Sulfate

The concentration of dissolved sulfate in water from the middle Wilcox aquifer, based on median values of all samples in each 100-square-mile area, ranges from 0.1 mg/L in several parts of the Mississippi embayment aquifer system area to 39,700 mg/L in a downdip area in southern Texas (table 1). There is no apparent areal trend in concentration across the aquifer (fig. 13). However locally the concentration appears to increase from updip to downdip in southern Mississippi and Alabama and from updip to middip in southern Arkansas, northern Louisiana, and eastern Texas.

The concentration of dissolved sulfate ranges from less than 5 to about 20 mg/L in the outcrop area extending from the Texas-Arkansas border eastward to southwestern Alabama and from 5 to 100 mg/L in the area extending from the Texas-Arkansas border southwestward to the San Marcos arch. The concentration ranges from less than 100 to about 1,000 mg/L in the outcrop area between the San Marcos arch and the Rio Grande.

From outcrop to middip the concentration of dissolved sulfate generally ranges from 5 mg/L to more than 100 mg/L but less than 1,000 mg/L in nearly all of the aquifer area. An exception is a localized area in northwestern Louisiana where the concentration exceeds 1,000 mg/L.

From middip to the downdip limit of the data the concentration of dissolved sulfate ranges from 10 to 1,000 mg/L in the area extending from the Mississippi River eastward to southwestern Alabama and from 10 to 100 mg/L in the area extending from the Mississippi River westward to the Sabine arch. From middip to the downdip limit of the data the concentration ranges from 5 to 10,000 mg/L in the area extending from the Sabine arch southwestward to the San Marcos arch and from 5 to 1,000 mg/L in the area between the San Marcos arch and the Rio Grande.

Chloride

The concentration of dissolved chloride in water from the middle Wilcox aquifer, based on median values of all samples in each 100-square-mile area, ranges from 0.1 mg/L in northern Mississippi and western Tennessee to 119,000 mg/L in a downdip area in southeastern Mississippi (table 1). From the Mississippi River eastward to southwestern Alabama the concentration increases from outcrop to downdip limit of data in southern Alabama and Mississippi (fig. 14). From the Mississippi River westward to the Sabine uplift the concentration increases from northern Arkansas to about middip in southern Arkansas and from the outcrop overlying the Sabine uplift to the downdip limit of the data. From the outcrop area overlying the Sabine uplift southwestward to the Rio Grande the concentration generally increases from middip to the downdip limit of the aquifer.

The concentration of dissolved chloride ranges from 5 to 50 mg/L in the outcrop area extending from the Mississippi River eastward to southwestern Alabama and from 5 to 50,000 mg/L in the area extending from the Mississippi River westward to the Texas-Arkansas border and in the area overlying the Sabine arch. The concentration ranges from 10 to 100 mg/L in the outcrop area extending from the Texas-Arkansas border southwestward to the San Marcos arch and from 50 to 1,000 mg/L in the area between the San Marcos arch and the Rio Grande.

From outcrop to middip the concentration of dissolved chloride ranges from 5 to 100 mg/L in the area extending from the Mississippi River eastward to southwestern Alabama and from 10 to 50,000 mg/L in the area extending from the Mississippi River westward to the Sabine uplift. From outcrop to middip the concentration ranges from 5 to 1,000 mg/L in the area extending from the Sabine uplift southwestward to the San Marcos arch and from 50 to 100 mg/L in the area between the San Marcos arch and the Rio Grande.

From middip to the downdip limit of the data the concentration of dissolved chloride ranges from 100 to 100,000 mg/L in the area extending from the Mississippi River eastward to southwestern Alabama and from 10 to 50,000 mg/L in the area extending from the Mississippi River westward to the Sabine arch. From middip to the downdip limit of the data the concentration ranges from 1,000 to 100,000 mg/L in the area extending from the Sabine arch southwestward to the San Marcos arch and from 100 to 10,000 mg/L in the area between the San Marcos arch and the Rio Grande. Part of the areas having a large concentration of chloride are generally coincident with the deeper part of the aquifer and with the location of salt domes (fig. 4).

