Sulfate

The concentration of dissolved sulfate in water from permeable zone D, based on the median values of all samples in each 100-square-mile area, ranges from 0.2 mg/L in outcrop areas in southwestern Alabama to 5,700 mg/L in southern Texas (table 1). The concentration generally increases from the outcrop to the downdip limit of data in the area that extends from about midway between the Sabine arch and the San Marcos arch eastward to southeastern Mississippi and Louisiana (fig. 13). Whereas the concentration generally decreases from the outcrop to the downdip limit of the data in the area that extends from about midway between the Sabine arch and the San Marcos arch southwestward to the Rio Grande.

In the outcrop area that extends from the San Marcos arch eastward to southwestern Alabama the concentration of dissolved sulfate ranges from less than 5 to about 10 mg/L except for two small areas of 100 mg/L. In the outcrop area that extends from the San Marcos arch southwestward to the Rio Grande the concentration ranges from about 100 mg/L at the San Marcos arch to more than 5,000 mg/L near the Rio Grande.

From about midway between the Sabine arch and the San Marcos arch eastward to southeastern Mississippi and Louisiana the concentration of dissolved sulfate generally ranges from 5 to 10 mg/L from outcrop to middip and from 10 to 100 mg/L from middip to the downdip limit of the data. However, there are three localized areas in southern Louisiana where the concentration exceeds 1,000 mg/L. From about midway between the Sabine arch and the San Marcos arch southwestward to the Rio Grande the concentration ranges from about 10 mg/L to more than 5,000 mg/L. The concentration generally increases from the midway point between the arches southwestward to the Rio Grande but decreases from the outcrop to the downdip limit of the data.

Chloride

The concentration of dissolved chloride in water from permeable zone D, based on the median values of all samples in each 100-square-mile area, ranges from 0.4 mg/L in updip areas east of the Sabine arch to 142,000 mg/L in the Continental Shelf area southeast of the Louisiana coastline (table 1). The concentration generally increases from the outcrop to the downdip limit of the data (fig. 14).

The concentration of dissolved chloride is about 10 mg/L in most of the outcrop area that extends from the Sabine arch eastward to southwestern Alabama except for a large area that adjoins the western side of the Mississippi River and a smaller area that adjoins the Mobile River where the concentration exceeds 100 mg/L. From the Sabine arch southwestward to the Rio Grande the concentration in the outcrop area ranges from about 10 mg/L at the Sabine arch to more than 1,000 mg/L near the Rio Grande.

The concentration of dissolved chloride is about 10 mg/L in most of the area from outcrop to middip and extending from the Sabine arch eastward to southwestern Alabama and southeastern Louisiana. There are two exceptions, one is a large area that adjoins the western side of the Mississippi River where the chloride concentration exceeds 10,000 mg/L and the other is an area adjoining the Mobile River where the concentration exceeds 100 mg/L. From middip to the downdip limit of the data the concentration ranges from 10,000 to more than 100,000 mg/L. From the Sabine arch southwestward to the San Marcos arch the concentration generally increases from about 100 mg/L near the outcrop to 10,000 mg/L near middip and continues to increase in a downdip direction to more than 50,000 mg/L along the downdip limit of the data. From the San Marcos arch southwestward to the Rio Grande the concentration increases from about 1,000 mg/L near the outcrop to 10,000 mg/L near middip and to more than 50,000 mg/L near the downdip limit of the data.

The concentration pattern of dissolved chloride is very similar to the concentration pattern of dissolved sodium. Also the areas of large concentration of dissolved chloride are coincident with the deeper parts of the permeable zone and with the location of salt domes (fig. 4).

Silica

The concentration of dissolved silica in water from permeable zone D, based on the median values of all samples in each 100-square-mile area, ranges from 2 mg/L in a downdip area in southern Louisiana to 98 mg/L in the outcrop in southern Texas (table 1). The concentration generally decreases from outcrop to the downdip limit of the data except east of the Mississippi River where there appears to be no specific trend (fig. 15).

The concentration of dissolved silica generally ranges from 10 to 50 mg/L from outcrop to the downdip limit of data and shows no specific trend in the area east of the Mississippi River. The absence of a trend in this area may be largely due to the random distribution of small areas of large and small concentrations. From the Mississippi River southwestward to the limit of the data the concentration ranges from less than 20 mg/L in downdip areas to about 50 mg/L in the outcrop area. The absence of data in the downdip part of this area and particularly southern Texas probably affects the trend observed.

