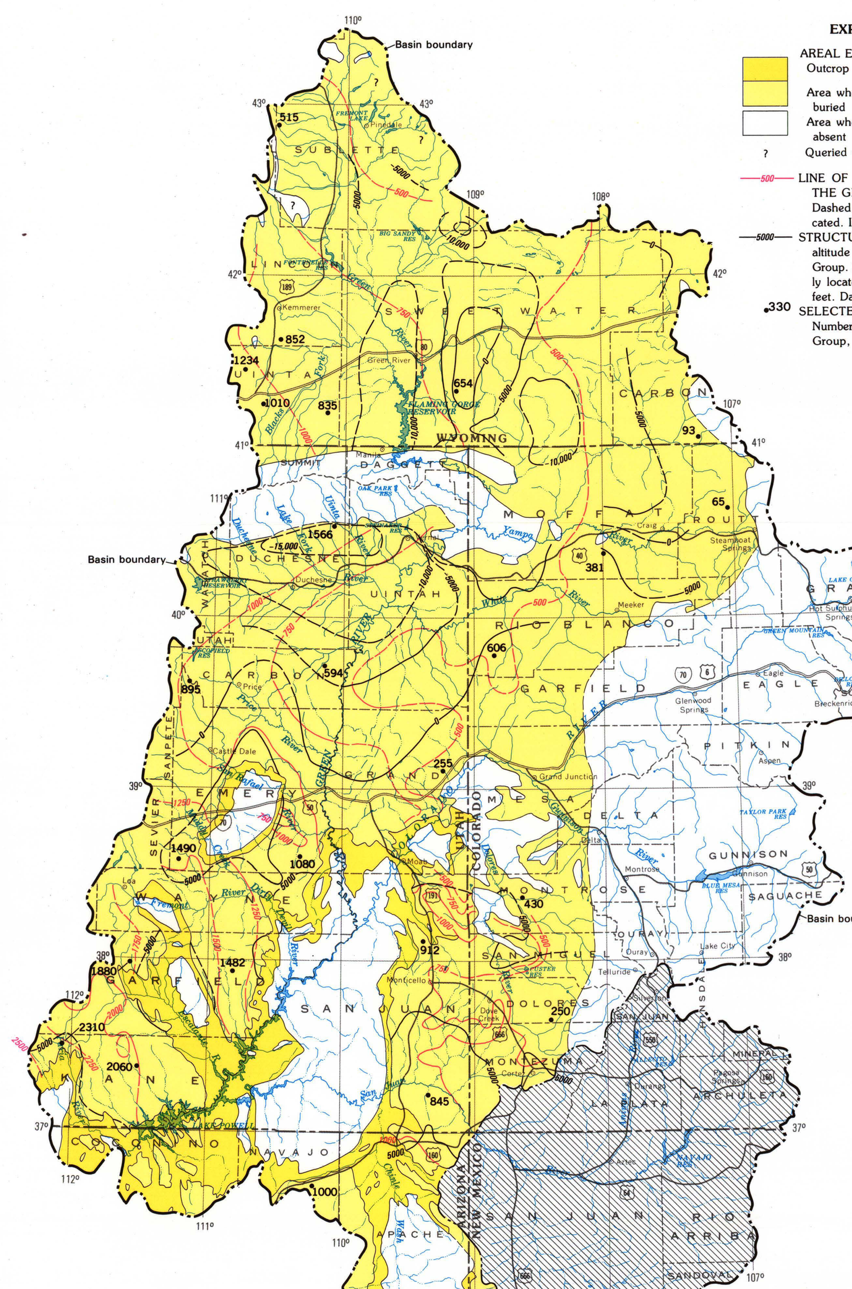

Figure 14.—Areal extent, structure, and thickness of the Glen Canyon Group and equivalent formations