Silica

The concentration of dissolved silica in water from the middle Wilcox aquifer, based on median values of all samples in each 100-square-mile area, ranges from 1 to 100 mg/L (table 1). There appears to be no areal trend in silica concentration in water from the aquifer (fig. 15).

The concentration of dissolved silica ranges from 10 to about 20 mg/L but less than 50 mg/L in the outcrop area extending from the Texas-Arkansas border eastward to southwestern Alabama. The concentration ranges from about 10 to more than 20 mg/L in the outcrop area extending from the Texas-Arkansas border southwestward to the Rio Grande and in the outcrop area overlying the Sabine uplift.

From outcrop to middip the concentration of dissolved silica ranges from 10 to 50 mg/L in the area extending from the Mississippi River eastward to southwestern Alabama. From outcrop to middip the concentration ranges from 10 to 20 mg/L in the area extending from the Mississippi River southwestward to the San Marcos Arch and from 20 to 50 mg/L in the area between the San Marcos arch and the Rio Grande.

From middip to the downdip limit of the data the concentration of dissolved silica ranges from 10 to 20 mg/L in the area extending from Mississippi River eastward to southwestern Alabama and from 20 to 50 mg/L in the area extending from the Mississippi River westward to the Sabine arch. From middip to the downdip limit of the data the concentration ranges from 10 to 20 mg/L in the area extending from the Sabine arch southwestward to the San Marcos arch and from 20 to 100 mg/L in the area between the San Marcos arch and the Rio Grande.

IONIC RATIOS

Selected ionic ratios were mapped to show any trends from the outcrop to the downdip limit of the data. A characteristic of ionic ratios is that they are not affected by dilution, assuming that all constituents are diluted to the same degree. Consequently, upward leakage of brine into a freshwater aquifer would not mask the signature of the brine. For example, if the brine was seawater trapped in deep sediments, the ionic ratio would remain that of seawater. Whereas if the ionic ratio is different from seawater and the relative concentrations of sodium and chloride are larger than for seawater, the brine could be the product of dissolution of evaporites composing salt domes.

Mapped ionic ratios can be used to show trends that may indicate processes or mechanisms that have major control on the water chemistry from outcrop to downdip limit of the data. For example an ionic ratio of magnesium plus calcium to bicarbonate that is equal to 1 in outcrop areas indicates the dissolution of dolomite or calcite, whereas downdip of the outcrop this same ionic ratio greater than 1 indicates an additional source of calcium or magnesium ions such as would result from the dissolution of gypsum. If the downdip area is in a salt dome basin, dissolution of evaporites could provide the additive calcium and magnesium ions. However, if this same ratio were less than 1, it would indicate an increase in bicarbonate ions due to a process such as the alteration of silicates. The ionic ratio maps were constructed by calculating the indicated ratio for each sample within each 100-square-mile area. The median value of all ratios for each 100-square-mile area was then plotted and used as the basis for drawing the lines of equal median ionic ratio.

Magnesium to Calcium

The areal distribution of the milliequivalent ratio of magnesium to calcium (Mg:Ca) in water from the middle Wilcox aquifer, based on the median Mg:Ca ratio in each 100-square-mile area, shows that the ratio ranges from 0.03 to 12.8 (table 1). The mapped data shows no apparent areal trend in the Mg:Ca ratio across the aquifer area (fig. 16). Most of the mapped data show that the ratio is near 0.5.

The Mg:Ca ratio generally ranges from 0.25 to 1 in the outcrop area extending from the Texas-Arkansas border eastward to southwestern Alabama and from 0.25 to 2 in the outcrop area extending from the Texas-Arkansas border to the San Marcos arch. The Mg:Ca ratio generally ranges from 0.25 to 0.50 in the outcrop area between the San Marcos arch and the Rio Grande.

