Ground-Water Reconnaissance at Pinnacles National Monument, California

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GROUND-WATER RECONNAISSANCE AT PINNACLES NATIONAL MONUMENT, CALIFORNIA

By R. E. Evenson

ABSTRACT

Ground-water supplies at Pinnacles National Monument have been obtained from springs that occur in fractures and along bedding planes of volcanic flows and deposits, and from springs discharged from perched water in a sedimentary fanglomerate formation. The spring-water yield is barely adequate to supply existing camp facilities, and therefore a supplemental water supply is necessary before existing campgrounds can be expanded.

This supplemental water can be supplied by good-quality ground water obtained from shallow wells drilled in the alluvium of Chalone Creek. The yield of properly constructed wells in this area should exceed 10 gallons per minute.

PURPOSE AND SCOPE OF THE INVESTIGATION

Water for public use at Pinnacles National Monument has been obtained in the past from tanks which store water yielded from small springs. This spring-water yield is barely adequate to supply the existing camp facilities and therefore, when the National Park Service considered enlarging the camp facilities, it became necessary to obtain a supplementary water supply. The National Park Service, by letter dated April 17, 1959, requested the Geological Survey to make a ground-water reconnaissance of the monument area. Specifically, this investigation included: (a) a reconnaissance of the geology of the monument and its relation to hydrologic conditions in the area; (b) the supervision of drilling one shallow test well and interpretation of the data obtained from this well; (c) a study of the source, occurrence, and movement of ground water; and (d) the preparation of a report outlining the results of items (a) to (c) above.

LOCATION OF THE AREA

Pinnacles National Monument, in San Benito and Monterey Counties, Calif., is about 130 highway miles south of San Francisco, 37 miles south of Hollister, and 32 miles north of King City. The monument is in the Gabilan Range on the east side of Salinas Valley and includes about 23 square miles of volcanic spines and crags and rugged topography. Bear Gulch and Chalone Creek, the two major campgrounds, are in the eastern half of the monument and access to them by paved road is only from the east.

EXISTING WATER SUPPLY

Water for public supply at Bear Gulch campground and that for domestic use at the monument headquarters cabins is obtained from a small spring (yield, 2½ quarts per minute) in Bear Gulch and is stored in a 20,000-gallon tank.

Water for public supply at Chalone Creek campground is piped from a small spring to storage tanks and thence into the campground distribution system.

Water for fire protection is obtained from a surface reservoir in Bear Gulch. This water is not suitable for domestic or campground use.

GEOLOGIC AND HYDROLOGIC FEATURES

The geology of Pinnacles National Monument has been mapped and discussed in detail by Andrews (1936).[1] The geology shown on plate 22 is taken predominantly from his report, except that the contacts of the alluvium have been modified and some minor changes made in the alinement of a fault.

The oldest rocks in the monument area are those of the Gabilan limestone, which crops out in small patches near the western boundary and is composed of limestone, mostly metamorphosed to marble. It has been intruded by granite and granodiorite, and the intrusives are exposed over extensive areas west, south, and southeast of the monument.

A series of massive lava flows, predominantly rhyolitic, occurs in the eastern part of the monument as a narrow belt about 1 mile wide and several miles long. In contact with these flows on the west is a similar belt of predominantly rhyolitic volcanic breccias that have been weathered to form the characteristic pinnacles (fig. 46).

In the northeastern corner of the monument the volcanic rocks are in fault contact with the Temblor formation—a sedimentary formation consisting of fanglomerate grading upward into gravel and diatomaceous shale. Recent alluvium, consisting predominantly of sand and gravel, occurs in Chalone Creek valley and in Bear Valley.

[1] Andrews, Phillip, 1936, Geology of the Pinnacles National Monument: California Univ., Dept. Geol. Sci. Bull., v. 24, 38 p.

FIGURE 46.—View east from entrance to Pinnacles National Monument toward Bear Gulch. Characteristic pinnacles in middle skyline are rhyolitic breccias; light-colored cliff in upper middle is massive rhyolite; lower middle is alluvium of Chalone Creek; and foreground is fanglomerate of Temblor formation. Fault that parallels Chalone Creek is concealed beneath alluvium.

Small springs and seeps occur in fractures and along bedding planes of the volcanic flows and deposits. Along the northeast side of Chalone Creek valley, water perched in the Temblor formation is discharged from small springs and seeps.

The source of grond water in the alluvium of Chalone Creek is percolation of surface water flowing over the permeable stream-channel deposits, direct infiltration of precipitation on the alluvial deposits, subsurface inflow from tributary valleys, and possibly some subsurface inflow of water along the major northwestward-trending fault zone. Excess water from the area of springs and seeps also percolates into and recharges ground water in the alluvium of Chalone Creek.

Ground water in the alluvium is consumed by phreatophytes growing along the channel of Chalone Creek, moves as underflow down the valley, appears as a small surface flow about 200 feet upstream from the bridge where the alluvial deposits are constricted by rhyolite on both sides of the valley, and, as the valley widens downstream from the bridge, leaves the monument as ground-water outflow into Bear Valley.