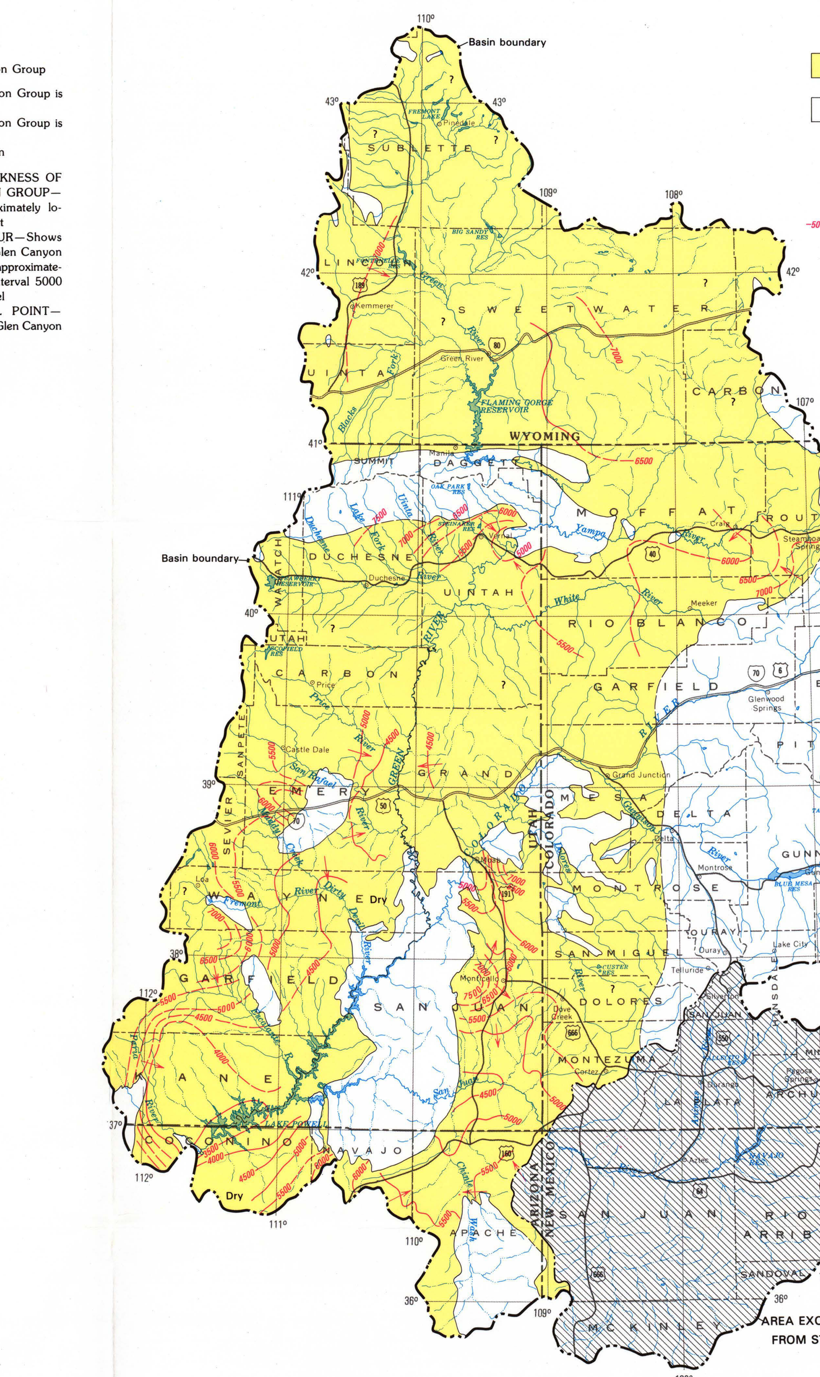

Figure 15.—Ground-water occurrence and movement in the Glen Canyon Group and equivalent formations

MIDDLE HYDROGEOLOGIC AQUIFER UNIT—continued

Glen Canyon Group and equivalent formations

The Glen Canyon Group is the principal aquifer of the middle hydrogeologic unit. It consists of, from youngest to oldest, the Navajo Sandstone, the Kayenta Formation, and the Wingate Sandstone. The Moenave Formation replaces the Wingate Sandstone in the extreme southwestern part of the study area. The Glen Canyon Sandstone is the stratigraphic equivalent to the Glen Canyon Group in northeastern Utah and northwestern Colorado. The Nugget Sandstone occupies the same stratigraphic interval in southwestern Wyoming. The Glen Canyon Group as described above thins eastward and northward from 2,500 feet in the southwest corner of the study area to extinction in western Colorado (fig. 14). Along the western boundary of the study area thicknesses typically are more than 1,200 feet.

Lithologic character of formations that comprise the Glen Canyon Group changes little throughout the study area. The fine- to medium-grained sandstone that characterizes the Nugget Sandstone in Wyoming changes to very fine to fine-grained Glen Canyon Sandstone in the Uinta Basin and to fine-grained Navajo and very fine grained Wingate Sandstone to the south. The fluvial Kayenta Formation is fine- to medium-grained sandstone but includes interbedded mudstone and limestone lenses, hydrostratigraphically similar to the interbedded shales in the Nugget Sandstone.

The Glen Canyon Group was subjected to structural deformation during the Laramide and Sevier Orogenies and is fractured almost everywhere outcrops can be examined. Fracturing is more intense near the margins of uplifted areas where layers are tilted more than 60° from horizontal. Transmissivity of the Navajo Sandstone determined from an aquifer test performed near the southern end of the San Rafael Swell was 1,500 feet squared per day, more than three times larger than the transmissivity of 450 feet squared per day calculated using the average permeability obtained from laboratory analysis of core samples (Hood and Danielson, 1979, p. 36). Because depth of burial in the Uinta, Green River, Washakie, and Great Divide Basins is large, the compaction by overburden probably has closed fractures and decreased permeability that is attributed to fracturing. The potentiometric-surface contours indicate that ground-water movement generally is toward the center of the study area (fig. 15) into the major drains of the region, the Colorado and Green Rivers.

Where exposed the Glen Canyon Group is only partially saturated. Yet the quantity of water stored in the interstitial pores of theses formations is relatively large. If only the areas where the base of formations is within 2,500 feet of land surface are considered and specific yield ranges from 0.05 to 0.10, the approximate quantity of water drainable from storage would range from 600 to 1,200 million acre-feet. However, owing to the sluggish rate of ground-water drainage possible, the feasible quantity of recoverable water in the Glen Canyon Group probably is less than one-tenth of the total in drainable storage. Water quality may impose further limitations on the usable quantity.

UPPER HYDROGEOLOGIC AQUIFER AND CONFINING UNIT

The upper hydrogeologic unit includes all formations of the Cretaceous Period and the Upper Jurassic fine-grained member of the Morrison Formation. The upper hydrogeologic unit extends throughout about 58,000 square miles of the study area and crops out in about 22,000 square miles (fig. 16). Overall, this unit is considered a confining layer but it includes two groups of formations that are significant aquifer systems—the Dakota and Mesaverde. The aquifers are separated by the thick Mancos Shale that is a confining unit. Within the Dakota, the Mesaverde, and even the Mancos are many less areally extensive local aquifers.

The Dakota, Cedar Mountain, Burro Canyon, and equivalent formations comprise an aquifer system at the base of the Cretaceous System. These individual aquifers are thin and discontinuous; they yield water to wells mainly in west-central and southwestern Colorado and in southeastern Utah. Hydraulic conductivities are small where the aquifers are unfractured, owing to their generally fine-grained character. Because aggregate aquifer thickness rarely exceeds 500 feet, except near the western edge of the study area, the transmissive character of the system is controlled by its fracture permeability. Lithologic character of the Dakota Sandstone is relatively consistent compared to other formations in this aquifer system, and the Dakota truncates progressively older formations to the south (Molenaar, 1981, p. 125) locally resulting in a greater areal distribution than underlying formations. The Burro Canyon Formation grades from sandstone and conglomerate to varicolored shale and mudstone, and intertongues with the equally variable Cedar Mountain Formation west of the Colorado River. The Burro Canyon Formation is more than 50 percent sandstone, whereas the Cedar Mountain Formation is typically less than 30 percent sandstone (Craig, 1981, p. 197). The Bear River Formation in Wyoming contains relatively thin sandstone, thick siltstone, and shale strata with minor beds of conglomerate.

