PREPARED IN COOPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY

ARIZONA DEPARTMENT OF WATER RESOURCES

DEPTH TO WATER AND ALTITUDE OF THE WATER LEVEL, QUALITY OF WATER, AND HYDROGRAPHS OF SELECTED WELLS

INDEX MAP SHOWING AREA OF REPORT (SHADED)

INTRODUCTION

The San Bernardino Valley basin lies in the extreme southeastern corner of Arizona in Cochise County, and encompasses 387 square miles in Arizona. Included in the study area is 35 square miles of surface-water drainage in southwestern New Mexico. The hydrologic basin extends southward and includes as much as 400 square miles within the Republic of Mexico. For purposes of this report, the southern boundary of the basin is defined as the United States-Mexico international border. The basin is bounded on the east by the Peloncillo Mountains, on the west by the Perilla and Pedregosa Mountains, and on the north by the Chiricahua Mountains and the southern part of the San Simon Valley sub-basin. There are no incorporated cities or towns within the basin.

The San Bernardino Valley basin is an elongated, gently-sloping valley situated between parallel mountain ranges. The basin is 18 miles wide at the international border and approximately 21 miles long from the southern end of the San Simon Valley sub-basin to the international border. The average topographic gradient along the length of the valley floor is 49 feet per mile and slopes to the south. Land-surface altitudes within the basin range from 3,715 feet on the valley floor at the international border to 6,410 feet in the Pedregosa Mountains. Black Draw, the primary stream in the San Bernardino Valley basin, flows southward into Mexico where it is known as the Rio San Bernardino. The draw is ephemeral over its entire length in the basin, except in the area of the U.S. Fish and Wildlife Refuge where it is perennial due to springs and unregulated flowing wells. Tributaries to Black Draw include Mulberry Draw, Silver Creek, and Cottonwood Draw.

The semiarid climate in the San Bernardino Valley basin is typical of that in southeast Arizona, with mild winters and hot summers. Although there are no temperature recording stations within the basin, there are stations at Douglas, approximately 10 miles to the east, and at Apache, 6 miles north of the basin's northern boundary. Average daily maximum temperatures during June, the hottest month, range from 95°F at Douglas to 87°F at Apache. Average daily minimum temperatures during December, the coldest month, range from 28°F to 26°F, respectively. Average annual precipitation ranges from 13 inches measured at a rain gage in sec. 18, T.23S., R.31E., to 18 inches at Apache (Sellers and others, 1985, p. 88-93, 112-115). Nearly half of the annual rainfall occurs during the months of July and August as a result of moist tropical air from the eastern Pacific Ocean creating intense, short-duration thunderstorms.

Vegetation within the basin includes palo verde, mesquite, manzanita, creosote, agave, cacti, and warm season grasses, such as grama. Pinyon, juniper, and oak trees grow in the higher elevations of the surrounding mountains. Near the center of the southern end of the San Bernardino Valley lies a lush grassy oasis of cottonwoods, willows, small lakes, and several springs known as the San Bernardino Ranch, or Slaughter Ranch. The plentiful water here has made the area an important stopover for Indians, cross-country travelers, and soldiers since the late 1600's. This marshy area was once a part of the 73,240-acre San Bernardino Land Grant awarded to Ignacio Perez in 1822 by the Mexican government. In 1853, approximately one-fourth of the land grant was annexed to the United States under the Gadsden Purchase. John Slaughter, Cochise County sheriff and cattle rancher, purchased the entire land grant in 1884 and developed the land (Gregor, 1958, p.37). Today, the San Bernardino Ranch consists of 300 acres with a museum. Located directly east of the present San Bernardino Ranch, on part of the original land grant, is a 2,309-acre U.S. Fish and Wildlife Refuge for endangered fish.