RESULTS OF TEST DRILLING IN THE ALLUVIUM

The adequacy of the alluvium as a water-bearing aquifer was explored by a test well drilled in July 1959. The test well was drilled by a commercial drilling company using the rotary method. The well was drilled to a depth of 41 feet, cased with extra-heavy-duty 8-inch casing to a depth of 35 feet below ground surface. The casing from 14 to 35 feet below ground surface was perforated by 8-inch-long acetylene-torch cuts, spaced in a pattern of 4 cuts per linear foot of casing. When pumped, the well yielded 11 gpm at a pumping level of 14 feet below the top of the casing and a drawdown of 4 feet below the standing level in the casing.

Difficulties were encountered in the development of the well as shown by the record of development and test pumping (p. 381). The highly permeable character of the alluvium coupled with a low hydraulic pressure of the ground water undoubtedly were conducive to permitting the drilling mud to invade a large volume around the well bore. It is probable, even though the water did clear, that the mud has sealed a part of the adjacent gravel and sand, and thus has reduced the yield of the well.

To minimize the possibility of introducing mud into the permeable alluvium, future wells drilled in Chalone Creek could be constructed by the cable-tool method, using 12-inch-diamenter screen or standard casing that is machine perforated throughout the interval 10 to 25 feet. Depth of these wells may be about 30 to 35 feet below ground surface. They should yield more than 10 gpm.

To permit measurement of the water level it would be advisable to place an access pipe through the foundation into the casing.

POSSIBILITIES FOR INCREASED GROUND-WATER SUPPLY

The most readily available source of water supply within the boundaries of the monument is ground water contained in the alluvium of Chalone Creek.

The test drilling indicates that the alluvium is at least 30 feet thick near the Chalone Creek campground and that it is composed of very coarse sediments—predominantly gravel, cobbles, boulders, and some very coarse sand. Two wells penetrate the alluvium: 35R1 (sec. 35, T. 16 S., R. 7 E.), the test well drilled in July 1959; and 35J1 (in the same section), a dug well constructed by the Civilian Conservation Corps in the early thirties. Depth to water in these two wells was about 10 feet below land surface on July 13, 1959.

The dug well consists of a concrete- and wood-cribbed shaft about 5 feet square and 17 feet deep. Gravel and sand and 2 or 3 large boulders are visible at the bottom of the shaft. This well could provide an additional supply of water if it were deepened from 17 feet to 30 or 35 feet. Deepening the dug well could be most effectively accomplished by the cable-tool method using 12-inch casing, thereby avoiding any possibility of introducing drilling fluid into the formation and also simplifying the drilling of large gravel and cobbles. The volume between the casing and the cribbing could be backfilled with gravel to the top of the water (10 feet) and then filled to the surface with clay or concrete to provide a sanitary seal.

Another potential source of ground water may be the Temblor formation exposed northeast of Chalone Creek and across the fault. Test drilling would be required, however, to provide information concerning the yield and quality of water in this formation.

Although many springs serve as proof that ground water occurs in fractures, fissures, and other openings in the volcanic formations of the monument, it is doubtful whether adequate supplies of water could be obtained from wells drilled in the volcanic rocks.

CHEMICAL QUALITY OF THE WATER

A water sample was collected at the end of the pumping test and was analyzed by the Quality of Water Branch, U.S. Geological Survey, Sacramento, Calif. The results of the analysis show that the ground water in the alluvium of Chalone Creek is of good quality, pH 6.7, medium hardness, and contains 280 ppm (parts per million) of dissolved solids. The following table shows in detail the results of the analysis.

Chemical analysis, in parts per million, of water from well 35R1, sampled July 21, 1959

Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)
47	23	60	54	2.1	126	24	51	0.4

Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$		Percent sodium	Specific conductance (micromhos at 25° C)	pH
			Total	Noncarbonate			
1.2	0.1	280	82	0	58	407	6.7

During the preliminary test pumping of well 35R1 a strong hydrogen sulfide odor was noted at the time the pumping level was at or near the bottom of the well (37 feet). The sulfurous odor disappeared from a sample after allowing the sample to stand for a few minutes.

The sulfurous odor may be the result of water moving into the alluvium from the nearby fault; however, no increase in water temperature was noted. The sulfurous water is believed to be sealed off from the well by the cement plug.

SUMMARY AND CONCLUSIONS

Abundant ground water for the Pinnacles National Monument can be obtained from wells, less than 50 feet deep, drilled in the alluvium of Chalone Creek. The yield of properly constructed wells in the alluvium should exceed 10 gpm, because test well 35R1 yielded 11 gpm at a pumping level of 14 feet below the top of casing. The low yield of this well probably was due to the fact that much of the water-yielding formation was sealed off by the drilling fluid.

Supplemental water, if desired, can be obtained by drilling additional wells in the alluvium of Chalone Creek, or by deepening the existing dug well from 17 feet to 30 or 35 feet. To avoid the possibility of introducing drilling mud into the permeable gravel, the deepening could be done by the cable-tool method. Care should be taken to see that the annular space between the casing and the dug well is backfilled with gravel below the water level and with clay above the water level.

