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DEPARTMENT OF THE INTERIOR
Geological Survey

Geologic and ground-water reconnaissance of the Patagonia area, Arizona

By

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Prepared in cooperation with
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Roger Ernst, Commissioner

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INTRODUCTION

This memorandum presents the results of a reconnaissance of the geology and ground-water resources of the Patagonia area, Santa Cruz County, Ariz., made as part of the cooperative ground-water investigations in Arizona by the United States Geological Survey and the State Land Department.

The area studied is about 20 miles northeast of Nogales and is in the valley of Sonoita Creek, a west-flowing tributary of the Santa Cruz River. The Santa Rita Mountains are north of the creek and the Patagonia Mountains are south. About 4½ square miles was investigated in and immediately adjacent to Patagonia, including all or parts of secs. 4, 5, 6, 7, 8, 9, and 16, T. 22 S., R. 16 E. (fig. 1). The altitude at Patagonia is about 4,100 feet, and the annual precipitation, about 17 inches. The population of the community is approximately 700.

At the time of the investigation in 1949 the town of Patagonia did not have a public water supply and was considering the development of a community system utilizing ground-water. Robert Lenon, Town Engineer, estimated that the minimum sustained yield necessary for a water supply for the community is 100 gallons per minute for 24 hours each day. Each home has an individual sewage-disposal system, which led the State

Health Department to recommend that development of a supply of ground water should not be downstream from the community. As several previous well-drilling ventures in the vicinity had been only partially successful, the members of the community requested assistance from the State Land Department. This reconnaissance was arranged as a part of the Statewide program to determine the general availability of ground water in the vicinity of Patagonia. The writer spent a week in the area in June 1948, and this memorandum gives the results of that work. Additional studies would be needed to obtain enough information to serve as a sound basis for water developments in the area.

The maps available for the field work consisted of a plat of T. 22 S., R. 16 E., and a topographic map prepared by the U. S. Forest Service, both on a scale of 2 inches per mile. The accompanying map showing geology, locations of wells visited, and ground-water contours (fig. 1), was prepared from these base maps.

The assistance and information provided by residents of the area is gratefully acknowledged. Thanks are extended particularly to Robert Lenon, Town Engineer, and Louis Ambrose and R. C. Bisbee, well drillers.

GEOLOGY AND ITS RELATION TO GROUND-WATER SUPPLIES

The rocks identified and mapped in the field include alluvium of Quaternary age and igneous rocks of Tertiary (?) and Quaternary age.

Sedimentary Rocks

A series of Pleistocene (?) terrace deposits, unconsolidated and essentially horizontally bedded, extends along the valley. These terraces comprise the "older alluvial fill" that is found in all the Basin and Range valleys of Arizona, and they consist of silt, sand, gravel, and boulder deposits, normally well sorted, and fairly continuous. Only one terrace level is prominent in the area mapped, although high gravel hills adjacent to Red Mountain, about 1½ miles southeast of Patagonia, suggest the presence of two or three higher levels in former times. About 3 miles northeast of Patagonia, four levels are distinguishable along the flanks of the Santa Rita Mountains.

During thesis work on the Rail X Ranch, 7 miles northeast of Patagonia, the author determined the age of the lowest terrace deposits there as late Pleistocene. The gastropod fauna on which the determination was based occurs in a spring-deposited travertine which is in part overlain by gravels, suggesting that at least some of the gravels are very late Pleistocene, or Recent, in age.

The gravels of the lower terrace are considered to be, at least in part of local origin. This is indicated by the abundance of volcanic materials in the fragments of pebble and cobble size, and especially by the marked red color of the terrace deposits near the base of Red Mountain, which contrasts with the buff and tan colors of the terrace materials at the same

levels elsewhere in the valley. The red pigment appears very strongly in the silt-size materials adjacent to Red Mountain. The effect is more striking when seen from across the valley than when the observer is on the red terraces themselves.

It appears probable that some beds in the gravel potentially are good aquifers, as the degree of cementation is slight and, in some beds, sorting is good. However, gullying of the gravels to the present level of Sonoita Creek makes it unlikely that any water is long trapped in the alluvium above the level of Sonoita Creek. Only the materials extending below the bottom-land levels can be considered potentially water-bearing. They no doubt serve to conduct runoff from mountain canyons underground.

A deposit of Recent alluvial fill, made up of sand, silt, local gravel beds, and soil, forms the floor of the Sonoita Creek valley and its tributaries. In the fields where irrigation is possible, the soil consists for the most part of dark loam. The coarser-grained material is generally limited to the beds of Sonoita Creek and its tributaries, and it is probably only in the creek beds that significant recharge takes place. Wells reaching gravel in the Recent fill generally yield 3 to 10 gallons per minute.

Igneous Rocks

A series consisting of tuff, agglomerate, and acidic to intermediate lava flows, believed to be of Tertiary age, bounds the area mapped along the southeast. A similar series occurs also along Harshaw Creek, as

small outliers from the main mass. Volcanic rocks, mostly tuffaceous where observed, crop out along the base of Red Mountain.

