISK =    1 COUNTS.
MAGNESIUM
 N=  100 MEAN=     6.272 MINMAX=          0    28.010 VAR= .41874287E+02
    CLASS        NO.
     1.00         28      ****************************
     5.00         27      ***************************
    10.00         20      ********************
    15.00         16      ****************
    20.00          4      ****
    25.00          3      ***
    30.00          2      **


                          1 ASTERISK =    1 COUNTS.
SODIUM
 N=  100 MEAN=   648.255 MINMAX=    62.800  2081.600 VAR= .2229S942E+06
    CLASS        NO.
   200.00         17      *****************
   400.00         22      **********************
   600.00         18      ******************
   800.00          9      *********
  1000.00          5      *****
  1200.00         12      ************
  1400.00         12      ************
  1600.00          1      *
  1800.00          2      **
  2000.00          1      *
  2200.00          1      *


                          1 ASTERISK =    1 COUNTS.
HCO3
 N=  100 MEAN=    18.097 MINMAX=       .210    68.340 VAR= .33094435E+03
    CLASS        NO.
    10.00         54      ***************************
    20.00         14      *******
    30.00         12      ******
    40.00          8      ****
    50.00          1      *
    60.00          4      **
    70.00          7      ****


                          1 ASTERISK =    2 COUNTS.
```

Histograms of chemical parameters and depth, Yegua formation waters (cont.)

```
SO4
 N=  100 MEAN=     1.422 MINMAX=          0    11.970 VAR= .94641664E+01
    CLASS        NO.
     1.00        80     ****************************************
     2.00         5     ***
     4.00         6     ***
     6.00         0
     8.00         2     *
    10.00         0
    12.00         7     ****


                        1 ASTERISK =    2 COUNTS.
SO4
 N=  100 MEAN=     1.422 MINMAX=          0    11.970 VAR= .94641664E+01
    CLASS        NO.
      .10        38     **************************************
      .20        10     **********
      .30         8     ********
      .40         6     ******
      .50         1     *
      .60         1     *
      .70         5     *****
      .80         2     **
      .90         7     *******
     1.00         2     **


                        1 ASTERISK =    1 COUNTS.
CHLORIDE
 N=  100 MEAN=   663.897 MINMAX=    32.400  2254.100 VAR= .26283002E+06
    CLASS        NO.
   200.00        19     *******************
   400.00        21     *********************
   600.00        15     ***************
   800.00         9     *********
  1000.00         7     *******
  1200.00         9     *********
  1400.00        15     ***************
  1600.00         1     *
  1800.00         0
  2000.00         3     ***
  2200.00         0
  2400.00         1     *


                        1 ASTERISK =    1 COUNTS.
APPROXIMATE DEPTH
 N=   94 MEAN= 4846.298 MINMAX=   701.000  9950.000 VAR= .33176364E+07
    CLASS        NO.
  1000.00         2     **
  2000.00         2     **
  3000.00         8     ********
  4000.00        20     ********************
  5000.00         8     ********
  6000.00        36     ************************************
  7000.00         4     ****
  8000.00        11     ***********
  9000.00         1     *
 10000.00         2     **
```

Histograms of chemical parameters and depth, Wilcox formation waters

```
CALCIUM
 N=   237 MEAN=    36.729 MINMAX=       .250   412.280 VAR= .30001886E+04
     CLASS        NO.
   100.00         215     *******************************************
   200.00          17     ****
   300.00           3     *
   400.00           1     *
   500.00           1     *


                          1 ASTERISK =    5 COUNTS.
CALCIUM
 N=   237 MEAN=    36.729 MINMAX=       .250   412.280 VAR= .30001886E+04
     CLASS        NO.
    10.00          88     ********************************************
    20.00          25     *************
    30.00          42     *********************
    40.00          17     *********
    50.00          13     *******
    60.00          13     *******
    70.00           9     *****
    80.00           1     *
    90.00           5     ***
   100.00           2     *