The Dakota and Mesaverde aquifer systems are separated stratigraphically by the Mancos Shale—more than 5,000 feet of shale with thin layers of interbedded sandstone. The shale functions mainly as a confining layer between the Dakota and Mesaverde aquifer systems, but includes locally significant sandstone aquifers that were formed by oscillations of the shoreline of the Cretaceous seaway. The Frontier, Ferron, and Emery Sandstone Members represent the most extensive aquifers in the Mancos system, but typically comprise less than 10 percent of the total thickness of an otherwise nearly impermeable unit. Ground-water occurrence and movement in the Dakota aquifer system, the Mancos Shale system, and related formations is illustrated in figure 17.

Figure 16.—Areal extent and thickness of the upper hydrogeologic unit

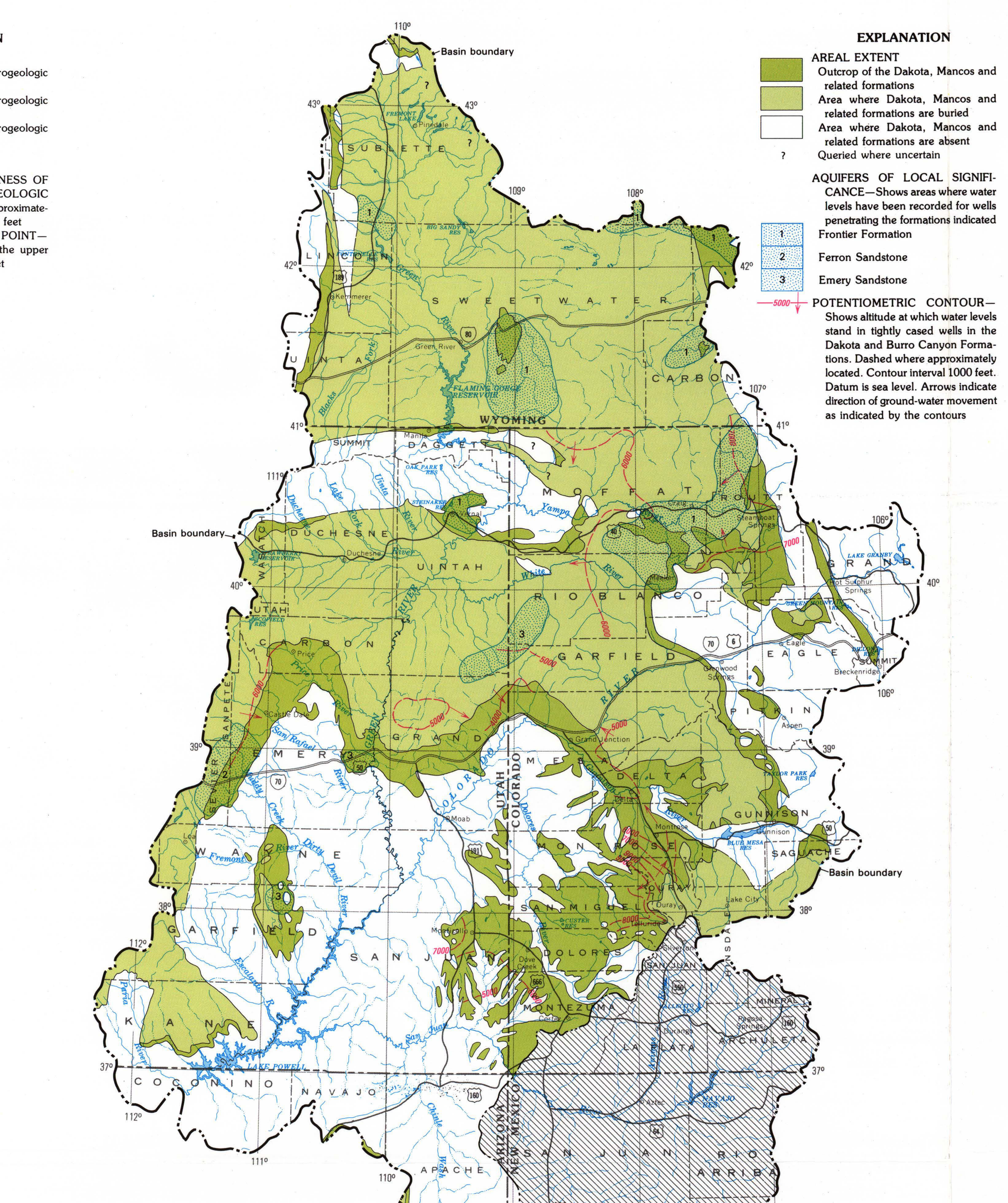

Figure 17.—Ground-water occurrence and movement in the Dakota aquifer system, the Mancos Shale system, and related formations

Table 2.—*Summary of quality of water in aquifers and potential aquifers of Mesozoic age*

The central range is a measure of the spread of values around the geometric mean and contains all values within one geometric deviation of this mean.
Water types: Ca, calcium; Mg, magnesium; Na, sodium; Cl, chloride; SO_4, sulfate; CO_3, alkalinity as $CaCO_3$. Where a single cation or anion is listed, it accounts for greater than 90 percent of the charge. Where two or three ions are listed without parentheses they individually account for 20 to 90 percent of the charge. Where an ion is shown in parentheses it accounts for 5 to 20 percent of the charge, and if an ion is not listed it accounts for less than 5 percent of the charge.