The lowest group exposed is made up of 50 to 100 feet of poorly consolidated gray (andesite ?) tuff, which commonly weathers to red and pink variegated cliffs. The cliffs result because the tuff erodes rapidly to form steep-walled amphitheaters devoid of plant cover, rather than because it is resistant to weathering. Two such bowls cut in the tuffs are prominent on the lower slopes of Red Mountain and can be seen from the road entering Patagonia from the northeast.

A cliff-forming andesite (?) overlies the series of tuffs along the lower slopes of Red Mountain, and makes a useful marker bed for interpretation of structure. The faults shown near the center of sec. 17 (fig. 1) were mapped on the basis of displacement of this flow.

The road between Patagonia and Sonoita is in many places cut through the bases of older alluvial terraces extending toward the axis of the Sonoita Creek Valley. Many of the cuts expose a series of gray agglomerates overlain by unconsolidated gravel. The tuff and agglomerate are well bedded, in general well indurated, and almost horizontal. A dip of 5° N. was tentatively determined, and no higher dips were noted. A similar series is exposed in a small canyon in the northeast corner of sec. 8 and the southeast corner of sec. 5 (fig. 1). It is noteworthy that, in proceeding northeast from Patagonia, the gray agglomerate remains dis-

tinguishable in the road cuts, but changes in character, the degree of induration becoming less, and the color trending toward buff and tan. The color change is believed to be the result of dimunition of tuff in the matrix, and a corresponding increase in the amount of silt present among the pebbles. This gradation laterally, and the rather high degree of sorting and good development of bedding, is thought to indicate deposition in a lake, the shore of the lake being somewhere near the Rail X Ranch. There, the gray tuff matrix is almost entirely absent, and the presumably shore-derived silt makes up the entire body of matrix around the pebbles.

On the basis of field examination it is concluded that the Tertiary (?) volcanic series is a poor aquifer, primarily because the tuff weathers so readily into clay. However, in at least one locality the agglomerate may be water-bearing. In deepening a well near the Patagonia grade school the driller reported encountering 3 feet of gray water-bearing material between a depth of 209 and 215 feet, intercalated in a sequence of fine-grained beds, mostly red clay. The yield of the well increased appreciably after the gray bed had been penetrated. Examination of a sample on the dump led to the conclusion that this material is a thin stringer of agglomerate tuff.

A series of volcanic rocks of Quaternary (?) age was also mapped. These volcanic rocks are for the most part a series of flows of basalt with some intercalated tuffaceous beds. Some flows are very coarse

grained and friable; other are thinner, more dense, and only slightly weathered. Outcrops of the basalt are limited to areas northwest of Patagonia and to a few small exposures within the town and immediately southwest. The attitude of the flows ranges from horizontal to a dip of 30° SE. The total thickness of basaltic rocks was not measured, but is known to exceed 100 feet. Terrace gravels overlie the basalt in various exposures. The basalt flows are considered to be essentially non-water-bearing, although locally the more friable zones would be likely to yield small amounts of water.

Three small exposures in and just adjacent to the bed of Sonoita Creek, between the Patagonia Grade School and the railroad bridge across Sonoita Creek northeast of town in the NW¼NE¼ sec. 7, suggest the presence of a dike or ridge of basalt across the axis of the valley. If an impermeable barrier exists in this locality it would tend to impede downstream movement of ground water in the Recent fill along the creek.

OCCURRENCE AND DEVELOPMENT OF GROUND WATER

Most of the wells in the community were visited in August 1949 by E. K. Morse and Sam Gray of the Geological Survey. Work done by these men included determining the altitude of the water level, determining the locations of the wells, collecting water samples for analysis, measuring depths of the wells, and collecting drillers' logs or other records.

The contour lines showing the position of the water table (fig. 1) show that the direction of ground-water movement is generally downstream along Sonoita Creek. A relatively flat area exists along the southeast side of Sonoita Creek, and the south of Harshaw Creek, indicating either coarser materials through which the water moves more readily or heavier withdrawals of ground water in that locality.

The water table in the townsite of Patagonia is at a depth of approximately 35 feet, in the Recent sand and gravel of the bottom lands. Yields of the wells range from half a gallon a minute to a maximum of 150 gallons per minute. The Southern Pacific Railroad well in the center of town is estimated to produce 10 gallons per minute. The well is reported to be 150 feet deep and to have an 8-inch casing; the pump is set at 50 feet, and the water level is at a depth of about 37 feet.

The most extensive attempt to develop a ground-water supply for the community was made about 25 years ago. A shaft was sunk in about the NE¼NW¼ sec. 7. It is reported that the shaft bottomed on conglomerate at a depth of 90 feet. At this level, a drift was driven 200 feet to a point under the bed of Sonoita Creek. At the end of the drift, cross cuts were driven parallel to the bed of Sonoita Creek 100 feet in each direction. The development was completed by putting two churn-drill holes down through each cross cut. It is reported that after the water in storage in the system was pumped out, the whole development produced

only about 5 gallons per minute. It is especially interesting to note this small yield, because the location of the development is only a short distance upstream from the presumed basalt dike across the axis of drainage in Sonoita Valley. If the dike served as a ground-water barrier impounding water upstream of the structure, the shaft and drift development should have produced a larger amount of water.

