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INTRODUCTION

The Monument Valley and the northern part of the Black Mesa areas include about 2,700 mi² in northeastern Arizona and are entirely in the Navajo and Hopi Indian Reservations. The main source of water is the ground water in the several aquifers that are made up of one or more formations. The aquifers are stacked one on the other and generally are not hydraulically connected; the composite stratigraphic column indicates the relative position of the formations (see sheet 2). The main water-bearing units are the C, N, and D aquifers; the Toreva and Mopu Formations; and the alluvium. The geologic structure and topographic relief preclude a uniform depth to water in the area; therefore, recommended drilling depths should be determined on an individual site basis. Ground-water development has been mainly for public, domestic, and livestock supplies. In the early 1970's, the Peabody Coal Co. began withdrawing water from the N aquifer for transportation of coal by slurry pipeline. In 1975 about 4,500 acre-ft of ground water was withdrawn from the aquifers in the northern part of the Black Mesa area; most of the water was from the N aquifer. In the Monument Valley area the amount of ground-water withdrawal probably was less than 20 acre-ft. In 1951-76 the period for which data were used to compile these maps—withdrawals from the N aquifer resulted in water-level declines in places in the northern part of the Black Mesa area. Measurable changes in water levels have not occurred in the other aquifers in the areas in the 25-year period.

The hydrologic data on which these maps are based are available, for the most part, in computer-printout form for consultation at the Arizona Water Commission, 222 North Central Avenue, Suite 800, Phoenix, and at U.S. Geological Survey offices in: Federal Building, 301 West Congress Street, Tucson; Valley Center, Suite 1800, Phoenix; and 2255 North Gemini Drive, Building 3, Flagstaff. Material from which copies can be made at private expense is available at the Tucson, Phoenix, and Flagstaff offices of the U.S. Geological Survey.

C AQUIFER

The C aquifer consists of the Shinarump Member of the Chinle Formation, the Moenkopi Formation, and the De Chelly Sandstone Member and Organ Rock Tongue of the Cutler Formation. All the units of the aquifer are present in the western part of the Monument Valley area; in most of the eastern part, however, erosion has removed the units that overlie the Cutler Formation. In the northern part of the Black Mesa area the C aquifer is at considerable depth and is about 4,700 ft below the land surface in the Peabody well field. In the Monument Valley area the Shinarump Member of the Chinle Formation is composed of lenticular crossbedded sandstone, conglomerate, and siltstone. The Shinarump is a maze of interlaced channel deposits of varying thickness; the change in thickness may be several feet in a lateral distance of only a few hundred feet. Although the Shinarump is as much as 200 ft thick in the western part of the Monument Valley area, the average thickness probably is about 75 ft. The Moenkopi Formation is a sequence of siltstone and sandstone beds that has an average thickness of about 200 ft. The De Chelly Sandstone Member of the Cutler Formation is a thick-bedded fine- to medium-grained sandstone that is about 350 ft thick. In most of the eastern part of the Monument Valley area, the De Chelly has been removed by erosion. The Organ Rock Tongue of the Cutler Formation consists of silty sandstone, mudstone, and siltstone and is about 500 ft in most of the Monument Valley area.

The amount of water available to wells from the C aquifer is dependent on the unit tapped by the well. The Shinarump Member may yield 5 to 10 gal/min of water to wells; the De Chelly Sandstone Member may yield 5 gal/min, and the Organ Rock Tongue may yield 1 to 2 gal/min. The Moenkopi Formation generally does not yield water to wells. The water from the Shinarump and De Chelly Sandstone Members generally is of suitable chemical quality for domestic use. Water from the Organ Rock Tongue may contain more than 2,000 mg/L (milligrams per liter) of dissolved solids and is unfit for domestic use.

N AQUIFER

The N aquifer underlies the entire northern part of the Black Mesa area and the southwestern part of the Monument Valley area. The aquifer is not present in the southeastern part of the Monument Valley area. The N aquifer consists of the Navajo Sandstone, the Kayenta Formation, the Moenave Formation, and the Lukachukai Member of the Wingate Sandstone. The aquifer is composed of a thick upper section of dominantly fine-grained sandstone that overlies a basal section of silty sandstone and siltstone and is from 1,000 to 1,200 ft thick. The depth to the top of the aquifer ranges from zero in the area of outcrop of the Navajo Sandstone to more than 3,000 ft near the center of the northern part of the Black Mesa area.