Age	Geologic unit	Major aquifer	Location of samples	Number of values	Dissolved-solids concentration (milligrams per liter): Geometric mean	Central range	Minimum recorded	Maximum recorded	Water types: 1. Minimum concentration 2. Geometric mean 3. Maximum concentration	Comments
Upper Cretaceous	Mesaverde Group	Mesaverde undivided	Tertiary basins of Wyoming, Utah, and Colorado	390	3,590	742-17,401	41	125,000	Ca-Mg-(Na)/CO_3-(SO_4) Na/CO_3-(SO_4)-(Cl) Na/Cl	Mostly oil field samples.
		Almond Formation	Tertiary basins of Wyoming	53	4,880	836-28,500	224	100,000	Na-Ca-Mg/CO_3 Na/Cl-CO_3-(SO_4) Na-(Ca)-(Mg)/SO_4-CO_3-(Cl)	--
		Blackhawk Formation	Primarily Uinta Basin and San Rafael swell	92	304	140-661	40	3,300	Ca-(Mg)-(Na)/CO_3-(SO_4)-(Cl) Ca-Mg/CO_3 Na-Mg-(Ca)/SO_4-(CO_3)	--
		Ericson Formation	Near Green River, Wyoming	10	4,010	517-31,100	325	116,000	Ca-Mg-(Na)/SO_4-CO_3 Na-(Ca)-(Mg)/Cl-CO_3-(SO_4) Na/Cl-(SO_4)	--
		Rock Springs Formation	North of Uinta Mountains in Wyoming	9	2,110	847-5,250	697	9,430	Ca-Mg-(Na)/SO_4-CO_3 Na/CO_3-(SO_4)-(Cl) Na-Mg-(Ca)/SO_4-(CO_3)	--
		Blair Formation	Near Green River, Wyoming	4	2,220	438-11,200	415	11,900	Ca-Mg/SO_4-CO_3 -- Na/Cl	--
		Adaville Formation	Near Kemmerer, Wyoming	2	1,280	--	397	4,106	Na-Ca-(Mg)/CO_3-(SO_4)-(Cl) -- Na-(Ca)/Cl-(SO_4)-(CO_3)	--
		Castlegate Sandstone	Wasatch Plateau to Uinta Basin, Utah	27	673	85-4,790	141	73,500	Ca-(Mg)-(Na)/ Ca-Mg/SO_4-CO_3 Na/Cl	--
		Price River Formation	Primarily Uinta Basin and San Rafael swell	53	267	134-535	50	1,640	Ca-Mg-(Na)/CO_3-(SO_4)-(Cl) Ca-(Mg)-(Na)/SO_4-CO_3-(Cl) Na/CO_3-(Cl)	--
		Upper map unit summary	See upper unit map	446	1,160	281-4,790	40	65,100	Na-(Ca)-(Mg)/SO_4-CO_3 Na/CO_3 Na/Cl	--
	Mancos Shale members and equivalents	Mancos Shale undivided	Widely present in Wyoming, Utah and Colorado	98	2,340	410-13,400	52	28,300	Ca-(Mg)-(Na)/CO_3-(SO_4) Na-Mg-(Ca)/SO_4-(CO_3) Na/Cl	Samples tend toward fresh-water.
		Frontier Sandstone Member	Green River Basin, Wyoming, and the Uinta Basin, Utah	118	7,540	1,960-29,000	187	78,200	Ca-(Mg)/CO_3-(SO_4) Na/Cl-(CO_3) Na-Ca/Cl	Mostly oil field samples.
		Emery Sandstone Member	Near Wasatch Plateau, Utah	8	1,820	869-3,790	759	8,830	Ca-Mg-(Na)/SO_4-CO_3 Na-Ca-Mg/SO_4-(CO_3) Na-Mg-(Ca)/SO_4-(CO_3)	--
		Ferron Sandstone Member	Near Wasatch Plateau, Utah	73	1,710	657-4,470	291	23,200	Ca-(Mg)-(Na)/SO_4-(CO_3) Ca-Mg-(Na)/SO_4-(CO_3) Na-Ca/SO_4-(Cl)	--
Lower Cretaceous	Dakota and Cedar Mountain Formations or equivalents	Bear River Formation	Near Kemmerer, Wyoming	3	294	--	283	505	Ca-(Mg)-(Na)/CO_3-(SO_4) -- Ca-(Mg)-(Na)/SO_4-CO_3-(Cl)	--
		Cloverly Formation	Mostly in Wyoming basins	44	6,190	2,350-16,300	1,100	89,700	Na/CO_3-(Cl) Na/Cl-(CO_3) Na-(Ca)-(Mg)/Cl	--
		Dakota Sandstone	Sampled in many areas of Wyoming, Utah	99	1,430	315-6,441	28	27,900	Ca-(Mg)-(Na)/SO_4-CO_3-Cl Ca-Mg-(Na)/Cl-SO_4-(CO_3) Na/Cl	--
		Burro Canyon Formation	Southeast Utah and Southwest Colorado	13	324	141-744	69	1,140	Ca-(Mg)-(Na)/CO_3-(SO_4) Na-Ca-(Mg)/CO_3-(SO_4) Na-Mg-(Ca)/SO_4-CO_3-(Cl)	--
Upper Jurassic	Members of the Morrison Formation	Morrison Formation undivided	Sampled in many areas of Wyoming, Utah, and Colorado	164	5,160	1,340-19,900	142	96,500	Ca-(Mg)/CO_3 Na/Cl-(SO_4)-(CO_3) Na-(Ca)/Cl	--
		Brushy Basin Shale Member	West and Southwest Colorado, East and Southeast Utah	13	726	246-2,150	129	4,040	Ca-(Mg)-(Na)/CO_3-(SO_4) --/SO_4-CO_3-(Cl) Na/SO_4-CO_3-(Cl)	--
		Westwater Canyon Sandstone Member	Southern Utah, northern Arizona and New Mexico	2	428	--	191	960	Na-Ca/CO_3-(SO_4) -- Na-(Ca)-(Mg)/CO_3-(SO_4)-(Cl)	--