Cattle ranching has been the primary industry in the San Bernardino Valley since 1822. However, approximately 300 acres of land was cultivated and irrigated in the early 1950's (U.S. Geological Survey, 1976, p. 59). In 1991, 100 to 200 acres just south of the international border was observed to be under irrigation from wells (M. Magoffin, U.S. Fish and Wildlife Refuge, Douglas, Arizona, oral commun., 1991). Continued irrigation of this farmland may result in a lowering of the water surface in wells north of the border. The U.S. Geological Survey estimates that 100 acre-feet of groundwater per year is pumped from the Arizona portion of the San Bernardino Valley basin, all of which is used for domestic and stock purposes (Alice Konieczki, U.S. Geological Survey, Tucson, Arizona, oral commun., 1991).

HYDROGEOLOGY

The San Bernardino Valley basin was formed during a period of extensional tectonics and vertical faulting from about 15 million years ago to the present. Movement along high-angle normal faults that lie along the basin margins produced the north-south trending basin and the paralleling mountain ranges. At least one of these faults on the eastern edge of the basin, in Sonora, Mexico, exhibited activity as recently as 1887 (Sumner, 1977, p. 1219). The mountains surrounding the San Bernardino Valley basin are composed primarily of Cretaceous and Tertiary andesitic and rhyolitic volcanics. Outcrops of Cretaceous and Paleozoic sedimentary rocks occur in the Perilla Mountains, the southern end of the Chiricahua Mountains, the northern Pedregosa Mountains, and the southeastern corner of the valley floor in Arizona (Drewes, 1980, sheet 1).

Over half of the basin floor is covered by basalt flows. Several episodes of volcanism have occurred. Radiometric dates of rocks range from 3.3 million years old in a lava flow on the western flank of the basin, to 274,000 years old in a flow near the center of the basin (Lynch, 1978, p. 266). The log from an 809-foot deep well in sec. 13, T.22S., R.30E., revealed layering of at least four basalt flows separated by basin-fill sediments of sand and clay. Total thickness of the basalt flows decreases to the south. Well-log data revealed an 8-foot interval of basalt in a 100-foot deep well in sec. 16, T.24S., R.30E., and no basalt present in a 580-foot well about 2 miles east, in sec. 14. Another well, in sec. 2, T.24S., R.31E., also revealed no basalt, but penetrated 5,679 feet of Paleozoic strata, starting in Permian limestone and bottoming in Cambrian quartzite. Data from well-construction logs are insufficient to compare lithological characteristics such as particle size, percentage, and degree of consolidation of the basin-fill sediments. A thin layer of alluvium covers the basalt flows around the southern and western margins of the basin (Lynch, 1973, p. 13).

Each lava flow that occurs interbedded within the basin fill has the potential of acting locally as an aquifer or a confining layer, depending on the extent of fracturing and these flows are likely hydraulically connected to some degree. This interconnection creates the effect of a single aquifer system, and water-level altitudes are contoured as such on map 2. Depths to water measured in 1990 and 1991 ranged from 798 feet below land surface at the northern end of the basin to 24 feet below land surface in the southern end of the basin. Flowing wells are present in the area of the San Bernardino Ranch and the U.S. Fish and Wildlife Refuge near the international border. Hydraulic head measured in February 1992 on four of the flowing wells ranged from 3 to 42 feet above land surface.

Groundwater also occurs in the surrounding mountains within zones of fractured or weathered volcanics, in isolated blocks of sedimentary rocks, and in thin layers of alluvial deposits overlying the bedrock. Differences in elevation suggest these zones are not hydraulically connected to the basin aquifer. Depths to water measured in 1990 ranged from 293 feet below land surface to 8 feet below land surface.

Infiltration of mountain-front runoff is the major source of groundwater recharge in the San Bernardino Valley basin. There is also an unknown amount of inflow to the basin from the San Simon Valley sub-basin located to the north. The shapes of water-level altitude contours suggest that groundwater flows from the mountain fronts and the San Simon Valley sub-basin toward the basin center and then flows south.