From outcrop to middip the Mg:Ca ratio generally ranges from 0.25 to 2 in the area extending from the Mississippi River to southwestern Alabama and from 0.25 to 1 in the area extending from the Mississippi River westward to the Sabine uplift. From outcrop to middip the Mg:Ca ratio generally ranges from 0.25 to 2 in the area extending from the Sabine uplift southwestward to the San Marcos arch and from 0.25 to 1 in the area between the San Marcos arch and the Rio Grande.

From middip to the downdip limit of the data the Mg:Ca ratio generally ranges from 0.5 to 10 in the area extending from the Mississippi River eastward to southwestern Alabama and 0.25 to 0.50 in the area extending from the Mississippi River westward to the Sabine arch. From middip to the downdip limit of the data the Mg:Ca ratio ranges from 0.25 to 1 in the area extending from the Sabine arch southwestward to the Rio Grande.

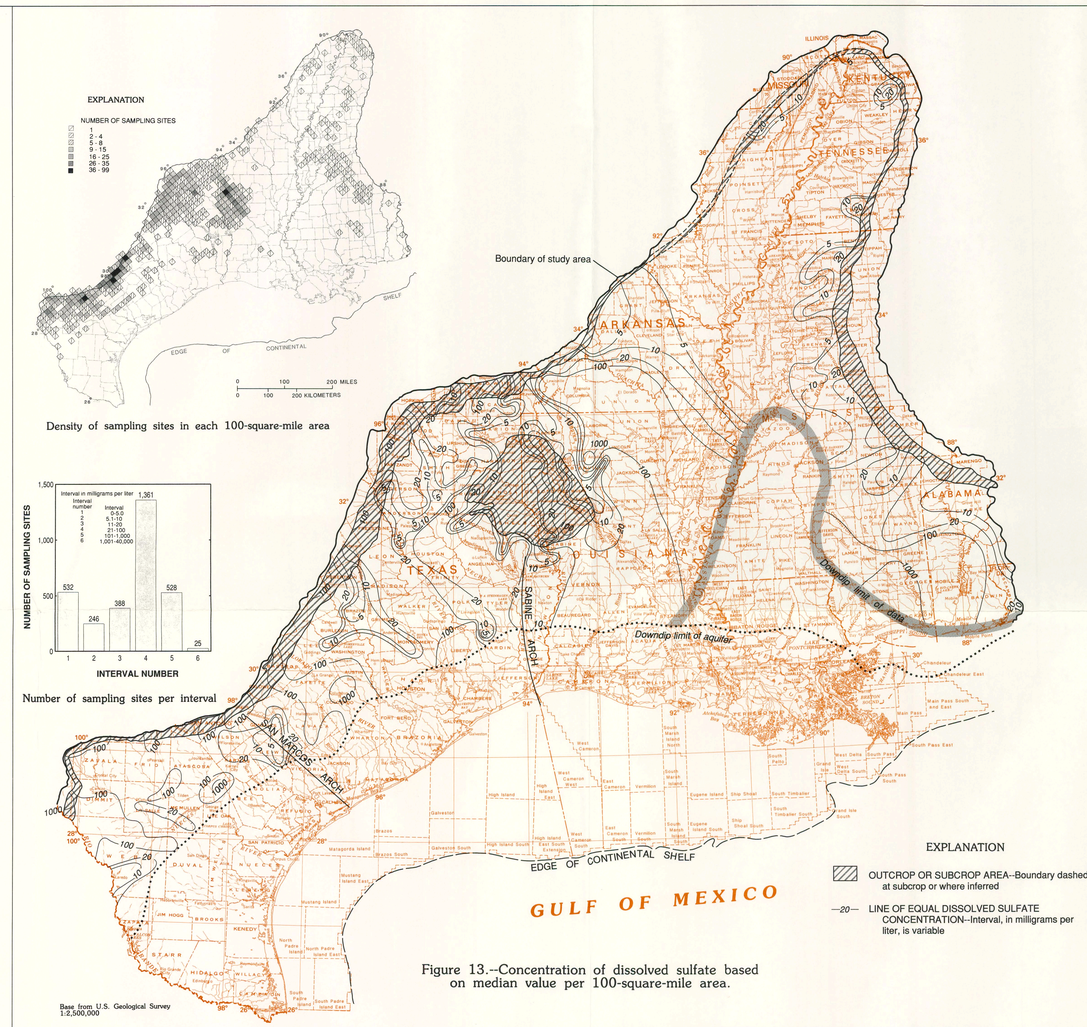

Figure 13.--Concentration of dissolved sulfate based on median value per 100-square-mile area.