IONIC RATIOS

Selected ionic ratios were mapped to show any trends from 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 fresh water aquifer would not mask the signature of the brine. For example if the brine were sea water trapped in deep sediments, the ionic ratio would remain that of sea water. Whereas if the ionic ratios are different from sea water and the concentrations of sodium and chloride are larger than for sea water, the brine could be the product of the 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 the 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 or if the downdip area is in a salt dome basin, it could be the dissolution of evaporites. However if this same ratio was less than 1 it would indicate an increase in bicarbonate ions due to a process such as the alteration of silicates. The median ion concentration for each 100-square-mile area, expressed in milliequivalents per liter, was used to calculate an ionic ratio.

Magnesium to Calcium

The areal distribution of the milliequivalent ratio of magnesium to calcium (Mg:Ca) in water from permeable zone D ranges from 0.01 near the coastline in southern Texas to 7 along the outcrop in southwestern Alabama (table 1). For most of the permeable zone area the ratio ranges from 0.2 to 0.5 (fig. 16). The map shows no general areal trend in the Mg:Ca ratio.

From the Sabine arch eastward to the western edge of Florida the Mg:Ca ratio generally ranges from 0.1 to 0.5 in the outcrop area except in southwestern Alabama where it increases to more than 5. From the outcrop to the downdip limit of data in this area the ratio ranges from 0.1 to 1 with the smaller ratios occurring along the Mississippi, Sabine, and Pearl Rivers. From the Sabine arch southwestward to the Rio Grande the Mg:Ca ratio ranges from 0.1 to 0.5 along the outcrop and from 0.1 to 1 from outcrop to downdip limit of the data. The ratio downdip of the outcrop ranged from 0.1 to 0.5 in the area southwest of the San Marcos arch and from 0.2 to 1.0 in the area east of the San Marcos arch.