WATER-LEVEL CHANGES

While few in number, water-level measurements from wells in the San Bernardino Valley basin date to the early 1950's. Wells having more than three recorded water levels are shown in hydrographs A through C. The data presented reflect no trend in water levels over the past 40 years. Hydrographs B and C show a slight decline in water levels between 1968 and 1976; these are 9 feet and 11 feet, respectively.

WATER QUALITY

Groundwater within the San Bernardino Valley basin is of suitable quality for domestic and stock purposes. Water samples from 31 wells within the basin were incorporated for this study. Of these samples, 16 had detailed inorganic mineral and trace metal analyses performed and the remainder were analyzed for fluoride concentration and specific conductance only. Water temperatures were measured at the time of collection.

The maximum contaminant level (MCL) for fluoride in Arizona public drinking water is 4.0 mg/L, as established by the U.S. Environmental Protection Agency (1986, p. 11396-11397) and the Arizona Department of Environmental Quality (1989, p. 7). The MCL is an enforceable standard set by the U.S. Environmental Protection Agency for drinking water. States must comply with this standard, but are free to set levels which are more stringent. Fluoride concentrations in the collected water samples ranged from 0.1 to 3.0 mg/L.

Specific-conductance values ranged from 300 to 1,800 microsiemens per centimeter at 25°C (uS/cm). Dissolved-solids concentrations may be approximated by multiplying specific-conductance values by 0.6, which is the approximate ratio of dissolved solids in milligrams per liter (mg/L) to specific conductance in uS/cm. The U.S. Environmental Protection Agency has established the secondary maximum contaminant level (SMCL) for total dissolved solids at 500 milligrams per liter (mg/L), which is approximately equivalent to 833 uS/cm. SCML's are guidelines only, and are not enforceable standards (U.S. Environmental Protection Agency, 1988, p. 9). SCML's are based on aesthetic qualities of water, such as taste, odor, and color. Water with contaminant levels above the SCML are not necessarily a health risk. Six of the water samples exceeded the SMCL for dissolved solids. Two of the six samples exceeding the SMCL for dissolved solids were from wells completed in the Cretaceous sedimentary rocks of the Perilla Mountains. The other four samples were collected from wells in the southern portion of the basin, near outcrops of Paleozoic sedimentary rocks, predominately limestone. Concentrations of all other major ions analyzed were below MCL and SMCL levels. Water temperatures ranged from 21°C to 32°C.

SELECTED BIBLIOGRAPHY

Anderson, T.W., Freethey, G.W., and Tucci, Patrick, 1990, Geohydrology and water resources of alluvial basins in south-central Arizona and parts of adjacent states: U.S. Geological Survey Open-File Report 89-378, 87 p.

Arizona Department of Environmental Quality, 1989, Public and semi-public water supply systems rules, State of Arizona: Department of Environmental Quality, Phoenix, Arizona, 44 p.

Cooper, J.R., 1959, Reconnaissance geologic map of southeastern Cochise County, Arizona: U.S. Geological Survey Mineral Investigations Field Studies Map MF-213, 1 sheet.

Drewes, Harald, 1980, Tectonic map of southeast Arizona: U.S. Geological Survey Map I-109, 2 sheets.

Gregor, K., 1958, The waters of the San Bernardino: Arizona Highways, Phoenix, Arizona, vol.34, no.4, p. 36-38.

Longsworth, S.A., 1991, Geohydrology and chemical quality of ground water, San Bernardino National Wildlife Refuge, Arizona: U. S. Geological Survey Water-Resources Investigations Report 90-4190, 26 p.

Lynch, D.J., 1973, Reconnaissance geology of the Bernardino volcanic field, Cochise County, Arizona. M.S. thesis: University of Arizona, Tucson, 101 p.

_____, 1978, The San Bernardino volcanic field of southeastern Arizona, in Callender, J.F., Wilt, J.C., and Clemons, R.E., eds., Land of Cochise: New Mexico Geologic Guidebook, 29th Field Conference, [Socorro], New Mexico Geological Society, p. 261-268.

