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HYDRAULIC CONDUCTIVITY, PERCENT SAND AND GRAVEL, AND TRANSMISSIVITY

An empirical relation between hydraulic conductivity and percent of sand and gravel was developed for the middle unit (fig. 11) (G. W. Freethey, hydrologist, U.S. Geological Survey, written commun., 1982). Hydraulic conductivity, which ranged from about 20 to 100 ft/d, was determined mainly by analysis of data for water-level recovery tests made on more than 150 wells in the eastern part of the Salt River Valley (Niccoli and Long, 1981). Values of transmissivity determined from the recovery tests were divided by the length of the well casing open to the aquifer to obtain average values of hydraulic conductivity. Data were used only from wells in which at least 90 percent of the perforated casing or well screen was opposite the middle unit. The mean percentage of sand and gravel for the middle unit at the location of the well was determined from the maps of percent sand and gravel (fig. 7). The results of plotting mean hydraulic conductivity versus mean percent sand and gravel indicate that the hydraulic properties are different for material containing less than 50 percent sand and gravel from those containing more than 50 percent sand and gravel. The relation indicates that about 50 percent sand and gravel is a reasonable "hydrologic break point" at which to divide the middle unit into a coarse-grained and fine-grained facies. Hydraulic conductivity increases rapidly with small increases in the percent sand and gravel above 50 percent but decreases slowly with small decreases in percent sand and gravel below 50 percent.

Transmissivity for the middle unit was estimated by using the maps showing percent sand and gravel and saturated thickness of the middle unit (figs. 7 and 8) and the graph of hydraulic conductivity versus percent sand and gravel (fig. 11). The map showing percent sand and gravel was converted into a map of the distribution of hydraulic conductivity by using the graph in figure 11. The resulting hydraulic conductivity map was then superimposed on the saturated thickness map (fig. 8) and values of transmissivity calculated at intersection of the two sets of contours (fig. 12). Most values of transmissivity for the middle unit range from about 10,000 to 60,000 ft^2/d. Highest values of transmissivity-- about 40,000 to 60,000 ft^2/d--are in the area between Scottsdale and Mesa, where saturated thickness ranges from about 500 to 700 ft and the percent sand and gravel ranges from about 50 to 80 percent. Lowest values of transmissivity--less than 10,000 ft^2/d--generally are along the margins of the basin. The middle unit in these areas may contain more than 50 percent sand and gravel, but the saturated thickness is small. In contrast, transmissivity ranges between 10,000 and 20,000 ft^2/d near the central axis of the basin where the percent sand and gravel is less than 30 percent but the saturated thickness is greater.

Values of hydraulic conductivity were not calculated for the upper and lower units because of the lack of data from wells perforated or screened mainly in the individual units. However, the relation of hydraulic conductivity and particle size determined for the middle unit is a useful indicator of hydrologic properties in a large part of the area because the middle unit is the principal water-bearing unit. The upper unit generally is less consolidated than the middle unit and thus, therefore, have higher values of hydraulic conductivity for a given sand and gravel percentage. The lower unit generally is more consolidated than the middle unit and thus would have lower values of hydraulic conductivity for a given sand and gravel percentage. Estimates of the range of hydraulic conductivity and transmissivity for the upper and lower units are given on table 1. In the Tucson basin, the Fort Lowell Formation and the Tinaja beds have a similar stratigraphic position as the middle and the lower units of the eastern part of the Salt River valley. Values of hydraulic conductivity for the Fort Lowell Formation are as much as two times greater than those in the underlying and more consolidated Tinaja beds for the same percentage of sand and gravel (G. W. Freethey, written commun., 1980). A similar relation may be expected for the middle and lower units of the study area.

SUMMARY

The sedimentary deposits in the eastern part of the Salt River Valley area are divided into four water-bearing units -- the red unit, the lower unit, the middle unit, and the upper unit. The red unit consists mostly of coarse-grained, well-cemented red beds that predate a period of high-angle faulting that formed the present-day sedimentary basins and mountain ranges. As a result, the sedimentary facies of the red unit are not related to present-day basins and mountain ranges as are the deposits of the lower, middle, and upper units.

The lower unit consists of mudstone, gypsiferous and anhydritic mudstone, anhydrite, clay, silt, conglomerate, sand and gravel, and interbedded andesitic basalt that were deposited in a closed basin. The unit, which includes the largest volume of sedimentary material in the area, may be more than 10,000 ft thick in the central parts of the basin. Most of the unit has a low hydraulic conductivity and most of the recoverable ground water is in the coarse-grained sand and gravel and conglomerate that is as much as 600 ft thick near the perimeter of the basin. The coarse-grained material, yields as much as 3,500 gal/min of water to wells, whereas, the fine-grained material yields less than 50 gal/min of water to wells.