Ground water is under confined conditions in most of the report area, and as much as 1,800 ft of artesian head occurs in wells in the Peabody well field. In the recharge area near Shonto and in the northern and eastern parts of the report area the aquifer is partly saturated, and ground water is under unconfined or water-table conditions. Ground water moves southeastward from the recharge area toward the center of Black Mesa and then moves south out of the area and northeastward toward Dinnehotso.

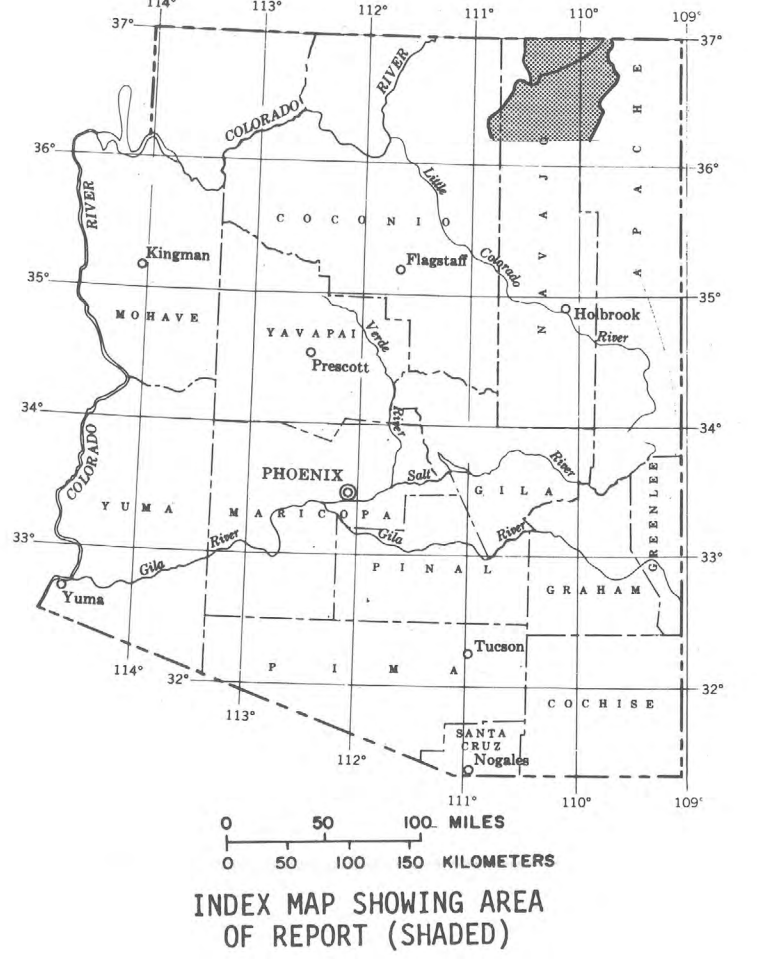
The N aquifer yields small to moderate quantities of water to wells. Well yields range from less than 10 to more than 500 gal/min and depend on the saturated thickness of the aquifer. The water is of suitable chemical quality for most uses. In general, the water contains less than 500 mg/L of dissolved solids and generally has a sodium bicarbonate composition; in places calcium is a dominant constituent. The fluoride concentration ranges from 0.0 to 2.4 mg/L; however, fluoride concentrations generally are less than the recommended average concentration in drinking water (U.S. Public Health Service, 1962). The recommended average optimum fluoride concentration for a water supply differs according to the annual average maximum daily air temperatures. In the Monument Valley and the northern part of the Black Mesa areas the annual average maximum daily air temperature is about 67°F, and the optimum concentration of fluoride in drinking water is 0.3 mg/L. The presence of concentrations greater than 1.0 mg/L is grounds for rejection of the water for public supply.

SELECTED REFERENCES

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- Repenning, C. A., Cooley, M. E., and Akers, J. P., 1969, Stratigraphy of the Chinle and Moenkopi Formations, Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah: U.S. Geol. Survey Prof. Paper 521-B, 34 p.