Pool, D.R., 1985, Aquifer geology of alluvial basins of Arizona, in Anderson, T.W., and Johnson, A.I., eds., Regional aquifer systems of the United States, southwest alluvial basins of Arizona: American Water Resources Association Monograph, Series 7, p. 25-36.

Sellers, W.D., Hill, R.H., and Sanderson-Rae, Margaret, 1985, Arizona climate, the first hundred years, 1885-1985: Institute of Atmospheric Physics, University of Arizona, 143 p.

Shafiqullah, M., Damon, P.E., Lynch, D.J., Kuck, P.H., and Rehrig, W.A., 1978, Mid-Tertiary magmatism in southeastern Arizona, in Callender, J.F., Wilt, J.C., and Clemons, R.E., eds., Land of Cochise: New Mexico Geologic Guidebook, 29th Field Conference, [Socorro], New Mexico Geological Society, p. 231-241.

Sumner, J.R., 1977, The Sonora earthquake of 1887: Bulletin of the Seismological Society of America, vol. 67, no. 4, p. 1219-1223.

U.S. Environmental Protection Agency, 1986, National primary and secondary drinking water regulations; fluoride; final rule: Washington, Federal Register, v. 51, no. 63, p. 11396-11397.

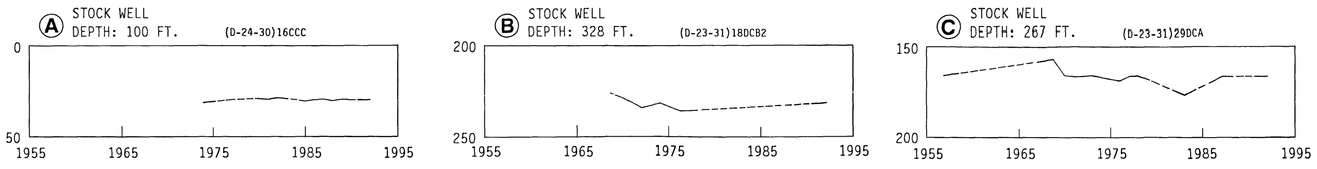
U.S. Geological Survey, 1976, Summary of hydrologic conditions along the United States-Mexico international boundary from the Pacific Ocean to El Paso, Texas: U.S. Geological Survey admin. report, p. 59-61.

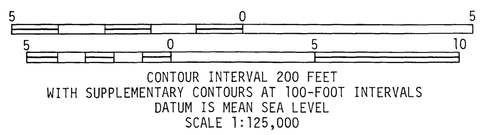
Wilson, R.P., 1976, Maps showing ground-water conditions in the San Bernardino Valley area, Cochise County, Arizona - 1975: U.S. Geological Survey Water-Resources Investigations Report 76-81, 2 sheets.

For readers who prefer to use metric units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
inch	25.4	millimeter
foot	0.3048	meter
mile	1.609	kilometer
square mile	2.590	square kilometer
acre	0.4047	square hectometer
acre-foot	0.001233	cubic hectometer
gallons per minute	0.06309	liters per second

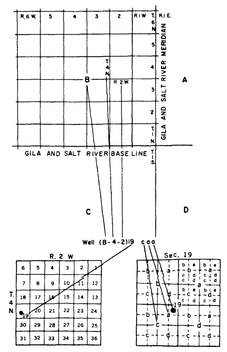
HYDROGRAPHS OF THE WATER LEVEL IN SELECTED WELLS SHOWN ON THE MAP
(Dashed line indicates inferred water level)





CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100-FOOT INTERVALS
DATUM IS MEAN SEA LEVEL
SCALE 1:125,000

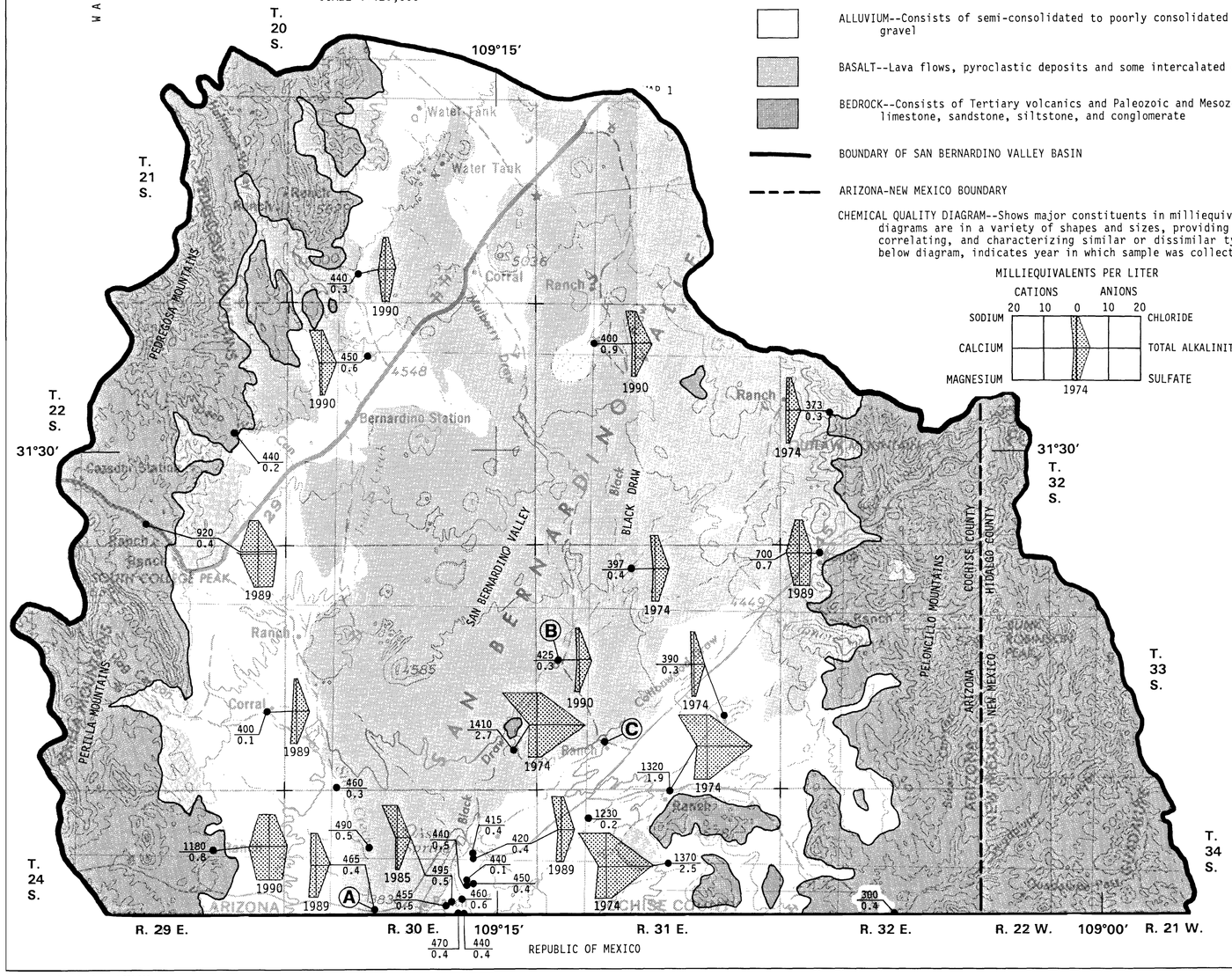
The well numbers used by the Department of Water Resources are in accordance with the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River meridian and base line, which divide the state into four quadrants. These quadrants are designated counter-clockwise by the capital letters A, B, C, and D. All land north and east of the point of origin is in A quadrant, that north and west in B quadrant, that south and west in C quadrant, and that south and east in D quadrant. The first digit of a well number indicates the township, the second the range, and the third the section in which the well is situated. The lowercase letters, a, b, c, and d, after the section number, indicate the well location within the section. The first letter denotes a particular 160-acre tract, the second the 40-acre tract, and the third the 10-acre tract. These letters also are assigned in a counter-clockwise direction, beginning in the northeast quarter. If the location is known within the 10-acre tract, three lowercase letters are shown in the well number. In the example shown, well number (B-4-2)19caa designates the well as being in the NE¼NE¼SW¼ sec. 19, T. 4N., R. 2W. Where more than one well is within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes.