		Recapture Shale Member	Southeast Utah	4	267	--	216	429	Na-Mg-(Ca)/CO_3-(SO_4) -- Na-Ca-(Mg)/SO_4-CO_3-(Cl)	--
		Salt Wash Sandstone Member	Southern Utah	14	541	264-1,110	267	2,250	Na-Mg-Ca/CO_3-(SO_4) Na-(Ca)-(Mg)/SO_4-CO_3-(Cl) Na-Ca-(Mg)/SO_4-(CO_3)-(Cl)	--
	Members of the San Rafael Group and equivalents	Sundance Formation	Basins of Wyoming	67	7,450	2,800-19,800	1,060	102,000	Na/CO_3-(SO_4) Na/Cl-CO_3-(SO_4) Na-(Ca)/Cl	--
		Bluff Sandstone	Southeast Utah	1	1,270	--	--	--	-- Na-Ca-(Mg)/CO_3-(SO_4) --	Part of middle hydrogeologic unit.
		Cow Springs Sandstone	Northern Arizona	6	3,110	2,160-4,480	2,090	4,780	Na-(Mg)-(Ca)/SO_4-(CO_3) Ca-Na-Mg/SO_4-(CO_3) Na-(Ca)-(Mg)/SO_4	--
		Junction Creek Sandstone	Southeast Utah and southwest Colorado	2	485	--	485	485	-- Na-Ca-(Mg)/CO_3-(SO_4)-(Cl) --	Part of middle Mesozoic map unit.
Middle Jurassic		Summerville Formation	Eastern Utah Northeastern Arizona	5	1,220	292-5,070	262	5,440	Na-Ca-(Mg)/CO_3-(SO_4) Na/Cl-SO_4-(CO_3) Na-(Ca)-(Mg)/Cl-(SO_4)-(CO_3)	--
		Entrada Sandstone	Central and southern Utah	94	2,190	274-17,500	136	113,000	Ca-(Mg)-(Na)/CO_3 Mg-Na-(Ca)/SO_4-(CO_3) Na-(Ca)/Cl	About 20 percent of middle map unit.
		Carmel Formation	South central Utah	27	2,250	786-6,430	268	14,300	Ca-Mg-(Na)/CO_3-(SO_4)-(Cl) Ca-Mg/SO_4-(CO_3) Na-(Ca)-(Mg)/Cl-SO_4	Some samples are in middle map unit.
		San Rafael Group undivided	Samples in Utah, Wyoming, and Colorado	11	4,510	1,010-20,100	272	64,000	Na-(Ca)-(Mg)/CO_3-(SO_4) Na-(Ca)/Cl-CO_3 Na/Cl	--
Upper Triassic/Lower Jurassic	Glen Canyon Group and equivalents	Nugget Sandstone	Mostly in Green River Basin, Wyoming	127	20,400	4,770-87,500	198	138,000	Ca-(Mg)-(Na)/CO_3 Na/Cl-SO_4-(CO_3) Ca-(Na)/Cl	About 11 percent of middle map unit.
		Glen Canyon Sandstone	Central Utah	3	1,590	--	692	3,650	Ca-Mg-(Na)/SO_4-CO_3 -- Ca-Mg-(Na)/SO_4-(CO_3)-(Cl)	In middle map unit.
		Navajo Sandstone	Mostly in southern Utah and northern Arizona	272	499	166-1,500	103	70,800	Ca-(Mg)/CO_3-(SO_4) Na/SO_4-CO_3-(Cl) Na/Cl	About 47 percent of middle map unit.
		Kayenta Formation	Central and southern Utah	5	709	69-7,270	144	41,700	Ca-Mg-(Na)/CO_3-(SO_4)-(Cl) Na-Ca-(Mg)/CO_3-(SO_4)-(Cl) Na/Cl	Part of the middle map unit.
		Wingate Sandstone	Central and southern Utah and northern Arizona	47	480	225-1,030	133	4,250	Ca-Mg-Na/CO_3-(SO_4)-(Cl) Na-Ca-(Mg)/CO_3-(SO_4)-(Cl) Ca-Mg-(Na)/SO_4	Part of middle map unit.
		Moenave Formation	Northern Arizona	3	214	--	152	302	Na-Ca-Mg/CO_3-(SO_4)-(Cl) -- Na-Ca-(Mg)/CO_3-(SO_4)-(Cl)	Part of middle map unit.
		Middle map unit summary	See figure 19.	341	916	169-4,950	103	113,000	Ca-(Mg)/CO_3-(SO_4) Ca-Mg-(Na)/SO_4-CO_3 Na-(Ca)/Cl	Several values represent mean values at site.
Upper Triassic	Members of the Chinle Formation or equivalents	Chinle Formation undivided	Central Utah and northern Arizona	15	799	391-1,630	260	2,250	Ca-(Mg)/CO_3 Ca-Mg-(Na)/SO_4-CO_3 Ca-Mg-Na/SO_4-(CO_3)	--
		Mossback Member	Central Utah	1	4,980	--	--	--	-- Na/CO_3-SO_4-(Cl) --	--
		Shinarump Member	Northeast, central and southern Utah and Arizona	62	1,070	181-6,350	94	172,000	Ca-Mg-(Na)/SO_4-CO_3-Cl Na/CO_3-(SO_4)-(Cl) Na-(Ca)/Cl	--
Lower Triassic	Thaynes Formation or Moenkopi Formation members and equivalents	Thaynes Formation	Wyoming and north-east Utah	2	390	--	390	17,100	Ca-Mg/SO_4-(CO_3) -- Na-(Ca)-(Mg)/Cl-SO_4	--
		Moenkopi Formation	Central Utah and northern Arizona	15	3,520	1,280-9,640	336	15,300	Ca-Mg-(Na)/SO_4-CO_3-(Cl) Ca-Mg-(Na)/SO_4-(CO_3) Na/Cl-CO_3	--
		Sinbad Limestone Member	Central Utah	3	2,670	--	1,990	4,440	Mg-Ca-(Na)/SO_4-(CO_3) -- Na/Cl-SO_4-(CO_3)	--