The middle unit is the principal water-bearing unit in the area. It consists mostly of silt, siltstone, and silty sand and gravel that were deposited in a closed basin. The unit is as much as 1,000 ft thick; as much as 700 ft is saturated in the central parts of the area. The coarsest grained and most productive part of the unit is north of Mesa near the Salt River, where wells yield as much as 4,000 gal/min. Elsewhere in the area, where the saturated thickness is at least 500 ft, the middle unit may yield as much as 1,000 gal/min of water to wells.

The upper unit consists of gravel, sand, and silt that were deposited in the basin as through-flowing or integrated drainage was developed. This unit is as much as 300 ft thick, but a maximum of only about 150 ft is saturated in the southwestern part of the area. Where saturated, the unit may yield as much as 4,500 gal/min. The upper unit near the major drainages is important in transmitting water to the water table during periods of flood flow. Perched water has collected in fine-grained parts of the unit as a result of infiltrating irrigation water and occasional flood flow.

An empirical relation between mean hydraulic conductivity and percent of sand and gravel was developed for the middle unit by comparing results of recovery tests on more than 150 wells to maps of distribution of percent sand and gravel. Values of hydraulic conductivity ranged from about 20 to 100 ft/day. Values of transmissivity were estimated for the middle unit by using the maps of percent sand and gravel and saturated thickness of the middle unit and the graph of hydraulic conductivity versus percent sand and gravel. Transmissivity ranges from about 10,000 to 60,000 ft^2/d in the middle unit. Data were insufficient to develop similar quantitative relationships for the lower and upper units. However, the relations between hydraulic conductivity and percent sand and gravel that were developed for the middle unit are useful indicators of the hydrologic properties in the area because the middle unit is the principal water-bearing unit.

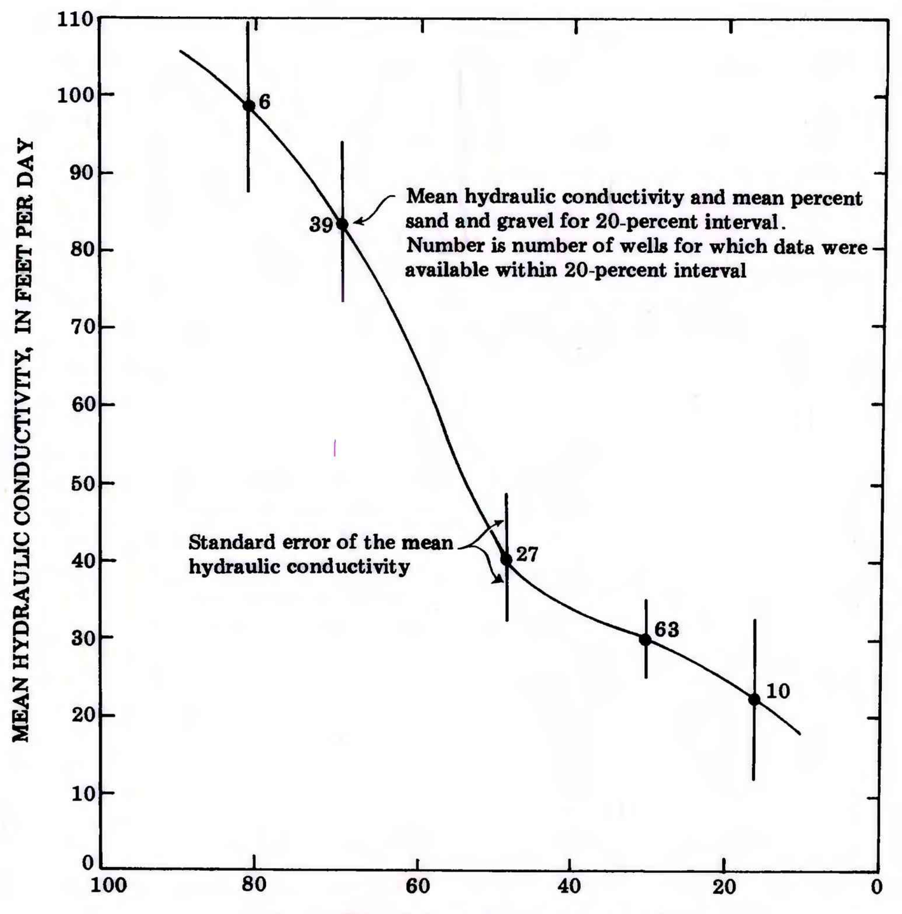

Figure 11.-- Relation between hydraulic conductivity and percent sand and gravel in the middle unit (G.W. Freethey, written communication, 1982).