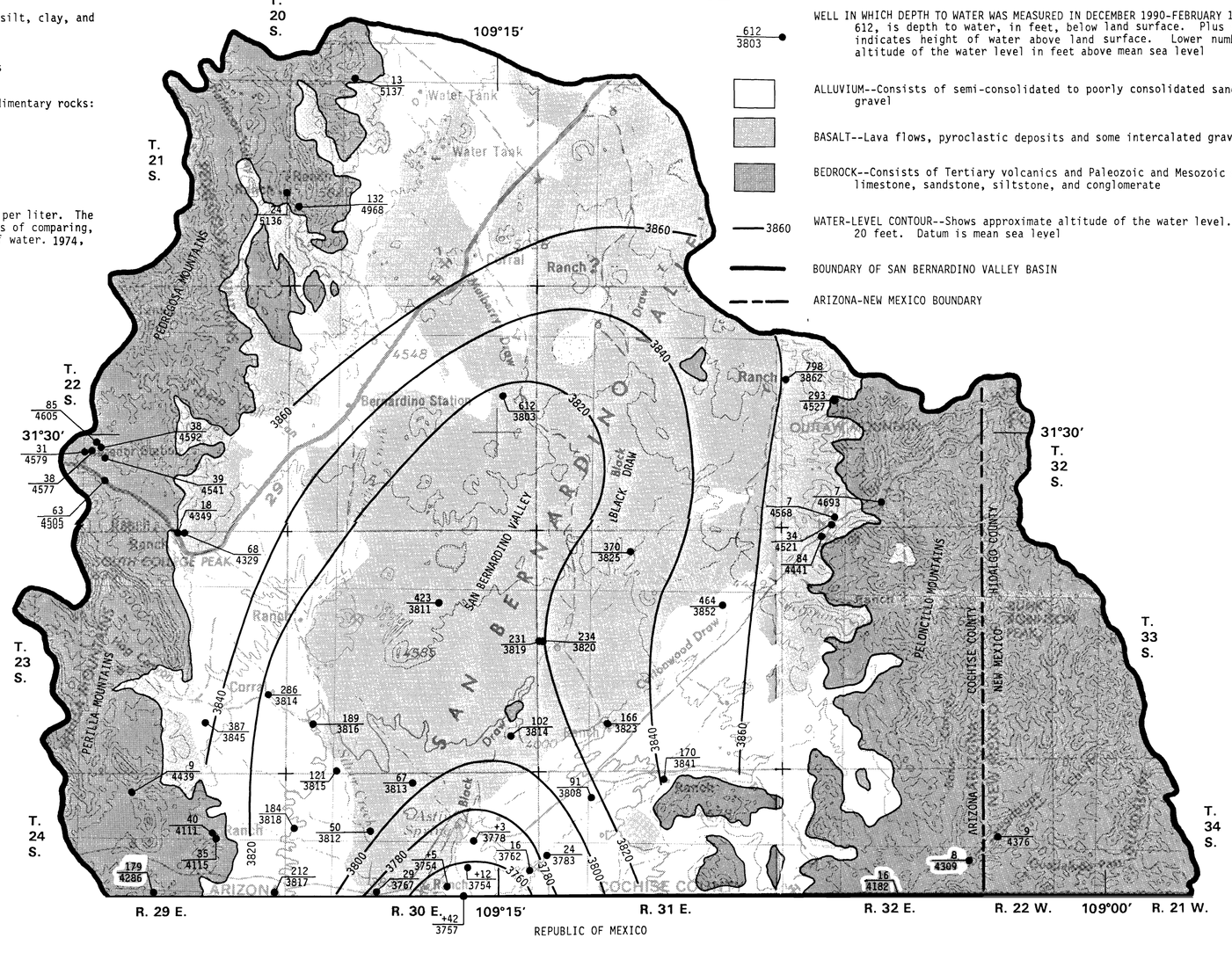


EXPLANATION

- 400 / 0.9 — WELL FOR WHICH A WATER SAMPLE WAS COLLECTED IN 1974-1992--Upper number, 400, is specific conductance in microsiemens per centimeter at 25°C. Lower number, 0.9, is the fluoride concentration in milligrams per liter
- (A) — WELL FOR WHICH A HYDROGRAPH DEPICTING CHANGES IN depth to water is shown
- ALLUVIUM--Consists of semi-consolidated to poorly consolidated sand, silt, clay, and gravel
- BASALT--Lava flows, pyroclastic deposits and some intercalated gravels
- BEDROCK--Consists of Tertiary volcanics and Paleozoic and Mesozoic sedimentary rocks: limestone, sandstone, siltstone, and conglomerate
- BOUNDARY OF SAN BERNARDINO VALLEY BASIN
- ARIZONA-NEW MEXICO BOUNDARY
- CHEMICAL QUALITY DIAGRAM--Shows major constituents in milliequivalents per liter. The diagrams are in a variety of shapes and sizes, providing a means of comparing, correlating, and characterizing similar or dissimilar types of water. 1974, below diagram, indicates year in which sample was collected

MILLIEQUIVALENTS PER LITER
CATIONS 20 10 0 ANIONS 10 20
SODIUM — CHLORIDE
CALCIUM — TOTAL ALKALINITY
MAGNESIUM — SULFATE
1974





EXPLANATION

- 612 / 3803 — WELL IN WHICH DEPTH TO WATER WAS MEASURED IN DECEMBER 1990-FEBRUARY 1992--Upper number, 612, is depth to water, in feet, below land surface. Plus sign before number indicates height of water above land surface. Lower number, 3803, is the altitude of the water level in feet above mean sea level