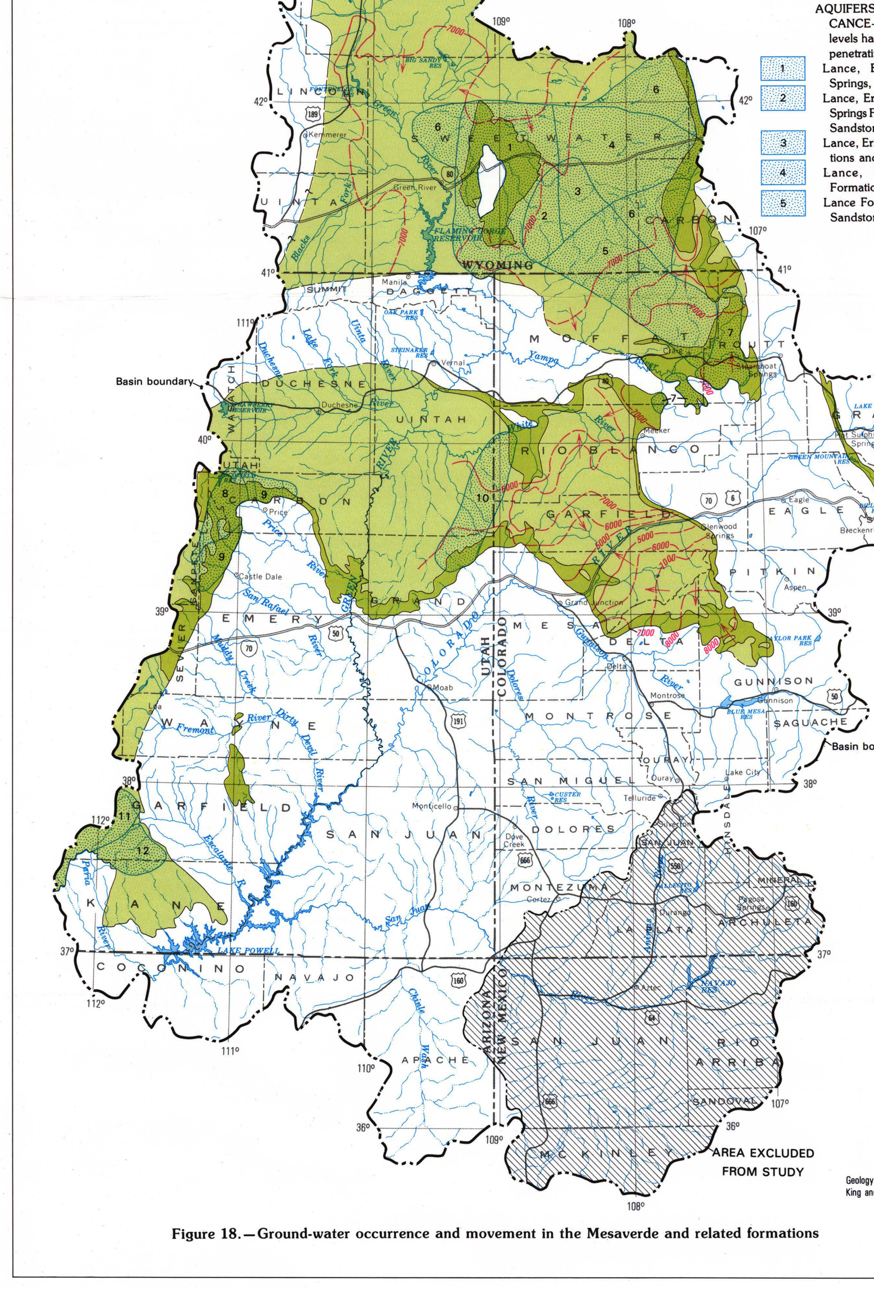

Figure 18.—Ground-water occurrence and movement in the Mesaverde and related formations

The Mesaverde Group and all younger Mesozoic formations, the uppermost aquifer system in the upper hydrogeologic unit, is continuous throughout west-central and northwestern Colorado, northeastern and central Utah and southwestern Wyoming; it is more irregularly distributed in southern Utah, southern Colorado, and Arizona (fig. 18). The Mesaverde includes formations of various lithologic types, sandstone being predominant. Lateral and vertical changes in lithologic type, and thus in hydrologic properties, are common owing to sporadic transgressions and regressions of the Upper Cretaceous shoreline. Primary hydraulic conductivity is typically less than 1 foot per day. Fracturing, however, increases the value one or two orders of magnitude. This is based on differences between core permeabilities and hydraulic conductivities estimated from specific capacities of wells that are completed in the aquifers.

QUALITY OF GROUND WATER

Data used to summarize the water quality of the Mesozoic aquifers come from the WATSTORE files of the U.S. Geological Survey, the Brine File of Petroleum Data Services, and from published reports. Chemical analyses in the WATSTORE file generally are for water samples collected from water wells. Chemical analyses in the Brine File are for water and brine samples collected by petroleum companies, usually during drill-stem tests of oil wells. In the data summary (table 2) that follows, the files have been combined despite their biases. The two files represent the extremes of the water-quality spectrum in the Mesozoic aquifers. Both files contain codes that identify the formation from which the sample was collected; however, the two files do not have the same codes. Information on sample age and sample formation from the brine file was evaluated to assign a code that corresponded to the standard Geological Survey unit codes. The summary of basic information about each of the aquifer units includes summary statistics of dissolved-solids concentrations and a summary of the water types.

Geochemical data usually contain a few values that are much larger than the majority of the other values. Miesch (1967) suggested that the best estimate of a central value for geochemical data is given by a geometric mean rather than an arithmetic mean. The arithmetic mean is too biased by a few extreme values. The summary statistics were calculated from the data after transforming the values to logarithms, making the values fit a more normal distribution. The mean of log-transformed data is the geometric mean. One measure of the spread of the values around the geometric mean is called the central range. This range contains 67 percent of the analyses, or those analyses within one geometric deviation of the geometric mean. Because these data come from two contrasting files, the central range may be larger than it would be if there were a more complete sampling of dissolved-solids concentrations of water in the formations. The central range is reported for those groups that have at least five analyses. The minimum and maximum values for each of the groups also are given in table 2. These can be compared to the central range to see if they are extreme values.

The classifications of water types in this atlas are after Eugster and Hardie (1978). Because of the extreme range of dissolved-solids concentrations in formation water and the presence of brines, this classification allows the necessary latitude to describe in detail existing water types.