It is suggested that the water levels in all wells be measured periodically (preferably monthly) and that records be kept of the measurements. Also, it would be desirable to make chemical and bacteriological analyses of the water at least semiannually. These basic records would provide the necessary data for periodic appraisal of the adequacy of the ground-water supply.

WELL LOG

Test well T16S/R7E–35R1 was drilled on the west bank of Chalone Creek at an altitude of about 1,020 feet. The following well log is the lithologic description of the drill cuttings and the chronologic record of the development and pumping test of well 35R1.

July 9:

Started drilling (11:30 a.m.). 9⅝ in. rotary hole. Drilling fluid consists of bentonite and lime.

Remarks	*Thickness (feet)*	*Depth (feet)*
Sand, grayish-brown, medium to coarse, friable, subangular; predominantly clear quartz, but also fragments of rhyolite and granite	5	5
Sand, same as above, and gravel, loose	13	18
Sand, brown, coarse, friable, subangular; predominantly clear and white quartz	4	22

Remarks	*Thickness (feet)*	*Depth (feet)*
July 9—Continued		
Gravel, medium-gray, probably cobbles and small boulders, loose, almost no sand; fragments of granite pegmatite, rhyolite, andesite; white quartz is minor	12	34
Boulders, apparently larger than above because of very difficult drilling, fragments chiefly rhyolite	4	38
Rhyolite, either very large boulder or bedrock	3	41

July 10:

Stopped drilling (5:30 p.m.).

July 13:

Fluid level 9.5 ft. below land-surface datum. Cleaned hole to 41 ft., set 41 ft. 7 in. of heavy-duty casing, 8 in. I.D., with 1 ft. 6 in. above ground surface. Bottom 21 ft. of casing perforated with torch cuts: 6–8 in. long, 4–6 in. apart, 4 cuts around.

July 14:

Kelly lowered with packer at top of casing. Clear water pumped through casing into bore to wash out drilling mud; 5½ tanks or about 2,500 gallons failed to clear well of drilling mud. Bailed about 130 bailers (14 to 25 gallons each) for a total of about 2,600 gallons and well still failed to clear.

July 15:

Depth to water 9.30 ft. below land-surface datum. Set test pump. Pumped at rates of 5 to 60 gpm, broke suction at 37 ft. whenever pumping rate exceeded 7½ gpm. Pumped about 10 hours or more. Depth to water level outside casing 17 ft. when water inside casing was at 35 ft. Small amount of water moving through perforations. Failed to clear. Water has sulfur odor.

July 16:

Depth to water 9.25 ft. below land-surface datum. Pulled casing 5.35 ft. and 5.0 ft. cut off. Top casing now 1.85 ft. above land-surface datum, and uppermost perforation at 13.75 ft. below land-surface datum. Pumped from 9:20 a.m. to July 17 at 4:00 a.m.—about 19 hours—at rates from 12 to 30 gpm. Failed to clear.

July 17:

7:30 a.m. Depth to water 9.06 ft. below land-surface datum. Alternating pumping and surging. Attempted pumping and simultaneous jetting between casing and bore with no observed improvement. Rigged up leather gasket and and swabbed for about an hour. Pumped 2 hours from 6:00 p.m. to 8:00 p.m. Water clear at 8:00 p.m.

July 20:

Depth to water 9.03 ft. below land-surface datum, 10.88 ft. below top of casing (measuring point). Started pump at 12:00 noon, pumping 7.5 to 9.5 gpm until 2:45 p.m., pumping level reached 13.40 ft. below measuring point. Increased rate to 13 gpm until 4:00 p.m., pumping level reached 14.05 ft. below measuring point. Averaged about 17 gpm until 7:50 p.m., pumping level reached 20.05 ft. below measuring point.

	Thickness (feet)	Depth (feet)

Remarks

July 21:

Pumped at 10 to 15 gpm until 1:58 a.m.; pumping level ± 19 ft. Pump stopped for 2 minutes; 2:00 a.m. to 3:00 a.m. pumped about 20 gpm to reach maximum pumping level of 28 ft. below measuring point. Pumped 13.6 gpm from 3:15 a.m. to 5:10 a.m. At maximum pumping level of 28 ft. below measuring point. Water level 17.10 ft. below measuring point outside casing and 28.0 ft. inside casing.

Pump stopped 5:10 a.m., water level recovered to 12.00 ft. below measuring point at 6:00 a.m. Pump started 6:04 a.m., rate varied from 9 to 13 gpm until 10:27 a.m. when rate was reasonably stabilized at 11.5 gpm. Pumped until 7:00 p.m. with maximum pumping level at 14.90 ft. below measuring point. Pump off 7:00 p.m. Water level 11.23 ft. below measuring point at 8:00 p.m.

July 22:

Depth to water 11.00 ft. at 7:45 a.m. Cement placed at 29 ft.

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