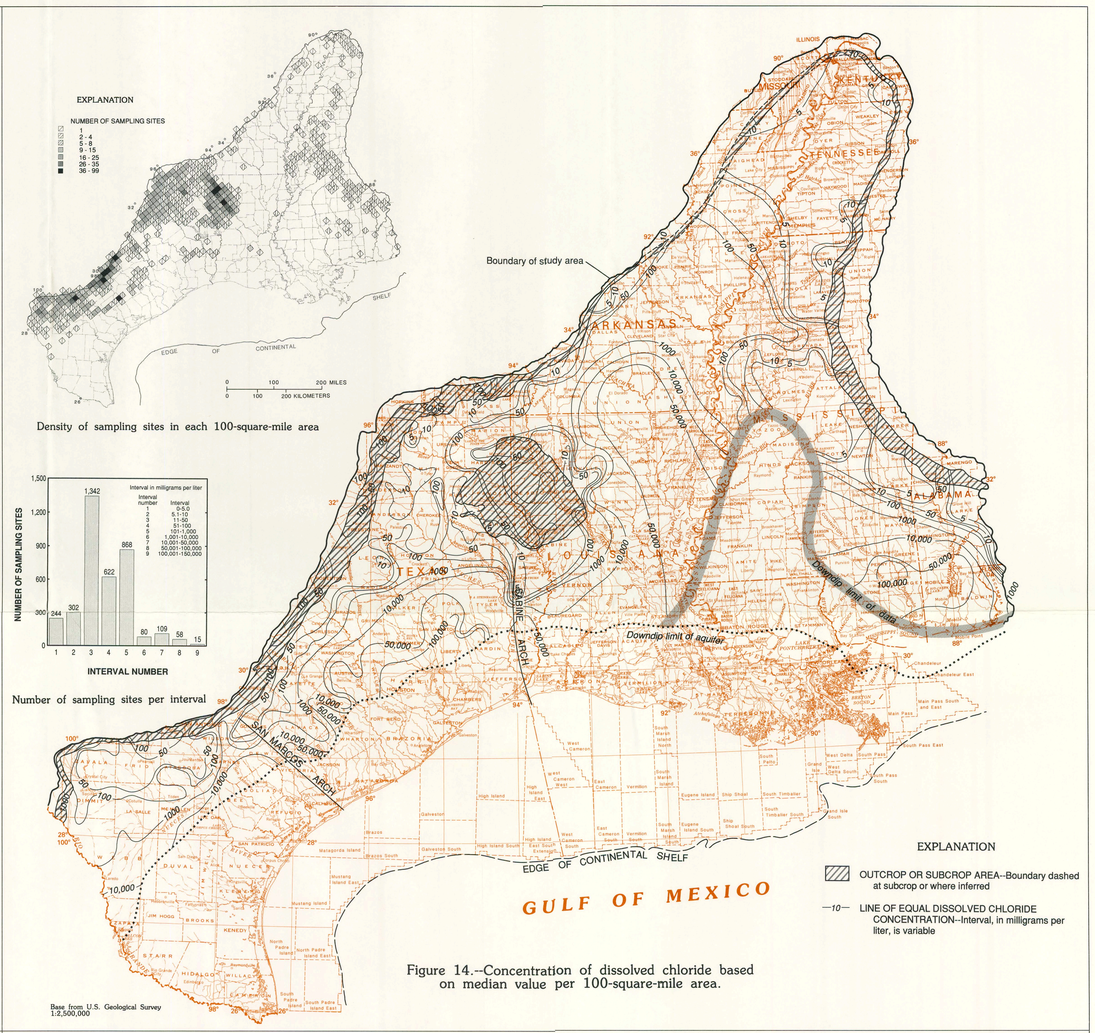

Figure 14.--Concentration of dissolved chloride based on median value per 100-square-mile area.