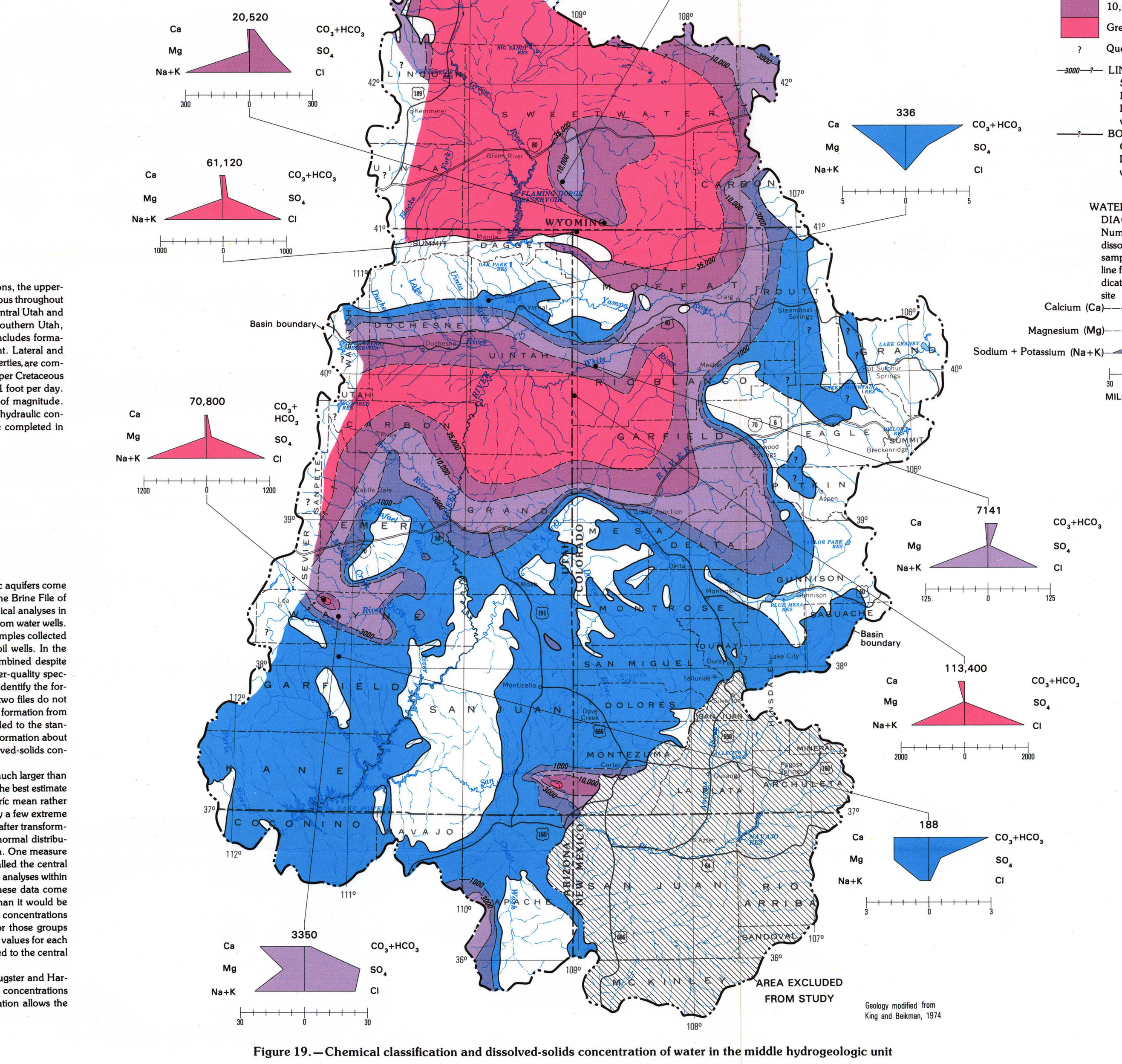

Figure 19.—Chemical classification and dissolved-solids concentration of water in the middle hydrogeologic unit