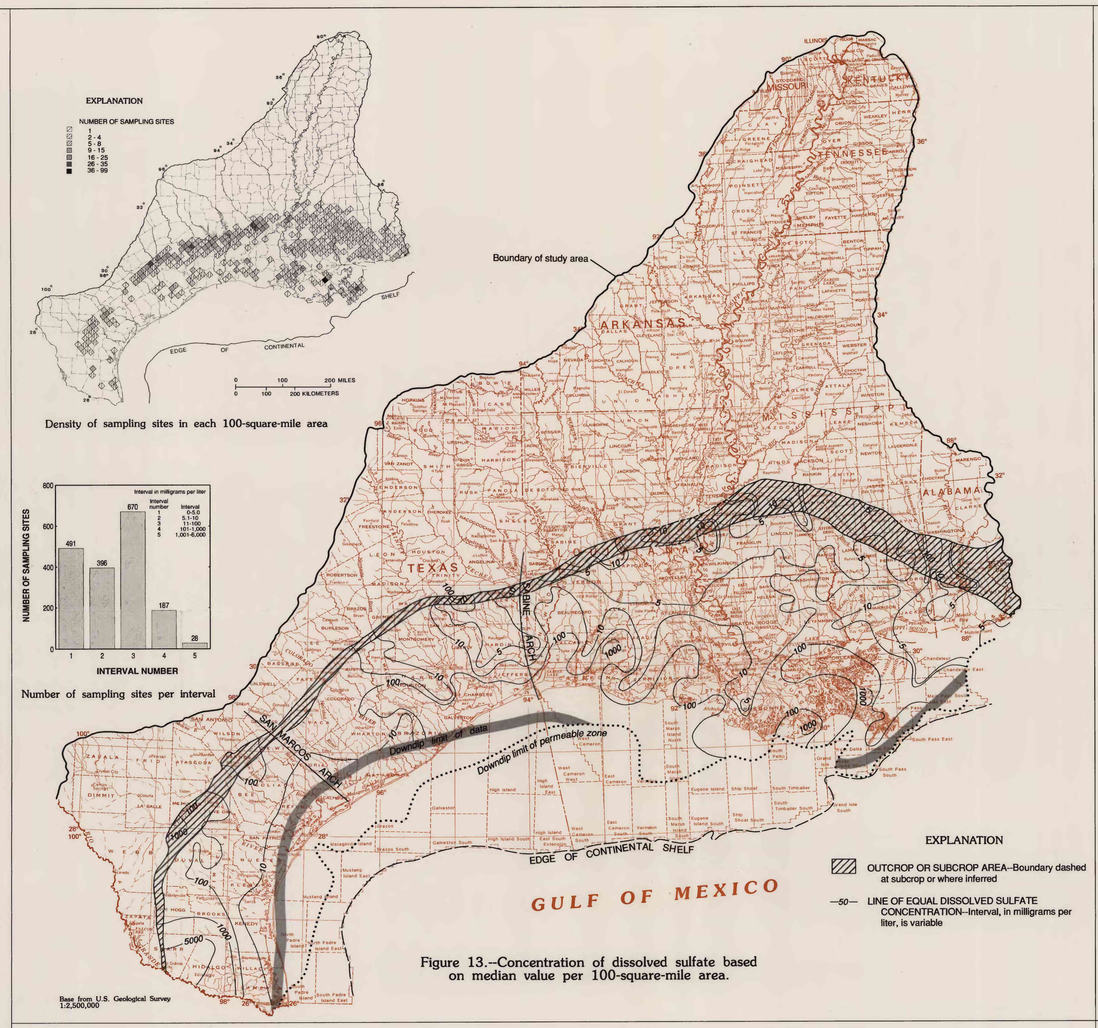

Figure 13.--Concentration of dissolved sulfate based on median value per 100-square-mile area.