                          1 ASTERISK =    2 COUNTS.
MAGNESIUM
 N=   237 MEAN=     9.629 MINMAX=       .040   127.850 VAR= .16742622E+03
     CLASS        NO.
     1.00          47     ************************
     2.00          28     **************
     3.00          14     *******
     4.00           6     ***
     5.00           9     *****
    10.00          54     ***************************
    20.00          46     ***********************
    30.00          22     ***********
    40.00           5     ***
    50.00           2     *
    60.00           2     *
    70.00           1     *
    80.00           0
    90.00           0
   100.00           0
   110.00           0
   120.00           0
   130.00           1     *


                          1 ASTERISK =    2 COUNTS.
```

Histograms of chemical parameters and depth, Wilcox formation waters (cont.)

```
SODIUM
 N=  237 MEAN=   718.057 MINMAX=      8.310 3692.740 VAR= .21791918E+06
    CLASS        NO.
  1000.00        193      *************************************************
  2000.00         41      ***********
  3000.00          2      *
  4000.00          1      *
  5000.00          0

                          1 ASTERISK =    4 COUNTS.
SODIUM
 N=  237 MEAN=   718.057 MINMAX=      8.310 3692.740 VAR= .21791918E+06
    CLASS        NO.
   200.00         27      **************
   400.00         43      **********************
   600.00         32      ****************
   800.00         31      ****************
  1000.00         60      ******************************
  1200.00         15      ********
  1400.00          9      *****
  1600.00         12      ******
  1800.00          4      **
  2000.00          1      *

                          1 ASTERISK =    2 COUNTS.
HCO3
 N=  237 MEAN=    13.744 MINMAX=       .020    77.680 VAR= .14704683E+03
    CLASS        NO.
    10.00         98      *************************************************
    20.00         86      *******************************************
    30.00         30      ***************
    40.00         10      *****
    50.00         12      ******
    60.00          0
    70.00          0
    80.00          1      *
    90.00          0
   100.00          0

                          1 ASTERISK =    2 COUNTS.
SO4
 N=  237 MEAN=      .830 MINMAX=       .010    20.000 VAR= .53137647E+01
    CLASS        NO.
     2.00        214      *******************************************
     4.00         12      ***
     6.00          5      *
     8.00          2      *
    10.00          1      *
    12.00          0
    14.00          0
    16.00          1      *
    18.00          0
    20.00          2      *

                          1 ASTERISK =    5 COUNTS.
```

```
SO4
 N=   237 MEAN=       .830 MINMAX=       .010    20.000 VAR= .53137647E+01
     CLASS        NO.
        .20       128       *******************************************
        .40        35       ************
        .60        17       ******
        .80         7       ***
       1.00         5       **
       1.20        13       *****
       1.40         4       **
       1.60         4       **
       1.80         0
       2.00         1       *

                            1 ASTERISK  =    3 COUNTS.
CHLORIDE
 N=   237 MEAN=  801.954 MINMAX=     7.620  4776.700 VAR= .34824465E+06
     CLASS        NO.
    1000.00       177       *********************************************
    2000.00        53       **************
    3000.00         5       **
    4000.00         1       *
    5000.00         1       *

                            1 ASTERISK  =    4 COUNTS.
CHLORIDE
 N=   237 MEAN=  801.954 MINMAX=     7.620  4776.700 VAR= .34824465E+06
     CLASS        NO.
     200.00        28       **************
     400.00        43       **********************
     600.00        26       *************
     800.00        22       ***********
    1000.00        58       *****************************
    1200.00        19       **********
    1400.00        10       *****
    1600.00        10       *****
    1800.00         7       ****
    2000.00         7       ****

                            1 ASTERISK  =    2 COUNTS.
APPROXIMATE DEPTH
 N=   237 MEAN= 7570.278 MINMAX=   303.00013530.000 VAR= .38500001E+07
     CLASS        NO.
    3000.00         6       ***
    4000.00         6       ***
    5000.00         8       ****
    6000.00        12       ******
    7000.00        55       ****************************
    8000.00        48       ************************
    9000.00        62       *******************************
   10000.00        24       ************
   11000.00         8       ****
   12000.00         2       *
   13000.00         2       *
   14000.00         4       **

                            1 ASTERISK  =    2 COUNTS.
```