U.S. Public Health Service, 1962, Drinking water standards, 1962: U.S. Public Health Service Pub. 956, 61 p.

INDEX MAP SHOWING AREA OF REPORT (SHADED)



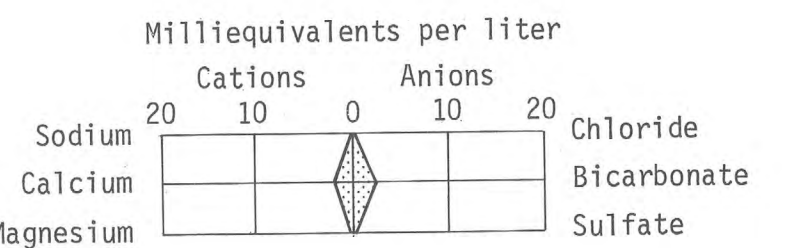
EXPLANATION

POTENTIOMETRIC CONTOUR, N AQUIFER—Shows altitude at which water level would have stood in tightly cased well. Contour interval 200 ft. Datum is mean sea level

WELL THAT PENETRATES THE C AQUIFER—First entry, BK-417, is well number or name. Second entry, 65M, is depth to water in feet below land surface (R, depth to water reported; M, depth to water measured; F, flowing well). Third entry, 5135, is altitude of the water level in feet above mean sea level. Fourth entry, 392, is specific conductance in micromhos per centimeter at 25°C (specific conductance is an indication of the dissolved-solids concentration in water). Fifth entry, 0.4, is fluoride concentration in milligrams per liter

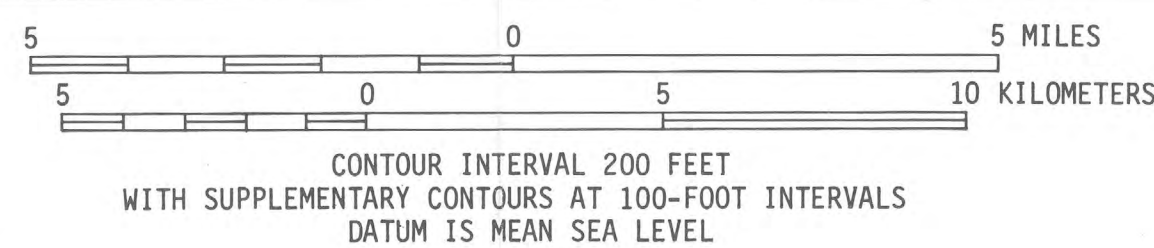
WELL THAT PENETRATES THE N AQUIFER—First entry, BT-537, is well number or name. Second entry, 374M, is depth to water in feet below land surface (R, depth to water reported; M, depth to water measured; F, flowing well). Third entry, 5409, is altitude of the water level in feet above mean sea level. Fourth entry, 530, is specific conductance in micromhos per centimeter at 25°C (specific conductance is an indication of the dissolved-solids concentration in the water). Fifth entry, 0.5, is fluoride concentration in milligrams per liter

CHEMICAL-QUALITY PATTERN DIAGRAM—Shows major chemical constituents in milliequivalents per liter. The pattern is in a variety of shapes and sizes, which provides a means of comparing, correlating, and characterizing similar or dissimilar types of water. The pattern tends to maintain its characteristic shape as the sample becomes dilute or concentrated, and the pattern size varies in proportion to the variation in dissolved solids



- APPROXIMATE AREAL EXTENT OF THE N AQUIFER
- APPROXIMATE BOUNDARY BETWEEN CONFINED AND UNCONFINED CONDITIONS IN THE N AQUIFER
- GENERALIZED DIRECTION OF GROUND-WATER FLOW
- ARBITRARY BOUNDARY OF GROUND-WATER AREA

BASE FROM U.S. GEOLOGICAL SURVEY
MAPS: MARBLE CANYON, 1:250,000, 1970 AND
SHEPHERD, 1:250,000, 1969



GROUND-WATER CONDITIONS IN THE C AND N AQUIFERS

MAPS SHOWING GROUND-WATER CONDITIONS IN THE MONUMENT VALLEY AND NORTHERN PART OF THE BLACK MESA AREAS, NAVAJO, APACHE, AND COCONINO COUNTIES, ARIZONA—1976

By

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