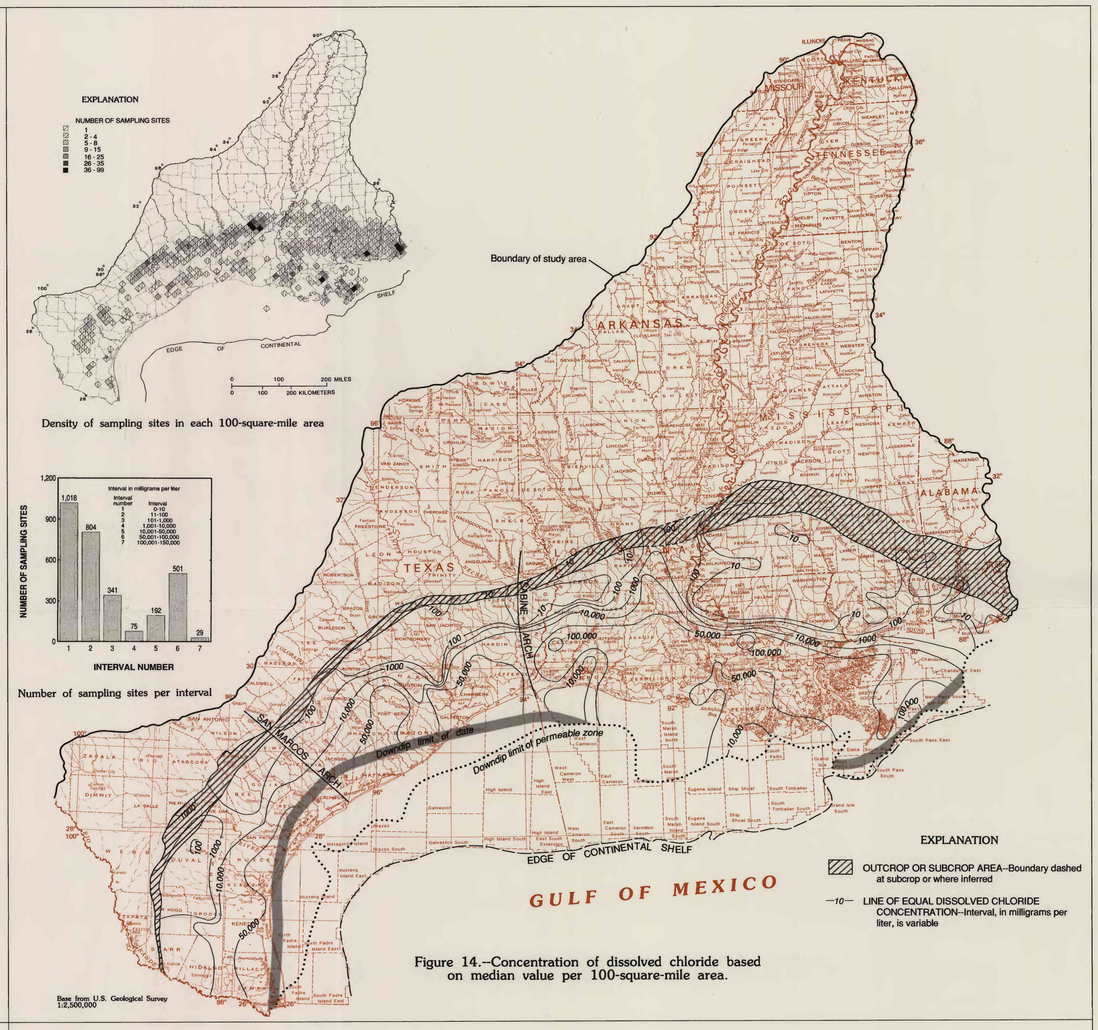

Figure 14.--Concentration of dissolved chloride based on median value per 100-square-mile area.

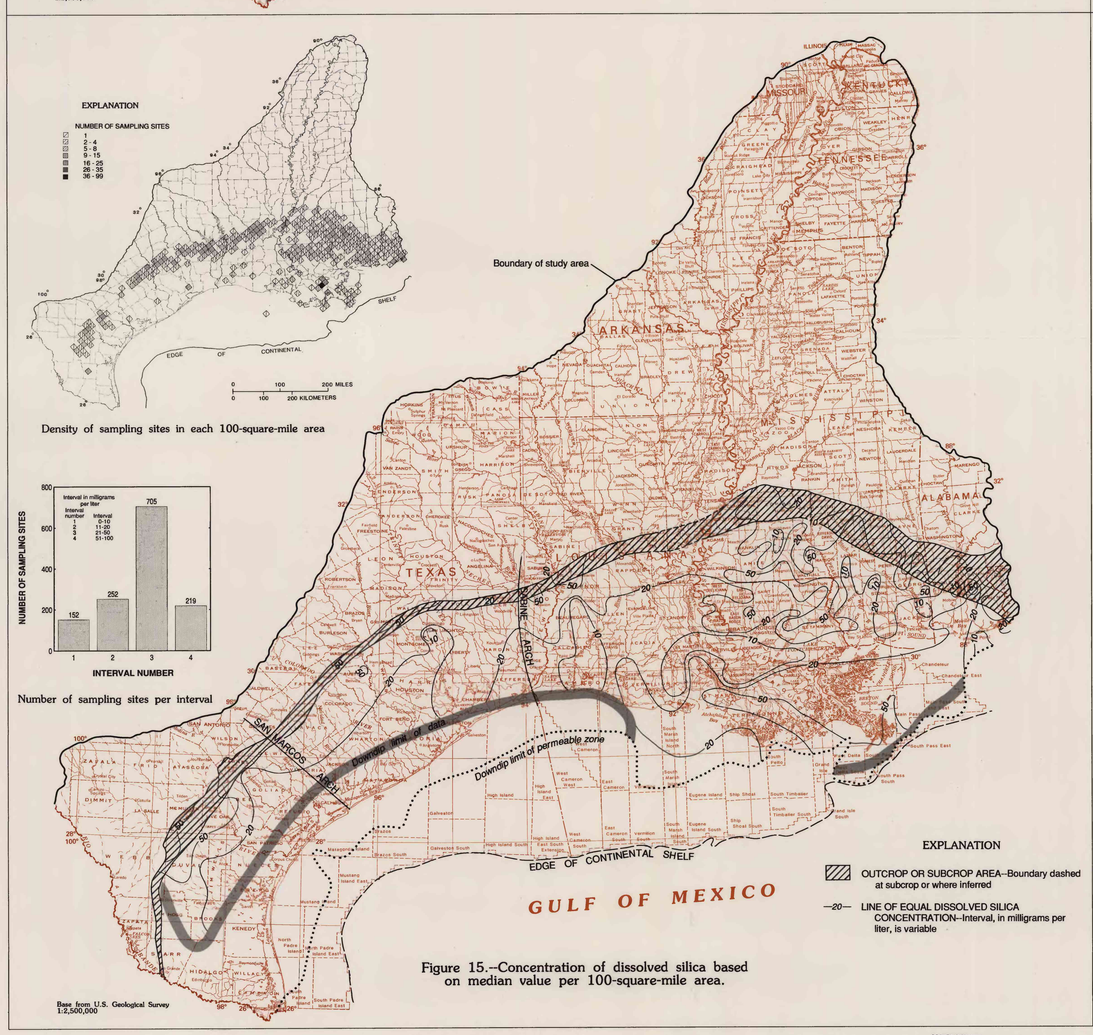

Figure 15.--Concentration of dissolved silica based on median value per 100-square-mile area.