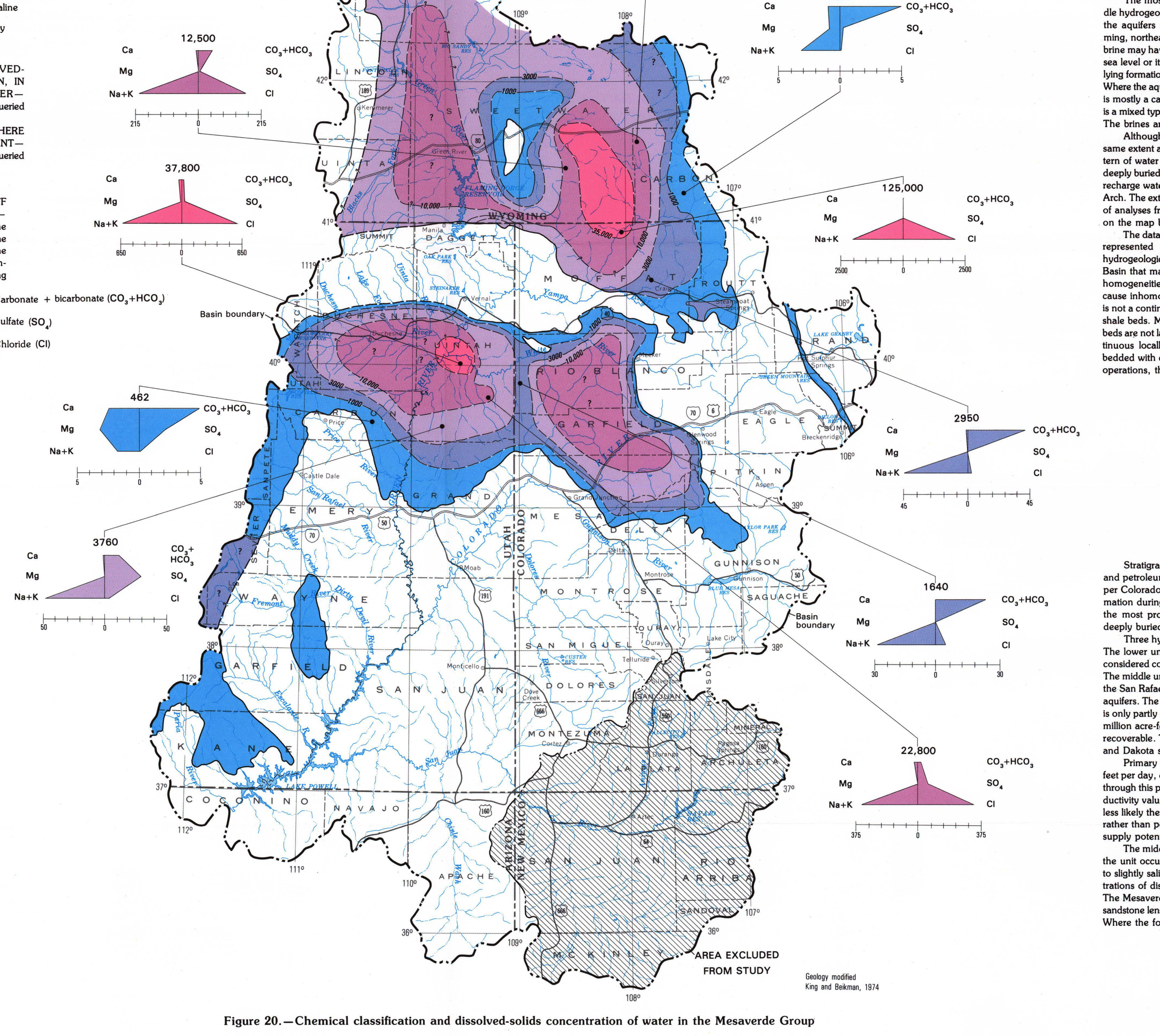

Figure 20.—Chemical classification and dissolved-solids concentration of water in the Mesaverde Group

Water-quality maps for the middle hydrogeologic unit and for the Mesaverde Group are shown in figures 19 and 20. Usually, areal transitions from freshwater to brine are gradual, and several intermediate water types are present. The changes in water quality from fresh to briny are shown by diagrammatic patterns for samples from selected wells.

The most important factor determining the quality of water in the middle hydrogeologic unit seems to be the depth of burial of the aquifers. Where the aquifers are deeply buried under Tertiary sedimentary rocks in Wyoming, northeastern Utah, and northwestern Colorado the water is briny. This brine may have been trapped in the formations when they were buried below sea level or it may have migrated into the aquifers from overlying or underlying formations containing considerable quantities of readily soluble minerals. Where the aquifers are near the surface they contain freshwater. The freshwater is mostly a calcium bicarbonate type. The water that is slightly to very saline is a mixed type of calcium, magnesium, sodium, sulfate, and bicarbonate ions. The brines are dominantly sodium chloride waters.

Although the Mesaverde Group does not appear to contain brine to the same extent as the aquifers in the middle hydrogeologic unit, the general pattern of water quality is the same. The brine occurs where the Mesaverde is deeply buried under the Tertiary sedimentary rocks. There is addition of fresh recharge water near the Rock Springs Uplift, and also at the Douglas Creek Arch. The extent of the brine is not certain, because there are a limited number of analyses from which to delineate the brine. This uncertainty is indicated on the map by question marks.

The data in both figures 19 and 20 may give the impression that the units represented are continuous throughout the study area. This middle hydrogeologic unit is one of the few aquifer units in the Upper Colorado River Basin that may be a homogeneous "sheet" of sand. Even so, there are inhomogeneities and in many cases, breaks in the continuity of the unit that cause inhomogeneities in the ground-water quality. The Mesaverde Group is not a continuous aquifer, but instead consists of alternating sandstone and shale beds. Most of the water samples are from the sandstone beds. These beds are not laterally continuous throughout large regional areas, but are continuous locally and are important sources of water. They also are interbedded with coal, and thus usually are considered in planning of coal-mine operations, that could affect the ground-water quality.

SUMMARY

Stratigraphic, hydraulic, and water-level data obtained from water-well and petroleum test-hole records indicate that the Mesozoic rocks in the Upper Colorado River Basin include many potential aquifers. Structural deformation during late Mesozoic and early Cenozoic time caused large parts of the most productive aquifers to be removed by erosion; other parts are deeply buried by younger deposits.

Three hydrogeologic units, defined in an earlier report, include aquifers. The lower unit consists of the Moenkopi and Chinle Formations. They are considered confining units, but include locally significant water-yielding strata. The middle unit consists of, from oldest to youngest, the Glen Canyon Group, the San Rafael Group, and the Morrison Formation; all containing sandstone aquifers. The Glen Canyon Group, an aquifer system of regional significance, is only partly saturated where it crops out. It may contain from 600 to 1,200 million acre-feet of drainable water in storage, but only a fraction is feasibly recoverable. The upper unit consists of two aquifers systems, the Mesaverde and Dakota systems, separated by a confining system, the Mancos Shale.

Primary hydraulic-conductivity values are characteristically less than 10 feet per day, even for the most productive aquifers; making water movement through this porous media extremely slow. Fracturing increases hydraulic conductivity values near land surface; however, the thicker the overburden, the less likely the effect of this secondary permeability factor. The large volume rather than permeability of saturated rock accounts for the favorable water-supply potential of the Mesozoic age formations.

The middle hydrogeologic unit contains water of varying quality. Where the unit occurs near the surface or only at shallow depths it contains fresh to slightly saline water. Where deeply buried it contains water with concentrations of dissolved solids greater than 35,000 milligrams per liter (brine). The Mesaverde Group also contains water of varying quality; however, the sandstone lenses that contain usable water supplies are only locally continuous. Where the formation is deeply buried, it contains brine.

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Base from U.S. Geological Survey
United States base map 1:2,500,000

SCALE 1:2,500,000
50 0 50 100 150 200 250 MILES
50 0 50 100 150 200 250 KILOMETERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1988

GENERAL HYDROGEOLOGY OF THE AQUIFERS OF MESOZOIC AGE, UPPER COLORADO RIVER BASIN— EXCLUDING THE SAN JUAN BASIN—COLORADO, UTAH, WYOMING, AND ARIZONA

By
Geoffrey W. Freethey, Briant A. Kimball, Dale E. Wilberg, and James W. Hood
1988