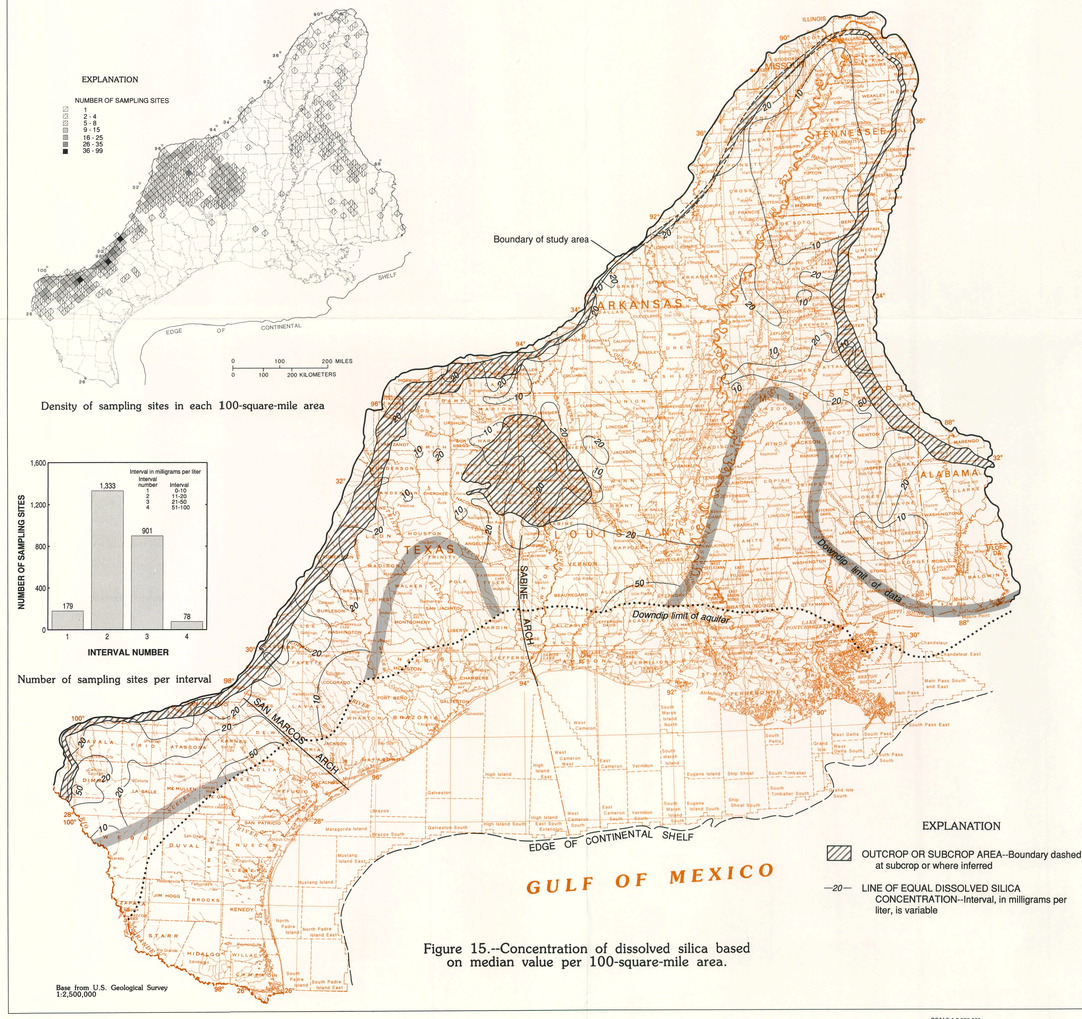

Figure 15.--Concentration of dissolved silica based on median value per 100-square-mile area.