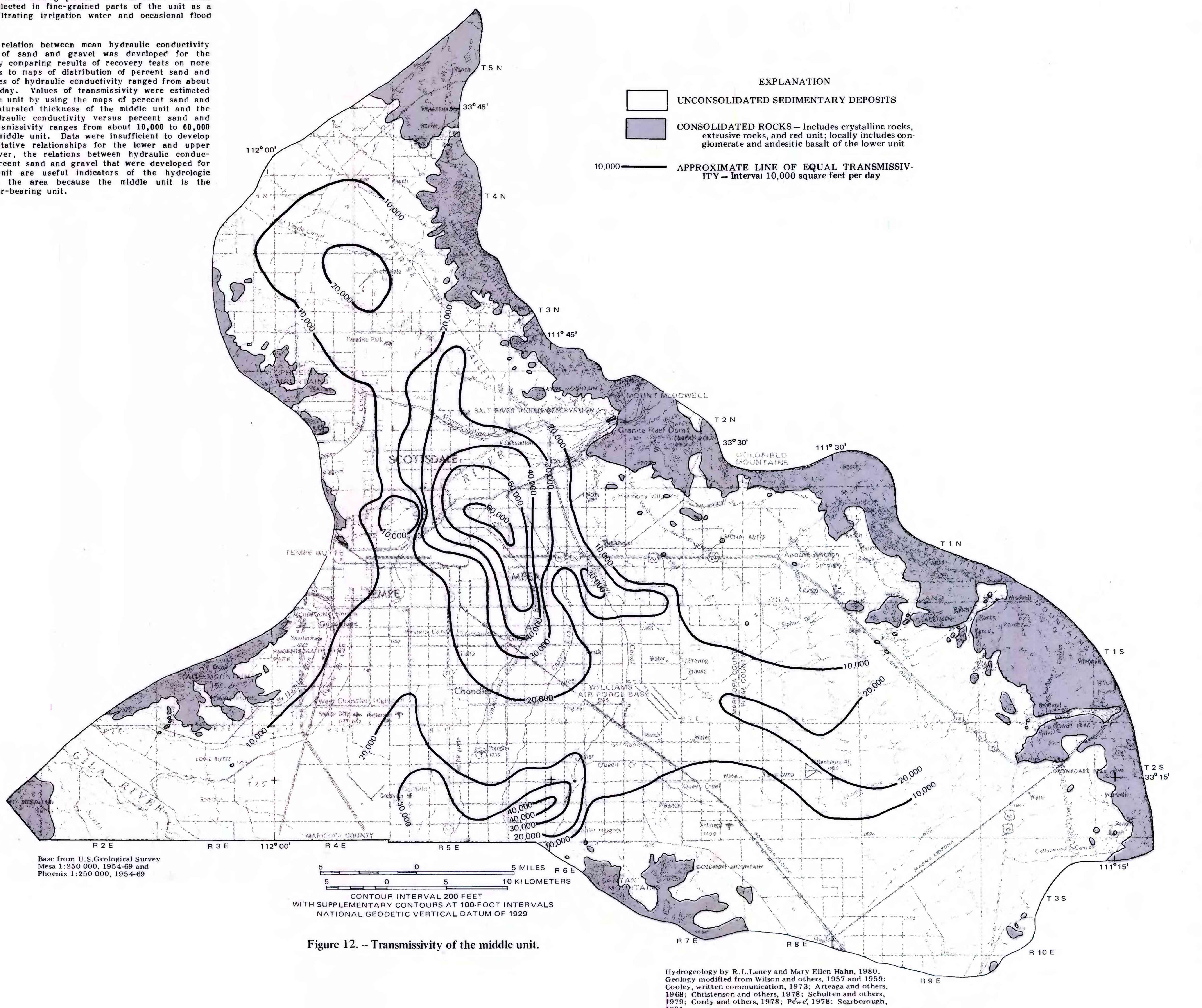

Figure 12. -- Transmissivity of the middle unit.

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HYDROGEOLOGY OF THE EASTERN PART OF THE SALT RIVER VALLEY AREA, MARICOPA AND PINAL COUNTIES, ARIZONA

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