- ALLUVIUM--Consists of semi-consolidated to poorly consolidated sand, silt, clay, and gravel
- BASALT--Lava flows, pyroclastic deposits and some intercalated gravels
- BEDROCK--Consists of Tertiary volcanics and Paleozoic and Mesozoic sedimentary rocks: limestone, sandstone, siltstone, and conglomerate
- 3860 — WATER-LEVEL CONTOUR--Shows approximate altitude of the water level. Contour interval 20 feet. Datum is mean sea level
- BOUNDARY OF SAN BERNARDINO VALLEY BASIN
- ARIZONA-NEW MEXICO BOUNDARY

Base from U.S. Geological Survey 1:250,000,
Douglas, 1969; Nogales, 1956; Silver City, 1954; and Tucson, 1956

MAPS SHOWING GROUNDWATER CONDITIONS IN THE SAN BERNARDINO VALLEY BASIN, COCHISE COUNTY, ARIZONA, AND HIDALGO COUNTY, NEW MEXICO--1991

BY
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These hydrologic maps are available upon request from the Department of Water Resources, Basic Data Section, 2810 South 24th Street, Suite 122, Phoenix, Arizona, 85034. The hydrologic data on which these maps are based are available, for the most part, in computer-printout form and may be consulted at the Department of Water Resources and at the U.S. Geological Survey offices located at: 375 S. Euclid, Tucson, Arizona, 85719, and 1545 West University, Tempe, Arizona, 85281.