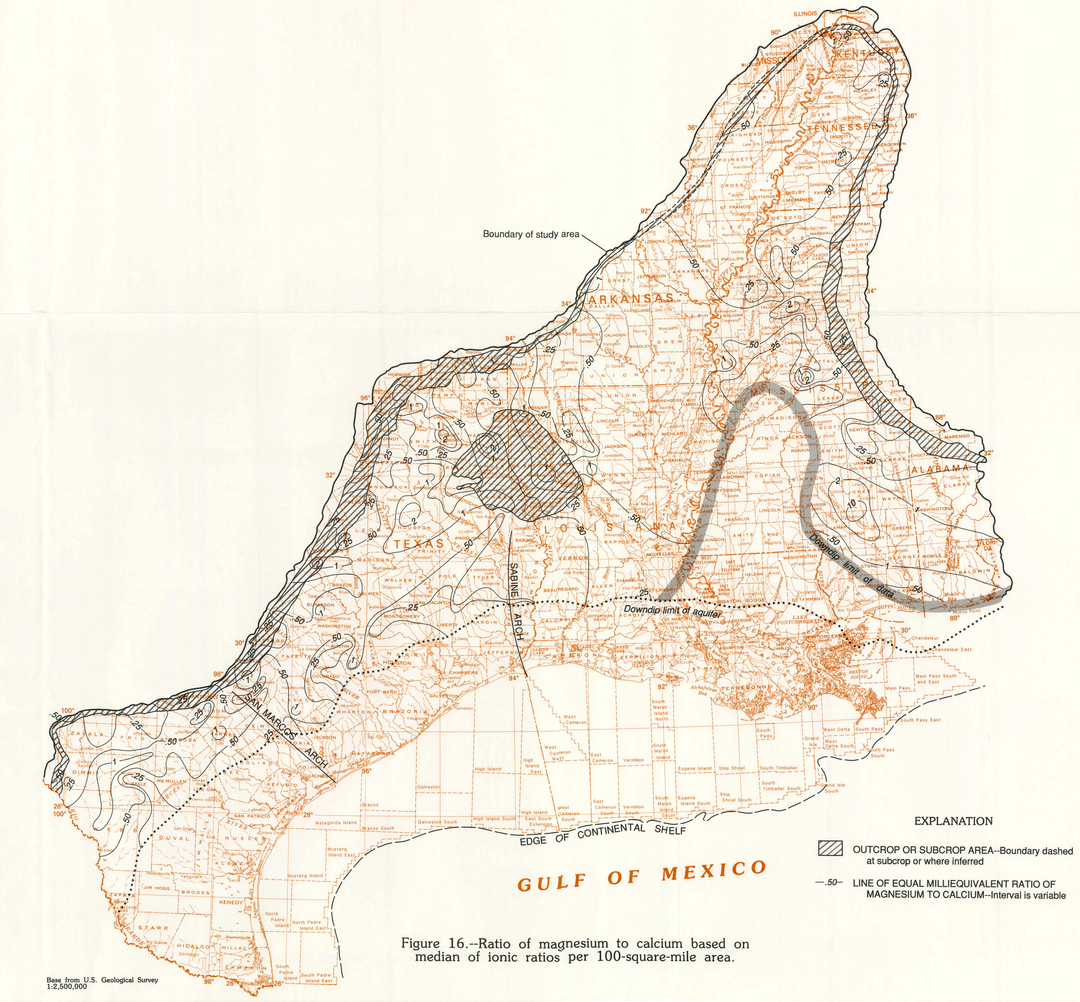

Figure 16.--Ratio of magnesium to calcium based on median of ionic ratios per 100-square-mile area.

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PROPERTIES AND CHEMICAL CONSTITUENTS IN GROUND WATER FROM THE MIDDLE WILCOX AQUIFER, GULF COAST REGIONAL AQUIFER SYSTEMS, SOUTH-CENTRAL UNITED STATES

by

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1993