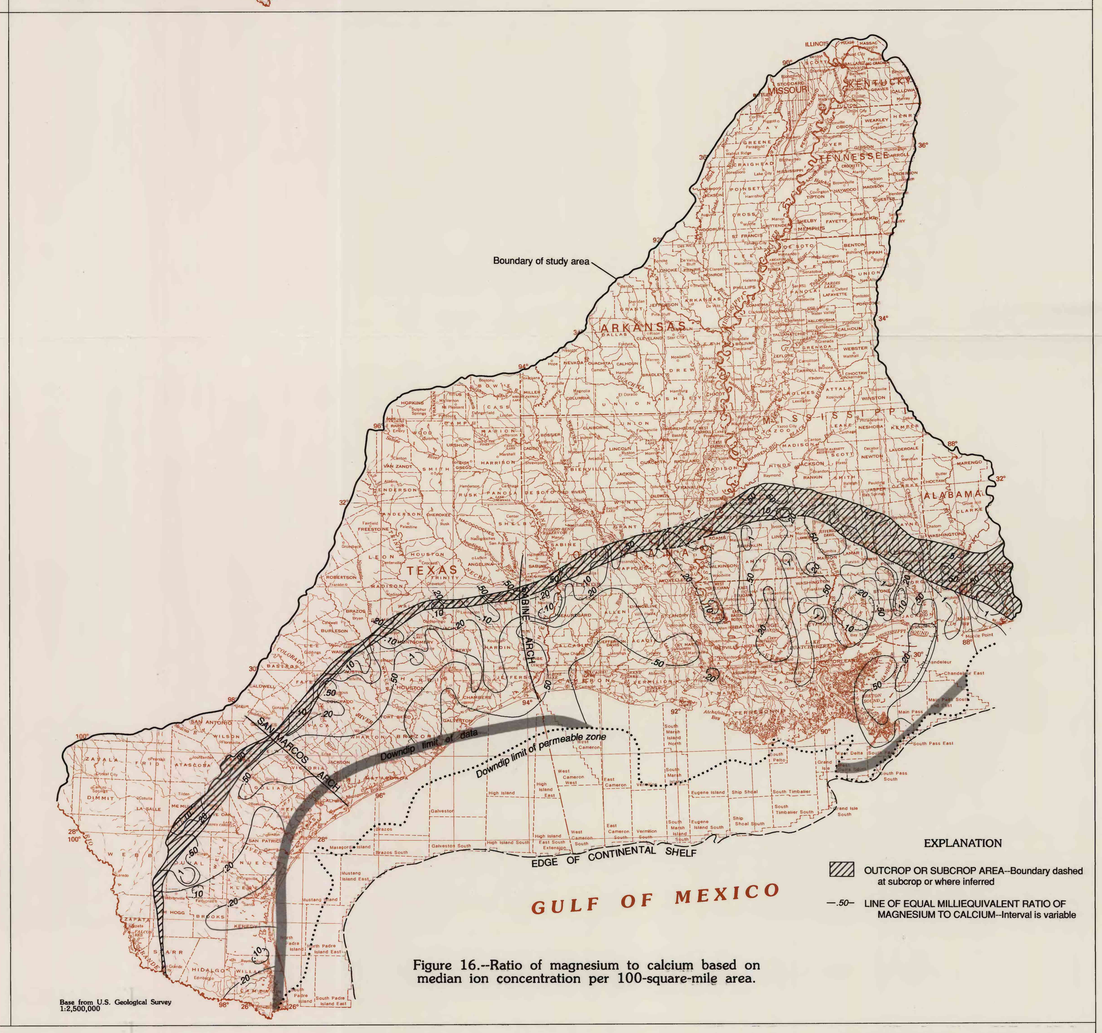

Figure 16.--Ratio of magnesium to calcium based on median ion concentration per 100-square-mile area.

SCALE 1:3 500 000

PROPERTIES AND CHEMICAL CONSTITUENTS IN GROUND WATER FROM PERMEABLE ZONE D (MIDDLE MIOCENE DEPOSITS), COASTAL LOWLANDS AQUIFER SYSTEM, SOUTH-CENTRAL UNITED STATES

by

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