At least half a dozen other wells in the community, both immediately upstream from and immediately downstream from the basalt dike, are reported to have small yields. The U. S. Forest Service well, which was being pumped for high-school construction during the 1949 investigation, yielded about 3 gallons per minute, the Gatlin well about 7 gallons per minute, and the Waggoner well about 10 gallons per minute. The Riggs well, which is a shaft with about 50 feet of drift from the bottom, yields about 20 gallons per minute, but goes dry in some seasons.

In contrast to the low yields of most wells in the northeast part of town, a stock well upstream from Patagonia, (D-22-16)5cdb3, is reported to be capable of yielding 150 gallons per minute. It is situated on the south side of Sonoita Creek a short distance upstream from the mouth of Harshaw Creek (fig. 1).

Two wells of high yield were noted southwest of Patagonia. The Vincent Farley well, (D-22-15)12aad, was pumped at a reported rate of 80 gallons per minute steadily for about 4 months during World War II to

supply a small manganese-ore mill. The well was not in use in 1949, although equipped with a small gasoline-powered pump jack. The water level was about 27 feet below the land surface.

The Harris well, at the southwestern edge of town, (D-22-16)7bcc, supplies water for 3 houses and a swimming pool. The well was drilled to a depth of 62 feet and is equipped with 6-inch casing. R. C. Bishop, who services many wells in the area, estimates the yield to be as high as 150 gallons per minute with a 12-inch drawdown.

The Farley well is about 50 yards from both the edge of the fill and from basalt cropping out on the northwest side of the valley, and about half a mile downstream from the basalt dike. The Harris well is within 30 yards of the edge of the Recent fill and about half a mile downstream from the basalt dike. The Farley and Harris wells might be adequate for the needs of the town. However, their location downstream from the town is considered dangerous by the State Health Department because of danger of pollution.

It is probably significant that the Farley and Harris wells are near what is thought to be a second basalt barrier across Sonoita Creek. This barrier extends from an outcrop on the southeast side of Sonoita Creek in the $SE\frac{1}{4}$ sec. 12, T. 22 S., R. 15 E., about half a mile southwest of the Harris well, across the valley to a hill of basalt. It is between these two outcrops, or very slightly upstream from them, that

surface flow began in Sonoita Creek at the time of the investigation.

QUALITY OF WATER

Water samples collected from nine wells in the Patagonia area were analyzed for dissolved mineral content at the laboratory of the Geological Survey at Albuquerque, N. Mex. With two exceptions the analyses indicate that ground water in the Patagonia area contains moderate amounts of dissolved mineral matter and is very hard. Dissolved solids in seven of the samples ranged from 455 to 695 parts per million. Hardness in these samples ranged from 342 to 510 parts per million. Fluoride content of the samples was half a part per million or less.

One of the two samples whose analyses did not fit the general pattern was collected from a dug well, (D-21-16)31dcc, about a mile north of Patagonia. The water from this well was lower in dissolved solids and much softer than the waters from most of the wells along Sonoita Creek. The content of dissolved solids was 265 parts per million, and the hardness, 188 parts per million.

The water sample collected from the Forest Service well, (D-22-16)6dcc1, at the northeast side of Patagonia, had a dissolved-solids content of 387 parts per million and a hardness of 118 parts per million. The reasons for the water in that area being of better quality than in the rest of Sonoita Creek valley is not known.

CONCLUSIONS

The brief field reconnaissance provided data leading to development of the following conclusions:

1. That an aquifer test on the Harris well, (D-22-16)5cdb2, would be warranted to determine whether the well would be capable of a sustained yield of 100 gallons per minute.

2. That more complete well data are needed before a full evaluation of the problem can be made.

3. That geophysical probes, with electrical resistivity equipment, would be warranted to determine the location and thickness of the most permeable portions of the Recent fill.

Chief, Ground-Water Branch January 8, 1954

J.H. Feth, Ogden

Open file release of report: "Geologic and ground-water reconnaissance of the Patagonia area, Ariz."

Reference is made to the memorandum of January 6, addressed to you by L.C. Halpenny on the subject report. In the memorandum he suggested that comments should be addressed directly to your office.

Considering the limited circulation intended, I believe the text can stand as is, although there are a few rough spots that I didn't catch when it went through this office last time. There are, however, a few points that need attention on the map (fig. 1), as follows:

A series of faults in section 17 is mentioned in the text (p. 5) but not shown on the map;

Under "Explanation"

1. There is no consistency in treatment of hyphenating "non-water-bearing" in the several places where it occurs.

2. Under Quaternary(?) volcanic rocks, "tuffaceous" is misspelled.

J.H. Feth, Geologist

cc: L.C. Halpenny, Tucson
H.E. Thomas, Salt Lake City